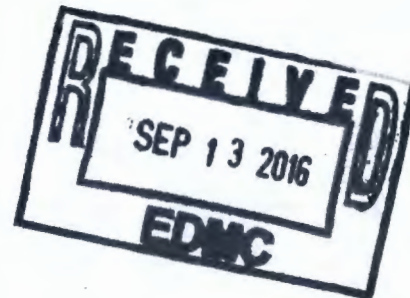


# Residual Waste Inventories in the Plugged and Abandoned Pipelines at the Hanford Site

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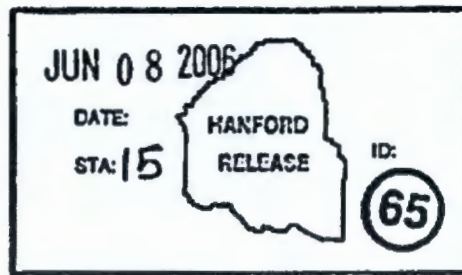
Key Words: residual waste, waste inventory, abandoned pipelines

**Abstract:** The purpose of this study is to develop an estimate of the residual waste inventories in the waste transfer lines in the Hanford Site 200 East and 200 West Area waste management areas (WMA). The focus of this study is pipelines within WMAs that can be documented as being plugged and are therefore believed to contain residual waste. This study identifies 100 pipelines that have failed at the Hanford Site.

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Table 14. Proportional Amount of Residual Waste in Plugged Pipelines in Tank Farms. (4 sheets)

| Waste Parameters           | Plugged Pipeline                      |                                       |                           |                           |                              |             |             |  |  |          |
|----------------------------|---------------------------------------|---------------------------------------|---------------------------|---------------------------|------------------------------|-------------|-------------|--|--|----------|
|                            | SL101                                 | SL101                                 | SN216                     | SN216                     | V412                         | V453        | V465        | Cascade line from 241-BX-102 to 241-BX-103 | Cascade line from 241-C-110 to 241-C-111 |          |
| Blockage Location          | 241-S-152                             | 241-U-D                               | 241-S-152                 | 241-U-D                   | 241-TY-153                   | 241-U-101   | 241-U-153   | 241-BX-102                                 | 241-C-110                                |          |
| Residual Waste Volume (l)  | 19.6                                  | 111.5                                 | 45.2                      | 257.5                     | 102.0                        | 183.9       | 153.0       | 28   | 28                                       |          |
| Tank Farm (241-)           | S                                     | U                                     | S                         | U                         | TX                           | U           | U           | BX   | C  |          |
| Waste Type                 | Partially neutralized REDOX supernate | Partially neutralized REDOX supernate | 241-U-107 Saltwell liquid | 241-U-107 Saltwell liquid | Concentrated REDOX supernate | Metal waste | REDOX waste | Metal waste                                | First-cycle waste                        |          |
| Solids Volume Fraction     | 0                                     | 0                                     | 0                         | 0                         | 0                            | 0.213       | 0.068       | 0.213                                      | 0.134                                    |          |
| Liquid Volume Fraction     | 1                                     | 1                                     | 1                         | 1                         | 1                            | 0.787       | 0.932       | 0.787                                      | 0.866                                    |          |
| Waste Concentration Factor | 3.9                                   | 3.9                                   | 1                         | 1                         | 2.6                          | 1           | 1           | 1  | 1  |          |
| Analyte                    | Units                                 |                                       |                           |                           |                              |             |             |  |  |          |
| Al                         | kg                                    | 1.75E+00                              | 9.96E+00                  | 1.85E+00                  | 1.05E+01                     | 6.07E+00    | 0.00E+00    | 5.26E+00                                   | 0.00E+00                                 | 4.36E-02 |
| Bi                         | kg                                    | 0.00E+00                              | 0.00E+00                  | 1.06E-03                  | 6.03E-03                     | 0.00E+00    | 1.00E-02    | 0.00E+00                                   | 1.53E-03                                 | 6.58E-02 |
| Ca                         | kg                                    | 1.15E-02                              | 6.54E-02                  | 2.85E-03                  | 1.62E-02                     | 3.98E-02    | 2.14E-01    | 1.60E-01                                   | 3.26E-02                                 | 1.97E-02 |
| Cl                         | kg                                    | 2.59E-01                              | 1.47E+00                  | 4.77E-01                  | 2.72E+00                     | 8.99E-01    | 1.93E-02    | 5.07E-01                                   | 2.94E-03                                 | 4.80E-02 |
| TIC as CO <sub>2</sub>     | kg                                    | 1.72E-02                              | 9.78E-02                  | 7.27E-01                  | 4.14E+00                     | 5.96E-02    | 7.97E+00    | 2.39E-01                                   | 1.21E+00                                 | 2.96E-02 |
| Cr                         | kg                                    | 2.20E-01                              | 1.25E+00                  | 2.86E-03                  | 1.63E-02                     | 7.63E-01    | 2.79E-02    | 1.13E+00                                   | 4.25E-03                                 | 1.05E-02 |
| F                          | kg                                    | 0.00E+00                              | 0.00E+00                  | 6.54E-03                  | 3.73E-02                     | 0.00E+00    | 0.00E+00    | 0.00E+00                                   | 0.00E+00                                 | 1.10E-01 |
| Fe                         | kg                                    | 7.99E-03                              | 4.55E-02                  | 2.76E-04                  | 1.57E-03                     | 2.78E-02    | 2.77E-01    | 6.05E-01                                   | 4.21E-02                                 | 7.33E-02 |
| Hg                         | kg                                    | 2.47E-05                              | 1.41E-04                  | 1.19E-05                  | 6.77E-05                     | 8.60E-05    | 3.31E-03    | 4.02E-04                                   | 5.04E-04                                 | 6.27E-05 |
| K                          | kg                                    | 7.98E-02                              | 4.55E-01                  | 1.55E-01                  | 8.83E-01                     | 2.77E-01    | 4.63E-03    | 1.57E-01                                   | 7.04E-04                                 | 1.15E-02 |
| La                         | kg                                    | 0.00E+00                              | 0.00E+00                  | 5.38E-08                  | 3.07E-07                     | 0.00E+00    | 0.00E+00    | 0.00E+00                                   | 0.00E+00                                 | 0.00E+00 |
| Mn                         | kg                                    | 2.33E-03                              | 1.33E-02                  | 2.12E-04                  | 1.21E-03                     | 8.09E-03    | 0.00E+00    | 7.22E-02                                   | 0.00E+00                                 | 0.00E+00 |
| Na                         | kg                                    | 9.78E+00                              | 5.57E+01                  | 9.25E+00                  | 5.27E+01                     | 3.40E+01    | 1.23E+01    | 1.92E+01                                   | 1.87E+00                                 | 2.08E+00 |
| Ni                         | kg                                    | 8.16E-03                              | 4.65E-02                  | 6.93E-04                  | 3.95E-03                     | 2.84E-02    | 1.57E-02    | 4.59E-02                                   | 2.40E-03                                 | 2.91E-03 |
| NO <sub>2</sub>            | kg                                    | 2.70E+00                              | 1.54E+01                  | 5.76E+00                  | 3.29E+01                     | 9.38E+00    | 1.82E-01    | 6.03E+00                                   | 2.76E-02                                 | 7.13E-02 |
| NO <sub>3</sub>            | kg                                    | 1.07E+01                              | 6.07E+01                  | 6.41E+00                  | 3.65E+01                     | 3.70E+01    | 1.68E+00    | 1.99E+01                                   | 2.55E-01                                 | 3.13E+00 |
| Free OH                    | kg                                    | 0.00E+00                              | 0.00E+00                  | 3.46E-02                  | 1.97E-01                     | 0.00E+00    | 0.00E+00    | 0.00E+00                                   | 0.00E+00                                 | 0.00E+00 |
| Pb                         | kg                                    | 0.00E+00                              | 0.00E+00                  | 6.54E-04                  | 3.73E-03                     | 0.00E+00    | 0.00E+00    | 0.00E+00                                   | 0.00E+00                                 | 0.00E+00 |

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Table 14. Proportional Amount of Residual Waste in Plugged Pipelines in Tank Farms. (4 sheets)

| Waste Parameters |       | Plugged Pipeline |          |          |          |          |          |          |          | Cascade line from 241-BX-102 to 241-BX-103 | Cascade line from 241-C-110 to 241-C-111 |
|------------------|-------|------------------|----------|----------|----------|----------|----------|----------|----------|--|--|
|                  |       | SL101            | SL101    | SN216    | SN216    | V412     | V453     | V465     |          |  |  |
| Analyte          | Units |                  |          |          |          |          |          |          |          |  |  |
| PO <sub>4</sub>  | kg    | 0.00E+00         | 0.00E+00 | 1.83E-01 | 1.04E+00 | 0.00E+00 | 4.63E+00 | 0.00E+00 | 7.05E-01 | 7.46E-01                                   |  |
| Si               | kg    | 2.26E-02         | 1.29E-01 | 1.88E-03 | 1.07E-02 | 7.84E-02 | 1.88E-02 | 7.24E-02 | 2.87E-03 | 4.02E-02                                   |  |
| SO <sub>4</sub>  | kg    | 1.41E-01         | 8.05E-01 | 1.97E-01 | 1.12E+00 | 4.91E-01 | 4.94E+00 | 2.77E-01 | 7.52E-01 | 2.07E-01                                   |  |
| Sr               | kg    | 3.67E-06         | 2.09E-05 | 7.10E-06 | 4.05E-05 | 1.28E-05 | 1.40E-04 | 2.77E-04 | 2.14E-05 | 2.56E-07                                   |  |
| Th               | kg    | 0.00E+00         | 0.00E+00 | 2.05E-05 | 1.17E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00                                   |  |
| TOC              | kg    | 0.00E+00         | 0.00E+00 | 2.83E-01 | 1.62E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00                                   |  |
| U Total          | kg    | 2.37E-03         | 1.35E-02 | 9.77E-05 | 5.57E-04 | 8.22E-03 | 1.86E+01 | 1.31E-01 | 2.83E+00 | 6.09E-03                                   |  |
| Zr               | kg    | 0.00E+00         | 0.00E+00 | 3.86E-05 | 2.20E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 8.86E-04                                   |  |
| H-3              | Ci    | 2.11E-03         | 1.20E-02 | 4.82E-05 | 2.75E-04 | 7.33E-03 | 3.89E-03 | 4.14E-03 | 5.93E-04 | 1.78E-04                                   |  |
| C-14             | Ci    | 1.15E-04         | 6.56E-04 | 4.39E-05 | 2.50E-04 | 4.00E-04 | 9.24E-05 | 2.26E-04 | 1.41E-05 | 2.37E-06                                   |  |
| Ni-59            | Ci    | 1.35E-05         | 7.72E-05 | 3.06E-05 | 1.75E-04 | 4.71E-05 | 2.06E-05 | 7.62E-05 | 3.14E-06 | 7.78E-07                                   |  |
| Co-60            | Ci    | 1.55E-04         | 8.86E-04 | 1.51E-04 | 8.58E-04 | 5.40E-04 | 7.24E-05 | 3.05E-04 | 1.10E-05 | 9.30E-06                                   |  |
| Ni-63            | Ci    | 1.22E-03         | 6.97E-03 | 2.86E-03 | 1.63E-02 | 4.25E-03 | 1.82E-03 | 6.87E-03 | 2.77E-04 | 1.08E-04                                   |  |
| Se-79            | Ci    | 5.33E-06         | 3.04E-05 | 6.71E-05 | 3.83E-04 | 1.85E-05 | 3.58E-06 | 1.05E-05 | 5.45E-07 | 7.78E-08                                   |  |
| Sr-90            | Ci    | 1.89E-01         | 1.08E+00 | 2.01E-02 | 1.15E-01 | 6.57E-01 | 6.28E+00 | 1.43E+01 | 9.56E-01 | 1.14E-02                                   |  |
| Y-90             | Ci    | 1.89E-01         | 1.08E+00 | 2.01E-02 | 1.15E-01 | 6.57E-01 | 6.28E+00 | 1.43E+01 | 9.56E-01 | 1.14E-02                                   |  |
| Zr-93            | Ci    | 3.19E-04         | 1.82E-03 | 1.41E-03 | 8.04E-03 | 1.11E-03 | 9.59E-07 | 6.26E-04 | 1.46E-07 | 4.07E-05                                   |  |
| Nb-93m           | Ci    | 2.74E-04         | 1.56E-03 | 1.17E-03 | 6.69E-03 | 9.53E-04 | 8.40E-07 | 5.38E-04 | 1.28E-07 | 3.58E-05                                   |  |
| Tc-99            | Ci    | 2.02E-03         | 1.15E-02 | 1.57E-02 | 8.97E-02 | 7.03E-03 | 1.73E-03 | 3.97E-03 | 2.64E-04 | 5.92E-06                                   |  |
| Ru-106           | Ci    | 4.25E-12         | 2.42E-11 | 2.43E-10 | 1.39E-09 | 1.48E-11 | 1.52E-15 | 8.34E-12 | 2.32E-16 | 3.86E-14                                   |  |
| Cd-113m          | Ci    | 2.19E-04         | 1.25E-03 | 1.27E-03 | 7.26E-03 | 7.61E-04 | 1.18E-04 | 4.30E-04 | 1.80E-05 | 4.72E-06                                   |  |
| Sb-125           | Ci    | 1.36E-05         | 7.73E-05 | 8.73E-05 | 4.98E-04 | 4.71E-05 | 4.14E-06 | 2.66E-05 | 6.31E-07 | 1.36E-07                                   |  |
| Sn-126           | Ci    | 2.16E-05         | 1.23E-04 | 2.96E-04 | 1.69E-03 | 7.50E-05 | 1.38E-05 | 4.23E-05 | 2.10E-06 | 3.03E-07                                   |  |
| I-129            | Ci    | 3.24E-06         | 1.85E-05 | 1.33E-05 | 7.58E-05 | 1.13E-05 | 1.98E-06 | 6.35E-06 | 3.01E-07 | 5.17E-08                                   |  |
| Cs-134           | Ci    | 3.02E-07         | 1.72E-06 | 4.39E-06 | 2.50E-05 | 1.05E-06 | 4.73E-08 | 5.93E-07 | 7.20E-09 | 1.58E-10                                   |  |

Table 14. Proportional Amount of Residual Waste in Plugged Pipelines in Tank Farms. (4 sheets)

| Waste Parameters |       | Plugged Pipeline |          |          |          |          |          |          |  |  |
|------------------|-------|------------------|----------|----------|----------|----------|----------|----------|--|--|
|                  |       | SL101            | SL101    | SN216    | SN216    | V412     | V453     | V465     | Cascade line from 241-BX-102 to 241-BX-103 | Cascade line from 241-C-110 to 241-C-111 |
| Analyte          | Units |                  |          |          |          |          |          |          |  |  |
| Cs-137           | Ci    | 5.72E+00         | 3.26E+01 | 1.54E+01 | 8.80E+01 | 1.99E+01 | 3.97E+00 | 1.12E+01 | 6.04E-01                                   | 1.34E-02                                 |
| Ba-137m          | Ci    | 5.40E+00         | 3.08E+01 | 1.45E+01 | 8.29E+01 | 1.88E+01 | 3.75E+00 | 1.06E+01 | 5.70E-01                                   | 1.26E-02                                 |
| Sm-151           | Ci    | 2.24E-01         | 1.28E+00 | 1.79E-01 | 1.02E+00 | 7.78E-01 | 1.32E-01 | 4.39E-01 | 2.00E-02                                   | 6.20E-03                                 |
| Eu-152           | Ci    | 2.27E-05         | 1.29E-04 | 1.84E-05 | 1.05E-04 | 7.88E-05 | 6.28E-06 | 4.45E-05 | 9.57E-07                                   | 3.40E-07                                 |
| Eu-154           | Ci    | 1.53E-03         | 8.74E-03 | 1.49E-03 | 8.51E-03 | 5.33E-03 | 4.61E-04 | 3.01E-03 | 7.03E-05                                   | 2.38E-05                                 |
| Eu-155           | Ci    | 6.30E-04         | 3.59E-03 | 4.65E-04 | 2.65E-03 | 2.19E-03 | 2.54E-04 | 1.24E-03 | 3.86E-05                                   | 1.08E-05                                 |
| Ra-226           | Ci    | 3.06E-10         | 1.74E-09 | 2.15E-09 | 1.23E-08 | 1.06E-09 | 1.63E-08 | 6.00E-10 | 2.48E-09                                   | 2.56E-10                                 |
| Ac-227           | Ci    | 1.31E-09         | 7.49E-09 | 7.44E-08 | 4.24E-07 | 4.56E-09 | 7.19E-08 | 2.58E-09 | 1.09E-08                                   | 7.76E-10                                 |
| Ra-228           | Ci    | 1.72E-15         | 9.80E-15 | 1.90E-07 | 1.08E-06 | 5.98E-15 | 9.62E-14 | 3.37E-15 | 1.47E-14                                   | 1.66E-15                                 |
| Th-229           | Ci    | 6.46E-12         | 3.68E-11 | 6.50E-10 | 3.70E-09 | 2.24E-11 | 3.64E-12 | 1.27E-11 | 5.54E-13                                   | 1.15E-12                                 |
| Pa-231           | Ci    | 1.95E-09         | 1.11E-08 | 6.88E-07 | 3.92E-06 | 6.77E-09 | 5.61E-10 | 3.82E-09 | 8.54E-11                                   | 1.70E-08                                 |
| Th-232           | Ci    | 1.85E-15         | 1.05E-14 | 2.25E-09 | 1.28E-08 | 6.42E-15 | 3.10E-14 | 3.63E-15 | 4.72E-15                                   | 9.73E-15                                 |
| U-232            | Ci    | 3.14E-11         | 1.79E-10 | 1.11E-09 | 6.35E-09 | 1.09E-10 | 9.28E-08 | 1.74E-09 | 1.41E-08                                   | 3.61E-11                                 |
| U-233            | Ci    | 1.54E-10         | 8.80E-10 | 6.88E-08 | 3.92E-07 | 5.36E-10 | 7.28E-09 | 8.54E-09 | 1.11E-09                                   | 2.72E-12                                 |
| U-234            | Ci    | 7.71E-07         | 4.39E-06 | 3.49E-08 | 1.99E-07 | 2.68E-06 | 6.08E-03 | 4.27E-05 | 9.27E-04                                   | 1.99E-06                                 |
| U-235            | Ci    | 3.32E-08         | 1.89E-07 | 1.46E-09 | 8.31E-09 | 1.15E-07 | 2.69E-04 | 1.84E-06 | 4.10E-05                                   | 8.77E-08                                 |
| U-236            | Ci    | 1.59E-08         | 9.09E-08 | 8.43E-10 | 4.81E-09 | 5.54E-08 | 8.27E-05 | 8.82E-07 | 1.26E-05                                   | 2.95E-08                                 |
| Np-237           | Ci    | 1.47E-05         | 8.40E-05 | 2.19E-06 | 1.25E-05 | 5.12E-05 | 9.96E-06 | 2.89E-05 | 1.52E-06                                   | 1.36E-07                                 |
| Pu-238           | Ci    | 7.40E-06         | 4.22E-05 | 6.32E-08 | 3.60E-07 | 2.57E-05 | 1.03E-05 | 1.11E-04 | 1.57E-06                                   | 6.03E-06                                 |
| U-238            | Ci    | 7.89E-07         | 4.50E-06 | 3.25E-08 | 1.85E-07 | 2.74E-06 | 6.21E-03 | 4.37E-05 | 9.46E-04                                   | 2.03E-06                                 |
| Pu-239           | Ci    | 3.90E-04         | 2.22E-03 | 1.81E-06 | 1.03E-05 | 1.35E-03 | 1.16E-03 | 5.83E-03 | 1.77E-04                                   | 5.92E-04                                 |
| Pu-240           | Ci    | 7.56E-05         | 4.31E-04 | 3.88E-07 | 2.21E-06 | 2.63E-04 | 1.47E-04 | 1.13E-03 | 2.24E-05                                   | 8.39E-05                                 |
| Am-241           | Ci    | 5.13E-04         | 2.93E-03 | 1.24E-04 | 7.09E-04 | 1.78E-03 | 6.98E-04 | 3.54E-03 | 1.06E-04                                   | 1.52E-05                                 |
| Pu-241           | Ci    | 2.63E-04         | 1.50E-03 | 2.56E-06 | 1.46E-05 | 9.14E-04 | 3.24E-04 | 3.94E-03 | 4.93E-05                                   | 1.94E-04                                 |
| Cm-242           | Ci    | 8.31E-07         | 4.73E-06 | 4.01E-07 | 2.29E-06 | 2.89E-06 | 1.86E-07 | 1.63E-06 | 2.83E-08                                   | 3.01E-09                                 |

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**Table 14. Proportional Amount of Residual Waste in Plugged Pipelines in Tank Farms. (4 sheets)**

| Waste Parameters |       | Plugged Pipeline |          |          |          |          |          |          |  |  |
|------------------|-------|------------------|----------|----------|----------|----------|----------|----------|--|--|
|                  |       | SL101            | SL101    | SN216    | SN216    | V412     | V453     | V465     | Cascade line from 241-BX-102 to 241-BX-103 | Cascade line from 241-C-110 to 241-C-111 |
| Analyte          | Units |                  |          |          |          |          |          |          |  |  |
| Pu-242           | Ci    | 2.30E-09         | 1.31E-08 | 2.43E-11 | 1.39E-10 | 7.98E-09 | 2.35E-09 | 3.44E-08 | 3.59E-10                                   | 1.47E-09                                 |
| Am-243           | Ci    | 1.88E-07         | 1.07E-06 | 7.23E-08 | 4.12E-07 | 6.52E-07 | 1.08E-07 | 1.29E-06 | 1.65E-08                                   | 1.75E-09                                 |
| Cm-243           | Ci    | 1.49E-08         | 8.48E-08 | 1.36E-08 | 7.77E-08 | 5.17E-08 | 2.25E-09 | 2.92E-08 | 3.42E-10                                   | 3.66E-11                                 |
| Cm-244           | Ci    | 3.67E-07         | 2.09E-06 | 3.17E-07 | 1.81E-06 | 1.28E-06 | 5.27E-08 | 7.20E-07 | 8.04E-09                                   | 8.60E-10                                 |

REDOX = reduction-oxidation.