ENGINEERING CHANGE NOTICE

1. ECN № 621364

Proj. ECN S

2. ECN Category (mark one) Supplemental [] Direct Revision [X] Change ECN [] Temporary [] Standby [] Supersedure [] Cancel/Void []	3. Originator's Name, Organization, MSIN, and Telephone No. Jim G. Field, Data Assessment and Interpretation, R2-12, 376-3753	4. USQ Required? [] Yes [X] No	5. Date 02/02/99
	6. Project Title/No./Work Order No. Tank 241-TX-104	7. Bldg./Sys./Fac. No. 241-TX-104	8. Approval Designator N/A
	9. Document Numbers Changed by this ECN (includes sheet no. and rev.) HNF-SD-WM-ER-672, Rev. 0-A	10. Related ECN No(s). ECN-636885	11. Related PO No. N/A

12a. Modification Work	12b. Work Package No.	12c. Modification Work Complete	12d. Restored to Original Condition (Temp. or Standby ECN only)
[] Yes (fill out Blk. 12b) [X] No (NA Blks. 12b, 12c, 12d)	N/A	N/A Design Authority/Cog. Engineer Signature & Date	N/A Design Authority/Cog. Engineer Signature & Date

13a. Description of Change — 13b. Design Baseline Document? [] Yes [X] No

The document has been totally revised to include the results of recent sampling to address technical issues associated with the waste, and to update the best basis standard inventory.

14a. Justification (mark one)

Criteria Change	[X]	Design Improvement	[]	Environmental	[]	Facility Deactivation	[]
As-Found	[]	Facilitate Const	[]	Const. Error/Omission	[]	Design Error/Omission	[]

14b. Justification Details

Changes required to incorporate new sampling data.

15. Distribution (include name, MSIN, and no. of copies)

See attached distribution.

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DATE: FEB 04 1999

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ENGINEERING CHANGE NOTICE	Page 2 of 2	1. ECN (use no. from pg. 1) ECN-621364

16. Design Verification Required	17. Cost Impact				18. Schedule Impact (days)	
	ENGINEERING		CONSTRUCTION			
[] Yes	Additional	[] $	Additional	[] $	Improvement	[]
[X] No	Savings	[] $	Savings	[] $	Delay	[]

19. Change Impact Review: Indicate the related documents (other than the engineering documents identified on Side 1) that will be affected by the change described in Block 13. Enter the affected document number in Block 20.

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
N/A		

21. Approvals

	Signature	Date		Signature	Date
Design Authority			Design Agent		
Cog. Eng. J.G. Field	J G Field	2/2/99	PE		
Cog. Mgr. K.M. Hall	Kathleen M. Hall	2/2/99	QA		
QA			Safety		
Safety			Design		
Environ.			Environ.		
Other J.W. Cammann	JW Cammann	2/3/99	Other		
R.J. Cash	RJ Cash	2/4/99			

DEPARTMENT OF ENERGY

Signature or a Control Number that tracks the Approval Signature

ADDITIONAL

DISTRIBUTION SHEET

To	From	
Distribution	Data Assessment and Interpretation	Page 1 of 2 Date 02/02/99
Project Title/Work Order Tank Characterization Report for Single-Shell Tank 241-TX-104, HNF-SD-WM-ER-672, Rev. 1		EDT No. N/A ECN No. ECN-621364

Name	MSIN	Text With All Attach.	Text Only	Attach./ Appendix Only	EDT/ECN Only
<u>OFFSITE</u>					
<u>Sandia National Laboratory</u> P.O. Box 5800 MS-0744, Dept. 6404 Albuquerque, NM 87815					
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<u>Nuclear Consulting Services Inc.</u> P. O. Box 29151 Columbus, OH 43229-01051					
J. L. Kovach		X			
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<u>Tank Advisory Panel</u> 102 Windham Road Oak Ridge, TN 37830					
D. O. Campbell		X			

DISTRIBUTION SHEET

To	From	Page 2 of 2
Distribution	Data Assessment and Interpretation	Date 02/02/99
Project Title/Work Order		EDT No. N/A
Tank Characterization Report for Single-Shell Tank 241-TX-104, HNF-SD-WM-ER-672, Rev. 1		ECN No. ECN-621364

Name	MSIN	Text With All Attach.	Text Only	Attach./ Appendix Only	EDT/ECN Only
<u>ONSITE</u>					
<u>Department of Energy - Richland Operations</u>					
J. F. Thompson	S7-54	X			
W. S. Liou	S7-54	X			
J. A. Poppiti	S7-54	X			
DOE/RL Reading Room	H2-53	X			
<u>DE&S Hanford, Inc.</u>					
G. D. Johnson	S7-73	X			
<u>Fluor Daniel Hanford Corporation</u>					
J. S. Hertzel	H8-67	X			
<u>Lockheed Martin Hanford, Corp.</u>					
J. W. Cammann	R2-11	X			
J. G. Field	R2-12	X			
R. E. Larson	T4-07	X			
L. M. Sasaki	R2-12	X			
B. C. Simpson	R2-12	X			
A. M. Templeton	R2-12	X			
R. R. Thompson	R2-12	X			
S. R. Wilmarth	R2-12	X			
ERC (Environmental Resource Center)	R1-51	X			
T.C.S.R.C.	R1-10	5			
<u>Lockheed Martin Services, Inc.</u>					
B. G. Lauzon	R1-08	X			
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<u>Numatec Hanford Corporation</u>					
J. S. Garfield	R3-73	X			
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<u>Pacific Northwest National Laboratory</u>					
A. F. Noonan	K9-91	X			
<u>Scientific Applications International Corporation</u>					
M. D. LeClair	R3-75	X			

RECORD OF REVISION	(1) Document Number HNF-SD-WM-ER-672	Page I

(2) Title
Preliminary Tank Characterization Report for Single-Shell Tank 241-TX-104: Best-Basis Inventory

CHANGE CONTROL RECORD

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HNF-SD-WM-ER-672, Rev. 1

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Tank Characterization Report for Single-Shell Tank 241-TX-104

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Abstract: This document summarizes the information on the historical uses, present status, and the sampling and analysis results of waste stored in Tank 241-TX-104. This report supports the requirements of the Tri-Party Agreement Milestone M-44-15C.

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Tank Characterization Report for Single-Shell Tank 241-TX-104

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LIST OF TERMS

ANOVA	analysis of variance
BM	benchmark
Btu/hr	British thermal units per hour
Ci	curie
Ci/g	curies per gram
Ci/L	curies per liter
CI	confidence interval
cm	centimeter
df	degrees of freedom
DQO	data quality objective
DSC	differential scanning calorimetry
FIC	Food Instrument Corporation
ft	feet
g	gram
g/L	grams per liter
g/mL	grams per milliliter
GEA	gamma energy analysis
HDW	Hanford defined waste
HTCE	historical tank content estimate
IC	ion chromatography
ICP	inductively coupled plasma spectroscopy
in.	inch
J/g	joules per gram
kg	kilogram
kgal	kilogallon
kL	kiloliter
kW	kilowatt
LFL	lower flammability limit
LL	lower limit
m	meter
m^2	square meters
M	moles per liter
mm	millimeter
MOU	memorandum of understanding
MW	metal waste
n/a	not applicable
PHMC	Project Hanford Management Contractor
ppm	parts per million
ppmv	parts per million by volume
PUREX	Plutonium Uranium Reduction Extraction
QC	quality control
R	high-level REDOX waste
R1	high-level REDOX waste from 1952 to 1957)
REDOX	reduction oxidation (S Plant)
REML	restricted maximum likelihood

LIST OF TERMS (Continued)

RPD	relative percent difference
rpm	revolutions per minute
SAP	sampling and analysis plan
SMM	supernatant mixing model
SpG	specific gravity
TCD	Tank Characterization Database
TCR	tank characterization report
TGA	thermogravimetric analysis
TIC	total inorganic carbon
TLM	layer modelI
TOC	total organic carbon
TWRS	Tank Waste Remediation System
UL	upper limit
W	watt
WSTRS	Waste Status and Transaction Record Summary
wt%	weight percent
%	percent
°C	degrees Celsius
°F	degrees Fahrenheit
µCi/g	microcuries per gram
µCi/mL	microcuries per milliliter
µeq/g	microequivalents per gram
µg	microgram
µg C/g	micrograms of carbon per gram
µg/g	micrograms per gram
µg/mL	micrograms per milliliter

1.0 INTRODUCTION

A major function of the Tank Waste Remediation System (TWRS) is to characterize waste in support of waste management and disposal activities at the Hanford Site. Analytical data from sampling and analysis and other available information about a tank are compiled and maintained in a tank characterization report (TCR). This report and its appendices serve as the TCR for single-shell tank 241-TX-104.

The objectives of this report are 1) to use characterization data in response to technical issues associated with tank 241-TX-104 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 shows the best-basis inventory estimate, Section 4.0 makes recommendations about the safety status of the tank and additional sampling needs. The appendices contain supporting data and information. This report supports the requirements of the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1997), Milestone M-44-15c, change request M-44-97-03 to "issue characterization deliverables consistent with the Waste Information Requirements Document developed for FY 1999" (Adams et al. 1998).

1.1 SCOPE

The characterization information in this report originated from sample analyses and known historical sources. Samples were obtained and assessed to fulfill requirements for tank specific issues discussed in Section 2.0 of this report. Other information was used to support conclusions derived from these results. Appendix A contains historical information for tank 241-TX-104 including surveillance information, records pertaining to waste transfers and tank operations, and expected tank contents derived from a process knowledge model. Appendix B summarizes recent sampling events (see Table 1-1), sample data obtained before 1989, and sampling results. Appendix C provides 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. Appendix E is a bibliography that resulted from an in-depth literature search of all known information sources applicable to tank 241-TX-104 and its respective waste types.

Table 1-1. Summary of Recent Sampling. (2 sheets)

Sample/Date[1]	Phase	Location	Segmentation	% Recovery
Vapor sample (5/05/97)	Gas	Tank headspace, Riser 13A, 6.1 m (20 ft) below top of riser	n/a	n/a
Push core 230 (2/18/98)	Solid/liquid	Riser 9A	2 segments, upper half and lower half	100% segment 1, 13.5 in stroke for segment 2 and 2A, 100% for seg. 2, 67% for segment 2A, stopped because of high downforces.

Table 1-1. Summary of Recent Sampling. (2 sheets)

Sample/Date[1]	Phase	Location	Segmentation	% Recovery
Push core 231 (2/23/98)	Solid/liquid	Riser 13A	2 segments, upper half and lower half	100% of segment 1, 5.25 in stroke for segment 2 and 2A. 100% recovery. Stopped because of high down forces.

Notes:

n/a = not applicable

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

1.2 TANK BACKGROUND

Tank 241-TX-104 is located in the 200 West Area TX Tank Farm on the Hanford Site. The tank went into service in 1950. Tank 241-TX-104 began filling in November 1950 with metal waste. The tank contained metal waste until the fourth quarter of 1956 when the tank was declared empty. The tank later received REDOX waste. The tank was labeled inactive in 1977. The tank was interim stabilized in September 1979 with intrusion prevention completed in August 1984. The tank is classified as a sound stabilized tank.

Table 1-2 is an overall description of tank 241-TX-104. The tank has a maximum storage capacity of 2,870 kL (758 kgal), and presently contains an estimated 246 kL (65 kgal) of noncomplexed waste (Hanlon 1998). The tank is not on the Watch List (Public Law 101-510).

Table 1-2. Description of Tank 241-TX-104.

TANK DESCRIPTION	
Type	Single Shell
Constructed	1947-1948
In-service	1950
Diameter	22.9 m (75 ft)
Operating Depth	7 m (23 ft)
Design Capacity	2,870 kL (758 kgal)
Bottom shape	Dish
Ventilation	Passive
TANK STATUS	
Waste Classification	Non-complexed waste
Total Waste Volume	246 kL (65 kgal)
Supernatant[1]	20.8 kL (5.5kgal)
Saltcake Volume[2]	157 kL (41.5 kgal)
Sludge Volume[3]	68 kL (18 kgal)
Drainable Interstitial Liquid Volume[2]	58.7 kL (15.5 kgal)
Waste Surface Level[4] (9/30/98)	83.1 cm (32.7 in)
Temperature[4] (9/30/97 to 9/30/98)	16.9 °C (62.4 °F) to 20.7 °C (69.3 °F)
Integrity	Sound
Watch List Status	None
Flammable Gas Facility Group	3
SAMPLING DATE	
Core Samples[4]	February 1998
Vapor Samples[4]	5/5/1997
SERVICE STATUS	
Declared Inactive	1977
Interim Stabilization	September 1979
Intrusion Prevention	August 1984

Notes:

[1]Based on observations during sampling.
[2]Differs from Hanlon (1998), see Appendix D.
[3]Agnew et al. (1997)
[4]Dates are in the mm/dd/yy format.

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2.0 RESPONSE TO TECHNICAL ISSUES

Technical issues required by Brown et al. (1997) and addressed by sampling events include:

- **Safety screening**: Does the waste pose or contribute to any recognized potential safety problems?
- **Organic complexants**: Does the possibility exist for a point source ignition in the waste followed by a propagation of the reaction in the solid/liquid phase of the waste?
- **Organic solvents**: Does an organic solvent pool exist that may cause a fire or ignition of organic solvents in entrained waste solids?

No new issues were identified for this tank in Brown et al. (1998).

Data from the analysis of February, 1998 push core samples (Steen 1998) and tank vapor space measurements (Duchsherer et al. 1997), along with available historical information, provided the means to respond to the technical issues. Sections 2.1 and 2.2 present the response. Data from the May 1997 vapor sample provided the means to address the vapor screening issue. See Appendix B for sample and analysis data for tank 241-TX-104.

2.1 SAFETY SCREENING

The data needed to screen the waste in tank 241-TX-104 for potential safety problems are documented in *Tank Safety Screening Data Quality Objective*, (Dukelow et al. 1995). These potential safety problems are exothermic conditions in the waste, flammable gases in the waste and/or tank headspace, and criticality conditions in the waste. Each condition is addressed separately below.

2.1.1 Exothermic Conditions (Energetics)

The first requirement outlined in the safety screening Data Quality Objective (DQO) (Dukelow et al. 1995) is to ensure there are not sufficient exothermic constituents (organic or ferrocyanide) in tank 241-TX-104 to pose a safety hazard. The safety screening DQO required the waste sample profile be tested for energetics every 24 cm (9.5 in.) to determine whether the energetics exceeded the safety threshold limit. The threshold limit for energetics is 480 J/g on a dry weight basis.

Results obtained using differential scanning calorimetry (DSC) indicated that there were no exotherms in any of the samples analyzed. Therefore exothermic activity is not a concern for tank 241-TX-104.

2.1.2 Flammable Gas

Headspace measurements were taken from riser 13A before taking the February 1998, push core samples. Flammable gas was not detected in the tank headspace (0 percent of the lower flammability limit [LFL]). This is well below the safety screening limit of 25 percent of the LFL. Data for the February1998, July 1996 and May 1997 headspace vapor measurements and May 1997 vapor phase samples are presented in Appendix B.

2.1.3 Criticality

The safety screening DQO threshold for criticality, based on total alpha activity, is 1 g/L. Because total alpha activity is measured in µCi/g instead of g/L, the 1 g/L limit is converted into units of µCi/g by assuming that all alpha decay originates from ^{239}Pu. The safety threshold limit is 1 g ^{239}Pu per liter of waste. Assuming that all alpha is from ^{239}Pu for a maximum density of 2.05 g/mL, 1 g/L of ^{239}Pu is 30.0 µCi/g of alpha activity. The maximum total alpha activity result for solids was 1.22 µCi/g, with a maximum upper limit to a 95 percent confidence interval on the mean of 2.7 µCi/g. For drainable liquids, the maximum total alpha was 6.89 µCi/mL with a maximum upper limit to a 95 percent confidence interval on the mean of 10.2 µCi/mL. This is well below the liquid threshold value of 61.5 µCi/mL. Therefore, criticality is not a concern for this tank. Appendix C contains the method used to calculate confidence limits.

2.2 ORGANIC COMPLEXANTS

The data required to support the organic complexants issue are documented in *Memorandum of Understanding for the Organic Complexant Safety Issue Data Requirements* (Schreiber 1997). Energetics by DSC and sample moisture analyses were conducted to address the organic complexants issue (Meacham et al. 1998)..

Data results showed that there were no exotherms for this tank. The total organic carbon (TOC) values ranged from 315 to 2,750 µgC/g for solids and 1,190 to 1,510 µgC/mL for drainable liquids. Because all TOC values were well below 4.5 percent, and the probability of a propagating event is not a concern for this tank. Therefore, the tank is classified as "safe" for this issue.

The organic complexant safety issue was closed in December 1998 (Owendoff 1998).

2.3 ORGANIC SOLVENTS SAFETY SCREENING

The data required to support the organic solvent screening issue are documented in the *Data Quality Objective to Support Resolution of the Organic Solvent Safety Issue* (Meacham et al. 1997). The DQO requires tank headspace samples be analyzed for total nonmethane organic compounds to determine whether the organic extractant pool in the tank is a hazard. The purpose of this assessment is to ensure that an organic solvent pool fire or ignition of organic solvents cannot occur.

Vapor samples taken May 5, 1997 showed the concentration of total nonmethane organic hydrocarbon in tank 241-TX-104 was 1.39 mg/m^3 with an estimated organic solvent pool size of 0.381 m^2 (Huckaby and Sklarew 1997), below the limit of 1 m^2.

The organic solvent safety issue is expected to be closed in 1999.

2.4 OTHER TECHNICAL ISSUES

2.4.1 Hazardous Vapor Screening

Vapor samples were taken to address the *Data Quality Objectives for Tank Hazardous Vapor Safety Screening* (Osborne and Buckley 1995). However, this is no longer an issue because headspace vapor (sniff) tests are required for the safety screening DQO (Dukelow et al. 1995), and the toxicity issue was closed for all tanks (Hewitt 1996).

2.4.2 Tank Waste Heat Load

A factor in assessing tank safety is the heat generation and temperature of the waste. Heat is generated in the tanks from radioactive decay. Heat load estimates based on 1998 core samples were not possible because radionuclide analyses were not required. However, the heat load estimate based on the tank process history was 291 W (992 Btu/hr) (Agnew et al. 1997). The heat load estimate based on tank headspace temperature was 40 W (1,380 Btu/hr) (Kummerer 1995). Both of these estimates are quite low, and are well below the limit of 11,700 W (40,000 Btu/hr) that separates high- and low-heat-load tanks (Smith 1986).

2.5 SUMMARY

The results of all analyses performed to address potential safety issues showed that primary analytes did not exceed safety decision threshold limits.

The analyses results are summarized in Table 2-1.

Table 2-1. Summary of Technical Issues.

Issue	Sub-issue	Result
Safety screening	Energetics	No exotherms observed in any sample.
	Flammable gas	Vapor measurement reported 0 percent of lower flammability limit. (Combustible gas meter).
	Criticality	Maximum total alpha activity result was1.22 µCi/g for solids, well below 30.0 µCi/g total alpha and 6.89 µCi/mL for liquids below 615 µCi/mL.
Organic complexants[1]	Safety categorization (safe)	No exotherms observed.
Organic solvents[2]	Solvent pool size	Organic pool size estimate 0.381 m^2.

Notes:

[1]The organic complexants safety issue was closed in December 1998 (Owendoff 1998).

[2]The organic solvents safety issue is expected to be closed in 1999.

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3.0 BEST-BASIS STANDARD INVENTORY ESTIMATE

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

Chemical and radiological inventory information is generally derived using three approaches: 1) component inventories are estimated using the results of sample analyses, 2) component inventories are predicted using the HDW model based on process knowledge and historical information, or 3) a tank-specific process estimate is made based on process flowsheets, reactor fuel data, essential material usage, and other operating data.

An effort is underway to provide waste inventory estimates that will serve as standard characterization source terms for the various waste management activities (Hodgson and LeClair 1996). As part of this effort, an evaluation of chemical information for tank 241-TX-104 was performed, and a best-basis inventory was established. This work, follows the methodology established by the standard inventory task. The following information was used in the evaluation:

- Analytical results from two 1998 push mode core samples
- Tank waste photographs
- Inventory estimates generated by the HDW model (Agnew et al. 1997).

Based on this evaluation, a best-basis inventory was developed for tank 241-TX-104. The sampling-based inventory was chosen as the best basis for those analytes for which analytical values were available. The HDW model results were used if no sample based information was available.

Best-basis tank inventory values are derived for 46 key radionuclides (as defined in Section 3.1 of Kupfer et al. 1998), all decayed to a common report date of January 1, 1994. Often, waste sample analyses have only reported ^{90}Sr, ^{137}Cs, $^{239/240}$Pu, and total uranium (or total beta and total alpha), while other key radionuclides such as ^{60}Co, ^{99}Tc, ^{129}I, ^{154}Eu, ^{155}Eu, and ^{241}Am have been infrequently reported. For this reason it has been necessary to derive most of the 46 key radionuclides by computer models. These models estimate radionuclide activity in batches of reactor fuel, account for the split of radionuclides to various separations plant waste streams, and track their movement with tank waste transactions. These computer models are described in Kupfer et al. (1998), Section 6.1 and in Watrous and Wootan (1997). Model-generated values for radionuclides in any of the 177 Hanford Site tanks are reported in the HDW Rev. 4 model results (Agnew et al. 1997). The best-basis value for any one analyte may be either a model result or a sample-or engineering assessment-based result, if available.

The best-basis inventory estimate for tank 241-TX-104 is presented in Tables 3-1 and 3-2. Mercury values were specified in Simpson (1998).

The inventory values reported in Tables 3-1 and 3-2 are subject to change. Refer to the Tank Characterization Database (TCD) (LMHC 1998) for the most current inventory values.

Table 3-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-TX-104. (Effective December 1, 1998)

Analyte	Total Inventory (kg)	Basis (S, M, E, or C)[1]	Comment
Al	28,600	S	
Bi	38.2	S/E	Upper bounding estimate
Ca	110	S	
Cl	1,390	S	
TIC as CO_3	12,100	S	
Cr	950	S	
F	543	S	
Fe	609	S	
Hg	0	E	Simpson (1998)
K	473	S	
La	11.0	S/E	Upper bounding estimate
Mn	132	S	
Na	53,900	S	
Ni	4.69	S/E	Upper bounding estimate
NO_2	13,100	S	
NO_3	1.08E+05	S	
OH_{TOTAL}	49,800	C	Charge balance calculation
Pb	28.3	S/E	Upper bounding estimate
PO_4	5,950	S	Based on IC
Si	101	S	Upper bounding estimate
SO_4	715	S	Based on ICP
Sr	2.2	S	
TOC	475	S	
U_{TOTAL}	275	S/E	Upper bounding estimate
Zr	5.47	S	

Notes:

IC = ion chromatography

ICP= inductively coupled plasma spectroscopy

[1]S = sample-based (see Appendix B), M = HDW model-based, Agnew et al. (1997a), E = engineering assessment-based, and C = calculated by charge balance; includes oxides as hydroxides, not including CO_3, NO_2, NO_3, PO_4, SO_4, and SiO_3.

Table 3-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-TX-104 Decayed to January 1, 1994. (Effective December 1, 1998). (2 sheets)

Analyte	Total Inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{3}H	27.5	M	
^{14}C	4.01	M	
^{59}Ni	0.292	M	
^{60}Co	4.33	M	
^{63}Ni	28.6	M	
^{79}Se	0.429	M	
^{90}Sr	14,900	M	
^{90}Y	14,900	M	
^{93}Zr	2.11	M	
^{93m}Nb	1.53	M	
^{99}Tc	27.4	M	
^{106}Ru	8.52E-04	M	
^{113m}Cd	10.9	M	
^{125}Sb	18.9	M	
^{126}Sn	0.648	M	
^{129}I	0.0528	M	
^{134}Cs	0.493	M	
^{137}Cs	40,600	M	
^{137m}Ba	38,400	M	
^{151}Sm	1,510	M	
^{152}Eu	0.566	M	
^{154}Eu	74.5	M	
^{155}Eu	34.3	M	
^{226}Ra	2.90E-05	M	
^{227}Ac	1.50E-04	M	
^{228}Ra	0.0293	M	
^{229}Th	6.79E-04	M	
^{231}Pa	5.87E-04	M	
^{232}Th	0.00180	M	
^{232}U	0.00141	S/E/M	Based on total uranium and HDW model isotopic distribution.
^{233}U	0.00539	S/E/M	Based on total uranium and HDW model isotopic distribution.
^{234}U	0.0908	S/E/M	Based on total uranium and HDW model isotopic distribution.

Table 3-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-TX-104 Decayed to January 1, 1994. (Effective December 1, 1998). (2 sheets)

Analyte	Total Inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{235}U	0.00408	S/E/M	Based on total uranium and HDW model isotopic distribution.
^{236}U	6.10E-04	S/E/M	Based on total uranium and HDW model isotopic distribution.
^{237}Np	0.0988	M	
^{238}Pu	2.25	S/M	Based on total alpha and HDW model isotopic distribution.
^{238}U	0.0918	S/E/M	Based on total uranium and HDW model isotopic distribution.
^{239}Pu	81.2	S/M	Based on total alpha and HDW model isotopic distribution.
^{240}Pu	13.4	S/M	Based on total alpha and HDW model isotopic distribution.
^{241}Am	97.0	S/M	Based on total alpha and HDW model isotopic distribution.
^{241}Pu	150	S/M	Based on total alpha and HDW model isotopic distribution.
^{242}Cm	0.269	S/M	Based on total alpha and HDW model isotopic distribution.
^{242}Pu	8.27E-04	S/M	Based on total alpha and HDW model isotopic distribution.
^{243}Am	0.00345	S/M	Based on total alpha and HDW model isotopic distribution.
^{243}Cm	0.0248	S/M	Based on total alpha and HDW model isotopic distribution.
^{244}Cm	0.223	S/M	Based on total alpha and HDW model isotopic distribution.

Notes:

[1]S = sample-based, M = HDW model-based (Agnew et al. 1997a), and E = engineering assessment-based.

4.0 RECOMMENDATIONS

The results of all analyses performed to address potential safety issues showed the primary analytes did not exceed safety decision threshold limits. No exotherms were found in any of the samples. The maximum total alpha value was 1.22 µCi/g for solids and 6.89 µCi/mL for liquids, well below the threshold limits of 30.0 µCi/g and 61.5 µCi/mL. No flammable gas (0% LFL) was measured in the tank headspace. Vapor samples showed the estimated organic pool size of 0.381 m^2, was well below the safety limit of 1 m^2.

Table 4-1 summarizes the Project Hanford Management Contractor (PHMC) TWRS Program review status and acceptance of the sampling and analysis results reported in this TCR. All issues required to be addressed by sampling and analysis are listed in column 1 of Table 4-1. Column-2 indicates by "yes" or "no" whether issue requirements were met by the sampling and analysis performed. Column 3 indicates concurrence and acceptance by the program in PHMC/TWRS that is responsible for the applicable issue. A "yes" in column 3 indicates that no additional sampling or analyses are needed. Conversely, "no"indicates additional sampling or analysis may be needed to satisfy issue requirements.

Table 4-1. Acceptance of Tank 241-TX-104 Sampling and Analysis.

Issue	Sampling and Analysis Performed	TWRS/PHMC Program Acceptance
Organic complexants MOU[1] (Schrieber 1997)	Yes	Yes
Organic solvents DQO[2] (Meacham et al. 1997)	Yes	Yes
Safety screening DQO (Dukelow et al. 1995)	Yes	Yes

Note:

[1] The organic complexant safety issue was close December 1998 (Owendoff 1998).

[2]The-organic solvent safety issue is expected to be closed in 1999.

Table 4-2 summarizes the status of PHMC TWRS Program review and acceptance of the evaluations and other characterization information contained in this report. Column 1 lists the different evaluations performed in this report. Column 2 shows whether issue evaluations have been completed or are in progress. Column 3 indicates concurrence and acceptance with the evaluation by the program in PHMC/TWRS that is responsible for the applicable issue. A "yes" indicates that the evaluation is completed and meets all issue requirements.

Table 4-2. Acceptance of Evaluation of Characterization Data and Information for Tank 241-TX-104.

Issue	Evaluation Performed	TWRS/PHMC Program Acceptance
Organic complexants MOU[1]	Yes	Yes
Organic solvents DQO[2]	Yes	Yes
Safety screening DQO	Yes	Yes

Notes:

MOU = memorandum of understanding

[1]The organic complexants safety issue was closed in December 1998 (Owendoff 1998).

[2]The organic solvents safety issue is expected to be closed in 1999.

5.0 REFERENCES

Adams, M. R., T. M. Brown, J. W. Hunt, L. J. Fergestrom, 1998, *Fiscal Year 1999 Waste Information Requirements Document*, HNF-2884, Rev. 0, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

Agnew, S. F., J. Boyer, R. A. Corbin, T. B. Duran, J. R. Fitzpatrick, K. A. Jurgensen, T. P. Ortiz, and B. L. Young, 1997, *Hanford Tank Chemical and Radionuclide Inventories: HDW Model Rev. 4*, LA-UR-96-3860, Los Alamos National Laboratory, Los Alamos, New Mexico.

Brown, T. M., J. W. Hunt, and L. J. Fergestrom, 1997, *Tank Characterization Technical Sampling Basis*, HNF-SD-WM-TA-164, Rev. 3, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

Brown, T. M., J. W. Hunt, and L. J. Fergestrom, 1998, *Tank Characterization Technical Sampling Basis*, HNF-SD-WM-TA-164, Rev. 4, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

Dukelow, G. T., J. W. Hunt, H. Babad, and J. E. Meacham, 1995, *Tank Safety Screening Data Quality Objective*, WHC-SD-WM-SP-004, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

Duchsherer, M. J., E. S. Mast, L. A. Pingel, M. Stauffer, R. S. Viswanath, D. B. Bonfoey, G. A. Fies, C. V. Dormant, 1997, *Tank Vapor Sampling and Analysis Data Package for Tank 241-TX-104, Sampled May 5, 1997*, HNF-SD-WM-DP-281, Rev. 0, Numatec Hanford Corp. for Fluor Daniel Hanford, Inc., Richland Washington.

Ecology, EPA, and DOE, 1997, *Hanford Federal Facility Agreement and Consent Order*, as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.

Hanlon, B. M., 1998, *Waste Tank Summary Report for Month Ending September 30, 1998*, HNF-EP-0182-126, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

Hewitt, E. R., 1996, *Tank Waste Remediation System Resolution of Potentially Hazardous Vapor Issues*, WHC-SD-TWR-RPT-001, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Hodgson, K. M., and M. D. LeClair, 1996, *Work Plan for Defining a Standard Inventory Estimate for Wastes Stored in Hanford Site Underground Tanks*, WHC-SD-WM-WP-311, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

Huckaby, J. L. and D. S. Sklarew, 1997, *Screening for Organic Solvents in Hanford Waste Tanks Using Organic Vapor Concentrations*, PNNL-11698, Pacific Northwest Laboratory, Richland, Washington.

Kummerer, M., 1995, *Heat Removal Characteristics of Waste Storage Tanks*, WHC-SD-WM-SARR-010, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

Kupfer, M. J., A. L. Boldt, B. A. Higley, K. M. Hodgson, L. W. Shelton, B. C. Simpson, and R. A. Watrous , S. L. Lambert, D. E. Place , R. M. Orme , G. L. Borsheim , N. G. Colton, M. D. LeClair , R. T. Winward , and W. W. Schulz , 1998, *Standard Inventories of Chemicals and Radionuclides in Hanford Site Tank Wastes*, HNF-SD-WM-TI-740, Rev. 0B, Lockheed Martin Hanford Corp., for Fluor Daniel Hanford, Inc., Richland, Washington.

LMHC, 1998, Best-Basis Inventory for Tank 241-TX-104, December 19, Tank Characterization Database, Internet at http://twins.pnl.gov:8001/TCD/main.html.

Meacham, J. E., D. L. Banning, M. R. Allen, and L. D. Muhlestein, 1997, *Data Quality Objective to Support Resolution of the Organic Solvent Safety Issue*, HNF-SD-WM-DQO-026, Rev. 0, DE&S Hanford, Inc. for Fluor Daniel Hanford, Inc., Richland, Washington.

Meacham, J. E., W. L. Cowley, A. B. Webb, N. W. Kirch, J. A. Lechelt, D. A. Reynolds, L. A. Stauffer, D. B. Bechtold, D. M. Camaioni, F. Gao, R. T. Hallen, P. G. Heasler, J. L. Huckaby, R. D. Scheele, C. S. Simmons, J. J. Toth, and L. M. Stock, 1998, *Organic Complexant Topical Report*, HNF-3588, Rev. 2, DE&S Hanford, Inc. for Fluor Daniel Hanford, Inc., Richland, Washington.

Osborne, J. W. and L. L. Buckley, 1995, *Data Quality Objectives for Tank Hazardous Vapor Safety Screening*, WHC-SD-WM-DQO-002, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

Owendoff, J. M., 1998, *Approval to Close the Organic Complexant Safety Issue and Remove 18 Organic Complexant Tanks from the Watch List*, (memorandum to John Wagoner, December 9), U.S. Department of Energy, Washington, D.C.

Public Law 101-510, 1990, "Safety Measures for Waste Tanks at Hanford Nuclear Reservation," Section 3137 of *National Defense Authorization Act for Fiscal Year 1991*.

Schreiber, R. D., 1997, *Memorandum of Understanding for the Organic Complexant Safety Issue Data Requirements*, HNF-SD-WM-RD-060, Rev. 0, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

Simpson, B. C., 1998, *Best-Basis Inventory Change Package for Reconciliation of Mercury Values, change package #7*, (internal memorandum 7A120-98-005 to J. W. Cammann, February 26) Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

Smith, D. A., 1986, *Single-Shell Tank Isolation Safety Analysis Report*, WHC-SD-WM-SAR-006, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

Steen, F. H., 1998, *Tank 241-TX-104, Cores 230 and 231 Analytical Results for the Final Report*, HNF-SD-WM-DP-305, Rev. 0, Rust Federal Services of Hanford, Inc. for Fluor Daniel Hanford, Inc., Richland, Washington.

Watrous, R. A., and D. W. Wootan, 1997, *Activity of Fuel Batches Processed Through Hanford Separations Plants, 1944 Through 1989*, HNF-SD-WM-TI-794, Rev. 0, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

APPENDIX A

HISTORICAL TANK INFORMATION

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APPENDIX A

HISTORICAL TANK INFORMATION

Appendix A describes tank 241-TX-104 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 sampling and analytical results.

This appendix contains the following information:

- **Section A1.0**: Current tank status, including the current waste levels and the tank stabilization and isolation status
- **Section A2.0**: Information about the tank design
- **Section A3.0**: Process knowledge about the tank, the waste transfer history, and the estimated contents of the tank based on modeling data
- **Section A4.0**: Surveillance data for tank 241-TX-104, including surface-level readings, temperatures, and a description of the waste surface based on photographs
- **Section A5.0**: References for Appendix A.

A1.0 CURRENT TANK STATUS

As of September 30, 1998, tank 241-TX-104 contained an estimated 246 kL (65 kgal) of noncomplexed waste (Hanlon 1998). Table A1-1 shows the volumes of the waste phases found in the tank.

In 1977, tank 241-TX-104 was labeled inactive. It was interim stabilized in September 1979 and intrusion prevention (interim isolation) was completed in August 1984. The tank is classified as a sound stabilized tank. The tank is not on the Watch List (Public Law 101-510).

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

Waste Type	kL (kgal)
Total waste	246 (65)
Supernatant	20.8(5.5)
Sludge	68 (18)
Saltcake	157 (41.5)
Drainable interstitial liquid	58.7(15.5)
Drainable liquid remaining	79.5(21)
Pumpable liquid remaining	20.8 (5.5)

Note:

[1]See Appendix D for details.

A2.0 TANK DESIGN AND BACKGROUND

The 241-TX Tank Farm was constructed between 1947 and 1948 in the 200 West Area. Tank 241-TX-107 is one of eighteen 100 series tanks in the TX Tank Farm. These tanks have a capacity of 2,870 kL (758 kgal), a diameter of 23 m (75 ft), and an operating depth of 7.0 m (23 ft). Tank 241-TX-107 first went into operation in the fourth quarter of 1951. Built as a second generation tank farm, the 241-TX Tank Farm was designed for non-boiling waste with a maximum fluid temperature of 104 °C (220 °F). Tank 241-TX-104 is the fourth tank in the four-tank cascade series that consists of tanks 241-TX-101 through 241-TX-104 (Brevick et al. 1997).

This tank has a dished bottom with a 1.2-m (4-ft) radius knuckle. Similar to all other single-shell tanks, tank 241-TX-104 was built with a primary mild steel liner and a concrete dome with various risers. The tank is set on a reinforced concrete foundation and is covered with approximately 2.63 m (8.62 ft) of overburden.

Tank 241-TX-104 has 22 risers according to the drawings and engineering change notices. The risers range in diameter from 100 mm (4 in.) to 1.1 m (42 in.). Table A2-1 shows numbers, diameters, and descriptions of the risers. A plan view that depicts the riser and nozzle configuration is shown as Figure A2-1. Risers 9A and 13A are tentatively available for sampling. Riser 9A is 102 mm (4 in.) in diameter and riser 13A is 305 mm (12 in.) in diameter (Lipnicki 1997). Figure A2-2 shows the tank cross section and approximate waste level along with a schematic of the tank equipment.

Table A2-1. Tank 241-TX-104 Risers[1,2]

Number	Diameter (In.)	Description and Comments
R1	4	Not used, covered with concrete
R2	4	Pit drain, weather covered
R3	4	Not used, covered with concrete
R4	4	Thermocouple tree
R5	12	Unused, weather covered
R6	12	Saltwellscreen, weather covered
R7	12	Unused, weather covered
R8	4	Level gauge (ENRAF1)
R9	42	Cover plate, below grade
R9A[3]	4	Air filter
R9B	18	Flange
R10	42	Cover plate, weather covered
R10A	6	Recirculating nozzle, weather covered
R10B	14	Sluicing nozzle, weather covered
R11	42	Cover plate, weather covered
R11A	4	Flange, below grade
R11B	18	Flange, below grade
R12	42	Cover plate, weather covered
R12A	6	Recirculating nozzle, weather covered
R12B	14	Sluicing nozzle, weather covered
R13	42	Cover plate, weather covered
R13A[3]	12	Observation port, weather covered, benchmark
N1	3	Overflow outlet
N2	3	Spare
N3	3	Spare
N4	3	Inlet overflow
N5	3	Spare
N6	3	Spare

Notes:

[1]Alstad (1993)
[2]Vitro (1985)
[3]Denotes risers tentatively available for sampling (Lipnicki 1997)

1 ENRAF is a trademark of the ENRAF Corporation, Houston, Texas.

Figure A2-1. Riser Configuration for Tank 241-TX-104.

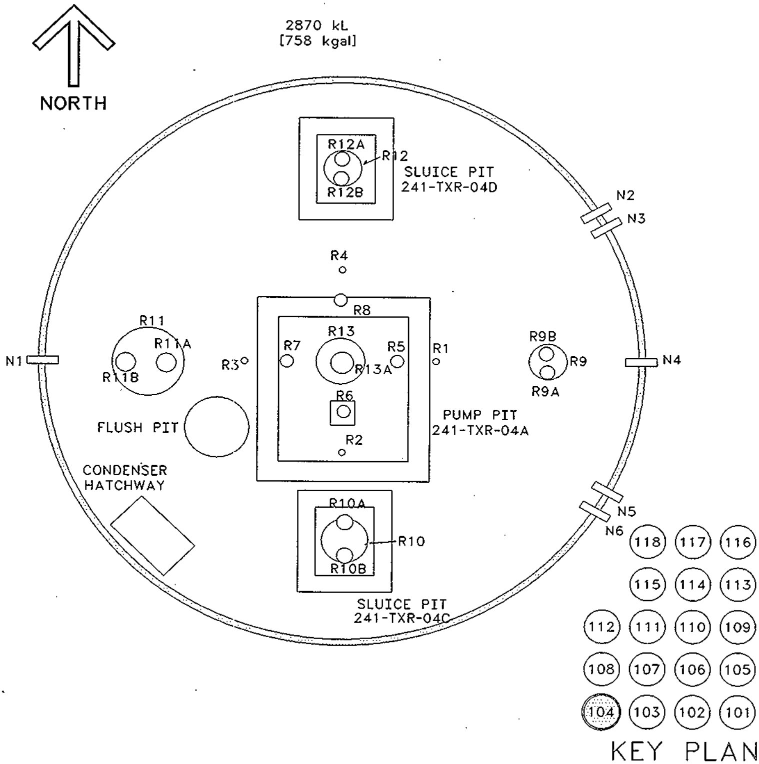
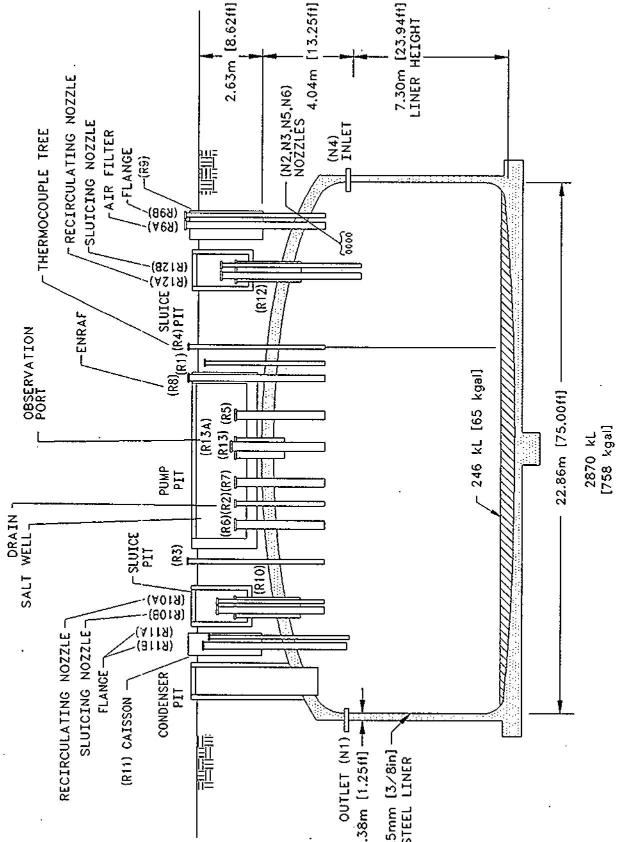


Figure A2-2. Tank 241-TX-104 Cross Section and Schematic.



A3.0 PROCESS KNOWLEDGE

The sections below 1) provide information about the transfer history of tank 241-TX-104, 2) describe the process wastes that made up the transfers, and 3) estimate the current tank contents based on transfer history.

A3.1 WASTE TRANSFER HISTORY

Table A3-1 summarizes the waste transfer history of tank 241-TX-104 (Agnew et al. 1997b). Tank 241-TX-104 began receiving metal waste in November 1950. The tank contained metal waste until the fourth quarter of 1956 when the tank was declared empty. The tank received reduction oxidation (REDOX) waste between the second quarter of 1957 and the second quarter of 1973. From the third quarter of 1973 until the first quarter of 1975, the tank received B Plant low-level waste, plutonium uranium reduction extraction (PUREX) organic wash waste, REDOX ion exchange waste, REDOX waste, and tributyl phosphate waste (also referred to as uranium recovery waste). The tank received evaporator bottoms from the 242-T Evaporator from the second quarter of 1975 until the second quarter of 1976. In the third quarter of 1976, the waste was classified as evaporator feed. (Brevick et al, 1997).

Table A3-1. Tank 241-TX-104 Major Transfers[1,2]

Transfer Source	Transfer Destination	Waste Type	Time Period	Estimated Waste Volume KL	Kgal
241-TX-103		Metal Waste	1950-1951	2,661	703
	U Plant	Uranium	1954	-1366	-361
Miscellaneous		Water	1954-1957	4,620	1,220
	241-TX-106	Slurry	1954	-2,839	-750
	U Plant	Uranium	1955-1956	-3,142	-830
241-TX-103		Metal Waste	1957	68	18
241-TX-101		Supernatant	1963	2,706	715
	241-TX-118	Supernatant	1966	-2,562	-677
241-TX-118		Supernatant	1966	41.6	11
241-TX-101		Supernatant	1966	2,411	637
	241-TX-101	Supernatant	1971	-1995	-527
Miscellaneous		Water	1971	41.6	11
241-TY-103		Supernatant	1973	859	227
241-TY-101		Supernatant	1973	806	213
	241-S-110	Supernatant	1974	-2,002	-529
	241-TX-118	EB	1975	-4,322	-1,142
241-TX-118		EB	1975-1976	6,571	1,736
	241-S-102	Supernatant	1977	-2,487	-657

Notes:

EB = evaporator bottoms; a slurry from the evaporators

1Agnew et al. (1997b)

2This table does not include minor gains and losses because of evaporation or condensation therefore transfer volumes may not be indicative of current waste volumes.

A3.2 HISTORICAL ESTIMATION OF TANK CONTENTS

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

- Waste Status and Transaction Record Summary: WSTRS, Rev. 4, (Agnew et al. 1997b) is a tank-by-tank quarterly summary spreadsheet of waste transactions.
- Hanford Tank Chemical and Radionuclide Inventories: HDW Model Rev. 4 (Agnew et al. 1997a) contains the Hanford defined waste (HDW) list, the supernatant mixing model (SMM), the tank layer model (TLM), and the inventory estimates.
- The HDW list is comprised of approximately 50 waste types defined by concentration for major analyes/compounds for sludge and supernatant layers.
- The TLM defines the solid layers in each tank using waste composition and waste transfer information.
- The SMM 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 solid layers in each tank. The SMM uses information from the WSTRS, the TLM, and the HDW list to describe the supernatants and concentrates in each tank. Together the WSTRS, TLM, SMM, and HDW list determine the inventory estimate for each tank. These model predictions are considered estimates that require further evaluation using analytical data.

Based on the TLM and SMM, tank 241-TX-104 contains two layers, a layer of 178 kL (47 kgal.) of SMMT2 waste and a layer of 68 kL (18 kgal) of Metal Waste (MW). Figure A3-1 is a graphical representation of the estimated waste type and volume for the tank layer. The 241-TX-104 SMMT2 layer should contain the following major constiuents listed from highest concentration above one percent by weight: sodium, aluminum, hydroxide, nitrate, nitrite, carbonate, and sulfate. Constituents below one percent but above 0.1 percent by weight are: chromium, potassium phosphate, silica, fluoride ,chloride, organic carbon, and uranium. The primary radionuclide is ^{137}Cs and ^{90}Sr. The 241-TX-104 MW layer should contain the following major constituents listed from highest concentration above one percent by weight: sodium uranium, hydroxide, carbonate, and phosphate. Constituents below one percent but above 0.1 percent by weight are: iron, calcium, nitrate, and sulfate. The primary radionuclide are ^{137}Cs and ^{90}Sr. Table A3-2 shows the historical estimate of the expected waste constituents and their concentrations.

Figure A3-1. Tank Layer Model.

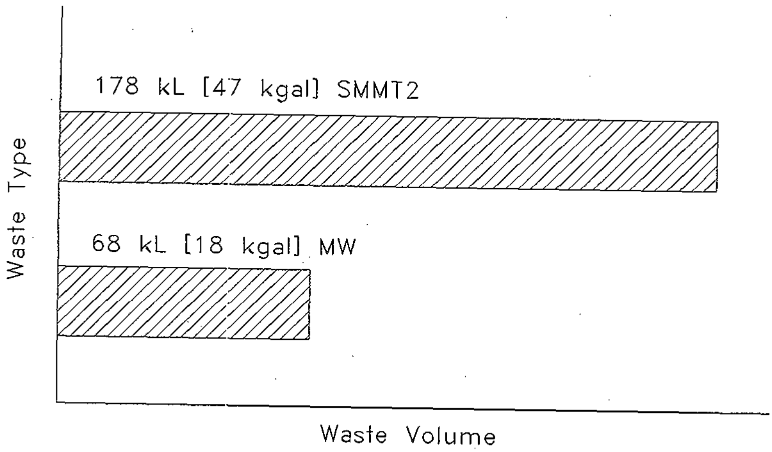


Table A3-2. Historical Tank Inventory Estimate.[1, 2] (3 sheets)

Total Inventory Estimate					
Physical Properties				**-95 CI**	**+95 CI**
Total waste	3.7E+05 (kg)	(65.0 kgal)	-	-	-
Heat load	0.291 (kW)	(992 Btu/hr)	-	0.262	0.319
Bulk density[4]	1.50 (g/cc)	-	-	1.48	1.52
Water wt%[4]	45.8	-	-	44.6	48.3
TOC wt% C (wet)[4]	0.523	-	-	0.270	0.777
Constituents		**ppm**	**kg[5]**		**+95 CI**
Na^{+}	8.79	1.34E+05	4.97E+04	8.09	9.13
Al^{3+}	0.775	1.39E+04	5.14E+03	0.691	0.859
Fe^{3+}	3.89E-02	1.44E+03	534	3.71E-02	4.07E-02
Cr^{3+}	6.07E-02	2.10E+03	777	5.25E-02	6.31E-02
Bi^{3+}	1.20E-03	167	61.8	1.07E-03	1.34E-03
La^{3+}	5.95E-10	5.49E-05	2.03E-05	4.80E-10	7.10E-10
Hg^{2+}	6.85E-06	0.913	0.338	6.14E-06	7.03E-06
Zr	2.58E-04	15.6	5.78	2.33E-04	2.82E-04
Pb^{2+}	6.37E-04	87.8	32.5	5.02E-04	7.72E-04
Ni^{2+}	4.02E-03	157	58.0	3.82E-03	4.42E-03
Sr^{2+}	0	0	0	0	0
Mn^{4+}	1.54E-03	56.4	20.8	1.21E-03	1.88E-03
Ca^{2+}	4.38E-02	1.17E+03	432	3.67E-02	5.09E-02
K^{+}	3.50E-02	911	337	3.11E-02	4.06E-02
OH^{-}	7.48	8.46E+04	3.13E+04	7.15	7.82
NO^{3-}	2.95	1.21E+05	4.49E+04	2.51	3.06
NO^{2-}	1.12	3.41E+04	1.26E+04	0.972	1.26
CO_3^{2-}	0.789	3.15E+04	1.16E+04	0.642	0.899
PO_4^{3-}	0.176	1.11E+04	4.12E+03	0.113	0.223
SO_4^{2-}	0.174	1.11E+04	4.10E+03	0.138	0.205
Si	4.29E-02	801	296	3.81E-02	4.77E-02
F^{-}	5.90E-02	746	276	4.74E-02	6.93E-02
Cl^{-}	0.135	3.18E+03	1.18E+03	0.112	0.144
$C_6H_5O_7^{3-}$ (citrate)	1.05E-02	1.32E+03	490	9.29E-03	1.18E-02
$EDTA^{4-}$	1.26E-02	2.42E+03	895	3.28E-03	2.21E-02

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

Total Inventory Estimate					
Constituents (Cont'd)	**M**	**ppm**	**kg[5]**	**-95 CI**	**+95 CI**
Glycolate$^-$	5.63E-02	2.81E+03	1.04E+03	3.76E-02	7.54E-02
Acetate$^-$	1.73E-03	68.1	25.2	1.40E-03	2.06E-03
Oxalate^{2-}	7.79E-10	4.56E-05	1.69E-05	7.17E-10	8.41E-10
DBP	8.51E-03	1.19E+03	440	7.33E-03	9.67E-03
Butanol	8.51E-03	420	155	7.33E-03	9.67E-03
NH_3	5.84E-02	660	244	4.48E-02	7.24E-02
$Fe(CN)_6^{4-}$	0	0	0	0	0
Radiological Constituents	**(Ci/L)**	**(µCi/g)**	**(Ci[3])**	**-95 CI (Ci/L)**	**95 CI (Ci/L)**
^{3}H	1.12E-04	7.43E-02	27.5	6.9E-05	1.28E-04
^{14}C	1.63E-05	1.08E-02	4.01	7.35E-06	1.73E-05
^{59}Ni	1.19E-06	7.89E-04	0.292	7.66E-07	1.24E-06
^{63}Ni	1.16E-04	7.72E-02	28.6	7.44E-05	1.21E-04
^{60}Co	1.76E-05	1.17E-02	4.33	7.37E-06	1.89E-05
^{79}Se	1.74E-06	1.16E-03	0.429	1.17E-06	2.15E-06
^{90}Sr	6.07E-02	40.4	1.49E+04	5.70E-02	6.35E-02
^{90}Y	6.07E-02	40.4	1.49E+04	4.10E-02	6.35E-02
^{93}Zr	8.56E-06	5.69E-03	2.11	5.70E-06	1.06E-05
^{93m}Nb	6.22E-06	4.13E-03	1.53	4.22E-06	7.64E-06
^{99}Tc	1.11E-04	7.40E-02	27.4	7.80E-05	1.45E-04
^{106}Ru	3.46E-09	2.30E-06	8.52E-04	2.14E-09	4.03E-09
^{113m}Cd	4.42E-05	2.94E-02	10.9	2.70E-05	5.63E-05
^{125}Sb	7.68E-05	5.11E-02	18.9	3.24E-05	8.27E-05
^{126}Sn	2.63E-06	1.75E-03	0.648	1.78E-06	3.24E-06
^{129}I	2.15E-07	1.43E-04	5.28E-02	1.50E-07	2.80E-07
^{134}Cs	2.01E-06	1.33E-03	0.493	1.30E-06	2.72E-06
^{137}Cs	0.165	110	4.06E+04	0.140	1.190
^{137m}Ba	0.156	104	3.84E+04	0.133	0.180
^{151}Sm	6.15E-03	4.09	1.51E+03	4.15E-03	7.56E-03
^{152}Eu	2.30E-06	1.53E-03	0.566	1.59E-06	2.81E-06
^{154}Eu	3.03E-04	0.201	74.5	1.60E-04	3.75E-04
^{155}Eu	1.39E-04	9.26E-02	34.3	9.72E-05	1.71E-04

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

Total Inventory Estimate					
Radiological Constituents (Cont'd)	(Ci/L)	(µCi/g)	(Ci[3])	-95 CI (Ci/L)	95 CI (Ci/L)
^{226}Ra	1.18E-10	7.83E-08	2.90E-05	8.82E-11	2.07E-10
^{228}Ra	1.19E-07	7.92E-05	2.93E-02	4.55E-08	2.09E-07
^{227}Ac	6.12E-10	4.07E-07	1.50E-04	5.09E-10	1.13E-09
^{231}Pa	2.38E-09	1.59E-06	5.87E-04	1.81E-09	2.84E-09
^{229}Th	2.76E-09	1.84E-06	6.79E-04	1.15E-09	4.74E-09
^{232}Th	7.32E-09	4.87E-06	1.80E-03	3.25E-09	1.14E-08
^{232}U	5.97E-07	3.97E-04	0.147	3.02E-07	9.58E-07
^{233}U	2.29E-06	1.52E-03	0.563	1.16E-06	3.67E-06
^{234}U	3.86E-05	2.56E-02	9.49	3.84E-05	3.87E-05
^{235}U	1.73E-06	1.15E-03	0.426	1.73E-06	1.74E-06
^{236}U	2.59E-07	1.72E-04	6.37E-02	2.58E-07	2.60E-07
^{238}U	3.91E-05	2.60E-02	9.63	3.90E-05	3.92E-05
^{237}Np	4.01E-07	2.67E-04	9.88E-02	2.92E-07	5.12E-07
^{238}Pu	7.38E-07	4.91E-04	0.182	6.10E-07	8.67E-07
^{239}Pu	2.66E-05	1.77E-02	6.55	2.33E-05	3.83E-05
^{240}Pu	4.39E-06	2.92E-03	1.08	3.78E-06	5.07E-06
^{241}Pu	4.91E-05	3.27E-02	12.1	4.04E-05	5.79E-05
^{242}Pu	2.71E-10	1.80E-07	6.67E-05	2.19E-10	3.23E-10
^{241}Am	3.18E-05	2.11E-02	7.82	2.57E-05	3.78E-05
^{243}Am	1.13E-09	7.51E-07	2.78E-04	8.76E-10	1.42E-09
^{242}Cm	8.82E-08	5.87E-05	2.17E-02	5.92E-08	1.08E-07
^{243}Cm	8.13E-09	5.41E-06	2.00E-03	5.36E-09	9.88E-09
^{244}Cm	7.30E-08	4.86E-05	1.80E-02	4.45E-08	8.89E-08
Totals		ug/g	kg	-95 CI (M or g/L)	+95 CI (M or g/L)
Pu	3.69E-04 (g/L)	n/a	9.07E-02	3.07E-04	5.59E-04
U	0.491	7.76E+04	2.87E+04	0.489	0.492

Notes:

CI = confidence interval

[1]Agnew et al. (1997a)
[2]These predictions have not been validated and should be used with caution.
[3]Unknowns in tank solids inventory are assigned by the TLM.
[4]This is the volume average for density, mass average water wt% and TOC wt% carbon.
[5]Differences exist among the inventories in this column and the inventories calculated from the two sets of concentrations.

A4.0 SURVEILLANCE DATA

Tank 241-TX-104 surveillance consists of surface-level measurements (liquid and solid) and 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. Dry wells located around the tank perimeter may show increased radioactivity because of leaks.

A4.1 SURFACE-LEVEL READINGS

An automatic Food Instrument Corporation (FIC) gauge set in intrusion mode was used to monitor the surface level through riser 8 until January 1996. Manual and automatic ENRAF[1] gauges replaced the FIC gauge starting in April 1996 and September 1996 respectively. Automatic ENRAF™ readings are taken daily and manual ENRAF™ readings are taken quarterly. The surface-level plot indicates a relatively steady waste level from January 1991 to January 1994 with FIC readings ranging from 77.98 cm (30.7 in.) to 83.82 cm (33 in.) (Brevick et al 1997). The surface level on September 30, 1998 was 83.1 cm (32.7 in). Figures A4-1 and A4-2 show the surface level history from 1954 to present. Discrepancy reports were issued on the June 1996 surface level measurement and on high surface level measurements taken between May and August 1997. All discrepancies were attributed to instrument error, and were resolved by flushing and calibrating the displacer for the ENRAF gauge.

Tank 241-TX-104 has no liquid observation well, but it has six identified dry wells. Dry well 51-04-05 is active with readings below 200 counts/sec. Dry well 51-04-02 was active before 1990 but currently has readings below 50 counts/sec (Brevick et al 1997).

A4.2 INTERNAL TANK TEMPERATURES

Tank 241-TX-104 has a single thermocouple tree with 14 thermocouples to monitor the waste temperature through riser 4. In the past, other risers and equipment have been used to monitor the temperature in the tank (Brevick et al. 1997). Thermocouple 1 is 29.9 cm (0.982 ft) from the tank bottom and is the only thermocouple that measures waste temperature. Thermocouples 2 through 10 are spaced at 61-cm (2-ft) intervals above thermocouple 1 and measures dome space temperatures. Thermocouples 10 through 14 are at 1.22 m (4 ft) intervals (Tran 1993).

Temperature data for the first 12 thermocouples recorded from November 1975 to October 1998 were available from the surveillance analysis computer system. Thermocouples 13 and 14 had only two data points each and were not plotted. Within this time span, there was one large break and several small breaks that occurred in the temperature data sequence for all of the thermocouples. The large break occurred between November 1983 and August 1994.

The maximum temperature was 58.3 °C (137 °F) taken by thermocouples 8,9 and 10 on November 5, 1975. The minimum temperature was 10 °C (50 °F) taken by thermocouple 1 on August 15, 1982. The average tank temperature for all the thermocouples from November 5, 1975 to September 30, 1998 is 20.0 °C (68 °F) (Brevick et al. 1997). Only thermocouple 1 is in the waste, all other temperatures are headspace measurements. Figure A4-3 is a graph of the weekly high temperature.

[1]ENRAF is a trademark of ENRAF Corporation, Houston, Texas.

A4.3 TANK 241-TX-104 PHOTOGRAPHS

The October 1984 photographic montage of tank 241-TX-104's interior shows a dark surface of supernatant surrounded by a tan-colored saltcake. The tan-colored saltcake crust covers nearly the entire right half of the tank surface. In the foreground, a recirculating nozzle can be seen. A Food Instrument Corporation (FIC) level probe and a temperature probe can be seen in the background. The bright light near the center of the tank is the reflection from the camera light. Although the photographs were taken in 1984 they should be representative of the current contents of the tank because no transfers have occurred since the photographs were taken (Brevick et al. 1997).

Figure A4-1. Tank 241-TX-104 Level History.

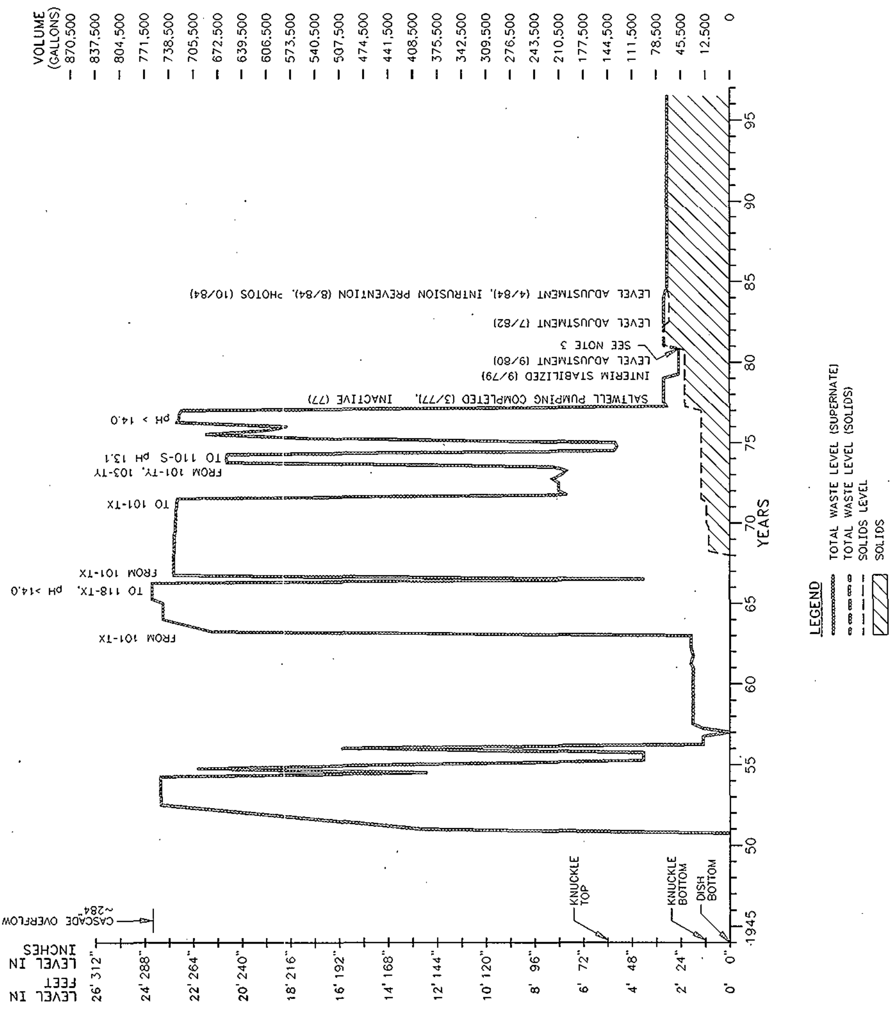
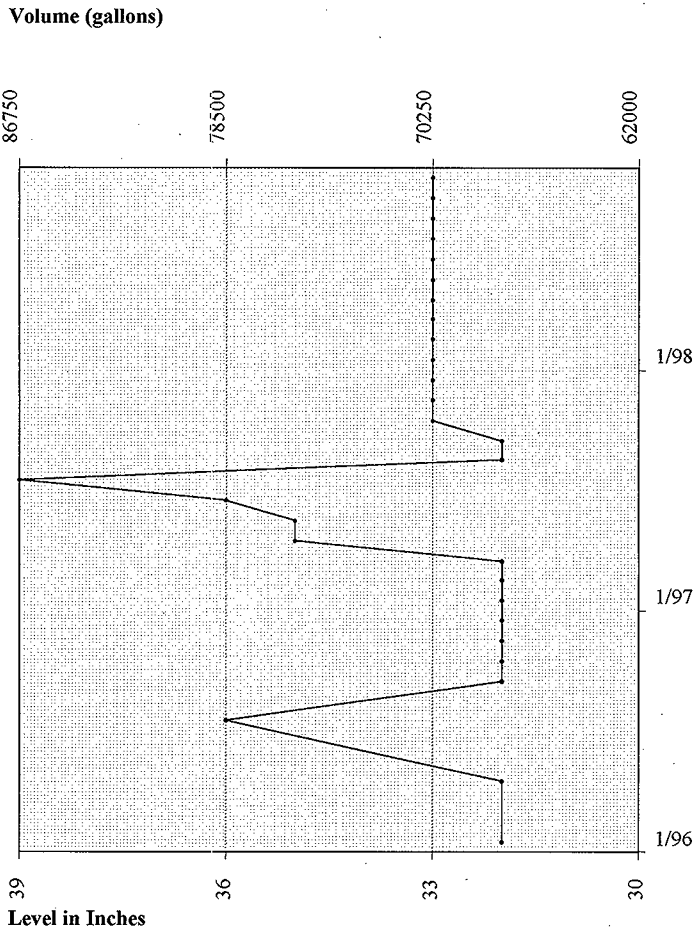
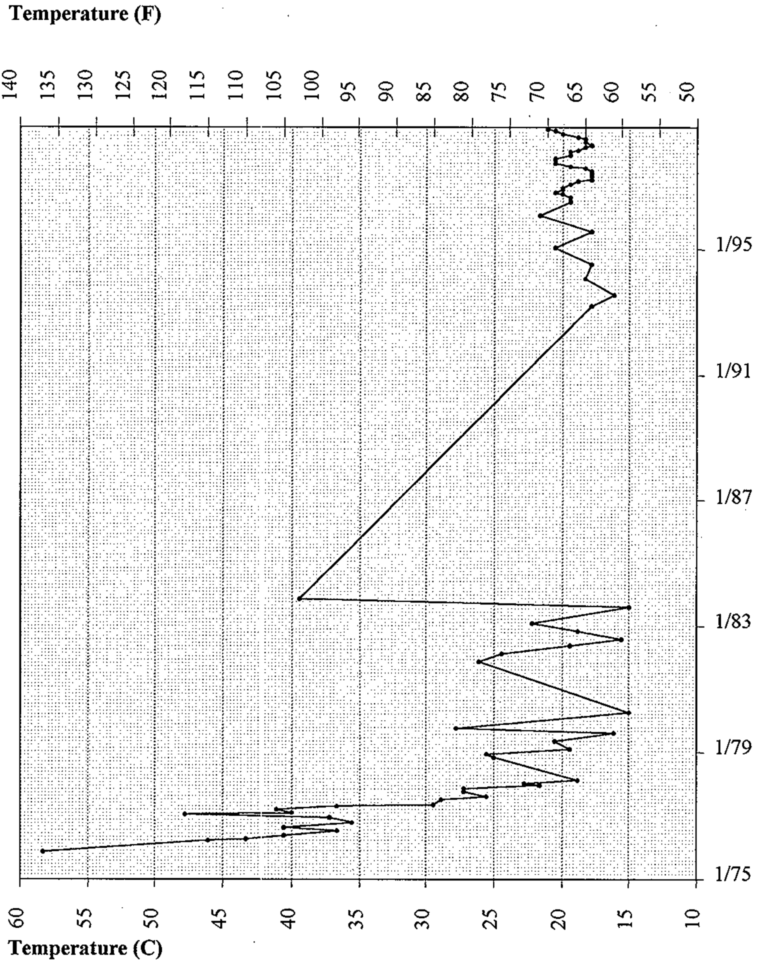


Figure A4-2. Tank 241-TX-104 Current Surface Level Measurements[1]



[1] Fluctuations in measurements in January 1996 and May through August 1997 attributed to instrument error (see Section A4.1).

Figure A4-3. Tank 241-TX-104 High Temperature Plot.[1]



[1] No temperature measurements were obtained between May 1983 and July 1994.

A5.0 APPENDIX A REFERENCES

Agnew, S. F., J. Boyer, R. A. Corbin, T. B. Duran, J. R. Fitzpatrick, K. A. Jurgensen, T. P. Ortiz, and B. L. Young, 1997a, *Hanford Tank Chemical and Radionuclide Inventories: HDW Model* Rev. 4, LA-UR-96-3860, Los Alamos National Laboratory, Los Alamos, New Mexico.

Agnew, S. F., P. Baca, R. A. Corbin, T. B. Duran, and K. A. Jurgensen, 1997b, *Waste Status and Transaction Record Summary (WSTRS)* Rev. 4, LA-UR-97-311, Los Alamos National Laboratory, Los Alamos, New Mexico.

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

Brevick, C. H., J. L. Stroup and J. W. Funk, 1997, *Supporting Document for the Historical Tank Content Estimate for the TX Tank Farm*, HNF-SD-WM-ER-321, Rev. 1, Fluor Daniel Northwest for Fluor Daniel Hanford, Inc., Richland, Washington.

Hanlon, B. M., 1998, *Waste Tank Summary Report for September 30, 1998*, HNF-EP-0182-126, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

Lipnicki, J., 1997, *Waste Tank Risers Available for Sampling*, HNF-SD-WM-TI-710, Rev. 4, Numatec Hanford Corporation for Fluor Daniel Hanford, Inc., Richland, Washington.

Public Law 101-510, 1990, "Safety Measures for Waste Tanks at Hanford Nuclear Reservation," Section 3137 of *National Defense Authorization Act for Fiscal Year 1991*.

Tran, T. T., 1993, *Thermocouple Status Single-Shell & Double-Shell Waste Tanks*, WHC-SD-WM-TI-553, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Vitro, 1985, *Piping Waste Tank Isolation 241-TX-104*, H-2-73122, Rev. 2, Vitro Engineering Corporation, Richland, Washington.

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APPENDIX B

SAMPLING OF TANK 241-TX-104

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APPENDIX B

SAMPLING OF TANK 241-TX-104

Appendix B provides sampling and analysis information for each known sampling event for tank 241-TX-104 and assesses sample results. It includes the following.

- **Section B1.0**: Tank Sampling Overview
- **Section B2.0**: Sampling Events
- **Section B3.0**: Assessment of Characterization Results
- **Section B4.0**: Appendix B References

B1.0 TANK SAMPLING OVERVIEW

This section describes the sampling and analysis events for tank 241-TX-104. Core samples were taken in February 1998 to satisfy the requirements of the *Tank Safety Screening Data Quality Objective* (Dukelow et al. 1995), and the *Memorandum of Understanding for the Organic Complexant Safety Issue Data Requirements* (Schreiber 1997). Core sampling and analyses were performed in accordance with the *Tank 241-TX-104 Core Sampling and Analysis Plan* (McCain 1997). Further discussions of the sampling and analysis procedures can be found in the *Tank Characterization Reference Guide* (DeLorenzo et al. 1994). Vapor samples were taken May 5, 1997 to satisfy the requirements of the *Data Quality Objective to Support Resolution of the Organic Solvent Safety Issue* (Meacham et al. 1997) and the *Data Quality Objectives for Tank Hazardous Vapor Safety Screening* (Osborne and Buckley 1995).

Historical samples for tank 241-TX-104 are described in Section B2. 3.

B2.0 SAMPLING EVENTS

This section describes sampling events. Tables B2-6 through B2-48 show analytical results. The February 1998 core sample results and May 1997 vapor sample results were used to characterize current tank contents. Historical sampling results are discussed in Section B2.3. Table B2-1 summarizes the sampling and analytical requirements for tank 241-TX-104.

B2.1 1998 CORE SAMPLING EVENT

A vertical profile was used to satisfy the safety screening DQO (Dukelow et al. 1995). safety screening analyses included: total alpha activity to determine criticality, DSC to ascertain the fuel energy value, and thermogravimetric analysis (TGA) to obtain the moisture content. In addition, combustible gas meter readings in the tank headspace were performed to measure tank headspace flammability. The safety screening DQO required bulk density measurements and the organic complexants safety issue required DSC analyses. Although no exotherms were observed, total inorganic carbon (TIC) and TOC analyses were conducted for this issue. To assess possible hydrostatic head fluid intrusion, lithium by inductively coupled plasma spectroscopy (ICP) and bromide (IC) analyses were conducted.

Table B2-1 summarizes the sampling and analytical requirements for applicable issues.

Description of Core 230. Three push mode core segments were removed from tank 241-TX-104, riser 9A, on February 18, 1998 and sent to the 222-S Laboratory on February 19, 1998. Two segments were expected for this core. However, because of poor sample recovery and a hard layer resulting in high downforces, an additional segment was taken and identified as segment 2A. Table B2-2 summarizes the extrusion information.

Description of Core 231. Four push mode core segments were removed from tank 241-TX-104, riser 13A, between February 19 and February 23, 1998. Samples were received by the 222-S Laboratory on February 24, 1998. Two segments were expected. However, because of poor sample recovery and a hard layer resulting in high downforces, additional segments were taken and identified as segments 2A and 2B. Table B2-2 summarizes the extrusion information.

Field Blank. A field blank was provided to the 222-S Laboratory with core 230. It underwent the same analyses as the drainable liquid as indicated in the tank sampling and analysis plan (McCain 1997).

Hydrostatic Head Fluid. A sample of the hydrostatic head fluid lithium bromide solution was provided with core 230 and analyzed by IC and ICP.

Table B2-1. Integrated Data Quality Objective Requirements for Tank 241-TX-104.[1]

Sampling Event	Applicable DQOs	Sampling Requirements	Analytical Requirements
Push mode core sampling	Safety screening - Energetics - Moisture content - Total alpha - Flammable gas Dukelow et al. (1995) Organic complexants Schreiber (1997)	Core samples from a minimum of two risers separated radially to the maximum extent possible. Combustible gas measurement	Flammability, energetics, moisture, total alpha activity, density, anions, cations
Vapor sampling	Organic solvents Meacham et al.(1997) Hazardous vapor screening, Osborne and Buckley (1995)	Steel canisters, triple sorbent traps, sorbent trap systems	Flammable gas, organic vapors, permanent gases

Note:
[1]McCain (1997)

B2.1.1 Sample Handling

The push mode samples were shipped to the 222-S Laboratory for subsampling and analysis. Samples were assigned LABCORE numbers and were visually inspected for color, clarity, and solids content. The radiation dose rate on contact was also measured. Drainable liquid (and liner liquid, when present in sufficient amount) was collected and clarified by centrifugation. Segments containing solids were divided into upper and lower half segments. Sample extrusion and subsampling descriptions for cores 230 and 231 are presented in Table B2-2.

Table B2-2. Tank 241-TX-104 Subsampling Scheme and Sample Description.[1]

Core: Riser	Sample ID	Weight (g)	Sample Portion	Sample Characteristics
230:9A	230-01	132.9 168.5	Lower half Drainable liquid	Approximately 10 cm (4 in.) of dark brown solids resembling a salt slurry. Liquid (120 mL) was brown and opaque. No organic layer observed.
	230-02	260.0 54.8	Lower half Drainable liquid	Approximately 20 cm (8 in.) of gray and white solids resembling a wet sludge. Liquid (50 mL) was amber and opaque. No organic layer observed.
	230-2A	86.5	Lower half	Approximately 7.6 cm (3 in.) of white solids resembling a wet sludge. No drainable liquid.
231:13A	231-01	114.1 116.3	Lower half Drainable liquid	Approximately 7.6 cm (3 in.) of black solids resembling a salt slurry. Liquid (100 mL) was dark brown and opaque. No organic layer observed.
	231-02	67.0 97.9	Lower half Drainable liquid	Approximately 7.6 cm (3 in.) of gray and white solids resembling a salt slurry. Liquid (75 mL) was dark brown and opaque. No organic layer observed.
	231-2A	47.2 184.1 51.1	Lower half Drainable liquid Liner liquid	Approximately 5 cm (2 in.) of gray and white solids resembling a salt slurry. Liquid was olive green and opaque. No organic layer observed. Liner liquid was hydrostatic head fluid.
	231-2B	0.0	n/a	Less than 2 mL of liquid. Not retained. No solids.

Note:

[1]Steen (1998)

B2.1.2 Sample Analysis

Samples and subsamples from cores 230 and 231 were analyzed to satisfy requirements for safety screening and organic complexant safety issues. Analyses included total alpha activity, energetics, water content, flammable gas, TOC, TIC, bulk density, specific gravity, IC and ICP. Samples were separated for analysis at the half-segment level where both drainable liquid and solids were present.

Solids analyses were performed by the laboratory on homogenized samples, and liquids were measured directly. Weight percent water was determined by TGA. The fuel content of the waste was determined by DSC and metals were measured using ICP. Before analysis, solid subsamples were prepared by a fusion and an acid digest. Anions were measured on water-leached samples using IC. Total organic carbon was measured using hot persulfate oxidation. Total alpha activity and gamma energy analyses were performed on fusion-digested samples, and density was measured using centrifugation.

Table B2-3 lists the approved analytical procedures used for reported analyses,and Table B2-4 summarizes the sample portions, sample numbers, and analyses performed on each sample.

Table B2-3. Analytical Procedures.[1]

Analysis	Method	Procedure Number
Energetics	Differential scanning calorimetery	LA-514-113 LA-514-114
Percent water	Thermogravimetric analysis	LA-514-114
Total alpha activity	Alpha proportional counter	LA-508-101
Flammable gas	Combustible gas analysis	WHC-IP-0030 IH 1.4 and IH-2.1[2]
TOC/TIC	Persulfate oxidation coulometry	LA-342-100
Metals	Inductively coupled plasma atomic emission spectrometry	LA-505-161
Anions	Ion chromatography	LA-533-105
Bulk density	Gravimetry	LA-519-132
Specific gravity	Gravimetry	LA-508-101

Notes:

[1]Steen (1998)
[2]WHC(1992)

Table B2-4. Sample Analyses Summary [1] (2 sheets)

Segment	Segment Portion	Sample Number	Analyses
Core 230, Riser 9A			
1	Lower half	S98T000649	DSC, TGA
		S98T000672	Total alpha
		S98T000681	ICP (acid)
		S98T000687	IC (water)
		S98T000614	Bulk density
	Drainable liquid	S98T000665	DSC, TGA, specific gravity, Total alpha
		S98T000667	ICP, IC
2	Lower half	S98T000654	DSC, TGA
		S98T000678	Total alpha
		S98T000684	ICP (acid)
		S98T000688	IC (water)
		S98T000640	Bulk density
	Drainable liquid	S98T000666	DSC, TGA, specific gravity, Total alpha
		S98T000668	ICP, IC
2A	Lower half	S98T000655	DSC, TGA
		S98T000679	Total alpha
		S98T000685	ICP (acid)
		S98T000689	IC (water)
		S98T000641	Bulk density
Core 231, Riser 13A			
1	Lower half	S98T000743	DSC, TGA
		S98T000749	Total alpha
		S98T000752	ICP (acid)
		S98T000755	IC (water)
		S98T000740	Bulk density
	Drainable liquid	S98T000761	DSC, TGA, specific gravity, Total alpha
		S98T000764	ICP, IC

Table B2-4. Sample Analyses Summary [1] (2 sheets)

Segment	Segment Portion	Sample Number	Analyses
Core 231, Riser 13A (Cont'd)			
2	Lower half	S98T000744	DSC, TGA
		S98T000750	Total alpha
		S98T000753	ICP
		S98T001733	IC
		S98T000741	Bulk density
	Drainable liquid	S98T000762	DSC, TGA, specific gravity, total alpha
		S98T000765	ICP, IC
2A	Lower half	S98T000745	DSC, TGA
		S98T000751	Total alpha
		S98T000754	ICP (acid)
		S98T000757	IC (water)
		S98T000742	Bulk density
	Drainable liquid	S98T000763	DSC, TGA, specific gravity, total alpha
		S98T000766	ICP, IC

Note:

[1]Steen (1998)

B2.1.3 Analytical Results

This section summarizes the sampling and analytical results associated with the February 1998 sampling and analysis of tank 241-TX-104. Table B2-5 shows the table numbers for the total alpha activity, percent water, energetics, IC, and ICP analytical results associated with this tank. These results are documented in Steen (1998).

Table B2-5. Analytical Tables.

Analysis	Table Number
Inductively coupled plasma atomic emission spectroscopy	B2-8 to 44
Ion chromatography	B2-45 to 52
Bulk density	B2-53
Specific gravity	B2-55
Percent water by thermogravimetric analysis	B2-54
Total alpha	B2-56 and 57
Total organic carbon by persulfate	B2-59
Total inorganic carbon	B2-58

The quality control (QC) parameters assessed in conjunction with tank 241-TX-104 samples were standard recoveries, spike recoveries, duplicate analyses, relative percent difference (RPDs), and blanks. The QC criteria are specified in the Sampling and Analysis Plan (McCain 1997). Sample and duplicate pairs in which any QC parameter was outside these limits are footnoted in the sample mean column of the following data summary tables with an a, b, c, d, e, f, or g as follows.

- "a" indicates the standard recovery was below the QC limit.
- "b" indicates the standard recovery was above the QC limit.
- "c" indicates the spike recovery was below the QC limit.
- "d" indicates the spike recovery was above the QC limit.
- "e" indicates the RPD was above the QC limit.
- "f" indicates blank contamination.
- "g" indicates serial dilutions were within the QC limits.

In the analytical tables in this section, the "mean" is the average of the result and duplicate value. All values, including those below the detection level (denoted by "<") were averaged. If both sample and duplicate values were nondetected, or if one value was detected while the other was not, the mean is expressed as a nondetected value. If both values were detected, the mean is expressed as a detected value.

B2.1.3.1 Total Alpha Activity. Analyses for total alpha activity were performed on the samples recovered from tank 241-TX-104. The samples were prepared by fusion digestion. Two fusions were prepared for each sample (for duplicate results). Each fused dilution was analyzed twice, and the results were averaged and reported as one value. The highest results returned were 1.22 µCi/g for core 230, segment 1 lower half and 6.89 µCi/mL for core 231, segment 1 drainable liquid.

B2.1.3.2 Thermogravimetric Analysis. Thermogravimetric analysis measures the mass of a sample as its temperature is increased at a constant rate. Nitrogen is passed over the sample during heating to remove any released gases. A decrease in the weight of a sample during TGA 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 TGA sample weight loss up to a certain temperature (typically 150 to 200 °C [300 to 390 °F]) 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 weight percent water TGA results ranged from 36 percent to 51.5 percent in the solid samples and from 47.8 to 53.8 percent in the drainable liquid samples.

B2.1.3.3 Differential Scanning Calorimetry. In a DSC analysis, heat absorbed or emitted by a substance is measured while the sample 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.

No exothermic reactions were noted in any of the samples.

B2.1.3.4 Inductively Coupled Plasma. Samples were prepared by acid and fusion digestion. Although a full suite of analytes was reported, only lithium was requested for the safety screening DQO. All other analytes are considered "opportunistic" and do not have customer-defined QC parameters. The primary ICP analytes detected were aluminum and sodium; other analytes observed at concentrations above detection limits were chromium, iron, phosphorous, calcium, potassium, magnesium, and silicon.

Lithium values analyzed were below detection levels for all solids and drainable liquids analyzed.

B2.1.3.5 Ion Chromatography (Ions). Samples were prepared by water digest. Although a full suite of analytes was reported, only bromide was requested for the safety screening DQO. All other analytes are considered "opportunistic" and do not have customer-defined QC parameters. The primary ICP analytes were nitrate and phosphate. Chloride, nitrite, fluoride, and sulfate were also detected. Bromide was below detection levels in all solid and drainable liquid samples.

B2.1.3.6 Specific Gravity and Bulk Density. Specific gravity and bulk density were measured on direct samples. The solids bulk density values ranged from 1.59 to 2.05 g/mL. The specific gravity values for drainable liquid samples ranged from 1.40 to 1.58. No quality control parameters were defined for the bulk density analysis.

B2.1.3.10 Total Inorganic Carbon/Total Organic Carbon. Total inorganic carbon/total organic carbon (TIC/TOC) analyses by persulfate oxidation/coulometry were performed on direct subsamples. The analyses were not required for the organic complexants DQO because no exotherms were observed. As a result, the TIC/TOC analytical results are considered "opportunistic" and QC parameters were not assessed. Solids TOC results ranged from 315 to 2,750 μgC/g. Liquids TOC results ranged from 1,190 to 1,510 μgC/mL.

B2.2 VAPOR PHASE MEASUREMENT

Before the February 1998 core sampling of tank 241-TX-104, a vapor phase measurement was taken. Vapor phase measurements (industrial health and safety field managements) were also taken in July 1996 and May 1997. Vapor samples were taken on May 5, 1997. These measurements supported the hazardous vapor safety screening DQO (Osborne and Buckley 1995) and the organic solvents DQO (Meacham et al. 1997). The vapor phase screening was taken for flammability issues. The vapor phase measurements were taken 6.1 m (20 ft) below riser 13A in the tank headspace. The results of the vapor phase measurements are provided in Tables B2-6 and B2-7.

Table B2-6. Results of Headspace Measurements of Tank 241-TX-104.

Measurement	Result		
	February 1998	July 23, 1996	May 5, 1997
Total organic carbon	1.5 ppm	1.5 ppmv	1.2 ppmv
Lower flammability limit	0%	<1%	0%
Oxygen	21	Nm	20.8%
Ammonia	100 ppm	<5 ppmv	150 ppmv

Table B2-7. Results of May 5, 1997 Headspace Vapor Sample Measurements.[1,2]

Category	Sample Medium	Analyte	Concentration	Units
Inorganic analytes	Sorbent traps	NH_3	29	ppmv
		NO_2	<2.7	ppmv
		NO	<4.1	ppmv
		H_2O	10,800	ppmv
Permanent gases	SUMMA™ canister	H_2	<50	ppmv
		CH_4	<50	ppmv
		CO_2	<50	ppmv
		CO	<50	ppmv
		N_2O	<50	ppmv
TNMOC	SUMMA™ canister	TNMOC	1.39	mg/m^3 at 25°C

Notes:

TNMOC = total non-methane organic carbon

[1]Duchsherer et al. (1997), also many organic compounds detected.
[2]SUMMA is a trademark of Molectrics, Inc., Cleveland, Ohio.

B2.3 DESCRIPTION OF HISTORICAL SAMPLING EVENTS

Limited data are available for four liquid grab samples for tank 241-TX-104. These samples were analyzed in September 1965, September 1974, September 1976, and February 1977. The tank has since been interim stabilized and contains no supernatant. Therefore, these samples are not likely representative of current tank contents and were not included in this report. References to these historical sampling events are included in Appendix E.

PUSH CORE DATA TABLES

Table B2-8. Tank 241-TX-104 Analytical Results: Aluminum (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: acid digest			µg/g	µg/g	µg/g
S98T000681	Core 230:1	Lower half	35,500	33,400	34,500[QC:d,h]
S98T000684	Core 230:2	Lower half	1.93E+05	2.00E+05	1.97E+05[QC:d]
S98T000685	Core 230:2A	Lower half	1.73E+05	1.96E+05	1.85E+05
S98T000752	Core 231:1	Lower half	4,160	4,490	4,330
S98T000753	Core 231:2	Lower half	93,600	82,300	88,000
S98T000754	Core 231:2A	Lower half	38,100	64,600	51,400[QC:d,e,g]
Liquids			µg/mL	µg/mL	µg/mL
S98T000667	Core 230:1	Drainable liquid	3,300	3,290	3,300
S98T000668	Core 230:2	Drainable liquid	3,220	3,040	3,130[QC:c]
S98T000764	Core 231:1	Drainable liquid	3,760	3,610	3,690[QC:d]
S98T000765	Core 231:2	Drainable liquid	2,850	2,890	2,870
S98T000766	Core 231:2A	Drainable liquid	2,900	3,030	2,970

Table B2-9. Tank 241-TX-104 Analytical Results: Antimony (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: acid digest			µg/g	µg/g	µg/g
S98T000681	Core 230:1	Lower half	<35.6	<36.5	<36
S98T000684	Core 230:2	Lower half	<34.1	<33.2	<33.7
S98T000685	Core 230:2A	Lower half	<33.1	<31.9	<32.5
S98T000752	Core 231:1	Lower half	<35.4	<34.5	<35
S98T000753	Core 231:2	Lower half	<32.5	<32.1	<32.3
S98T000754	Core 231:2A	Lower half	<35.4	<35.6	<35.5
Liquids			µg/mL	µg/mL	µg/mL
S98T000667	Core 230:1	Drainable liquid	<36.1	<36.1	<36.1
S98T000668	Core 230:2	Drainable liquid	<36.1	<36.1	<36.1
S98T000764	Core 231:1	Drainable liquid	<36.1	<36.1	<36.1
S98T000765	Core 231:2	Drainable liquid	<36.1	<36.1	<36.1
S98T000766	Core 231:2A	Drainable liquid	<36.1	<36.1	<36.1

Table B2-10. Tank 241-TX-104 Analytical Results: Arsenic (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: acid digest			µg/g	µg/g	µg/g
S98T000681	Core 230:1	Lower half	<59.4	<60.9	<60.1
S98T000684	Core 230:2	Lower half	<56.8	<55.3	<56
S98T000685	Core 230:2A	Lower half	<55.2	<53.2	<54.2
S98T000752	Core 231:1	Lower half	<59	<57.6	<58.3
S98T000753	Core 231:2	Lower half	<54.1	<53.5	<53.8
S98T000754	Core 231:2A	Lower half	<58.9	<59.3	<59.1

Table B2-10. Tank 241-TX-104 Analytical Results: Arsenic (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Liquids			µg/mL	µg/mL	µg/mL
S98T000667	Core 230:1	Drainable liquid	<60.1	<60.1	<60.1
S98T000668	Core 230:2	Drainable liquid	<60.1	<60.1	<60.1
S98T000764	Core 231:1	Drainable liquid	<60.1	<60.1	<60.1
S98T000765	Core 231:2	Drainable liquid	<60.1	<60.1	<60.1
S98T000766	Core 231:2A	Drainable liquid	<60.1	<60.1	<60.1

Table B2-11. Tank 241-TX-104 Analytical Results: Barium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: acid digest			µg/g	µg/g	µg/g
S98T000681	Core 230:1	Lower half	<29.7	<30.4	<30
S98T000684	Core 230:2	Lower half	<28.4	<27.7	<28
S98T000685	Core 230:2A	Lower half	<27.6	<26.6	<27.1
S98T000752	Core 231:1	Lower half	<29.5	<28.8	<29.1
S98T000753	Core 231:2	Lower half	<27.1	<26.7	<26.9
S98T000754	Core 231:2A	Lower half	<29.5	<29.7	<29.6
Liquids			µg/mL	µg/mL	µg/mL
S98T000667	Core 230:1	Drainable liquid	<30.1	<30.1	<30.1
S98T000668	Core 230:2	Drainable liquid	<30.1	<30.1	<30.1
S98T000764	Core 231:1	Drainable liquid	<30.1	<30.1	<30.1
S98T000765	Core 231:2	Drainable liquid	<30.1	<30.1	<30.1
S98T000766	Core 231:2A	Drainable liquid	<30.1	<30.1	<30.1

Table B2-12. Tank 241-TX-104 Analytical Results: Beryllium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: acid digest			µg/g	µg/g	µg/g
S98T000681	Core 230:1	Lower half	<2.97	<3.04	<3
S98T000684	Core 230:2	Lower half	<2.84	<2.77	<2.8
S98T000685	Core 230:2A	Lower half	<2.76	<2.66	<2.71
S98T000752	Core 231:1	Lower half	<2.95	<2.88	<2.92
S98T000753	Core 231:2	Lower half	<2.71	<2.67	<2.69
S98T000754	Core 231:2A	Lower half	<2.95	<2.97	<2.96
Liquids			µg/mL	µg/mL	µg/mL
S98T000667	Core 230:1	Drainable liquid	<3	<3	<3
S98T000668	Core 230:2	Drainable liquid	<3	<3	<3
S98T000764	Core 231:1	Drainable liquid	<3	<3	<3
S98T000765	Core 231:2	Drainable liquid	<3	<3	<3
S98T000766	Core 231:2A	Drainable liquid	<3	<3	<3

Table B2-13. Tank 241-TX-104 Analytical Results: Bismuth (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: acid digest			µg/g	µg/g	µg/g
S98T000681	Core 230:1	Lower half	393	335	364
S98T000684	Core 230:2	Lower half	<56.8	<55.3	<56
S98T000685	Core 230:2A	Lower half	<55.2	<53.2	<54.2
S98T000752	Core 231:1	Lower half	69.4	78.5	74
S98T000753	Core 231:2	Lower half	<54.1	<53.5	<53.8
S98T000754	Core 231:2A	Lower half	<58.9	<59.3	<59.1

Table B2-13. Tank 241-TX-104 Analytical Results: Bismuth (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Liquids			**µg/mL**	**µg/mL**	**µg/mL**
S98T000667	Core 230:1	Drainable liquid	<60.1	<60.1	<60.1
S98T000668	Core 230:2	Drainable liquid	<60.1	<60.1	<60.1
S98T000764	Core 231:1	Drainable liquid	<60.1	<60.1	<60.1
S98T000765	Core 231:2	Drainable liquid	<60.1	<60.1	<60.1
S98T000766	Core 231:2A	Drainable liquid	<60.1	<60.1	<60.1

Table B2-14. Tank 241-TX-104 Analytical Results: Boron (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: acid digest			**µg/g**	**µg/g**	**µg/g**
S98T000681	Core 230:1	Lower half	123	159	141[QC:e]
S98T000684	Core 230:2	Lower half	119	147	133[QC:e]
S98T000685	Core 230:2A	Lower half	91.5	147	119[QC:e]
S98T000752	Core 231:1	Lower half	76.7	132	104[QC:e]
S98T000753	Core 231:2	Lower half	42.5	41.3	41.9
S98T000754	Core 231:2A	Lower half	46	85.3	65.7[QC:e]
Liquids			**µg/mL**	**µg/mL**	**µg/mL**
S98T000667	Core 230:1	Drainable liquid	45.6	48	46.8
S98T000668	Core 230:2	Drainable liquid	49	51.3	50.1
S98T000764	Core 231:1	Drainable liquid	58.6	54.1	56.4
S98T000765	Core 231:2	Drainable liquid	45.1	47.7	46.4
S98T000766	Core 231:2A	Drainable liquid	47.7	47.7	47.7

Table B2-15. Tank 241-TX-104 Analytical Results: Cadmium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: acid digest			µg/g	µg/g	µg/g
S98T000681	Core 230:1	Lower half	8.81	8.01	8.41
S98T000684	Core 230:2	Lower half	<2.84	<2.77	<2.8
S98T000685	Core 230:2A	Lower half	<2.76	<2.66	<2.71
S98T000752	Core 231:1	Lower half	<2.95	3.05	<3
S98T000753	Core 231:2	Lower half	4.71	3.83	4.27[QC:e]
S98T000754	Core 231:2A	Lower half	<2.95	<2.97	<2.96
Liquids			µg/mL	µg/mL	µg/mL
S98T000667	Core 230:1	Drainable liquid	<3	<3	<3
S98T000668	Core 230:2	Drainable liquid	<3	<3	<3
S98T000764	Core 231:1	Drainable liquid	<3	<3	<3
S98T000765	Core 231:2	Drainable liquid	<3	<3	<3
S98T000766	Core 231:2A	Drainable liquid	<3	<3	<3

Table B2-16. Tank 241-TX-104 Analytical Results: Calcium (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: acid digest			µg/g	µg/g	µg/g
S98T000681	Core 230:1	Lower half	149	207	178[QC:e]
S98T000684	Core 230:2	Lower half	498	382	440[QC:e]
S98T000685	Core 230:2A	Lower half	326	330	328
S98T000752	Core 231:1	Lower half	275	219	247[QC:e]
S98T000753	Core 231:2	Lower half	581	619	600
S98T000754	Core 231:2A	Lower half	233	342	288[QC:e]

Table B2-16. Tank 241-TX-104 Analytical Results: Calcium (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: acid digest			µg/g	µg/g	µg/g
S98T000667	Core 230:1	Drainable liquid	75.5	<60.1	<67.8[QC:e]
S98T000668	Core 230:2	Drainable liquid	<60.1	<60.1	<60.1
S98T000764	Core 231:1	Drainable liquid	<60.1	<60.1	<60.1
S98T000765	Core 231:2	Drainable liquid	<60.1	<60.1	<60.1
S98T000766	Core 231:2A	Drainable liquid	<60.1	<60.1	<60.1

Table B2-17. Tank 241-TX-104 Analytical Results: Cerium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: acid digest			µg/mL	µg/Ml	µg/mL
S98T000681	Core 230:1	Lower half	<59.4	<60.9	<60.1
S98T000684	Core 230:2	Lower half	<56.8	<55.3	<56
S98T000685	Core 230:2A	Lower half	<55.2	<53.2	<54.2
S98T000752	Core 231:1	Lower half	<59	<57.6	<58.3
S98T000753	Core 231:2	Lower half	<54.1	<53.5	<53.8
S98T000754	Core 231:2A	Lower half	<58.9	<59.3	<59.1
Liquids			µg/Ml	µg/mL	µg/mL
S98T000667	Core 230:1	Drainable liquid	<60.1	<60.1	<60.1
S98T000668	Core 230:2	Drainable liquid	<60.1	<60.1	<60.1
S98T000764	Core 231:1	Drainable liquid	<60.1	<60.1	<60.1
S98T000765	Core 231:2	Drainable liquid	<60.1	<60.1	<60.1
S98T000766	Core 231:2A	Drainable liquid	<60.1	<60.1	<60.1

Table B2-18. Tank 241-TX-104 Analytical Results: Chromium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: acid digest			µg/g	µg/g	µg/g
S98T000681	Core 230:1	Lower half	4,120	3,890	4,010[QC:d]
S98T000684	Core 230:2	Lower half	1,110	1,170	1,140
S98T000685	Core 230:2A	Lower half	1,080	1,120	1,100
S98T000752	Core 231:1	Lower half	3,570	3,730	3,650
S98T000753	Core 231:2	Lower half	2,140	1,960	2,050
S98T000754	Core 231:2A	Lower half	1,090	1,410	1,250[QC:d,e,g]
Liquids			µg/mL	µg/mL	µg/mL
S98T000667	Core 230:1	Drainable liquid	3,720	3,710	3,720
S98T000668	Core 230:2	Drainable liquid	3,560	3,440	3,500[QC:c]
S98T000764	Core 231:1	Drainable liquid	4,170	4,010	4,090[QC:d]
S98T000765	Core 231:2	Drainable liquid	3,170	3,210	3,190
S98T000766	Core 231:2A	Drainable liquid	3,250	3,400	3,330

Table B2-19. Tank 241-TX-104 Analytical Results: Cobalt (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: acid digest			µg/g	µg/g	µg/g
S98T000681	Core 230:1	Lower half	<11.9	<12.2	<12.1
S98T000684	Core 230:2	Lower half	<11.4	<11.1	<11.3
S98T000685	Core 230:2A	Lower half	<11	<10.6	<10.8
S98T000752	Core 231:1	Lower half	<11.8	<11.5	<11.7
S98T000753	Core 231:2	Lower half	<10.8	<10.7	<10.8
S98T000754	Core 231:2A	Lower half	<11.8	<11.9	<11.9

Table B2-19. Tank 241-TX-104 Analytical Results: Cobalt (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Liquids			µg/mL	µg/mL	µg/mL
S98T000667	Core 230:1	Drainable liquid	<12	<12	<12
S98T000668	Core 230:2	Drainable liquid	<12	<12	<12
S98T000764	Core 231:1	Drainable liquid	<12	<12	<12
S98T000765	Core 231:2	Drainable liquid	<12	<12	<12
S98T000766	Core 231:2A	Drainable liquid	<12	<12	<12

Table B2-20. Tank 241-TX-104 Analytical Results: Copper (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: acid digest			µg/g	µg/g	µg/g
S98T000681	Core 230:1	Lower half	<5.94	<6.09	<6.02
S98T000684	Core 230:2	Lower half	15.5	15.6	15.6
S98T000685	Core 230:2A	Lower half	12.9	16.9	14.9[QC:e]
S98T000752	Core 231:1	Lower half	<5.9	<5.76	<5.83
S98T000753	Core 231:2	Lower half	8.47	7.41	7.94
S98T000754	Core 231:2A	Lower half	6.56	9.95	8.25[QC:e]
Liquids			µg/mL	µg/mL	µg/mL
S98T000667	Core 230:1	Drainable liquid	<6.01	<6.01	<6.01
S98T000668	Core 230:2	Drainable liquid	<6.01	<6.01	<6.01
S98T000764	Core 231:1	Drainable liquid	<6.01	<6.01	<6.01
S98T000765	Core 231:2	Drainable liquid	<6.01	<6.01	<6.01
S98T000766	Core 231:2A	Drainable liquid	<6.01	<6.01	<6.01

Table B2-21. Tank 241-TX-104 Analytical Results: Iron (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: acid digest			**µg/g**	**µg/g**	**µg/g**
S98T000681	Core 230:1	Lower half	3,130	2,930	3,030[QC:d,g]
S98T000684	Core 230:2	Lower half	177	197	187
S98T000685	Core 230:2A	Lower half	125	4,900	2,510[QC:e]
S98T000752	Core 231:1	Lower half	780	879	830
S98T000753	Core 231:2	Lower half	6,080	1,700	3,890[QC:e]
S98T000754	Core 231:2A	Lower half	1,120	1,760	1,440[QC:d,e]
Liquids			**µg/mL**	**µg/mL**	**µg/mL**
S98T000667	Core 230:1	Drainable liquid	<30.1	<30.1	<30.1
S98T000668	Core 230:2	Drainable liquid	<30.1	<30.1	<30.1
S98T000764	Core 231:1	Drainable liquid	325	288	307
S98T000765	Core 231:2	Drainable liquid	<30.1	<30.1	<30.1
S98T000766	Core 231:2A	Drainable liquid	<30.1	<30.1	<30.1

Table B2-22. Tank 241-TX-104 Analytical Results: Lanthanum (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: acid digest			**µg/g**	**µg/g**	**µg/g**
S98T000681	Core 230:1	Lower half	<29.7	<30.4	<30
S98T000684	Core 230:2	Lower half	<28.4	<27.7	<28
S98T000685	Core 230:2A	Lower half	<27.6	<26.6	<27.1
S98T000752	Core 231:1	Lower half	<29.5	<28.8	<29.1
S98T000753	Core 231:2	Lower half	<27.1	<26.7	<26.9
S98T000754	Core 231:2A	Lower half	<29.5	<29.7	<29.6

Table B2-22. Tank 241-TX-104 Analytical Results: Lanthanum (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Liquids			µg/mL	µg/mL	µg/mL
S98T000667	Core 230:1	Drainable liquid	<30.1	<30.1	<30.1
S98T000668	Core 230:2	Drainable liquid	<30.1	<30.1	<30.1
S98T000764	Core 231:1	Drainable liquid	<30.1	<30.1	<30.1
S98T000765	Core 231:2	Drainable liquid	<30.1	<30.1	<30.1
S98T000766	Core 231:2A	Drainable liquid	<30.1	<30.1	<30.1

Table B2-23. Tank 241-TX-104 Analytical Results: Lead (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: acid digest			µg/g	µg/g	µg/g
S98T000681	Core 230:1	Lower half	185	165	175
S98T000684	Core 230:2	Lower half	<56.8	<55.3	<56
S98T000685	Core 230:2A	Lower half	<55.2	<53.2	<54.2
S98T000752	Core 231:1	Lower half	<59	71.8	<65.4
S98T000753	Core 231:2	Lower half	57.6	<53.5	<55.5
S98T000754	Core 231:2A	Lower half	<58.9	<59.3	<59.1
Liquids			µg/mL	µg/mL	µg/mL
S98T000667	Core 230:1	Drainable liquid	<60.1	<60.1	<60.1
S98T000668	Core 230:2	Drainable liquid	<60.1	<60.1	<60.1
S98T000764	Core 231:1	Drainable liquid	<60.1	<60.1	<60.1
S98T000765	Core 231:2	Drainable liquid	<60.1	<60.1	<60.1
S98T000766	Core 231:2A	Drainable liquid	<60.1	<60.1	<60.1

Table B2-24. Tank 241-TX-104 Analytical Results: Lithium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: acid digest			µg/g	µg/g	µg/g
S98T000681	Core 230:1	Lower half	<5.94	<6.09	<6.02
S98T000684	Core 230:2	Lower half	<5.68	<5.53	<5.61
S98T000685	Core 230:2A	Lower half	<5.52	<5.32	<5.42
S98T000752	Core 231:1	Lower half	<5.9	<5.76	<5.83
S98T000753	Core 231:2	Lower half	<5.41	<5.35	<5.38
S98T000754	Core 231:2A	Lower half	<5.89	<5.93	<5.91
Liquids			µg/mL	µg/mL	µg/mL
S98T000667	Core 230:1	Drainable liquid	<6.01	<6.01	<6.01
S98T000668	Core 230:2	Drainable liquid	<6.01	<6.01	<6.01
S98T000764	Core 231:1	Drainable liquid	<6.01	<6.01	<6.01
S98T000765	Core 231:2	Drainable liquid	<6.01	<6.01	<6.01
S98T000766	Core 231:2A	Drainable liquid	<6.01	<6.01	<6.01

Table B2-25. Tank 241-TX-104 Analytical Results: Magnesium (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: acid digest			µg/g	µg/g	µg/g
S98T000681	Core 230:1	Lower half	418	385	402
S98T000684	Core 230:2	Lower half	<56.8	<55.3	<56
S98T000685	Core 230:2A	Lower half	<55.2	<53.2	<54.2
S98T000752	Core 231:1	Lower half	72.9	77.6	75.3
S98T000753	Core 231:2	Lower half	142	149	146
S98T000754	Core 231:2A	Lower half	67.6	104	85.8[QC:e]

Table B2-25. Tank 241-TX-104 Analytical Results: Magnesium (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Liquids			**µg/mL**	**µg/mL**	**µg/mL**
S98T000667	Core 230:1	Drainable liquid	<60.1	<60.1	<60.1
S98T000668	Core 230:2	Drainable liquid	<60.1	<60.1	<60.1
S98T000764	Core 231:1	Drainable liquid	<60.1	<60.1	<60.1
S98T000765	Core 231:2	Drainable liquid	<60.1	<60.1	<60.1
S98T000766	Core 231:2A	Drainable liquid	<60.1	<60.1	<60.1

Table B2-26. Tank 241-TX-104 Analytical Results: Manganese (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: acid digest			**µg/g**	**µg/g**	**µg/g**
S98T000681	Core 230:1	Lower half	1,840	1,300	1,570[QC:c,e,g]
S98T000684	Core 230:2	Lower half	35	44.5	39.8[QC:e]
S98T000685	Core 230:2A	Lower half	24.7	53.6	39.1[QC:e]
S98T000752	Core 231:1	Lower half	288	327	308
S98T000753	Core 231:2	Lower half	420	412	416
S98T000754	Core 231:2A	Lower half	134	217	176[QC:e]
Liquids			**µg/mL**	**µg/mL**	**µg/mL**
S98T000667	Core 230:1	Drainable liquid	<6.01	<6.01	<6.01
S98T000668	Core 230:2	Drainable liquid	7.17	<6.01	<6.59
S98T000764	Core 231:1	Drainable liquid	141	127	134
S98T000765	Core 231:2	Drainable liquid	<6.01	<6.01	<6.01
S98T000766	Core 231:2A	Drainable liquid	<6.01	<6.01	<6.01

Table B2-27. Tank 241-TX-104 Analytical Results: Molybdenum (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: acid digest			µg/g	µg/g	µg/g
S98T000681	Core 230:1	Lower half	<29.7	<30.4	<30
S98T000684	Core 230:2	Lower half	<28.4	<27.7	<28
S98T000685	Core 230:2A	Lower half	<27.6	<26.6	<27.1
S98T000752	Core 231:1	Lower half	41.3	41.6	41.5
S98T000753	Core 231:2	Lower half	<27.1	<26.7	<26.9
S98T000754	Core 231:2A	Lower half	<29.5	<29.7	<29.6
Liquids			µg/mL	µg/mL	µg/mL
S98T000667	Core 230:1	Drainable liquid	67.1	67.8	67.4
S98T000668	Core 230:2	Drainable liquid	64	61.6	62.8
S98T000764	Core 231:1	Drainable liquid	62.8	61.1	62
S98T000765	Core 231:2	Drainable liquid	62	61.9	62
S98T000766	Core 231:2A	Drainable liquid	64	66.4	65.2

Table B2-28. Tank 241-TX-104 Analytical Results: Neodymium (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: acid digest			µg/g	µg/g	µg/g
S98T000681	Core 230:1	Lower half	<59.4	<60.9	<60.1
S98T000684	Core 230:2	Lower half	<56.8	<55.3	<56
S98T000685	Core 230:2A	Lower half	<55.2	<53.2	<54.2
S98T000752	Core 231:1	Lower half	<59	<57.6	<58.3
S98T000753	Core 231:2	Lower half	<54.1	<53.5	<53.8
S98T000754	Core 231:2A	Lower half	<58.9	<59.3	<59.1

Table B2-28. Tank 241-TX-104 Analytical Results: Neodymium (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Liquids			µg/mL	µg/mL	µg/mL
S98T000667	Core 230:1	Drainable liquid	<60.1	<60.1	<60.1
S98T000668	Core 230:2	Drainable liquid	<60.1	<60.1	<60.1
S98T000764	Core 231:1	Drainable liquid	<60.1	<60.1	<60.1
S98T000765	Core 231:2	Drainable liquid	<60.1	<60.1	<60.1
S98T000766	Core 231:2A	Drainable liquid	<60.1	<60.1	<60.1

Table B2-29. Tank 241-TX-104 Analytical Results: Nickel (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: acid digest			µg/g	µg/g	µg/g
S98T000681	Core 230:1	Lower half	18.6	15	16.8[QC:e]
S98T000684	Core 230:2	Lower half	<11.4	<11.1	<11.3
S98T000685	Core 230:2A	Lower half	<11	<10.6	<10.8
S98T000752	Core 231:1	Lower half	<11.8	<11.5	<11.7
S98T000753	Core 231:2	Lower half	12.2	10.8	11.5
S98T000754	Core 231:2A	Lower half	<11.8	<11.9	<11.9
Liquids			µg/mL	µg/mL	µg/mL
S98T000667	Core 230:1	Drainable liquid	<12	<12	<12
S98T000668	Core 230:2	Drainable liquid	<12	<12	<12
S98T000764	Core 231:1	Drainable liquid	<12	<12	<12
S98T000765	Core 231:2	Drainable liquid	<12	<12	<12
S98T000766	Core 231:2A	Drainable liquid	<12	<12	<12

Table B2-30. Tank 241-TX-104 Analytical Results: Phosphorus (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: acid digest			µg/g	µg/g	µg/g
S98T000681	Core 230:1	Lower half	7,900	7,960	7,930[QC:d]
S98T000684	Core 230:2	Lower half	1,530	1,230	1,380[QC:c,e]
S98T000685	Core 230:2A	Lower half	784	1,480	1,130[QC:e]
S98T000752	Core 231:1	Lower half	869	883	876[QC:a,c]
S98T000753	Core 231:2	Lower half	9,510	12,300	10,900[QC:a,e]
S98T000754	Core 231:2A	Lower half	6,270	9,740	8,010[QC:a,e]
Liquids			µg/mL	µg/mL	µg/mL
S98T000667	Core 230:1	Drainable liquid	1,150	1,140	1,150
S98T000668	Core 230:2	Drainable liquid	1,230	1,220	1,230
S98T000764	Core 231:1	Drainable liquid	1,260	1,250	1,260
S98T000765	Core 231:2	Drainable liquid	1,160	1,190	1,180
S98T000766	Core 231:2A	Drainable liquid	1,240	1,280	1,260

Table B2-31. Tank 241-TX-104 Analytical Results: Potassium (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: acid digest			µg/g	µg/g	µg/g
S98T000681	Core 230:1	Lower half	589	608	599
S98T000684	Core 230:2	Lower half	645	622	634
S98T000685	Core 230:2A	Lower half	631	875	753[QC:e]
S98T000752	Core 231:1	Lower half	1,900	1,830	1,870
S98T000753	Core 231:2	Lower half	688	672	680
S98T000754	Core 231:2A	Lower half	<295	407	<351[QC:d,e]

Table B2-31. Tank 241-TX-104 Analytical Results: Potassium (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Liquids			**µg/mL**	**µg/mL**	**µg/mL**
S98T000667	Core 230:1	Drainable liquid	3,110	3,140	3,130
S98T000668	Core 230:2	Drainable liquid	2,810	2,760	2,790
S98T000764	Core 231:1	Drainable liquid	2,700	2,670	2,690
S98T000765	Core 231:2	Drainable liquid	2,610	2,790	2,700
S98T000766	Core 231:2A	Drainable liquid	2,910	2,950	2,930

Table B2-32. Tank 241-TX-104 Analytical Results: Samarium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: acid digest			**µg/g**	**µg/g**	**µg/g**
S98T000681	Core 230:1	Lower half	<59.4	<60.9	<60.1
S98T000684	Core 230:2	Lower half	<56.8	<55.3	<56
S98T000685	Core 230:2A	Lower half	<55.2	<53.2	<54.2
S98T000752	Core 231:1	Lower half	<59	<57.6	<58.3
S98T000753	Core 231:2	Lower half	<54.1	<53.5	<53.8
S98T000754	Core 231:2A	Lower half	<58.9	<59.3	<59.1
Liquids			**µg/mL**	**µg/mL**	**µg/mL**
S98T000667	Core 230:1	Drainable liquid	<60.1	<60.1	<60.1
S98T000668	Core 230:2	Drainable liquid	<60.1	<60.1	<60.1
S98T000764	Core 231:1	Drainable liquid	<60.1	<60.1	<60.1
S98T000765	Core 231:2	Drainable liquid	<60.1	<60.1	<60.1
S98T000766	Core 231:2A	Drainable liquid	<60.1	<60.1	<60.1

Table B2-33. Tank 241-TX-104 Analytical Results: Selenium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: acid digest			µg/g	µg/g	µg/g
S98T000681	Core 230:1	Lower half	<59.4	<60.9	<60.1
S98T000684	Core 230:2	Lower half	132	122	127
S98T000685	Core 230:2A	Lower half	114	115	115
S98T000752	Core 231:1	Lower half	<59	<57.6	<58.3
S98T000753	Core 231:2	Lower half	58.8	54.3	56.5
S98T000754	Core 231:2A	Lower half	<58.9	<59.3	<59.1
Liquids			µg/mL	µg/mL	µg/mL
S98T000667	Core 230:1	Drainable liquid	<60.1	<60.1	<60.1
S98T000668	Core 230:2	Drainable liquid	<60.1	63.4	<61.8
S98T000764	Core 231:1	Drainable liquid	<60.1	67.9	<64
S98T000765	Core 231:2	Drainable liquid	<60.1	<60.1	<60.1
S98T000766	Core 231:2A	Drainable liquid	<60.1	<60.1	<60.1

Table B2-34. Tank 241-TX-104 Analytical Results: Silicon (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: acid digest			µg/g	µg/g	µg/g
S98T000681	Core 230:1	Lower half	252	238	245[QC:b]
S98T000684	Core 230:2	Lower half	137	179	158[QC:b,e]
S98T000685	Core 230:2A	Lower half	220	213	217[QC:b]
S98T000752	Core 231:1	Lower half	115	112	114[QC:a,c]
S98T000753	Core 231:2	Lower half	543	706	625[QC:a,e]
S98T000754	Core 231:2A	Lower half	424	633	529[QC:a,c,e]

Table B2-34. Tank 241-TX-104 Analytical Results: Silicon (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Liquids			µg/mL	µg/mL	µg/mL
S98T000667	Core 230:1	Drainable liquid	44.8	46.1	45.5
S98T000668	Core 230:2	Drainable liquid	116	59.8	87.9[QC:e]
S98T000764	Core 231:1	Drainable liquid	91.1	78.1	84.6
S98T000765	Core 231:2	Drainable liquid	86.5	76.2	81.3
S98T000766	Core 231:2A	Drainable liquid	64.4	60.7	62.6

Table B2-35. Tank 241-TX-104 Analytical Results: Silver (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: acid digest			µg/g	µg/g	µg/g
S98T000681	Core 230:1	Lower half	17.1	15.8	16.5
S98T000684	Core 230:2	Lower half	<5.68	<5.53	<5.61
S98T000685	Core 230:2A	Lower half	<5.52	<5.32	<5.42
S98T000752	Core 231:1	Lower half	11.1	10.9	11
S98T000753	Core 231:2	Lower half	25.6	16.5	21.1[QC:e]
S98T000754	Core 231:2A	Lower half	17.1	14.7	15.9
Liquids			µg/mL	µg/mL	µg/mL
S98T000667	Core 230:1	Drainable liquid	14.7	14.2	14.4
S98T000668	Core 230:2	Drainable liquid	14.8	14.6	14.7
S98T000764	Core 231:1	Drainable liquid	15.9	15.2	15.6
S98T000765	Core 231:2	Drainable liquid	14.5	14.3	14.4
S98T000766	Core 231:2A	Drainable liquid	14.3	15.3	14.8

Table B2-36. Tank 241-TX-104 Analytical Results: Sodium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: acid digest			µg/g	µg/g	µg/g
S98T000681	Core 230:1	Lower half	1.72E+05	1.69E+05	1.71E+05[QC:c]
S98T000684	Core 230:2	Lower half	64,500	60,500	62,500[QC:c]
S98T000685	Core 230:2A	Lower half	63,800	55,100	59,500
S98T000752	Core 231:1	Lower half	1.43E+05	1.42E+05	1.43E+05[QC:b,c]
S98T000753	Core 231:2	Lower half	1.25E+05	1.36E+05	1.31E+05[QC:b]
S98T000754	Core 231:2A	Lower half	1.91E+05	1.64E+05	1.78E+05[QC:b,c]
Liquids			µg/mL	µg/mL	µg/mL
S98T000667	Core 230:1	Drainable liquid	2.08E+05	2.06E+05	2.07E+05[QC:c]
S98T000668	Core 230:2	Drainable liquid	2.03E+05	1.94E+05	1.99E+05[QC:c]
S98T000764	Core 231:1	Drainable liquid	2.11E+05	2.03E+05	2.07E+05[QC:c]
S98T000765	Core 231:2	Drainable liquid	1.99E+05	2.02E+05	2.01E+05
S98T000766	Core 231:2A	Drainable liquid	2.07E+05	2.17E+05	2.12E+05

Table B2-37. Tank 241-TX-104 Analytical Results: Strontium (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: acid digest			µg/g	µg/g	µg/g
S98T000681	Core 230:1	Lower half	<5.94	<6.09	<6.02
S98T000684	Core 230:2	Lower half	<5.68	<5.53	<5.61
S98T000685	Core 230:2A	Lower half	<5.52	<5.32	<5.42
S98T000752	Core 231:1	Lower half	<5.9	<5.76	<5.83
S98T000753	Core 231:2	Lower half	<5.41	<5.35	<5.38
S98T000754	Core 231:2A	Lower half	<5.89	<5.93	<5.91

Table B2-37. Tank 241-TX-104 Analytical Results: Strontium (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Liquids			µg/mL	µg/mL	µg/mL
S98T000667	Core 230:1	Drainable liquid	<6.01	<6.01	<6.01
S98T000668	Core 230:2	Drainable liquid	<6.01	<6.01	<6.01
S98T000764	Core 231:1	Drainable liquid	<6.01	<6.01	<6.01
S98T000765	Core 231:2	Drainable liquid	<6.01	<6.01	<6.01
S98T000766	Core 231:2A	Drainable liquid	<6.01	<6.01	<6.01

Table B2-38. Tank 241-TX-104 Analytical Results: Sulfur (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: acid digest			µg/g	µg/g	µg/g
S98T000681	Core 230:1	Lower half	285	314	300
S98T000684	Core 230:2	Lower half	329	336	333
S98T000685	Core 230:2A	Lower half	344	343	344
S98T000752	Core 231:1	Lower half	968	965	967
S98T000753	Core 231:2	Lower half	357	322	340
S98T000754	Core 231:2A	Lower half	165	220	193[QC:e]
Liquids			µg/mL	µg/mL	µg/mL
S98T000667	Core 230:1	Drainable liquid	1,510	1,500	1,510
S98T000668	Core 230:2	Drainable liquid	1,440	1,390	1,420
S98T000764	Core 231:1	Drainable liquid	1,430	1,370	1,400
S98T000765	Core 231:2	Drainable liquid	1,360	1,410	1,390
S98T000766	Core 231:2A	Drainable liquid	1,410	1,480	1,450

Table B2-39. Tank 241-TX-104 Analytical Results: Thallium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: acid digest			µg/g	µg/g	µg/g
S98T000681	Core 230:1	Lower half	<119	<122	<121
S98T000684	Core 230:2	Lower half	<114	<111	<113
S98T000685	Core 230:2A	Lower half	<110	<106	<108
S98T000752	Core 231:1	Lower half	<118	<115	<117
S98T000753	Core 231:2	Lower half	<108	<107	<108
S98T000754	Core 231:2A	Lower half	<118	<119	<119
Liquids			µg/mL	µg/mL	µg/mL
S98T000667	Core 230:1	Drainable liquid	<120	<120	<120
S98T000668	Core 230:2	Drainable liquid	<120	<120	<120
S98T000764	Core 231:1	Drainable liquid	<120	<120	<120
S98T000765	Core 231:2	Drainable liquid	<120	<120	<120
S98T000766	Core 231:2A	Drainable liquid	<120	<120	<120

Table B2-40. Tank 241-TX-104 Analytical Results: Titanium (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: acid digest			µg/g	µg/g	µg/g
S98T000681	Core 230:1	Lower half	8.38	7.91	8.14
S98T000684	Core 230:2	Lower half	<5.68	<5.53	<5.61
S98T000685	Core 230:2A	Lower half	<5.52	<5.32	<5.42
S98T000752	Core 231:1	Lower half	<5.9	<5.76	<5.83
S98T000753	Core 231:2	Lower half	90.2	75.3	82.8
S98T000754	Core 231:2A	Lower half	46.2	55	50.6

Table B2-40. Tank 241-TX-104 Analytical Results: Titanium (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Liquids			µg/mL	µg/mL	µg/mL
S98T000667	Core 230:1	Drainable liquid	<6.01	<6.01	<6.01
S98T000668	Core 230:2	Drainable liquid	<6.01	<6.01	<6.01
S98T000764	Core 231:1	Drainable liquid	<6.01	<6.01	<6.01
S98T000765	Core 231:2	Drainable liquid	<6.01	<6.01	<6.01
S98T000766	Core 231:2A	Drainable liquid	<6.01	<6.01	<6.01

Table B2-41. Tank 241-TX-104 Analytical Results: Total Uranium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: acid digest			µg/g	µg/g	µg/g
S98T000681	Core 230:1	Lower half	3,330	3,120	3,230[QC:d]
S98T000684	Core 230:2	Lower half	<284	<277	<281
S98T000685	Core 230:2A	Lower half	<276	<266	<271
S98T000752	Core 231:1	Lower half	575	671	623
S98T000753	Core 231:2	Lower half	<271	<267	<269
S98T000754	Core 231:2A	Lower half	<295	<297	<296
Liquids			µg/mL	µg/mL	µg/mL
S98T000667	Core 230:1	Drainable liquid	<300	<300	<300
S98T000668	Core 230:2	Drainable liquid	<300	<300	<300
S98T000764	Core 231:1	Drainable liquid	<300	<300	<300
S98T000765	Core 231:2	Drainable liquid	<300	<300	<300
S98T000766	Core 231:2A	Drainable liquid	<300	<300	<300

Table B2-42. Tank 241-TX-104 Analytical Results: Vanadium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: acid digest			µg/g	µg/g	µg/g
S98T000681	Core 230:1	Lower half	<29.7	<30.4	<30
S98T000684	Core 230:2	Lower half	<28.4	<27.7	<28
S98T000685	Core 230:2A	Lower half	<27.6	<26.6	<27.1
S98T000752	Core 231:1	Lower half	<29.5	<28.8	<29.1
S98T000753	Core 231:2	Lower half	<27.1	<26.7	<26.9
S98T000754	Core 231:2A	Lower half	<29.5	<29.7	<29.6
Liquids			µg/mL	µg/mL	µg/mL
S98T000667	Core 230:1	Drainable liquid	<30.1	<30.1	<30.1
S98T000668	Core 230:2	Drainable liquid	<30.1	<30.1	<30.1
S98T000764	Core 231:1	Drainable liquid	<30.1	<30.1	<30.1
S98T000765	Core 231:2	Drainable liquid	<30.1	<30.1	<30.1
S98T000766	Core 231:2A	Drainable liquid	<30.1	<30.1	<30.1

Table B2-43. Tank 241-TX-104 Analytical Results: Zinc (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: acid digest			µg/g	µg/g	µg/g
S98T000681	Core 230:1	Lower half	25.7	27.7	26.7
S98T000684	Core 230:2	Lower half	22.4	17.8	20.1[QC:e]
S98T000685	Core 230:2A	Lower half	21.8	25.8	23.8
S98T000752	Core 231:1	Lower half	19.9	354	187[QC:e]
S98T000753	Core 231:2	Lower half	17.6	12.1	14.9[QC:e]
S98T000754	Core 231:2A	Lower half	11.8	15.1	13.4[QC:e]

Table B2-43. Tank 241-TX-104 Analytical Results: Zinc (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Liquids			µg/mL	µg/mL	µg/mL
S98T000667	Core 230:1	Drainable liquid	<6.01	<6.01	<6.01
S98T000668	Core 230:2	Drainable liquid	<6.01	<6.01	<6.01
S98T000764	Core 231:1	Drainable liquid	<6.01	<6.01	<6.01
S98T000765	Core 231:2	Drainable liquid	<6.01	<6.01	<6.01
S98T000766	Core 231:2A	Drainable liquid	<6.01	<6.01	<6.01

Table B2-44. Tank 241-TX-104 Analytical Results: Zirconium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: acid digest			µg/g	µg/g	µg/g
S98T000681	Core 230:1	Lower half	59.2	56.7	58[QC:c]
S98T000684	Core 230:2	Lower half	<5.68	<5.53	<5.61
S98T000685	Core 230:2A	Lower half	<5.52	<5.32	<5.42
S98T000752	Core 231:1	Lower half	13.8	16.4	15.1[QC:a,c]
S98T000753	Core 231:2	Lower half	8.55	7.89	8.22[QC:a]
S98T000754	Core 231:2A	Lower half	<5.89	<5.93	<5.91[QC:a,c]
Liquids			µg/mL	µg/mL	µg/mL
S98T000667	Core 230:1	Drainable liquid	<6.01	<6.01	<6.01
S98T000668	Core 230:2	Drainable liquid	<6.01	<6.01	<6.01
S98T000764	Core 231:1	Drainable liquid	6.91	6.48	6.7
S98T000765	Core 231:2	Drainable liquid	<6.01	<6.01	<6.01
S98T000766	Core 231:2A	Drainable liquid	<6.01	<6.01	<6.01

Table B2-45. Tank 241-TX-104 Analytical Results: Bromide (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: water digest			µg/g	µg/g	µg/g
S98T000687	Core 230:1	Lower half	<1,030	<1,030	<1,030
S98T000688	Core 230:2	Lower half	<471	<467	<469
S98T000689	Core 230:2A	Lower half	<515	<506	<510
S98T000755	Core 231:1	Lower half	<915	<927	<921
S98T001733	Core 231:2	Lower half	<1,260	<1,260	<1,260
S98T000757	Core 231:2A	Lower half	<917	<930	<924
Liquids			µg/mL	µg/mL	µg/mL
S98T000667	Core 230:1	Drainable liquid	<1,280	<1,280	<1,280
S98T000668	Core 230:2	Drainable liquid	<1,280	<1,280	<1,280
S98T000764	Core 231:1	Drainable liquid	<1,280	<1,280	<1,280
S98T000765	Core 231:2	Drainable liquid	<1,280	<1,280	<1,280
S98T000766	Core 231:2A	Drainable liquid	<1,280	1,420	<1,350

Table B2-46. Tank 241-TX-104 Analytical Results: Chloride (IC). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: water digest			µg/g	µg/g	µg/g
S98T000687	Core 230:1	Lower half	1,320	1,430	1,370
S98T000688	Core 230:2	Lower half	1,540	1,390	1,460
S98T000689	Core 230:2A	Lower half	1,270	1,410	1,340
S98T000755	Core 231:1	Lower half	5,400	5,210	5,300
S98T001733	Core 231:2	Lower half	1,210	1,100	1,150
S98T000757	Core 231:2A	Lower half	1,060	1,420	1,240[QC:e]

Table B2-46. Tank 241-TX-104 Analytical Results: Chloride (IC). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Liquids			**µg/mL**	**µg/mL**	**µg/mL**
S98T000667	Core 230:1	Drainable liquid	7,670	7,930	7,800
S98T000668	Core 230:2	Drainable liquid	7,770	7,800	7,780[QC:d]
S98T000764	Core 231:1	Drainable liquid	7,110	7,140	7,130
S98T000765	Core 231:2	Drainable liquid	19,700	19,000	19,300
S98T000766	Core 231:2A	Drainable liquid	7,750	7,970	7,860

Table B2-47. Tank 241-TX-104 Analytical Results: Fluoride (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
S98T000687	Core 230:1	Lower half	3,060	4,380	3,720[QC:e]
S98T000688	Core 230:2	Lower half	210	175	193
S98T000689	Core 230:2A	Lower half	55.3	65.5	60.4
S98T000755	Core 231:1	Lower half	116	<89	<102[QC:e]
S98T001733	Core 231:2	Lower half	1,850	5,450	3,650[QC:e]
S98T000757	Core 231:2A	Lower half	2,570	3,010	2,790
Liquids			**µg/mL**	**µg/mL**	**µg/mL**
S98T000667	Core 230:1	Drainable liquid	<122	<122	<122
S98T000668	Core 230:2	Drainable liquid	<122	260	<191[QC:e]
S98T000764	Core 231:1	Drainable liquid	<122	<122	<122
S98T000765	Core 231:2	Drainable liquid	<122	<122	<122
S98T000766	Core 231:2A	Drainable liquid	<122	<122	<122

Table B2-48. Tank 241-TX-104 Analytical Results: Nitrate (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: water digest			µg/g	µg/g	µg/g
S98T000687	Core 230:1	Lower half	3.82E+05	3.81E+05	3.82E+05
S98T000688	Core 230:2	Lower half	1.18E+05	1.12E+05	1.15E+05[QC:e]
S98T000689	Core 230:2A	Lower half	1.90E+05	94,600	1.42E+05[QC:e]
S98T000755	Core 231:1	Lower half	2.09E+05	2.01E+05	2.05E+05
S98T001733	Core 231:2	Lower half	4.03E+05	2.84E+05	3.43E+05[QC:e]
S98T000757	Core 231:2A	Lower half	4.10E+05	3.79E+05	3.94E+05
Liquids			µg/mL	µg/mL	µg/mL
S98T000667	Core 230:1	Drainable liquid	2.70E+05	2.72E+05	2.71E+05
S98T000668	Core 230:2	Drainable liquid	2.82E+05	2.83E+05	2.82E+05
S98T000764	Core 231:1	Drainable liquid	2.85E+05	2.83E+05	2.84E+05
S98T000765	Core 231:2	Drainable liquid	6.48E+05	6.46E+05	6.47E+05
S98T000766	Core 231:2A	Drainable liquid	2.88E+05	2.89E+05	2.88E+05

Table B2-49. Tank 241-TX-104 Analytical Results: Nitrite (IC). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: water digest			µg/g	µg/g	µg/g
S98T000687	Core 230:1	Lower half	13,500	14,700	14,100
S98T000688	Core 230:2	Lower half	14,600	13,200	13,900
S98T000689	Core 230:2A	Lower half	12,400	13,700	13,100
S98T000755	Core 231:1	Lower half	50,400	48,800	49,600
S98T001733	Core 231:2	Lower half	10,700	9,880	10,300
S98T000757	Core 231:2A	Lower half	9,740	11,100	10,400

Table B2-49. Tank 241-TX-104 Analytical Results: Nitrite (IC). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Liquids			µg/mL	µg/mL	µg/mL
S98T000667	Core 230:1	Drainable liquid	72,800	74,700	73,800
S98T000668	Core 230:2	Drainable liquid	72,400	72,700	72,500
S98T000764	Core 231:1	Drainable liquid	66,800	66,900	66,900
S98T000765	Core 231:2	Drainable liquid	1.87E+05	1.82E+05	1.84E+05
S98T000766	Core 231:2A	Drainable liquid	71,800	75,100	73,500

Table B2-50. Tank 241-TX-104 Analytical Results: Phosphate (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: water digest			µg/g	µg/g	µg/g
S98T000687	Core 230:1	Lower half	29,100	42,900	36,000[QC:e]
S98T000688	Core 230:2	Lower half	4,380	3,980	4,180
S98T000689	Core 230:2A	Lower half	1,570	1,500	1,540
S98T000755	Core 231:1	Lower half	3,430	3,700	3,560
S98T001733	Core 231:2	Lower half	23,700	50,600	37,200[QC:e]
S98T000757	Core 231:2A	Lower half	24,400	28,200	26,300
Liquids			µg/mL	µg/mL	µg/mL
S98T000667	Core 230:1	Drainable liquid	4,730	4,670	4,700
S98T000668	Core 230:2	Drainable liquid	4,250	3,380	3,810[QC:e]
S98T000764	Core 231:1	Drainable liquid	4,520	4,730	4,620
S98T000765	Core 231:2	Drainable liquid	11,500	10,400	10,900
S98T000766	Core 231:2A	Drainable liquid	4,330	4,160	4,240

Table B2-51. Tank 241-TX-104 Analytical Results: Sulfate (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: water digest			µg/g	µg/g	µg/g
S98T000687	Core 230:1	Lower half	<1,140	<1,140	<1,140
S98T000688	Core 230:2	Lower half	<520	<516	<518
S98T000689	Core 230:2A	Lower half	<569	706	<637[QC:e]
S98T000755	Core 231:1	Lower half	1,380	1,380	1,380
S98T001733	Core 231:2	Lower half	<1,390	<1,390	<1,390
S98T000757	Core 231:2A	Lower half	<1,010	<1,030	<1,020
Liquids			µg/mL	µg/mL	µg/mL
S98T000667	Core 230:1	Drainable liquid	4,470	4,550	4,510
S98T000668	Core 230:2	Drainable liquid	1,650	<1,410	<1,530
S98T000764	Core 231:1	Drainable liquid	2,290	2,590	2,440
S98T000765	Core 231:2	Drainable liquid	11,500	7,850	9,690[QC:e]
S98T000766	Core 231:2A	Drainable liquid	1,900	4,620	3,260[QC:e]

Table B2-52. Tank 241-TX-104 Analytical Results: Oxalate (IC). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: water digest			µg/g	µg/g	µg/g
S98T000687	Core 230:1	Lower half	5,320	6,120	5,720
S98T000688	Core 230:2	Lower half	655	490	573[QC:e]
S98T000689	Core 230:2A	Lower half	464	<425	<444
S98T000755	Core 231:1	Lower half	3,460	4,060	3,760
S98T001733	Core 231:2	Lower half	4,230	5,000	4,610
S98T000757	Core 231:2A	Lower half	1,080	1,280	1,180

Table B2-52. Tank 241-TX-104 Analytical Results: Oxalate (IC). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Liquids			µg/mL	µg/mL	µg/mL
S98T000667	Core 230:1	.Drainable liquid	<1,070	<1,070	<1,070
S98T000668	Core 230:2	Drainable liquid	<1,070	<1,070	<1,070
S98T000764	Core 231:1	Drainable liquid	<1,070	<1,070	<1,070
S98T000765	Core 231:2	Drainable liquid	1,870	1,870	1,870
S98T000766	Core 231:2A	Drainable liquid	<1,070	<1,070	<1,070

Table B2-53. Tank 241-TX-104 Analytical Results: Bulk Density .

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids			g/mL	g/mL	g/mL
S98T000614	Core 230:1	Lower half	1.65	n/a	1.65
S98T000640	Core 230:2	Lower half	2.05	n/a	2.05
S98T000641	Core 230:2A	Lower half	1.89	n/a	1.89
S98T000740	Core 231:1	Lower half	1.59	n/a	1.59
S98T000741	Core 231:2	Lower half	1.88	n/a	1.88
S98T000742	Core 231:2A	Lower half	1.81	n/a	1.81

Table B2-54. Tank 241-TX-104 Analytical Results: Percent Water (TGA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids			%	%	%
S98T000649	Core 230:1	Lower half	36.0	42.0	39.0
S98T000654	Core 230:2	Lower half	41.8	42.1	41.9
S98T000655	Core 230:2A	Lower half	44.7	41.6	43.1
S98T000743	Core 231:1	Lower half	51.5	51.3	51.4
S98T000744	Core 231:2	Lower half	48.9	48.3	48.6
S98T000745	Core 231:2A	Lower half	49.6	48.9	49.2
Liquids			%	%	%
S98T000665	Core 230:1	Drainable liquid	52.9	53.0	53.0
S98T000666	Core 230:2	Drainable liquid	51.9	51.9	51.9
S98T000761	Core 231:1	Drainable liquid	47.8	49.4	48.6
S98T000762	Core 231:2	Drainable liquid	52.8	53.1	52.9
S98T000763	Core 231:2A	Drainable liquid	53.8	52.3	53.1

Table B2-55. Tank 241-TX-104 Analytical Results: Specific Gravity.

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Liquids			unitless	unitless	Unitless
S98T000665	Core 230:1	Drainable liquid	1.4	1.4	1.4
S98T000666	Core 230:2	Drainable liquid	1.41	1.41	1.41
S98T000761	Core 231:1	Drainable liquid	1.58	1.57	1.58
S98T000762	Core 231:2	Drainable liquid	1.42	1.44	1.43
S98T000763	Core 231:2A	Drainable liquid	1.41	1.41	1.41

Table B2-56. Tank 241-TX-104 Liquid Analytical Results: Total Alpha.

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Liquids			µCi/mL	µCi/mL	µCi/mL
S98T000665	Core 230:1	Drainable liquid	0.00734	0.00706	0.0072
S98T000666	Core 230:2	Drainable liquid	0.044	0.0301	0.0371[QC:e]
S98T000761	Core 231:1	Drainable liquid	6.89	5.66	6.28
S98T000762	Core 231:2	Drainable liquid	0.0062	0.00393	0.00507[QC:e]
S98T000763	Core 231:2A	Drainable liquid	0.00563	0.00478	0.00521

Table B2-57. Tank 241-TX-104 Solid Analytical Results: Total Alpha.

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: fusion			µCi/g	µCi/g	µCi/g
S98T000672	Core 230:1	Lower half	1.22	0.662	0.941[QC:e]
S98T000678	Core 230:2	Lower half	0.0378	0.0368	0.0373
S98T000679	Core 230:2A	Lower half	0.0265	0.0305	0.0285
S98T000749	Core 231:1	Lower half	0.395	0.397	0.396
S98T000750	Core 231:2	Lower half	0.25	0.292	0.271
S98T000751	Core 231:2A	Lower half	0.173	0.185	0.179

Table B2-58. Tank 241-TX-104 Analytical Results: Total Inorganic Carbon.

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids			µg/g	µg/g	µg/g
S98T000649	Core 230:1	Lower half	6,520	7,290	6,910
S98T000654	Core 230:2	Lower half	2,540	2,560	2,550[QC:d]
S98T000655	Core 230:2A	Lower half	2,790	2,740	2,770
S98T000743	Core 231:1	Lower half	9,730	9,550	9,640
S98T000744	Core 231:2	Lower half	3,920	3,300	3,610
S98T000745	Core 231:2A	Lower half	2,820	2,580	2,700
Liquids			µg/mL	µg/mL	µg/mL
S98T000665	Core 230:1	Drainable liquid	12,100	11,200	11,700
S98T000666	Core 230:2	Drainable liquid	12,800	12,100	12,500
S98T000761	Core 231:1	Drainable liquid	12,700	13,700	13,200
S98T000762	Core 231:2	Drainable liquid	12,800	12,800	12,800
S98T000763	Core 231:2A	Drainable liquid	13,000	12,800	12,900

Table B2-59. Tank 241-TX-104 Analytical Results: Total Organic Carbon. (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids			µg/g	µg/g	µg/g
S98T000649	Core 230:1	Lower half	2,540	2,750	2,650
S98T000654	Core 230:2	Lower half	315	413	364[QC:e]
S98T000655	Core 230:2A	Lower half	426	421	424
S98T000743	Core 231:1	Lower half	2,010	1,680	1,850
S98T000744	Core 231:2	Lower half	1,440	1,300	1,370
S98T000745	Core 231:2A	Lower half	562	650	606

Table B2-59. Tank 241-TX-104 Analytical Results: Total Organic Carbon. (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Liquids			µg/mL	µg/mL	µg/mL
S98T000665	Core 230:1	Drainable liquid	1,370	1,360	1,370
S98T000666	Core 230:2	Drainable liquid	1,400	1,380	1,390
S98T000761	Core 231:1	Drainable liquid	1,190	1,300	1,250
S98T000762	Core 231:2	Drainable liquid	1,430	1,510	1,470
S98T000763	Core 231:2A	Drainable liquid	1,340	1,290	1,320

B3.0 ASSESSMENT OF CHARACTERIZATION RESULTS

This section discusses the overall quality and consistency of the current sampling results for tank 241-TX-104. This section also evaluates sampling and analysis factors that may impact data interpretation. These factors are used to assess overall data quality and consistency and to identify limitations in data use.

B3.1 FIELD OBSERVATIONS

Sample recovery from cores 230 and 231 was good except for the hard layer encountered in both cores. Both saltcake and sludge samples were recovered for core 230, while core 231 appeared to be primarily saltcake. The samples recovered are expected to be representative of tank contents. Hydrostatic head fluid was added in a subsequent attempt to recover additional material, resulting in liner liquid that was mostly hydrostatic head fluid in core 231, segment 2A. No significant hydrostatic head fluid contamination was noted in any of the samples.

B3.2 QUALITY CONTROL ASSESSMENT

The usual QC assessment includes an evaluation of the appropriate standard recoveries, spike recoveries, duplicate analyses, and blanks, performed in conjunction with the chemical analyses. All pertinent QC tests were conducted on February 1998 push core samples, allowing a full assessment regarding the accuracy and precision of the data. The SAP (McCain 1997) established specific criteria for all analytes. Sample and duplicate pairs with one or more QC results outside the specified criteria were identified by footnotes in the data summary tables.

Quality control checks and criteria for ICP and IC analyses were applied to lithium and bromide, respectively. All other results for the ICP and IC analytical methods are opportunistic. Total inorganic carbon and TOC results were performed in support of the organic complexants safety issue. However, because no exotherms were observed in any of the samples, these analyses were considered opportunistic, and QC results were not included in the analytical report (Steen 1998).

The standard and spike recovery results provide an estimate of analysis accuracy. If a standard or spike recovery is above or below the given criterion, the analytical results may be biased high or low, respectively. The precision is estimated by the relative percent difference (RPD), which is defined as the absolute value of the difference between the primary and duplicate samples, divided by their mean, times 100. Two RPDs were outside the target level for total alpha activity. Reruns were deemed unnecessary because the sample results were far below the action limit. All other QC values were within the limits for other requested analytes

In summary, the vast majority of QC results were within the boundaries specified in the SAP. The discrepancies mentioned here and footnoted in the data summary tables should not impact data validity or use.

B3.3 DATA CONSISTENCY CHECKS

Comparing different analytical methods is helpful in assessing the consistency and quality of the data. Two comparisons were possible with the data set provided by the two core samples: a comparison of phosphorous as analyzed by ICP to phosphate as analyzed by IC, and a comparison of sulfur as analyzed by ICP to sulfate as analyzed by IC. 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. Agreement between the two methods strengthens the credibility of both results, but poor agreement brings the reliability of the data into question. All analytical mean results were taken from Section B2.0 tables.

The solids analytical phosphorous mean result as determined by ICP was 5,040 µg/g, which converts to 15,500 µg/g of phosphate. This is lower than the solids IC phosphate mean result of 18,100 µg/g, indicating that the phosphorous is likely entirely soluble. The RPD between these two phosphate results is 15.8 percent. The liquid analytical phosphorous mean result as determined by ICP was 1,210 µg/mL, which converts to 3,710 µg/mL of phosphate. This is much lower than the liquid IC phosphate mean result of 5,660 µg/mL. The phosphate IC result will be used for the mass balance calculations. The RPD between these two phosphate results is 41.6 percent.

The solids analytical sulfur mean result as determined by ICP was 412 µg/g, which converts to 1,230 µg/g of sulfate. This is higher than the solids IC sulfate mean result of <1,010 µg/g. The data indicate that the sulfur may be only partly soluble. The RPD between the two results (based on the less than detect IC value) is 18.5 percent. The liquid analytical sulfur mean result as determined by ICP was 1,430 µg/mL, which converts to 4,290 µg/mL of sulfate. This is the same as the IC sulfate mean result. The RPD between the two results is 0.0 percent.

B3.3.2 Mass and Charge Balance.

The principle objective in performing mass and charge balances is to determine whether the measurements are consistent. In calculating the balances, only the analytes listed in Section B2.0, which were detected at a concentration of 1,000 µg/g or greater, were considered.

SOLIDS

Except sodium, all cations listed in Table B3-1 were assumed to be in their most common hydroxide or oxide form, and the concentrations of the assumed species were calculated stoichiometrically. Aluminum may occur as aluminum hydroxide only in the sludge and as aluminate (AlO_2^-) in the saltcake portion of the waste. However, it is all assumed to be aluminum hydroxide for these calculations. Because precipitates are neutral species, all positive charge was attributed to the sodium cation. The anions listed in Table B3-2 were assumed to be present as sodium salts and were expected to balance the positive charge exhibited by the cations. Phosphate, as determined by IC, is assumed to be completely water soluble and appears only in the anion mass and charge calculations. The concentrations of cationic species in Table B3-1, the anionic species in Table B3-2, and the percent water were ultimately used to calculate the mass balance.

The mass balance was calculated from the formula below. The factor 0.0001 is the conversion factor from µg/g to weight percent.

$$\text{Mass balance} = \%\ \text{water} + 0.0001 \times \{\text{total analyte concentration}\}$$

$$= \%\ \text{water} + 0.0001 \times \{Al(OH)_3 + Cr(OH)_3 + FeO(OH) + Na^+ + Cl^- + F^- + NO_2^- + NO_3^- + PO_4^{-3} + CO_3^{-2}\}.$$

The total analyte concentrations calculated from the above equation is 7.29E+05 µg/g. The mean weight percent water (obtained from the gravimetric analyses reported in Table B3-3) is 45.5 percent or 4.55E+05 µg/g. The mass balance resulting from adding the percent water to the total analyte concentration is 118 percent (see Table B3-3).

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

Total cations (μeq/g) = $[Na^+]/23.0 = 5{,}390$ μeq/g
Total anions (μeq/g) = $[F^-]/19.0 + [Cl^-]/35.5 + [NO_2^-]/46.0 + [NO_3^-]/62.0 + [PO_4^{-3}]/31.7 + [CO_3^{-2}]/30 = 6{,}160$ μeq/g.

The solids charge balance, obtained by dividing the sum of the positive charge by the sum of the negative charge, was 0.87.

The solids charge balance calculation is a little low and the solids mass balance is high. The high mass balance may be due to including hydrated aluminum hydroxide as percent water in the mass balance calculation, thereby double counting the aluminum hydroxide. If hydrated aluminum hydroxide is removed from the percent water value, the mass balance is about 109 percent. However, there appears to be a cation deficit or anion surplus in the data.

Table B3-1. Cation Mass and Charge Data for Solids.

Analyte	Concentration (μg/g)	Assumed Species	Concentration of Assumed Species (μg/g)	Charge (μeq/g)
Na	1.24E+05	Na^+	1.24E+05	5,390
Al	93,200	$Al(OH)_3$	2.69E+05	0
Fe	1,980	FeO(OH)	3,150	0
Cr	2,200	$Cr(OH)_3$	4,360	0
Totals			4.01E+05	5,390

Table B3-2. Anion Mass and Charge Data for Solids

Analyte	Concentration (μg/g)	Charge (μeq/g)
F^-	1,750	92.1
Cl^-	1,980	55.8
NO_2^-	18,600	404
NO_3^-	2.64E+05	4,260
CO_3^{-2}	23,500	783
PO_4^{-3}	18,100	571
Totals	3.28E+05	6,160

Table B3-3. Anion Mass and Charge Data for Solids

Totals	Concentrations (µg/g)	Charge (µeq/g)
Total from Table B3-1 (cations)	4.01E+05	+5,390
Total from Table B3-2 (anions)	3.28E+05	- 6,160
Water percent	45.5	n/a
Totals	118%	0.87 ratio

LIQUIDS

Aluminum is assumed to be present as aluminate (AlO_2^-) in the drainable liquid. Sodium and potassium are present as ions. The concentrations of the assumed species were calculated stoichiometrically. The anions listed in Table B3-5 were expected to balance the positive charge exhibited by the cations. The concentrations of cationic species in Table B3-4, the anionic species in Table B3-5, and the percent water were ultimately used to calculate the mass balance.

The mass balance was calculated from the formula below. The factor 0.0001 is the conversion factor from µg/g to weight percent. An average specific gravity of 1.45 was used to convert from µg/mL to µg/g.

Mass balance = % water + 0.0001 x {total analyte concentration}

$$= \% \text{ water} + 0.0001 \times \{AlO_2^- + Na^+ + K^+ + Cl^- + F^- + NO_2^- + NO_3^- + PO_4^{-3} + CO_3^{-2}\}.$$

The total analyte concentration calculated from the above equation is 5.22E+05 µg/g. The mean weight percent water (obtained from the gravimetric analyses reported in Table B3-6) is 51.9 percent or 5.19E+05 µg/g. The mass balance resulting from adding the percent water to the total analyte concentration is 103 percent (see Table B3-6).

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

Total cations (µeq/g) = $[Na^+]/23.0 + [K^+]/39.1 =$ 6,213 µeq/g

Total anions (µeq/g) = $[Cl-]/35.5 + [NO_2^-]/46.0 + [NO_3^-]/62.0 + [PO_4^{-3}]/31.7 + [CO_3^{-2}]/30 =$ 6,477 µeq/g.

The solids charge balance, obtained by dividing the sum of the positive charge by the sum of the negative charge, was0.85.

Table B3-4. Cation Mass and Charge Data for Liquids.

Analyte	Concentration (µg/g)	Assumed Species	Concentration of Assumed Species (µg/g)	Charge (µeq/g)
Na	1.41E+05	Na^+	1.41E+05	6,150
K	1,970	K^+	1,970	50
Totals			1.43E+05	6,200

Table B3-5. Anion Mass and Charge Data for Liquids.

Analyte	Concentration (µg/g)	Charge (µeq/g)
AlO_2^-	4,810	81.5
Cl^-	6,880	194
NO_2^-	65,000	1,410
NO_3^-	2.45E+05	3,950
CO_3^-	43,100	1,435
PO_4^{-3}	3,900	123
Totals	3.69E+05	7,257

Table B3-6. Mass and Charge Balance Totals Liquids.

Totals	Concentrations (µg/g)	Charge (µeq/ml)
Total from Table B3-4 (cations)	1.43E+05	+6,213
Total from Table B3-5 (anions)	3.69E+05	-7,257
Percent water	51.9%	n/a
Totals	103%	0.85 ratio

B3.4 MEAN CONCENTRATIONS AND CONFIDENCE INTERVALS

B3.4.1 Solid Data

A nested analysis of variance (ANOVA) model was fit to the core segment data. Mean values, and 95 percent confidence intervals on the mean, were determined from the ANOVA (Table B3-7). Four variance components were used in the calculations. The variance components represent concentration differences between risers, segments, laboratory samples, and analytical replicates. The model is:

$$Y_{ijk} = \mu + R_i + S_{ij} + L_{ijk} + A_{ijkm},$$

$$i = 1,2,\ldots,a;\ j = 1,2,\ldots,b_i;\ k = 1,2,\ldots,c_{ij};\ m = 1,2,\ldots,n_{ijk}$$

where

Y_{ijkm}	=	concentration from the m^{th} analytical result of the k^{th} sample of the j^{th} segment of the i^{th} riser
μ	=	the mean
R_i	=	the effect of the i^{th} riser
S_{ij}	=	the effect of the j^{th} segment from the i^{th} riser
L_{ijk}	=	the effect of the k^{th} sample from the j^{th} segment of the i^{th} riser
A_{ijkm}	=	the analytical error
a	=	the number of risers
b_i	=	the number of segments from the i^{th} riser
c_{ij}	=	the number of samples from the j^{th} segment of the i^{th} riser
n_{ijk}	=	the number of analytical results from the ijk^{th} sample.

The variables R_i, S_{ij}, and L_{ijk} are random effects. These variables, as well as A_{ijkm}, are assumed to be uncorrelated and normally distributed with means zero and variances $\sigma^2(R)$, $\sigma^2(S)$, $\sigma^2(L)$ and $\sigma^2(A)$, respectively.

The restricted maximum likelihood (REML) method was used to estimate the mean concentration and standard deviation of the mean for all analytes that had 50 percent or more of their reported values greater than the detection limit. The mean value and standard deviation of the mean were used to calculate the 95 percent confidence intervals. The following table gives the mean, degrees of freedom, and confidence interval for each constituent.

Some analytes had results that were below the detection limit. In these cases, the value of the detection limit was used for nondetected results. For analytes with a majority of results below the detection limit, a simple average is all that is reported. Using the detection limit in the computation of the mean value may bias the mean high.

The lower and upper limits, LL(95%) and UL(95%), of a two-sided 95 percent confidence interval on the mean were calculated using the following equation:

$$LL(95\%) = \hat{\mu} - t_{(df,\ 0.025)} \times \hat{\sigma}(\hat{\mu}),$$
$$UL(95\%) = \hat{\mu} + t_{(df,\ 0.025)} \times \hat{\sigma}(\hat{\mu}).$$

In this equation, $\hat{\mu}$ is the REML estimate of the mean concentration, $\hat{\sigma}(\hat{\mu})$ is the REML estimate of the standard deviation of the mean, and $t_{(df,\ 0.025)}$ is the quantile from Student's t distribution with df degrees of freedom. The degrees of freedom equals the number of risers with data minus one. In cases where the lower limit of the confidence interval was negative, it is reported as zero.

Table B3-7. Tank 241-TX-104 95 Percent Two-Sided Confidence Interval for the Mean Concentration for Solid Data. (2 sheets)

Analyte	Method	Mean	df	LL	UL	Units
Aluminum	ICP:A	93,200	1	0.00	6.69E+05	µg/g
Antimony*	ICP:A	<34.2	n/a	n/a	n/a	µg/g
Arsenic*	ICP:A	<56.9	n/a	n/a	n/a	µg/g
Barium*	ICP:A	<28.5	n/a	n/a	n/a	µg/g
Beryllium*	ICP:A	<2.85	n/a	n/a	n/a	µg/g
Bismuth*	ICP:A	<110	n/a	n/a	n/a	µg/g
Boron	ICP:A	<101	1	0.00	485	µg/g
Bromide*	IC:W	<852	n/a	n/a	n/a	µg/g
Cadmium*	ICP:A	<4.03	n/a	n/a	n/a	µg/g
Calcium	ICP:A	347	1	0.00	1,130	µg/g
Cerium*	ICP:A	<56.9	n/a	n/a	n/a	µg/g
Chloride	IC:W	1,980	1	0.00	10,400	µg/g
Chromium	ICP:A	2,200	1	0.00	9,010	µg/g
Cobalt*	ICP:A	<11.4	n/a	n/a	n/a	µg/g
Copper*	ICP:A	9.75	1	0.00	40.3	µg/g
Fluoride*	IC:W	1,750	1	0.00	11,200	µg/g
Gross alpha	Alpha:F	0.309	1	0.00	2.07	µCi/g
Iron	ICP:A	1,980	1	0.00	9,270	µg/g
Lanthanum*	ICP:A	<28.5	n/a	n/a	n/a	µg/g
Lead*	ICP:A	<77.5	n/a	n/a	n/a	µg/g
Lithium*	ICP:A	<5.69	n/a	n/a	n/a	µg/g
Magnesium*	ICP:A	136	1	0.00	832	µg/g
Manganese	ICP:A	425	1	0.00	3,440	µg/g
Molybdenum*	ICP:A	<30.5	n/a	n/a	n/a	µg/g
Neodymium*	ICP:A	<56.9	n/a	n/a	n/a	µg/g
Nickel*	ICP:A	<12.3	n/a	n/a	n/a	µg/g
Nitrate	IC:W	2.64E+05	1	0.00	9.10E+05	µg/g
Nitrite	IC:W	18,600	1	0.00	97,900	µg/g
Oxalate*	IC:W	2,710	1	0.00	14,500	µg/g
Percent Water	DSC/TGA	45.5	1	0.00	98.8	%

Table B3-7. Tank 241-TX-104 95 Percent Two-Sided Confidence Interval for the Mean Concentration for Solid Data. (2 sheets)

Analyte	Method	Mean	df	LL	UL	Units
Phosphate	IC:W	18,100	1	0.00	1.06E+05	µg/g
Phosphorus	ICP:A	5,040	1	0.00	28,000	µg/g
Potassium*	ICP:A	814	1	0.00	3,580	µg/g
Samarium*	ICP:A	<56.9	n/a	n/a	n/a	µg/g
Selenium*	ICP:A	79.3	1	0.00	350	µg/g
Silicon	ICP:A	314	1	0.00	1,680	µg/g
Silver*	ICP:A	12.6	1	0.00	55.9	µg/g
Sodium	ICP:A	1.24E+05	1	0.00	4.59E+05	µg/g
Strontium*	ICP:A	<5.69	n/a	n/a	n/a	µg/g
Sulfate*	IC:W	<1,010	n/a	n/a	n/a	µg/g
Sulfur	ICP:A	412	1	0.00	1,850	µg/g
Thallium*	ICP:A	<114	n/a	n/a	n/a	µg/g
Titanium*	ICP:A	26.4	1	0.00	281	µg/g
Total inorganic carbon	TIC/TOC	4,700	1	0.00	19,900	µg/g
Total organic carbon	TIC/TOC	1,210	1	0.00	n/a	µg/g
Uranium*	ICP:A	<827	n/a	n/a	n/a	µg/g
Vanadium*	ICP:A	<28.5	n/a	n/a	n/a	µg/g
Zinc	ICP:A	47.6	1	0.00	403	µg/g
Zirconium*	ICP:A	16.4	1	0.00	124	µg/g

Notes:

*A "less than" value was used in the calculation.

A = acid digest
F = fusion
W = water digest

B3.4.2 Liquid Data

The model fit to the liquid data was a nested ANOVA model. The model determined the mean value, and 95 percent confidence interval, for each constituent (Table B3-8). Two variance components were used in the calculations. The variance components represent concentration differences between samples taken from different risers, and between analytical replicates. The model is:

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

$i=1,2,\ldots,a;\ j=1,2,\ldots,n_i;$

where

Y_{ijk} = concentration from the k^th^ analytical result of the j^th^ sample from the i^th^ segment

μ = the mean

R_i = the effect of the i^th^ riser

A_{ij} = the analytical error

a = the number of segments

n_i = the number of analytical results from the i^th^ riser.

The variable R_i is a random effect. This variable, along with A_{ij}, is assumed to be uncorrelated and normally distributed with means zero and variances $\sigma^2(R)$ and $\sigma^2(A)$, respectively. The df associated with the standard deviation of the mean is the number of risers with data minus one.

Table B3-8. Tank 241-TX-104 95 Percent Two-Sided Confidence Interval for the Mean Concentration for Liquid Data. (2 sheets)

Analyte	Method	Mean	*df*	LL	UL	Units
Aluminum	ICP	3,190	1	1,360	5,010	µg/mL
Antimony*	ICP	<36.1	n/a	n/a	n/a	µg/mL
Arsenic*	ICP	<60.1	n/a	n/a	n/a	µg/mL
Barium*	ICP	<30.1	n/a	n/a	n/a	µg/mL
Beryllium*	ICP	<3.00	n/a	n/a	n/a	µg/mL
Bismuth*	ICP	<60.1	n/a	n/a	n/a	µg/mL
Boron	ICP	49.5	1	26.1	72.8	µg/mL
Bromide*	IC	<1,290	n/a	n/a	n/a	µg/mL
Cadmium*	ICP	<3.00	n/a	n/a	n/a	µg/mL
Calcium*	ICP	<61.6	n/a	n/a	n/a	µg/mL
Cerium*	ICP	<60.1	n/a	n/a	n/a	µg/mL
Chloride	IC	9,980	1	0.00	39,700	µg/mL
Chromium	ICP	3,560	1	1,550	5,570	µg/mL
Cobalt*	ICP	<12.0	n/a	n/a	n/a	µg/mL
Copper*	ICP	<6.01	n/a	n/a	n/a	µg/mL
Fluoride*	IC	<136	n/a	n/a	n/a	µg/mL
Gross alpha	Alpha Rad	1.27	1	0.00	17.2	µCi/mL

Table B3-8. Tank 241-TX-104 95 Percent Two-Sided Confidence Interval for the Mean Concentration for Liquid Data. (2 sheets)

Analyte	Method	Mean	*df*	LL	UL	Units
Iron*	ICP	<85.4	n/a	n/a	n/a	µg/mL
Lanthanum*	ICP	<30.1	n/a	n/a	n/a	µg/mL
Lead*	ICP	<60.1	n/a	n/a	n/a	µg/mL
Lithium*	ICP	<6.01	n/a	n/a	n/a	µg/mL
Magnesium*	ICP	<60.1	n/a	n/a	n/a	µg/mL
Manganese*	ICP	<31.7	n/a	n/a	n/a	µg/mL
Molybdenum	ICP	63.9	1	5.02	77.5	µg/mL
Neodymium*	ICP	<60.1	n/a	n/a	n/a	µg/mL
Nickel*	ICP	<12.0	n/a	n/a	n/a	µg/mL
Nitrate	IC	3.55E+05	1	0.00	1.28E+06	µg/mL
Nitrite	IC	94,200	1	0.00	3.81E+05	µg/mL
Oxalate*	IC	<1,230	n/a	n/a	n/a	µg/mL
Percent Water	DSC/TGA	51.9	1	41.2	62.6	%
Phosphate	IC	5,660	1	0.00	22,500	µg/mL
Phosphorus	ICP	1,210	1	925	1,500	µg/mL
Potassium	ICP	2,850	1	1,700	4,000	µg/mL
Samarium*	ICP	<60.1	n/a	n/a	n/a	µg/mL
Silicon	ICP	72.4	1	0.00	175	µg/mL
Silver	ICP	14.8	1	12.2	17.4	µg/mL
Sodium	ICP	2.05E+05	1	1.74E+05	2.36E+05	µg/mL
Strontium*	ICP	<6.01	n/a	n/a	n/a	µg/mL
Sulfate*	IC	4,290	1	0.00	22,500	µg/mL
Sulfur	ICP	1,430	1	1,120	1,750	µg/mL
Thallium*	ICP	<120	n/a	n/a	n/a	µg/mL
Titanium*	ICP	<6.01	n/a	n/a	n/a	µg/mL
Total inorganic carbon	TIC/TOC	12,500	1	6,700	18,300	µg/mL
Total organic carbon	TIC/TOC	1,360	1	880	1,830	µg/mL
Uranium*	ICP	<300	n/a	n/a	n/a	µg/mL
Vanadium*	ICP	<30.1	n/a	n/a	n/a	µg/mL
Zinc*	ICP	<6.01	n/a	n/a	n/a	µg/mL
Zirconium*	ICP	<6.15	n/a	n/a	n/a	µg/mL

Note:

* A "less than" value was used in the calculation.

B4.0 APPENDIX B REFERENCES

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

Dukelow, G. T., J. W. Hunt, H. Babad, and J. E. Meacham, 1995, *Tank Safety Screening Data Quality Objective*, WHC-SD-WM-SP-004, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

Duchsherer, M. J., E. S. Mast, L. A. Pingel, M. Stauffer, R. S. Viswanath, D. B. Bonfoey, G. A. Fies, C. V. Dormant, 1997, *Tank Vapor Sampling and Analysis Package for Tank 241-TX-104, Sampled May 5, 1997*, HNF-SD-WM-DP-281, Rev. 0, Numatec Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

McCain, D. J., 1997, *Tank 241-TX-104 Push Core Sampling and Analysis Plan*, HNF-SD-WM-TSAP-151, Rev. 0, Lockheed Martin Hanford Corp. for FluorDaniel Hanford, Inc., Richland, Washington.

Meacham, J. E., D. L. Banning, M. R. Allen, and L. D. Muhlestein, 1997, *Data Quality Objective to Support Resolution of the Organic Solvent Safety Issue*, HNF-SD-WM-DQO-026, Rev. 0, Duke Engineering and Services Hanford, Inc. for Fluor Daniel Hanford, Inc., Richland, Washington.

Osborne, J. W., and L. L. Buckley, 1995, *Data Quality Objectives for Tank Hazardous Vapor Safety Screening*, WHC-SD-WM-DQO-002, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

Schreiber, R. D., 1997, *Memorandum of Understanding for the Organic Complexant Safety Issue Data Requirements*, HNF-SD-WM-RD-060, Rev. 0, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

Steen, F. H., 1998, *Tank 241-TX-104, Cores 230 and 231 Analytical Results for the Final Report*, HNF-SD-WM-DP-305, Rev. 0, Waste Management Federal Services of Hanford Inc., Richland, Washington.

WHC, 1992, *Safety Department Administration Manual*, WHC-IP-0030, Westinghouse Hanford Company, Richland, Washington.

APPENDIX C

STATISTICAL ANALYSIS FOR ISSUE RESOLUTION

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APPENDIX C

STATISTICAL ANALYSIS FOR ISSUE RESOLUTION

Appendix C documents the results of the analyses and statistical and numerical manipulations required by the DQOs applicable to tank 241-TX-104. The analyses required for tank 241-TX-104 are reported as follows:

- **Section C1.0**: Statistical analysis and numerical manipulations supporting the safety screening DQO (Dukelow et al. 1995).
- **Section C2.0**: Appendix C References.

C1.0 STATISTICS FOR THE SAFETY SCREENING DATA QUALITY OBJECTIVE

The safety screening DQO (Dukelow et al. 1995) defines decision limits in terms of one-sided 95 percent confidence intervals. The safety screening DQO limits are 30.0 µCi/g for total alpha activity and 480 J/g for dry weight DSC. Confidence intervals were calculated for the mean values from each laboratory sample. Table C1-1 shows the total Alpha activity results. Because none of the 22 DSC results had an exothermic reaction, no upper limits for DSC were calculated.

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

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

In this equation, $\hat{\mu}$ is the arithmetic mean of the data, $\hat{\sigma}_{\mu}$ 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. The degrees of freedom equals the number of samples minus one.

For sample numbers with at least one value above the detection limit, the upper limit of a 95 percent confidence interval is given in Table C1-1. Each confidence interval can be used to make the following statement. If the upper limit is less than 30.0 µCi/g (61.5 µCi/mL for drainable liquid), then one would reject the null hypothesis that the alpha is greater than or equal to 30.0 µCi/g (61.5 µCi/mL for drainable liquid) at the 0.05 level of significance.

All 22 of the total alpha activity results were above the detection limit. The UL closest to the threshold was 2.70 µCi/g for core 230, segment 1. This is well below the limit of 30.0 µCi/g. For drainable liquid, the maximum total alpha activity was 6.28 with a UL of 10.2 for core 231, segment 1. This is below the limit of 61.5 µCi/mL.

Table C1-1. 95 Percent Upper Confidence Limits for Gross Alpha.

Lab Sample ID	Description	$\hat{\mu}$	df	UL	Units
S98T000665	Core 230, segment 1	7.20E-03	1	8.08E-03	µCi/mL
S98T000666	Core 230, segment 2	3.70E-02	1	8.09E-02	µCi/mL
S98T000672F	Core 230, segment 1, lower half	9.41E-01	1	2.70E+00	µCi/g
S98T000678F	Core 230, segment 2, lower half	3.73E-02	1	4.05E-02	µCi/g
S98T000679F	Core 230, segment 2A lower half	2.85E-02	1	4.11E-02	µCi/g
S98T000749F	Core 231, segment 1, lower half	3.96E-01	1	4.02E-01	µCi/g
S98T000750F	Core 231, segment 2, lower half	2.71E-01	1	4.04E-01	µCi/g
S98T000751F	Core 231, segment 2A lower half	1.79E-01	1	2.17E-01	µCi/g
S98T000761	Core 231, segment 1	6.28E+00	1	1.02E+01	µCi/mL

C2.0 APPENDIX C REFERENCES

Dukelow, G. T., J. W. Hunt, H. Babad, and J. E. Meacham, 1995, *Tank Safety Screening Data Quality Objective*, WHC-SD-WM-SP-004, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

APPENDIX D

EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR SINGLE-SHELL TANK 241-TX-104

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APPENDIX D

EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR SINGLE-SHELL TANK 241-TX-104

An effort is underway to provide waste inventory estimates that will serve as standard characterization source terms for the various waste management activities (Hodgson and LeClair 1996). As part of this effort, an evaluation of available information for single-shell tank 241-TX-104 was performed, and a best-basis inventory was established. This work follows the methodology established by the standard inventory task.

D1.0 CHEMICAL INFORMATION SOURCES

Available waste (chemical) information for tank 241-TX-104 includes the following:

- Tank 241-TX-104 core samples obtained February 1998, and
- Hanford Defined Waste (HDW) model document (Agnew et al. 1997a) tank content estimates in terms of component concentrations and inventories.

D2.0 COMPARISON OF COMPONENT INVENTORY VALUES

The tank 241-TX-104 chemical and radionuclide inventories predicted from the HDW model estimates (Agnew et al. 1997a) and previous best-basis estimates are shown in Tables D2-1 and D2-2. The chemical species are reported without charge designation according to the best-basis inventory convention. Only ^{90}Sr and ^{137}Cs radionuclide isotopes are shown in Table D2-2 because all other isotope values in the previous bestbasis were based on the HDW model.

Because samples were not obtained from tank 241-TX-104 until February 1998, the previous best-basis estimates were based on sample data from tanks expected to contain similar waste types. The saltcake layer was assumed to be similar to waste from tanks 241-U-102 (Hu et al. 1997), tank 241-U-105 (Brown and Franklin 1996) and tank 241-TX-116 (Horton 1977), with a density of 1.7 g/mL. The sludge layer was assumed to be similar to waste in tanks 241-S-101 (Kruger et al. 1996), 241-S-104 (DiCenso et al. 1994) and 241-S-107 (Simpson et al. 1996) with a sludge density of 1.77 g/mL. Agnew et al. (1997a) reports tank 241-TX-104 to contain 68.1 kL (18 kgal) of metal waste sludge and 174 kL (46 kgal) of saltcake from the 242-T Evaporator. Both the HDW and previous best-basis inventory calculations are based on a total tank volume of 246 kL (65 kgal). The HDW model is based on a density of 1.5 g/mL.

Table D2-1. Comparison of Inventory Estimates for Nonradioactive Components in Tank 241-TX-104.

Analyte	HDW[1] Inventory Estimate (kg)	Previous Best Basis Estimate[2] (kg)
Al	5,140	20,400
Bi	61.8	61.8
Ca	432	122
Cl	1,180	1,870
Cr	777	629
F	276	597
Fe	534	418
Hg	0.338	0
K	337	566
La	2.03E-05	0
Mn	20.8	232
Na	49,700	75,500
Ni	58.0	42
NO_2	12,600	13,000
NO_3	44,900	1.08E+05
OH_{TOTAL}	31,300	46,300
Pb	32.5	36.5
PO_4	4,120	2,530
Si	296	202
SO_4	4,100	5,110
Sr	0	52.6
TIC as CO_3	11,600	16,900
TOC	1,940	2,990
U_{TOTAL}	28,700	1,040
Zr	5.78	5.78

Notes:

[1]Agnew et al. (1997a)
[2]Effective January 31, 1997 (LMHC 1998), based on U, TX, and S farm tanks expected to contain similar waste types.

Table D2-2. Comparison of Inventory Estimates for Selected Radioactive Components in Tank 241-TX-104.

Analyte	HDW[1] Inventory Estimate (Ci)	Previous Best Basis Estimate[2] (Ci)
^{90}Sr	14,900	34,700
^{137}Cs	40,600	43,000

Notes:

[1]Agnew et al. (1997a), decayed to January 1, 1994.

[2]Effective January 31, 1997 (LMHC 1998), based on U, TX, and S farm tanks expected to contain similar waste types.

D3.0 COMPONENT INVENTORY EVALUATION

D3.1 WASTE HISTORY

Tank 241-TX-104 began receiving metal waste (MW) in November 1950. The tank contained MW until the fourth quarter of 1956 when the tank was declared empty (Rodenhizer 1987). The tank received REDOX waste between 1957 and 1973. According to Anderson (1990), this tank was essentially full of high-level R waste from 1963 until 1971. At that point, 1,995 kL (527 kgal) of waste was transferred to tank 241-TX-101. Anderson notes that the tank contained 68.1 kL (18 kgal) of solids after the transfer.

From 1973 until 1975, the tank received B Plant low-level wastes, PUREX organic wash waste, REDOX ion exchange waste, REDOX waste, and tributyl phosphate waste. The tank received evaporator bottoms from the 242-T Evaporator in 1976 and 1977 (Agnew et al. 1997b). The tank was labeled inactive in 1977. The supernatant was pumped and the tank was interim stabilized in September 1979, with intrusion prevention completed in August 1984. The tank is classified as a sound, stabilized tank. For a more complete history of the waste in this tank, refer to the supporting document (Brevick et al. 1997).

D3.2 CONTRIBUTING WASTE TYPES

Expected waste types in tank 241-TX-104, based on the various source documents, are as follows:

Agnew et al. (1997a): SMMT2 and MW
Hanlon (1998): saltcake
Hill et al.(1995): R, EB, and MIX

SMMT2 = a mixture of concentrated supernatant coming from the 242-T Evaporator.
EB = evaporator bottoms
MIX = mixture of several miscellaneous wastes.

The three references list the waste volume in tank 241-TX-104 as 246 kL (65 kgal). Hanlon (1998) and Hill et al. (1998) identify the waste as saltcake. Agnew et al. (1997a) separates the waste into a 68.1-kL (18-kgal) sludge layer and a 174-kL (46-kgal) SMMT2 saltcake layer with 3.8 kL (1 kgal) of supernatant. Agnew et al. (1997a) identifies the sludge layer as "unknown" but assigns it as MW. However, a review of the information in Anderson (1990) suggests that it may be more appropriate to assign the waste type as R rather than MW.

The previous best-basis inventory assumed there was no supernatant, sample results indicate that the tank contains approximately 5.1 cm (2 in.) of supernatant and more drainable liquid than predicted by Hanlon (1998).

D3.3 ASSUMPTIONS USED

An engineering evaluation based on tank 241-TX-104 sample results was conducted to predict tank contents and compare results with the previous best basis and HDW model results. The engineering evaluation assumes the following:

The total tank volume listed in Hanlon (1998) of 246 kL (65 kgal) is used.

The liquid and solids volumes used to calculate analyte inventories are specified in Section D3.4. The average solids analytical mean density was 1.82 g/mL and specific gravity of the liquids was 1.45.

All radionuclide data were corrected to January 1, 1994.

D3.4 BASIS FOR CALCULATIONS USED IN THIS ENGINEERING EVALUATION

Tank samples showed a heterogeneous mixture of sludge and saltcake in the segments analyzed. As a result, no attempt was made in this inventory evaluation to determine the relative proportions of sludge and saltcake in the samples or to compare analytical results with other tank results. Total inventory results were based on the mean solids analytical result for all segments (see Section B3.4) multiplied by the total estimated solids volume and the mean drainable liquid results multiplied by the estimated liquid volume. The methodology used is shown in Table D3-1.

Based on sample stroke lengths and percent recovery (see Table 1-1), samples were representative of only the top 61 percent of the tank waste or 151 kL (40 kgal). The mass of solid and drainable liquid in the samples was 708 g solid and 622 g liquid. For a mean solids density of 1.82 g/mL and mean specific gravity of 1.45, this equates to 389 mL solid (48 percent) and 429 mL liquid (52 percent). Therefore, the volume of tank solids represented by the samples was 72 kL (19 kgal) and the volume of drainable liquids was 79.5 kL (21 kgal). Assuming the waste not represented by the samples (95 kL [25 kgal]) contains no drainable liquid, the total volume of solids in the tank is 167 kL (44 kgal).

Field sampling results indicated that the top 5 cm (2 in.) or 20.8 kL (5.5 kgal) of waste in tank 241-TX-104 is supernatant. Therefore, the volume of drainable interstitial liquid is estimated to be 58.7 kL (15.5 kgal). The supernatant and interstitial drainable liquid are combined to calculate liquid inventories.

Uranium isotope values are based on total uranium sample results ratioed to HDW model isotope values. Alpha isotope values are based on total alpha sample results ratioed to HDW model isotope values. Total alpha analysis was the only radioactivity analysis conducted for tank 241-TX-104 samples.

The HDW model values were used as the best-basis inventory for radionuclides when sample results were not available. Engineering based values were not used because the solids recovered were a mixture of saltcake and sludge. It would appear that the tank contains more sludge than shown in Hanlon (1998), but a specific volume could not be determined.

Measured drainable liquid and solids concentrations and inventory calculations are presented in Table D3-2. Hanford Defined Waste model inventory values are also shown for comparison.

Table D3-1. Inventory Calculations for Tank 241-TX-104.

Type of Waste	How Calculated
Supernatant/drainable liquid	Multiplied mean drainable liquid sample concentrations (see Section B3.4) by a volume of 79 kL (21 kgal).
Saltcake and sludge	Multiplied mean solids sample concentrations (see Section B3.4) by an average density of 1.82 g/mL and solids volume of 167 kL (44 kgal).

Table D3-2. Anion Mass and Charge Data for Solids .

Component	Solids (µg/g)[1]	Solids (kg)[2]	Liquids (µg/mL)[1]	Liquids (kg)[3]	Total (kg)	HDW Model (kg)
Al	93,200	28,300	3,190	252	28,600	5,140
Bi	<110	33.4	<60.1	4.75	38.2	61.8
Ca	347	105	<61.6	4.87	110	432
Cl	1,980	602	9,980	788.4	1,390	1,180
TIC as CO_3	23,500	7,140	62,500	4,940	11,900	11,600
Cr	2,200	669	3,560	281	950	777
F	1,750	532	<136	10.7	543	276
Fe	1,980	602	<85.4	6.75	609	534
K	814	247	2,850	225	473	337
La	<28.5	8.66	<30.1	2.38	11.0	0
Mn	425	129	<31.7	2.50	132	20.8
Na	1.24E+05	37,700	2.05E+05	16,200	53,900	49,700
Ni	<12.3	3.74	<12.0	0.948	4.69	58.0
NO_2	18,600	5,650	94,200	7,440	13,100	12,600
NO_3	2.64E+05	80,200	3.55E+05	28,000	1.08E+05	44,900
Pb	<77.5	23.6	<60.1	4.75	28.3	32.5
PO_4	18,100	5,500	5,660	447	5,950	4,120
Si	314	95.4	72.4	5.72	101	296
SO_4	1,236	375	4,290	339	715	4,100
Sr	<5.69	1.73	<6.01	0.475	2.20	0
TOC	1,210	368	1,360	107	475	1,940
U	<827	251	<300	23.7	275	28,700
Zr	16.4	5.31	<6.15	0.486	5.47	5.78
Total alpha	0.31	94.2	1.27	100	195	

Notes:

[1]Mean sample value (see Section B3.4)
[2]Based on a volume of 178 kL and density of 1.82 g/mL
[3]Based on a volume of 68 kL

D3.5 DOCUMENT ELEMENT BASIS

This section compares inventory estimates derived from sample data to the inventory estimates calculated by the HDW model. Once the best-basis inventories were determined, the hydroxide inventory was calculated by performing a charge balance with the valences of other analytes. This charge balance approach is consistent with that used by Agnew et al. (1997a).

In general, good correlation was observed between the HDW model estimates and sample-based inventory. The following exceptions were noted.

Aluminum. The sample-based inventory was approximately six times larger than the HDW model estimate for aluminum. This difference may be attributed to the HDW model assuming that the sludge layer is MW which contains no aluminum. The higher aluminum concentrations support the assumption that the sludge is high-level REDOX waste from 1952 to 1957 (R1) rather than MW.

Uranium. The sample-based inventory for uranium was approximately 100 times smaller than the HDW model estimate. Uranium is typically much greater in MW waste (~ 248,000 ppm) than in R1 waste (~200 ppm). Again, the difference is attributed to the assumption in the HDW model that the sludge is MW.

Calcium. The sample-based inventory was approximately five times smaller than the HDW model estimate for calcium. The calcium inventory in the HDW model estimate is frequently high in other tanks also, and the difference is attributed to blending assumptions made in the SMM.

Nitrate. The sample-based inventory for nitrate was approximately two and a half times larger than the HDW model estimate. This difference is because the HDW assumes that the sludge is MW waste.

Sulfate. The sample-based inventory for sulfate was approximately seven times lower than the HDW model estimate. This difference is consistent with assumptions that the sludge is MW.

Total Organic Carbon. The sample-based inventory for TOC was approximately four times smaller than the HDW model estimate. Neither MW nor R1 waste is expected to contain TOC analytes. Therefore, the difference is attributed to blending assumptions made in the SMM.

D4.0 DEFINE THE BEST BASIS AND ESTABLISH COMPONENT INVENTORIES

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

Chemical and radiological inventory information is generally derived using three approaches: 1) component inventories are estimated using the results of sample analyses, 2) component inventories are predicted using the HDW model based on process knowledge and historical information, or 3) a tank-specific process estimate is made based on process flowsheets, reactor fuel data, essential material usage, and other operating data.

An effort is underway to provide waste inventory estimates that will serve as standard characterization source terms for the various waste management activities (Hodgson and LeClair 1996). As part of this effort, an evaluation of chemical information for tank 241-TX-104 was performed, and a best-basis inventory was established. This work, follows the methodology established by the standard inventory task. The following information was used in the evaluation:

- Analytical results for two 1998 push mode core samples
- Tank waste photographs
- Inventory estimates generated by the HDW model (Agnew et al. 1997a).

Based on this evaluation, a best-basis inventory was developed for tank 241-TX-104. The sampling-based inventory was chosen as the best basis for those analytes for which analytical values were available. The HDW model results were used if no sample based information was available.

Best-basis tank inventory values are derived for 46 key radionuclides (as defined in Section 3.1 of Kupfer et al. 1998), all decayed to a common report date of January 1, 1994. Often, waste sample analyses have only reported ^{90}Sr, ^{137}Cs, $^{239/240}$Pu, and total uranium (or total beta and total alpha), while other key radionuclides such as ^{60}Co, ^{99}Tc, ^{129}I, ^{154}Eu, ^{155}Eu, and ^{241}Am have been infrequently reported. For this reason it has been necessary to derive most of the 46 key radionuclides by computer models. These models estimate radionuclide activity in batches of reactor fuel, account for the split of radionuclides to various separations plant waste streams, and track their movement with tank waste transactions. These computer models are described in Kupfer et al. (1998), Section 6.1 and in Watrous and Wootan (1997). Model-generated values for radionuclides in any of the 177 Hanford Site tanks are reported in the HDW Rev. 4 model results (Agnew et al. 1997a). The best-basis value for any one analyte may be either a model result or a sample-or engineering assessment-based result, if available.

The best-basis inventory estimate for tank 241-TX-104 is presented in Tables D4-1 and D4-2. Mercury values were specified in Simpson (1998).

The inventory values reported in Tables D4-1 and D4-2 are subject to change. Refer to the Tank Characterization Database (TCD) (LMHC 1998) for the most current inventory values.

Table D4-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-TX-104. (Effective December 1, 1998)

Analyte	Total Inventory (kg)	Basis (S, M, E, or C)[1]	Comment
Al	28,600	S	
Bi	38.2	S/E	Upper bounding estimate
Ca	110	S	
Cl	1,390	S	
TIC as CO_3	12,100	S	
Cr	950	S	
F	543	S	
Fe	609	S	
Hg	0	E	Simpson (1998)
K	473	S	
La	11.0	S/E	Upper bounding estimate
Mn	132	S	
Na	53,900	S	
Ni	4.69	S/E	Upper bounding estimate
NO_2	13,100	S	
NO_3	1.08E+05	S	
OH_{TOTAL}	49,800	C	Charge balance calculation
Pb	28.3	S/E	Upper bounding estimate
PO_4	5,950	S	Based on IC
Si	101	S/E	Upper bounding estimate
SO_4	715	S	Based on ICP
Sr	2.2	S/E	Upper bounding estimate
TOC	475	S	
U_{TOTAL}	275	S/E	Upper bounding estimate
Zr	5.47	S	

Notes:

[1]S = sample-based (see Appendix B), M = HDW model-based, Agnew et al. (1997a), E = engineering assessment-based, and C = calculated by charge balance; includes oxides as hydroxides, not including CO_3, NO_2, NO_3, PO_4, SO_4, and SiO_3.

Table D4-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-TX-104 Decayed to January 1, 1994. (Effective December 1, 1998). (2 sheets)

Analyte	Total Inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{3}H	27.5	M	
^{14}C	4.01	M	
^{59}Ni	0.292	M	
^{60}Co	4.33	M	
^{63}Ni	28.6	M	
^{79}Se	0.429	M	
^{90}Sr	14,900	M	
^{90}Y	14,900	M	
^{93}Zr	2.11	M	
^{93m}Nb	1.53	M	
^{99}Tc	27.4	M	
^{106}Ru	8.52E-04	M	
^{113m}Cd	10.9	M	
^{125}Sb	18.9	M	
^{126}Sn	0.648	M	
^{129}I	0.0528	M	
^{134}Cs	0.493	M	
^{137}Cs	40,600	M	
^{137m}Ba	38,400	M	
^{151}Sm	1,510	M	
^{152}Eu	0.566	M	
^{154}Eu	74.5	M	
^{155}Eu	34.3	M	
^{226}Ra	2.90E-05	M	
^{227}Ac	1.50E-04	M	
^{228}Ra	0.0293	M	
^{229}Th	6.79E-04	M	
^{231}Pa	5.87E-04	M	
^{232}Th	0.00180	M	
^{232}U	0.00141	S/E/M	Based on total uranium and HDW model isotopic distribution.
^{233}U	0.00539	S/E/M	Based on total uranium and HDW model isotopic distribution.
^{234}U	0.0908	S/E/M	Based on total uranium and HDW model isotopic distribution.

Table D4-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-TX-104 Decayed to January 1, 1994. (Effective December 1, 1998). (2 sheets)

Analyte	Total Inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{235}U	0.00408	S/E/M	Based on total uranium and HDW model isotopic distribution.
^{236}U	6.10E-04	S/E/M	Based on total uranium and HDW model isotopic distribution.
^{237}Np	0.0988	M	
^{238}Pu	2.25	S/M	Based on total alpha and HDW model isotopic distribution.
^{238}U	0.0918	S/E/M	Based on total uranium and HDW model isotopic distribution.
^{239}Pu	81.2	S/M	Based on total alpha and HDW model isotopic distribution.
^{240}Pu	13.4	S/M	Based on total alpha and HDW model isotopic distribution.
^{241}Am	97.0	S/M	Based on total alpha and HDW model isotopic distribution.
^{241}Pu	150	S/M	Based on total alpha and HDW model isotopic distribution.
^{242}Cm	0.269	S/M	Based on total alpha and HDW model isotopic distribution.
^{242}Pu	8.27E-04	S/M	Based on total alpha and HDW model isotopic distribution.
^{243}Am	0.00345	S/M	Based on total alpha and HDW model isotopic distribution.
^{243}Cm	0.0248	S/M	Based on total alpha and HDW model isotopic distribution.
^{244}Cm	0.223	S/M	Based on total alpha and HDW model isotopic distribution.

Notes:

[1]S = sample-based, M = HDW model-based (Agnew et al. 1997a), and E = engineering assessment-based.

D5.0 APPENDIX D REFERENCES

Agnew, S. F., J. Boyer, R. A. Corbin, T. B. Duran, J. R. Fitzpatrick, K. A. Jurgensen, T. P. Ortiz, and B. L. Young, 1997a, *Hanford Tank Chemical and Radionuclide Inventories: HDW Model Rev. 4*, LA-UR-96-3860, Los Alamos National Laboratory, Los Alamos, New Mexico.

Agnew, S. F., R. A. Corbin, T. B. Duran, K. A. Jurgensen, T. P. Ortiz, and B. L. Young, 1997b, *Waste Status and Transaction Record Summary (WSTRS Rev. 4)*, LA-UR-97-311, Los Alamos National Laboratory, Los Alamos, New Mexico.

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

Brevick, C. H., 1997, *Supporting Document for the Historical Tank Content Estimate for TX Tank Farm*, HNF-SD-WM-ER-321, Rev. 1, Fluor Daniel Northwest, Inc. for Fluor Daniel Hanford, Inc., Richland, Washington.

Brown, T. D., and J. D. Franklin, 1996, *Tank Characterization Report for Single-Shell Tank 241-U-105*, WHC-SD-WM-ER-617, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

DiCenso, A. T., L. C. Amato, J. D. Franklin, G. L. Nuttall, K. W. Johnson, P. Sathyanarayana, and B. C. Simpson, 1994, *Tank Characterization Report for Single-Shell Tank 241-S-104*, WHC-SD-WM-ER-370, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Hanlon, B. M., 1998, *Waste Tank Summary Report for Month Ending September 30, 1998*, HNF-EP-0182-126, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

Hill, J. G., G. S. Anderson, and B. C. Simpson, 1995, *The Sort on Radioactive Waste Type Model: A Method to Sort Single-Shell Tanks into Characteristic Groups*, PNL-9814, Rev. 2, Pacific Northwest Laboratory, Richland, Washington.

Hodgson, K. M., and M. D. LeClair, 1996, *Work Plan for Defining a Standard Inventory Estimate for Wastes Stored in Hanford Site Underground Tanks*, WHC-SD-WM-WP-311, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

Horton, J.E. 1977, *Physical and Chemical Characterization of 116-TX*, Letter Report, Atlantic Richfield Hanford Company, Richland, Washington.

Hu, T. A., L. C. Amato, R. T. Winward, and R. D. Cromar, 1997, *Tank Characterization Report for Single-Shell Tank 241-U-102*, HNF-SD-WM-ER-618, Rev. 0, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

Kruger, A. A., B. J. Morris, and L. J. Fergestrom, 1996, *Tank Characterization Report for Single-Shell Tank 241-S-101*, WHC-SD-WM-ER-613, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Kupfer, M. J., A. L. Boldt, B. A. Higley, K. M. Hodgson, L. W. Shelton, B. C. Simpson, R. A. Watrous, S. L. Lambert, D. E. Place, R. M. Orme, G. L. Borsheim, N. G. Colton, M. D. LeClair, R. T. Winward, and W. W. Schulz, 1998, *Standard Inventories of Chemicals and Radionuclides in Hanford Site Tank Wastes*, HNF-SD-WM-TI-740, Rev. 0B, Lockheed Martin Hanford Corp., Richland, Washington.

LMHC, 1998, *Best-Basis Inventory for Tank 241-TX-104*, Tank Characterization Database, Internet at http://twins.pnl.gov:8001/TCD/main.html.

Rodenhizer, D. G.,1987, *Hanford Waste Tank Sluicing History*, WHC-SD-WM-TI-302, Westinghouse Hanford Company, Richland, Washington.

Simpson, B. C., J. G. Field, D. W. Engel, and D. S. Daly, 1996, *Tank Characterization Report for Single-Shell Tank 241-S-107*, WHC-SD-WM-ER-589, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Simpson, B. C., 1998, *Best Basis Inventory Change Package for Reconciliation of Mercury Values*, change package #7 (internal memorandum 7A120-98-005 to J. W. Cammann, February 26), Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

Watrous, R. A., and D. W. Wootan, 1997, *Activity of Fuel Batches Processed Through Hanford Separations Plants, 1944 Through 1989*, HNF-SD-WM-TI-794, Rev. 0, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

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APPENDIX E

BIBLIOGRAPHY FOR TANK 241-TX-104

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APPENDIX E

BIBLIOGRAPHY FOR TANK 241-TX-104

Appendix E is a bibliography that supports the characterization of tank 241-TX-104. This bibliography represents an in-depth literature search of all known information sources that provide sampling, analysis, surveillance, modeling information, and processing occurrences associated with tank 241-TX-104 and its respective waste types.

The references in this bibliography are separated into three 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-TX-104

III. COMBINED ANALYTICAL/NON-ANALYTICAL DATA

- IIIa. Inventories Using Both Campaign and Analytical Information
- IIIb. Compendium of Existing Physical and Chemical Documented Data Sources

This bibliography is broken down into the appropriate sections of material with an annotation at the end of each reference describing the information source. Most information listed below is available in the Lockheed Martin Hanford Corporation Tank Characterization and Safety Resource Center.

I. NON-ANALYTICAL DATA

Ia. Models/Waste Type Inventories/Campaign Information

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 and waste information 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 per tank. Assumptions about waste/waste types and solubility parameters and constraints are also given.

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, 1997, *Waste Status and Transaction Record Summary (WSTRS) Rev. 4*, LA-UR-97-311, Los Alamos National Laboratory, Los Alamos, New Mexico.

- Contains spreadsheets showing all available data on tank additions and transfers.

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 and waste information to 1981.

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 a tank aerial view and a description of risers and their contents.

Lipnicki, J., 1997, *Waste Tank Risers Available for Sampling*, HNF-SD-RE-TI-710, Rev. 4, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

- Assesses riser locations for each tank; however, not all tanks are included or completed. An estimate of the risers available for sampling is also included.

Tran, T. T., 1993, *Thermocouple Status Single-Shell & Double-Shell Waste Tanks*, WHC-SD-WM-TI-553, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Contains riser and thermocouple information for Hanford Site waste tanks.

Id. Sample Planning/Tank Prioritization

Adams, M. R., T. M. Brown, J. W. Hunt, L. J. Fergestrom, 1998, *Fiscal Year 1999 Waste Information Requirements Document*, HNF-2884, Rev. 0, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

- Contains Tri-Party Agreement (Ecology et al. 1997) requirement-driven TWRS Characterization Program information.

Brown, T. M., J. W. Hunt, and L. J. Fergestrom, 1997, *Tank Characterization Technical Sampling Basis*, HNF-SD-WM-TA-164, Rev. 3, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

- Summarizes the 1997 technical basis for characterizing tank waste and assigns a priority number to each tank.

Brown, T. M., J. W. Hunt, and L. J. Fergestrom, 1998, *Tank Characterization Technical Sampling Basis,* HNF-SD-WM-TA-164, Rev. 4, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

- Summarizes the 1998 technical basis for characterizing tank waste and assigns a priority number to each tank.

DOE-RL, 1996, *Recommendation 93-5 Implementation Plan*, DOE/RL-94-0001, Rev. 1, U. S. Department of Energy, Richland, Washington.

- Describes the organic solvents issue and other tank issues.

McCain, D. J., 1997, *Tank 241-TX-104 Push Mode Core Sampling and Analysis Plan*, HNF-SD-WM-TSAP-151, Rev. 0, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

- Contains sampling and analysis requirements for tank 241-TX-104 based on applicable DQOs.

Ie. Data Quality Objectives and Customers of Characterization Data

Dukelow, G. T., J. W. Hunt, H. Babad, and J. E. Meacham, 1995, *Tank Safety Screening Data Quality Objective*, WHC-SD-WM-SP-004, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

- Determines whether tanks are under safe operating conditions.

Meacham, J. E., D. L. Banning, M. R. Allen, and L. D. Muhlestein, 1997, *Data Quality Objective to Support Resolution of the Organic Solvent Safety Issue*, HNF-SD-WM-DQO-026, Rev. 0, DE&S Hanford, Inc. for Fluor Daniel Hanford, Inc., Richland, Washington.

- Contains requirements for the organic solvents DQO.

Osborne, J. W., and L. L. Buckley, 1995, *Data Quality Objectives for Tank Hazardous Vapor Safety Screening*, WHC-SD-WM-DQO-002, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

- Contains requirements for addressing hazardous vapor issues.

Schreiber, R. D., 1997, *Memorandum of Understanding for the Organic Complexant Safety Issue Data Requirements*, HNF-SD-WM-RD-060, Rev. 0, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

- Contains requirements, methodology and logic for analyses to support organic complexant issue resolution.

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

IIa. Sampling of Tank 241-TX-104

Analytical Services, 1977, *Analyses of Tank Farm Samples, Sample No. T832, Tank 104-TX, Received 1-12-77*, (internal memorandum, no number, to File, February 11), Atlantic Richfield Hanford Company, Richland, Washington.

- Contains results for 1977 grab samples.

Analytical Services, 1976, *Analyses of Tank Farm Sample, Sample No. T4391, Tank 104-TX, Received 4-19-76*, (internal memorandum, no number, to J. C. Womack, September 17), Atlantic Richfield Hanford Company, Richland, Washington.

- Contains results for 1976 grab samples.

Duchsherer, M. J., E. S. Mast, L. A. Pingel, M. Stauffer, R. S. Viswanath, D. B. Bonfoey, G. A. Fies, C.V. Dormat, 1997, *Tank Vapor Sampling and Analysis Package for Tank 241-TX-104, Sampled May 5, 1997*, HNF-SD-WM-DP-281, Rev. 0, Numatec Hanford Corporation for Fluor Daniel Hanford, Inc., Richland, Washington.

- Contains 1997 vapor sample results.

Godfrey, W. L., 1965, *242-T Evaporator Feed*, (internal memorandum, to S. J. Beard, September 24), General Electric Company, Richland, Washington.

- Contains results for 1965 grab samples.

Steen, F. H., 1998, *Tank 241-TX-104, Cores 230 and 231, Analytical Results for the Final Report*, HNF-SD-WM-DP-305, Rev. 0, Waste Management Federal Services of Hanford, Inc. for Fluor Daniel Hanford, Inc., Richland, Washington.

- Contains results for 1998 core sample analyses.

Wheeler, R. E., 1974, *Analysis of Tank Farm Samples, Sample: T-5118, 104-TX*, (internal memorandum, to R. L. Walser, September 17), Atlantic Richfield Hanford Company, Richland, Washington.

- Contains results for 1974 grab sample analyses.

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, 1997, *Hanford Tank Chemical and Radionuclide Inventories: HDW Model Rev. 4*, LA-UR-96-3860, 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.

Brevick, C. H., J. L. Stroup, and J. W. Funk, 1997, *Historical Tank Content Estimate for the Northwest Quadrant of the Hanford 200 Areas*, HNF-SD-MW-ER-351, Rev. 1, Fluor Daniel Northwest, Inc. for Fluor Daniel Hanford, Inc., Richland, Washington.

- Document contains summary information from the supporting document as well as in-tank photo collages and the solid composite inventory estimates Rev. 0 and Rev. 0A.

Schmittroth, F. A., 1995, *Inventories for Low-Level Tank Waste*, WHC-SD-WM-RPT-164, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Document contains tank inventory information.

IIIb. Compendium of Data from Other Physical and Chemical Sources

Brevick, C. H., J. L. Stroup, and J. W. Funk, 1997, *Supporting Document for the Historical Tank Content Estimate for TX Farm*, HNF-SD-WM-ER-321, Rev. 1, Fluor Daniel Northwest, Inc. for Fluor Daniel Hanford, Inc., Richland, Washington.

- Document contains historical data and solid inventory estimates. The appendices contain the following information: Appendix C - Level History AutoCAD sketch; Appendix D - Temperature Graphs; Appendix E - Surface Level Graph; Appendix F, pg F-1 - Cascade/ Drywell Chart; Appendix G - Riser Configuration Drawing and Table; Appendix I - In-Tank Photos; and Appendix K - Tank Layer Model Bar Chart and Spreadsheet.

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

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

Hanlon, B. M., 1998, *Waste Tank Summary Report for Month Ending September 30, 1998*, WHC-EP-0182-126, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., 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.

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

- Contains in-tank photographs and summaries on the tank description, leak detection system, and tank status.

Husa, E. I., 1995, *Hanford Waste Tank Preliminary Dryness Evaluation*, WHC-SD-WM-TI-703, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Assesses relative dryness between tanks.

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

- Document contains a statistical evaluation to group tanks into classes with similar waste properties.

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.

Van Vleet, R. J., 1993, *Radionuclide and Chemical Inventories*, WHC-SD-WM-TI-565, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

- Contains tank inventory information.

LMHC, 1998, *Tank Characterization Data Base*, Internet at http://twins.pnl.gov:8001/htbin/TCD/main.html

- Contains analytical data for each of the 177 Hanford Site waste tanks.