RPP-RPT-43704
Revision 0

# Hanford BY-Farm Leak Assessments Report


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## EXECUTIVE SUMMARY

The Tank Farms Operating Contractor developed jointly with U.S. Department of Energy, Office of River Protection and State of Washington Department of Ecology a process to reassess selected tank leak estimates (volumes and inventories), and to update single-shell tank leak and unplanned release volumes and inventory estimates as emergent field data is obtained (RPP-32681, *Process to Assess Tank Farm Leaks in Support of Retrieval and Closure Planning*). This process does not represent a formal tank leak assessment in accordance with procedure TFC-ENG-CHEM-D-42, "Tank Leak Assessment Process." This report documents reassessment of past leaks in the 241-BY Tank Farm. This revision of the report will be distributed for public review as appropriate and comments will be incorporated in Revision 1.

Tank waste loss events were reassessed for single-shell tanks 241-BY-103, 241-BY-105, 241-BY-106, 241-BY-107 and 241-BY-108 which have previously been designated as suspected leakers. Table ES-1 summarizes the results of the reassessment of tank waste loss events for these single-shell tanks and provides a comparison to the waste loss estimates contained in HNF-EP-0182, *Waste Tank Summary Report for Month Ending March 31, 2010*. In addition, tanks currently assumed "sound" were reviewed to assess the potential for other tank leaks. Where known, the estimated volume of waste lost and the waste type can be used to derive an estimated inventory of constituents released to soil to update current estimates in RPP-26744, *Hanford Soil Inventory Model, Rev. 1*. Available data suggest that several tanks were filled beyond capacity during operations in the 1950s and 1960s resulting in the potential for release of waste to soil without any loss of tank integrity.

DOE/RL-88-30, *Hanford Site Waste Management Units Report*, contains the official listing of unplanned releases identified at the Hanford Site. The operational history for the 241-BY Tank Farm was reviewed to determine if additional information exists for the unplanned releases within the 241-BY Tank Farm not associated with tank waste loss events. No significant new information was located for these unplanned releases. However, potential new unplanned releases as a result of pipeline failures were identified through review of the operational histories for the 241-BY Tank Farm, as summarized in Section 5.0. Insufficient information was available to estimate a volume or inventory of tank waste potentially discharged to the soil from most of the identified pipeline failures.

**Table ES-1. Summary of Tank Waste Loss Events**

| Tank | Description | HNF-EP-0182 (Rev 264) Estimate | Revised Estimate |
|---|---|---|---|
| 241-BY-103 | Tank BY-103 was classified as a confirmed leaker in 1973 based on elevated gross gamma-ray activity in drywells surrounding the tank. No unaccounted for liquid level decreases observed. <5,000 gal leak based on uncertainty in manual tape measurements. Drywell activity estimates indicate the leak may have been smaller, but are inconclusive. SIM composition estimates consistent with sample data, Increases SIM volume estimate from 400 gal to 5,000 gal. | <5,000 gal | <5,000 gal<br>$^{137}$Cs: 14,500 |
| 241-BY-105<br>241-BY-106<br>241-BY-107<br>241-BY-108 | QI or assumed leaker based on dry well activity (low compared to BY-103). No basis for tank leak estimates. Line leaks, Overfills (spares/cascades), ITS process spills and other operations spills could account for activity observed. Extensive near surface activity. Low $^{137}$Cs but $^{60}$Co below tanks. Recommended TFC-ENG-CHEM-D-42 assessments for all to reassess tank integrity. | No estimate | No estimate |
| Sound BY-Farm Tanks | Due to uncertainty of the liner integrity for ITS and ITS bottoms tanks, the leak assessment panel recommended that formal leak integrity assessments be conducted for all BY-Farm tanks including tanks currently classified as "sound" in HNF-EP-0182, except BY-103 (confirmed to have leaked in the past), per TFC-ENG-CHEM-D-42. The assessments are needed to support determination of technologies to retrieve waste from BY-Farm tanks in the future. | | |
| Line losses | Line leaks and operations spills identified for BY, BX and B, some are current UPRs, many are not. | NA | No estimate for most line leaks identified in the report |

ITS = In-Tank Solidification
NA = not applicable
QI = questionable integrity (tank)
SIM = Hanford Soil Inventory Model
UPR = unplanned release

References:
HNF-EP-0182, *Waste Status Summary Report for Month Ending March 31, 2010*, Rev. 264.
TFC-ENG-CHEM-D-42, "Tank Leak Assessment Process."

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## Acronyms and Abbreviations

| | |
|---|---|
| 1C | first cycle decontamination (waste) |
| bgs | below ground surface |
| DOE | U.S. Department of Energy |
| DOE-ORP | U.S. Department of Energy, Office of River Protection |
| dpm | disintegrations per minute |
| DST | double-shell tank |
| Ecology | State of Washington Department of Ecology |
| FIC | Food Instrument Corporation (conductivity gauge) |
| HDW | Hanford Defined Waste |
| HRLS | high rate logging system |
| HRR | high resolution resistivity |
| ITS | In-Tank Solidification |
| ITS-1 | In-Tank Solidification Unit #1 |
| ITS-2 | In-Tank Solidification Unit #2 |
| LOW | liquid observation well |
| PFeCN | sludge from the ferrocyanide scavenging process |
| PNNL | Pacific Northwest National Laboratory |
| PUREX | Plutonium Uranium Extraction (Plant) |
| QI | questionable integrity (tank) |
| RAS | Radionuclide Assessment System |
| RCRA | *Resource Conservation and Recovery Act of 1976* |
| RHO | Rockwell Hanford Operations |

| | |
|---|---|
| SGE | surface geophysical exploration |
| SGLS | spectral gamma logging system |
| SIM | Hanford Soil Inventory Model |
| SST | single-shell tank |
| TBP | tributyl phosphate (waste) |
| TSD | temporary storage and disposal |
| UPR | unplanned release |
| WMA | Waste Management Area |
| WRPS | Washington River Protection Solutions, LLC |
| WTW | well to well |

**Units**

| | |
|---|---|
| Ci | curie |
| kL | kiloliter ($10^3$ liters) |
| mrem | millirem ($10^{-3}$ rem) |
| mR | milliroentgen ($10^{-3}$ roentgen) |
| pCi | picocurie ($10^{-12}$ curies) |
| rad | radiation adsorbed dose |
| µCi | microcurie ($10^{-6}$ curies) |
| µg | microgram ($10^{-6}$ grams) |
| µS/cm | microsiemens ($10^{-6}$ siemens) per centimeter ($10^{-2}$ meter) |

# 1.0 INTRODUCTION

Vadose zone inventories are estimated by multiplying the leak volume by the contaminant concentration in the leak. This concentration is based on process knowledge of the composition of waste in the tank at the time the release occurred. For some major tank leaks and unplanned releases (UPR), historical records confirm the waste loss event and provide a strong technical basis for leak volume and inventory estimates. However, for many tank leaks and UPRs little data is available.

Numerous studies and investigations have estimated the inventory of contaminants in the tank farms vadose zone. HNF-EP-0182[1], *Waste Status Summary Report for Month Ending March 31, 2010* provides the commonly accepted basis for tank leak volume estimates, but it does not provide associated inventory estimates or UPR volumes. 241-BY Tank Farm tank leak volume estimates reported in HNF-EP-0182 have not been updated for many years. RPP-23405, *Tank Farm Vadose Zone Contamination Volume Estimates* summarizes vadose zone tank leak characterization and investigations. It is consistent with many of the tank leak volume estimates listed in HNF-EP-0182 and provides UPR volume estimates. However, RPP-23405 shows large differences in estimated leak volumes, both higher and lower, compared to some tank leak volume estimates in HNF-EP-0182. The RPP-23405 volume estimates were used in RPP-26744, *Hanford Soil Inventory Model, Rev. 1* (SIM) to estimate leak inventories for DOE/ORP-2005-01, *Initial Single-Shell Tank System Performance Assessment for the Hanford Site*. RPP-23405 does not address volume uncertainties and some of the leak volume estimates, data interpretations, and conclusions presented in RPP-23405 are in question.

The Tank Farm Operations Contractor developed jointly with U.S. Department of Energy, Office of River Protection (DOE-ORP) and State of Washington Department of Ecology (Ecology) a process to reassess selected tank leak estimates (volumes and inventories), and to update tank leak and UPR volumes and inventory estimates as emergent field data is obtained (RPP-32681, *Process to Assess Tank Farm Leaks in Support of Retrieval and Closure Planning*). This report documents the results of applying the process described in RPP-32681 to reassess UPRs and tank leak estimates in the 241-BY Tank Farm. Current SIM estimates and leak volume estimates in the tank waste status report (HNF-EP-0182) should be updated to reflect revised estimates in this report.

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[1] HNF-EP-0182 was originally prepared as a monthly compendium of a multitude of data on the current status of the tanks and changes thereto. The purpose of this monthly report was to facilitate management of the tanks and tank farms and to alert operating personnel as to relevant information pertaining to whether waste could or should be safely stored in the various tanks. It was never intended to be a compendium of the volume estimated to have been lost or the inventory of potentially released waste from any tank(s). The document took on a more official role in the 1990s when it became the repository for information in response to "Watch List" tanks established by congressional action to focus on potential problems of high heat tanks, organic vapor tanks and those containing potentially flammable gases.

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# 2.0 SCOPE AND CRITERIA

An assessment team comprised of representatives from DOE-ORP, Ecology, and Washington River Protection Solutions, LLC (WRPS) was assembled to review available information relating to waste loss events in the 241-BY Tank Farm. The assessment team membership is listed in Table 3-1. Minutes from team meetings are included in Appendix A.

**Table 2-1. Waste Loss Event Assessment Team**

| Name | Organization | Role |
|---|---|---|
| Joe Caggiano | Washington State Department of Ecology | Regulatory oversight (primary focus vadose zone and groundwater data) |
| Jim Field | Washington River Protection Solutions | Process lead<br>Knowledge and experience in reviewing, analyzing, and interpreting in-tank (i.e., surface liquid level and liquid observation well) and vadose zone data, and of tank process history. |
| Les Fort | Washington State Department of Ecology | Lead regulatory oversight (primary focus tank waste processing operations) |
| Paul Henwood | S. M. Stoller, Inc. | Knowledge and experience in obtaining and analyzing drywell data. |
| Bob W. Lober | U.S. Department of Energy Office of River Protection | Tank Farms Programs and Project Division representative |
| Beth Rochette | Washington State Department of Ecology | Regulatory oversight<br>(primary focus: UPRs and direct exposure pathway) |
| Dennis Washenfelder | CH2M HILL Plateau Remediation Contract | Knowledge and experience with operations of the tank farm and individual tank, tank history, tank waste characteristics, and in-tank processes. |
| Marcus I. Wood | CH2M HILL Plateau Remediation Contract | Knowledge and experience in reviewing, analyzing, and interpreting drywell and groundwater monitoring data. |

In accordance with RPP-32681, the following steps were conducted in reassessing waste losses within the 241-BY Tank Farm.

- Collect information and data regarding past tank leaks in BY-Farm (see RPP-32681).
- Collect information and data regarding UPRs, including pipeline leaks, spills, and near surface contamination, in BX-Farm.
- Compile information from previously reported waste tank leaks and UPRs to estimate the volume of tank waste which leaked to the vadose zone and the time at which these leaks occurred.

- Compile data regarding the waste composition at the time of a tank leak or UPR from the available sources, such as Sample data, Tank Waste Information Network System, Best Basis Inventory, Hanford Defined Waste (HDW) model, etc.

- Combine waste leak volume with waste composition to estimate radionuclide and chemical inventory of tank leaks and UPRs.

# 3.0 BACKGROUND

Approximately 57 million gal of radioactive waste from chemical processing and plutonium processing operations are stored in 177 underground storage tanks on the Hanford Site. Of these tanks, 149 are single-shell tanks (SSTs), which consist of a single carbon steel liner inside a concrete shell. Nominal capacities range from 55,000 to 1,000,000 gal. For the immediate future, plans call for retrieval of waste from the SSTs and transfer to the 28 double-shell tanks (DSTs), with eventual transfer for treatment in the Waste Treatment and Immobilization Plant currently under construction.

## 3.1 241-BY TANK FARM DESCRIPTION

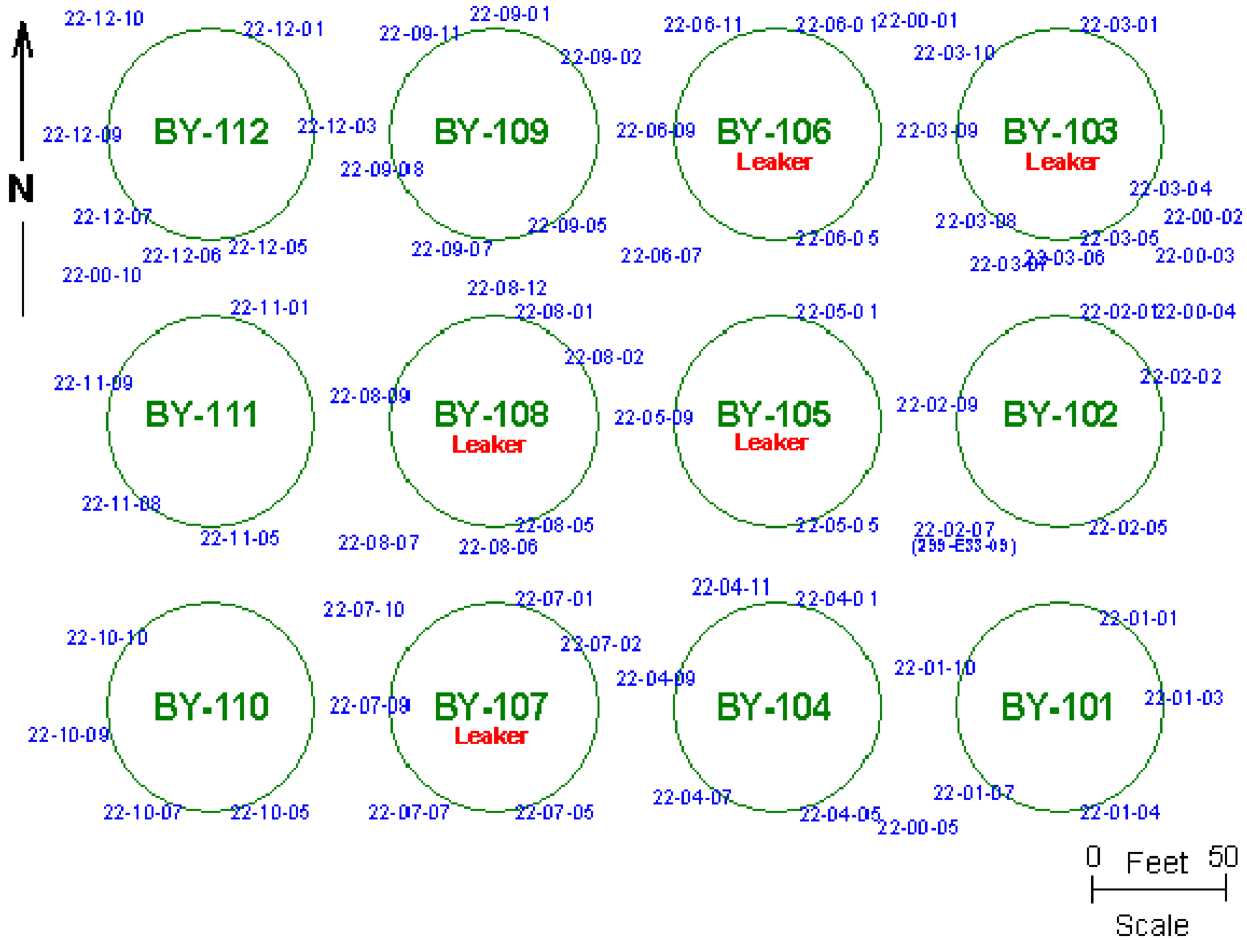
The 241-BY Tank Farm is a second-generation tank farm constructed at the Hanford Site to store high-level radioactive waste generated from chemical processing of irradiated uranium fuel. Located in the north-central part of the 200 East Area, north of B Plant, BY-Farm was constructed in 1948 and 1949 by General Electric Company, the Hanford operations contractor at that time. BY-Farm consists of twelve 758,000-gal underground waste storage tanks. Figure 3-1 shows the relative positions of these tanks and the monitoring drywells around them. Table 3-1 lists and describes the drywells. The drywells were drilled to roughly 100 ft below ground surface (bgs) and the water table is currently~247 ft below BY-Farm.

The tanks in BY-Farm are a modified 241-B Tank Farm design and are a second generation design or Type III tank. They are domed tanks 75 ft in diameter with a maximum operational height (maximum waste level) of ~23 ft above the tank bottom (Figure 3-2). The tops of the tanks are covered with ~8 ft of fill material, and the bottoms of the tanks are dished down. The tanks have a steel-reinforced concrete shell that is 1 ft thick and a mild carbon steel inner liner that covers the bottom and sides of the shell. The steel liner on the tank sides extends ~1 ft above the cascade-line connections. The tanks were designed for a maximum fluid temperature of 220 °F (WHC-SD-WM-ER-312, *Supporting Document for the Historical Tank Content Estimate for BY Tank Farm*).

The BY-Farm tanks are sited at slightly different elevations, creating a gradient from south to north that allows fluids to flow from one tank to another as they are filled (Figure 3-3). The tanks are arranged in four cascades, each consisting of a three-tank cascade series with the receiving tank 1 ft lower than the feed tank. The cascade inlet and overflow connections to the tank are ~23 ft above the tank bottom, which is ~22 ft bgs. The inlet and overflow line connections are sleeved through the concrete shell and welded to the steel tank liner. The domes of the BY-Farm tanks were modified from previous designs to accommodate additional tank risers, which allowed more uniform access to the tank interior. The BY-Farm tanks are connected to the end tanks of the 241-BX Tank Farm in the following configurations: tank 241-BX-103 (BX-103) to tank 241-BY-101 (BY-101); tank 241-BX-106 (BX-106) to tank 241-BY-104 (BY-104); tank 241-BX-109 (BX-109) to tank 241-BY-107 (BY-107); and tank 241-BX-112 (BX-112) to tank 241-BY-110 (BY-110) (WHC-SD-WM-ER-312).

**Figure 3-1. 241-BY Tank Farm Laterals and Drywells**

Note: Tanks marked "**Leaker**" are confirmed or assumed leakers per HNF-EP-0182




Reference: HNF-EP-0182, *Waste Status Summary Report for Month Ending March 31, 2010*, Rev. 264.

Various coatings and sealants were used to prevent leaks and intrusions. For each tank in BY-Farm, a three-ply asphalt waterproofing was applied over the foundation and steel tank. Two coats of "Du Lux Seachrome" primer were sprayed on all exposed interior tank surfaces. The tank ceiling dome was covered with three applications of magnesium zinc fluorosilicate wash. Lead flashing was used to protect the joint where the steel liner meets the concrete dome. Asbestos gaskets were used to seal the risers in the tank dome. The tank was waterproofed on the sides and top with tar and welded wire reinforced gunite (HW-3783, *Specifications for Construction of Additional Waste Storage Facilities, 200 East Area, Bldg. 241-BY*). Welding and inspecting the inside of the tank liners was facilitated by cutting an access hole (~3 $ft^2$) in one of the knuckle plates to allow welders and X-ray inspectors to move their equipment directly into the tank, eliminating the time consuming procedure of elevating and lowering the equipment over the sides of the tank liners.

**Table 3-1. 241-BY Tank Farm Drywells**

| Well No. | Well ID | Well Name | Drill Date | Drill Depth (ft) |
|---|---|---|---|---|
| 22-00-01 | A6893 | 299-E33-85 | 31-Aug-49 | 150 |
| 22-00-02 | A7047 | 299-E33-240 | 31-Dec-73 | 100 |
| 22-00-03 | A6892 | 299-E33-84 | 31-Jul-49 | 150 |
| 22-00-04 | A7048 | 299-E33-241 | 31-Dec-73 | 100 |
| 22-00-05 | A6891 | 299-E33-83 | 31-Jul-49 | 150 |
| 22-00-10 | A6896 | 299-E33-88 | 31-Aug-49 | 150 |
| 22-01-01 | A6984 | 299-E33-176 | 31-Dec-71 | 100 |
| 22-01-03 | A7052 | 299-E33-245 | 31-May-74 | 100 |
| 22-01-04 | A6985 | 299-E33-177 | 31-Dec-71 | 100 |
| 22-01-07 | A6986 | 299-E33-178 | 31-Dec-71 | 100 |
| 22-01-10 | A7053 | 299-E33-246 | 31-May-74 | 100 |
| 22-02-01 | A6909 | 299-E33-101 | 31-Jul-70 | 100 |
| 22-02-02 | A7034 | 299-E33-227 | 31-Oct-73 | 100 |
| 22-02-05 | A7035 | 299-E33-228 | 31-Oct-73 | 100 |
| 22-02-09 | A6910 | 299-E33-102 | 31-Aug-70 | 100 |
| 22-02-07 | A4873 | 299-E33-9 | 31-Jul-49 | 275 (Webster Completion : Potential multiple casing, liner to 234 ft, grouted) |
| 22-03-01 | A6912 | 299-E33-104 | 31-Aug-70 | 100 |
| 22-03-04 | A7018 | 299-E33-211 | 31-Dec-72 | 100 |
| 22-03-05 | A6911 | 299-E33-103 | 31-Aug-70 | 100 |
| 22-03-06 | A7017 | 299-E33-210 | 31-Dec-72 | 100 |
| 22-03-07 | A7049 | 299-E33-242 | 31-Dec-73 | 100 |
| 22-03-08 | A7051 | 299-E33-244 | 31-Dec-73 | 100 |
| 22-03-09 | A6913 | 299-E33-105 | 31-Aug-70 | 100 |
| 22-03-10 | A7050 | 299-E33-243 | 31-Dec-73 | 100 |
| 22-04-01 | A6914 | 299-E33-106 | 31-Aug-70 | 100 |
| 22-04-05 | A6915 | 299-E33-107 | 31-Jul-70 | 100 |
| 22-04-07 | A7055 | 299-E33-248 | 31-May-74 | 100 |
| 22-04-09 | A6916 | 299-E33-108 | 31-Aug-70 | 125 |
| 22-04-11 | A7056 | 299-E33-249 | 31-May-74 | 100 |
| 22-05-01 | A6917 | 299-E33-109 | 31-Jul-70 | 100 |
| 22-05-05 | A6918 | 299-E33-110 | 31-Jul-70 | 100 |
| 22-05-09 | A6919 | 299-E33-111 | 31-Jul-70 | 100 |
| 22-06-01 | A6920 | 299-E33-112 | 31-Jul-70 | 100 |
| 22-06-05 | A6921 | 299-E33-113 | 31-Jul-70 | 100 |
| 22-06-07 | A6894 | 299-E33-86 | 31-Aug-49 | 150 |

**Table 3-1. 241-BY Tank Farm Drywells**

| Well No. | Well ID | Well Name | Drill Date | Drill Depth (ft) |
|---|---|---|---|---|
| 22-06-09 | A6922 | 299-E33-114 | 31-Jul-70 | 100 |
| 22-06-11 | A7057 | 299-E33-250 | 31-May-74 | 100 |
| 22-07-01 | A6923 | 299-E33-115 | 31-Aug-70 | 100 |
| 22-07-02 | A7013 | 299-E33-206 | 31-Jan-73 | 100 |
| 22-07-05 | A6924 | 299-E33-116 | 31-Jul-70 | 100 |
| 22-07-07 | A7058 | 299-E33-251 | 31-May-74 | 100 |
| 22-07-09 | A6925 | 299-E33-117 | 31-Aug-70 | 100 |
| 22-07-10 | A7059 | 299-E33-252 | 31-May-74 | 100 |
| 22-08-01 | A6926 | 299-E33-118 | 31-Jul-70 | 100 |
| 22-08-02 | A7015 | 299-E33-208 | 31-Jan-73 | 100 |
| 22-08-05 | A6927 | 299-E33-119 | 31-Jul-70 | 100 |
| 22-08-06 | A7014 | 299-E33-207 | 31-Jan-73 | 100 |
| 22-08-07 | A6895 | 299-E33-87 | 31-Aug-49 | 150 |
| 22-08-09 | A6928 | 299-E33-120 | 31-Jul-70 | 100 |
| 22-08-12 | A7016 | 299-E33-209 | 31-Jan-73 | 100 |
| 22-09-01 | A6931 | 299-E33-123 | 28-Feb-70 | 100 |
| 22-09-02 | A7066 | 299-E33-259 | 30-Jun-74 | 100 |
| 22-09-05 | A6930 | 299-E33-122 | 28-Feb-70 | 100 |
| 22-09-07 | A7067 | 299-E33-260 | 30-Jun-74 | 100 |
| 22-09-08 | A6929 | 299-E33-121 | 28-Feb-70 | 100 |
| 22-09-11 | A7060 | 299-E33-253 | 31-May-74 | 100 |
| 22-10-05 | A6932 | 299-E33-124 | 31-Aug-70 | 100 |
| 22-10-07 | A7061 | 299-E33-254 | 31-May-74 | 100 |
| 22-10-09 | A7062 | 299-E33-255 | 31-May-74 | 100 |
| 22-10-10 | A6933 | 299-E33-125 | 31-Aug-70 | 100 |
| 22-11-01 | A6934 | 299-E33-126 | 31-Aug-70 | 100 |
| 22-11-05 | A6935 | 299-E33-127 | 31-Aug-70 | 100 |
| 22-11-08 | A7063 | 299-E33-256 | 31-May-74 | 100 |
| 22-11-09 | A6936 | 299-E33-128 | 31-Aug-70 | 100 |
| 22-12-01 | A6908 | 299-E33-100 | 30-Nov-67 | 100 |
| 22-12-03 | A6902 | 299-E33-94 | 30-Nov-67 | 100 |
| 22-12-05 | A6903 | 299-E33-95 | 30-Nov-67 | 100 |
| 22-12-06 | A6904 | 299-E33-96 | 31-Dec-67 | 100 |
| 22-12-07 | A6905 | 299-E33-97 | 30-Nov-67 | 100 |
| 22-12-09 | A6906 | 299-E33-98 | 31-Dec-67 | 100 |
| 22-12-10 | A6907 | 299-E33-99 | 31-Dec-67 | 100 |

**Figure 3-2. Simplified Sketch of 241-BY Farm Tank**

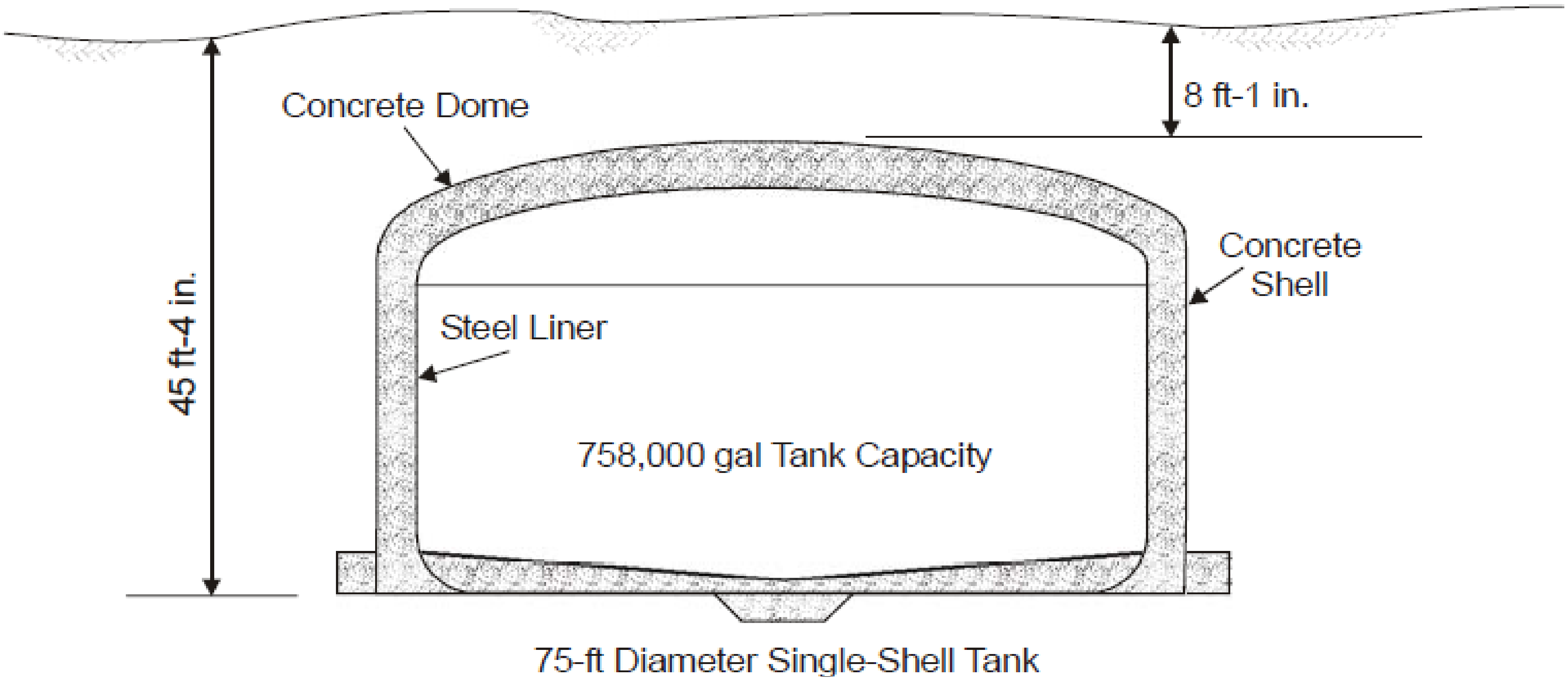
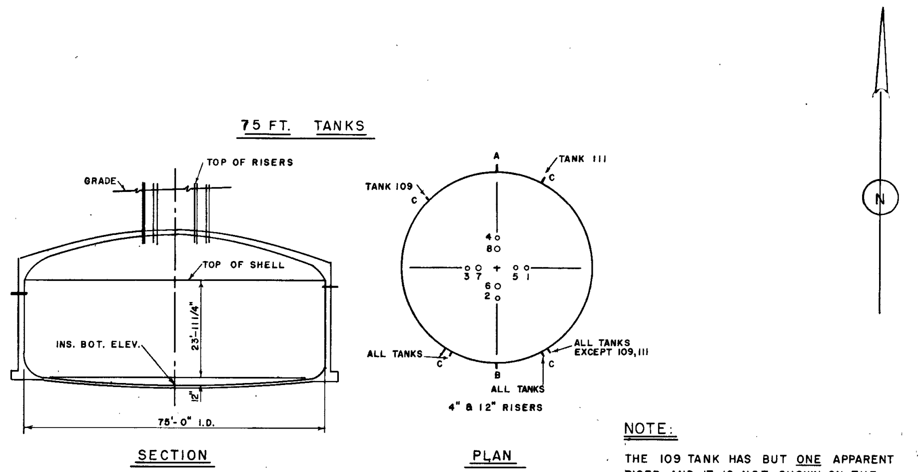


**Figure 3-3. 241-BY Tank Farm Cascade Line, Spare Inlet Line and Riser Elevations (H-2-1746)**

75 FT. TANKS




NOTE:
THE 109 TANK HAS BUT ONE APPARENT RISER AND IT IS NOT SHOWN ON THE ABOVE SKETCH. ELEV. 648.75 *

| TANK NO. | INS.BOT. ELEV. | RISER NO. 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| 241-BY-101 | 602.65 | 650.27 | 650.26 | | 649.98 | 650.29 | | | |
| 241-BY-104 | 602.65 | 649.91 | 650.12 | | 650.11 | 650.85 | | | |
| 241-BY-107 | 602.65 | 649.86 | 649.86 | 649.86 | 649.85 | 649.94 | 649.94 | 649.94 | 649.85 |
| 241-BY-110 | 602.65 | 649.87 | 649.87 | 649.86 | 649.85 | 649.88 | 649.91 | 649.88 | 649.85 |
| 241-BY-102 | 601.65 | 648.94 | 649.24 | | 649.05 | 648.96 | | | |
| 241-BY-105 | 601.65 | 649.11 | | | 649.18 | 648.80 | | | |
| 241-BY-108 | 601.65 | 648.91 | 648.85 | 648.89 | 648.84 | 648.91 | 648.87 | 648.90 | 648.86 |
| 241-BY-111 | 601.65 | 648.77 | 648.77 | | 648.79 | 650.13 | | | |
| 241-BY-103 | 600.65 | 647.77 | 648.11 | | 648.40 | 649.02 | | | |
| 241-BY-106 | 600.65 | 647.83 | 648.22 | | 648.04 | 649.01 | | | |
| 241-BY-109 | 600.65 | | | | | | | | |
| 241-BY-112 | 600.65 | 647.76 | 648.27 | | 648.05 | 649.03 | | | |

* SEE DWG. H-2-34682

| TANK NO. | "A" NOZZLE | "B" NOZZLE | "C" NOZZLE |
|---|---|---|---|
| 101, 104, 107, 110 | INV. 626.34 | INV. 626.72 | INV. 626.72 |
| 102, 105, 108, 111 | INV. 625.34 | INV. 625.72 | INV. 625.72 |
| 103, 106, 109, 112 | NONE | INV. 624.72 | INV. 624.72 |

| No. | DESCRIPTION | REV. BY DATE | APP'D BY | DIV. | DATE |
|---|---|---|---|---|---|
| SM 2 | REVISED PER (FCN-1067) | EEB 1-29-73 | | ARHCO DFTG | 2-20-73 2/20/73 |
| M 1 | RISERS CHANGED (REDRAWN) | G.R.B. 1-5-53 | E.W.B. | P.S.U. | 1-6-53 |

REVISIONS

SCALE: NONE
DRAWN G.R.B. DATE 1-5-53
CHECKED EWB DATE 1-6-53
ISSUED DATE
DES. ENG. DIV.
ENGINEER REQUEST NO.
PROJECT NO.

APPROVALS — BY / DIV. P.S.U. / DATE 1/6/53

DWG. NO. | DRAWING TITLE
REFERENCE DRAWINGS
NEXT USED ON

NONE
CLASSIFICATION

**U. S. ATOMIC ENERGY COMMISSION**
**HANFORD WORKS**
**GENERAL ELECTRIC**

8404
TANK FARM
RISER & NOZZLE ELEV.

PROJECT TITLE

BLDG. NO. 241-BY | DWG. NO. H-2-1746 | SHEET NO. 1 | SHEETS 1

FORM NO. 1-39-E8—E. D. CO. 121

Tanks 241-BY-103 (BY-103) and 241-BY-108 (BY-108) are classified confirmed leakers and tanks 241-BY-105 (BY-105), 241-BY-106 (BY-106) and BY-107 were questionable integrity tanks and are currently classified assumed leakers (HNF-EP-0182). Also, tank 241-BY-102 (BY-102) was classified in 1972 as a dormant leaker. This interim classification described a tank where initial elevated radiation levels in drywells or an initial drop in liquid level stabilized. Occasionally a tank that had shown liquid level losses or an increasing radiation level had been stabilized by lowering the operating level in that tank. [Letter LET-020172, "Atlantic Richfield Hanford Company's Decision Rationale for Leaking Non-Boiling Waste-Storage Tanks Contract AT(45-1)-2130"].

The BY-Farm was initially operated as a backup to the BX-Farm. Tanks BY-101 through BY-106 received B Plant metal wastes in cascade after the BX-Farm tanks were filled. Tanks BY-107 through BY-110 received B Plant first-cycle and tributyl phosphate (TBP) waste, while tanks 241-BY-111 (BY-111) and 241-BY-112 (BY-112) provided temporary storage of metal waste. A series of aggressive evaporation campaigns used several BY-Farm tanks for feed staging and evaporator bottoms receiving. A sluicing operations program for uranium recovery began in January 1954 to remove waste from the tank and was completed by August 1955.

From about 1955 to 1958 there was an aggressive program to free up tank space. For example, TBP waste that had been previously stored in tanks was routed to U building for scavenging. U Plant used nickle ferrocyanide to scavenge $^{137}Cs$. The waste stream was kept agitated and was sent back to BY-Farm tanks and allowed to settle for 7 to 10 days before sending the supernate to BY Cribs. Sometimes calcium additions were made to precipitate $^{90}Sr$ as well. This process is referred to as "in tank scavenging." By 1956 it was realized cesium and cobalt were both in the groundwater in the area, with cobalt exceeding the then maximum permissible limits. Operations had no way to scavenge the cobalt so the specific retention trenches concept was developed such that the waste exceeding criteria for cribs could be sent to these trenches.

A discussion of scavenging operations is included in HW-38955, *"In-Farm Scavenging" Operating Procedure And Control Data*. For example it is stated: "Three of the tanks (101, 102, 103-BY) were filled during periods when nickel ferrocyanide scavenging was employed in the TBP Plant. Although the cesium concentrations in these supernatants is low enough to permit cribbing, the strontium concentrations is too high. Therefore, these supernatants require only calcium addition to reduce the strontium concentration to acceptable cribbing concentrations." Initial concentrations of cesium and strontium in tanks BY-101, BY-102, and BY-103 of 0.033/0.91, 0.044/3.12, 0.057/1.6 microcuries/ml, respectively, would be reduced to 0.018/0.079, 0.053/0.99, 0.024/0.055 after adding $Ca(NO^{-}_{3})_{2}$. If waste of this concentration leaked and saturated the ground from overflows or tank leaks, $^{137}Cs$ soil concentrations would be expected to be less, and probably much less, than 1,000 pCi/g in 2010.

An immobilization method selected for high-level waste solutions containing relatively low fission product concentrations was the conversion to saltcakes within the underground storage tanks, i.e., In-Tank Solidification (ITS). It was necessary for the fission product content of feed for this process to be low. Otherwise excessive temperatures within the solidified waste could decompose some of the saltcake constituents and volatilize fission products (HW-83218, *First In-Tank Solidification Unit Information Manual*). Supernate or condensate waste leaked in the area during ITS operations would also be expected to be low in $^{137}Cs$.

The tanks in the BY-Farm were filled with several types of wastes: metal waste, first-cycle decontamination waste, TBP waste, and evaporator feed and bottoms waste. Metal waste consisted of waste from the extraction of plutonium and contained all of the uranium, 90% of the fission products, and ~1% of the plutonium. First-cycle decontamination waste consisted of byproduct cake and solutions that contained ~10% of the original fission products and 1% of the plutonium. The first-cycle waste contained a mixture of suspended solids, hydroxides, carbonates and phosphates, and scavenger metals and other metals. Tributyl phosphate waste was produced from the process that used TBP solvent to recover uranium from metal waste. Evaporator waste was contained in the BY-Farm tanks in two basic forms: evaporator feed staging waste and evaporator bottoms waste. Evaporator feed staging waste was waste that was evaporated to produce saltcake, while evaporator bottoms waste was the resultant solids following liquid evaporation.

## 3.2 TANK LEAK DETECTION MONITORING

Historically, SST integrity was assessed by two independent methods. From the beginning of Hanford Site tank farm operations, the primary leak detection system was routine monitoring of static liquid-surface levels within each tank. Routine monitoring of gross gamma activity in drywells near the SSTs provided the second leak detection method. A few drywells were constructed in BX-Farm as early as 1947, but most drywells were constructed in the 1970s. After the SSTs were pumped and interim stabilized gross gamma monitoring was no longer required except as specified in tank waste retrieval work plans (RPP-9937, *Single-Shell Tank System Leak Detection and Monitoring Functions and Requirements Document*).

### 3.2.1 In-Tank Monitoring

Originally liquid levels were measured using pneumatic dip tubes (HW-10475-C-DEL, *Hanford Technical Manual Section C*, p. 908). This practice was later replaced with the use of a manual tape that had a conductivity electrode to detect the static liquid surface (H-2-2257, *Conductor Reel for Liquid Level Measurement*). The biggest limitations of the manual tape measurements were failures of the electrodes, solids forming on the electrode and the surface of the waste within the tank, as well as measurement precision. The statistical accuracy of the manual tape and electrode measurement technique was 0.75 in. (~2,060 gal), as determined in July 1955 (HW-51026, *Leak Detection – Underground Storage Tanks*, p. 4). Later, liquid-level determinations were automated in many of the SSTs to provide more accurate and reliable measurements. However, surface-level measurements remain highly uncertain in the waste tanks that contained boiling wastes (e.g., 241-A, 241-AX, and 241-SX Tank Farms), when supernate has been removed from tanks leaving solids or precipitated salts, or where solid crusts have formed on the waste surfaces. Liquid levels are generally unavailable for periods of waste transfer during which large volumes of liquids were on the move among tanks and other facilities. A static surface liquid was not present during such operations to allow a meaningful measurement. This is a particularly important factor in 241-BY Tank Farm where numerous transfers were made during the ITS program between 1966 and 1976.

In addition to uncertainty in measurements, liquid level decreases may be caused by a leak, evaporation, barometric pressure changes or physical changes in waste surfaces (i.e., floating solids, surface collapse, gas release events or forming salt crystals). Liquid level increases may be caused by intrusions into a tank or by gas pressure build-up in the waste.

All of the BY-Farm tanks were initially monitored using manual tape and/or Food Instrument Corporation conductivity gauge (FIC[2]) surface level measurements. In 1996 FIC gauges were removed and replaced by ENRAFs in all of the BX-Farm tanks. Liquid observation wells (LOWs) were installed in many of the tanks to measure interstitial liquid levels using gamma and neutron probe measurements. Following is a description of in-tank monitoring instrumentation summarized from RPP-9645, S*ingle-Shell Tank System Surveillance and Monitoring Program*.

**ENRAF™.** The ENRAF[3] gauge is the most accurate level gauge currently used in the tank farms. This gauge tracks level changes in tank waste by using a load cell to monitor the weight of a displacer. For the purposes of leak detection, the ENRAF gauge needs a free liquid surface below the displacer. The vendor quotes an ENRAF precision of ± 0.004 in. and an accuracy of ± 0.04 inches. However, in-tank ENRAF instruments are calibrated to an accuracy of ± 0.1 in. and the 2-decimal readout on the gauge provides a precision of ± 0.01 inch.

The condition providing the highest sensitivity to a potential leak is a smooth, pure liquid waste surface combined with the most accurate gauge (ENRAF). These measurements are impacted very little by day-to-day variation from either the waste surface or gauge error. If the waste surface becomes more irregular or a gauge with lower resolution is used, the measurement data becomes more scattered (increases) during the normal day-to-day readings. For a heavy slurry waste with a highly irregular surface and a low-resolution instrument, the day-to-day readings exhibit a higher degree of nominal data scatter. Surface level gauges are not used for leak detection if the waste has a solid surface, since the level would not decrease in response to a leak. Liquid levels cannot be measured accurately during waste transfer operations or in self-boiling tanks with a dynamic surface.

**Manual Tape.** The manual tape is still used in a few tanks. It relies on a metal tape with a plummet contacting an electrically conductive waste surface. A manual tape in good working order on a highly conductive surface should be accurate and repeatable to ~0.25 inch. As the waste dries out, the device becomes less accurate, until ultimately no signal is received. Uncertainty for different tanks varied from 0.25 in. to 2 inches. The drying out of the waste surface is typically observed as increasing levels of data scatter during routine data reviews. Most DSTs use the manual tape as a backup to the ENRAF.

The FIC is no longer used. The FIC was functionally equivalent to the manual tape, except that the tape and plummet are raised and lowered by a motor rather than manually. All FICs have now been replaced by ENRAF gauges.

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[2] FIC is a product of Food Instrument Corporation, Federalsburg, Maryland.

[3] ENRAF - Nonius Series 854 is a trademark of ENRAF-Nonius, N.V. Verenigde Instrumentenfabrieken, ENRAF Nonius Corporation Netherlands, Rontegenweg 1, Delft, Netherlands.

**Interstitial Liquid Level Measurements.** Levels of waste phases can be measured by using geophysical techniques deployed inside a LOW placed in a tank. The LOWs were installed in tanks containing permeable waste (i.e., tanks containing saltcake vs. sludge) and/or tanks with a solid waste surface. Originally the uncertainty of waste surface level measurements varied from 1 to 3 in. depending on the waste and barometric pressure changes. Interpreting LOW measurements is complicated, especially when the liquid level was moved between two waste layers with different permeability (e.g., saltcake and sludge). Updated methodologies have improved the accuracy of current LOW measurements, including such actions as calibrating the waste depth measuring system daily before going to the field to ensure measurements are within ± 0.25 in. of its known value; verifying the neutron and gamma probes before each use; and comparing all of the measurement scans to a "reference scan" to identify any spikes, drifting, dead zones, or other anomalous problems.

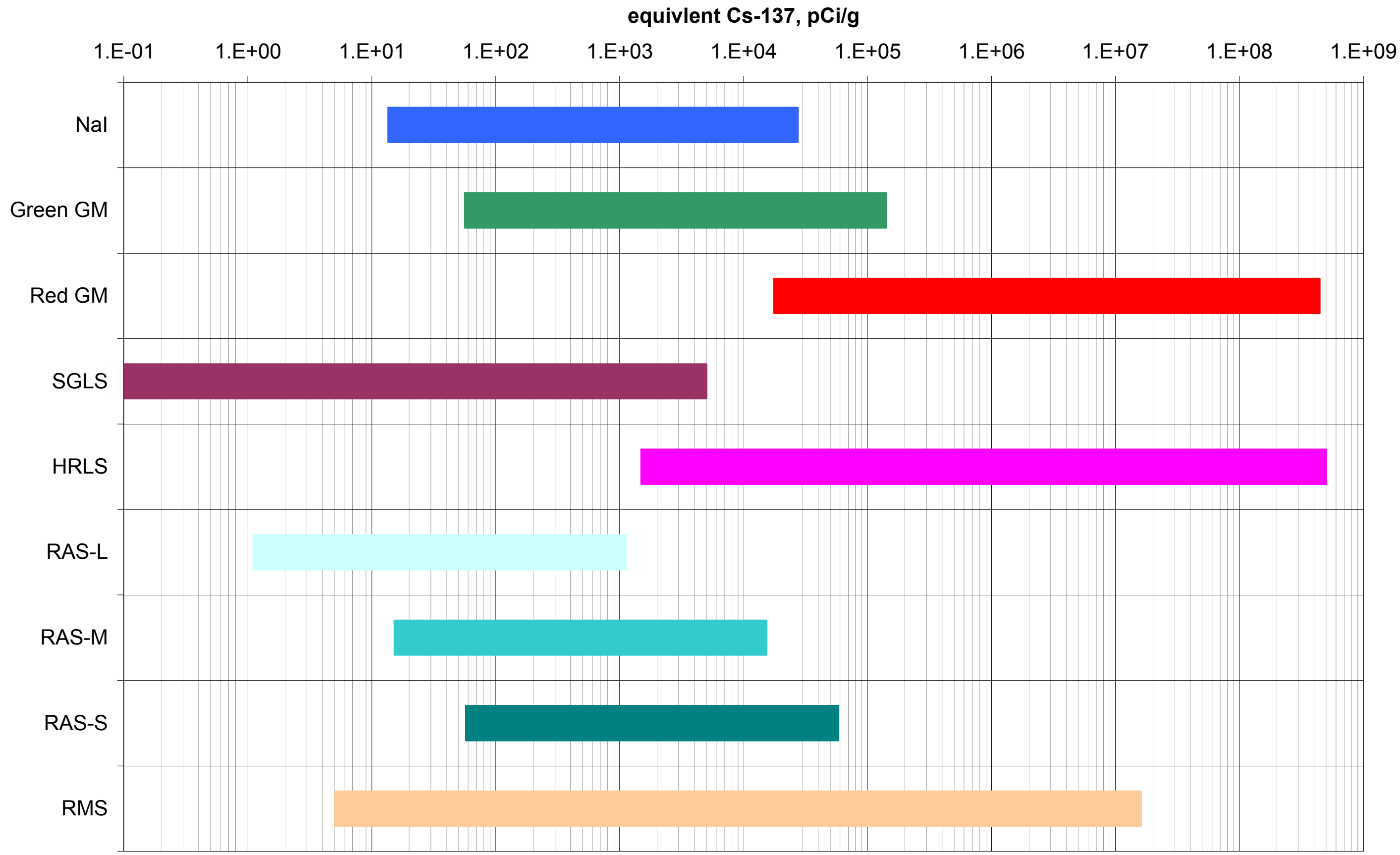
### 3.2.2 Ex-Tank Monitoring

Seventy monitoring drywells were installed around the 12 tanks in BY-Farm for leak detection in the vadose zone. Three "00" drywells located some distance from the tanks and drywell 22-08-07 were drilled in 1949. No additional wells were drilled until 1967. Most of the wells were drilled to depths of 100 ft or less (SD-WM-TI-356, *Waste Storage Tank Status and Leak Detection Criteria*). Figure 3-1 shows the relative positions of the BX-Farm tanks and vadose zone monitoring drywells installed around them between 1949 and 1974.

Total gamma logging was initially performed in the drywells using NaI and Green and Red total gamma monitoring detectors (Figure 3-4). The total gamma logs were digitized starting in 1975, but much of the data before 1975 was not available. Between 1995 and 2000 all of the drywells were logged using a spectral gamma logging system (SGLS). The SGLS provides isotope-specific gamma measurements (e.g., cesium, europium, cobalt and uranium isotopes). Detection and quantification of low specific activity radionuclides such as uranium-238/235 ($^{238/235}$U) and other transuranics or radionuclides that have experienced significant decay such as cobalt-60 ($^{60}$Co), generally require an SGLS. For areas of higher activity (> 2,000 pCi/g) a high rate logging system (HRLS) is used to quantify activity levels as high as 10E8 pCi/g. The SGLS uses a high-purity germanium detector. Figure 3-4 shows measurement ranges for SGLS and HRLS.

The Radionuclide Assessment System (RAS) truck was designed for routine gamma monitoring against the baseline established from the SGLS data. The RAS uses a series of three interchangeable NaI(Tl)-based scintillation detectors (RAS-L, RAS-M, and RAS-S) for measurement over the range from background levels to about $10^5$ pCi/g cesium-137 ($^{137}$Cs). The size of a leak that can be detected by RAS depends on the radioactivity level of the waste leaked, the leak rate, proximity of a dry borehole to the leak, and subsurface soil properties controlling flow rate and direction. Consequently, there is no single value that can be stated as the maximum leak that could go undetected by drywell monitoring for an SST. Leak detection approximations presented in Appendix B of RPP-10413, *Tank S-112 Saltcake Waste Retrieval Demonstration Project Leak Detection, Monitoring, and Mitigation Strategy* range from a mean of 100 gal for a leak located 10 ft from a drywell to a mean of 6,200 gal for a leak 45 ft from a drywell. However, 13,000 gal of saline solution injected for leak detection monitoring tests in 241-S Tank Farm was not detected by surrounding drywells (RPP-30121, *Tank 241-S-102 High-Resolution Resistivity Leak Detection and Monitoring Test Report*).

**Figure 3-4. Measurement Ranges of Tank Farm Gamma Detectors**




Notes:

| | | |
|---|---|---|
| NaI | = | Sodium iodide or scintillation detector used to measure total gamma in lower activity wells |
| Green GM | = | Geiger Mueller tube used to measure moderate gamma activity. |
| Red GM | = | Geiger Mueller tube used to measure high gamma activity |
| SGLS | = | Spectral gamma logging system, uses a high Purity Germanium detector to measure gamma energy spectra for separate gamma radionuclides (i.e., $^{137}$Cs, $^{60}$Co, $^{154}$Eu, $^{238}$U) |
| HRLS | = | High rate logging system, uses shielding to investigate gamma activity too intense for the SGLS |
| RAS-L | = | Radionuclide Assessment System – large NaI detector |
| RAS-M | = | Radionuclide Assessment System – medium NaI detector |
| RAS-S | = | Radionuclide Assessment System – small NaI detector |
| RMS | = | radionuclide monitoring system (not used at Hanford) |

Approximate measurement ranges of different types of gamma radiation detectors are shown in Figure 3-4.

Routine monitoring of gross gamma activity in drywells near the SSTs provides a secondary leak detection method. Most drywells were constructed in the early 1970s after many SSTs had been in operation for a decade or more. For 241-A SSTs and some 241-SX SSTs, laterals (horizontal boreholes) were installed ~10 ft beneath the tank bottom for gross gamma monitoring beneath these tanks. However, there are no laterals in BY-Farm. As with the tank waste surface-level measurements, there are uncertainties associated with these secondary leak detection methods. Three sources of uncertainty are as follows.

- Number and location of wells: There were rarely more than six drywells surrounding the 100-series SSTs (covering a circumference of ~235 ft) and often fewer. These drywells are generally 6-in.-diameter steel casings that extend vertically 75 to 125 ft bgs (groundwater is between 245 and 300 ft bgs) and that allow access to geophysical probes. Because the holes had to be cased to prevent collapse and loss of the borehole, only gamma-emitting radionuclides within about a 12 in. radius of a drywell are detected so large areas between drywells are not covered. Alpha- and beta-emitting radionuclides, including daughter products, are not detected, and most of the long-lived, mobile radionuclides do not emit gamma radiation during decay. Consequently, the absence of gamma activity in a well, lateral, or leak detection pit does not necessarily indicate that a tank did not leak. Over the course of historical drywell logging, probe types changed several times, thus changing detection limits. The rate of withdrawal of any probe from a borehole and count times also affect the detection capability of any instrument and these too changed with time. Chemical contaminants are not detected during logging and can only be found through soil sampling and analyses.

- Waste type: The overall effectiveness of gross gamma logging in drywells as a leak detection system depends on the waste type in the tank. It can be used to evaluate the approximate time period when tank waste may have entered the sediments. Early gross gamma logging can indicate the nature of waste streams by considering the decay rate of gamma activity. The gross gamma logging system is most effective with waste types containing high concentrations (activities) of gamma emitting radionuclides (e.g., $^{137}Cs$ or $^{60}Co$ at the present time and short-lived radionuclides in the past) and large releases, and less effective with low-activity waste types such as aluminum cladding waste or waste that contains transuranics. In addition to limitations on the effectiveness of gamma measurements for different waste types, lags of months to years between release and detection were possible wherein multiple waste transfers may have occurred. Consequently, the type of waste in the nearest tank when a leak was detected may not be the same as the waste that leaked. This contributes to uncertainty in inventory and leak volume estimates.

- Other contamination sources: Gamma activity observed in drywells may also have originated from near-surface waste loss events, transfer line leaks or tank overfills, in which case there is no loss of integrity of the steel liner in the tank.

Geophysical techniques can also be used outside of a tank to measure increased moisture and gamma-emitting contaminants. Dry borehole neutron moisture and/or radionuclide assessment system (RAS) total gamma leak detection monitoring is performed during retrieval in accordance with tank waste retrieval work plans. The accuracy of dry borehole logging count rate is roughly the square of the total number of counts (*Radiation Detection and Measurement*, 3rd Ed., [Knoll 2000] pp. 94-96). The correlation between counts per second and radioactivity or moisture measurements varies by detector.

Leak detection monitoring for retrieval is conducted by observing changes in neutron readings (counts per second) compared to an established baseline for the detector being used. Therefore, for a given detector, accuracy of calibration is not a factor. The level of moisture change that triggers additional RAS monitoring is specified in process control plans.

The RAS truck was designed for routine gamma monitoring against the baseline established from the SGLS data. The RAS uses a series of three interchangeable NaI(Tl)-based scintillation detectors (RAS-L, RAS-M, and RAS-S) for measurement over the range from background levels to about $10^5$ pCi/g $^{137}$Cs. The size of a leak that can be detected by RAS depends on the radioactivity level of the waste leaked, the leak rate, proximity of a dry borehole to the leak, and subsurface soil properties controlling flow rate and direction. Consequently, there is no single value that can be stated as the maximum leak that could go undetected by drywell monitoring for an SST. Leak detection approximations presented in Appendix B of RPP-10413 range from a mean of 100 gal for a leak located 10 ft from a drywell to a mean of 6,200 gal for a leak 45 ft from a drywell. Approximate measurement ranges of different types of gamma radiation detectors are shown in Figure 3-4.

In addition to the RAS truck and instrumentation which perform only total gamma measurements, the SGLS provides isotope specific gamma measurements. For areas of higher activity (> 2,000 pCi/g) an HRLS is used to quantify activity levels as high as 10E8 pCi/g. The SGLS uses a high-purity germanium detector. Baseline spectral gamma logging of tank farm drywells was performed between 1995 and 2000. Figure 3-4 shows measurement ranges for SGLS and HRLS. Detection and quantification of low specific activity radionuclides such as $^{238/235}$U and other transuranics or radionuclides that have experienced significant decay such as $^{60}$Co generally require an SGLS.

**Ex-Tank High Resolution Resistivity.** High resolution resistivity is used during retrieval operations and measures changes in soil resistivity against baseline conditions as specified in tank waste retrieval work plans. Because tank waste is high in sodium and nitrate, changes in resistivity/conductivity of the soil are a potential indicator of a tank leak. In leak injection tests in 241-S Tank Farm, where 13,000 gal of saline solution were injected to the soil near tank 241-S-102, it was determined that high resolution resistivity could detect a leak of 2,100 gal or more with 95% accuracy. Initial tests showed responses after only a few hundred gallons of saline solution were injected (RPP-30121). In comparison, drywell neutron moisture measurements showed negligible changes during leak injection tests. The high resolution resistivity system does not quantify leak volume or rate, but provides a continuous measure of resistivity during retrieval as compared to weekly moisture measurements and provides more three-dimensional spatial measurements compared to measurements indicating conditions within about a radius of 1 ft from a drywell. Furthermore, high resolution resistivity (HRR) senses a much larger volume than a drywell, including beneath a tank. However, HRR is affected by the presence of steel infrastructure and corrections must be made for such facilities. Retrieval has not started in BY-Farm and HRR leak detection has not been used in BY-Farm.

## 3.3 RETAINED GAS

Many radioactive wastes generate and retain hydrogen, nitrogen, nitrous oxide, ammonia, methane, and other volatile organic compounds. Retained gas is defined as that gas held in the waste predominately by yield strength, producing particle displacing bubbles. The generation rates of the major fuel (hydrogen, ammonia, methane) and diluent species (nitrogen) aid in assessing the long-term behavior of tank wastes (surface level measurements) and support analyses of potential changes in waste storage conditions (to assess postulated deflagrations). The presence of such gases as ammonia, methane, and nitrous oxide can have a significant influence on the flammability characteristics of a gas mixture. Increases in retained gas may result in interstitial liquid level growth or an increase in the measured surface level. Interstitial liquid levels in BY-Farm have been observed to increase over time by as much as 40 in. due to gas formation. Gas release events may result in the tank head space exceeding flammability limits and a decrease in the interstitial liquid level. For some tanks containing retained gas, the interstitial liquid levels may also increase and decrease with changes in barometric pressure.

The original wastes that were discharged to the waste tanks from the evaporator were essentially free of retained gas. The gases that are now retained in the wastes have been generated during interim storage. Non-convective layers and crusts retain large quantities of the permanent gases. In contrast, connective layers do not retain significant amounts of such gases. The principal soluble gas, ammonia, is widely distributed throughout the liquid phases of the waste. Retained gas sampling observations and other findings show the gases that have been retained in the waste for long intervals are enriched in hydrogen. An evaluation of the empirically measured rates of gas generation results from the slow decomposition of nitrogen and ammonia, and differences in transportation rates (RPP-6664, *The Chemistry of Flammable Gas Generation*).

Tanks BY-101, BY-103, BY-105, 241-BY-108 (BY-108), 241-BY-109 (BY-109), BY-111 contain some volume fraction of retained gas. Based on retained gas samples taken from tank BY-109 (PNNL-13000, *Retained Gas Sampling Results for the Flammable Gas Program*), the likely retained gas volume fraction for tanks BY-101, BY-103, BY-105, BY-108 and BY-111 is between 6 and 12%. The measured (sampled) retained gas volume fraction for tank BY-109 was determined to be 9.5 volume percent.

## 3.4 TANK LEAKS

Sixty-seven of 149 SSTs have been designated as “confirmed or suspected leakers” over the SST operational timeline (1945 to 1980) (HNF-EP-0182). During the active operation of the SST farms, either an anomalous liquid-level measurement or a significant increase in gamma activity in a drywell, lateral, or leak detection pit was generally sufficient reason for the tank to be listed as "questionable integrity" or an "assumed leaker" as discussed in SD-WM-TI-356. When a tank was designated as "questionable integrity" it was pumped to a "minimum heel" and taken out of service. In a limited number of cases the "questionable integrity" designation was followed up with additional investigations. However, in many cases no additional investigations were performed. In the late 1980s, all SSTs that had been flagged as potential or known leakers were combined into the list contained in the monthly waste tank summary report (HNF-EP-0182) and flagged as "confirmed or assumed leakers." Because of the uncertainty associated with the measurements, unexplained waste level decreases were generally considered as an inadequate basis for designating a tank as a "confirmed leaker." The "confirmed leaker" designation required an observed waste level decrease combined with increasing gamma activity in a nearby drywell. The "assumed leaker" designation could be assigned based on either measurement (an observed waste level decrease or increasing gamma activity in a nearby drywell), without confirmation from the other measurement.

## 3.5 INTERIM STABILIZATION

Uncertainties associated with both the primary and secondary leak detection systems for the SSTs led to a number of decisions. By the early 1960s, decisions were made to move from an SST design to a DST design for construction of new tanks. The double-shell design provided both secondary containment and reliable leak detection systems between the two liners. A decision was also made to pump liquids stored in the SSTs into the DSTs to remove pumpable liquid from the SSTs. This process was referred to as interim stabilization of the SSTs.

A consent decree (CT-99-5076-EFS, entered in *State of Washington Department of Ecology versus the U.S. Department of Energy*) was established that set a time table and specified criteria to complete interim stabilization, and by 2003 all of the SSTs were interim stabilized except a couple that went directly to retrieval without undergoing interim stabilization (HNF-EP-0182). A tank was considered interim stabilized when it contained less than 50,000 gal of drainable interstitial liquid and less than 5,000 gal of supernate. If the tank was jet pumped to achieve interim stabilization, then the jet pump flow or saltwell screen inflow must have been at or below 0.05 gpm. Due to equipment failure some jet pump tanks were administratively stabilized before reaching the 0.05 gpm criteria (see HNF-EP-0182).

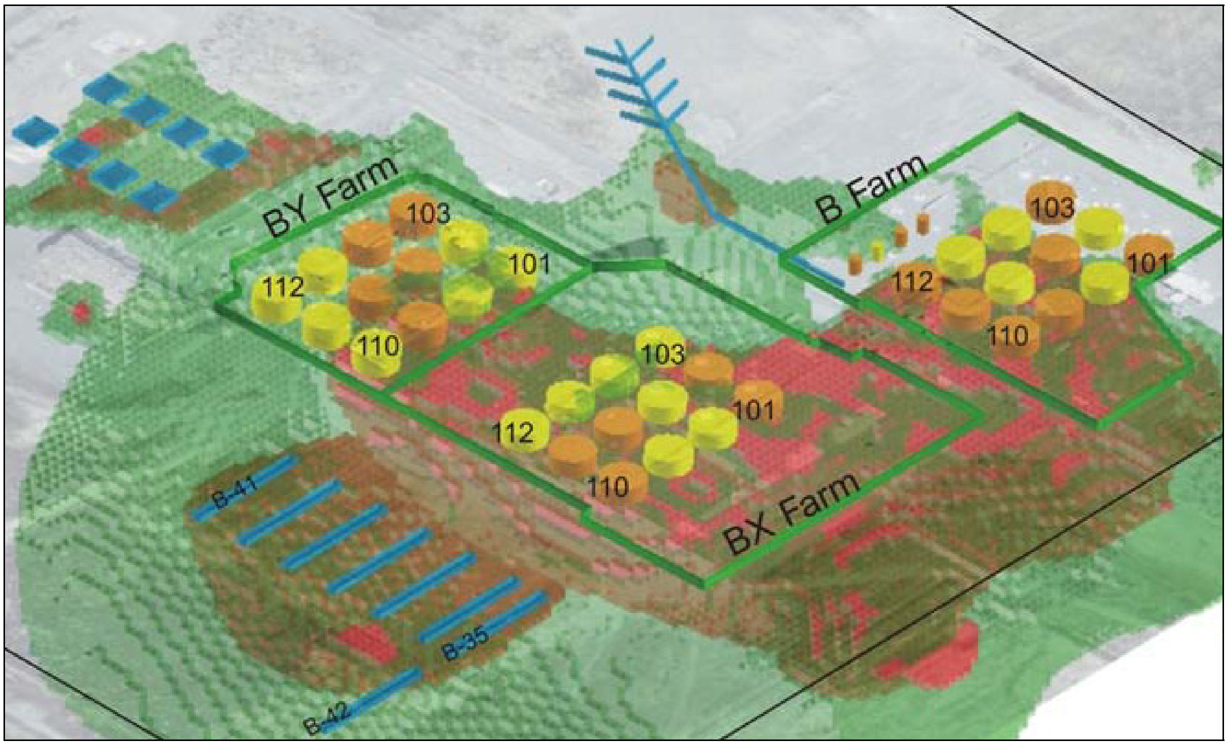
## 3.6 SURFACE GEOPHYSICAL EXPLORATION

Surface geophysical exploration (SGE) is an application of HRR (see Section 3.2.2), however, rather than measuring resistivity over time and looking for changes in resistivity, SGE consists of one-time measurements to identify resistivity anomalies or low resistivity areas. Because tank waste is high in nitrate and sodium, areas of low resistivity indicate locations where waste may have been released to the soil. Surface geophysical exploration is used to guide the selection of sampling locations and as a tool to assess resistivity anomalies (potential waste releases) across large areas.

Surface geophysical exploration was deployed in Waste Management Area (WMA) B-BX-BY in October 2006. Resistivity surveys covered both the farms and adjacent liquid disposal sites.

Figure 3-5 shows 40-50 ohm-m resistivity results for a well to well (WTW) resistivity survey with electrical connections to and between tank farm drywells and groundwater monitoring wells. It is difficult to identify a specific tank leak source within BY-Farm based on these results. Infrastructure obstructions and other physical features appear to have impacted the ability to obtain better defined images of resistivity anomalies in the soils around WMA B-BX-BY that would point to specific sources of released waste.

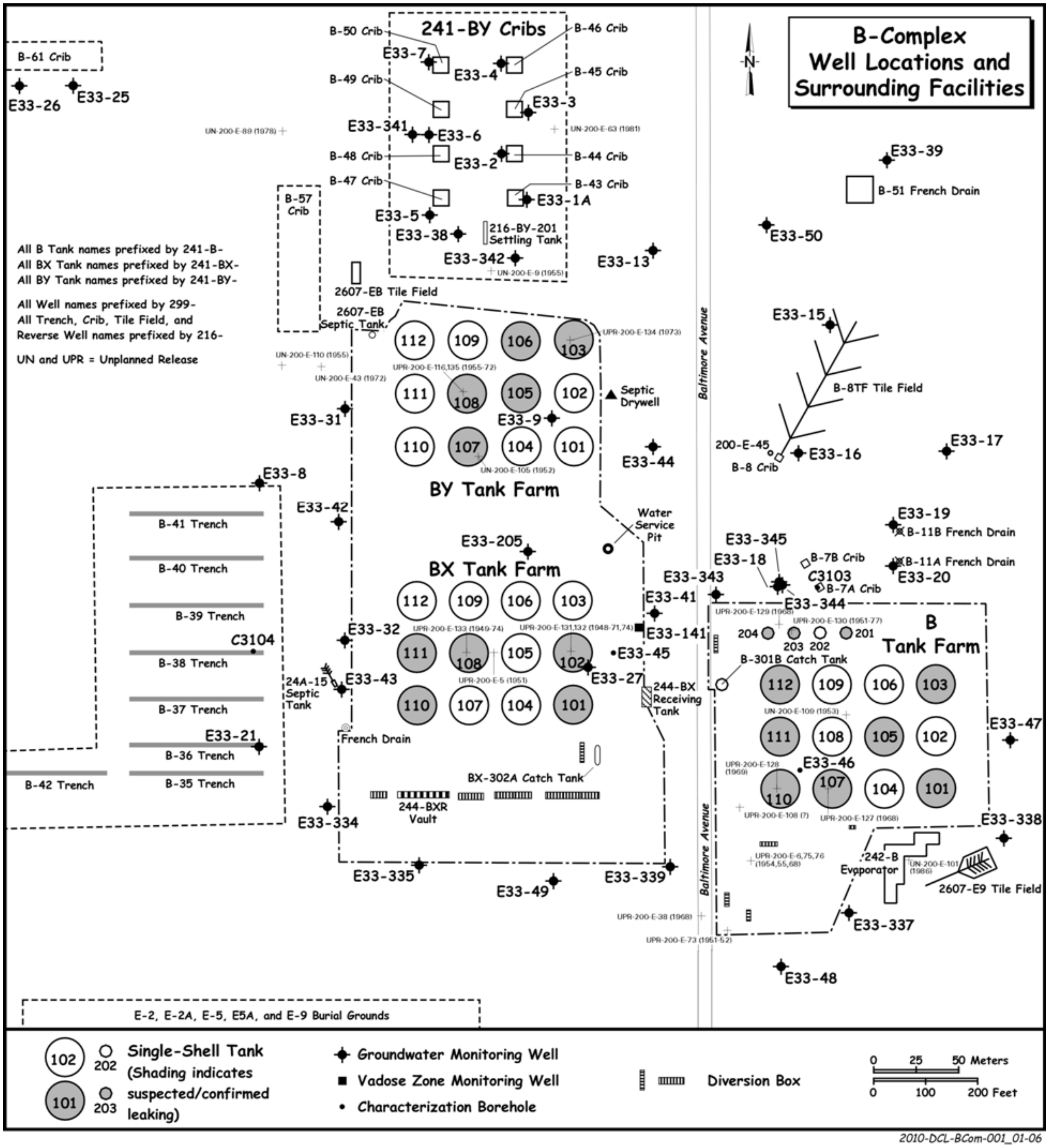
**Figure 3-5. 241-BY Tank Farm Surface Geophysics Exploration Results**




## 3.7 SUMMARY OF GROUNDWATER CONTAMINATION IN THE UNCONFINED AQUIFER UNDERLYING WASTE MANAGEMENT AREA B-BX-BY

Several contaminants are present in much of the unconfined aquifer underlying WMA B-BX-BY including uranium, $^{99}$Tc, tritium and nitrate. Because wastes were released from several sources during the Hanford waste processing operations period that lasted more than two decades, these contaminants can have several sources. In addition to the waste leaks from tanks and transfer lines discussed in previous sections, several sets of cribs and trenches around the tank farms were intentional discharge sites, some of which received tank supernate from the last tank in a cascade. The dominant facilities included the BY Cribs north of BY-Farm, the BX trenches west of BX-Farm, the 7A, 7B and 8 Cribs and the 11A and 11B French drains north of B-Farm and east or southeast of BY-Farm (Figure 3-6).

**Figure 3-6. Map View of Waste Disposal Facilities in Waste Management Area B-BX-BY**




Over the last 10 years substantial efforts have been made to characterize the nature and extent of contamination in the vadose zone and unconfined aquifer at WMA B-BX-BY (e.g., RPP-10098, *Field Investigation Report for Waste Management Area B-BX-BY*). Groundwater monitoring data were sparse during the operations period because there were fewer wells and less frequent sampling. The SSTs are *Resource Conservation and Recovery Act of 1976* (RCRA) temporary storage and disposal (TSD) units that require groundwater monitoring. Many wells have been installed in the last two decades and routine sampling and analysis data have been collected since the early 1990s. Recently, a conceptual model describing the origin and evolution of uranium and $^{99}$Tc has been developed (PNNL-19277, *Conceptual Models for Migration of Key Groundwater Risk Contaminants Through the Vadose Zone and Into the Unconfined Aquifer Below the B-Complex*) that incorporates most data that has been collected in the area. The conceptual model report concludes that the majority of uranium in the subsurface came from the uranium-rich metal waste release that occurred in 1951 through a spare inlet port in tank 241-BX-102 (BX-102), and that the majority of the $^{99}$Tc came from scavenged uranium recovery waste discharged to the BY Cribs in the mid-1950s. Discussions of other prominent contaminants (e.g., nitrate, cyanide, and chromium) were also provided, concluding that their primary sources were crib and trench discharges. A summary of this discussion is provided below.

### 3.7.1 Uranium Aquifer Contamination

The nature and extent of uranium contamination in the aquifer underlying WMA B-BX-BY can only be discussed from the mid-1990s forward because of the lack of monitoring frequency in earlier years. However, it is known that groundwater was contaminated in 1956 with $^{137}$Cs and $^{60}$Co, and perhaps other radionuclides such as $^{99}$Tc that were not measured at the time. This contamination is thought to have originated from the BY Cribs. In the mid-1990s low levels of uranium contamination (< 30 µg/L) were measured under much of WMA B-BX-BY. Since then, concentrations in the groundwater below WMA B-BX-BY have been increasing over the last decade, though the amount of uranium in the groundwater is thought to be small when compared to uranium estimated to be present in the vadose zone in this area. Snapshots of uranium plume evolution beginning in 2000 are shown in Figure 3-7. The snapshots show that the heart of the plume has been centered underneath the tank farms in the last decade. In 2003 the plume was centered at monitoring well 299-E33-9 in the eastern portion of BY-Farm. By 2006 a second maximum concentration area appeared at the northeast corner of B-Farm at monitoring well 299-E33-18. Finally, by 2009 this high concentration zone had grown and superseded the hot spot underneath BY-Farm. Currently, the highest uranium concentrations are occurring at monitoring well 299-E33-343. Generally, plume migration is oriented along a northwest to southeast axis with minor secondary migration to the south. Overall, the most consistent migration direction appears to be toward the northwest.

Unambiguous identification of the source for the current plume has been complicated by the existence of numerous discharges of uranium at various locations in WMA B-BX-BY. These include the BY Cribs north of BY-Farm, the BX trenches west of the BX-Farm, liquid discharge facilities north of B-Farm and tank leaks, particularly the 1951 metal waste leak from tank BX-102. Major contributors of inventory are summarized in Table 3-2. Table 3-2 clearly indicates that the great majority of discharged uranium came from the metal waste leak from tank BX-102 in 1951 and various characterization efforts have shown that a large quantity of the leaked uranium is distributed at an intermediate vadose zone depth 120 to 150 ft bgs east of tank BX-102. These observations and the general observation that the heart of the uranium plume resides under the middle of the tank farms suggests that the tank BX-102 leak is the predominant source of the observed contamination.

**Figure 3-7. Uranium Plume Distribution in the Unconfined Aquifer Underlying Waste Management Area B-BX-BY in 2000, 2003, 2006, and 2009**

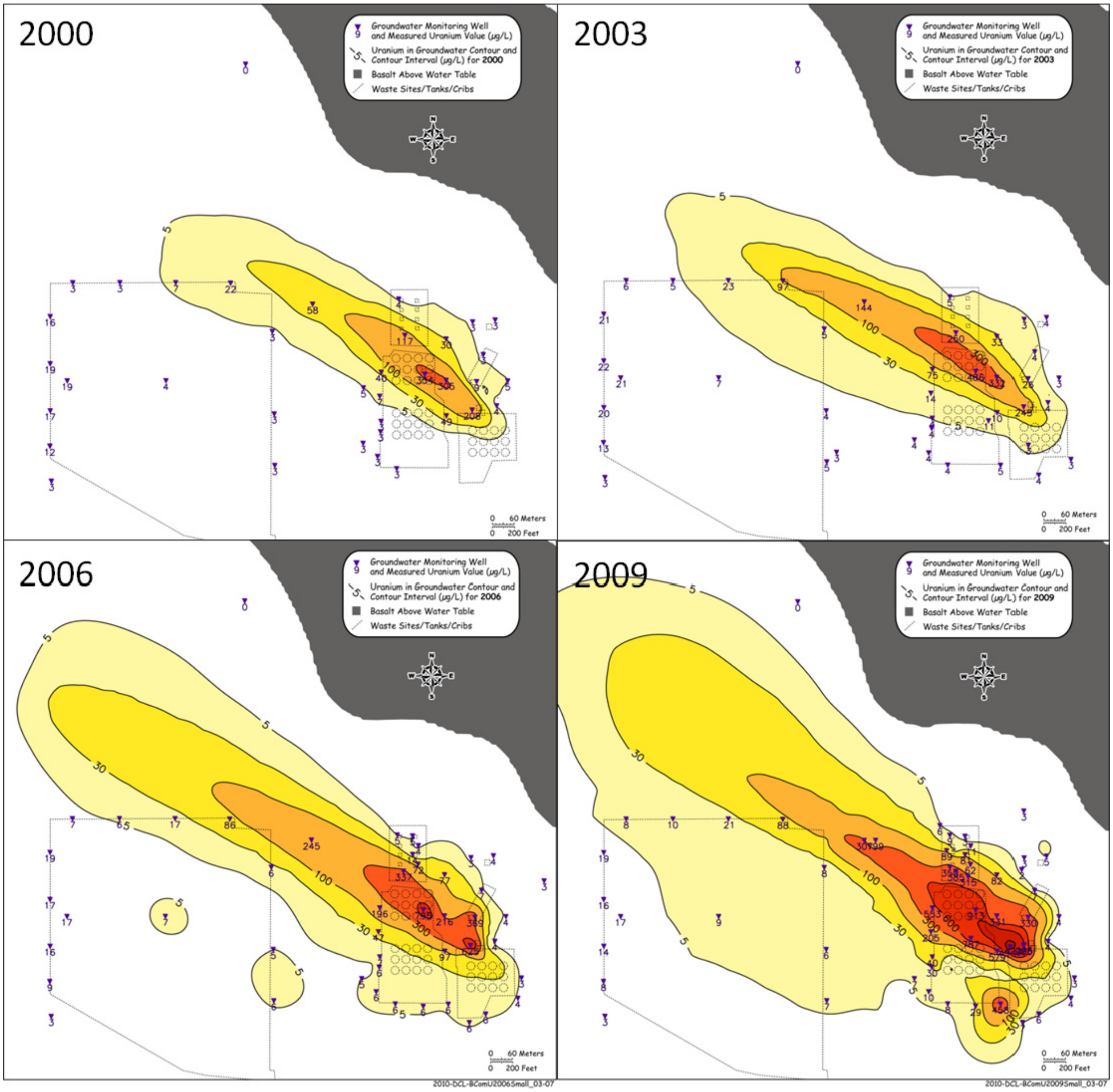



**Table 3-2. Summary of Inventory Estimates at Major Potential Sources of Groundwater Contamination in Waste Management Area B-BX-BY**

| Facility | Uranium (kg) | Technetium-99 | Chromium (kg) | Nitrate (kg) | Cyanide (kg) |
|---|---|---|---|---|---|
| 216-B-7-A & -B | 197 | 0.095 | 11,600 | 2,710,000 | 0 |
| 216-B-8 | 191 | 0.008 | 6,230 | 91.2 | 0 |
| BY Cribs | 1,060 | 129 | 5,030 | 3,310 | 18,900 |
| BX trenches | 504 | 8.4 | 5,860 | 1,730,000 | 0 |
| Tank BX-102 | 10,100 | 2.27 | 60.5 | 3,800 | 0 |

Two other types of characterization data also support this conclusion. First, an extensive silt-rich soil stratigraphic unit exists in the deep vadose zone under most of BX-Farm's footprint (see Figure 3-8). This unit, identified as the lower subunit of the Cold Creek Unit, is about 20 ft above the current water table, contains high levels of uranium contamination and is high in moisture content. Part of this unit contains a fully saturated perched water zone. Such units are known to store relatively large volumes of water and mobile contaminants, if present. The conceptual model then is that uranium was washed down from the shallower uranium mass existing in the intermediate vadose zone by repeated operational water discharges after 1951 and temporarily captured in the Cold Creek Silt Unit. Current aquifer contamination is now being fed by uranium in this unit.

The second type of information that supports the concept of the tank BX-102 metal waste leak as the primary source of uranium is uranium isotopic data measured in a variety of subsurface water samples in the vadose zone and the unconfined aquifer. Collectively, these data indicate that a unique isotopic signature can be assigned to the metal waste fluid, a signature which is found in most of the analyzed samples. A summary diagram of these data are shown in Figure 3-9.

In Figure 3-9 $^{236}$U to $^{238}$U ratios are plotted against $^{234}$U to $^{238}$U for water samples taken in the vadose zone and unconfined aquifer. In the upper left hand corner are the porewater samples taken from the intermediate depth vadose zone soils containing high concentrations of metal waste uranium. On the x-axis are the $^{234}$U to $^{238}$U ratios of uncontaminated water in the Cold Creek Silt Unit and the unconfined aquifer. Note that the $^{236}$U to $^{238}$U ratio is zero because $^{236}$U is not naturally occurring. The lines drawn between the tank BX-102 water samples and the groundwater $^{234}$U to $^{238}$U ratios are mixing lines which indicate the potential changes in these ratios as various proportions of contaminated and uncontaminated waters mix. If ratios fall outside of the triangle formed by the two mixing lines then another source is indicated. Figure 3-9 shows that only a few samples fall outside the mixing triangle, notably those near the BY and 216-B-7A Cribs. These results are used to conclude that the tank BX-102 isotopic signature is distinguishable from the other plausible uranium sources and the one that matches most of the aquifer water.

Currently, between the intermediate vadose zone and the Cold Creek Silt Unit, there is more uranium in the vadose zone than the aquifer. Given this condition, the uranium contamination in the unconfined aquifer underlying WMA B-BX-BY is likely to continue for an indeterminate time span.

### 3.7.2 Nitrate, Technetium-99 and Cyanide Aquifer Contamination

The combination of historical process knowledge and subsurface characterization data in both the vadose zone and aquifer strongly indicate that the dominant sources for these contaminants are the BY Cribs and/or the Cribs north of B-Farm with some secondary contribution from the tank BX-102 leak. The early histories of flow and transport of these contaminants are not well known but more frequent and extensive groundwater monitoring that has occurred since the early to mid-1990s allows a more complete picture of plume evolution. Snapshots of recent plume distributions are shown in Figures 3-10, 3-11 and 3-12.

**Figure 3-8. Isopach Map of the Lower Cold Creek Silt Unit Underlying Waste Management Area B-BX-BY**

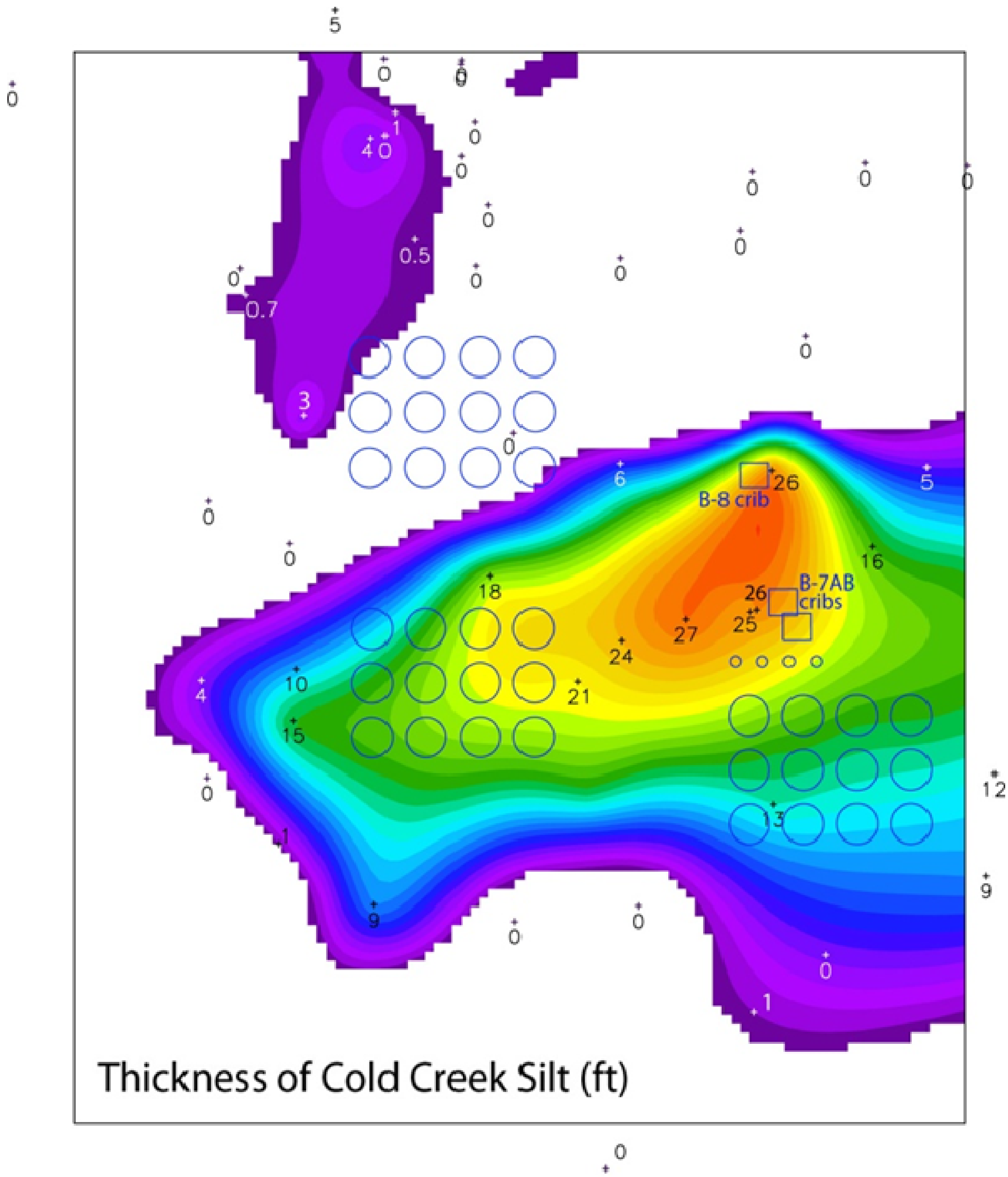
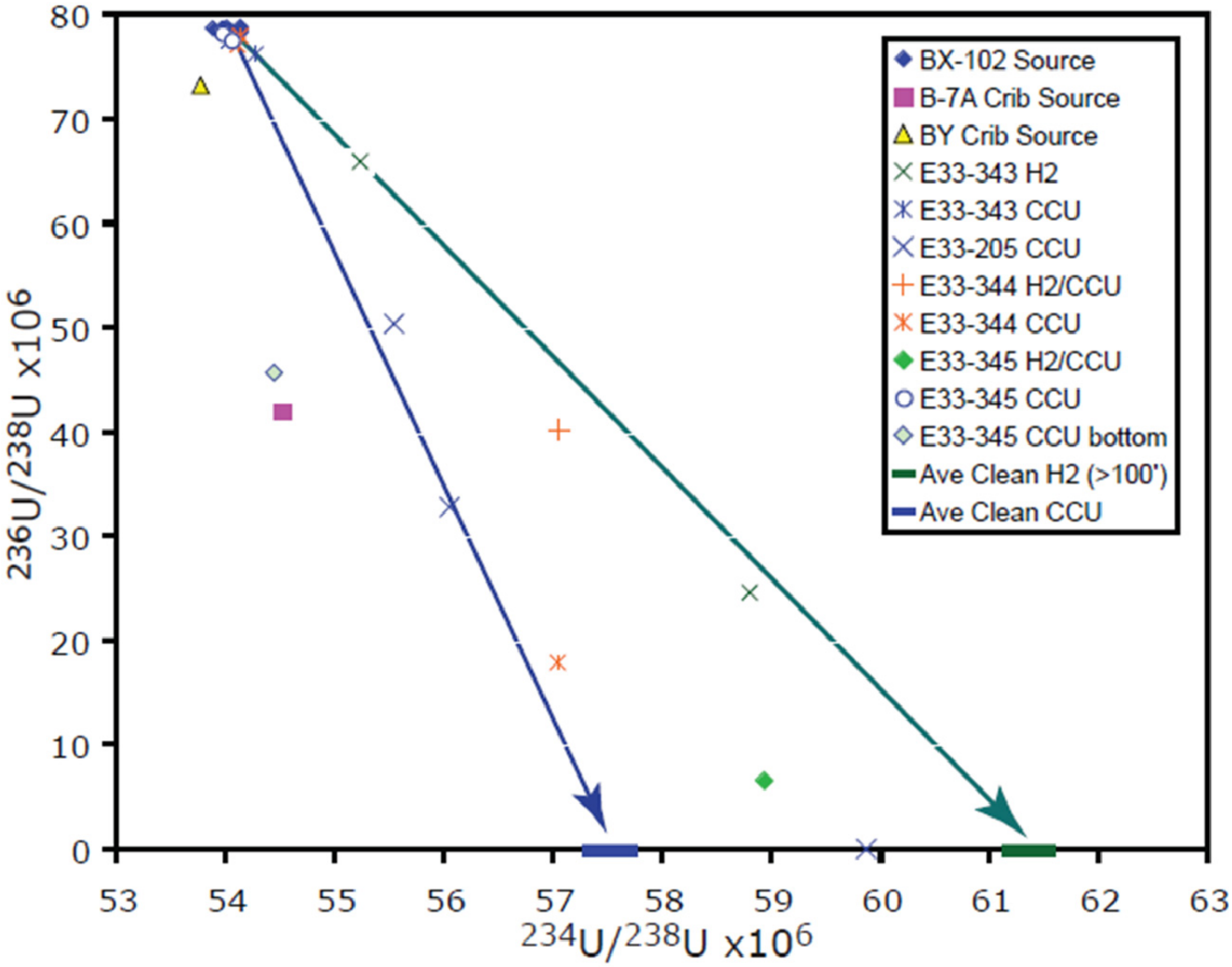


**Figure 3-9. Uranium Isotopic Ratio Data for Subsurface Water Samples Taken at Waste Management Area B-BX-BY (PNNL-19277)**




Reference: PNNL-19277, *Conceptual Models for Migration of Key Groundwater Risk Contaminants Through the Vadose Zone and Into the Unconfined Aquifer Below the B-Complex*

Given the assumption of similar sources and a common regional groundwater flow history, it is not surprising that current plume distributions of these contaminants are grossly similar. Furthermore, these contaminants share a similar chemical behavior in the soil-water environment being largely inert and therefore remaining dissolved in solution. The most contaminated parts of these plumes are found underneath the BY Cribs and/or Cribs north of B- Farm. As with uranium, the plume concentration contours extend along a northwest to southeast axis between the two sets of cribs. Also, extended migration has occurred northward through Gable Gap. Most of this northern extension is attributed to the large crib releases to the Gable Mountain Pond which occurred primarily in the mid-1950s. Because of these releases the overall water table was more than 10 m above its present level and this condition facilitated northward migration.

**Figure 3-10. Nitrate Plume Distribution in the Unconfined Aquifer Underlying Waste Management Area B-BX-BY in 1995, 1998, 2001, 2004, and 2007**

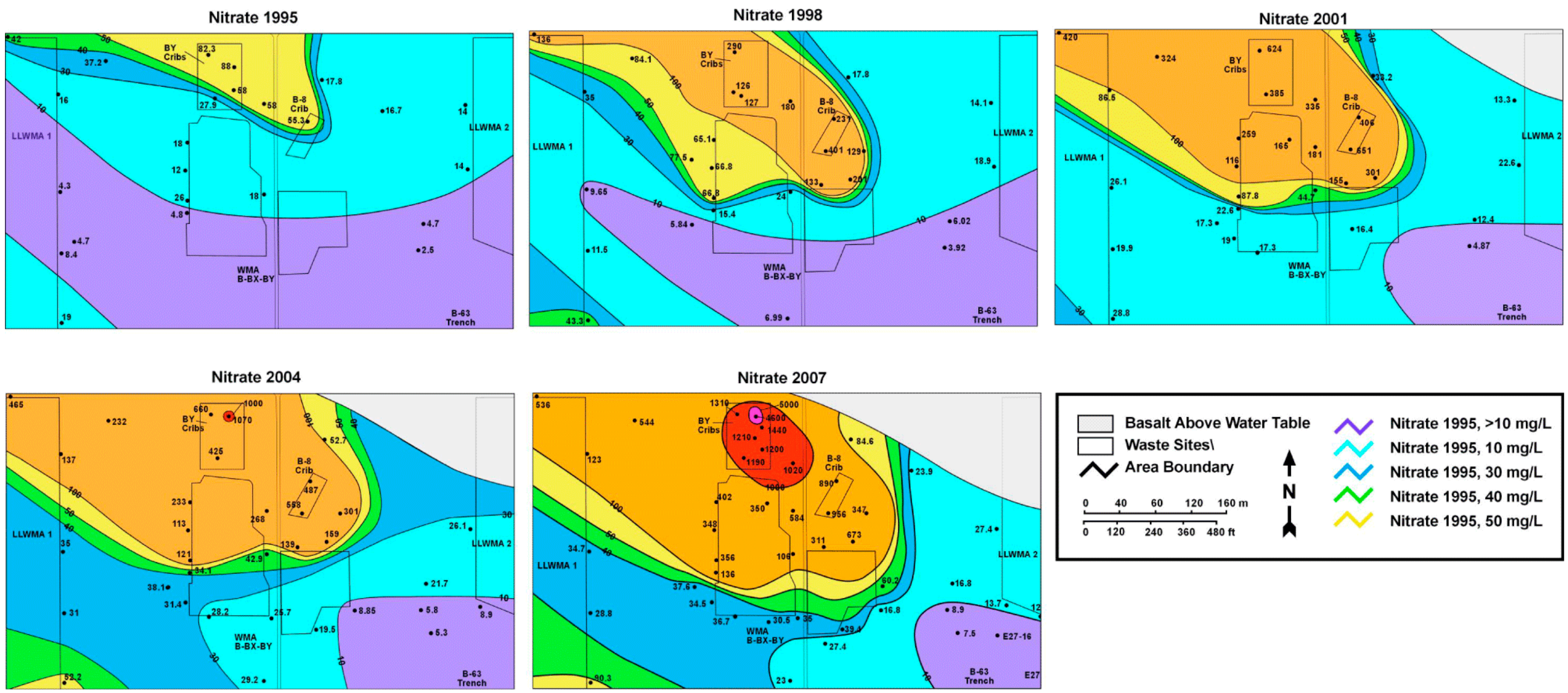
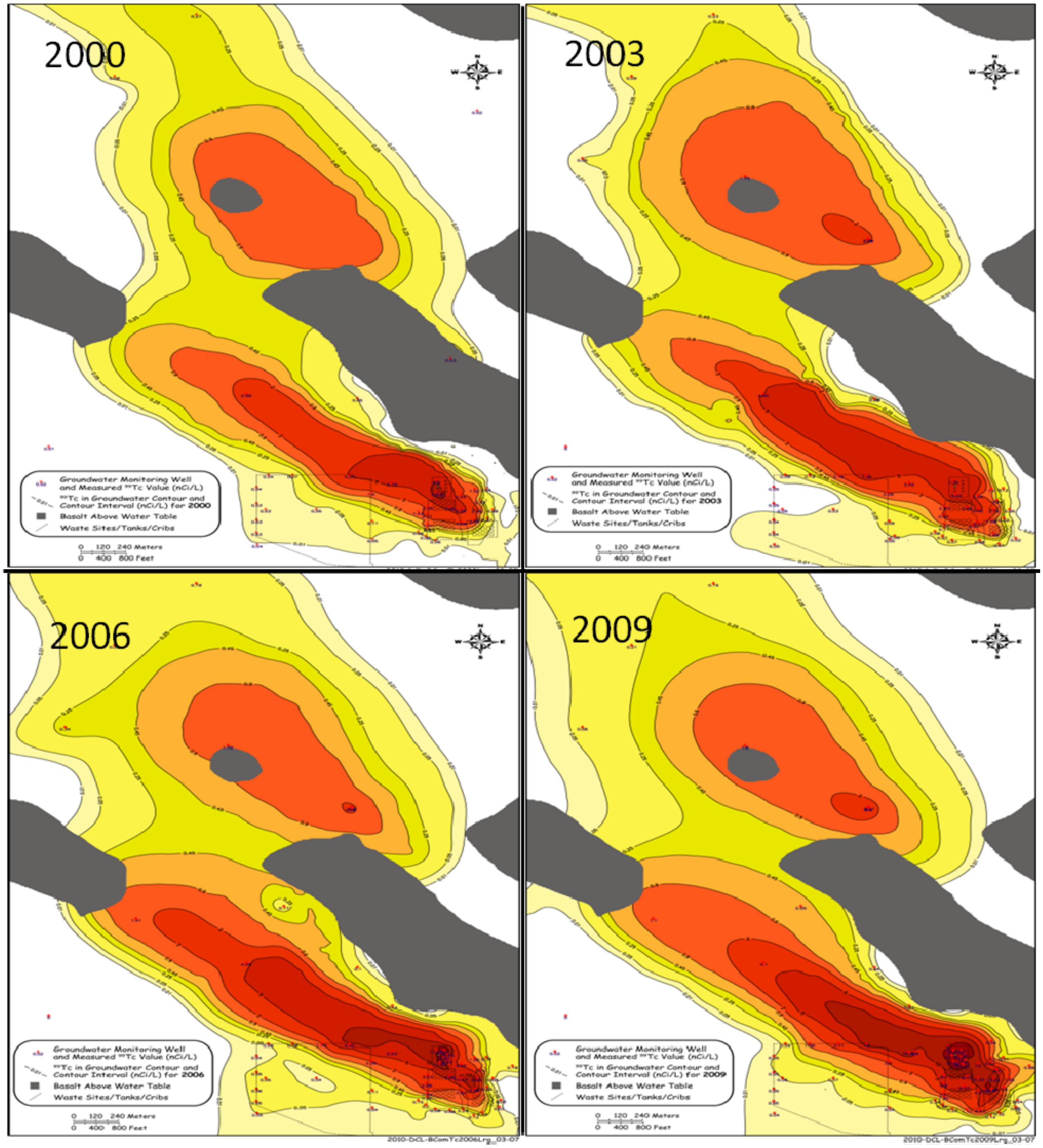
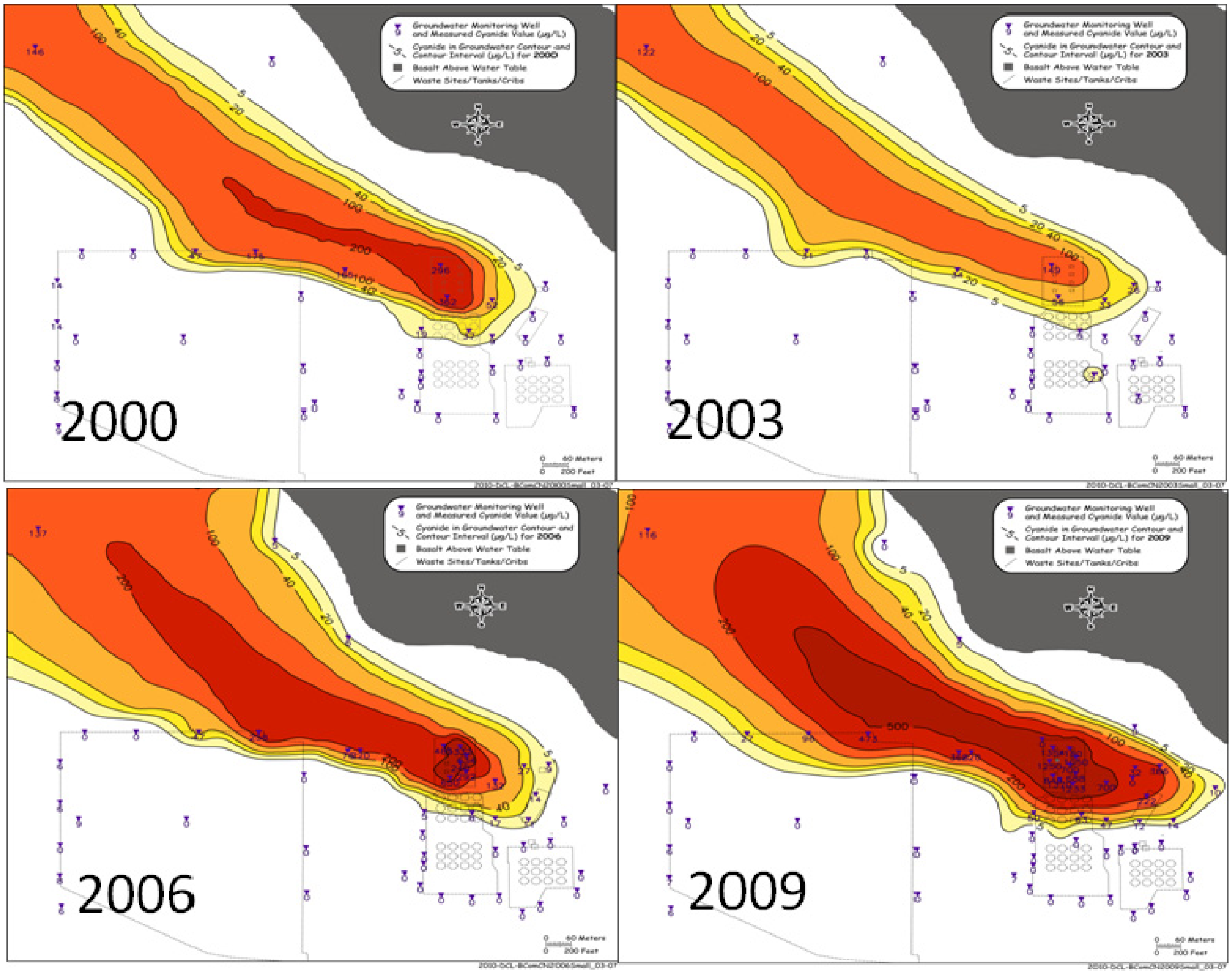


**Figure 3-11. Technetium-99 Plume Distribution in the Unconfined Aquifer Underlying Waste Management Area B-BX-BY in 2000, 2003, 2006, and 2009**




The current migration rates are quite slow because of the low regional hydraulic gradient making it difficult to determine the preferred direction. It appears that movement to the northwest is most frequent with some apparent intermittent influence from the river stage effects to the north. At high river stage, there is an apparent southerly gradient that slows or stops northwesterly flow. Also, during this time period, the contaminant concentrations have increased as have the aquifer volumes exhibiting higher concentrations.

**Figure 3-12. Cyanide Plume Distribution in the Unconfined Aquifer Underlying Waste Management Area B-BX-BY in 1995, 1998, 2001, 2004, and 2007**




Brief summaries of historical subsurface flow and transport processes for each of these contaminants are provided below.

Sporadic early measurements of nitrate contamination in the aquifer around WMA B-BX-BY suggest aquifer concentration levels of several thousand mg/L. In the early 1990s much lower contamination levels were observed (< 100 mg/L). Since then contamination levels have increased steadily, first in the vicinity of the Cribs 216-B-7-A&B and 216-B-8 north of B-Farm and then underneath the northern BY Cribs (Figure 3-11) at well 299-E33-4 beginning in 2004. By 2007, contamination levels exceeded 5,000 mg/L at this well.

Early $^{99}$Tc contamination levels in the mid 1950s appear to have been about 200,000 to 300,000 pCi/L using an approximate ratio to nitrate. In the early 1990s concentrations less than 1,000 pCi/L were measured and then began to increase. In the late 1990s concentrations in wells north of the BY Cribs steadily increased, ranging from 2,000 to 10,000 pCi/L. Snapshots of $^{99}$Tc since 2000 (Figure 3-11) show continued maximum concentrations in the vicinity of the BY Cribs, and generally increasing along a northwest-southeast axis. A hotspot (~7,000 pCi/L) occurred at well 299-E33-44 (east of BY-Farm) in 2004 and by 2006 concentrations above 20,000 and 10,000 pCi/L were measured underneath and south of the BY Cribs, respectively. In July 2008 concentrations reached a maximum of 100,000 pCi/L in well 299-E33-4 at the north end of the BY Cribs. The high concentration zone has continued to extend southward but has apparently also been shaped by highly contaminated releases from a secondary source in the vicinity of well 299-E33-343 (drilled in 2008). In July 2008 concentrations reached a maximum of 100,000 pCi/L in well 299-E33-4 at the north end of the BY Cribs. Possible sources at this location include the 216-B-7-A&B Cribs and the tank BX-102 leak. Using the vadose zone characterization data collected underneath the BY Cribs, estimates are that 34 to 68% of the $^{99}$Tc inventory (43 and 87 Ci, respectively) are still present in the vadose zone and 6 to 70 Ci are within 90 ft of the water table. If so, $^{99}$Tc contamination will persist in the aquifer for many years.

Operations history clearly shows that the only facilities that received significant quantities of cyanide were the BY Cribs, which received waste fluids from the uranium recovery program that use ferrocyanide. Sediments in the deep vadose zone underneath the BY Cribs area seem to be a major source of contaminants entering the WMA B-BX-BY groundwater plume. No aquifer measurements were completed before 1987, preventing development of cyanide groundwater plume maps prior to this date. More frequent measurements began in the early 1990s, and cyanide concentrations have generally increased just around the BY Cribs from 100 to 200 μg/L in the late 1990s to as much as 7,000 μg/L in 2009 beneath the northern BY Cribs. Cyanide has been measured in borehole soils underneath the BY Cribs, but data is insufficient to estimate the possible inventory that remains in the vadose zone. However, estimated groundwater cyanide masses (15 to 40 kg) are only about 0.3% of the total discharge to the BY Cribs. The fate of the missing cyanide mass has not been determined and it is not certain how long deep vadose zone contamination may support the present plume.

In summary, based on the data currently available it cannot be stated whether the vadose zone below the 241-BY Tank Farm has impacted groundwater in the past or whether the deep vadose zone contains significant concentrations of potentially mobile contaminants that could reach the water table in the future. At borehole E33-205 quite a distance south of tank BY-104, there is some indication of slightly elevated water extractable uranium in the $CCU_z$ sediments between 222 and 230 ft bgs and one sediment sample at 225.5 ft bgs had 1 pCi/g water extractable $^{99}$Tc, but both might have come from the tank BX-102 overfill fluids that are migrating north-east of tank BX-102. Based on the low volumes of waste liquids released and the low masses of potentially mobile contaminants in the released fluids from the 241-BY Tank Farm, it does not appear that BY-Farm is currently, or in the future will be, as significant a contributor to the groundwater plumes as the 241-BY Cribs, 216-B7A&B and 216-B8 Cribs and the tank BX-102 overfill event (PNNL-19277 p. 3 to 125).

## 3.8 IN-TANK SOLIDIFICATION

Tanks within the BY-Farm were used as feed staging or evaporator bottoms waste receiving tanks for the ITS program from 1965 to 1974. The ITS program operated as an in-tank heating system to evaporate liquids and concentrate waste. A prototype heater was placed into tank BY-101 and ITS Unit #1 (ITS-1) started March 19, 1965. In 1966 a second heater was placed in tank BY-102 with tank BY-103 acting as the primary feed tank. Feed was circulated to the heated tanks (BY-101 and BY-102), then transferred to other tanks in BY-Farm. A third heater was placed in tank BY-112 and ITS Unit #2 (ITS-2) started up on February 17, 1968 with BY-109 as the primary feed tank. On August 24, 1971, ITS-l was converted from an evaporator to a cooler for ITS-2. Both ITS-1 and ITS-2 units were shut down on June 30, 1974 (WHC-MR-0132, *A History of the 200 Area Tank Farms*).

### 3.8.1 In-Tank Solidification Unit #1 (ITS-1) Description

The 241-BY In-Tank Solidification Unit #1, ITS-1, is located in the 241-BY Tank Farm between tanks BY-101 and BY-102. The ITS-1 unit was used to concentrate non-boiling waste in underground storage tanks using evaporation. This technique was achieved by sparging hot air into the waste solution in the tanks and condensing the off-gas (RPP-RPT-32085, *241-BY-ITS1 Liquid Level Assessment Report*, p. 3). The ITS system (Figure 3-13) included a heat exchanger for water evaporation and a series of bottom tanks (bottoms loop). After concentration in the evaporator, the bottoms stream was routed through the bottoms loop. Heat losses to the ground and the tank ventilation systems progressively lowered the bottoms temperature so that eventually the stream was saturated and solids were formed and deposited in the bottoms tanks. Some crystal growth occurred in tanks upon cooling but most occurred in the crystallizer. The saturated bottoms supernate stream was blended with fresh feed and recycled back to the evaporator. In-Tank Solidification Unit #1 started up March 19, 1965, and operated until August 24, 1971, when it was converted from an evaporator to a cooler for ITS-2. Both units were shut down June 30, 1974 (WHC-MR-0132).

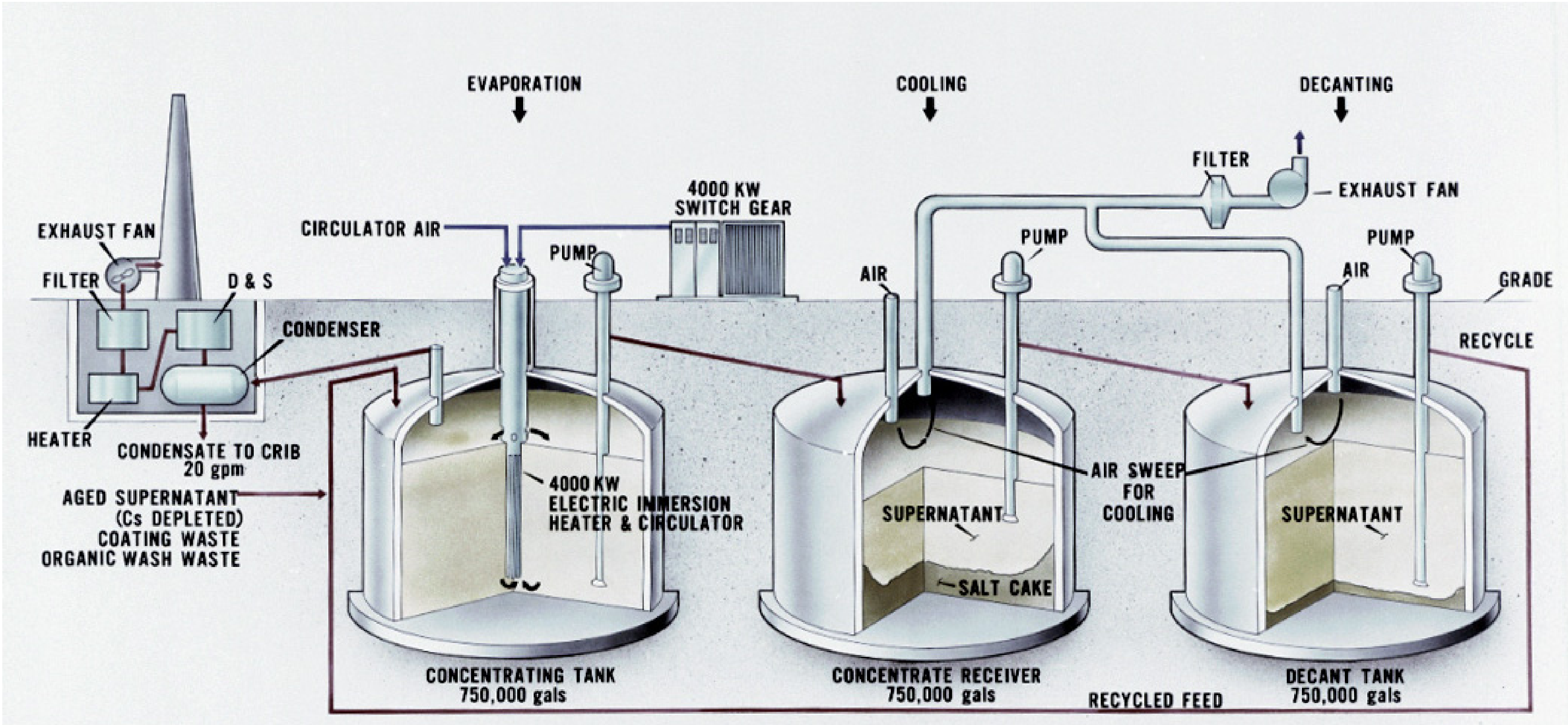
In-Tank Solidification Unit #1 had three miscellaneous underground storage tanks associated with it (Figure 3-14): 241-BY-ITS1-TK1 (Tank 1 – Scrub Solution Circulation Tank) used to scrub the off-gas from the process and recirculate to the system, 241-BY-ITS1-TK2 (Tank 2 – Ion Exchange Feed Tank) which received condensate from the condensate hold tank/separator, and 241-BY-ITS1-IX (Ion Exchange Column) which received and treated filtered waste from the Ion Exchange Feed Tank (Tank 2).

**Tank 1 – Scrub Solution Circulation Tank**
The Scrub Solution Circulation Tank is located below grade just at tank 241-BY-101. This tank is located within a 7 ft 6 in. by 10 ft concrete pit containing a small sump (H-2-33479, *ITS No. 1 Circulating Scrubbing System Prototype*). The tank is a 7 ft by 3 ft 3 in. by 4 ft high oval shape (H-2-50260, *Continuous Concentrator Cooler Assembly-Sections-Details and Cell Orientation*).

The tank was inspected on December 10, 2006. The inspection indicated there was no significant amount of solids, although there was a thin layer of sediment on the bottom of the tank. The tank contained 347 gal of liquid waste. The sump and pit were dry (RPP-RPT-32085, p. 2).

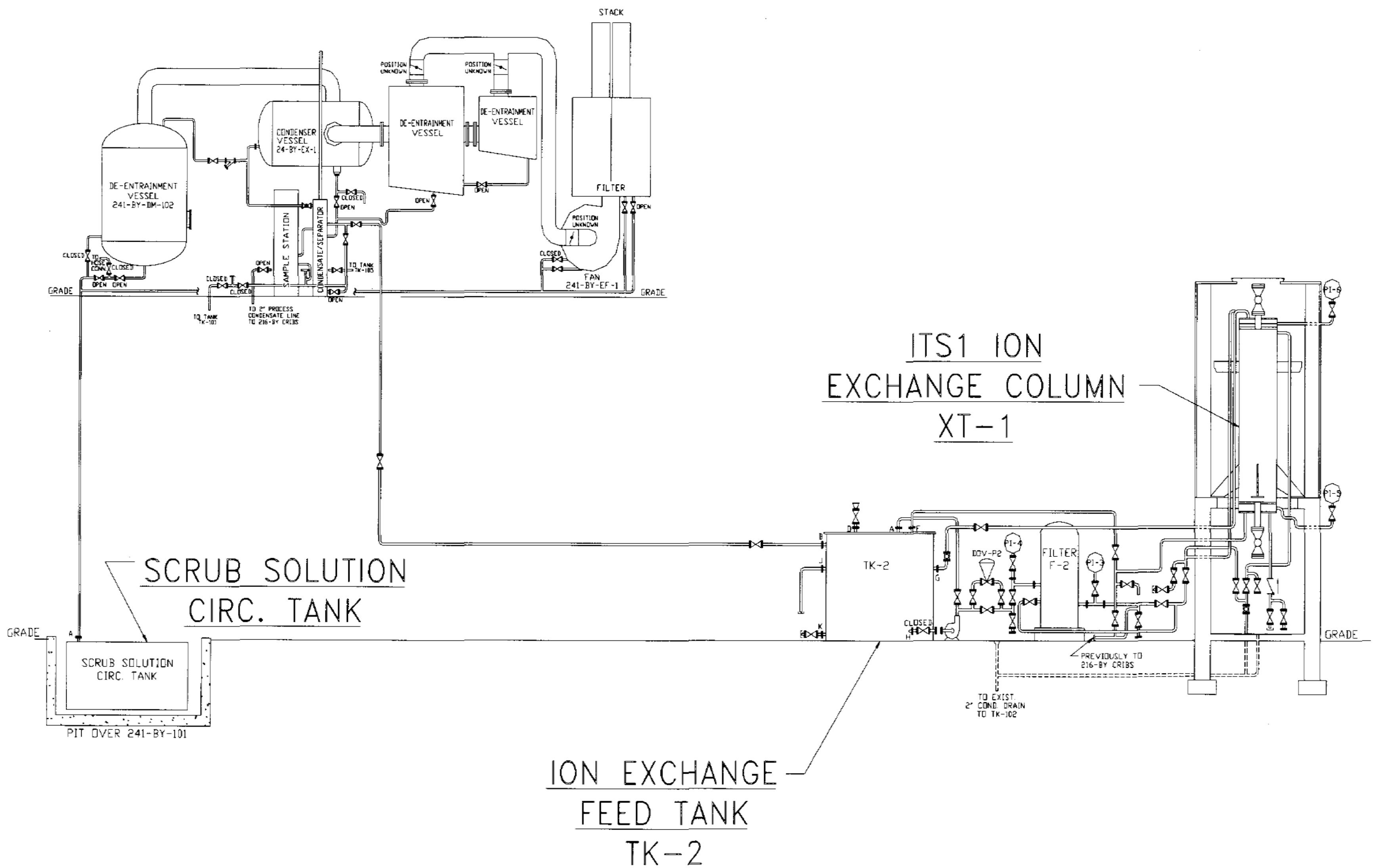
**Tank 2 – Ion Exchange Feed Tank**
Tank 2 has a diameter of 5 ft and is 4 ft 6 in. tall (H-2-33476, *Feed Tank 2 Modifications*). The tank is above grade, resting on a concrete slab in close proximity to the Ion Exchange Column.

**Figure 3-13. In-Tank Stabilization Process Schematic (49142-1-CN)**




Aged wastes are received into the concentrating tank, which is equipped with a 4,000 KW electric immersion heater contained in an air lift circulator. After boiling off water as steam which is condensed and discharged to ground, the concentrated liquor is pumped to receiving tanks where the concentrate is allowed to cool. Solids and dissolved salts that crystallize upon cooling settle in the receiver tanks. The remaining cooled supernatant is then decanted, mixed with fresh feed and recycled to the concentrating vessel.

**Figure 3-14. Miscellaneous Tanks in In-Tank Solidification System #1**



A video inspection of Tank 2 was performed on December 4, 2006. The tank appeared structurally sound, although slight discoloration and corrosion was observed on the inside top. The tank contained a very small amount of solids located in a drift by the pump suction line (no volume reported). The tank had no liquid inside of it (RPP-RPT-32085, p. 2).

**Ion Exchange Column**

The Ion Exchange Column has a radius of 9 in. and is 9 ft tall. The column contains two screens located 6 in. from the top and bottom that retain the resin in place. The column is placed on top of a 6-ft-6-in.-square platform with 8 in.-thick walls, and a drain to tank BY-102. The platform is 6 ft 8 in. high, and is equipped with a small access door on the north side. The platform supports a 10-ft-tall reinforced concrete pipe, with an inside diameter of 5 ft and an outside diameter of 5 ft 10 in. enclosing the ion exchange column. The top is closed with a cover of 3/16-in. carbon steel (H-2-33483, *Struct. Plan & Details*; H-2-33481, *Ion Exchange Column Assembly & Details*).

The column received filtered waste from Tank 2. The waste gravity-flowed through the column with the waste stream routed to either the 216-BY Cribs or Tank 2 for rework (RPP-18251, *241-BY-ITS1 Assessment Plan*).

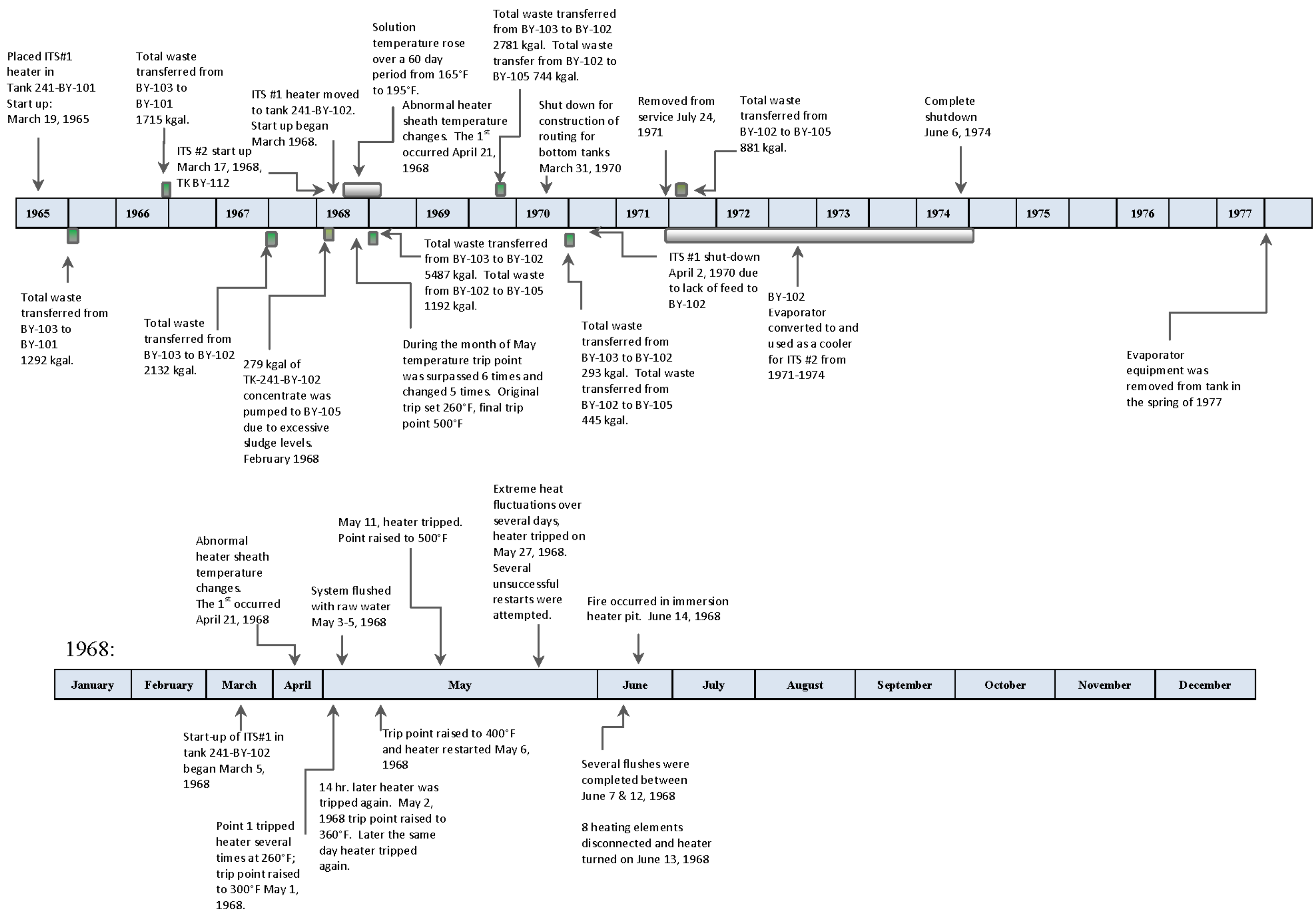
A video inspection on the column was performed on December 12, 2006. There were 78 gal of resin in the column (RPP-RPT-32085, p. 2). The inspection revealed no liquid present within the column.

Figure 3-15 shows events and waste transfers associated with ITS-1 operations. Figure 3-16 outlines ITS-1 history and shows transfers to and from tanks BY-101 and BY-102.

### 3.8.2 In-Tank Solidification Unit #2 (ITS-2) Description

The 241-BY In-Tank Solidification Unit #2, ITS-2, was a second generation stabilization system placed between tanks BY-111 and BY-112. A heater was placed in tank BY-112. BY-111, BY-109, and BY-106 were bottom tanks, BY-103 and BY-105 were feed tanks and BY-102 was used as a cooling unit. In-Tank Solidification Unit #2 started up December 1967. Figure 3-17 shows events associated with ITS-2 operations. In-Tank Solidification Unit #2 was shut down in 1968 due to increased temperatures > 300 °F and a fire in the heater immersion pit caused by failed heating elements (ARH-1381, *Electric Immersion Heater Failures in the Hanford Waste Solidification Program Task Force Report*). After repair, ITS-2 resumed operations and operated until June 30, 1974 (WHC-MR-0132). The unit was shut down as a result of a creep crack analysis (ARH-2883, *Creep and Cracking Analyses of the 241-BY-112 Reinforced Concrete, Underground Waste Storage Tank*) showing that tank BY-112 integrity would be compromised if ITS-2 continued. Waste surface levels show that tank BY-112 and tanks BY-109, BY-110 and BY-111 were overfilled during the ITS process. This was confirmed by photos. Figure 3-18 shows a history of the ITS-2 process and table showing transfers to and from tank BY-112 during the process.

# Figure 3-15. In-Tank Solidification Unit #1 Timeline of Events



# Figure 3-16. In-Tank Solidification Unit #1 History and Process Outline

**1) History**

a. Placed in Tank 241-BY-101, start up March 19, 1965
b. Moved from Tank BY-101 to BY-102 in March of 1968
c. Fire in immersion heater pit June 14, 1968
d. Removed from service as an Evaporator Unit July 24, 1971
e. BY-102 Evaporator was converted to a cooling Unit for ITS-2
f. Complete shutdown of Unit occurred June 6, 1974
g. Evaporator Equipment was removed from tank BY-102 and buried in the spring of 1977

**2) Abnormal heater activities**

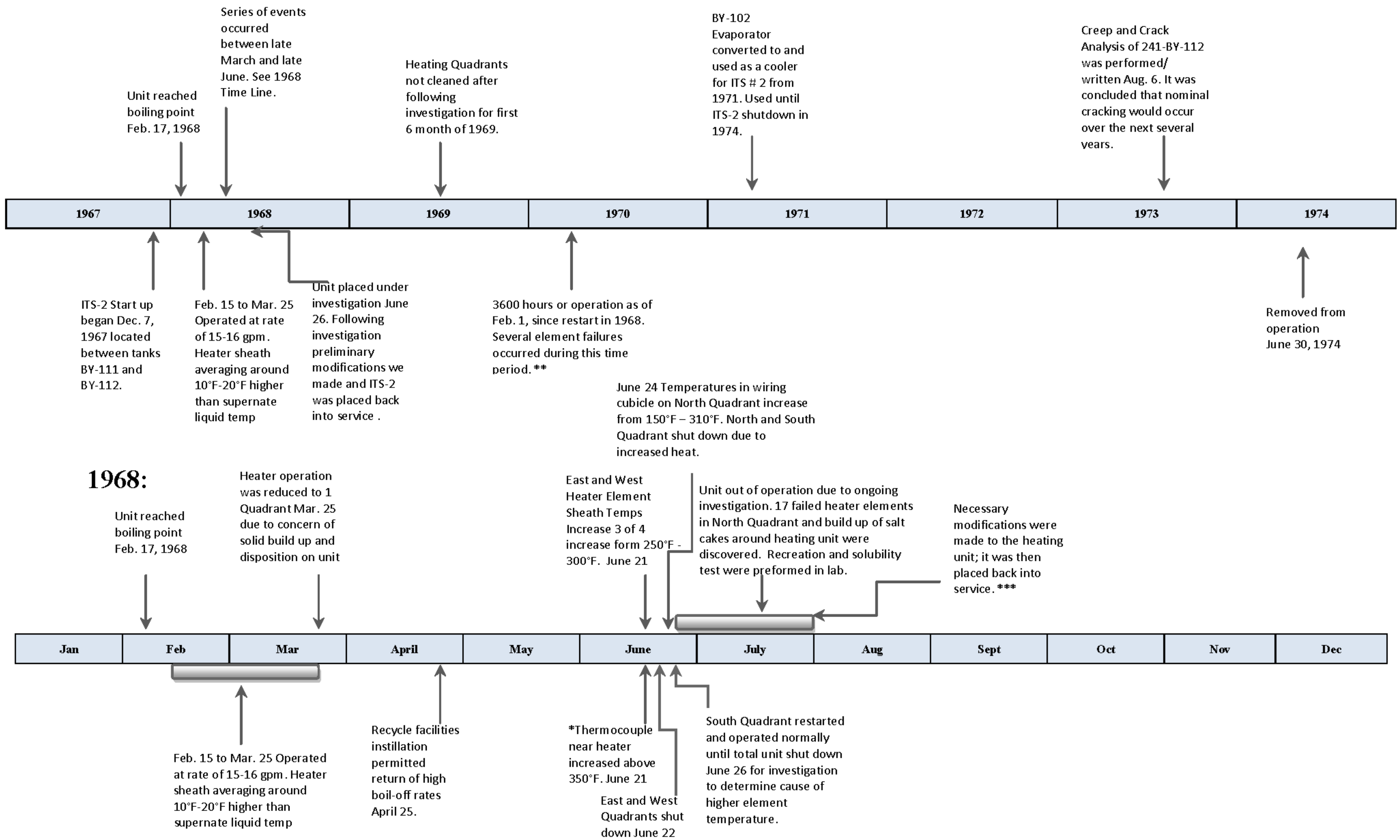
a. Abnormal Heater sheath temperature change began April 1, 1968
b. Heater Trip point exceeded at 260 °F, changed to 300 °F May 1, 1968
c. 14 hours later trip point reached again; May 2, 1968 trip point raised to 360 °F
d. Trip point exceeded again later the same day
e. System flush with raw water May 3-5 1968
f. Trip point raised to 400 °F May 6, 1968
g. Extreme heat fluctuation over a several day period
h. Heater once again tripped May 27, 1968
i. Several unsuccessful attempts were made to restart the heating unit
j. Several flushes were completed between June 7 & 12, 1968
k. Fire in immersion heater pit June 14, 1968
l. Following the fire Evaporator ran normally, no significant heat fluctuations

**3) Waste Transfers**

a. Quarterly transfer amounts of waste to/from In-Tank Solidification (ITS) Tank for the years 1965-1971

| ITS Tank | Year | Quarter | Sent/Received | Waste Type | Amount (gal) | To/From |
|---|---|---|---|---|---|---|
| BY-101 | 1965 | 2 | Received | Supernate | 143,000 | BY-103 |
| BY-101 | 1965 | 3 | Received | Supernate | 1,149,000 | BY-103 |
| BY-101 | 1965 | 4 | Received | Supernate | 233,000 | BY-103 |
| BY-101 | 1966 | 1 | Received | Supernate | 289,000 | BY-103 |
| BY-101 | 1966 | 2 | Sent | Supernate | 432,000 | BY-105 |
| BY-101 | 1966 | 3 | Sent | Supernate | 994,000 | BY-105 |
| BY-101 | 1966 | 4 | Received | Supernate | 119,000 | BY-103 |
| BY-102 | 1966 | 4 | Received | Supernate | 50,000 | BY-103 |
| BY-102 | 1967 | 1 | Received | ITS | 547,000 | BY-103 |
| BY-102 | 1967 | 2 | Received | ITS | 743,000 | BY-103 |
| BY-102 | 1967 | 3 | Received | ITS | 454,000 | BY-103 |
| BY-102 | 1967 | 4 | Received | ITS | 477,000 | BY-103 |
| BY-102 | 1968 | 1 | Received | ITS | 994,000 | BY-103 |
| BY-101 | 1968 | 1 | Sent | Supernate | 279,000 | BY-105 |
| BY-102 | 1968 | 2 | Received | ITS | 2,652,000 | BY-103 |
| BY-102 | 1968 | 3 | Received | ITS | 1,027,000 | BY-103 |
| BY-102 | 1968 | 3 | Sent | Supernate | 256,000 | BY-105 |
| BY-102 | 1968 | 4 | Received | Supernate | 814,000 | BY-103 |
| BY-101 | 1968 | 4 | Sent | Supernate | 330,000 | BY-105 |
| BY-102 | 1969 | 1 | Received | Supernate | 693,000 | BY-103 |
| BY-101 | 1969 | 1 | Sent | Supernate | 408,000 | BY-105 |
| BY-102 | 1969 | 2 | Received | Supernate | 696,000 | BY-103 |
| BY-102 | 1969 | 3 | Received | Supernate | 620,000 | BY-103 |
| BY-101 | 1969 | 3 | Sent | Supernate | 154,000 | BY-105 |
| BY-102 | 1969 | 4 | Received | Supernate | 657,000 | BY-103 |
| BY-101 | 1969 | 4 | Sent | Supernate | 182,000 | BY-105 |
| BY-102 | 1970 | 1 | Received | Supernate | 293,000 | BY-103 |
| BY-101 | 1970 | 1 | Sent | Supernate | 70,000 | BY-105 |
| BY-102 | 1970 | 2 | Sent | Supernate | 89,000 | BY-105 |
| BY-102 | 1970 | 4 | Sent | Supernate | 286,000 | BY-105 |
| BY-102 | 1971 | 1 | Sent | Supernate | 514,000 | BY-105 |
| BY-102 | 1971 | 2 | Sent | Supernate | 367,000 | BY-105 |
| BY-101 | | TOTAL | Sent | | (sum of volumes from above) | |
| BY-101 | | | Received | | (sum of volumes from above) | |
| BY-102 | | TOTAL | Sent | | (sum of volumes from above) | |
| BY-102 | | | Received | | (sum of volumes from above) | |

## Figure 3-17. In-Tank Solidification Unit #2 Timeline of Events




*Thermocouple christmas tree, sheath thermocouples and differential pressure dip tubes installed in the air lift circulator operated normally from Dec. 7, 1967 to June 1968.
**Dates of failures not specified in ARH-1381
***Dates of restart and modifications are unknown (ARH-1381)

## Figure 3-18. In-Tank Solidification Unit #2 History and Process Outline

**1) History**

a. Start up began December 7, 1967
b. Unit reached boiling point February 17, 1968
c. Heater operation was reduced to 1 Quadrant March 25, 1968
d. Recycle facilities were installed April 25, 1968
e. Complete unit shut down for investigation June 26, 1968
f. Restart of heating unit sometime between August and December of 1968
g. 3,600 Hours of operation as of February 1, 1970
h. BY-102 Evaporator was converted into a cooler for ITS-2, 1971
i. Creep and Crack Analysis of 241-BY-112 was performed/written August 6, 1973
j. ITS-2 removed from operation June 30, 1974

**2) 1968**

a. February 15 to March 25 Unit operates within acceptable limits
b. Heater operation was reduced to 1 Quadrant March 25
c. Recycle facilities installation permitted return of high boil-off rates April 25
d. East and west heater element sheath temperatures increase from 250 °F to 300 °F June 21
e. Thermocouple near heater increased above 350 °F June 21
f. June 24 temperatures in wiring cubicle on north Quadrant increase from 150 °F to 310 °F. North and south Quadrant shut down due to increased heat
g. Total unit shut down June 26 for investigation to determine cause of higher element temperature
h. During investigation 17 failed heating elements were discovered along with large amounts of saltcake build-up
i. Lab tests were performed to determine the reproducibility and solubility of saltcakes
j. Needed modifications were made to Evaporator unit
k. Unit placed back into service sometime between August and December 1968

**3) Waste Transfers**

a. Quarterly transfer amounts of waste to/from In-Tank Solidification (ITS) tank for the years 1968-1974

| ITS Tank | Year | Quarter | Sent/Received | Waste Type | Amount (gal) | To/From |
|---|---|---|---|---|---|---|
| BY-112 | 1970 | 3 | Received | Supernate | 543,000 | BY-105 |
| BY-112 | 1970 | 4 | Received | Supernate | 66,000 | BY-105 |
| BY-112 | 1971 | 1 | Received | Supernate | 125,000 | BY-103 |
| BY-112 | 1971 | 1 | Received | Supernate | 620,000 | BY-105 |
| BY-112 | 1971 | 2 | Received | Supernate | 22,000 | BY-103 |
| BY-112 | 1971 | 2 | Received | Supernate | 378,000 | BY-105 |
| BY-112 | 1971 | 3 | Sent | ITS | 32,000 | BY-105 |
| BY-112 | 1971 | 4 | Received | Supernate | 616,000 | BY-103 |
| BY-112 | 1971 | 4 | Received | ITS | 11,000 | BY-105 |
| BY-112 | 1972 | 1 | Sent | Supernate | 537,000 | BY-103 |
| BY-112 | 1972 | 1 | Received | Supernate | 33,000 | BY-105 |
| BY-112 | 1972 | 2 | Sent | Supernate | 11,000 | BY-103 |
| BY-112 | 1972 | 2 | Sent | ITS | 23,000 | BY-105 |
| BY-112 | 1972 | 3 | Received | Supernate | 566,000 | BY-103 |
| BY-112 | 1972 | 3 | Received | Supernate | 59,000 | BY-105 |
| BY-112 | 1972 | 4 | Received | Supernate | 144,000 | BY-103 |
| BY-112 | 1972 | 4 | Sent | ITS | 22,000 | BY-105 |
| BY-112 | 1973 | 1 | Received | Supernate | 465,000 | BY-103 |
| BY-112 | 1973 | 1 | Received | Supernate | 2,000 | BY-105 |
| BY-112 | 1973 | 2 | Sent | Supernate | 14,000 | BY-103 |
| BY-112 | 1973 | 3 | Received | ITS | 9,000 | BY-105 |
| BY-112 | 1974 | 1 | Received | Supernate | 1,000 | BY-105 |
| BY-112 | 1974 | 2 | Received | Supernate | 4,000 | BY-105 |
| BY-112 | 1974 | 4 | Sent | ITS | 12,000 | BY-105 |
| BY-112 | | TOTAL | Sent | | (sum of volumes from above) | |
| | | | Received | | (sum of volumes from above) | |

# 4.0 LEAK ASSESSMENT RESULTS

The information gathered and the reassessment results for each of the SSTs and UPRs in the 241-BY Tank Farm are summarized in the following sections and discussed in further detail in Appendix B.

## 4.1 TANK 241-BY-103

### 4.1.1 Leak Status of Tank 241-BY-103

Tank BY-103 was declared a confirmed leaker and removed from service in May 1973 based on increasing gamma activity in drywell 22-03-09.

On November 24, 1997 interim stabilization was completed (HNF-SD-RE-TI-178, *Single-Shell Tank Leak Stabilization Record*). As of January 2009 the tank is estimated to contain 9,000 gal of sludge and 405,000 gal of saltcake with an estimated 55,000 gal of drainable interstitial liquid and no supernate (HNF-EP-0182).

### 4.1.2 Leak Assessment Considerations

On the basis of continued high count rates in drywell 22-00-03, tank BY-103 was suspected of leaking in 1970. The liquid operating level in tank BY-103 was lowered to ~13 ft to permit continued operation of the tank. In 1972 and 1973, count rates in drywell 22-03-09 (the opposite side of the tank) spread over a widening interval. On the basis of elevated gross gamma-ray count rates in the drywells around the tank, tank BY-103 was classified as a confirmed leaker in 1973. In 1974, a changing radiation profile and increase in radiation in drywell 22-03-09 at a depth of ~32 ft prompted an occurrence report (OR-74-106, *Increasing Radioactivity in Dry Well 22-03-09 at Tank 103-BY*) that concluded the tank may have leaked in early 1974, but that it probably no longer was leaking after the liquid level was lowered below the depth at which the radiation peak was observed (GJ-HAN-20, *Vadose Zone Characterization Project at the Hanford Tank Farms Tank Summary Data Report for Tank BY-103*). Drywell activity in 1975 indicates significant contamination from 15 to 80 ft and in most drywells with the peak activity generally near the tank base.

The current leak estimate for tank BY-103 (HNF-EP-0182) is based on a table in PNL-4688, *Assessment of Single-Shell Tank Residual Liquid Issues at Hanford Site, Washington* which shows a leak of <5,000 gal, which in turn is based on RHO-RE-SR-14, *Waste Status Summary November 1986* that shows a "small" leak for BY-103 and BY-108 but gives no volume estimate. No documented evaluation for the leak volume was found. A volume of 5,000 gal is roughly equivalent to a 2-in. difference in the waste surface level and may be based on a 2-in. uncertainty for manual tape measurements. There is no evidence of an unaccounted-for liquid level decrease in tank BY-103.

### 4.1.3 Conclusions and Recommendations

Tank BY-103 appears to have leaked near the tank base sometime before increasing gamma activity was first observed in drywell 22-03-09 in May 1973. No unaccounted-for liquid level decreases were observed for this tank. The previous leak volume estimate of <5,000 gal, apparently based on uncertainty in manual tape surface level measurements, appears to be a reasonable upper volume for the leak; drywell activity estimates shown in Appendix B indicate that the leak may have been smaller. Hanford Soil Inventory Model inventory estimates for the leak are reasonably consistent with sample data and should be used for leak composition estimates.

## 4.2 TANK 241-BY-105

### 4.2.1 Leak Status of Tank 241-BY-105

Tank BY-105 is suspected of leaking in the past based on increasing activity measured in drywell 22-05-09 in August 1974, and was classified as an "assumed leaker" in 1984 (OR-74-117, *Symptoms of Leakage at Waste Tank 105-BY as Indicated by Increasing Dry Well Radiation Levels*). Occurrence Reports and memos for BY-105 were issued for potential intrusions to the tank, though liquid level changes were attributed to other sources.

A saltwell system for removal of interstitial liquids was installed in the tank in January 1975 and removed in October 1976. Jet pumping of BY-105 took place from July 2001 to September 2002, and the tank was declared "interim stabilized" on March 7, 2003. As of January 2009, the tank is estimated to contain 40,000 gal of PFeCN sludge, 8,000 gal of Portland Cement and 433,000 gal of saltcake with an estimated 47,000 gal of drainable interstitial liquid and no supernate (HNF-SD-RE-TI-178). No leak volume has been estimated for tank BY-105 (HNF-EP-0182).

### 4.2.2 Leak Assessment Considerations

Occurrence Report OR-74-117 notes that a drywell roughly 10 ft west of tank BY-105 (22-05-09) experienced increased radiation levels at a depth of 67 ft. The report identifies several possible sources for the radiation increase, including liquid leaking from tank BY-105 itself, liquid leaking from tank BY-108, or contamination leaching from an old pre-existing tank leak, line leak or pump pit leak. Later monitoring of three drywells around tank BY-105 occurred in 1995, and it was concluded that the drywell data obtained indicates that tank BY-105 probably did not leak, and the drywell activity likely came from another source (GJ-HAN-22, *Vadose Zone Characterization Project at the Hanford Tank Farms Tank Summary Data Report for Tank BY-105*).

Though historical surface level changes were observed in tank BY-105, these changes were attributed to the shifting of solid waste inside the tank.

### 4.2.3 Conclusions and Recommendations

It was concluded that available data does not indicate that tank BY-105 leaked. More plausible sources for activity in drywells near the tank were identified based on logging data collected after 1973. It is recommended that the leak classification for tank BY-105 be re-evaluated per TFC-ENG-CHEM-D-42, "Tank Leak Assessment Process."

## 4.3 TANK 241-BY-106

### 4.3.1 Leak Status of Tank 241-BY-106

Tank BY-106 was categorized as a "questionable integrity" tank in 1977 due to the presence of tar rings observed near the top of the liner as seen on in-tank photographs and labeled an "assumed leaker" in 1984 (SD-WM-TI-356). Jet pumping was completed in 2003, after which the tank was declared interim stabilized (HNF-SD-RE-TI-178 p. 110). As of April 30, 2009, tank BY-106 is reported to contain 430,000 gal of total waste, with 37,000 gal of drainable interstitial liquid and no supernate. In addition, tank BY-106 contains 32,000 gal of sludge and 398,000 gal of saltcake (HNF-EP-0182).

### 4.3.2 Leak Assessment Considerations

Historical Tank Farms gross gamma-ray logs show enhanced count rates for borehole 22-06-05 since 1972 (earliest record located). The logs indicate contamination throughout a broad interval, with a peak initially near 31 ft. By 1994 the initial high activity previously exhibited from 30 to 58 ft had mostly decayed away and the highest activity existed from 64 to 85 ft. The lower depth interval indicated an influx in approximately 1980. Currently, $^{60}Co$ is identified from approximately 29 to 88 ft. Activity may indicate downward contaminant movement with time. However, repeat logging from well 22-06-05 and other nearby wells suggests a lateral influx of contaminants from 64 to 85 ft, possibly from nearby tank BY-108. The highest initial activity, from 30 to 58 ft, may have originated from tank BY-106. Waste may have flowed over the steel liner or through the liner above the location where tar rings were observed.

Reviews of waste transfer data and liquid level data do not reveal any discrepancies in waste surface levels that would indicate a leak. There were no indications of a liquid level decrease from surface level measurements, and potential intrusions between 1974 and 1977 were attributed to malfunctions of the manual measuring tape and shifting of the solids inside the tank (OR-77-69, *Tank 106-BY Liquid Level Increase*; OR-77-161, *Tank 106-BY Liquid Level Exceeding Increase Criterion*).

### 4.3.3 Conclusions and Recommendations

There was no basis for an inventory estimate and some question whether tank BY-106 actually leaked. It is recommended that the leak classification for tank BY-106 be re-evaluated per TFC-ENG-CHEM-D-42. Additional logging and characterization are also recommended to further assess any changes in the gamma profile near the tank.

## 4.4 TANK 241-BY-107

### 4.4.1 Leak Status of Tank 241-BY-107

Tank BY-107 was designated as an assumed leaker in 1984, with an estimated leak volume of 15,100 gal based on liquid level decreases (HNF-EP-0182). Tank BY-107 was interim stabilized in July, 1979 via jet pumping. A manual tape was used to measure surface liquid levels inside the tank from June 1973 to October 1978 (SD-WM-TI-356). As of April 30, 2009 the tank contains 271,000 gal of total waste, including no supernatant liquid, 42,000 gal of drainable interstitial liquid, 15,000 gal of sludge, and 256,000 gal of saltcake (HNF-EP-0182).

### 4.4.2 Leak Assessment Considerations

The current leak volume estimate of ~15,000 gal appears to be based on a liquid level decrease of 5.5 in. between June 15, 1973 and April 11, 1974. OR-74-27, *Significant Liquid Level Decrease – Tank 241-107-BY* notes an unexpected liquid level decrease accompanied by increased activity between 27 and 39 ft in depth in nearby drywell 22-07-02 in April 1974. In December 1974, four adjacent drywells experienced increased radiation levels at depths ranging from 48 to 70 ft while liquid levels remained static (OR-74-153, *Increasing Dry Well Radiation Adjacent To Tank 107-BY*). In general, drywells indicated two intervals of contamination from ~40 to 50 ft and from 60 to 90 ft. OR-74-153 attributed this activity to migration of old contamination. OR-75-56, *Increasing Dry Well Radiation Adjacent to Tank 107-BY* shows the location of a French drain and raw water outlet between tanks BY-107 and BY-104 believed to be the source of high moisture in the area and a contributing factor to migration of contaminants.

However, following the OR-74-153 report, the liquid volume in the tank was reduced by removing ~167,000 gal of supernatant liquid. Two boreholes (22-07-09 and 22-07-10) exhibited contamination from the ground surface to approximately 35 ft in 1975.

Based on the occurrence reports and other information reviewed, it was determined that if tank BY-107 leaked it was probably during 1974 prior to April when 167,000 gal was pumped from the tank. After pumping, the liquid level was 185.5 in. above the base of the tank. The manual tape was flushed several times in 1973 and 1974 raising a question of whether actual liquid level decreases occurred. Drywell activity may also be attributed to a December 16, 1952 leak of 23,000 gal of first cycle waste from a loose flange in an overground transfer system (HW-28471, *Unconfined Underground Radioactive Waste and Contamination in the 200 Areas*, p. 5).

### 4.4.3 Conclusions and Recommendations

Based on the information reviewed it was concluded that liquid level measurement discrepancies were due to the nature of the waste surface and frequent flushing of the manual tape and do not appear to be an indication of a tank leak. Drywell activity may be explained by the 23,000 gal UPR near the tank (HW-28471) and moisture sources in the subsurface. If a tank leak did occur, it was likely above the 185.5–in. level. A formal tank leak assessment per TFC-ENG-CHEM-D-42 is recommended to further assess the integrity of tank BY-107.

## 4.5 TANK 241-BY-108

### 4.5.1 Leak Status of Tank 241-BY-108

Tank BY-108 was categorized as an “assumed leaker” in 1972 based on observed high activity in surrounding drywells. A leak volume estimate of less than 5,000 gal appears to be based on uncertainty in manual tape surface level measurements. Supernate pumping of the tank was completed in May 1972 (SD-WM-TI-356), while jet pumping ended in December 1984 (HNF-SD-RE-TI-178). Tank BY-108 was declared “interim stabilized” in February 1985 (SD-WM-TI-356).

As of July, 2009, the tank contains 182,000 gal of saltcake and 33,000 gal of drainable interstitial liquid with no supernate (HNF-EP-0182).

### 4.5.2 Leak Assessment Considerations

Seven 100-ft deep vadose zone drywells that were drilled in the early to mid-1970s surround tank BY-108. Historical gross gamma logs indicate elevated activity in varying amounts in all drywells associated with tank BY-108. Four boreholes indicate historical contamination between 38 and 100 ft in depth and two indicate contamination between 22 and 25 ft. The contamination below 40 ft generally consisted of $^{60}$Co (measured currently) and other short-lived gamma emitters not currently detectable. Generally drywell data around the tank showing extensive $^{137}$Cs contamination in the top 10 ft bgs and $^{60}$Co contamination below the base of the tank starting at 35 to 40 ft bgs. It is thought that $^{60}$Co present in drywells around tank BY-108 may have originated from releases through spare inlet ports, cascade lines or by overflowing the steel liner. However, the fact that contamination is indicated near the tank base may suggest tank leaks. Possible indications of a subsurface source originating from the tank are shown by elevated $^{137}$Cs concentrations in drywells 22-08-06 and 22-08-02 at ~23 to 26 ft in depth, respectively. This depth range corresponds with the depth to the top of the tank liner and ancillary piping where fluids may have spilled (GJ-HAN-25, *Vadose Zone Characterization Project at the Hanford Tank Farms Tank Summary Data Report for Tank BY-108*).

No surface level measurements are present before 1972. Manual tape surface level measurements indicate an unexplained decrease in 1973, though this appears to be a result of transfers to tank BY-109. Two occurrence reports [OR-76-142, *Liquid Level Increase in Excess of 3 Inches*; OR-80-5, *Tank 108-BY Liquid Level Measurement (Manual Tape) Exceeding the Increase Criterion*] were issued in 1976 and 1980, respectively, for liquid level increases, though these were attributed to equipment malfunctions and a snowmelt intrusion.

### 4.5.3 Conclusions and Recommendations

Several potential sources, including a tank leak, were identified for radioactivity in drywells surrounding tank BY-108. However, the location of $^{137}$Cs in the drywells indicates that if the tank leaked, the release would have occurred near the top of the tank. It is recommended that a formal TFC-ENG-CHEM-D-42 assessment be performed to further assess the mechanism of a release from the tank. Additional field investigations are also recommended, including direct push/logging near the transfer line and sampling to further investigate $^{60}$Co co-speciation and sources of the contamination.

## 4.6 POTENTIAL PIPELINE FAILURES, OVERFILLS AND OTHER UNPLANNED RELEASES

DOE/RL-88-30, *Hanford Site Waste Management Units Report* contains the official listing of UPRs identified at the Hanford Site. Unplanned releases, pipeline failures and near-surface releases summarized in Table 4-1 were identified through review of operational histories for the BY-Farm. Some of these releases are not currently included in the Waste Information Data System as UPRs. Figures 4-1 and 4-2 show BY-Farm pipeline diagrams. UPR-200-E-134 and UPR-200-E-135 are associated with tank leaks from BY-103 and BY-108, respectively. UPR-200-E-110 and UPR-200-E-116 were established for a valve pit and piping leak at tank BY-112 (BHI-00179, *B Plant Aggregate Area Management Study Technical Baseline Report*).

Figures 4-3, 4-4 and 4-5 are cross-section visualizations based on SGLS drywell measurements. The figures illustrate the near-surface UPR at tank BY-112 and show that low levels of cesium activity are widely distributed across the farm in the top 9 ft bgs. At 35 ft, except for the UPR at tank BY-112 the highest activity for cesium is observed near tank BY-103 and cobalt plumes begin to be observed at about the same location as surface cesium activity is observed.

Except as noted, information available was insufficient to estimate a leak volume or inventory for pipeline failures and surface releases. Additional near-surface data needs will be determined through data quality objective workshops in support of 241-BY Tank Farm performance assessments and corrective management studies.

## 4.7 POTENTIAL OVERFLOWS AND TAR RINGS

During ITS transfers, many of the BY-Farm tanks were overfilled, as shown by process history and in-tank photos. In addition, photos show a black substance (referred to as tar rings) around the top of the steel liner in tanks BY-103, BY-106, BY-107, BY-108, BY-109, BY-110, BY-111 and BY-112 (see Figures 4-6 and 4-7). A study of tar rings in ITS tanks (ARH-1496, *Review of Storage Tank Integrity*) concluded that the tar observed on the liner was from the mastic compound (tar) placed between the steel tank liner and the concrete walls during construction. The tar rings appear to be the result of mastic compound melting and flowing from the dome of the tank and through gaps, holes, corrosion pits, and similar discontinuities at the top of the liner. ARH-1496 indicates that tar was flowing through perforations in the liner (below the top of the liner) in some locations in tank BY-110. However, this was not apparent from a review of the photos referenced.

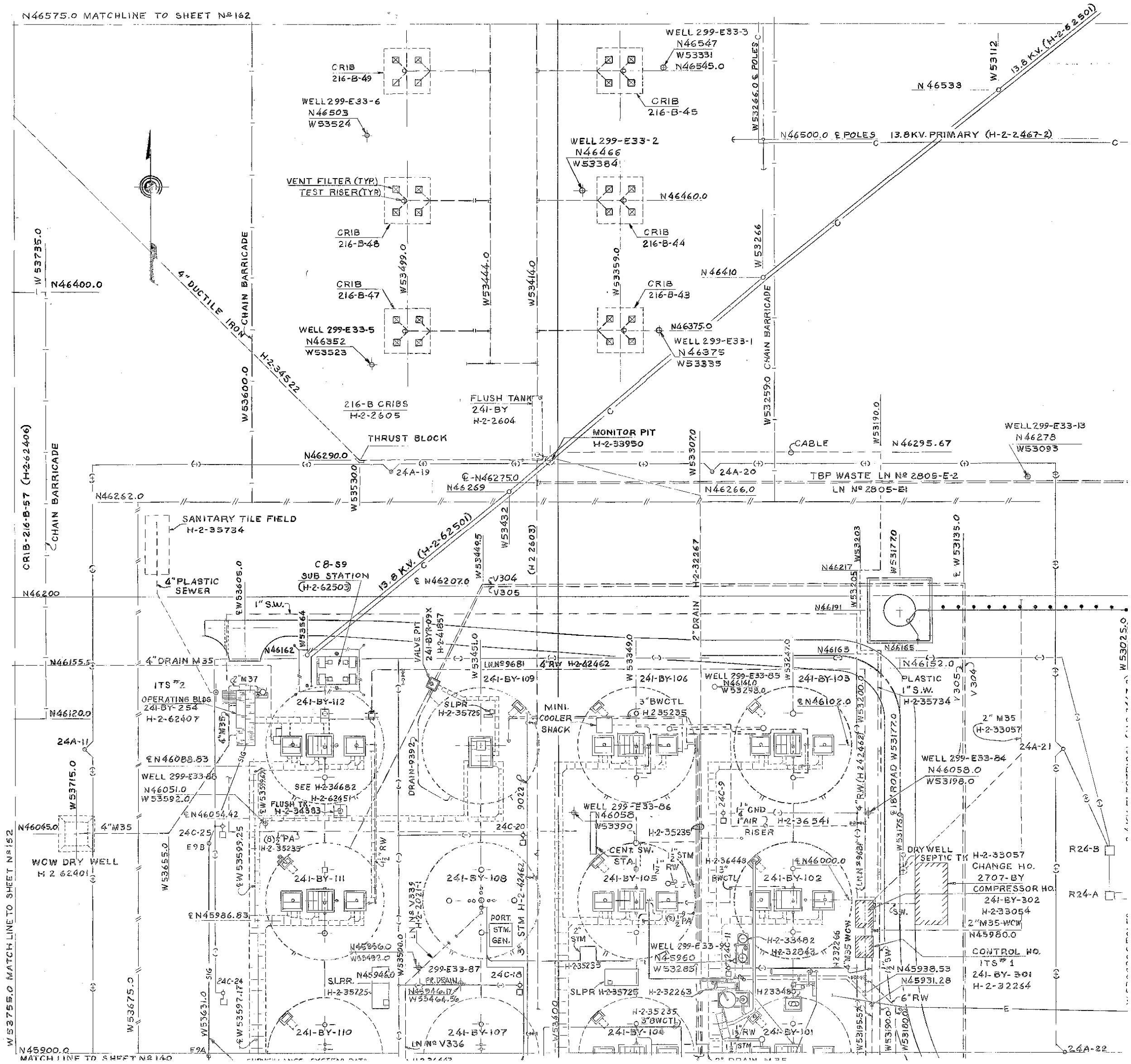
## Table 4-1. Potential Pipeline Failures and Other Unplanned Waste Releases

| Date | Event | Reference | Comments |
|---|---|---|---|
| 12/16-17/1952 | About 23,000 gal of first cycle waste leaked from a manifold header at tank BY-107. The leak covered 300 $ft^2$ of ground surface. Rad surveys recorded a maximum dose rate of 150 rad/hr 2 in. from the surface of the release. | UPR-200-E-105<br>HW-28471 p. 5 | After evaluating the spill it was deemed impractical to decontaminate the area and was instead covered with concrete. |
| 8/7/1955 | Liquid contaminant spread through the soil from the 112-BY valve pit. A crescent-shaped soil mass around the pit, a fire hose and workers gloves were contaminated. The release covered approximately 25,000 $ft^2$ with radioactivity levels up to 22 rad/hr. | UPR-200-E-110<br>BHI-00179 | Probably metal waste based on the time of the leak. UPR-200-E-110 states that it was 1C waste, but BY-110 never received 1C waste. SIM estimates 5,100 gal, assuming 1-in. depth. UPR also says 700 cubic meters (typo?) |
| 9/15/1955 | Approximately 11,000 gal of scavenged TBP overflowed the 216-BY flush tank associated with the 216-B-43 through 216-B-50 Cribs. | UPR-200-E-9<br>BHI-00179 | Most of the contaminated soil was excavated and placed in a shallow pit south of the 216-B-43 Crib and covered with 2 ft of clean topsoil. The remaining contaminated area near the flush tank was reported to be covered with 10 ft of clean soil. |
| 10/14/1969 | When placing the ITS heater into a 42-in. riser on tank BY-112 a "cloud" was released and blown in a westerly direction. 4 pickups, 3 employees outside the zone, the control shack, transformer area, the crane and ground area were contaminated to up to 100,000 dpm. | Historical Radiation Reports | Perimeter roads were clean, contaminated areas were marked and hosed down to prevent further spread. Cleanup begun.<br>Not in WIDS/SIM |
| 6/2/1970 | Leak in encased process line between the 111-BY and 112-BY tanks. Operators decontaminating the trench with steam and water were exposed to 2.5 rads/hr. | Historical Radiation Reports | No volume estimate for leak |
| 1/10/1972 | 102-BY pump, sleeved in plastic for burial, broke while loading onto trailer permitting liquid to run from the sleeving. Contamination to 100 mrads/hr by riser. | UN-200-E-43<br>BHI-00179 | Not in SIM |
| 11/20/1972 | Gasket failure while backflushing a pump at tank BY-112. 1 to 3 rad/hr in pit. | UPR-200-E-116 | The pit was covered with dirt |
| 2/3/1975 | During overground transfer from 105-BY to 109-BY, a flange leaked contaminating the ground under the flange over a 5 by 6 ft area to 5 rads/hr at 6 in. | East Tank Farm Historical Occurrence Reports | Pump secured and 1 ft of dirt placed over contaminated area, which was then covered with plastic |

1C = first cycle (waste)
UPR = unplanned release
SIM = Hanford Soil Inventory Model
WIDS = Waste Information Data System
TBP = tributyl phosphate

References: BHI-00179, *B Plant Aggregate Area Management Study Technical Baseline Report*
HW-28471, *Unconfined Underground Radioactive Waste and Contamination in the 200 Areas*

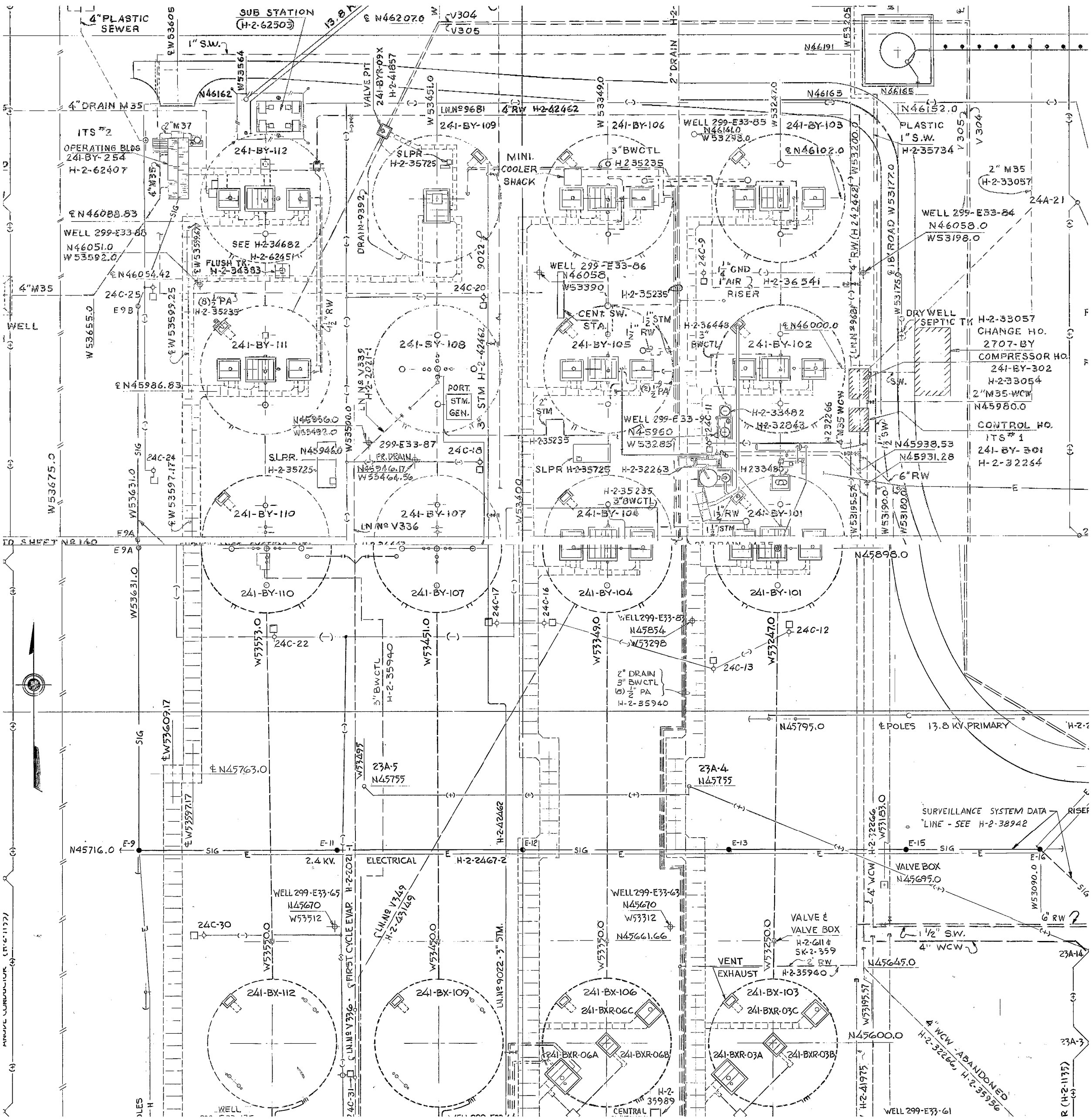
**Figure 4-1. Pipeline Diagram (H-2-44501, Sheet 151)**




Reference: H-2-44501, *Area Map – 200 East "B" Plant Facilities*

The photos do show a black substance (tar) flowing from the top of the liners. A break in the seals between the liners may have resulted in supernate leaking between the liner and the concrete, then leaking to the soil through cracks in the concrete. However, ARH-1496 suggests that the mastic compound found between the liner and the concrete wall would tend to seal any cracks in the concrete as the tanks were heated, thus improving the containment. ARH-1496 further notes that the presence of tar rings in the tanks do not necessarily indicate that a tank has leaked. As a precaution the liquid operating level in tanks was lowered to below tar rings after they were observed.

**Figure 4-2. Pipeline Diagram (H-2-44501, Sheets 151 and 140)**




Due to uncertainty of the liner integrity for ITS and ITS bottoms tanks, the leak assessment panel recommended that formal leak integrity assessments be conducted for all BY-Farm tanks including tanks currently classified as "sound" in HNF-EP-0182, except BY-103 (confirmed to have leaked in the past), per TFC-ENG-CHEM-D-42. The assessments are needed to support determination of technologies to retrieve waste and to determine a basis for inventory calculations from BY-Farm tanks in the future. Additional information for BY-Farm tanks currently classified as "sound" is included in Appendix C.

**Figure 4-3. Visual Based on Drywell Logging Activity at 4 feet in 241-BY Tank Farm**

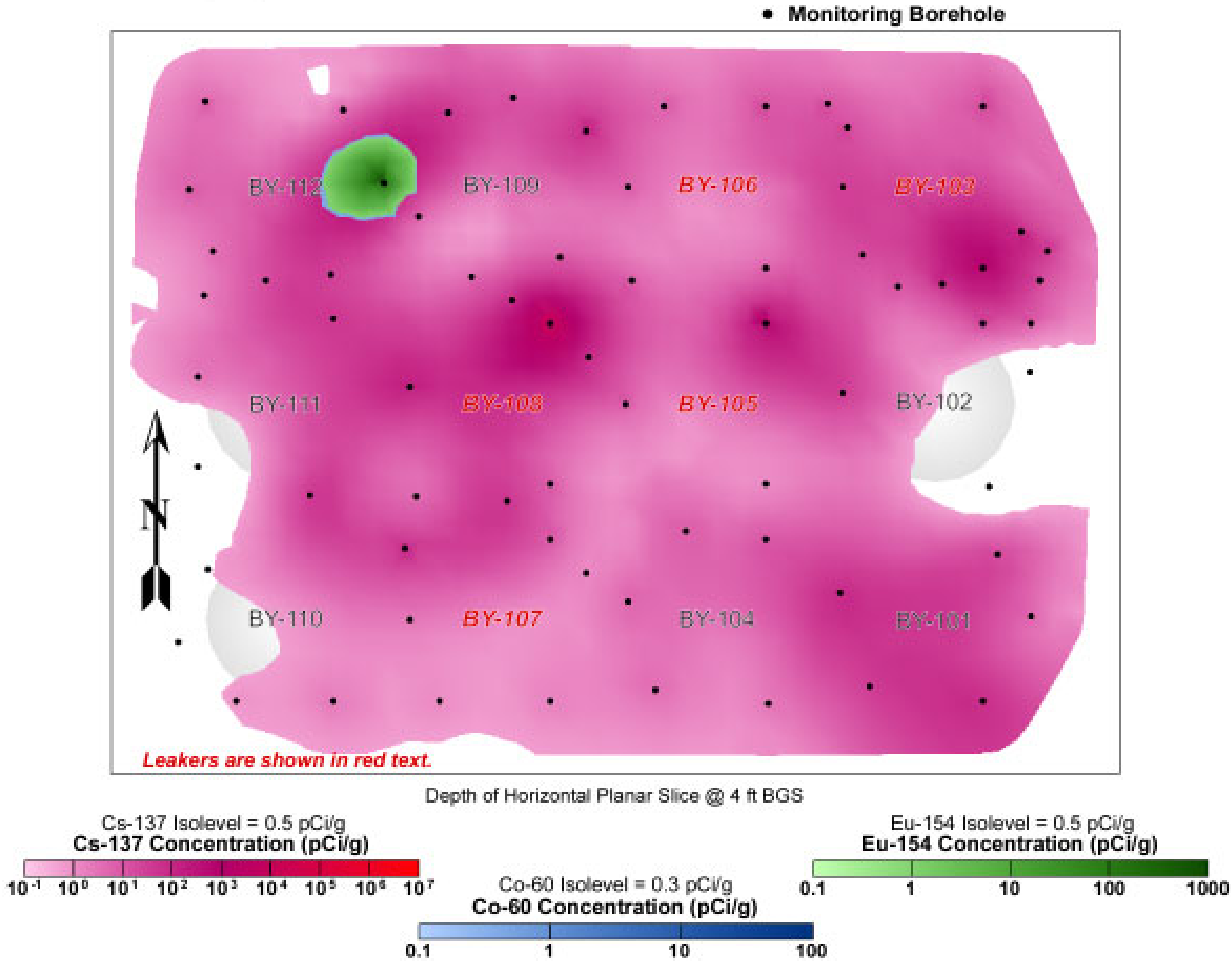


**Figure 4-4. Visual Based on Drywell Logging Activity at 9 feet in 241-BY Tank Farm**

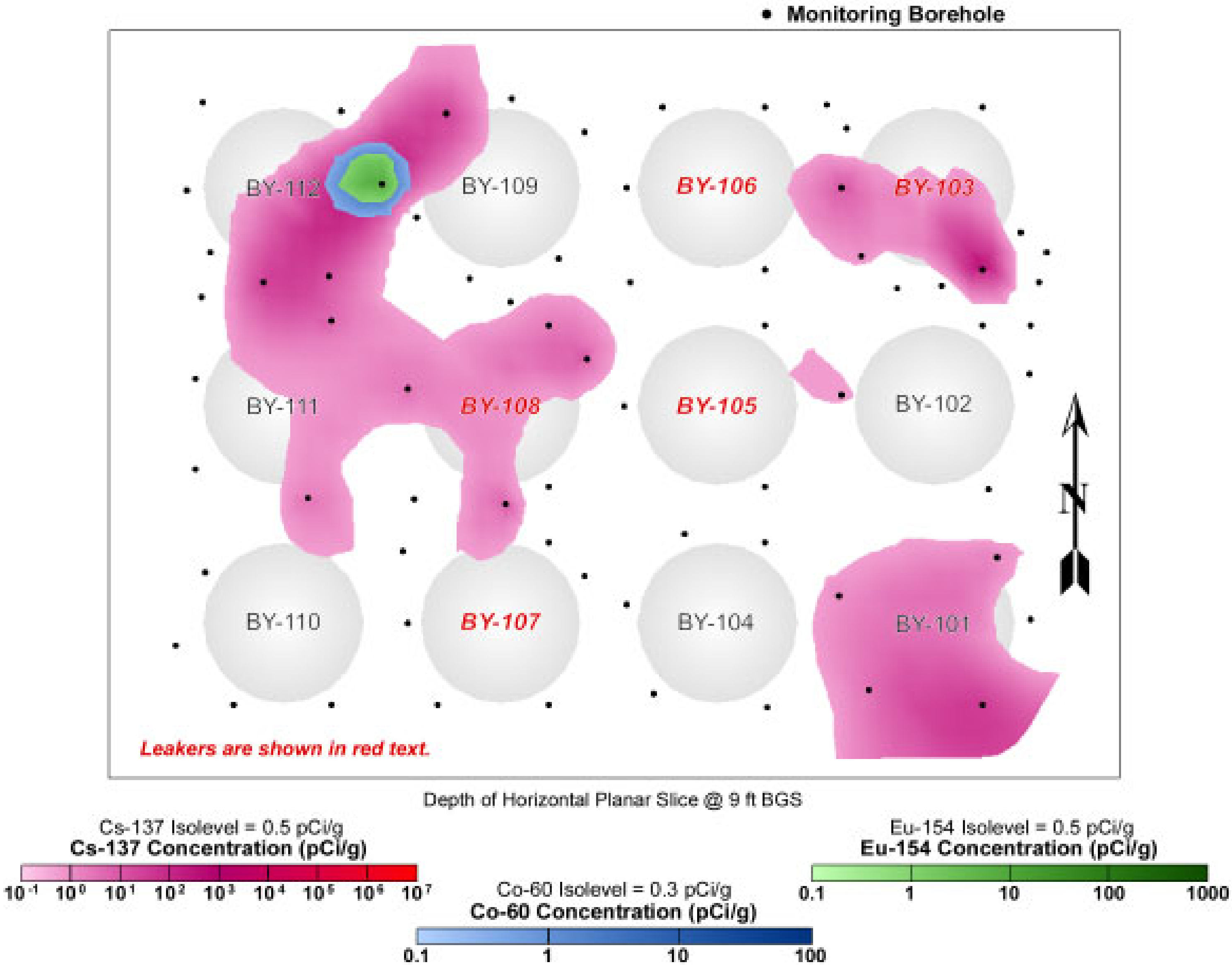


**Figure 4-5. Visual Based on Drywell Logging Activity at 35, 55 and 69 feet in 241-BY Tank Farm**

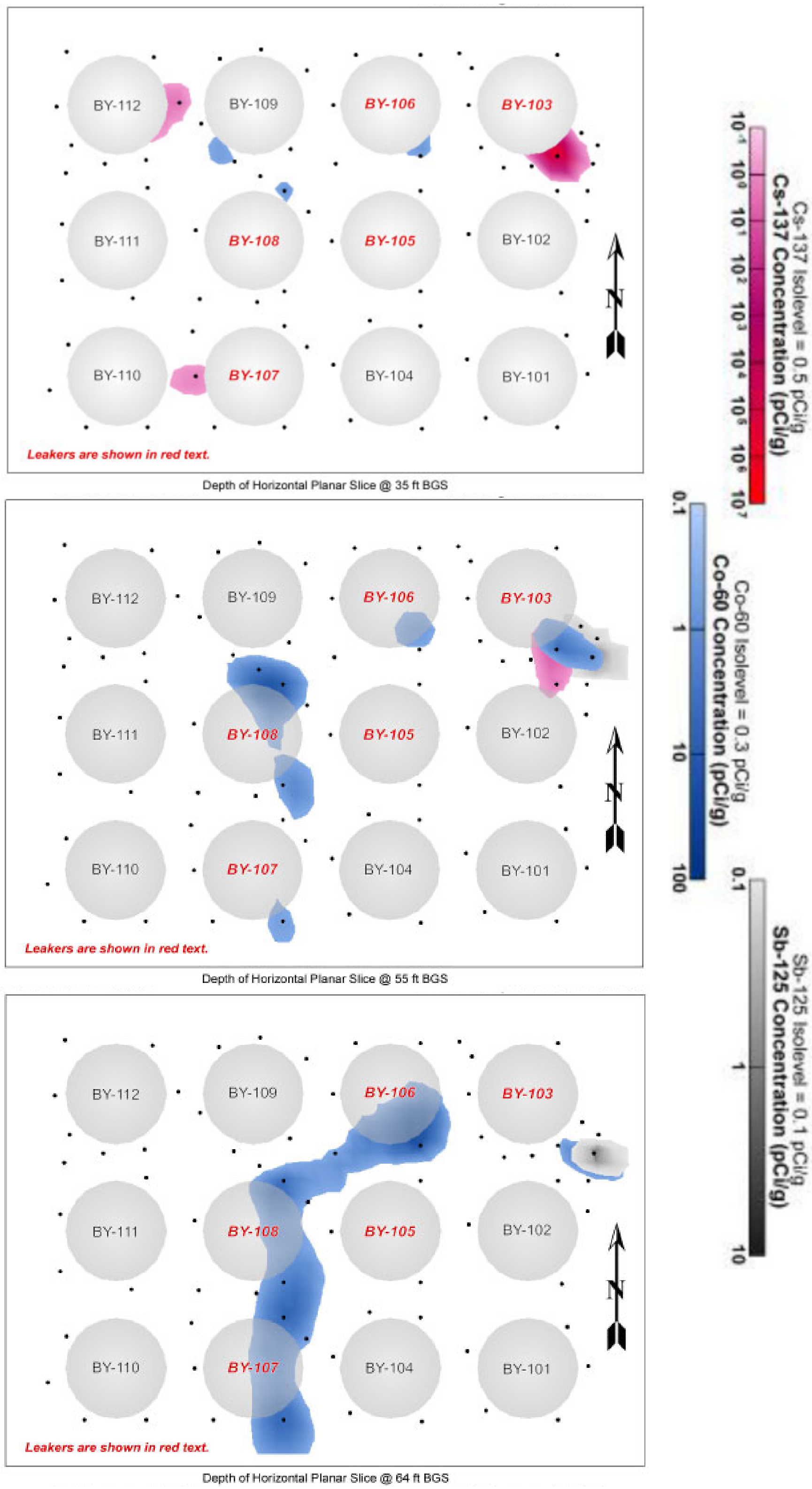


**Figure 4-6. Tar Rings Photos for Tank 241-BY-108**

Except as noted for tank BY-103, there was no basis to assign a leak inventory estimate for BY-Farm tanks at this time. Leak volume estimates are provided for some of the UPRs shown in Table 4-1. The SIM inventory estimates were determined to be reasonable for these releases.

## 4.8 OTHER UNPLANNED RELEASES

In addition to documented releases and potential overflows described in the previous sections, other line leaks from both process waste and raw water lines apparently occurred. For example, a 1984 BWIP water balance study (Internal letter B048656, "Status of the BWIP Water Balance

Study") showed that between 1977 and 1984 between 15% and 41% (24% average) of the 8E9 L (2E9 gal) of water discharged to East Area general raw water lines was unaccounted for, suggesting either error in process measurements or significant losses in the water lines. While raw water losses do not increase the inventory of waste lost to the soil, they provide a substantial driving force to move mobile contaminants toward groundwater and these raw water loss estimates give an indication of other potential losses from waste process lines.

**Figure 4-7. Tar Ring Photos for Tank 241-BY-110**

Water was also released indiscriminately to "wash down" surface contamination and reduce surface radioactivity (mentioned in Table 4-1 for some events) and for fire hydrant testing.

Flooding of the farms also occurred due to rapid snow melt and flooding and pipeline breaks or inadvertently leaving a valve open. The volume of waste or raw water released in these events is generally unknown.

## 4.9 INTENTIONAL RELEASES

### 4.9.1 Facilities in 241-BY Tank Farm (Descriptions in BHI-00179)

This section summarizes facilities and intentional releases to facilities in or near the 241-BY Tank Farm. These facilities, shown in Figure 4-8, are further described in BHI-00179.

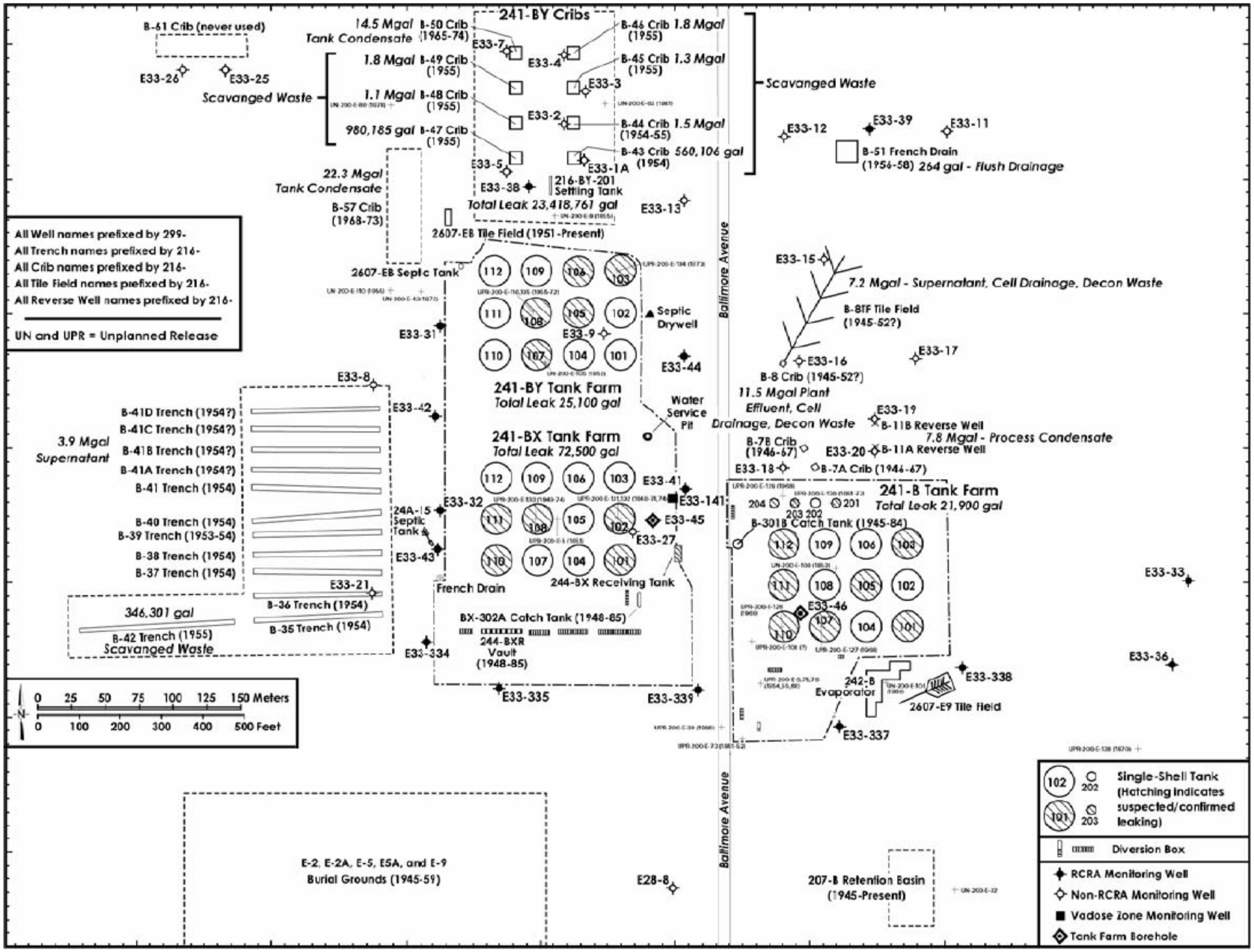
### 4.9.2 216-B-43 Through 216-B-50 Cribs (From BHI-00179)

The 216-B-43 through 216-B-50 Cribs are inactive waste sites located adjacent to the northern boundary of the 241-BY Tank Farm. Although discharges to the Cribs were outside the BY-Farm and not included in BY-Farm soil inventory estimates, discharges to the cribs may have contributed to increased recharge rates and increased the rate of movement and extent of distribution of UPRs in BY-Farm. Also the total volume of releases in BY-Farm is small compared to discharge to the cribs. Each crib received between 2,120,000 to 6,700,000 L of scavenged TBP supernatant waste from the 221-B and 221-U buildings. Some inorganic liquids disposed at this site contained ferrocyanide, nitrate, phosphate, sodium, and sulfate-based compounds. Radionuclides contained within the waste stream sent to these cribs include $^{137}$Cs, $^{90}$Sr, $^{106}$Ru, plutonium, and uranium. Each crib was individually deactivated by disconnecting the pipeline to the unit when the calculated specific retention of the underlying soil column was achieved.

The 216-B-50 Crib did not receive waste until January 1965 due to the crib site being taken out of operation when a $^{60}$Co and $^{137}$Cs breakthrough occurred. The decision to use the 216-B-50 Crib for ITS system condensate was made following 8 to 9 years of observations when it was shown that the groundwater activity levels were definitely decreasing. Groundwater wells 299-E33-1, 299-E33-2, 299-E33-3, 299-E33-5, 299-E33-6, 299-E33-7, 299-E33-13, 299-E33-22, and 299-E33-23 monitor the soil column beneath the crib site. Scintillation probe profiles indicate the radioactive contaminant plume extends to groundwater beneath almost all cribs. Crib 216-B-47 appears to be an exception where the radioactive contaminants may still be suspended in the soil column.

From January 1965 until January 1973 the 216-B-50 Crib received 54,800,000 L of waste storage tank condensate from ITS-1 in the 241-BY Tank Farm. Discharge to the crib was ~5 to 6 gal/min of condensate. Around 1968 the capacity of ITS-1 was doubled. The quantity of waste generated (~12 gal/min) was now greater than the designed disposal rate (5 to 6 gal/min) of the 216-B-50 Crib. This created concern that an increase in water level could drive the condensate through the highly contaminated zone under the other seven cribs.

**Figure 4-8. 241-B/BX/BY Area**



### 4.9.3 216-B-57 Trench

The 216-B-57 trench is an inactive waste site located adjacent to the northwest corner of the 241-BY Tank Farm. From February 1968 to June 1973, 84,400,000 L of waste storage tank condensate from the ITS-2 unit of the 241-BY Tank Farm were disposed at this site.

Vadose well 200-E33-24 monitors the soil column beneath the trench site. Scintillation probe profiles indicate the radioactive contaminant plume is suspended in the sediment column from 7.6 to 19.8 m below the ground surface.

In 1991 contaminated soil from the open area between the 216-B-43 through 216-B-50 Cribs, 12th Street, and Baltimore Avenue was excavated and placed on top of the 216-B-43 through 216-B-50 Cribs and the 216-B-57 trench. The crib and trench areas were then capped with clean soil and re-posted with underground radioactive material warning signs (prior to remedial activities, crib and trench areas were posted with surface contamination signs).

The designated area for the 216-B-57 waste site is about 2 ft above grade and covered with gravel. A 6-in. steel vent pipe is located at each end. The north vent extends about 36 in. above grade and has a 6-in. by 6-in. by 6-in. square filter box. The south vent riser is capped with a “china man hat” type vent cover. No vegetation is present atop the crib area.

### 4.9.4 2607-EB Septic Tank and Tile Field

This waste site was activated in 1951 and as of 1995 was generating about 0.02 $m^3$ of sanitary wastewater and sewage per day. The site is listed as nonhazardous nonradioactive. Adjacent to the septic tank is a drain field composed of vitrified clay pipe, concrete pipe, and/or drain tile forming the main line and laterals from the tank. The approximate location is listed on Hanford drawing H-2-44500, *Key Plan Area Map-200 East “B” Plant Facilities*, Sheet 6, but is missing from detailed Hanford drawing H-2-44501, *Area Map – 200 East “B” Plant Facilities*, Sheet 151.

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# APPENDIX A

# BY FARM LEAK ASSESSMENT MEETING SUMMARIES

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## MEETING SUMMARY

From: J. G. Field
Phone: 376-3753
Location: Ecology Office,
Date: June 9, 2009
Subject: Tank Farm Leak Evaluation

To: Distribution/Attendees

Attendees: Joe Caggiano, ECOLOGY
Jim Field, WRPS
Les Fort, ECOLOGY
Brendan Hedel, WRPS
Aaron, Pope, S.M. Stoller
Dennis Washenfelder, WRPS
Kayle Boomer, WRPS

**PURPOSE**:
Assess tank BY-103 and BY-105 leak inventory estimates

**Review of Previous Meeting Summary:**
The April 21, 2009 meeting summary was reviewed and approved. A sentence will be added to the summary to state that evidence of contamination along pipelines East of TY Farm includes three areas marked as underground radioactivity, surface geophysics exploration (SGE) measurements and direct push probe data.

**SX-Farm Historical Leak Model (HLM):**
A draft revision of the SX-Farm HLM was distributed for review. The revision is being conducted in support of previous SX-Farm leak evaluations. Ecology will review the report and Steve Agnew will be invited to respond to comments and discuss the HLM model during the next tank leak evaluation meeting. This will require revisiting leak inventory estimates for tanks SX-108, SX-109, SX-111 and SX-112. Completion of the SX-Farm Leak Assessment Report is pending incorporation of the revised HLM estimates.

**Tank BY-103 Evaluation**
Information about tank BY-103 to be included in the assessment report was presented.
Tank BY-103 was suspected to be a leaking tank based on total gamma activity observed at drywells 22-00-03 in 1969 and at 22-03-05 at about 35 ft below ground surface (bgs) in 1971 (note the tank bottom is about 50 ft bgs). The tank liquid operating level was lowered about 13 ft to permit continued operation of BY-103 as a feed tank for In-tank Solidification (ITS). In 1973 the tank was classified a "confirmed leaker" and removed from service based on elevated gross

gamma count rates in drywells 22-03-09, 22-03-04 and 22-03-06. No technical basis was found for the leak volume estimate of <5,500 gal in HNF-EP-0182).

Given the information reviewed, it appears that there may have been an interplay between the BY Farm tanks and the ITS system contributing to observed vadose zone activity in the drywells. It was also observed that the highest activity occurs near spare inlet ports N4 and N5 on the SW edge of the tank. Since the base of the tank is at about 50 ft bgs it is possible that the activity was the result of an overflow. Additional information on the ITS system and regarding tank liquid levels and potential overflows and tank BY-101 and BY-102 profiles will be reviewed to further evaluate all three tanks in future meetings.

Tank BY-105 evaluations were deferred to a future meeting.

**NEXT MEETING**

Discuss the HLM report and implications for SX-Farm leak inventory estimates and uncertainties.

**ACTIONS:**

1. All: Review meeting summary
2. J. Field: Prepare and distribute June 9, 2009 Meeting Summary.
3. J. Field: Prepare BY-101 and BY-102 information
4. P. Henwood: Review drywell data near tanks BY-101 and BY-102
5. J. Field/ D. Washenfelder: Review ITS #1 and #2 system information, and BY-101, 102 and 103 liquid levels and tank overflow levels.

**NEXT MEETING:**

| | |
|---|---|
| Date: | June 23, 2009 |
| Time: | 3:00-4:30 |
| Location: | ECOLOGY Office |

# MEETING SUMMARY

washington river protection solutions

| | |
|---|---|
| From: | J. G. Field |
| Phone: | 376-3753 |
| Location: | Ecology Office, |
| Date: | June 23, 2009 |
| Subject: | Tank Farm Leak Evaluation |
| To: | Distribution/Attendees |
| Attendees: | Steve Agnew, CEES<br>Joe Caggiano, ECOLOGY<br>Jim Field, WRPS<br>Les Fort, ECOLOGY<br>Brendan Hedel, WRPS<br>Bob Lober, ORP<br>Paul Henwood, S.M. Stoller<br>Dennis Washenfelder, WRPS<br>Marcus Wood, CHPRC |

**PURPOSE**:
Review Historical Leak Model (HLM) revisions

**Review of Previous Meeting Summary:**
The June 9, 2009 meeting summary was reviewed and approved.

**Tank T-102 Leak Assessment**
A brief overview was given of the Tank 241-T-102 leak assessment that formally kicked off earlier in the day. The assessment is due to an increase in a Cs-137 spike observed this week during logging of drywell 50-02-05 at a depth of 40 ft below ground surface. The source of the increased activity is unknown at this time.

**SX-Farm Historical Leak Model (HLM):**
Steve Agnew discussed the approach and preliminary results for revisions to the HLM model. The HLM results will be summarized in the SX-Farm leak assessment report. Questions about the model and model uncertainty were discussed. As discussed, the report will further clarify the technical basis for model inputs and uncertainties in both model calculations and inputs. For example, the basis for leak durations will be clarified and modified as needed because lateral data suggests that leak durations may be much shorter than the durations currently included in the model. A discussion of model limitations and uses will also be added to the report. Completion of the SX-Farm Leak Assessment Report is pending release of the revised HLM report.

**NEXT MEETING**
Discuss the In-Tank Solidification #1 (ITS1) process and impact to associated tanks. After discussing ITS1, BY-101, 102 and 103 will be reviewed.

**ACTIONS:**
1. All: Review meeting summary
2. J. Field: Prepare and distribute June 23, 2009 Meeting Summary.
3. J. Field/D. Washenfelder: Prepare ITS1 information
4. J. Field/S. Agnew: discuss HLM comments and questions

**NEXT MEETING:**

| | |
|---|---|
| Date: | July 7, 2009 |
| Time: | 3:00-4:30 |
| Location: | ECOLOGY Office |

## MEETING SUMMARY

washington river protection solutions

| | |
|---|---|
| From: | J. G. Field |
| Phone: | 376-3753 |
| Location: | Ecology Office, |
| Date: | July 7, 2009 |
| Subject: | Tank Farm Leak Evaluation |
| To: | Distribution/Attendees |
| Attendees: | Jennifer Barton, WRPS<br>Joe Caggiano, ECOLOGY<br>Jim Field, WRPS<br>Les Fort, ECOLOGY<br>Bob Lober, ORP<br>Jeff Lyon, ECOLOGY<br>Paul Henwood, S.M. Stoller<br>Jeanne Wallace, ECOLOGY<br>Dennis Washenfelder, WRPS<br>Marcus Wood, CHPRC |

**PURPOSE**:
Review BY In-Tank Solidification (ITS) #1 Information and Continue BY-103 assessment

**Review of Previous Meeting Summary:**
The June 23, 2009 meeting summary was reviewed and approved.

**ITS Information**
A brief overview was given of the ITS#1 process with the intent to better understand possible interactions between BY-101, BY-102 and BY-103. Information presented will be included in the BY-Farm leak assessment report. A timeline was presented showing when heaters were installed in tanks BY-101 and BY-102. Tanks BY-103 and BY-105 received concentrated bottoms waste circulated from the tanks BY-101 and BY-102. Several problems, including overheating in BY-102 and a fire were discussed. Occurrence reports and tank temperatures during ITS operations were also discussed and in-tank photographs showing waste levels in the tanks were discussed. There was no evidence of leaks or overflows for tank BY-101. Tar rings were observed in BY-102, the operating level decreased and activity was observed in nearby drywells. Tank BY-102 is currently classified as sound and will be further reviewed in future meetings. ITS#2 tanks will be reviewed in a future assessment meeting. An action was assigned to WRPS to send Ecology the occurrence report data base when it is completed.

**BY-103 Assessment Conclusion**
After review of ITS#1 operations and based on previous assessments of tank BY-103 the assessment team agreed with previous assessments of the tank that classified Tank BY-103 as a leaker in May 1973 based on increasing gamma activity first observed in drywell 22-03-09 in 1973. No unaccounted for liquid level decreases were observed during this time. Therefore, the team concurred that the previous estimate of <5,500 gal, apparently based on uncertainty in manual tape service level measurements, is a reasonable upper volume for the leak. Drywell activity estimates indicate that the leak may have been smaller. Soil inventory model inventory estimates for the leak are reasonably consistent with sample data and should be used for leak composition estimates.

**NEXT MEETINGS**
Assess leak inventory estimates for tanks BY-105, BY-106 and BY-107. After assessing these tanks, SX-Farm heat load model estimates, and discussing ITS#2 operations and other tanks in BY Farm.

**ACTIONS:**
1. All: Review meeting summary
2. J. Field: Prepare and distribute July 7, 2009 Meeting Summary
3. J. Field/B. Hedel: Prepare BY-105, BY-106 and BY-107 information
4. P. Henwood: Review logging data for BY-105, 106 and 107

**NEXT MEETING:**

| | |
|---|---|
| Date: | July 21, 2009 |
| Time: | 3:00-4:30 |
| Location: | ECOLOGY Office |

## MEETING SUMMARY

| | |
|---|---|
| From: | J. G. Field |
| Phone: | 376-3753 |
| Location: | Ecology Office, |
| Date: | July 21, 2009 |
| Subject: | Tank Farm Leak Evaluation |
| To: | Distribution/Attendees |
| Attendees: | Jennifer Barton, WRPS<br>Jim Field, WRPS<br>Les Fort, ECOLOGY<br>Brendan Hedel, WRPS<br>Paul Henwood, S.M. Stoller<br>Dennis Washenfelder, WRPS<br>Marcus Wood, CHPRC |

**PURPOSE**:
Review BY-102, BY-105, BY-106 and BY-107 tank process information

**Review of Previous Meeting Summary:**
The July 7, 2009 meeting summary was reviewed and approved with changes to identify open questions and need to further review BY-102.

**BY-102 Assessment (Continued)**
Information provided by P. Henwood, occurrence report 74-123 and a 1980 letter 65260-80-0832, History and Status of Tank 241-BY-102 were discussed. The letter raises questions about the current classification of BY-102 as "sound" and it appears that a formal leak assessment for tank BY-102 was not conducted. It was recommended that BY-102 be reviewed following the TFC-ENG-CHEM-D-42 process. Information discussed for BY-102 will be summarized in the section for "other potential leaks" in the BY-Farm leak assessment report.

**BY-105 and BY-106 Assessments**
Information was presented and discussed regarding these two tanks currently classified as assumed leakers and previously designated "questionable integrity." Information presented will be documented in the BY-Farm leak assessment report.

Other than Occurrence Report (OR-74-117), no assessment for the assumed BY-105 tank leak was found. Based on the data reviewed, the surface level data is unstable and appears to be unreliable because of visible cave-ins and holes in the waste surface. Additional logging of drywells indicates that a previous determination that 1973 drywell activity may have originated

from a leak from tank BY-105 may be incorrect. Logging results since 1973 indicate that the drywell activity likely originated from other sources including a BY-108 tank leak.
The available data does not indicate that tank BY-105 leaked. More plausible sources for activity in drywells near the tank were identified based on logging data collected after 1973. However, photos were observed showing salt build up above the spare inlets indicating the possibility of an overflow from tank BY-105. It was recommended that tank BY-105 be considered for sluicing and that the leak classification for tank BY-105 be re-evaluated per TFC-ENG-CHEM-D-42.

BY-106 was classified questionable integrity based on drywell activity measured in 22-06-05 in 1972. No unexplained liquid level decreases in the tank were observed, and the activity in 22-06-05 may be from BY-108 or another source. It was recommended that tank BY-106 also be considered for sluicing and the leak classification for tank BY-106 should be re-evaluated per TFC-ENG-CHEM-D-42.

**BY-107 Assessment**
BY-107 was classified an assumed leaker based on a liquid level decrease in 1974 and increased activity in drywell 22-07-02 at a depth of 29 ft in April 1974. In response approximately 167,000 gal of supernate were immediately removed from the tank to reduce liquid levels below the level of activity observed in the drywell. In December 1974, additional drywells near BY-107 showed increased activity at depths of 48 to 70 feet (OR-75-153). A December 16, 1952 leak of 23,000 gal of first cycle supernatant from a loose flange in the over ground system (HW-28471, p. 5) is a potential source of at least some of the activity measured in the drywell and a nearby french drain accounts for high moisture in the area. Occurrence reports and additional information for tank BY-107 will be discussed in the next meeting and incorporated into the BY-Farm leak assessment report.

**NEXT MEETING**
Continue to assess leak inventory for tank BY-107and Review changes to SX-Farm heat load model estimates.

**ACTIONS:**
1. All: Review meeting summary
2. J. Field: Prepare and distribute July 21, 2009 Meeting Summary
3. J. Field: Provide BY-107 occurrence reports and 22-07-02 historical gamma log
4. J. Field: Prepare BY-108 summary
5. P. Henwood: Review logging data for BY-108

**NEXT MEETING:**

| | |
|---|---|
| Date: | August 4, 2009 |
| Time: | 3:00-4:30 |
| Location: | ECOLOGY Office |

washington river protection solutions

## MEETING SUMMARY

From: J. G. Field
Phone: 376-3753
Location: Ecology Office,
Date: August 4, 2009
Subject: Tank Farm Leak Evaluation

To: Distribution/Attendees

Attendees: Steve Agnew, CEES
Jim Field, WRPS
Les Fort, ECOLOGY
Brendan Hedel, WRPS
Paul Henwood, S.M. Stoller

**PURPOSE**:
Continue review of BY-107 and discuss SX Farm Heat Load Model Revisions

**Review of Previous Meeting Summary:**
The July 21, 2009 meeting summary was reviewed and approved.

**BY-107 Assessment**
Six occurrence reports were reviewed and discussed (OR 74-27, OR 74-153, OR 75-56, OR 77-77, OR 80-2 and OR 80-58). The occurrence reports are for both liquid level decreases and increased drywell activity. The current leak estimate of 15,000 gal appears to be based on a liquid level decrease of 5.5 inches from June 15, 1973 to April 11, 1974s.

Based on the occurrence reports and other information reviewed, it was determined that if BY-107 leaked it was probably during 1974 prior to April when 167,000 gallons was pumped from the tank. After pumping the liquid level was 185.5 inches above the base of the tank. The manual tape was flushed several times in 1973 and 1974 raising a question of whether actual liquid level decreases occurred. Small drywell activity increases from (<100 to 200) cps were observed in drywell 22-07-02 between January 14 and February 12, 1974 with peak reading at 29 ft below ground surface. In December 1974 OR 74-153 reported increased activity from 48 to 70 ft at 4 additional wells around the tank . OR 74-153 attributed this activity to migration of old contamination. Dry well activity observed in 1974 may be attributed to a December 16, 1952 leak of 23,000 gal of first cycle waste from a loose flange in an overground transfer system (HW-28471, p. 5). The 1952 leak is not identified as a UPR but will be included in future discussions of surface releases in BY Farm. OR 75-56 shows the location of a french drain and raw water outlet between BY-107 and BY-104 believed to be the source of high moisture in the area and a contributing factor to migration of contaminants.

No record of a previous assessment was conducted. If the tank leaked, it was likely above the 185.5 inch level and therefore appears to be a candidate for sluicing. A formal tank leak assessment per TFC-ENG-CHEM-D-42 is recommended.

**SX Farm Heat Load Model Revision**
The HLM and model uncertainty were previously discussed in the June 23, 2009 leak assessment meeting. HLM revisions were incorporated some of the previous comments from the assessment team. The team requested further evaluation to include uncertainties such as differences in heat losses between tanks in the HLM report. Participants agreed that a statement should be added to the report acknowledging that thermal/heat load modeling is but one of many tools/lines of evidence that can be used to estimate release volumes and masses in a situation of limited real time data. Uncertainties and model limitations as well as results should be emphasized in an executive summary. HLM results were consistent with combined SX Farm leak volume estimates. However, the HLM Cs-137 mass estimates were high compared to measured soil laterals, drywells and samples. Additional HLM report revisions will be completed next week.

**NEXT MEETING**
Assess leak inventory for tank BY-108.

**ACTIONS:**
1. All: Review meeting summary
2. J. Field: Prepare and distribute August 4, 2009 Meeting Summary
3. J. Field: Prepare BY-108 summary
4. D. Washenfelder: Prepare information for In-Tank Stabilization #2 and impact on tanks BY-110 and BY-112.
5. P. Henwood: Review logging data for BY-108

**<u>NEXT MEETING:</u>**

| | |
|---|---|
| Date: | August 18, 2009 |
| Time: | 3:00-4:30 |
| Location: | ECOLOGY Office |

# MEETING SUMMARY

From: J. G. Field
Phone: 376-3753
Location: Ecology Office,
Date: August 18, 2009
Subject: Tank Farm Leak Evaluation

To: Distribution/Attendees

Attendees: Joe Caggiano, ECOLOGY
Jim Field, WRPS
Les Fort, ECOLOGY
Paul Henwood, S.M. Stoller
Gerri Mason, WRPS
Dennis Washenfelder, WRPS
Marcus Wood, CHPRC

**PURPOSE**:
Review of Tank BY-108 waste process information

**Review of Previous Meeting Summary:**
The August 4, 2009 meeting summary was reviewed and approved with minor changes.

**SX-Farm Assessment Report Status**
The SX-Farm heat load model report (HNF-3233, Rev. 1) has been completed except for editing and will be distributed to assessment team members for review along with the SX-Farm leak assessments report (RPP-ENV-39658).

**BY-108 Assessment**
Tank 241-BY-108 waste process information was presented including discussion of past tank transfer history, basis for classification as an assumed leaker, surface level measurements, drywell gamma logging measurements and occurrence reports.

The tank was classified as a leaking tank in 1972 with a leak volume estimate of <5,000 gallons. The leak is based on observed activity in drywells and the volume estimate appears to be based on uncertainty in manual tape surface level measurements. No unexplained liquid level decrease was identified in waste transfer records or surface level data. However, surface level data were only available starting in 1973. Drywell data around the tank shows extensive $^{137}Cs$ contamination in the top 10 feet below ground surface (bgs) and $^{60}Co$ below the base of the tank, starting at 35 to 40 ft bgs. In June 1971, PPD-453-DEL p. AIV-18 reported the following:

A high radiation reading situation from an adjacent monitoring well to tank 108-BY has been investigated. Frequent scintillation probe checks, coupled with neutron-probe readings, revealed an active leak in the vicinity of the bottom and northerly quadrant of the tank. The tank has been removed from service as a bottom tank for the In-Tank Solidification Program and the contents were pumped down to a level of approximately twelve feet – the apparent salt-cake level in the tank. Design for a well point casing, which will enable the removal of interstitial liquor from the tank, is in progress. Monitoring surveillance is continuing."

This suggests a leak source "in the vicinity of the bottom of the tank," but not necessarily the tank itself. The main indicator of a tank leak is the $^{60}$Co observed in drywell spectral gamma measurements around the tank. The questions were raised: If the $^{60}$Co near the base of the tank is from a tank leak, where is the $^{137}$Cs, and if the $^{60}$Co is migration from surface $^{137}$Cs where is the trail? The presence of large amounts of $^{60}$Co in BY farm was noted and questions were raised as to whether the In-Tank Stabilization (ITS) process and/or type of waste affect $^{60}$Co chemistry. These questions will be further investigated and discussed in the next meeting.

**NEXT MEETING**

Continue BY-108 Assessment for tank BY-108 and review information for the In-Tank Stabilization (ITS) #2 process and tanks BY-110 and BY-112.

**ACTIONS:**

1. All: Review meeting summary
2. J. Field: Prepare and distribute August 18, 2009 Meeting Summary
3. D. Washenfelder: Prepare information for In-Tank Stabilization #2 and impact on tank BY-110 and BY-112.
4. D. Washenfelder/J. Field: Review $^{60}$Co chemistry, explain temperature drops, and locate water lines near BY-108.
5. P. Henwood: Review logging data for BY-110 and 112

**NEXT MEETING:**

Date: September 1, 2009
Time: 3:00-4:30
Location: ECOLOGY Office

## MEETING SUMMARY

From: J. G. Field
Phone: 376-3753
Location: Ecology Office,
Date: September 1, 2009
Subject: Tank Farm Leak Evaluation

To: Distribution/Attendees

Attendees: Joe Caggiano, ECOLOGY
Jim Field, WRPS
Les Fort, ECOLOGY
Paul Henwood, S.M. Stoller
Dennis Washenfelder, WRPS

**PURPOSE**:
Continue BY-108 Assessment for tank BY-108 and review information for the In-Tank Stabilization (ITS) #2 process and tanks BY-110 and BY-112.

**Review of Previous Meeting Summary:**
The August 18, 2009 meeting summary was reviewed and approved.

**SX-Farm Assessment Report Review**
The SX-Farm leak assessment report (draft RPP-ENV-39658) and draft SX-Farm Historical Leak Model (HLM) Report (HNF-3233, Rev. 1) will be delivered to team members during the week for review by September 30, 2009.

**BY-108 Assessment**
Questions about C-108 were further discussed. No documentation was found stating the cause of the change. However, abrupt changes in liquid level temperatures occurred in 1992 when temperature measurements changed from manual to more frequent automated measurements; It was also noted that the downward trend for manual measurements in the late 70's followed the same trend as measurements from 1992 to present; consequently manual measurements are suspect.

BY-Farm scavenged waste is high in cyanide compared to other waste types. Discussions with PNNL and WRPS chemists confirmed that $^{60}$Co and cyanide appear to complex to form a more mobile waste form. The exact form and chemistry appears to be unknown. A discussion of $^{60}$Co mobility is included in Appendix D of the B/BX/BY Field Investigation report (HNF-5507). This information suggests that the $^{60}$Co in drywells around BY-108 may have originated from near surface spills. Drawings were reviewed showing the locations of pipelines and transfer lines. It was noted that a bend in a transfer line is located near drywell 22-08-01. Although no evidence of a leak from this line was found, this could be the source of the surface contamination.

The depth and thickness of the $^{60}$Co plume raised questions about alternate sources. It was observed that BY-108 was overfilled several times and that waste may have been released through spare inlet ports, cascade lines or overflowing the steel liner (compromised by tar rings). Photos of BY-110 and BY-111 showed tar rings at the top of the tank liners and showed saltcake buildup above the liners further indicating that the tanks were overfilled. A report on tar rings in tanks (ARH-1496) was discussed.

Based on the information presented the panel concluded that although several potential sources were identified for radioactivity in drywells surrounding tank BY-108, there is probably insufficient evidence to refute previous assessments that tank BY-108 leaked in the past (HNF-0182). However, there is strong evidence that any tank release would have occurred near the top of the tank. Therefore, tank BY-108 should be considered for retrieval by sluicing. A formal TFC-ENG-CHEM-D-42 assessment is recommended to further assess the mechanism of a release from the tank and inventory of the release. Additional field investigations were also recommended such as direct push/logging near the transfer line and sampling to further investigate $^{60}$Co speciation and source of the contamination.

**In Tank Stabilization 2 (ITS 2) and Impact**
The ITS 2 process and timeline were presented and discussed briefly. High temperatures >300 F, failed heating elements, and a creep and crack analysis (ARH-2883) indicating that tank BY-112 integrity would be compromised if ITS 2 continued, resulted in shutting down the system in June 1974. Waste surface levels show that tank BY-112 and tanks BY-109, 110 and 111 were overfilled during the ITS process This was confirmed by photos. Drywell data shows $^{137}$Cs activity at the surface and $^{60}$Co near tanks BY-109, 110, 11 and 112. Occurrence reports showing liquid level decreases in tanks BY-110, 111, and 112 were reviewed. None of the reports were attributed to tank leaks. Two unplanned releases (UPRs) at BY-112 were identified UPR-200-E-110 a valve pit release in 1955 and UPR-200-E-116 a pump gasket failure in 1972.

**NEXT MEETING**
Continue discussion of ITS 2 process and further review spectral gamma and historical gross gamma data for tanks BY-109, 110, 111 and 112.

**ACTIONS:**
1. All: Review meeting summary
2. J. Field: Prepare and distribute September 1, 2009 Meeting Summary
3. P. Henwood: Prepare logging data for BY-109, 110, 111 and 112

**NEXT MEETING:**

| | |
|---|---|
| Date: | September 15, 2009 |
| Time: | 3:00-4:30 |
| Location: | ECOLOGY Office |

## MEETING SUMMARY

From: J. G. Field
Phone: 376-3753
Location: Ecology Office,
Date: September 15, 2009
Subject: Tank Farm Leak Evaluation

To: Distribution/Attendees

Attendees: Joe Caggiano, ECOLOGY
Jim Field, WRPS
Les Fort, ECOLOGY
Paul Henwood, S.M. Stoller
Beth Rochette, ECOLOGY
Dennis Washenfelder, WRPS
Marc Wood, CHPRC

**PURPOSE**:
Review information for tanks BY-109, 110, 111 and 112.

**Review of Previous Meeting Summary:**
The September 1, 2009 meeting summary was reviewed and approved.

**BY-109, 110, 111 and 112 Reviews**
Spectral gamma and historical gamma logging information was presented and discussed for these tanks. All of these tanks are currently classified as “sound.” The gamma data reviewed appeared to be consistent with this conclusion. However, as for other BY-Farm tanks, these tanks are surrounded by surface contamination and show low levels of $^{60}Co$ below the tanks. In-tank photos show clear evidence of tar rings and of saltcake buildup and liquid levels above the steel liners and tar rings in the tanks and above the spare inlet ports for tanks BY-110 and 112. Near surface contamination observed in drywells may be in part attributed to filling the tank above the top of the liners.

There was little or no basis for an inventory estimate for contamination around tanks BY-109, 110, 111 or 112. However, information presented for these tanks will be incorporated into the BY-Farm assessment report.

Future characterization for barrier design or for corrective actions for WMA B/BX/BY may help to better understand tank overflows and or leaks in BY Farm and quantify contamination. The review team recommended that after additional characterization information is obtained these tanks should be further assessed by the TFC-ENG-CHEM-D-42 process. The review is needed to support a decision for selecting future retrieval technologies for these tanks and to better understand the impact of the ITS #2 process and the condition of the tank liners.

**NEXT MEETING**

Review BY Farm near surface releases including known pipeline failures, leaks and spills.

**ACTIONS:**

1. All: Review meeting summary
2. J. Field: Prepare and distribute September 15, 2009 Meeting Summary
3. J. Field: Prepare BY Farm surface release information for next meeting

**NEXT MEETING:**

| | |
|---|---|
| Date: | September 29, 2009 |
| Time: | 3:00-4:30 |
| Location: | ECOLOGY Office |

## MEETING SUMMARY

From: J. G. Field
Phone: 376-3753
Location: Ecology Office,
Date: October 6, 2009
Subject: Tank Farm Leak Evaluation

To: Distribution/Attendees

Attendees: Joe Caggiano, ECOLOGY
Jim Field, WRPS
Les Fort, ECOLOGY
Paul Henwood, S.M. Stoller
Beth Rochette, ECOLOGY
Marc Wood, CHPRC

**PURPOSE**:
Review BY Farm near surface releases including known pipeline failures, leaks and spills.

**Review of Previous Meeting Summary:**
The September 15, 2009 meeting summary was reviewed and approved.

**Discussion and Review of Near Surface Releases in BY Farm**
Near surface releases and pipeline failures in Table 1 were discussed. A basis for inventory estimates was determined for UPR-200-E-105 and UPR-200-E-9. Volume estimates and units described in WIDS for UPR-200-E-110 were inconsistent. The correct volume for this UPR was discussed. Recommendations are in Table 1.

Except as noted, information available was insufficient to estimate a leak volume or inventory for other pipeline failures and surface releases. In general, drywell data shows extensive near surface (top 10 ft) gamma contamination in BY-farm. However, near surface gamma activity appears to be smaller, with lower activity levels (< 100 pCi/g gamma), compared to the waste leaked from the tanks. Waste types and composition of other constituents released near surface are unknown and additional investigations are needed.

Near surface data needs will be determined through data quality objective workshops in support of TY-Farm performance assessments and corrective management studies.

**ACTIONS:**
1. All: Review meeting summary
2. J. Field: Prepare and distribute October 6, 2009 Meeting Summary

3. M. Wood: Complete TY Farm groundwater write-up
4. ECOLGY: Complete review of SX farm leak assessment report
5. J. Field: Prepare summary for tank BX-101 for next meeting

**NEXT MEETING:**

Begin to review BX Farm tank releases, starting with releases associated with tank BX-101.
Date: November 17, 2009
Time: 3:00-4:30
Location: ECOLOGY Office
Note: The group agreed to delay the next meeting to allow time to draft and review assessment reports for assessments previously completed, and to prepare for the WMA-C soil inventory performance assessment workshop.

| **Table 1. Potential Pipeline Failures and Other Unplanned Waste Releases** | | | |
|---|---|---|---|
| **Date** | **Event** | **Reference** | **Comments** |
| 12/16-17/1952 | About 23,000 gallons of first cycle waste leaked from a manifold header at tank BY-107. The leak covered 300 square ft of ground surface.Rad surveys recorded a maximum dose rate of 150 rad per hour 2 inches from the surface of the release. | UPR-200-E-105<br>HW-26653<br>HW-28471 p. 5 | After evaluating the spill it was deemed impractical to decontaminate the area and was instead covered with concrete. Use SIM concentrations for first cycle waste and 23,000 gal.. |
| 8/7/1955 | Liquid contaminant spread through the soil from the 112-BY valve pit. A crecent shape around the pit, a fire hose and workers gloves were contaminated. The release covered approximately 2,500 square feet with radioactivity levels up to 22 rad per hour. | UPR-200-E-110<br>BHI-00179<br>HW-38901, page 5 | Probably metal waste based on the time of the leak. UPR-200-E-110 states that it was 1C waste, but BY-110 never received 1C waste. SIM estimates 5,100 gal, assuming 1 inch depth. UPR says 25,000 sq ft and 700 <u>cubic</u> meters (*~25,000 cubic ft, it. added*). However, HW-38901 states that the release contaminated an area over 2,500 sq. ft. with an activity of 1 R/hr at 6 in. An MW waste type should be used and the volume of release should be rounded to 10,000 gal (2,500 X .5 ft depth *7.48 gal/cubic ft). |
| 9/15/1955 | Approximately 11,000 gal of scavenged TBP overflowed the 216-BY flush tank associated with the 216-B-43 through 216-B-50 cribs. | UPR-200-E-9<br>BHI-00179 | Most of the contaminated soil was excavated and placed in a shallow pit south of the 216-B-43 crib and covered with 2 ft of clean topsoil. The remaining contaminated area near the flush tank was reported to be covered with 10 ft of clean soil. Use SIM concentrations for TBP waste and 11,000 gal. |
| 10/14/1969 | When placing the ITS heater into a 42 in riser on tank BY-112 a “cloud” was released and blown in a westerly | Historical radiation occurrence Report (doc # unknown) | Perimeter roads were clean, contaminated areas were marked and <u>hosed down</u> to prevent further |

| Table 1. Potential Pipeline Failures and Other Unplanned Waste Releases | | | |
|---|---|---|---|
| **Date** | **Event** | **Reference** | **Comments** |
| | direction. 4 pickups, 3 employees outside the zone, the control shack, transformer area, the crane and ground area were contaminated to up to 100,000 dpm. | | spread. Cleanup begun.<br>Not in WIDS/SIM. No basis for inventory estimate |
| 6/2/1970 | Leak in encased process line between the 111-BY and 112-BY tanks. Operators decontaminating the trench with steanm and water were exposed to 2.5 rads/hr | Historical radiation occurrence Report (doc # unknown) | No volume estimate for leak. Not in WIDS/SIM |
| 1/10/1972 | 102-BY pump, sleeved in plastic for burial, broke while loading onto trailer permitting liquid to run from the sleeving. Contamination to 100 mrads/hr by riser | UN-200-E-43<br>BHI-00179 | Not in SIM. Release appears small. No inventory estimate. |
| 11/20/1972 | Gasket failure while backflushing a pump at tank BY-112. 1 to 3 rad per hour in pit | UPR-200-E-116<br>ARH-2666 | The pit was covered with dirt. Inventory of release unknown. Not in SIM. |
| 2/3/1975 | During overground transfer from 105-BY to 109-BY, a flange leaked contaminating the ground under the flange over a 5 by 6 ft area to 5 rads/hr at 6 in. | Historical radiation occurrence Report (doc # unknown) | Pump secured and 1 ft of dirt placed over contaminated area, which was then covered with plastic. Not in WIDS/SIM |

# APPENDIX B

# TANK LEAK DETAIL DATA

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## Acronyms and Abbreviations

| | |
|---|---|
| 1C | first cycle decontamination (waste) |
| ARHCO | Atlantic Richfield Hanford Company |
| bgs | below ground surface |
| BT2 | BY saltcake waste type |
| cps | counts per second |
| CW | aluminum cladding (coating) (waste) |
| CWP | PUREX cladding waste, aluminum clad fuel |
| EB | Evaporator Bottoms (waste) |
| ITS | In-Tank Solidification |
| ITS-1 | ITS Unit #1 |
| ITS-2 | ITS Unit #2 |
| LOW | liquid observation well |
| MW | metal waste |
| OWW | organic wash waste |
| PFeCN | sludge from the ferrocyanide scavenging process |
| PUREX | Plutonium Uranium Extraction (Plant) |
| RHO | Rockwell Hanford Operations |
| SACS | Surveillance Analysis Computer System |
| SGLS | spectral gamma logging system |
| SIM | Hanford Soil Inventory Model |
| TBP | tributyl phosphate (waste) |
| TD | total depth |

## Units

| | |
|---|---|
| Ci | curie |
| kgal | kilogallon ($10^3$ gallons) |
| kL | kiloliter ($10^3$ liters) |
| mrem | millirem |
| mR | milliroentgen |
| pCi | picocurie ($10^{-12}$ curies) |
| rad | radiation adsorbed dose |
| µCi | microcuries |
| µg | micrograms |
| µS/cm | microsiemens per centimer |

# B.0 LEAK ASSESSMENT RESULTS

The information gathered and the reassessment results for each of the single-shell tanks and unplanned releases in the 241-BY Tank Farm are discussed in the following sections. Several processes were conducted at the Hanford Site that generated wastes transferred to the 241-BY Tank Farm. These processes and the waste types generated are discussed in HNF-SD-WM-TI-740, *Standard Inventories of Chemicals and Radionuclides in Hanford Tank Wastes*.

## B.1 TANK 241-BY-103 WASTE LOSS EVENT

This section provides information on the historical waste loss event associated with tank 241-BY-103 (BY-103). Figure B.1-1 shows a plan view of tank BY-103. The following subsections summarize the waste operating history for tank BY-103 shown in Figures B.1-2 and B.1-3.

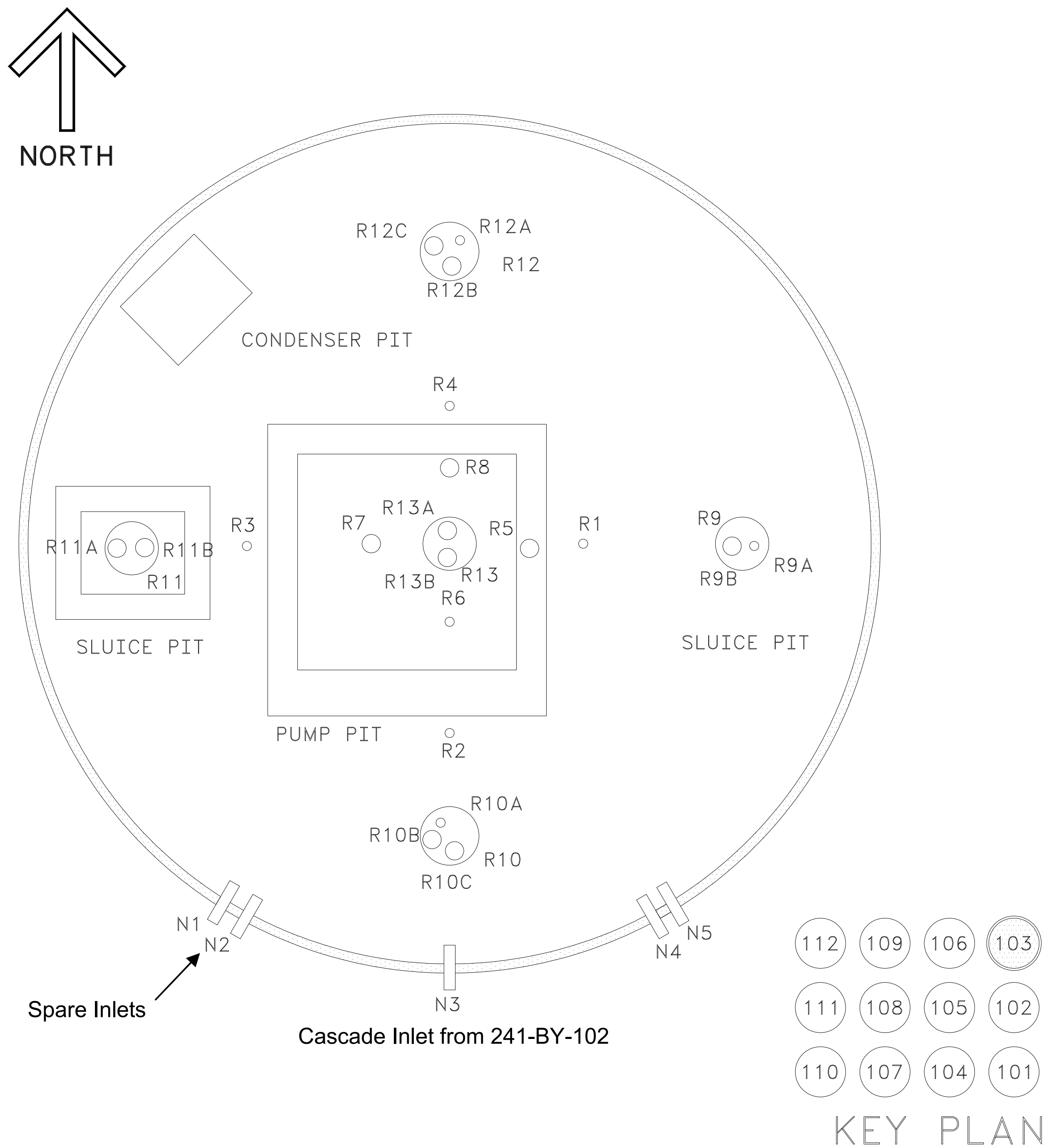
### B.1.1 Tank 241-BY-103 Waste History

Tank BY-103 was constructed from 1948 to 1949 and placed into service October 1950. Tank BY-103 first received metal waste in October 1950 from the cascade line, and the tank was full by March 1951. The tank contained 744,000 gal of liquid metal waste at that time. After transfer of the waste to other tanks, tank BY-103 was emptied on June 3, 1954. From February 1955 through January 1958 the tank received tributyl phosphate (TBP) scavenged waste and plutonium-uranium extraction (PUREX) high-level waste. From January through September 1965 combined TBP and PUREX high-level waste was transferred out of the tank and PUREX cladding waste, aluminum clad fuel (CWP) waste was transferred in and out of the tank from July 1965 through March 1967. In April 1967 this tank became an In-Tank Solidification (ITS) feed tank and continued so until May 1973 when it was removed from service (WHC-MR-0132, *A History of the 200 Area Tank Farms*). Table B.1-1 shows waste transfers for tank BY-103 from 1950 to 1981.

**B.1.1.1 Integrity of Tank 241-BY-103.** Tank BY-103 was categorized as a confirmed leaker and removed from service in May 1973 due to increasing gamma activity in drywell 22-03-09. Although activity readings remained at <1,000 cps, the radiation peak increased and spread from a range of 59 to 62 ft to a range of 56 to 77 ft by mid-March 1973 (SD-WM-TI-356, *Waste Storage Tank Status and Leak Detection Criteria*). No unaccounted-for liquid level decreases were observed during this time. HW-37301, *Summary of Tank Farm Operations 1/1/54 to 5/27/55* notes a discharge of waste to the ground near this well/tank in March 1954 during a supernate transfer to tank 241-C-104, as shown in Table B.1-1.

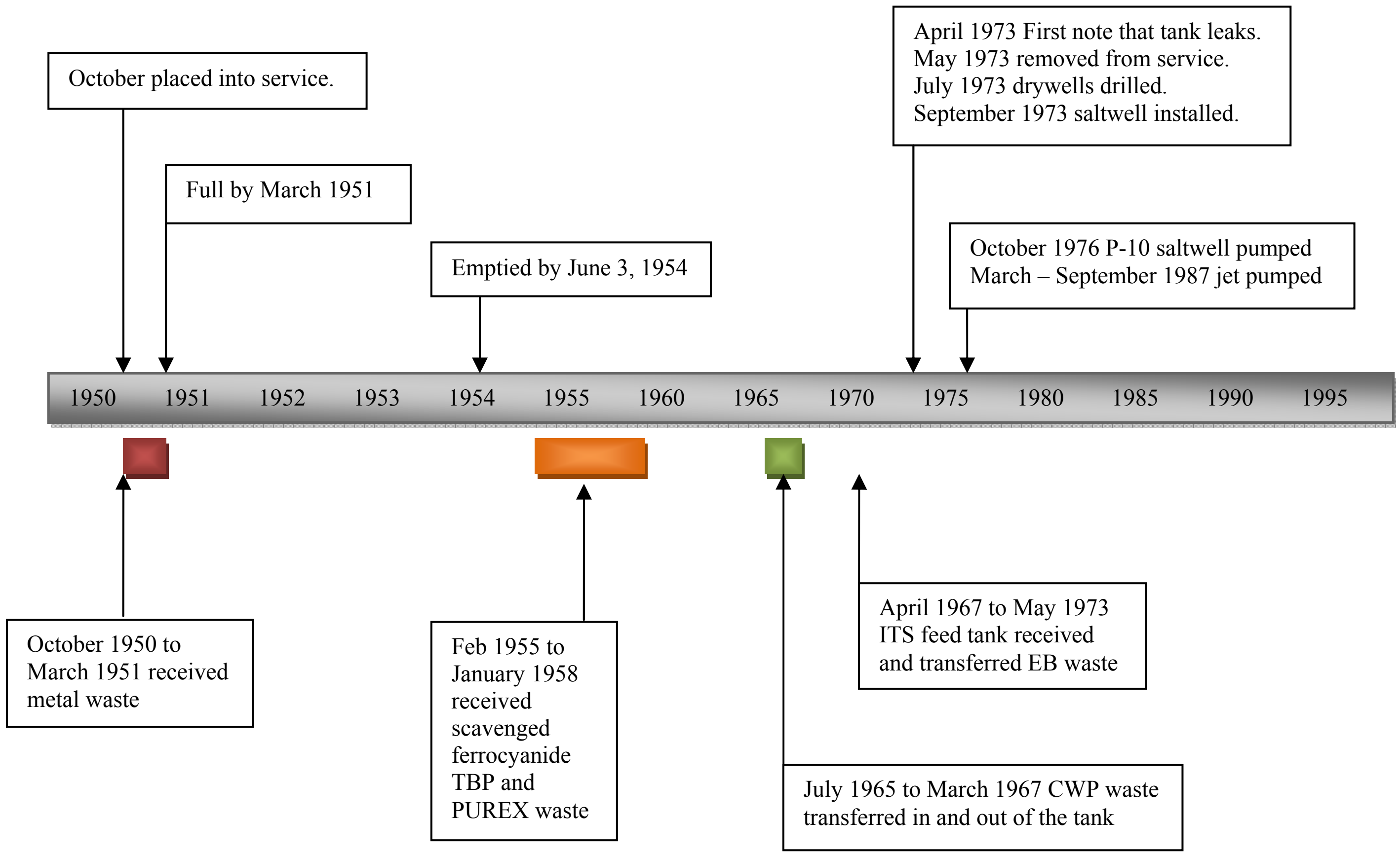
The current leak estimate for tank BY-103 is <5,000 gal (HNF-EP-0182, *Waste Tank Summary Report for Month Ending April 30, 2009*). This estimate is based on a table in PNL-4688, *Assessment of Single-Shell Tank Residual Liquid Issues at Hanford Site, Washington* which shows a leak of <5,000 gal, which itself is based on RHO-RE-SR-14, *Waste Status Summary November 1986* that shows a “small” leak for tanks BY-103 and 241-BY-108 (BY-108) but gives no volume estimate. No documented evaluation for the leak volume was found. A volume of 5,000 gal is roughly equivalent to 2 in. of tank capacity and may be based on a 2-in. uncertainty for manual tape measurements. As shown in Table B.1-2, WHC-MR-0132 first noted the tank was leaking in the June 1973 waste status report (ARH-2794 B, *Chemical Processing Division Waste Status Summary, April 1, 1973 through June 30, 1973*).

**Figure B.1-1. Tank 241-BY-103 Plan View**




R# = Riser number

**Figure B.1-2. Tank 241-BY-103 Waste Operating History**




CWP = PUREX cladding waste, aluminum clad fuel
PUREX = Plutonium Uranium Extraction (Plant)
EB = Evaporator Bottoms waste
TBP = tributyl phosphate (waste)
ITS = In-Tank Solidification

**Figure B.1-3. Tank 241-BY-103 Waste Fill History**

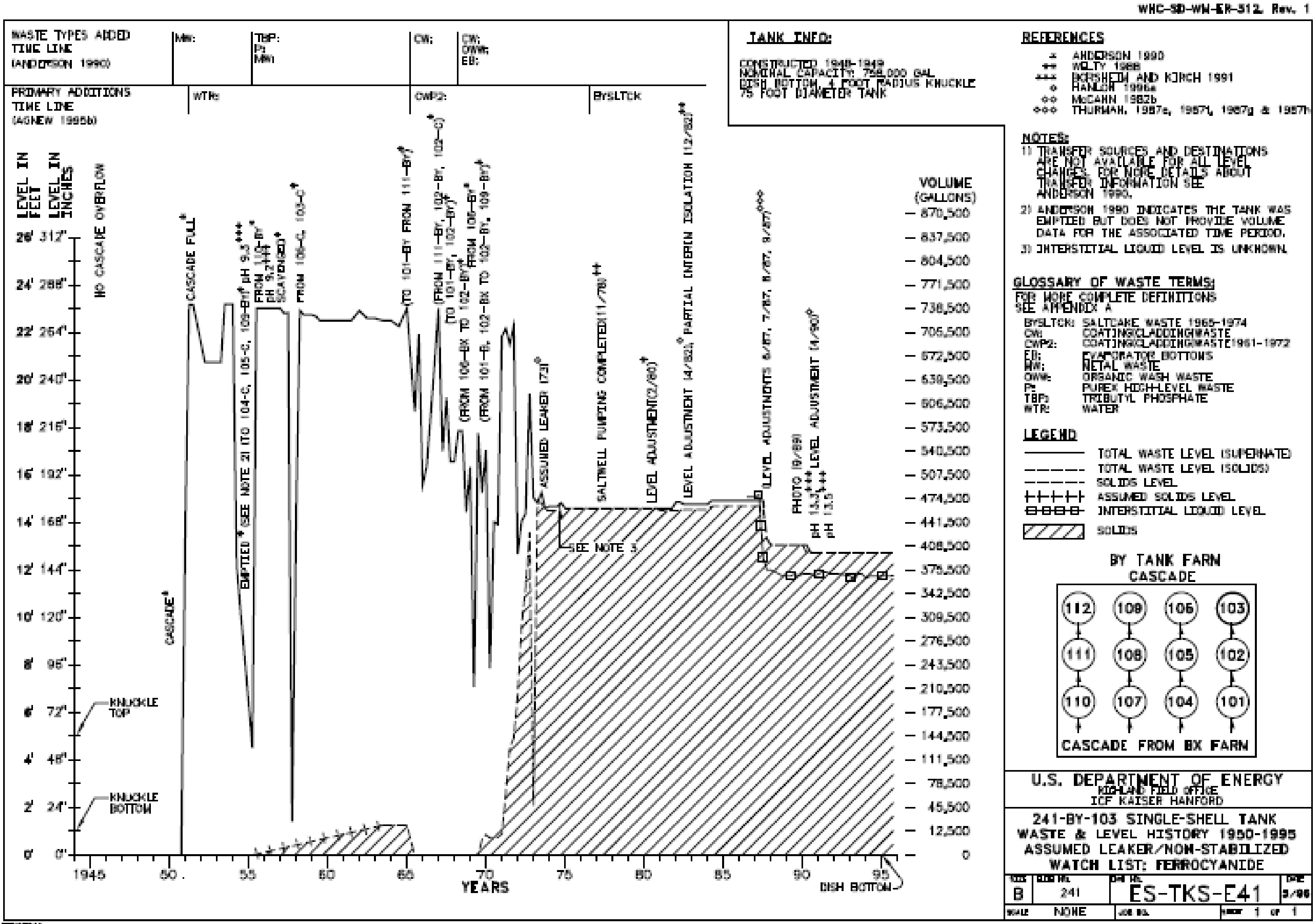


**Table B.1-1. Tank 241-BY-103 Transfers 1950 through 1981 (5 sheets)**

| Date | Transfer Type | Transfer Volume (gal*1000) | Total Vol. in Tank (gal*1000) | Discrepancy with Previous Reading (gal*1000) | Waste Type | Transfer Tank to/from | Document Number (full titles in Section B.6 REFERENCES) | Comment |
|---|---|---|---|---|---|---|---|---|
| July-September 1950 | STAT | 0 | 0 | 0 | | | WHC-MR-0132 | cascade began filling in October |
| October-December 1950 | IN | 429 | 429 | | MW | 102-BY | WHC-MR-0132 | cascade |
| January-June 1951 | IN | 315 | 744 | | MW | 102-BY | WHC-MR-0132 | cascade, full in March |
| July-December 1951 | STAT | | 744 | | MW | | WHC-MR-0132 | |
| January-December 1952 | OUT | -80 | 664 | | MW | UR | WHC-MR-0132 LA-UR-97-311 | |
| January-April 1953 | STAT | | 664 | | MW | | HW-27841 | |
| May 1953 | IN | 81 | 745 | | Water | | HW-28377 LA-UR-97-311 | |
| June 1953- February 1954 | STAT | | 745 | | MW | | HW-28712, HW-30851 | |
| March 1954 | OUT | -363 | 382 | | MW | 104, 105-C | HW-31374 | |
| March 1954 | Waste discharge to ground | Unknown | | | MW | | HW-37301, pg. 126 | The transfer of supernate from 103-BY to 104-C was started and proceeded without incident after initial leaks were repaired. |
| April 1954 | STAT | -9 | 373 | -9 | MW | 104, 105-C | HW-31811 | |
| May 1954 | OUT | -373 | 0 | | MW | 109-BY | HW-32110 | Emptied on 6/3/54 |
| June 1954-January 1955 | STAT | | 0 | | MW | | HW-32389, HW-35022 | |
| February 1955 | IN | 128 | 128 | | TBP | 110-BY | HW-35628 | |
| March 1955 | STAT | | 128 | | TBP | | HW-36001 | |
| April-May 1955 | IN | 93 | 221 | | TBP | 107-BY | HW-36553 LA-UR-97-311 | |

**Table B.1-1. Tank 241-BY-103 Transfers 1950 through 1981 (5 sheets)**

| Date | Transfer Type | Transfer Volume (gal*1000) | Total Vol. in Tank (gal*1000) | Discrepancy with Previous Reading (gal*1000) | Waste Type | Transfer Tank to/from | Document Number (full titles in Section B.6 REFERENCES) | Comment |
|---|---|---|---|---|---|---|---|---|
| June 1955 | IN | 518 | 739 | | TBP | 107-BY | HW-38000 LA-UR-97-311 | |
| July-December 1955 | STAT | | 739 | | TBP | | HW-38401 | |
| January-December 1956 | STAT | | 739 | | TBP | | HW-41038 | 2/56 scvg waste awaiting rework\ |
| January-May 1957 | STAT | | 732 | -7 | TBP | | HW-48144 | latest electrode reading |
| June 1957 | STAT | | 733 | 1 | TBP | | HW-51348 | |
| July 1957 | OUT | -550 | 183 | | TBP | | HW-51858 | 550M scvg |
| August 1957 | OUT | -157 | 26 | | TBP | | HW-52414 | scvg |
| September-October 1957 | STAT | | 26 | | TBP | | HW-52932 | |
| November 1957 | IN | 421 | 447 | | TBP-P | 106-C | HW-54067 | |
| December 1957 | STAT | | 447 | | TBP-P | | HW-54519 | |
| January 1958 | IN | 286 | 733 | | TBP-P | 103-C | HW-54916 | |
| February to April 1958 | STAT | | 736 | 3 | TBP-P | | HW-55264 | |
| May-December 1958 | STAT | | 730 | -6 | TBP-P | | HW-56357 | May-new electrode reading |
| January-February 1959 | STAT | | 730 | | TBP-P | | HW-59204 | |
| March-May 1959 | STAT | | 728 | -2 | TBP-P | | HW-60065 | |
| June-December 1959 | STAT | | 722 | -8 | TBP-P | | HW-61095 | |
| January-December 1960 | STAT | | 722 | | TBP-P | | HW-63896 | |
| January-June 1961 | STAT | | 722 | | TBP-P | | HW-71610 | |
| July-December 1961 | STAT | | 736 | 14 | TBP-P | | HW-72625 | latest electrode reading |
| January-June 1962 | STAT | | 725 | -11 | TBP-P | | HW-74647 | |
| July-December 1962 | STAT | | 725 | | | | HW-76223 | |
| January-June 1963 | STAT | | 722 | -3 | TBP-P | | HW-78279 | |
| July-December 1963 | STAT | | 722 | | | | HW-80379 | |
| January-June 1964 | STAT | | 714 | -8 | TBP-P | | HW-83308 | new electrode |

## Table B.1-1. Tank 241-BY-103 Transfers 1950 through 1981 (5 sheets)

| Date | Transfer Type | Transfer Volume (gal*1000) | Total Vol. in Tank (gal*1000) | Discrepancy with Previous Reading (gal*1000) | Waste Type | Transfer Tank to/from | Document Number (full titles in Section B.6 REFERENCES) | Comment |
|---|---|---|---|---|---|---|---|---|
| July-December 1964 | STAT | | 739 | 25 | TBP-P | | RL-SEP-260 | new electrode/ read confirmed, (measurements suspect since April 1958) |
| January-June 1965 | OUT | -143 | 596 | | TBP-P | 101-BY | RL-SEP-659 | |
| July-September 1965 | IN | 628 | | | CW | 111-BY | RL-SEP-821 | |
| | OUT | -521 | 703 | | TBP-P | 101-BY | RL-SEP-821 | |
| October-December 1965 | IN | 24 | | | CW | 111-BY | RL-SEP-923 | |
| | OUT | -233 | 494 | | CW | 101-BY | | |
| January-March 1966 | IN | 314 | | | CW | 111-BY | ISO-226 | |
| | OUT | -289 | 519 | | CW | 101-BY | | |
| April-June 1966 | IN | 503 | | | CW | 105-BY | ISO-404 | |
| | OUT | -432 | 590 | | CW | 101-BY | | |
| July-September 1966 | IN | 533 | | | CW | 105-BY 109-BY | ISO-538 | |
| | OUT | -461 | 662 | | CW | 101-BY | | |
| October-December 1966 | IN | 127 | | | CW | 102-C | ISO-674 | |
| | OUT | -50 | 739 | | CW | 102-BY | | |
| January-March 1967 | IN | 349 | | | CW | 106-BY | ISO-806 | |
| | OUT | -547 | 541 | | CW | 102-BY | | |
| April-June 1967 | IN | 74 | 615 | | CW | | ISO-967 | ITS feed tank |
| July-September 1967 | OUT | -46 | 569 | | CW | | ARH-95 | ITS feed tank |
| October-December 1967 | OUT | -43 | 526 | | CW | | ARH-326 | ITS feed tank |
| January-March 1968 | IN | 43 | 569 | | CW | | ARH-534 | ITS-1 & -2 feed tank |
| April-June 1968 | OUT | -133 | 436 | | CW | | ARH-721 | ITS-1 & -2 feed tank |
| July-September 1968 | IN | 20 | 456 | | CW | | ARH-871 | ITS-1 & -2 feed tank |
| October-December 1968 | IN | 2,153 | | | CW-OWW | 106-BX | ARH-1061 | |
| | OUT | -2,090 | 519 | | CW-OWW | 102, 109-BY | ARH-1061 | |

**Table B.1-1. Tank 241-BY-103 Transfers 1950 through 1981 (5 sheets)**

| Date | Transfer Type | Transfer Volume (gal*1000) | Total Vol. in Tank (gal*1000) | Discrepancy with Previous Reading (gal*1000) | Waste Type | Transfer Tank to/from | Document Number (full titles in Section B.6 REFERENCES) | Comment |
|---|---|---|---|---|---|---|---|---|
| January-March 1969 | IN | 1,585 | | | EB-CW | 101, 102, 103-B | ARH-1200 A | |
| | OUT | -1890 | 214 | | EB-CW | 102, 109-BY | ARH-1200 A | |
| April-June 1969 | IN | 2425 | | | CW-OWW | 103-B | ARH-1200 B | |
| | OUT | -2072 | 566 | | CW-OWW | 102, 109-BY | ARH-1200 B | |
| July-September 1969 | IN | 2095 | | | CW-OWW | 103-B | ARH-1200 C | |
| | OUT | -2178 | 483 | | | 102, 109-BY | ARH-1200 C | |
| October-December 1969 | IN | 1888 | | | CW-OWW | 102-BX | ARH-1200 D | |
| | OUT | -1829 | 542 | | CW-OWW | 102, 109-BY | ARH-1200 D | |
| January-March 1970 | IN | 608 | | | CW-OWW | 102-BY | ARH-1666 A | |
| | OUT | -910 | 239 | | CW-OWW | 102-BX, 109-BY | ARH-1666 A | |
| April-June 1970 | IN | 202 | 442 | 1 | CW-OWW-EB | 105-BY | ARH-1666 B | |
| July-September 1970 | STAT | | 439 | | CW-OWW-EB | | ARH-1666 C | |
| October-December 1970 | IN | 261 | 700 | | EB | 105-BY | ARH 1666 D | |
| January-March 1971 | IN/OUT | * | 711 | | EB | | ARH-2074 A* | ITS-2 bottom service in Jan. |
| April-June 1971 | IN/OUT | * | 689 | | EB | | ARH-2074 B* | ITS-2 bottoms & recycle |
| July-September 1971 | IN/OUT | * | 714 | | EB | | ARH-2074 C* | ITS-2 bottoms & recycle |
| October-December 1971 | IN/OUT | * | 398 | | EB | | ARH-2074 D* | ITS-2 bottoms & recycle |
| January-March 1972 | IN/OUT | * | 443 | | EB | | ARH-2456 A* | ITS-2 bottoms & recycle |

**Table B.1-1. Tank 241-BY-103 Transfers 1950 through 1981 (5 sheets)**

| Date | Transfer Type | Transfer Volume (gal*1000) | Total Vol. in Tank (gal*1000) | Discrepancy with Previous Reading (gal*1000) | Waste Type | Transfer Tank to/from | Document Number (full titles in Section B.6 REFERENCES) | Comment |
|---|---|---|---|---|---|---|---|---|
| April-June 1972 | IN/OUT | * | 454 | | EB | | ARH-2074 B* | ITS-2 bottoms & recycle |
| July-September 1972 | IN/OUT | * | 620 | | EB | | ARH-2074 C* | ITS-2 bottoms & recycle |
| October-December 1972 | IN/OUT | * | 476 | | EB | | ARH-2074 D* | ITS-2 bottoms & recycle |
| January-March 1973 | IN/OUT | * | 469 | | EB | | ARH-2794 A* | ITS-2 bottoms & recycle |
| April-June 1973 | IN/OUT | * | 483 | | EB | | ARH-2794 B* | ITS-2 bottoms & recycle, Tank leaks |
| July-September 1973 | OUT | -25 | 461 | 3 | EB | 109-BY | ARH-2794 C* | Tank leaks |
| October-December 1973 | OUT | -4 | 464 | | EB | 109-BY | ARH-2794 D* | Tank leaks, pumping interstitial liquid , no surface change |
| January-June 1974 | STAT | | 464 | | EB | | ARH-CD-133A | |
| July-September 1974 | OUT | -5 | 4641 | | EB | 109-BY | ARH-CD-133C | |
| October-December 1974 | STAT | | 461 | | EB | | ARH-CD-133D | |
| January-December 1975 | STAT | | 461 | | EB | | ARH-CD-336 A | |
| January-December 1976 | OUT | 6 | 461 | | EB | 109-BY | ARH-CD-702 A | |
| January 1977-December 1981 | STAT | | 461 | | EB | | ARH-CD-822 JAN | |

IN defines a transfer into the tank, OUT defines a transfer out of the tank, STAT refers to a volume reading where no transfer occurred.
"Total Volume In Tank" refers to measured STAT values following the transfers shown.
Except as noted, discrepancies are attributed to effects such as evaporation, questionable surface level measurements and/or undocumented water additions.

* Numerous transfers in and out of tank, volumes not shown except as specified in the waste status summary.

ITS = In-Tank Solidification  ITS-1 = ITS Unit #1  ITS-2 = ITS Unit #2

Waste types:
CW = cladding (coating) waste  EB = Evaporator Bottoms waste  MW = metal waste
OWW = Organic wash waste  P = PUREX Plant high-activity neutralized acid waste  TBP = tributyl phosphate waste

**Table B.1-2. Tank 241-BY-103 1971 and 1987 Sample Data (Tank Waste Information Network System historical data)**

| Constituent | Reported Value | Units | Date | Density | Sample State |
|---|---|---|---|---|---|
| $Cs^{137}$ | 2.81E+05 | uCi/L | 3/9/1987 | 1.3 | Liquid |
| $Cs^{137}$ | 4.21E+05 | uCi/L | 10/14/1971 | 1.5 | Supernatant |
| $Cs^{137}$ | 3.23E+05 | uCi/L | 10/14/1971 | 1.5 | Supernatant |
| $Cs^{137}$ | 3.44E+05 | uCi/L | 10/14/1971 | 1.5 | Supernatant |
| $Cs^{137}$ | 3.44E+05 | uCi/L | 10/14/1971 | 1.5 | Supernatant |
| Al | 1.69 | M | 3/9/1987 | 1.3 | Liquid |
| Al | 1.64 | M | 10/14/1971 | 1.5 | Supernatant |
| Al | 1.82 | M | 10/14/1971 | 1.5 | Supernatant |
| Al | 1.82 | M | 10/14/1971 | 1.5 | Supernatant |
| Al | 2.17 | M | 10/14/1971 | 1.5 | Supernatant |
| $Tc^{99}$ | 1.03E+02 | uCi/L | 3/9/1987 | 1.3 | Liquid |
| $NO_3$ | 7.41E-01 | M | 3/9/1987 | 1.3 | Liquid |
| $NO_3$ | 3.04 | M | 10/14/1971 | 1.5 | Supernatant |
| $NO_3$ | 2.98 | M | 10/14/1971 | 1.5 | Supernatant |
| $NO_3$ | 2.33 | M | 10/14/1971 | 1.5 | Supernatant |
| $NO_3$ | 2.57 | M | 10/14/1971 | 1.5 | Supernatant |
| Na | 12 | M | 10/14/1971 | 1.5 | Supernatant |
| Na | 11.7 | M | 10/14/1971 | 1.5 | Supernatant |
| Na | 11.6 | M | 10/14/1971 | 1.5 | Supernatant |
| Na | 11.9 | M | 10/14/1971 | 1.5 | Supernatant |

Sample data for tank BY-103 was obtained in 1971 and 1987. Table B.1-2 shows relatively little difference in the data obtained before and after the leak event ($2.8\times10^5$ for 1987 $^{137}Cs$ data [$4.0\times10^5$ back decayed to 1971] vs. range from $3.2\times10^5$ to $4.2\times10^5$ for 1971 data). RPP-26744, *Hanford Soil Inventory Model, Rev. 1* (SIM), using Hanford Defined Waste Revision 5 composition estimate for BY saltcake, uses a mean $^{137}Cs$ value of $3.2\times10^5$ decayed to 1971. The SIM value is reasonably consistent with the sample data.

**B.1.1.2 Interim Stabilization.** In September 1973 a P-10 saltwell system was installed in tank BY-103. Three pumping events in October 1976 yielded only 1,200 gal of supernate (SD-WM-TI-356). Jet pumping was initiated on March 31, 1987 and total pump production was 78,500 gal with an average flowrate of 0.1 gpm before the pump failed on September 8, 1987. Due to a possible intrusion tank BY-103 was not declared stabilized even though the stabilization criteria had apparently been met [Note: Occurrence Report OR-80-6, *Tank 103-BY Liquid Level Measurement (Manual Tape) Exceeding the Increase Criterion* was issued in January 1980 due to an estimated 1,100-gal water intrusion attributed to snow melt runoff entering the tank via pump pits]. In 1989 it was discovered that dip tube liquid levels had risen in the tank and pumping resumed on August 5, 1995. An additional 17,000 gal was pumped out before the pump was shut down on October 20, 1995 as a result of a flammable gas unreviewed safety question. Shutdown of the pump and settling of solids resulted in a blockage in the transfer line. Attempts to remove the blockage failed. An attempt was made to by-pass the blockage and upon start-up the pump motor casing leaked constituting a major equipment failure. On November 24, 1997 interim stabilization was determined to be completed with less than 38,000 gal of pumpable liquid remaining in the tank (HNF-SD-RE-TI-178, *Single-Shell Tank Interim Stabilization Record*).

A photo mosaic (Figure B.1-4) of the waste surface in tank BY-103 as of September 7, 1989 shows a dry, caked surface with no visible liquid. As of January 2009 the tank is estimated to contain 9,000 gal of sludge and 405,000 gal of saltcake with an estimated 55,000 gal of drainable interstitial liquid and no supernate (HNF-EP-0182).

**B.1.1.3 Tank 241-BY-103 Temperature History.** Figure B.1-5 shows a thermal history for thermocouple 2 in Riser 1 of tank BY-103 from 1974 through 2000. The tank temperature for all thermocouples in Risers 1 and 5 varied between 50 and 110 °F during this time. These measurements are shown in the Surveillance Analysis Computer System (SACS). No temperature information was found before 1974.

### B.1.2 Data Review and Observations

**B.1.2.1 Surface Level Data.** There is no evidence of an unaccounted-for liquid level decrease in tank BY-103 that might be attributed to a leak. Table B.1-3 shows surface level measurements from June 1973 to March 1987. No surface level data was available before June of 1973.

An intrusion of ~1,100 gal occurred January 12 to 13, 1980 (OR-80-6). The intrusion was attributed to a rapid snow melt. Excavations around tank pump pits and risers in support of saltwell pumping provided runoff water a pathway into the tank's pump pit, then directly into the tank through the pit floor drain. No intrusions were observed after excavating around the tank before the rapid snow melt in 1979.

**B.1.2.2 Drywell Logging Data.** In 1969, high radiation count rates were obtained in drywell 22-00-03, which is located southeast of the tank. On the basis of continued high count rates in drywell 22-00-03, tank BY-103 was classified as a borderline leaker in 1970. In 1971, high count rates were also obtained in drywell 22-03-05, a newly drilled monitoring drywell. The liquid operating level in tank BY-103 was lowered to ~13 ft to permit continued operation of the tank as a bottoms receiver in the ITS program. In 1972 and 1973, count rates in drywell 22-03-09 spread over a widening interval from ~56 to 77 ft, although the count rates were low. Initial logging of new drywells 22-03-04 and 22-03-06 in 1973 showed enhanced count rates (Internal letter J17-30, "Integrity of Tanks 241-BY-103 and 241-TY-103"). On the basis of elevated gross gamma-ray count rates in the drywells around the tank, tank BY-103 was classified as a confirmed leaker in 1973. In 1974, a changing radiation profile and increase in radiation in drywell 22-03-09 at a depth of ~32 ft prompted an occurrence report (OR-74-106, *Increasing Radioactivity in Dry Well 22-03-09 at Tank 103-BY*) that concluded the tank may have leaked in early 1974, but that it probably no longer was leaking after the liquid level was lowered below the depth at which the radiation peak was observed (GJ-HAN-20, *Vadose Zone Characterization Project at the Hanford Tank Farms Tank Summary Data Report for Tank BY-103*).

**Figure B.1-4. Tank 241-BY-103 Waste Surface Photo Mosaic**

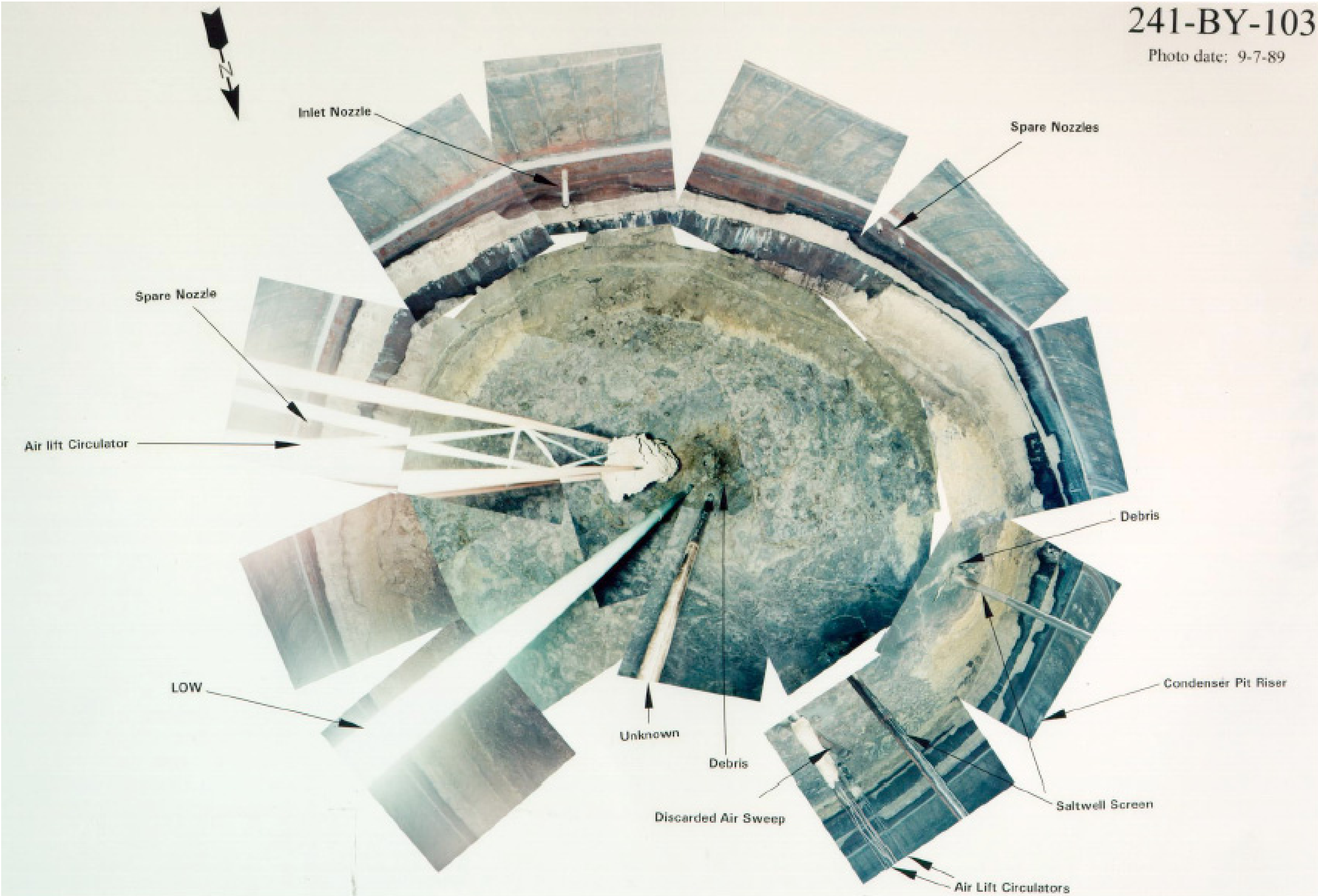


**Figure B.1-5. Tank 241-BY-103 Temperature Measurements**

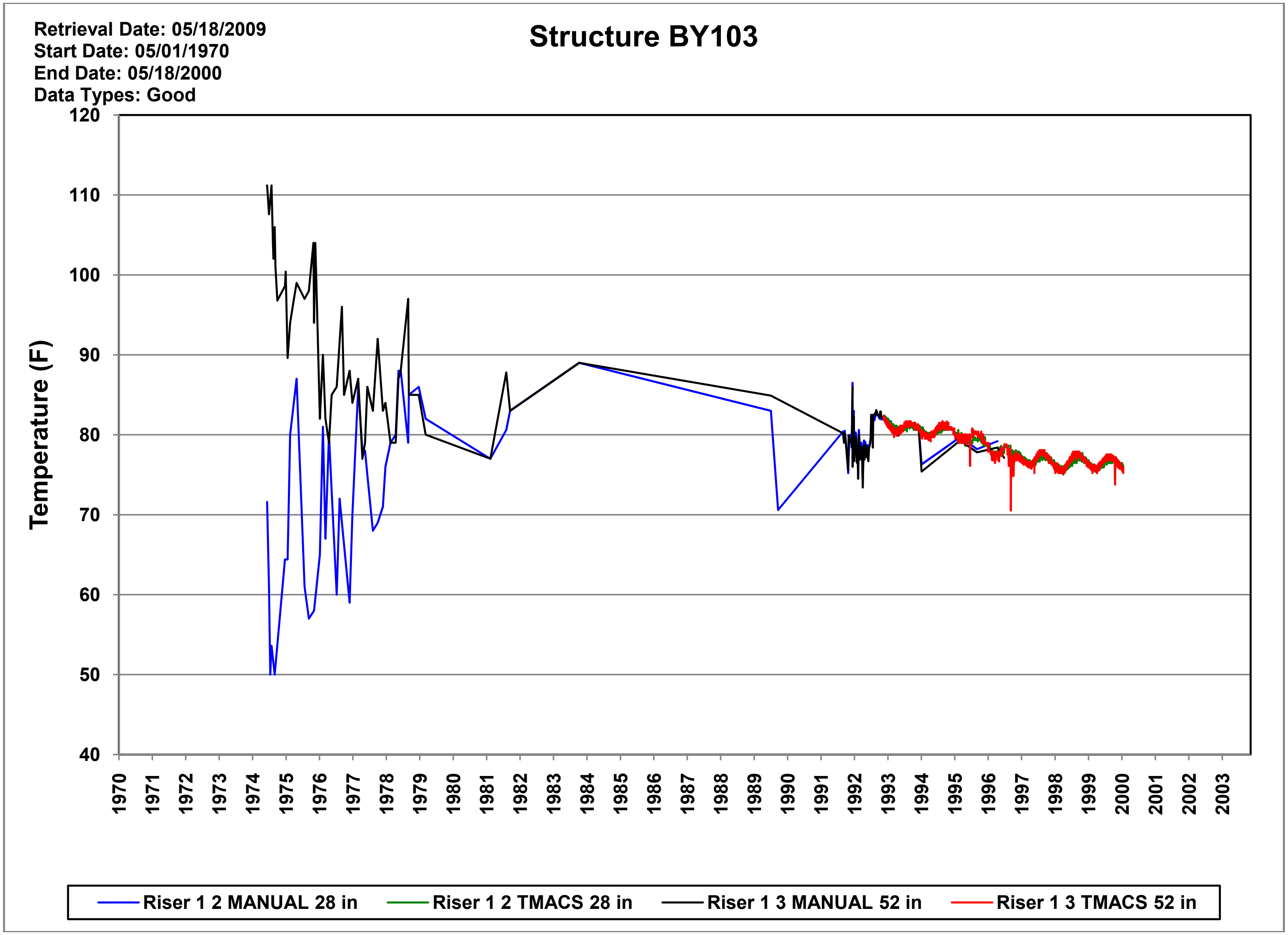


**Table B.1-3. 1973 to 1987 Tank 241-BY-103 Liquid Level Measurements**

| Date | Liquid Level (in.) | Comments |
|---|---|---|
| 6/15/73 | 183.0 | Manual Tape |
| 7/17/73 | 183.0 | Stable |
| 7/18/73 | 185.0 | Sluiced in salt well |
| 9/17/73 | 186.0 | Slow increase |
| 9/20/73 | 175.0 | Transfer |
| 10/28/73 | 176.0 | Slow increase |
| 11/03/73 | 174.0 | Salt-well transfer |
| 12/26/74 | 175.75 | Steady increase |
| 4/5/74 | 175.75 | Stable |
| 4/26/74 | 174.75 | Salt-well transfer |
| 5/17/74 | 175.75 | Steady increase |
| 5/18/74 | 175.0 | Transfer |
| 6/10/74 | 175.5 | Slow increase |
| 6/11/74 | 181.5 | New tape |
| 12/31/74 | 176.5 | Salt-well transfer |
| 9/8/75 | 176.25 | Slow-erratic decrease |
| 1/9/76 | 176.0 | Salt-well transfer |
| 4/5/76 | 175.0 | Slow decrease |
| 5/20/76 | 175.0 | Salt-well transfer |
| 7/20/76 | 174.5 | Slow decrease |
| 10/30/76 | 174.75 | Salt-well transfer |
| 3/13/77 | 174.25 | Slow decrease |
| 5/29/77 | 174.5 | Salt-well transfer |
| 12/28/77 | 174.5 | Stable |
| 1/02/09 | 173.25 | Slow decrease salt well transfer |
| 12/7/79 | 173.5 | Readings 172.5 -173.5 in. |
| 1/19/80 | 174.0 | Increase due snow melt water drainage via pump pit (OR-80-6) |
| 2/13/80 | 174.0 | Stable |
| 5/9/80 | 175.0 | Increase due water use and rain intrusions (OR-80-6) |
| 3/31/81 | 176.25 | Slow unexplained increase |
| 11/22/81 | 177.25 | Surface movement and precipitation (OR-81-04) |
| 3/24/82 | 177.25 | Stable |
| 12/15/82 | 178.0 | Steady increase |
| 3/16/83 | 178.0 | Stable, 177.75 – 178.5 in. |
| 3/11/84 | 179.0 | Steady increase, 178.0-179.0 in. |
| 3/14/85 | 179.75 | Slow increase |
| 9/3/85 | 180.0 | Intrusions, source unknown |
| 3/17/86 | 181.25 | Slow, gradual increase |
| 3/2/87 | 182.0 | Erratic increase |
| 3/16/87 | 182.0 | Stable |

References:
OR-81-04, *Tank 110-BX Liquid Level Measurement and Apparent Surface Liquid Increase*
OR-80-6, *Tank 103-BY Liquid Level Measurement (Manual Tape) Exceeding the Increase Criterion*
SD-WM-TI-356, *Waste Storage Tank Status and Leak Detection Criteria*.

Figure B.1-6 shows the 1995 and later concentrations of $^{137}Cs$, $^{60}Co$, $^{125}Sb$, and $^{154}Eu$ measured in drywells near tank BY-103 using the spectral gamma logging system (SGLS) and high rate logging system. All of the drywells had some $^{137}Cs$ contamination near the surface that migrated downward to various depths.

The logs of drywells located at the north side of tank BY-103 (drywells 22-03-01, 22-03-10, and 22-00-01) only showed $^{137}Cs$ contamination, and the contamination extended to total depth (TD) for one of the drywells (22-03-01). All other drywells had $^{60}Co$ in addition to $^{137}Cs$, and four of them also had $^{125}Sb$. Only drywell 22-03-09 had $^{154}Eu$, and that contaminant was at a shallow depth and at a low concentration, clearly originating at or near the surface. Drywell 22-03-05 had the highest $^{137}Cs$ concentrations, which were detectable throughout an extended interval (24 to 44 ft).

For the drywells having $^{60}Co$, contamination generally started no higher than ~40 ft and reached to TD, although the presence of $^{60}Co$ was not continuous. Tank BY-103 is the most probable source for the $^{60}Co$ contamination. At drywell 22-03-09, the $^{60}Co$ contamination started higher in the drywell. Antimony-125 occurred at depths where $^{60}Co$ was also present, but the distribution of $^{125}Sb$ was much more limited in vertical extent. Europium-154 was limited to a narrow interval near 6 ft at drywell 22-03-09.

Drywells 22-00-01 and 22-00-03 were drilled and perforated before any waste was placed into the BY-Farm tanks near these drywells. No records were located that indicate why the casings of these drywells were perforated from 40 to 100 ft at the time the drywells were drilled in 1949. In addition, no logs were located to check the radiation in these drywells for the first 20 years after these drywells were drilled. The first records located indicate that elevated radiation existed in drywell 22-00-03 by at least 1969 and in drywell 22-00-01 by at least 1973.

Most of the contamination at drywells 22-00-01 and 22-00-03 is located above the perforated intervals; hence, the perforations have apparently not served as a conduit for contamination to enter the casing and move downward. A small amount of $^{137}Cs$ is located at the bottom of drywell 22-00-03, perhaps having entered through the perforations.

Figure B.1-7 shows total gamma data obtained between 1975 and 1995 for drywells 22-03-04, 22-03-05, 22-03-06, 22-03-07, 22-03-08 and 22-03-09. Consistent with the spectral gamma data, drywell 22-03-05 showed the highest activity with 170,000 cps measured between 15 and 60 ft below ground surface (bgs). The activity attributed to $^{137}Cs$ was present in 1975 and began to stabilize and decrease following a $^{137}Cs$ decay trend after 1980. The next highest activity was observed in drywell 22-03-09, with 29,000 cps at 24 to 52 ft bgs attributed to $^{60}Co$, $^{125}Sb$ and $^{106}Ru$. The activity was unstable and continued to move. In 1993 the activity moved below the bottom of the drywell. On July 31, 1974 OR-74-106 noted a continued increase in activity at 34 ft bgs. A leak in the saltwell transfer line was suspected as a possible source. To investigate this possibility a test hole was augered over the tank dome and between the drywell and the center of the tank. The test hole revealed some contamination, but it could not be determined if it was from a recent event. Two possibilities for the continued increase were 1) seepage of interstitial liquid from a new leak in the tank or 2) migration of contamination from a new source (e.g., the saltwell pump transfer line [Note: the sluicing pit is near drywell 22-03-09]).

**Figure B.1-6. Tank 241-BY-103 Drywell Spectral Gamma Data Collected after 1995**

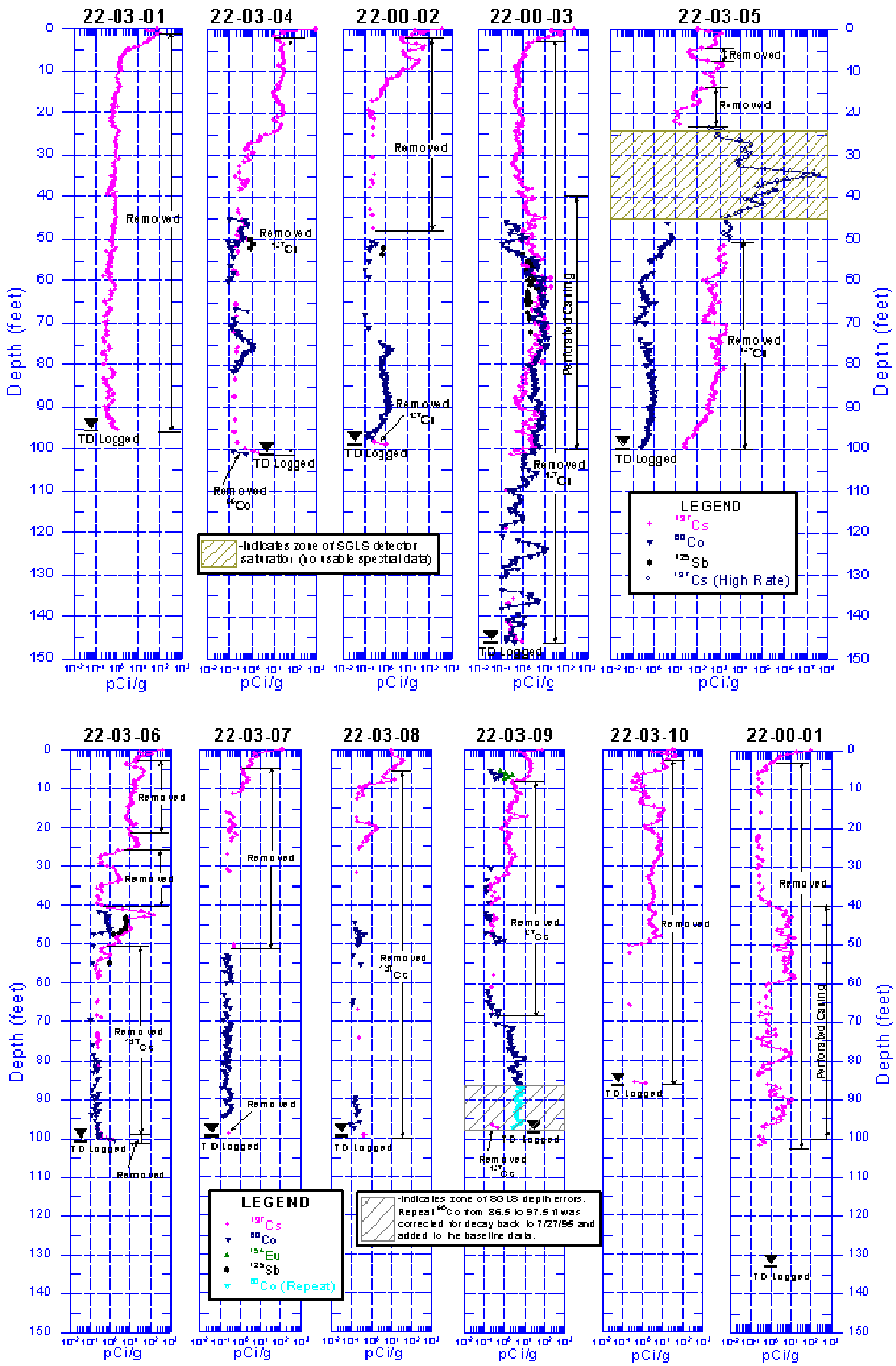


**Figure B.1-7. Total Gamma Results 1975 to 1995 (sheet 1 of 6)**

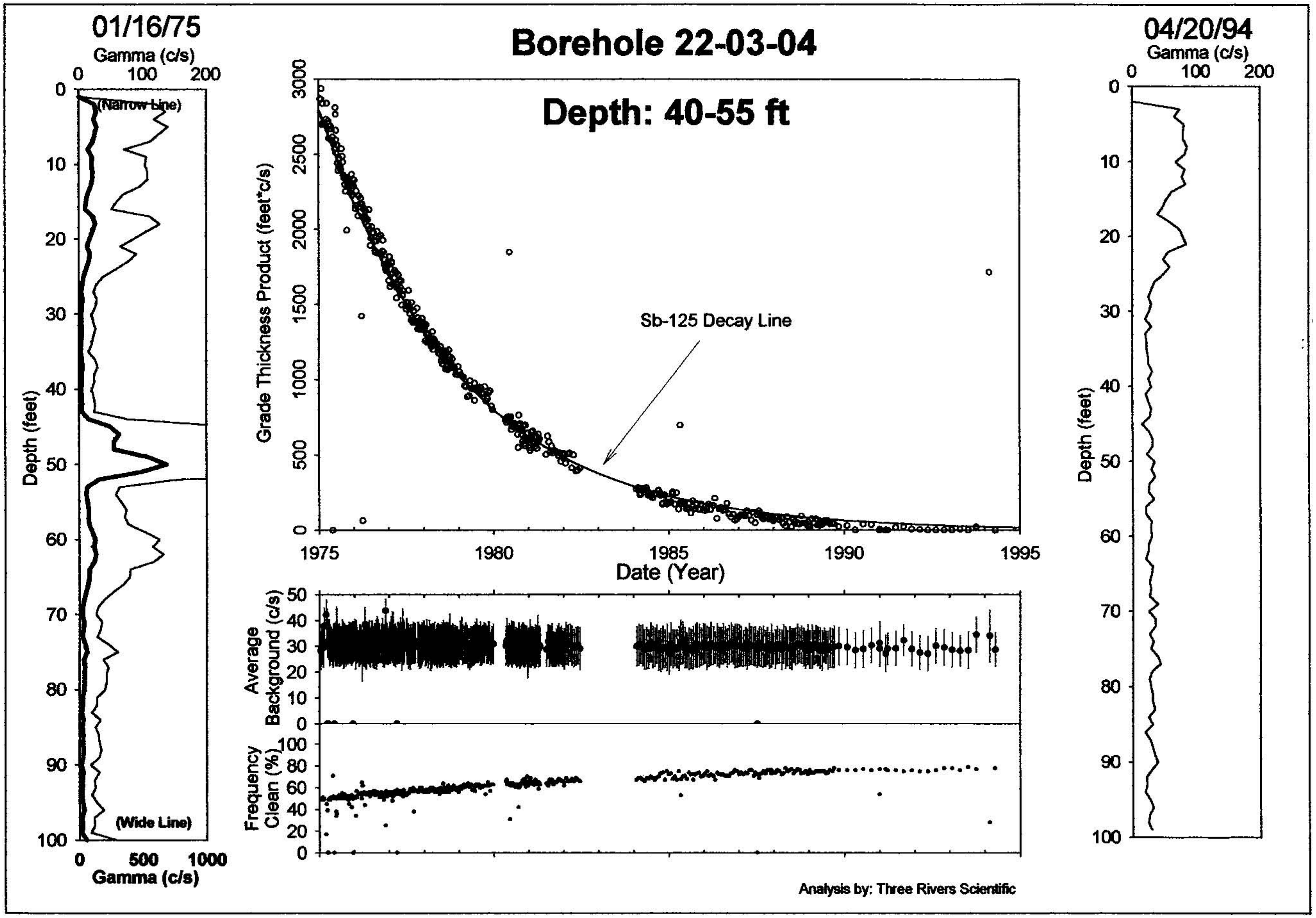


**Figure B.1-7. Total Gamma Results 1975 to 1995 (sheet 2 of 6)**

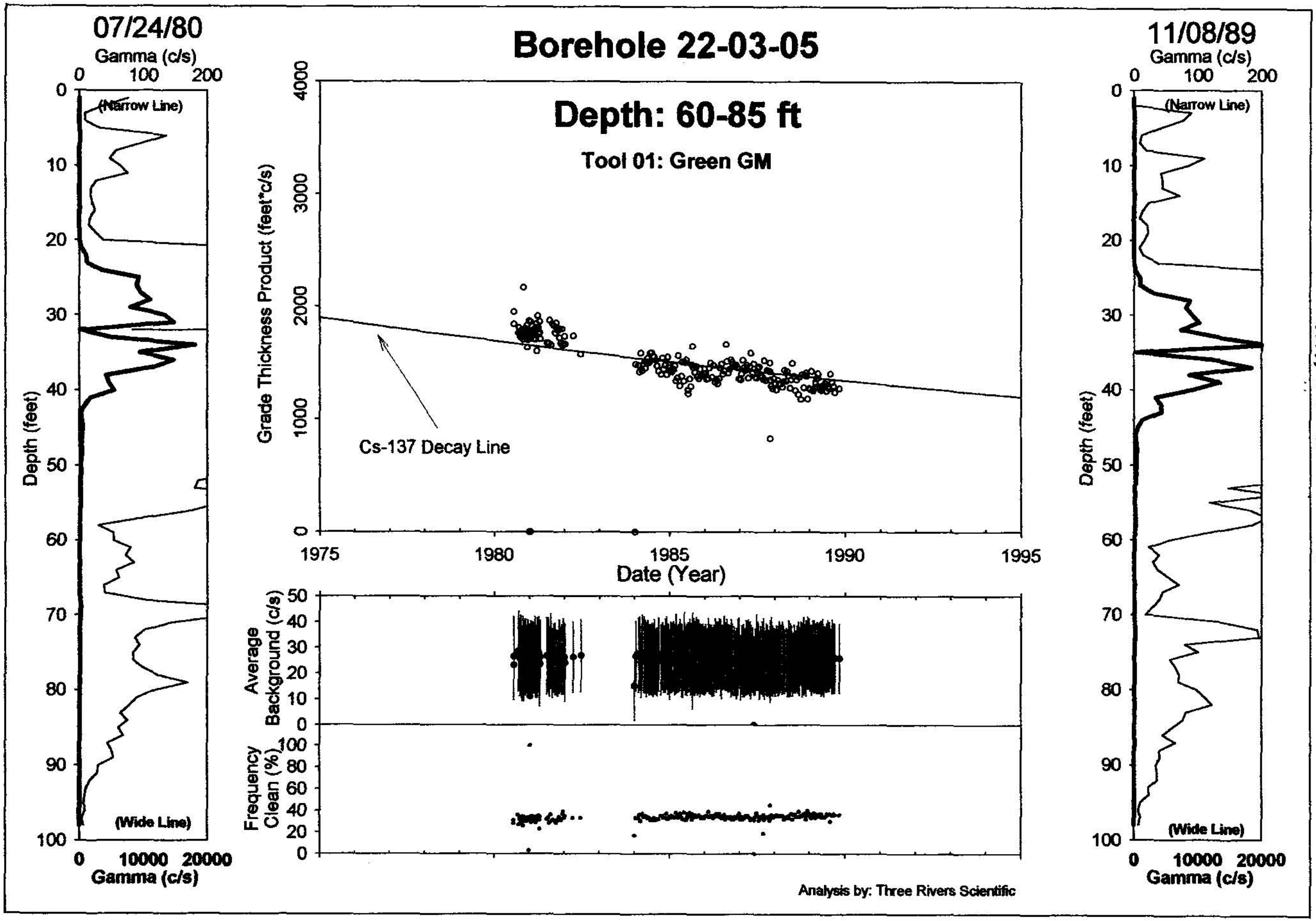


**Figure B.1-7. Total Gamma Results 1975 to 1995 (sheet 3 of 6)**

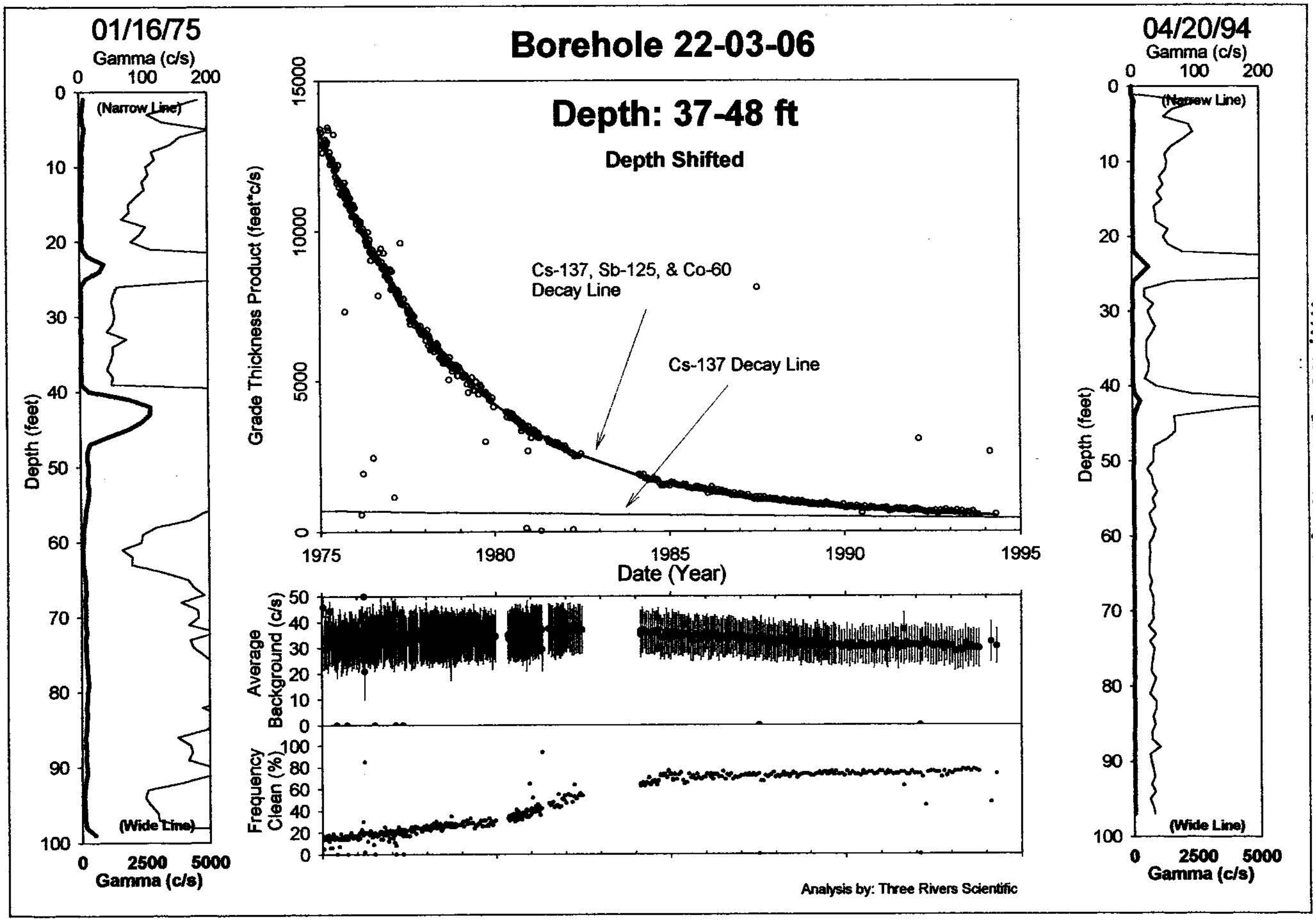


**Figure B.1-7. Total Gamma Results 1975 to 1995 (sheet 4 of 6)**

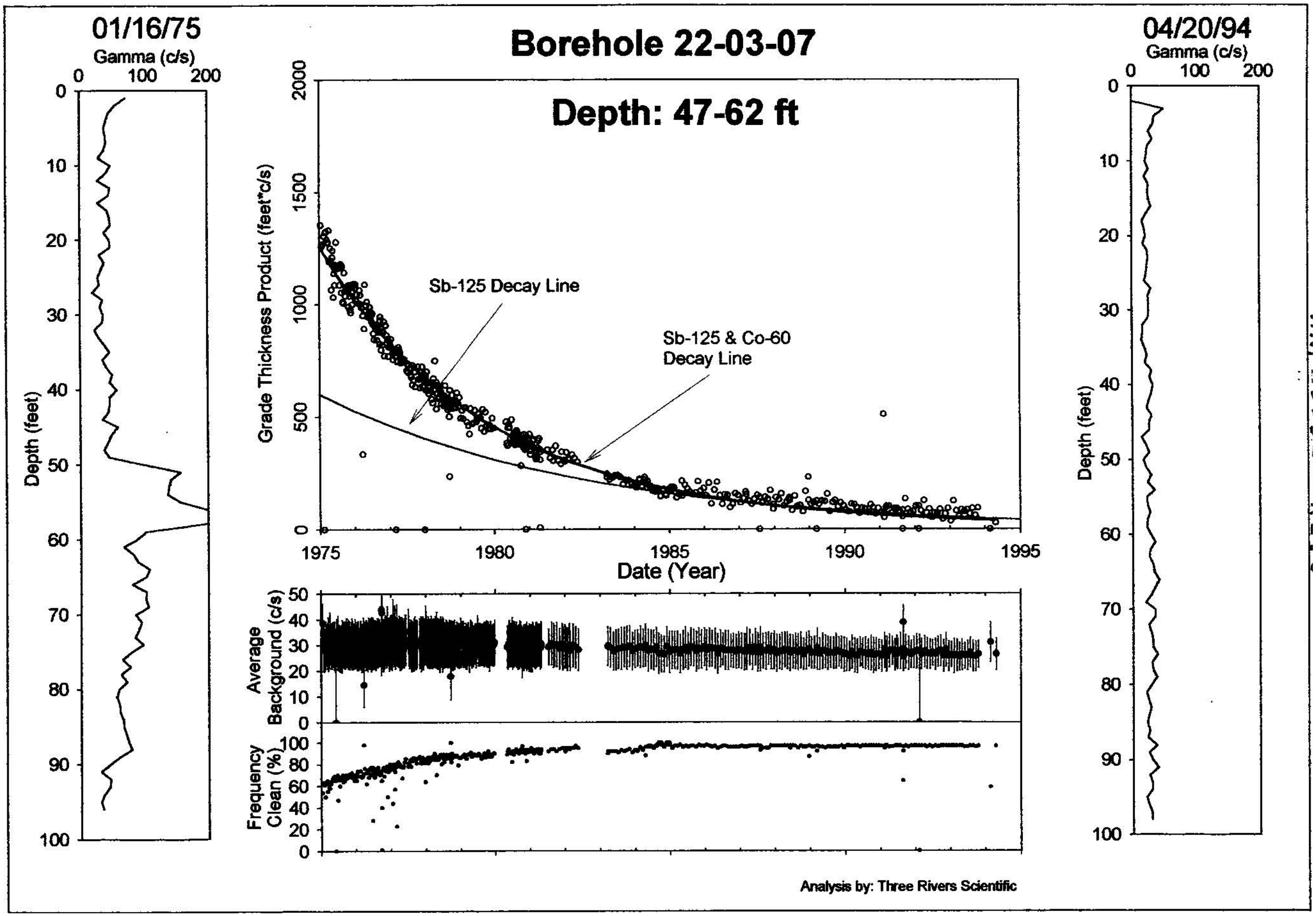


**Figure B.1-7. Total Gamma Results 1975 to 1995 (sheet 5 of 6)**

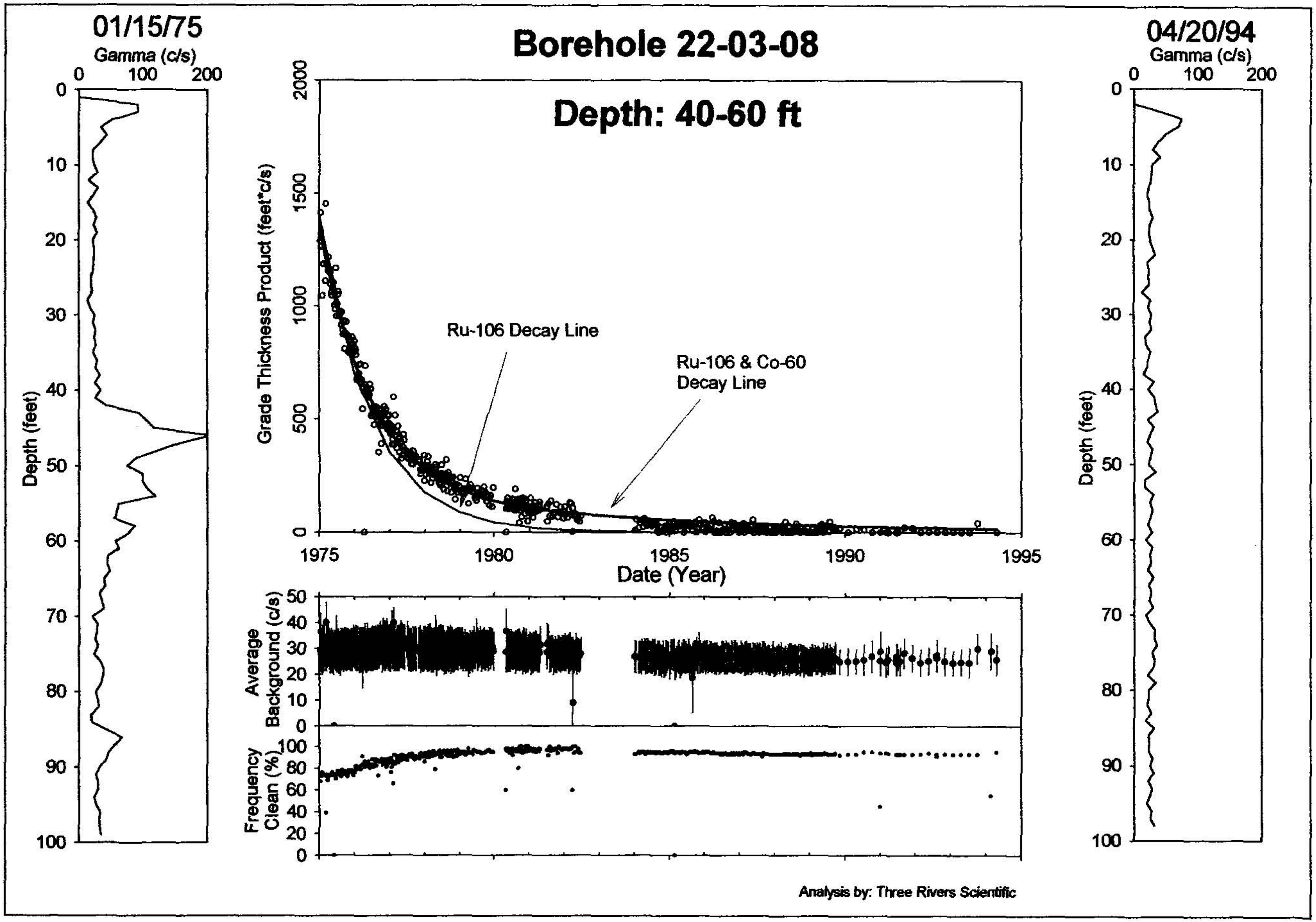
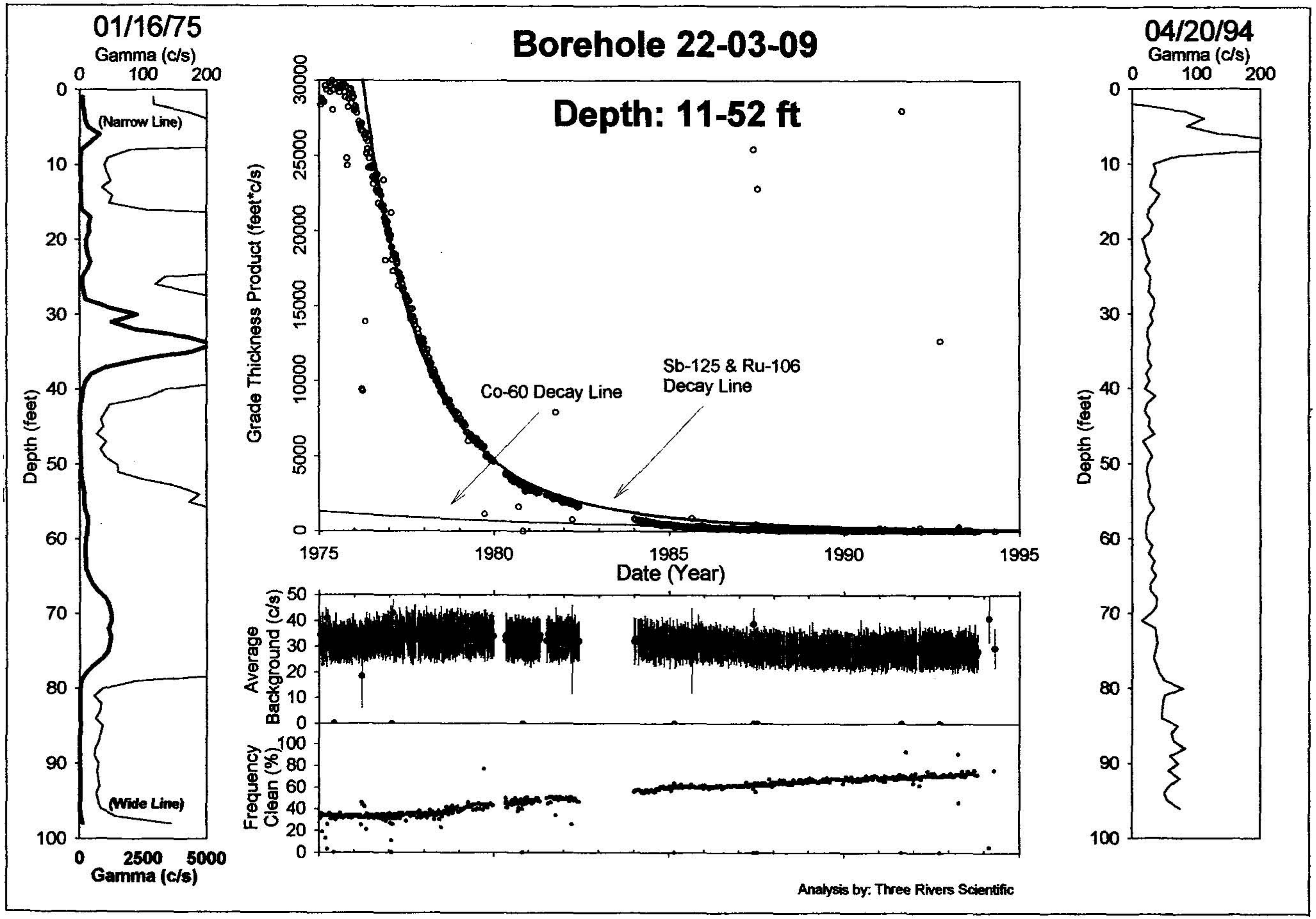


**Figure B.1-7. Total Gamma Results 1975 to 1995 (sheet 6 of 6)**



Drywell 22-03-06 showed a maximum of 2,300 cps from 20 to 28 ft bgs and 13,000 cps from 37 to 100 ft bgs in 1975 attributed to $^{137}Cs$, $^{60}Co$, $^{125}Sb$ and $^{106}Ru$. Activity levels were stabilized and began to decrease after 1975. Drywells 22-03-04, 22-03-06, 22-03-07 and 22-03-08 all showed lower levels of activity which stabilized after 1975 following decay curves for $^{60}Co$, $^{125}Sb$ and $^{106}Ru$.

**B.1.2.3 Tank 241-BY-103 Assessment.** An attempt to estimate the inventory of liquid leaked from tank BY-103 based on drywell logging results was made in RPP-23405, *Tank Farm Vadose Zone Contamination Volume Estimates*, by estimating the inventory of waste that could have leaked in the entire BY-Farm based on drywell measurements. The result was an estimate of 1,200 Ci of waste in the entire farm.

Calculations and assumptions were as follows. The 241-BY Tank Farm spectral gamma logging data (GJO-96-2-TARA/GJO-HAN-6, *Hanford Tank Farms Vadose Zone: Addendum to the BY Tank Farm Report*) identify five regions of high $^{137}Cs$ gamma activity (i.e., at $>1\times10^4$ pCi/g). The decay date for these $^{137}Cs$ estimates is 1996 (the date data was collected). The regions are as follows.

1. Drywells 22-08-01 and 22-08-02 from 2 to 7 ft bgs at $1\times10^5$ pCi/g (assume a 50-ft diameter circular plume).

2. Drywell 22-05-01 from 0 to 3 ft bgs at $1\times10^4$ pCi/g (assume a 25-ft circle).

3. Drywell 22-12-03 from 5 to 7 ft bgs at $1\times10^4$ pCi/g (assume a 25-ft circle).

4. Drywell 22-03-05 from 27 to 45 ft bgs at $3\times10^3$ to $4\times10^7$ pCi/g (assume a 25-ft circle).

5. Finally, there is the generally contaminated region from 0 to 10 ft bgs all across the 241-BY Tank Farm at $<1\times10^2$ pCi/g.

Assuming an average soil density of 1.8 g/cc, 1 $ft^3$ equals $2.832\times10^4$ $cm^3$; thus, 1 $ft^3$ would contain $5.1\times10^4$ g of soil. A 25-ft circle of cesium contamination with a 1 ft depth would contain 491 $ft^3$ or $2.5\times10^7$ g of soil. A 50-ft circle 1 ft thick would include 1,964 $ft^3$ or $1.0\times10^8$ g of soil. A 5-ft thick by 50-ft circular plume would include $5.0\times10^8$ g of soil.

1. Drywells 22-08-01 and 22-08-02 from 2 to 7 ft bgs at $1\times10^5$ pCi/g (assume a 50-ft diameter circular plume); a $^{137}Cs$ activity of $1\times10^5$ pCi/g would lead to an estimate of 50 Ci of $^{137}Cs$ in this plume.

2. Drywell 22-05-01 from 0 to 3 ft bgs at $1\times10^4$ pCi/g (assume a 75-ft circle); leads to an estimate of 0.25 Ci of $^{137}Cs$ in this plume.

3. Drywell 22-12-03 from 5 to 7 ft bgs at $1\times10^4$ pCi/g (assume a 25-ft circle); leads to an estimate of 0.5 Ci of $^{137}Cs$ in this plume.

4. Because of the depth and activity variations in the plume associated with drywell 22-03-05, a “layer cake” model was used to develop the inventory estimate. The “layer cake” model for drywell 22-03-05 assumes a 25-ft diameter circle and presents the following.

   - From 27 to 32 ft bgs, $^{137}Cs$ activity = $2 \times 10^4$ pCi/g. This leads to an estimate of 2.5 Ci of $^{137}Cs$.
   - From 32 to 34 ft bgs, $^{137}Cs$ activity = $1 \times 10^6$ pCi/g. This leads to an estimate of 50 Ci of $^{137}Cs$.
   - From 34 to 35 ft bgs, $^{137}Cs$ activity = $4 \times 10^7$ pCi/g. This leads to an estimate of 1,000 Ci of $^{137}Cs$.
   - From 35 to 37 ft bgs, $^{137}Cs$ activity = $1 \times 10^6$ pCi/g. This leads to an estimate of 50 Ci of $^{137}Cs$.
   - From 37 to 45 ft bgs, $^{137}Cs$ activity = $1 \times 10^4$ pCi/g. This leads to an estimate of 2 Ci of $^{137}Cs$.
   - The “layer cake” model estimate for the plume around drywell 22-03-05 leads to an estimate of ~1,100 Ci of $^{137}Cs$.

5. Finally, excluding the drywells shown above, there is the generally contaminated region from 0 to 10 ft bgs all across BY-Farm at $<1 \times 10^2$ pCi/g. Assume the tank farm area is 300 by 400 ft. The total volume is $1.2 \times 10^6$ ft$^3$. This leads to $6.12 \times 10^{10}$ g of soil. At a uniform activity of 100 pCi/g, this leads to an estimate of 6.1 Ci of $^{137}Cs$.

This analysis leads to a total estimate of ~1,160 Ci of $^{137}Cs$ in the entire BY-Farm vadose zone, of which 1,110 Ci is near tank 241-TY-103. For comparison, a BY-Farm vadose zone $^{137}Cs$ inventory estimate of ~30 Ci is provided in GJO-96-2-TARA/GJO-HAN-6. Thus, the current $^{137}Cs$ inventory estimate is considerably more conservative than that provided in GJO-96-2-TARA/GJO-HAN-6.

The SIM distributed the leaks between the tanks based on previous leak volume estimates (HNF-EP-0182) and estimated a leak volume for tank BY-103 assuming a BY saltcake waste type (BT2) of 400 gal. A volume of 400 gal was also estimated for tank BY-108 and 1,200 gal for tank 241-BY-107 (BY-107).

Another approach to distribute the estimates would be to assume all of the contamination in drywell 22-03-05 originated from tank BY-103. Because activity levels in this drywell are significantly higher than other drywells in BY-Farm this would indicate that most of the 1,160 Ci was attributed to tank BY-103 for a leak volume of ~2,000 gal.

Other than the occurrence reports referenced, no other documentation assessing the tank BY-103 leak was available.

### B.1.3 Conclusion

Based on the available data it was determined that tank BY-103 leaked somewhere between 27 ft and the base of the tank. The assessment team agreed with previous assessments of the tank that classified tank BY-103 as a leaker in May 1973 based on increasing gamma activity first observed in drywell 22-03-09 in 1973. No unaccounted-for liquid level decreases were observed during this time. Therefore, the team concurred that the previous estimate of <5,000 gal, apparently based on uncertainty in manual tape service level measurements, is a reasonable upper volume for the leak. Drywell activity estimates indicate that the leak may have been smaller, but are inconclusive. Hanford Soil Inventory Model inventory estimates for the leak are reasonably consistent with sample data and should be used for leak composition estimates.

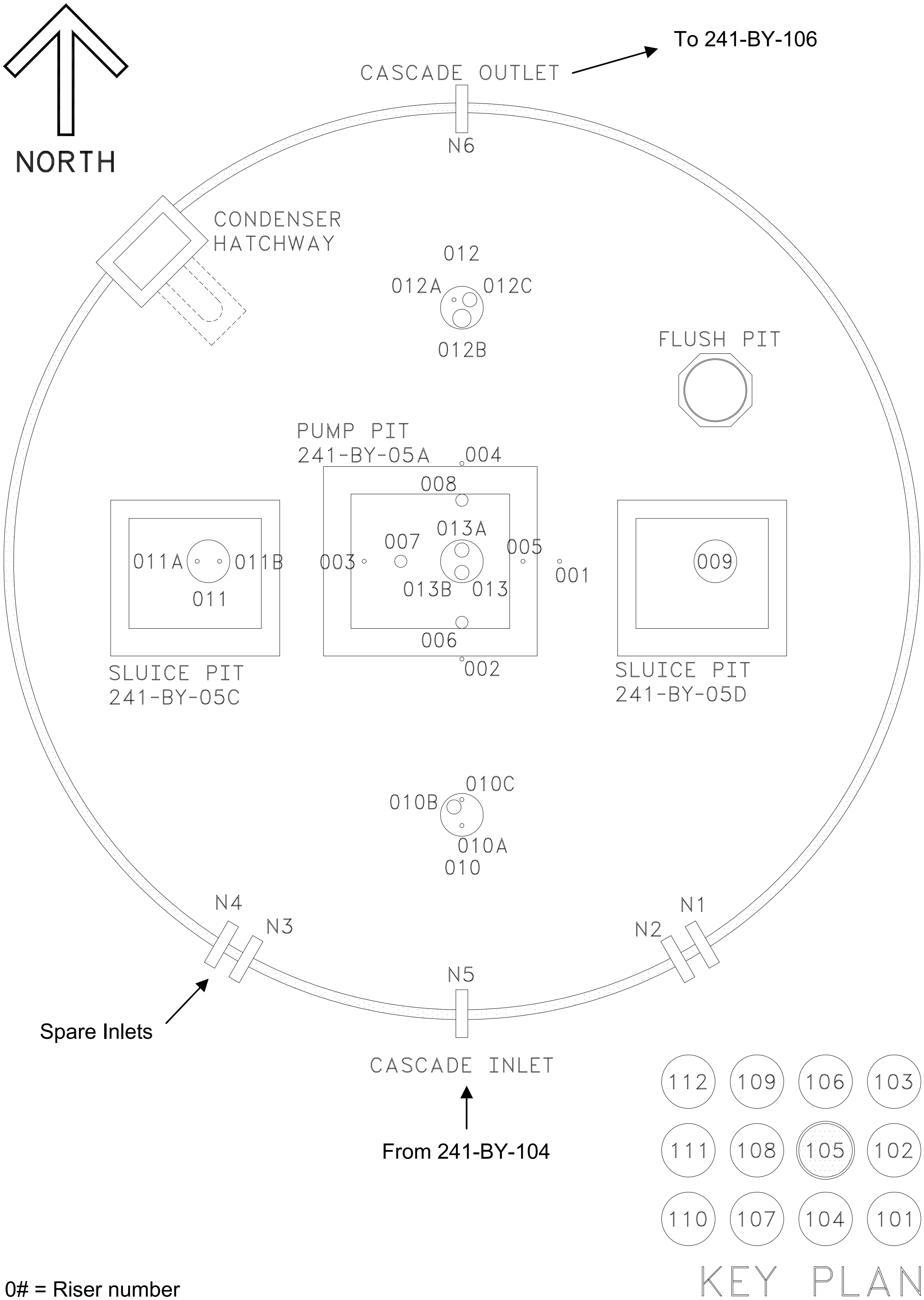
## B.2 TANK 241-BY-105 WASTE LOSS EVENT

This section provides information on the historical waste loss event associated with tank 241-BY-105 (BY-105). This tank is part of a six-tank cascade that includes tanks 241-BX-104 (BX-104), 241-BX-105 (BX-105), 241-BX-106 (BX-106), 241-BY-104 (BY-104), BY-105, and 241-BY-106 (BY-106). Tank BX-106 cascades across tank farms to tank BY-104. However, anecdotal evidence indicates that the cascade from the BX-Farm to the BY-Farm did not function well. As a result, the BX-Farm and BY-Farm cascades often operated separately. In the BY-Farm a 7.5-cm (3-in.) cascade overflow line connects tank BY-105 as second in a three-tank cascade series that includes tanks BY-104 and BY-106. The cascade overflow height is approximately 6.9 m (22.7 ft) from the tank bottom and 0.6 m (2 ft) below the top of the steel liner. Figure B.2-1 shows a plan view of tank BY-105. The following subsections summarize the waste operating history for tank BY-105 shown in Figures B.2-2 and B.2-3.

### B.2.1 Tank 241-BY-105 Waste History

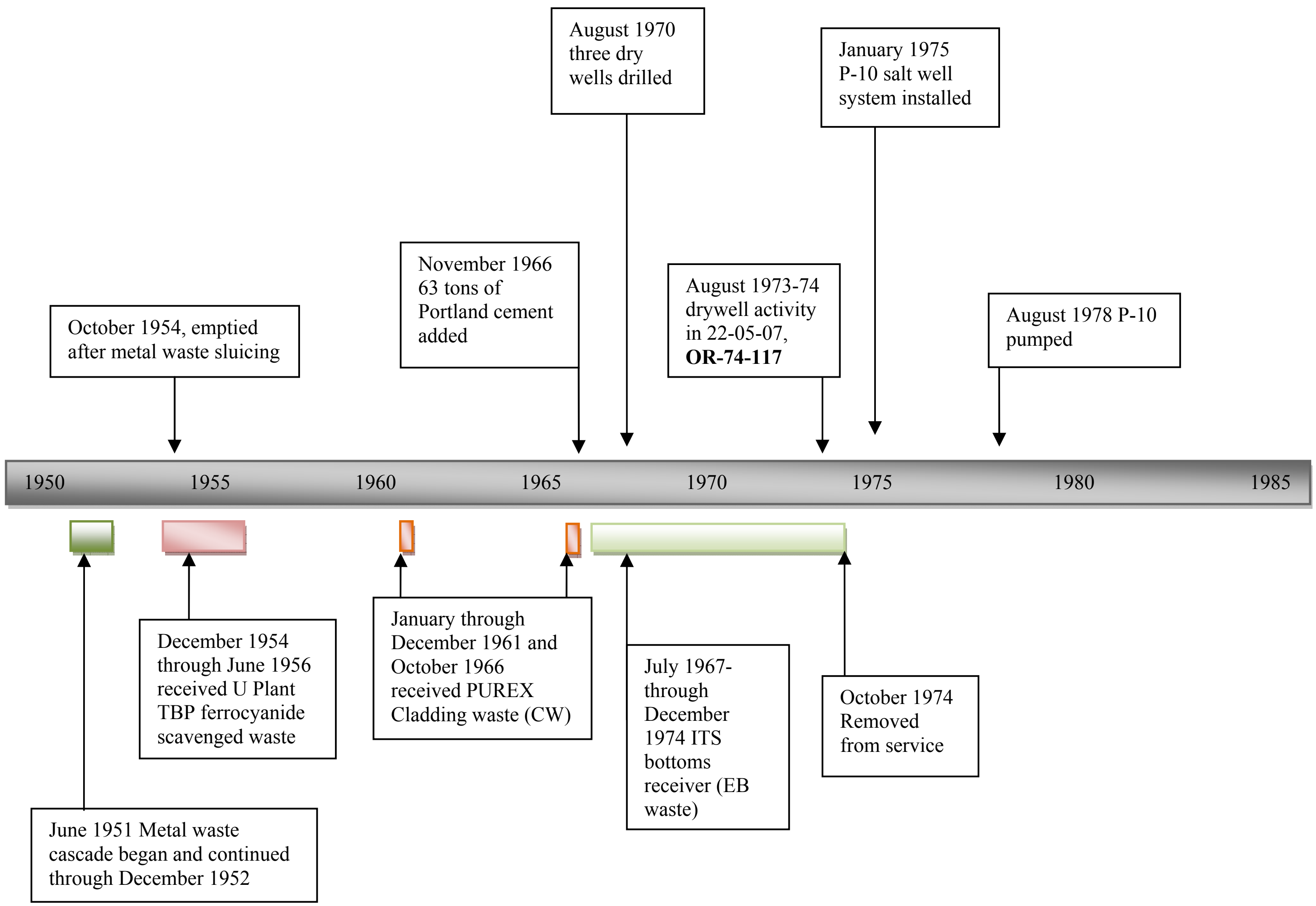
Tank BY-105 was constructed during 1948 and 1949 and was placed into operation in June 1951, when the tank received metal wastes from tank BY-104 cascade overflow (SD-WM-TI-356). Waste was transferred into the tank via the cascade lines through the first quarter of 1954. As reported in SD-WM-TI-302, *Hanford Waste Tank Sluicing History*, tank BY-105 was declared empty in 1954 after sluicing of the metal waste; a small heel of metal waste was assumed to remain. From 1954 to 1956, tank BY-105 was a sludge collection tank and received in-plant ferrocyanide waste from tanks BY-106, BY-107, BY-108 and 241-BY-110 (BY-110). However in 1956, the ferrocyanide scavenged waste had settled and the supernate was transferred to the BY caverns and #16 BC trench. Flush water from miscellaneous sources was added to tank BY-105 during 1957. Plutonium Uranium Extraction Plant cladding waste was received by tank BY-105 in 1961. Additional cladding waste originating from tanks 241-C-107, 241-C-108, and 241-BY-101 (BY-101) was received in 1966. In November 1966, 63 tons of Portland cement were added to the tank to test its properties as an immobilization agent for liquid waste (SD-WM-TI-356, Internal memo 71330-95-004, “Portland Cement in Tank 241-BY-105”). The test was conducted in support of the ITS process to assess different immobilizing agents; there was no suggestion or indication in the references reviewed

**Figure B.2-1. Tank 241-BY-105 Plan View**



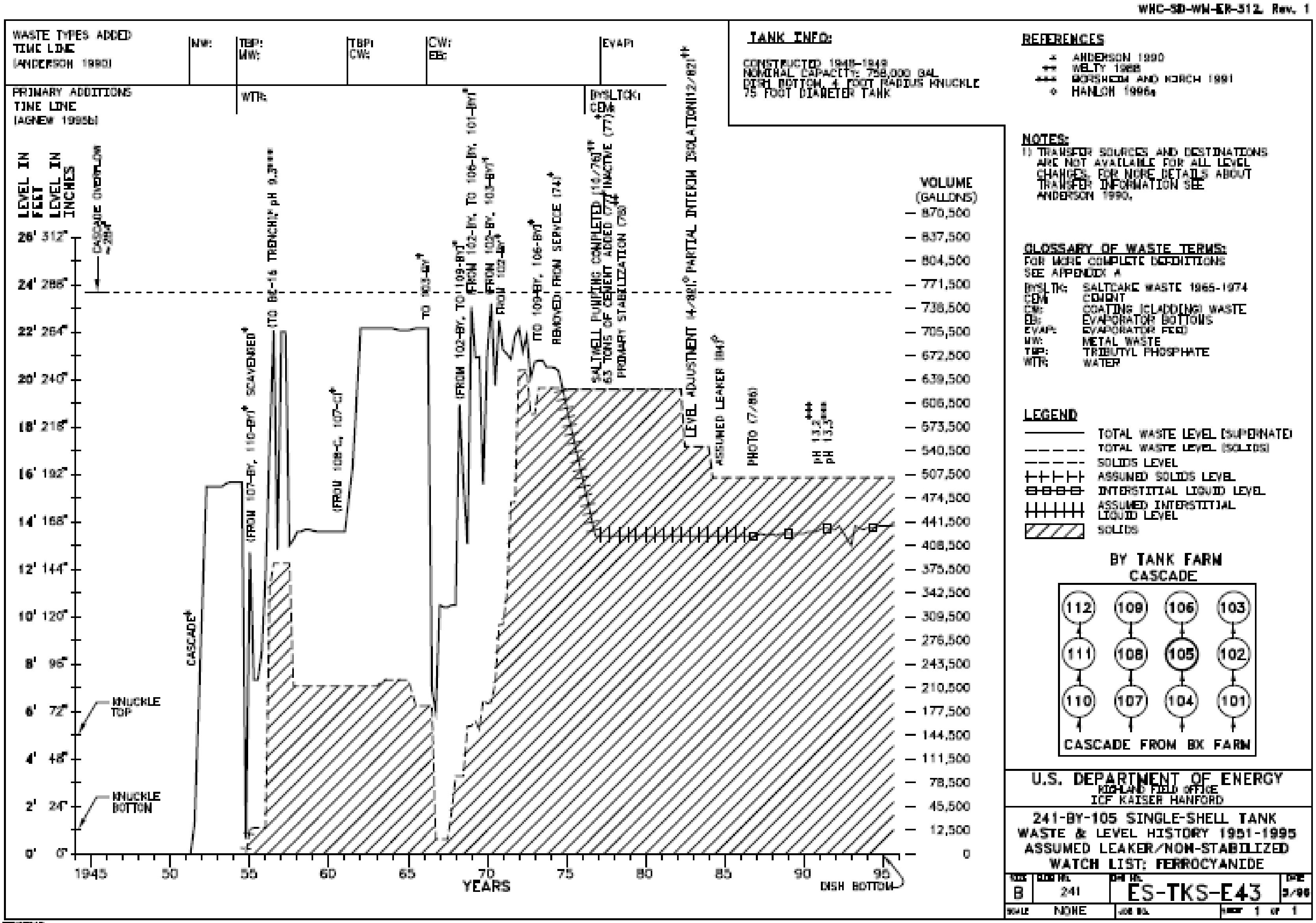

0# = Riser number

**Figure B.2-2. Tank 241-BY-105 Waste Operating History**




CWP = PUREX cladding waste, aluminum clad fuel
PUREX = Plutonium Uranium Extraction (Plant)
EB = Evaporator Bottoms waste
TBP = tributyl phosphate (waste)
ITS = In-Tank Solidification

**Figure B.2-3. Tank 241-BY-105 Waste Fill History**



that tank BY-105 was leaking at that time or that the cement was added to stop a release. In 1967, tank BY-105 was designated as an ITS bottoms receiver. From 1968 until 1974, tank BY-105 received ITS waste, ITS evaporator bottoms waste, and evaporator bottoms waste from tanks 241-BY-102 (BY-102), 241-BY-109 (BY-109), or 241-BY-112 (BY-112). During 1971 and 1974, flush water from miscellaneous sources was again added to tank BY-105. LA-UR-97-311, *Waste Status and Transaction Record Summary (WSTRS Rev. 4)* recorded the addition of BY saltcake waste to tank BY-105 in 1976. This addition is not noted in the waste status summaries or other documents. WHC-MR-0132 reported that the additional 63 tons of Portland cement were added in 1977. This is probably incorrect because the same document also reported the 1966 transfer of cement to the tank. Two cement additions are not consistent with analytical results, and no reference could be found to support the 1977 addition (WHC-SD-WM-ER-598, *Tank Characterization Report for Single-Shell Tank 241-BY-105*). Table B.2-1 shows waste transfers for tank BY-105 from 1950 to 1975.

**B.2.1.1 Integrity of Tank 241-BY-105.** Tank BY-105 was categorized as an assumed leaker in 1984 as a result of increasing activity (from <100 cps to 244 cps) measured in drywell 22-05-09 in August 1974 (OR-74-117, *Symptoms of Leakage at Waste Tank 105-BY as Indicated by Increasing Dry Well Radiation Levels*). Although a “slow erratic” liquid level decrease of 1.25 in. was observed between June 15, 1973 and September 17, 1973 and an additional 2 in. “unexplained drop” between September 17 and September 18, the final occurrence report (dated August 22, 1974) states that the apparent cause of the activity increase is “*... leaching of contamination from an old tank leak, line leak or pump pit leak. Contamination is known to exist in this area from 108-BY, confirmed as a leaking tank in 1971. The motivating force would be the migration of water caused by a leaking water line, French drains or tile field drain.*” A leak from tank BY-103 and interstitial liquid leaking from tank BY-105 were other potential sources identified. No leak volume has been estimated for tank BY-105 (HNF-EP-0182).

Occurrence Report OR-75-15, *Spill Of Contamination To The Ground* was issued as a result of a February 13, 1975 leak from a pipe joint in an overground line used for saltwell pumping. The leak contaminated an area 5 ft by 7 ft with contamination of up to 5 rad/hr.

Several occurrence reports were also issued for potential intrusions to the tanks but other explanations were determined for observed increases in liquid levels.

- A 1-in. surface level increase in tank BY-105 resulted in an occurrence report in April 1976 (OR-76-49, *Surface Level Increase Exceeding Criteria for Tank 105-BY*). A further increase of 32 in. was recorded two days later, following a change from a rod plummet to a doughnut plummet measuring device. Apparently the rod plummet had extended through a “hole” in the surface crust, which caused false readings of the actual surface level. The corrective action was to replace the rod plummet with the doughnut plummet to provide a larger contact surface and reduce the action causing the penetration. The surface-level baseline was adjusted upward ~32 in.

**Table B.2-1. Tank 241-BY-105 Transfers 1951 through 1975 (5 sheets)**

| Date | Transfer Type | Transfer Volume (gal*1000) | Total Volume in Tank (gal*1000) | Discrepancy with Previous Reading (gal*1000) | Waste Type | Transfer to/from | Document Number (full titles in Section B.6 REFERENCES) | Comment |
|---|---|---|---|---|---|---|---|---|
| January-April 1951 | | 0 | 0 | 0 | | | WHC-MR-0132 | |
| June 1951 | IN | 20 | 20 | | MW | BY-104 | WHC-MR-0132 | cascade began filling in June |
| July 1951-March 1952 | IN | 471 | 491 | | MW | BY-104 | | cascade |
| April-December 1952 | STAT | | 491 | | MW | | HW-27838 | |
| January-March 1953 | STAT | | 491 | | MW | | HW-27841 | |
| April-August 1953 | STAT | | 491 | | MW | | HW-28043 | |
| September-December 1953 | STAT | | 495 | 4 | MW | | HW-29624 | |
| January-July 1954 | STAT | | 497 | 2 | MW | | HW-30851 | |
| August 1954 | OUT | -496 | 1 | | MW | 222-U | HW-33002 | to be used for TBP scvg waste |
| September 1954 | STAT | | 1 | | MW | | HW-33396 | |
| October 1954 | STAT | 1 | 0 | -1 | MW | | HW-33544 | |
| November 1954 | STAT | | 0 | | MW | | HW-33904 | |
| December 1954 | IN | 399 | 399 | | TBP | BY-107, 110 | HW-34412 | |
| January 1955 | STAT | | 399 | | TBP | | HW-35022 | |
| February 1955 | IN | 149 | | | TBP | BY-110 | HW-35628 | |
| | OUT | -326 | 222 | | TBP | BY-102 | HW-35628 | |
| March-August 1955 | STAT | | 222 | | TBP | | HW-36001, HW-38926 | |
| September 1955 | IN | 38 | 260 | 38 | TBP | Water | HW-39850, HW-40208 | Source given in LA-UR-97-311 |
| October-November 1955 | STAT | | 260 | | TBP | | HW-39216 | |

**Table B.2-1. Tank 241-BY-105 Transfers 1951 through 1975 (5 sheets)**

| Date | Transfer Type | Transfer Volume (gal*1000) | Total Volume in Tank (gal*1000) | Discrepancy with Previous Reading (gal*1000) | Waste Type | Transfer to/from | Document Number (full titles in Section B.6 REFERENCES) | Comment |
|---|---|---|---|---|---|---|---|---|
| December 1955 | IN | 190 | | | TBP | BY-107, 108 | HW-40816, LA-UR-97-311 | |
| | OUT | -79 | 371 | | TBP | Cribbed to BY caverns | HW-40816, WHC-MR-0132 | volume estimated from mass balance |
| January-February 1956 | STAT | | 371 | | TBP | | HW-41038 | |
| March 1956 | IN | 180 | 551 | | TBP | BY-106, 107, 110 | HW-42394, LA-UR-97-311 | |
| April 1956 | STAT | | 551 | | TBP | | HW-42993 | |
| May 1956 | IN | 28 | 582 | 3 | TBP | BY-106 | HW-43490, LA-UR-97-311 | |
| June 1956 | IN | 126 | 708 | | TBP | BY-107, 108, 110 | HW-43895, LA-UR-97-311 | |
| July-September 1956 | STAT | | 708 | | TBP | | HW-44860, HW-45738 | HW-44860 STAT value of 108 in July appears to be a typo. |
| October-December 1956 | STAT | | 706 | -2 | TBP | | HW-46382 | |
| January-May 1957 | STAT | | 706 | | TBP | | HW-48144 | |
| June 1957 | OUT | -297 | 409 | | TBP | #16-BC trench | HW-51348 | |
| July 1957 | IN | 8 | 417 | | TBP | line flush | HW-51858 | |
| August-November 1957 | STAT | | 417 | | TBP | | HW-52414 | |
| December 1957 | STAT | | 428 | 11 | TBP | | HW-54519 | New electrode reading |
| January-May 1958 | STAT | | 428 | | TBP | | | |

## Table B.2-1. Tank 241-BY-105 Transfers 1951 through 1975 (5 sheets)

| Date | Transfer Type | Transfer Volume (gal*1000) | Total Volume in Tank (gal*1000) | Discrepancy with Previous Reading (gal*1000) | Waste Type | Transfer to/from | Document Number (full titles in Section B.6 REFERENCES) | Comment |
|---|---|---|---|---|---|---|---|---|
| June 1958 | STAT | | 431 | 3 | TBP | | HW-56761 | latest electrode reading |
| July-November 1958 | STAT | | 431 | | TBP | | HW-57122 | |
| December 1958 | STAT | | 429 | -2 | TBP | | HW-58831 | latest electrode reading |
| January-December 1959 | STAT | | 429 | | TBP | | HW-59204 | |
| January-December 1960 | STAT | | 428 | -1 | TBP | | HW-63896 | |
| January-June 1961 | IN | 91 | 519 | | TBP/CW | 108-C | HW-71610 | |
| July-December 1961 | IN | 192 | 711 | | TBP/CW | 107-C | HW-72625 | |
| January 1962-December 1963 | STAT | | 711 | | TBP/CW | | HW-74647, HW-83906-E-RD, HW-76223, HW-78279, HW-80379 | |
| January-June 1964 | STAT | | 708 | -3 | TBP/CW | | HW-83308 | |
| July-December 1964 | STAT | | 708 | | TBP/CW | | RL-SEP-260 | |
| January-December 1965 | STAT | | 711 | 3 | TBP/CW | | RL-SEP-659 | |
| January-March 1966 | STAT | | 711 | | | | ISO-226 | |
| April-June 1966 | OUT | -503 | 208 | | TBP/CW | 103-BY | ISO-404 | |
| July-September 1966 | OUT | -30 | 178 | | TBP/CW | 103-BY | ISO-538 | |
| October-December 1966 | IN | 119 | 326 | 29* | CW | 101-BY | ISO-674, ISO-610 DEL, WHC-SD-WM-ER-598 Rev 0 | *addition of 63T of Portland cement |
| January-June 1967 | STAT | | 323 | | CW | | ISO-806 | "status not determined" |

Table B.2-1. Tank 241-BY-105 Transfers 1951 through 1975 (5 sheets)

| Date | Transfer Type | Transfer Volume (gal*1000) | Total Volume in Tank (gal*1000) | Discrepancy with Previous Reading (gal*1000) | Waste Type | Transfer to/from | Document Number (full titles in Section B.6 REFERENCES) | Comment |
|---|---|---|---|---|---|---|---|---|
| July-December 1967 | STAT | | 326 | 3 | | | ARH-326 | ITS bottom receiver |
| January-March 1968 | IN | 279 | 605 | | EB | 102-BY | ARH-534 | ITS bottom receiver |
| April-June 1968 | OUT | -110 | 495 | | EB | 109-BY | ARH-721 | ITS bottom receiver |
| July-September 1968 | IN | 256 | | | EB | 102-BY | ARH-871 | ITS bottom receiver |
| | OUT | -340 | 411 | | EB | 109-BY | | ITS bottom receiver |
| October-December 1968 | IN | 330 | 741 | | EB | 102-BY | ARH-1061 | ITS bottom receiver |
| January-March 1969 | IN | 408 | | | EB | 102-BY | ARH-1200 A | ITS bottom receiver |
| | OUT | -481 | 670 | 2 | EB | 106-BY | | ITS bottom receiver |
| April-June 1969 | STAT | | 671 | | EB | | ARH-1200 B | ITS bottom receiver |
| July-September 1969 | IN | 154 | | | EB | 102-BY | ARH-1200 C | ITS bottom receiver |
| | OUT | -331 | 494 | | EB | 101-BY | | ITS bottom receiver |
| October-December 1969 | IN | 182 | 676 | | EB | 102-BY | ARH-1200 D/ WHC-MR-0132 | ITS bottom receiver |
| January-March 1970 | IN | 70 | 745 | -1 | EB | 102-BY | ARH-1666 A | ITS bottom receiver |
| April-June 1970 | IN | 89 | | | EB | 102-BY | ARH-1666 B | ITS bottom receiver |
| | OUT | -202 | 631 | -1 | EB | 103-BY | | ITS bottom receiver |
| July-September 1970 | IN/OUT | 66 | 722 | -25 | EB | 102-BY ITS | ARH-1666 C | Jul: Dry wells drilled, 22-05-01, 22-05-05, 22-05-09 Aug: ITS bottom service |
| October-December 1970 | IN/OUT | * | 681 | | EB | 102, 103-BY ITS | ARH-1666 D | ITS bottom service |
| January-March 1971 | IN/OUT | | 675 | | EB | 102-BY ITS | ARH-2074 A | ITS bottom service |
| April-June 1971 | IN/OUT | 4 | 668 | | EB | 102-BY ITS | ARH-2074 B | ITS bottom service |

**Table B.2-1. Tank 241-BY-105 Transfers 1951 through 1975 (5 sheets)**

| Date | Transfer Type | Transfer Volume (gal*1000) | Total Volume in Tank (gal*1000) | Discrepancy with Previous Reading (gal*1000) | Waste Type | Transfer to/from | Document Number (full titles in Section B.6 REFERENCES) | Comment |
|---|---|---|---|---|---|---|---|---|
| July-September 1971 | IN/OUT | * | 700 | | EB | 112-BY ITS | ARH-2074 C | ITS bottom service |
| October-December 1971 | IN/OUT | * | 711 | | EB | | ARH-2074 D* | ITS bottom service |
| January-March 1972 | IN/OUT | * | 678 | | EB | | ARH-2456 A | ITS bottom service |
| April-June 1972 | IN/OUT | * | 701 | | EB | | ARH-2456 B | ITS bottom service |
| July-September 1972 | IN/OUT | * | 642 | | EB | | ARH-2456 C | ITS bottom service |
| October-December 1972 | IN/OUT | * | 664 | | EB | | ARH-2456 D | ITS bottom service |
| January-June 1973 | IN/OUT | * | 666 | | EB | | ARH-2794 A | ITS bottom service |
| July-December 1973 | IN/OUT | * | 657 | | EB | | ARH-2794 C | ITS bottom service |
| January-March 1974 | IN/OUT | * | 656 | | EB | | ARH-CD-133A | ITS bottom service |
| April-June 1974 | IN/OUT | * | 652 | | EB | | ARH-CD-133B | ITS bottom service |
| July-September 1974 | IN/OUT | * | 628 | | EB | | WHC-MR-0132 | ITS bottom service |
| October-December 1974 | IN/OUT | * | 626 | | EB | 109-BY | ARH-CD-133D | removed from service |
| January-March 1975 | OUT | -4 | 626 | 4 | EB | 109-BY | ARH-CD-336 A | |
| April-June 1975 | OUT | -27 | 626 | | EB | 109-BY | ARH-CD-336 B | |
| July-September 1975 | OUT | -11 | 626 | | EB | 109-BY | ARH-CD-336 C | |
| October-December 1975 | OUT | -6 | 626 | | EB | 109-BY | ARH-CD-336 D | |

IN defines a transfer into the tank, OUT defines a transfer out of the tank, STAT refers to a volume reading where no transfer occurred.
"Total Volume In Tank" refers to measured STAT values following the transfers shown.
Except as noted, discrepancies are attributed to effects such as evaporation, questionable surface level measurements and/or undocumented water additions.

* Numerous transfers in and out of tank, volumes not shown except as specified in the waste status summary.

ITS = In-Tank Solidification

Waste types:
CW = cladding (coating) waste EB = Evaporator Bottoms MW = metal waste TBP = tributyl phosphate

- Environmental Protection Deviation Report (EPDR)-87-09, *Intrusions into 241-BY-105, 241-BY-107, and 241-BY-109* was issued in May 1987 as a result of photographs that indicated possible intrusions of water into three BY-Farm tanks, one of which was tank BY-105. The report was closed in September 1988. No source of intrusion to the tank could be identified (SD-WM-TI-356).

- Finally, Internal memo 23550-88-036, "Environmental Protection Deviation Report 88-02, Interstitial Liquid Level Increase In Tank 241-BY-105" was issued in May 1988 as a result of an apparent interstitial liquid level increase that was measured with a gamma probe. The change in gamma profile was attributed to the affects of condensation within the liquid observation well.

**B.2.1.2 Interim Stabilization.** In January 1975 a P-10 saltwell system was installed in tank BY-105. The pump was removed in October 1976. Jet pumping was performed from July 12, 2001 to September 11, 2002 after the jet pump rate decreased to less than 0.05 gpm. An in-tank video taken on January 5, 2003 showed a "*rough yellowish brown saltcake waste with an irregular surface of visible lumps and shelves that were created as the surface was dried out by saltwell pumping. ... The waste surface appears to be dry and shows no standing water within the tank.*" "*A large hole (~12.5 ft in diameter) around the saltwell screen shows no evidence of supernatant liquid.*" The liquid level in dip tubes reached equilibrium and interim stabilization was declared complete on March 7, 2003 with an estimated 47,000 gal of drainable interstitial liquid remaining in the tank (HNF-SD-RE-TI-178).

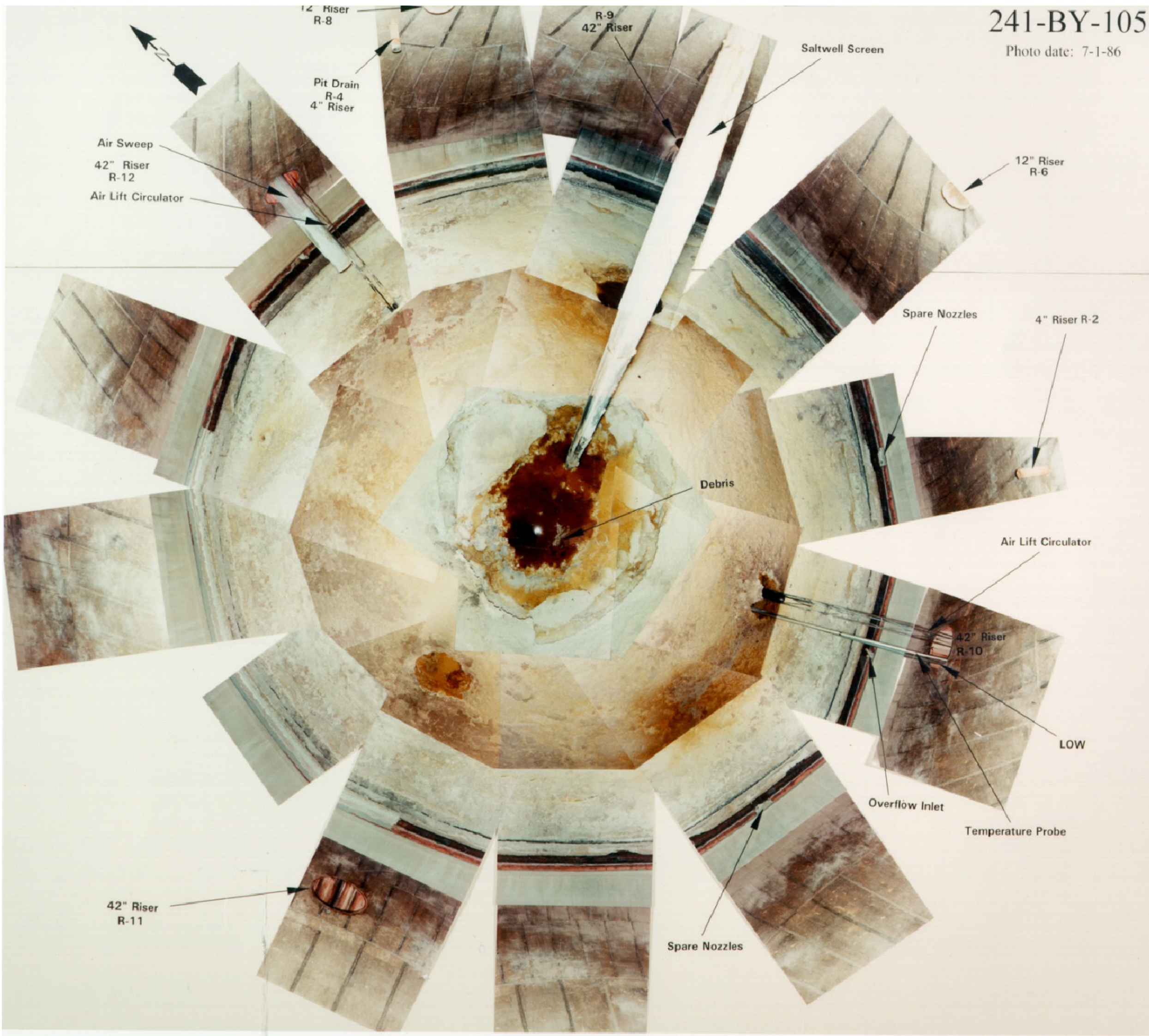
A photo mosaic (Figure B.2-4) of the waste surface in tank BY-105 as of July 1, 1986 also shows a dry surface with no visible liquid. As of January 2009 the tank is estimated to contain 40,000 gal of PFeCN sludge, 8,000 gal of Portland Cement and 433,000 gal of saltcake with an estimated 47,000 gal of drainable interstitial liquid and no supernate (HNF-EP-0182).

**B.2.1.3 Tank 241-BY-105 Temperature History.** Figure B.2-5 shows a thermal history for thermocouple 1 in Riser 1 of tank BY-105 from 1974 through 2000. The tank temperature for other thermocouples in Risers 1 and 10C varied between 50 and 110 °F during this time. These measurements are shown in SACS. No temperature information was found before 1974. A maximum temperature of close to 160 °F is shown in 1974. The temperature gradually decreased to ~90 °F in 2009.

### B.2.2 Data Review and Observations

**B.2.2.1 Surface Level Data.** No surface level data was available before March 1973. Table B.2-2 shows manual tape surface level measurements from June 1973 to March 1987 (SD-WM-TI-356). Although the table indicates a 4-in. liquid level decrease between June 15, 1973 and March 5, 1974 no occurrence reports related to liquid level decreases were issued during this period. The only occurrence reports issued were for increased drywell activity (OR-74-117) and potential intrusions. OR-74-117 states that "*there is insufficient data to identify the source of the radiation increase in dry well 22-05-09*" and "*it is believed to be associated with movement of the old contamination originating from 108-BY.*"

**Figure B.2-4. Tank 241-BY-105 Waste Surface Photo Mosaic**




The 1966 cement additions may have contributed to "erratic" surface level measurements, as well as the shelves shown in Figure B.2-6 and observed in the video taken when the tank was interim stabilized. The SACS includes the following comments regarding tank BY-105 manual tape surface level measurements:

> 2/29/1998 This tank had a very thin, brittle crust. The M.T. broke through the crust around January, 1994 and began reading the true liquid level. A barometric pres. correlation done & recent drops are due to height.

Figure B.2-5.  Tank 241-BY-105 Temperature Measurements

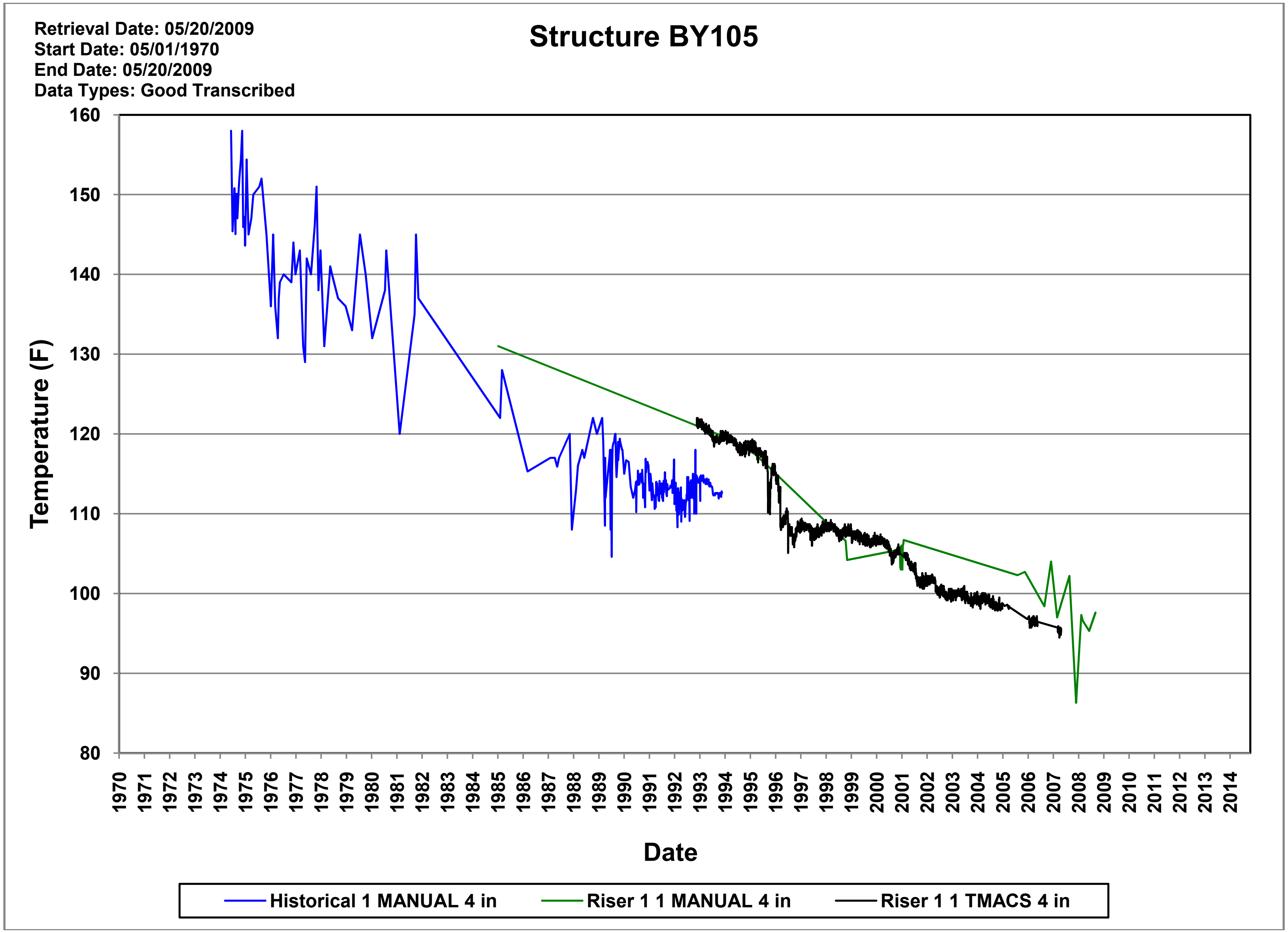
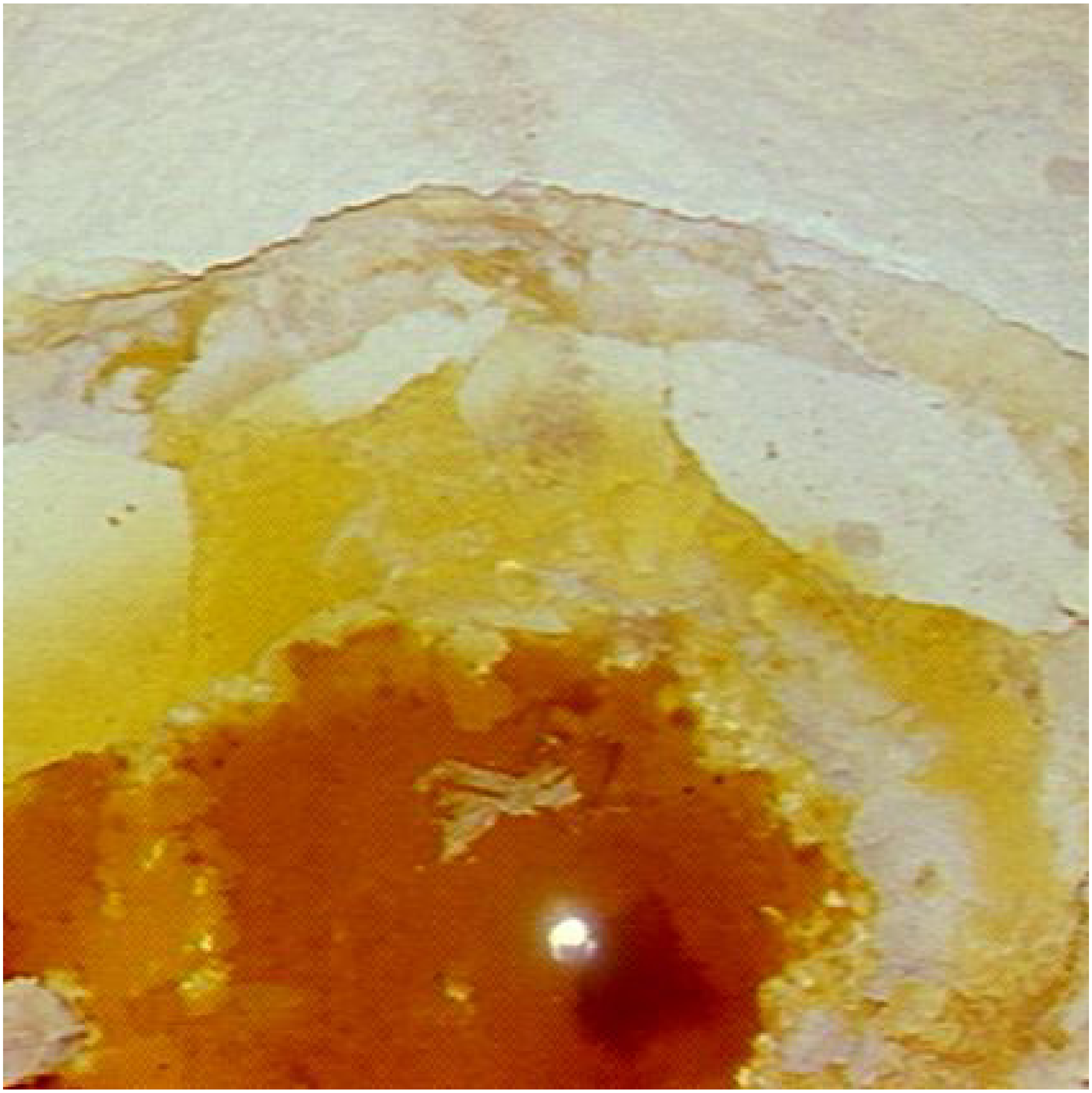


**Table B.2-2. Tank 241-BY-105 Liquid Level Measurements 1973 through 1983**

| Date | Liquid Level (in.) | Comments |
|---|---|---|
| 6/15/73 | 250.0 | Manual Tape |
| 9/17/73 | 248.75 | Slow erratic decrease |
| 9/18/73 | 246.75 | Unexplained drop |
| 3/5/74 | 246.0 | Slow decrease |
| 6/10/74 | 246.0 | Stable |
| 6/11/74 | 244.5 | New tape |
| 8/15/74 | 244.5 | Stable |
| 12/7/74 | 217.0 | Salt-well transfers |
| 12/28/74 | 216.5 | Erratic decrease |
| 2/4/75 | 213.25 | Steady decrease |
| 3/8/75 | 192.0 | Salt-well transfer followed by erratic readings |
| 7/31/75 | 184.0 | Salt-well transfers |
| 1/11/76 | 179.0 | Salt-well transfers |
| 4/11/76 | 176.0 | Slow decrease |
| 4/13/76 | 178.25 | Unexplained rise |
| 4/14/76 | 210.5 | New tape |
| 4/23/76 | 210.25 | Salt-well transfers |
| 8/18/76 | 206.0 | Slow decrease |
| 11/4/76 | 203.75 | Salt-well transfers |
| 5/14/78 | 198.25 | Slow decrease |
| 5/19/78 | 198.25 | Erratic redings |
| 3/14/79 | 196.25 | Slow decrease |
| 3/31/80 | 195.0 | Slow decrease |
| 7/8/80 | 194.25 | Slow decrease |
| 3/31/81 | 193.5 | Slow decrease |
| 3/18/82 | 192.25 | Baseline adjustment |
| 3/24/82 | 192.25 | Stable |
| 3/16/83 | 190.75 | Slow erratic decrease |
| 7/17/83 | 190.25 | Manual tape contacting solids in depression as shown by 11/8/82 photos |

Reference: SD-WM-TI-356, *Waste Storage Tank Status and Leak Detection Criteria*.

**Figure B.2-6. Tank 241-BY-105 In-Tank Waste Surface Photo (July 1, 1986)**



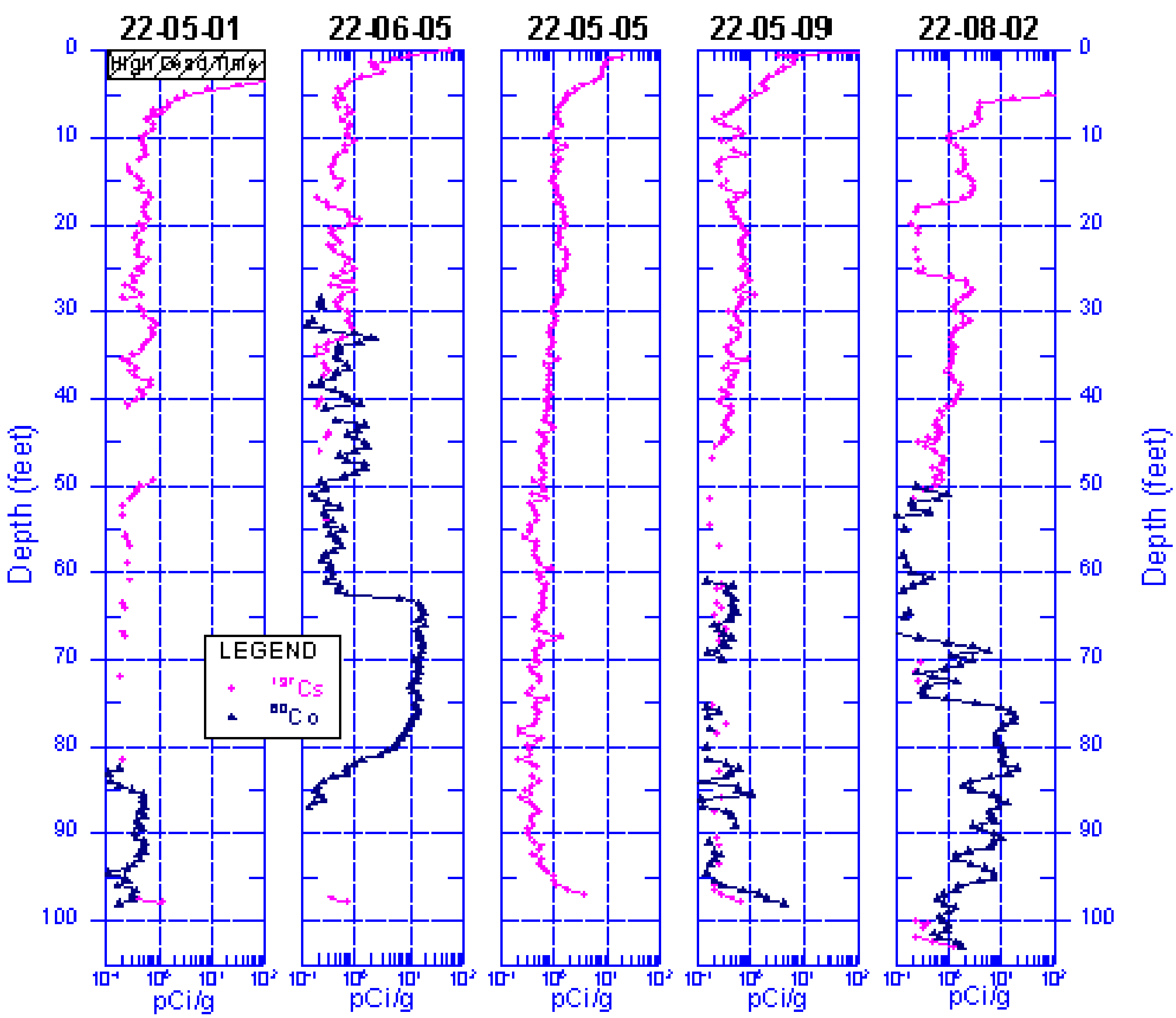
Note: Figure shows saltcake surface crust and multiple levels of shelves near the tank center.

11/25/2002 BY-105 level dropped over 19 inches during the last week. PER 2002-6226. Confirm level change is due to movement of saltcake and is not a leak from the tank. LOW *[liquid observation well]* scan on 11/26/02 show no significant change. Solid waste surface most likely collapse.

11/25/2002 Assumed the surface collapsed after saltwell pumping the tank. They tried to set it back up on the top ledge, but it kept going to the lower value. Upper ledge may be gone.

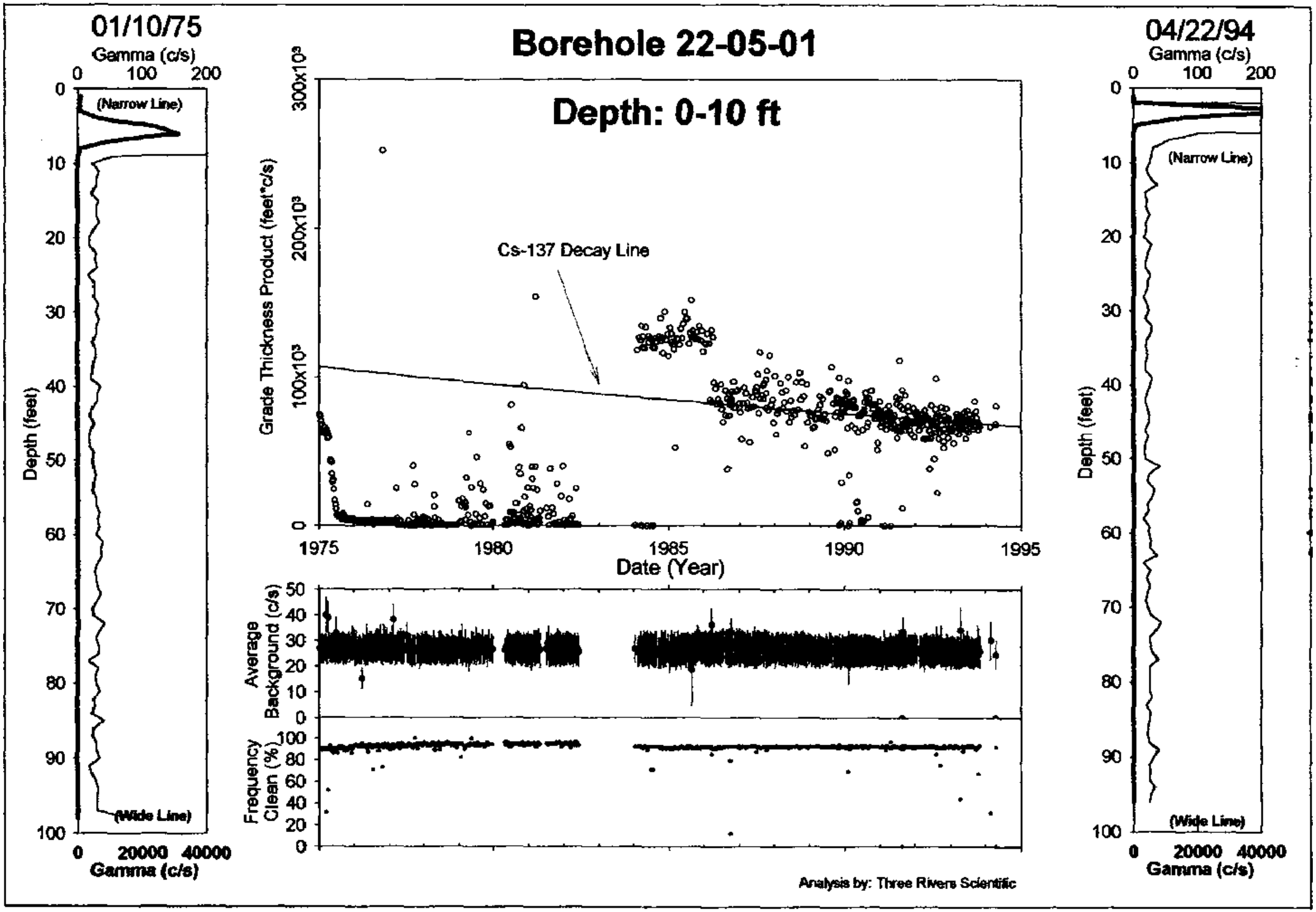
**B.2.2.2 Drywell Logging Data. Three drywells (22-05-01, 22-05-05 and 22-05-09) are located around tank BY-105 (see Figure 4-1 of the main text). In addition, drywells 22-06-05 and 22-08-06 are located near tank BY-105. Figure B.2-7 shows spectral gamma logging results collected after 1995 for these drywells (GJ-HAN-22, *Vadose Zone Characterization Project at the Hanford Tank Farms Tank Summary Data Report for Tank BY-105*). Figures B.2-8 and B.2-9 show total gamma results and decay curves from 1975 to 1995 (HNF-3532, *Analysis of Historical Gross Gamma Logging Data from BY Tank Farm*). It was concluded that the drywell data obtained does not indicate that tank BY-105 leaked (GJ-HAN-22).**

**Figure B.2-7. Tank 241-BY-105 Dry Well Spectral Gamma Data Collected after 1995**



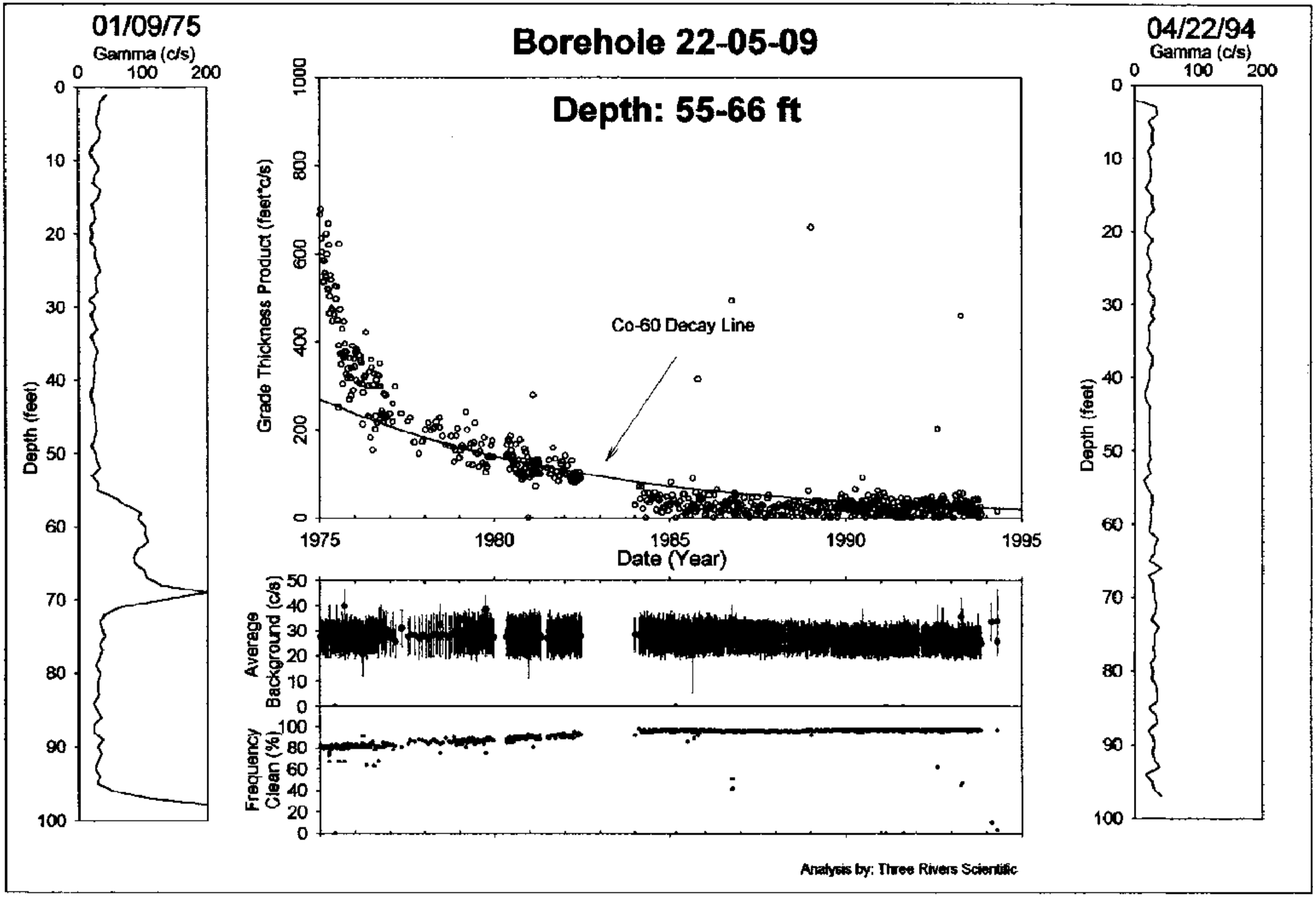

Reference: GJ-HAN-22, *Vadose Zone Characterization Project at the Hanford Tank Farms Tank Summary Data Report for Tank BY-105*.

**Figure B.2-8. Drywell 22-05-01 Total Gamma Results 1975 to 1995**




Reference: HNF-3532, *Analysis of Historical Gross Gamma Logging Data from BY Tank Farm*.

**Figure B.2-9. Drywell 22-05-09 Total Gamma Results**



**Drywell 22-05-01**
Drywell 22-05-01 is located ~6 ft from the northeast side of tank BY-105. The TD achieved through logging operations was 98 ft. Total gamma log data collected from this drywell from 1972 to 1993 (Figure B.2-8) showed elevated gamma activity at ~200 cps between 0 and 10 ft from 1975 through 1994. Activity near the reported limit (50 cps) was also observed in 1984 at ~85 ft in depth. Between 1984 and 1987, the reported count rate remained at about the same level (50 to 55 cps). By March 1987, the count rate measured less than 50 cps and was no longer tracked (SD-WM-TI-356). Near-surface $^{137}$Cs and deep $^{60}$Co were identified in this drywell in spectral gamma logs collected after 1995 (Figure B.2-7). The presence of $^{137}$Cs was measured almost continuously from the ground surface to ~41 ft, and intermittently below 1 pCi/g from ~49 ft to TD. The $^{137}$Cs contamination measured from the surface to ~41 ft is near-surface contamination that has migrated downward. Intermittent occurrences of $^{137}$Cs in the drywell below 49 ft are probably the result of contamination inside the casing or migration downward on the outside of the casing.

The $^{60}$Co measured at 0.5 pCi/g from 84 ft to TD corresponds with the depth of the elevated count rates measured by gross gamma logging from 1984 to 1987. Data collected from drywell 22-06-05, which is located on the southeast side of tank BY-106 and ~26 ft north of drywell 22-05-01, indicate tank BY-106 may be the origin of $^{60}$Co contamination detected in drywell 22-05-01.

**Drywell 22-05-05**
Drywell 22-05-05 is located ~6 ft from the southeast side of tank BY-105. The TD achieved through logging operations was 97 ft. Log data collected from this drywell from 1972 to 1994 indicated no elevated gamma activity. Cesium-137 was the only man-made contaminant identified in this drywell in spectral gamma logging after 1995. Cesium-137 was measured continuously from the ground surface to TD. The maximum concentration measured was ~20 pCi/g at 0.5 ft. Concentrations of $^{137}$Cs generally decreased with increasing depth, except at the bottom of the drywell, where a concentration of ~4 pCi/g was measured. The $^{137}$Cs contamination measured from the ground surface to TD was attributed to near-surface contamination that has migrated down inside or along the outside of the casing.

**Drywell 22-05-09**
Drywell 22-05-09 is located ~7 ft from the west side of tank BY-105. The TD achieved through logging operations was 98 ft. Log data collected from this drywell from 1972 to 1994 (Figure B.2-9) show elevated gamma activity at depths from 66 to 90 ft during the period from 1974 to 1984. The highest peak count rate decreased with time and appeared at lower depth intervals with each successive year. By 1984 the count rates were at the gross gamma system's detection level, and the depth of the highest peak count rate was at 90 ft.

Cesium-137 and $^{60}$Co were detected in this drywell in spectral gamma logging after 1995. Concentrations of $^{137}$Cs were measured continuously from the surface to ~45 ft, and intermittently to TD. Concentrations measured ~1 pCi/g or less, except in the near-surface sediments above ~5 ft in depth. The origin of the $^{137}$Cs contamination measured from the surface to ~45 ft was attributed to near-surface contamination that has migrated downward. Intermittent occurrences of $^{137}$Cs from 45 to 60 ft in depth were also attributed to downward migration of near-surface contaminants. Contamination below 60 ft may have been from a subsurface source.

Cobalt-60 was measured intermittently from ~60 ft to TD at below 1 pCi/g, except near the bottom of the drywell, where a maximum concentration of 5 pCi/g was measured. The $^{60}$Co appears to be associated with the $^{137}$Cs contamination below 60 ft, and both contaminants may have originated from near-surface spills that have migrated downward. However, on the basis of the lack of continuity of contamination from 45 to 60 ft, the $^{137}$Cs and $^{60}$Co may have originated from a subsurface source. Data collected from drywell 22-08-02, which is located on the east side of tank BY-108 and ~28 ft northwest of drywell 22-05-09, indicate an extensive $^{60}$Co contamination zone beginning at ~50 ft and extending to TD. This may be the origin of the $^{60}$Co contamination detected in drywell 22-05-09.

**B.2.2.3 Tank 241-BY-105 Assessment.** Other than Occurrence Report OR-74-117, no assessment for the assumed BY-105 tank leak was found. Based on the data reviewed, the surface level data is unstable and appears to be unreliable because of visible cave-ins and holes in the waste surface. Additional logging of drywells indicates that a previous determination that 1973 drywell activity may have originated from a leak from tank BY-105 was incorrect. Logging results since 1973 indicate that the drywell activity likely originated from other sources including a BY-108 tank leak.

### B.2.3 Conclusion

The assessment team concluded that the available data does not indicate that tank BY-105 leaked. More plausible sources for activity in drywells near the tank were identified based on logging data collected after 1973. It was recommended that tank BY-105 be considered for sluicing and that the leak classification for tank BY-105 be re-evaluated per TFC-ENG-CHEM-D-42, "Tank Leak Assessment Process."

## B.3 TANK 241-BY-106 WASTE LOSS EVENT

This section provides information on the historical waste loss event associated with tank BY-106. Figure B.3-1 shows a plan view of tank BY-106. The following subsections summarize the waste operating history for tank BY-106 shown in Figure B.3-2. Figure B.3-3 details the waste fill history for tank BY-106.

### B.3.1 Tank 241-BY-106 Waste History

Tank BY-106 first received waste in May 1953. The waste consisted of 758,000 gal of first cycle decontamination waste (1C) filling the tank. In October 1954, the 1C waste was pumped to a trench. From February 1955 to May 1957, TBP ferrocyanide scavenged waste was transferred in and out of the tank. During the period from July 1961 to September 1967, the tank received CWP. From January 1969 to December 1975 tank BY-106 received and transferred evaporator bottoms waste as part of the ITS process (WHC-MR-0132). Tank BY-106 never received waste through the cascade line connection with tank BY-105. No additional transfers occurred until the tank was put on restricted use in September 1976 and the tank was saltwell pumped in February and March 1977. Table B.3-1 shows waste transfers for tank BY-106 from 1951 to 1978.

**Figure B.3-1. Tank 241-BY-106 Plan View**

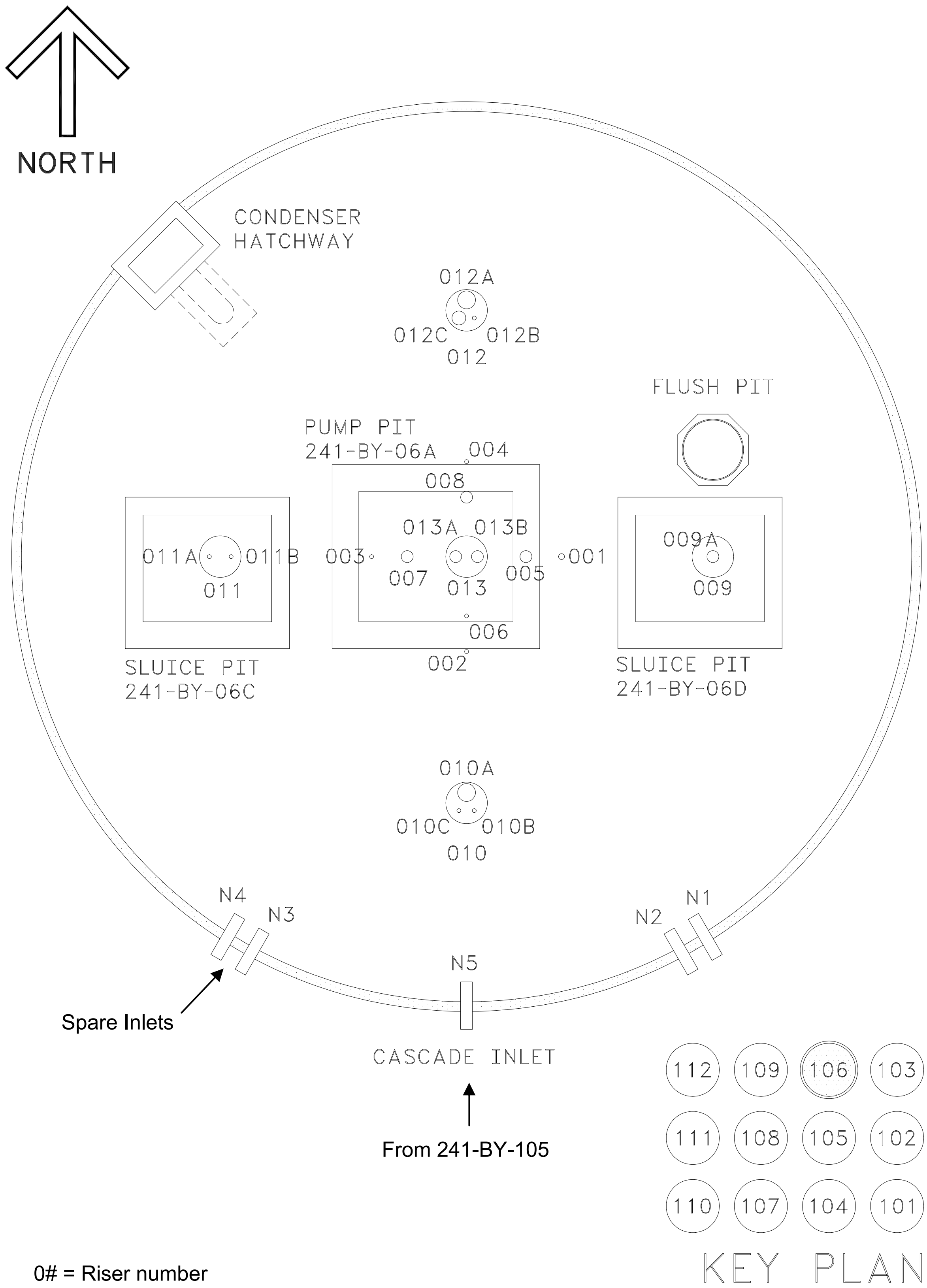
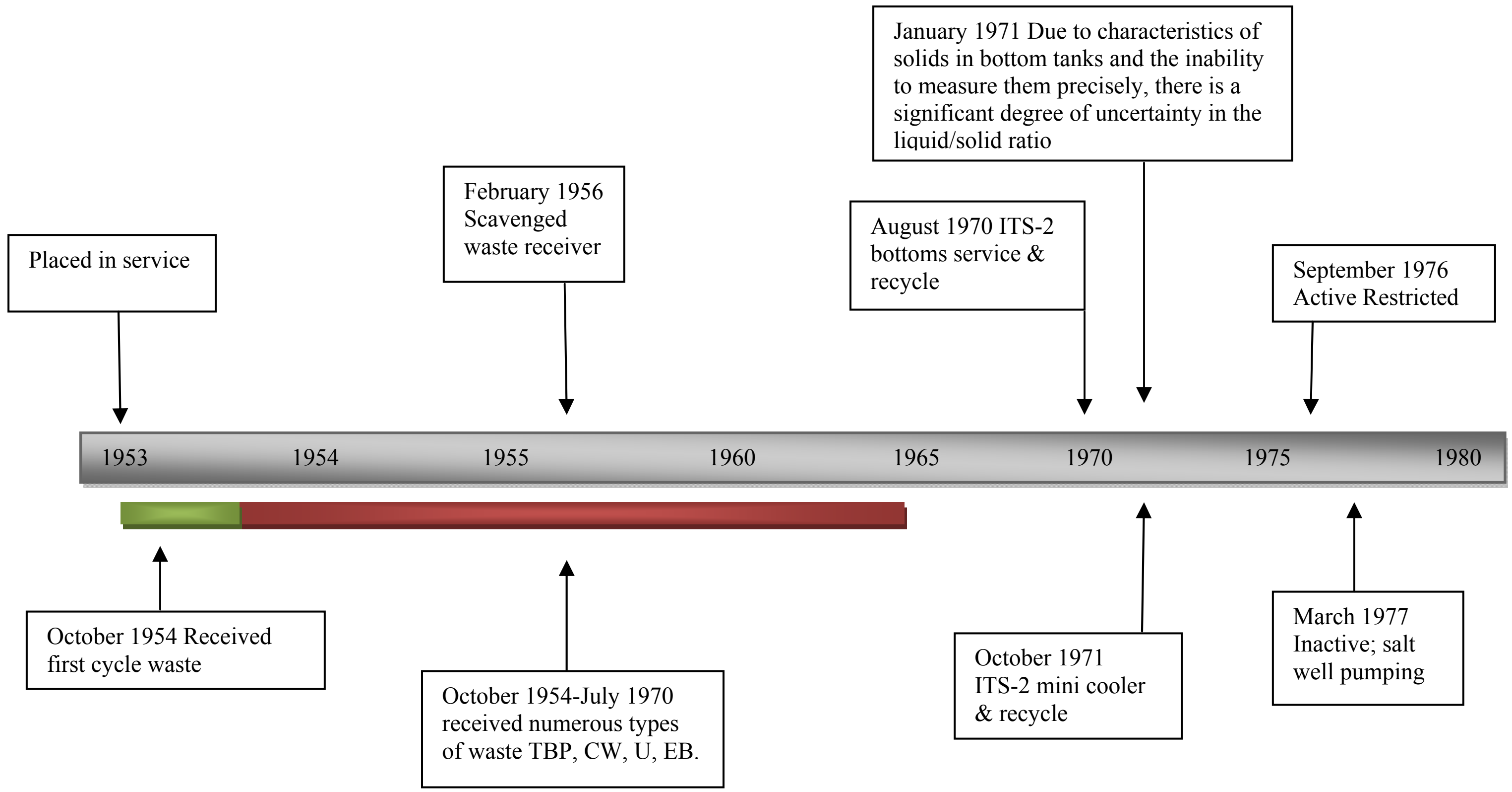


**Figure B.3-2. Tank 241-BY-106 Waste Operating History**




CW = cladding (coating) waste
TBP = tributyl phosphate (waste)
EB = Evaporator Bottoms waste
U = Uranium Recovery Plant waste
ITS-2 = In-Tank Solidification Unit #2

**Figure B.3-3. Tank 241-BY-106 Waste Fill History**

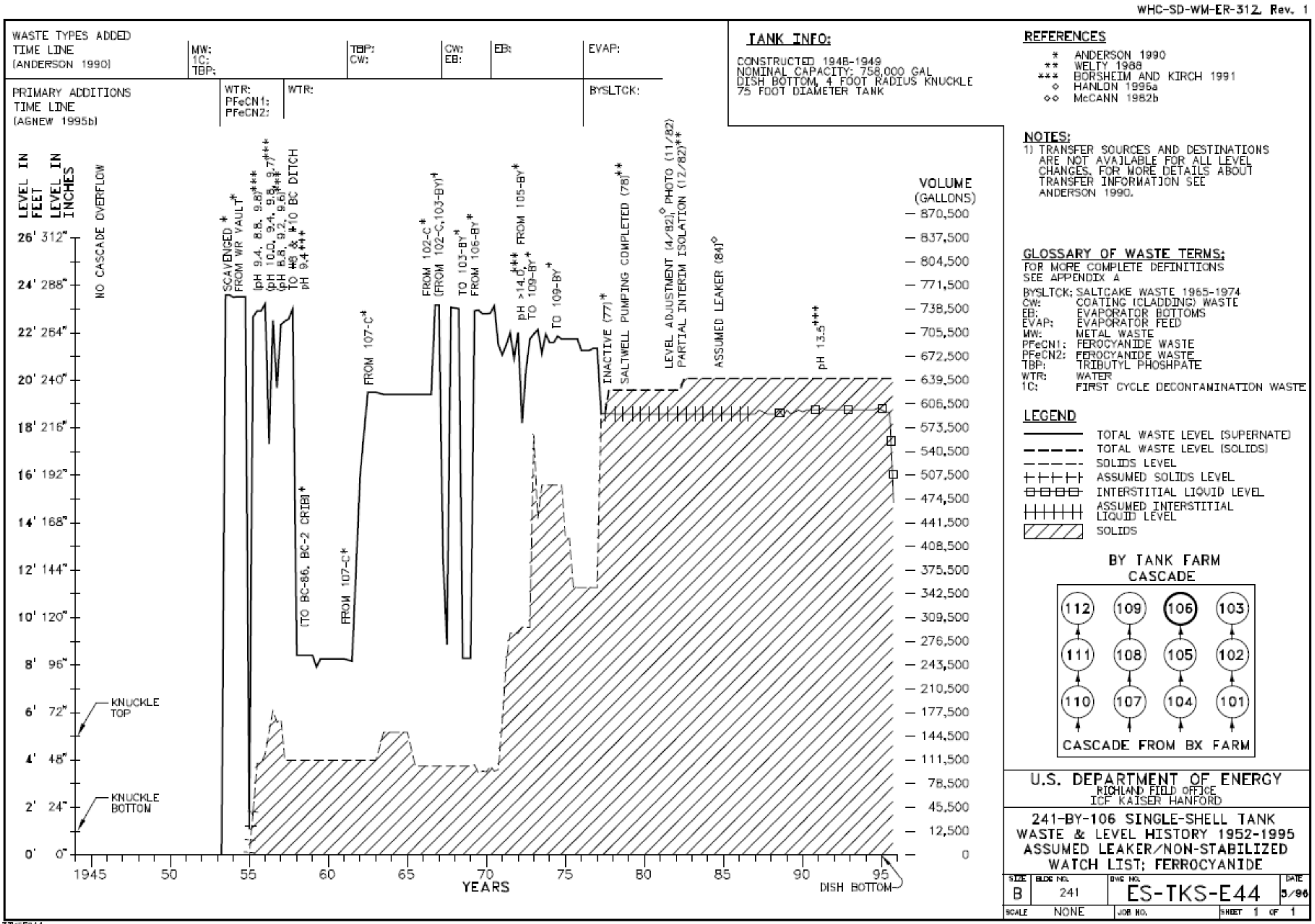


**Table B.3-1. Tank 241-BY-106 Transfers 1951 through 1978 (5 sheets)**

| Date | Transfer Type | Transfer Volume (gal*1000) | Total Volume in Tank (gal*1000) | Discrepancy with Previous Reading (gal*1000) | Waste Type | Transfer to/from | Document Number (full titles in Section B.6 REFERENCES) | Comment |
|---|---|---|---|---|---|---|---|---|
| January-April 1953 | 0 | 0 | 0 | 0 | 0 | 0 | WHC-MR-0132 | |
| May 1953 | IN | 758 | 758 | | 1C | 108-BY | HW-28377 | on 5/24 |
| June-October 1953 | STAT | | 758 | | 1C | | HW-29054 | |
| November-December 1953 | STAT | | 755 | -3 | 1C | | HW-30250 | |
| January 1954 | STAT | | 755 | | 1C | | HW-30851 | |
| February 1954 | STAT | | 751 | -4 | 1C | | HW-31126 | |
| March-September 1954 | STAT | | 756 | 5 | 1C | | HW-31374 | |
| October 1954 | OUT | -741 | 15 | | | BY-crib | HW-33544 | Started as TBP scavenging tank |
| November-December 1954 | STAT | | 15 | | | | HW-33904 | TBP scavenging |
| January 1955 | STAT | | 15 | | | | HW-35022 | TBP scavenging |
| February 1955 | IN | 628 | 643 | | TBP | WR vault | HW-35628 | TBP scavenging |
| March 1955 | IN/OUT | * | 728 | | TBP | WR vault | HW-36001 | TBP scavenging |
| April 1955 | IN/OUT | * | 34(est) | | TBP | BY #3 crib | HW-36553 LA-UR-97-311 | TBP scavenging |
| May 1955 | IN/OUT | * | 469 | | TBP | TBP Plant | HW-37143 | TBP scavenging |
| June 1955 | IN/OUT | * | 736 | | TBP | TBP Plant | HW-38000 | TBP scavenging |
| July-October 1955 | STAT | * | 736 | | TBP | | HW-38401 | TBP scavenging |
| November 1955 | IN/OUT | * | 218 | | TBP | BC-1 ditch | HW-40208 | cribbed during month |
| December 1955 | IN/OUT | * | 746 | | TBP | TBP Plant | HW-40816 | TBP scavenging |
| January 1956 | IN/OUT | * | 705 | | TBP | BC-5 Crib | HW-41038 | TBP scavenging |
| February 1956 | IN/OUT | * | 736 | | TBP | TBP Plant | HW-41812 | scvg waste receiver |
| March 1956 | IN/OUT | * | 551 | | TBP | BC-5 Crib | HW-42394 LA-UR-97-311 | scvg waste receiver |

**Table B.3-1. Tank 241-BY-106 Transfers 1951 through 1978 (5 sheets)**

| Date | Transfer Type | Transfer Volume (gal*1000) | Total Volume in Tank (gal*1000) | Discrepancy with Previous Reading (gal*1000) | Waste Type | Transfer to/from | Document Number (full titles in Section B.6 REFERENCES) | Comment |
|---|---|---|---|---|---|---|---|---|
| April 1956 | OUT | | 150 | | TBP | BC-2 CRIB | HW-42993 | scvg waste receiver |
| May 1956 | IN | | 721 | | TBP | TBP Plant | HW-43490 | scvg waste receiver |
| June 1956 | STAT | | 723 | | TBP | | HW-43895 | scvg waste receiver |
| July 1956 | OUT | | 161 | | TBP | 101-BX, 112-BY | HW-44860 | scvg waste receiver |
| August 1956 | IN | | 727 | | TBP | TBP Plant | HW-45140 | scvg waste receiver |
| September 1956 | OUT | | 639 | | TBP | BC-8 ditch | HW-45738 | 539 to BC 8 ditch |
| October 1956 | OUT | | 268 | | TBP | BC-10 ditch | HW-46382 | 484m to BC 10 ditch |
| November 1956 | IN/OUT | | 717 | | TBP | WR Vault | HW-47052 | 77 kgal to BC 10 ditch |
| December 1956 | STAT | | 717 | | TBP | | HW-47640 | scvg waste receiver |
| January 1957 | OUT | -176 | 540 | | TBP | BC-6 | HW-48144 | scvg waste receiver |
| February-April 1957 | IN | | 722 | | TBP | | HW-48846 | scvg waste receiver |
| May 1957 | IN | 3 | 725 | | TBP | | HW-50617 | increase due to flushes |
| June 1957 | STAT | | 725 | | TBP | | HW-51348 | |
| July 1957 | IN | 14 | 739 | | TBP | line flush | HW-51858 | |
| August-November 1957 | STAT | | 739 | | TBP | | HW-52414 | |
| December 1957 | OUT | -482 | 257 | | TBP | BC-2 crib | HW-54519 | |
| January-December 1958 | STAT | | 257 | | TBP | | HW-54916 | |
| January 1959 | STAT | | 251 | -6 | TBP | | HW-59204 | new electrode reading |
| February-March 1959 | STAT | | 241 | -10 | TBP | | HW-59586 | Feb; new electrode reading |
| April 1959 | STAT | | 252 | 10 | TBP | | HW-60419 | new electrode |
| May-December 1959 | STAT | | 252 | | TBP | | HW-60738 | |

## Table B.3-1. Tank 241-BY-106 Transfers 1951 through 1978 (5 sheets)

| Date | Transfer Type | Transfer Volume (gal*1000) | Total Volume in Tank (gal*1000) | Discrepancy with Previous Reading (gal*1000) | Waste Type | Transfer to/from | Document Number (full titles in Section B.6 REFERENCES) | Comment |
|---|---|---|---|---|---|---|---|---|
| January-December 1960 | STAT | | 252 | | TBP | | HW-63896 | |
| January-June 1961 | STAT | | 249 | -3 | TBP | | HW-71610 | |
| July-December 1961 | IN | 256 | 505 | | TBP-CW | 107-C | HW-72625 | Began to receive CW waste |
| January-June 1962 | IN | 118 | 623 | | TBP-CW | 107-C | HW-74647 | 118M from 107-C |
| July-December 1962 | STAT | | 623 | | TBP-CW | | HW-76223 | |
| January-June 1963 | STAT | | 620 | -3 | TBP-CW | | HW-78279 | |
| July-December 1963 | STAT | | 620 | | TBP-CW | | HW-80379 | |
| January-December 1964 | STAT | | 620 | | TBP-CW | | HW-83308 | |
| January-December 1965 | STAT | | 620 | | TBP-CW | | RL-SEP-659 | |
| January-April 1966 | STAT | | 620 | | TBP-CW | | ISO-226 | |
| July-September 1966 | IN | 124 | 744 | | TBP-CW | 102-C | ISO-538 | |
| October-December 1966 | STAT | | 744 | | TBP-CW | | ISO-674 | |
| January-March 1967 | OUT | -349 | 395 | | TBP-CW | 103-BY | ISO-806 | |
| April-June 1967 | OUT | -294 | | | CW | 103-BY | ISO-967 | |
| | IN | 171 | 272 | | CW | 102-C | | |
| July-September 1967 | IN | | 741 | -1 | CW | 102-C | ARH-95 | rec'd 469M from 102 C |
| October-December 1967 | STAT | | 740 | -1 | CW | | ARH-326 | |

**Table B.3-1. Tank 241-BY-106 Transfers 1951 through 1978 (5 sheets)**

| Date | Transfer Type | Transfer Volume (gal*1000) | Total Volume in Tank (gal*1000) | Discrepancy with Previous Reading (gal*1000) | Waste Type | Transfer to/from | Document Number (full titles in Section B.6 REFERENCES) | Comment |
|---|---|---|---|---|---|---|---|---|
| January-March 1968 | STAT | | 739 | | | | ARH-534 | |
| April-June 1968 | OUT | -486 | 253 | | CW | 103-BY | ARH-721 | |
| July-December 1968 | STAT | | 253 | | CW | | ARH-871 | |
| January-March 1969 | IN | 481 | 736 | 2 | CW-EB | 106-BY | ARH-1200 A | |
| April-June 1969 | STAT | | 737 | 1 | CW-EB | | ARH-1200 B | |
| July-December 1969 | STAT | | 732 | -5 | CW-EB | | ARH-1200 C | |
| January-March 1970 | STAT | | 733 | 1 | CW-EB | | ARH-1666 A | |
| April-June 1970 | STAT | | 743 | 10 | CW-EB | | ARH-1666 B | |
| July-September 1970 | IN/OUT | | 689 | | EB | | ARH-1666 C | bottoms service in August |
| October-December 1970 | IN/OUT | | 675 | | EB | | ARH-1666 D | ITS-2 bottoms & recycle |
| January-March 1971 | IN/OUT | | 689 | | EB | | ARH-2074 A | ITS-2 bottoms & recycle |
| April-June 1971 | IN/OUT | | 706 | | EB | | ARH-2074 B | ITS-2 bottoms & recycle |
| July-September 1971 | IN/OUT | | 670 | | EB | | ARH-2074 C | ITS-2 bottoms & recycle |
| October-December 1971 | IN/OUT | | 706 | | EB | | ARH-2074 D | ITS-2 Mini-cooler & recycle *due to characteristics of solids etc… |
| January-March 1972 | IN/OUT | | 580 | | EB | | ARH-2456 A | *, ITS bottoms & recycle |
| April-June 1972 | IN/OUT | | 655 | | EB | | ARH-2456 B | *, ITS bottoms & recycle |
| July-September 1972 | IN/OUT | | 697 | | EB | | ARH-2456 C | *, ITS bottoms & recycle |
| October-December 1972 | IN/OUT | | 704 | | EB | | ARH-2456 D | *, ITS bottoms & recycle |

**Table B.3-1. Tank 241-BY-106 Transfers 1951 through 1978 (5 sheets)**

| Date | Transfer Type | Transfer Volume (gal*1000) | Total Volume in Tank (gal*1000) | Discrepancy with Previous Reading (gal*1000) | Waste Type | Transfer to/from | Document Number (full titles in Section B.6 REFERENCES) | Comment |
|---|---|---|---|---|---|---|---|---|
| January-March 1973 | IN/OUT | | 710 | | EB | | ARH-2794 A | *, ITS bottoms & recycle |
| April-June 1973 | IN/OUT | | 677 | | EB | | ARH-2794 B | *, ITS bottoms & recycle |
| July-September 1973 | IN/OUT | | 704 | | EB | | ARH-2794 C | *, ITS bottoms & recycle |
| October-December 1973 | IN/OUT | | 692 | | EB | | ARH-2794 D | *, ITS bottoms & recycle |
| January-March 1974 | STAT | | 692 | | EB | | ARH-CD-133A | *, ITS bottoms & recycle |
| April-June 1974 | IN/OUT | | 701 | | EB | | ARH-CD-133B | *, ITS bottoms & recycle |
| July-December 1974 | STAT | | 697 | | EB | | WHC-MR-0132 | *, ITS bottoms & recycle |
| January-September 1975 | STAT | | 697 | | EB | | ARH-CD-336 A | *, ITS bottoms & recycle |
| October-December 1975 | IN/OUT | | 681 | | EB | 109-BY | ARH-CD-336 D | *, ITS bottoms & recycle |
| January-August 1976 | STAT | | 681 | | EB | | ARH-CD-702 A | *, ITS bottoms & recycle |
| September 1976 | STAT | | 684 | 3 | EB | | ARH-CD-702 I | Active Restricted |
| October-December 1976 | STAT | | 684 | | EB | | ARH-CD-822 DEC | Restricted |
| January 1977 | STAT | | 686 | 2 | EB | | ARH-CD-822 JAN | Restricted |
| February 1977 | OUT | -40 | 648 | | EB | | ARH-CD-822 FEB | R; salt well pumping |
| March 1977 | OUT | -55 | 593 | | EB | | ARH-CD-822 MAR | Inactive; salt well pumping |
| April-June 1977 | STAT | | 593 | | | | ARH-CD-822 APR | Inactive |
| July 1977 | STAT | | 626 | 33 | EB | | RHO-CD-14 JUL | Inactive |
| August-December 1977 | STAT | | 626 | | EB | | RHO-CD-14 AUG | Inactive |
| January-December 1978 | STAT | | 626 | | EB | | RHO-CD-14 JAN | Inactive |

* Numerous transfers in and out of tank, volumes not shown except as specified in the waste status summary.

ITS = In-Tank Solidification  ITS-2 = ITS Unit #2

Waste types:
1C = first cycle waste
TBP = tributyl phosphate waste
CW = cladding (coating) waste
U Plant = Uranium Recovery Plant waste
EB = Evaporator Bottoms waste

**B.3.1.1 Integrity of Tank 241-BY-106.** In 1977, tank BY-106 was categorized as a questionable integrity tank (SD-WM-TI-356). Occurrence Report OR-77-69, *Tank 106-BY Liquid Level Increase*, related to an apparent unexpected liquid-level increase ("intrusion"), stated that the tank had questionable integrity "*due to known tar rings above the 270-inch level*." The tar rings resulted from seepage of the tar sealant into the interior of the tank between the concrete tank shell and steel tank liner. The tar may have seeped through pitting or corrosion of the steel tank liner.

Tank BY-106 has had apparent liquid-level increases, as have some of the other tanks in BY-Farm. Occurrence Reports OR-77-69 and OR-77-161, *Tank 106-BY Liquid Level Exceeding Increase Criterion* attributed these increases to faulty measuring equipment or shifting of material in the tank. Water additions to the tank could also have created the liquid-level increases.

Occurrence reports issued for tank BY-106 include the following:

- On May 10, 1977, a 2-in. liquid level increase was observed. The apparent cause was a malfunction of the tank's manual liquid level measuring device (OR-77-69).
- On September 15, 1977, a ¼-in. liquid level increase was observed. This was attributed to slight shifting of the uneven salt crust. An uneven salt crust was observed in photos taken on February 24, 1977. Water intrusion was considered and discounted as a possible cause, and drywell radiation profiles showed no significant changes and were stable (OR-77-161).

**B.3.1.2 Interim Stabilization.** The tank supernate was pumped down in February and March 1977. Jet pumping of tank BY-106 began with a starting liquid level of 202.9 in. on July 3, 2001. Pumping was completed on December 31, 2003 and the tank was declared interim stabilized (HNF-SD-RE-TI-178 p. 110). As of April 30, 2009 tank BY-106 is reported to contain 430,000 gal of total waste, with 37,000 gal of drainable interstitial liquid and no supernatant liquid. In addition, tank BY-106 contains 32,000 gal of sludge and 398,000 gal of saltcake (HNF-EP-0182). A photo mosaic (Figure B.3-4) details the surface in tank BY-106 as of November 4, 1982.

**B.3.1.3 Tank 241-BY-106 Temperature History.** Figure B.3-5 shows a thermal history for thermocouple 1 in Riser 1 of tank BY-106 from July 1974 through July 2007. No temperature information was found before 1974. A maximum temperature of close to 155 °F is shown in 1974. The temperature gradually decreased to ~95 °F in 2007.

### B.3.2 Data Review and Observations

**B.3.2.1 Surface Level Data.** Table B.3-2 shows manual tape surface level measurements from June 1973 to February 1983 (SD-WM-TI-356). The surface level data indicates a potential intrusion between 1974 and 1977, but this was determined to be due to a malfunction of the manual tape. There was no indication of a liquid level decrease from the surface level measurements.

Figure B.3-4.  Tank 241-BY-106 Waste Surface Photo Mosaic

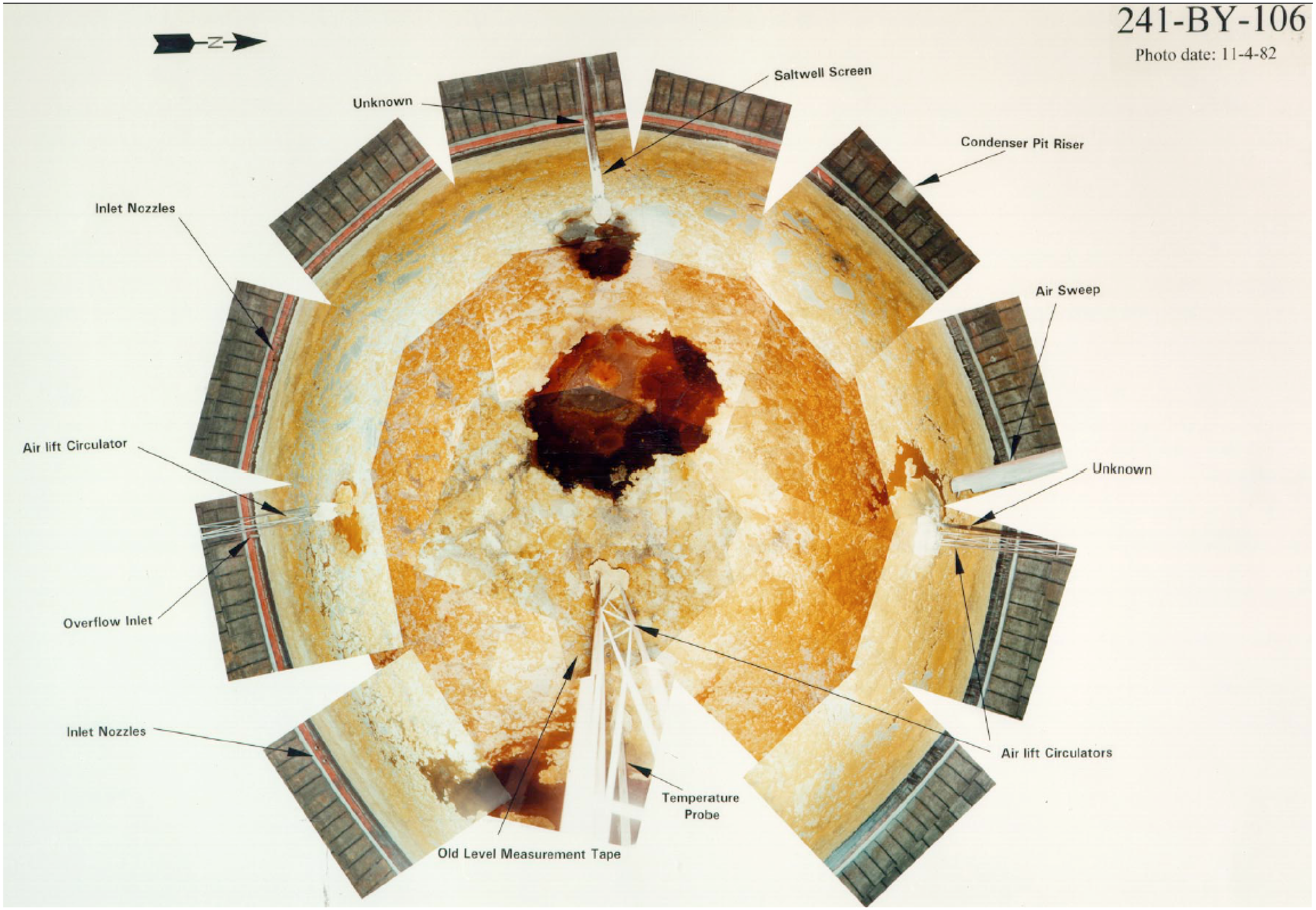


Figure B.3-5. Tank 241-BY-106 Temperature Measurements

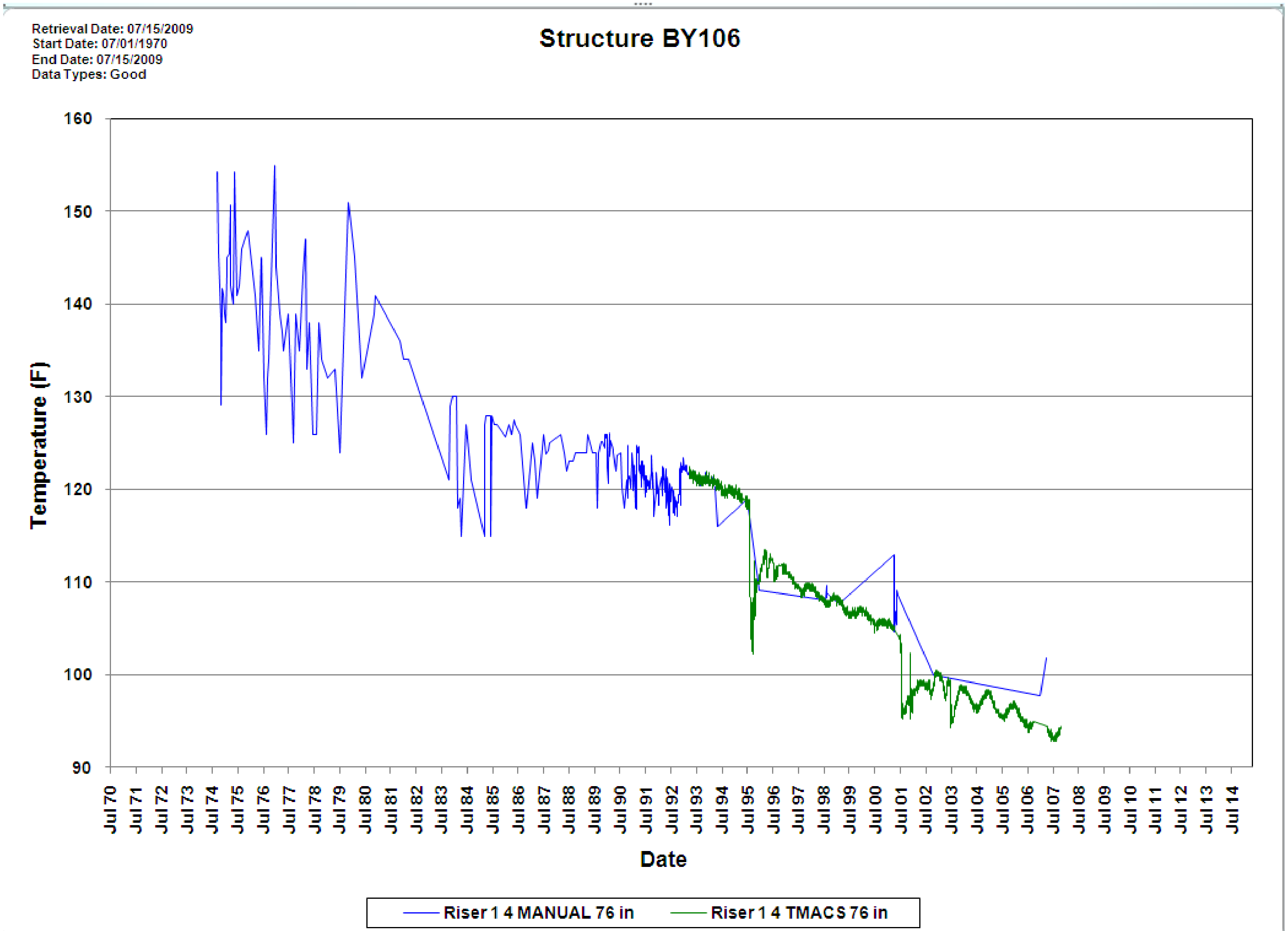


**Table B.3-2. 1973 to 1983 Tank 241-BY-106 Liquid Level Measurements**

| Date | Liquid Level (in.) | Baseline Ref. | Change from previous reading (in.) | Cumulative change (in.) | Comments |
|---|---|---|---|---|---|
| 6/15/1973 | 254.5 | | - | - | Manual tape |
| 9/17/1973 | 254.5 | | - | - | Readings vary to 253.00 in. |
| 9/18/1973 | 263.5 | | - | - | Transfer |
| 10/27/1973 | 263.5 | | - | - | Stable |
| 11/11/1973 | 259 | | - | - | Transfer |
| 5/8/1974 | 259 | | - | - | Stable |
| 5/9/1974 | 262.5 | | - | - | New tape and spoolpiece |
| 8/12/1974 | 263 | | +0.5 | +0.5 | Slow increase |
| 8/24/1974 | 260.5 | | - | +0.5 | Transfers |
| 10/23/1975 | 261.5 | | +1.00 | +1.5 | Very slow increase |
| 10/24/1975 | 255 | | - | +1.5 | Transfer |
| 1/18/1977 | 256 | | +1.00 | +2.5 | Very slow increase |
| 4/1/1977 | 232.25 | | | +2.5 | Transfers |
| 6/30/1977* | 235.5 | | | | Erratic increase, OR No. 77-69 written |
| 9/14/1977 | 235.5 | | | | Stable |
| 9/15/1977 | 236.25 | | | | Unexplained increase, OR No. 77-161 written |
| 5/14/1978 | 237.25 | | | | Slow increase |
| 5/20/1978 | 237.25 | | | | Erractic readings |
| 8/30/1978 | 237.25 | | | | Slow increase |
| 12/3/1978 | 238 | | | | Erratic increase |
| 12/8/1978 | 231 | | | | Salt-well transfers |
| 1/16/1979 | 233 | | | | Increase attributed to sludge movement |
| 3/14/1979 | 232.5 | | | | Erratic decrease |
| 8/7/1979 | 234.5 | | | | Rain and sludge movement |
| 5/29/1980 | 235.25 | | | | Slow increase |
| 5/30/1980 | | 237.75 | | | New tape installed |
| 3/31/1981 | 238.75 | | | | Slow increase |
| 3/24/1982 | 239.25 | | | | Stable |
| 6/30/1982 | 239.25 | | | | Stable |
| 2/8/1983 | | 239.75 | | | Associated with intrusions and surface solids buildup |

* Liquid levels beyond this date are not accumulated because the manual tape plummet is contacting solids and measurements are primarily to detect intrusions.

References:

OR 77-69, 1977, *Tank 106-BY Liquid Level Increase*.
OR 77-161, 1977, *Tank 106-BY Liquid Level Exceeding Increase Criterion*.
SD-WM-TI-356, *Waste Storage Tank Status and Leak Detection Criteria*.

**B.3.2.2 Drywell Logging Data.** Five drywells (22-06-01, 22-06-05, 22-06-07, 22-06-09 and 22-06-11) surround tank BY-106 (see Figure 4-1 of the main text). In addition, drywell 22-03-09 is located nearby tank BY-106. Figure B.3-6 shows spectral gamma logging results collected after 1995 for these drywells (GJ-HAN-23, *Vadose Zone Characterization Project at the Hanford Tank Farms Tank Summary Data Report for Tank BY-106*).

**Drywell 22-06-01**

Drywell 22-06-01 is located ~6 ft northeast of tank BY-106 and has a depth of 100 ft. Cesium-137 and $^{60}$Co were the man-made contaminants detected in this drywell. Cesium-137 occurred almost continuously from the surface to the TD of the drywell. The $^{137}$Cs concentration was less than ~1 pCi/g, except near the surface and TD. The uniformity of the distribution of $^{137}$Cs suggests that the $^{137}$Cs originated at the surface, at least for depths above ~45 ft. The slight increase in concentration shown on the $^{137}$Cs log at 45 ft might mark the addition of $^{137}$Cs from a subsurface leak near that depth. The subsurface leak could be the same leak that produced the $^{60}$Co peak near 47 ft, where the $^{60}$Co concentration was ~1.2 pCi/g. Additional $^{60}$Co was located in the interval from ~55 to 63 ft. The $^{137}$Cs and $^{60}$Co below ~45 ft may have originated from a leak of tank BY-103. Elevated $^{137}$Cs levels occur at the 0- to 8-ft depth level (Figure B.3-7) around 1985, indicating a possible surface spill.

**Drywell 22-06-05**

Drywell 22-06-05 is located ~7 ft southeast of tank BY-106 and also has a depth of 100 ft. Historical Tank Farms gross gamma-ray logs show enhanced count rates for this drywell since 1972 (the earliest record located) (Figure B.3-8). The logs indicate contamination throughout a broad interval, with a peak initially near 31 ft. This contamination has moved downward with time and in 1994 extended from ~62 to 85 ft (Figures B.3-8 and B.3-9). The rate of decrease in activity is approximately the same as the decay rate of $^{60}$Co (5.3-year [y] half-life).

Cesium-137 and $^{60}$Co are the man-made contaminants detected in this drywell since 1995. Cesium-137 was detected almost continuously from the surface to ~45 ft. The maximum concentration of $^{137}$Cs (other than at the surface) was ~1 pCi/g. This $^{137}$Cs likely originated at the surface and migrated down later. Increased amounts of $^{137}$Cs are present in the 0- to 8-ft depth range around 1985, which is similar to what is observed in drywell 22-06-01. Cobalt-60 was the primary contaminant detected, occurring almost continuously from ~30 to 87 ft. The maximum $^{60}$Co concentration was ~15 pCi/g throughout the broad interval from ~63 to 77 ft. The shallowest location of $^{60}$Co was at ~29 ft, perhaps indicating a leak in the side of the tank or in ancillary piping. Repeat logging from drywell 22-06-05 and 22-08-05 suggest movement may be due to a lateral influx of contaminants (GJO-96-2-TARA/GJO-HAN-6).

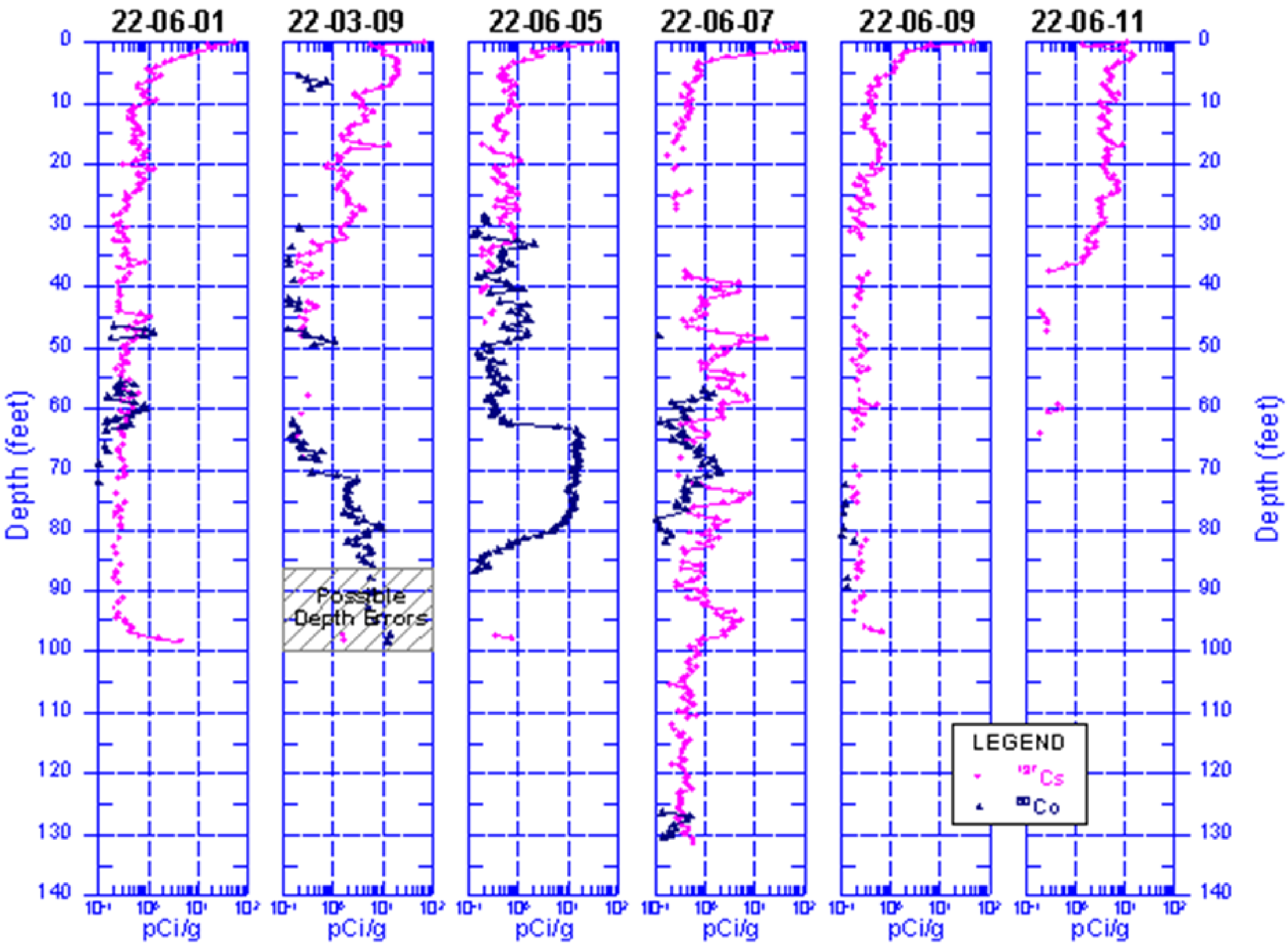
**Drywell 22-03-09**

This drywell is discussed in Section B.1.2.2.

**Drywell 22-06-07, 22-06-09 and 22-06-11**

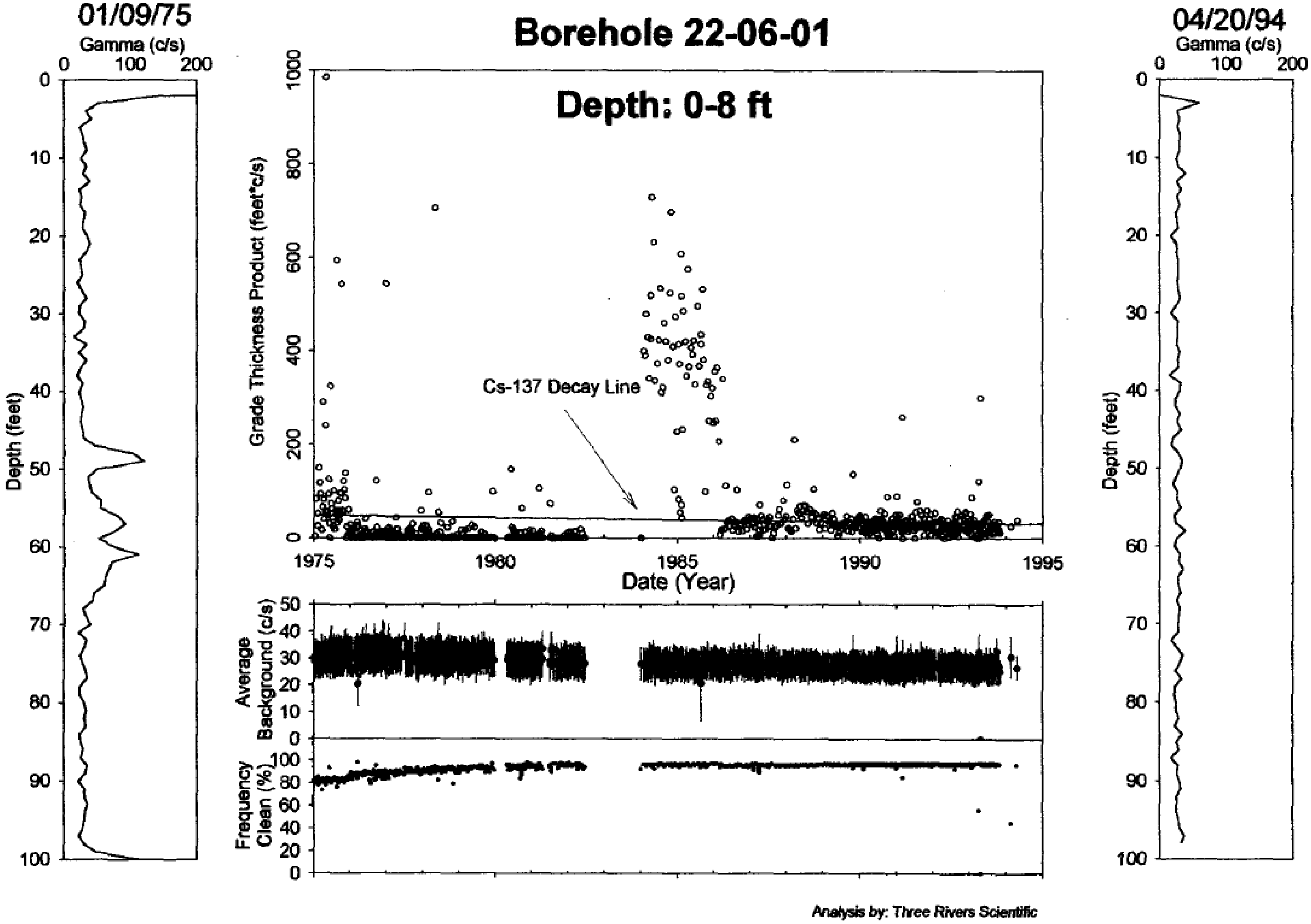
Drywell 22-06-07 was drilled to a depth of 150 ft and is located 21 ft southwest of tank BY-106, drywell 22-06-09 was drilled to a depth of 100 ft and is located 6 ft west of tank BY-106 and drywell 22-06-11 was drilled to a depth of 100 ft and is located 9 ft northwest of tank BY-106.

**Figure B.3-6. Tank 241-BY-106 Drywell Spectral Gamma Data Collected after 1995**



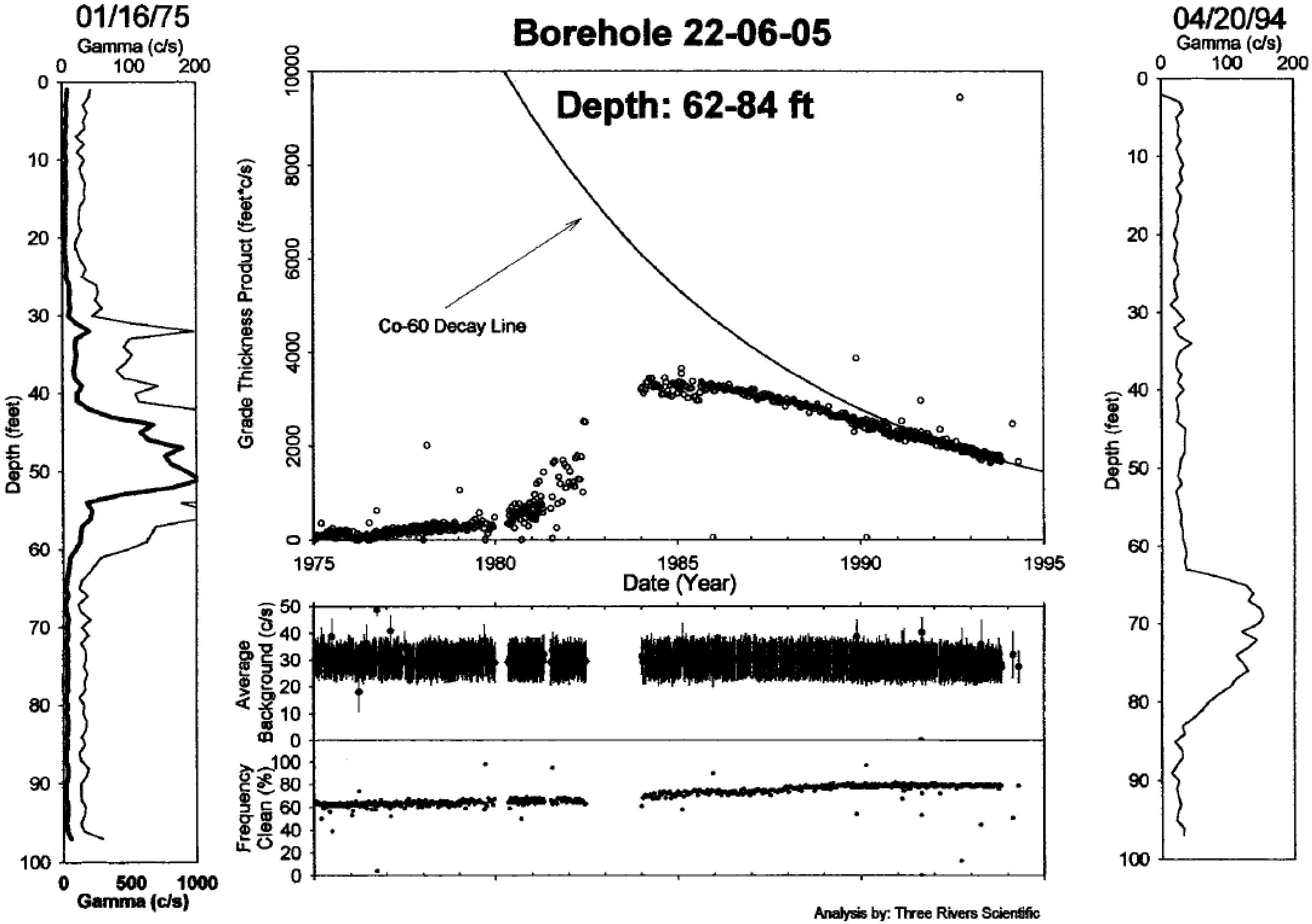

Reference: GJ-HAN-23, *Vadose Zone Characterization Project at the Hanford Tank Farms Tank Summary Data Report for Tank BY-106*.

**Figure B.3-7. Drywell 22-06-01 Total Gamma Results 1975 to 1994**



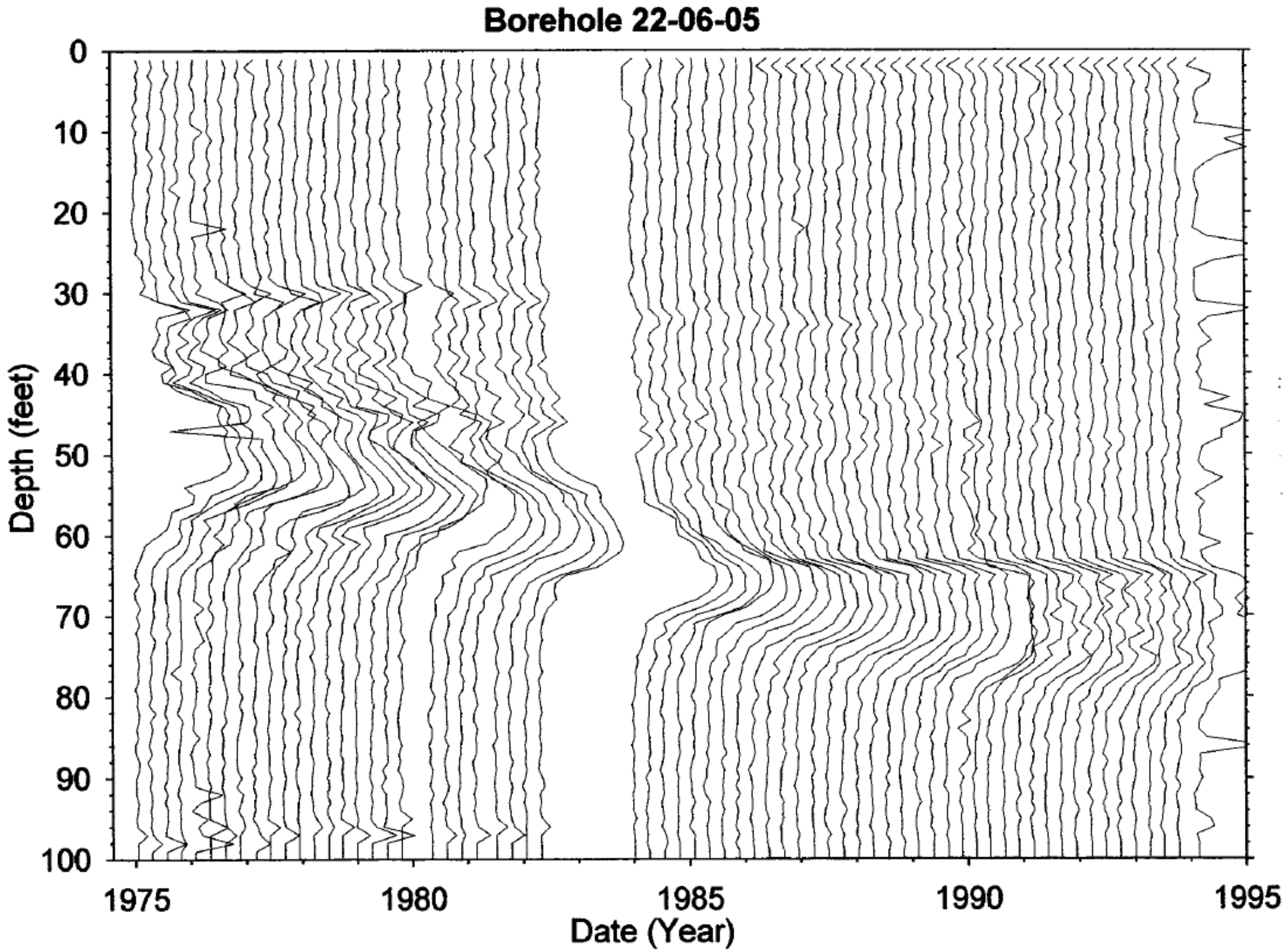

Reference: HNF-3532, *Analysis of Historical Gross Gamma Logging Data from BY Tank Farm.*

**Figure B.3-8. Drywell 22-06-05 Total Gamma Results 1975 to 1994**




Reference: HNF-3532, *Analysis of Historical Gross Gamma Logging Data from BY Tank Farm*.

**Figure B.3-9. Drywell 22-06-05 Total Gamma Results Over Time, 1975 through 1994**




Reference: HNF-3532, *Analysis of Historical Gross Gamma Logging Data from BY Tank Farm*.

The $^{137}Cs$ patterns shown in Figure B.3-6 for these drywells are similar to the other drywells discussed. Again, cesium activity is highest near the surface, indicating surface spills during operations. Cobalt-60 activity was highest in drywell 22-06-07 at 70 ft bgs. Cobalt-60 was significantly lower in 22-06-07 compared to drywells 22-06-01, 22-03-09 and 22-06-05. Cobalt-60 activity was lower still in drywell 22-06-09 and was not detected in 22-06-11. As for the spectral gamma scans, historical gross gamma scans for these drywells showed low levels of activity, and no indication of a sudden increase or anomaly.

**B.3.2.3 Tank 241-BY-106 Assessment.** No previous assessments for tank BY-106 were found. Tank BY-106 was classified to be of questionable integrity based on drywell activity measured in drywell 22-06-05 in 1972. A review of waste transfer data and liquid level data does not reveal any discrepancies in waste levels that would indicate a leak. WHC-MR-0132 comments that in 1980 the surface in tank BY-106 contained "liquid pools," which may call into question the reliability of liquid level measurements. Activity in drywell 22-06-05 may be from tank BY-108 or another source.

There is the possibility that waste may have flowed over the steel liner or through the liner above the location where tar rings were observed. However, if it did, the leak volume was probably small.

### B.3.3 Conclusion

There was no basis for an inventory estimate and some question whether tank BY-106 actually leaked. It is recommended that the leak classification for tank BY-106 be re-evaluated per TFC-ENG-CHEM-D-42. Additional logging and characterization are recommended to further assess any changes in the gamma profile near the tank.

## B.4 TANK 241-BY-107 WASTE LOSS EVENT

This section provides information on the historical waste loss event associated with tank BY-107. Figure B.4-1 shows a plan view of tank BY-107. The following subsections summarize the waste operating history for tank BY-107 shown in Figure B.4-2. Figure B.4-3 details the waste fill history for tank BY-107.

### B.4.1 Tank 241-BY-107 Waste History

Tank BY-107 was constructed from 1948 to 1949 and put into service in 1950. Tank BY-107 is the first tank in a cascade that includes tanks BY-108 and BY-109. Tank BY-107 began receiving first cycle bismuth phosphate process waste from B Plant starting December 1950. The tank was filled in the first quarter of 1951 and continued to receive waste through September 1952. The first-cycle supernate was pumped to tank 241-B-106 (B-106) and the tank was emptied in November 1952. Uranium recovery supernate from tank 241-BX-109 (BX-109) was transferred to tank BY-107 in February and March of 1953. On March 25, 1953 the BX-109 to BY-107 cascade was abandoned. Tributyl phosphate supernate in tank BY-107 was pumped out from January to September 1954. From October 1954 to September 1957, waste from U-Plant via the CR vault was sent to tanks in the 241-BY Tank Farm including tank BY-107 for settling during the ferrocyanide scavenging campaign. After settling, supernate was pumped to cribs. Flush water and CWP was received from tank 241-C-105 in October 1958 and January 1959. No transfers in or out of the tank occurred until the fourth quarter of 1969, when waste was sent to tank BY-112. From the first quarter of 1970 until July 1975, BY-107 was a bottoms tank for the ITS system, transferring waste to and from tank BY-112 and other tanks in the B, BX, and BY tank farms. Tank BY-107 was removed from service in 1975. Table B.4-1 shows waste transfers for tank BY-107 from 1951 to 1994.

**Figure B.4-1. Tank 241-BY-107 Plan View**

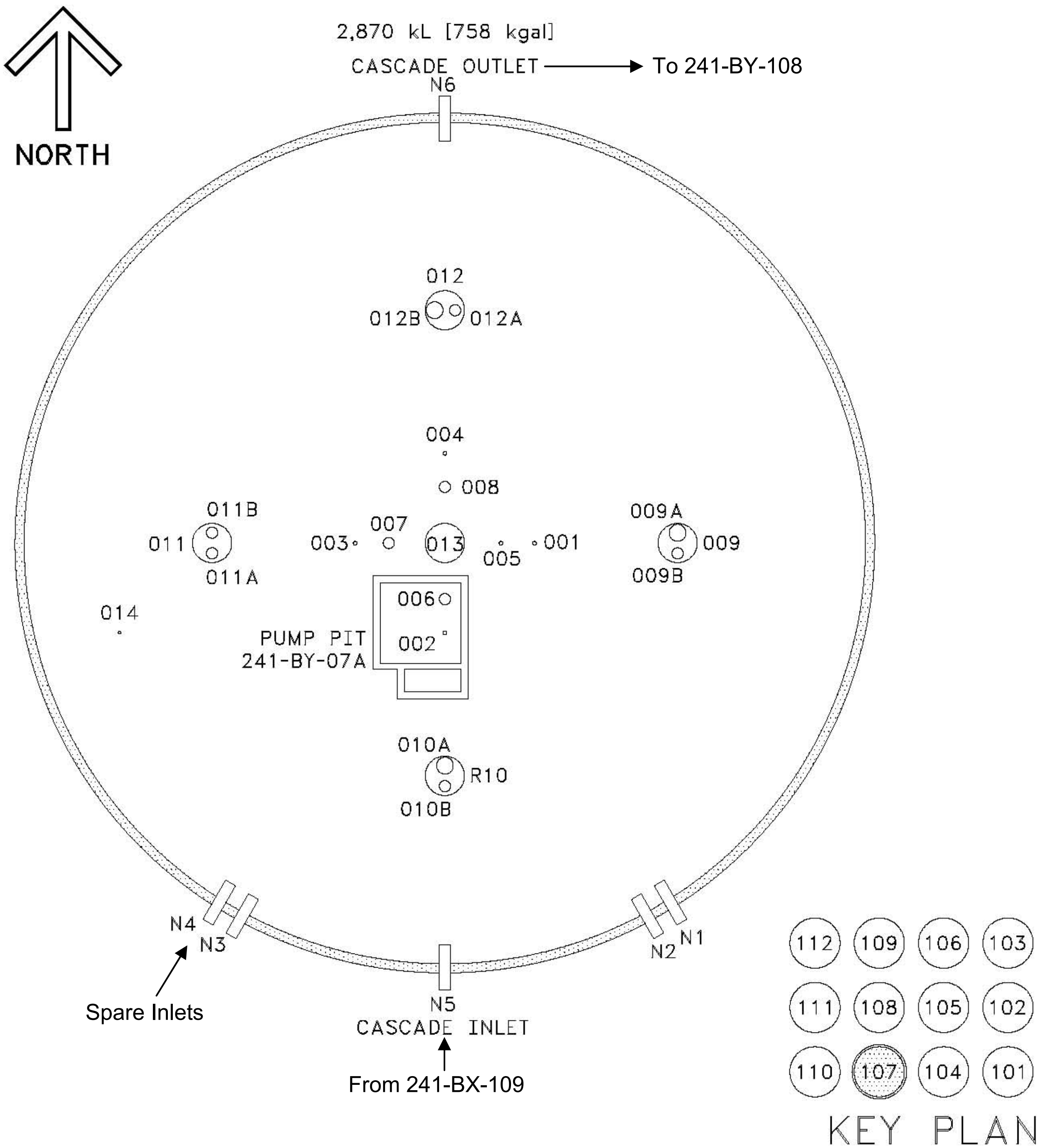
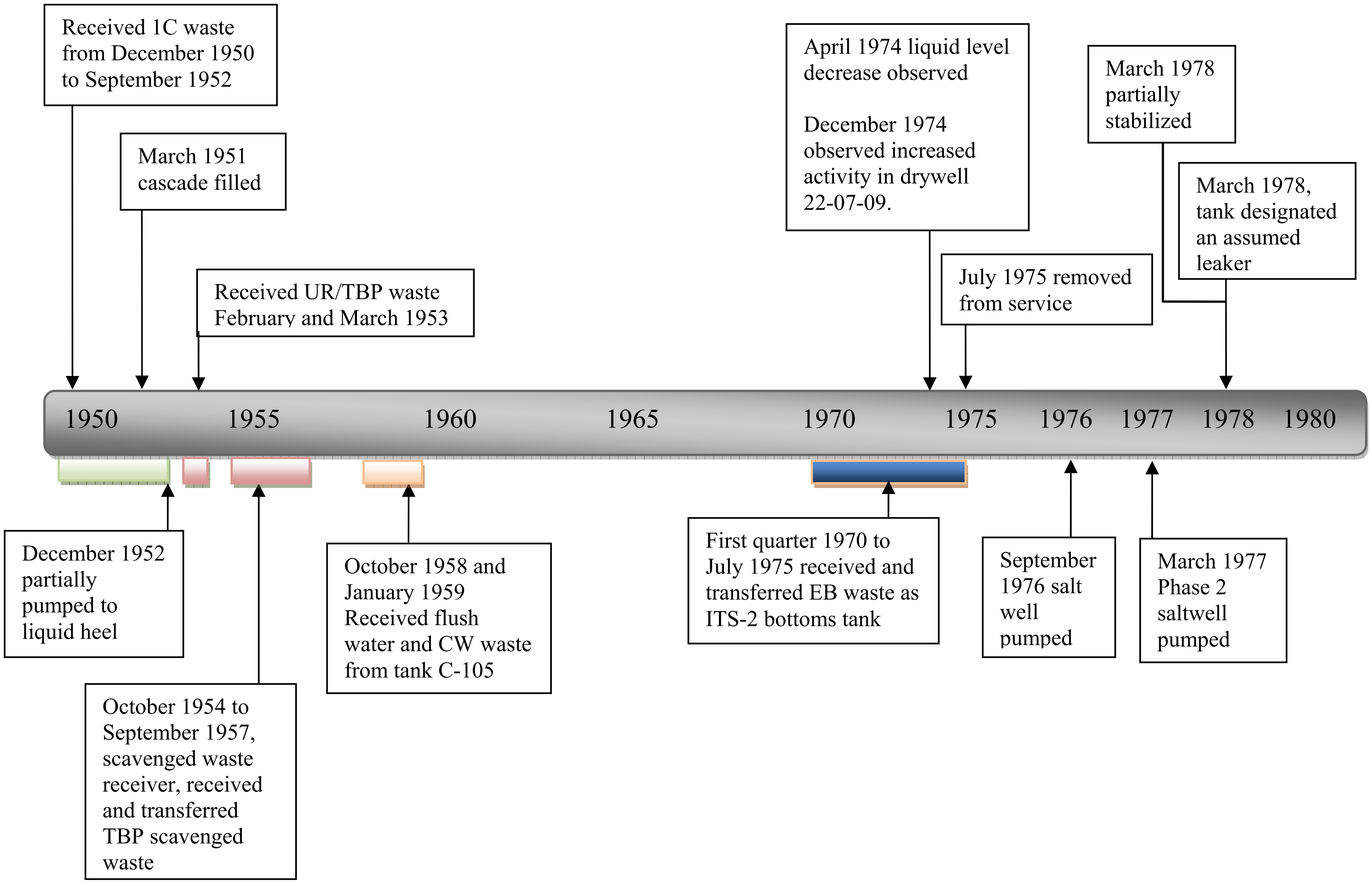


**Figure B.4-2. Tank 241-BY-107 Waste Operating History**




1C = first cycle decontamination (waste)
ITS-2 = In-Tank Solidification Unit #2
CW = cladding (coating) waste
TBP = tributyl phosphate (waste)
EB = Evaporator Bottoms waste
UR = Uranium Recovery Plant waste

# Figure B.4-3. Tank 241-BY-107 Waste Fill History

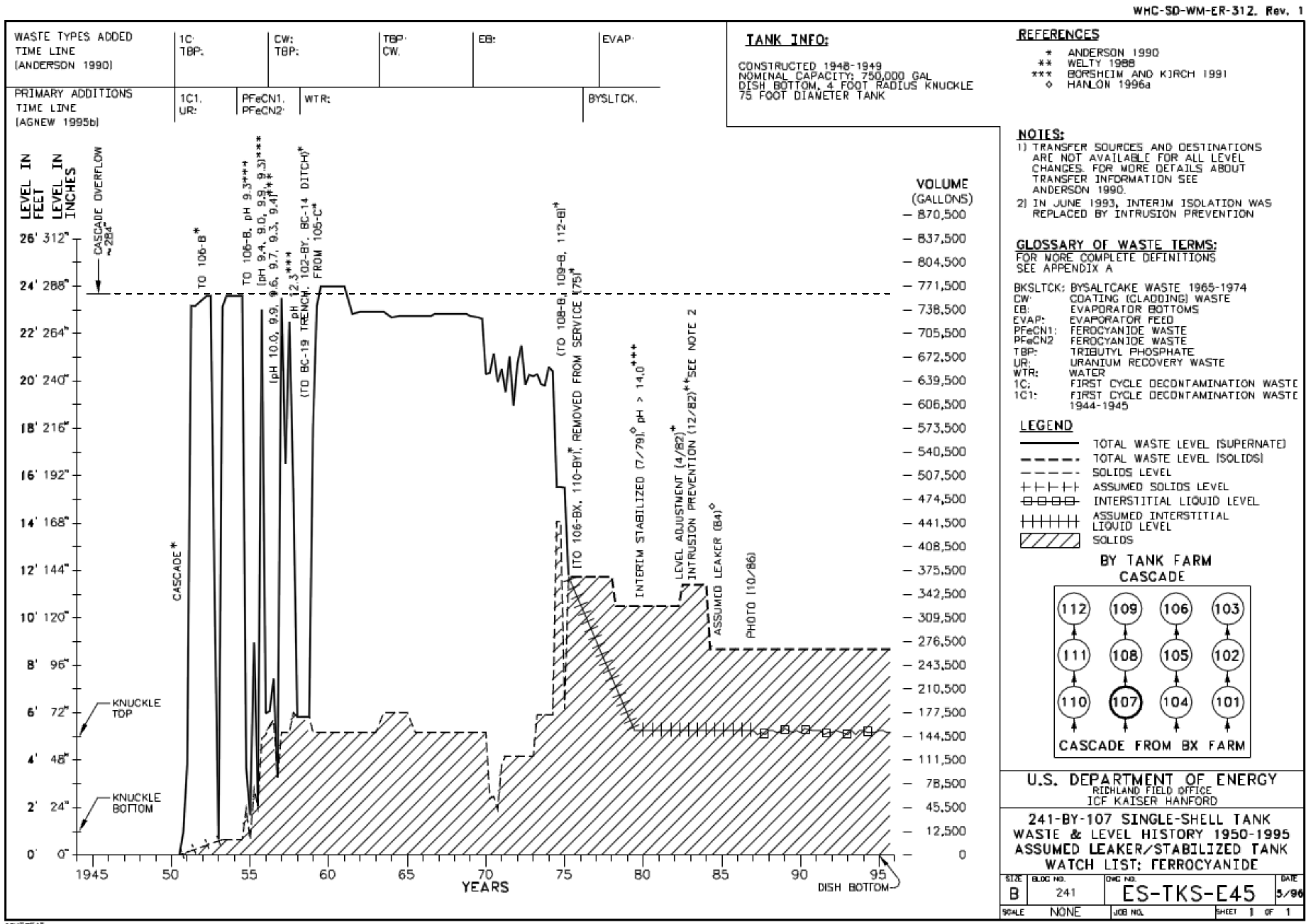


**Table B.4-1. Tank 241-BY-107 Transfers 1951 through 1979 (4 sheets)**

| Date | Transfer Type | Transfer Volume (gal*1000) | Total Volume in Tank (gal*1000) | Waste Type | Transfer to/from | Document Number (full titles in Section B.6 REFERENCES) | Comment |
|---|---|---|---|---|---|---|---|
| July-September 1950 | IN | 11 | 11 | 1C | | WHC-MR-0132 | |
| October-December 1950 | IN | 95 | 106 | 1C | | WHC-MR-0132 | began filling |
| January-December 1951 | IN | 638 | 744 | 1C | | WHC-MR-0132 | cascade filled in March |
| January-September 1952 | IN/OUT | 14 | 758 | 1C | | HW-27838 | Cascade, 9/25-9/28 partially pumped. |
| October-December 1952 | OUT | | 1 | 1C,TBP | 106-B | WHC-MR-0132 | Nov. pumped to liquid heel,12/6 no supernate to 106-B |
| January 1953 | STAT | | 0 | 1C,TBP | | HW-27841 | CASCADE 109-BX to 107-BY |
| February 1953 | IN | 92 | 92 | 1C,TBP | 109-BX | HW-27842 | 2/27/1953 |
| March-April 1953 | IN | | 743 | 1C,TBP | 109-BX, 107-BY | HW-27775 | Cascade from BX-109 abandoned 3/25/53 |
| May 1953 | IN | | 758 | 1C,TBP | unknown | HW-28377 | |
| June 1953-June 1954 | STAT | | 758 | 1C,TBP | | HW-29054 HW-30851 | |
| July 1954 | OUT | -79 | 679 | 1C,TBP | 106-B | HW-32697 | |
| August-September 1954 | OUT | -578 | 101 | 1C,TBP | 106-B | HW-33002 | to be used for TBP scvg waste |
| October 1954 | IN/OUT | * | 528 | 1C,TBP | | HW-33544 | TBP scvg waste receiver |
| November 1954 | IN | * | 752 | 1C,TBP | | HW-33904 | scvg waste receiver |
| December 1954 | IN/OUT | * | 35 | 1C,TBP | | HW-34412 | scvg waste receiver |
| January-February 1955 | IN/OUT | * | 738 | 1C,TBP | | HW-35022 | scvg waste receiver |
| March 1955 | IN/OUT | * | 276 | 1C,TBP | | HW-36001 | scvg waste receiver |
| April-May 1955 | IN/OUT | * | 735 | 1C,TBP | | HW-36553 | scvg waste receiver |
| June 1955 | IN/OUT | * | 48 | 1C,TBP | | HW-38000 | scvg waste receiver |
| July 1955 | IN/OUT | * | 571 | 1C,TBP | | HW-38401 | receiving waste at months end |
| August 1955 | IN/OUT | * | 392 | 1C,TBP | BY-#4 cavern at 8/31 | HW-38926 | |
| September 1955 | IN/OUT | * | 739 | 1C,TBP | | HW-39216 | scvg waste receiver |

## Table B.4-1. Tank 241-BY-107 Transfers 1951 through 1979 (4 sheets)

| Date | Transfer Type | Transfer Volume (gal*1000) | Total Volume in Tank (gal*1000) | Waste Type | Transfer to/from | Document Number (full titles in Section B.6 REFERENCES) | Comment |
|---|---|---|---|---|---|---|---|
| October 1955 | IN/OUT | * | 147 | 1C,TBP | | HW-39850 | scvg waste receiver |
| November 1955 | IN/OUT | * | 724 | 1C,TBP | | HW-40208 | scvg waste receiver |
| December 1955 | IN/OUT | * | 177 | 1C,TBP | | HW-40816 | caverned during month |
| January 1956 | IN/OUT | * | 738 | 1C,TBP | | HW-41038 | scvg waste receiver |
| February 1956 | IN/OUT | * | 729 | 1C,TBP | | HW-41812 | scvg waste receiver |
| March 1956 | IN/OUT | * | 180 | 1C,TBP | | HW-42394 | |
| April-May 1956 | IN/OUT | * | 721 | 1C,TBP | | HW-42993 | In May pumped to 111-BY and recv'd again |
| June 1956 | IN/OUT | * | 225 | 1C,TBP | 109 & 112-BY | HW-43895 | |
| July 1956 | IN/OUT | * | 544 | 1C,TBP | 102-BX | HW-44860 | |
| August 1956 | IN/OUT | * | 715 | 1C,TBP | | HW-45140 | |
| September 1956 | IN/OUT | * | 87 | 1C,TBP | #8 BC ditch | HW-45738 | 522M to #8 BC ditch |
| October 1956 | IN/OUT | * | 714 | TBP | | HW-46382 | 627 M rec'd |
| November 1956 | IN/OUT | * | 454 | TBP | | HW-47052 | rec'd from 241-WR & ditched 588M gals |
| December 1956 | IN/OUT | * | 755 | TBP | | HW-47640 | 301M from U Plant |
| January 1957 | STAT | | 755 | TBP | | HW-48144 | estimated reading |
| February 1957 | IN/OUT | * | 194 | TBP | BC Ditch | HW-48846 | 561M sent #14 BC ditch |
| March 1957 | IN/OUT | * | 524 | TBP | | HW-49523 | rec'd 330M gals |
| April-June 1957 | IN/OUT | * | 722 | | | HW-50127 | rec'd 198M gals |
| July 1957 | IN/OUT | * | 524 | TBP | BC-18 trench | HW-51858 | 198M to BC 18 trench |
| August 1957 | STAT | | 524 | TBP | | HW-52414 | |
| September 1957 | IN/OUT | * | 486 | TBP | BC-19 trench | HW-52932 | |
| October 1957 | OUT | -3 | 483 | TBP, CW | | HW-53573 | latest electrode reading |
| November 1957 | OUT | -311 | 172 | TBP, CW | 102-BY | HW-54067 | |
| December 1957 | STAT | | 172 | TBP, CW | | HW-54519 | |

**Table B.4-1. Tank 241-BY-107 Transfers 1951 through 1979 (4 sheets)**

| Date | Transfer Type | Transfer Volume (gal*1000) | Total Volume in Tank (gal*1000) | Waste Type | Transfer to/from | Document Number (full titles in Section B.6 REFERENCES) | Comment |
|---|---|---|---|---|---|---|---|
| January-September 1958 | STAT | | 172 | TBP-CW | | HW-54916 | |
| October 1958 | IN | 363 | | TBP, CW | 105-C | HW-58201 | |
| | IN | 11 | 546 | TBP, CW | flush | | |
| November 1958 | STAT | | 552 | TBP, CW | | HW-58579 | latest electrode reading |
| December 1958 | STAT | 22 | 574 | TBP, CW | | HW-58831 | latest electrode reading |
| January 1959 | IN | 170 | 744 | TBP, CW | 105-C | HW-59204 | |
| February-May 1959 | STAT | | 744 | TBP, CW | | HW-59586 | |
| June 1959-December 1960 | STAT | | 771 | TBP, CW | | HW-61095<br>HW-63896 | No explanation for increase |
| January-June 1961 | STAT | | 733 | TBP, CW | | HW-71610 | |
| July 1961 -June 1963 | STAT | | 736 | TBP, CW | | HW-72625<br>HW-74647<br>HW-78279 | latest electrode reading |
| June-December 1963 | STAT | | 728 | TBP, CW | | | new electrode installed |
| January 1964-September 1969 | STAT | | 726-733 | TBP, CW | | HW-83308<br>ARH-1200 C | |
| October-December 1969 | OUT | -79 | 649 | EB | BY-112 | ARH-1200 D | ITS-2 bottoms & recycle |
| January-March 1970 | IN/OUT | * | 651 | EB | | ARH-1666 A | ITS-2 bottoms & recycle |
| April-June 1970 | IN/OUT | * | 678 | EB | | ARH-1666 B | ITS-2 bottoms & recycle |
| July-September 1970 | IN/OUT | * | 638 | EB | | ARH-1666 C | ITS-2 bottoms & recycle |
| October-December 1970 | IN/OUT | * | 656 | EB | | ARH-1666 D | ITS-2 bottoms & recycle |
| Janury-March 1971 | IN/OUT | * | 624 | EB | | ARH 2074 A | ITS-2 bottoms & recycle |
| April-June 1971 | IN/OUT | * | 674 | EB | | ARH-2074 B | ITS-2 bottoms & recycle |
| July-September 1971 | IN/OUT | * | 605 | EB | | ARH-2074 C | ITS-2 bottoms & recycle |
| October-December 1971 | IN/OUT | * | 664* | EB | | ARH-2074 D | ITS-2 bottoms & recycle |
| January-March 1972 | IN/OUT | * | 689 | EB | | ARH-2456 A | ITS-2 bottoms & recycle |

**Table B.4-1. Tank 241-BY-107 Transfers 1951 through 1979 (4 sheets)**

| Date | Transfer Type | Transfer Volume (gal*1000) | Total Volume in Tank (gal*1000) | Waste Type | Transfer to/from | Document Number (full titles in Section B.6 REFERENCES) | Comment |
|---|---|---|---|---|---|---|---|
| April-June 1972 | IN/OUT | * | 634 | EB | | ARH-2456 B | ITS-2 bottoms & recycle |
| July-September 1972 | IN/OUT | * | 648 | EB | | ARH-2456 C | ITS-2 bottoms & recycle |
| October-December 1972 | IN/OUT | * | 646 | EB | | ARH-2456 D | ITS-2 bottoms & recycle |
| January-March 1973 | IN/OUT | * | 649 | EB | | ARH-2794 A | ITS-2 bottoms & recycle |
| April-June 1973 | IN/OUT | * | 635 | EB | | ARH-2794 B | ITS-2 bottoms & recycle |
| July-September 1973 | IN/OUT | * | 633 | EB | | ARH-2794 C | ITS-2 bottoms & recycle |
| October-December 1973 | IN/OUT | * | 659 | EB | | ARH-2794 D | ITS-2 bottoms & recycle |
| January-March 1974 | IN/OUT | * | 653 | EB | | ARH-CD-133A | ITS-2 bottoms & recycle |
| April-June 1974 | IN/OUT | * | 492 | EB | | ARH-CD-133B | ITS-2 bottoms & recycle |
| July-September 1974 | IN/OUT | * | 492 | EB | | ARH-CD-133C | BY farm of this doc missing |
| October-December 1974 | IN/OUT | * | 491 | EB | | ARH-CD-133D | ITS-2 bottoms & recycle |
| January-December 1975 | IN/OUT | * | 367 | EB | 106-BX, 110-BY | ARH-CD-336 A | Jul-Sep 1975 removed from service |
| January-December 1976 | STAT | | 367 | EB | | ARH-CD-702 A | 9/76 inactive salt well pumping |
| January-December 1977 | STAT | | 367 | EB | | ARH-CD-822 | March 1976-PHASE 2 PUMPING |
| January 1978 | OUT | -41 | 326 | EB | | RHO-CD-14-JAN | |
| March 1978 | STAT | | 326 | EB | | RHO-CD-14-MAR | PARTIALLY STABILIZED |
| May 1979 | STAT | | 326 | EB | | RHO-CD-14-May 1979 | QUESTIONABLE INTEGRITY/ INACTIVE P.S. |
| July 1979 | STAT | | 326 | EB | | RHO-CD-14-July 1979 | QUESTIONABLE INTEGRITY/ INTERIM STABILIZED |

*Numerous transfers in and out of tank, volumes not shown except as specified in the waste status summary.

ITS-2 = In-Tank Solidification Unit #2

Waste types:
1C = first cycle waste
TBP = tributyl phosphate waste
CW = cladding (coating) waste
U Plant = Uranium Recovery Plant waste
EB = Evaporator Bottoms waste

**B.4.1.1 Integrity of Tank 241-BY-107.** In April 1974, a significant liquid-level decrease was reported in ARHCO Occurrence Report OR-74-27, *Significant Liquid Level Decrease – Tank 241-107-BY*. Concurrent with the decrease in liquid level was an increase in the radiation intensity, which was detected by the tank farm's gross gamma-ray logging system in drywell 22-07-02 at a depth of 29 ft. The liquid volume in the tank was immediately reduced by removal of ~167,000 gal of supernatant liquid. Because the liquid-level readings stabilized after the pump-down, the tank was considered sound at the decreased (pumped) liquid level. The drywell radiation readings also stabilized. In 1984 tank BY-107 was designated as an assumed leaker, with a leak volume of 15,100 gal based on liquid level decreases from 1974 (HNF-EP-0182).

Occurrence reports issued for tank BY-107 include the following:

- On April 5, 1974 an unexpected liquid level decrease occurred in tank BY-107. New photographs indicated a possible new tar ring near the surface of the waste crust, and drywell 22-07-02 experienced a new peak reading. Following these occurrences, ~167,000 gal of supernate was pumped from the tank, and liquid-level and radiation levels appeared to be stabilized (OR-74-27).

- On December 13, 1974 four drywells adjacent to tank BY-107 experienced increased levels of radiation in the 48- to 70-ft depth range. In the previous six months, the liquid level had remained static. The report felt that these readings were the result of migration of old contamination. Following the increases, a salt-well pumping system was installed and pumping of drainable interstitial liquid was initiated (OR-74-153, *Increasing Dry Well Radiation Adjacent To Tank 107-BY*).

- On April 18, 1975 continued increases in two of the drywells surrounding tank BY-107 were observed. Due to previous pumping of supernate, the report notes that use of liquid-level readings as a means for leak detection is no longer accurate. The report raised the possibility of the increased radiation being a result of redistribution of existing waste in the soil rather than from a leak. Salt well pumping was resumed on May 1, 1975 to remove any additional liquid (OR-75-56, *Increasing Dry Well Radiation Adjacent to Tank 107-BY*).

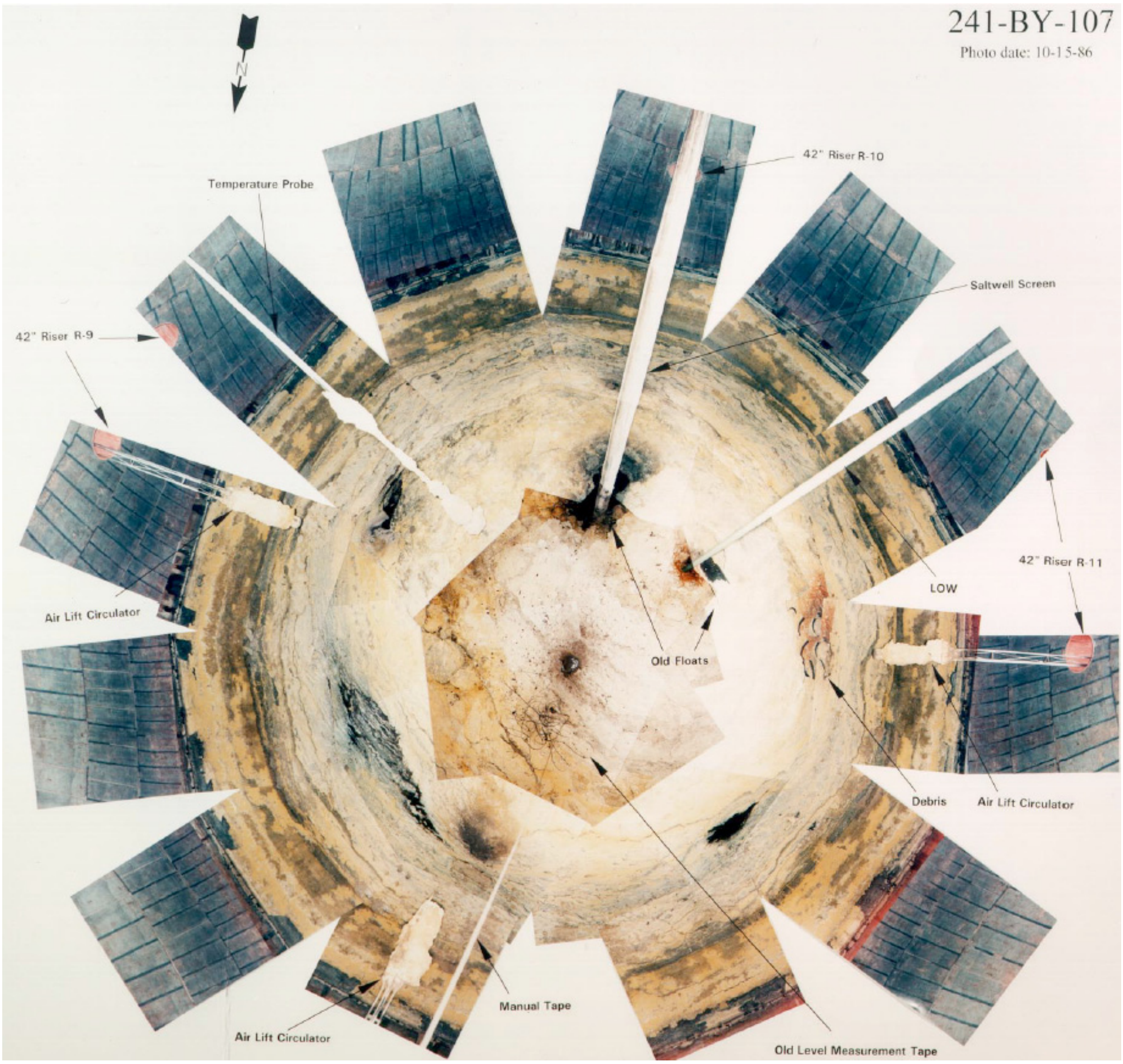
- On May 24, 1975 a liquid level increase of 1.25 in. was observed. The report attributed this increase to inconsistent readings resulting from the uneven nature of the waste surface (OR-77-77, *Liquid Level Exceeding Criterion*).

**B.4.1.2 Interim Stabilization.** Tank BY-107 was interim stabilized in July, 1979 via jet pumping. HNF-SD-RE-TI-178 notes that from a photographic evaluation at the time, "*the surface is 100% dry solids. There appears to be a mound at the center of the tank. There is salt encrusted on the tank wall, and tar can be seen under the flashing and on the tank wall.*"

As of April 30, 2009 the tank contains 271,000 gal of total waste, including 256,000 gal of saltcake, 42,000 gal of drainable interstitial liquid, 15,000 gal of sludge, and no supernatant liquid (HNF-EP-0182). A photo mosaic (Figure B.4-4) details the surface in tank BY-107 as of

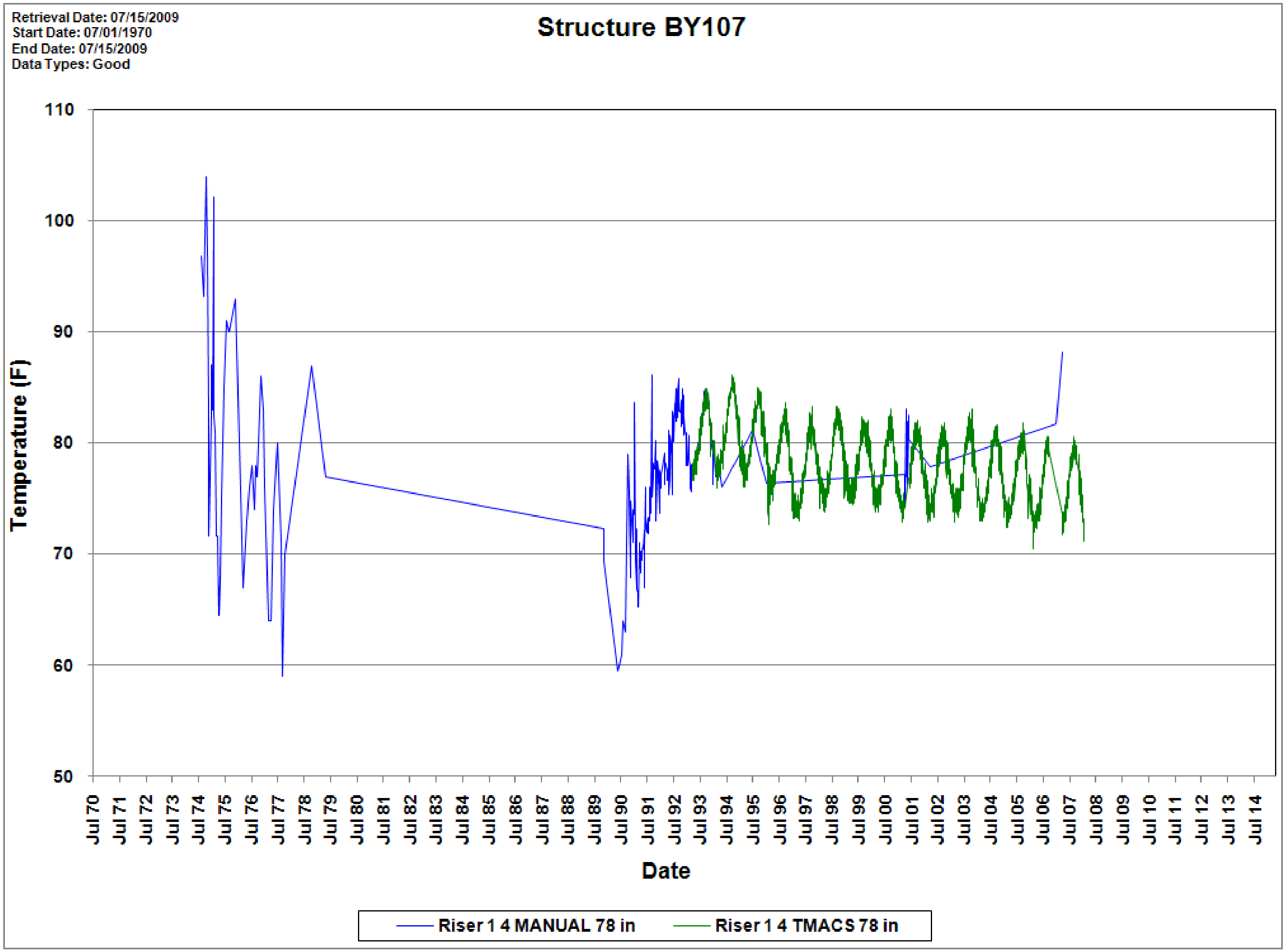
October 15, 1986. The level of the solids in tank BY-107 is ~8 ft above the dished tank bottom (WHC-SD-WM-ER-312, *Supporting Document for the Historical Tank Content Estimate for BY Tank Farm*).

**Figure B.4-4. Tank 241-BY-107 Waste Surface Photo Mosaic**




**B.4.1.3 Tank 241-BY-107 Temperature History.** Figure B.4-5 shows a thermal history for thermocouple 1 in Riser 1 of tank BY-107 from July 1974 through July 2008. No temperature information was found before 1974. A maximum temperature of close to 112 °F is shown in 1974. The waste temperature gradually decreased to ~ 80 °F in 2008 due to removal of waste and decay of radionuclides. Annual waste temperature cycles shown in Figure B4-5 are due to changing atmospheric temperatures during the year.

**Figure B.4-5. Tank 241-BY-107 Temperature Measurements**



### B.4.2 Data Review and Observations

**B.4.2.1 Surface Level Data.** Table B.4-2 shows manual tape surface level measurements from June 1973 to October 1978 (SD-WM-TI-356). The primary unexplained liquid level drop was observed between June 15 and June 28, 1973. However, there was no occurrence report until April 5, 1974 (OR-74-27), which was apparently based on a decrease of 2.5 in. observed between March 16 and March 20, 1974. The manual tape was flushed during this period and the liquid level increased until supernate was transferred during April 1974.

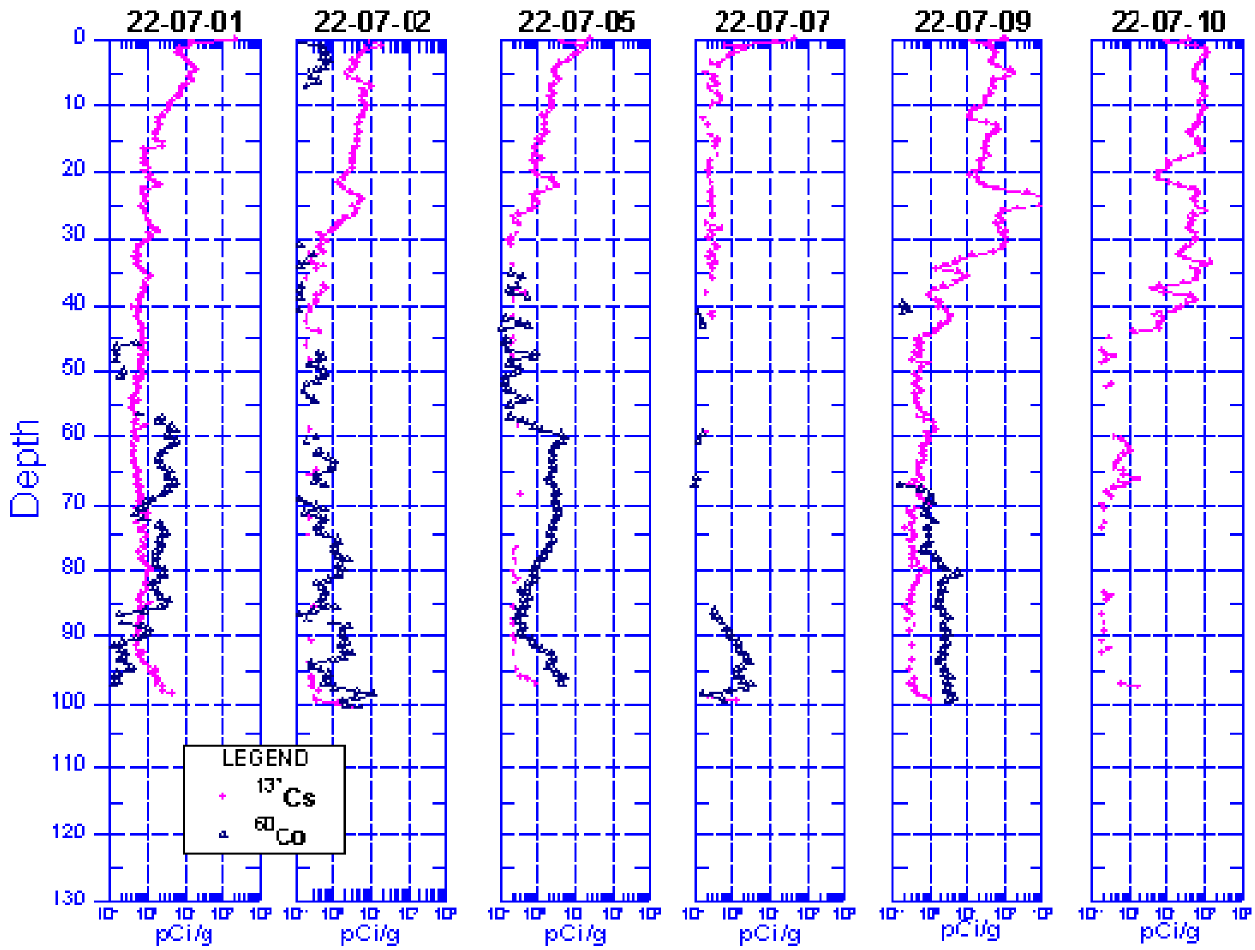
**Table B.4-2. 1973 to 1983 Tank 241-BY-107 Liquid Level Measurements**

| Date | Liquid level (in.) | Baseline ref. | Change from previous reading (in.) | Cumulative change (in.) | Comments |
|---|---|---|---|---|---|
| 6/15/1973 | 243.5 | | - | - | Manual tape |
| 6/28/1973 | 241 | | -2.5 | -2.5 | Unexplained drop |
| 6/29/1973 | 238.5 | | - | -2.5 | New tape |
| 8/10/1973 | 240 | | +1.5 | -1.5 | Slow increase |
| 9/11/1973 | 239.25 | | -0.75 | -1.75 | Slow decrease |
| 9/12/1973 | 237.5 | | -1.75 | -3.5 | Flushed tape |
| 10/9/1973 | 237.75 | | +0.25 | -3.25 | Slow increase |
| 10/10/1973 | 247.25 | | - | -3.25 | Transfer |
| 3/16/1974 | 247 | | -0.25 | -3.5 | Slow decrease |
| 3/20/1974 | 244.5 | | -2.5 | -6 | Tape flushes |
| 4/10/1974 | 245.25 | | +0.75 | -5.25 | Slow increase |
| 5/3/1974 | 185 | | - | -5.25 | Transfers |
| 6/10/1974 | 185.25 | | -0.25 | -5.5 | Slow decrease |
| 6/11/1974 | 186.5 | | - | -5.5 | New tape and spoolpiece for tape |
| 1/9/1975 | 186.5 | | - | -5.5 | Stable |
| 1/22/1976 | 111 | | - | -5.5 | Salt-well transfers |
| 2/19/1976 | 109 | | -2.00 | -7.5 | Steady decrease |
| 1/25/1977 | 109 | | - | -7.5 | Stable |
| 2/4/1977 | 108.5 | | -0.5 | -8.00 | Erratic decrease |
| 3/21/1977 | 129 | | - | -8.00 | Transfers and new tape installed |
| 10/12/1977 | 127.25 | | | | Salt-well transfers |
| 11/30/1977 | 127.25 | | | | Stable |
| 3/27/1978 | 125.75 | | | | Salt-well transfers |
| 5/10/1978 | 125.25 | | | | Slow decrease |
| 7/26/1978 | 124.5 | | | | Salt-well transfers |
| 9/19/1978 | 124.25 | | | | Slow decrease |
| 10/11/1978 | 124 | | | | Salt-well transfers |

Reference: SD-WM-TI-356, *Waste Storage Tank Status and Leak Detection Criteria*.

**B.4.2.2 Drywell Logging Data.** Six vadose zone monitoring drywells surround tank BY-107 (see Figure 4-1 of the main text). They were drilled in the early to mid-1970s, ~20 years after the tank went into service. The drywells are all 100 ft deep, and they are located at distances ranging from 6 to 20 ft outside the steel tank liner. Figure B.4-6 shows spectral gamma logging results collected after 1995 for these drywells (GJ-HAN-24, *Vadose Zone Characterization Project at the Hanford Tank Farms Tank Summary Data Report for Tank BY-107*). Results for 22-07-01, 22-07-02, 22-07-05 and 22-07-09 are discussed below.

**Figure B.4-6. Tank 241-BY-107 Drywell Spectral Gamma Data Collected after 1995**




Reference: GJ-HAN-24, *Vadose Zone Characterization Project at the Hanford Tank Farms Tank Summary Data Report for Tank BY-107.*

**Drywell 22-07-01**

Drywell 22-07-01 is located ~6 ft from the north side of tank BY-107. This drywell was drilled in 1970 to a depth of 100 ft and was not perforated or grouted.

Cesium-137 and $^{60}$Co were detected in this drywell (Figure B.4-6). Cesium-137 was detected throughout the drywell at concentrations of ~1 pCi/g or less, with the exception of a zone from the surface to a depth of ~17 ft, and contamination at the bottom of the drywell. Cobalt-60 was detected from 46 to 51 ft, and from 57 ft to TD. Most of the $^{60}$Co concentrations ranged from 1 to 5 pCi/g. The absence of $^{60}$Co above a depth of 45 ft suggests that the contamination likely originated from a subsurface source.

In 1972, a peak gamma count rate of 4,300 cps was observed in drywell 22-07-01 at a depth of 69 ft (SD-WM-TI-356). In 1973 the activity decayed to a peak of 309 cps and spread from 56 to 90 ft. By 1976 the contamination zone had increased in thickness from 40 to 90 ft. The intensity of the contamination decreased at a rate consistent with the half-life decay rate of $^{60}$Co (Figure B4-7). Gross gamma-ray log data acquired in 1994 indicated a contamination plume at depths from 56 to 87 ft consistent with a zone of $^{60}$Co contamination identified with the SGLS.

**Drywell 22-07-02**

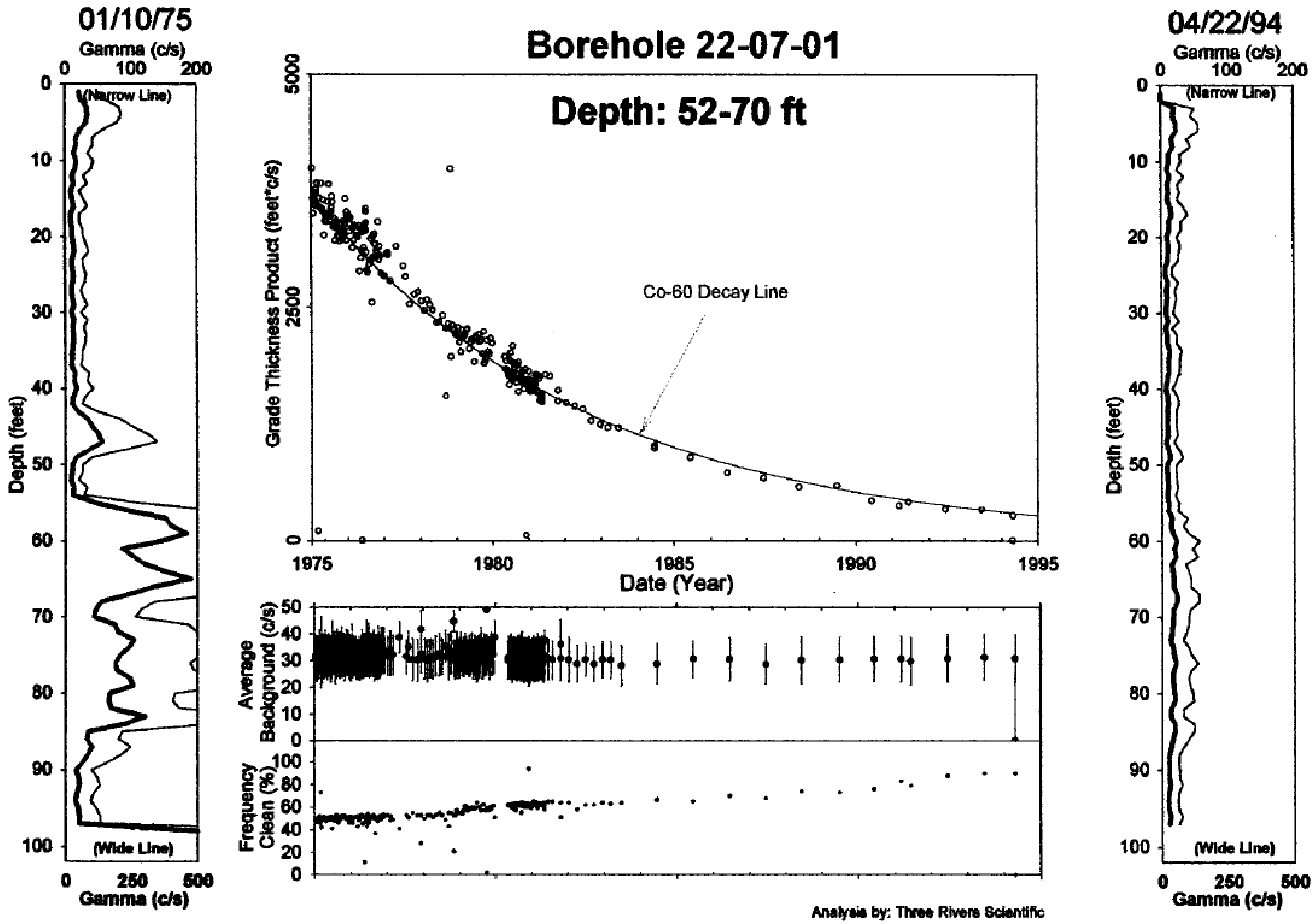
Drywell 22-07-02 is located ~7 ft from the northeast side of tank BY-107. This drywell was drilled in 1973 to a depth of ~100 ft and was not perforated or grouted.

Cesium-137 and $^{60}$Co contamination were detected in this drywell (Figure B.4-6). Cesium-137 was detected from the surface to a depth of ~40 ft, at a few isolated occurrences of low concentration (less than 1 pCi/g), and at the bottom of the drywell. The concentrations in the near-surface zone (0 to 40 ft) ranged between 0.5 and 20 pCi/g. This $^{137}$Cs contamination most likely originated from a surface or near-surface spill or leak that migrated down the drywell casing. The contamination may have been in the sediments prior to drywell drilling and spread by the drilling process. The $^{137}$Cs peak at 23 ft may be indicative of contamination from a subsurface source near that depth. This is the approximate location of the top of the steel tank liner.

Cobalt-60 was detected at several locations throughout the drywell. The most extensive interval of $^{60}$Co contamination occurred from a depth of 60 ft to TD. The concentrations in this zone ranged from 0.1 to 10 pCi/g. Cobalt-60 was also detected from 1 to 7 ft. The $^{60}$Co contamination probably resulted from a surface spill or leak and possibly a subsurface source, either from tank BY-107 or from another tank. The $^{60}$Co contamination appears to have settled in fine-grained sediments at a depth of 60 ft. The vertical extent of the $^{60}$Co contamination is not known, because it is present at the bottom of the drywell.

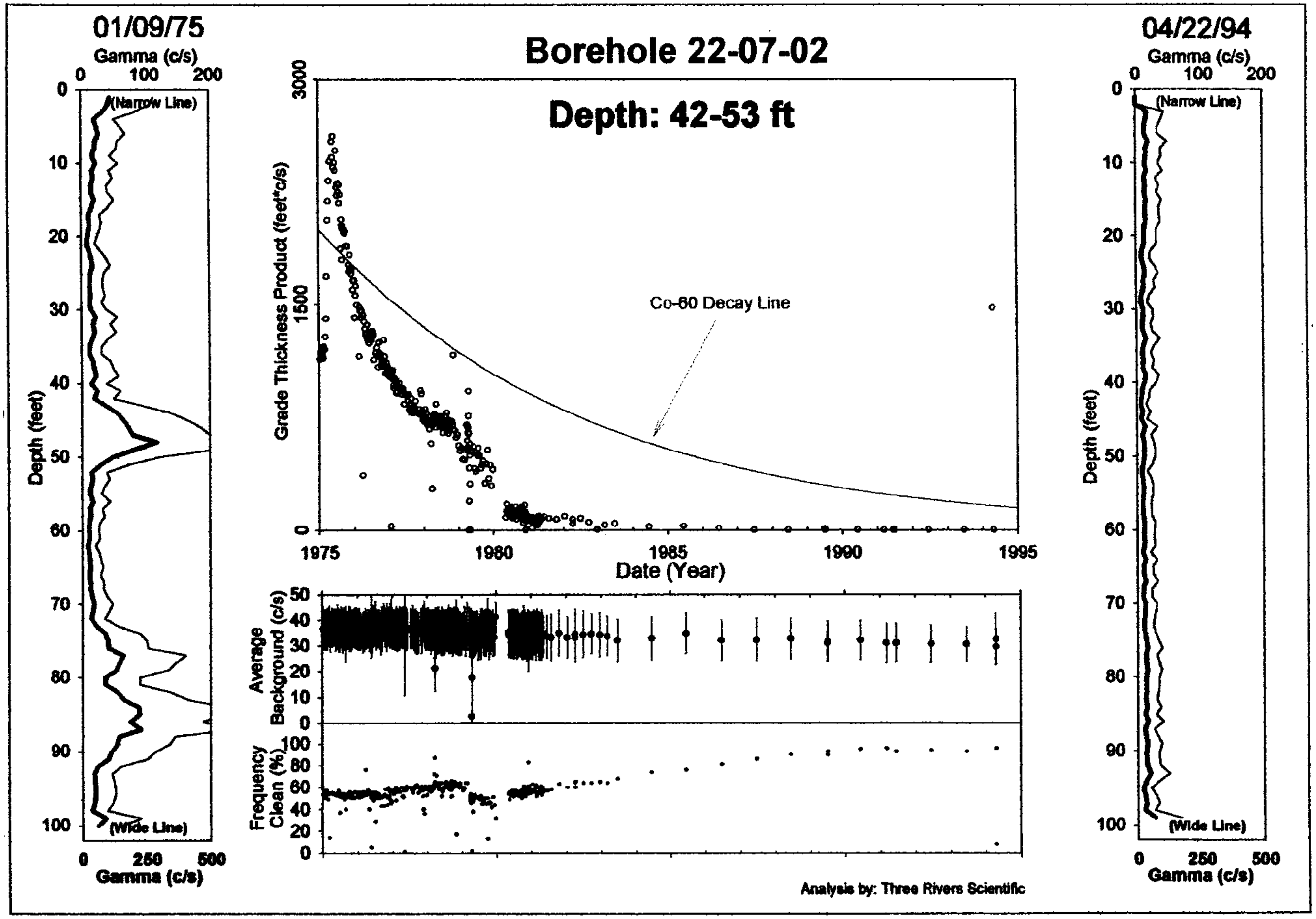
The historical Tank Farms gross gamma-ray log data (Figure B.4-8) indicate the presence of a peak of enhanced count rate (less than 700 cps) at a depth of 83 ft in the log data acquired in 1973. In 1974 a new peak of enhanced count rate (300 cps) was detected at a depth of 48 ft. A zone of contamination was identified in 1979 that contained three peaks at depths of 48, 64, and 90 ft, respectively. The intensities of the peaks measured by the Tank Farms gross gamma-ray system ranged from 150 to 200 cps. Subsequent logging tracked a peak between 75 and 79 ft. The intensities of the gamma-ray activities appeared to diminish at a rate consistent with the half-life of $^{60}$Co. Because the concentrations of the contamination detected with the SGLS are low, the most recent log data do not distinctly show any of the contamination zones.

**Figure B.4-7. Drywell 22-07-01 Total Gamma Results 1975 through 1994**




Reference: HNF-3532, *Analysis of Historical Gross Gamma Logging Data from BY Tank Farm*.

**Figure B.4-8. Drywell 22-07-02 Total Gamma Results 1975 through 1995**




Reference: HNF-3532, *Analysis of Historical Gross Gamma Logging Data from BY Tank Farm*.

**Drywell 22-07-05**
Drywell 22-07-05 is located ~7 ft from the southeast side of tank BY-107. This drywell was drilled in 1970 to a depth of 100 ft and was not perforated or grouted.

Cesium-137 and $^{60}$Co were detected in this drywell (Figure B.4-9). Cesium-137 was detected from the surface to a depth of ~28 ft, and at several isolated locations at low concentration throughout the drywell. This zone of $^{137}$Cs contamination probably resulted from a surface spill or leak that migrated downward.

Cobalt-60 was detected from 57 ft to TD, and at several intermittent locations from 35 to 55 ft in depth. The concentrations of the $^{60}$Co contamination in the continuous zone ranged from 0.2 to 6 pCi/g. The absence of $^{60}$Co from the surface to a depth of 28 ft indicates that the $^{60}$Co contamination may have originated from the subsurface. The maximum depth extent of the $^{60}$Co contamination into the vadose zone is not known, because the contamination migrated beyond the depth of the drywell at a depth of 100 ft. The continuous zone of $^{60}$Co contamination occurs within a zone of fine-grained sediments.

The historical Tank Farms gross gamma-ray log data indicated a peak of elevated count rate at a depth of 68 ft in the log data acquired in 1973 (SD-WM-TI-356). A new peak was identified at 50 ft in the data acquired in 1975 (Figure B4-9). Subsequent logging defined a contamination zone from a depth of 40 to 70 ft. The intensity of the contamination diminished at a rate consistent with the half-life of Co-60. This contamination zone is not distinguishable above background in the SGLS data.

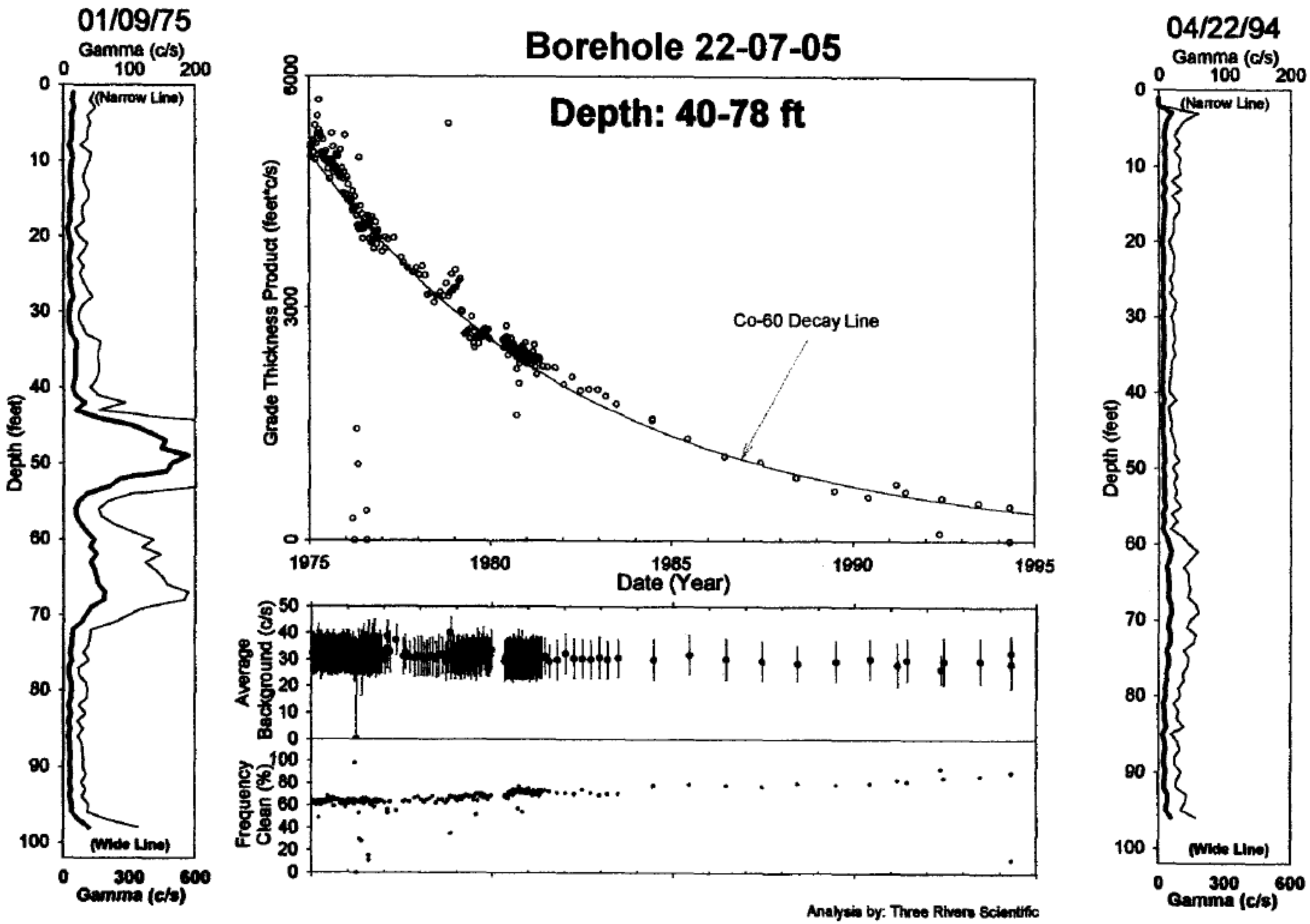
**Drywell 22-07-09**
Drywell 22-07-09 is located ~7 ft from the west side of tank BY-107. This drywell was drilled in 1970 to a depth of ~100 ft and not perforated or grouted.

Cesium-137 and $^{60}$Co were detected in this drywell (Figure B.4-6). Cesium-137 was detected throughout the drywell. The $^{137}$Cs concentrations from the surface to a depth of 45 ft ranged between 0.5 and almost 4,000 pCi/g. The highest concentration of $^{137}$Cs contamination was measured at a depth of 24 ft. The contamination from the surface to a depth of 45 ft is most likely the result of the downward migration of surface contamination and contamination from a subsurface source near a depth of 24 ft.

Cobalt-60 was detected at depths from 39 to 41 ft, and from 67 ft to TD. The $^{60}$Co concentration in the lower zone ranged between 0.7 and 6 pCi/g. The $^{60}$Co concentration from 39 to 41 ft was less than 0.5 pCi/g.

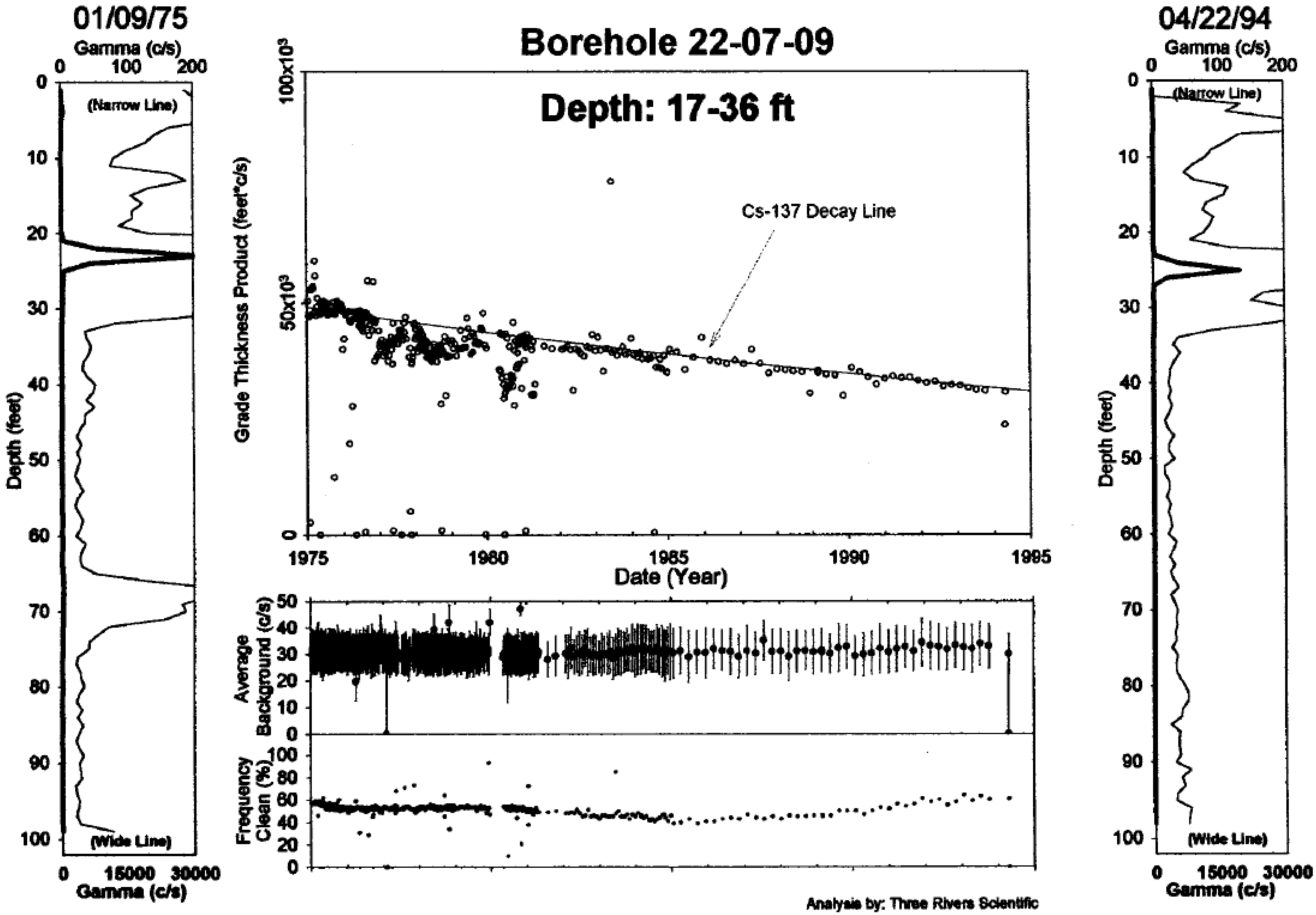
Historical Tank Farms gross gamma-ray logging data identified two peaks of enhanced count rate: one at a depth of 25 ft and one from 68 to 70 ft. The intensity of the peak at 25 ft between 1974 and 1975 was from 22,000 to 31,000 cps. The intensity of this peak decayed gradually through 1994 following a $^{137}$Cs decay curve. The peak observed at a depth of 68 to 70 ft increased in intensity from 50 cps in 1974 to 300 cps in 1975, then migrated to a depth of about 80 ft and decayed to near background levels by 1994.

**Figure B.4-9. Drywell 22-07-05 Total Gamma Results 1975 through 1994**




Reference: HNF-3532, *Analysis of Historical Gross Gamma Logging Data from BY Tank Farm*.

**Figure B.4-10. Drywell 22-07-09 Total Gamma Results 1975 through 1994**




Reference: HNF-3532, *Analysis of Historical Gross Gamma Logging Data from BY Tank Farm.*

**B.4.2.3 Tank 241-BY-107 Assessment.** Six occurrence reports for BY-107 (OR 74-27, OR 74-153, OR 75-56, OR 77-77 and OR 80-58, *The Unplanned Removal of the Manual Liquid Level Measurement Unit from Tank 107-BY*) were reviewed and discussed. The occurrence reports are for both liquid level decreases and increased drywell activity. The current leak estimate of 15,100 gal appears to be based on a liquid level decrease of 5.5 in. from June 15, 1973 to April 11, 1974.

Based on the occurrence reports and other information reviewed, it was determined that if tank BY-107 leaked it was probably during 1974 prior to April when 167,000 gal was pumped from the tank. After pumping, the liquid level was 15.46 ft above the base of the tank. The manual tape was flushed several times in 1973 and 1974 raising a question of whether actual liquid level decreases occurred.

Small drywell activity increases from <100 to 200 cps were observed in drywell 22-07-02 between January 14 and February 12, 1974 with peak reading at 29 ft below ground surface. In December 1974 OR 74-153 reported increased activity from 48 to 70 ft at 4 additional wells around the tank. OR 74-153 attributed this activity to migration of old contamination. Drywell activity observed in 1974 may also be attributed to a December 16, 1952 leak of 23,000 gal of first cycle waste from a loose flange in an overground transfer system (HW-28471, *Unconfined Underground Radioactive Waste and Contamination in the 200 Areas*, p. 5). OR 75-56 shows the location of a French drain and raw water outlet between tanks BY-107 and BY-104 believed to be the source of high moisture in the area and a contributing factor to migration of contaminants.

**B.4.2.4 Conclusion.** Based on the information reviewed it was concluded that liquid level measurement discrepancies were due to the nature of the waste surface and frequent flushing of the manual tape and do not appear to be an indication of a tank leak. Drywell activity may be explained by the 23,000 gal unplanned release near the tank (HW-28471) and moisture sources in the subsurface. If a tank leak did occur, it was likely above the 15.46 ft level. A formal tank leak assessment per TFC-ENG-CHEM-D-42 is recommended to further assess the integrity of tank BY-107.

## B.5 TANK 241-BY-108 WASTE LOSS EVENT

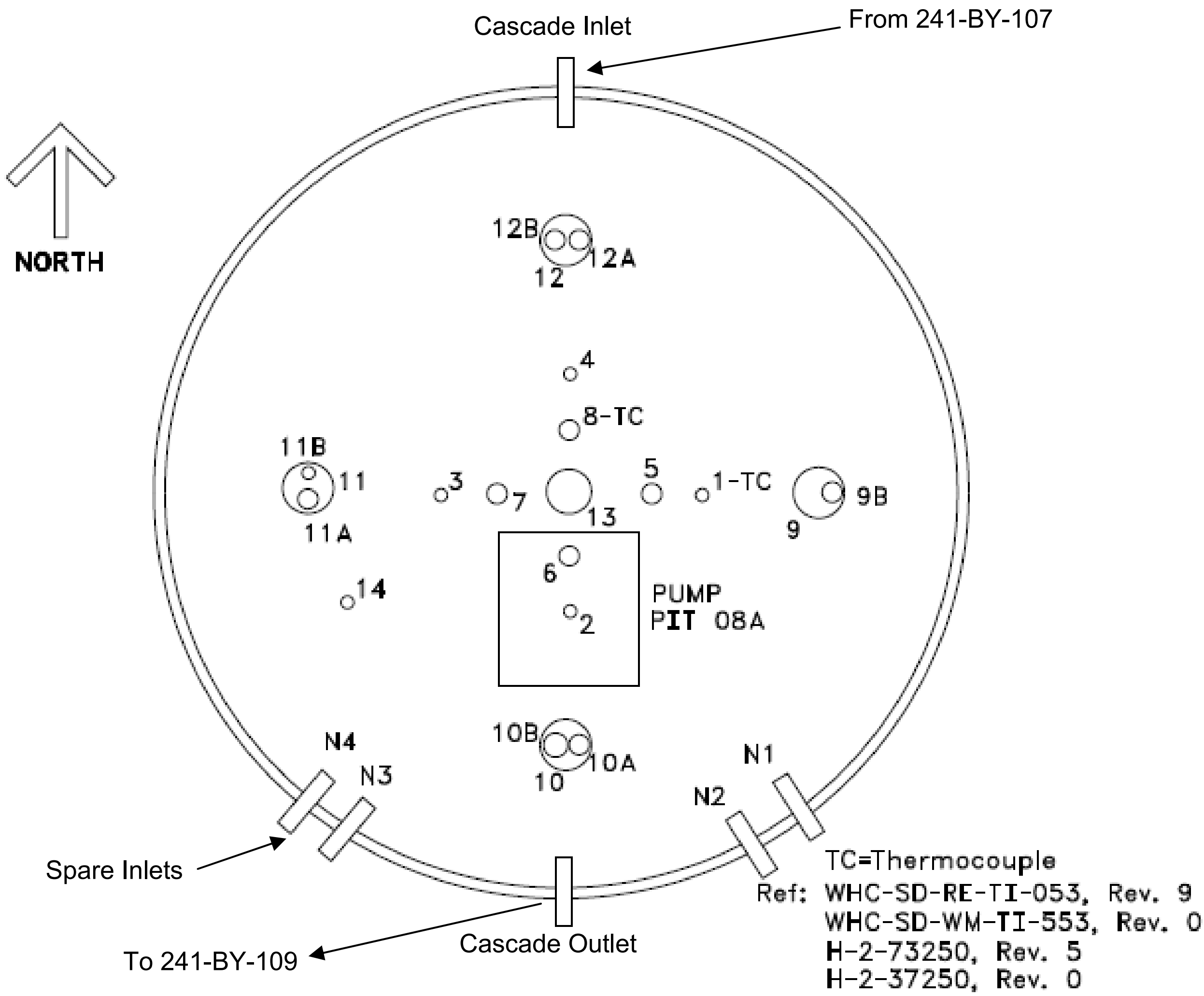
This section provides information on the historical waste loss event associated with tank BY-108. Figure B.5-1 shows a plan view of tank BY-108. The following subsections summarize the waste operating history for tank BY-108 shown in Figure B.5-2. Figure B.5-3 details the waste fill history for tank BY-108.

### B.5.1 Tank 241-BY-108 Waste History

Tank BY-108 was constructed during 1948 and 1949 and was placed into operation in 1951. Tank BY-108 received first cycle waste that cascaded from tank BY-107 from March 1951 through December 1952. During this time BY-108 supernate was sent to tank B-106. Supernate was again sent to tank B-106 in September 1954. From September 1954 through

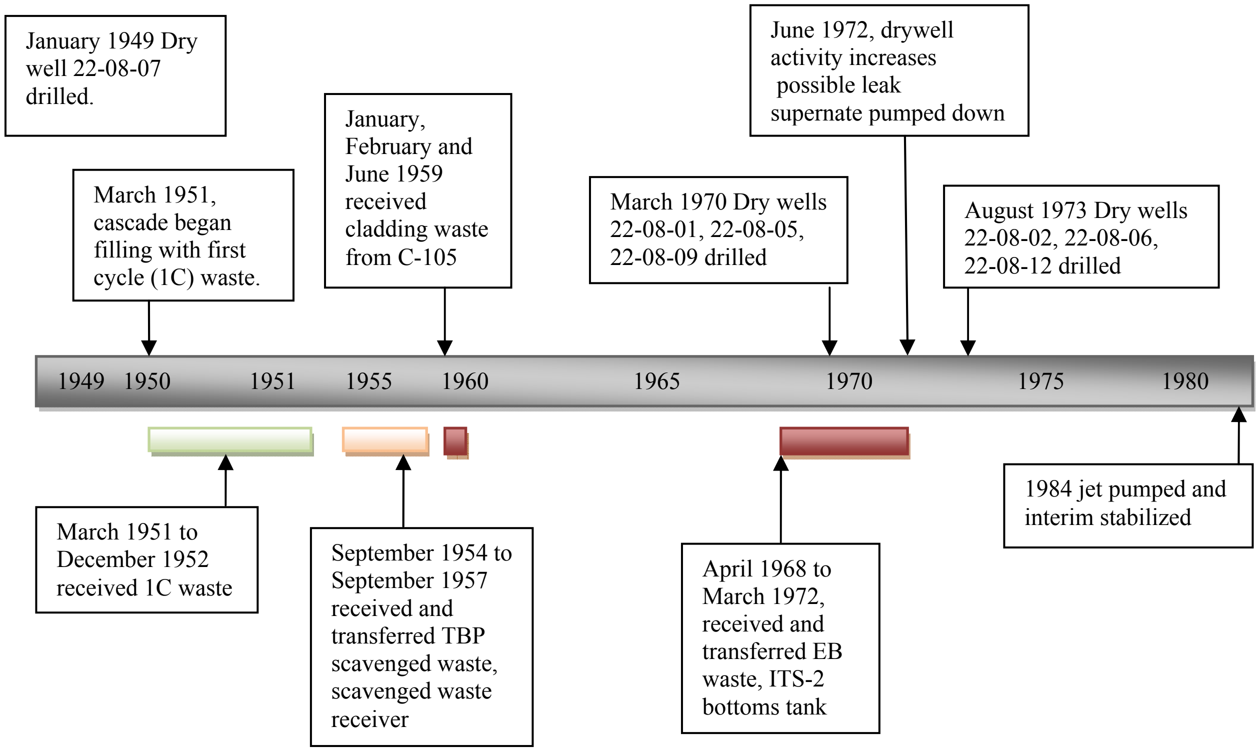
September 1957 BY-108 was a primary settling tank and received and transferred ferrocyanide-scavenged uranium recovery waste. After settling in tank BY-108, the supernatant liquid was transferred to various cribs.

**Figure B.5-1. Tank 241-BY-108 Plan View**




In January, February and June 1959, tank BY-108 received CWP from tank 241-C-105. No additional transfers occurred until the second quarter of 1968, when supernate was pumped to tank BY-109 and tank BY-108 began to receive ITS waste from tank 241-BY-111 (BY-111). From April 1968 until March 1972 tank BY-108 received evaporator bottoms waste from the ITS process. In the second quarter of 1972 the tank was suspected of leaking and supernate was again transferred to tank BY-109. Water was intermittently added to tank BY-108 from 1972 until 1975. Approximately 228,000 gal of waste was left in tank BY-108 after the final transfer in 1984. Table B.5-1 shows the waste transfer history for tank BY-108.

**Figure B.5-2. Tank 241-BY-108 Waste Operating History**




EB = Evaporator Bottoms waste ITS-2 = In-Tank Solidification Unit #2 TBP = tributyl phosphate (waste)

**B.5.1.1 Integrity of Tank 241-BY-108.** Tank BY-108 was categorized as an assumed leaker in 1972 based on increased activity in surrounding drywells. A review of available records did not provide the basis for the current leak volume estimate of <5,000 gal; it appears to be based on uncertainty in manual tape surface level measurements.

In June 1971, PPD-453-DEL, *Monthly Status and Progress Report June 1971* p. AIV-18 reported the following:

> "*Suspect Leaking Tank 108-BY*
>
> *A high radiation reading situation from an adjacent monitoring well to tank 108-BY has been investigated. Frequent scintillation probe checks, coupled with neutron-probe readings, revealed an active leak in the vicinity of the bottom and northerly quadrant of the tank. The tank has been removed from service as a bottom tank for the In-Tank Solidification Program and the contents were pumped down to a level of approximately twelve feet – the apparent salt-cake level in the tank. Design for a well point casing, which will enable the removal of interstitial liquor from the tank, is in progress. Monitoring surveillance is continuing.*"

**Figure B.5-3. Tank 241-BY-108 Waste Fill History**

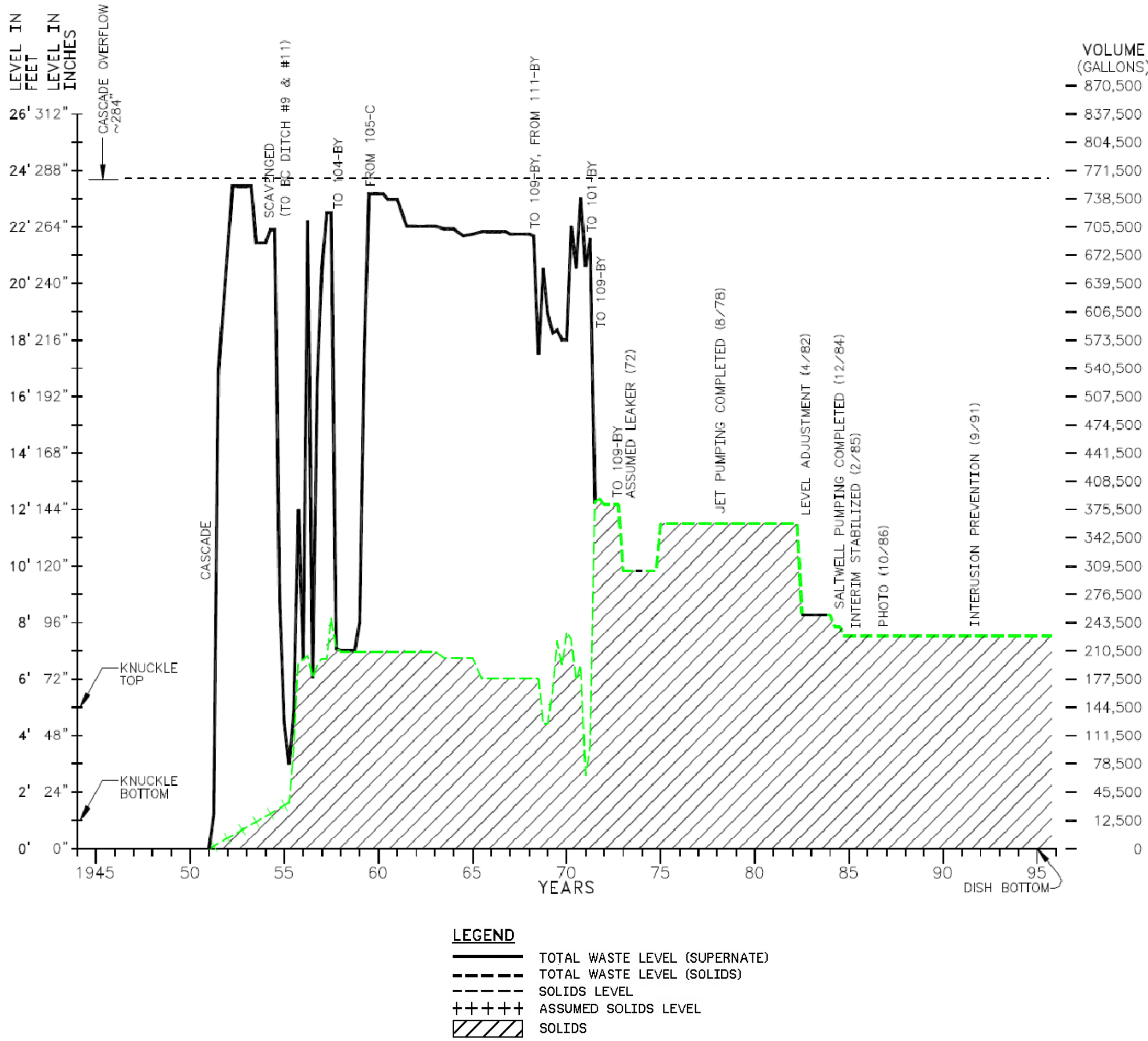


**Table B.5-1. Tank 241-BY-108 Transfers 1951 through 1984 (5 sheets)**

| Date | Transfer Type | Transfer Volume (gal*1000) | Total Volume in Tank (gal*1000) | Discrepancy with Previous Reading (gal*1000) | Waste Type | Transfer to/from | Document Number (full titles in Section B.6 REFERENCES) | Comment |
|---|---|---|---|---|---|---|---|---|
| January-March 1951 | IN | 20 | 20 | | 1C | | WHC-MR-0132 | cascade began filling March |
| April-June 1951 | IN | 518 | 538 | -1 | 1C | | WHC-MR-0132 | cascade |
| July 1951 - December 1952 | IN/OUT | | 758 | | 1C | | HW-27838 | cascade |
| January 1953 | STAT | | 753 | -5 | 1C | | HW-27841 | |
| February-April 1953 | STAT | | 753 | | 1C | | HW-28403 | |
| May 1953 | STAT | | 233 | | TBP | | HW-28377 | receiving TBP waste |
| June-December 1953 | IN | | 687 | | TBP | | HW-28712 | receiving TBP waste |
| January-February 1954 | STAT | | 687 | | TBP | | HW-30851 | |
| March-August 1954 | IN | | 702 | 15 | TBP | | HW-31374 | Aug. to be used for scvg waste |
| September 1954 | IN/OUT | * | 266 | | TBP | | HW-33396 | to be used for scvg waste |
| October 1954 | IN/OUT | * | 7 | | TBP | | HW-33544 | to be used for scvg waste |
| November 1954 | IN/OUT | * | 505 | | TBP | | HW-33904 | to be used for scvg waste |
| December 1954 | IN/OUT | * | 127 | | TBP | | HW-34412 | scvg waste receiver |
| January 1955 | IN/OUT | * | 212 | | TBP | | HW-35022 | scvg waste receiver |
| February 1955 | IN/OUT | * | 738 | | TBP | | HW-35628 | scvg waste receiver |
| March 1955 | IN/OUT | * | 78 | | TBP | | HW-36001 | scvg waste receiver |
| April 1955 | IN/OUT | * | 435 | | TBP | | HW-36553 | scvg waste receiver |
| May 1955 | IN/OUT | * | 736 | | TBP | | HW-37143 | scvg waste receiver |

**Table B.5-1. Tank 241-BY-108 Transfers 1951 through 1984 (5 sheets)**

| Date | Transfer Type | Transfer Volume (gal*1000) | Total Volume in Tank (gal*1000) | Discrepancy with Previous Reading (gal*1000) | Waste Type | Transfer to/from | Document Number (full titles in Section B.6 REFERENCES) | Comment |
|---|---|---|---|---|---|---|---|---|
| June-July 1955 | IN/OUT | * | 140 | | TBP | | HW-38000 | |
| August 1955 | IN/OUT | * | 714 | | TBP | | HW-38926 | receiving TBP waste w/o strontium nitrate additive at month end |
| September 1955 | IN/OUT | * | 376 | | TBP | | HW-39216 | scvg waste receiver |
| October 1955 | IN/OUT | * | 736 | | TBP | | HW-39850 | scvg waste receiver |
| November 1955 | IN/OUT | * | 565 | | TBP | | HW-40208 | scvg waste receiver |
| December 1955 | IN/OUT | * | 120 | | TBP | | HW-40816 | scvg waste receiver |
| January 1956 | IN/OUT | * | 726 | | TBP | | HW-41038 | scvg waste receiver |
| February 1956 | IN/OUT | * | 153 | | TBP | | HW-41812 | scvg waste receiver |
| March 1956 | IN/OUT | * | 34 | | TBP | | HW-42394 | scvg waste receiver |
| April 1956 | IN/OUT | * | 727 | | TBP | BC-5 | HW-42993 | scvg waste receiver |
| May 1956 | IN/OUT | * | 277 | | TBP | | HW-43490 | |
| June 1956 | IN/OUT | * | 179 | | TBP | | HW-43895 | active receiver |
| July 1956 | IN/OUT | * | 722 | | TBP | | HW-44860 | |
| August 1956 | IN/OUT | * | 278 | | TBP | | HW-45140 | |
| September 1956 | IN/OUT | * | 523 | | TBP | | HW-45738 | |
| October 1956 | IN/OUT | * | 722 | | TBP | BC-10 | HW-46382 | 258M transferred to ditch bc-10 |
| November 1956 | IN/OUT | * | 206 | | TBP | BC-11 | HW-47052 | 539M transferred to ditch bc-11 |
| December 1956 | IN/OUT | * | 656 | | TBP | 221-U | HW-47640 | 457M received from 221-U |
| January 1957 | IN/OUT | * | 720 | | TBP | | HW-48144 | latest electrode reading |

**Table B.5-1. Tank 241-BY-108 Transfers 1951 through 1984 (5 sheets)**

| Date | Transfer Type | Transfer Volume (gal*1000) | Total Volume in Tank (gal*1000) | Discrepancy with Previous Reading (gal*1000) | Waste Type | Transfer to/from | Document Number (full titles in Section B.6 REFERENCES) | Comment |
|---|---|---|---|---|---|---|---|---|
| February 1957 | IN/OUT | * | 422 | | TBP | BC-6 crib | HW-48846 | 512M to bc-6 crib; active |
| March 1957 | IN/OUT | * | 722 | | TBP | | HW-49523 | latest electrode reading |
| April 1957 | IN/OUT | * | 447 | | TBP | BC-15 | HW-50127 | 470m TO 15-BC DITCH |
| May 1957 | IN | 279 | 718 | -8 | TBP | 112-C | HW-50617 | 279M |
| June 1957 | STAT | | 722 | 4 | TBP | | HW-51348 | latest electrode reading |
| July-September 1957 | OUT | 509 | 213 | | TBP | 104-BY, BC-18 | HW-51858 | 27M to 104-BY, 482M to BC-18 |
| October-December 1957 | STAT | | 211 | -3 | TBP | | HW-53573 | |
| January-October 1958 | STAT | | 211 | | TBP | | HW-54916 | |
| November-December 1958 | STAT | | 244 | 33 | TBP | | HW-58579 | latest electrode reading |
| January 1959 | STAT | | 244 | | TBP | | HW-59204 | |
| February 1959 | IN | 305 | 577 | -28 | TBP/CW | 105-C | HW-59586 | REC'D 305m from 105-C |
| March-May 1959 | STAT | | 557 | -8 | | | HW-60065 | new electrode reading |
| June 1959 | IN | 187 | 744 | | TBP/CW | 105-C | HW-61095 | |
| July-December 1959 | STAT | | 744 | | TBP/CW | | HW-61582 | |
| January-April 1960 | STAT | | 744 | | TBP/CW | | HW-63896 | |
| May-December 1960 | STAT | | 738 | -6 | TBP/CW | | HW-65643 | latest electrode reading |
| January-December 1961 | STAT | | 706 | -32 | TBP/CW | | HW-71610 | |
| January-December 1962 | STAT | | 706 | | TBP/CW | | HW-74647 | Jul-Dec "latest electrode reading" |

**Table B.5-1. Tank 241-BY-108 Transfers 1951 through 1984 (5 sheets)**

| Date | Transfer Type | Transfer Volume (gal*1000) | Total Volume in Tank (gal*1000) | Discrepancy with Previous Reading (gal*1000) | Waste Type | Transfer to/from | Document Number (full titles in Section B.6 REFERENCES) | Comment |
|---|---|---|---|---|---|---|---|---|
| January-December 1963 | STAT | | 703 | -3 | TBP/CW | | HW-78279 | |
| January-June 1964 | STAT | | 695 | -8 | TBP/CW | | HW-83308 | new electrode reading |
| July-December 1964 | STAT | | 697 | 2 | TBP/CW | | RL-SEP-260 | latest electrode reading |
| January-December 1965 | STAT | | 700 | 6 | TBP/CW | | RL-SEP-659 | |
| January-December 1966 | STAT | | 700 | | TBP/CW | | ISO-226 | |
| Janaury-December 1967 | STAT | | 697 | -3 | TBP/CW | | ISO-806 | |
| January-March 1968 | STAT | | 695 | -2 | TBP/CW | | ARH-534 | "13m correction" ????? |
| April-June 1968 | IN/OUT | * | 557 | | EB | 109 & 111 BY | ARH-721 | 532 109 BY, 394 FROM 111-BY |
| July-September 1968 | IN/OUT | * | 657 | | EB | | ARH-871 | ITS-2 bottoms & recycle |
| October-December 1968 | IN/OUT | * | 479 | | EB | | ARH-1061 | ITS-2 bottoms & recycle |
| January- March 1969 | IN/OUT | * | 582 | | EB | | ARH-1200 A | ITS-2 bottoms & recycle |
| April-June 1969 | IN/OUT | * | 585 | | EB | | ARH-1200 B | ITS-2 bottoms & recycle |
| July-December 1969 | IN/OUT | * | 574 | | EB | | ARH-1200 C | ITS-2 bottoms & recycle |
| January-March 1970 | IN/OUT | * | 706 | | EB | | ARH-1666 A | ITS-2 bottoms & recycle |
| April-June 1970 | IN/OUT | * | 657 | | EB | | ARH-1666 B | ITS-2 bottoms & recycle |
| July-September 1970 | IN/OUT | * | 640 | | EB | | ARH-1666 C | ITS-2 bottoms & recycle |
| October-December 1970 | IN/OUT | * | 659 | | EB | | ARH-1666 D | ITS-2 bottoms & recycle |
| January-March 1971 | IN/OUT | * | 692 | | EB | | ARH-2074 A | ITS-2 bottoms & recycle |
| April-June 1971 | IN/OUT | * | 385 | | EB | | ARH-2074 B | 296 evap by ITS-2, 769 to 101 BY |
| July-September 1971 | IN/OUT | * | 388 | | EB | | ARH-2074 C | ITS-2 bottoms & recycle |
| October-December 1971 | IN/OUT | * | 381* | | EB | | ARH-2074 D | ITS-2 bottoms & recycle |

**Table B.5-1. Tank 241-BY-108 Transfers 1951 through 1984 (5 sheets)**

| Date | Transfer Type | Transfer Volume (gal*1000) | Total Volume in Tank (gal*1000) | Discrepancy with Previous Reading (gal*1000) | Waste Type | Transfer to/from | Document Number (full titles in Section B.6 REFERENCES) | Comment |
|---|---|---|---|---|---|---|---|---|
| January-September 1972 | STAT | | 381 | | EB | | ARH-2456 A | Apr-Jun; TANK LEAKS, 49 to 109 BY Jul-Sep; 7 flush water, 18 to 109 BY |
| October-December 1972 | IN/OUT | * | 312 | | EB | | ARH-2456 D | TANK LEAKS, 16 flush water added |
| January-December 1973 | STAT | | 312 | | EB | | ARH-2794 A | TANK LEAKS |
| January-June 1974 | IN/OUT | * | 304 | | EB | 109-BY | ARH-CD-133A | Tank LEAKS, Jan-Mar; 8 to BY-109 Apr-June; 5 to 109 BY |
| July-September 1974 | IN/OUT | * | | | | | ARH-CD-133C | |
| October-December 1974 | IN | * | 359 | | EB | 109-BY | ARH-CD-133D | TANK LEAKS, 2 water, 6 to BY-109 |
| January 1975-Sept 1982 | STAT | | 359 | | EB | 109-BY | ARH-CD-336 A | TANK LEAKS, 4 TO 109-BY |
| January-December 1984 | OUT | -139 | 228 | | | | RHO-RE-SR-14 JULY HNF-SD-RE-TI-178 | Jet Pumped and interim stabilized |

* Numerous transfers in and out of tank, volumes not shown except as specified in the waste status summary.

ITS-2 = In-Tank Solidification Unit #2

Waste types:
1C = first cycle waste
TBP = tributyl phosphate waste
CW = cladding (coating) waste
U Plant = Uranium Recovery Plant waste
EB = Evaporator Bottoms waste

Two occurrence reports were issued for surface level increases. None were issued for surface level decreases.

- Occurrence Report OR-76-142, *Liquid Level Increase in Excess of 3 Inches* was issued in October 1976 as a result of a 3.5-in. liquid-level increase in tank BY-108. Photographs indicate the rod plummet used to measure the surface level had become entangled with an old discarded measuring tape. The measuring tape was removed, and a new "doughnut" plummet with a larger surface area replaced the rod plummet. The surface-level depth was adjusted for the new measurement readings and no further action was required.

- In 1980, OR-80-5, *Tank 108-BY Liquid Level Measurement (Manual Tape) Exceeding the Increase Criterion* was issued as a result of liquid-level measurements exceeding the increase criterion of 1 in. from the established baseline. The apparent liquid intrusion was attributed to snowmelt that had flowed through excavations around the tank into the tank's pump pit and directly into the tank via the pit drain. An estimated 2,600 gal of snowmelt entered the tank during the intrusion.

**B.5.1.2 Interim Stabilization.** Tank BY-108 supernatant P-10 pumping was completed May 1972 (SD-WM-TI-356). Jet pumping to interim stabilize the tank began on January 9, 1984 and was halted December 9, 1984 due to failure of the jet pump (HNF-SD-RE-TI-178). 1986 photographs showed an uneven crusted surface of saltcake and a pool of liquid around the saltwell casing (Figure B.5-4).

As of July, 2009, the tank contains 182,000 gal of saltcake and 33,000 gal of drainable interstitial liquid with no supernate (HNF-EP-0182).

**B.5.1.3 Tank 241-BY-108 Temperature History.** Figure B.5-5 shows a thermal history for thermocouple 1 in Riser 1 of tank BY-108 from 1974 through July 2008. No temperature information was found before 1974. A maximum temperature of 140 °F is shown in January 1975. The temperature decreased to ~80 °F by 1991, then increased. The temperature as of July 2009 is ~100 °F. Temperature cycling after 1993 is due to more frequent measurements and annual atmospheric temperature changes.

### B.5.2 Data Review and Observations

**B.5.2.1 Surface Level Data.** Table B.5-2 shows manual tape surface level measurements from June 1973 to March 1987 (SD-WM-TI-356). The liquid level showed a steady decrease in August 1973, after supernate pumping and well after the high activity was observed in drywells, but before jet pumping started in January 1984. SD-WM-TI-356 does not explain the steady decrease. However, there was no occurrence report issued for the decrease. Based on transfer records (Table B.5-1), the decrease appears to be due to supernate transfers to tank BY-109 during this period. Other than transfer records and static volume measurements (Table B.5-2), no surface level data was found for tank BY-108 before June 1972.

An occurrence report was filed in 1980 due to an intrusion in the tank, attributed to snow melt.

**Figure B.5-4. Tank 241-BY-108 Waste Surface Photo Mosaic**

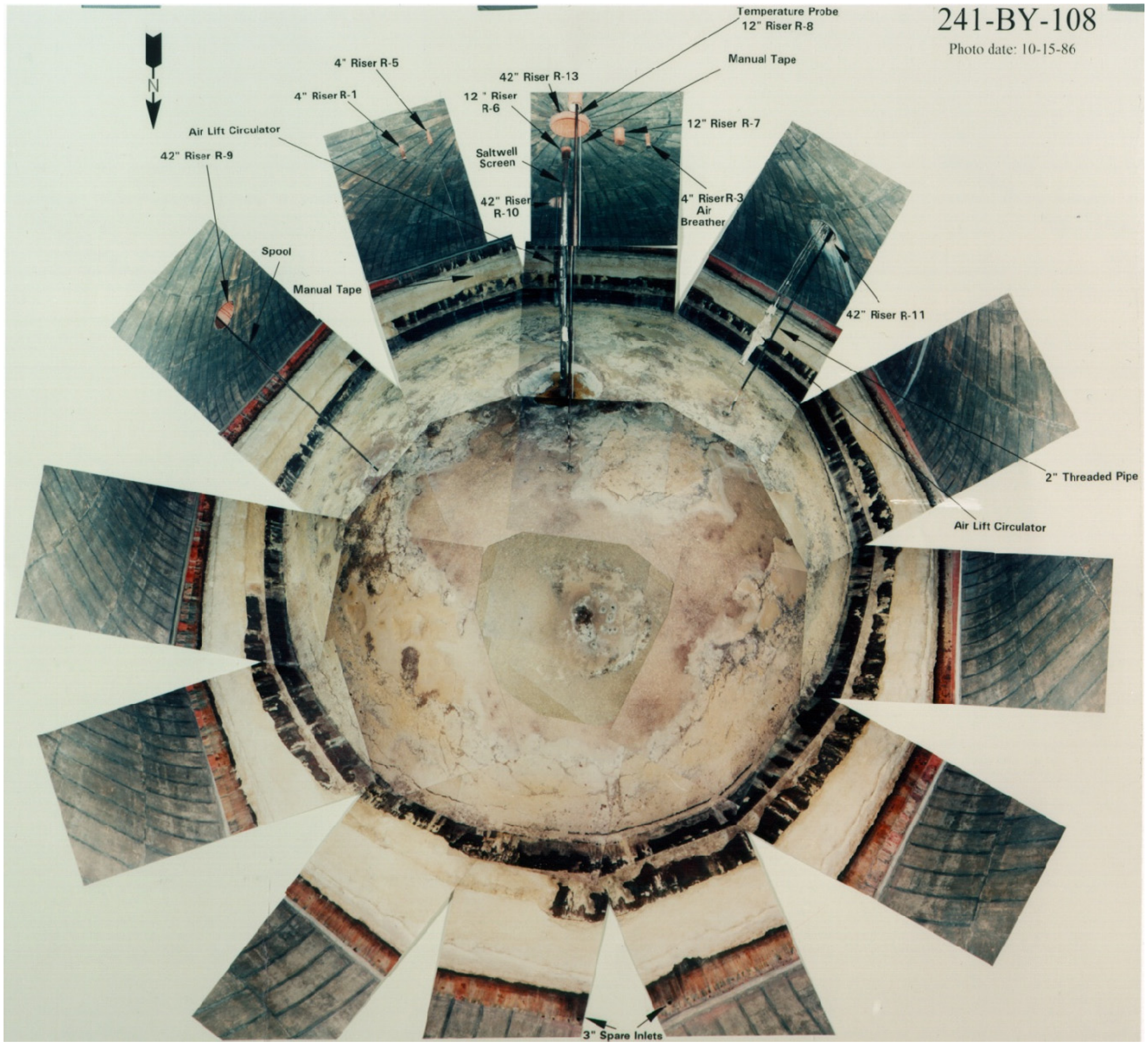
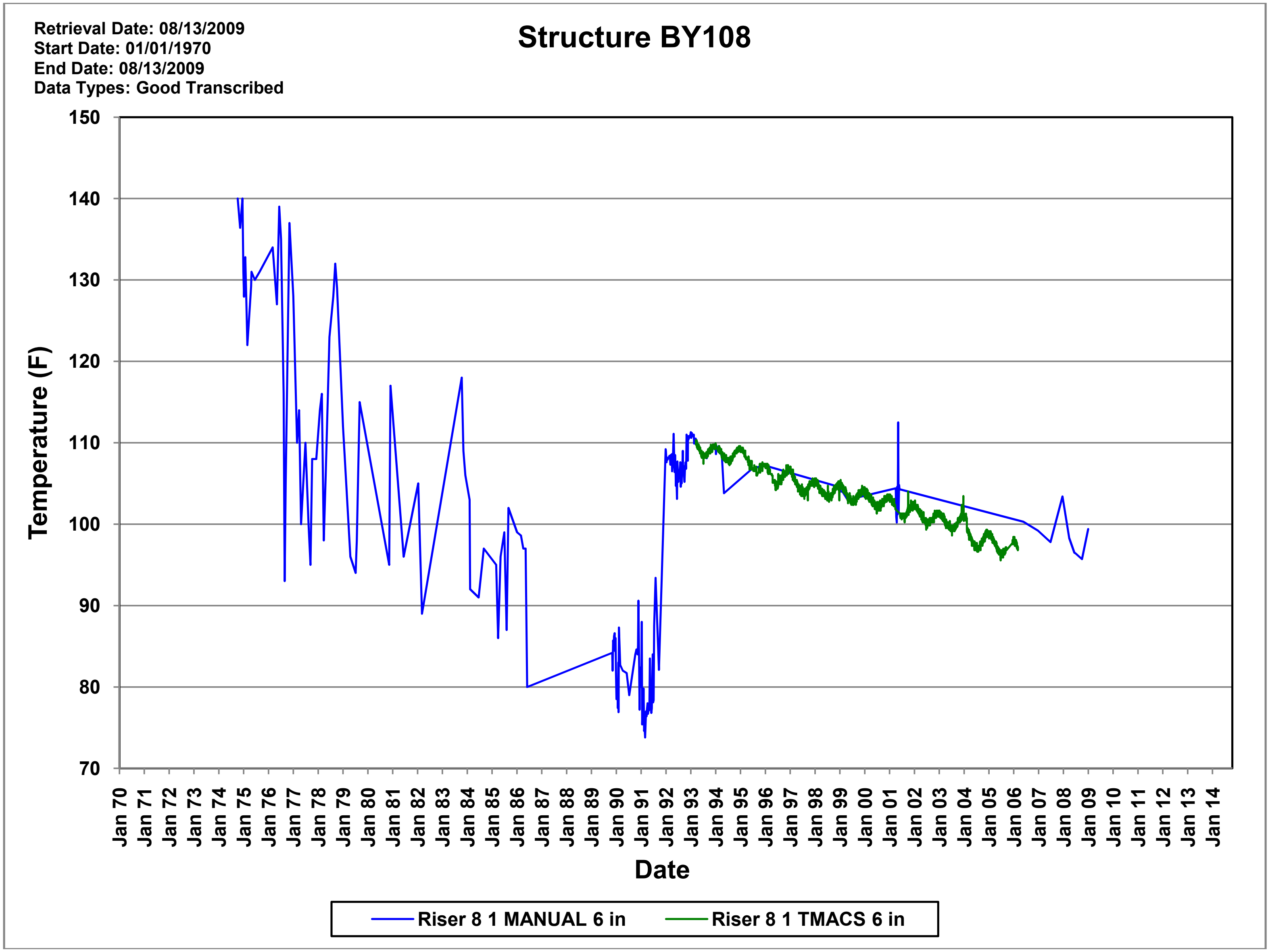


Figure B.5-5. Tank 241-BY-108 Temperature Measurements



## Table B.5-2. Tank 241-BY-108 Liquid Level 1973 to 1987

SD-WM-TI-356
22-08-02

**TANK 108-BY**

Liquid Level.

| Date | Liquid level (in.) | Baseline ref. | Change from previous reading (in.) | Cumulative change (in.) | Comments |
|---|---|---|---|---|---|
| 06/15/73 | 116.50 | | - | - | Manual tape |
| 08/11/73 | 113.00 | | -3.50 | -3.50 | Steady decrease |
| 09/26/73 | 114.00 | | +1.00 | -2.50 | Slow increase |
| 01/25/74 | 113.00 | | -1.00 | -3.50 | Slow decrease |
| 12/20/74 | 113.50 | | - | -3.50 | Salt-well transfers and new tape and spoolpiece |
| 06/24/75 | 112.50 | | -1.00 | -4.50 | Slow decrease |
| 02/24/76 | 106.50 | | - | -4.50 | Salt-well transfers |
| 04/06/76 | 106.50 | | - | -4.50 | Stable |
| 04/28/76 | 106.75 | | +0.25 | -4.25 | Increase despite salt-well transfers |
| 07/04/76 | 106.75 | | - | -4.25 | Readings vary 105.75 to 106.75 in. |
| 10/15/76 | 106.00 | | - | -4.25 | Salt-well transfers |
| 10/16/76 | 109.00 | | +3.00 | -1.25 | Unexplained increase OR 76-142 written |
| 12/13/76 | 109.00 | | - | -1.25 | Stable |
| 12/14/76 | 97.00 | | - | -1.25 | New tape |
| 02/07/77 | 97.00 | | - | -1.25 | Stable |
| 02/08/77 | 97.00 | | - | -1.25 | Salt-well transfer |
| 03/08/77 | 95.00 | | -2.00 | -3.25 | Erratic decrease |
| 11/03/77 | 95.00 | | - | -3.25 | Stable |
| 11/16/77 | 94.75 | | - | -3.25 | Salt-well transfer |
| 05/16/78 | 94.75 | | - | -3.25 | Stable |
| 08/25/78 | 94.75 | | - | -3.25 | Salt-well transfers |
| 12/15/78 | 94.75 | | - | -3.25 | Stable |
| 03/15/79 | 94.25 | | -0.50 | -3.75 | Slow decrease |
| 12/30/79 | 94.50 | | +0.25 | -3.50 | Slow increase |
| 12/31/79 | 96.00 | | - | -3.50 | New tape installed |
| 01/15/80 | | 99.50 | - | -3.50 | Snow melt, water drainage; OR 80-05 |
| 03/04/80 | 100.00 | | +0.50 | -3.00 | Readings vary from 99.50 to 100.00 in. |
| 03/31/81 | 100.75 | | +0.75 | -2.25 | Stable ±0.50 |
| 03/24/82 | 100.00 | | -0.75 | -3.00 | Stable |
| 03/15/83 | 100.00 | | - | -3.00 | Stable |
| 01/09/84 | 99.75 | | -0.25 | -3.25 | Stable |
| 01/10/84 | 97.25 | | - | -3.25 | Salt-well pumping |
| 03/12/84 | 94.50 | | - | -3.25 | Salt-well pumping |
| 10/01/84 | | 90.00 | - | -3.25 | Salt-well pumping |
| 03/14/85 | | 88.25 | - | -3.25 | Associated with salt-well pumping |
| 01/01/86 | 88.00 | | -0.25 | -3.50 | Slow decrease |
| 03/03/86 | 87.00 | | -1.00 | -4.50 | Unexplained decrease |
| 04/01/86 | 88.00 | | +1.00 | -3.50 | |
| 03/02/87 | 88.00 | | | -3.50 | Stable |

Rev. 0

**B.5.2.2 Drywell Logging Data.** Seven vadose zone monitoring drywells surround tank BY-108 (see Figure 4-1 of the main text). They were drilled in the early to mid-1970s, ~20 years after the tank went into service. The drywells are all 100 ft deep, and they are located at distances ranging from 6 to 20 ft outside the steel tank liner. Figure B.5-6 shows spectral gamma logging results collected after 1995 for these drywells (GJO-96-2-TARA/GJO-HAN-6).

Historical gross gamma logs shown in Figures B.5-7 to B.5-13 indicate elevated activity in varying amounts in all drywells associated with tank BY-108. This activity has decreased in intensity with time in each drywell and generally corresponds with intervals of contamination identified as $^{60}$Co as measured by the SGLS. The $^{60}$Co contamination is typically located at and below depths corresponding to the historical tank waste level indicating possible subsurface leaks. Drywells 22-08-06 and 22-08-12 are the exceptions, where minor amounts of $^{60}$Co contamination also occur in near-surface deposits.

Possible indications of a subsurface source originating from the tank are shown by elevated $^{137}$Cs concentrations in drywells 22-08-06 and 22-08-02 at ~23 to 26 ft in depth, respectively. This depth range corresponds with the depth to the top of the tank liner and ancillary piping where fluids may have spilled (GJ-HAN-25, *Vadose Zone Characterization Project at the Hanford Tank Farms Tank Summary Data Report for Tank BY-108*). The following sections discuss gamma logging results for each of the seven drywells.

**Drywell 22-08-01**

Drywell 22-08-01 is located ~6 ft from the northeast side of tank BY-108 with a depth of 99 ft. This drywell was drilled in 1970 and completed to a depth of 100 ft.

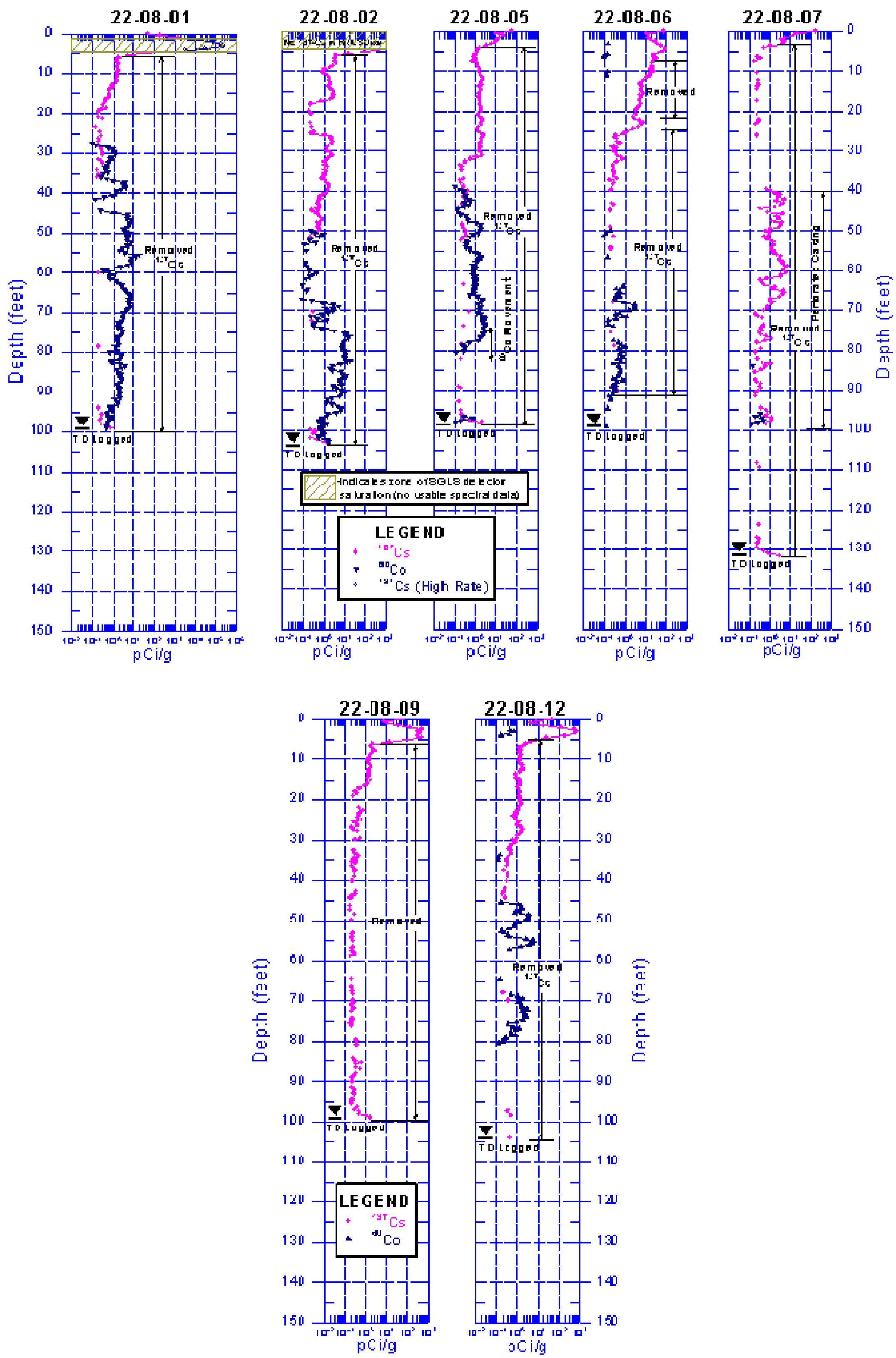
A review of gross-gamma log data collected from this drywell from 1972 to 1994 (Figure B.5-7) shows elevated gamma activity from ~22 to 90 ft in depth. The maximum peak count rate was at 57 ft and measured 21,000 cps in 1972. The count rate steadily decreased to just more than 100 cps in 1994. The rate of decay indicates the activity is a combination of $^{60}$Co and $^{125}$Sb.

Spectral gamma logging system data obtained in 1995 show $^{137}$Cs and $^{60}$Co contaminants in this drywell. The presence of $^{137}$Cs is shown almost continuously from the ground surface to ~36 ft, at a few locations below 36 ft, and near the bottom of the drywell. Cesium-137 concentrations were less than 3 pCi/g except near the ground surface where a maximum concentration of ~1,500 pCi/g was measured at 1 ft. Concentrations of $^{60}$Co were measured continuously from ~28 ft to 99 ft except for an interval from 42 to 44 ft. The concentrations were 10 pCi/g or less with a maximum concentration of ~20 pCi/g at 55.5 ft. The depths where peak concentrations of $^{60}$Co occur correspond with the depths where the historical gross gamma-ray log indicated peak count rates.

**Drywell 22-08-02**

Drywell 22-08-02 is located 8 ft from the northeast side of tank BY-108 with a depth of 103 ft. This drywell was drilled in 1973 to a depth of 100 ft.

**Figure B.5-6. Tank 241-BY-108 Drywell Spectral Gamma Data**




Reference: GJO-96-2-TARA/GJO-HAN-6, *Hanford Tank Farms Vadose Zone: Addendum to the BY Tank Farm Report*.

Figure B.5-7. Drywell 22-08-01 Historical Gamma Logging Plots (sheet 1 of 7)

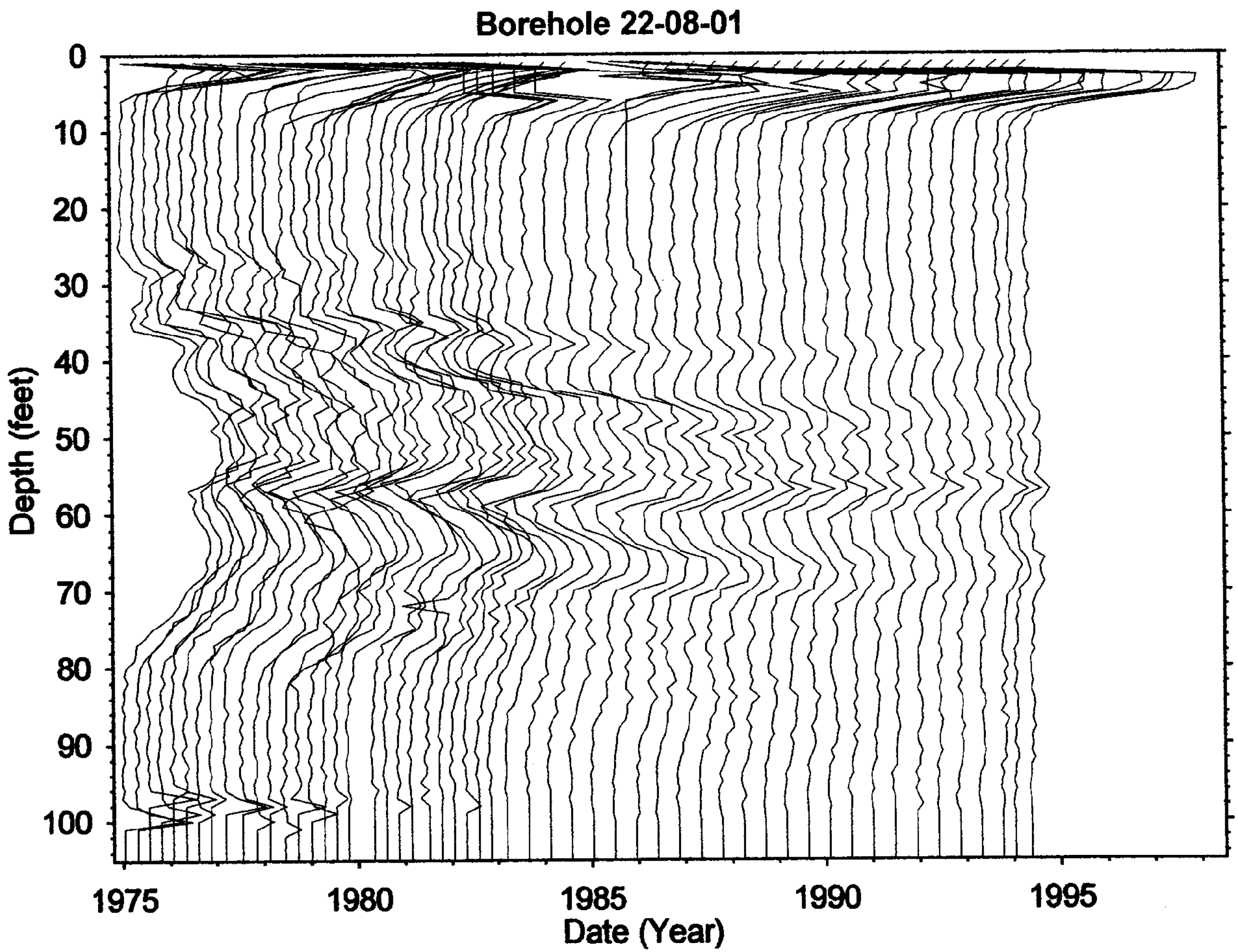


Figure B.5-7. Drywell 22-08-01 Historical Gamma Logging Plots (sheet 2 of 7)

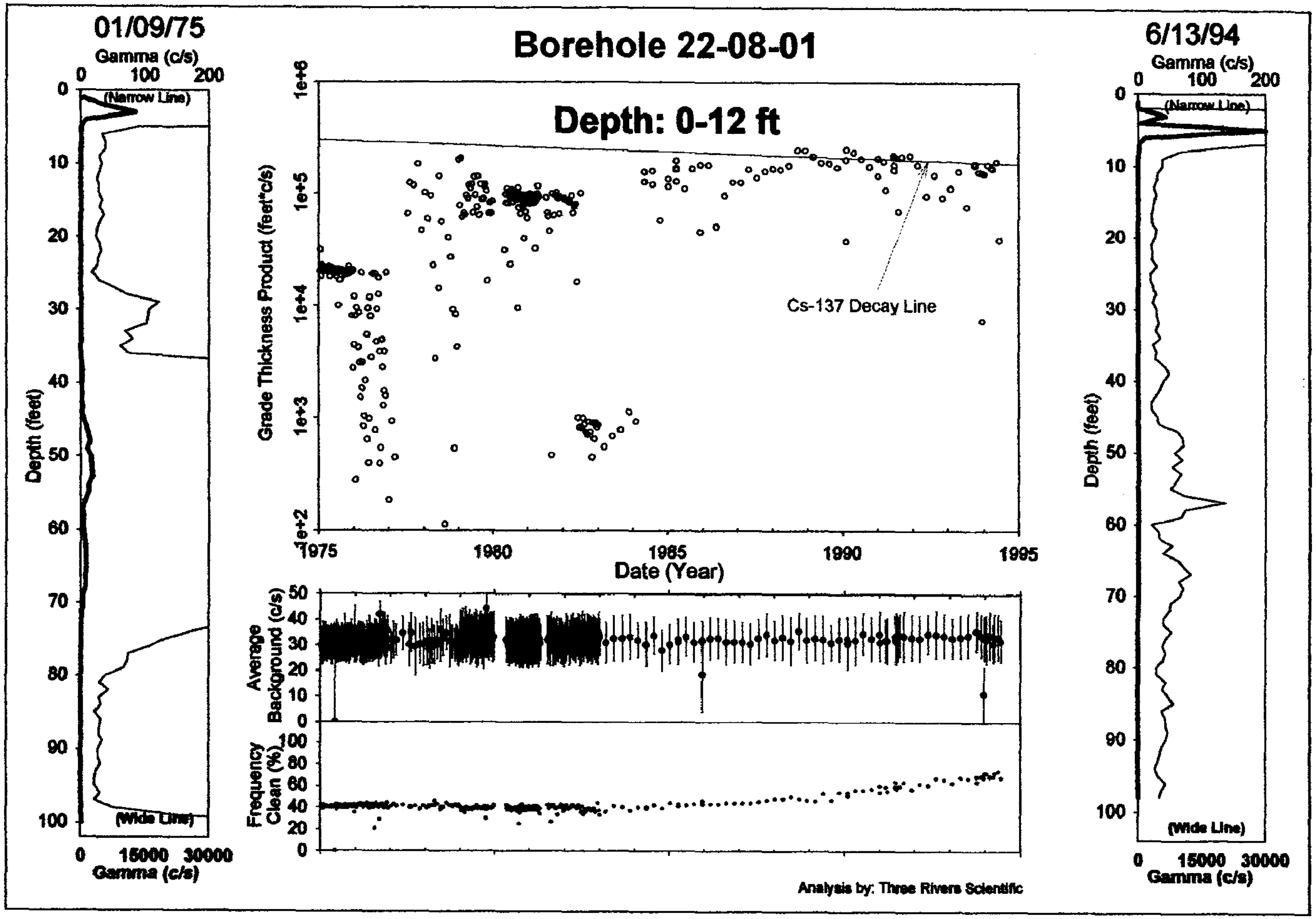


**Figure B.5-7. Drywell 22-08-01 Historical Gamma Logging Plots (sheet 3 of 7)**

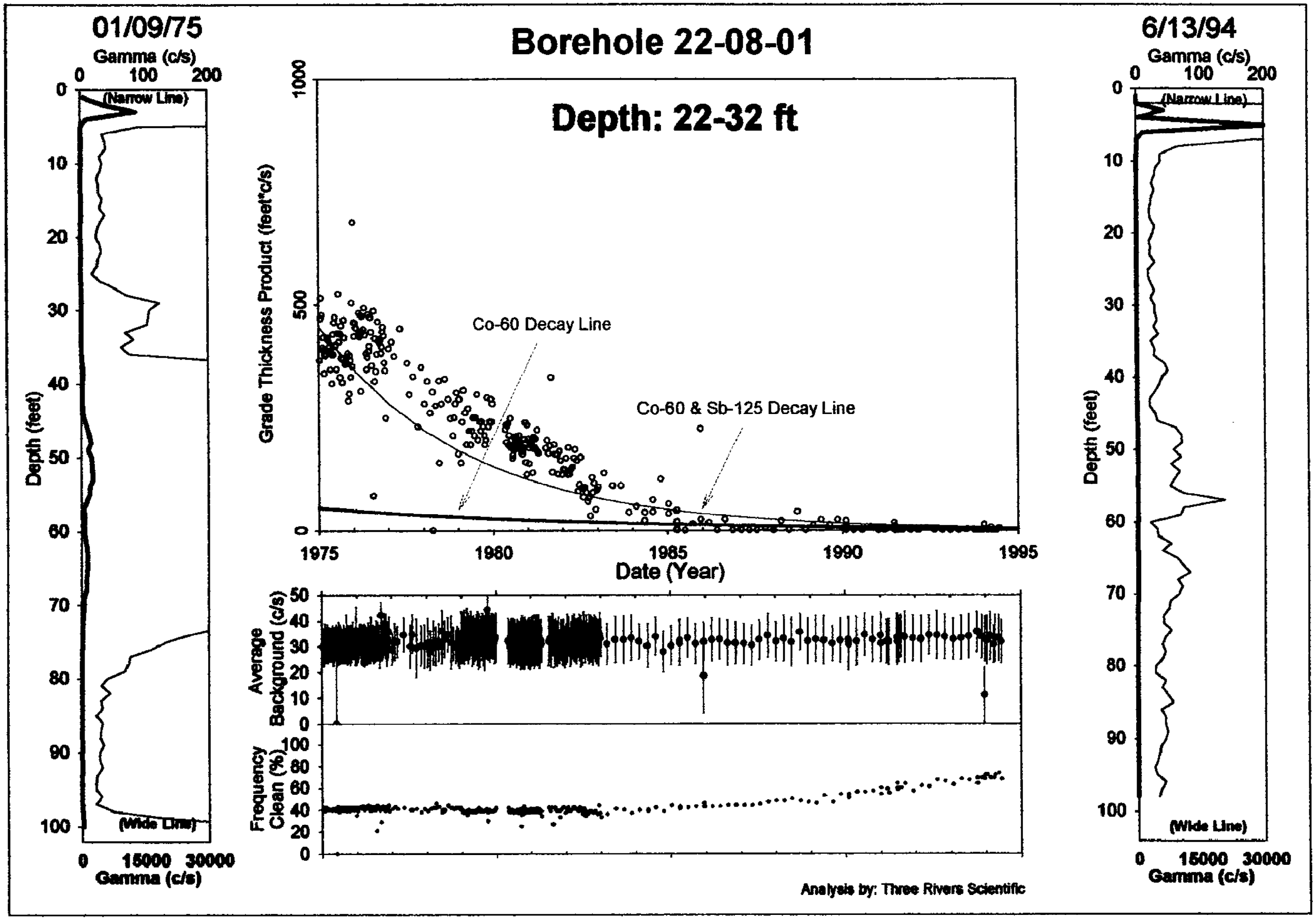


Figure B.5-7. Drywell 22-08-01 Historical Gamma Logging Plots (sheet 4 of 7)

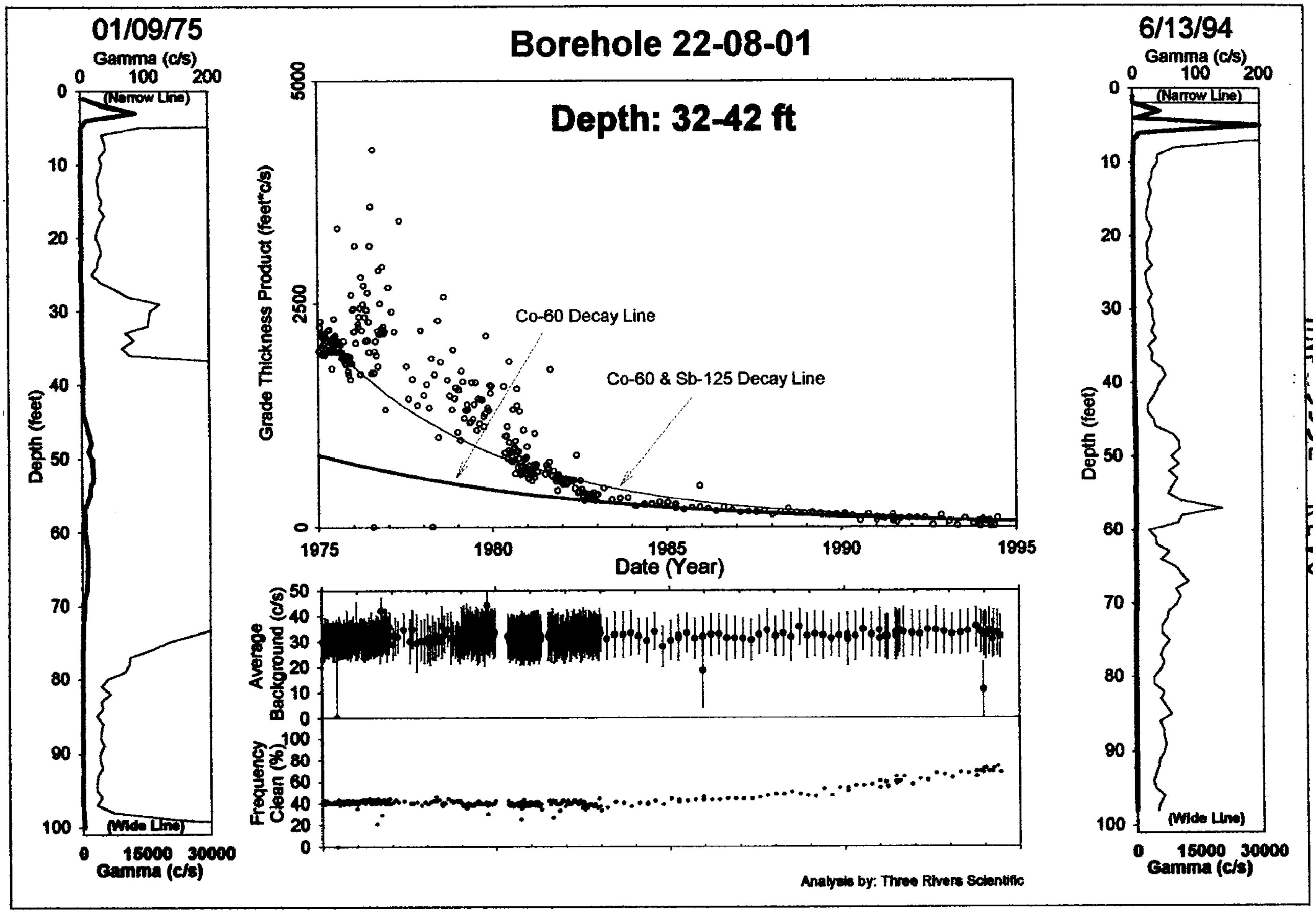


Figure B.5-7. Drywell 22-08-01 Historical Gamma Logging Plots (sheet 5 of 7)

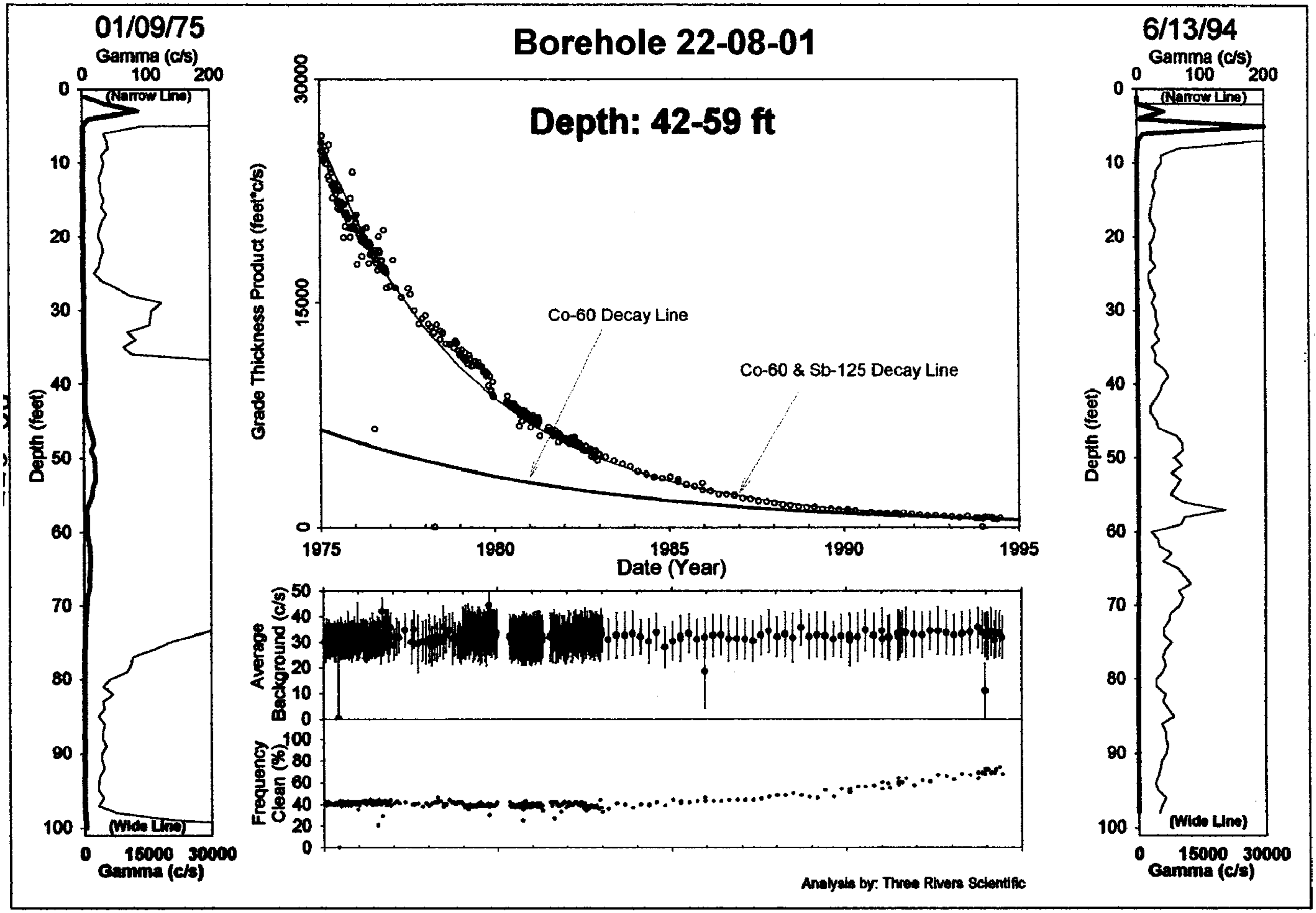


Figure B.5-7. Drywell 22-08-01 Historical Gamma Logging Plots (sheet 6 of 7)

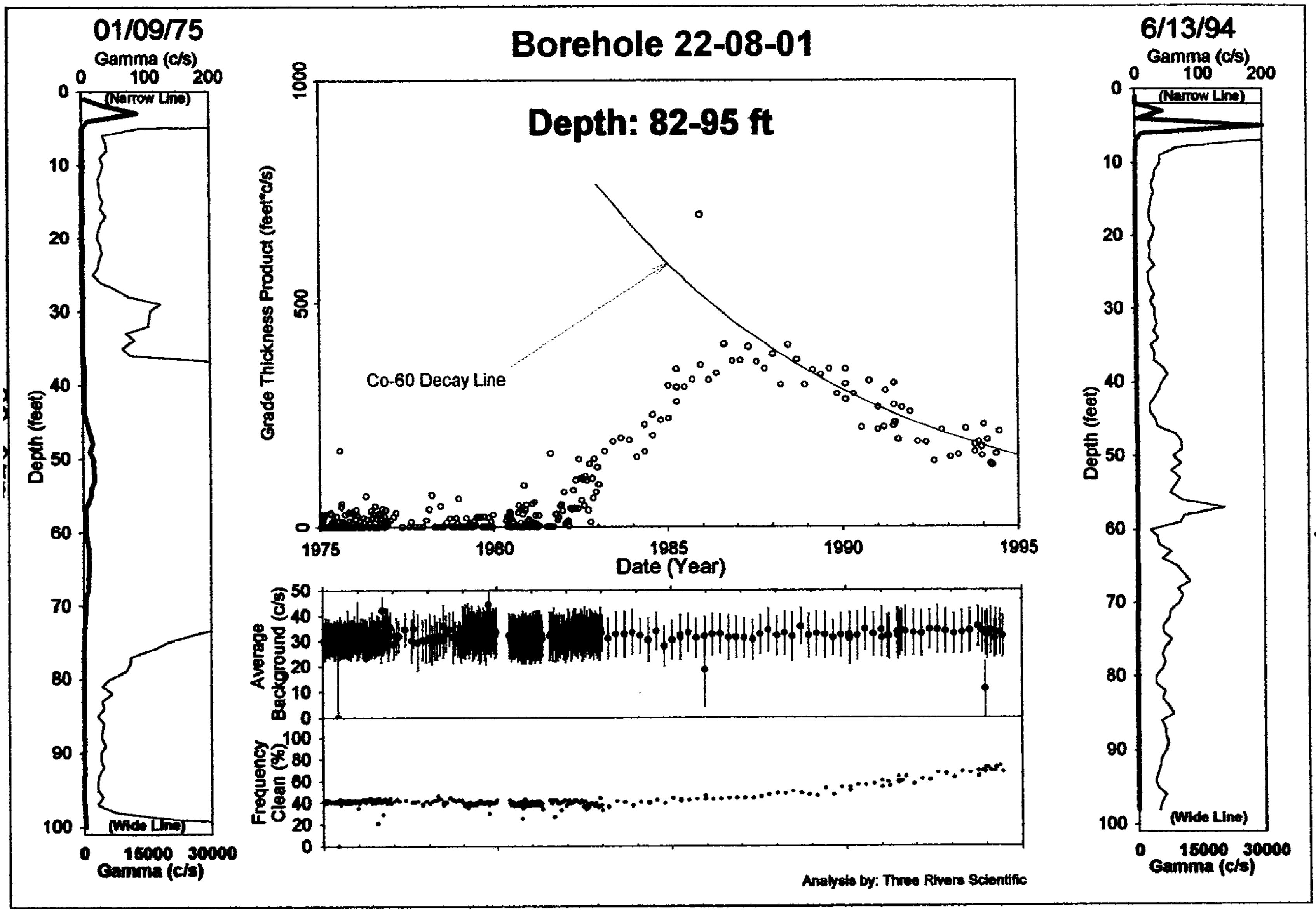


**Figure B.5-7. Drywell 22-08-01 Historical Gamma Logging Plots (sheet 7 of 7)**

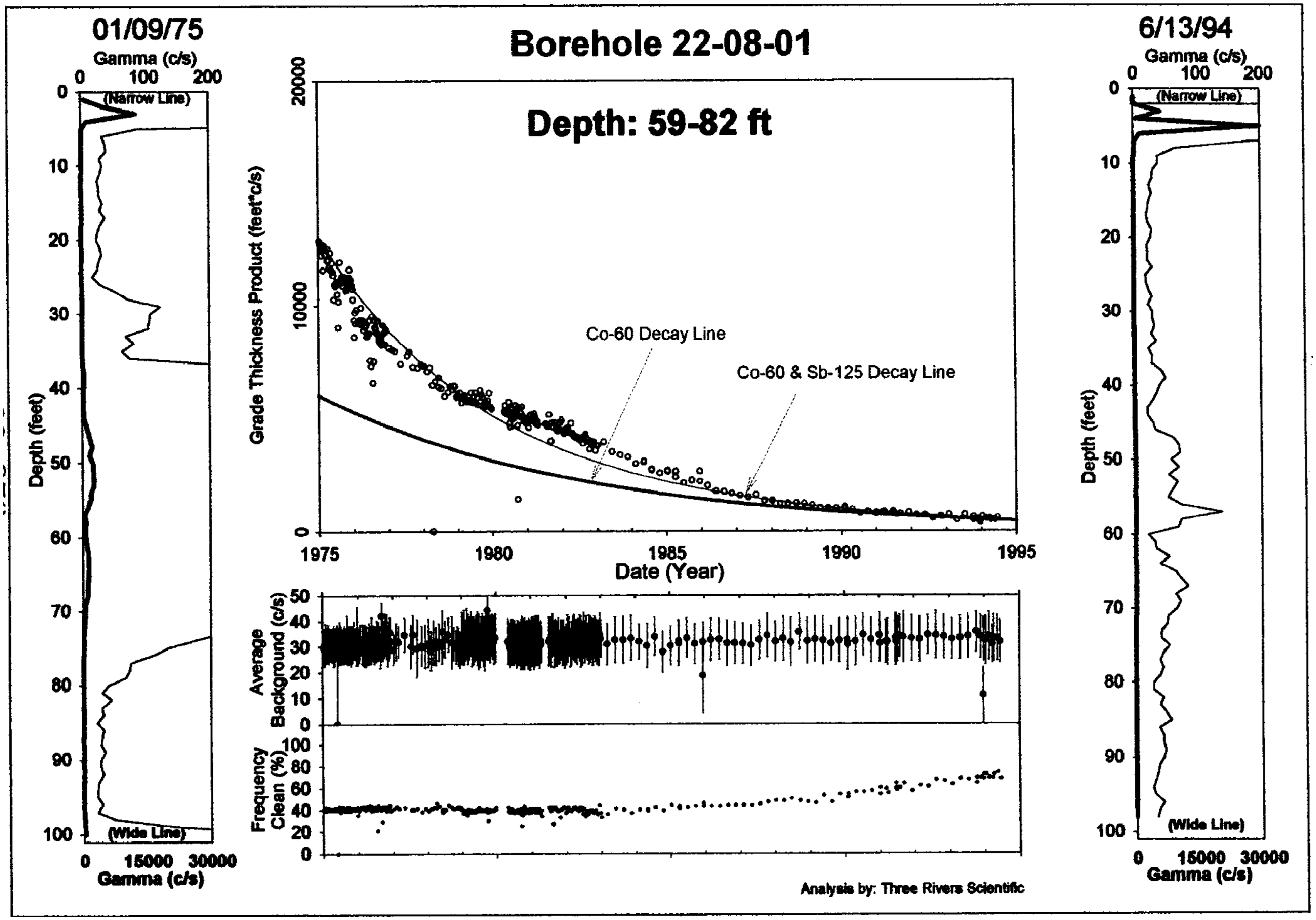


Figure B.5-8. Drywell 22-08-02 Historical Gamma Logging Plots (sheet 1 of 4)

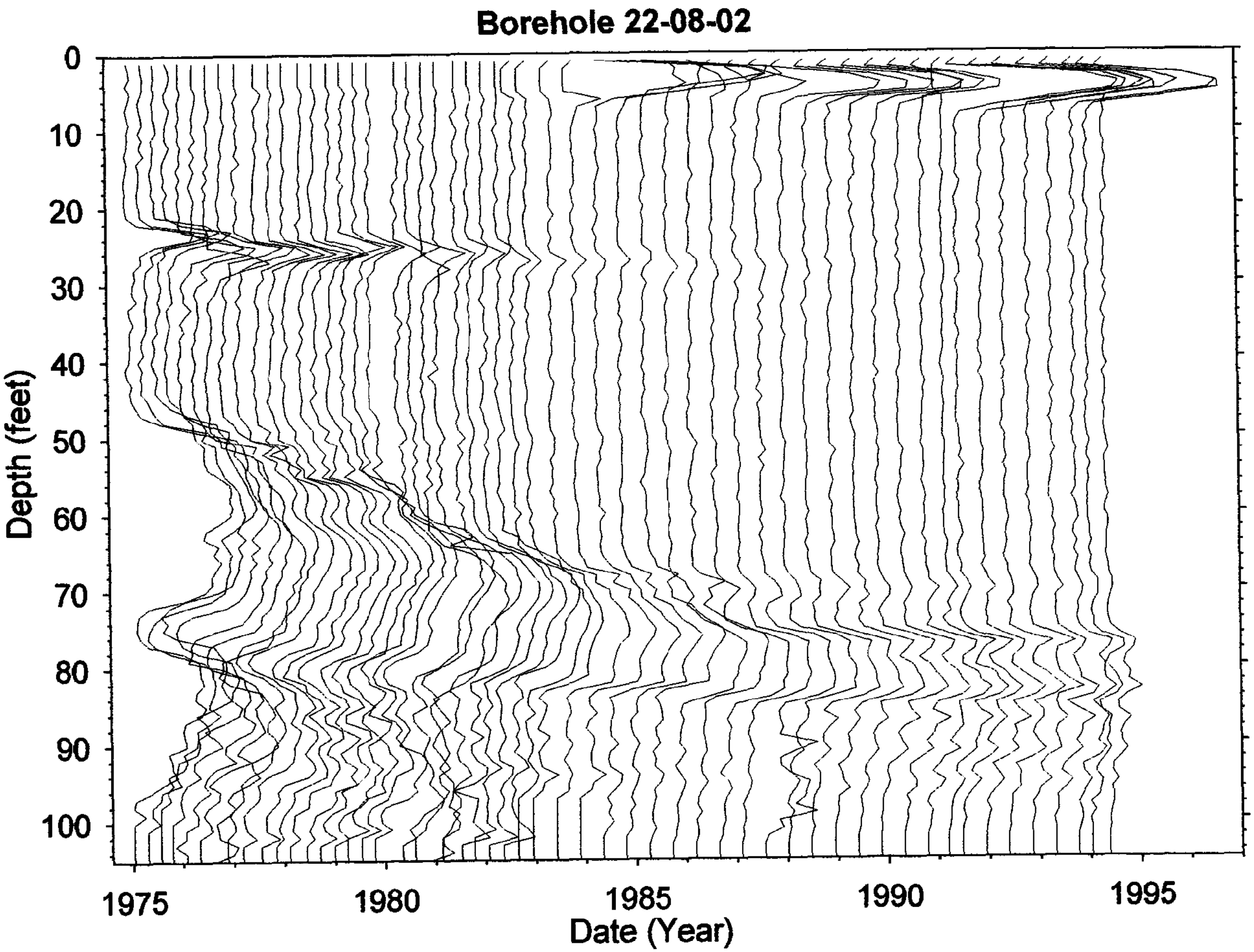


**Figure B.5-8. Drywell 22-08-02 Historical Gamma Logging Plots (sheet 2 of 4)**

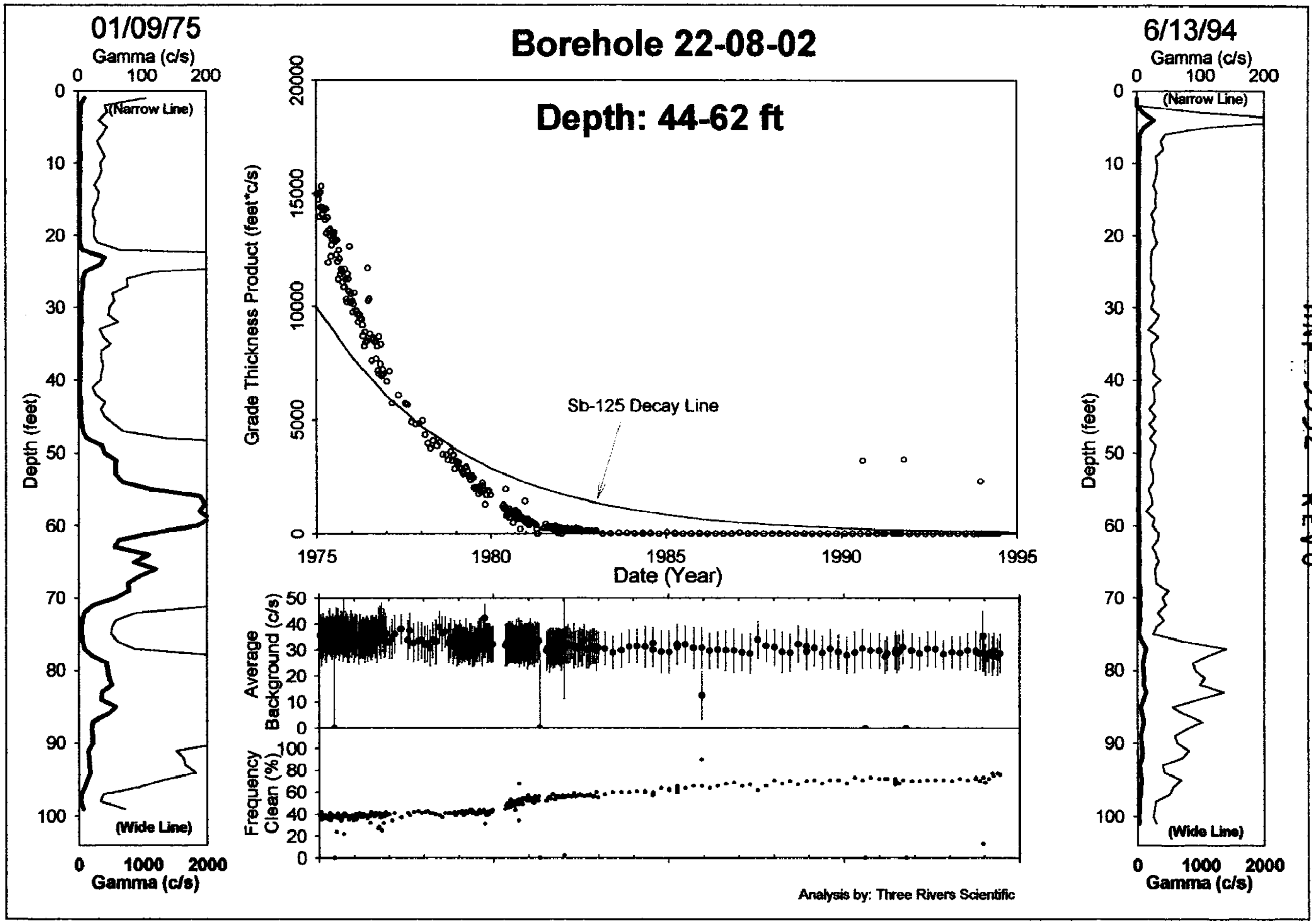


Figure B.5-8. Drywell 22-08-02 Historical Gamma Logging Plots (sheet 3 of 4)

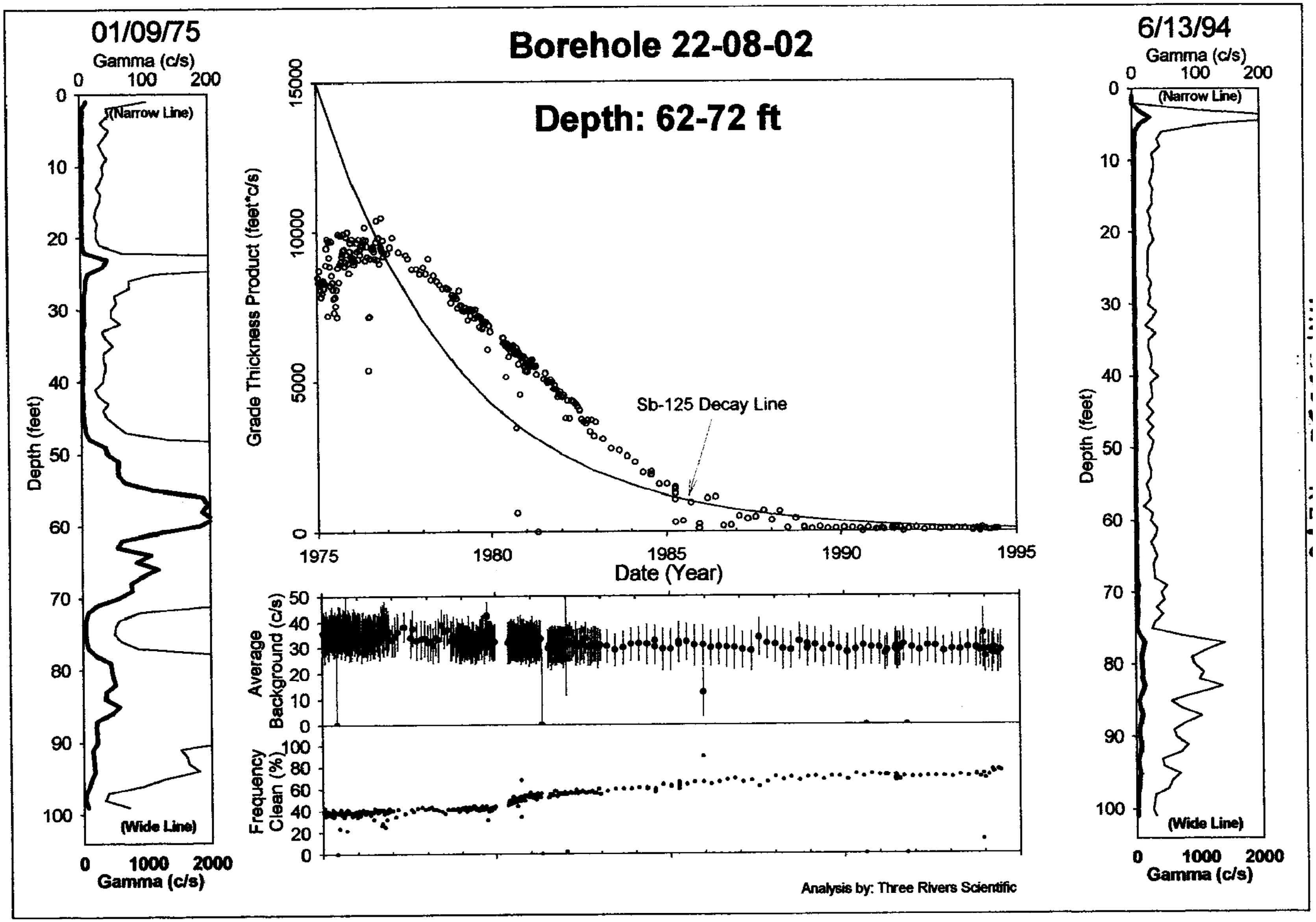


Figure B.5-8. Drywell 22-08-02 Historical Gamma Logging Plots (sheet 4 of 4)

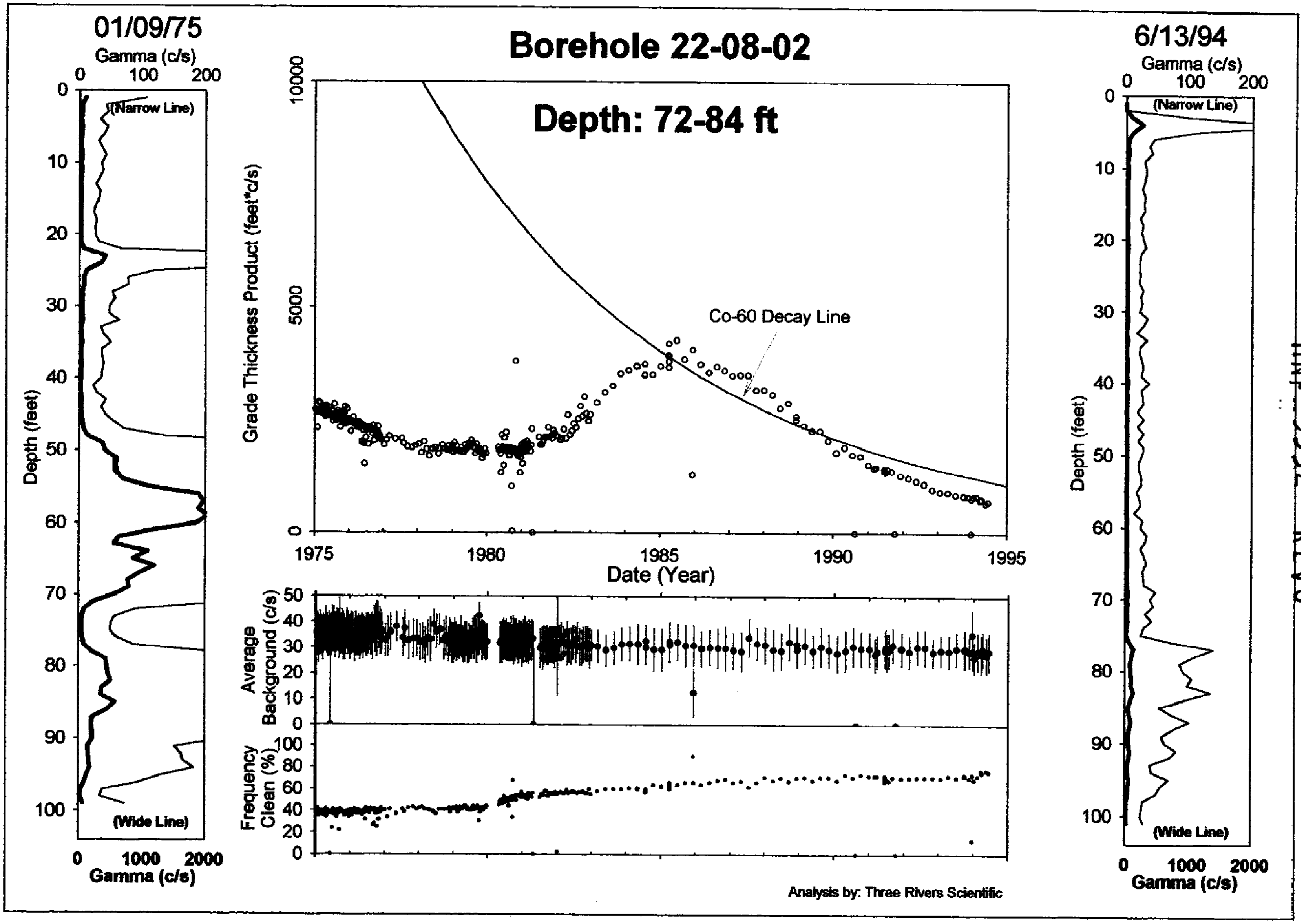


**Figure B.5-9. Drywell 22-08-05 Historical Gamma Logging Plots (sheet 1 of 2)**

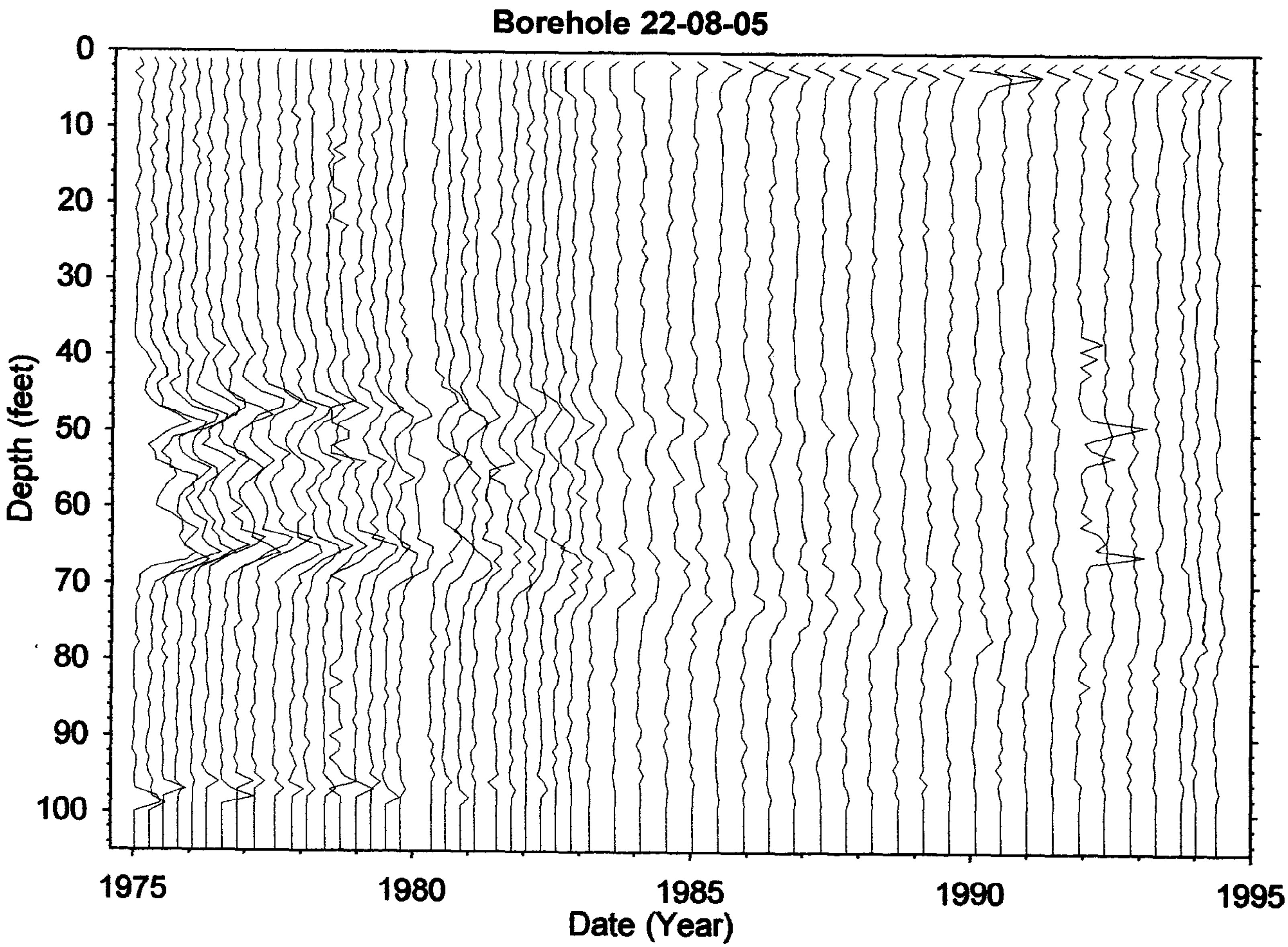


Figure B.5-9. Drywell 22-08-05 Historical Gamma Logging Plots (sheet 2 of 2)

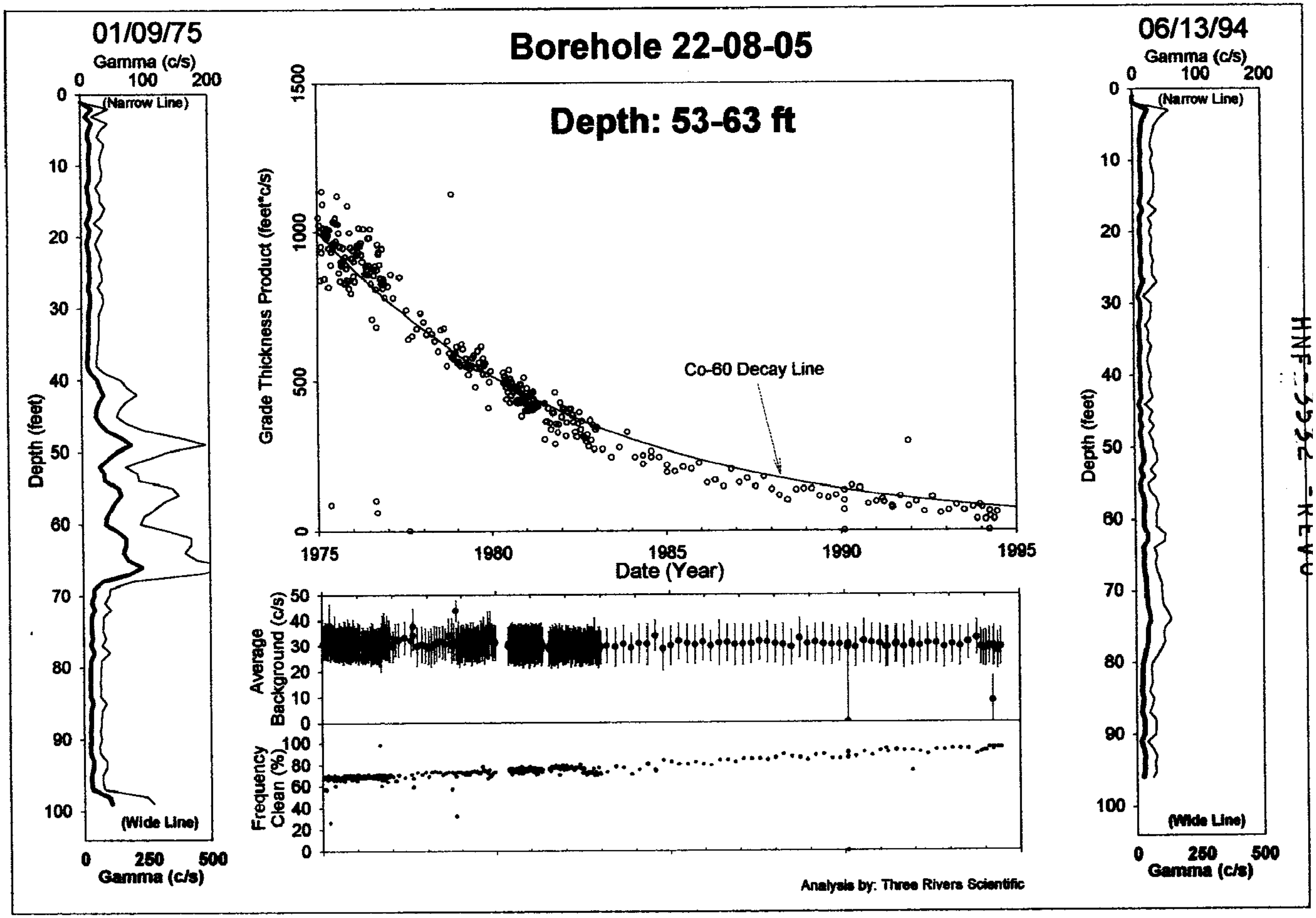


**Figure B.5-10. Drywell 22-08-06 Historical Gamma Logging Plots (sheet 1 of 2)**

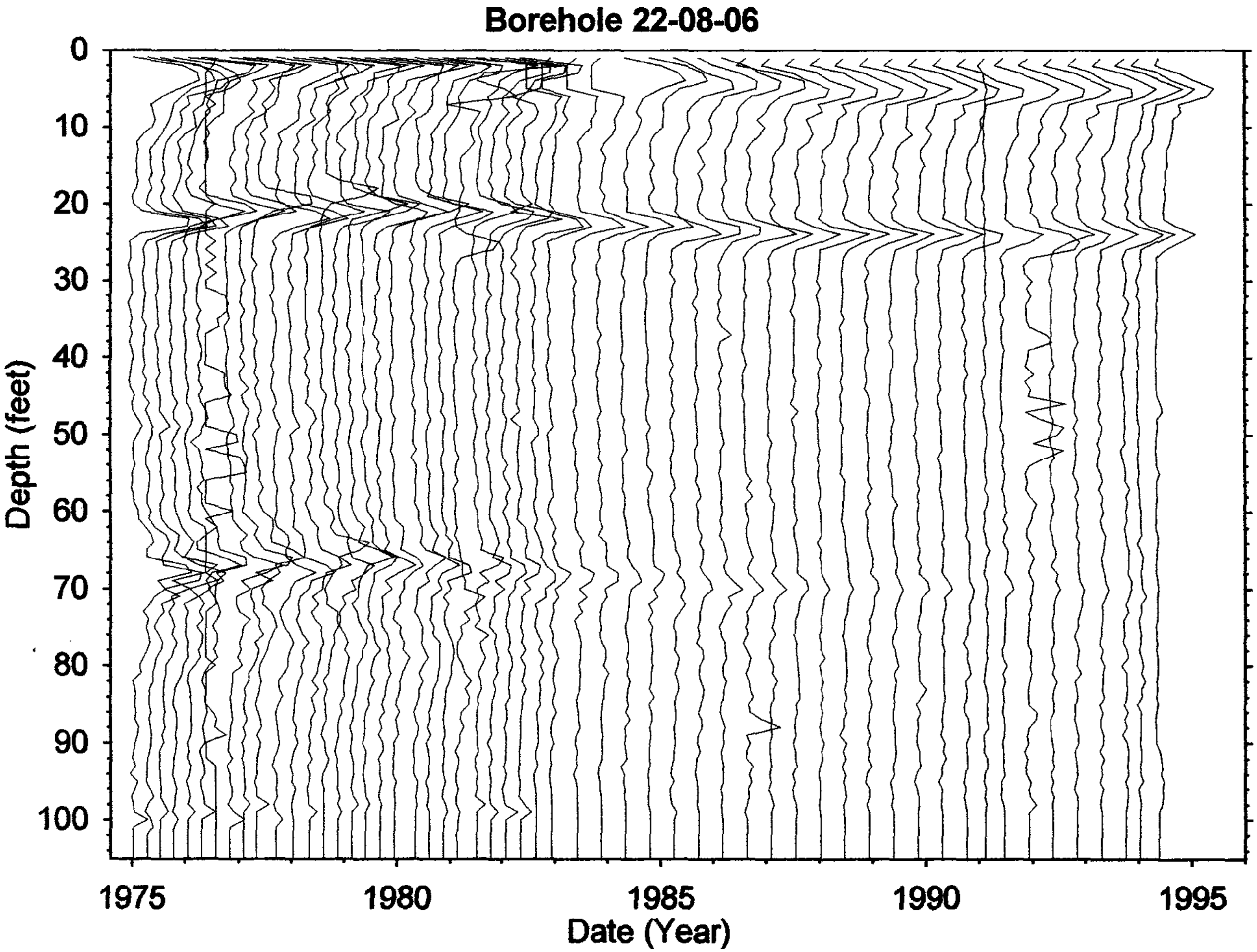


**Figure B.5-10. Drywell 22-08-06 Historical Gamma Logging Plots (sheet 2 of 2)**

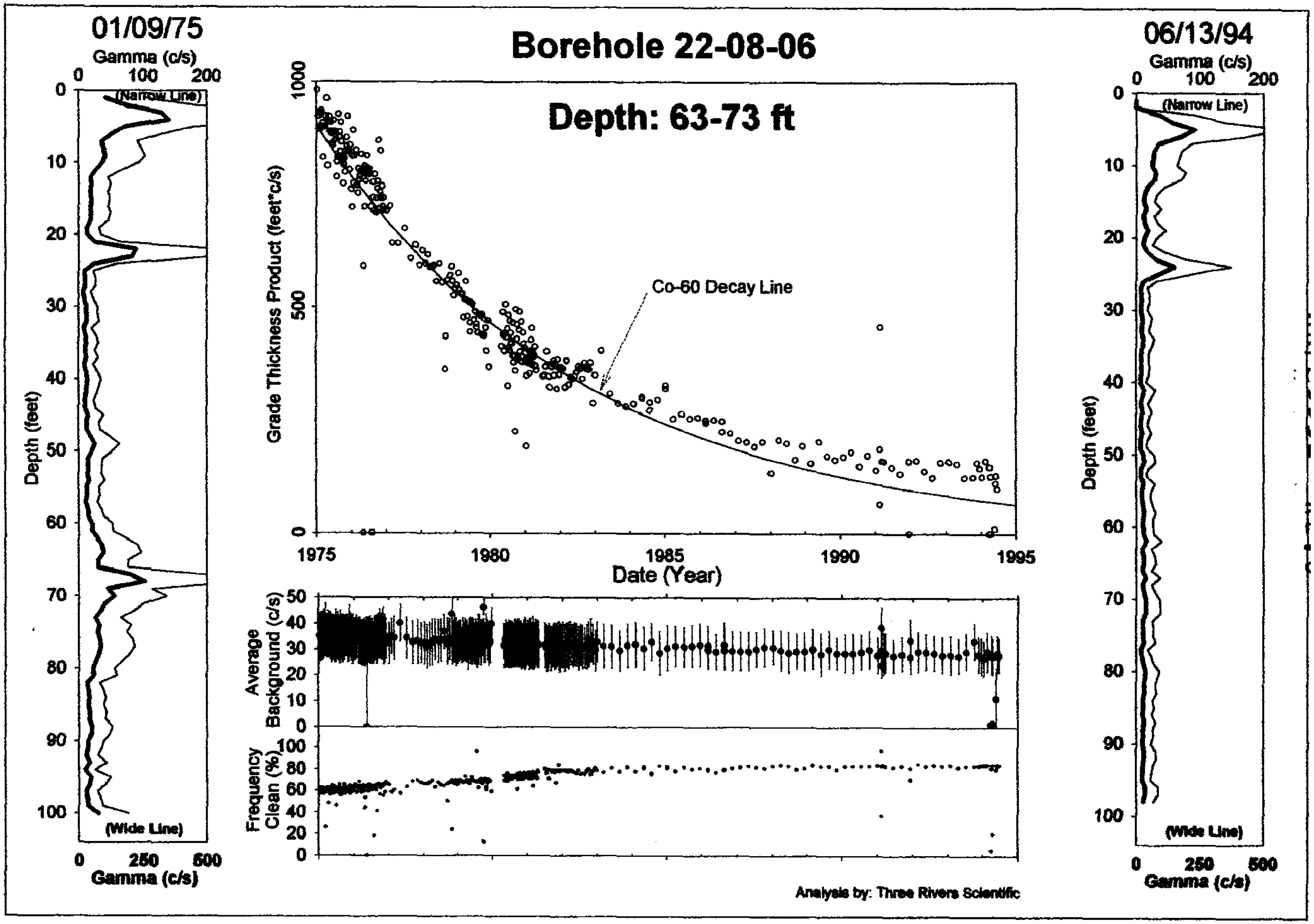


**Figure B.5-11. Drywell 22-08-07 Historical Gamma Logging Plots**

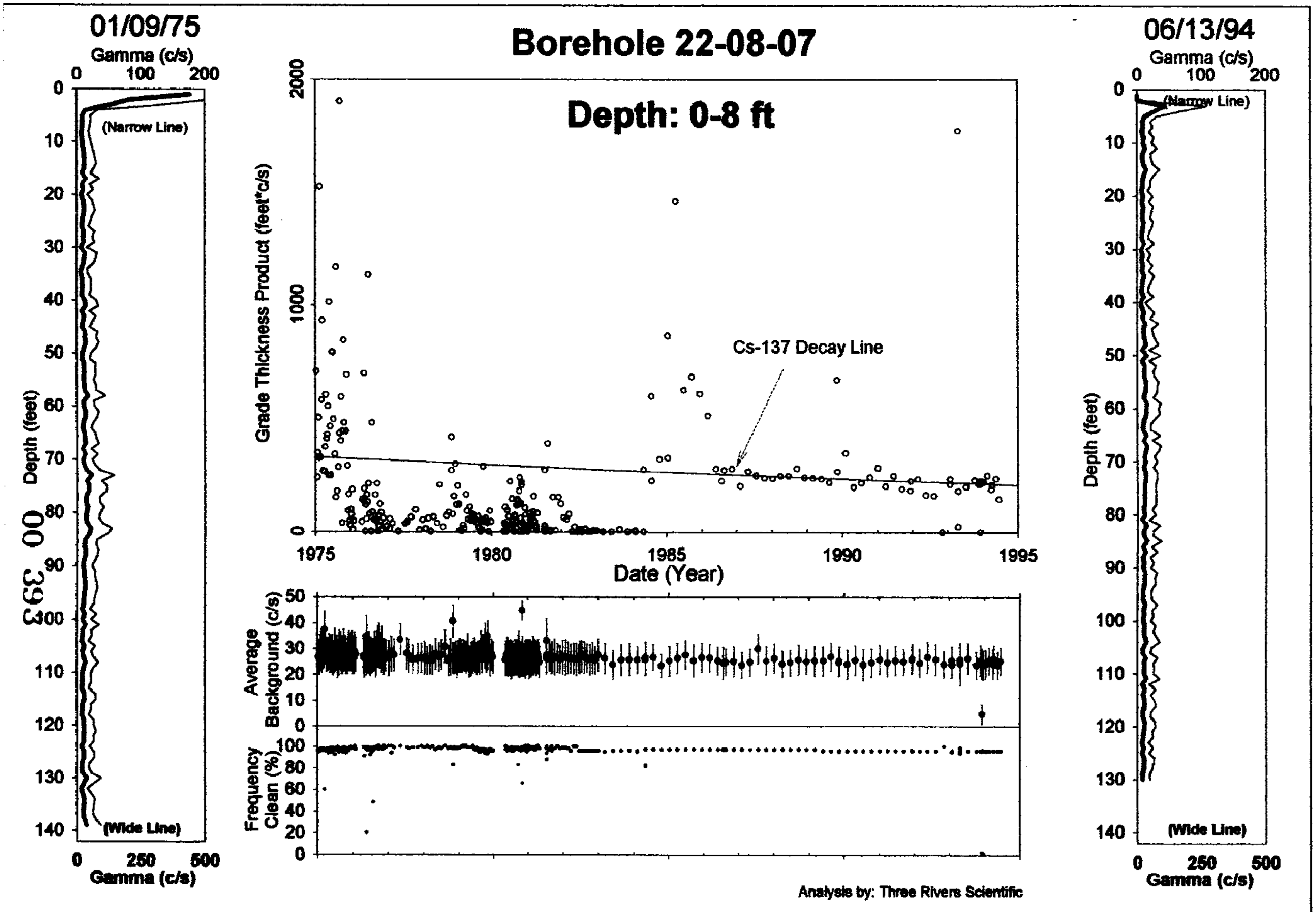



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**Figure B.5-12. Drywell 22-08-09 Historical Gamma Logging Plots**

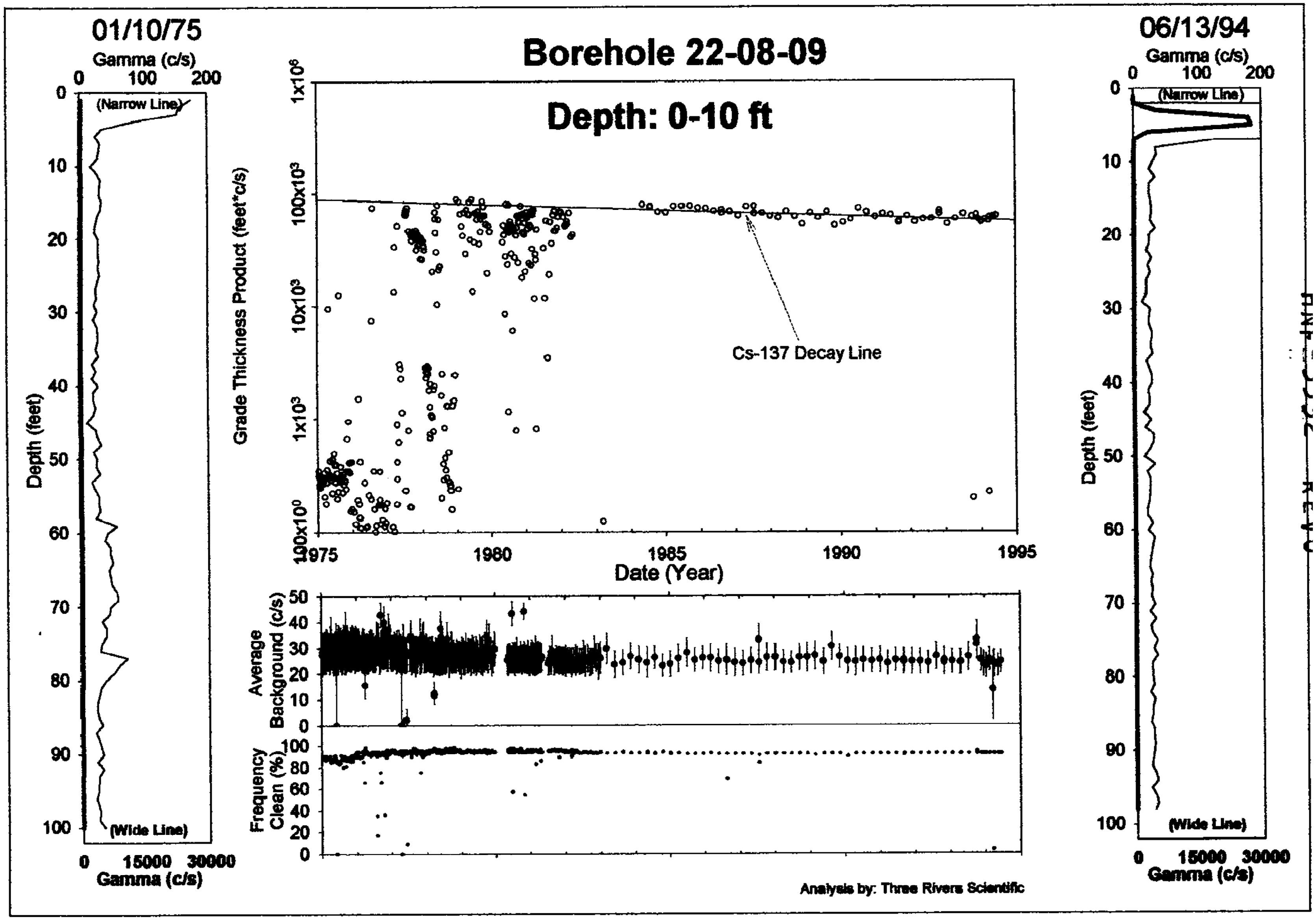


Figure B.5-13. Drywell 22-08-12 Historical Gamma Logging Plots (sheet 1 of 2)

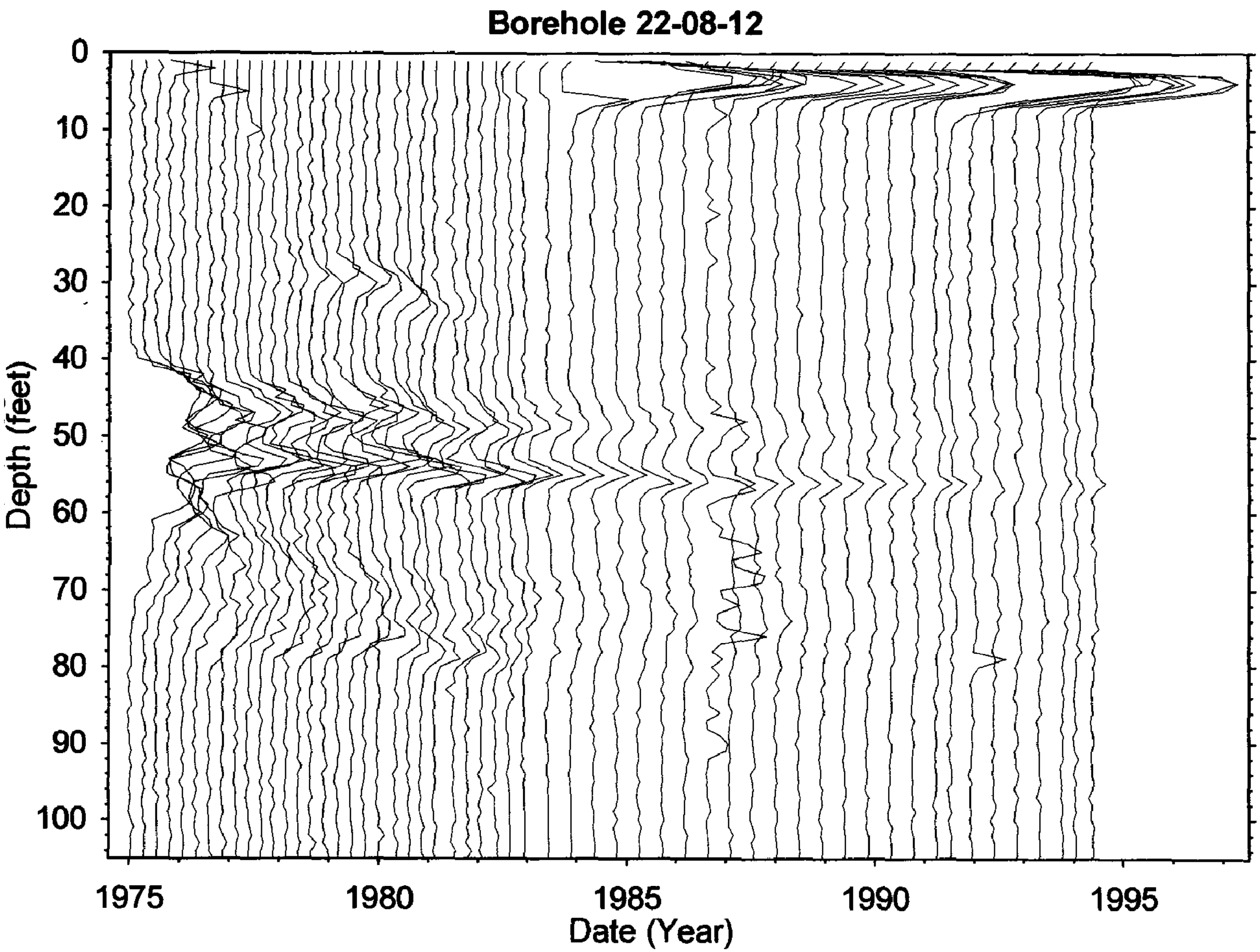
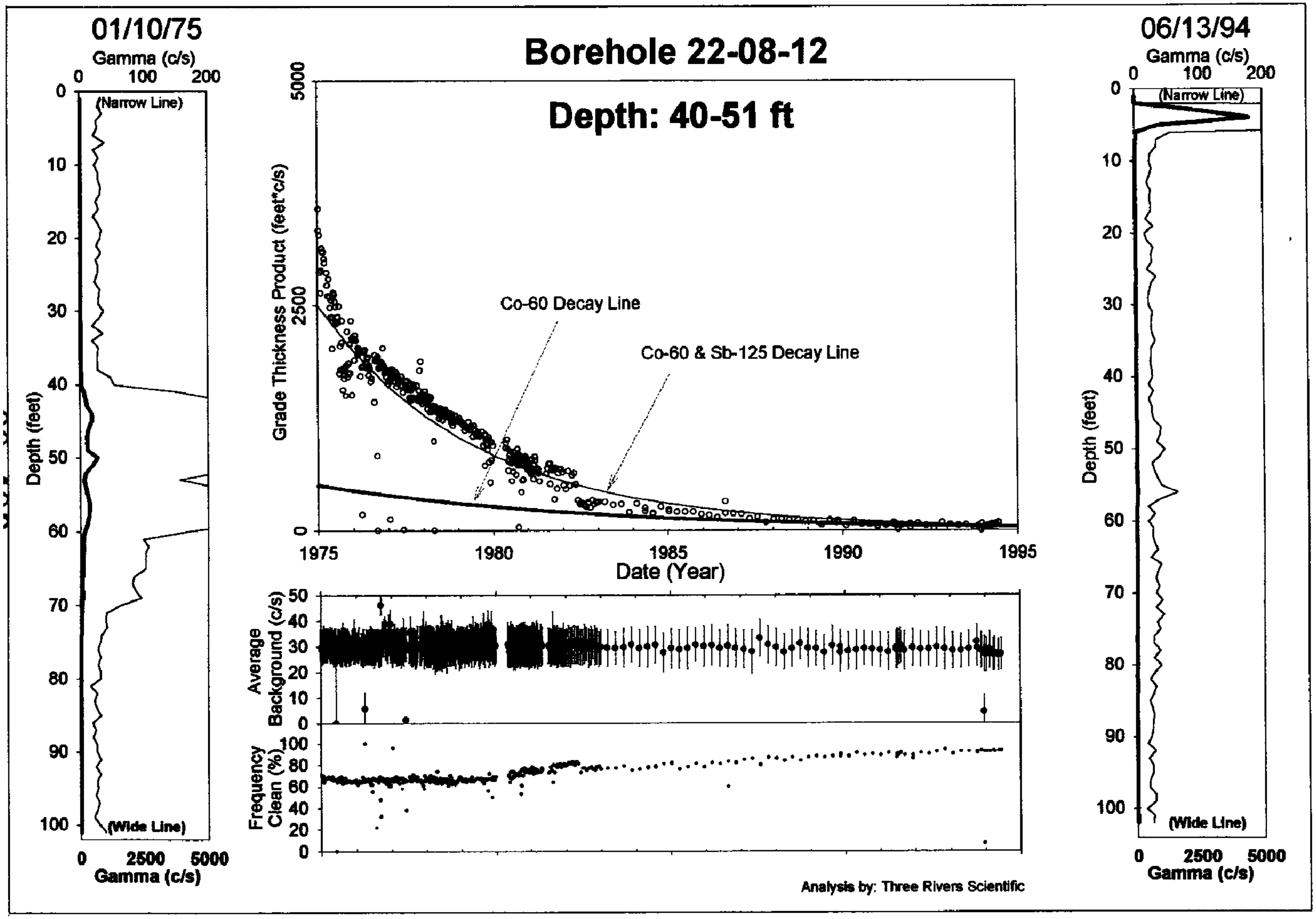


Figure B.5-13. Drywell 22-08-12 Historical Gamma Logging Plots (sheet 2 of 2)



A review of gross-gamma log data collected from this drywell from 1972 to 1994 (Figure B.5-8) indicates elevated gamma activity at ~24 ft in 1973. In 1974, a new peak was recorded at ~56 ft in depth. This peak had a four-fold increase (820 to 3,230 cps) in count rate within 6 months. In 1977, activity was measured from 40 to 95 ft. The maximum count rate decreased in intensity with time indicating the activity is probably $^{60}$Co and $^{125}$Sb.

In 1995 SGLS data $^{137}$Cs and $^{60}$Co were the man-made contaminants identified in this drywell. Cesium-137 was measured almost continuously from 4 to ~50 ft, at a few locations below 50 ft, and near the bottom of the drywell. Concentrations of $^{137}$Cs were measured at levels below 10 pCi/g except near the ground surface where concentrations are in excess of 1,000 pCi/g. Logging engineers determined the high count rates at this depth were caused by the presence of a transfer line that was being used to pump liquid from tank BY-103. The transfer line traverses the area within a few feet of the drywell. Concentrations of $^{60}$Co were measured almost continuously from ~50 ft to TD. Concentrations of $^{60}$Co ranged from ~0.1 to 20 pCi/g with a maximum concentration of ~20 pCi/g occurring at 77 and 83 ft.

**Drywell 22-08-05**

Drywell 22-08-05 is located ~6 ft from the southeast side of tank BY-108 with a depth of 98 ft. This drywell was drilled in 1970 and completed with ¼ (0.25)-in.-thick, 6-in.-nominal-diameter steel casing to a depth of 100 ft. No information is available that suggests this drywell has been perforated or grouted between the casing and formation.

A review of gross-gamma log data collected from this drywell from 1972 to 1994 (Figure B.5-9) shows elevated gamma activity from ~42 to 66 ft in 1972, with a count-rate peak at 50 ft. The maximum count-rate decreased and was at lower depths in successive years. This fits a $^{60}$Co decay line.

In 1995 SGLS data $^{137}$Cs and $^{60}$Co were the man-made contaminants detected in this drywell. Concentrations of $^{137}$Cs were measured continuously from the surface to ~34 ft, intermittently from 34 to 96 ft, and at the bottom of the drywell. The concentrations were less than 2 pCi/g except from the ground surface to ~4 ft. The presence of $^{60}$Co was measured almost continuously from ~40 to 80.5 ft, with concentrations ranging from 0.1 to 3 pCi/g, and at the bottom of the drywell with similar concentrations.

**Drywell 22-08-06**

Drywell 22-08-06 is located ~9 ft from the south side of tank BY-108 with a depth of 99 ft. This drywell was drilled in 1973 and completed with 5/16 (0.3125)-in.-thick, 6-in.-nominal-diameter steel casing to a depth of 100.25 ft.

A review of gross-gamma log data collected from this drywell from 1973 to 1994 (Figure B.5-10) shows elevated gamma activity at the surface, at 23 ft and from ~65 to 80 ft bgs. The gamma peak at 68 ft decayed following a $^{60}$Co decay curve and was no longer present by 1994. The peaks at ground surface and 23 ft decayed more gradually and were still present in 1994.

In 1995 SGLS data $^{137}Cs$ and $^{60}Co$ were the man-made contaminants detected in this drywell. Concentrations of $^{137}Cs$ were measured continuously from the surface to ~40 ft and intermittently to TD. The maximum $^{137}Cs$ concentration was measured at ~100 pCi/g at 4 ft in depth. The presence of $^{60}Co$ was measured almost continuously from ~63 to 92 ft, and at a few discontinuous locations above 63 ft. The $^{60}Co$ concentrations ranged from ~0.1 to 3 pCi/g.

The zone of high count rates indicated by the SGLS total gamma log at ~23 ft may be caused by $^{90}Sr$ in addition to the $^{137}Cs$ activity. Enhanced low-energy counts are present in the spectra near this depth, and these enhanced count rates may be due to the effect of bremsstrahlung radiation from $^{90}Sr$. Alternatively, the $^{137}Cs$ at this depth might be more concentrated away from the drywell, leading to increased scatter of the gamma rays to lower energies.

**Drywell 22-08-07**

Drywell 22-08-07 is located ~23 ft from the southwest side of tank BY-108 with a depth of 131.5 ft. This drywell was drilled in 1949 and completed to a depth of 150 ft. The depth achieved through logging operations was 131.5 ft. Drilling logs show that the casing was perforated from 49 to 100 ft with 5 holes per foot, but the casing may be perforated from 40 to 100 ft. The reason for the perforations is not known.

Gross-gamma log data collected from this drywell from 1975 to 1994 (Figure B.5-11) shows elevated gamma activity in 1975 that decreased in count rate from 1975 to 1978 at ~72 to 80 ft in depth.

In 1995 SGLS data $^{137}Cs$ and $^{60}Co$ were the man-made contaminants detected in this drywell. Intermittent concentrations of $^{137}Cs$ were measured near the surface to ~26 ft, almost continuously from 40 to 100 ft, and at the bottom of the drywell. Because $^{137}Cs$ was detected at 40 ft and because other BY-Farm drywells had casing perforations from 40 to 100 ft, the casing perforations may begin at 40 ft rather than at 49 ft as stated in the driller's record. The highest measured concentrations, except the near-surface, were ~10 pCi/g and occur in the zone of perforations. Contamination at the bottom of the drywell is probably inside the casing.

Cobalt-60 was detected at ~84 ft and from 95 to 98 ft. The $^{60}Co$ at 84 ft corresponds with the historical record that shows increased gamma count rates near this depth in the mid-1970s. This contamination has probably decayed or migrated downward. Cobalt-60 and $^{137}Cs$ contamination from 95 to 98 ft is reflected in the gross gamma logs from 1982 and 1991 and in the SGLS total gamma log.

**Drywell 22-08-09**

Drywell 22-08-09 is located ~7 ft from the west side of tank BY-108. This drywell was drilled in 1970 and completed with 5/16 (0.3125)-in.-thick, 6-in.-nominal-diameter steel casing to a depth of 100 ft. The TD achieved through logging operations was 99 ft.

A review of gross-gamma log data collected from this drywell from 1975 to 1994 (Figure B.5-12) shows near surface elevated gamma activity, first noticed in 1974, increased from 75 cps in 1974 to 96 cps in 1975 and steadily decreased to 37 cps in 1981 following a $^{137}Cs$ decay line. Low gamma activity was also observed from 89 to 95 ft bgs.

In 1995 SGLS data $^{137}Cs$ was the only man-made contaminant positively identified in this drywell. Concentrations of $^{137}Cs$ were measured continuously near the surface to ~19 ft, and intermittently to the bottom of the drywell. An interval of $^{137}Cs$ contamination measuring ~600 pCi/g occurred from ~1 to 6 ft in depth. Concentrations in the remainder of the drywell were ~3 pCi/g or less.

The enhanced count rate in the total gamma log at ~79 ft corresponds approximately with the depth of elevated gross gamma activity observed in 1975 log data; recent gross gamma log data do not show this elevated count rate.

**Drywell 22-08-12**
Drywell 22-08-12 is located ~9 ft from the north side of tank BY-108. The TD achieved through logging operations was 104 ft. This drywell was drilled in 1973 and completed to a depth of 104 ft.

A review of gross-gamma log data collected from this drywell from 1975 to 1994 (Figure B.5-13) indicates elevated gamma activity from 38 to 72 ft in depth. SD-WM-TI-356 shows that in 1974, a new peak was recorded at ~41 ft. The maximum count rate decreased in intensity with time following a combined $^{60}Co$ and $^{125}Sb$ decay curve and was measured at a lower depth (ranging from 41 to 55 ft) in successive years.

In 1995 SGLS data $^{137}Cs$ and $^{60}Co$ were the man-made contaminants identified in this drywell. The presence of $^{137}Cs$ was measured almost continuously from the ground surface to ~45 ft and at a few locations below 45 ft to TD. The maximum concentration was measured at ~800 pCi/g at 3 ft. Concentrations of $^{60}Co$ were measured at low concentrations (i.e., less than 1 pCi/g) at about 3 and 34 ft, and at higher concentrations (i.e., maximum of ~6 pCi/g) from ~45 to 57 ft, and from ~69 to 80 ft.

An interval of high $^{137}Cs$ concentration occurs between 1 and 6 ft in drywells 22-08-01, 22-08-02, 22-08-06, 22-08-09, and 22-08-12. Logging engineers report that the high count rates in drywells 22-08-02 and 22-08-12 are probably associated with pipelines near the drywell that contain contamination.

**B.5.2.3 Tank 241-BY-108 Assessment.** Tank 241-BY-108 waste process information was presented including discussion of past tank transfer history, basis for classification as an assumed leaker, surface level measurements, drywell gamma logging measurements and occurrence reports.

The tank was classified as a leaking tank in 1972 with a leak volume estimate of <5,000 gal. The leak is based on observed activity in drywells and the volume estimate appears to be based on uncertainty in manual tape surface level measurements. No unexplained liquid level decrease was identified in waste transfer records or surface level data. However, surface level data were only available starting in 1973. Abrupt changes in liquid level temperatures occurred in 1992 when temperature measurements changed from manual to more frequent automated measurements. It was also noted that the downward trend for manual measurements in the late 1970s followed the same trend as measurements from 1992 to present; consequently manual measurements are suspect.

Drywell data around the tank shows extensive $^{137}$Cs contamination in the top 10 ft bgs and $^{60}$Co below the base of the tank, starting at 35 to 40 ft bgs. In June 1971, PPD-453-DEL p. AIV-18 reported the following:

> "*A high radiation reading situation from an adjacent monitoring well to tank BY-108 has been investigated. Frequent scintillation-probe checks, coupled with neutron-probe readings, revealed an active leak in the vicinity of the bottom and northerly quadrant of the tank. The tank has been removed from service as a bottom tank for the In-Tank Solidification Program and the contents were pumped down to a level of approximately twelve feet--the apparent salt-cake level in the tank. Design for a well point casing, which will enable the removal of interstitial liquor from the tank, is in progress. Monitoring surveillance is continuing.*" (underline added)

This suggests a leak source "*in the vicinity of the bottom … of the tank*," but not necessarily the tank itself. The main indicator of a tank leak is the $^{60}$Co observed in drywell spectral gamma measurements around the tank.

BY-Farm scavenged waste is high in cyanide compared to other waste types. Discussions with Pacific Northwest National Laboratory and Washington River Protection Solutions, LLC chemists confirmed that $^{60}$Co and cyanide appear to complex and create a more mobile waste form. The exact form and chemistry of the scavenged waste appears to be unknown.
A discussion of $^{60}$Co mobility is included in Appendix D of the B/BX/BY Field Investigation report (HNF-5507, *Subsurface Conditions Description of the B-BX-BY Waste Management Area*). This information suggests that the $^{60}$Co in drywells around tank BY-108 may have originated from near surface spills without leaving a trail.

The depth and thickness of the $^{60}$Co plume raised questions about alternate sources. It was observed that tank BY-108 was overfilled several times and that waste may have been released through spare inlet ports, cascade lines or overflowing the steel liner (compromised by tar rings). Drawings were reviewed showing the locations of pipelines and transfer lines. It was noted that a bend in a transfer line is located near drywell 22-08-01. No evidence of a leak from this line was found, however a leak in this line would explain the observed surface contamination.

### B.5.3 Conclusion

Based on the information presented, the panel concluded that although several potential sources were identified for radioactivity in drywells surrounding tank BY-108, there is probably insufficient evidence to refute previous assessments that tank BY-108 leaked in the past (HNF-EP-0182). However, there is strong evidence that any tank release would have occurred near the top of the tank. Therefore, a formal TFC-ENG-CHEM-D-42 assessment is recommended to further assess the mechanism of a release from the tank and inventory of the release. Additional field investigations are also recommended such as direct push/logging near the transfer line and sampling to further investigate $^{60}$Co speciation and source of the contamination.

## B.6 REFERENCES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# APPENDIX C

# 241-BY-TANK FARM DESIGNATED AS SOUND TANKS ACCORDING TO HNF-EP-0182

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## Acronyms and Abbreviations

| | |
|---|---|
| 1C | first cycle decontamination (waste) |
| CW | aluminum cladding (waste) |
| CWP | plutonium-uranium extraction cladding waste |
| CWP2 | plutonium-uranium extraction cladding, aluminum clad fuel (1961-1972) |
| EB | evaporator bottoms |
| ILL | interstitial liquid level |
| ITS | In-Tank Solidification |
| ITS#1 | in-tank solidification unit #1 |
| MW | metal waste |
| PFeCN | sludge from the ferrocyanide scavenging process |
| PUREX | plutonium-uranium extraction |
| TBP | tributyl phosphate |
| UR | uranium recovery |

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# C.1 TANK 241-BY-101

## C.1.1 Tank 241-BY-101 History

Tank 241-BY-101 (BY-101) was filled with metal waste (MW) from the tank 241-BX-103 (BX-103) cascade which overflowed between March 1950 and the first quarter of 1951. The tank contained MW from 1950 until it was transferred to tank 241-BY-103 (BY-103) during the first quarter of 1954. The tank was then sluiced and emptied in May 1954. Ferrocyanide scavenging waste was transferred into and out of the tank from the first quarter of 1955 until the end of 1960. The tank received ferrocyanide scavenging process sludge material (PFeCN) and first cycle decontamination (1C)/aluminum cladding (CW) waste from the first quarter of 1961 until 1964. At that time it had 37 kgal of stored solids. In-tank solidification (ITS) occurred from 1964 through 1967. In the third quarter of 1967 the tank had 109 kgal of solids. The reported solids level increased to 300 kgal over the next two years with the continued receipt of ITS waste. From 1967 to 1976 evaporator bottoms (EB) were recycled through the tank as part of the ITS process.

The tank was initially salt well pumped in the first and second quarters of 1977, and was declared inactive in the first quarter of 1978. The tank was saltwell pumped again in 1983 and 1984, and was declared interim stabilized in May 1984 (HNF-SD-RE-TI-178, *Single-Shell Tank Stabilization Record*). As of October 2009 tank BY-101 contains 370 kgal (142 in.) of waste type BY-Saltcake with PFeCN, with 14 kgal of saltcake interstitial liquid (RPP-RPT-42995, *2009 Auto-TCR for Tank 241-BY-101*).

## C.1.2 Tank 241-BY-101 Waste Surface Level

No indications were observed as to unknown surface level decreases. In 1975, tank BY-101 was filled to a waste volume greater than 770 kgal above the cascade overflow level of 760 kgal (284 in. from bottom of tank). Historical surface levels are shown in Figures C-1 and C-2. Gradually increasing surface levels with time likely indicate water intrusions into the tank.

## C.1.3 Tank 241-BY-101 Logging and Assessments

Per SD-WM-TI-356, *Waste Storage Tank Status and Leak Detection Criteria*, it was stated that drywell readings were stable; high readings in drywell 22-01-04 are not considered to be due to tank leakage, for the depth of the contamination is above the normal operating level. GJ-HAN-18, *Vadose Zone Characterization Project at the Hanford Tank Farms Tank Summary Data Report for Tank BY-101* reports $^{137}$Cs and $^{60}$Co contamination at depths of 25 and 29 ft respectively in drywell 22-01-04, within range of the tank waste surface during the tank's operating period. In addition, GJ-HAN-18 notes the presence of low concentration zones of $^{137}$Cs throughout various depths and at the bottom of drywells, as seen in Figure C-3.

**Figure C-1. 241-BY-101 Historical Tank Content Estimate Waste Fill History**

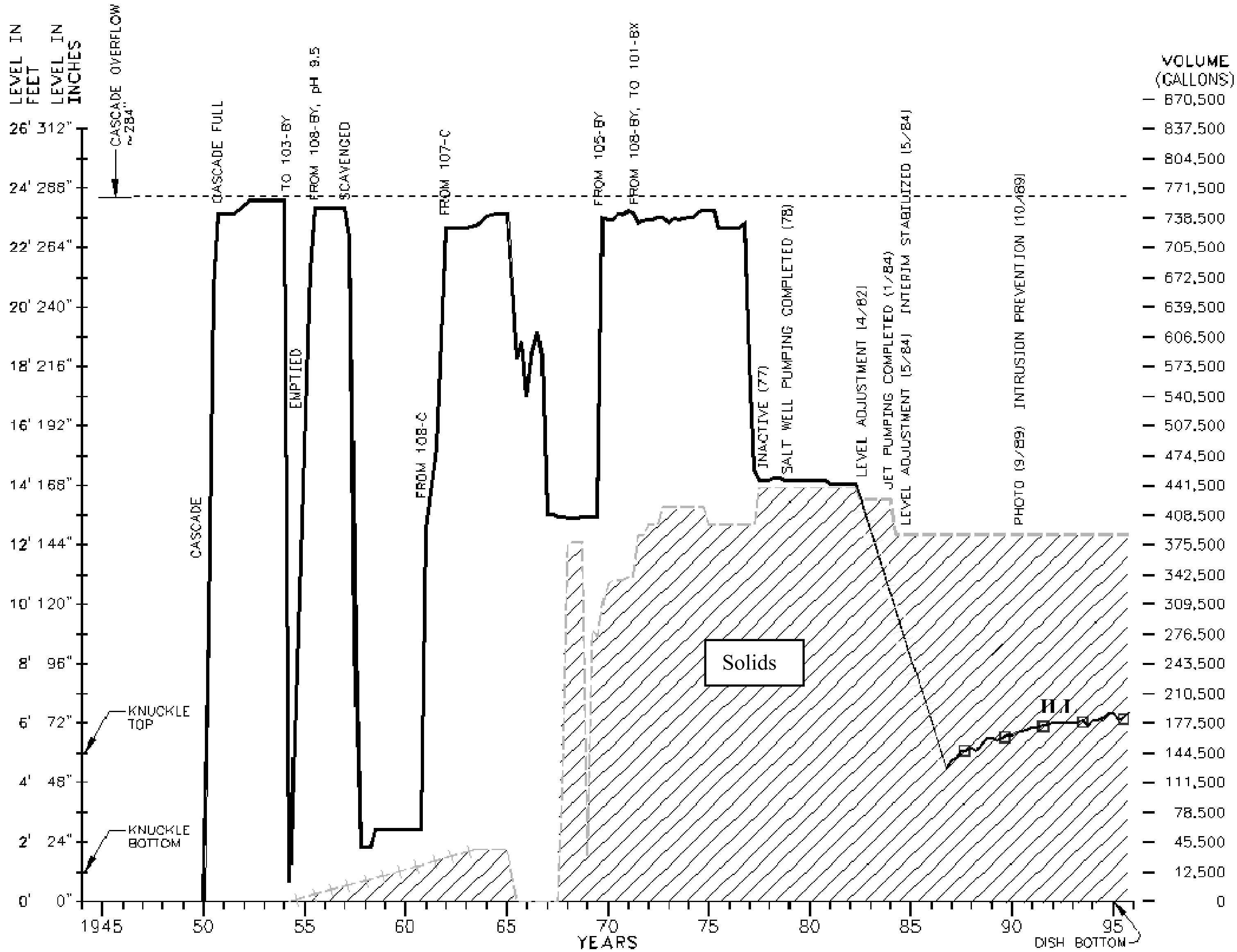


Figure C-2. 241-BY-101 Tank Waste Monitoring Data

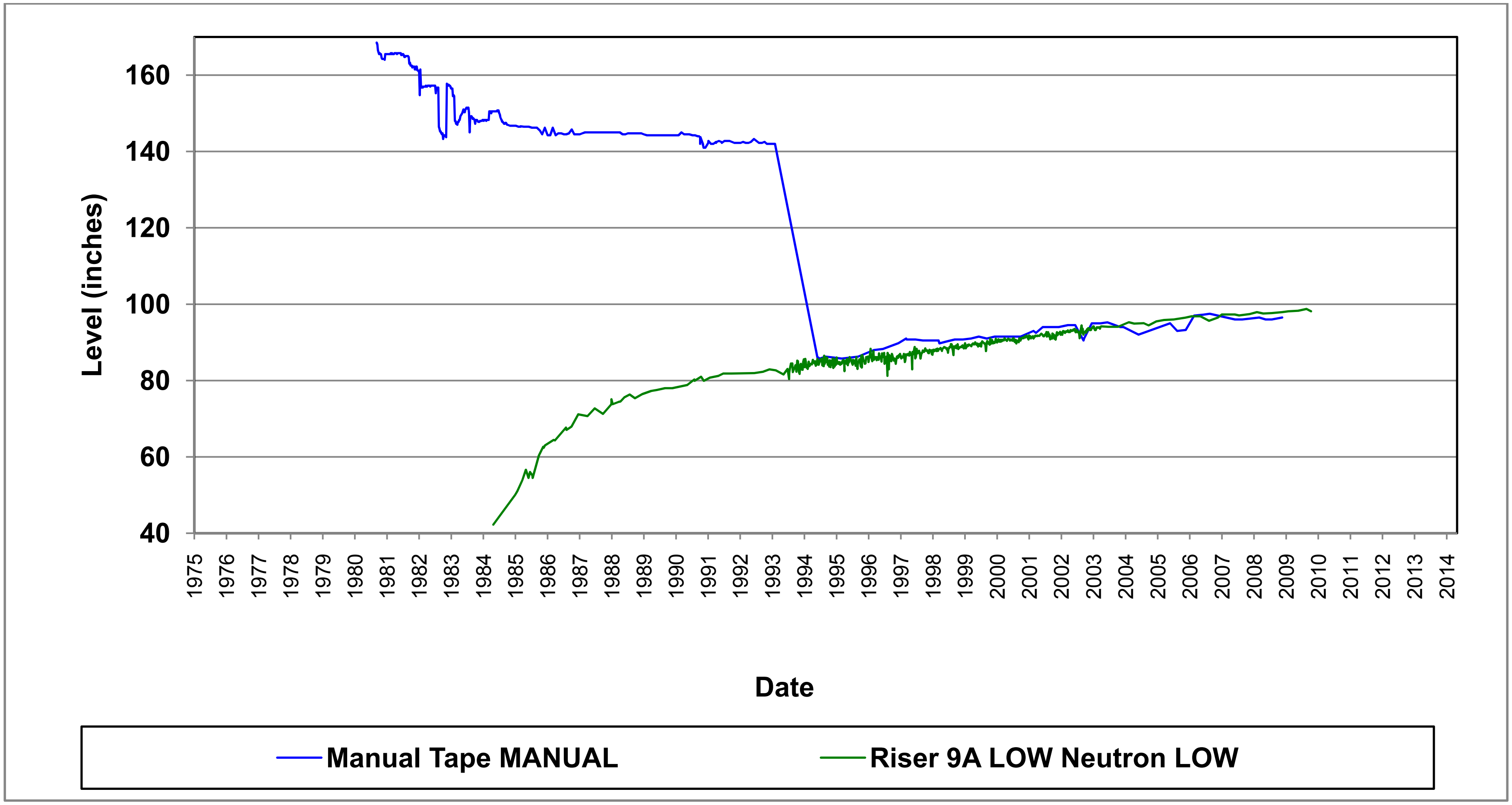
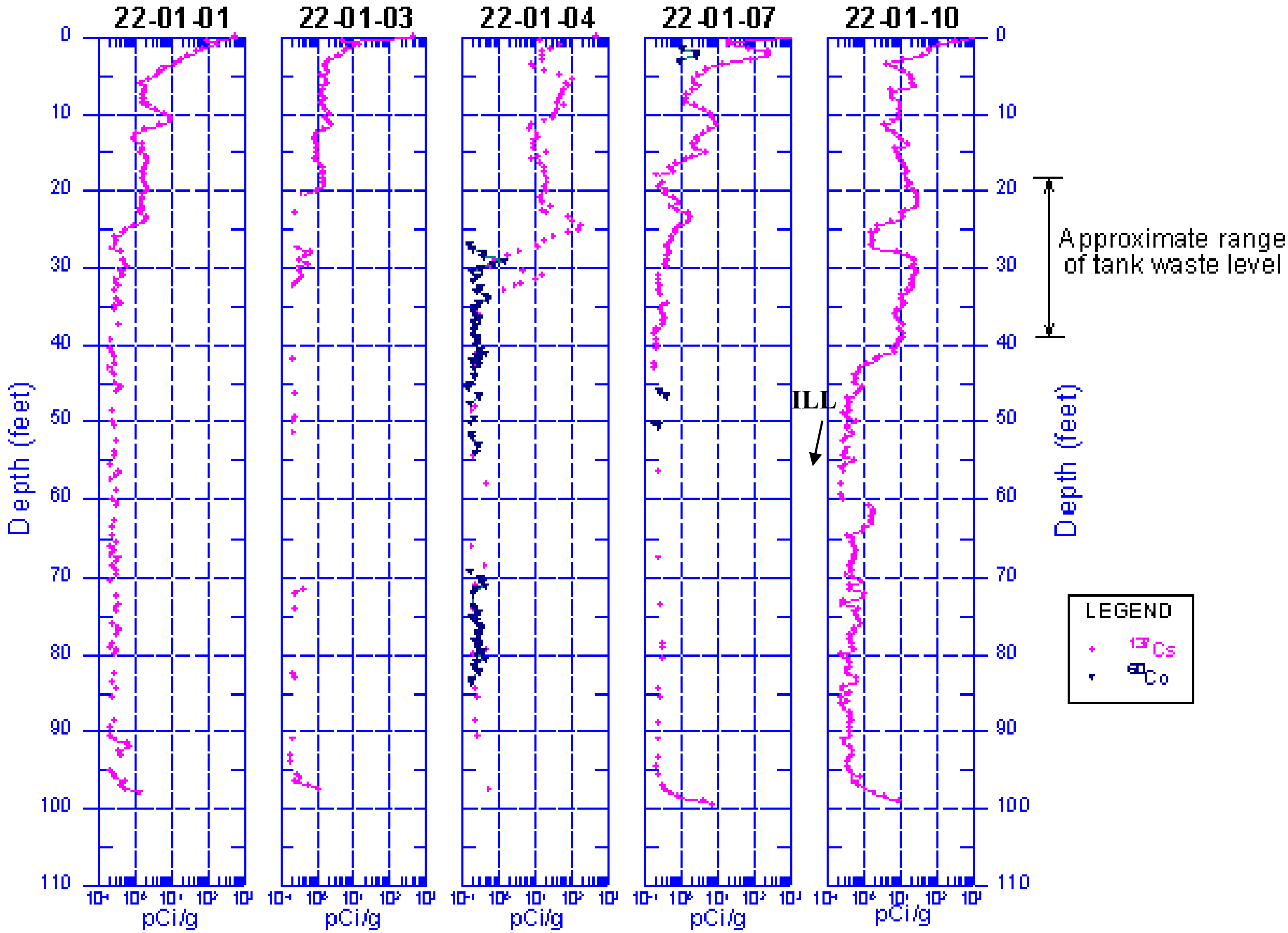


**Figure C-3. Tank 241-BY-101 Drywell Spectral Gamma Data, 1995**




Reference: GJO-96-2-TAR/GJO-HAN-6, *Vadose Zone Characterization Project at the Hanford Tank Farms: BY Tank Farm Report*.

A review of WHC-SD-WM-ER-526, *Evaluation of Hanford Tanks for Trapped Gas*, Rev. 1E, showed that the interstitial liquid level (ILL) increase was due to growth of trapped gas. Based on the available data there was a high correlation between the inverse barometric pressure and surface level and retained (trapped) gas was estimated at levels of 6 to 12%. The source of this retained gas waste characteristic stems from the 1970s when this tank was an ITS bottom receiver and an ITS recycle tank (analogous to tank 241-SY-101). The report also states that the ILL increase may be caused by solids settling and retained gas (see EM-RL--WHC-TANKFARM-1990-0291, *Interstitial Liquid Level Increase in Single-Shell Tank 241-BY-101*).

The following occurrence reports are associated with tank BY-101.

ARHCO Occurrence Report 75-38, *Violation ARH-1601, Section D, Part 4.4.3, Liquid Level in Excess of 23.3 Feet (280 inches) in Tank 101-BY* (greater than 770 kgal):

> "On April 9, 1975, liquid level for 101-BY reached 280.25 inches, 0.25 inches in excess of the reference specification limit of 280 inches. This violation was caused by uncontrolled water additions to the tank which occurred during installation, pressure testing and flushing of a new pump. The pump was being installed for the purpose of reducing the liquid level in the tank below operating limits."

EM-RL--WHC-TANKFARM-1990-0291:

> "The direct and root cause of this event is ambient conditions. It is suspected that conditions within the tank resulted in crystalliferous growth, migration of liquid from the salt cake and sloughing of solids from the tank wall. The combination of these factors probably resulted in the liquid level increase."

## C.2 TANK 241-BY-102

### C.2.1 Tank 241-BY-102 History

Tank 241-BY-102 (BY-102) was the fifth tank in a cascade series of six tanks beginning with tanks 241-BX-101 (BX-101), 241-BX-102 (BX-102), and BX-103 in the 241-BX Tank Farm (BX-Farm) and tank BY-101 in the 241-BY Tank Farm (BY-Farm) and cascading into tank BY-103. Each tank in the cascade series is set 1 ft lower in elevation from the preceding tank. Tank BY-102 is passively ventilated. Tank BY-102 first received waste in 1950, with a cascade of MW from tank BY-101. The MW began cascading from tank BY-102 to tank BY-103 in 1950, and the cascade continued until 1951.

In 1953, the tank received water repeatedly and supernate was sent to tanks 241-B-103, 241-C-106, and BX-103. The tank was emptied in 1954 when the waste was sent for uranium recovery (UR). Water and tributyl phosphate (TBP) waste were sent to the tank in 1955 and supernate cascaded to tank BY-103. Tank BY-102 received supernate from tanks 241-BY-105 (BY-105) and 241-BY-110 (BY-110) in 1955. Waste was again sent for UR. In 1957 tank BY-102 received supernate from tank 241-C-112. Waste was sent to tanks 241-C-109 and 241-C-111 for ferrocyanide scavenging. Supernate was received from tanks 241-BX-105 (BX-105), 241-BX-106 (BX-106), 241-C-105 (C-105) and 241-BY-107 (BY-107) during late 1957. Also, during this time, supernate was sent from tank BY-102 to cribs B-032, B-033, B-034, and B-035. No additional transfers occurred until 1964. In late 1964 and into 1965, the tank received supernate containing CW from tank 241-C-102 (C-102).

Tank BY-102 was used as an in-tank solidification unit #1 (ITS#1) in 1966 (after the pilot experiment in tank BY-101 in 1965). A heater was placed in the tank to cause evaporation. In 1966, the tank received waste from BY-101, and then tank BY-103 became the feed tank (source of supernate) for ITS#1 from late 1966 to 1970. Waste was also received from tank 241-B-110 during 1967. In late 1966, waste was sent to tank C-102. In 1968, waste was sent to tanks BY-105 and 241-BY-112 (BY-112), and supernate was received from tank 241-BY-109 (BY-109). Tank BY-102 received waste from BX-Farm tanks BX-103 through 241-BX-112 (BX-112) in 1969. Supernate was sent to tank BY-105 from 1969 to 1971. Tank BY-102 received waste from tanks BX-102, BX-103, BX-106, and BY-109 in 1970 and 1971. Waste was exchanged between tank BY-102 and tank BY-112 from late 1971 to late 1974 while tank BY-112 functioned as ITS#2. Supernate was sent from tank BY-102 to tanks BY-110 and 241-BX-111 (BX-111) during 1974 (RPP-RPT-42996, *2009 Auto-TCR for Tank 241-BY-102*).

Tank BY-102 was declared inactive and no longer receiving waste in 1977. During 1977 and 1978, waste was sent from tank BY-102 to tank 241-A-102 (A-102). Waste was also sent to tank BX-105 during 1978. In 1983, waste was sent to tank 241-AN-103. Waste was sent to tank 241-AN-101 (AN-101) in 1991. Tank BY-102 was saltwell jet pumped in 1994 and 1995, removing a total of 159 kgal of liquid, and was declared interim stabilized in April 1995 (HNF-SD-RE-TI-178).

As of October 2009 tank BY-102 contains 237 kgal (71.8 in.) of waste type BY-Saltcake material, with a saltcake interstital liquid volume of 41 kgal (RPP-RPT-42996).

### C.2.2 Tank 241-BY-102 Waste Surface Level

No indications were observed as to unknown surface level decreases, though SD-WM-TI-356 notes that surface level readings may be influenced by measurement anomalies stemming from the presence of surface solids. Tank BY-102 was filled to a maximum waste level of 758 kgal (283 in.) during operations in 1952 and 1953, below the cascade overflow level of 760 kgal (284 in.). During this period, there was concern over dome loading due to salt buildup on dome supported equipment, and surface level measurement anomalies were evident. Figures C-4 and C-5 detail historical surface level monitoring in tank BY-102. Tank BY-102 exhibits characteristics of having retained (trapped) gas (WHC-SD-WM-ER-526). This could contribute to the waste surface anomalies observed. The large surface level decrease in 1991 was due to transfers to tank AN-101.

**Figure C-4. 241-BY-102 Historical Tank Content Estimate Waste Fill History**

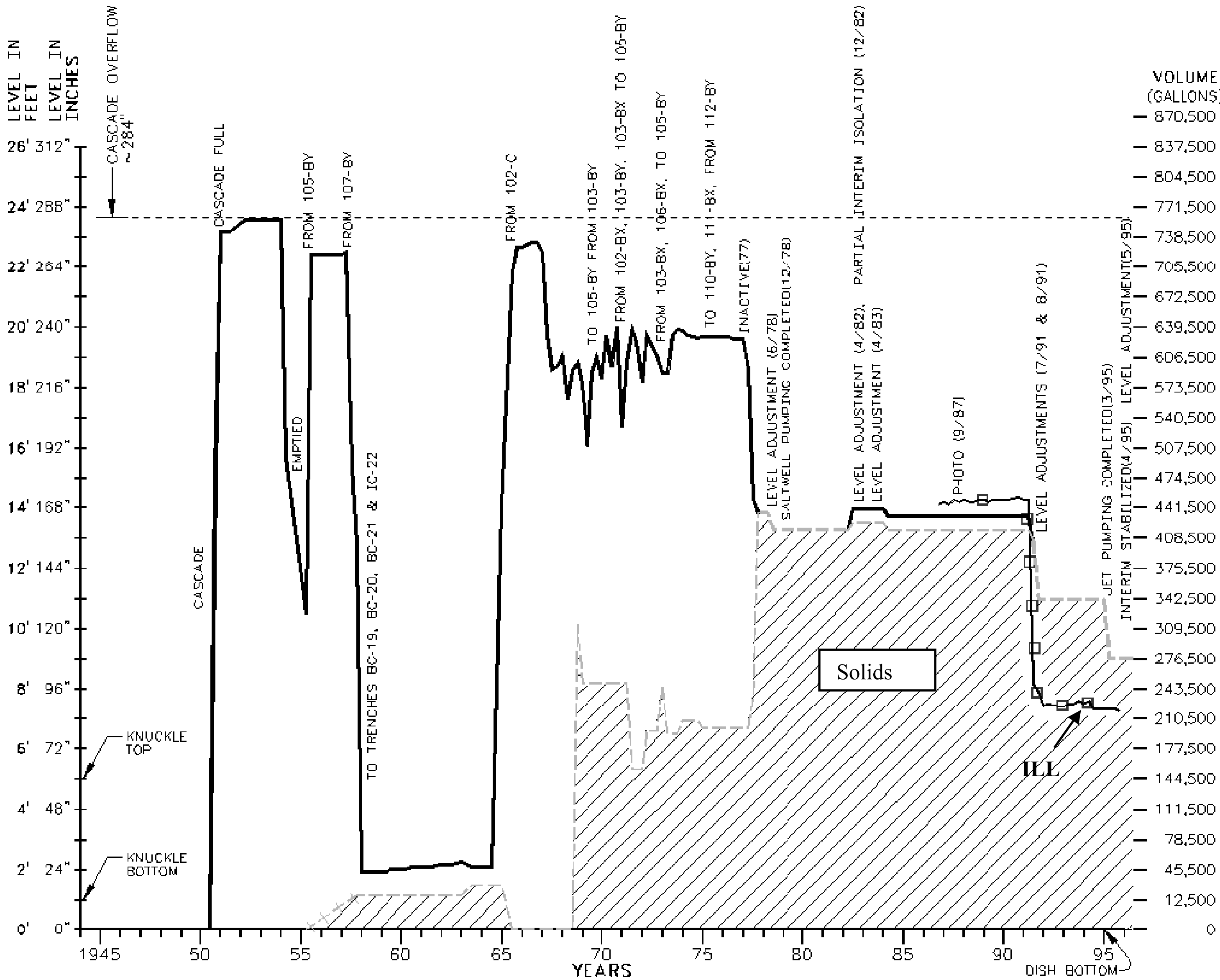
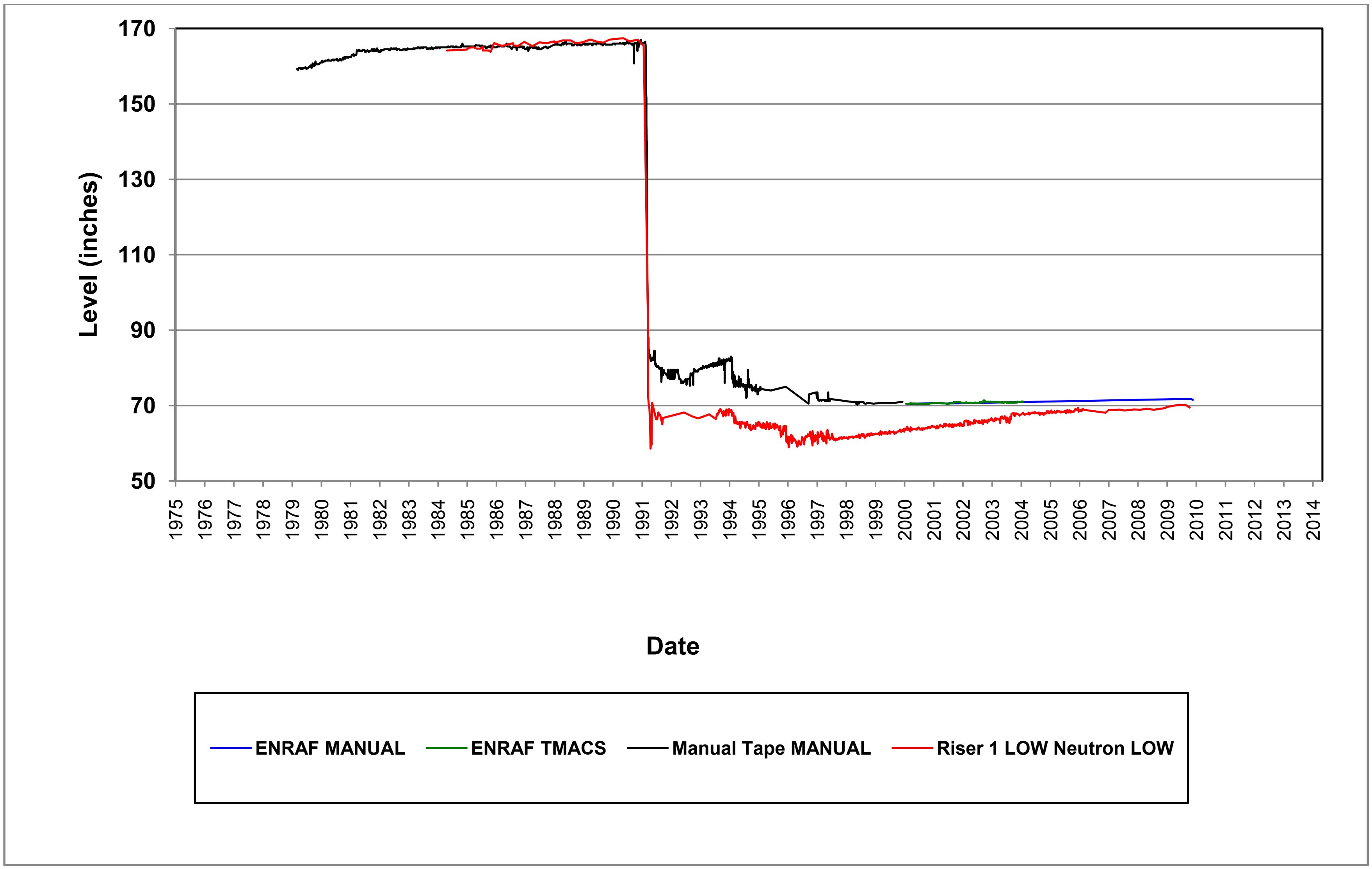


Figure C-5. 241-BY-102 Tank Waste Monitoring Data



### C.2.3 Tank 241-BY-102 Logging and Assessments

SD-WM-TI-356 notes that tank BY-102 was previously restricted due to tar rings above the 240 in. level. GJ-HAN-19, *Vadose Zone Characterization Project at the Hanford Tank Farms Tank Summary Data Report for Tank BY-102* logging data indicates contamination profiles that may suggest subsurface sources intersecting drywells surrounding tank BY-102, as seen in Figure C-6. Drywell 22-02-01 displays $^{137}Cs$ contamination below the tank waste level, though it is suspected that this is the result of lateral migration of existing waste from nearby tank BY-103.

The following occurrence reports are associated with tank BY-102.

ARHCO Occurrence Report 74-123, *Increasing Dry Well Readings at Waste Tank 102-BY*:

> "The 102-BY tank is considered to be sound. The source of the observed radiation increase in Dry Well 22-02-01 is believed to be due to lateral migration of existing soil contamination. Neutron measurements in the general area indicate an above average moisture content which would promote contamination movement. The liquid level has shown an accumulated decrease of three-fourths inch between periods involving six transfers. The liquid surface, however, is entirely covered with a crust and it is normal for liquid level measurements to decrease as the liquid surface stabilizes following a transfer in or out of a tank."

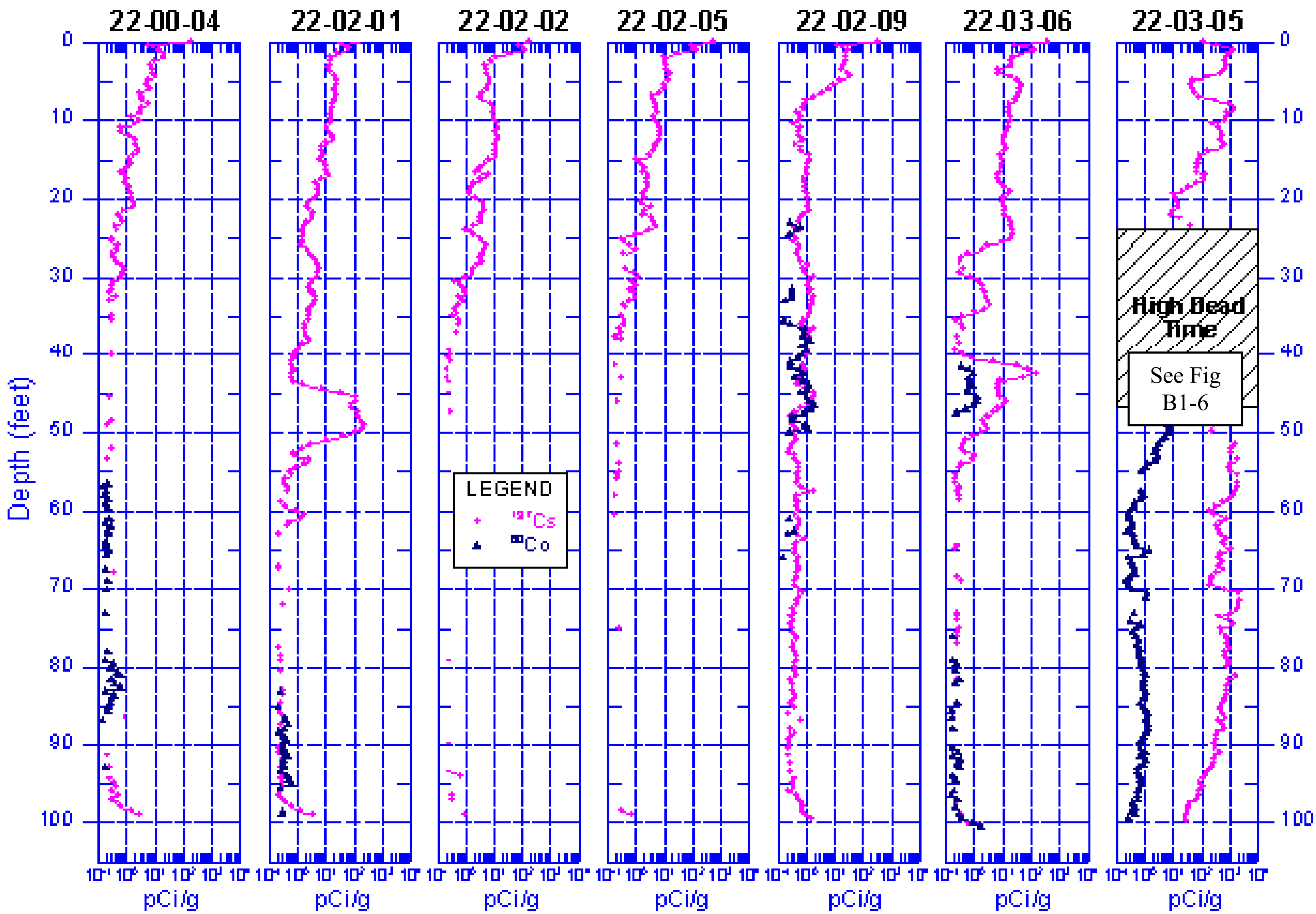
Occurrence Report 76-36, *Liquid Level Decrease Meeting Action Criteria Limit*

> "Since September 1, 1974, the liquid level has gradually decreased from a baseline value of 236.00 inches to 235.00 inches, a one inch decrease which is the established action criteria.
>
> Photographs were taken of the tank and show a clear open liquid surface with only minor flakes of crystals floating on the surface. The photographs indicated crystal buildup on the plummet which could be the cause of liquid level increases followed by eventual sloughing off."

Occurrence Report 77-163, *Tank 102-BY Liquid Level Increase Exceeding Criterion*

> "A liquid level baseline of 162.75 inches was established for Tank 102-BY on 9-6-77, following a saltwell transfer to Tank 105-BX. On 9-19-77 the liquid level measurement was 164.00 inches, exceeding the allowed one inch rise above the baseline.
>
> The apparent cause is osmotic redistribution of liquid following the saltwell transfer."

**Figure C-6. Tank 241-BY-102 Drywell Spectral Gamma Data, 1995**




Reference: GJO-96-2-TAR/GJO-HAN-6, *Vadose Zone Characterization Project at the Hanford Tank Farms: BY Tank Farm Report.*

# C.3 TANK 241-BY-104

## C.3.1 Tank 241-BY-104 History

In 1956 and 1957, tank 241-BY-104 (BY-104) received waste from the in-plant ferrocyanide scavenging process from tanks 241-BY-106 (BY-106), BY-107, 241-BY-108 (BY-108), and BY-110. During 1961 and 1962, tank BY-104 received plutonium-uranium extraction (PUREX) cladding waste (CWP) from tank 241-C-107. No further transfers occurred until 1967 when the supernate was sent to tank A-102. During 1967 and 1968, the tank received cladding waste from tank C-102. Supernate was sent to tank BY-103 in 1968. In 1968 ion-exchange waste from cesium recovery operations was received from tank 241-BX-104 (BX-104). Supernate was sent to tanks 241-A-103 and 241-C-110 in early 1970 (RPP-RPT-42998, *2009 Auto-TCR for Tank 241-BY-104*).

Tank BY-104 received EB waste from the ITS process conducted in the BY-Farm from tanks BY-109 and BY-112 from 1970 to 1974. Waste was sent to tank A-102 in late 1976 and early 1977. Tank 241-BY-104 was saltwell pumped beginning in May 1983 and was interim stabilized in 1985 (HNF-SD-RE-TI-178).

As of October 2009 BY-104 contains 405 kgal of waste consisting of 360 kgal of BY-Saltcake and 45 kgal of PFeCN sludge (RPP-RPT-42998).

## C.3.2 Tank 241-BY-104 Waste Surface Level

Tank BY-104 was filled to a maximum waste level of 758 kgal (about the level of cascade line inlets) during the cascade process campaign of 1953 through 1954. Figures C-7 and C-8 show tank waste surface levels from 1950 to 2010. The sharp decrease in 1983 was due to saltwell pumping. No occurrence reports were issued and no explanation was given for changes in the tank waste surface level after 1983; the ILL gradually increased from 1984 to 2010.

## C.3.3 Tank 241-BY-104 Logging and Assessments

GJ-HAN-21, *Vadose Zone Characterization Project at the Hanford Tank Farms Tank Summary Data Report for Tank BY-104* identified low $^{137}Cs$ activity in all drywells surrounding tank BY-104 (shown in Figure C-9), while $^{60}Co$ activity is present on the side of BY-104 adjacent to tank BY-107, assumed to have leaked in the past (HNF-EP-0182, *Waste Tank Summary Report for Month Ending April 30, 2009*, Rev. 253). The report notes that there were no indications in the drywell data of releases from tank BY-104.

SD-WM-TI-356 notes that tank BY-104 had a restricted use status due to a historical process limitation of 270 in., but is considered sound below this level.

Figure C-7. 241-BY-104 Historical Tank Content Estimate Waste Fill History

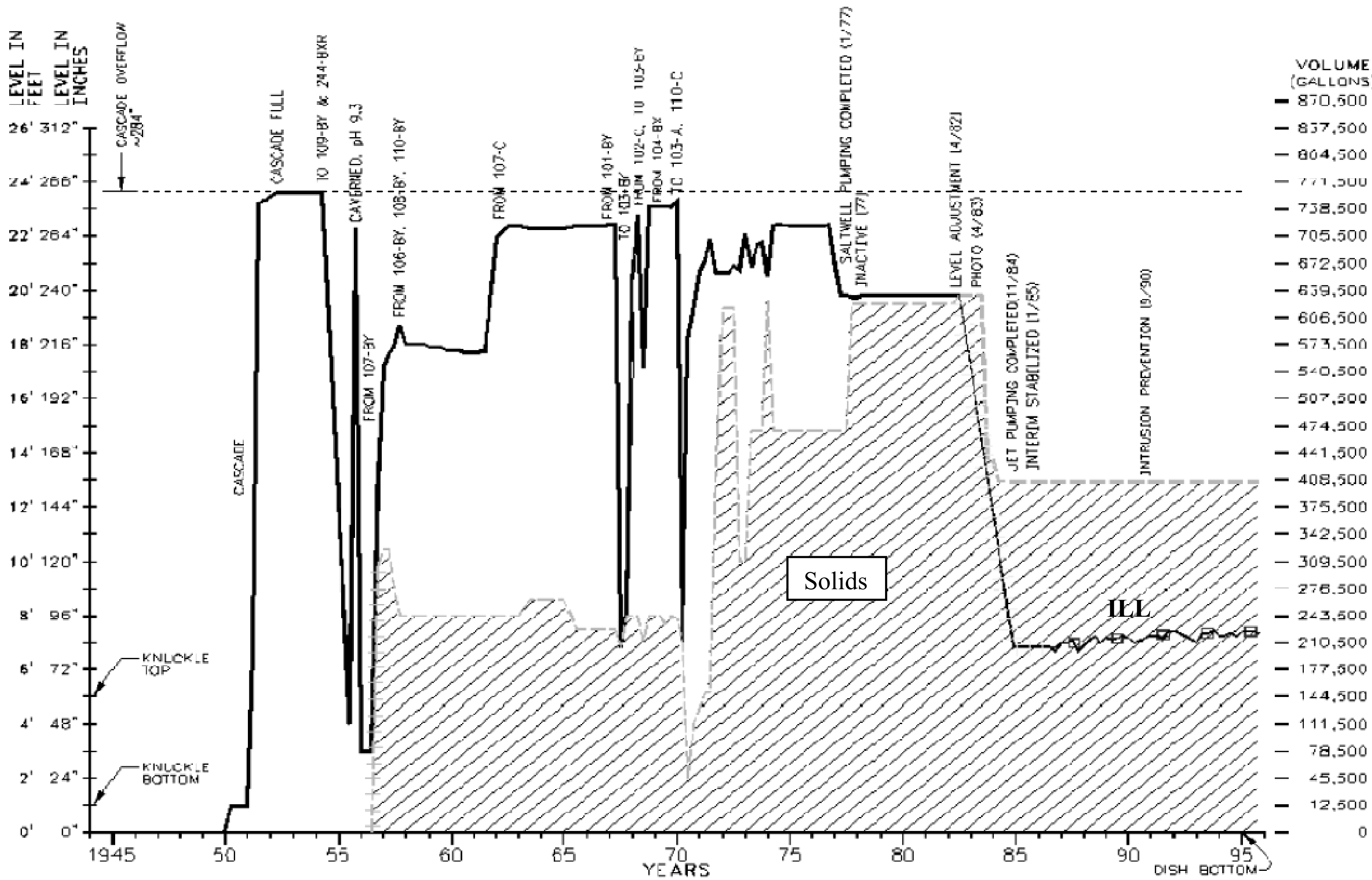


**Figure C-8. 241-BY-104 Tank Waste Monitoring Data**

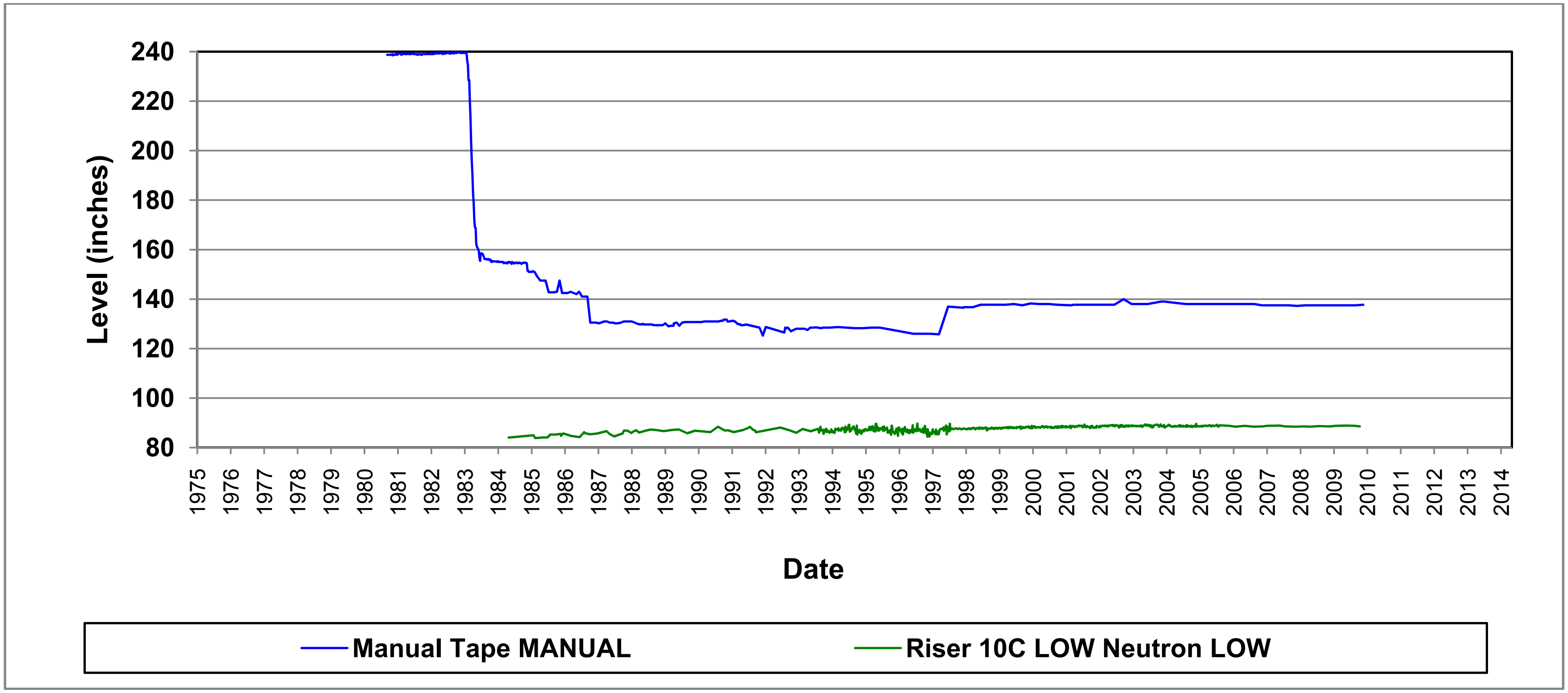
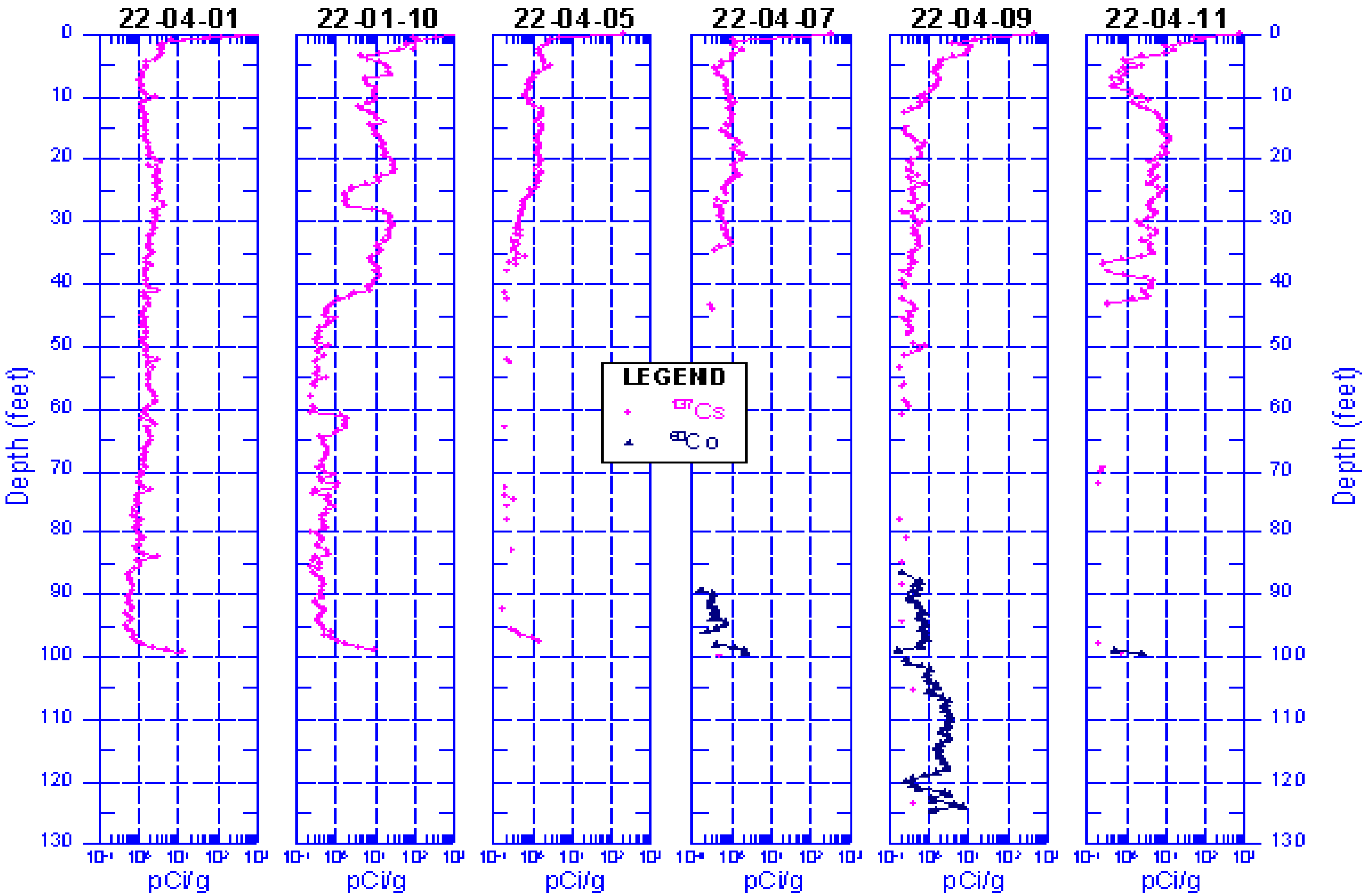


**Figure C-9. Tank 241-BY-104 Drywell Spectral Gamma Data, 1995**




Reference: GJ-HAN-21, *Vadose Zone Characterization Project at the Hanford Tank Farms Tank Summary Data Report for Tank BY-104*.

# C.4 TANK 241-BY-109

## C.4.1 History

Tank BY-109 entered service in 1953, receiving flush water and TBP supernatant wastes from tank 241-B-103. From 1953 through 1955, using tank 241-C-104 and a few other 241-BY tanks as transfer tanks, supernatant waste from the tank was transferred to the UR process, and supernate was received from tanks BY-112, 241-C-104, BY-101, and BY-108, via the pump in BY-103. In 1956, the tank received TBP waste from tanks BY-106 and BY-107. Most of this supernatant waste was sent to a crib in 1957. In 1962, tank BY-109 received CWP from tanks 241-C-107 and 241-C-109. From 1965 to 1968, the tank received CWP from tanks BY-105, BY-108, BY-112, and C-102, and supernatant waste was transferred to tank BY-103. Starting in 1968, various transfers occurred into and out of the tank to support ITS. Because tank BY-109 was a feed tank for the ITS process, these transfers continued until 1976. From 1977 to 1978, supernatant waste was transferred to tank A-102 as feed for the 242-A Evaporator and was received from the 242-A Evaporator as EB. Tank BY-109 was saltwell pumped in 1982, and the resulting liquor was sent to tank 241-AW-102. From 1991 to 1997, tank BY-109 was again saltwell pumped, and the resulting liquor sent to tank AN-101 via a 244-BX double-contained receiver tank. The tank was declared interim stabilized in 1997 (HNF-SD-RE-TI-178).

As of October 2009, BY-109 contains 287 kgal of waste consisting of 263 kgal BY-Saltcake and 24 kgal of CWP2 sludge (RPP-RPT-43003, *2009 Auto-TCR for Tank 241-BY-109*).

## C.4.2 Tank 241-BY-109 Waste Surface Level

Tank BY-109 was filled to a maximum waste level of 742 kgal in 1967 and 1968. Figures C-10 and C-11 show tank waste levels and monitoring data from 1953 to 2010. SD-WM-TI-356 notes slight liquid level increases in tank BY-109. The large liquid level decrease in 1991 was due to saltwell pumping.

## C.4.3 Tank 241-BY-109 Logging and Assessments

SD-WM-TI-356 notes that tank BY-109 had a restricted use status due to tar rings above the 235 in. level (~650 kgal). Measureable contamination was detected in several drywells around the tank. GJ-HAN-26, *Vadose Zone Characterization Project at the Hanford Tank Farms Tank Summary Data Report for Tank BY-109* reports high cesium activity at 24 ft bgs in drywell 22-09-08, likely due to pipeline leaks near tank BY-109. Drywell data also indicates $^{60}Co$ present below 22 ft in drywells 22-09-07, 22-09-08, and 22-09-11 on the west side of the tank (see Figure C-12). No occurrence reports were issued for liquid level decreases.

**Figure C-10. 241-BY-109 Historical Tank Content Estimate Waste Fill History**

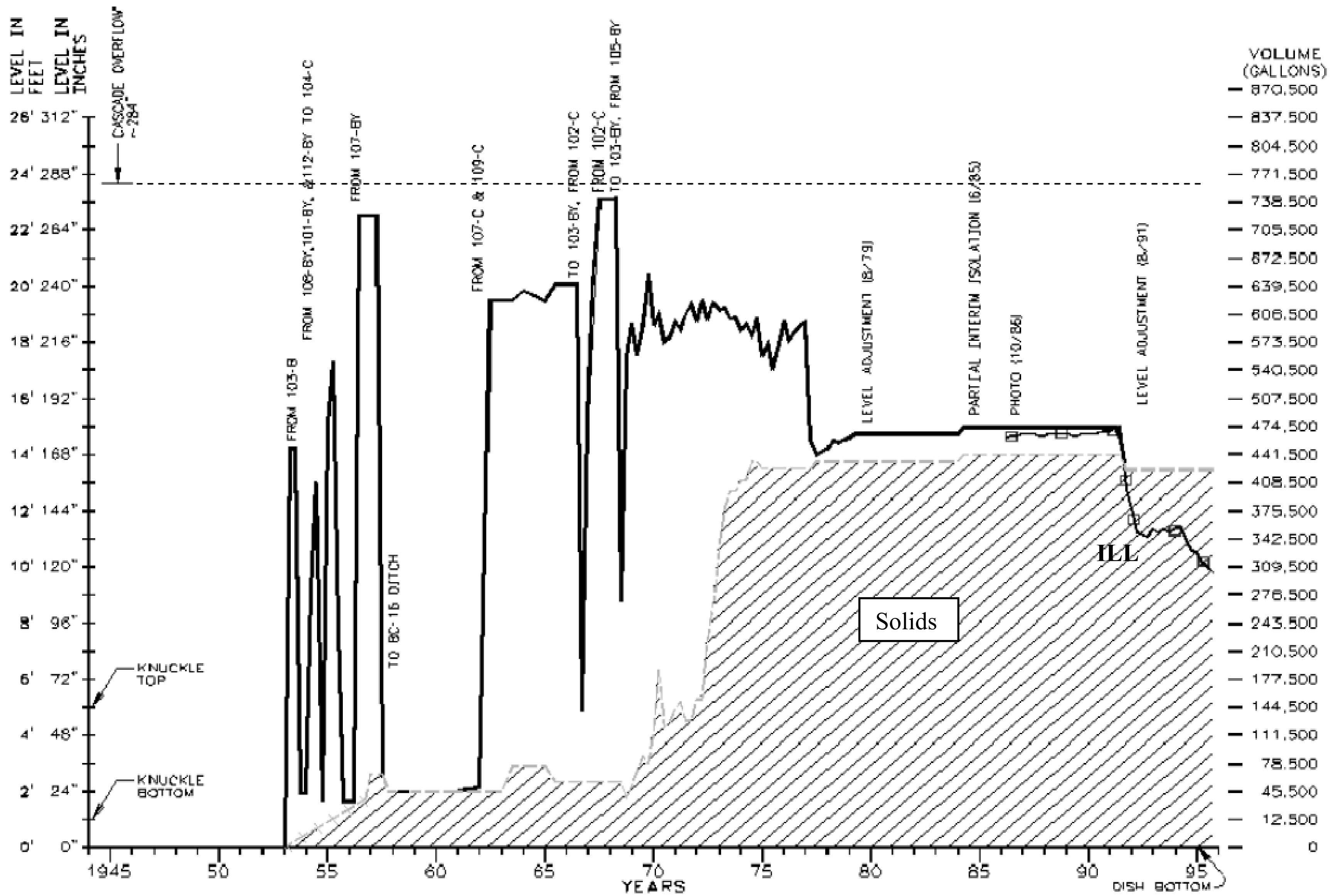


**Figure C-11. 241-BY-109 Tank Waste Monitoring Data**

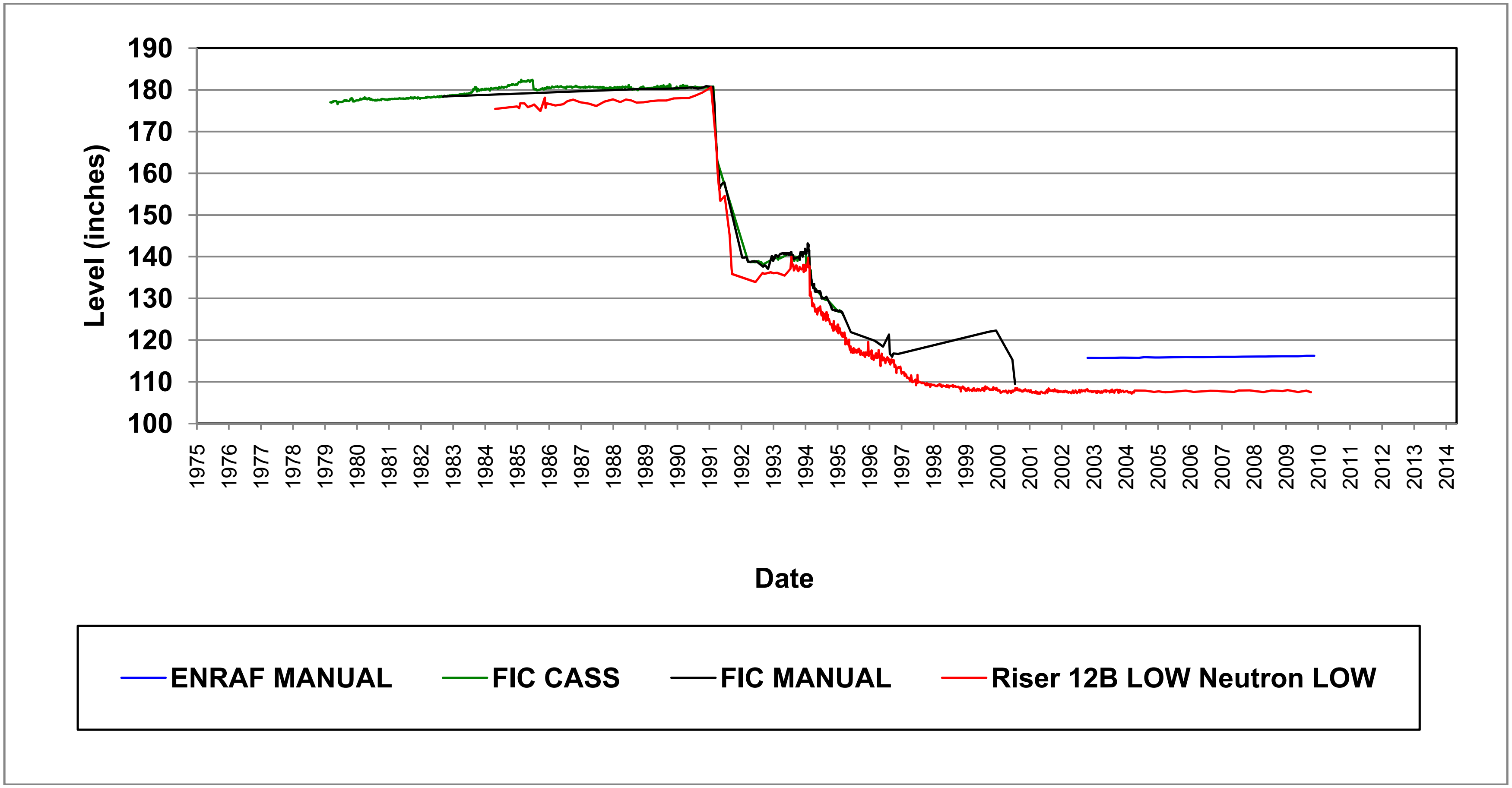
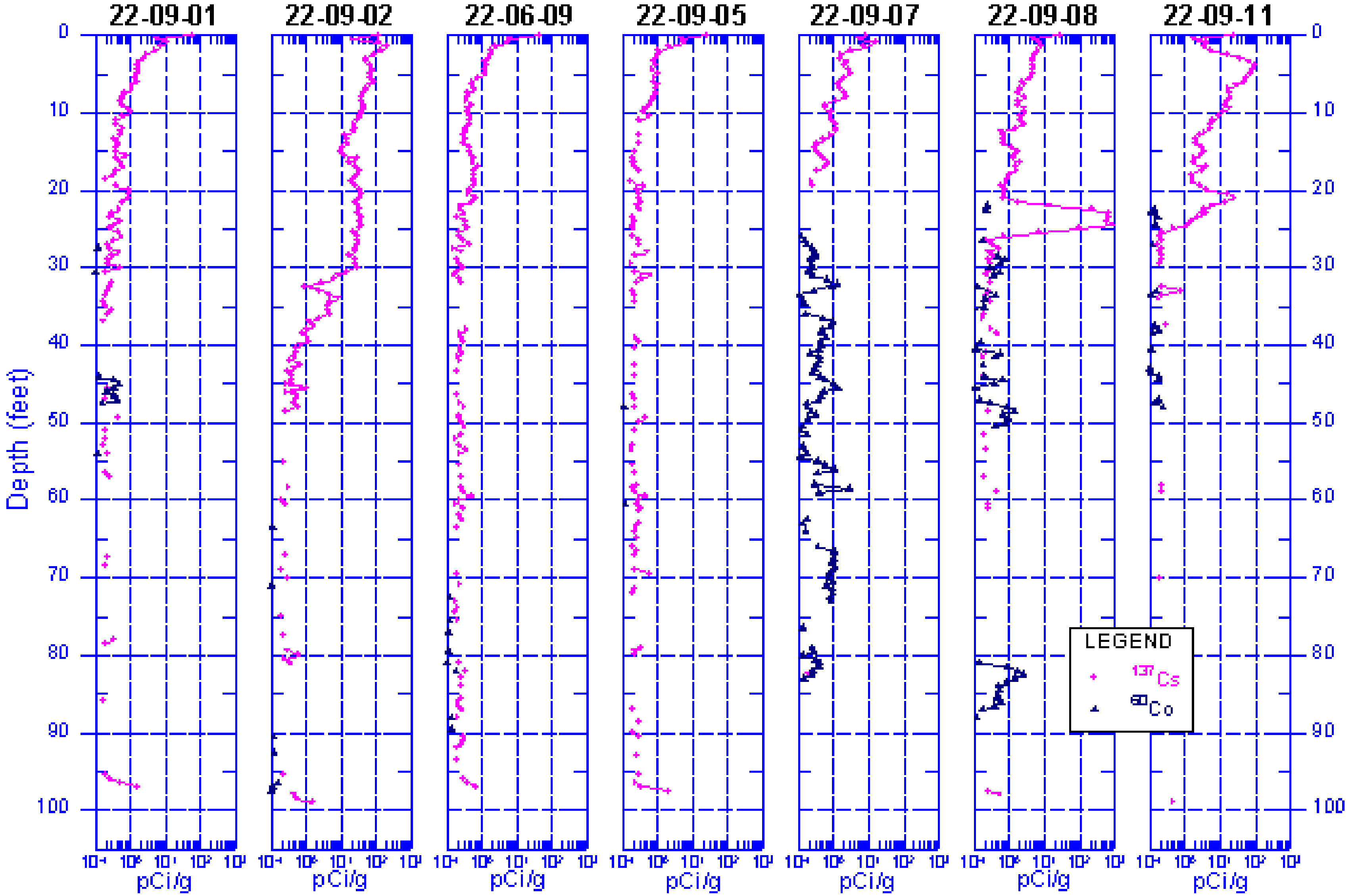


Figure C-12. Tank 241-BY-109 Drywell Spectral Gamma Data, 1995




Reference: GJO-96-2-TAR/GJO-HAN-6, *Vadose Zone Characterization Project at the Hanford Tank Farms: BY Tank Farm Report.*

# C.5 TANK 241-BY-110

## C.5.1 Tank 241-BY-110 History

Tank BY-110 was placed into service in 1951 and received 1C waste into 1952. In 1952, the tank received 1C waste from an unknown source; likely from B-Plant. In 1954, 95% of the waste (693 kgal) was transferred to crib B-038. From 1954 to 1957, the tank received in-plant ferrocyanide scavenged waste from the UR process. Tank BY-110 was a primary settling tank. During this process, ferrocyanide and nickel sulfate were added to the UR waste to precipitate cesium. After settling, the scavenged ferrocyanide supernatant waste (which was relatively free of cesium) was transferred from tank BY-110 to various cribs and tanks BY-102, BY-103, BY-104, BY-105, and BX-105. Cladding waste was added to the tank from tank C-105 during 1957 and 1958. In 1958, CW was also transferred into the tank from tank 241-C-106. No further transfers occurred until 1969. From 1969 to 1976, tank BY-110 sent waste to tank BY-112 and received ITS waste from tank BY-112. In 1970, 1974, and 1975, EB waste was added from tanks BY-109, BY-102, and BY-107, respectively. In 1975, waste was sent to tank BX-106. In 1976, tank BY-110 received EB waste from tank BY-107. Finally, from 1977 to 1979, the tank received evaporator feed waste and noncomplexed waste from tank A-102. Waste was sent to tank BX-105 in 1979 and to tank 241-AW-102 in 1982 (RPP-RPT-43004, *2009 Auto-TCR for Tank 241-BY-110*).

Tank BY-110 was removed from service in 1979 and declared interim stabilized in 1985 (HNF-SD-RE-TI-178). As of October 2009 tank BY-110 contains 366 kgal of waste consisting of 323 kgal of BY-Saltcake and 43 kgal of PFeCN sludge (RPP-RPT-43004).

## C.5.2 Tank 241-BY-110 Waste Surface Level

Tank BY-110 was filled to a maximum waste level of 739 kgal in 1960. Figures C-13 and C-14 show waste levels between 1953 and 2010. Surface level decreases were evident over time. The sudden surface level drop in 1990 followed by a sudden increase in 1996 is attributed to instrument error. The ILL remained steady during this time.

## C.5.3 Tank 241-BY-110 Logging and Assessments

SD-WM-TI-356 states that tank BY-110 had a restricted use status due to tar rings above the 266 in. level (~730 kgal). An example of tar rings inside tank BY-110 can be seen in Figure C-15.

GJ-HAN-27, *Vadose Zone Characterization Project at the Hanford Tank Farms Tank Summary Data Report for Tank BY-110* reports $^{60}$Co contamination detected in drywells 22-10-05 and 22-10-07 at a depth of 48 ft, approximately 3 ft below the tank's bottom depth (Figure C-16). Other $^{60}$Co zones were observed deeper in the vadose zone in drywells 22-07-09 and 22-10-10. Low levels of $^{137}$Cs contamination were present in all drywells surrounding tank BY-110, while slight $^{137}$Cs and $^{60}$Co peaks were observed in drywell 22-07-09 at a depth of approximately 80 ft (Figure C-16).

**Figure C-13. 241-BY-110 Historical Tank Content Estimate Waste Fill History**

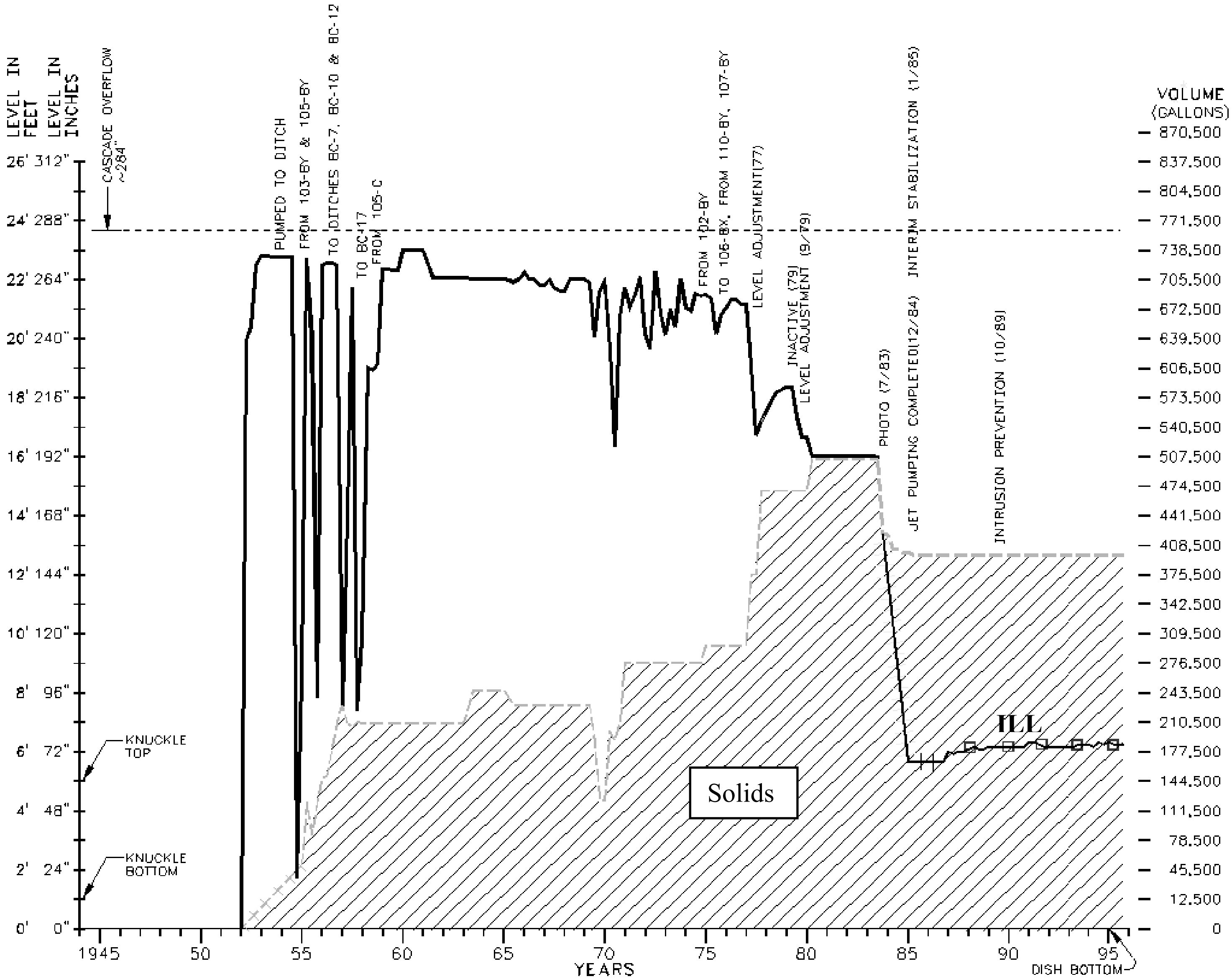


Figure C-14.  241-BY-110 Tank Waste Monitoring Data

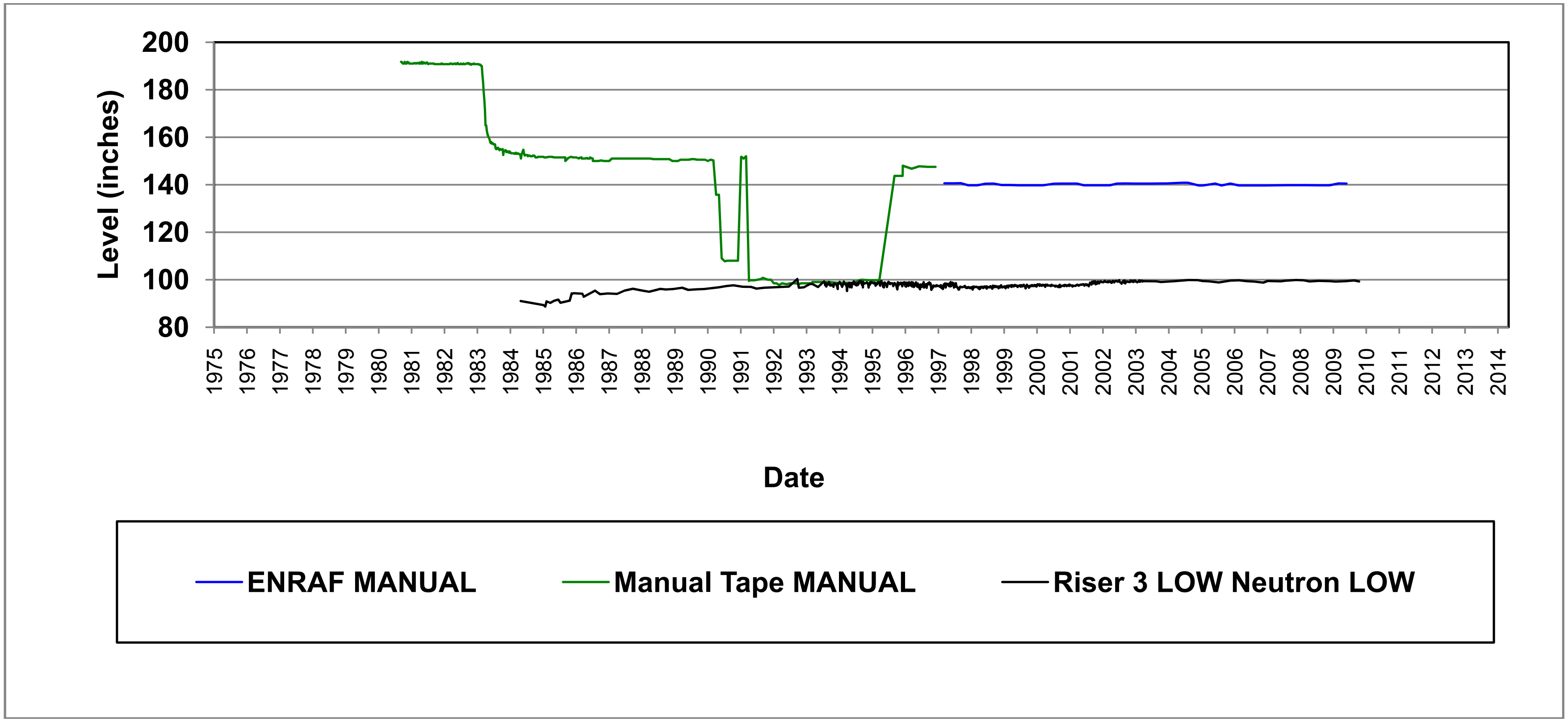
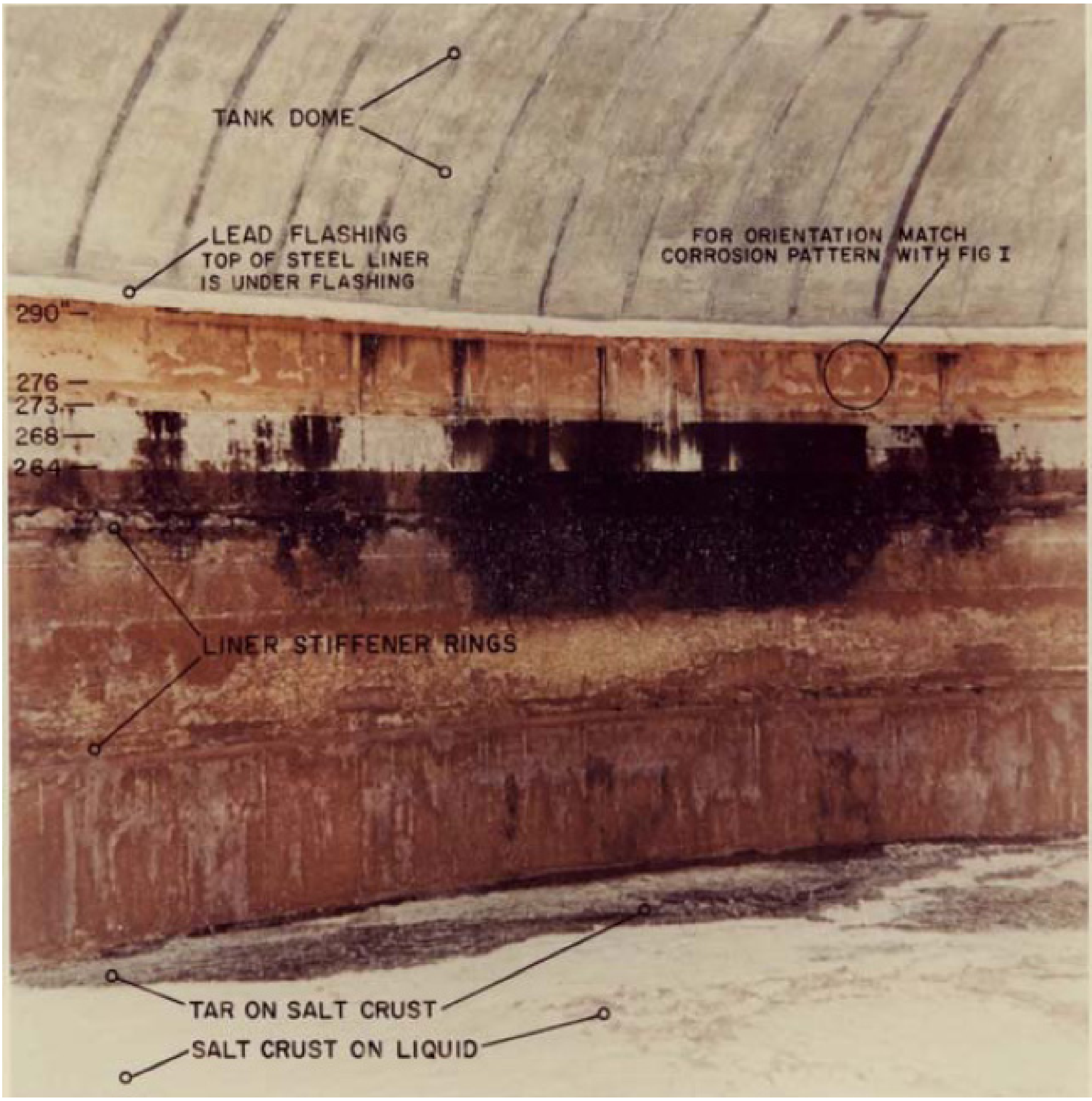


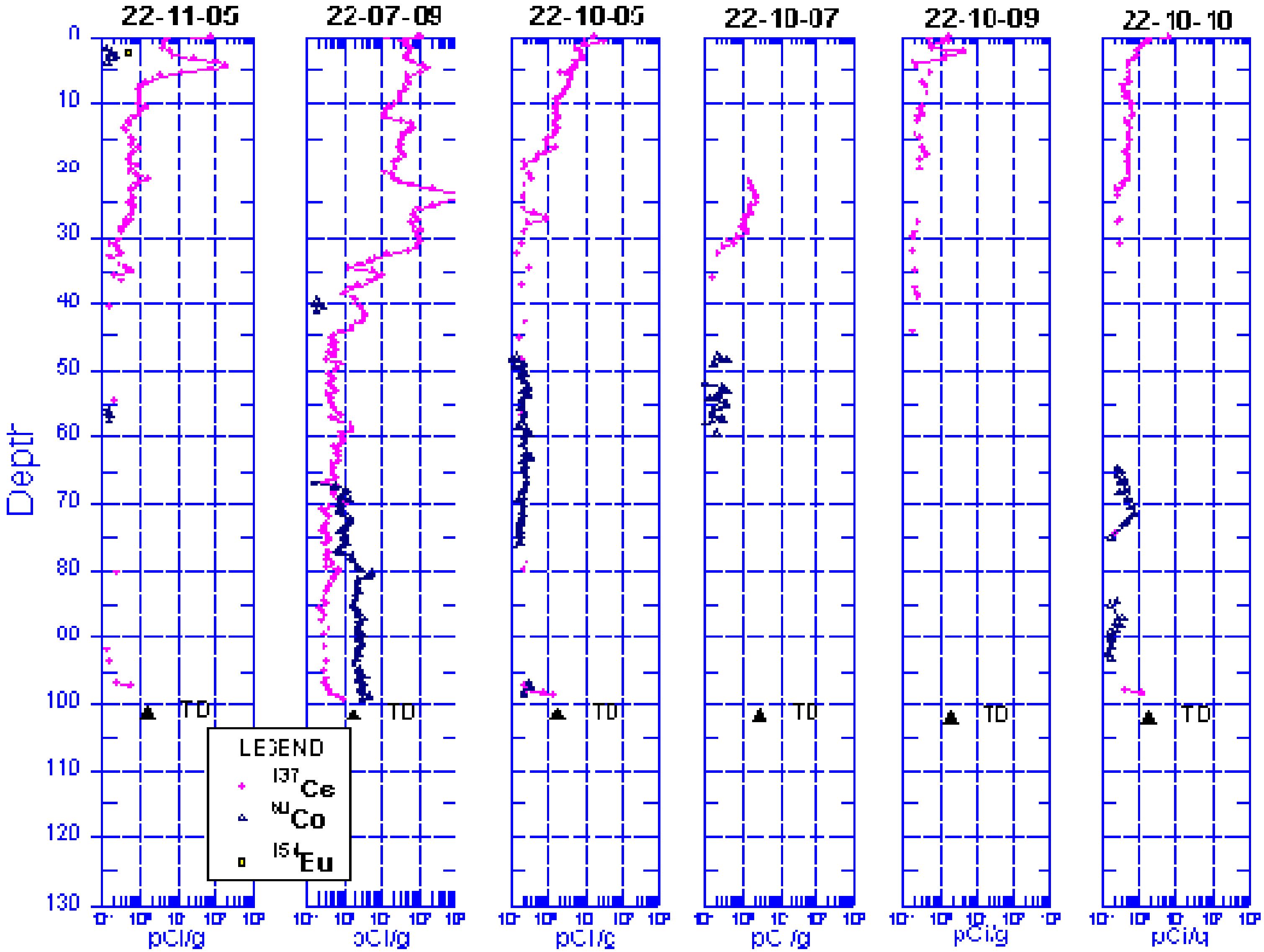
**Figure C-15. Tank 241-BY-110 Interior Tar Rings, October 1969**




The following occurrence reports and deviation reports were found related to tank BY-110 liquid levels.

Operating Limit Deviation Report 79-14, *Liquid Level Decrease in Tank 110-BY Exceeding the Criterion* was issued in 1979 because of a 1.5 in. decrease. The cause of the decrease was attributed to the manual tape plummet creating a depression in the moist salt surface.

**Figure C-16. Tank 241-BY-110 Drywell Spectral Gamma Data, 1995**




Reference: GJO-96-2-TAR/GJO-HAN-6, *Vadose Zone Characterization Project at the Hanford Tank Farms: BY Tank Farm Report.*

ARHCO Occurrence Report 75-117, *Liquid Level Decrease in Tank 110-BY*

> "A salt well transfer from 107-BY to 110-BY resulted in a sudden liquid level drop in 110-BY following the transfer. A similar situation was observed in July 1975 following a salt well transfer. Photographs were taken at that time and included a personal viewing of the waste surface. The transfer procedure at the time of a salt well pumping of 107-BY includes use of steam and hot water to back flush the salt well and clean out the transfer line. The introduction of this heated solution to the encrusted surface in 110-BY caused a disruption which appears as a sudden liquid level drop."

## C.6 TANK 241-BY-111

### C.6.1 History

Tank 241-BY-111 (BY-111) first received MW from B-Plant in the fourth quarter of 1951, and continued to receive MW through the first quarter of 1952. Waste cascaded from tank BY-111 to tank BY-112 during 1952. Also during 1952, the tank received UR waste and again cascaded supernate to tank BY-112. Supernate was sent to tank BX-106 during 1954 and sludge was received from tank BY-112. Waste was sluiced from the tank in 1955 and sent for UR. In 1956, the tank received MW from B-Plant and supernate from tank BY-107, and supernate was sent to crib B-016. Tank BY-111 received supernate from tanks C-105 and 241-C-111 during the second quarter of 1957.

Supernate was sent from tank BY-111 to tank BY-103 in 1965 and 1966. During 1966, supernate was sent to tank BY-112, and supernate was received from tank C-102. Tank BY-111 received CWP during 1967. In 1968, supernate was sent to tanks BY-103 and BY-108. Tank BY-111 exchanged EB waste and supernate from the ITS process with tank BY-112 from the second quarter of 1968 to 1976. A small amount of supernate was sent to tank BX-105 in 1978 (RPP-RPT-43005, *2009 Auto-TCR for Tank 241-BY-111*). Interstitial liquor was saltwell pumped to tank 241-AW-102 in 1982. Tank BY-111 was removed from service in 1977 and interim stabilized in 1985 (HNF-SD-RE-TI-178).

As of October 2009 tank BY-111 contains 402 kgal of BY-Saltcake (RPP-RPT-43005).

### C.6.2 Tank 241-BY-111 Waste Surface Level

Tank BY-111 was filled to a maximum waste level of 758 kgal from 1952 through 1954, approaching the cascade overflow level of 760 kgal (284 in.) Figures C-17 and C-18 show waste fill history and monitoring data for tank BY-111.

**Figure C-17. 241-BY-111 Tank Waste Monitoring Data**

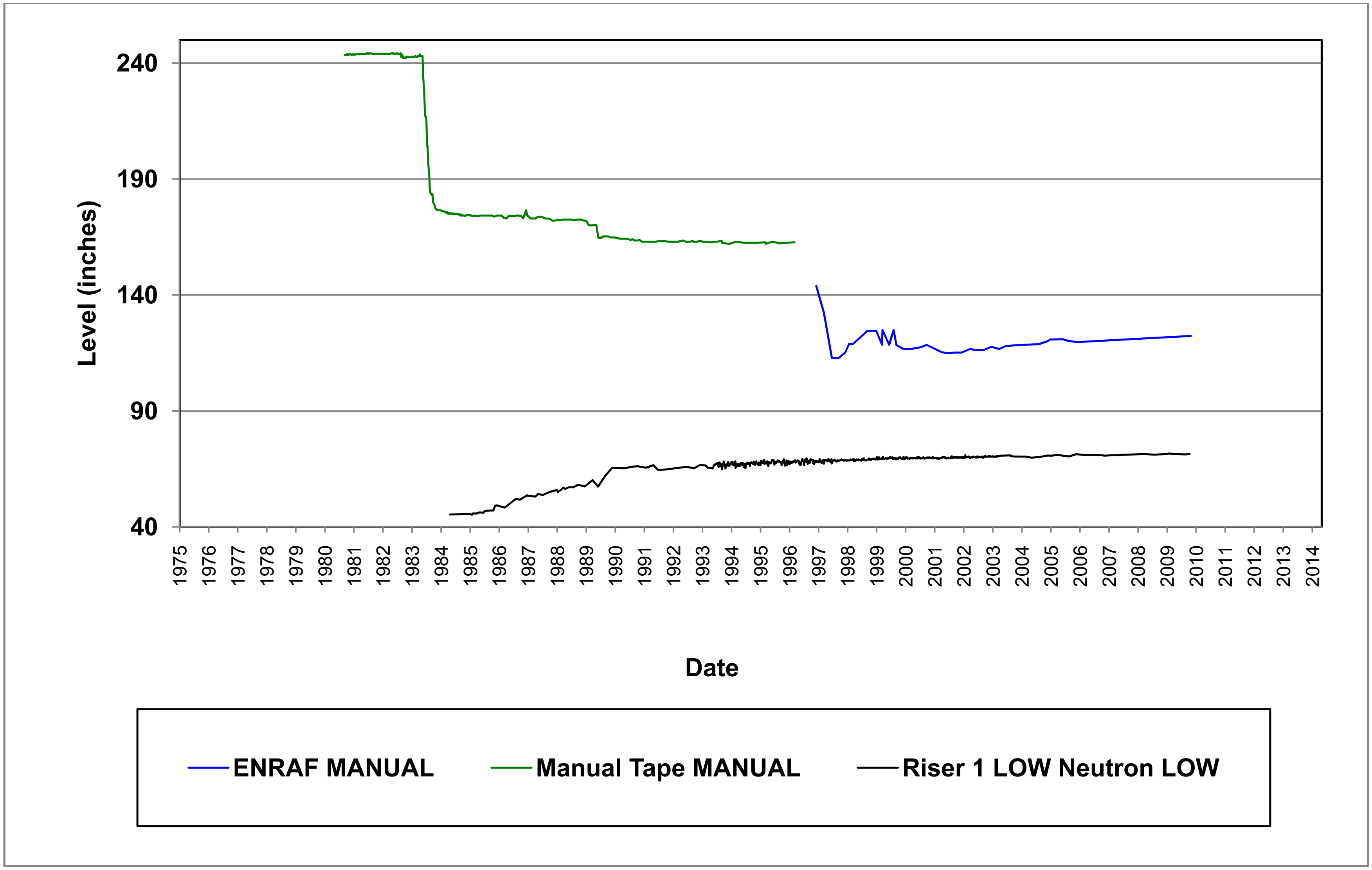
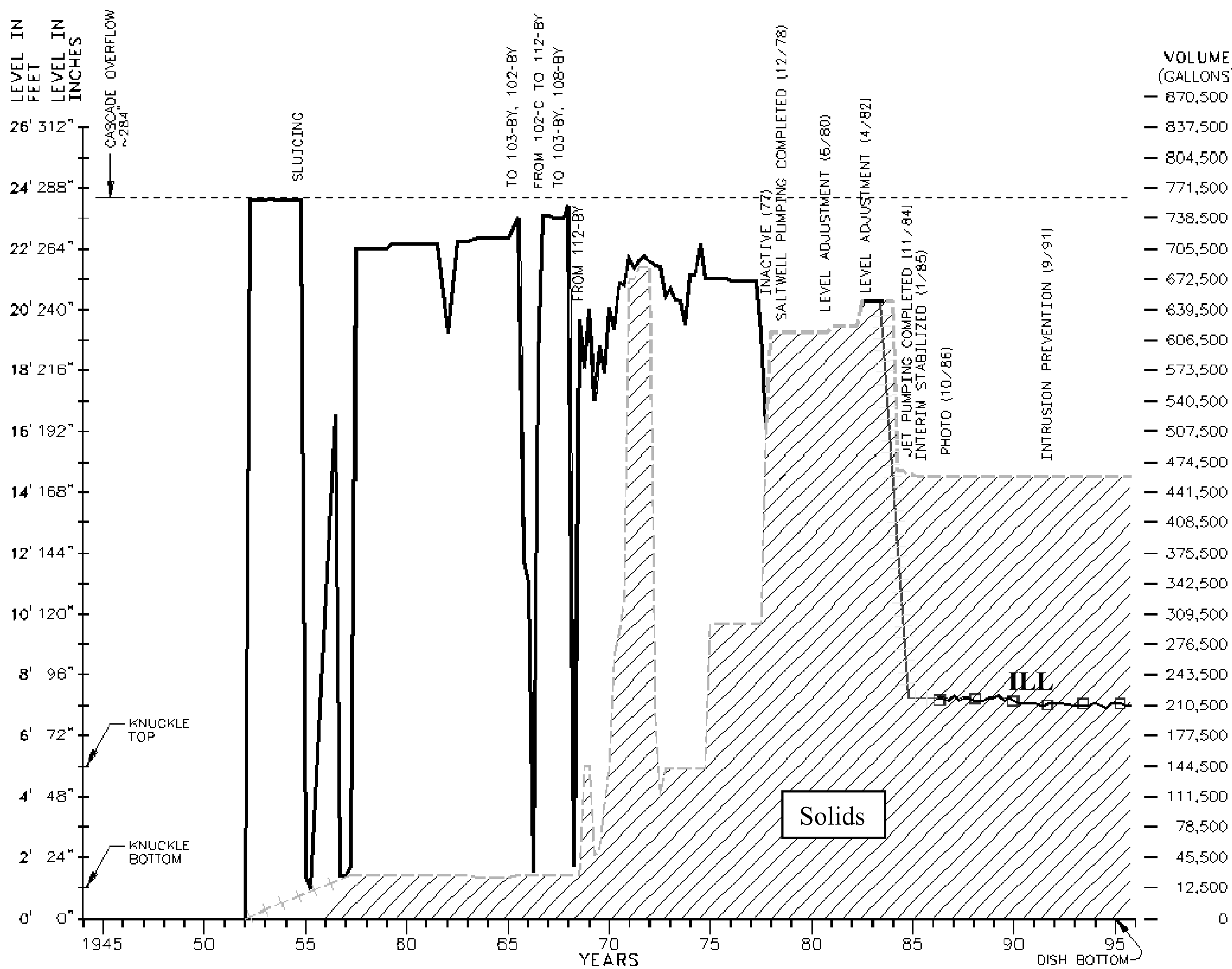


**Figure C-18. 241-BY-111 Historical Tank Content Estimate Waste Fill History**



### C.6.3 Tank 241-BY-111 Logging and Assessments

SD-WM-TI-356 states that the waste surface inside tank BY-111 is extremely irregular, and that there were no changes in drywell activity during the review period. There were no unexplained liquid level decreases observed in BY-111, though the tank was filled to capacity in the early 1950s.

GJ-HAN-28, *Vadose Zone Characterization Project at the Hanford Tank Farms Tank Summary Data Report for Tank BY-111* reports low levels of $^{137}$Cs activity (<100 pCi/g) above 10 ft and $^{60}$Co activity between 23 and 27 ft in depth in drywells near tank BY-111 (Figure C-19). Evidence exists in drywell 22-11-08 at about 62 ft that processed uranium has been introduced into the environment.

The following occurrence reports are associated with tank BY-111.

ARHCO Occurrence Report 75-132, *Violation of Liquid Level Specification*:

> "The slow loss of level is attributed to evaporation and the difficulty of getting good contact with the surface in reading liquid levels."

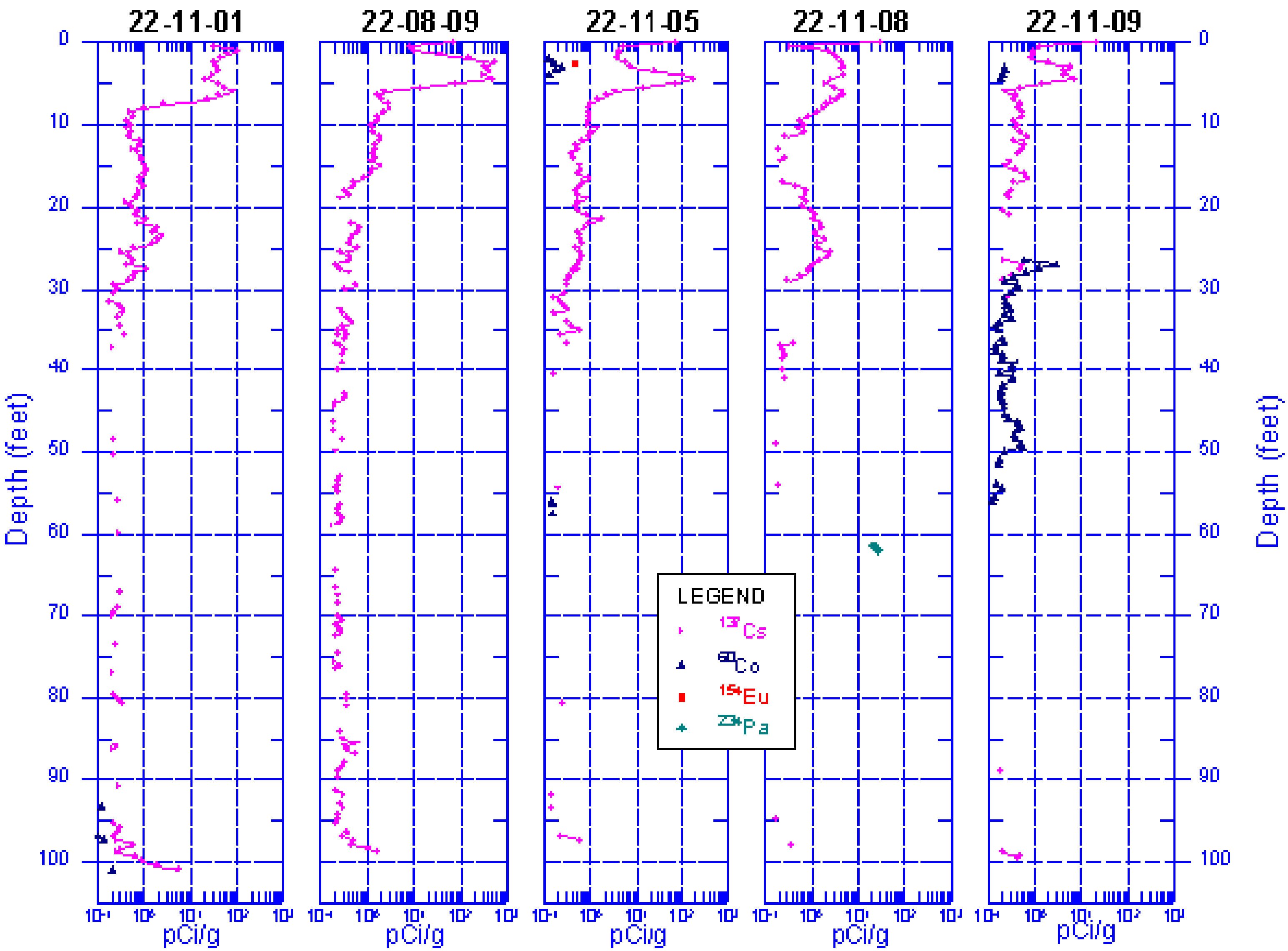
Occurrence Report 77-178, *Tank 111-BY Liquid Level Decrease Exceeding Criterion*:

> "The cause of the decrease is attributed to manual tape plummet reading variations caused by an uneven surface crust and possible interference by debris."

Occurrence Report 78-18, *Tank 111-BY Liquid Level Decrease Exceeding Criterion*:

> "The decrease is attributed to compaction of the surface by the plummet or to contact with a discarded tape lying on the surface crust."

**Figure C-19. Tank 241-BY-111 Drywell Spectral Gamma Data, 1995**




Reference: GJO-96-2-TAR/GJO-HAN-6, *Vadose Zone Characterization Project at the Hanford Tank Farms: BY Tank Farm Report.*

## C.7 TANK 241-BY-112

Tank BY-112 is currently classified as sound by HNF-EP-0182. The current best-basis inventory shows SST BY-112 contains 286 kgal (115 in.) of waste type BY-Saltcake and MW material, with 21 kgal of saltcake interstitial liquid (RPP-RPT-43006, *2009 Auto-TCR for Tank 241-BY-112*). This tank was interim stabilized in 1984 (HNF-SD-RE-TI-178).

### C.7.1 History

Tank BY-112 is the last tank in a three-tank cascade series. Tank BY-112 began receiving MW from B-Plant in 1951. During 1952, the tank received MW via the cascade from tank BY-111. Also during 1952, tank BY-112 again received MW directly from B-Plant. During 1955 MW sludge sent to tank BY-111 cascaded to tank BY-112. During 1956, tank BY-112 received supernate from tanks BY-106, BY-107, and BY-108. During 1957, ferrocyanide sludge was received, and supernate was sent to the B-028 and B-029 cribs. Also during 1957, tank BY-112 received supernate from tank C-105. The tank remained static until 1965 when supernate was sent to tanks BY-109, BY-101, and BY-103. Tank BY-112 received supernate from tanks C-102 and BY-111 from 1965 to 1966. During 1967, tank BY-112 received CWP.

In 1966, a heater was placed in the tank to cause evaporation (ITS#2). During late 1967 and early 1968, tank BY-112 received waste from cell 23 at B-Plant. Cell 23 was used to evaporate tank waste. From 1968 to 1976, the tank received waste from tank BY-102 as well as other SSTs in the 200 East Area. During this same time, waste was transferred from tank BY-112 to other SSTs in the 200 East Area.

### C.7.2 Tank 241-BY-112 Waste Surface Level

Tank BY-112 was filled as high as 755 kgal from 1957 through 1964 and again in 1966 and 1967. Figures C-20 and C-21 show waste level and monitoring histories.

### C.7.3 Tank 241-BY-112 Integrity Assessment

SD-WM-TI-356 notes that drywell activity remained steady during the review period.

GJ-HAN-29, *Vadose Zone Characterization Project at the Hanford Tank Farms Tank Summary Data Report for Tank BY-112* describes elevated $^{137}$Cs contamination at a depth of ~24 ft in drywell 22-12-03 (Figure C-22), but attributes that activity to nearby tank BY-109 and associated piping. The report concluded that spectral gamma-ray log data show no subsurface contamination that could be associated with a possible leak from tank BY-112.

**Figure C-20. 241-BY-112 Historical Tank Content Estimate Waste Fill History**

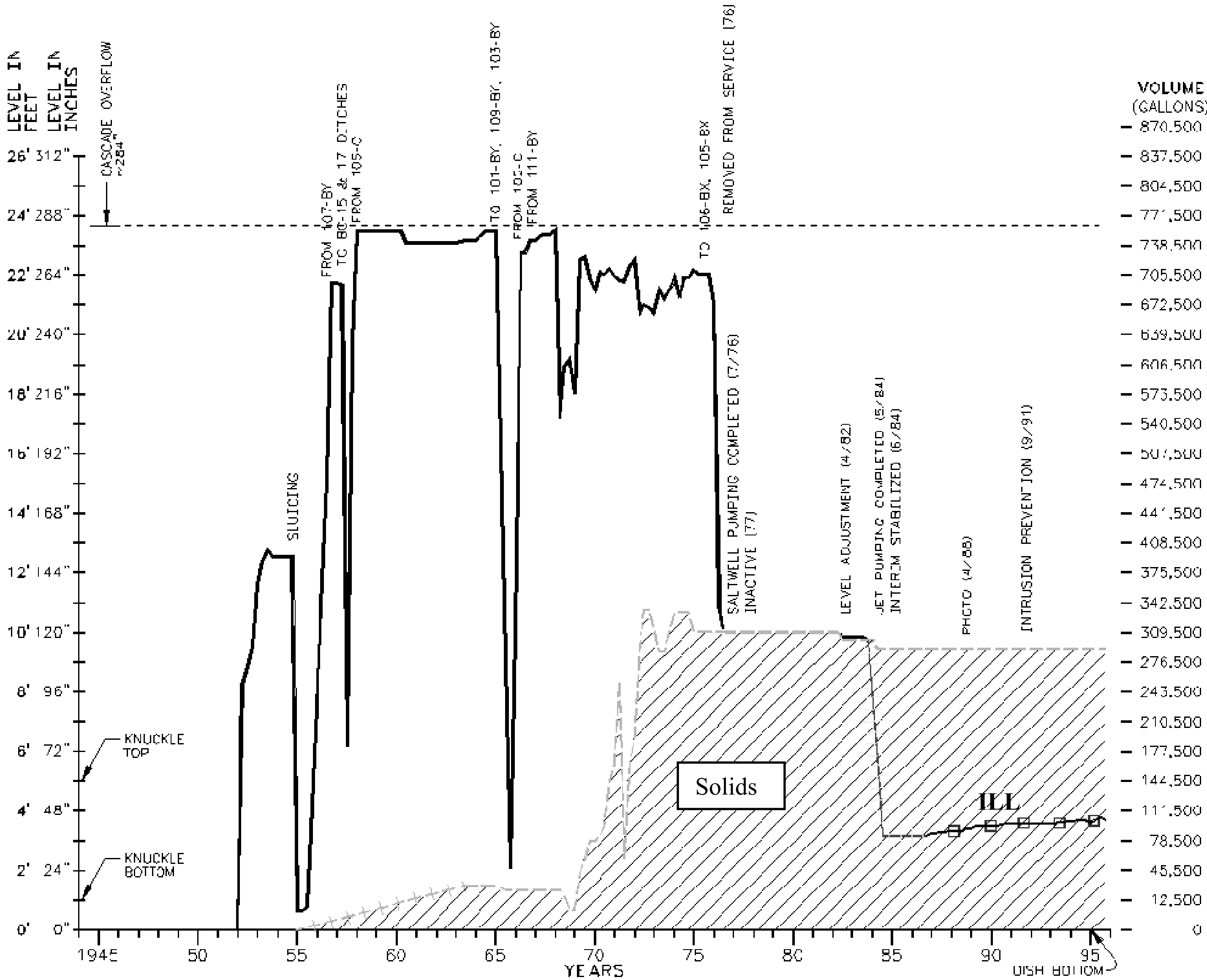


**Figure C-21. 241-BY-112 Tank Waste Monitoring Data**

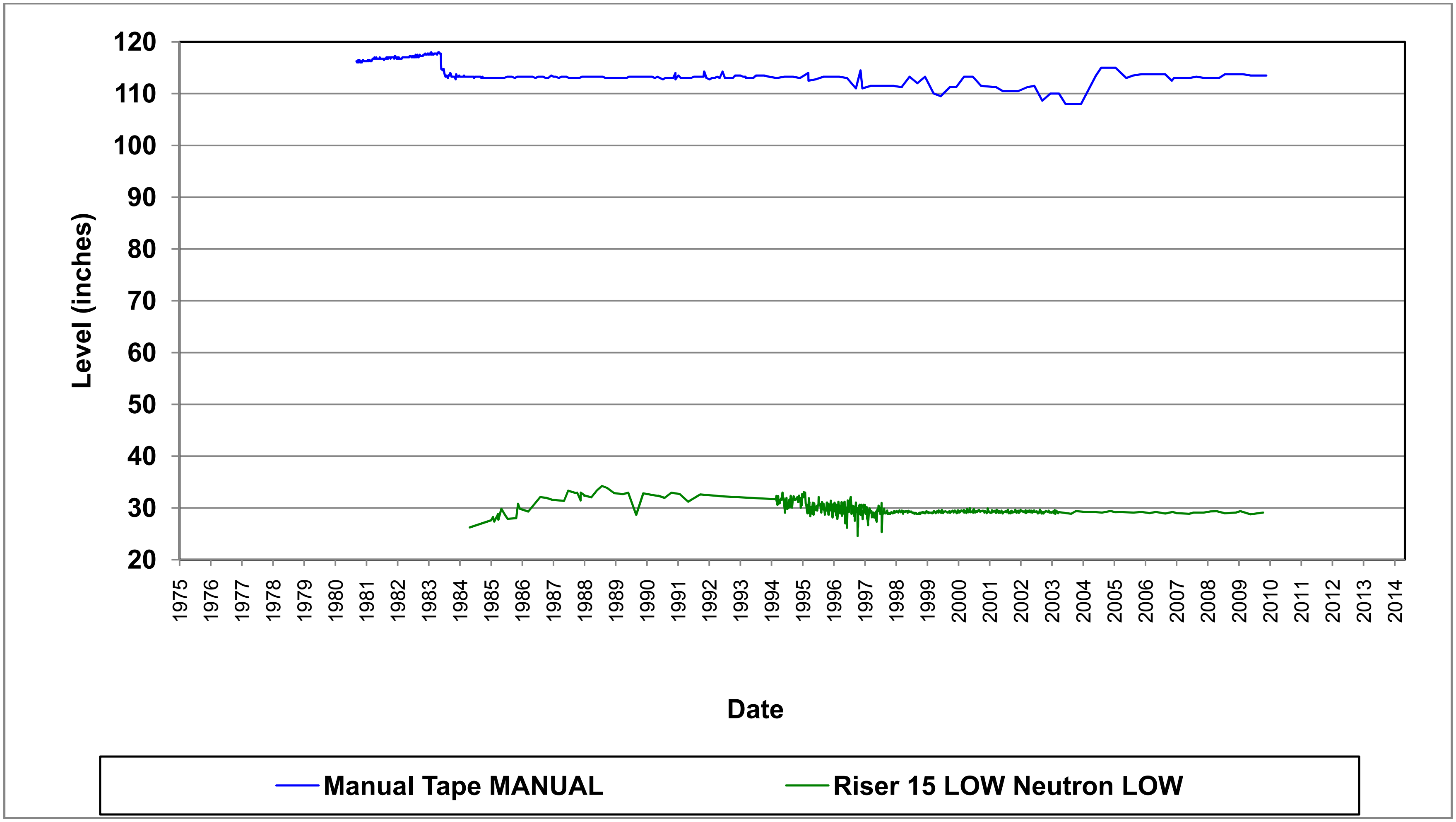
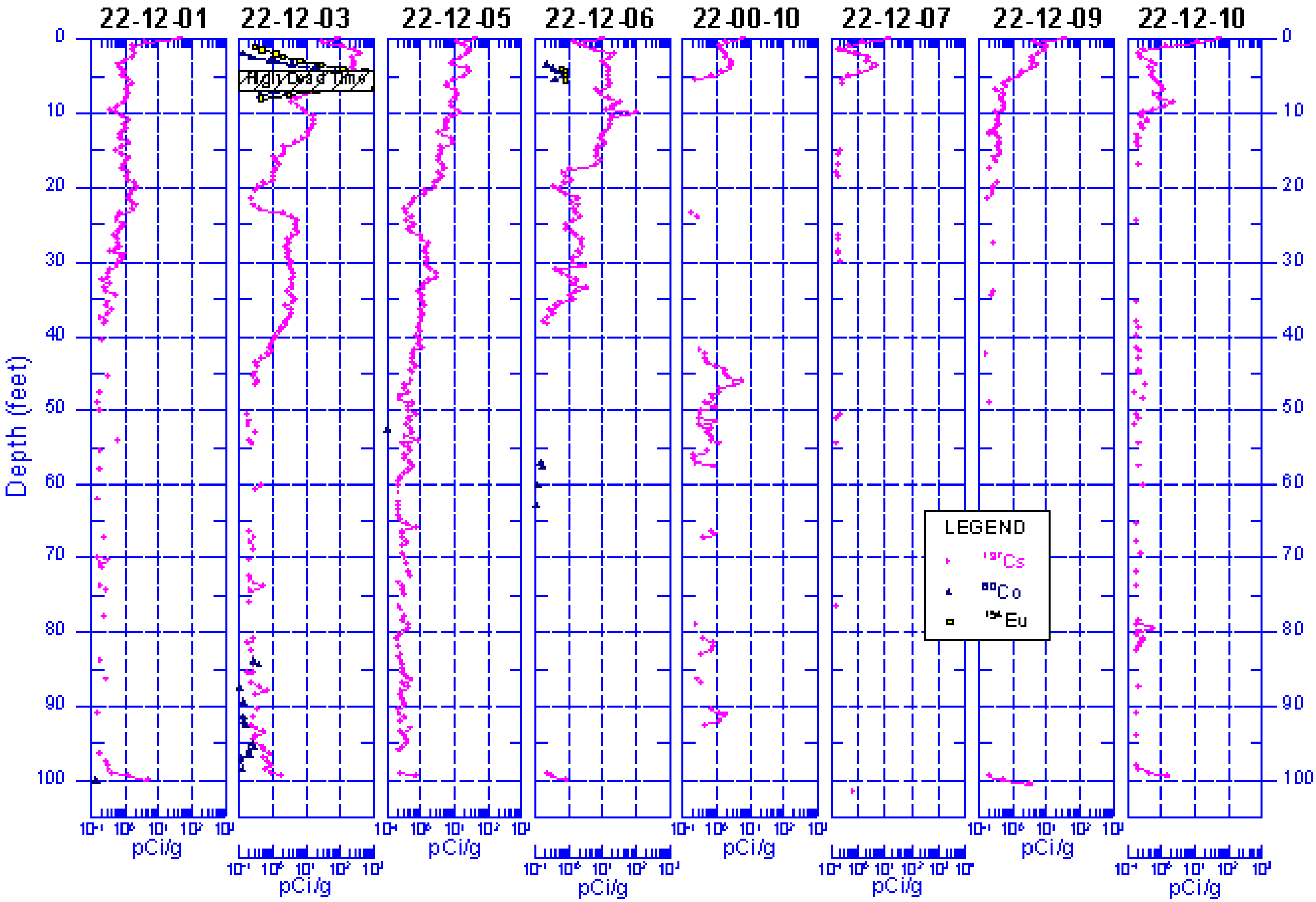


**Figure C-22. Tank 241-BY-112 Drywell Spectral Gamma Data, 1995**




Reference: GJO-96-2-TAR/GJO-HAN-6, *Vadose Zone Characterization Project at the Hanford Tank Farms: BY Tank Farm Report.*

The following occurrence or deviation reports are associated with tank BY-112.

ARHCO Occurrence Report 75-19, *Decreasing Liquid Level In Tank 112-BY*:

> "The tank is considered to be sound for continued waste storage. The measurement of liquid level in this tank was difficult due to the surface crusting and the apparent decrease in liquid level is not considered to be evidence of tank leakage. Due to the erratic nature of the crust, liquid level readings were being obtained anywhere within a range of two inches. The apparent liquid level has remained stable for three weeks and there has been no radiation increase in any of the seven dry wells. Photographs taken on February 26, 1975, indicate the surface was covered with crust in the area of liquid level measurement. Flushing of the tape has caused a dispersion of the crust and a relatively clean surface has been exposed which allows better measurement of liquid level."

Occurrence Report 76-31, *Liquid Level Decrease in Tank 112-BY*:

> "The liquid level in Tank 112-BY dropped approximately two and one half inches below the one and one half inch under the baseline specified in the tank status criteria. The drop was associated with repeated indications that the readings were erratic since different operators could get readings from 153.0 inches, "soft" reading to 151.0 inches."

RL--PHMC-TANKFARM-1997-0018, *241-BY-112 Liquid Observation Well Anomalous Reading*:

> "A technical review of the LOW data and other relevant surveillance data for the tank was conducted. There are two key conclusions from the review. The first conclusion is that the feature about 44 inches above the bottom, historically assumed to be the ILL, has not changed significantly. The majority of the additional below-limit scans are within the normal expected scatter for the equipment used. The current baseline and tolerances were statistically determined 18 months ago, and are too restrictive to accurately reflect present data scatter. A baseline which includes all available data from 1995 would have notably wider tolerances, and most of the LOW data points would fall within limits. The high degree of data scatter is further complicated by the fact that the historic ILL has become increasingly blurred over time as the interstitial liquid has slowly settled and the feature has changed shape."

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