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Revision 0

Preliminary Inventory Estimates for Single-Shell Tank Leaks in B, BX, and BY Tank Farms

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

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Contractor for the U.S. Department of Energy
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TERMS

HDW	Hanford Defined Waste
HLM	Historical Leak Model
PUREX	Plutonium-Uranium Extraction (process)
RCRA	*Resource Conservation and Recovery Act of 1976*
REDOX	Reduction-Oxidation (process)
SMM	supernatant mixing model
SST	single-shell tanks
TBP	tributyl phosphate
TFVZ	Tank Farm Vadose Zone
TRAC	track radioactive components
WMA	Waste Management Area
WSTRS	Waste Status and Transaction Summary

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1.0 INTRODUCTION

Sixty-seven of the 149 single-shell tanks (SST) containing high-level radioactive waste in the 200 Areas of the Hanford Site are listed as being known or suspected of having leaked during their operational lifetime (Hanlon 2000). The tank farm vadose zone (TFVZ) characterization team is reassessing the tank leak information for the tank farms currently being evaluated for compliance with the *Resource Conservation and Recovery Act of 1976* (RCRA). This assessment currently includes the S, SX, B, BX, BY, T, TX, and TY tank farms. This document focuses on the results of this effort for the three tank farms in the B and BX-BY Waste Management Areas (WMA) in the 200 East Area of the Hanford Site[1]. SST leak information needed to be reassessed to better define the composition and quantities of materials lost to the vadose zone because such data will be required for risk-assessment calculations.

This task was to develop preliminary inventory estimates for chemicals and radionuclides lost to the vadose zone in the B and BX-BY WMAs by integrating results from recent field investigations and modeling results with historical tank farm records. This task follows the methodology used in the S-SX WMA, T and TX-TY WMAs leak inventory estimates (Jones et al. 2000a and Jones et al. 2000b). The baseline spectral gamma-ray logging data reports provided the best perspective of the "nature and extent" of gamma-emitting radionuclide contamination in the B, BX, and BY tank farms, compiled to date (DOE-GJPO 2000, DOE-GJPO 1998, DOE-GJPO 1997).

The information for SSTs known to have leaked or suspected of having leaked is tabulated in Appendix H of the monthly *Waste Tank Summary Status Report*, commonly referred to as the Hanlon Report (Hanlon 2000). Hanlon (2000) identifies seven 100-series tanks in the B tank farm as confirmed or assumed leakers, five in the BX farm, and five in the BY farm. Estimated leak volumes are provided for only 8 of these 17 tanks. The historical tank waste transfer records compiled in the *Waste Status and Transaction Summary* (WSTRS), Rev. 4 (Agnew et al. 1997), can be used for tracking discrepancies in waste levels in any tank at any time. The Hanford Defined Waste (HDW) model (Agnew 1997) is a tool for estimating tank waste compositions as a function of time. The reference list included in Appendix H of the Hanlon Report (Hanlon 2000) is a starting point for uncovering historical SST leak documentation.

Detailed discussions of the B, BX, and BY tank farms construction, operations, and tank leak histories are presented in Williams (1999), Brevick et al. (1995), Narbutovskih (1998), DOE-GJPO (2000), DOE-GJPO (1998), and DOE-GJPO (1997). These documents also provide some information on intentional waste discharges near the tank farms. In addition to tank farms operational history, the cited references include discussions of the pertinent geology, hydrology, and geochemistry, and the groundwater monitoring system. An assessment of the historical

[1] Although these three tank farms are officially divided into two WMAs, B and BX-BY, they are treated as a single WMA in this document because no logical separation exists between the tank farms based on waste type or tank use.

gross gamma-ray logging data collected as part of the leak detection systems also is available for each farm (Randall et al., 2000, Myers 1999a, and Myers 1999b).

In this assessment, attempts have been made to distinguish between transfer line leaks and tank overfills from cases where the waste originated from loss of containment from the tank (i.e., failure of both the tank's steel-liner and its surrounding concrete-shell) for a number of reasons.

- The Hanlon report generally does not track near-surface contamination in tank farms.
- While waste-level measurements in the tanks frequently provide information useful for leak volume estimates, losses from the piping system generally are non-quantifiable.
- Mobile gamma-emitting radionuclides from near-surface leaks frequently migrate down to the level of the tank base confounding the interpretation of tank leak monitoring data.
- Remediation strategies may differ for near-surface leaks and leaks originating at the tank bases.

In many cases, the gamma logging data provide considerable insight into the origins of tank waste in the vadose zone. Waste plumes originating within 20 ft of the surface can reasonably be attributed to losses from waste transfer pipes or from tank overfill events. Waste plumes originating from the failure of the steel liner-concrete shell system likely would be found near or below the level of the tank base. Plumes originating from leaks near the tank base are expected to exhibit ^{137}Cs gamma-ray activity levels greater than 1,000 pCi/g in bands several feet thick. (The exception may be for waste originating from the ^{137}Cs recovery process.) When limited gamma activity is reported near the tank base, the data are more difficult to interpret. Such activity could be exhibited by the edge of a tank leak plume or could originate from other sources. Nevertheless, without other drivers, such lower activity measurements would not trigger additional investigation.

The inventory of chemicals and radionuclides lost to the vadose zone in the B and BX-BY WMAs is a function of the waste types stored in the tanks over their decades of use. The B farm, one of the first Hanford Site tank farms, was constructed in 1943-1944. This farm received each tanked waste stream discharged from the bismuth phosphate process operating in B Plant. The BX farm was constructed in 1946-1947 and initially was used to support the bismuth phosphate process. The BY farm was constructed in 1948-1949 and initially was used to support the bismuth phosphate process. In 1954, the BY farm began receiving scavenged uranium recovery waste coming from the U Plant. In later years tanks within these farms received waste from the Plutonium-Uranium Extraction (PUREX) Plant and the B Plant isotope recovery processes. The spectral gamma logging data for this WMA reflects contamination from these waste types.

The composition and volume of waste lost from many of the B, BX, and BY tanks are highly uncertain. Except for losses from tank 241-BX-102, no detailed analyses have been conducted of known or suspected leaks in this WMA. An analysis of spectral gamma logging records clearly shows that tank waste was lost from both tanks and the near-surface tank infrastructure. Detailed tank-specific krieging analysis of spectral gamma logging data could provide another window into lost tank waste volume estimates. However, until the complete digitized data set becomes available for the spectral gamma logging data for this WMA, the krieging analyses cannot be initiated. Also, no tank waste analysis data were found for tank waste samples taken near or during leak events (except for tank BX-102). Thus, the only sources of leak volumes are the historical waste transfer records and the leak volumes listed in the Hanlon report. The leak volume estimates developed in this effort were developed by analyzing waste transfer records, spectral gamma logging data, and the historical leak volumes listed in Hanlon (2000).

Efforts to estimate tank compositions at the time of suspected leaks and inventory estimates benefited from the modeling efforts to determine current waste inventories for the 177 high-level waste tanks at the Hanford Site (Kupfer et al. 1998). Attempts to estimate tank compositions based on waste process flow sheets and waste transfer records began in the 1970's (Jungfleisch 1984) with the development of the Track Radioactive Components (TRAC) model. In the 1990's, Agnew and coworkers (Agnew et al. 1997) continued this effort by developing the HDW model. The HDW model predicts waste concentrations for 26 chemical components and 46 radionuclides in each of the 177 Hanford Site waste tanks. Radionuclide levels are decayed to a common date of January 1, 1994.

Agnew and Corbin (1998) demonstrated that the HDW model could be used to predict tank composition as a function of time in their efforts to develop a leak model for Hanford Site high-heat tanks. A recently developed model using the HDW model framework coupled with a probabilistic uncertainty analysis provided revised waste composition estimates and uncertainties for waste discharges to cribs, ponds, and ditches, and tank leaks (Corbin et al. 2000). The inventory estimates reported in this document were developed using this new Hanford Soil Inventory and Uncertainty model. The current inventory estimates for the B, BX, and BY tanks do not include values for the organic compounds that initially were present in some of the waste streams. Future revisions of the inventory estimates will include the organic compounds provided in the HDW model, Rev. 4.

2.0 RESULTS

2.1 WASTE TYPES LOST IN B, BX, AND BY TANK FARMS

As noted, the spectral gamma logging data provide the best overall assessment of the nature and extent of gamma contamination in the vadose zone underlying the B and BX-BY WMAs. Frequently, certain gamma-emitting radionuclide compositions (fingerprints) reported in the spectral gamma logging data can be correlated with specific waste types. Because historical waste transfer records (Agnew 1997) provide information on the waste types residing in specific tanks as a function of time, gamma contamination found in the soil column frequently can be traced back to when the waste was in the tank. The gamma fingerprints were developed empirically because we currently lack sufficient understanding of the process chemistries used in the Hanford Site production facilities to develop a realistic estimate of mobile gamma-emitting radionuclides for each waste type. The specific set of radionuclides that remained in the solution with each waste type generally depended on subtle chemical reactions that were peripheral to the primary mission of the process and, unless they caused a process upset, were not closely studied or documented.

Metal Waste. The best example of fingerprinting waste types is the ^{238}U and ^{235}U peaks found in soils associated with losses of metal waste. After fuel rod dissolution, metal waste was the first waste stream generated in the bismuth phosphate process. The metal waste stream contained approximately 0.5 lb/gal of uranium and 2.5 molar carbonate; the carbonate was added to keep the uranium mobilized until it reached the tanks (Anderson 1990). Metal waste is the only large-volume waste stream generated at the Hanford Site that contained high concentrations of uranium. Given the very low specific activities of ^{238}U and ^{235}U, significant quantities must be present in the soil column to be detectable by spectral gamma logging techniques. Thus, ^{238}U and ^{235}U identified by spectral gamma logging is clearly linked to a metal waste source. Because the metal waste resided in the SSTs only from 1945 through 1956, the presence of a metal waste fingerprint provides a time frame for the leak event. Less certainty is associated with the other radionuclides that would be expected in a metal waste leak event. Metal waste contained approximately 90 percent of the radionuclides originally present in the irradiated fuel rods. Thus, the isotopic composition of the metal waste would have been dictated by the process chemistry. That is, radionuclides that remained in the solution phase would tend to have been lost during a leak event, whereas radionuclides trapped in the solids would have remained in the tank. Cesium-137 appears to be a soluble contaminant in this type of waste. Isotopes with half-lives of less than 3 years would likely have decayed away before the baseline spectral gamma logging was done.

Four areas containing high concentrations of uranium isotopes have been identified. One is in the BX farm, two are in the TX farm, and one is in the U farm. These are assumed to have come from metal waste. However, the current uranium-containing plumes in the BX and TX farms appear to have been generated from multiple leak events involving different waste types. The metal waste plume in the U farm contains only ^{238}U, ^{235}U, and ^{137}Cs. The 1951 tank overfill event at BX-102 provides a well-defined uranium plume. However, the isotopic composition of this plume is complicated by an apparent leak from the 241-BXR-01C sluice pit in 1974. This apparent leak involved a B Plant isotope recovery waste type. The TX farm metal waste plumes also are complicated by leak events involving multiple waste types.

1C and 2C Waste. The radionuclide fingerprint of 1C and 2C (second cycle) waste should be similar to the metal waste fingerprint, but without the uranium isotopes. The basic chemistry for each of the three precipitation steps of the bismuth phosphate process is very similar. Frequently, the cladding waste stream was combined with the 1C waste stream. The activity of the 1C waste would have been significantly higher than the 2C waste stream. Thus, ^{137}Cs would be expected to be the only observable isotope associated with 1C and 2C waste.

Uranium Recovery Waste (or TBP Waste). TBP waste is essentially metal waste after the uranium was removed, ferric oxide was added, and the solution was diluted by a factor of two. The ^{60}Co present in the metal waste was mobilized during the uranium recovery process. We do not yet know why this occurred, but the Pacific Northwest National Laboratory might conduct some experiments to address this question.

REDOX High-Level Waste. Cesium-137 is the only radionuclide currently identified by spectral gamma logging for the reduction-oxidation (REDOX) process high-level waste (Jones et al. 2000). Ruthenium-106 and, likely, other short-lived isotopes initially were present in the REDOX waste lost from the tanks; however, because of their short half-lives, these isotopes have long since decayed to less than detection limits. The interpretation is that other gamma-emitting radionuclides such as ^{60}Co, $^{152,\,154}$Eu, and ^{125}Sb that were known to have been present in the waste stream must have precipitated in the sludge fraction of the REDOX waste and likely remained in the tanks during leak events.

B Plant High-Level Waste. The most isotopically-rich waste type appears to have been the waste generated in the isotope recovery programs conducted in the B Plant. Most PUREX high-level waste and REDOX high-level waste supernatant liquids were reprocessed to remove the heat-generating isotopes, ^{137}Cs and ^{90}Sr. The ^{137}Cs recovery waste streams coming from B Plant contained organic complexing agents that likely mobilized many of the radionuclides. For example, the material leaked from tank T-106 in 1973 appears to have come from the ^{137}Cs recovery process in B Plant. The spectral gamma logging data from drywells around this tank report finding ^{137}Cs, ^{60}Co, ^{152}Eu, ^{154}Eu, ^{125}Sb, and ^{126}Sn. Many of these radionuclides were likely mobilized by organic complexing agents. The near-surface leak from tank BX-101 in 1974 appears to have involved a waste type similar to that lost at tank T-106 in 1973.

These general observations about the radionuclide composition of the various waste types are used in the following sections. Once compete sets of spectral gamma logging data are available for all the tank farms, a much more rigorous statistical analysis can be completed to better define clustering of specific radionuclides with waste types.

2.2 ESTIMATED LEAK DATES, VOLUMES, AND LEAK INVENTORIES

The leak timing is critical in developing a tank waste composition using the HDW model and the leak volume is critical in estimating the inventory of lost material. The rationale for leak times used in this assessment and reported leak volumes is discussed by tank in Sections 2.2.1 through 2.2.19.

2.2.1 Tank 241-B-101

This tank has a 530,000-gal capacity. Hanlon (2000) does not list a leak volume for this tank but reports a declared leak date of 1974. One drywell exhibited a ^{137}Cs spike of less than 100 pCi/g at the tank base level. A review of the waste transfer records suggests a 5,000-gal leak volume. The inventory estimate for the suspected leak from this tank was based on this 5,000-gal leak volume estimate. The estimated waste composition at the time of the leak and leak inventory estimate are shown in Table 1.

Table 1. Inventory Estimate for Tank 241-B-101.

Leak Vol = 324.9 kgal or 94,600 L 5.0 kgal or 18,900 L					
Leak Date - 1974					
Analyte	Median (kg)	Ci/L	Analyte	Median (Ci)	Ci/L
Na	1.49E+03	3.42 E+00	Nb-93m	7.71 E-02	4.08 E-06
Al	1.34 E+02	2.62 E-01	Tc-99	2.12 E-01	1.12 E-05
Fe	2.12 E+00	2.01 E-03	Ru-106	9.49 E-05	5.02 E-09
Cr	8.41 E-04	8.56 E-07	Cd-113m	3.28 E-01	1.74 E-05
Bi	3.21 E-05	8.12 E-09	Sb-125	4.35 E-01	2.30 E-05
La	0.00 E+00	0.00 E+00	Sn-126	3.38 E-02	1.79 E-06
Hg	1.75 E-07	4.60 E-11	I-129	4.12 E-04	2.18 E-08
Zr	8.67 E-07	5.03 E-10	Cs-134	1.12 E-05	5.94 E-10
Pb	1.73 E-05	4.43 E-09	Cs-137	1.60 E-01	8.45 E-06
Ni	2.00 E+00	1.81 E-03	Ba-137m	1.51 E-01	8.00 E-06
Sr	0.00 E+00	0.00 E+00	Sm-151	7.77 E+01	4.11 E-03
Mn	0.00 E+00	0.00 E+00	Eu-152	1.94 E-02	1.03 E-06
Ca	6.85 E+00	9.06 E-03	Eu-154	2.15 E+00	1.14 E-04
K	1.00 E+01	1.35 E-02	Eu-155	1.11 E+00	5.86 E-05
NO3	9.79 E+02	8.36 E-01	Ra-226	1.17 E-06	6.21 E-11
NO2	4.65 E+01	5.34 E-02	Ra-228	5.40 E-11	2.86 E-15
CO3	3.06 E+02	2.70 E-01	Ac-227	6.82 E-06	3.61 E-10
PO4	1.81 E+01	1.01 E-02	Pa-231	1.90 E-05	1.01 E-09
SO4	8.04 E+01	4.43 E-02	Th-229	1.55 E-09	8.20 E-14
Si	1.81 E+01	3.41 E-02	Th-232	1.06 E-10	5.61 E-15

Table 1. Inventory Estimate for Tank 241-B-101.

Leak Vol = 324.9 kgal or 94,600 L 5.0 kgal or 18,900 L					
Leak Date - 1974					
Analyte	Median (kg)	Ci/L	Analyte	Median (Ci)	Ci/L
F	1.23 E-04	3.44 E-07	U-232	4.72 E-08	2.50 E-12
Cl	4.17 E+01	6.21 E-02	U-233	7.72 E-09	4.08 E-13
DBP	2.54 E-05	8.33 E-09	U-234	1.70 E-04	9.02 E-09
Butanol	8.96 E-06	6.41 E-09	U-235	6.59 E-06	3.48 E-10
TBP	0.00 E+00	0.00 E+00	U-236	1.24 E-05	6.57 E-10
NPH	0.00 E+00	0.00 E+00	U-238	1.31 E-04	6.94 E-09
U-Total	3.93 E-01	8.74 E-05	Np-237	6.76 E-04	3.57 E-08
			Pu-238	9.38 E-03	4.96 E-07
Analyte	Median (Ci)	Ci/L	Pu-239	1.64 E-01	8.69 E-06
H-3	4.69 E-01	2.48 E-05	Pu-240	3.57 E-02	1.89 E-06
C-14	3.16 E-02	1.67 E-06	Pu-241	6.58 E-01	3.48 E-05
Ni-59	5.35 E-03	2.83 E-07	Pu-242	4.28 E-06	2.26 E-10
Ni-63	5.31 E-01	2.81 E-05	Am-241	5.69 E-01	3.01 E-05
Co-60	7.14 E-02	3.78 E-06	Am-243	4.31 E-05	2.28 E-09
Se-79	2.14 E-02	1.13 E-06	Cm-242	1.03 E-03	5.46 E-08
Sr-90	6.45 E+02	3.41 E-02	Cm-243	1.10 E-04	5.82 E-09
Y-90	6.45 E+02	3.41 E-02	Cm-244	1.89 E-03	1.00 E-07
Zr-93	9.62 E-02	5.09 E-06			

2.2.2 Tank 241-B-103

This tank has a 530,000-gal capacity. Hanlon (2000) does not list a leak volume for this tank but reports a declared leak date of 1978. Although the waste transfer records are inconclusive (Agnew 1997), they do indicate the tank was filled above the nominal 530 kgal capacity from 1954 until 1969. Essentially no gamma activity was reported in the vadose zone for any drywells around this tank. No attempt was made to develop an inventory estimate for the suspected leak from this tank.

2.2.3 Tank 241-B-105

This tank has a 530,000-gal capacity. Hanlon (2000) does not list a leak volume for this tank but reports a declared leak date of 1978. The waste transfer records indicate a 3,000-gal liquid loss (Agnew 1997). The spectral gamma logging data show narrow bands of ^{137}Cs activity at the tank bottom level in the drywells nearest the cascade line inlet and outlet. The inventory estimate for the suspected leak from this tank was based on this 3,000-gal leak volume. The estimated waste composition at the time of the leak and leak inventory estimate are shown in Table 2.

Table 2. Inventory Estimate for Tank 241-B-105.

Location: B-105					
Leak Vol = 3 kgal or 11,400 L					
Leak Date - 1968					
Analyte	Median (kg)	Conc (m/L)	Analyte	Median (Ci)	Ci/L
Na	1.31 E+03	4.98 E+00	Nb-93m	8.46 E-03	7.42 E-07
Al	8.18 E+00	2.66 E-02	Tc-99	6.91 E-02	6.06 E-06
Fe	1.30 E+00	2.03 E-03	Ru-106	8.61 E-10	7.55 E-14
Cr	5.48 E+00	9.25 E-03	Cd-113m	2.41 E-02	2.11 E-06
Bi	9.68 E+00	4.06 E-03	Sb-125	1.98 E-03	1.74 E-07
La	0.00 E+00	0.00 E+00	Sn-126	3.17 E-03	2.78 E-07
Hg	2.33 E-02	1.02 E-05	I-129	1.30 E-04	1.14 E-08
Zr	2.63 E-01	2.53 E-04	Cs-134	1.03 E-05	9.05 E-10
Pb	0.00 E+00	0.00 E+00	Cs-137	1.80 E+02	1.58 E-02
Ni	1.23 E+00	1.84 E-03	Ba-137m	1.71 E+02	1.50 E-02
Sr	0.00 E+00	0.00 E+00	Sm-151	7.86 E+00	6.89 E-04
Mn	0.00 E+00	0.00 E+00	Eu-152	1.52 E-04	1.33 E-08
Ca	4.19 E+00	9.18 E-03	Eu-154	3.90 E-02	3.42 E-06
K	1.13 E+01	2.55 E-02	Eu-155	1.17 E-02	1.02 E-06
NO3	2.02 E+03	2.85 E+00	Ra-226	6.05 E-07	5.31 E-11
NO2	2.11 E+02	4.03 E-01	Ra-228	6.05 E-13	5.30 E-17
CO3	1.42 E+02	2.07 E-01	Ac-227	3.09 E-06	2.71 E-10
PO4	1.66 E+02	1.53 E-01	Pa-231	6.66 E-06	5.84 E-10
SO4	2.42 E+02	2.21 E-01	Th-229	1.18 E-10	1.03 E-14
Si	1.11 E+01	3.47 E-02	Th-232	2.87 E-12	2.52 E-16
F	3.75 E+01	1.73 E-01	U-232	7.72 E-08	6.77 E-12
Cl	5.71 E+01	1.41 E-01	U-233	3.67 E-09	3.22 E-13
DBP	7.88 E-02	4.29 E-05	U-234	3.63 E-03	3.18 E-07
Butanol	2.79 E-02	3.30 E-05	U-235	1.62 E-04	1.42 E-08
TBP	0.00 E+00	0.00 E+00	U-236	3.41 E-05	2.99 E-09
NPH	0.00 E+00	0.00 E+00	U-238	3.69 E-03	3.24 E-07
U-Total	1.11 E+01	4.08 E-03	Np-237	4.26 E-04	3.73 E-08
			Pu-238	5.82 E-04	5.10 E-08
Analyte	Median (Ci)	Ci/L	Pu-239	1.04 E-01	9.16 E-06

Table 2. Inventory Estimate for Tank 241-B-105.

Location: B-105					
Leak Vol = 3 kgal or 11,400 L					
Leak Date - 1968					
Analyte	Median (kg)	Conc (m/L)	Analyte	Median (Ci)	Ci/L
H-3	6.87 E-02	6.03 E-06	Pu-240	8.14 E-03	7.14 E-07
C-14	9.96 E-03	8.74 E-07	Pu-241	2.01 E-02	1.76 E-06
Ni-59	1.57 E-03	1.38 E-07	Pu-242	8.86 E-08	7.77 E-12
Ni-63	1.41 E-01	1.24 E-05	Am-241	1.77 E-02	1.55 E-06
Co-60	2.20 E-03	1.93 E-07	Am-243	1.22 E-07	1.07 E-11
Se-79	2.10 E-03	1.85 E-07	Cm-242	2.76 E-06	2.42 E-10
Sr-90	2.37 E+02	2.07 E-02	Cm-243	5.62 E-08	4.93 E-12
Y-90	2.37 E+02	2.08 E-02	Cm-244	2.88 E-06	2.53 E-10
Zr-93	1.00 E-02	8.77 E-07			

2.2.4 Tank 241-B-107

This tank has a 530,000-gal capacity. Hanlon (2000) lists a leak volume of 8,000 gal for this tank and a declared leak date of 1980. The waste transfer records do not indicate any unaccounted-for liquid losses (Agnew 1997), but instead a rather consistent unexplained waste volume increase in the 1964 to 1965 time frame leading to a tank volume of 549 kgal—well above the 530 kgal capacity of the tank. The waste volume decreased slowly from 1965 until 1969. In 1969 a large volume of supernatant was transferred out of the tank and drywells were installed around the tank. It appears this tank contained primarily PUREX cladding waste supernatant at the time of the leak. Currently, drywell 20-07-02 exhibits a "tank leak" waste profile (>1,000 pCi/g) at the tank bottom level. Drywell 20-07-02 has a band of ^{137}Cs contamination from 35 to 60 ft bgs (at less than 1000 pCi/g) and a second band from 80 to 100 ft bgs. Two europium isotopes and ^{60}Co also are identified in the upper zone. The inventory estimate for this tank is based on a review of the waste transfer records that suggest a 14,000-gal leak volume. The estimated waste composition at the time of the leak and leak inventory estimate are shown in Table 3.

2.2.5 Tank 241-B-110

This tank has a 530,000-gal capacity. Hanlon (2000) lists a leak volume of 10,000 gal for this tank and a declared leak date of 1981. The waste transfer records (Agnew 1997) indicate this tank was filled above the cascade lines from about 1965 through 1969. During that time the tank contained PUREX and B Plant waste. Drywell 20-10-12, located near the cascade line is highly contaminated from 25 ft down to 100 ft (MACTEC-ERS 1997) suggesting a transfer line leak rather than a tank leak. Interestingly, the spectral gamma logging data interpretation suggests that high levels of ^{90}Sr may be present at depths of 60 to 90 ft. The inventory estimate for this tank is based on a review of the waste transfer records that suggest a 25,000-gal leak volume. The estimated waste composition at the time of the leak and leak inventory estimate are shown in Table 4.

Table 3. Inventory Estimate for Tank 241-B-107.

Leak Vol =14 kgal or 53,000 L					
Leak Date - 1966					
Analyte	Median (kg)	Conc (m/L)	Analyte	Median (Ci)	Ci/L
Na	2.28 E+03	1.87E+00	Nb-93m	2.93 E-02	5.53 E-07
Al	8.04 E+02	5.62 E-01	Tc-99	4.30 E-01	8.11 E-06
Fe	5.78 E+00	1.95 E-03	Ru-106	1.15 E-05	2.17 E-10
Cr	1.02 E+01	3.70 E-03	Cd-113m	2.12 E-01	4.01 E-06
Bi	3.05 E+00	2.76 E-04	Sb-125	1.76 E-01	3.33 E-06
La	0.00 E+00	0.00 E+00	Sn-126	1.25 E-02	2.35 E-07
Hg	9.40 E-02	8.83 E-06	I-129	8.29 E-04	1.56 E-08
Zr	6.48 E-02	1.34 E-05	Cs-134	7.98 E-03	1.51 E-07
Pb	1.46 E+01	1.33 E-03	Cs-137	1.42 E+03	2.69 E-02
Ni	4.78 E+00	1.54 E-03	Ba-137m	1.35 E+03	2.54 E-02
Sr	0.00 E+00	0.00 E+00	Sm-151	2.93 E+01	5.52 E-04
Mn	0.00 E+00	0.00 E+00	Eu-152	7.30 E-03	1.38 E-07
Ca	1.87 E+01	8.82 E-03	Eu-154	9.74 E-01	1.84 E-05
K	7.80 E+00	3.76 E-03	Eu-155	4.57 E-01	8.63 E-06
NO3	2.55 E+03	7.77 E-01	Ra-226	4.65 E-07	8.78 E-12
NO2	9.05 E+02	3.71 E-01	Ra-228	5.35 E-05	1.01 E-09
CO3	7.07 E+01	2.22 E-02	Ac-227	1.48 E-05	2.80 E-10
PO4	5.20 E+01	1.03 E-02	Pa-231	7.86 E-05	1.48 E-09
SO4	1.47 E+02	2.88 E-02	Th-229	2.42 E-05	4.57 E-10
Si	1.19 E+01	7.97 E-03	Th-232	1.15 E-04	2.17 E-09
F	1.24 E+01	1.23 E-02	U-232	2.25 E-03	4.24 E-08
Cl	3.51 E+01	1.86 E-02	U-233	8.71 E-03	1.64 E-07
DBP	9.21 E+00	1.08 E-03	U-234	1.60 E-02	3.02 E-07
Butanol	3.25 E+00	8.29 E-04	U-235	6.63 E-04	1.25 E-08
TBP	0.00 E+00	0.00 E+00	U-236	4.17 E-04	7.87 E-09
NPH	0.00 E+00	0.00 E+00	U-238	1.54 E-02	2.90 E-07
U-Total	4.62 E+01	3.66 E-03	Np-237	1.72 E-03	3.25 E-08
			Pu-238	9.30 E-03	1.75 E-07
Analyte	Median (Ci)	Ci/L	Pu-239	4.47 E-01	8.43 E-06
H-3	2.18E-01	4.114E-06	Pu-240	7.35 E-02	1.39 E-06

Table 3. Inventory Estimate for Tank 241-B-107.

Leak Vol =14 kgal or 53,000 L					
Leak Date - 1966					
Analyte	Median (kg)	Conc (m/L)	Analyte	Median (Ci)	Ci/L
C-14	6.13E-02	1.156E-06	Pu-241	7.27E-01	1.37 E-05
Ni-59	8.57E-03	1.617E-07	Pu-242	2.19 E-06	4.13 E-11
Ni-63	8.34E-01	1.573E-05	Am-241	1.31 E-01	2.46 E-06
Co-60	5.20E-02	9.806E-07	Am-243	1.55 E-06	2.92 E-11
Se-79	8.27E-03	1.561E-07	Cm-242	1.57 E-04	2.96 E-09
Sr-90	2.83E+02	0.005341	Cm-243	6.77 E-06	1.28 E-10
Y-90	2.83E+02	0.0053369	Cm-244	1.26 E-04	2.39 E-09
Zr-93	4.09E-02	7.711E-07			

Table 4. Inventory Estimate for Tank 241-B-110.

Leak Date - 1970/71					
Analyte	Median (kg)	Conc (m/L)	Analyte	Median (Ci)	Ci/L
Na	8.22 E+03	3.78 E+00	Nb-93m	4.97 E-01	5.25 E-06
Al	1.48 E+03	5.79 E-01	Tc-99	1.38 E+01	1.46E-04
Fe	2.28 E+01	4.31 E-03	Ru-106	3.41 E-04	3.60 E-09
Cr	1.34 E+02	2.72 E-02	Cd-113m	4.21 E+00	4.45 E-05
Bi	6.26 E+00	3.17 E-04	Sb-125	1.23 E+01	1.30 E-04
La	7.81 E-06	5.94 E-10	Sn-126	2.13 E-01	2.25 E-06
Hg	1.19 E-01	6.28 E-06	I-129	2.66 E-02	2.81 E-07
Zr	6.49 E-02	7.52 E-06	Cs-134	2.09 E-01	2.21 E-06
Pb	1.94 E+01	9.92 E-04	Cs-137	1.60 E+04	1.69 E-01
Ni	1.37 E+01	2.47 E-03	Ba-137m	1.52 E+04	1.60 E-01
Sr	0.00 E+00	0.00 E+00	Sm-151	4.95 E+02	5.24 E-03
Mn	8.22 E+00	1.58 E-03	Eu-152	2.49 E-01	2.63 E-06
Ca	4.97 E+01	1.31 E-02	Eu-154	3.46 E+01	3.66 E-04
K	5.44 E+01	1.47 E-02	Eu-155	1.54 E+01	1.63 E-04
NO3	7.81 E+03	1.33 E+00	Ra-226	4.84 E-06	5.12 E-11
NO2	3.37 E+03	7.74 E-01	Ra-228	6.48 E-03	6.85 E-08
CO3	6.14 E+02	1.08 E-01	Ac-227	4.50 E-05	4.76 E-10
PO4	1.72 E+02	1.92 E-02	Pa-231	2.44 E-04	2.58 E-09
SO4	9.78 E+02	1.08 E-01	Th-229	1.89 E-04	2.00 E-09

Table 4. Inventory Estimate for Tank 241-B-110.

Leak Date - 1970/71					
Analyte	Median (kg)	Conc (m/L)	Analyte	Median (Ci)	Ci/L
Si	7.57 E+01	2.85 E-02	Th-232	8.47 E-04	8.96 E-09
F	3.36 E+01	1.87 E-02	U-232	8.62 E-03	9.11 E-08
Cl	1.86 E+02	5.53 E-02	U-233	3.37 E-02	3.56 E-07
DBP	1.68 E+02	1.10 E-02	U-234	3.65 E-02	3.86 E-07
Butanol	5.94 E+01	8.48 E-03	U-235	1.50 E-03	1.59 E-08
TBP	0.00 E+00	0.00 E+00	U-236	1.10 E-03	1.16 E-08
NPH	0.00 E+00	0.00 E+00	U-238	3.44 E-02	3.64 E-07
U-Total	1.03 E+02	4.58 E-03	Np-237	4.21 E-02	4.45 E-07
			Pu-238	7.09 E-02	7.49 E-07
Analyte	Median (Ci)	Ci/L	Pu-239	2.03 E+00	2.15 E-05
H-3	9.38 E+00	9.92 E-05	Pu-240	3.71 E-01	3.92 E-06
C-14	1.96E+00	2.07E-05	Pu-241	5.04 E+00	5.33 E-05
Ni-59	1.61E-01	1.70E-06	Pu-242	2.74 E-05	2.89 E-10
Ni-63	1.62E+01	1.71E-04	Am-241	2.13 E+00	2.25 E-05
Co-60	2.61E+00	2.75E-05	Am-243	9.29 E-05	9.82 E-10
Se-79	1.42E-01	1.50E-06	Cm-242	1.19 E-02	1.25 E-07
Sr-90	3.90E+03	4.12E-02	Cm-243	1.23 E-03	1.30 E-08
Y-90	3.89E+03	4.11E-02	Cm-244	6.90 E-03	7.29 E-08
Zr-93	7.06E-01	7.46E-06			

2.2.6 Tank 241-B-111

This tank has a 530,000-gal capacity. Hanlon (2000) does not list a leak volume for this tank but reports a declared leak date of 1978. Neither the waste transfer records nor spectral gamma logging provide strong evidence of a leak from this tank. No inventory estimate is provided.

2.2.7 Tank 241-B-112

This tank has a 530,000-gal capacity. Hanlon (2000) lists a leak volume of 2,000 gal for this tank and a declared leak date of 1978. Neither the waste transfer records nor spectral gamma logging provide strong evidence of a leak from this tank. No inventory estimate is provided.

2.2.8 Tanks 241-B-201, -203, and -204

The 200-series tanks are 55,000-gal capacity and were used in a cascade for treating low-level waste associated with the bismuth phosphate process. The estimated waste compositions at the time of the leak and leak inventory estimates are shown in Tables 5, 6, and 7.

Table 5. Inventory Estimate for Tank B-201.

Leak Vol =1.2 kgal or 4,540 L					
Leak Date - 1966					
Analyte	Median (kg)	Conc (m/L)	Analyte	Median (Ci)	Ci/L
Na	2.82 E+02	2.70 E+00	Nb-93m	1.26 E-05	2.78 E-09
Al	0.00 E+00	0.00 E+00	Tc-99	1.06 E-04	2.33 E-08
Fe	9.18 E-01	3.61 E-03	Ru-106	3.66 E-12	8.07 E-16
Cr	2.91 E+00	1.23 E-02	Cd-113m	4.27 E-05	9.40 E-09
Bi	6.86 E+00	7.23 E-03	Sb-125	5.63 E-06	1.24 E-09
La	4.34 E+00	6.88 E-03	Sn-126	4.85 E-06	1.07 E-09
Hg	0.00 E+00	0.00 E+00	I-129	2.00 E-07	4.42 E-11
Zr	0.00 E+00	0.00 E+00	Cs-134	2.44 E-07	5.36 E-11
Pb	0.00 E+00	0.00 E+00	Cs-137	1.81 E+00	3.98 E-04
Ni	7.74 E-01	2.90 E-03	Ba-137m	1.71 E+00	3.76 E-04
Sr	0.00 E+00	0.00 E+00	Sm-151	1.22 E-02	2.68 E-06
Mn	2.30 E+00	9.22 E-03	Eu-152	5.30 E-07	1.17 E-10
Ca	2.96 E+00	1.63 E-02	Eu-154	7.86 E-05	1.73 E-08
K	7.44 E+01	4.19 E-01	Eu-155	4.80 E-05	1.06 E-08
NO3	7.04 E+02	2.50 E+00	Ra-226	7.16 E-10	1.58 E-13
NO2	7.25 E-01	3.47 E-03	Ra-228	1.54 E-15	3.40 E-19
CO3	4.44 E+00	1.63 E-02	Ac-227	3.78 E-09	8.33 E-13
PO4	2.81 E+01	6.52 E-02	Pa-231	8.74 E-09	1.92 E-12
SO4	2.38 E+00	5.45 E-03	Th-229	2.98 E-13	6.56 E-17
Si	0.00 E+00	0.00 E+00	Th-232	4.03 E-15	8.88 E-19
F	3.74 E+01	4.34 E-01	U-232	4.69 E-09	1.03 E-12
Cl	7.80 E+00	4.84 E-02	U-233	2.13 E-10	4.70 E-14
DBP	0.00 E+00	0.00 E+00	U-234	2.33 E-04	5.14 E-08
Butanol	0.00 E+00	0.00 E+00	U-235	1.04 E-05	2.28 E-09
TBP	0.00 E+00	0.00 E+00	U-236	2.04 E-06	4.50 E-10
NPH	0.00 E+00	0.00 E+00	U-238	2.37 E-04	5.22 E-08
U-Total	7.10 E-01	6.57 E-04	Np-237	6.57 E-07	1.45 E-10
			Pu-238	2.80 E-05	6.16 E-09

Table 5. Inventory Estimate for Tank B-201.

Leak Vol =1.2 kgal or 4,540 L					
Leak Date - 1966					
Analyte	Median (kg)	Conc (m/L)	Analyte	Median (Ci)	Ci/L
Analyte	Median (Ci)	Ci/L	Pu-239	4.06 E-03	8.94 E-07
H-3	4.93 E-05	1.09 E-08	Pu-240	3.57 E-04	7.85 E-08
C-14	1.53 E-05	3.36 E-09	Pu-241	1.18 E-03	2.59 E-07
Ni-59	4.33 E-06	9.53 E-10	Pu-242	5.46 E-09	1.20 E-12
Ni-63	4.00 E-04	8.81 E-08	Am-241	3.31 E-05	7.29 E-09
Co-60	4.90 E-06	1.08 E-09	Am-243	2.70 E-10	5.94 E-14
Se-79	3.21 E-06	7.07 E-10	Cm-242	1.08 E-08	2.38 E-12
Sr-90	1.60 E+00	3.51 E-04	Cm-243	2.32 E-10	5.12 E-14
Y-90	1.59 E+00	3.51 E-04	Cm-244	6.84 E-09	1.51 E-12
Zr-93	1.53 E-05	3.36 E-09			

Table 6. Inventory Estimate for Tank 241-B-203.

Leak Vol = 0.3 kgal or 1,140 L					
Leak Date - 1966					
Analyte	Median (kg)	Conc (m/L)	Analyte	Median (Ci)	Ci/L
Na	3.41 E+02	1.30 E+01	Nb-93m	1.53 E-05	1.34 E-08
Al	0.00 E+00	0.00 E+00	Tc-99	1.28 E-04	1.12 E-07
Fe	1.14 E+00	1.79 E-02	Ru-106	4.43 E-12	3.88 E-15
Cr	3.66 E+00	6.18 E-02	Cd-113m	5.16 E-05	4.52 E-08
Bi	8.25 E+00	3.46 E-02	Sb-125	6.81 E-06	5.97 E-09
La	5.23 E+00	3.30 E-02	Sn-126	5.86 E-06	5.14 E-09
Hg	0.00 E+00	0.00 E+00	I-129	2.42 E-07	2.12 E-10
Zr	0.00 E+00	0.00 E+00	Cs-134	2.93 E-07	2.57 E-10
Pb	0.00 E+00	0.00 E+00	Cs-137	2.17 E+00	1.91 E-03
Ni	9.67 E-01	1.45 E-02	Ba-137m	2.06 E+00	1.81 E-03
Sr	0.00 E+00	0.00 E+00	Sm-151	1.47 E-02	1.29 E-05
Mn	2.79 E+00	4.45 E-02	Eu-152	6.40 E-07	5.61 E-10
Ca	3.70 E+00	8.11 E-02	Eu-154	9.49 E-05	8.32 E-08
K	8.97 E+01	2.01 E+00	Eu-155	5.79 E-05	5.08 E-08
NO3	8.51 E+02	1.20 E+01	Ra-226	8.65 E-10	7.59 E-13
NO2	1.24 E+00	2.37 E-02	Ra-228	1.86 E-15	1.63 E-18
CO3	5.37 E+00	7.85 E-02	Ac-227	4.58 E-09	4.02 E-12
PO4	3.39 E+01	3.13 E-01	Pa-231	1.05 E-08	9.25 E-12

Table 6. Inventory Estimate for Tank 241-B-203.

Leak Vol = 0.3 kgal or 1,140 L					
Leak Date - 1966					
Analyte	Median (kg)	Conc (m/L)	Analyte	Median (Ci)	Ci/L
SO4	3.00 E+00	2.74 E-02	Th-229	3.60 E-13	3.16 E-16
Si	0.00 E+00	0.00 E+00	Th-232	4.88 E-15	4.28 E-18
F	4.51 E+01	2.08 E+00	U-232	5.64 E-09	4.95 E-12
Cl	9.43 E+00	2.33 E-01	U-233	2.59 E-10	2.27 E-13
DBP	0.00 E+00	0.00 E+00	U-234	2.82 E-04	2.47 E-07
Butanol	0.00 E+00	0.00 E+00	U-235	1.25 E-05	1.10 E-08
TBP	0.00 E+00	0.00 E+00	U-236	2.46 E-06	2.16 E-09
NPH	0.00 E+00	0.00 E+00	U-238	2.86 E-04	2.51 E-07
U-Total	8.57 E-01	3.16 E-03	Np-237	7.94 E-07	6.96 E-10
			Pu-238	3.38 E-05	2.96 E-08
Analyte	Median (Ci)	Ci/L	Pu-239	4.90 E-03	4.29 E-06
H-3	5.95 E-05	5.22 E-08	Pu-240	4.30 E-04	3.77 E-07
C-14	1.84 E-05	1.61 E-08	Pu-241	1.42 E-03	1.25 E-06
Ni-59	5.23 E-06	4.59 E-09	Pu-242	6.57 E-09	5.76 E-12
Ni-63	4.82 E-04	4.23 E-07	Am-241	4.01 E-05	3.51 E-08
Co-60	5.91 E-06	5.19 E-09	Am-243	3.25 E-10	2.85 E-13
Se-79	3.89 E-06	3.41 E-09	Cm-242	1.30 E-08	1.14 E-11
Sr-90	1.92 E+00	1.68 E-03	Cm-243	2.81 E-10	2.46 E-13
Y-90	1.92 E+00	1.68 E-03	Cm-244	8.27 E-09	7.25 E-12
Zr-93	1.84 E-05	1.62 E-08			

Table 7. Inventory Estimate for Tank 241-B-204.

Leak Vol = 0.4 kgal or 1,510 L					
Leak Date - 1966					
Analyte	Median (kg)	Conc (m/L)	Analyte	Median (Ci)	Ci/L
Na	6.13E+00	1.77E-01	Nb-93m	1.68E-08	1.11E-11
Al	0.00E+00	0.00E+00	Tc-99	1.41E-07	9.35E-11
Fe	1.44E-01	1.70E-03	Ru-106	4.88E-15	3.23E-18
Cr	5.37E-01	6.83E-03	Cd-113m	5.69E-08	3.77E-11
Bi	9.13E-03	2.89E-05	Sb-125	7.54E-09	4.99E-12
La	5.78E-03	2.76E-05	Sn-126	6.45E-09	4.27E-12
Hg	0.00E+00	0.00E+00	I-129	2.66E-10	1.76E-13
Zr	0.00E+00	0.00E+00	Cs-134	3.23E-10	2.14E-13

Table 7. Inventory Estimate for Tank 241-B-204.

Leak Vol = 0.4 kgal or 1,510 L					
Leak Date - 1966					
Analyte	Median (kg)	Conc (m/L)	Analyte	Median (Ci)	Ci/L
Pb	0.00E+00	0.00E+00	Cs-137	2.40E-03	1.59E-06
Ni	1.36E-01	1.53E-03	Ba-137m	2.27E-03	1.50E-06
Sr	0.00E+00	0.00E+00	Sm-151	1.62E-05	1.07E-08
Mn	3.07E-03	3.70E-05	Eu-152	7.07E-10	4.68E-13
Ca	4.66E-01	7.71E-03	Eu-154	1.04E-07	6.92E-11
K	1.34E-01	2.27E-03	Eu-155	6.40E-08	4.24E-11
NO3	1.34E+01	1.43E-01	Ra-226	9.57E-13	6.34E-16
NO2	1.42E+00	2.04E-02	Ra-228	2.05E-18	1.36E-21
CO3	1.57E-01	1.73E-03	Ac-227	5.04E-12	3.34E-15
PO4	3.74E-02	2.61E-04	Pa-231	1.17E-11	7.72E-15
SO4	4.94E-01	3.41E-03	Th-229	3.97E-16	2.63E-19
Si	0.00E+00	0.00E+00	Th-232	5.37E-18	3.56E-21
F	4.98E-02	1.73E-03	U-232	6.23E-12	4.13E-15
C	1.54E-01	2.88E-03	U-233	2.84E-13	1.88E-16
DBP	0.00E+00	0.00E+00	U-234	3.10E-07	2.05E-10
Butanol	0.00E+00	0.00E+00	U-235	1.38E-08	9.14E-12
TBP	0.00E+00	0.00E+00	U-236	2.71E-09	1.79E-12
NPH	0.00E+00	0.00E+00	U-238	3.15E-07	2.09E-10
U Total	9.46E-04	2.63E-06	Np-237	8.74E-10	5.79E-13
			Pu-238	3.72E-08	2.47E-11
Analyte	Median (Ci)	Ci/L	Pu-239	5.41E-06	3.58E-09
H-3	6.55E-08	4.34E-11	Pu-240	4.74E-07	3.14E-10
C-14	2.02E-08	1.34E-11	Pu-241	1.57E-06	1.04E-09
Ni-59	5.78E-09	3.82E-12	Pu-242	7.25E-12	4.80E-15
Ni-63	5.32E-07	3.52E-10	Am-241	4.41E-08	2.92E-11
Co-60	6.51E-09	4.31E-12	Am-243	3.57E-13	2.37E-16
Se-79	4.29E-09	2.84E-12	Cm-242	1.44E-11	9.53E-15
Sr-90	2.12E-03	1.40E-06	Cm-243	3.09E-13	2.05E-16
Y-90	2.12E-03	1.40E-06	Cm-244	9.12E-12	6.04E-15
Zr-93	2.03E-08	1.34E-11			

2.2.9 Tank 241-BX-101

This tank has a 530,000-gal capacity. Hanlon (2000) does not list a leak volume for this tank but reports a declared leak date of 1972. Two drywells (21-01-01 and 21-01-2) exhibit significant contamination. However, the isotopic mixture suggest this contamination originated from two sources, the 91.6 kgal metal waste overfill of tank BX-102 in 1951 and a 1974 sluice pit leak (DOE-GJP 1998). The isotopic mixture observed in drywell 21-01-01 beginning at about 20 ft bgs is consistent with a ^{137}Cs recovery waste type being transferred through this tank at that point in time. Current data do not support this tank being listed as a leaker. The waste loss event should be listed as a "near-surface" spill. The waste transfer records suggest a 4,000-gal leak from this tank. The inventory estimate is based on the 4,000-gal volume. The estimated waste composition at the time of the leak and leak inventory estimate are shown in Table 8.

Table 8. Inventory Estimate for Tank 241-BX-101.

Leak Vol = 4.0 kgal or 15,100 L					
Leak Date - 1972					
Analyte	Median (kg)	Ci/L	Analyte	Median (Ci)	Ci/L
Na	1.36 E+03	3.90 E+00	Nb-93m	7.52 E-02	4.98 E-06
Al	1.30 E+02	3.19 E-01	Tc-99	1.10 E+00	7.28 E-05
Fe	2.56 E+00	3.03E-03	Ru-106	7.47 E-05	4.95 E-09
Cr	1.28 E+01	1.63 E-02	Cd-113m	4.54 E-01	3.01 E-05
Bi	1.12 E-01	3.55 E-05	Sb-125	9.40 E-01	6.22 E-05
La	8.92 E-07	4.25 E-10	Sn-126	3.26 E-02	2.16 E-06
Hg	1.12 E-03	3.68 E-07	I-129	2.13 E-03	1.41 E-07
Zr	6.40 E-03	4.65 E-06	Cs-134	1.32 E-03	8.73 E-08
Pb	1.54 E-01	4.92 E-05	Cs-137	1.76 E+02	1.16 E-02
Ni	1.61 E+00	1.82 E-03	Ba-137m	1.67 E+02	1.10 E-02
Sr	0.00 E+00	0.00 E+00	Sm-151	7.53 E+01	4.99 E-03
Mn	9.35 E-01	1.13 E-03	Eu-152	2.21 E-02	1.46 E-06
Ca	5.50 E+00	9.10 E-03	Eu-154	3.45 E+00	2.29 E-04
K	9.83 E+00	1.67 E-02	Eu-155	1.29 E+00	8.55 E-05
NO3	9.52 E+02	1.02 E+00	Ra-226	9.46 E-07	6.26 E-11
NO2	2.48 E+02	3.57 E-01	Ra-228	4.77 E-06	3.16E-10
CO3	2.34 E+02	2.59 E-01	Ac-227	5.49 E-06	3.64 E-10
PO4	1.61 E+01	1.12 E-02	Pa-231	1.98 E-05	1.31 E-09
SO4	1.01 E+02	6.96 E-02	Th-229	2.16 E-07	1.43 E-11
Si	1.46 E+01	3.44 E-02	Th-232	1.97 E-06	1.31 E-10
F	4.48 E-01	1.56 E-03	U-232	2.88 E-04	1.91 E-08
Cl	3.70 E+01	6.90 E-02	U-233	1.11 E-03	7.38 E-08

Table 8. Inventory Estimate for Tank 241-BX-101.

Leak Vol = 4.0 kgal or 15,100 L					
Leak Date - 1972					
Analyte	Median (kg)	Ci/L	Analyte	Median (Ci)	Ci/L
DBP	1.65 E+01	6.79 E-03	U-234	1.60 E-03	1.06 E-07
Butanol	5.84 E+00	5.23 E-03	U-235	6.56 E-05	4.35 E-09
TBP	0.00 E+00	0.00 E+00	U-236	5.38 E-05	3.56 E-09
NPH	0.00 E+00	0.00 E+00	U-238	1.48 E-03	9.81 E-08
U-Total	4.43 E+00	1.23 E-03	Np-237	3.71E-03	2.45 E-07
			Pu-238	9.80 E-03	6.49 E-07
Analyte	Median (Ci)	Ci/L	Pu-239	2.36 E-01	1.56 E-05
H-3	9.32 E-01	6.17 E-05	Pu-240	4.51 E-02	2.99 E-06
C-14	1.57 E-01	1.04 E-05	Pu-241	6.85 E-01	4.54 E-05
Ni-59	9.63 E-03	6.38 E-07	Pu-242	4.16 E-06	2.76 E-10
Ni-63	9.55 E-01	6.32 E-05	Am-241	4.58 E-01	3.03 E-05
Co-60	2.00 E-01	1.32 E-05	Am-243	2.87 E-05	1.90 E-09
Se-79	2.11 E-02	1.40 E-06	Cm-242	1.05 E-03	6.92 E-08
Sr-90	6.73 E+02	4.46 E-02	Cm-243	1.07 E-04	7.07 E-09
Y-90	6.76 E+02	4.48 E-02	Cm-244	1.53 E-03	1.01 E-07
Zr-93	9.94 E-02	6.58 E-06			

2.2.10 Tank 241-BX-102

This tank has a 530,000-gal capacity. Hanlon (2000) lists a leak volume of 70,000 gal for this tank and a declared leak date of 1971. The Hanlon report leak information about tank 241-BX-102 is derived from a 1971 report prepared by Womack and Larkin (Womack and Larkin 1971) documenting the results of an extensive field investigation. The 70,000-gal leak volume reported by Womack and Larkin (1971) was based on analyses of gross gamma logging data and neutron logging (soil moisture) data from 19 new drywells installed to investigate the plume from the suspected tank leak event that was thought to have taken place in 1969 or 1970. Although the data analyses performed by Womack and Larkin (1971) appear to be valid, their conclusions were not. Based on spectral gamma logging data reported in 1997 and detailed information about the 1951 tank overfill event (Hanford Works Monthly Report, 1951, declassified in 1992), clearly the waste plume investigated by Womack and Larkin (1971) originated in the1951 tank overfill event. Womack and Larkin (1971) likely "found" 70,000 gal of the 91,600 gal of metal waste lost in 1951.

Spectral gamma logging data reported by MACTEC-ERS for the group of drywells examined by Womack and Larkin (1971) show the primary source of deep gamma activity to be ^{238}U and ^{235}U, not ^{137}Cs as assumed in the 1971 study. It was reported that 22.5 tons of uranium were lost in the 91,600 gal of "metal waste" that overflowed from tank 241-BX-102 in the 1951. However, information about the 1951 tank overfill event was included in the Hanford Works monthly production report classified "secret" in 1951 and declassified in 1992. Womack and Larkin had misinformation about the 1951 tank overfill event. They believed it to involve 1C waste rather than metal waste. 1C waste would have contained almost no uranium. Thus, given the information they had in hand, their conclusions were based on the most logical interpretation of the field data. Only with the spectral gamma logging data could one distinguish gamma activity from uranium from that emitted by ^{137}Cs.

Spectral gamma logging data from the tank 241-BX-102 plume includes radionuclides from at least two waste types. The metal waste would have contributed ^{238}U, ^{235}U, and ^{137}Cs. Other radionuclides likely originated from the sluice pit leak from tank 241-BX-101 and involved an IX waste type.

The inventory estimate reported here is based on the 91.6 kgal metal waste tank overfill in 1951. The total uranium inventory estimate listed in Table 9 for the tank 241-BX-102 is considerably different from the uranium inventory loss estimates reported in 1951 (Hanford Works 1951). The 1951 report estimates that 22.5 tons of uranium were lost in the 91 kgal of metal waste lost from tank 241-BX-102. This uranium estimate assumes that the lost waste contained 0.5 lb/gal uranium as reported by Anderson (1990). However, according to the *Uranium Recovery Technical Manual* (HW-19140), most of the uranium in the metal waste stream ended up as well-formed uranium phosphate crystals (soft sludge) and less well-defined uranium carbonate solids (hard sludge). HW-19140 provides solubility data for the phosphate and carbonate solids and sludge levels in each tank of the three-, four-, and six-tank cascades. For example, in the six-tank cascade of most interest to us (i.e., tanks 241-BX-101 through 241-BY-103) 64 percent of the (assumed to be uranium bearing) sludge ended up in the first tank in the cascade, 29 percent in the second tank, and 7 percent in the third tank. The other three tanks contained no sludge. Based on the HW-19140 data, only about 36 percent of the uranium would have moved from tank 241-BX-101 to tank 241-BX-102 and the reported amount of uranium lost in the 1951 tank overfill event would need to be reduced accordingly. These data would suggest the uranium loss from tank 241-BX-102 should have been estimated to be much closer to 8 tons than the reported 22.5 tons. The estimated waste composition at the time of the leak and leak inventory estimate are shown in Table 10.

2.2.11 Tank 241-BX-108

This tank has a 530,000-gal capacity. Hanlon (2000) lists a leak volume of 2,500 gal for this tank and a declared leak date of 1974. Neither the waste transfer records nor spectral gamma logging provide much evidence suggesting a leak from this tank. An inventory estimate could be based on the 2.5-kgal leak volume from Hanlon (2000) and as assumption that the composition of the waste in tank 241-BX-108 would be similar to waste from tank 241-T-106. However, no inventory estimate is provided.

Table 9. Inventory Estimate for Tank BX-102.

Leak Vol = 91.3 kgal or 347,000 L

Leak Date - 1951

Analyte	Median (kg)	Conc (m/L)	Analyte	Median (Ci)	Ci/L
Na	2.33 E+04	2.92 E+00	Nb-93m	3.92 E-01	1.13 E-06
Al	0.00 E+00	0.00 E+00	Tc-99	3.27 E+00	9.42 E-06
Fe	1.48 E+02	7.62 E-03	Ru-106	6.43 E-08	1.85 E-13
Cr	2.90 E+01	1.60 E-03	Cd-113m	1.23 E+00	3.56 E-06
Bi	0.00 E+00	0.00 E+00	Sb-125	1.29 E-01	3.71 E-07
La	0.00 E+00	0.00 E+00	Sn-126	1.50 E-01	4.32 E-07
Hg	0.00 E+00	0.00 E+00	I-129	6.17 E-03	1.78 E-08
Zr	0.00 E+00	0.00 E+00	Cs-134	3.88 E-04	1.12 E-09
Pb	0.00 E+00	0.00 E+00	Cs-137	3.53 E+03	1.02 E-02
Ni	3.30 E+01	1.62 E-03	Ba-137m	3.35 E+03	9.66 E-03
Sr	0.00 E+00	0.00 E+00	Sm-151	3.65 E+02	1.05 E-03
Mn	0.00 E+00	0.00 E+00	Eu-152	2.61 E-02	7.53 E-08
Ca	1.85 E+02	1.33 E-02	Eu-154	2.40 E+00	6.93 E-06
K	3.70 E+01	2.73 E-03	Eu-155	1.75 E+00	5.04 E-06
NO3	1.14 E+04	5.30 E-01	Ra-226	2.01 E-05	5.80 E-11
NO2	7.36 E+02	4.61 E-02	Ra-228	7.19 E-11	2.07 E-16
CO3	1.34 E+04	6.43 E-01	Ac-227	5.28 E-05	1.52 E-10
PO4	1.19 E+04	3.60 E-01	Pa-231	1.40 E-04	4.02 E-10
SO4	7.67 E+03	2.30 E-01	Th-229	1.37 E-08	3.95 E-14
Si	3.94 E+01	4.05 E-03	Th-232	1.24 E-10	3.57 E-16
F	0.00 E+00	0.00 E+00	U-232	7.42 E-05	2.14 E-10
Cl	1.54 E+02	1.25 E-02	U-233	3.38 E-06	9.75 E-12
DBP	0.00 E+00	0.00 E+00	U-234	3.07 E+00	8.85 E-06
Butanol	0.00 E+00	0.00 E+00	U-235	1.36 E-01	3.91 E-07
TBP	0.00 E+00	0.00 E+00	U-236	3.16 E-02	9.10 E-08
NPH	0.00 E+00	0.00 E+00	U-238	3.15 E+00	9.07 E-06
U-Total (kg)	9.43 E+03	1.14 E-01	Np-237	1.97 E-02	5.67 E-08
			Pu-238	1.78 E-02	5.14 E-08
Analyte	Median (Ci)	Ci/L	Pu-239	2.23 E+00	6.42 E-06
H-3	8.76 E+00	2.52 E-05	Pu-240	2.17 E-01	6.26E-07
C-14	3.02 E-01	8.69 E-07	Pu-241	7.85 E-01	2.26 E-06

Table 9. Inventory Estimate for Tank BX-102.

Leak Vol = 91.3 kgal or 347,000 L					
Leak Date - 1951					
Ni-59	1.31 E-01	3.78 E-07	Pu-242	3.59 E-06	1.03 E-11
Ni-63	1.20 E+01	3.45 E-05	Am-241	1.07 E+00	3.07 E-06
Co-60	1.24 E-01	3.58 E-07	Am-243	7.70 E-06	2.22 E-11
Se-79	9.89 E-02	2.85 E-07	Cm-242	5.07 E-04	1.46 E-09
Sr-90	2.96 E+03	8.53 E-03	Cm-243	1.04 E-05	3.01 E-11
Y-90	2.96 E+03	8.53 E-03	Cm-244	2.06 E-04	5.95 E-10
Zr-93	4.70 E-01	1.35 E-06			

Table 10. Inventory Estimate for Tank BX-111.

Leak Vol = 4.0 kgal or 15,100 L					
Leak Date - 1965					
Analyte	Median (kg)	Ci/L	Analyte	Median (Ci)	Ci/L
Na	6.30 E+02	1.81 E+00	Nb-93m	1.64 E-03	1.09 E-08
Al	2.49 E+02	6.11 E-01	Tc-99	1.50 E-02	9.93 E-08
Fe	1.70 E+00	2.01 E-03	Ru-106	3.31 E-06	2.19 E-11
Cr	2.47 E+00	3.14 E-03	Cd-113m	8.85 E-03	5.86 E-08
Bi	1.95 E-01	6.19 E-05	Sb-125	1.12 E-02	7.40 E-08
La	0.00 E+00	0.00 E+00	Sn-126	6.93 E-04	4.59 E-09
Hg	2.92 E-02	9.62 E-06	I-129	2.87 E-05	1.90 E-10
Zr	7.08 E-03	5.14 E-06	Cs-134	7.27 E-04	4.81 E-09
Pb	4.76 E+00	1.52 E-03	Cs-137	5.17 E+01	3.43 E-04
Ni	1.39 E+00	1.57 E-03	Ba-137m	4.89 E+01	3.24 E-04
Sr	0.00 E+00	0.00 E+00	Sm-151	1.65 E+00	1.09 E-05
Mn	0.00 E+00	0.00 E+00	Eu-152	2.83 E-04	1.87 E-09
Ca	5.54 E+00	9.17 E-03	Eu-154	4.37 E-02	2.89 E-07
K	1.91 E+00	3.23 E-03	Eu-155	1.99 E-02	1.32 E-07
NO3	7.50 E+02	8.01 E-01	Ra-226	5.53 E-08	3.66 E-13
NO2	2.21 E+02	3.19 E-01	Ra-228	2.07 E-05	1.37 E-10
CO3	1.46 E+01	1.61 E-02	Ac-227	5.04 E-06	3.33 E-11
PO4	1.28 E+01	8.94 E-03	Pa-231	2.73 E-05	1.81 E-10
SO4	2.72 E+01	1.88 E-02	Th-229	9.40 E-06	6.23 E-11
Si	7.22 E-01	1.70 E-03	Th-232	4.43 E-05	2.93 E-10

Table 10. Inventory Estimate for Tank BX-111.

Leak Vol = 4.0 kgal or 15,100 L					
Leak Date - 1965					
Analyte	Median (kg)	Ci/L	Analyte	Median (Ci)	Ci/L
F	8.60 E-01	3.00 E-03	U-232	8.67 E-04	5.74 E-09
Cl	8.42 E+00	1.57 E-02	U-233	3.37 E-03	2.23 E-08
DBP	5.23 E-03	2.15 E-06	U-234	4.98 E-03	3.30 E-08
Butanol	1.85 E-03	1.66 E-06	U-235	2.05 E-04	1.36 E-09
TBP	0.00 E+00	0.00 E+00	U-236	1.42 E-04	9.43 E-10
NPH	0.00 E+00	0.00 E+00	U-238	4.73 E-03	3.14 E-08
U-Total	1.42 E+01	3.94 E-03	Np-237	1.06 E-04	7.01 E-10
			Pu-238	3.00 E-03	1.98 E-08
Analyte	Median (Ci)	Ci/L	Pu-239	1.33 E-01	8.78 E-07
H-3	1.46 E-02	9.65 E-08	Pu-240	2.28 E-02	1.51 E-07
C-14	2.08 E-03	1.38 E-08	Pu-241	2.38 E-01	1.57 E-06
Ni-59	5.58 E-04	3.69 E-09	Pu-242	6.81 E-07	4.51 E-12
Ni-63	5.44 E-02	3.61 E-07	Am-241	1.01 E-02	6.72 E-08
Co-60	2.21 E-03	1.46 E-08	Am-243	1.03 E-07	6.79 E-13
Se-79	4.54 E-04	3.01 E-09	Cm-242	4.22 E-06	2.80 E-11
Sr-90	4.51 E+01	2.99 E-04	Cm-243	1.14 E-07	7.54 E-13
Y-90	4.51 E+01	2.98 E-04	Cm-244	3.84 E-06	2.55 E-11
Zr-93	2.14 E-03	1.42 E-08			

2.2.11 Tank 241-BX-110

This tank has a 530,000-gal capacity. Hanlon (2000) does not list a leak volume for this tank, but reports a declared leak date of 1976. The waste transfer records provide no evidence of a leak from this tank. Drywell 21-10-03 exhibits high ^{137}Cs contamination from the surface down to the 90-ft level. Drywell 21-10-05 exhibits high ^{137}Cs contamination beginning at about 32 ft and continuing down to the 90-ft level. Although the spectral gamma logging data indicate high levels of contamination in the southeast side of this tank, no volume estimates are available. Thus, no inventory estimate is reported.

2.2.12 Tank 241-BX-111

This tank has a 530,000-gal capacity. Hanlon (2000) does not list a leak volume for this tank, but reports a declared leak date of 1984. Drywells 21-11-03 and 21-11-04 exhibit very narrow bands of high ^{137}Cs activity at the 40-ft depth. Based on a review of the waste transfer records, the inventory estimate was calculated assuming a 4,000-gal leak volume.

2.2.13 Tanks 241-B-201, -203, and -204

The 200-series tanks are 55,000-gal capacity and were used in a cascade to treat low-level waste associated with the bismuth phosphate process. The estimated waste compositions at the time of the leak and the leak inventory estimates are shown in Tables 5, 6, and 7.

2.2.14 Drywell Contamination Near BX Tanks Currently Assumed Non-Leakers

Drywell 21-06-05, located on the southeast side of tank 241-BX-106, exhibited a spike of ^{137}Cs contamination at 40 ft bgs and ^{238}U and ^{235}U contamination between 40 and 55 ft bgs. The uranium contamination is clearly linked to metal waste stored in this tank between 1948 and 1953. Although this tank remained active until the late 1970's, no other waste types are observed. This leads to the conclusion that the metal waste originated from a pipe leak or tank overfill event rather a failure of the tank.

Drywell 21-07-06 exhibits "high dead zone" ^{137}Cs regions beginning at 25 ft bgs. The ^{137}Cs likely came from one of the many transfer lines in the area. Drywell 21-03-12 exhibits a high dead zone region between 21 and 15 ft bgs. Again, the ^{137}Cs likely originated from a transfer line leak.

2.2.15 Tank 241-BY-103

This tank has a 758,000-gal capacity. Hanlon (2000) lists a leak volume of less than 5,000 gal and a declared leak date of 1973. The waste transfer records are so complex that they are inconclusive. This tank was a "receiver tank" as part of the in-tank solidification project from 1967 through the early 1970's. Drywell 22-03-05 is highly contaminated from the surface to the bottom of the well (100 ft) with a zone between 25 and 45 ft where gamma activity saturated the probe. No inventory estimate was developed for this tank.

2.2.16 Tank 241-BY-105

This tank has a 758,000-gal capacity. Hanlon (2000) does not list a leak volume for this tank, but reports a declared leak date of 1984. Neither the waste transfer records nor spectral gamma logging data provide strong evidence of a leak from this tank. No inventory estimate is provided.

2.2.17 Tank 241-BY-106

This tank has a 758,000-gal capacity. Hanlon (2000) does not list a leak volume for this tank, but reports a declared leak date of 1984. Neither the waste transfer records nor spectral gamma logging data provide strong evidence of a leak from this tank. No inventory estimate is provided.

2.2.18 Tank 241-BY-107

This tank has a 758,000-gal capacity. Hanlon (2000) lists a leak volume of 15,100 gal and a declared leak date of 1984. Neither the waste transfer records nor spectral gamma logging data provide strong evidence of a leak from this tank. The highest contamination is near-surface and essentially ^{137}Cs. Most deep contamination is ^{60}Co. The ^{60}Co likely percolated down from the surface. Although the available data suggest a large (non-quantified) waste loss near-surface, loss volumes could not be estimated.

2.2.19 Tank 241-BY-108

This tank has a 758,000-gal capacity. Hanlon (2000) lists a leak volume of less than 5,000 gal and a declared leak date of 1972. Neither the waste transfer records nor spectral gamma logging data provide strong evidence of a leak from this tank. The highest contamination is found near-surface. Most deep contamination is ^{60}Co, which likely percolated down from the surface.

3.0 REFERENCES

Agnew, S. F., 1997, *Hanford Tank Chemical and Radionuclide Inventories: HDW Model, Rev. 4*, LA-UR-96-3860, Rev. 4, Los Alamos National Laboratory, Los Alamos, New Mexico.

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

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

Brevick, C. H., L. A. Gaddis, and E. D. Johnson, 1995, *Historical Tank Content Estimate for the Northeast Quadrant of the Hanford 200 East Area,* WHC-SD-WM-ER-349, Rev 0, Westinghouse Hanford Company, Richland, Washington.

Corbin, R.A., B.C. Simpson, and S.F, Agnew, 2000, *Hanford Soil Inventory and Uncertainty Model Rev. 1*, LA-UR-00-4050, Los Alamos National Laboratory, Los Alamos, New Mexico.

DOE-GJPO, 2000, *Vadose Zone Characterization Project at the Hanford Tank Farms, B Tank Farm Report*, GJO-99-113-TAR, U.S. Department of Energy, Albuquerque Operations Office and Grand Junction Projects Office, Grand Junction, Colorado.

DOE-GJPO, 1998, *Hanford Tank Farms Vadose Zone BX Tank Farm Report*, GJO-98-40-TAR, U.S. Department of Energy, Albuquerque Operations Office and Grand Junction Projects Office, Grand Junction.

DOE-GJPO, 1997, *Hanford Tank Farms Vadose Zone BY Tank Farm Report*, GJO-96-2-TAR, U.S. Department of Energy, Albuquerque Operations Office and Grand Junction Projects Office, Grand Junction, Colorado.

Hanford Works, 1951, *Hanford Works Monthly Report for February 1951*, HW-20438-Del, Richland, Washington.

Hanlon, B. M., 2000, *Waste Tank Summary Report for Month Ending July 31, 2000,* HNF-EP-0182-148, CH2M HILL Hanford Group, Inc., Richland, Washington.

MACTEC-ERS, 1997, *Tank Summary Data Report for Tank BX-102*, GJ-HAN-89, Prepared by MACTEC-ERS for the U.S. Department of Energy, Grand Junction Projects Office, Grand Junction, Colorado.

Narbutovskih S. M., 1998, *Results of Phase 1 Groundwater Quality Assessment for Single-Shell Tank Farm Waste Management Areas B-BX-BY at the Hanford Site,* PNNL-11826, Pacific Northwest National Laboratory, Richland, Washington.

Jones, T. E., R. A. Watrous, G. T. Maclean, April 2000a, *Inventory Estimates for Single-Shell Tank Leaks in S and SX Tank Farms*, RPP-6285, CH2M HILL Hanford Group, Inc., Richland, Washington.

Jones, T. E., M. I. Wood, R. A. Corbin, and B. C. Simpson, 2000b, *Preliminary Inventory Estimates for Single-Shell Tank Leaks in T, TX, And TY Tank Farms*, RPP-7218 Rev 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

Jungfleisch, F. M., 1984, *Preliminary Estimation of Waste Tank Inventories in Hanford Tanks Through 1980*, WHC-SD-WM-TI-057, Westinghouse Hanford Company, Richland, Washington.

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

Randall, R., R. Price, J. Caggiano, January 2000, *Analysis and Summary Report of Historical Dry Well Gamma Logs for 241-B Tank Farm – 200 East*, RPP-5433, Rev 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

Myers, D. A., October 1999a, *Analysis of Historical Dry Well Gamma Logs for 241-BX Tank Farm*, RPP-3531, Rev 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

Myers, D. A., October 1999b, *Analysis of Historical Dry Well Gamma Logs for 241-BY Tank Farm*, RPP-3532, Rev 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

Williams, J. C., September 1999, *Historical Vadose Zone Contamination From B, BX, and BY Tank Farm Operations*, RPP-5231, Rev 0, Fluor Daniel Northwest, Inc., Richland, Washington.

Womack, J. C., and D. J. Larkin, 1971, *Investigation and Evaluation of 102-BX Tank Leak*, ARH-2035, Atlantic Richfield Hanford Company, Richland, Washington.

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