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Organic Carbon in Hanford Single-Shell Tank Waste

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Executive Summary

This report documents an analysis performed by Pacific Northwest Laboratory (PNL) involving the organic carbon laboratory measurement data for Hanford single-shell tanks (SSTs) obtained from a review of the laboratory analytical data. This activity was undertaken at the request of Westinghouse Hanford Company (WHC). The objective of this study is to provide a best-estimate, including confidence levels, of total organic carbon (TOC) in each of the 149 SSTs at Hanford. The TOC information presented in this report is useful as part of the criteria to identify SSTs for additional measurements or monitoring for the organic safety program.

Measured laboratory data were obtained for 75 of the 149 SSTs. The data represent a thorough investigation of data from 223 tank characterization datasets, including core-sampling and process laboratory data. Liquid and solid phase TOC values were investigated by examining selected tanks with both reported TOC values in solid and liquid phases. Some relationships were noted, but there was no clustering of data or significance between the solid and liquid phases.

A methodology was developed for estimating the distribution and levels of TOC in SSTs using a logarithmic scale and an analysis of variance (ANOVA) technique. The methodology grouped tanks according to waste type using the Sort On Radioactive Waste Type (SORWT) grouping method. The SORWT model categorizes Hanford SSTs into groups of tanks expected to exhibit similar characteristics based on major waste types and processing histories. The methodology makes use of laboratory data for the particular tank and information about the SORWT group of which the tank is a member. If the tank has no TOC laboratory data, known information about the SORWT group is used to infer the TOC value in that tank. Recommendations for a simpler tank grouping strategy, based on organic transfer records, were made.

Of the 149 SSTs, 59 had no TOC observations but did belong to a SORWT group with at least one TOC observation, and 15 tanks had no TOC observations where the SORWT group had no TOC data. A significant number (28) of the 75 tanks had only one TOC measurement. The laboratory data were used to obtain best-estimates of TOC at 95% confidence levels for all SSTs. Best-estimate TOC concentrations for each of the 149 SSTs are represented by the wet (as-is) median values, as shown in Table 4.10. The top ten tanks for the wet median basis are U-106, SX-103, U-105, U-107, U-108, U-109, U-102, S-101, S-103, and S-105. Two of these (U-106 and U-107) are on the original organic watchlist. The laboratory data, which present the TOC estimates on a wet basis, are converted to a dry basis to be consistent with the TOC criteria used in the organic safety program (Babad and Turner 1993). For comparison to TOC criteria of 5%, the dry mean TOC values are recommended (Table 4.13). The top ten tanks for the dry mean basis are C-103, T-104, U-106, SX-106, U-203, U-204, T-102, U-105, U-201, and U-202. Three of these tanks (C-103, U-106, and SX-106) are on the original organic watchlist. It should be noted that recent laboratory measurements and studies indicate that previous measured high TOC values for T-104 are suspect because of measurement problems.

The organic constituents of the Track Radioactive Components Code (TRAC) waste inventories were also used to estimate organic concentrations in each of the SSTs. Inventories of six species were taken as TOC contributors: oxalate, citrate, acetate, EDTA, HEDTA, and ferrocyanide. TRAC organic waste concentrations were compared to the laboratory data when they were available, but no correlation between the TRAC estimate and laboratory estimate was found.

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1.0 Introduction

Safety of Hanford single-shell tanks (SSTs) containing organic carbon is a concern because the carbon in the presence of oxidizers (NO_3 or NO_2) is combustible when sufficiently concentrated and exposed to elevated temperatures. A propagating chemical reaction could potentially occur at high temperature (above 200°C). The rapid increase in temperature and pressure within a tank might result in the release of radioactive waste constituents to the environment (Fisher 1990).

WHC has placed nine tanks on the watchlist that collectively represents a Hanford Site high-level waste storage tank "safety issue." Eight of the tanks are included on the watchlist based on inferred TOC content > 3 wt% (dry basis) from limited data. Some of the tanks are on the watchlist because TRAC data indicate organic levels above 3%; others are on the list based on liquid sample TOC measurement results. A ninth tank (C-103) is included because it has a floating organic layer (Babad 1993). The basis for the 3 wt% threshold is based on laboratory tests involving mixtures of sodium acetate, sodium nitrate, and inert diluents (Fisher 1990). The nine tanks on the organic tanks Watch List are: B-103, C-103, S-102, SX-106, TX-105, TX-118, U-106, U-107 and U-111. Approximately 11,000 metric tons (5 million pounds) of organic agents (principally complexing agents) are known to have been disposed as waste to the SST system.

The purpose of this study is to gather available laboratory information about the organic carbon waste inventories stored in the Hanford SSTs. Specifically, the major objectives of this investigation are:

- Review laboratory analytical data and measurements for SST composite core and supernatant samples for available organic data.
- Assess the correlation of organic carbon estimated utilizing the TRAC computer code compared to laboratory measurements.
- From the laboratory analytical data, estimate the TOC content with confidence levels for each of the 149 SSTs.

The laboratory information gathered in this report will be used to assess the TOC for each of the SSTs. These estimates are to be used in a value of information (VOI) computerized risk assessment model being developed for a Data Requirement Study (DRS) assessment for organics. Therefore, the study must produce estimates for TOC and also some measure of uncertainty (standard deviations, confidence bounds) so the distribution functions can be constructed. Results from the VOI risk assessment model will be used to determine the best mitigation strategy for a tank, and to determine which tanks might be of highest risk concern. But most importantly, the model can be used to determine the value of obtaining better information about tank TOC. Use of the model will determine whether or not it is worthwhile to sample TOC more precisely.

TOC has been estimated at Hanford by using transfer records. From these records, one can determine what waste streams were directed into a specific tank, and it is conceptually an easy matter to use this information to obtain a TOC estimate. A computer program (TRAC) makes estimates using this strategy. However, the estimates can differ by orders of magnitude from measured results because the transfer records are incomplete and the transfer history of some tanks is very complex. One of the objectives of this study is to assess TRAC estimates of TOC.

For this study, we produced estimates using tank sampling data. The data consist of a set of compiled recorded measurements taken during the past 15 years. This dataset consists of 223 measurements that were made on core and supernatant samples analyzed in both Hanford 222-S and 325 analytical laboratories. These measurements were assembled from various reports and are tabulated in Appendix B of this report.

The measurements express concentration in terms of wet weight. To make the reported TOC values consistent with the risk calculations, a correction factor must be applied to the wet TOC values to reduce them to dry weight. In this study, we first calculate estimates on a wet-weight basis and then convert the estimates to dry weight. All of the results in this report, except where noted, are expressed in wet-weight units.

At present, about half the SSTs are represented in the database, so direct estimates of TOC can only be calculated for only half the tanks. To produce estimates for the unsampled tanks, a statistical model is constructed to relate to unsampled tanks. A random-effects ANOVA model was used to estimate TOC for unsampled tanks.

Since this dataset did not result from a designed experiment, the measurements may contain substantial bias. At least two potential sources of bias could be eliminated if more information was gathered. If the sample location (riser, depth) for each sample could be supplied, location biases could be better defined, and if measurement method could be supplied, biases associated with the laboratory procedure could be eliminated. The best-estimate TOC concentrations are based on the median estimates. The selection of the median instead of the mean is based on the assumption that the predominant contribution to within-tank variation is measurement error, and not spatial distribution. These issues are discussed in Section 4 of this report.

In this report, following the background and scope discussions, the analyses results are described in terms of laboratory data, TRAC results, ANOVA statistical model, and TOC estimates for all 149 SSTs using wet (median and mean) and dry (median and mean) basis. Probabilities of exceeding the 5% threshold value are also given. The 5% threshold value is described in Babad and Turner (1993). This material is described in Sections 4.1 through 4.8.

2.0 Background

The Tank Waste Remediation System (TWRS) Program at Hanford is using the Data Requirements Study (DRS) concept specifically to build a database of characterization data with an understanding of its confidence level, using process knowledge and characterization data. Two methods of assessing the organic carbon levels are investigated in this report: 1) the analysis of Variance (ANOVA) technique and 2) TRAC inventories. The ANOVA technique groups tanks of similar waste type according to the Sort on Radioactive Waste Type (SORWT) method.

The ANOVA technique utilizes laboratory data reporting TOC measurements as the sample exists in the tank (i.e., wet basis, or with moisture present). However, the criteria for organic watchlist tanks are on a dry basis (Babad and Turner 1993). Therefore, the ANOVA results are converted from a wet to dry basis to be consistent with the organic safety watchlist criteria (see Section 4.6).

Westinghouse Hanford Company reviewed much of the historical TOC laboratory data and conducted preliminary organic carbon assessments based on the TRAC inventory. Klem (1990) estimated values of TOC for 47 SSTs, averaging laboratory values when multiple data were available. Schulz (1980) reported on results of the organic complexant concentrations (wet basis) for the purpose of understanding the effect of strontium removal in an ion exchange process. The Schulz results indicated high levels of TOC, up to 10% TOC for tank number U-106. Crippen, in his 1991 letter (see page 4.2 for title), summarized historical data for 49 SSTs based on TRAC inventories, on a dry basis. Crippen's results indicated TOC levels up to 4.93% for tank number SX-106.

Fisher (1990) presented assessments for TOC of selected tanks based on laboratory values and TRAC inventory estimates. Fisher identifies seven tanks that may contain explosive mixtures of organic salts from the laboratory data and TRAC estimates, based on Schulz (1980). The laboratory values are based on Schulz (1980), and the TRAC data are based on Jungfleisch (1984).

During the 1970s and 1980s there were many characterization studies made of the Hanford radioactive waste and reports written documenting laboratory measurements of core and supernatant samples. The level of detail in the documents depended upon the requirements for the measurement, the number of cores or samples taken, and amount of core recovery. During the 1990s statistical evaluation of the core samples was initiated to estimate spacial variability within the tanks. Species or component-level data for the organic constituents were usually not measured or reported.

The TRAC waste characterization, developed in 1983, was based on process knowledge and tank transfer records. The TRAC system was developed primarily for radionuclides, but chemical inventories for 30 species are included. The only organic species inventoried in the TRAC dataset are hydroxyacetate, oxalate, citrate, ethylenediaminetetraacetic acid (ETDA), and hydroxyethylenediaminetriacetic acid (HEDTA). The ferrocyanide inventory is also included in the TRAC database. TRAC inventory assessments are made on a dry basis. The TRAC database has not been validated for process chemicals. Estimates of process chemical inventories were input to the TRAC database, but

there were no validation studies with laboratory analysis. In this report, the TOC laboratory measurements are compared with TOC inventories calculated in the TRAC dataset to assess or validate TRAC inventories with actual measurements.

The SORWT grouping technique was developed as a methodology to group tanks of similar radioactive waste types (Hill et al. 1991). In the SORWT methodology, tanks are fit into families or groups according to the types of wastes admitted to the tanks. The resulting groups can be used to compare tank properties within the same group. In this report, the organic carbon levels determined from laboratory measurements of tanks are grouped according to the SORWT families. Determination of the organic carbon levels for all SSTs is based on available laboratory data and SORWT grouping.

3.0 Scope

This report provides estimates of the organic carbon concentrations for the SST wastes by using statistical evaluations applied to chemical analysis information gathered from tank reports. The laboratory data are collected from historical tank characterization information and process laboratory reports. The laboratory measurements collected are used to estimate the median total organic carbon level in the tank, and variation between and within tanks. Organic carbon levels of selected tanks without laboratory measurements are estimated. These estimates are provided by comparing tanks of similar waste types (SORWT groups).

This report also assesses the quality of organic constituent information in the TRAC inventory database as it compares to measured total organic carbon concentrations in the SSTs. Historical information about tank transfers is not directly included as a source of information in the determination of TOC for this report. However, the SORWT grouping model does contain information pertaining to waste types, volumes, and tank transfers (Hill 1991).

The laboratory data used in this report were obtained from two types of reports: characterization reports and process laboratory documents. Characterization reports involved full laboratory analysis of core samples and included multiple sample analysis. Laboratory procedures and standards were often documented in the core report characterization studies. The core characterization reports were prepared to provide detailed characterization of the tank in question.

Process laboratory analysis reports were the second important source of analytical information used for total organic carbon. Process laboratory reports were prepared on many supernatant samples for the purpose of gathering chemical information to identify certain characteristics of the tank. The process laboratory reports often analyze for a few constituents that are important characteristics at the time of the analysis, not a full detailed characterization of the tank. When organic carbon analysis was reported, the TOC values were included in the laboratory measurement database.

4.0 Results

In Section 4.1, the TRAC inventory dataset is examined to identify possible correlations to the laboratory data. TRAC TOC values for both supernatants and sludges are compared to laboratory data.

In order to establish a basis for determining a best estimate of TOC for all tanks, a statistical model is employed. To estimate the concentration of TOC for all the SSTs where laboratory measurements are available for a limited number of the tanks, it is necessary to have a basis for establishing the distribution of TOC in all the tanks, and a basis for selecting the best estimate of TOC for all tanks. Laboratory results are collected into a single dataset and analyzed using an Analysis of Variance (ANOVA) statistical technique. The ANOVA method applies distributional assumptions to the entire dataset to assess averages and standard deviations. To characterize the TOC tanks with similar waste types, the SORWT grouping technique was used in the ANOVA methodology. Conversion of the ANOVA TOC results from a wet basis to a dry basis is required to be consistent with the organic safety watchlist criteria.

Before evaluating the TRAC and ANOVA results, a brief overview of the data, shown in Appendix B, would be useful so that the reader can develop a feeling for the "raw data." The ANOVA model results presented in the following sections also produce an accurate description of the raw data but the reader may feel less comfortable using them in this manner. Table 4.1 below gives a brief summary of the distribution of TOC measurements across SSTs.

There is a significant number of SSTs with only one TOC measurement, 28 out of 75 tanks, and 74 tanks without a TOC measurement of any kind.

Table 4.1. Distribution of TOC Measurements Across Tanks

Number of tanks without TOC measurements	74
Total number of tanks with TOC measurements	75
Number of tanks with 1 TOC measurements	28
Number of tanks with 2 TOC measurements	17
Number of tanks with 3 TOC measurements	12
Number of tanks with 4 TOC measurements	5
Number of tanks with 5 TOC measurements	3
Number of tanks with more than 5 TOC measurements	10

4.1 TRAC Inventory System Applied to TOC Laboratory Data

The Hanford TRAC system estimates the inventory of stable chemical species and radionuclides from process knowledge, storage tank transfers, and radiological degradation effects (Jungfleisch 1984). The TRAC dataset inventory estimated for 1990, first quarter, was used in the assessment of total organic carbon in each of the SSTs. The inventories of six species that were taken as contributors to TOC are oxalate, citrate, acetate, EDTA, HEDTA and ferrocyanide. The contributors to TOC include all carbon contained in energetic constituents. Although the carbon contribution from ferrocyanide is inorganic, it is included in the TOC TRAC assessment because of its contribution to fuel content in the tank.

A comparison of the TRAC assessments to laboratory-measured values indicates there is little correlation between the two (correlation of fit value is only 4%, out of a possible 100% for liquids), as shown in Figures 4.1 and 4.2 for liquids and solids, respectively. A correlation would be evident by a linear pattern and none is apparent. The TOC laboratory data and TRAC data used in the figures are shown in Tables 4.2 and 4.3. TRAC dataset values are on a wet basis.

The TOC results generated in this report using the TRAC database agree with the TRAC-generated estimates provided by M. D. Crippen.[a] The TOC estimates employing the TRAC dataset are summarized for each tank in Table 4.6 (page 4.9), in descending order of percent TOC. Crippen used the same organic constituents plus ferrocyanide to estimate the TOC values in the SSTs.

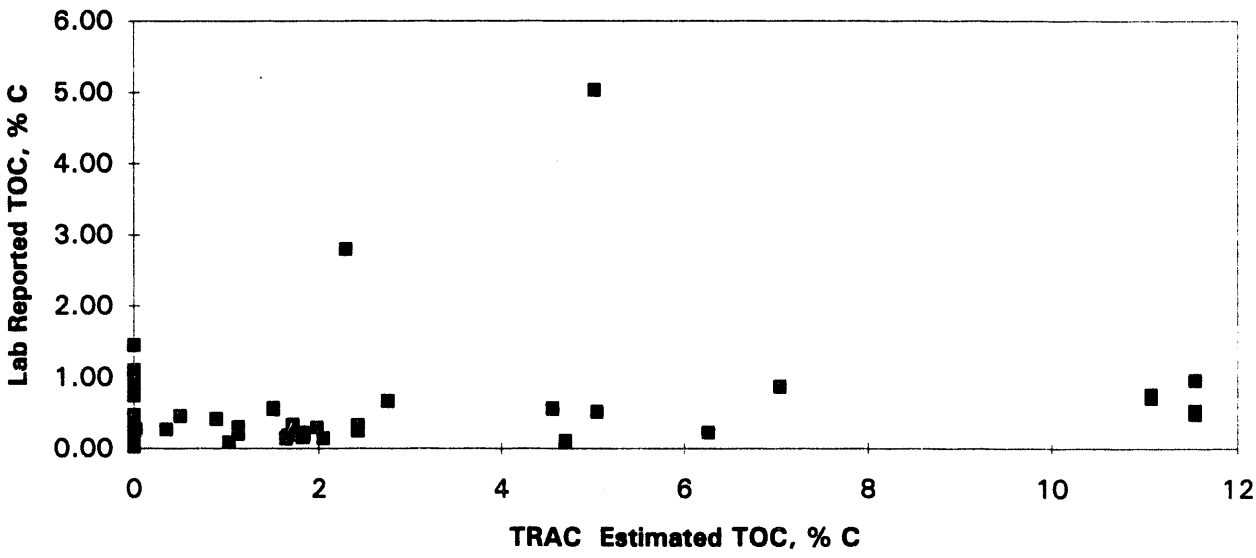

Figure 4.1. TRAC Versus Laboratory Measurement Data (Wet) for Selected SSTs, Liquid Phase

(a) Letter, Crippen, M. D. to P. Hill, "Historical Data for Organic Tanks," Westinghouse Hanford Company, November 20, 1991.

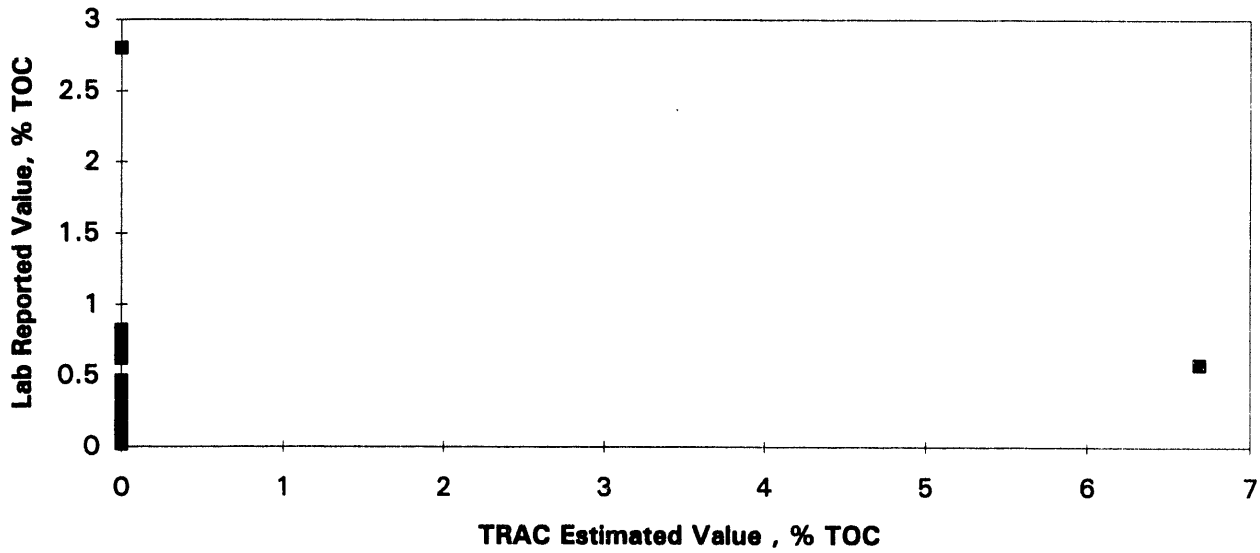

Figure 4.2. TRAC Versus Laboratory Measurement Data (Wet) for Selected SSTs, Solid Phase (Correlation of fit is 0.5% out of a possible 100%)

Table 4.2. Laboratory Values (Wet) Versus TRAC Estimates for Supernatant for Selected SSTs

Tank	TRAC % TOC	Lab Reported Percent	Tank	TRAC % TOC	Lab Reported Percent
A-101	0	0.40	C-103	1.51	0.55
A-101	0	0.84	C-104	0	0.87
A-102	11.54	0.49	C-105	6.26	0.23
A-102	11.54	0.53	C-106	0	0.19
A-102	11.54	0.96	C-107	1.03	0.09
A-102	11.54	0.96	C-110	0	0.05
A-103	4.56	0.57	C-112	0	0.33
A-103	4.56	0.56	S-111	0.89	0.42
A-106	0	0.42	SX-101	0	0.24
AX-101	0	1.10	SX-104	2.43	0.25
AX-101	0	0.90	SX-104	2.43	0.33
AX-101	0	0.75	SX-106	5.02	5.03
AX-102	0	0.91	T-107	0	0.07

Table 4.2. (contd)

Tank	TRAC % TOC	Lab Reported Percent	Tank	TRAC % TOC	Lab Reported Percent
AX-102	0	1.45	T-112	0	0.19
AX-103	2.3	2.80	TX-102	1.83	0.16
BX-104	0	0.48	TX-103	0.35	0.27
BX-104	0	0.43	TX-105	7.04	0.87
BX-105	11.07	0.71	TX-106	0	0.43
BX-105	11.07	0.76	TX-109	2.75	0.67
BY-102	1.65	0.15	TX-110	1.98	0.30
BY-102	1.65	0.14	TX-111	0.5	0.46
BY-103	1.67	0.19	TX-112	0.02	0.27
BY-105	1.84	0.20	TX-114	0	0.20
BY-105	1.84	0.22	TX-115	0	0.03
BY-106	1.13	0.22	TX-116	0	0.08
BY-106	1.13	0.21	TX-118	4.7	0.10
BY-107	1.13	0.31	TX-118	4.7	0.11
BY-109	1.72	0.32	TY-103	2.05	0.15
BY-109	1.72	0.34	TY-104	0	0.17
C-103	1.51	0.57	TY-104	0	0.16
C-103	1.51	0.57	TY-104	0	0.20
C-103	1.51	0.57	U-111	5.05	0.52

Table 4.3. Laboratory Data for Solids Versus TRAC Estimates for Solids for Selected SSTs

Tank	Solid Wastes TRAC % TOC	Lab Reported Percent TOC
A-102	0	0.72
A-102	0	0.79
A-103	0	0.80
A-103	0	0.77
A-106	0	0.62
A-106	0	0.72
A-106	0	0.62
A-106	0	0.72
B-110	0	0.04
BX-104	0	0.18
BX-105	0	0.38
BX-105	0	0.18
C-103	0	0.39
C-103	0	0.26
C-104	0	0.44
C-105	0	0.10
C-106	0	0.08
C-106	0	0.46
C-112	6.69	0.58
SX-102	0	0.82
TY-101	0	0.07
TY-102	0	0.02
TY-103	0	0.07
TY-103	0	0.15
TY-104	0	0.09
TY-104	0	0.21
TY-104	0	0.28

Table 4.3. (contd)

Tank	Solid Wastes TRAC % TOC	Lab Reported Percent TOC
TY-104	0	0.20
TY-105	0	0.08
TY-106	0	0.09
TY-106	0	0.25
TY-106	0	0.21
U-110	0	0.05
U-110	0	0.04
U-110	0	0.06
U-110	0	0.07
U-110	0	0.05
U-110	0	0.04
U-110	0	0.11
U-110	0	0.11
U-105	0	2.80

4.2 Methodology of Statistical Evaluation

The tank data for which laboratory measurements exist can be used in assessing the concentration of TOC for tanks where no data are available by comparing tanks containing similar wastes. All tanks are classified according to the SORWT model as a methodology of grouping the tanks into similar waste types (Hill and Simpson 1991).

Several variables, or factors, are present in the datasets that may help explain the distribution of TOC measurements. The strategy is to include these factors in ANOVA models, so that the best predictive model can be constructed. Important factors that may affect TOC measurements are:

- type of waste measured (salt cake, liquid, sludge)
- tank 'SORWT' classification (tank group)
- Specific tank

- Riser (horizontal) location of measurement

- Vertical location of measurement

- Laboratory measurement technique, or laboratory performing the analysis.

These factors could be used to produce many different ANOVA models, some that are quite complex. To obtain a reasonable class of ANOVA models to fit to the data, we plotted the data and performed some preliminary ANOVA analyses. The incompleteness of some information (primarily the location of the sample within the tank) also limits the type of model that could be fit to the data.

Some general observations about the distribution of laboratory measurements by waste type of liquids and solids (sludge + saltcake) are illustrated by the data in Table 4.4. Liquid measurements of TOC represent about two-thirds of the dataset.

The number of tanks with TOC measurements above 3, 4, and 5% TOC (wet basis) is provided in Table 4.5.

To determine whether or not to include waste type (solid, liquid) in the ANOVA model, TOC laboratory measurements of the two waste types, made on the same tank, and at the same time, are compared in Figure 4.3. The results in the figure indicate little comparison between the type of waste measure (liquid or sludge) and the TOC obtained.

The TOC estimates employing the TRAC dataset are summarized for each tank in Table 4.6, in descending order of percent TOC.

Table 4.4. TOC Measurement Counts, Raw Data (Wet Basis)

	Liquids	Solids	Total
All Data	150	73	223
> 1 percent TOC	24	11	35
> 2 percent TOC	13	9	22
> 3 percent TOC	9	6	15
> 4 percent TOC	6	3	9
> 5 percent TOC	6	2	8

Table 4.5. Distribution of TOC Measurement Values (Wet) Across Tanks

TOC Concentration, (wet wt%)	Number of Tanks	Tank Identification
> 5%	4	A101, SX106, T104, C106
4-5 %	1	SX103
3-4 %	5	B202, TX118, C103, C105, C111
2-3 %	4	AX102, AX103, S102, S111
1-2 %	6	A103, AX101, BX112, BY104, S110, TY105
< 1%	55	(All Others)

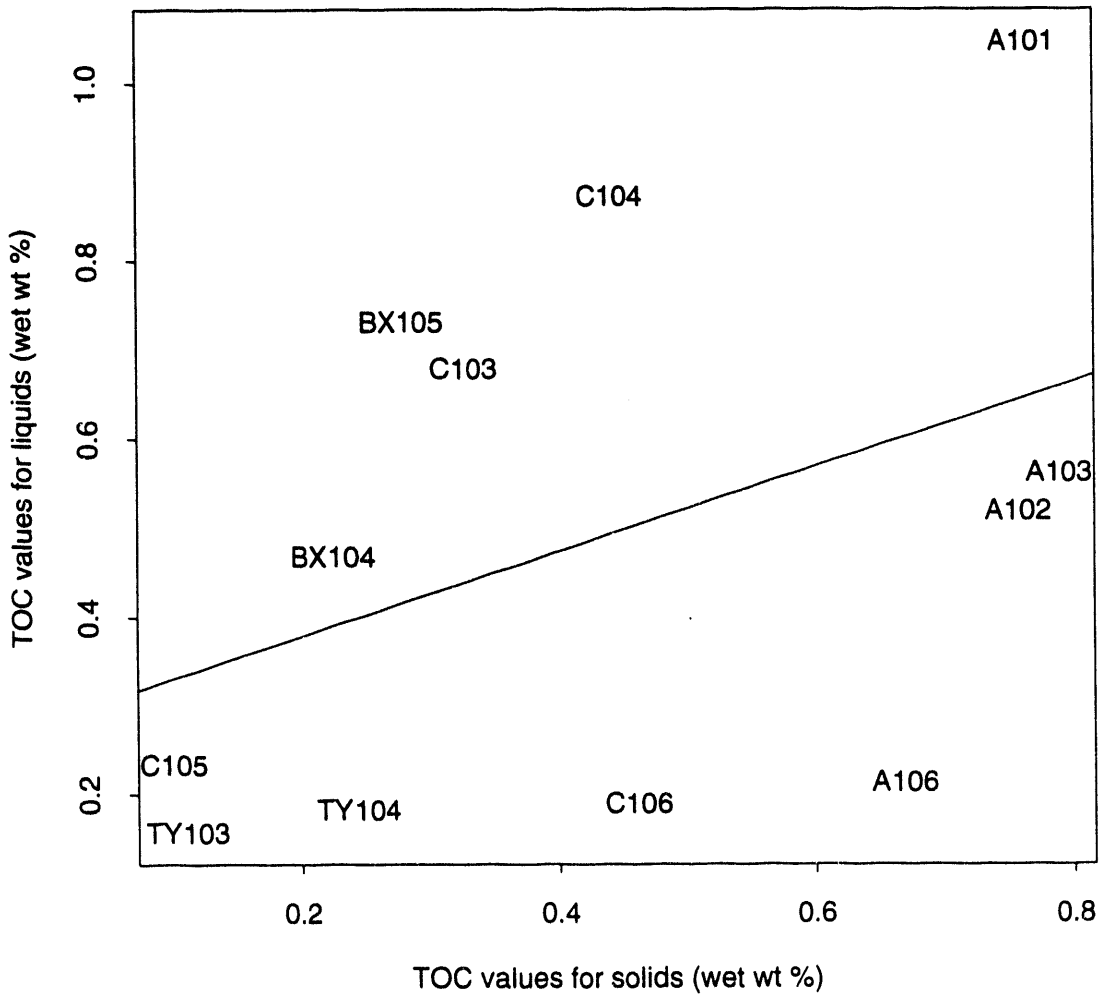

Figure 4.3. Laboratory TOC Measurements (Wet) Versus Waste Type, Liquid or Solid, for Selected SSTs

Table 4.6. Estimate of Percent TOC (Dry) for 149 Single-Shell Tanks According to the TRAC Dataset, in Descending Order of TOC

Tank Total	TOC, wt% (dry)	Tank Total	TOC, wt% (dry)	Tank Total	TOC, wt% (dry)
SX-106*	5.02	BY-102	0.23	B-204	0.00
TX-105*	4.94	B-108	0.21	BX-107	0.00
U-107*	4.81	C-107	0.20	C-106	0.00
C-112	4.27	B-106	0.18	C-201	0.00
C-109	3.52	C-108	0.16	C-202	0.00
B-103*	3.17	S-109	0.14	C-203	0.00
B-102	2.87	B-109	0.11	C-204	0.00
TX-109	2.45	TX-102	0.07	S-104	0.00
AX-103	2.30	U-102	0.07	S-105	0.00
A-103	2.27	S-106	0.03	SX-107	0.00
SX-105	2.07	BY-103	0.02	SX-108	0.00
BY-110	1.91	B-101	0.01	SX-109	0.00
C-105	1.88	TX-112	0.01	SX-111	0.00
TX-110	1.87	T-108	0.01	SX-112	0.00
BY-105	1.84	BX-109	0.00	SX-113	0.00
BX-105	1.73	BX-101	0.00	SX-114	0.00
BX-110	1.72	B-111	0.00	SX-115	0.00
BX-111	1.71	TY-104	0.00	T-104	0.00
BY-108	1.70	BX-103	0.00	T-106	0.00
BY-104	1.67	SX-102	0.00	T-110	0.00
B-112	1.60	BX-104	0.00	T-111	0.00
BY-111	1.46	SX-101	0.00	T-112	0.00
BX-102	1.43	B-107	0.00	T-201	0.00
BY-107	1.30	T-109	0.00	T-202	0.00
A-102	1.28	AX-101	0.00	T-203	0.00
TY-103	1.23	S-102*	0.00	T-204	0.00
T-101	1.18	TX-101	0.00	TX-106	0.00

Table 4.6. (contd)

Tank Total	TOC, wt% (dry)	Tank Total	TOC, wt% (dry)	Tank Total	TOC, wt% (dry)
BY-106	1.14	C-101	0.00	TX-107	0.00
T-102	1.11	U-106*	0.00	TX-108	0.00
BY-101	1.11	BX-108	0.00	TX-113	0.00
C-111	1.08	A-107	0.00	TX-114	0.00
B-110	0.99	TX-104	0.00	TX-115	0.00
SX-103	0.72	A-105	0.00	TX-116	0.00
B-202	0.70	A-106	0.00	TX-117	0.00
S-111	0.69	SX-110	0.00	TY-101	0.00
S-108	0.66	S-103*	0.00	TY-105	0.00
TX-118*	0.63	C-104	0.00	TY-106	0.00
BX-106	0.61	C-103	0.00	U-101	0.00
S-110	0.54	C-110	0.00	U-103	0.00
TY-102	0.49	AX-102	0.00	U-104	0.00
S-101	0.49	T-107	0.00	U-105	0.00
TX-111	0.45	BX-112	0.00	U-108	0.00
S-112	0.40	T-105	0.00	U-109	0.00
TX-103	0.35	C-102	0.00	U-110	0.00
BY-112	0.33	A-104	0.00	U-112	0.00
T-103	O.31	A-101	0.00	U-201	0.00
AX-104	0.30	B-104	0.00	U-202	0.00
U-111*	0.24	B-105	0.00	U-203	0.00
BY-109	0.24	B-201	0.00	U-204	0.00
SX-104	0.23	B-203	0.00		

* Original organic watchlist tank.

4.3 Relationship of TOC to Other Variables in the Dataset

Some important observations can be made about the data and present sources of skew which impact the best estimates of TOC for each tank. The TOC measurements plotted against time indicate higher laboratory measurements were obtained in the years prior to 1985. Figure 4.4 displays the laboratory measurements according to when it was recorded. A quantitative documented basis why pre-1985 TOC data contain higher TOC values than post-1985 data could not be established. It should be noted that the selection criteria for identifying which tanks to sample may have had an impact on the higher TOC values in earlier years.

TOC measurement techniques were examined in an attempt to explain the pre-1985 TOC data. All the TOC determinations used in the laboratory were based on oxidation of organics and detection of the CO_2 gas by either infrared (IR) or coulometric measurement systems. The IR system is very sensitive with a limited dynamic range and requires large dilutions of the samples before analysis. One problem with the system that would account for the larger values in earlier years is that the high sodium in the samples is very detrimental to the furnace tubes. One of the problems with old data is that it did not include any quality control information such as blanks, spikes standards or duplicates to determine if the instrument was operating "properly." The high sensitivity and large dilutions required by this method can magnify the effect of TOC contamination. Furnace oxidation systems also have the disadvantage that they produce other gases (NO_X, SO_2, etc.) which potentially could interfere in the method if 1) they are not adequately trapped or 2) the IR detector selectivity is inadequate to differentiate between CO_2 and the other gas. Sometimes TOC is determined by the difference between the total carbon (TC) and the total inorganic carbon (TIC): TOC = TC - TIC. This can result in additional errors caused by the difference of two large numbers.

Measurement method was investigated as an additional source of variance to see if a relationship between measurement method and reported TOC concentration unit exists. This is summarized in Table 4.7. A disproportionate number of high observations were reported in units of moles/L. Although it does not seem to be coincidence, an explanation of this association was not found.

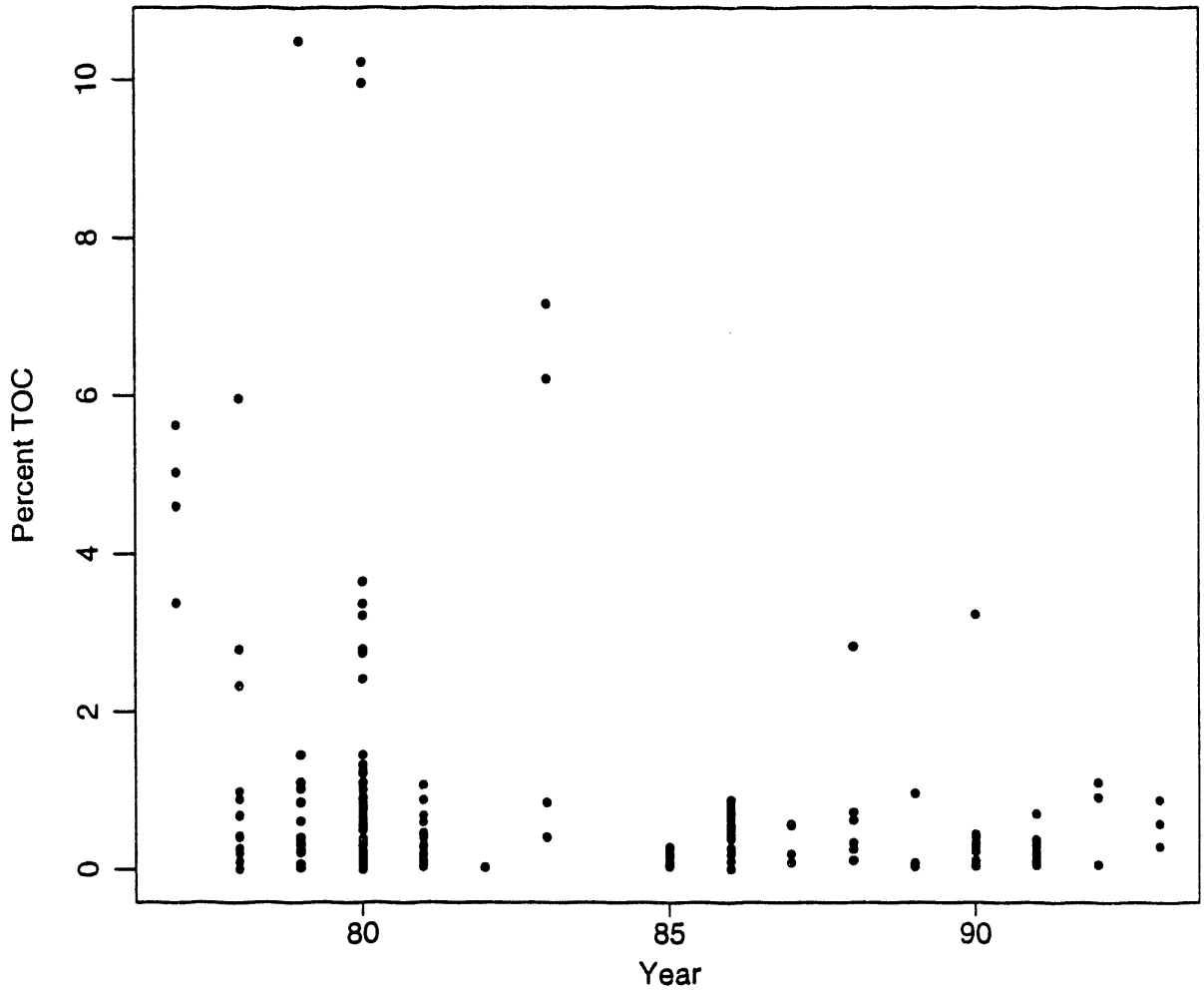

Figure 4.4. Percent TOC Measurements (Wet) Plotted Against the Year of the Document in Which the Measurement Was Reported

Table 4.7. TOC (Wet) Observations and Measurement Units Reported

Reporting Units	% TOC < 2%	% TOC > 2%
gm/gm	9	3
gm/L	120	6
moles/L	13	7
ug/g	2	0
ugm/gm	28	0
wt%	30	5

4.4 Distributional Assumptions

ANOVA makes fairly specific assumptions about the distribution of the data (i.e., the effects are normally distributed, with constant variance). While the violation of these assumptions may not strongly affect some ANOVA results (for example the estimate of the mean), the distributional assumptions are very important. To assign uncertainties to the tank estimates the distributions implied by the ANOVA models should be accurately represented from the data available. In this analysis it is assumed that all data, in each laboratory measurement, is weighted equally.

To examine the distribution of the data, Quantile-Quantile (Q-Q) plots of the TOC data were made. For the TOC data, the Q-Q plot locates the data relative to its standard normal distribution. A normal distribution is displayed as points following a straight line. Figure 4.5 displays a Q-Q plot of the TOC data from the dataset. From the figure, it is apparent that the data is skewed, with a heavy left-hand tail; the data does not seem to be normally distributed. Of course, this data contains several difference sources of variability, in different amounts, and this may be causing the effects. To see if the data could be made normal by a transformation, a Q-Q plot of the logged TOC data is given in Figure 4.6 and the plot, although not exactly linear, is much better with a correlation coefficient of 0.98. This Q-Q plot gives a strong indication that logged TOC data would fit the normal-distribution assumptions of ANOVA models much better than the unlogged data. Similar improved results are obtained by taking the log of the components of Equation 4.1, indicating a log-normal distribution.

A log transformation can be explained further. The logged model produces positive values, while the unlogged model allows the data to be negative, which is not possible for TOC data. Also, the logged model extrapolates to large TOC values in a more conservative manner. Since most of the TOC measurements in the tank are fairly low (i.e., much less than 5%), the logged models will assign higher variabilities to large values than an unlogged model would. (In a logged ANOVA model, the standard deviations will be proportional to the mean, but in unlogged models, the standard deviations are constant). Therefore, a logged model should produce more conservative prediction intervals than an unlogged model.

The distribution of the effects (on the unlogged) scale are also skewed, with a heavy right-hand distribution. Since distributions with heavy right-hand tails will give more conservative exceedance probabilities than symmetric distributions, this aspect of the log transformation produces conservative estimates. It is important to note that since the distributions are skewed, the ANOVA estimates being produced (on the unlogged scale) are no longer best estimates for distribution means; The ANOVA estimates are best estimates for distribution medians. Taking the exponential value of the mean logarithm TOC transforms the value into the median TOC. However, taking the exponential value of the sum of the mean logarithm TOC plus an error correction term transforms the value into the mean TOC. This is shown in equations 4.2 through 4.5.

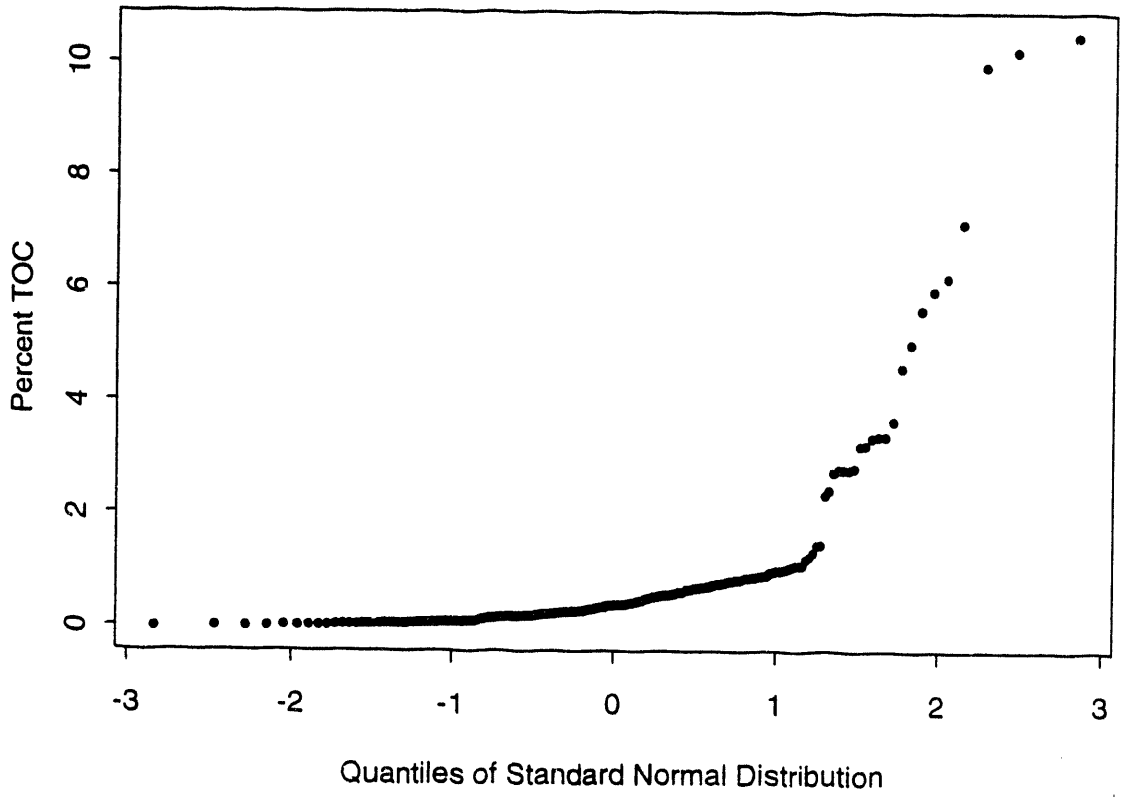

Figure 4.5. Q-Q Plot of Untransformed Laboratory TOC Measurements

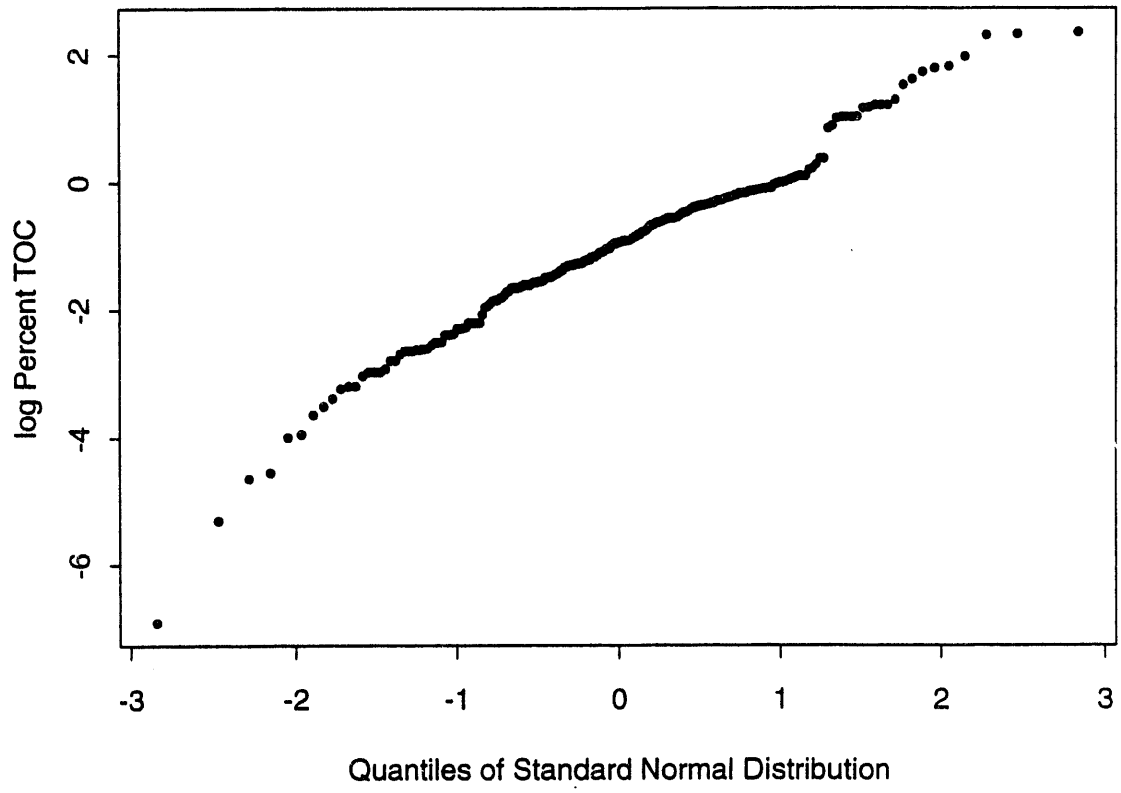

Figure 4.6. Q-Q Plot of the Logarithm of the Laboratory TOC Measurements

4.5 Factors Included in the ANOVA Analysis

In the TOC data, the sample was classified as a sludge, saltcake, or liquid sample. Since no direct correlation between solid and liquid values was found, as shown in Section 4.2, a waste type term was not included in the ANOVA technique.

The SORWT model groups tanks of similar waste type. The SORWT group was evaluated to identify if it was a significant factor. Plots of TOC verses SORWT group did not indicate that SORWT group was highly correlated with TOC, but it was apparent that a relationship existed. A simple ANOVA fit confirmed that SORWT group is a significant factor, so it was included in the ANOVA model.

As a result, the ANOVA model utilized was:

$$\log(TOC_{ijk}) = u + G_i + T_{ij} + E_{ijk} \tag{4.1}$$

where exp(u) is the median TOC value for all Hanford waste, $\exp(u+G_i)$is the median TOC value for the SORWT group i, the term $\exp(u+G_i+T_{ij})$ is the median TOC in tank ij, and the term E_{ijk} represents the within tank variability. The ANOVA model does not explicitly treat the spatial distribution or laboratory measurement error directly. These two effects are included in the E_{ijk} term of the ANOVA model which represent the residual error term. The ANOVA results produce standard errors (standard deviations) for all the estimates used in the above formula, so it is possible to calculate an uncertainty associated with the tank estimate. The ANOVA model produces estimates for the variability associated with each effect.

The ANOVA results can be used to assess the wet basis TOC for each tank. If the particular tank of interest is represented in the dataset, then one can consider the following estimates for TOC content;

$$\text{Median TOC Content in Tank ij} = \exp(u + G_i + T_{ij}) \tag{4.2}$$

or, if the mean is desired,

$$\text{Mean TOC content in the tank ij} = \exp(u + G_i + T_{ij} + 0.5\ \sigma_E^2) \tag{4.3}$$

where σ_E = standard deviation of residuals E.

If the tank is not present in the dataset, but is known to be a member of SORWT group i, then the best estimate for its contents are

$$\text{Median TOC Content in Tank ij} = \exp(u + G_i) \tag{4.4}$$

or, if the mean is desired,

$$\text{Mean TOC content in the Tank ij} = \exp[u + G_i + 0.5 * (\sigma_T^2 + \sigma_E^2)] \tag{4.5}$$

where σ_T is the standard deviation for the tank-to-tank factor T and σ_E represents the standard deviation for the residuals term.

The median is used to provide a best estimate of TOC for all the tanks. The decision to select the median as a best estimate for TOC is based on the assumption that the residuals error term is based on measurement error as the key contributor. The mean value would be a better assessment of the TOC if the spatial distributions within the tank are a greater contributor to error than the measurement error.

The ANOVA model described in Equation 4.1 is a random effects model. That is, the terms G(i) and T(ij) are assumed to be normally distributed random variables. The assumption that these terms are random effects provides enough information to allow us to estimate TOC in tanks with no measurements. The alternative to this assumption would be to assume that these terms are fixed effects: i.e., the terms G(i) and T(ij) represent unknown parameters that must be estimated from the data. If this perspective would be adopted, then nothing could be assumed about unsampled tanks, but the ANOVA fit will produce a description of the data using less modeling assumptions. The random effects model used to assess the TOC in each tank utilizes the characteristic information known about the tanks. The tank estimates tend to be shrunk towards the group means.

4.6 Conversion of TOC to Dry Basis

To be consistent with the organic safety watchlist criteria, the TOC assessments from the ANOVA model must be converted to a dry basis. The conversion utilized the ANOVA TOC assessment values and information from the Westinghouse Hanford Company Tank Waste Surveillance reports (Hanlon 1993). The total inventory of organic carbon is calculated using the following equation:

$$T_{ij}\,(\text{toc}) = \%\ \text{TOC(wet)} * \text{M(tank)} \tag{4.6}$$

where T_{ij} (toc) = total amount of organic carbon in the tank ij.

% TOC(wet) = % TOC from ANOVA analysis

M (tank) = total mass of the tank inventory, (kg), from Tank Farm Surveillance report.

The dry basis mass for the SSTs is determined by knowing the volume of sludge and saltcake in each tank. It is assumed 60% of the sludge volume is water, and 40% of the saltcake volume is water. Therefore, the following equation is used to estimate the dry volume is each tank:

$$\text{V(dry)} = 0.4 * (\text{sludge volume}) + 0.6 * (\text{saltcake volume}) \tag{4.7}$$

where V(dry) = dry volume of tank, thousand gallon.

The V(dry) is converted to M(dry), dry mass assuming an overall density of 1.3 gm/cubic centimeter.

The Dry Basis TOC is calculated using the following ratio:

$$\text{Percent dry basis TOC} = 100 * T(ij)\,(toc) / M(dry) \tag{4.8}$$

The wet-to-dry correction factor is calculated as follows:

$$C_{W/D} = \frac{\text{TOC (dry basis)}}{\text{TOC (wet basis)}} \tag{4.9}$$

The correction factors for all tanks are provided in Table A.4 in Appendix A.

4.7 Results of Fits to TOC Data

The combined data consists of 223 measurements on 75 tanks. Most tanks in the dataset have more than two TOC measurements associated with them, but a few (18) have more than 4. The most heavily sampled tank in the dataset is A-101, with 17 TOC measurements. Although SORWT grouping is used in this analyses, it is not ideal. There are too many SORWT groups with data on only one tank (14). Plus some of the tanks with data are ungrouped.

The ANOVA fit produces estimates for all three dataset alternatives using the model parameters listed in Table 4.8. These estimates apply to a logged scale, so the sigma estimates are converted to unlogged relative standard deviations (RSDs).

The tables give us important information about how good the SORWT grouping is in predicting TOC content in a tank. If SORWT grouping were highly effective, the between group standard deviation would be much larger than the other two sources of variability, between tank and within tank standard deviation. One can see that this is definitely not the case; in fact, within tank variability is the largest source of variability for the entire dataset. This will have important implications for an efficient estimation formula for tank TOC content. Since an individual tank measurement displays so much variability, it is most efficient to use information about the group to estimate what is in an individual tank. In fact, this is just what the ANOVA does.

Best estimates for each SORWT group using the ANOVA method are provided in Table 4.9.

The estimators for tank TOC that the ANOVA logarithmic model produces are weighted averages of the overall mean, the group mean, and the tank mean (on the scale). This causes the estimate to be

weighted towards the overall group mean. The amount of weighting towards the overall mean, or shrinkage, is displayed by the estimator and reflects the variabilities present in each the tank's data. Figures 4.7, 4.8, and 4.9 represent how the estimates for each group $u + G_i$ and each tank $u + G_i + T_{ij}$ are shrunk towards the mean for both datasets. In these figures, the solid dots represent the laboratory measurements associated with the tank, the "f" represents the fixed effect tank estimate, and the circle the random effects estimate, and finally the vertical line the group estimate. From this plot, one can see how much the random effects estimate is shrunk towards the group mean. For a tank like S110, with only one laboratory measurement, we can see that the shrinkage is substantial; for a tank like A101 with 17 laboratory measurements, the shrinkage is very small.

Table 4.10 presents the best estimate TOC values for all 149 SSTs (median estimates, wet basis). Table 4.11 presents mean estimates for each tank on a wet basis. Table 4.12 and 4.13 present median and mean results for each SST on a dry basis. Tanks without a SORWT group listed indicate the tank is ungrouped. The logarithm values are included in these tables for use by other organic analyses and follow-on studies.

The fits produced on Table 4.10 are used to give best estimates of the average dry weight TOC concentrations in each SST. To obtain such an estimate, two correction factors must be used. First, the median result must be transformed to mean estimates. Secondly, the estimate must be transformed to dry weight units. Both of these corrections involve a multiplication by a correction factor.

The correction factor for transforming the median estimate to an average is given by:

$$\frac{1}{2}\sigma_E^2 = 1.85 \text{ if the tank has been sampled}$$

$$\exp\left[\frac{1}{2}\left(\sigma_G^2 + \sigma_T^2 + \sigma_E^2\right)\right] = 2.50 \text{ if neither the tank nor the group it belongs to was sampled}$$

$$\exp\left[\frac{1}{2}\left(\sigma_T^2 + \sigma_E^2\right)\right] = 2.40 \text{ if the tank was not sampled but is a member of a SORWT group which was sampled}$$

The wet median and mean TOC values are transformed to a dry basis by multiplying the values by the wet to dry correction factor provided in Table A.4 in Appendix A.

Table 4.8. Estimates of ANOVA Model Parameters (logged) for the Laboratory Dataset

Parameter	Estimate	SD[a] (estimate)	RSD
Mean, u	-1.137	0.019	NA
Between Group Standard Deviation (SD) G_i	0.080	0.143	0.080
Between Tank SD T_{ij}	0.519	0.210	0.556
Within Tank SD E_{Eijk}	1.232	0.140	1.887

(a) SD = Standard Deviation.

Table 4.9. Best Estimates for Each SORWT Group (wet% weight)

SORWT Group	$\mu + G_i$	Median	Mean
1	-0.93 ± 0.22	0.40	0.44
2	-1.22 ± 0.26	0.29	0.34
3	-1.14 ± 0.27	0.32	0.37
4	-1.11 ± 0.27	0.33	0.38
5	-1.19 ± 0.29	0.30	0.35
6	-1.14 ± 0.30	0.32	0.37
7	-0.96 ± 0.27	0.38	0.44
8	-1.19 ± 0.29	0.30	0.35
9	-0.90 ± 0.25	0.41	0.46
10	-0.99 ± 0.30	0.37	0.43
11	-1.27 ± 0.30	0.28	0.33
12	-1.10 ± 0.30	0.33	0.39
13	-1.16 ± 0.31	0.31	0.37
14	-1.16 ± 0.31	0.31	0.37
15	-1.23 ± 0.31	0.29	0.34
16	-1.08 ± 0.31	0.34	0.40
17	-1.31 ± 0.30	0.27	0.31
19	-1.22 ± 0.31	0.30	0.35
21	-1.18 ± 0.29	0.31	0.36
22	-1.16 ± 0.29	0.31	0.36
23	-1.12 ± 0.28	0.32	0.37
24	-1.20 ± 0.29	0.30	0.35
25	-1.19 ± 0.29	0.30	0.35
26	-1.15 ± 0.30	0.32	0.37
27	-1.30 ± 0.28	0.27	0.31
28	-0.93 ± 0.29	0.39	0.45

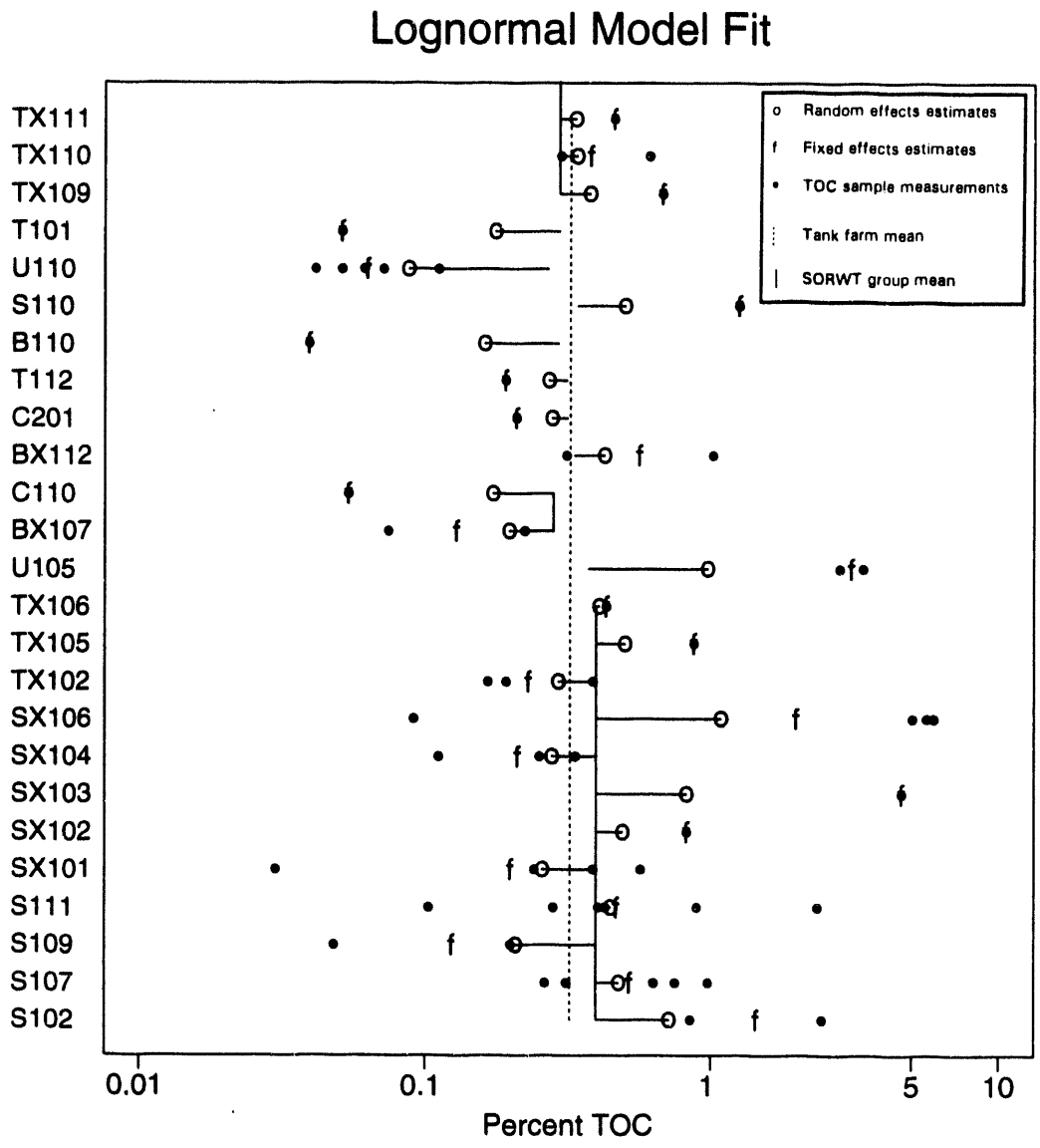

Figure 4.7. Estimated Effects (Wet Data) from ANOVA Model

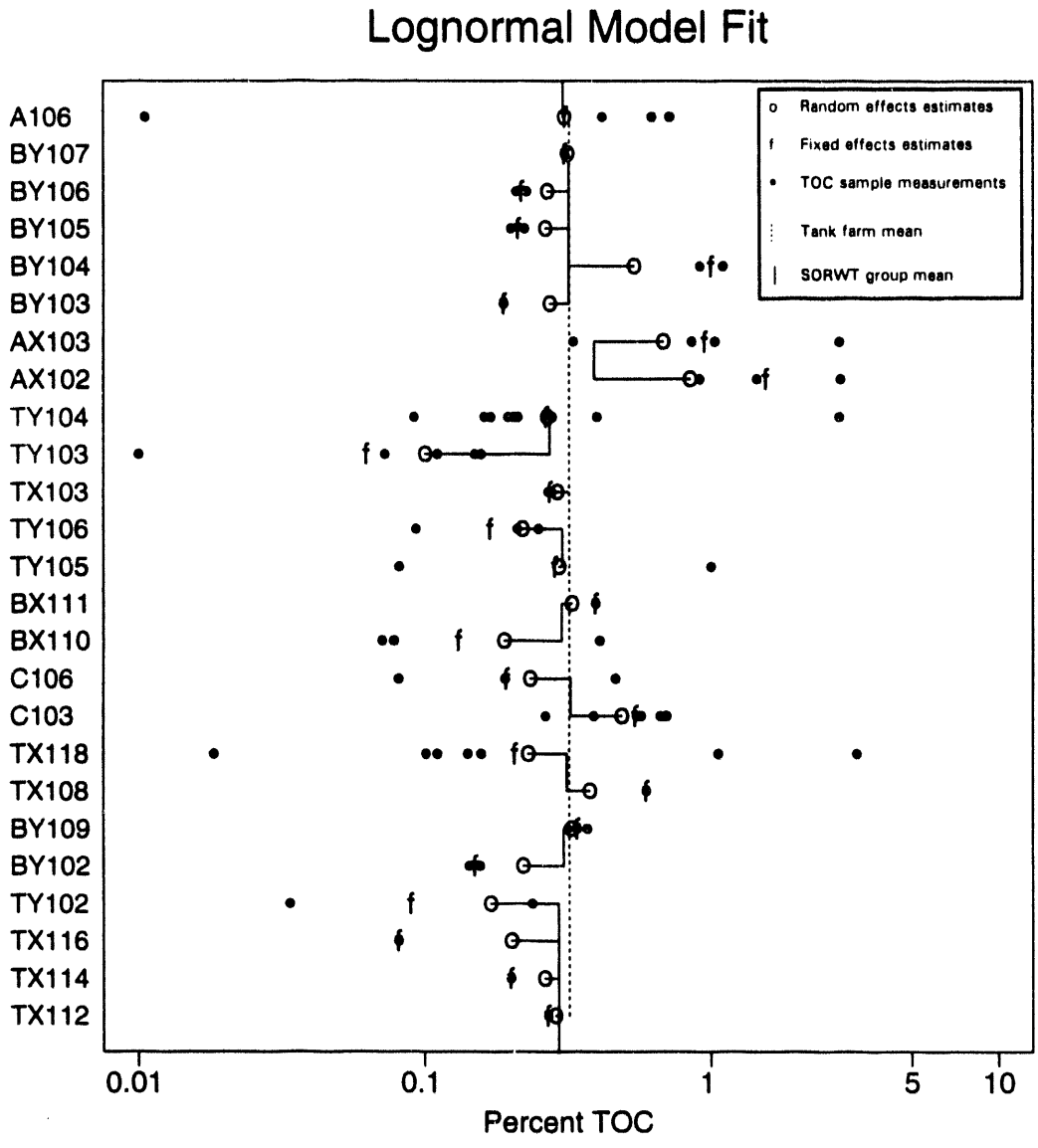

Figure 4.8. Estimated Effects (Wet Data) from ANOVA Model (continued)

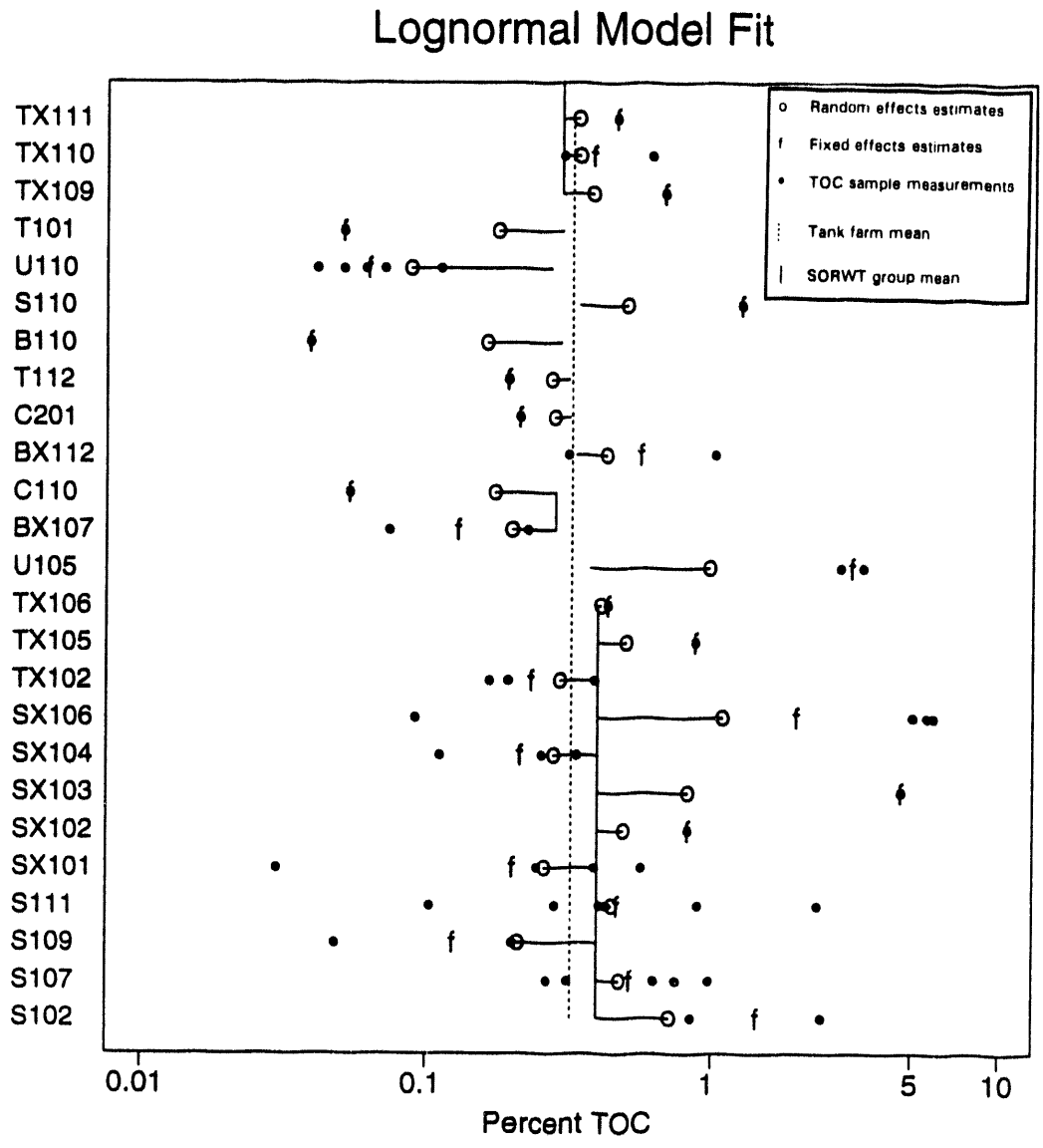

Figure 4.9. Estimated Effects (Wet Data) from ANOVA Model (continued)

Table 4.10. TOC Wet Units, Median Estimate

Tank	SORWT Number	Mean Log TOC	SD Log TOC	Median TOC wet %	95% Confidence Limit
SX106*	1	0.08	0.45	1.09	2.27
A101	9	0.06	0.25	1.06	1.61
U106*	7	0.01	0.63	1.01	2.86
U105	10	-0.02	0.56	0.98	2.44
AX102	28	-0.17	0.5	0.85	1.91
T104	30	-0.17	0.49	0.84	1.88
SX103	1	-0.2	0.62	0.82	2.28
U103	7	-0.33	0.55	0.72	1.78
S102*	1	-0.34	0.54	0.71	1.74
AX103	28	-0.38	0.45	0.68	1.44
AX101	9	-0.4	0.42	0.67	1.33
U111*	7	-0.42	0.49	0.66	1.48
A103	9	-0.5	0.35	0.61	1.08
BY104	3	-0.62	0.55	0.54	1.33
S110	16	-0.69	0.64	0.5	1.44
TX105*	1	-0.69	0.62	0.5	1.4
SX102	1	-0.71	0.62	0.49	1.37
C103*	23	-0.72	0.33	0.49	0.85
S107	1	-0.74	0.41	0.48	0.94
S111	1	-0.81	0.39	0.45	0.84
BX112	12	-0.86	0.56	0.42	1.06
C104	30	-0.86	0.55	0.42	1.04
C112	8	-0.88	0.5	0.41	0.93
TX106	1	-0.9	0.62	0.41	1.13
S101	1	-0.93	0.75	0.4	1.36
S103	1	-0.93	0.75	0.4	1.36
S105	1	-0.93	0.75	0.4	1.36
S106	1	-0.93	0.75	0.4	1.36
S108	1	-0.93	0.75	0.4	1.36
S112	1	-0.93	0.75	0.4	1.36
SX105	1	-0.93	0.75	0.4	1.36
TX104	1	-0.93	0.75	0.4	1.36
TX107	1	-0.93	0.75	0.4	1.36
BX105	4	-0.93	0.45	0.39	0.83

Table 4.10. (contd)

Tank	SORWT Number	Mean Log TOC	SD Log TOC	Median TOC wet %	95% Confidence Limit
T204	5	-0.95	0.64	0.39	1.1
U102	7	-0.96	0.77	0.38	1.36
TX108	22	-0.97	0.64	0.38	1.08
TX109	2	-0.98	0.63	0.38	1.06
BX104	4	-0.98	0.39	0.37	0.71
U107*	10	-0.99	0.78	0.37	1.35
U108	10	-0.99	0.78	0.37	1.35
U109	10	-0.99	0.78	0.37	1.35
SX110	16	-1.08	0.78	0.34	1.23
SX111	16	-1.08	0.78	0.34	1.23
SX114	16	-1.08	0.78	0.34	1.23
TX110	2	-1.08	0.49	0.34	0.76
SX107	6	-1.08	0.64	0.34	0.97
TX111	2	-1.09	0.63	0.34	0.95
BX106	4	-1.11	0.63	0.33	0.94
BX101	4	-1.11	0.77	0.33	1.17
BX102	4	-1.11	0.77	0.33	1.17
BX103	4	-1.11	0.77	0.33	1.17
C101	4	-1.11	0.77	0.33	1.17
BX111	24	-1.12	0.64	0.33	0.94
BY109	21	-1.12	0.5	0.33	0.74
A104	30	-1.14	0.79	0.32	1.17
A105	30	-1.14	0.79	0.32	1.17
AX104	30	-1.14	0.79	0.32	1.17
B101	18	-1.14	0.79	0.32	1.17
B102	18	-1.14	0.79	0.32	1.17
B103*	18	-1.14	0.79	0.32	1.17
B104	30	-1.14	0.79	0.32	1.17
SX113	29	-1.14	0.79	0.32	1.17
T109	26	-1.14	0.79	0.32	1.17
TX101	30	-1.14	0.79	0.32	1.17
U104	29	-1.14	0.79	0.32	1.17
U112	30	-1.14	0.79	0.32	1.17
U201	20	-1.14	0.79	0.32	1.17

Table 4.10. (contd)

Tank	SORWT Number	Mean Log TOC	SD Log TOC	Median TOC wet %	95% Confidence Limit
U202	20	-1.14	0.79	0.32	1.17
U203	20	-1.14	0.79	0.32	1.17
U204	30	-1.14	0.79	0.32	1.17
SX108	6	-1.14	0.78	0.32	1.15
SX109	6	-1.14	0.78	0.32	1.15
SX112	6	-1.14	0.78	0.32	1.15
SX115	6	-1.14	0.78	0.32	1.15
U101	6	-1.14	0.78	0.32	1.15
BY107	3	-1.15	0.63	0.32	0.9
C202	13	-1.16	0.78	0.31	1.14
C203	13	-1.16	0.78	0.31	1.14
C204	13	-1.16	0.78	0.31	1.14
T110	14	-1.16	0.78	0.31	1.14
T111	14	-1.16	0.78	0.31	1.14
A106	30	-1.18	0.39	0.31	0.59
B201	5	-1.19	0.78	0.3	1.09
B203	5	-1.19	0.78	0.3	1.09
T201	5	-1.19	0.78	0.3	1.09
T202	5	-1.19	0.78	0.3	1.09
T203	5	-1.19	0.78	0.3	1.09
BY101	3	-1.19	0.78	0.3	1.09
BY108	3	-1.19	0.78	0.3	1.09
BY110	3	-1.19	0.78	0.3	1.09
BY111	8	-1.19	0.78	0.3	1.09
BY112	8	-1.19	0.78	0.3	1.09
C108	8	-1.19	0.78	0.3	1.09
C109	8	-1.19	0.78	0.3	1.09
C111	8	-1.19	0.78	0.3	1.09
C102	30	-1.21	0.63	0.3	0.84
T102	19	-1.22	0.78	0.3	1.07
T103	19	-1.22	0.78	0.3	1.07
TY105	25	-1.22	0.55	0.3	0.73
BX109	4	-1.22	0.63	0.29	0.84
B105	2	-1.22	0.77	0.29	1.04

Table 4.10. (contd)

Tank	SORWT Number	Mean Log TOC	SD Log TOC	Median TOC wet %	95% Confidence Limit
TX113	2	-1.22	0.77	0.29	1.04
TX117	2	-1.22	0.77	0.29	1.04
TX102	1	-1.23	0.49	0.29	0.65
B111	15	-1.23	0.78	0.29	1.06
B112	15	-1.23	0.78	0.29	1.06
A102	9	-1.23	0.28	0.29	0.46
TX103	26	-1.23	0.5	0.29	0.66
S104	6	-1.24	0.64	0.29	0.83
TX112	2	-1.25	0.63	0.29	0.81
B106	11	-1.27	0.78	0.28	1.01
B107	12	-1.27	0.78	0.28	1.01
B108	12	-1.27	0.78	0.28	1.01
B109	12	-1.27	0.78	0.28	1.01
BX108	4	-1.27	0.78	0.28	1.01
T108	11	-1.27	0.78	0.28	1.01
C201	13	-1.28	0.64	0.28	0.8
SX104	1	-1.28	0.49	0.28	0.62
BY103	3	-1.29	0.63	0.27	0.78
T112	14	-1.31	0.64	0.27	0.78
T105	17	-1.31	0.78	0.27	0.97
T106	17	-1.31	0.78	0.27	0.97
TY104	27	-1.32	0.33	0.27	0.46
BY106	3	-1.32	0.55	0.27	0.66
BY105	3	-1.33	0.55	0.26	0.65
TX114	2	-1.34	0.63	0.26	0.74
SX101	1	-1.36	0.45	0.26	0.54
B202	5	-1.44	0.55	0.24	0.59
C106	23	-1.45	0.45	0.23	0.49
TX118*	22	-1.47	0.37	0.23	0.42
C105	30	-1.5	0.55	0.22	0.55
BY102	21	-1.51	0.55	0.22	0.55
B204	5	-1.51	0.64	0.22	0.63
TY106	25	-1.52	0.5	0.22	0.5
C107	30	-1.54	0.63	0.21	0.6

Table 4.10. (contd)

Tank	SORWT Number	Mean Log TOC	SD Log TOC	Median TOC wet %	95% Confidence Limit
S109	1	-1.58	0.49	0.21	0.46
TX116	2	-1.61	0.63	0.2	0.57
BX107	11	-1.63	0.55	0.2	0.49
BX110	24	-1.66	0.5	0.19	0.43
T101	19	-1.74	0.64	0.18	0.5
C110	11	-1.76	0.64	0.17	0.49
TY102	2	-1.77	0.55	0.17	0.42
B110	15	-1.83	0.64	0.16	0.46
T107	8	-1.85	0.55	0.16	0.39
TX115	7	-1.96	0.55	0.14	0.35
TY101	30	-2.16	0.55	0.12	0.28
TY103	27	-2.3	0.42	0.1	0.2
U110	17	-2.44	0.35	0.09	0.16

* Original watchlist tanks.

Table 4.11. TOC Wet Units, Mean Estimate

Tank	SORWT Number	Mean Log TOC	SD Log TOC	Mean TOC wet %	95% Confidence Limit
SX106*	1	0.08	0.45	2.01	4.2
A101	9	0.06	0.25	1.97	2.99
U106*	7	0.01	0.63	1.86	5.29
U105	10	-0.02	0.56	1.81	4.52
AX102	28	-0.17	0.5	1.57	3.54
T104	30	-0.17	0.49	1.56	3.49
SX103	1	-0.2	0.62	1.52	4.23
U103	7	-0.33	0.55	1.33	3.3
S102*	1	-0.34	0.54	1.32	3.22
AX103	28	-0.38	0.45	1.27	2.67
AX101	9	-0.4	0.42	1.24	2.46
U111*	7	-0.42	0.49	1.22	2.74
A103	9	-0.5	0.35	1.13	2
BY104	3	-0.62	0.55	1	2.47
S101	1	-0.93	0.75	0.95	3.28
S103	1	-0.93	0.75	0.95	3.28
S105	1	-0.93	0.75	0.95	3.28
S106	1	-0.93	0.75	0.95	3.28
S108	1	-0.93	0.75	0.95	3.28
S112	1	-0.93	0.75	0.95	3.28
SX105	1	-0.93	0.75	0.95	3.28
TX104	1	-0.93	0.75	0.95	3.28
TX107	1	-0.93	0.75	0.95	3.28
S110	16	-0.69	0.64	0.93	2.66
TX105	1	-0.69	0.62	0.93	2.58
U102	7	-0.96	0.77	0.92	3.26
SX102	1	-0.71	0.62	0.91	2.53
C103*	23	-0.72	0.33	0.91	1.57
U107*	10	-0.99	0.78	0.89	3.23
U108	10	-0.99	0.78	0.89	3.23
U109	10	-0.99	0.78	0.89	3.23
S107	1	-0.74	0.41	0.88	1.74
S111	1	-0.81	0.39	0.82	1.56
SX110	16	-1.08	0.78	0.82	2.96

Table 4.11. (contd)

Tank	SORWT Number	Mean Log TOC	SD Log TOC	Mean TOC wet %	95% Confidence Limit
SX111	16	-1.08	0.78	0.82	2.96
SX114	16	-1.08	0.78	0.82	2.96
A104	30	-1.14	0.79	0.8	2.92
A105	30	-1.14	0.79	0.8	2.92
AX104	30	-1.14	0.79	0.8	2.92
B101	18	-1.14	0.79	0.8	2.92
B102	18	-1.14	0.79	0.8	2.92
B103*	18	-1.14	0.79	0.8	2.92
B104	30	-1.14	0.79	0.8	2.92
SX113	29	-1.14	0.79	0.8	2.92
TX101	30	-1.14	0.79	0.8	2.92
U104	29	-1.14	0.79	0.8	2.92
U112	30	-1.14	0.79	0.8	2.92
U201	20	-1.14	0.79	0.8	2.92
U202	20	-1.14	0.79	0.8	2.92
U203	20	-1.14	0.79	0.8	2.92
U204	30	-1.14	0.79	0.8	2.92
BX101	4	-1.11	0.77	0.79	2.81
BX102	4	-1.11	0.77	0.79	2.81
BX103	4	-1.11	0.77	0.79	2.81
C101	4	-1.11	0.77	0.79	2.81
BX112	12	-0.86	0.56	0.78	1.95
C104	30	-0.86	0.55	0.78	1.93
T109	26	-1.14	0.79	0.77	2.81
C112	8	-0.88	0.5	0.77	1.73
SX108	6	-1.14	0.78	0.77	2.76
SX109	6	-1.14	0.78	0.77	2.76
SX112	6	-1.14	0.78	0.77	2.76
SX115	6	-1.14	0.78	0.77	2.76
U101	6	-1.14	0.78	0.77	2.76
C202	13	-1.16	0.78	0.76	2.74
C203	13	-1.16	0.78	0.76	2.74
C204	13	-1.16	0.78	0.76	2.74
T110	14	-1.16	0.78	0.75	2.73

Table 4.11. (contd)

Tank	SORWT Number	Mean Log TOC	SD Log TOC	Mean TOC wet %	95% Confidence Limit
T111	14	-1.16	0.78	0.75	2.73
TX106	1	-0.9	0.62	0.75	2.09
B201	5	-1.19	0.78	0.73	2.62
B203	5	-1.19	0.78	0.73	2.62
T201	5	-1.19	0.78	0.73	2.62
T202	5	-1.19	0.78	0.73	2.62
T203	5	-1.19	0.78	0.73	2.62
BY101	3	-1.19	0.78	0.73	2.62
BY108	3	-1.19	0.78	0.73	2.62
BY110	3	-1.19	0.78	0.73	2.62
BY111	8	-1.19	0.78	0.73	2.62
BY112	8	-1.19	0.78	0.73	2.62
C108	8	-1.19	0.78	0.73	2.62
C109	8	-1.19	0.78	0.73	2.62
C111	8	-1.19	0.78	0.73	2.62
BX105	4	-0.93	0.45	0.73	1.53
T204	5	-0.95	0.64	0.71	2.04
T102	19	-1.22	0.78	0.71	2.58
T103	19	-1.22	0.78	0.71	2.58
B105	2	-1.22	0.77	0.71	2.49
TX113	2	-1.22	0.77	0.71	2.49
TX117	2	-1.22	0.77	0.71	2.49
TX108	22	-0.97	0.64	0.7	2.01
B111	15	-1.23	0.78	0.7	2.55
B112	15	-1.23	0.78	0.7	2.55
TX109	2	-0.98	0.63	0.7	1.97
BX104	4	-0.98	0.39	0.69	1.32
B106	11	-1.27	0.78	0.68	2.43
B107	12	-1.27	0.78	0.68	2.43
B108	12	-1.27	0.78	0.68	2.43
B109	12	-1.27	0.78	0.68	2.43
BX108	4	-1.27	0.78	0.68	2.43
T108	11	-1.27	0.78	0.68	2.43
T105	17	-1.31	0.78	0.65	2.33

Table 4.11. (contd)

Tank	SORWT Number	Mean Log TOC	SD Log TOC	Mean TOC wet %	95% Confidence Limit
T106	17	-1.31	0.78	0.65	2.33
TX110	2	-1.08	0.49	0.63	1.41
SX107	6	-1.08	0.64	0.63	1.79
TX111	2	-1.09	0.63	0.62	1.76
BX106	4	-1.11	0.63	0.61	1.74
BX111	24	-1.12	0.64	0.61	1.73
BY109	21	-1.12	0.5	0.6	1.37
BY107	3	-1.15	0.63	0.59	1.66
A106	30	-1.18	0.39	0.57	1.08
C102	30	-1.21	0.63	0.55	1.55
TY105	25	-1.22	0.55	0.55	1.36
BX109	4	-1.22	0.63	0.55	1.55
TX102	1	-1.23	0.49	0.54	1.21
A102	9	-1.23	0.28	0.54	0.85
TX103	26	-1.23	0.5	0.54	1.22
S104	6	-1.24	0.64	0.54	1.54
TX112	2	-1.25	0.63	0.53	1.5
C201	13	-1.28	0.64	0.52	1.48
SX104	1	-1.28	0.49	0.51	1.15
BY103	3	-1.29	0.63	0.51	1.44
T112	14	-1.31	0.64	0.5	1.44
TY104	27	-1.32	0.33	0.5	0.86
BY106	3	-1.32	0.55	0.5	1.23
BY105	3	-1.33	0.55	0.49	1.21
TX114	2	-1.34	0.63	0.49	1.37
SX101	1	-1.36	0.45	0.48	0.99
B202	5	-1.44	0.55	0.44	1.09
C106	23	-1.45	0.45	0.43	0.91
TX118*	22	-1.47	0.37	0.42	0.78
C105	30	-1.5	0.55	0.41	1.02
BY102	21	-1.51	0.55	0.41	1.02
B204	5	-1.51	0.64	0.41	1.16
TY106	25	-1.52	0.5	0.41	0.92
C107	30	-1.54	0.63	0.4	1.11

Table 4.11. (contd)

Tank	SORWT Number	Mean Log TOC	SD Log TOC	Mean TOC wet %	95% Confidence Limit
S109	1	-1.58	0.49	0.38	0.86
TX116	2	-1.61	0.63	0.37	1.05
BX107	11	-1.63	0.55	0.36	0.91
BX110	24	-1.66	0.5	0.35	0.79
T101	19	-1.74	0.64	0.33	0.93
C110	11	-1.76	0.64	0.32	0.91
TY102	2	-1.77	0.55	0.32	0.78
B110	15	-1.83	0.64	0.3	0.86
T107	8	-1.85	0.55	0.29	0.72
TX115	7	-1.96	0.55	0.26	0.65
TY101	30	-2.16	0.55	0.21	0.52
TY103	27	-2.3	0.42	0.19	0.37
U110	17	-2.44	0.35	0.16	0.29

* Original watchlist tanks.

Table 4.12. TOC Dry Units, Median Estimate

Tank	SORWT Number	Mean Log TOC	SD Log TOC	Median TOC dry %	95% Confidence Limit
C103*	23	1.35	0.33	3.84	6.66
T104	30	0.75	0.49	2.11	4.74
SX106*	1	0.72	0.45	2.06	4.3
U106*	7	0.63	0.63	1.87	5.32
U105	10	0.61	0.56	1.84	4.59
A101	9	0.57	0.25	1.77	2.69
AX102	28	0.49	0.5	1.63	3.69
A103	9	0.43	0.35	1.54	2.74
SX103	1	0.37	0.62	1.45	4.05
U103	7	0.23	0.55	1.26	3.13
T102	19	0.22	0.78	1.25	4.52
BX106	4	0.2	0.63	1.23	3.48
U203	20	0.18	0.79	1.2	4.39
U204	30	0.18	0.79	1.2	4.39
S102*	1	0.17	0.54	1.19	2.91
AX103	28	0.14	0.45	1.15	2.42
U111*	7	0.12	0.49	1.13	2.54
AX101	9	0.11	0.42	1.12	2.21
S107	1	0.1	0.41	1.1	2.18
BX112	12	0.06	0.56	1.06	2.66
BX105	4	0.06	0.45	1.06	2.22
C104	30	0.05	0.55	1.06	2.6
C112	8	0.03	0.5	1.03	2.34
U201	20	0	0.79	1	3.66
U202	20	0	0.79	1	3.66
T204	5	-0.04	0.64	0.96	2.75
BX104	4	-0.04	0.39	0.96	1.83
S110	16	-0.06	0.64	0.94	2.7
BY104	3	-0.07	0.55	0.93	2.3
U101	6	-0.1	0.78	0.91	3.27
SX102	1	-0.13	0.62	0.88	2.46
BX103	4	-0.13	0.77	0.88	3.12
U112	30	-0.14	0.79	0.87	3.18
T103	19	-0.14	0.78	0.87	3.15

Table 4.12. (contd)

Tank	SORWT Number	Mean Log TOC	SD Log TOC	Median TOC dry %	95% Confidence Limit
SX110	16	-0.16	0.78	0.85	3.09
SX111	16	-0.16	0.78	0.85	3.09
SX114	16	-0.16	0.78	0.85	3.09
BX101	4	-0.17	0.77	0.85	3
SX107	6	-0.17	0.64	0.85	2.42
S101	1	-0.17	0.75	0.84	2.91
TX105*	1	-0.18	0.62	0.83	2.33
TX101	30	-0.19	0.79	0.83	3.03
BX102	4	-0.19	0.77	0.83	2.93
C101	4	-0.19	0.77	0.83	2.93
S111	1	-0.2	0.39	0.82	1.55
C109	8	-0.21	0.78	0.81	2.9
B112	15	-0.22	0.78	0.8	2.92
A104	30	-0.22	0.79	0.8	2.92
A105	30	-0.22	0.79	0.8	2.92
AX104	30	-0.22	0.79	0.8	2.92
B101	18	-0.22	0.79	0.8	2.92
B103*	18	-0.22	0.79	0.8	2.92
SX113	29	-0.22	0.79	0.8	2.92
T109	26	-0.22	0.79	0.8	2.92
U104	29	-0.22	0.79	0.8	2.92
SX108	6	-0.23	0.78	0.8	2.88
SX109	6	-0.23	0.78	0.8	2.88
SX112	6	-0.23	0.78	0.8	2.88
SX115	6	-0.23	0.78	0.8	2.88
T110	14	-0.24	0.78	0.79	2.87
B201	5	-0.24	0.78	0.79	2.83
T201	5	-0.24	0.78	0.79	2.83
T111	14	-0.24	0.78	0.79	2.86
C202	13	-0.24	0.78	0.79	2.85
C203	13	-0.24	0.78	0.79	2.85
C204	13	-0.24	0.78	0.79	2.85
B102	18	-0.25	0.79	0.78	2.84
B203	5	-0.25	0.78	0.78	2.78

Table 4.12. (contd)

Tank	SORWT Number	Mean Log TOC	SD Log TOC	Median TOC dry %	95% Confidence Limit
A106	30	-0.26	0.39	0.77	1.46
T202	5	-0.27	0.78	0.76	2.73
T203	5	-0.27	0.78	0.76	2.73
C108	8	-0.27	0.78	0.76	2.73
C111	8	-0.27	0.78	0.76	2.73
T112	14	-0.28	0.64	0.76	2.17
T106	17	-0.29	0.78	0.74	2.68
C102	30	-0.3	0.63	0.74	2.09
TY105	25	-0.3	0.55	0.74	1.84
BX109	4	-0.31	0.63	0.74	2.09
B104	30	-0.31	0.79	0.74	2.68
B111	15	-0.31	0.78	0.73	2.66
TX103	26	-0.32	0.5	0.73	1.65
S104	6	-0.32	0.64	0.73	2.08
S103	1	-0.33	0.75	0.72	2.48
TY104	27	-0.33	0.33	0.72	1.24
B106	11	-0.34	0.78	0.71	2.55
B107	12	-0.35	0.78	0.71	2.55
B108	12	-0.35	0.78	0.7	2.53
B109	12	-0.35	0.78	0.7	2.53
BX108	4	-0.35	0.78	0.7	2.53
T108	11	-0.35	0.78	0.7	2.53
U102	7	-0.36	0.77	0.7	2.48
C201	13	-0.36	0.64	0.7	2
SX105	1	-0.38	0.75	0.68	2.36
U107*	10	-0.38	0.78	0.68	2.46
C106	23	-0.39	0.45	0.68	1.43
TX107	1	-0.39	0.75	0.68	2.34
TX106	1	-0.39	0.62	0.68	1.88
T105	17	-0.39	0.78	0.67	2.43
S106	1	-0.4	0.75	0.67	2.32
U109	10	-0.4	0.78	0.67	2.43
TX104	1	-0.4	0.75	0.67	2.31
U108	10	-0.4	0.78	0.67	2.42

Table 4.12. (contd)

Tank	SORWT Number	Mean Log TOC	SD Log TOC	Median TOC dry %	95% Confidence Limit
BX111	24	-0.4	0.64	0.67	1.91
S112	1	-0.41	0.75	0.66	2.28
S108	1	-0.41	0.75	0.66	2.28
S105	1	-0.41	0.75	0.66	2.28
BY108	3	-0.43	0.78	0.65	2.34
TX108	22	-0.46	0.64	0.63	1.81
A102	9	-0.47	0.28	0.63	0.99
TX109	2	-0.47	0.63	0.63	1.77
B202	5	-0.52	0.55	0.59	1.47
BY109	21	-0.54	0.5	0.58	1.32
BY107	3	-0.56	0.63	0.57	1.62
TX110	2	-0.57	0.49	0.56	1.27
B204	5	-0.58	0.64	0.56	1.6
TX111	2	-0.58	0.63	0.56	1.58
BY101	3	-0.58	0.78	0.56	2
C105	30	-0.58	0.55	0.56	1.37
BY110	3	-0.59	0.78	0.55	1.99
TY106	25	-0.6	0.5	0.55	1.24
C107	30	-0.63	0.63	0.53	1.5
BY111	8	-0.66	0.78	0.51	1.84
B105	2	-0.67	0.77	0.51	1.81
BY112	8	-0.67	0.78	0.51	1.83
SX104	1	-0.69	0.49	0.5	1.12
BX107	11	-0.71	0.55	0.49	1.23
TX113	2	-0.71	0.77	0.49	1.73
TX117	2	-0.71	0.77	0.49	1.73
TX102	1	-0.72	0.49	0.49	1.09
TX112	2	-0.74	0.63	0.48	1.35
BY106	3	-0.76	0.55	0.47	1.16
SX101	1	-0.76	0.45	0.47	0.98
BX110	24	-0.76	0.5	0.47	1.05
BY103	3	-0.78	0.63	0.46	1.3
BY105	3	-0.79	0.55	0.45	1.12
T101	19	-0.81	0.64	0.44	1.28

Table 4.12. (contd)

Tank	SORWT Number	Mean Log TOC	SD Log TOC	Median TOC dry %	95% Confidence Limit
TX114	2	-0.83	0.63	0.44	1.24
C110	11	-0.84	0.64	0.43	1.23
T107	8	-0.88	0.55	0.41	1.03
B110	15	-0.91	0.64	0.4	1.16
TX118*	22	-0.96	0.37	0.38	0.7
BY102	21	-1	0.55	0.37	0.92
S109	1	-1.06	0.49	0.35	0.78
TX116	2	-1.09	0.63	0.33	0.95
TY101	30	-1.25	0.55	0.29	0.71
TY102	2	-1.26	0.55	0.28	0.7
TY103	27	-1.38	0.42	0.25	0.5
TX115	7	-1.44	0.55	0.24	0.58
U110	17	-1.52	0.35	0.22	0.39

* Original watchlist tanks.

Table 4.13. TOC Dry Units, Mean Estimate

Tank	SORWT Number	Mean Log TOC	SD Log TOC	Mean TOC dry %	95% Confidence Limit
C103*	23	1.35	0.33	7.12	12.33
T104	30	0.75	0.49	3.91	8.78
SX106*	1	0.72	0.45	3.82	7.96
U106*	7	0.63	0.63	3.47	9.84
U105	10	0.61	0.56	3.41	8.5
A101	9	0.57	0.25	3.28	4.99
AX102	28	0.49	0.5	3.03	6.83
U203	20	0.18	0.79	3.01	10.96
U204	30	0.18	0.79	3.01	10.96
T102	19	0.22	0.78	2.99	10.85
A103	9	0.43	0.35	2.85	5.06
SX103	1	0.37	0.62	2.69	7.5
U201	20	0	0.79	2.5	9.13
U202	20	0	0.79	2.5	9.13
U103	7	0.23	0.55	2.34	5.8
BX106	4	0.2	0.63	2.27	6.44
S102*	1	0.17	0.54	2.2	5.39
U112	30	-0.14	0.79	2.18	7.96
U101	6	-0.1	0.78	2.17	7.85
AX103	28	0.14	0.45	2.13	4.47
BX103	4	-0.13	0.77	2.11	7.48
U111*	7	0.12	0.49	2.09	4.7
T103	19	-0.14	0.78	2.08	7.56
TX101	30	-0.19	0.79	2.08	7.57
AX101	9	0.11	0.42	2.07	4.1
S107	1	0.1	0.41	2.04	4.04
SX110	16	-0.16	0.78	2.04	7.41
SX111	16	-0.16	0.78	2.04	7.41
SX114	16	-0.16	0.78	2.04	7.41
BX101	4	-0.17	0.77	2.03	7.2
S101	1	-0.17	0.75	2.03	6.99
A104	30	-0.22	0.79	2	7.31
A105	30	-0.22	0.79	2	7.31
AX104	30	-0.22	0.79	2	7.31

Table 4.13. (contd)

Tank	SORWT Number	Mean Log TOC	SD Log TOC	Mean TOC dry %	95% Confidence Limit
B101	18	-0.22	0.79	2	7.31
B103*	18	-0.22	0.79	2	7.31
SX113	29	-0.22	0.79	2	7.31
U104	29	-0.22	0.79	2	7.31
BX102	4	-0.19	0.77	1.98	7.03
C101	4	-0.19	0.77	1.98	7.03
BX112	12	0.06	0.56	1.97	4.92
BX105	4	0.06	0.45	1.96	4.11
C104	30	0.05	0.55	1.96	4.81
B102	18	-0.25	0.79	1.94	7.08
C109	8	-0.21	0.78	1.94	6.96
B112	15	-0.22	0.78	1.93	7
T109	26	-0.22	0.79	1.92	7.02
C112	8	0.03	0.5	1.92	4.33
SX108	6	-0.23	0.78	1.91	6.91
SX109	6	-0.23	0.78	1.91	6.91
SX112	6	-0.23	0.78	1.91	6.91
SX115	6	-0.23	0.78	1.91	6.91
T110	14	-0.24	0.78	1.9	6.88
B201	5	-0.24	0.78	1.89	6.78
T201	5	-0.24	0.78	1.89	6.78
T111	14	-0.24	0.78	1.89	6.85
C202	13	-0.24	0.78	1.89	6.85
C203	13	-0.24	0.78	1.89	6.85
C204	13	-0.24	0.78	1.89	6.85
B203	5	-0.25	0.78	1.86	6.68
B104	30	-0.31	0.79	1.84	6.7
T202	5	-0.27	0.78	1.83	6.55
T203	5	-0.27	0.78	1.83	6.55
C108	8	-0.27	0.78	1.82	6.54
C111	8	-0.27	0.78	1.82	6.54
T106	17	-0.29	0.78	1.79	6.44
T204	5	-0.04	0.64	1.78	5.09
BX104	4	-0.04	0.39	1.78	3.39

Table 4.13. (contd)

Tank	SORWT Number	Mean Log TOC	SD Log TOC	Mean TOC dry %	95% Confidence Limit
B111	15	-0.31	0.78	1.76	6.39
S110	16	-0.06	0.64	1.74	5
S103	1	-0.33	0.75	1.73	5.95
BY104	3	-0.07	0.55	1.72	4.26
B106	11	-0.34	0.78	1.7	6.13
B107	12	-0.35	0.78	1.7	6.12
B108	12	-0.35	0.78	1.69	6.08
B109	12	-0.35	0.78	1.69	6.08
BX108	4	-0.35	0.78	1.69	6.08
T108	11	-0.35	0.78	1.69	6.08
U102	7	-0.36	0.77	1.68	5.96
SX105	1	-0.38	0.75	1.64	5.66
U107*	10	-0.38	0.78	1.63	5.91
SX102	1	-0.13	0.62	1.63	4.55
TX107	1	-0.39	0.75	1.63	5.62
T105	17	-0.39	0.78	1.62	5.82
S106	1	-0.4	0.75	1.62	5.57
U109	10	-0.4	0.78	1.61	5.83
TX104	1	-0.4	0.75	1.61	5.55
U108	10	-0.4	0.78	1.6	5.81
S112	1	-0.41	0.75	1.59	5.48
S108	1	-0.41	0.75	1.59	5.47
S105	1	-0.41	0.75	1.59	5.47
BY108	3	-0.43	0.78	1.57	5.63
SX107	6	-0.17	0.64	1.56	4.48
TX105*	1	-0.18	0.62	1.54	4.31
S111	1	-0.2	0.39	1.52	2.87
A106	30	-0.26	0.39	1.43	2.71
T112	14	-0.28	0.64	1.4	4.02
C102	30	-0.3	0.63	1.38	3.87
TY105	25	-0.3	0.55	1.37	3.4
BX109	4	-0.31	0.63	1.36	3.87
TX103	26	-0.32	0.5	1.35	3.06
S104	6	-0.32	0.64	1.35	3.86

Table 4.13. (contd)

Tank	SORWT Number	Mean Log TOC	SD Log TOC	Mean TOC dry %	95% Confidence Limit
BY101	3	-0.58	0.78	1.34	4.81
BY110	3	-0.59	0.78	1.33	4.77
TY104	27	-0.33	0.33	1.33	2.3
C201	13	-0.36	0.64	1.29	3.7
C106	23	-0.39	0.45	1.26	2.64
TX106	1	-0.39	0.62	1.25	3.49
BX111	24	-0.4	0.64	1.23	3.53
BY111	8	-0.66	0.78	1.23	4.43
B105	2	-0.67	0.77	1.23	4.34
BY112	8	-0.67	0.78	1.22	4.39
TX113	2	-0.71	0.77	1.18	4.15
TX117	2	-0.71	0.77	1.18	4.15
TX108	22	-0.46	0.64	1.17	3.35
A102	9	-0.47	0.28	1.16	1.83
TX109	2	-0.47	0.63	1.16	3.28
B202	5	-0.52	0.55	1.1	2.73
BY109	21	-0.54	0.5	1.08	2.44
BY107	3	-0.56	0.63	1.06	3
TX110	2	-0.57	0.49	1.04	2.35
B204	5	-0.58	0.64	1.04	2.97
TX111	2	-0.58	0.63	1.04	2.93
C105	30	-0.58	0.55	1.03	2.54
TY106	25	-0.6	0.5	1.01	2.29
C107	30	-0.63	0.63	0.99	2.78
SX104	1	-0.69	0.49	0.93	2.07
BX107	11	-0.71	0.55	0.91	2.27
TX102	1	-0.72	0.49	0.9	2.02
TX112	2	-0.74	0.63	0.89	2.5
BY106	3	-0.76	0.55	0.87	2.15
SX101	1	-0.76	0.45	0.87	1.81
BX110	24	-0.76	0.5	0.86	1.95
BY103	3	-0.78	0.63	0.85	2.41
BY105	3	-0.79	0.55	0.84	2.08
T101	19	-0.81	0.64	0.82	2.36

Table 4.13. (contd)

Tank	SORWT Number	Mean Log TOC	SD Log TOC	Mean TOC dry %	95% Confidence Limit
TX114	2	-0.83	0.63	0.81	2.29
C110	11	-0.84	0.64	0.8	2.28
T107	8	-0.88	0.55	0.77	1.9
B110	15	-0.91	0.64	0.75	2.15
TX118*	22	-0.96	0.37	0.71	1.3
BY102	21	-1	0.55	0.68	1.69
S109	1	-1.06	0.49	0.64	1.44
TX116	2	-1.09	0.63	0.62	1.75
TY101	30	-1.25	0.55	0.53	1.31
TY102	2	-1.26	0.55	0.53	1.3
TY103	27	-1.38	0.42	0.47	0.93
TX115	7	-1.44	0.55	0.44	1.08
U110	17	-1.52	0.35	0.4	0.72

* Original watchlist tanks.

4.8 TOC Criteria for Watchlist Tanks

The TOC and standard deviation estimates developed using the ANOVA model can be used to determine the likelihood of a tank exceeding 5% TOC. The 5% TOC threshold is established in Babad and Turner (1993). The likelihood a tank will exceed 5% can be expressed on an exceedance probability plot. The probability is expressed as a number less than 1, 1 indicating 100% likelihood the tank exceeds 5% TOC.

The exceedance probability is given by the following equation:

$$\Pr(\text{Tank}_{ij}\ \text{Mean} > 5\%) = \Phi\left[\frac{\log(5\%) - \log(U_{ij})}{\sigma_{ij}}\right]$$

where Φ is the normal probability function, log (u_{ij}) is given from equation 4.1, and σ_{ij} is standard deviation of the estimate for tank ij.

The plots showing the probability that a tank will exceed 5% TOC are represented in Figures 4.10, 4.11, 4.12, and 4.13 for wet-TOC median, wet-TOC mean, dry-TOC median and dry-TOC mean, respectively. The ten tanks with the greatest probability of exceeding 5% TOC are listed on the plots in decreasing order. Sampled tanks tend to occur either at the high end or low end of the curve. Sampling tends to put the tank in a definite state, either higher or lower probability that the tank will exceed 5% TOC compared to unsampled tanks. The results shown in Figures 4.10 through 4.13 should be used with caution. At a 1/1000 probability level, many tanks would exceed the 5% threshold for the dry mean basis. As Figure 4.13 shows, many of these tanks are unmeasured tanks.

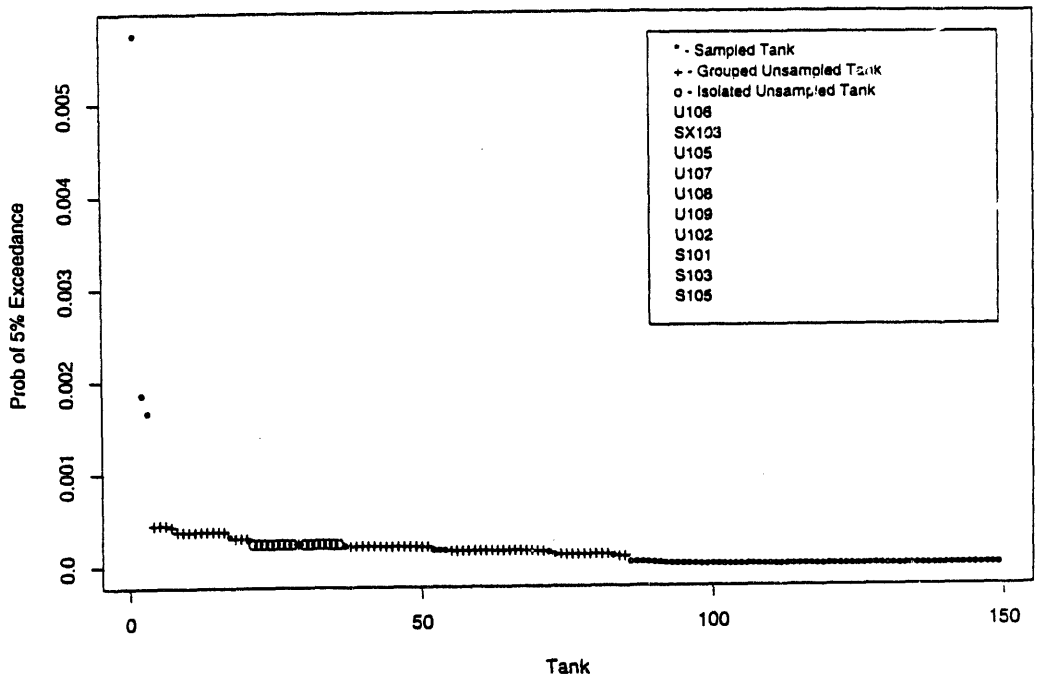

Figure 4.10. Probability of 5% Exceedance for 149 SSTs, Wet Median Basis (Top ten tanks with highest probability of exceeding 5% are noted in the legend.)

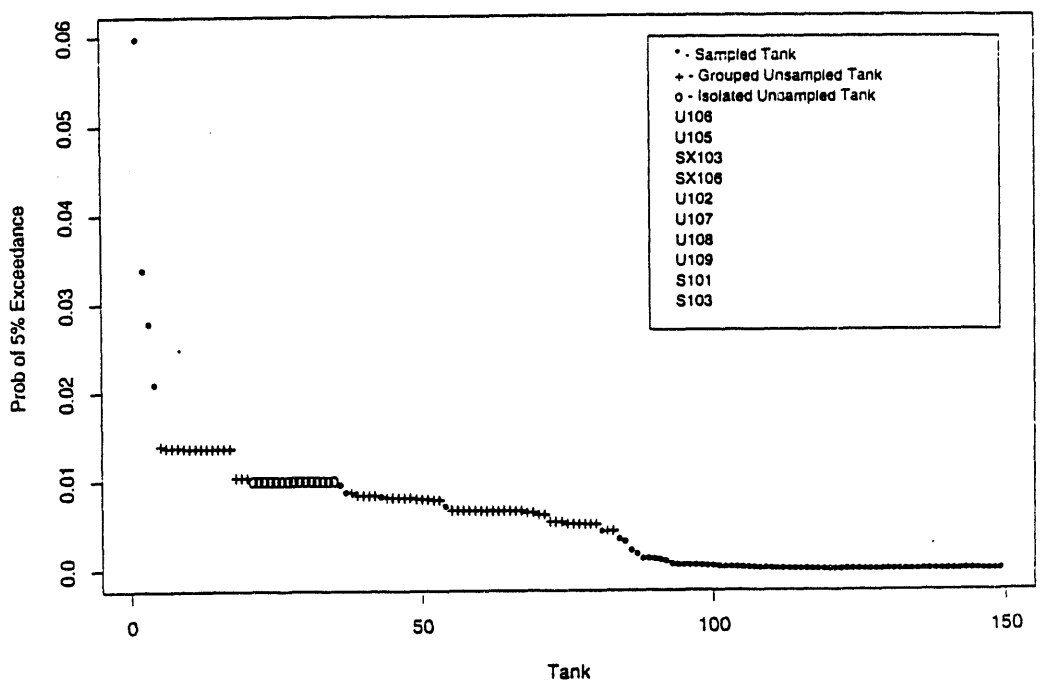

Figure 4.11. Probability of 5% exceedance for 149 SSTs, Wet Mean Basis (Top ten tanks with highest probability of exceeding 5% are noted in the legend.)

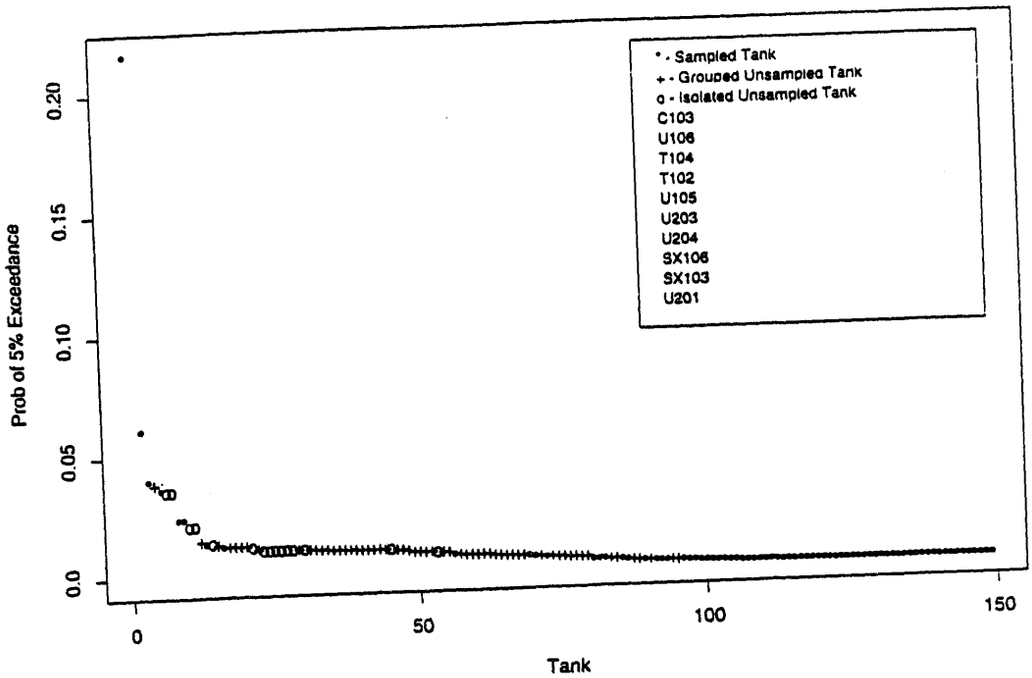

Figure 4.12. Probability of 5% Exceedance for 149 SSTs, Dry Median Basis (Top ten tanks with highest probability of exceeding 5% are noted in the legend.)

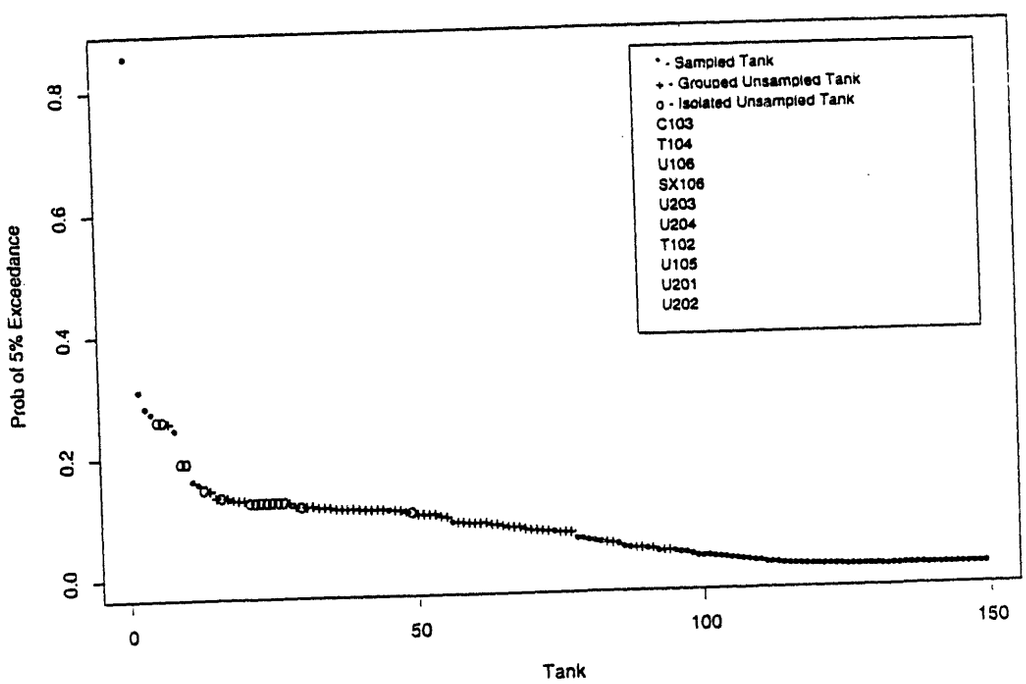

Figure 4.13. Probability of 5% Exceedance for 149 SSTs, Dry Mean Basis (Top 10 tanks with highest probability of exceeding 5% are noted in the legend.)

5.0 Conclusions and Recommendations

Conclusions

To support the Tank Waste Remediation System Program at Hanford, it has been determined that a best estimate, including confidence level, of total organic carbon (TOC) for each of the 149 single-shell tanks (SSTs) is required. This document provides estimates and confidence levels for each of the 149 tanks, with a methodology and ranking under which additional SST monitoring or measuring can proceed for the Organic Tank Safety Program. The methodology makes use of chemical analysis information provided in tank process laboratory results and tank characterization reports. The methodology also makes use of an Analysis of Variance (ANOVA) statistical technique and a tank grouping method based on the different types of wastes introduced into each SST (SORWT grouping technique).

Characteristic reports and laboratory analytical results from 75 of the 149 SSTs at Hanford were provided. Most of the reports provide data on the liquid phase total organic carbon, but core composite, sludge, and salt cake data are also represented. Organic species measurements are not well characterized. When organic species data are reported, only EDTA and HEDTA are represented, and these account for only 10% of the TOC content. A significant number of tanks, 28 out of 75, had only one TOC observation for the tank. Of the 149 SST tanks, 59 had no TOC measurement but did belong to a SORWT group with at least one observation. Another 15 tanks had no TOC measurement and belonged to a SORWT group that had no TOC measurements. It was shown in Section 4.7 that the SORWT grouping scheme is not statistically effective since the between-tank and within-tank standard deviations are much larger than the SORWT group standard deviation.

The data did not indicate any significant correlation of TOC values to waste phase (liquid or solids). There were no data clusters or grouping of liquid and solid phases. Therefore, waste phase dependence (solid, liquid) was not included in the statistical model for this study.

The TRAC inventories of organic components were used to estimate the total organic concentration of the 149 Hanford SSTs. The TRAC estimates of organic carbon are usually zero, and the method cannot be relied upon to give realistic estimates of organic carbon in the tanks. If a determination of organic carbon is required, a comparison of laboratory values within similar groups is recommended as a more accurate preliminary determination over the TRAC estimates.

Both median and mean TOC estimates for each tank are provided on a wet and dry basis (Tables 4.10 through 4.13). The TOC median values provide estimates that approximate the determination of TOC inventory added to the tanks according to Fisher (1990). Based on a wet median basis, the current study estimates the total carbon in all 149 SSTs to be 760 metric tons, and the Fisher (1990) study estimates quantity of organic carbon added to the tanks to be 850 metric tons. If the TOC mean is used in place of the median, the TOC added to the tanks is 1500 metric tons, well above the

Fisher (1990) estimate. For best-estimate TOC values, it is recommended that the Table 4.10 values indicating wet basis median values be used. To be consistent with the organic safety watchlist criteria, the dry mean values are estimated and are provided in Table 4.13.

Recommendations

Although the TOC information compiled and modeled statistically in this report represents a significant improvement in our knowledge about TOC in single-shell tanks, the dataset could be improved upon. Specifically:

- Construct a TOC dataset that can be updated with additional TOC measurements as they become available.
- Determine TOC measurement bias with respect to individual laboratories and analytical technique employed.
- Evaluate measurement data and tanks with outlying observations in the dataset.
- Determine availability of information on TOC spatial variations. Include spatial variations in the statistical model.
- Validate the current TOC estimates with additional sampling results.

The tank grouping scheme should be simplified and improved. A recommended grouping technique is:

- Group 1 - tanks for which the transfer records show low TOC present.
- Group 2 - tanks that have an ambiguous transfer record.
- Group 3 - tanks for which transfer records show high TOC present.

6.0 References

Babad, H., and D. A. Turner. September 1993. *Interim Criteria for Organic Watch List Tanks at the Hanford Site*. WHC-EP-0681, Westinghouse Hanford Company, Richland, Washington.

Fisher, F. D. August 1990. *The Kyshtym Explosion and Explosion Hazards with Nitrate - Nitrite Bearing Waste with Acetates and Other Organic Salts*. WHC-SD-CP-LB-033, Westinghouse Hanford Company, Richland, Washington.

Herting, D. L. et al. 1992. *1992 Tank 101-SY Characterization Report*. WHC-SD-WM-DTR-026, Westinghouse Hanford Company, Richland, Washington.

Hill, J. G., and B. C. Simpson. August 1991. *The Sort on Radioactive Waste Type Model: A Method to Sort Single Shell Tanks Into Characteristic Groups*. WHC-EP-0449, Westinghouse Hanford Company, Richland, Washington.

Hill, J. G., W. I. Winters, B. C. Simpson, J. W. Buck, P. J. Chamberlain, and V. L. Hunter. September 1991. *Waste Tank Characterization Plan for the Hanford Site Single-Shell Tanks, Appendix I - Test Plan for Sampling and Analysis of Ten Single-Shell Tanks*. WHC-EP-0210, Rev. 3, Westinghouse Hanford Company, Richland, Washington.

Jensen, L. 1993. *Characterization Report for Single-Shell Tank 241-U-110*. WHC-SD-WM-TI-560, Rev 0., Westinghouse Hanford Company, Richland, Washington.

Jungfleisch, F. M. 1984. *Preliminary Estimation of the Waste Inventories in Hanford Tanks Through 1980*. SD-WM-TI-057, Rockwell Hanford Operations, Richland, Washington.

Schulz, W. W. January 1980. *Removal of Radionuclides from Hanford Defense Waste Solutions*. RHO-SA-51, Rockwell Hanford Operations, Richland, Washington.

Appendix A

Laboratory Techniques

Appendix A

Laboratory Techniques

The total organic carbon (TOC) is reported in the laboratory reports. All laboratory reports with units of measure are used. Laboratory measurements are covered from 1977 to the present, as shown in Appendix B.

Factors for converting laboratory measurements to Percent TOC are presented in Table A.1.

Table A.1. Conversion Factors for Laboratory Data

Reported Lab Units of TOC	Conversion Factor	Comments
gm/gm	100	
gm/L	100/1000/D	D=density; default = 1.3
moles/L	12.01*100/1000/1.3	
moles/L	12.01*100/1000/D	
ugm/gm	100/1,000,000	

Where no density was reported with the measured TOC value, a density of 1.3 was assigned as a default value.

Laboratory Measurements Techniques

Two techniques were used to determine TOC, combustion and chemical oxidation.

In combustion, samples are burned in an oxygen atmosphere to convert the organic forms of carbon to CO_2. The combustion temperature is selected (app 1100^0 C) to oxidize the organic carbon components. The combustion products are swept through a barium chomate catalyst and scrubbed to insure complete oxidation of the carbon to CO_2. Noncarbon combustion products such as CO_2 and NO_x are removed from the gas stream by a series of chemical scrubbers. The CO_2 released is quantified in a CO_2 calorimetry cell and the amount of TOC is calculated. Inorganic carbon is first

removed from the sample before analysis by adding acid to convert the inorganic carbon to gaseous CO_2. In the combustion samples, for solids, samples are diluted with water 1 part sample to make up 5 parts sample volume.

In chemical oxidation, the samples are oxidized with potassium persulfate or potassium permaganate to evolve CO_2 in the presence of ultraviolet light.

Samples may have been contaminated with NPH (normal pariffin hydrocarbon) during the core sampling procedure; therefore, some samples record higher than actual TOC measurements.

TRAC Computer Code Inventory Evaluation

The TRAC inventory dataset used was provided by WHC and is the dataset representing the inventories of waste for January 1990. The TOC calculations provided in this report match to the values of the TRAC/TOC calculations reported in Crippen (1991).

Details of Organic Carbon Constituents listed in the 1990 TRAC database are presented in Table A.2.

Table A.2. TRAC Label Description

TRAC Label	Formula Name		
C2H3O3	Hydroxyacetate	HOCH,COO-	[anion]
C6H5O7	Citrate	$-OOCCH_2C(OH)(COO-)CH_2COO-$	[anion]
EDTA	Ethylenediamine N,N,N',N'tetraacetate		
HEDTA	N-(2-hydroxyethyl)-ethylene diamine N,N',N'-triacetate		
C2O4	Oxalate	-OOCCOO-	[anion]

The following conversion factors are used to change moles to grams of carbon employing the formula weights for each of the six species, as shown in Table A.3.

For each SST, the moles for each of the organic components are given in the TRAC database.

Table A.3. Conversion Factors for TRAC Organics

Moles of Organic Species	Conversion Factor
Hydroxyacetate	2*12 = 24
Citrate	6*12 = 72
Oxylate	2*12 = 24
EDTA	10*12 = 120
HEDTA	10*12 = 120
$Fe(CN)_6$	6*12 = 72

Example Conversion:

Formula weight of carbon is 12.

Moles Citrate ($C_6H_5O_7$) * 72 = grams of carbon in citrate.

There are six carbons in each molecule of citrate. There are 6 X 12, or 72 grams of carbon, in each citrate mole. The conversion factor for citrate is 72.

Total Mass:

The moles of each constituent are multiplied by the formula weight of each constituent and summed to provide the total mass for each of the tanks for the solids and the liquids. The following species were used in the summation:

Ag, Al, Ba, Bi, CO_3, Ca, Cd, Ce, CL, Cr, F, Fe, Hg, K, La, Mn, NO_2, NO_3, Na, Ni, OH, PO_4, Pb, SeO_4, SiO3, Sn, SO_4, Sr, WO_4, ZrO.

Conversion of TOC Data from Wet-to-Dry Basis

Table A.4 provides the wet-to-dry basis correction factor, $C_{W/D}$, as described in Section 4.6.

Table A.4. $C_{W/D}$ = TOC Correction Factor Wet-to-Dry Basis

Tank	Correction Factor, Wet-to-Dry Basis
101A	1.67
102A	2.15
103A	2.53
104A	2.5
105A	2.5
106A	2.5
101AX	1.67
102AX	1.93
103AX	1.68
104AX	2.5
101B	2.5
102B	2.42
103B	2.5
104B	2.29
105B	1.74
106B	2.52
107B	2.52
108B	2.5
109B	2.5
110B	2.51
111B	2.51
112B	2.75
201B	2.59

Table A.4. (contd)

Tank	Correction Factor, Wet-to-Dry Basis
202B	2.5
203B	2.55
204B	2.55
101BX	2.56
102BX	2.5
103BX	2.66
104BX	2.57
105BX	2.68
106BX	3.71
107BX	2.51
108BX	2.5
109BX	2.5
110BX	2.46
111BX	2.04
112BX	2.52
101BY	1.84
102BY	1.67
103BY	1.67
104BY	1.72
105BY	1.72
106BY	1.75
107BY	1.8
108BY	2.15
109BY	1.78
110BY	1.82
111BY	1.69

Table A.4. (contd)

Tank	Correction Factor, Wet-to-Dry Basis
112BY	1.68
101C	2.5
102C	2.5
103C	7.86
104C	2.5
105C	2.5
106C	2.91
107C	2.5
108C	2.5
109C	2.66
110C	2.5
111C	2.5
112C	2.5
201C	2.5
202C	2.5
203C	2.5
204C	2.5
101S	2.13
102S	1.67
103S	1.82
104S	2.51
105S	1.67
106S	1.7
107S	2.32
108S	1.67
109S	1.68

Table A.4. (contd)

Tank	Correction Factor, Wet-to-Dry Basis
110S	1.88
111S	1.84
112S	1.67
101SX	1.82
102SX	1.8
103SX	1.77
104SX	1.8
105SX	1.73
106SX	1.9
107SX	2.5
108SX	2.5
109SX	2.5
110SX	2.5
111SX	2.5
112SX	2.5
113SX	2.5
114SX	2.5
115SX	2.5
101T	2.53
102T	4.21
103T	2.94
104T	2.52
105T	2.5
106T	2.76
107T	2.63
108T	2.5

Table A.4. (contd)

Tank	Correction Factor, Wet-to-Dry Basis
109T	2.5
110T	2.52
111T	2.51
112T	2.79
201T	2.59
202T	2.5
203T	2.5
204T	2.5
101TX	2.59
102TX	1.67
103TX	2.5
104TX	1.69
105TX	1.67
106TX	1.67
107TX	1.71
108TX	1.67
109TX	1.67
110TX	1.67
111TX	1.67
112TX	1.67
113TX	1.67
114TX	1.67
115TX	1.67
116TX	1.67
117TX	1.67
118TX	1.67

Table A.4. (contd)

Tank	Correction Factor, Wet-to-Dry Basis
101TY	2.5
102TY	1.67
103TY	2.5
104TY	2.67
105TY	2.5
106TY	2.5
101U	2.84
102U	1.82
103U	1.76
104U	2.5
105U	1.88
106U	1.86
107U	1.83
108U	1.8
109U	1.8
110U	2.5
111U	1.71
112U	2.72
201U	3.13
202U	3.13
203U	3.75
204U	3.75

Appendix B

Laboratory Data

Appendix B,Laboratory Measurements

Tank Farm	Number	SORWT Group	Sample ID	Sample Type	Reference Date	% T.O.C	Reference	Analyte	Value	Units	SORWT GROUP #
A	101	DSSF-NCPLX	RAT-A101-3	Filtrate	10/22/80	1.32	I.L. 65453-80-336 Rockwell Int.	TOC	19.1	gm/l	9
A	101	DSSF-NCPLX	RAT-A101-4B	Filtrate	11/10/80	0.51	I.L. 65453-80-337 Rockwell Int.	TOC	7.51	gm/l	9
A	101	DSSF-NCPLX	RAT-A101-5B	Filtrate	11/11/80	0.69	I.L. 65453-80-337 Rockwell Int.	TOC	9.94	gm/l	9
A	101	DSSF-NCPLX	RAT-A101-7B	Filtrate	11/02/79	1.45	I.L. 65124-79-005 Rockwell Int.	TOC	20	gm/l	9
A	101	DSSF-NCPLX	4493	Sludge	09/22/80	0.76	I.L. 65453-80-267 Rockwell Int.	TOC	11.025	gm/l	9
A	101	DSSF-NCPLX	RAT-A101-4A	Slurry	11/10/80	0.58	I.L. 65453-80-337 Rockwell Int.	TOC	9.51	gm/l	9
A	101	DSSF-NCPLX	RAT-A101-5A	Slurry	11/11/80	0.84	I.L. 65453-80-337 Rockwell Int.	TOC	15.61	gm/l	9
A	101	DSSF-NCPLX	7879	Slurry	10/10/83	6.20	I.L. 65453-80-003 Rockwell Int.	TOC	7.02	moles/l	9
A	101	DSSF-NCPLX	7898	Slurry	10/11/83	7.16	I.L. 65453-84-003 Rockwell Int.	TOC	9.78	moles/l	9
A	101	DSSF-NCPLX	4218	Supernate	09/22/80	1.21	I.L. 65453-80-267 Rockwell Int.	TOC	16.24	gm/l	9
A	101	DSSF-NCPLX	4378	Supernate	09/22/80	0.89	I.L. 65453-80-267 Rockwell Int.	TOC	10.14	gm/l	9
A	101	DSSF-NCPLX	RAT-A101-1	Supernate	10/13/80	0.82	I.L. 65453-80-302 Rockwell Int.	TOC	10.71	gm/l	9
A	101	DSSF-NCPLX	RAT-A101-2	Supernate	10/13/80	0.90	I.L. 65453-80-302 Rockwell Int.	TOC	11.52	gm/l	9
A	101	DSSF-NCPLX	T-2691	Supernate	08/22/80	2.74	I.L. 65453-80-241 Rockwell Int.	TOC	35.16	gm/l	9
A	101	DSSF-NCPLX	T-2692	Supernate	08/22/80	3.36	I.L. 65453-80-241 Rockwell Int.	TOC	43.79	gm/l	9
A	101	DSSF-NCPLX	7879	Supernate	10/10/83	0.40	I.L. 65453-84-003 Rockwell Int.	TOC	5.23	moles/l	9
A	101	DSSF-NCPLX	7898	Supernate	10/11/83	0.84	I.L. 65453-84-003 Rockwell Int.	TOC	11	moles/l	9
A	102	DSSF-NCPLX	RAT-A102-1	Filtrate	12/23/80	0.12	I.L. 65453-80-395 Rockwell Int.	TOC	1.79	gm/l	9
A	102	DSSF-NCPLX	91DX00XX	Liquor	03/06/86	0.53	SD-RE-TI-201 Rev. 0	TOC	8.06	gm/l	9
A	102	DSSF-NCPLX	92DX00XX	Liquor	03/08/86	0.51	SD-RE-TI-201 Rev. 0	TOC	7.68	gm/l	9
A	102	DSSF-NCPLX	91XC00XX	Sludge/Composite	03/06/86	0.72	SD-RE-TI-201 Rev. 0	TOC	7200	ugm/gm	9
A	102	DSSF-NCPLX	92XC00XX	Sludge/Composite	03/08/86	0.79	SD-RE-TI-201 Rev. 0	TOC	7940	ugm/gm	9
A	102	DSSF-NCPLX	R-4656	Supernate	03/14/89	0.96	I.M. 12712-PCL89-112 Rev. 1 WHC	TOC	12.5	gm/l	9
A	102	DSSF-NCPLX	RAT-A102-3	Supernate	10/23/79	0.21	I.L. 65124-79-170 Rockwell Int.	TOC	2.44	gm/l	9
A	102	DSSF-NCPLX	RAT-A102-4	Supernate	03/14/79	0.35	I.L. 60120-79-044 Rockwell Int.	TOC	4.5	gm/l	9
A	102	DSSF-NCPLX	T-1243	Supernate	07/17/80	0.00	I.L. 65453-80-200 Rockwell Int.	TOC	0	gm/l	9
A	102	DSSF-NCPLX	T-1244	Supernate	07/17/80	0.35	I.L. 65453-80-200 Rockwell Int.	TOC	4.06	gm/l	9
A	102	DSSF-NCPLX	T-1245	Supernate	07/17/80	0.29	I.L. 65453-80-200 Rockwell Int.	TOC	3.38	gm/l	9
A	102	DSSF-NCPLX	T-2404	Supernate	08/04/80	0.49	I.L. 65453-80-213 Rockwell Int.	TOC	5.82	gm/l	9
A	102	DSSF-NCPLX	T-2405	Supernate	08/04/80	0.53	I.L. 65453-80-213 Rockwell Int.	TOC	6.34	gm/l	9
A	102	DSSF-NCPLX	T-6176	Supernate	12/08/79	0.40	I.L. from Manger, Services	TOC	4.88	gm/l	9
A	103	DSSF-NCPLX	B1XD00XX	Liquor	03/26/86	0.57	SD-RE-TI-198 Rev. 0	TOC	8.36	gm/l	9
A	103	DSSF-NCPLX	B2XD00XX	Liquor	04/03/86	0.56	SD-RE-TI-198 Rev. 0	TOC	8.26	gm/l	9
A	103	DSSF-NCPLX	B1XC00XX	Sludge/Composite	03/26/86	0.80	SD-RE-TI-198 Rev. 0	TOC	8040	ugm/gm	9
A	103	DSSF-NCPLX	B2XC00XX	Sludge/Composite	04/03/86	0.77	SD-RE-TI-198 Rev. 0	TOC	7730	ugm/gm	9
A	103	DSSF-NCPLX	RAT-A103-5	Supernate	10/02/80	0.35	I.L. 65453-80-287 Rockwell Int.	TOC	4.95	gm/l	9
A	103	DSSF-NCPLX	RAT-A103-6	Supernate	09/22/80	1.00	I.L. 65453-80-266 Rockwell Int.	TOC	14.4	gm/l	9
A	103	DSSF-NCPLX	RAT-A103-7	Supernate	08/02/79	1.10	I.L. 65120-79-123 Rockwell Int.	TOC	15.4	gm/l	9
A	103	DSSF-NCPLX	T-8951	Supernate	03/19/80	0.64	I.L. Manger, Services Rockwell Int.	TOC	7.92	gm/l	9
A	106	UNGROUPED	A1XD00XX	Liquor	03/11/86	0.42	SD-RE-TI-200 Rev.0	TOC	5.64	gm/l	30
A	106	UNGROUPED	A2XD00XX	Liquor	03/13/86	0.01	SD-RE-TI-200 Rev.0	TOC	0.13	gm/l	30
A	106	UNGROUPED	Riser 17	Solid	01/05/88	0.62		TOC	0.62	wt.%	30
A	106	UNGROUPED	Riser 20	Solid	01/05/88	0.72		TOC	0.72	wt.%	30
A	106	UNGROUPED	A1XC00XX	Sludge/Composite	03/11/86	0.62	SD-RE-TI-200 Rev.0	TOC	6230	ugm/gm	30
A	106	UNGROUPED	A2XC00XX	Sludge/Composite	03/13/86	0.72	SD-RE-TI-200 Rev.0	TOC	7150	ugm/gm	30
AX	101	DSSF	5169	Supernate	10/07/80	0.53	I.L. 65453-80-293 Rockwell Int.	TOC	7.46	gm/l	9
AX	101	DSSF-NCPLX	RAT-AX101-2	Supernate	11/11/80	1.10	I.L. 65453-80-331 Rockwell Int.	TOC	15	gm/l	9
AX	101	DSSF-NCPLX	RAT-AX101-3	Supernate	11/11/80	1.08	I.L. 65453-80-331 Rockwell Int.	TOC	15	gm/l	9
AX	101	DSSF-NCPLX	T-3102	Supernate	08/19/80	0.90	I.L. 65453-80-233 Rockwell Int.	TOC	13	gm/l	9

Note: All Laboratory Measurements in Appendix B are wet or "as-is" values.

Appendix B,Laboratory Measurements

Tank Farm	Number	SORWT Group	Sample ID	Sample Type	Reference Date	% T.O.C	Reference	Analyte	Value	Units	SORWT GROUP #
AX	101	DSSF-NCPLX	T-3103	Supernate	08/19/80	0.75	I.L. 65453-80-233 Rockwell Int.	TOC	11.4	gm/l	9
AX	102	CCPLX DSSF	7701	Liquor	02/22/80	0.91	I.L. 65453-80-093 Rockwell Int.	TOC	9.75	gm/l	28
AX	102	CCPLX DSSF	RAT-AX102-1	Liquor	01/23/80	1.45	I.L. 651240-80-064 Rockwell Int.	TOC	16.1	gm/l	28
AX	102	CCPLX DSSF	RAT-AX102-3	Supernate	11/14/88	2.83	I.M. 12712-PCL88-018 WHC	TOC	36.8	gm/l	28
AX	103	CCPLX DSSF	S-1423	Liquor	08/06/79	0.85	I.L. 65120-73-124 Rockwell Int.	TOC	12.3	gm/l	28
AX	103	CCPLX DSSF	4516	Liquid	09/24/80	2.80	I.L. 65453-80-277 Rockwell Int.	TOC	2.80	wt.%	28
AX	103	CCPLX DSSF	S-1439	Liquor	08/06/79	1.04	I.L. 65120-79-124 Rockwell Int.	TOC	15	gm/l	28
AX	103	CCPLX DSSF	7595	Supernate	03/14/79	0.33	I.L. 60120-79-044 Rockwell Int.	TOC	4.3	gm/l	28
B	110	2C 5-6		Solid	01/31/90	0.04	Core Report, TE Jones, Battelle	TOC	0.04	wt.%	15
B	202	224	2509	Sludge	12/04/78	0.01	60120-78-131 Rockwell 12/4/78	TOC	0.108	gm/l	5
B	204	224	1974	Sludge	12/04/78	0.10	60120-78-131 Rockwell 12/4/78	TOC	0.096	moles/l	5
BX	104	TBP CW	71XD00XX	Liquor	02/14/86	0.47	SD-RE-TI-206 Rev.0 1/21/81	TOC	6.18	gm/l	4
BX	104	TBP CW	72XD00XX	Liquor	02/26/86	0.46	SD-RE-TI-206 Rev.0 1/21/81	TOC	5.62	gm/l	4
BX	104	TBP CW	71XC00XX	Sludge/Composite	02/14/86	0.18	SD-RE-TI-206 Rev.0 1/21/81	TOC	1780	ugm/gm	4
BX	104	TBP CW	72XC00XX	Sludge/Composite	02/26/86	0.27	SD-RE-TI-206 Rev.0 1/21/81	TOC	2710	ugm/gm	4
BX	104	TBP CW	RAT-BX104-1	Solid/Liquid	04/27/90	0.44	I.M. 82316-90-032 WHC	TOC	5.7	gm/l	4
BX	104	TBP CW	T-1785	Supernate	08/14/80	0.78	65453-80-225 Rockwell 8/14/80	TOC	8.18	gm/l	4
BX	105	TBP CW	81XD00XX	Liquor	03/03/86	0.71	SE-RE-TI-202 Rev. 0	TOC	9.12	gm/l	4
BX	105	TBP CW	82XD00XX	Liquor	03/04/86	0.76	SE-RE-TI-202 Rev. 0	TOC	9.75	gm/l	4
BX	105	TBP CW	82XC00XX	Sludge	03/04/86	0.18	WHC-SD-TI-565 Rev 1	TOC	1800	ug/g	4
BX	105	TBP CW	81XC00XX	Sludge/Composite	03/03/86	0.38	SE-RE-TI-202 Rev. 0	TOC	3760	ugm/gm	4
BX	105	TBP CW	82XC00XX	Sludge/Composite	03/04/86	0.18	SE-RE-TI-202 Rev. 0	TOC	1800	ugm/gm	4
BX	106	TBP CW	R-6037	Supernate	03/16/90	0.33	D.S.I. from RL Weiss 3/16/90 WHC	TOC	4.4	gm/l	4
BX	107	1C TBP	RAT-BX107-2	Sludge	09/18/80	0.07	65453-80-265 Rockwell 9/18/80	TOC	0.00073	gm/gm	11
BX	107	1C TBP	R-6038	Supernate	03/16/90	0.22	D.S.I. from RL Weiss 3/16/90 WHC	TOC	2.7	gm/l	11
BX	109	TBP CW	R-6039	Supernate	03/16/90	0.22	D.S.I. from RL Weiss 3/16/90 WHC	TOC	3	gm/l	4
BX	110	EB ITS	RAT-BX110-1	Sludge	09/18/80	0.08	65453-80-265 Rockwell 9/18/80	TOC	0.00077	gm/gm	3
BX	110	EB ITS	1010-C	Sludge	02/14/79	0.07	60120-79-024 Rockwell 2/14/79	TOC	0.07	wt.%	3
BX	110	EB ITS	R-6040	Supernate	03/16/90	0.41	D.S.I. from RL Weiss 3/16/90 WHC	TOC	5.6	gm/l	3
BX	111	EB ITS	R-6041	Supernate	03/16/90	0.40	D.S.I. from RL Weiss 3/16/90 WHC	TOC	5.7	gm/l	24
BX	112	1C EB	RAT-BX112-1	Sludge	06/11/79	1.02	65120-79-112 Rockwell 8/15/79	TOC	0.01015	gm/gm	12
BX	112	1C EB	R-6042	Supernate	03/16/90	0.31	D.S.I. from RL WEiss 3/16/90 WHC	TOC	3.73	gm/l	12
BY	102	TBP IT	R-8081	Supernate	06/03/91	0.15	I.M. 28110-PCL91-048 WHC	TOC	2.2	gm/l	21
BY	102	TBP IT	R-8091	Supernate	06/03/91	0.14	I.M. 28110-PCL91-048 WHC	TOC	2	gm/l	21
BY	103	TBP F 1C	R-8088	Supernate	06/03/91	0.19	I.M. 28110-PCL91-048 WHC	TOC	2.73	gm/l	3
BY	104	TBP F EB	R-1773	Crust	11/12/92	0.91	WHC-SD-WM-TI-540 10/12/92	TOC	9100	ugm/gm	3
BY	104	TBP F EB	R-1775	Crust	11/12/92	1.10	WHC-SD-WM-TI-540 10/12/92	TOC	11000	ugm/gm	3
BY	105	TBP F EB	R-8082	Supernate	06/03/91	0.22	I.M. 28110-PCL91-048 WHC	TOC	3.06	gm/l	3
BY	105	TBP F EB	R-8092	Supernate	06/03/91	0.20	I.M. 28110-PCL91-048 WHC	TOC	2.79	gm/l	3
BY	106	TBP F EB	R-8083	Supernate	06/03/91	0.22	I.M. 28110-PCL91-048 WHC	TOC	3.28	gm/l	3
BY	106	TBP F EB	R-8093	Supernate	06/03/91	0.21	I.M. 28110-PCL91-048 WHC	TOC	3.04	gm/l	3
BY	107	TBP F EB	S-1450	Liquid	07/16/79	0.31	I.L. 65120-79-104_J	TOC	4	gm/l	3
BY	109	TBP-ITS		Liquid	01/01/91	0.37	28110-PCL91-048	TOC	0.37	wt.%	21
BY	109	TBP-ITS	R-8084	Supernate	06/03/91	0.32	I.M. 28110-PCL91-048 WHC	TOC	4.1	gm/l	21
BY	109	TBP-ITS	R-8094	Supernate	06/03/91	0.34	I.M. 28110-PCL91-048 WHC	TOC	4.77	gm/l	21
C	102	UNGROUPED	R-8089	Supernate	06/03/91	0.28	I.M. 28110-PCL91-048 WHC	TOC	3.2	gm/l	30
C	103	SRS-PSS	F1XD00XX	Liquor	05/07/86	0.66	SD-RE-TI-203 Rev.0	TOC	7.37	gm/l	23
C	103	SRS-PSS	F2XD00XX	Liquor	05/14/86	0.69	SD-RE-TI-203 Rev.0	TOC	7.5	gm/l	23
C	103	SRS-PSS	F1XC00XX	Sludge/Composite	05/07/86	0.39	SD-RE-TI-203 Rev.0	TOC	3900	ugm/gm	23

Note: All Laboratory Measurements in Appendix B are wet or "as-is" values.

Appendix B,Laboratory Measurements

Tank Farm	Number	SORWT Group	Sample ID	Sample Type	Reference Date	% T.O.C	Reference	Analyte	Value	Units	SORWT GROUP #
C	103	SRS-PSS	F2XCOOXX	Sludge/Composite	05/14/86	0.26	SD-RE-TI-203 Rev.0	TOC	2630	ugm/gm	23
C	103	SRS-PSS	riser 2	Liquid	05/19/87	0.57	WHC 13311C-88-049	TOC	0.57	wt.%	23
C	103	SRS-PSS	riser 2	Liquid	05/19/87	0.57	WHC 13311C-88-049	TOC	0.57	wt.%	23
C	103	SRS-PSS	riser 8	Liquid	05/19/87	0.55	WHC 13311C-88-049	TOC	0.55	wt.%	23
C	103	SRS-PSS	R-8108	Supernate	06/03/91	0.70	I.M. 28110-PCL91-048 WHC	TOC	7.46	gm/l	23
C	103	SRS-PSS	R-8109	Supernate	06/03/91	0.70	I.M. 28110-PCL91-048 WHC	TOC	7.44	gm/l	23
C	104	UNGROUPED	D1XDOOXX	Liquor	04/15/86	0.87	SD-RE-TI-199 Rev.0 1/21/88	TOC	10.3	gm/l	30
C	104	UNGROUPED	D1XCOOXX	Sludge/Composite	04/15/86	0.44	SD-RE-TI-199 Rev.0 1/21/88	TOC	4410	ugm/gm	30
C	105	UNGROUPED	C1XDOOXX	Liquor	04/11/86	0.23	SD-RE-TI-204 Rev.0 1/8/88	TOC	2.87	gm/l	30
C	105	UNGROUPED	C1XCOOXX	Sludge/Composite	04/11/86	0.10	SD-RE-TI-204 Rev.0 1/8/88	TOC	999	ugm/gm	30
C	106	SRS-PSS		Solid	05/08/87	0.08	WHC 13311C-88-049	TOC	0.08	wt.%	23
C	106	SRS-PSS	G1XCOOXX	Sludge/Composite	05/19/86	0.46	SD-RE-TI-205 Rev.0 1/8/88	TOC	4620	ugm/gm	23
C	106	SRS-PSS		Liquid	09/18/80	0.19	IL 65453-80-265 Rockwell	TOC	0.19	wt.%	23
C	107	UNGROUPED	R-8046	Supernate	06/03/91	0.09	I.M. 28110-PCL91-048	TOC	1.03	gm/l	30
C	110	1C,TBP	R-8087	Supernate	06/03/91	0.05	I.M. 28110-PCL91-048	TOC	0.632	gm/l	11
C	112	TBP-F 1C	core 34	Solid	04/01/93	0.58	WHC EP 0640	TOC	0.58	wt.%	8
C	112	TBP-F 1C	core 35	Solid	04/01/93	0.29	WHC EP 0640	TOC	0.29	wt.%	8
C	112	TBP-F 1C	core 36	Solid	04/01/93	0.87	WHC EP 0640	TOC	0.87	wt.%	8
C	201	HS	T-3421	Sludge	12/04/78	0.21	60120-78-132 12/4/78 JE Horton	TOC	0.2	moles/l	13
S	102	R EB		liquid	01/01/80	2.42	Schutz, 1980	TOC	2.63	moles/l	1
S	102	R EB	RAT-S102-3	Supernate	01/31/79	0.84	65120-79-062 Rockwell 4/5/79	TOC	10.6	gm/l	1
S	104	R	Composite	Sludge	04/13/90	0.23	WHC-SD-WM-TI-565	TOC	2280	ug/g	6
S	107	R EB	3148	Supernate	09/07/78	0.98	60120-78-091 Rockwell 9/7/78	TOC	11.8	gm/l	1
S	107	R EB	4251	Supernate	10/16/78	0.26	60120-78-106 Rockwell 10/16/78	TOC	4	gm/l	1
S	107	R EB	RAT-S107-1	Supernate	04/27/90	0.3	I.M. 82316-90-032	TOC	4	gm/l	1
S	107	R EB	RAT-S107-2	Supernate	09/22/80	0.63	65453-80-270 Rockwell 9/22/80	TOC	9	gm/l	1
S	107	R EB	RAT-S107-3	Supernate	09/22/80	0.75	65453-80-270 Rockwell 9/22/80	TOC	8.28	gm/l	1
S	109	R EB		Supernant				TOC	0.198	wt.%	1
S	109	R EB		salt cake	01/01/80	0.05	Schutz, 1980	TOC	0.051	moles/l	1
S	110	R EB		liquid	01/01/80	1.25	RHO-SA-51	TOC	1.25	wt.%	1
S	111	R EB	1001-C	Solids	08/25/78	0.10	I.L. 60120-78-087 Rockwell 8/25/75	TOC	1.29	gm/l	1
S	111	R EB	1003/1004-C	Solids	08/25/78	0.89	I.L. 60120-78-087 Rockwell 8/25/75	TOC	1.38	moles/l	1
S	111	R EB	1009-C	Solids	08/25/78	2.34	I.L. 60120-78-087 Rockwell 8/25/75	TOC	2.8	moles/l	1
S	111	R EB	1009-C	Supernate	08/25/78	0.42	I.L. 60120-78-087 Rockwell 8/25/75	TOC	6.2	gm/l	1
S	111	R EB	RAT-S111-1	Supernate	04/27/90	0.28	I.M. 82316-90-032 WHC 4/27/90	TOC	4.2	gm/l	1
S	111	R EB	RAT-S111-3	Supernate	08/25/78	0.40	I.L. 60120-78-087 Rockwell 8/25/75	TOC	6	gm/l	1
SX	101	R EB	E-00162	Supernate	02/07/79	0.24	I.L. 60120-79-016 Rockwell 2/7/79	TOC	3.12	gm/l	1
SX	101	R EB	R-4884	Supernate	04/26/89	0.03	I.M. 12712-PCL90-043 WHC 2/22/90	TOC	0.32	gm/l	1
SX	101	R EB	RAT-SX101-1	Supernate	10/29/80	0.38	I.L. 65453-80-316 Rockwell 10/29/80	TOC	0.326	moles/l	1
SX	101	R EB	RAT-SX101-2	Supernate	10/29/80	0.57	I.L. 65453-80-316 Rockwell 10/29/80	TOC	0.484	moles/l	1
SX	102	R EB		salt cake	01/01/80	0.20	Schultz, 1980	TOC	0.21	moles/l	1
SX	102	R EB	T-2959	Supernate/Solids	09/03/80	0.82	I.L. 65453-80-250 Rockwell 9/3/80	TOC	12.7	gm/l	1
SX	103	R EB		salt cake	01/01/80	0.20	Schultz, 1980	TOC	0.21	moles/l	1
SX	103	R EB	1104	Solids	10/10/77	4.60	I.L. from JL Starr Rockwell 12/16/7	TOC	92	gm/l	1
SX	104	R EB	RAT-SX104-3	Supernate	05/14/88	0.33	I.M. 12221-PCL88-147 WHC 8/15/88	TOC	5	gm/l	1
SX	104	R EB		Liquid	08/15/88	0.25	WHC IL. 12221-PCL88-147	TOC	0.25	wt.%	1
SX	104	R EB		Liquid	08/15/88	0.11	WHC IL. 12221-PCL88-147	TOC	0.11	wt.%	1
SX	106	R EB	5268	Supernate	11/13/78	0.09	60120-78-149 Rockwell 12/22/78	TOC	1.2	gm/l	1
SX	106	R EB	8301	Supernate	04/18/78	5.96	60120-78-055 Rockwell 6/29/78	TOC	6.8	moles/l	1

Note: All Laboratory Measurements in Appendix B are wet or "as-is" values.

Appendix B,Laboratory Measurements

Tank Farm	Number	SORWT Group	Sample ID	Sample Type	Reference Date	% T.O.C	Reference	Analyte	Value	Units	SORWT GROUP #
SX	106	R EB	RAT-SX106-2	Supernate	02/28/77	5.03	I.L. from JE Horton 3/31/77 ARHC	TOC	6.07	moles/l	1
SX	106	R EB	RAT-SX106-2	Supernate/Solids	02/28/77	5.63	I.L. from JE Horton 3/31/77 ARHC	TOC	7.5	moles/l	1
SX	107	R	RAT-SX107-1	Supernate	09/05/79	0.39	65120-79-134 Rockwell 9/5/79	TOC	4.8	gm/l	6
T	101	CW MIX	RAT-T101-2	Supernate	04/27/90	0.05	I.M. 82316-90-032 WHC 4/27/90	TOC	0.6	gm/l	19
T	104	UNGROUPED			09/01/92	0.01	WHC Internal Letter	TOC	0.01	wt.%	30
T	104	UNGROUPED	RAT-T104-1	Sludge	11/13/79	10.49	65124-79-017 Rockwell 11/13/79	TOC	0.1049	gm/gm	30
T	104	UNGROUPED	RAT-T104-2	Sludge	09/18/80	10.23	65453-80-265 Rockwell 9/18/80	TOC	0.10229	gm/gm	30
T	107	TBP-F,1C	R-3872	Supernate	03/05/85	0.07	65453-85-043 Rockwell 3/5/85	TOC	0.924	gm/l	8
T	107	TBP-F,1C	RAT-T107-1	Supernate	08/01/89	0.07	I.M. 12712-OCL89-144 WHC 8/1/89	TOC	0.864	gm/l	8
* T	111 *	There has been recent data on tank T 111, but was not available during report preparation									
T	112	2C,224	RAT-T112-1	Supernate	10/27/87	0.19	12221-PCL-016 WHC 10/27/87	TOC	2.52	gm/l	14
T	204	224	1914	Sludge	12/04/78	0.67	60120-78-132 Rockwell 12/4/78	TOC	0.6	moles/l	5
TX	102	R-EB	RAT-TX102-1A	Filtrate	02/03/81	0.38	65453-81-029 Rockwell 2/3/81	TOC	5.64	gm/l	1
TX	102	R-EB	RAT-TX102-2	Supernate	02/03/81	0.16	65453-81-029 Rockwell 2/3/81	TOC	2.36	gm/l	1
TX	102	R-EB	RAT-TX102-1	Supernate/Solids	02/03/81	0.19	65453-81-029 Rockwell 2/3/81	TOC	2.76	gm/l	1
TX	103	TBP,EB	T-1465	Liquor	09/21/79	0.27	65120-79-151 Rockwell 9/21/79	TOC	3.4	gm/l	26
TX	103	TBP,EB	T-1467	Liquor	09/21/79	0.27	65120-79-151 Rockwell 9/21/79	TOC	3.38	gm/l	26
TX	103	TBP,EB	T-1470	Liquor	09/21/79	0.28	65120-79-151 Rockwell 9/21/79	TOC	3.46	gm/l	26
TX	105	R EB	RAT-TX105-1	Supernate	02/03/81	0.87	65453-81-029 Rockwell 2/3/81	TOC	11.83	gm/l	1
TX	106	R EB	RAT-TX106-1	Supernate	02/03/81	0.43	65453-81-029 Rockwell 2/3/81	TOC	6.4	gm/l	1
TX	108	EB TBP	RAT-TX108-1	Supernate	02/05/81	0.59	65453-81-036 Rockwell 2/5/81	TOC	0.68	moles/l	22
TX	109	EB 1C	RAT-TX109-2	Supernate	02/03/81	0.67	65453-81-029 Rockwell 2/3/81	TOC	9.54	gm/l	26
TX	110	EB 1C	RAT-TX110-1	Supernate	08/04/79	0.61	I.L. from Special Analysis Rockwell	TOC	8.61	gm/l	2
TX	110	EB 1C	RAT-TX110-2	Supernate	02/10/81	0.30	65453-81-038 Rockwell 2/10/81	TOC	4.11	gm/l	2
TX	110	EB 1C	RAT-TX110-4	Supernate	02/03/81	0.30	65453-81-029 Rockwell 2/3/81	TOC	4.11	gm/l	2
TX	111	EB 1C	RAT-TX111-1	Supernate	02/03/81	0.46	65453-81-029 Rockwell 2/3/81	TOC	6.48	gm/l	2
TX	112	EB 1C	RAT-TX112-1	Supernate	02/03/81	0.27	65453-81-029 Rockwell 2/3/81	TOC	3.9	gm/l	2
TX	114	EB 1C	RAT-TX114-1	Supernate	02/03/81	0.20	65453-81-029 Rockwell 2/3/81	TOC	2.84	gm/l	2
TX	115	EB R	RAT-TX115-1	Supernate	02/03/81	0.03	65453-81-029 Rockwell 2/3/81	TOC	0.32	gm/l	7
TX	116	EB R	RAT-TX116-1	Supernate	02/03/81	0.07	65453-81-029 Rockwell 2/3/81	TOC	0.99	gm/l	7
TX	116	EB 1C		Liquid	02/03/81	0.08	I.L. 65453-81-029	TOC	0.08	wt.%	2
TX	118	EB TBP		liquid	01/01/80	3.22	RHO-SA-51	TOC	3.22	wt.%	22
TX	118	EB TBP	RAT-TX118-1	Liquor	01/28/80	0.16	65124-069-80 Rockwell 1/28/80	TOC	2.1	gm/l	22
TX	118	EB TBP	RAT-TX118-3	Liquor	01/28/80	0.14	65124-069-80 Rockwell 1/28/80	TOC	1.87	gm/l	22
TX	118	EB TBP	8385	Supernate	03/21/79	0.02	I.L. from Special Analysis ARHC	TOC	0.19	gm/l	22
TX	118	EB TBP	RAT-TX118-4	Supernate	10/16/81	0.10	65453-81-331 Rockwell 10/16/81	TOC	1.28	gm/l	22
TX	118	EB TBP	RAT-TX118-5	Supernate	10/16/81	0.11	65453-81-331 Rockwell 10/16/81	TOC	1.38	gm/l	22
TX	118	EB TBP	RAT-TX118-6	Supernate/Solids	10/16/81	1.06	65453-81-331 Rockwell 10/16/81	TOC	0.0106	gm/gm	22
TY	101	ungrouped	T-3533	Filtrate	12/06/82	0.02	65453-82-435 Rockwell 12/6/82	TOC	0.2	gm/l	30
TY	101	ungrouped	51XC0000	Sludge/Composite	09/11/85	0.07	SD-RE-TI-185 Rev.0 7/8/87	TOC	663	ugm/gm	30
TY	102	EB 1C	RAT-TY102-1	Salts	02/01/80	0.24	65124-80-077 Rockwell 2/1/80	TOC	0.00236	gm/gm	2
TY	102	EB 1C	41XC0000	Sludge/Composite	09/09/85	0.03	SD-RE-TI-183 Rev.0 7/30/87	TOC	327	ugm/gm	2
TY	103	TBP 1C,F	33XC000	Liquor	08/21/85	0.16	SD-RE-TI-184 Rev.0 7/30/87	TOC	1.94	gm/l	27
TY	103	TBP 1C,F	RAT-TY103-1	Sludge	09/18/80	0.11	65453-80-265 Rockwell 9/18/80	TOC	0.0011	gm/gm	27
TY	103	TBP 1C,F	RAT-TY103-2	Sludge	02/01/80	0.00	65124-80-077 Rockwell 2/1/80	TOC	0.004	wt.%	27
TY	103	TBP 1C,F	31XC0000	Sludge/Composite	08/21/85	0.07	SD-RE-TI-184 Rev.0 7/30/87	TOC	715	ugm/gm	27
TY	103	TBP 1C,F	32XC0000	Sludge/Composite	08/21/85	0.15	SD-RE-TI-184 Rev.0 7/30/87	TOC	1490	ugm/gm	27
TY	104	TBP 1C,F	211D0000	Liquor	08/06/85	0.16	SD-RE-TI-182 Rev.0 6/30/87	TOC	1.86	gm/l	27
TY	104	TBP 1C,F	232D0000	Liquor	08/12/85	0.17	SD-RE-TI-182 Rev.0 6/30/87	TOC	2.05	gm/l	27

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Appendix B,Laboratory Measurements

Tank Farm	Number	SORWT Group	Sample ID	Sample Type	Reference Date	% T.O.C	Reference	Analyte	Value	Units	SORWT GROUP #
TY	104	TBP 1C,F	241D0000	Liquor	08/06/85	0.20	SD-RE-TI-182 Rev.0 6/30/87	TOC	2.41	gm/l	27
TY	104	TBP 1C,F	RAT-TY104-1	Sludge	12/20/79	0.40	65124-79-046 Rockwell 12/20/79	TOC	0.004	gm/gm	27
TY	104	TBP 1C,F	RAT-TY104-2	Sludge	09/18/80	2.80	65453-80-265 Rockwell 9/18/80	TOC	0.028	gm/gm	27
TY	104	TBP 1C,F	232S0000	Sludge/Composite	08/06/85	0.21	SD-RE-TI-182 Rev.0 6/30/87	TOC	2100	ugm/gm	27
TY	104	TBP 1C,F	241S0000	Sludge/Composite	08/06/85	0.28	SD-RE-TI-182 Rev.0 6/30/87	TOC	2780	ugm/gm	27
TY	104	TBP 1C,F	251S0000	Sludge/Composite	08/14/85	0.20	SD-RE-TI-182 Rev.0 6/30/87	TOC	1950	ugm/gm	27
TY	104	TBP 1C,F	261S0000	Sludge/Composite	08/16/85	0.09	SD-RE-TI-182 Rev.0 6/30/87	TOC	907	ugm/gm	27
TY	105	TBP	RAT-TY105-2	Sludge	09/18/80	1.00	65453-80-265 Rockwell 9/18/80	TOC	0.01	gm/gm	25
TY	105	TBP	61XC0000	Sludge/Composite	09/13/85	0.08	SD-RE-TI-186 Rev.0 7/8/87	TOC	805	ugm/gm	25
TY	106	TBP	RAT-TY106-2	Sludge	09/18/80	0.09	65453-80-265 Rockwell 9/18/80	TOC	0.00092	gm/gm	25
TY	106	TBP	111C0000	Sludge/Composite	07/31/85	0.25	SD-RE-TI-181 Rev.0 7/8/87	TOC	2480	ugm/gm	25
TY	106	TBP	161C0000	Sludge/Composite	09/26/85	0.21	SD-RE-TI-181 Rev.0 7/8/87	TOC	2090	ugm/gm	25
U	103	EB R	8793	Salts	08/15/77	3.38	I.L. from JL Starr 12/14/77 Rockwel	TOC	44	gm/l	7
U	103	EB R	3064	Solids	12/04/78	0.69	60120-78-130 Rockwell 12/4/78	TOC	0.8	moles/l	7
U	105	EB CW	RAT-U105-3	Salts	12/04/78	2.80	60120-78-125 Rockwell 12/4/78	TOC	2.8	wt.%	10
U	105	EB CW	968	Solids	10/06/77	3.38	I.L. from JL Starr 1/10/78 Rockwell	TOC	44	gm/l	10
U	106	EB R			01/01/80	9.96	RH_-SA-51	TOC	9.96	wt.%	7
U	110	ungrouped	segment 1	Solids	01/01/90	0.05	Outline for Tank Characterization Report SST U-110	TOC	0.05	wt.%	30
U	110	ungrouped	segment 1	Solids	01/01/90	0.04	Outline for Tank Characterization Report SST U-110	TOC	0.04	wt.%	30
U	110	ungrouped	segment 2	Solids	01/01/90	0.06	Outline for Tank Characterization Report SST U-110	TOC	0.06	wt.%	30
U	110	ungrouped	segment 2	Solids	01/01/90	0.07	Outline for Tank Characterization Report SST U-110	TOC	0.07	wt.%	30
U	110	ungrouped	segment 3	Solids	01/01/90	0.05	Outline for Tank Characterization Report SST U-110	TOC	0.05	wt.%	30
U	110	ungrouped	segment 3	Solids	01/01/90	0.04	Outline for Tank Characterization Report SST U-110	TOC	0.04	wt.%	30
U	110	ungrouped	segment 4	Solids	01/01/90	0.11	Outline for Tank Characterization Report SST U-110	TOC	0.11	wt.%	30
U	110	ungrouped	segment 4	Solids	01/01/90	0.11	Outline for Tank Characterization Report SST U-110	TOC	0.11	wt.%	30
U	111			liquid	01/01/80	3.65	RHO-SA-51	TOC	3.65	wt.%	7
U	111	EB R	RAT-U111-2	Slurry	09/23/80	0.52	65453-80-273 Rockwell 9/23/80	TOC	0.52	wt.%	7
U	111	EB R	RAT-U111-3	Slurry	09/23/80	0.54	65453-80-273 Rockwell 9/23/80	TOC	0.54	wt.%	7

Note: All Laboratory Measurements in Appendix B are wet or "as-is" values.

Appendix C

Description of Sort On Radioactive Waste Type Groups

Appendix C

Description of Sort On Radioactive Waste Type Groups

To further elaborate on the results of the Sort On Radioactive Waste Type (SORWT) model, brief descriptions of the most significant waste type groups predicted by the model have been included and are given below. Acronyms identifying the waste types are listed at the end of this appendix.

R, EB	(Group Number 1)
As previously mentioned, this waste type group is the most significant group predicted by SORWT in terms of number of tanks and total waste volume. The 21 tanks within this group contain 9,798,000 gallons of total waste--8,361,000 gallons of salt cake and 1,328,000 gallons of sludge. All 21 Group I tanks can be found in three different 200 West Area Tank Farms--S, SX, and TX Farms. These tanks typically received a large amount of high-level reduction oxidation (REDOX) waste (R) during the 1950s. This waste is most likely responsible for the sludge accumulation in these tanks. These tanks also received large amounts of evaporator bottoms (EB), usually from the 242-S Evaporator in the early 1970s. This super-saturated, high-nitrate waste cooled in the SSTs and formed an extremely hard salt cake. Although the processing history of these tanks between the addition of the R in the 1950s and the EB in the 1970s differs slightly, it is believed that these two waste types predominantly dictate the physical and chemical characteristics of the waste. Some of the tanks in this group have no reported sludge accumulation. This is probably because poor measurements were taken before salt cake formation. Once the salt cake crystallized in a tank, it became impossible to measure the volume of sludge. Because of the extreme hardness of the salt cake, there are technical obstacles that prevent core sampling any of these tanks at this time.	
EB, 1C	**(Group Number 2)**
This 9-tank group contains approximately 3,985,000 gallons of waste. The vast majority of this waste--3,945,000 gallons--is salt cake. All but two of these tanks are located in the TX Tank Farm. One tank is located in B Tank Farm. These tanks are characterized as having received large quantities of EB, mainly from the 242-T Evaporator. They also received modest quantities of 1C waste. Tank B-105 received 1C before the EB, which might explain the limited sludge accumulation in this tank not exhibited by the others. Once again, the hard salt cake formation raises significant technical issues that must be solved before sampling these tanks.	

TBP-F, EB-ITS	(Group Number 3)
This group contains 10 tanks and is the second most significant in terms of number of tanks and total waste volume. The tanks in this group hold 3,980,000 gallons of waste. The majority of this waste--3,344,000 gallons--is salt cake. These tanks also contain substantial amount of sludge. All 10 of these tanks can be found in the BY Farm located in the 200 East Area. These tanks originally held metal waste (MW) from the bismuth phosphate process but were completely sluiced out in the early 1950s. No significant amounts of MW remained in the tanks and it is not considered by the SORWT model. After sluicing, these tanks received tributyl phosphate (TBP) ferrocyanide-scavenged waste from U Plant. This scavenged waste is probably responsible for the sludge buildup in the tank. During the late 1960s and early 1970s, these tanks were connected to the In-Tank Solidification (ITS-2) loops. This process, by which one tank in the loop was used as an in-tank evaporator and the rest of the tanks as liquid holders, concentrated the waste and reduced the liquid volume. This resulted in salt cake formation. In light of the presence of high concentrations of ferrocyanide in these tanks and the hardness of the salt cake, there are significant safety and technical difficulties associated with sampling this waste type group.	
TBP, CW	**(Group Number 4)**
This 7-tank group, located almost entirely in BX Tank Farm, contains 489,000 gallons of waste. Nearly all of the contents of this group is sludge. Salt cake has only been observed in one tank (BX-105) and the 3,000 gallons of salt cake is due to a small transfer of EB into that particular tank. These tanks were originally filled with MW in the 1940s. In the early 1950s they were sluiced of their contents to provide room for TBP waste. Addition of this waste type began in the mid-1950s. The addition of cladding waste began in the mid-1960s. The various other transfers that occurred in these tanks should not affect the characteristic of the waste significantly, relative to the primary and secondary wastes. Tanks BX-105 and Tank BX-106 were core sampled previously and provide insight into the chemical composition of these tanks. Additional sampling of these tanks poses no technical or safety issues. Tank BX-104 is on the Push-Mode List and would be a good choice for sampling.	

224	(Group Number 5)

This 8-tank group represents 280,000 gallons of waste. The majority of the waste is sludge. No salt cake formation has been observed in these tanks. All 8 tanks are 55,000-gallons, 200 Series tanks located in B Tank Farm and T Tank Farm. These tanks received exclusively 224 waste. In light of the singularity of the waste type introduced into these tanks and the similarity of process history (i.e., the near absence of any inter-tank transfers), the composition of this group should be very uniform between tanks. There are no safety or technical issues prohibiting the sampling of these tanks. Tanks B-201 and B-202 have been selected in the Waste Characterization Plan, Rev. 2 (WHC), as the next single-shell tanks (SST) to be sampled. These sampling events should occur in the summer of 1991. The two sets of core sample analyses will aid in measuring the uniformity of the waste in this tank group.

R	(Group Number 6)

Group V is a 7-tank group exclusively containing high-level R. These tanks hold 892,000 gallons of waste. The majority of waste--888,000 gallons--is sludge. No salt cake formation has been observed in these tanks. It is of interest to note that R forms sludge without any further waste volume-reduction processes. Five of these tanks can be found in the SX Tank Farm and all are located in the 200 West Area. There are no safety or technical sampling issues associated with the majority of this group. The exception is Tank SX-109, which is on the Wyden Bill List as a gas-generating tank. Tank S-104 is on the Push-Mode List core sampling list. Sampling and analysis of S-104 would contribute greatly to the existing body of characterization knowledge. The analysis of this tank would not only significantly aid in characterizing this particular 7-tank group but would also help characterize several other groups containing large amounts of R-type waste.

EB, R	(Group Number 7)

Group VII consists of five 200 West Area tanks, mostly from U Farm. These tanks contain 2,037,000 gallons of waste. The vast majority of waste is salt cake. These tanks were filled with MW in the 1940s, but were completely sluiced out in the early 1950s. Large quantities of high-level R were introduced into these tanks and allowed to remain there for many years. In the early 1970s, large volumes of R supernate were transferred from the tank and replaced with EB from the 242-S Evaporator. This caused a salt cake to form over the majority of these tanks. The small amount of sludge that accumulated in these tanks is probably due to the R present before the EB. In light of the hardness of the salt cake, these tanks offer technical difficulties that must be solved before sampling. These tanks should be very similar to Group I tanks and differ from Group I mainly in the ratios of R to EB. These tanks might be so similar that they can be included with that group; however, these similarities can only be verified by core samples.

TBP-F, 1C	(Group Number 8)
This 5-tank group contains 478,000 gallons of waste and approximately 465,000 gallons is sludge. No salt cake has been observed in these tanks. The 4C farm tanks were used as the primary settling tanks during the In-Farm Scavenging campaign during the 1950s. These four tanks were originally filled with 1C waste in the 1940s. The supernate was transferred out of the tanks to make room for the TBP-scavenged waste that was allowed to settle. These two wastes formed the vast majority of the solids located in these two tanks. The other tank in this group (T-107) has a processing history similar to the rest of this group. The difference is it received its ferrocyanide scavenged TBP waste from the U Plant scavenged test. These two TBP-F wastes may be slightly different. All of these tanks are on the Wyden Bill List because of their ferrocyanide content. Although none of these tanks are on the Push-Mode List, recent surveillance photographs of C-112 indicate that the crust is relatively soft and should pose no technical difficulties in sampling. However, significant safety issues need to be resolved before a sampling event. Because C-112 was the most frequently used In-Farm Scavenging tank, it would be of immense interest to the safety program and provide valuable insight into the ferrocyanide safety issue.	
DSSF, NCPLX	**(Group Number 9)**
This 4-tank group contains a total of 2,113,000 gallons of waste. Salt cake comprises 1,717,000 gallons of this waste while 387,000 gallons are sludge. These tanks initially received either plutonium-uranium extraction (PUREX) high-activity, neutralized acid waste (P) or B Plant high-level waste (B). However, all of these tanks were sluiced of their contents in 1976. The waste types added to these tanks after sluicing were DSSF and Noncomplexed waste. These waste types generic terms describing the potential for further processing of the waste instead of the original source of waste. Because these generic terms are so general, little can be determined concerning the homogeneity of the waste in this group. In fact, one tank in this group contains only sludge while the rest contain mostly salt cake. Although the total volume of this group is highly significant, the uncertainty of the waste types in these tanks makes this group less important.	

EB, CW	(Group Number 10)
These four tanks (all in U Farm) contain 1,755,000 gallons of waste. Salt cake comprises 1,520,000 gallons of this waste while sludge comprises only 124,000 gallons. These tanks were filled with MW in the late 1940s or early 1950s. In the mid- to late 1950s, the MW was sluiced from the tank to provide room for CW. The supernatant portions of the CW were flushed out of the tanks in the early 1970s by various liquid transfers. In the mid- to late 1970s, large amounts of EB from the REDOX evaporator and the 242-S Evaporator were added to these tanks. (The EB are responsible for the salt cake formation.) All of the tanks are on the Wyden Bill List for either gas generation or acetate contents; therefore, there are safety and technical issues pertaining to sampling this tank.	
1C, TBP	**(Group Number 11)**
This 5-tank group contains 715,000 gallons of waste. The vast majority of waste is sludge. Even though this group transcends four different Tank Farms in both the 200 East Area and the 200 West Area, these tanks have very similar processing histories. They were filled with 1C waste in the 1940s. A portion of this volume was drained in the early 1950s and that tanks began receiving TBP waste. The solids volume that was measured at this time did not accumulate further during the rest of these tanks' histories. The additional transfers were mostly liquid in nature and had little effect on the sludge volume. No salt cake has been observed in these tanks, even though a small amount of EB was introduced into T-108 (apparently not enough to catalyze crystallization). Although none of these tanks are on the Push-Mode List, recent surveillance photographs from Tank BX-107 indicate that the crust is soft and should not pose any problems for sampling.	
1C, EB	**(Group Number 12)**
This 4-tank group of B and BX Farm tanks contains 553,000 gallons of waste. Nearly all of the waste is sludge. These tanks all received 1C waste in the late 1940s and early 1950s. In the mid-1950s the supernatant portion of the 1C waste was transferred from the tanks and they began receiving EB waste. The EB must not have been very concentrated because the characteristic salt cake did not form. All of these tanks also received appreciable amounts of CW in the 1960s.	

HS	(Group Number 13)
This 4-tank group of 55,000-gallons, 200 Series tanks is located in the C Tank Farm. These tanks received MW in the 1940s but were sluiced in the early 1950s. After sluicing, these tanks received only waste from the Hot Semiworks. The majority of this waste was removed from these tanks in the late 1960s and early 1970s. The total waste remaining in these tanks is only 11,000 gallons. This minor volume designates this tank group as being insignificant relative to other groups or even single tanks.	
2C, 224	**(Group Number 14)**
This 3-tank group contains 904,000 gallons of total waste. The majority of waste--892,000 gallons--is sludge. These SSTs also were connected in a 3-tank cascade. The processing history of these tanks is very similar. They all received 2C waste in the 1940s and early 1950s until the cascade was full. In 1952, these tanks began receiving 224 waste and the excess supernate was cascaded to a crib. The first two tanks in the cascade (T-110 and T-111) only received these two wastes. Tank T-112 received dilute decontamination waste (DW) and a mixture of liquid wastes in the late 1960s and early 1970s. These transfers would not have significantly altered the characteristics of the waste relative to the first two waste types. Tank T-111 is on the Push Mode List, should not pose any safety or technical issues, and would be a good choice for core sampling. Tank T-110 is on the Wyden Bill List for gas generation.	
2C, 5-6	**(Group Number 15)**
This 3-tank group, located in the B Tank Farm of the 200 East Area, contains 516,000 gallons of waste. The majority of waste--511,000 gallons--is sludge. These three tanks also were connected in a 3-tank cascade. The cascade was originally filled with 2C waste in the 1940s, cribbed in 1950, and refilled with 2C waste. The continuous overflow in B-112 was cribbed. The cascade began receiving 5-6 waste from B Plant in 1952 and fission products in 1963. The cascade received B Plant low-level waste (BL) and ion exchange waste (IX) in the late 1960s and early 1970s, but these were mostly liquid in nature and are not considered significant contributors to the physical and chemical characteristics of the solids remaining in the tank, relative to the previous three wastes. Tank B-112 received EB and recycle from the ITS loop. This EB-ITS waste did not cause the formation of salt cake typically exhibited by this waste form. Seven core from Tank B-110 were obtained in 1989 and 1990 as part of Phase 1A and 1B of the Waste Characterization Program. These core samples underwent extensive analytical testing and provide excellent data for physical and chemical characterization of this group.	

R, RIX	(Group Number 16)
Group XVI consists of three SX farm tanks, which hold 368,000 gallons of waste. All of this waste is sludge. These tanks received REDOX high-level waste after they were released to operations in the mid- to late 1950s. These tanks received only R until the early 1970s when RIX was introduced into these tanks. In the mid- to late 1970s, these tanks received minor quantities of various waste types, mostly liquid in nature. Tank SX-114 received a small amount of EB waste but not in sufficient concentrations to catalyze crystal formation.	
1C, CW	**(Group Number 17)**
These two T Farm tanks contain 119,000 gallons of waste. The majority of waste--2,000 gallons--is sludge. No salt cake has been observed in these tanks. These tanks initially received 2C waste in 1947. The cascade was then filled with 1C waste from 1948 until 1955. These tanks then began receiving CW in large quantities. A large amount of solids accumulation has resulted from these three waste types. In the 1970s, a number of different liquid wastes was transferred through these two tanks but these wasted did not affect the solids content to the degree of the previous three wastes.	
CW, EB	**(Group Number 18)**
This 3-tank group contains 204,000 gallons of waste. The cast majority of this waste is sludge, but 10,000 gallons of salt cake has formed in one of the tanks. These tanks also were connected in a 3-tank cascade. The cascade was originally filled with MW in the 1940s and, as was typical with MW, sluiced out in the early 1950s. The cascade then began receiving evaporated cladding waste (CW). Apparently the CW was not concentrated to the point of salt cake formation because of the limited amount of this waste form observed in the tank. The cascade also received unconcentrated CW in the 1960s. These tanks received BL and IX in the 1970s, but these predominately liquid wastes are not considered to have significantly contributed to the solids formation in the tank.	

CW, MIX	(Group Number 19)
This 3-tank cascade currently hold 192,000 gallons of waste. The majority of waste--145,000 gallons--is sludge. No salt cake has been observed in these tanks. The cascade was initially filled with MW in the 1940s and emptied in 1951. Tank T-101 received a small amount of TBP scavenged waste from a plant pilot test of the process. This waste was then flushed from the tank. The cascade was again filled with MW in 1955 but emptied the following year. Tank T-101 is listed as a ferrocyanide tank, but this waste was removed and the tank was effectively sluiced twice afterwards. It is unlikely that any appreciable amount of ferrocyanide remains in this tank. The empty cascade was then filled with CW beginning in 1957. This single waste type remained until the early 1970s, when a mixture of liquid waste was flushed through this cascade. The liquid wastes are considered to have had only a limited impact on the characteristic of the solid waste remaining in the tank. Tank T-101 is on the Push-Mode List and would therefore present no technical difficulties in sampling. Its presence on the Wyden Bill List is due to the hypothesized ferrocyanide content. Successful sampling and analysis of this tank might ensure the absence of this compound and remove this tank from the Wyden Bill List. This makes the tank a quality selection for sampling.	
CW	**(Group Number 20)**
These three 200-Series tanks from U Farm contain only 13,000 gallons of waste. The history of these tanks indicates that the predominant waste type in these tanks is CW. The insignificant amount of waste contained in these tanks makes this group virtually irrelevant.	
TBP, EB-ITS	**(Group Number 21)**
This pair of BY Farm tanks contains a combined total of 907,000 gallons of waste. The majority of this waste--771,000 gallons-- is salt cake while 87,000 gallons is sludge. Both tanks received MW before 1955 but were sluiced of their contents. Beginning in 1955, both tanks received TBP waste. Both tanks received quantities of CW in the early 1960s and were connected to an ITS loop in the late 1960s. Tank BY-102 belonged to ITS No. 1 and BY-109 belonged to ITS No. 2. Despite being connected to different ITS loops (and operated by different principles), the solids remaining in the two tanks can be expected to be relatively similar. These tanks both received TBP and CW before ITS. The hardness of the salt cake will prohibit sampling until a hard cake sampler is developed.	

EB, TBP	(Group Number 22)
This pair of TX Farm tanks contains 481,000 gallons of waste and all of it is salt cake. The processing history of these two tanks is slightly different; however, the major waste types are the same. Tank TX-108 received MW in the late 1940s, which was sluiced out in the early 1950s. A minor quantity of R waste was introduced into this tank in the mid-1950s. On top of this R heel, a substantial amount of TBP waste was added. Tank TX-118 received 1C waste in the early 1950s. Most of this waste type was transferred out of the tank. The TBP waste was added on top of this heel. In the late 1960s and early 1970s, significant quantities of EB from the 242-T Evaporator were added to both of these tanks, which caused salt cake formation. Tank TX-118 is on the Wyden Bill List because of unconfirmed transfers of ferrocyanide-scavenged waste.	
SRS, TBP	**(Group Number 23)**
Both of the tanks in this group are located in C Farm and contain 429,000 gallons of waste. The bulk of this volume--372,000 gallons--is sludge. This group received MW in the 1940s but this waste type was removed from these tanks in the early 1950s. The group was then filled with TBP waste. During the 1960s, these tanks received various quantities of P and CW. In the early 1970s, these tanks received large quantities of a highly mixed liquid waste, which was later transferred out. This liquid probably did not greatly affect the solids. In 1976 and 1977 these tanks received a large transfer of strontium sludge (SRS), which greatly added to the solids volume in the tank. This waste type was considered the most significant contributor to the solids characteristics because of its relatively large volume and high radioactivity content.	

1C, EB-ITS	(Group Number 24)
The two BX Farm tanks contain 429,000 gallons of waste--152,000 gallons of salt cake and 257,000 gallons of sludge. Both of these tanks received 1C waste in the late 1940s and early 1950s. Tank BX-110 received some EB in the mid- to late 1950s. Both tanks received CW and IX wastes in the before 1960s before receiving EB from one of the ITS loops. The physical forms of the waste, as reported by Hanlon (1990), are very different for these two tanks. The majority of BX-110 is sludge and only 9,000 gallons ($\approx$ 3 1/4 inches) is salt cake. Tank BX-111 exhibits a greater amount of salt cake (143,000 gallons) than sludge (68,000 gallons). These differences in the reported physical form might result from imprecise sludge measurements during the early history of these tanks or it might be the consequence of real differences between the tanks. This question cannot be answered until one or both of the tanks has been core sampled.	
TBP	**(Group Number 25)**
This pair of TY Farm tanks contains 248,000 gallons of waste. All of this waste is sludge. These tanks had a very simple processing history. (They received only one waste type--TBP.) These tanks have been previously core sampled, and selected portions of the analytical results can be found in Appendix E.	
TBP, EB	**(Group Number 26)**
This pair of tanks T 109 and TX 103 comprise sludge waste with a total volume of 215,000 gallons of waste. These tank comprise 1% of the sludge of the total volume of all tanks. Both tanks received TBP waste.	
TBP, 1C-F	**(Group Number 27)**
This pair of ferrocyanide tanks is located in TY Farm and contains 208,000 gallons of waste. The majority of waste--205,000 gallons--is sludge. No salt cake has been observed in these tanks. These tanks received TBP waste in the early 1950s. During the mid-1950s, the supernate was transferred out and ferrocyanide-scavenged 1C waste placed on top of the TBP heel. These two waste types caused significant solids accumulation. During the 1960s and 1970s, a variety of waste was transferred into and out of these tanks. The solids accumulation did not substantially change during these transfers; therefore, these later transfers are not considered to have affected the physical and chemical characteristics of the solids already present in the tank.	

CCPLX, DSSF	(Group Number 28)
This group of two AX Farm tanks contains 151,000 gallons of waste. The waste consists of 40,000 gallons of salt cake, 9,000 gallons of sludge, and the remainder supernate. Both of these tanks were sluiced of their contents in 1977, leaving a 6,000-gal heel of P waste. The tanks then received wastes identified by unspecific waste names like concentrated complexed waste (CCPLX), double-shell slurry feed (DSSF), and evaporator feed (EVAP). Using such broad waste identifiers--based on suitability for further treatment, not waste source--precludes grouping by radioactive waste type.	
R, DIA	**(Group Number 29)**
This pair of assumed leaker tanks contains 148,000 gallons of waste. All of this waste is sludge. Tank U-104 initially received MW in the 1940s but this waste type was sluiced from the tank in the early 1950s. Tank SX-113 was not released to operation until the mid-1950s. Both tanks exclusively received R after 1958. Diatamaceous earth was added to both tanks after they were declared leakers in an attempt to prevent the escape of liquid waste.	
Solitary Tanks (Ungrouped)	**(Group Number 30)**
Of the 149 SSTs, only 18 did not fall into groups based on radioactive waste types. These 18 tanks transcend almost every waste type and every Tank Farm in the 200 East and 200 West Areas. They contain both salt cake and sludge. These ungrouped tanks represent 3,794,000 gallons of waste--1,241,000 gallons of salt cake and 2,509,000 gallons of sludge. Several of these tanks have significant quantities of waste in them and others have relatively little waste. Many of these tanks are related to some of the groups previously described.	

ACRONYMS

1C	first-cycle decontamination waste
224	lanthanum fluoride decontamination waste
2C	second-cycle decontamination waste
5-6	high-level B Plant waste
CCPLX	complex concentrate
CW	cladding waste
DIA	diatomateous earth
DSSF	double-shell slurry feed
EB	evaporator bottoms
F	ferrocyanide-scavenged waste
HS	hot semiworks waste
ITS	in-tank solidification
MIX	mixture of several miscellaneous wastes
NCPLX	noncomplexed waste
R	high-level REDOX (reduction oxidation) waste
RIX	REDOX ion exchange waste
SRS	strontium sludge
TBP	tributyl phosphate

Appendix D

Laboratory Report Source Information

Appendix D

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Letter, M. T. Jansky to J. W. Baily, "Sample From 108-TX," 65453-81-036, dated February 5, 1981.

Letter, A. J. DiLiberto to K. W. Owens, "Response to May 18th Request from Washington Department of Ecology (WDOE)," 13311C-88-0439, dated June 18, 1988.

Letter, M. T. Jansky to M. C. Teats, "Composition of 101-A Waste," 65453-80-302, dated October 13, 1980.

Letter, R. L. Weiss to J. A. Eaker, "Analysis of Tank 241-AX-102," 12712-PCL88-018, dated November 14, 1988.

Letter, R. L. Weiss to K. G. Carothers, "Analysis of Tank 241-SX-104 Samples, Revision 1," 12221-PCL88-190, dated August 15, 1988.

Letter, M. T. Jansky to D. E. Bowers, "Freezing of Tank 111-U Waste," 65453-80-273, dated September 23, 1980.

Letter, M. T. Jansky to M. C. Teats, "Solids in 101-A Waste," 65453-80-267, dated September 22, 1980.

Letter, R. L. Weiss to V. C. Boyles, "Analysis of Liquid Sample from Tank 241-A-102," 12712-PCL89-112, dated May 9, 1989.

Letter, M. T. Jansky to M. C. Teats, "Composition of 103-A Waste," 65453-80-277, dated September 24, 1980.

Letter, M. T. Jansky to D. E. Bowers and D. A. Reynolds, "Composition of Waste from Tank 101-AX," 65453-80-293, dated October 7, 1980.

Letter, M. E. Mitchell to D. J. Flesher, "Physical and Chemical Characterization of Tanks 104-TY and 106-TY," 65124-79-046, dated December 20, 1979.

Letter, M. J. Klem to R. E. Raymond "Total Organic Carbon Concentration of Single Shell Tank Waste", 82316-90-032, dated April 27, 1990.

Van Vleet, R. J., Radionuclide and Chemical Inventories for the Double Shell Tanks, WHC-SD-WM-TI-543, August 1993.

Weiss, R. L., and K. E. Schull. 1986. Data Transmittal for 241-A-106 Waste Tank Characterization. SD-RE-TI-200, Rev 0. Rockwell Hanford Operations, Richland, Washington.

Weiss, R. L., and K. E. Schull. 1986. Data Transmittal for 241-A-104 Waste Tank Characterization. SD-RE-TI-207, Rev 0. Rockwell Hanford Operations, Richland, Washington.

Weiss, R. L., and K. E. Schull. 198[illegible] Data Transmittal for 241-BX-104 Waste Tank Characterization. SD-RE-TI-206, Rev 0. Rockwell Hanford Operations, Richland, Washington.

Weiss, R. L., and K. E. Schull. 1986. Data Transmittal for 241-A-102 Waste Tank Characterization, SD-RE-TI-201, Rev 0. Rockwell Hanford Operations, Richland, Washington.

Weiss, R. L., and K. E. Schull. 1986. Data Transmittal for 241-BX-105 Waste Tank Characterization. SD-RE-TI-202, Rev 0. Rockwell Hanford Operations, Richland, Washington.

Weiss, R. L., and K. E. Schull. 1986. Data Transmittal for 241-A-103 Waste Tank Characterization. SD-RE-TI-198, Rev 0. Rockwell Hanford Operations, Richland, Washington.

Weiss, R. L., and K. E. Schull. 1986. Data Transmittal for 241-C-103 Waste Tank Characterization. SD-RE-TI-203, Rev 0. Rockwell Hanford Operations, Richland, Washington.

Weiss, R. L., and B. M. Mauss. 1985. Data Transmittal for 241-TY-102 Waste Tank Characterization. SD-RE-TI-183, Rev 0. Rockwell Hanford Operations, Richland, Washington.

Weiss, R. L., and B. M. Mauss. 1985. Data Transmittal for 241-TY-101 Waste Tank Characterization. SD-RE-TI-185, Rev 0. Rockwell Hanford Operations, Richland, Washington.

Weiss, R. L., and K. E. Schull. 1986. Data Transmittal for 241-C-106 Waste Tank Characterization. SD-RE-TI-204, Rev 0. Rockwell Hanford Operations, Richland, Washington.

Weiss, R. L., and B. M. Mauss. 1985. Data Transmittal for 241-TY-103 Waste Tank Characterization. SD-RE-TI-184, Rev 0. Rockwell Hanford Operations, Richland, Washington.

Weiss, R. L., and B. M. Mauss. 1985. Data Transmittal for 241-TY-104 Waste Tank Characterization. SD-RE-TI-182, Rev 0. Rockwell Hanford Operations, Richland, Washington.

Weiss, R. L., and K. E. Schull. 1986. Data Transmittal for 241-C-104 Waste Tank Characterization. SD-RE-TI-199, Rev 0. Rockwell Hanford Operations, Richland, Washington.

Weiss, R. L., and B. M. Mauss. 1985. Data Transmittal for 241-TY-106 Waste Tank Characterization. SD-RE-TI-181, Rev 0. Rockwell Hanford Operations, Richland, Washington.

Weiss, R. L., and B. M. Mauss. 1985. Data Transmittal for 241-TY-105 Waste Tank Characterization. SD-RE-TI-186, Rev 0. Rockwell Hanford Operations, Richland, Washington.

Weiss, R. L., and K. E. Schull. 1986. Data Transmittal for 241-C-105 Waste Tank Characterization. SD-RE-TI-204, Rev 0. Rockwell Hanford Operations, Richland, Washington.

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