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Prepared for the U.S. Department of Energy
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Pacific Northwest Laboratory
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Richland, Washington 99352

(a) Westinghouse Hanford Company.

Summary

The Sort on Radioactive Waste Type (SORWT) model presents a method to categorize Hanford Site single-shell tanks (SSTs) into groups expected to exhibit similar chemical and physical characteristics based on their major waste types and processing histories. This report contains the assumptions and methodologies used to develop the SORWT model and presents the grouping results, along with a detailed statistical verification study that integrated analysis of variance (ANOVA) and core sample analysis data collected since 1989 for five SORWT groups. Nominal compositions and inventories are given for these five SORWT groups.

The SORWT model has identified 24 different waste-type groups encompassing 133 of the 149 SSTs and 93% of the total waste volume in SSTs. The first 14 groups (those that contain four tanks per group or more) represent 109 tanks and over 83% of the total waste volume. Sixteen SSTs and associated wastes could not be grouped according to the established criteria and were placed in an ungrouped category.

The verification study showed that the SST groups predicted by the SORWT model are highly statistically significant and that grouping the tanks reduces the variability in the concentrations for all analytes examined. A high degree of agreement was found between the observed characteristics determined by laboratory analyses for the five SORWT groups and the expected characteristics based solely on the waste type. These similarities provide further evidence that the SORWT grouping methodology is accurately and effectively predicting real distinctions between groups of tanks.

The SORWT model organizes a large amount of information and presents options, depending on the criteria applied, for selecting the most desirable SSTs for sampling and for determining core sampling schedules. A list of tanks recommended for sampling based on the SORWT model results is included in this report. The list takes advantage of the SORWT model groups to establish a substantial amount of characterization information from a relatively small number of core and auger samples.

Thirty-two core samples from 16 tanks and 18 auger samples from six tanks are recommended. If this new sampling and analysis information is combined with the existing data, nominal compositions of 104 tanks (70%) could be established, which would represent approximately 79% of the total waste volume, 63% of the total sludge volume, and 88% of the salt cake volume. The information gained from this effort could greatly contribute to the base of knowledge concerning the characteristics of tank waste.

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Abbreviations

1C	first decontamination cycle waste
224	lanthanum fluoride decontamination waste
2C	second decontamination cycle waste
5-6	high-level B Plant waste from the bottom of Section 5
AES	atomic emission spectroscopy
ANN	aluminum nitrate nono hydrate
ANOVA	analysis of variance
$BiPO_4$	bismuth phosphate
B	high-level B Plant waste from waste fractionization process
BL	B Plant low-level waste
CV	coefficient of variance
CCPLX	complex concentrate
CW	cladding waste
DIA	diatomaceous earth
DOE	U.S. Department of Energy
DSSF	double-shell slurry feed
DSC/TGA	differential scanning calorimetry/thermal gravimetric analysis
DW	decontamination waste
EB	evaporator bottoms
EVAP	post-1976 evaporator feed
F	ferrocyanide-scavenged waste
GEA	gamma energy analysis
HDRL	Hanford defense residual liquor
HS	hot semiworks waste
ICP	inductively coupled plasma
ITS	in-tank solidification
IX	ion exchange waste
MIX	mixture of several miscellaneous wastes
MW	metal waste
NCPLX	noncomplexed waste
NWL	non-watch list
P	neutralized acid waste
PNL	Pacific Northwest Laboratory
PUREX	plutonium-uranium extraction
R	high-level REDOX waste

REDOX	reduction/oxidation
RESD	residual liquor
SEIS	Supplemental Environmental Impact Statement
SORWT	Sort on Radioactive Waste Type
SRS	strontium leached sludge
SR-WASH	particulates from Sr wash of PUREX wastes in the AR vault
SST	single-shell tank
TBP	tributyl phosphate
TL	terminal liquor
TOC	total organic carbon
TRAC	Track Radioactive Components
TWRS	Tank Waste Remediation System
WHC	Westinghouse Hanford Company

1.0 Introduction

This report discusses the Sort on Radioactive Waste Type (SORWT) model, which was developed to qualitatively categorize the Hanford single-shell tanks (SSTs) into characteristic groups. The results provided by this grouping model will contribute to a better understanding of the contents of the tanks and help predict the nominal physical and chemical characteristics of an entire group of tanks based on limited sampling and analysis. This model also provides a basis for guiding and prioritizing sampling and analytical efforts.

1.1 Scope

The SORWT model provides a qualitative grouping methodology for SSTs according to their significant waste types and processing history, and a best engineering judgment based on the available information. Tanks that received similar wastes and underwent similar process histories should have a high degree of similarity in chemical content and physical characteristics. This premise forms the basis of the grouping scheme. A limited number of tanks can provide sufficient information on which to base final processing and disposal decisions, if the tanks selected provide a representative sample of the waste types and conditions in the SSTs.

This report contains an overview of the model, the waste-type groups predicted, and the characteristics of the waste types included in a verification study, as well as the verification study itself. The verification study quantitatively supports the model using a detailed analysis of variance (ANOVA) of the relevant and available characterization data obtained from recent (post-1989) core sampling and analysis activities. The results from the ANOVA study demonstrated the SST groups predicted by the model to be highly statistically significant. In addition, the SORWT model has been used to predict the nominal waste characteristics of entire waste-type groups that have some recent characterization data available.

Several appendices have been included: Appendix A contains the detailed SORWT results; Appendix B lists the waste types determined for Hanford SSTs; Appendices C through F provide the core sample analytical data tables, box plots, ANOVA results, and descriptive statistics resulting from the verification study.

1.2 History of the SORWT Model Development

The SORWT model was first proposed by Westinghouse Hanford Company (WHC) in 1991 as a means to guide the waste tank characterization effort at Hanford and to help accelerate the acquisition of characterization data on the SST wastes in support of a Supplemental Environmental Impact Statement (SEIS). The model results provided a key to the selection of tanks to be core sampled in FY 1992, as discussed in the *Waste Characterization Plan for the Hanford Site Single-Shell Tanks* (Hill et al. 1991).

Eighteen core samples were collected and analyzed from seven SSTs in accordance with this plan. One of the selection criteria for these tanks was to provide data from pairs of tanks in the same group as well as from different SORWT groups for comparison with the predictions made by the SORWT model. These data would then be used to conduct a statistical verification study to assess the effectiveness of the grouping methodology. A draft document was prepared in August 1991 presenting the methodology, results, and statistical discussion of the SORWT model. However, because of shifts in U.S. Department of Energy (DOE) programmatic directions, formal documentation was postponed.

In the spring of 1994, the methodology and results portion of the original model was published for the Tank Waste Remediation System (TWRS), which is managed for DOE by WHC. The report, *The Sort on Radioactive Waste Type Model: A Method to Sort Single-Shell Tanks into Characteristic Groups* (Hill and Simpson 1994a), was revised in August 1994 (Hill and Simpson 1994b) to include additional descriptive information on waste types present in SSTs.

During the last quarter of FY 1994, further studies were conducted for the TWRS Tank Waste Treatment Science Task, which is being led by Pacific Northwest Laboratory (PNL)[a]. These studies were aimed at verifying the results of the SORWT model to provide a better technical basis for using the model results in overall tank waste pretreatment strategies. The laboratory data from the cores taken in 1992 were available, and the detailed statistical verification study using analysis of variance was conducted. In addition, the tank waste volumes used in the model were updated using the March 1994 *Tank Farm Surveillance and Waste Status Summary Report* (Hanlon 1994). The initial report used waste volume data from the July 1990 report (Hanlon 1990).

1.3 Tank Waste Background

Between 1943 and 1964, 149 SSTs were built for the storage of liquid and solid radioactive wastes at the Hanford Site. These tasks, which are located in 12 tank farms of four to 18 tanks each in the 200 East and 200 West Areas, have been removed from active service and have not received any additional wastes since November 1980. Before the tanks were removed from active service, various waste volume reduction programs were undertaken to minimize the amount of occupied tank volume. These programs involved inter-tank transfers, evaporation, and chemical alterations of the waste. These actions, combined with the ongoing chemical and radiolytic in-tank processes, have changed the character of the waste in the SSTs over time, and now the actual composition of the wastes in the SSTs needs to be determined to make further technical and regulatory disposal decisions.

The wastes in the SSTs originated from a limited number of chemical processes and waste solidification schemes. The primary chemical processes at Hanford were the bismuth phosphate ($BiPO_4$) plutonium recovery and purification process, the uranium recovery tributyl phosphate (TBP) process, the REDOX (reduction/oxidation with solvent extraction) process, and the PUREX (plutonium-uranium extraction) processes. Each of these major processes also had several affiliated operations, such as the

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first and second decontamination cycle processes, the lanthanum fluoride process, fuel element decladding, ferrocyanide scavenging, fission product recovery, and several minor associated processes. The waste solidification schemes generally involved processes that treated waste outside of the tanks, such as the 242-B and 242-T Concentrators and the 242-A and 242-S Evaporator/Crystallizers. These units took the dilute waste from the tank, evaporated the excess water, and returned the concentrated waste to the tank. However, there were in-tank solidification (ITS) processes that removed the excess water directly from tank wastes using a hot-air sparge (ITS-1) or from a series of tanks using an in-tank electric heater (ITS-2). Excess water was also removed simply from self concentration as a result of dissipating excess radioactive decay heat.

There have been several previous attempts to group the tanks; however, there is no currently accepted method. The previous methods were unacceptable because of their reliance on the TRAC (Track Radioactive Components) model as a basis (Jungfleisch 1984); the TRAC model can be shown to be internally inconsistent and inconsistent with other sources of reliable information regarding waste in the tanks (Adams et al. 1986; Morgan et al. 1988). The proposed method does not use the TRAC document's quantitative estimates regarding waste composition in the tanks for grouping. The grouping method is instead a qualitative judgment about the tanks that are similar in content and character based on the transaction information in *A History of the 200 Area Tank Farms* (Anderson 1990) and several generic assumptions about the physical and chemical makeup of the wastes in the tanks. This grouping method then uses a database to sort the tanks on the basis of similarity in overall waste types and processing history.

2.0 Overview of the SORWT Model

The SORWT model categorizes tanks into groups expected to have similar physical characteristics and chemical compositions. Because of the complex physical and chemical history of the SSTs, especially when several different waste types were mixed or processed together, the model does not attempt to predict the precise composition of a waste tank. Instead, the sorting method concentrates on the different types of waste introduced into each SST, each waste's distinct contribution to the known properties, the individual significance of each waste type, and the process history of each of the tanks. Although the actual chemical reactions and phase equilibria may be unknown when two waste types are combined in an SST, it can be assumed that similar reactions and equilibria occur in other SSTs when the same two waste types are mixed.

The fundamental premise of the SORWT model is that there are identifiable patterns with regard to the production and waste management practices that were conducted in the tank farms. Thus, tanks that received the same waste types in the same approximate proportion and had a similar processing history will be more similar to one another than SSTs that received several different waste types in varying amounts and had a relatively unique process history. In addition, largely supernatant waste types are presumed not to have as significant an effect on the character of the waste in the tank as solid-forming waste types. Therefore, if the primary and secondary solid-forming waste types can be identified for each SST, the tanks can be grouped based on these criteria. Thus, information about the character of the waste in the rest of the members in the group can be deduced from the information obtained by the analysis of the samples from the representative tank, or from a selected number of representative tanks.

2.1 Data Sources for the SORWT Model

The principal source of SST waste-type information used by this model has been *A History of the 200 Area Tank Farms* (Anderson 1990). This document contains much of the available processing history for each of the 149 SSTs from 1944 until 1980. However, the historical records used to generate Anderson (1990) were often inaccurate and/or incomplete. The methods utilized to measure accumulated solid and liquid volumes during the early history of the Hanford Site produced inconsistent inventories. Indeed, solids inventories were not routinely taken until the mid-1950s. Often, tank transfer information was missing. Despite these inconsistencies, Anderson (1990) is still one of the best sources of SST historical information, and it is believed a qualitative assessment of the principal solids-forming waste types contained in each SST can be accurately determined from this information.

Often in the course of the process histories of the SSTs, the wastes in the tanks were given new names to reflect their suitability for further processing or the presence of complexing agents. Occasionally, the same waste types were assigned different names at different times. For example, terminal liquor (TL), Hanford defense residual liquor (HDRL), and residual liquor (RESD) all identify the same waste. Whenever possible these broad, nonspecific waste category names were avoided, and the actual waste type from one of the process operations was used for the sorting criteria. In addition, the suffix F was added to some of the waste types to identify ferrocyanide-scavenged waste, and ITS was added to designate tanks that were in the In-Tank Solidification program.

The volumes of waste contained in each SST were obtained from the *Tank Farm Surveillance and Waste Status Summary Report* (Hanlon 1994). These values include, on a per-tank-basis, total waste volume, volume of salt cake, volume of sludge, and volume of supernatant liquid. It can be assumed that these values are more accurate than those final values found in Anderson (1990) because they were obtained more recently; however, it is understood that these values have deficiencies because of the limited access to the tanks.

2.2 SORWT Model Assumptions

The underlying assumptions utilized by the SORWT model are as follows:

- The information contained within Anderson (1990) is sufficient to qualitatively identify and rank relative to one another the waste types that contributed to the accumulated solids in each SST.

- The Hanlon (1994) inventory values and phase partition information regarding sludge and salt cake amounts are reasonably accurate.

- The SST process history, primary solids-forming, and secondary solids-forming waste types were responsible for the majority of the physical characteristics and chemical compositions of the waste remaining in each SST.

- Supernatant wastes that were not allowed to remain in a tank for a long period of time and were later pumped out of the SST had less influence on the physical and chemical character of the waste than did the insoluble solid waste types.

- SSTs were often sluiced at some time during their processing history. Sluicing involves removing solids from waste tanks using high-pressure water jets. Waste types present in the tank prior to the most recent sluicing were not considered relevant by this model.

- Broad-ranging, less descriptive waste types, such as NCPLX (noncomplexed waste), CCPLX (complex concentrate), EVAP (post-1976 evaporator feed), and/or DSSF (double-shell slurry feed), were avoided whenever possible. The previous nomenclature for those waste types was preferred, if available; however, a broad category identifying the tank waste as either non-complexed, complexed, or ferrocyanide-scavenged waste has, in some instances, been included in the SORWT model to aid in evaluating the results of the model.

2.3 SORWT Model Input Data Sheets

SORWT model input sheets were generated for each tank by thorough evaluation of the processing histories found in Anderson (1990) and Hanlon (1994). The waste type judged to be the most significant contributor to the solids volume in any specific SST was identified as the Primary Waste Type. This evaluation was made on the basis of waste volume introduced into each tank and the solids accumulation during the regime of that particular waste. The second most significant solids-forming waste type was identified as the Secondary Waste Type. When appropriate, a Tertiary and an Other Waste Type were also identified.

Because waste prior to sluicing has been disregarded by the SORWT model, the date of the most recent sluicing event for each tank has been included on the input sheets. The volume of waste remaining in the tank after sluicing has also been included to aid in the sorting and analysis. The data were obtained from Anderson (1990).

The waste volumes remaining in each SST, segregated into salt cake, sludge, supernatant liquid, and total, were collected from Hanlon (1994). Although the waste volume information was not used as a sorting criterion, it can be used as an indication of grouping feasibility. A realistic group, as predicted by the SORWT model, exhibiting similar physical and chemical characteristics, should not include tanks that have widely varying ratios between sludge and salt cake. If the majority of tanks in a group contain all sludge and one tank contains all salt cake, the membership of that tank in the group would be in question. The tank waste volume information also provides valuable insight into those tanks in a group that have greater significance due to their higher volume.

3.0 Presentation of SORWT Model Results

The SORWT model results were presented using a database software package to generate the report. Tanks possessing the same primary and secondary waste types were grouped together. Waste-type abbreviations are summarized in Table 3.1. From the database package, the report output was imported into a word processor for additional editing. The different groups were listed in descending order of importance with the most significant group first. Following each group was a subtotal providing the number of tanks and the volume of salt cake, sludge, and total waste represented by that particular waste group as collected from Hanlon (1994).

3.1 SORWT Model Report Format

A full printout of the SORWT model report is presented in Appendix A. The first column of the SORWT model report contains the group I.D. in Roman numerals. The lower the number, the more significant the group in terms of number of tanks and total waste volume. Column 2 contains the tank names of the individual tanks that make up each group. Columns 3 and 4 report the primary and secondary waste types, respectively. These are the waste types believed to have contributed most significantly to the solids volume in that particular tank relative to other waste types introduced into that same tank and are the criteria for tank grouping. Within any given group, the primary and secondary waste types will always be identical. Columns 5 and 6, respectively, contain the tertiary and other waste types. While the tertiary and other waste types are not actually used as grouping criteria, they are provided for further assistance in interpreting the results. Column 7 presents the safety watch list status of each tank. The codes used in this column are F, O, H, G, and N representing ferrocyanide, organic, high-heat, gas-generating, and non-public law tanks, respectively. The remaining columns list the volumes of waste in the corresponding phases and the total waste volume of each tank. The total waste volume does not include the interstitial liquid volume.

The second portion of Appendix A lists the volume percent of each phase and the percentage of the overall volume contained in each tank. In both the volume and the volume percentage portions of the appendix, the results have been subtotaled for each SORWT group.

3.2 Summary of SORWT Model Waste-Type Groups

The SORWT model has predicted the existence of 24 waste-type groups ranging from a high of 22 tanks per group to a low of two tanks per group. These 24 waste-type groups encompass 133 tanks and 93% of the total waste volume. An additional group contains the 16 solitary SSTs that did not fall into any waste-type groups. Table 3.2 presents a summary of the SST waste-type groups predicted by the SORWT model.

Table 3.1. Waste-Type Abbreviations

Abbreviation	Definition
5-6	High-level B Plant waste from bottom of Section 5
224	Lanthanum fluoride decontamination waste
1C	First decontamination cycle waste
2C	Second decontamination cycle waste
B	High-level waste from waste fractionization process at B Plant
BL	B Plant low-level waste
CCPLX	Complex concentrate
CW	Cladding waste
DIA	Diatomaceous earth
DSSF	Double-shell slurry feed
DW	Decontamination waste
EB	Evaporator bottoms
EVAP	Evaporator feed (post-1976)
F	Ferrocyanide-scavenged waste
HS	Hot semiworks waste
ITS	In-tank solidification
IX	Ion exchange waste
MIX	Mixture of several miscellaneous wastes
MW	Metal waste
NCPLX	Noncomplexed waste
P	High-activity, neutralized acid waste
PUREX	Plutonium-uranium extraction
R	High-level REDOX waste
SRS	Strontium leached sludge
SR-WASH	Particulates from Sr wash of PUREX wastes in the AR vault
TBP	Tributyl phosphate waste

FP fission prod

Table 3.2. Summary of SORWT Model Results

Group Number	Primary and Secondary Waste-Type Groups		Number of Tanks in Group	% of Total Salt Cake Volume	% of Total Sludge Volume	% of Total Supernatant Volume	% of Total Interstitial Liquid Volume	% of Total Waste Volume
I	R	EB	22	37%	12%	21%	42%	28%
II	EB	1C	10	20%	0%	0%	3%	13%
III	TBP-F	EB-ITS	10	14%	5%	0%	11%	11%
IV	R		10	0%	10%	1%	1%	3%
V	TBP	CW	9	0%	5%	5%	1%	2%
VI	EB	CW	8	8%	3%	20%	11%	6%
VII	224		8	0%	2%	1%	0%	1%
VIII	1C	EB	6	1%	6%	0%	1%	3%
IX	EB	R	5	8%	1%	8%	8%	6%
X	1C	CW	5	0%	6%	2%	1%	2%
XI	DSSF	NCPLX	4	7%	3%	2%	12%	6%
XII	1C	TBP	4	0%	6%	0%	1%	2%
XIII	TBP-F	1C	4	0%	2%	1%	1%	1%
XIV	HS		4	0%	0%	0%	0%	0%
XV	2C	224	3	0%	7%	2%	1%	2%
XVI	2C	5-6	3	0%	4%	1%	1%	1%
XVII	CW	MIX	3	0%	1%	3%	0%	0%
XVIII	CW		3	0%	0%	1%	0%	0%
XIX	TBP	EB-ITS	2	3%	1%	0%	2%	2%
XX	SRS	SR-WASH	2	0%	2%	29%	0%	1%
XXI	TBP	EB	2	0%	2%	0%	0%	1%
XXII	TBP	1C-F	2	0%	2%	1%	0%	1%
XXIII	CCPLX	DSSF	2	1%	0%	1%	1%	0%
XXIV	R	DIA	2	0%	1%	0%	0%	0%
Total			133	99%	82%	98%	97%	93%
XXV	Ungrouped Tanks		16	1%	18%	2%	3%	7%

A review of Table 3.2 will quickly reveal that Group I is by far the most significant group. This group includes 22 tanks, 37% of the total salt cake volume, and over one-quarter of the total waste in all 149 SSTs. The first three groups represent over one-half of the total waste volume in all 149 SSTs. This categorization demonstrates the potential usefulness of the SORWT model in making management decisions. Table 3.2 also identifies groups that have relatively no significance, such as Groups XIV and XVIII, which contain almost no waste. This information can be used in allocating time and resources for characterization activities, pretreatment, and immobilization development.

Larger families of related tank groups may exist. An example of a potential family is Group I (R, EB) and Group IX (EB, R). These two groups have the same primary and secondary waste types. The relative differences between these two groups are due to their respective designation for primary and secondary waste types. The differences caused by prioritizing the same waste types in different orders may be small compared with the overall group variability. Identifying larger families of tanks will reduce the overall number of different groups being evaluated and potential sampling and analysis events. The existence of families could be tested and reported at a later time.

3.3 Description of SORWT Waste-Type Groups

This section gives brief descriptions of each of the waste-type groups predicted by the model.

3.3.1 Group I - R, EB

This waste-type group is the most significant group predicted by SORWT in terms of number of tanks and total waste volume. The 22 tanks within this group contain an estimated 10,082,000 gallons of total waste consisting of 8,522,000 gallons of salt cake and 1,438,000 gallons of sludge. All 22 Group I tanks can be found in three different 200 West Area Tank Farms, S, SX, and TX. These tanks typically received a large amount of high-level 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 supersaturated, high-nitrate waste cooled in the SSTs and formed an extremely hard salt cake. Despite the slightly different processing history of these tanks between the addition of the R in the 1950s and the EB in the 1970s, 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, 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.

3.3.2 Group II - EB, 1C

This 10-tank group contains approximately 4,634,000 gallons of waste. The vast majority of this waste—4,594,000 gallons—is salt cake. All but two of these tanks are located in the TX Tank Farm; one is located in B Tank Farm and the other in TY 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 first decontamination cycle (1C) waste. Tank B-105 received 1C before the EB, which probably explains the limited sludge accumulation in this tank that is not exhibited by the others.

3.3.3 Group III - TBP-F, EB-ITS

This group contains 10 tanks and is the third most significant in terms of number of tanks and total waste volume. The tanks in this group hold 3,980,00 gallons of waste. The majority of this waste—3,344,000 gallons—is presumed to be salt cake. However, these tanks also contain substantial amounts of sludge. All 10 of these tanks, which originally held wastes from the $BiPO_4$ process [mostly 1C with some metal waste (MW)], can be found in the BY Farm located in the 200 East Area. They were completely emptied in the early 1950s, and no significant amounts of $BiPO_4$ solids remain in the tanks, so the presence of that waste type is not considered by the SORWT model. After sluicing, these tanks received tributyl phosphate (TBP) ferrocyanide-scavenged (F) waste from U Plant, which is probably responsible for the sludge buildup. During the late 1960s and early 1970s, these tanks were connected to the in-tank solidification (ITS-2) loops. This process, in 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, resulting in salt cake formation.

3.3.4 Group IV - R

Group IV is a 10-tank group containing high-level R waste. S-104 received R waste which still contained cladding waste (CW); all other tanks were filled with R waste only after the CW was removed. Tanks SX-111 and SX-114 received a small amount of EB waste from the REDOX waste evaporator but not in sufficient concentrations to support crystal formation.

Group IV tanks hold 1,232,000 gallons of waste. The majority of waste—1,228,000 gallons—is sludge; no salt cake formation has been observed. Eight 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 watch list as a gas-generating tank. It should also be mentioned that Hanlon (1994) currently lists the volume of SX-109 as salt cake but is in the process of being revised to indicate the volume is actually sludge as shown in Appendix A. Sampling and analysis of S-104 have been performed; assessment of the data has contributed greatly to the existing body of characterization knowledge. The analysis of this tank significantly aids in characterizing this particular 10-tank group and also several other groups containing large amounts of R-type waste.

3.3.5 Group V - TBP, CW

This nine-tank group, located almost entirely in BX Tank Farm, contains 708,000 gallons of waste. Nearly all of the contents of this group is sludge. Salt cake has only been observed in one tank, BX-105. The 3000 gallons of salt cake are due to a small transfer of EB into BX-105. These tanks were originally filled with MW or 1C in the 1940s. In the early 1950s MW tanks were sluiced and other tanks were pumped down to provide room for TBP waste. Additions of this waste type began in the mid-1950s. The addition of CW began in the mid-1960s. The various other transfers that occurred in these tanks should not significantly affect the characteristics of the waste relative to TBP and CW, the primary and secondary wastes. Tanks BX-104 and BX-105 were core-sampled previously (1985), and the results provide some insight into their chemical composition; however no recent (post-1989) characterization data have been obtained from this group.

3.3.6 Group VI - EB, CW

These eight tanks contain 2,306,000 gallons of waste. Salt cake comprises 1,877,000 gallons of this waste, while sludge comprises only 314,000 gallons. All of these tanks except TX-118 were filled with MW in the late 1940s or early 1950s; in the mid- to late 1950s, the MW was sluiced from the tanks to recover the uranium. The order that the tanks then received EB and CW varies, but the current volumes indicate that EB and CW are the primary and secondary waste types, respectively.

3.3.7 Group VII - 224

This eight-tank group represents 280,000 gallons of waste. The majority of the waste is sludge, and although some of these tanks received high-level B Plant waste from the bottom of Section 5 (5-6), no salt cake formation has been observed. All eight tanks are 55,000-gallon, 200 Series tanks located in B and T Tank Farms. These tanks received lanthanum fluoride decontamination (224) waste exclusively. 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 among the tanks of this group should be very uniform. Two tanks, B-201 and B-202, were core-sampled and analyzed in 1992. The data from these tanks have been used as part of the statistical verification study.

3.3.8 Group VIII - 1C, EB

This six-tank group of B and BX Farm tanks contains 960,000 gallons of waste, a large percentage of which 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. All of these tanks also received appreciable amounts of CW in the 1960s.

Tank BX-111 is the only tank in the group which exhibits a greater amount of salt cake (143,000 gallons) than sludge (68,000 gallons). This may be a result of imprecise sludge measurements during the early history of the tank, or it may indicate real differences between BX-111 and the other tanks in Group VIII. This observation cannot be properly addressed until one or more of the tanks in the group have been core sampled.

3.3.9 Group IX - EB, R

Group IX consists of five 200 West Area tanks, mostly from U Farm. These tanks contain 2,037,000 gallons of waste, with the vast majority as salt cake. Initially, these tanks held substantial amounts of supernatant before receiving solid wastes. Some tanks were filled with MW in the 1940s, but these MW receivers were completely sluiced out in the early 1950s. Large quantities of high-level R were then introduced into these tanks and allowed to remain there for many years. In the early 1970s, large volumes of R supernatant were transferred from the tanks and replaced with EB from the 242-S Evaporator, which caused a salt cake to form in the majority of the tanks. The small amount of sludge that accumulated in these tanks is probably due to the R present before the EB. Because of the hardness of the salt cake, these tanks present technical difficulties that must be solved before sampling. These tanks should be very similar to Group I tanks and differ from them 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.

3.3.10 Group X - 1C, CW

This five-tank group contains 760,000 gallons of waste, the majority of which, 749,000 gallons, is sludge. No salt cake has been observed in these tanks. T-105, T-106, and U-110 initially received second decontamination cycle waste (2C) waste in 1947. The cascade was then filled with 1C waste from 1948 until 1955 when it began receiving CW in large quantities. C-107 and T-107 both initially received 1C waste but eventually began receiving CW waste in the 1960s. A large amount of solids accumulated from these waste types. In the 1970s, a number of different liquid wastes were transferred through these tanks but did not affect the solids content to the degree of the previous wastes.

3.3.11 Group XI - DSSF, NCPLX

This four-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 from waste fractionization process (B). However, all of these tanks were sluiced of their contents in 1976. The waste types added to these tanks after sluicing were double shell slurry feed (DSSF) and noncomplexed (NCPLX) waste, which are generic terms describing the potential for further processing of the waste instead of the original source of the waste. Because these terms are so general, little can be determined about the homogeneity of the waste in this group. Although the total volume of waste in this group is significant, the high degree of uncertainty regarding the waste types in these tanks makes this group questionable, and different affiliations for these tanks may be found. However, it is also possible that the volume of waste reported for Tank A-103 is actually salt cake since the waste did pass through the 242-A Evaporator/Crystallizer. This would increase the probability that Group XI is a legitimate group, but this can only be verified by sampling Tank A-103.

3.3.12 Group XII - 1C, TBP

This four-tank group contains 693,000 gallons of waste, the vast majority of which is sludge. Even though this group transcends four different tank farms in both the 200 East and West Areas, 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 the tanks began receiving TBP waste. The solids volume that was measured at this time did not accumulate further during the rest of the history of these tanks. 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 records indicate a small amount of EB was introduced into T-108. Two of these tanks, C-110 and BX-107, have been core sampled and are included in the statistical verification study.

3.3.13 Group XIII - TBP-F, 1C

This four-tank group contains 293,000 gallons of waste, and approximately 289,000 gallons are sludge. No salt cake has been observed in these tanks. The tanks were used as the primary settling tanks during the In-Farm Scavenging campaign during the 1950s, and they were originally filled with 1C waste in the 1940s. The supernatant was transferred out of the tanks to make room for the TBP-F waste that was allowed to settle. These two wastes formed the vast majority of the solids located in these tanks. All of these tanks are on the watch list because of their ferrocyanide content.

3.3.14 Group XIV - HS

This four-tank group of 55,000-gallon, 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 waste only from the Hot Semiworks (HS). The majority of this waste was removed from these tanks in the late 1960s and early 1970s; the total waste remaining is only 11,000 gallons. This minor volume designates this tank group as being insignificant compared with other groups or even single tanks.

3.3.15 Group XV - 2C, 224

This three-tank group contains 904,000 gallons of total waste, the majority of which, 892,000 gallons, is sludge. These SSTs were connected in a three-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, they began receiving 224 waste, and the excess supernatant was cascaded to a crib. The cascade also received 5-6 waste after 1951 and Tanks T-111 and T-112 received dilute decontamination waste (DW) and a mixture of liquid wastes (MIX) in the late 1960s. These transfers would not have significantly altered the characteristics of the waste relative to the first two waste types. Tank T-110 is on the watch list for gas generation. T-111 is on the organic watch list, but has been core sampled and is included in the statistical verification study.

3.3.16 Group XVI - 2C, 5-6

This three-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 three-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 in 1952 as part of the shutdown and decontamination of B Plant. The tanks began receiving fission products in 1963. B Plant low-level waste (BL) and ion exchange waste (IX) were routed to the cascade 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 significant 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, or perhaps any salt cake that was formed was subsequently dissolved by waste transfers after the EB-ITS transfers. Seven cores from Tank B-110, obtained in 1989 and 1990, underwent extensive analytical testing and provide excellent data for physical and chemical characterization of this group. Tank B-111 has also been core sampled, and a comparison of the two tanks shows substantial agreement for the primary analytes (Remund et al. 1994).

3.3.17 Group XVII - CW, MIX

This three-tank cascade currently holds 161,000 gallons of waste, most of which (143,000 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-F waste from a pilot-plant test of the process; this waste was then pumped to a minimum level and flushed from the tank. The cascade was again filled with MW in 1955 but sluiced empty the following year. Tank T-101 is listed as a ferrocyanide tank, but this waste was removed, and the tank was sluiced empty later so it is unlikely that any appreciable amount of ferrocyanide remains. The empty cascade was then filled with CW beginning in 1957. This single waste type remained until the early 1970s, when a mixture of several miscellaneous liquid wastes was routed to these tanks. The liquid wastes are considered to have had only a limited impact on the characteristics of the solid waste remaining in the tank.

3.3.18 Group XVIII - CW

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 is CW. The small amount of waste contained in these tanks makes this group a poor choice for sampling, if inventory volume is a selection criterion. However, because of the straightforward process history of these tanks, adequate representation of CW (that may be extended to other tanks) may be achieved.

3.3.19 Group XIX - TBP, EB-ITS

This pair of BY Farm tanks contains a combined total of 764,000 gallons of waste. The majority of this waste—681,000 gallons—is salt cake, while 83,000 gallons are sludge. Both tanks received MW supernatants before 1955, but the tanks were sluiced to recover any residual solids that may have been suspended and eventually settled. 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 to ITS-1 and BY-109 to ITS-2. Despite being connected to different ITS loops (operated by different principles), the solids remaining in the two tanks, both salt cake and sludge, can be expected to be relatively similar.

3.3.20 Group XX - SRS, SR-WASH

Both of the tanks in this group are located in C Farm and contain 424,000 gallons of waste, the bulk of which—259,000 gallons—is sludge. This group received MW in the 1940s, which was removed in the early 1950s. The tanks were then filled with TBP waste that was scavenged in the CR vault in the mid-1950s. Also during the mid-1950s, these tanks received various quantities of P and CW. In the early 1970s, these tanks received large quantities of a variety of 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 leached sludge (SRS), which greatly added to the solids volume in the tank. These tanks also received a large quantity of high-level solids as suspended particulates from sludge washing in the AR vault (SR-WASH). These suspended solids settled in the tanks and are considered a significant contributor to the solids characteristics and high radioactivity. Both of the tanks were previously core sampled. Tank C-103 is on the watch list as an "organic" tank, because it has a separate organic liquid layer. Tank C-106 is on the same list as a "high heat" tank.

3.3.21 Group XXI - TBP, EB

These two 200 West Area tanks hold a total of 215,000 gallons of waste, all of which is sludge. Although these tanks received an appreciable amount of EB, the characteristic salt cake did not form or was washed away.

3.3.22 Group XXII - TBP, 1C-F

This pair of ferrocyanide tanks is located in TY Farm and contains 208,000 gallons of waste; 205,000 gallons are sludge. No salt cake has been observed in these tanks. These tanks received TBP waste in the early 1950s, then, during the mid-1950s, the supernatant was transferred out and 1C-F 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 significantly affected the physical and chemical characteristics of the solids already present in the tank. Both of these tanks have been previously sampled.

3.3.23 Group XXIII - CCPLX, DSSF

This group of two AX Farm tanks contains 151,000 gallons of waste, consisting of 139,000 gallons of salt cake, 9000 gallons of sludge, and the remainder supernatant liquid. Both of these tanks were sluiced of their contents in 1977, leaving a 6000-gallon heel of P waste. The tanks then received wastes identified by unspecific waste names like complex concentrate (CCPLX), DSSF, and post-1976 evaporator feed (EVAP). Using such broad waste identifiers—based on suitability for further treatment, not waste source—precludes grouping by radioactive waste type.

3.3.24 Group XXIV - R, DIA

This pair of assumed leaker tanks contains 148,000 gallons of waste, all of which 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. Diatomaceous earth (DIA) was added to both tanks after they were declared leakers, in an attempt to prevent the escape of liquid waste.

3.3.25 Group XXV - Solitary Tanks (Ungrouped)

Of the 149 SSTs, only 16 did not fall into groups based on radioactive waste types. These 16 tanks transcend almost every waste type and every tank farm in the 200 East and West Areas. They contain mostly sludge. These ungrouped tanks represent 2,502,000 gallons of waste—203,000 gallons of salt cake and 2,287,000 gallons of sludge. Several of these tanks have significant quantities of waste in them, while others have relatively little waste. Many of these tanks are probably related to some of the groups previously described.

4.0 Statistical Verification of the SORWT Model

The validity of the SORWT grouping model was tested by performing a statistical analysis verification study on a limited amount of core sample data, which came from earlier studies (Winters et al. 1989, 1990; Hill et al. 1991). It is important to note that, at the time these core samples were collected, there existed only the capability to sample relatively soft sludge-like wastes. Therefore, the statistical verification study is based upon core sample and analysis data from only sludge wastes and does not, at this time, include data from salt cake wastes. Furthermore, the core data used in the verification study was the core composite data. Core composites are composed of homogenized aliquots of segment material from various depths.

Evaluation of the SORWT model was only one of the driving factors in tank selection. The full rationale and justification for the requested core samples can be found in Hill et al. (1991). Due to sampling difficulties and changes in programmatic priorities, not all of the tanks requested for sampling in Hill et al. (1991) were actually sampled.

This section outlines the approach used for evaluating the model, including the analytical data sources, a graphical description of the data set, a summary of the characteristics of the waste types, and the analysis of variance (ANOVA) results and descriptive statistics of the grouped data.

4.1 Approach to Verification of the SORWT Model

Once the analytical results were arranged into groups as predicted by the SORWT model (as discussed in Section 3), an ANOVA was performed on the grouped data for a selected number of analytes. An ANOVA is a quantitative method to test the significance of the effect a particular treatment has on the response or dependent variable. In the SORWT model verification study, the treatment being studied is SORWT groups, and the dependent variable is analyte concentration. The ANOVA method was used to test whether the mean concentration of a particular SORWT group is statistically significantly different from the mean concentration of other SORWT groups. The null hypothesis tested by this statistical model was as follows:

> The deviations between the means of the different groups were due only to random variation within the entire data set.

If the null hypothesis was proved valid, then no group effects were present, and the SORWT model would be discredited. However, if the null hypothesis was proved incorrect, then the converse would be true (i.e., group effects are present and the SORWT model methodology is supported by the data). If significant group effects were observed, a Tukey pairwise comparison was conducted to investigate groups that differed significantly from the others.

In addition to the ANOVA, the magnitude of the individual analyte variances within the SORWT groups was investigated. These variances were compared to the variance results for the entire ungrouped data set. A reduction in the individual analyte variances by grouping the data according to SORWT further suggests that the SORWT model accurately predicts tank groups that exhibit similar chemical concentrations.

4.1.1 Analytical Data Sources for the Verification Study

The analytical results data utilized in the SORWT model verification study were obtained from the official core sample data packages produced by the Hanford analytical laboratories in support of the WHC Tank Waste Characterization Program. The SSTs and SORWT groups that were used in the verification study can be found in Table 4.1. The associated source documents from which analytical results data were obtained are summarized in Table 4.2. Tanks C-112, C-109, U-110, and T-107 were also core sampled. Although C-112 and C-109 were predicted to belong to the same SORWT group, incomplete sampling recoveries, a more complex waste processing history, and in-tank aging resulted in analytical data exhibiting larger than normal variability for most analytes. These dissimilarities are discussed in the respective tank characterization reports for these tanks (Simpson et al. 1993 a,b). U-110 was not included in the verification study because of uncertainty in the accuracy of the data. The U-110 cores were the first samples to be analyzed and there were significant problems in extracting the cores from the tank. T-107 was excluded from the SORWT model evaluation because of difficulties in sample recovery and incompleteness of the data set.

When the C-112 and C-109 (Group XIII) data were included in the data set, the ANOVA study showed that only Group XIII was significantly different from the remaining groups. The differences among the remaining groups were masked by the substantially larger variability in the Group XIII data. When the Group XIII data were not included in the data set, the significance of the differences between the SORWT groups could be tested against a more reasonable residual variability. Because of the disparate nature of the data associated with these tanks and the masking effect on the ANOVA study, C-112 and C-109 were not included in the statistical verification study.

Table 4.1. SORWT Groups and Tanks Included in Verification Study

Group No.	Tank No.	Primary Waste Type	Secondary Waste Type
VII	B-201 B-202	224	
IV	S-104	R	
XII	C-110 BX-107	1C	TBP
XV	T-111	2C	224
XVI	B-110 B-111	2C	5-6

Table 4.2. Core Sample Analytical Data Sources

Group No.	Tank No.	Core No.	Source
XII	C-110	37	Remund, K. M., L. Jensen. Statistical Characterization Report for Single-Shell Tank 241-C-110. Rev. 0. WHC-SD-WM-TI-585, Westinghouse Hanford Company, Richland, Washington.
XII	C-110	38	Remund, K. M., L. Jensen. Statistical Characterization Report for Single-Shell Tank 241-C-110. Rev. 0. WHC-SD-WM-TI-585, Westinghouse Hanford Company, Richland, Washington.
XII	C-110	39	Remund, K. M., L. Jensen. Statistical Characterization Report for Single-Shell Tank 241-C-110. Rev. 0. WHC-SD-WM-TI-585, Westinghouse Hanford Company, Richland, Washington.
XII	BX-107	40	WHC-EP-0739, Westinghouse Hanford Company, Richland, Washington.
XII	BX-107	40	WHC-SD-WM-TI-603, Rev. 0, Westinghouse Hanford Company, Richland, Washington.
XII	BX-107	41	WHC-EP-0739, Westinghouse Hanford Company, Richland, Washington.
XII	BX-107	41	WHC-SC-WM-TI-603, Rev. 0, Westinghouse Hanford Company, Richland, Washington.
VII	B-201	26	June 27, 1992. SST Waste Characterization Project: Core 26. Addendum 1A. Rev. 0. WHC-SD-WM-DP-037, Westinghouse Hanford Company, Richland, Washington.
VII	B-201	27	June 27, 1992. SST Waste Characterization Project: Core 27. Addendum 1A. Rev. 0. WHC-SD-WM-DP-037, Westinghouse Hanford Company, Richland, Washington.
VII	B-202	24	Ottmar, L., T. Frazier. January 23, 1992. 222-S Laboratory Analytical Batch: Core 24, Comp 1. Rev. 0. WHC-SD-WM-DP-034, Westinghouse Hanford Company, Richland, Washington.
VII	B-202	24	Ottmar, L., T. Frazier. January 23, 1992. 222-S Laboratory Analytical Batch: Core 24, Comp 2. Rev. 0. WHC-SD-WM-DP-034, Westinghouse Hanford Company, Richland, Washington.
VII	B-202	24	Wels, B., S. K. McFarland. June 11, 1992. 222-S Laboratory Analytical Batch: Core 24, Comp 1-Rework. Rev. 0. WHC-SD-WM-DP-034, Westinghouse Hanford Company, Richland, Washington.
VII	B-202	25	Ottmar, L., T. Frazier. January 23, 1992. 222-S Laboratory Analytical Batch: Core 25, Comp 1. Rev. 0. WHC-SD-WM-DP-034, Westinghouse Hanford Company, Richland, Washington.
VII	B-202	25	Ottmar, L., T. Frazier. January 23, 1992. 222-S Laboratory Analytical Batch: Core 25, Comp 2. Rev. 0. WHC-SD-WM-DP-034, Westinghouse Hanford Company, Richland, Washington.
VII	B-202	25	Wels, B., S. McFarland. June 11, 1992. 222-S Laboratory Analytical Batch: Core 25, Comp 2-Rework. Rev. 0. WHC-SD-WM-DP-034, Westinghouse Hanford Company, Richland, Washington.
XVI	B-110	1	Jones, T. E. May 14, 1990. SST Waste Characterization Project: Core 1 Data Report. Rev. 2. Pacific Northwest Laboratory, Richland, Washington.

Table 4.2. (contd)

Group No.	Tank No.	Core No.	Source
XVI	B-110	2	Jones, T. E., S. G. McKinley, J. M. Tingey, T. M. Longaker, J. A. Gibson. October 2, 1990. SST Waste Characterization Project: Core 2 Data Report. Rev. 1. Pacific Northwest Laboratory, Richland, Washington.
XVI	B-110	3	Jones, T. E., S. G. McKinley, J. M. Tingey, T. M. Longaker. September 7, 1990. SST Waste Characterization Report: Core 3 Data Report. Rev. 1. Pacific Northwest Laboratory, Richland, Washington.
XVI	B-110	4	Jones, T. E., S. G. McKinley, J. M. Tingey, T. M. Longaker, J. A. Gibson. October 19, 1990. SST Waste Characterization Report: Core 4 Data Report. Rev. 1. Pacific Northwest Laboratory, Richland, Washington.
XVI	B-110	9	Jones, T. E., S. G. McKinley, J. M. Tingey, T. M. Longaker, J. A. Gibson. December 5, 1990. SST Waste Characterization Report: Core 9 Data Report. Rev. 0. Pacific Northwest Laboratory, Richland, Washington.
XVI	B-110	10	Jones, T. E., S. G. McKinley, J. M. Tingey, T. M. Longaker, J. A. Gibson. January 7, 1990. SST Waste Characterization Report: Core 10 Data Report. Rev. 0. Pacific Northwest Laboratory, Richland, Washington.
XVI	B-110	16	Jones, T. E., S. G. McKinley, J. M. Tingey, T. M. Longaker, J. A. Gibson, B. M. Thornton. February 19, 1990. SST Waste Characterization Report: Core 16 Data Report. Rev. 0. Pacific Northwest Laboratory, Richland, Washington.
XVI	B-111	29	McKinley, S. G., L. R. Greenwood, E. W. Hoppe, R. T. Steele, J. M. Tingey, M. W. Urie. June 30, 1990. SST Waste Characterization Project: Cores 29 & 30 Data Report. Rev. 0. Pacific Northwest Laboratory, Richland, Washington.
XVI	B-111	29	April 15, 1993. SST Waste Characterization Project: Core 29. Addendum 1A. Rev. 0. WHC-SD-WM-DP-041, Westinghouse Hanford Company, Richland, Washington.
XVI	B-111	30	McKinley, S. G., L. R. Greenwood, E. W. Hoppe, R. T. Steele, J. M. Tingey, M. W. Urie. June 30, 1990. SST Waste Characterization Project: Cores 29 & 30 Data Report. Rev. 0. Pacific Northwest Laboratory, Richland, Washington.
IV	S-104	42	WHC-SD-WM-DP-031, Rev. 0, Westinghouse Hanford Company, Richland, Washington.
IV	S-104	43	WHC-SD-WM-DP-031, Rev. 0, Westinghouse Hanford Company, Richland, Washington.
IV	S-104	44	WHC-SD-WM-DP-031, Rev. 0, Westinghouse Hanford Company, Richland, Washington.
XV	T-111	31	WHC-SD-WM-DP-024, Westinghouse Hanford Company, Richland, Washington.
XV	T-111	33	WHC-SD-WM-DP-024, Westinghouse Hanford Company, Richland, Washington.

This situation may likely occur in the future due to the incomplete and sometime contradictory nature of some of the source data used in the sorting methodology, as well as deficiencies in the sampling and analytical procedures. However, it is expected that the majority of the tanks have been accurately grouped using the SORWT methodology. In the case of C-112 and C-109, it is uncertain what revisions to the tank groups should be made at this time. There are several possible outcomes. 1) This could be a poor group and all tanks should be shifted to the ungrouped category. 2) One of these tanks does not group with the others and only this tank should be shifted to the ungrouped category. It is impossible to know at this time which tank would not belong. 3) This is still a group, but the within group variability is large. The remaining tanks in this group have all been core sampled. When the analytical data on these samples are available, the appropriate response can be determined.

The core sample data packages contain a great deal of analytical data measured using several alternative digestion methods and analytical instrumentation. These measurements were often taken both on segment level aliquots and on core composites, which represent the nominal or average composition of an entire core. Since the SORWT model verification study is interested in comparing the differences between the mean nominal composition of one group versus the mean nominal composition of other groups, only core composite data for the analytes that significantly contribute to the overall character of the waste were considered. The analytes included in the verification study, along with the sample preparation method and analytical instrumentation, are presented in Table 4.3.

The analytical results data for the tanks and analytes included in the verification study were entered into a spreadsheet. The spreadsheet datafile used in the statistical analyses has been included in Appendix C. The first column identifies the SORWT group to which a tank belongs. Column 2 identifies the tank from which a particular core was sampled. Column 3 presents the core number of the analyzed sample. Core numbers have been assigned sequentially for each core sampled from Hanford Site waste tanks since 1989. Columns 4 and 5, respectively, identify the composite and sample from which analyses were obtained. Often, two separate but equivalent core composites were generated for a single core to investigate the ability to generate representative core composites. The analytical results for multiple core composites from a single core generally agree with one another. In addition, the analyses were conducted in duplicate for a particular sample. Occasionally, multiple samples for a single composite were analyzed. A complete set of Group No., Tank No., Core No., Composite No., and Sample No. represents a unique case of data. Columns 6 through 25 present the analytical results data for the analytes of interest. With the exception of ^{137}Cs, ^{90}Sr, and $^{239/240}Pu$, which are reported in units of μCi/g, all results are presented in units of μg/g. Column 26 presents the measured pH of the composite sample. The "." symbol represents missing data. If the data in the official core sample data packages were reported as below detection limit, then the detection limit was entered into the spreadsheet.

Bulk density was not reported for core composites in the data packages. Density was usually reported for each individual segment as it was extruded. Since the horizon for which density was measured is fundamentally different from the core composite analytical data, a separate spreadsheet was created for the density measurements. These data have also been presented in Appendix C.

Table 4.3. Analytes, Sample Preparation, and Analytical Method Used in the SORWT Model Verification Study

Analyte	Sample Digestion Method	Analytical Method
Al	Fusion Dissolution	Inductively Coupled Plasma/Atomic Emission Spectroscopy (ICP/AES)
Bi	Fusion Dissolution	ICP/AES
Cr	Fusion Dissolution	ICP/AES
Fe	Fusion Dissolution	ICP/AES
La	Fusion Dissolution	ICP/AES
Mn	Fusion Dissolution	ICP/AES
Na	Fusion Dissolution	ICP/AES
Pb	Fusion Dissolution	ICP/AES
Si	Fusion Dissolution	ICP/AES
Zr	Fusion Dissolution	ICP/AES
U	Fusion Dissolution	Laser Fluorimetry
PO_4 (aq)	Water Digestion	Ion Chromatography
NO_3	Water Digestion	Ion Chromatography
NO_2	Water Digestion	Ion Chromatography
F	Water Digestion	Ion Chromatography
Cl	Water Digestion	Ion Chromatography
TOC	Water Digestion	Furnace Combustion
	Direct Sample	Persulfate Oxidation
^{137}Cs	Fusion Dissolution	Gamma Energy Analysis (GEA)
^{90}Sr	Fusion Dissolution	Chemical Separations and Beta Counting
$^{239/240}Pu$	Fusion Dissolution	Alpha Energy Analysis

The first column reports the SORWT Group No. to which a particular tank is predicted to belong. The second column identifies the Tank No., and the final column reports the individual density measurements for each tank.

4.1.2 Graphical Description of the Verification Data Set

The data set utilized in the SORWT model verification study consists of 109 separate cases with 22 total measurements per case for a total of 2398 pieces of information to analyze. This is a rather large amount of information to assess and is only a small subset of the total data available. A useful tool for summarizing and understanding large data sets is a box plot, which is a graphical representation of the spread or variance in a given data set. Figure 4.1 is an example of a box plot for sodium (Na).

The example box plot shows the spread in the Na data for the five different SORWT groups included in the verification study. The vertical axis is Na concentration presented in units of $\mu g/g$. The horizontal axis represents the five different SORWT groups. The spread in the data is depicted by a box and whiskers plot. The median of a set of data is marked by a horizontal line in the box. The lower and upper hinges comprise the edges of the central box. The median splits the ordered set of data in half such that 50% of the values are above the median and 50% are below. The hinges split the remaining halves in half again such that the interior of the box represents 50% of the data. If we define the hinge-spread as the absolute value of the difference between the two values of the upper and lower hinges, the whiskers show the range in values that fall within 1.5 hinge-spreads of the hinges. Any data further than 1.5 hinge-spreads from the hinges are outliers and plotted as asterisks (*). Values that are more than three hinge-spreads away from the hinges are considered far outliers and plotted as open circles. Examples of both these types of outliers can be seen in Figure 4.1.

As can be clearly seen in the figure, the median value and range of values for analytes in some of the SORWT groups are substantially different from other SORWT groups. It is also clear that not all groups are different from one another for all analytes. It would appear that Groups XII and XVI show comparable Na concentrations and that Groups VII and XV are indistinguishable from one another. However, the spread of values from Groups XII and XVI do not approach the spread of values of Groups VII and XV. Group IV appears to be different from all the other groups presented.

Similar box plots were generated for each analyte included in the SORWT model verification study. These box plots have been presented as Appendix D. A review of these plots shows behavior similar to the example. The differences among groups for some of the analytes is quite striking. For aluminum, the concentration of Group IV is several times that of the other groups as would be expected for REDOX waste, since the REDOX solvent extraction process used aluminum nitrate as a salting agent. Lanthanum is another interesting plot. There is virtually no La in Groups XII, XVI, or IV, but there is a substantial concentration in Group VII and a lesser amount in Group XV. Again, this behavior is expected from process knowledge. A rare earth fraction (La) was used in a carrier precipitate in the Bismuth Phosphate 224 Building Plutonium Concentration Process, and Group VII is exclusively 224 waste, and 224 waste is the secondary waste in Group XV.

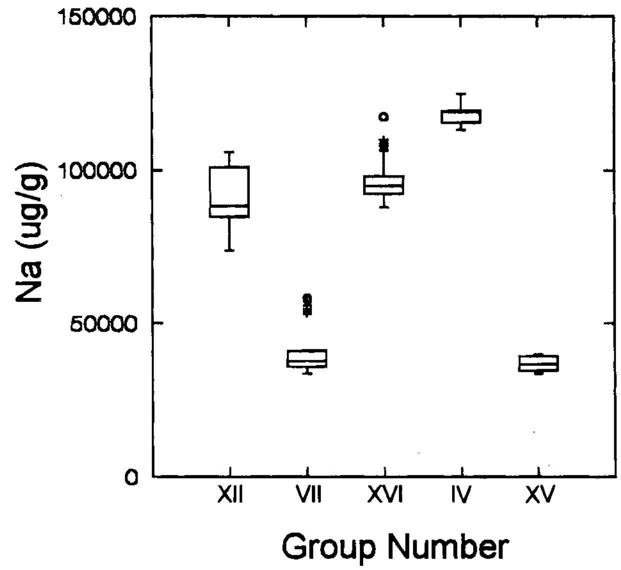

Figure 4.1. Box Plot of Sodium Concentration by SORWT Group

4.1.3 Characteristics of Waste Types Included in SORWT Verification Study

The five SORWT groups included in the verification study contain combinations of six different primary and secondary waste types (Table 4.1). These six different waste types are 224, 1C, 2C, TBP, 5-6, and R. The identifying characteristics of these six wastes are described below. These descriptions are based on Anderson (1990), Schneider (1951), discussions with senior technical staff, and information found in Appendix B of this document, which also provides a nominal composition for most major waste types.

4.1.3.1 Characteristics of 224 Waste

224 waste is from the final decontamination and concentration stage of the $BiPO_4$ process. Plutonium was decontaminated by oxidizing it with potassium permanganate and precipitating the byproducts with lanthanum fluoride. The decontaminated Pu-bearing solution was then reduced with ferrous ammonium sulfate, and the final product was precipitated with lanthanum fluoride. Lanthanum is the key indicator of 224 waste because this was the only stage at which La was introduced to the Hanford waste tanks. Manganese is a good analyte to differentiate from other $BiPO_4$ waste because permanganates were used as oxidizing agents only during the final decontamination and concentration stage.

224 waste will also contain appreciable amounts of Bi, Cr, Fe, and PO_4 from additions to the product stream in earlier $BiPO_4$ stages. These four analytes are characteristic of all $BiPO_4$ wastes.

Bismuth was added as both sodium bismuthate (strong oxidizer) and bismuth phosphate (precipitation agent). Iron was added in the form of ferrous ammonium sulfamate as a Pu reducing agent. Chromium was added in the form of sodium dichromate as a stabilizing oxidizer for the stronger sodium bismuthate. Although greater concentrations of fluoride ions in 224 waste would be expected relative to other $BiPO_4$ wastes because of the lanthanum fluoride precipitations, there are also appreciable amounts of fluoride ions in 1C and 2C wastes. Less U would be expected in 224 waste than earlier decontamination cycle wastes because the U is generally removed in the earlier stages of the process. According to the nominal compositions found in Appendix B, an order of magnitude lower concentration of PO_4 in 224 waste relative to other $BiPO_4$ wastes might be expected.

4.1.3.2 Characteristics of 1C Waste

1C waste is the aqueous solution remaining after the first product decontamination cycle of the $BiPO_4$ process. Nearly all of the U and 90% of the fission products were previously removed from the stream as metal waste. 1C wastes contained 10% of the fission products and 1% of the Pu (Anderson 1990). This waste type contains appreciable amounts of Bi, Cr, Fe, and PO_4 added as process chemicals for reasons detailed above. Cladding waste generated from the removal of aluminum cladding from the fuel slugs was added in many cases to the 1C waste and comprised approximately 24% of the waste stream. Thus, there may be instances where the model misclassifies a tank or number of tanks with 1C waste, depending on if CW was commingled and this fact was not well documented. The aluminum cladding was dissolved in a solution of sodium nitrate/sodium hydroxide. Therefore, much greater concentrations of Al, Na, and NO_3 relative to other $BiPO_4$ wastes would be expected in comparison with 1C/CW effluent streams. The CW was intended to contain few fission products; La and Mn would not be expected to be found in 1C waste.

4.1.3.3 Characteristics of 2C Waste

2C waste is the aqueous solution remaining after a second decontamination of the product cake from the first decontamination in the $BiPO_4$ process. 2C waste should have similar characteristics as 1C waste but with fewer fission products. This waste type contains appreciable amounts of Bi, Cr, Fe, and PO_4 added as process chemicals for reasons detailed for 224 waste. Anderson (1990) claims that 2C waste contains only 0.1% of the fission products and 1% of the Pu. This is consistent with the notion that most of the fission products would have been removed from the product stream in the previous decontamination cycle. 2C waste did NOT have CW added to the waste stream, so there should be a noticeable decrease in the Al, Na, and NO_3 concentrations relative to 1C wastes; La and Mn would not be expected to be found in 2C waste.

4.1.3.4 Characteristics of TBP Waste

Tributyl phosphate waste was generated as a result of the extraction process at U Plant to recover uranium metal from the metal waste produced in the $BiPO_4$ process. This waste was composed of concentrated, neutralized aqueous effluents from the primary extraction column and from the solvent wash. TBP waste should contain very little Pu and a larger concentration of U relative to other $BiPO_4$ wastes; La and Mn would not be expected to be found in TBP waste.

4.1.3.5 Characteristics of 5-6 Waste

In Appendix B, 5-6 is described as a very hot waste that collected in the bottom of Section 5 at B Plant as a result of boilover during dissolving and neutralization during the $BiPO_4$ process. This is not a very detailed description; however, "a very hot waste" can be assumed to mean a relatively large concentration of fission products. Also, this waste would have a relatively large concentration of Na and NO_3 from the dissolution in HNO_3 and neutralization with NaOH.

Further research has revealed that this waste could also be dilute MW, dilute 1C waste, or water from canyon deck flushes or cooling/heating coil leakage. According to the Bismuth Phosphate manual, the 5-6 waste was to be sent to the concrete 361 tank and overflow to ground like the 224 waste if it was low in radioactivity; or sent to the 1C cascade if it was high in radioactivity, according to George Borsheim, WHC. The highly variable composition of 5-6 waste raises some doubt on whether 5-6 should be considered a characteristic waste.

4.1.3.6 Characteristics of R Waste

R waste is the high-level fraction of the process waste generated in the REDOX process. The REDOX process was a fundamentally different process from the $BiPO_4$ process and generated characteristically different wastes. REDOX was an organic solvent extraction based process. REDOX was more efficient than $BiPO_4$ and generated high-level wastes that were much more concentrated in fission products. In fact, the concentrations of fission products were so great that R waste often generated enough heat to self-boil. The reduction and oxidation of the product Pu was generally carried out in the smaller volume organic phase and required fewer process chemicals.

One characteristic expected in R waste would be high Al concentrations from a compound commonly known as ANN (aluminum nitrate nono hydrate) although likely not as high as CW. This compound was added to Pu and U bearing solutions as a salting agent, enabling Pu to be extracted into the organic phase (hexone). Other characteristics expected of R waste would be the presence of Cr and Fe added as oxidizing (dichromates) and reducing agents (ferrous ammonium sulfamate), respectively.

A significantly lower concentration of Fe relative to the $BiPO_4$ wastes would be expected because the reduction of Pu was conducted in a much smaller volume organic phase in the REDOX process and required smaller amounts of ferrous ammonium sulfamate. Another contrast with $BiPO_4$ wastes would be the absence of Bi and La and a drastically smaller concentration of PO_4. A higher concentration of NO_3, relative to most $BiPO_4$ wastes, would also be expected.

4.2 Analysis of Variance Results

The ANOVA performed for each analyte included in the SORWT model verification study used the general linear model of the SYSTAT for Windows[a] statistical data analysis software package. If a significant grouping effect was observed, then a Tukey pairwise comparison was also conducted for each analyte to investigate which groups were significantly different from the others. The output reports generated by the statistical software for each analyte are presented in Appendix E. Each page of Appendix E represents the analysis of a different analyte; the top portion of each page displays the ANOVA table.

The ANOVA table provides two estimates for the variance, one between groups and one within groups. If the null hypothesis (i.e., no differences between SORWT groups) is accurate, then the estimate for the between-group variance should be similar in magnitude to the within-group estimate of the variance. Conversely, if the between-group estimate of the variance is significantly greater than the within-group estimate, then the null hypothesis would be untenable, and some of the between-group variation must be caused by real differences between treatment groups.

The F-Ratio is defined as the ratio of the between-treatment variance (mean sum of the squares) and the within-treatment variance. (This value is also reported in the ANOVA table.) This ratio should follow an F distribution for the appropriate numbers of degrees of freedom. The significance of the F-Ratio is called a P-value and can be determined from the relevant F distribution. The significance is the fractional probability of the F-Test ratio happening only by random chance. The benchmark probabilities typically used to test the significance of differences between means is 5% and 1%, which correspond to significances of 0.05 and 0.01. For the purposes of the SORWT model verification study, the 5% benchmark was selected. If the significance is greater than the benchmarks, then the differences between treatment means can be explained by random chance. If the significances are below the benchmarks, then the discrepancies between treatment means cannot be explained by random chance, and real differences exist between the subject groups. The P-Value for each analyte is included in the ANOVA table.

A summary of the ANOVA results for each of the analytes tested is presented in Table 4.4. As shown in Table 4.4, all 22 analytes and measurements listed have a significance well below the benchmark 5% level. In fact, all but two analytes have a significance below 0.1%. Table 4.4 indicates there is virtually no probability that the differences between the means of the SORWT groups are due only to random chance. Therefore, the null hypothesis is invalid, and the data strongly support the premise that SORWT groups exist.

Since a significant grouping effect was observed, a Tukey pairwise comparison was performed to identify which groups were significantly different from one another. This comparison can be found on the bottom portion of each page in Appendix E. The Tukey pairwise comparison first generates a matrix of pairwise mean differences. These are the differences between the mean concentrations of a

(a) SYSTAT for Windows is a registered trademark of SYSTAT, Inc.

Table 4.4. Summary of ANOVA for SORWT Verification Study

Analyte	F-Test Ratio	Significance (P-value)	Group VII Mean (μg/g)	Group IV Mean (μg/g)	Group XII Mean (μg/g)	Group XV Mean (μg/g)	Group XVI Mean (μg/g)
Al	5,514.85	0.000	3,490	117,000	14,323	570	1,425
Bi	45.15	0.000	61,753	39	17,356	23,563	19,354
Cr	199.78	0.000	2,835	2,353	685	1,799	854
Fe	75.35	0.000	10,156	1,424	10,812	18,038	17,486
La	2,284.41	0.000	13,592	9	8	4,108	74
Mn	64.67	0.000	14,508	1,150	58	6,283	97
Na	385.20	0.000	41,364	118,250	91,133	36,950	96,359
Pb	15.11	0.000	1,125	39	181	365	750
Si	5.58	0.000	15,648	1,326	6,933	5,565	10,173
Zr	3.76	0.007	29	21	153	4	134
U	11.95	0.000	414	6,685	4,249	2,555	209
PO_4 (aq)	59.63	0.000	1,706	1,310	22,256	15,538	24,555
NO_3	47.38	0.000	56,589	186,300	121,261	41,238	145,000
NO_2	21.38	0.000	719	25,730	7,638	897	22,910
F	206.39	0.000	6,134	132	8,261	2,301	1,761
Cl	106.63	0.000	1,225	3,162	1,116	450	1,153
TOC	5.38	0.001	8,768	1,606	739	3,119	634
			(μCi/g)	(μCi/g)	(μCi/g)	(μCi/g)	(μCi/g)
^{137}Cs	7.34	0.000	0.403	62.308	18.533	0.166	40.638
^{90}Sr	64.54	0.000	3.17	309.583	7.188	5.414	133.436
$^{239/240}Pu$	13.92	0.000	0.606	0.282	0.07	0.139	0.107
			(g/ml)	(g/ml)	(g/ml)	(g/ml)	(g/ml)
Density	13.89	0.000	1.171	1.64	1.286	1.235	1.271
pH	84.88	0.000	NA	12.803	10.631	11.65	8.221

pair of groups. The routine then compares this difference to the mean square error for the analyte calculated from the ANOVA table and calculates a P-value (probability) that the difference between the mean concentrations of any two groups is due to random chance. These P-values are presented as the matrix at the bottom of each page in Appendix E.

Tables 4.5 and 4.6 present a summary of the Tukey pairwise comparisons. These tables respectively present the number of analytes that are significantly different between any pair of SORWT

Table 4.5. Number of Analytes Showing Significant Difference Between Groups

Group No.	VII	IV	XII	XV
IV	18			
XII	14	12		
XV	10	14	9	
XVI	16	13	8	9

Table 4.6. Analytes Showing Significant Concentration Difference Between Groups

Group No.	VII	IV	XII	XV
IV	Al, Bi, Cr, Fe, La, Mn, Na, Pb, Si, ^{137}Cs, ^{90}Sr, $^{239/240}Pu$, U, NO_3, NO_2, F, Cl, TOC			
XII	Al, Bi, Cr, La, Mn, Na, Pb, Si, $^{239/240}Pu$, U, PO_4 (aq), NO_3, F, TOC	Al, Bi, Cr, Fe, Na, ^{137}Cs, ^{90}Sr, PO_4 (aq), NO_3, NO_2, F, Cl		
XV	Bi, Cr, Fe, La, Mn, Pb, $^{239/240}Pu$, PO_4 (aq), F, Cl	Al, Bi, Cr, Fe, La, Mn, Na, ^{137}Cs, ^{90}Sr, PO_4 (aq), NO_3, NO_2, F, Cl	Al, Cr, Fe, La, Mn, Na, NO_3, F, Cl	
XVI	Al, Bi, Cr, Fe, La, Mn, Na, Pb, ^{137}Cs, $^{239/240}Pu$, PO_4 (aq), NO_3, NO_2, F, TOC, ^{90}Sr	Al, Bi, Cr, Fe, Na, Pb, Si, ^{90}Sr, U, PO_4 (aq), NO_3, F, Cl	Al, Fe, Na, Pb, ^{90}Sr, U, NO_2, F	Cr, La, Mn, Na, ^{90}Sr, PO_4 (aq), NO_3, NO_2, Cl

groups and a listing of which analytes differ significantly in the pair. As shown in Table 4.5, 18 out of 20 analytes were significantly different between Group VII and Group IV. The smallest number of analytes that were significantly different between groups was eight analytes when comparing Group XVI to Group XII. More than half the analytes considered in this study were significantly different for 7 of the 10 pairwise comparisons. This is another strong indication that the grouping methodology utilized by the SORWT model predicts real differences between the characteristics of tank groups. Density and pH were not included in these Tukey summary tables.

4.3 Descriptive Statistics of SORWT Group Data

In addition to the ANOVA study, descriptive statistics were calculated for each analyte by SORWT group. The descriptive statistics routine provides useful information such as number of cases, maximum and minimum values, range of values, mean values, standard deviations, variance, and coefficient of variance (CV). The report outputs from this routine for each group and analyte are included as Appendix F.

A comparison between the ungrouped composite results and the SORWT group results is summarized in Table 4.7. This table presents the analyte mean value and the CV for the ungrouped data and

Table 4.7. Nominal Compositions of Five SORWT Groups

Analyte	Group VII Mean (µg/g)	C.V.	Group IV Mean (µg/g)	C.V.	Group XII Mean (µg/g)	C.V.	Group XV Mean (µg/g)	C.V.	Group XVI Mean (µg/g)	C.V.	Overall Mean (µg/g)	C.V.
Al	3,490	1.35	117,000	0.034	14,323	0.099	570	0.189	1,425	0.692	17,418	2.11
Bi	61,753	0.528	38.8	0.192	17,356	0.305	23,562	0.138	19,354	0.127	24,079	0.927
Cr	2,835	0.22	2,353	0.062	685	0.393	1,799	0.043	854	0.163	1,399	0.63
Fe	10,156	0.487	1,424	0.469	10,812	0.13	18,038	0.121	17,486	0.188	13,281	0.469
La	13,592	0.092	9.41	0.117	7.97	0.004	4,108	0.15	73.6	0.302	2,599	1.94
Mn	14,508	0.574	1,150	0.336	58.1	0.298	6,282	0.042	97.2	0.26	3,072	2.05
Na	41,364	0.206	118,250	0.031	91,133	0.105	36,950	0.073	96,359	0.061	84,305	0.323
Pb	1,125	0.574	38.6	0.076	181	0.828	365	0.288	750	0.732	600	0.969
Si	15,648	1.34	1,326	0.282	6,933	0.105	5,565	0.056	10,173	0.264	9,122	1.04
Zr	28.9	0.959	21.2	0.463	153	0.295	4	0.002	134	1.6	96.6	1.63
U	414	0.561	6,685	0.103	4,249	1.7	2,555	0.481	209	0.164	2,130	1.87
PO_4 (aq)	1,706	0.289	1,310	0.352	22,256	0.523	15,538	0.1	24,555	0.067	14,591	0.806
NO_3	56,589	0.131	186,300	0.076	121,261	0.15	41,238	0.079	145,000	0.361	112,950	0.503
NO_2	719	0.286	25,730	0.122	7,638	0.602	897	0.198	22,910	0.756	12,091	1.16
F	6,134	0.073	132	0.346	8,261	0.206	2,301	0.377	1,761	0.147	4,179	0.756
Cl	1,225	0.38	3,162	0.05	1,116	0.332	450	0.102	1,153	0.152	1,351	0.594
TOC	8,768	1.42	1,606	0.35	739	0.323	3,119	0.255	634	0.675	2,416	2.31
	(µCi/g)		(µCi/g)		(µCi/g)		(µCi/g)		(µCi/g)		(µCi/g)	
^{137}Cs	0.403	1.11	62.3	0.053	18.5	0.263	0.166	0.377	40.6	1.39	28.8	1.48
^{90}Sr	3.17	0.595	310	0.081	7.19	0.409	5.414	0.372	133	0.751	92.4	1.31
$^{239/240}Pu$	0.606	0.897	0.282	0.373	0.07	0.432	0.139	0.051	0.107	0.185	0.231	1.39
	(g/ml)		(g/ml)		(g/ml)		(g/ml)		(g/ml)		(g/ml)	
Density	1.171	0.114	1.64	0	1.286	0.124	1.235	0.052	1.271	0.074	1.24	0.109
pH	NA	NA	12.8	0.074	10.6	0.063	11.6	0	8.22	0.054	10.4	0.186

each of the SORWT groups. The CV is defined as the standard deviation divided by the mean value. Since the CVs is normalized by its mean, all CVs are unitless and comparable to each other.

As shown in Table 4.7, there is a dramatic decrease in the CV for most analytes when the data have been categorized by SORWT group. This observation tends to strengthen the conclusion that the SORWT grouping methodology accurately identifies real distinctions between the waste characteristics of different groups.

4.4 Pairwise Comparisons

The analytical data from recent core samples collected from the waste tanks strongly support the validity of the SORWT model grouping methodology. Another qualitative observation that can be made from these data is to compare expected indicator analytes for the various waste types found in the tanks contained in the verification study with the analytical data from the same tanks. There will be certain differences in waste characteristics of the various SORWT groups that would be expected based upon the waste type. The expected differences can be confirmed or dismissed by the actual analytical data.

4.4.1 Expected Compositional Differences Between SORWT Groups

This section makes pairwise comparisons between SORWT groups and identifies expected differences in characteristics based upon the waste types making up a SORWT group. This effort is somewhat complicated, because three of the five SORWT groups included in the verification study have a primary and secondary waste type. Some qualitative interpretation is required to determine the influence the characteristics of each waste type has on the overall character of the group. It is important to note that very few SORWT groups, 4 out of 24, have only a primary waste type.

First, the expected characteristics of each SORWT group are determined. These determinations are made in a semi-quantitative fashion such that the concentrations of 12 analytes are placed into one of several categories: very high, high, medium, low, and none. The definitions of these categories are provided in Table 4.8.

The categories have slightly different definitions for radionuclides and nonradionuclides. The characteristics of each SORWT group included in the verification study were determined using the categories above and the descriptions of the each waste type from the previous section. Fission products are the sum of the ^{137}Cs and ^{90}Sr activity concentrations. The expected characteristics are summarized in Table 4.9. A pairwise order-of-magnitude comparison was then made between each SORWT group. These pairwise comparisons represent the expected differences between the analyte concentrations of the respective SORWT groups. The pairwise comparisons are also included in Table 4.9.

The comparisons listed in Table 4.9 are the expected concentration category of the row group relative to the expected concentration category of the column group. If the expected concentration

Table 4.8. Concentration Categories for Expected Characteristics

Nonradionuclides (μg/g)	Radionuclides (μCi/g)
100,000 < Very High 10,000 < High < 100,000 1,000 < Medium < 10,000 100 < Low < 1,000 None < 100	100 < High 10 < Medium < 100 Low < 10

Table 4.9. Pairwise Comparison of Expected Characteristics

SORWT Group	Characteristic Summary of SORWT Group	Comparison Analytes	Pairwise Comparison Group: Group VII	Group IV	Group XII	Group XV	Group XVI
	High Na	Al		--	--	0	0
	High NO_3	Bi		+++	0	0	0
	High La	Cr		0	0	0	0
	High Mn	Fe		+	0	0	0
	High Bi	La		+++	+++	+	+++
VII	High Fe	Mn		?	+++	+	+++
224	Medium PO_4	Na		-	-	0	-
	Medium Cr	U		-	-	0	0
	Medium F	NO_3		-	-	0	-
	Low Al	PO_4 (aq)		+	-	-	-
	Low U	F		?	0	0	0
	Low Fission Products	Fission Products		--	-	0	--
		Al	++		0	++	++
	Very High NO_3	Bi	---		---	---	---
	Very High Na	Cr	0		0	0	0
	High Al	Fe	-		-	-	-
	High Fission Products	La	---		0	--	0
IV	Medium Iron	Mn	?		?	?	?
R	Medium Cr	Na	+		0	+	0
	Medium U	U	+		0	+	+
	Low PO_4	NO_3	+		0	+	0
	No Bi	PO_4 (aq)	-		--	--	--
	No La	F	?		?	?	?
		Fission Products	++		+	++	0

Table 4.9. (contd)

SORWT Group	Characteristic Summary of SORWT Group	Comparison Analytes	Pairwise Comparison Group Group VII	Group IV	Group XII	Group XV	Group XVI
	Very High Na	Al	++	0		++	++
	Very High NO_3	Bi	0	+++		0	0
	High Al	Cr	0	0		0	0
	High Bi	Fe	0	+		0	0
	High PO_4	La	---	0		--	0
XII	High Fe	Mn	---	?		--	0
1C TBP	Medium U	Na	+	0		+	0
	Medium Fission Products	U	+	0		+	+
	Medium Cr	NO_3	+	0		+	0
	Medium F	PO_4 (aq)	+	++		0	0
	No La	F	0	?		0	0
	No Mn	Fission Products	+	-		+	-
	High Na	Al	0	--	--		0
	High NO_3	Bi	0	+++	0		0
	High Bi	Cr	0	0	0		0
	High PO_4	Fe	0	+	0		0
	High Fe	La	-	++	++		++
XV	Medium F	Mn	-	?	++		++
2C 224	Medium La	Na	0	-	-		-
	Medium Mn	U	0	-	-		0
	Medium Cr	NO_3	0	-	-		-
	Low Al	PO_4 (aq)	+	++	0		0
	Low U	F	0	?	0		0
	Low Fission Products	Fission Products	0	--	-		--
	Very High Na	Al	0	--	--	0	
	Very High NO_3	Bi	0	+++	0	0	
	High Bi	Cr	0	0	0	0	
	High PO_4	Fe	0	+	0	0	
	High Fe	La	---	0	0	--	
XVI	High Fission Products	Mn	---	?	0	--	
2C 5-6	Medium F	Na	+	0	0	+	
	Medium Cr	U	0	-	-	0	
	Low Al	NO_3	+	0	0	+	
	Low U	PO_4 (aq)	+	++	0	0	
	No La	F	0	?	0	0	
	No Mn	Fission Products	++	0	+	++	

category of the row group is an order of magnitude lower than the expected concentration group of the column, a "-" was placed in Table 4.9. If the concentration category difference was two orders of magnitude lower, then "--" was placed in the table. If the expected concentration of the row group was greater than the expected concentration of the column group, then a "+" was entered into the table. The number of symbols represents the number of orders of magnitude difference that would be expected between the concentrations of the respective groups. If there was no expected order of magnitude difference between the groups, a "0" was entered in the table. The "?" designates a comparison that could not be made due to lack of information. The pairwise comparison was made for each of the analytes listed in Table 4.9.

An example of determining the expected difference between two SORWT groups is the comparison of Bi between row Group VII and column Group IV. The Bi concentration of the row group is expected to be "high," whereas the expected concentration of Bi in the column group is expected to be "none." Therefore, the concentration of Bi in Group VII is expected to be three orders of magnitude greater than Group IV and would be notated in Table 4.9 as "+++."

4.4.2 Comparison of Observed and Expected Differences Between Different SORWT Groups

A similar exercise was accomplished for the observed characteristic differences between SORWT groups. First, the observed characteristics of the SORWT groups were determined using the concentration categories in Table 4.8 and the nominal compositions of the SORWT groups from Table 4.7.

The observed characteristics of the SORWT groups are summarized in Table 4.10. The pairwise comparison was then repeated for the observed characteristics using the same notation scheme, and the results are also presented in Table 4.10.

The observed group characteristics and pairwise comparison were then compared with the expected characteristics, and the results are summarized in Table 4.11. The majority of the observed characteristics matched the corresponding expected characteristics. Table 4.11 presents the ratio of number of analytes in agreement to the total number of analytes compared. This comparison was made for the group characteristics and each of the pairwise comparisons.

There is a minimum agreement between the observed and expected characteristics of 8 out of 10 analytes compared for Group IV and a maximum agreement of 11 out of 12 for Groups VII, XII, and XV. In fact, there was almost a 12-for-12 agreement with Group XII, except that the concentration of Na was just barely below the threshold (91,133 compared with 100,000) of the concentration category expected. The high degree of agreement between the observed characteristics determined by laboratory analyses for each SORWT group and the expected characteristics based solely on the waste types is further evidence that the SORWT grouping methodology is accurately and effectively predicting real distinctions between groups of tanks.

Table 4.10. Pairwise Comparison of Observed Characteristics

SORWT Group	Observed Characteristics of SORWT Group	Comparison Analytes	Pairwise Comparison Group				
			Group VII	Group IV	Group XII	Group XV	Group XVI
	High Na	Al		--	-	+	0
	High NO_3	Bi		+++	0	0	0
	High La	Cr		0	0	0	0
	High Mn	Fe		+	0	0	0
	High Bi	La		+++	+++	+	+++
VII	High Fe	Mn		+	+++	+	+++
224	Medium PO_4	Na		-	0	0	0
	Medium Cr	U		-	-	-	0
	Medium F	NO_3		-	-	0	-
	Medium Al	PO_4 (aq)		0	-	-	-
	Low Fission Products	F		+	0	0	0
	Low U	Fission Products		--	-	0	--
	Very High Al	Al	++		+	+++	++
	Very High NO_3	Bi	---		---	---	---
	Very High Na	Cr	0		0	0	0
	High Fission Products	Fe	-		-	-	-
	Medium Iron	La	---		0	--	0
IV	Medium Cr	Mn	-		++	0	++
R	Medium U	Na	+		+	+	+
	Medium PO_4	U	+		0	0	+
	Medium Mn	NO_3	+		0	+	0
	Low F	PO_4 (aq)	0		-	-	-
	No Bi	F	-		-	-	-
	No La	Fission Products	+		+	++	0
	Very High NO_3	Al	+	-		++	+
	High Na (~Very High)	Bi	0	+++		0	0
	High Al	Cr	0	0		0	0
	High Bi	Fe	0	+		0	0
	High PO_4	La	---	0		--	0
XII	High Fe	Mn	---	--		--	0
1C TBP	Medium U	Na	0	-		0	0
	Medium Fission Products	U	+	0		0	+
	Medium F	NO_3	+	0		+	0
	Medium Cr	PO_4 (aq)	+	+		0	0
	No La	F	0	+		0	0
	No Mn	Fission Products	0	-		+	-

Table 4.10. (contd)

SORWT Group	Observed Characteristics of SORWT Group	Comparison Analytes	Pairwise Comparison Group				
			Group VII	Group IV	Group XII	Group XV	Group XVI
	High Na	Al	-	---	--		-
	High NO_3	Bi	0	+++	0		0
	High Bi	Cr	0	0	0		0
	High PO_4	Fe	0	+	0		0
	High Fe	La	-	++	++		++
XV	Medium F	Mn	-	0	++		++
2C 224	Medium La	Na	0	-	0		0
	Medium Mn	U	+	0	0		+
	Medium Cr	NO_3	0	-	-		-
	Medium U	PO_4 (aq)	+	+	0		0
	Low Al	F	0	+	0		0
	Low Fission Products	Fission Products	-	--	-		--
	Very High NO_3	Al	0	--	-	+	
	High Na (~Very High)	Bi	0	+++	0	0	
	High Bi	Cr	0	0	0	0	
	High PO_4	Fe	0	+	0	0	
	High Fe	La	---	0	0	--	
XVI	High Fission Products	Mn	---	--	0	--	
2C 5-6	Medium F	Na	0	-	0	0	
	Medium Cr	U	0	-	-	-	
	Medium Al	NO_3	+	0	0	+	
	Low U	PO_4 (aq)	+	+	0	0	
	No La	F	0	+	0	0	
	No Mn	Fission Products	+	0	+	++	

Table 4.11. Comparison of Observed to Expected Characteristics

SORWT Group	Comparison of Group Characteristic Summaries	Pairwise Comparison Group				
		Group VII	Group IV	Group XII	Group XV	Group XVI
VII	11/12					
IV	8/10	9/10				
XII	11/12 (~12/12)	10/12	7/10			
XV	11/12	10/12	7/10	10/12		
XVI	10/12 (~11/12)	11/12	8/10	11/12	9/12	

5.0 Nominal Compositions and Inventory of Five SORWT Groups

The nominal compositions of Groups VII, IV, XII, XV, and XVI were determined by calculating a mean concentration for each of the analytes included in the verification study across the tanks sampled within a particular SORWT group. The variance around these average group concentrations was also calculated. The inventory for each group was determined by projecting the average concentration to the total waste volume of the group.

In Section 4, Table 4.7 describes the nominal compositions of Groups VII, IV, XII, XV, and XVI. The overall composition (the nominal composition of all tanks regardless of group) is also included for comparison. In this section, Tables 5.1 through 5.5 describe each group individually, along with the corresponding nominal composition. The description of each group includes the number of tanks, the name of each tank, the primary and secondary waste types, and the total waste volume.

The nominal compositions of each group are based on the 20 analytes studied. The density and pH of each group are also included for comparison. The mean concentrations and coefficients of variance were calculated using the data from all core composites analyzed within the appropriate group. The mean concentration is listed in micrograms of analyte per gram of waste with the exception of ^{137}Cs, ^{90}Sr, and $^{239/240}$Pu. These values are listed as microcuries of radioactivity per gram of waste.

The CV is defined as the standard deviation divided by the mean concentration. The mass of each analyte was determined using the mean density and total waste volume of the group, the mean concentration of the analyte, and a conversion factor to obtain the appropriate units. The mass of each analyte and the total mass are listed in kilograms. The following equations illustrate the calculations performed to obtain the inventories for each group. Subscript A indicates analyte properties, while subscript W indicates total waste properties.

$$\text{Mass}_W(\text{kg}_w) = \begin{matrix}\text{Total}\\ \text{Waste}\\ \text{Volume}\end{matrix}(\text{kgal}_W) * \frac{1{,}000\text{gal}_W}{\text{kgal}_W} * \frac{3.785\text{L}_W}{\text{gal}_W} * \frac{1{,}000\text{ml}_W}{\text{L}_W} * \text{Denisty}\frac{\text{g}_W}{\text{ml}_W} * \frac{\text{kg}_W}{1{,}000\text{g}_W}$$

$$\text{Mass}_A(\text{kg}_A) = \text{Mass}_W(\text{kg}_w) * \frac{1{,}000\text{g}_W}{\text{kg}_W} * \begin{matrix}\text{Analyte}\\ \text{Conc.}\end{matrix}\frac{\mu\text{g}_A}{\text{g}_W} * \frac{\text{g}_A}{10^6\mu\text{g}_A} * \frac{\text{kg}_A}{1{,}000\text{g}_A}$$

$$\text{Radioactivity}_A(\text{Ci}_A) = \text{Mass}_W(\text{kg}_w) * \frac{1{,}000\text{g}_W}{\text{kg}_W} * \begin{matrix}\text{Analyte}\\ \text{Activity}\\ \text{Conc.}\end{matrix}\frac{\mu\text{Ci}_A}{\text{g}_W} * \frac{\text{Ci}_A}{10^6\mu\text{Ci}_A}$$

Table 5.1. Nominal Composition and Inventory of Group VII

Description of Individual Tanks Within Group VII				
No. of Tanks: 8				
Tank Name	**Number of Cores Taken**	**Primary Waste Type**	**Secondary Waste Type**	**Waste Volume (kgal)**
B-201	2	224		29
B-202	2	224		27
B-203	0	224		51
B-204	0	224		50
T-201	0	224		29
T-202	0	224		21
T-203	0	224		35
T-204	0	224		38
Total:	4			280

Analyte Inventory and Mean Concentrations of Group VII			
Analytes	**Mean Concentration**	**Coeff. of Variance**	**Inventory**
	($\mu g/g$)		(kg)
Al	3,490	1.35	4,331
Bi	61,753	0.528	76,637
Cr	2,835	0.22	3,518
Fe	10,156	0.487	12,604
La	13,592	0.092	16,868
Mn	14,508	0.574	18,005
Na	41,364	0.206	51,334
Pb	1,125	0.574	1,396
Si	15,648	1.34	19,420
Zr	28.9	0.959	36
U	414	0.561	514
PO_4 (aq)	1,706	0.289	2,117
NO_3	56,589	0.131	70,228
NO_2	719	0.286	892
F	6,134	0.073	7,612
Cl	1,225	0.38	1,520
TOC	8,768	1.42	NA
	($\mu Ci/g$)		(Ci)
^{137}Cs	0.403	1.11	500
^{90}Sr	3.17	0.595	3,934
$^{239/240}Pu$	0.606	0.897	752
	(g/ml)		(kg)
Density	1.171	0.114	1,241,026
pH	NA	NA	

Table 5.2. Nominal Composition and Inventory of Group IV

Description of Individual Tanks Within Group IV				
No. of Tanks: 10				
Tank Name	**Number of Cores Taken**	**Primary Waste Type**	**Secondary Waste Type**	**Waste Volume (kgal)**
SX-112	0	R		92
SX-108	0	R		87
SX-107	0	R		104
SX-109	0	R		250
SX-115	0	R		12
SX-110	0	R		62
SX-111	0	R		125
SX-114	0	R		181
U-101	0	R		25
S-104	3	R		294
Total:	3			1,232
Analyte Inventory and Mean Concentrations of Group IV				
Analytes	**Mean Concentration**	**Coeff. of Variance**	**Inventory**	
	($\mu g/g$)		(kg)	
Al	117,000	0.034	894,759	
Bi	38.8	0.192	297	
Cr	2,353	0.062	17,995	
Fe	1,424	0.469	10,890	
La	9.41	0.117	72	
Mn	1,150	0.336	8,795	
Na	118,250	0.031	904,319	
Pb	38.6	0.076	295	
Si	1,326	0.282	10,141	
Zr	21.2	0.463	162	
U	6,685	0.103	51,124	
PO_4 (aq)	1,310	0.352	10,018	
NO_3	186,300	0.076	1,424,732	
NO_2	25,730	0.122	196,771	
F	132	0.346	1,009	
Cl	3,162	0.05	24,181	
TOC	1,606	0.35	12,282	
	($\mu Ci/g$)		(Ci)	
^{137}Cs	62.3	0.053	476,440	
^{90}Sr	310	0.081	2,370,730	
$^{239/240}Pu$	0.282	0.373	2,157	
	(g/ml)		(kg)	
Density	1.64	NA	7,647,517	
pH	12.8	0.074		

Table 5.3. Nominal Composition and Inventory of Group XII

Description of Individual Tanks Within Group XII				
No. of Tanks: 4				
Tank Name	**Number of Cores Taken**	**Primary Waste Type**	**Secondary Waste Type**	**Waste Volume (kgal)**
C-110	3	1C	TBP	187
BX-107	2	1C	TBP	345
T-108	0	1C	TBP	44
B-106	0	1C	TBP	117
Total:	5			693

Analyte Inventory and Mean Concentrations of Group XII			
Analytes	**Mean Concentration**	**Coeff. of Variance**	**Inventory**
	(μg/g)		(kg)
Al	14,323	0.099	48,314
Bi	17,356	0.305	58,545
Cr	685	0.393	2,311
Fe	10,812	0.13	36,471
La	7.97	0.004	27
Mn	58.1	0.298	196
Na	91,133	0.105	307,408
Pb	181	0.828	611
Si	6,933	0.105	23,386
Zr	153	0.295	516
U	4,248	1.7	14,329
PO_4 (aq)	22,256	0.523	75,074
NO_3	121,261	0.15	409,036
NO_2	7,638	0.602	25,764
F	8,261	0.206	27,866
Cl	1,116	0.332	3,764
TOC	739	0.323	2,493
	(μCi/g)		(Ci)
^{137}Cs	18.5	0.263	62,404
^{90}Sr	7.19	0.409	24,253
$^{239/240}Pu$	0.07	0.432	236
	(g/ml)		(kg)
Density	1.286	0.124	3,373,184
pH	10.6	0.063	

Table 5.4. Nominal Composition and Inventory of Group XV

Description of Individual Tanks Within Group XV				
No. of Tanks: 3				
Tank Name	Number of Cores Taken	Primary Waste Type	Secondary Waste Type	Waste Volume (kgal)
T-110	0	2C	224	379
T-112	0	2C	224	67
T-111	2	2C	224	458
Total:	2			904

Analyte Inventory and Mean Concentrations of Group XV			
Analytes	Mean Concentration	Coeff. of Variance	Inventory
	(μg/g)		(kg)
Al	570	0.189	2,409
Bi	23,562	0.138	99,567
Cr	1,799	0.043	7,602
Fe	18,038	0.121	76,224
La	4,108	0.15	17,359
Mn	6,282	0.042	26,546
Na	36,950	0.073	156,141
Pb	365	0.288	1,542
Si	5,565	0.056	23,516
Zr	4	0.002	17
U	2,555	0.481	10,797
PO_4 (aq)	15,538	0.1	65,659
NO_3	41,238	0.079	174,260
NO_2	897	0.198	3,790
F	2,301	0.377	9,723
Cl	450	0.102	1,902
TOC	3,119	0.255	13,180
	(μCi/g)		(Ci)
^{137}Cs	0.166	0.377	701
^{90}Sr	5.414	0.372	22,878
$^{239/240}Pu$	0.139	0.051	587
	(g/ml)		(kg)
Density	1.235	0.052	4,225,725
pH	11.6	0	

Table 5.5. Nominal Composition and Inventory of Group XVI

Description of Individual Tanks Within Group XVI				
No. of Tanks: 3				
Tank Name	**Number of Cores Taken**	**Primary Waste Type**	**Secondary Waste Type**	**Waste Volume (kgal)**
B-112	0	2C	5-6	33
B-110	7	2C	5-6	246
B-111	2	2C	5-6	237
Total:	9			516

Analyte Inventory and Mean Concentrations of Group XVI			
Analytes	**Mean Concentration**	**Coeff. of Variance**	**Inventory**
	(μg/g)		(kg)
Al	1,425	0.692	3,535
Bi	19,354	0.127	48,005
Cr	854	0.163	2,118
Fe	17,486	0.188	43,372
La	73.6	0.302	183
Mn	97.2	0.26	241
Na	96,359	0.061	239,008
Pb	750	0.732	1,860
Si	10,173	0.264	25,233
Zr	134	1.6	332
U	209	0.164	518
PO_4 (aq)	24,555	0.067	60,906
NO_3	145,000	0.361	359,656
NO_2	22,910	0.756	56,826
F	1,761	0.147	4,368
Cl	1,153	0.152	2,860
TOC	634	0.675	1,573
	(μCi/g)		(Ci)
^{137}Cs	40.6	1.39	100,704
^{90}Sr	133	0.751	329,891
$^{239/240}Pu$	0.107	0.185	265
	(g/ml)		(kg)
Density	1.27	0.074	2,480,386
pH	8.22	0.054	

5.1 Nominal Composition of Group VII

The nominal composition of Group VII is listed in Table 5.1. Group VII consists of eight tanks containing 224 waste exclusively. Notice the significantly higher concentrations of La and Mn, which are indicative of 224 waste. Also, notice that the PO_4 concentrations are an order of magnitude lower in Group VII than in the other groups containing $BiPO_4$ process waste (Groups XII, XV, and XVI). This agrees with the predictions made earlier in this study.

Of the eight tanks in Group VII, B-201 and B-202 have been sampled. B-201 and B-202 each contain 29,000 and 27,000 gallons of waste, respectively; therefore, 20% of the total 280,000 gallons of waste has been sampled. The pH measurements for samples in Group VII were not available.

5.2 Nominal Composition of Group IV

Table 5.2 describes the nominal composition of the waste found in Group IV. All 10 tanks included in Group IV contain R waste. The high Al, low Fe, and almost absent Bi concentrations are consistent with the predicted profile of R waste. The differences between Group IV and the other groups in this study are attributed to the fact that R waste is a REDOX process waste. All other groups included in the verification study consist of wastes from the $BiPO_4$ process. This clearly demonstrates that observable differences exist in the waste and a logical categorization based on process origin is possible.

Although S-104 is the only tank that has been sampled from this group, it contains 294,000 of the total 1,232,000 gallons of waste; this is approximately 24% of the waste found in Group IV. Furthermore, the composition of this tank can provide insight into other tanks with substantial quantities of R waste. A CV for the nominal density of Group IV is not listed because only one value could be found in the available literature.

5.3 Nominal Composition of Group XII

Table 5.3 describes the nominal composition of Group XII waste. These four tanks primarily contain 1C and TBP waste. The waste contains appreciable amounts of Al, Na, NO_3, and U as would be expected from 1C and TBP waste. Tanks C-110 and BX-107, containing 187,000 and 345,000 gallons, respectively, have been sampled. This is approximately 77% of the 693,000 gallons of total waste volume in Group XII.

5.4 Nominal Composition of Group XV

The nominal composition of Group XV is described in Table 5.4. Although only one of the three tanks has been sampled, T-111 contains 458,000 of the total 904,000 gallons of waste material—51%

of the total waste volume. Group XV contains primarily 2C and 224 type wastes. The presence of 224 waste explains the high concentrations of La and Mn, while the lack of fission products is indicative of both 224 and 2C wastes.

5.5 Nominal Composition of Group XVI

The nominal composition of Group XVI is listed in Table 5.5. Of the three tanks included in Group XVI, B-110 and B-111 have been sampled. Their combined waste volume of 483,000 gallons is 94% of the total waste volume in Group XVI. 2C and 5-6 are the primary waste types found in this group. The high concentration of fission products is due primarily to the presence of the 5-6 waste. As with 1C waste, 5-6 waste also has appreciable amounts of Na and NO_3.

6.0 Conclusions and Recommendations

The SORWT model presents a methodology to group SSTs that is both simple to understand and logical in its assumptions and construction. The SORWT model has predicted the existence of 24 groups of SSTs ranging from 22 tanks per group to two tanks per group. These 24 groups encompass 133 tanks and 93% of the total waste contained in SSTs. The first 14 groups (i.e., those that contain four tanks per group or more) represent 109 tanks and 83% of the total waste volume. This demonstrates the potential for using the SORWT model to efficiently allocate resources and to maximize characterization information gained by a minimum number of sampling events. The verification study has shown that the SST groups predicted by the SORWT model are statistically significant and reduce the variability in the concentrations for all analytes examined.

The SORWT model organizes a vast amount of information and presents clear options on which SSTs are more desirable to sample. The model is also simple and flexible in its ability to incorporate new parameters such as new SST analytical data, shifting programmatic needs, and/or risk assessment-oriented criteria.

This report presents the nominal composition, inventory, and uncertainty for five of the 24 SORWT groups, representing 28 tanks, 10% of the total waste volume, and 29% of the total sludge volume in SSTs. Consequently, this document provides a logical beginning framework for tank waste characterization until further information becomes available or different programmatic needs are identified.

6.1 Recommended Tank Waste Sampling

Tanks recommended for sampling based on the results of the SORWT model are listed in Tables 6.1 and 6.2. The list takes advantage of the SORWT model groups to establish a substantial amount of characterization information from a relatively small number of core and auger samples. Thirty-two additional core samples are recommended. If this new sampling and analysis information is combined with the existing data, nominal compositions of 104 tanks (70% of the SSTs) could be established. This would represent approximately 79% of the total waste volume, 63% of the total sludge volume, and 88% of the salt cake volume.

Sampling priority for the following list of recommended sampling events should be based on sampling the largest SORWT groups first. In most cases, the largest volume tanks should be given higher priority. It is recognized that programmatic priorities and technical difficulties with the sampling equipment might not allow rigid implementation of the proposed sampling and priority and that suitable alternatives can be identified, should the tanks designated here not be deemed appropriate. If there is a significant (i.e., 6 months) delay in field deployment of the rotary-mode core sample truck, then auger samples instead of core samples from the major SORWT groups should seriously be considered to begin assessing the salt cake types of waste and other waste types contributing large

Table 6.1. List of Recommended Core Samples

Tank No.	SORWT Group	No. of Core Samples	Watch-List Status	Total Waste Volume in Tank (kgal)
TX-105	I	2	Organic	609
S-109	I	2	NWL[a]	568
S-108	I	2	NWL	604
TX-112	II	2	NWL	649
TX-116	II	2	NWL	631
TX-117	II	2	NWL	626
BY-106	III	2	Ferrocyanide	642
BY-105	III	2	Ferrocyanide	503
BY-104	III	2	Ferrocyanide	406
SX-114	IV	2	High Heat	181
TX-115	IX	2	NWL	640
U-111	IX	2	Organic	329
U-107	VI	2	Organic	406
TX-118	VI	2	Ferrocyanide, Organic	347
BX-110	VIII	2	NWL	198
B-107	VIII	2	NWL	165
Total		32		

(a) non-watch list

Table 6.2. List of Recommended Auger Samples

Tank No.	SORWT Group	No. of Auger Samples	Watch-List Status	Total Waste Volume in Tank (kgal)
TX-107	I	3	NWL	36
TX-104	I	3	NWL	65
BX-106	V	3	NWL	46
BX-101	V	3	NWL	43
SX-112	IV	3	NWL	92
U-101	IV	3	NWL	25
Total		18		

quantities of material to the overall waste inventory (e.g., R waste). There is a significant lack of information regarding certain waste types, and auger sampling provides a means of acquiring relevant information quickly.

6.2 Recommended Suite of Analyses

The following suite of analyses is recommended at a minimum for the tank waste sampling events identified in the previous section. Table 6.3 presents the sample preparations and analytical procedures to be conducted on each composite sample. Additional analytical data requirements could be developed by other programs interested in the same tank wastes. The recommended suite of analyses is designed to determine the general characteristics of the waste and should be compatible with the available laboratory resources. Because the overall tank characteristics are of interest, laboratory analyses will likely be conducted on composite samples, with other programmatic analytical requirements needing narrower horizons being designated in the appropriate implementation documentation. This suite will capture the major cations, anions, H_2O, total organic carbon (TOC), waste energetic characteristics, gamma-emitting radionuclides (^{137}Cs), ^{90}Sr, $^{239/240}Pu$, and total U. The suite would also measure water-soluble cations and gamma emitters to determine waste solubility.

Table 6.3. Recommended Suite of Analyses

Fusion Dissolution	Water Leach	Direct Sample
ICP GEA (^{137}Cs) RadChem (^{90}Sr) Alpha Energy Analysis ($^{239/240}Pu$) Laser Fluorimetry (Total U)	Ion Chromatography GEA ICP	wt% H_2O TOC DSC/TGA

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Appendices

Appendix A

Sort on Radioactive Waste Type (SORWT) Model Results

Sort on Radioactive Waste Type (SORWT) Model Results

SORWT Group	Tank No.	Primary Waste Type	Secondary Waste Type	Tertiary Waste Type	Other Waste Type	Watch List Status	Volume of Saltcake (Kgal)	Volume of Sludge (Kgal)	Volume of Supernate (Kgal)	Volume Interstitial Liquid (Kgal)	Total Waste Volume (Kgal)
I	S-101	R	EB	IX	MIX	N	171	244	12	84	427
I	S-102	R	EB	DSSF		OG	545	4	0	230	549
I	S-103	R	EB	DSSF		N	221	10	17	85	248
I	S-105	R	EB			N	454	2	0	35	456
I	S-106	R	EB			N	447	28	4	186	479
I	S-107	R	EB	CW	IX-MIX	N	69	293	14	45	376
I	S-108	R	EB			N	600	4	0	127	604
I	S-109	R	EB			N	555	13	0	141	568
I	S-110	R	EB	MIX		N	259	131	0	110	390
I	S-111	R	EB			G	447	139	10	195	596
I	S-112	R	EB			G	518	5	0	110	523
I	SX-101	R	EB	RIX		G	343	112	1	145	456
I	SX-102	R	EB	RIX		G	426	117	0	183	543
I	SX-103	R	EB	CW	OWW	G	536	115	1	232	652
I	SX-104	R	EB	RIX		G	478	136	0	201	614
I	SX-105	R	EB	RIX	HLO	G	610	73	0	261	683
I	SX-106	R	EB	RIX	HLO-MX	OG	465	12	61	194	538
I	TX-102	R	EB	MIX		N	217	0	0	22	217
I	TX-104	R	EB	MIX		N	64	0	1	14	65
I	TX-105	R	EB	MIX		O	609	0	0	20	609
I	TX-106	R	EB	MIX		N	453	0	0	10	453
I	TX-107	R	EB			N	35	0	1	1	36
Group I Subtotal				22 Tanks			8,522	1,438	122	2,631	10,082
II	B-105	EB	1C	2C		N	266	40	0	23	306
II	TX-109	EB	1C	TBP		N	384	0	0	10	384
II	TX-110	EB	1C	TBP		N	462	0	0	15	462
II	TX-111	EB	1C	TBP		N	370	0	0	9	370
II	TX-112	EB	1C			N	649	0	0	24	649
II	TX-113	EB	1C			N	607	0	0	16	607
II	TX-114	EB	1C			N	535	0	0	15	535
II	TX-116	EB	1C			N	631	0	0	23	631
II	TX-117	EB	1C			N	626	0	0	8	626
II	TY-102	EB	1C	MIX		N	64	0	0	14	64
Group II Subtotal				10 Tanks			4,594	40	0	157	4,634
III	BY-101	TBP-F	EB-ITS	CW	1C	F	278	109	0	5	387
III	BY-103	TBP-F	EB-ITS	P	CW-OW	F	395	5	0	160	400
III	BY-104	TBP-F	EB-ITS	CW	IX	F	366	40	0	18	406
III	BY-105	TBP-F	EB-ITS	CW		F	459	44	0	192	503
III	BY-106	TBP-F	EB-ITS	CW		F	547	95	0	235	642
III	BY-107	TBP-F	EB-ITS	CW		F	206	60	0	25	266
III	BY-108	TBP-F	EB-ITS	1C	CW	F	74	154	0	9	228
III	BY-110	TBP-F	EB-ITS	1C	CW	F	295	103	0	9	398
III	BY-111	TBP-F	EB-ITS	OWW	CW	F	438	21	0	0	459
III	BY-112	TBP-F	EB-ITS	CW		F	286	5	0	8	291
Group III Subtotal				10 Tanks			3,344	636	0	661	3,980

Sort on Radioactive Waste Type (SORWT) Model Results

SORWT Group	Tank No.	Primary Waste Type	Secondary Waste Type	Tertiary Waste Type	Other Waste Type	Watch List Status	Volume of Saltcake (Kgal)	Volume of Sludge (Kgal)	Volume of Supernate (Kgal)	Volume Interstitial Liquid (Kgal)	Total Waste Volume (Kgal)
IV	S-104	R				N	0	293	1	28	294
IV	SX-107	R				H	0	104	0	5	104
IV	SX-108	R				H	0	87	0	5	87
IV	SX-109	R				GH	0	250	0	10	250
IV	SX-112	R				H	0	92	0	3	92
IV	SX-115	R				N	0	12	0	0	12
IV	SX-110	R				H	0	62	0	0	62
IV	SX-111	R				H	0	125	0	7	125
IV	SX-114	R				H	0	181	0	14	181
IV	U-101	R				N	0	22	3	0	25
Group IV Subtotal				10 Tanks			0	1,228	4	72	1,232
V	BX-101	TBP	CW	BL	IX	N	0	42	1	0	43
V	BX-102	TBP	CW	BL	DIA	F	0	96	0	4	96
V	BX-103	TBP	CW	OWW	MIX	N	0	62	4	0	66
V	BX-104	TBP	CW	IX	R	N	0	96	3	30	99
V	BX-105	TBP	CW	IX	EB	N	3	43	5	6	51
V	BX-106	TBP	CW	EB-IX	BL	F	0	31	15	0	46
V	BX-108	TBP	CW	1C	IX	N	0	26	0	1	26
V	BX-109	TBP	CW	1C	IX	N	0	193	0	13	193
V	C-101	TBP	CW	P	OWW	N	0	88	0	3	88
Group V Subtotal				9 Tanks			3	677	28	57	708
VI	B-101	EB	CW	BL		N	0	113	0	6	113
VI	B-102	EB	CW	BL	IX	N	10	18	4	0	32
VI	B-103	EB	CW	IX	MIX	O	0	59	0	0	59
VI	TX-118	EB	CW	PNF		FO	347	0	0	27	347
VI	U-105	EB	CW	R		G	349	32	37	142	418
VI	U-107	EB	CW	MIX		O	360	15	31	147	406
VI	U-108	EB	CW	MIX		G	415	29	24	172	468
VI	U-109	EB	CW	R		G	396	48	19	163	463
Group VI Subtotal				8 Tanks			1,877	314	115	657	2,306
VII	B-201	224				N	0	28	1	3	29
VII	B-202	224				N	0	27	0	3	27
VII	B-203	224				N	0	50	1	5	51
VII	B-204	224				N	0	49	1	5	50
VII	T-201	224				N	0	28	1	3	29
VII	T-202	224				N	0	21	0	2	21
VII	T-203	224				N	0	35	0	4	35
VII	T-204	224				N	0	38	0	4	38
Group VII Subtotal				8 Tanks			0	276	4	29	280

Sort on Radioactive Waste Type (SORWT) Model Results

SORWT Group	Tank No.	Primary Waste Type	Secondary Waste Type	Tertiary Waste Type	Other Waste Type	Watch List Status	Volume of Saltcake (Kgal)	Volume of Sludge (Kgal)	Volume of Supernate (Kgal)	Volume Interstitial Liquid (Kgal)	Total Waste Volume (Kgal)
VIII	B-107	1C	EB	CW	TBP	N	0	164	1	12	165
VIII	B-108	1C	EB	CW	IX-TBP	N	0	94	0	4	94
VIII	B-109	1C	EB	CW	IX	N	0	127	0	8	127
VIII	BX-110	1C	EB-ITS	CW	IX	F	9	189	0	15	198
VIII	BX-111	1C	EB-ITS	CW	IX	F	143	68	0	0	211
VIII	BX-112	1C	EB	CW	IX	N	0	164	1	7	165
Group VIII Subtotal				6 Tanks			152	806	2	46	960
IX	TX-115	EB	R	CW	DW	N	640	0	0	19	640
IX	U-102	EB	R			N	313	43	18	126	374
IX	U-103	EB	R	MIX		G	423	32	13	176	468
IX	U-106	EB	R	BL	PL	O	185	26	15	68	226
IX	U-111	EB	R	1C		O	303	26	0	122	329
Group IX Subtotal				5 Tanks			1,864	127	46	511	2,037
X	C-107	1C	CW	SRS		N	0	275	0	26	275
X	T-105	1C	CW	2C	BL-IX	N	0	98	0	23	98
X	T-106	1C	CW	2C	MIX	N	0	19	2	0	21
X	T-107	1C	CW	TBP		F	0	171	9	13	180
X	U-110	1C	CW	R	LW	N	0	186	0	15	186
Group X Subtotal				5 Tanks			0	749	11	77	760
XI	A-101	DSSF	NCPLX	EVAP		G	950	3	0	413	953
XI	A-102	DSSF	NCPLX	EVAP		N	22	15	4	2	41
XI	A-103	DSSF	NCPLX	EVAP		N	0	366	5	15	371
XI	AX-101	DSSF	NCPLX	EVAP		G	745	3	0	320	748
Group XI Subtotal				4 Tanks			1,717	387	9	750	2,113
XII	B-106	1C	TBP	HLO	MIX	N	0	116	1	6	117
XII	BX-107	1C	TBP	CW	IX	N	0	344	1	29	345
XII	C-110	1C	TBP	OWW	EB-IX	N	0	187	0	7	187
XII	T-108	1C	TBP	EB	HLO	N	0	44	0	0	44
Group XII Subtotal				4 Tanks			0	691	2	42	693
XIII	C-108	TBP-F	1C	CW	OWW	F	0	66	0	0	66
XIII	C-109	TBP-F	1C	CW	IX	F	0	62	4	0	66
XIII	C-111	TBP-F	1C	CW	HS	F	0	57	0	0	57
XIII	C-112	TBP-F	1C	CW	IX	F	0	104	0	32	104
Group XIII Subtotal				4 Tanks			0	289	4	32	293

Sort on Radioactive Waste Type (SORWT) Model Results

SORWT Group	Tank No.	Primary Waste Type	Secondary Waste Type	Tertiary Waste Type	Other Waste Type	Watch List Status	Volume of Saltcake (Kgal)	Volume of Sludge (Kgal)	Volume of Supernate (Kgal)	Volume Interstitial Liquid (Kgal)	Total Waste Volume (Kgal)
XIV	C-201	HS				N	0	2	0	0	2
XIV	C-202	HS				N	0	1	0	0	1
XIV	C-203	HS				N	0	5	0	0	5
XIV	C-204	HS				N	0	3	0	0	3
Group XIV Subtotal				4 Tanks			0	11	0	0	11
XV	T-110	2C	224			G	0	376	3	39	379
XV	T-111	2C	224	DW		O	0	456	2	49	458
XV	T-112	2C	224	DW	MIX	N	0	60	7	0	67
Group XV Subtotal				3 Tanks			0	892	12	88	904
XVI	B-110	2C	5-6	FP	IX	N	0	245	1	22	246
XVI	B-111	2C	5-6	FP	IX	N	0	236	1	21	237
XVI	B-112	2C	5-6	FP	EB-ITS	N	0	30	3	0	33
Group XVI Subtotal				3 Tanks			0	511	5	43	516
XVII	T-101	CW	MIX	TBP-F	EVAP	F	0	101	1	16	102
XVII	T-102	CW	MIX	IX		N	0	19	13	0	32
XVII	T-103	CW	MIX			N	0	23	4	0	27
Group XVII Subtotal				3 Tanks			0	143	18	16	161
XVIII	U-201	CW				N	0	4	1	0	5
XVIII	U-202	CW				N	0	4	1	0	5
XVIII	U-203	CW				N	0	2	1	0	3
Group XVIII Subtotal				3 Tanks			0	10	3	0	13
XIX	BY-102	TBP	EB-ITS	CW	1C	N	341	0	0	41	341
XIX	BY-109	TBP	EB-ITS	CW	MW	N	340	83	0	78	423
Group XIX Subtotal				2 Tanks			681	83	0	119	764
XX	C-103	SRS	SR-WASH	P	TBP-CW	O	0	62	133	0	195
XX	C-106	SRS	SR-WASH	P	TBP	H	0	197	32	16	229
Group XX Subtotal				2 Tanks			0	259	165	16	424
XXI	T-109	TBP	EB	MIX		N	0	58	0	0	58
XXI	TX-103	TBP	EB			N	0	157	0	15	157
Group XXI Subtotal				2 Tanks			0	215	0	15	215
XXII	TY-103	TBP	1C-F	CW	R-MIX	F	0	162	0	5	162
XXII	TY-104	TBP	1C-F	DW	MIX-R	F	0	43	3	12	46
Group XXII Subtotal				2 Tanks			0	205	3	17	208

Sort on Radioactive Waste Type (SORWT) Model Results

SORWT Group	Tank No.	Primary Waste Type	Secondary Waste Type	Tertiary Waste Type	Other Waste Type	Watch List Status	Volume of Saltcake (Kgal)	Volume of Sludge (Kgal)	Volume of Supernate (Kgal)	Volume Interstitial Liquid (Kgal)	Total Waste Volume (Kgal)
XXIII	AX-102	CCPLX	DSSF	EVAP		N	29	7	3	14	39
XXIII	AX-103	CCPLX	DSSF	EVAP		G	110	2	0	36	112
Group XXIII Subtotal				2 Tanks			139	9	3	50	151
XXIV	SX-113	R	DIA			N	0	26	0	0	26
XXIV	U-104	R	DIA			N	0	122	0	7	122
Group XXIV Subtotal				2 Tanks			0	148	0	7	148
XXVA	A-104	SLUICE	P	H20	B	H	0	28	0	0	28
XXVB	A-105	P	IX			H	0	19	0	4	19
XXVC	A-106	CCPLX	NCPLX	EVAP	B	N	0	125	0	7	125
XXVD	AX-104	EVAP	NCPLX	P		N	0	7	0	0	7
XXVE	B-104	2C	EB	TBP	1C	N	69	301	1	46	371
XXVF	C-102	CW	TBP	OWW		N	0	423	0	37	423
XXVG	C-104	CW	OWW	SR-WAS	SRS	MX N	0	295	0	11	295
XXVH	C-105	TBP	SR-WASH	CW	P	H	0	150	0	11	150
XXVI	T-104	1C				N	0	442	3	47	445
XXVJ	TX-101	R	MIX	MIX		N	0	84	3	2	87
XXVK	TX-108	EB	DW			N	134	0	0	0	134
XXVL	TY-101	1C-F	EB	TBP	R	F	0	118	0	0	118
XXVM	TY-105	TBP				N	0	231	0	0	231
XXVN	TY-106	TBP	DIA			N	0	17	0	0	17
XXVO	U-204	R	2C	CW		N	0	2	1	0	3
XXVP	U-112	UK				N	0	45	4	0	49
Ungrouped Subtotal				16 Tanks			203	2,287	12	165	2,502
Total Inventory							23,096	12,431	568	6,258	36,095

Sort on Radioactive Waste Type (SORWT) Model Results

SORWT Group	Tank No.	Primary Waste Type	Secondary Waste Type	Tertiary Waste Type	Other Waste Type	Watch List Status	% of Total Saltcake Volume	% of Total Sludge Volume	% of Total Supernate Volume	% of Total Interstitial Liquid	% of Total Waste Volume
I	S-101	R	EB	IX	MIX	N	0.74%	1.96%	2.11%	1.34%	1.18%
I	S-102	R	EB	DSSF		OG	2.36%	0.03%	0.00%	3.68%	1.52%
I	S-103	R	EB	DSSF		N	0.96%	0.08%	2.99%	1.36%	0.69%
I	S-105	R	EB			N	1.97%	0.02%	0.00%	0.56%	1.26%
I	S-106	R	EB			N	1.94%	0.23%	0.70%	2.97%	1.33%
I	S-107	R	EB	CW	IX-MIX	N	0.30%	2.36%	2.46%	0.72%	1.04%
I	S-108	R	EB			N	2.60%	0.03%	0.00%	2.03%	1.67%
I	S-109	R	EB			N	2.40%	0.10%	0.00%	2.25%	1.57%
I	S-110	R	EB	MIX		N	1.12%	1.05%	0.00%	1.76%	1.08%
I	S-111	R	EB			G	1.94%	1.12%	1.76%	3.12%	1.65%
I	S-112	R	EB			G	2.24%	0.04%	0.00%	1.76%	1.45%
I	SX-101	R	EB	RIX		G	1.49%	0.90%	0.18%	2.32%	1.26%
I	SX-102	R	EB	RIX		G	1.84%	0.94%	0.00%	2.92%	1.50%
I	SX-103	R	EB	CW	OWW	G	2.32%	0.93%	0.18%	3.71%	1.81%
I	SX-104	R	EB	RIX		G	2.07%	1.09%	0.00%	3.21%	1.70%
I	SX-105	R	EB	RIX	HLO	G	2.64%	0.59%	0.00%	4.17%	1.89%
I	SX-106	R	EB	RIX	HLO-MX	OG	2.01%	0.10%	10.74%	3.10%	1.49%
I	TX-102	R	EB	MIX		N	0.94%	0.00%	0.00%	0.35%	0.60%
I	TX-104	R	EB	MIX		N	0.28%	0.00%	0.18%	0.22%	0.18%
I	TX-105	R	EB	MIX		O	2.64%	0.00%	0.00%	0.32%	1.69%
I	TX-106	R	EB	MIX		N	1.96%	0.00%	0.00%	0.16%	1.26%
I	TX-107	R	EB			N	0.15%	0.00%	0.18%	0.02%	0.10%
Group I Subtotal				22 Tanks			36.90%	11.57%	21.48%	42.04%	27.93%
II	B-105	EB	1C	2C		N	1.15%	0.32%	0.00%	0.37%	0.85%
II	TX-109	EB	1C	TBP		N	1.66%	0.00%	0.00%	0.16%	1.06%
II	TX-110	EB	1C	TBP		N	2.00%	0.00%	0.00%	0.24%	1.28%
II	TX-111	EB	1C	TBP		N	1.60%	0.00%	0.00%	0.14%	1.03%
II	TX-112	EB	1C			N	2.81%	0.00%	0.00%	0.38%	1.80%
II	TX-113	EB	1C			N	2.63%	0.00%	0.00%	0.26%	1.68%
II	TX-114	EB	1C			N	2.32%	0.00%	0.00%	0.24%	1.48%
II	TX-116	EB	1C			N	2.73%	0.00%	0.00%	0.37%	1.75%
II	TX-117	EB	1C			N	2.71%	0.00%	0.00%	0.13%	1.73%
II	TY-102	EB	1C	MIX		N	0.28%	0.00%	0.00%	0.22%	0.18%
Group II Subtotal				10 Tanks			19.89%	0.32%	0.00%	2.51%	12.84%
III	BY-101	TBP-F	EB-ITS	CW	1C	F	1.20%	0.88%	0.00%	0.08%	1.07%
III	BY-103	TBP-F	EB-ITS	P	CW-OW	F	1.71%	0.04%	0.00%	2.56%	1.11%
III	BY-104	TBP-F	EB-ITS	CW	IX	F	1.58%	0.32%	0.00%	0.29%	1.12%
III	BY-105	TBP-F	EB-ITS	CW		F	1.99%	0.35%	0.00%	3.07%	1.39%
III	BY-106	TBP-F	EB-ITS	CW		F	2.37%	0.76%	0.00%	3.76%	1.78%
III	BY-107	TBP-F	EB-ITS	CW		F	0.89%	0.48%	0.00%	0.40%	0.74%
III	BY-108	TBP-F	EB-ITS	1C	CW	F	0.32%	1.24%	0.00%	0.14%	0.63%
III	BY-110	TBP-F	EB-ITS	1C	CW	F	1.28%	0.83%	0.00%	0.14%	1.10%
III	BY-111	TBP-F	EB-ITS	OWW	CW	F	1.90%	0.17%	0.00%	0.00%	1.27%
III	BY-112	TBP-F	EB-ITS	CW		F	1.24%	0.04%	0.00%	0.13%	0.81%
Group III Subtotal				10 Tanks			14.48%	5.12%	0.00%	10.56%	11.03%

Sort on Radioactive Waste Type (SORWT) Model Results

SORWT Group	Tank No.	Primary Waste Type	Secondary Waste Type	Tertiary Waste Type	Other Waste Type	Watch List Status	% of Total Saltcake Volume	% of Total Sludge Volume	% of Total Supernate Volume	% of Total Interstitial Liquid	% of Total Waste Volume
IV	S-104	R				N	0.00%	2.36%	0.18%	0.45%	0.81%
IV	SX-107	R				H	0.00%	0.84%	0.00%	0.08%	0.29%
IV	SX-108	R				H	0.00%	0.70%	0.00%	0.08%	0.24%
IV	SX-109	R				GH	0.00%	2.01%	0.00%	0.16%	0.69%
IV	SX-112	R				H	0.00%	0.74%	0.00%	0.05%	0.25%
IV	SX-115	R				N	0.00%	0.10%	0.00%	0.00%	0.03%
IV	SX-110	R				H	0.00%	0.50%	0.00%	0.00%	0.17%
IV	SX-111	R				H	0.00%	1.01%	0.00%	0.11%	0.35%
IV	SX-114	R				H	0.00%	1.46%	0.00%	0.22%	0.50%
IV	U-101	R				N	0.00%	0.18%	0.53%	0.00%	0.07%
Group IV Subtotal				10 Tanks			0.00%	9.88%	0.70%	1.15%	3.41%
V	BX-101	TBP	CW	BL	IX	N	0.00%	0.34%	0.18%	0.00%	0.12%
V	BX-102	TBP	CW	BL	DIA	F	0.00%	0.77%	0.00%	0.06%	0.27%
V	BX-103	TBP	CW	OWW	MIX	N	0.00%	0.50%	0.70%	0.00%	0.18%
V	BX-104	TBP	CW	IX	R	N	0.00%	0.77%	0.53%	0.48%	0.27%
V	BX-105	TBP	CW	IX	EB	N	0.01%	0.35%	0.88%	0.10%	0.14%
V	BX-106	TBP	CW	EB-IX	BL	F	0.00%	0.25%	2.64%	0.00%	0.13%
V	BX-108	TBP	CW	1C	IX	N	0.00%	0.21%	0.00%	0.02%	0.07%
V	BX-109	TBP	CW	1C	IX	N	0.00%	1.55%	0.00%	0.21%	0.53%
V	C-101	TBP	CW	P	OWW	N	0.00%	0.71%	0.00%	0.05%	0.24%
Group V Subtotal				9 Tanks			0.01%	5.45%	4.93%	0.91%	1.96%
VI	B-101	EB	CW	BL		N	0.00%	0.91%	0.00%	0.10%	0.31%
VI	B-102	EB	CW	BL	IX	N	0.04%	0.14%	0.70%	0.00%	0.09%
VI	B-103	EB	CW	IX	MIX	O	0.00%	0.47%	0.00%	0.00%	0.16%
VI	TX-118	EB	CW	PNF		FO	1.50%	0.00%	0.00%	0.43%	0.96%
VI	U-105	EB	CW	R		G	1.51%	0.26%	6.51%	2.27%	1.16%
VI	U-107	EB	CW	MIX		O	1.56%	0.12%	5.46%	2.35%	1.12%
VI	U-108	EB	CW	MIX		G	1.80%	0.23%	4.23%	2.75%	1.30%
VI	U-109	EB	CW	R		G	1.71%	0.39%	3.35%	2.60%	1.28%
Group VI Subtotal				8 Tanks			8.13%	2.53%	20.25%	10.50%	6.39%
VII	B-201	224				N	0.00%	0.23%	0.18%	0.05%	0.08%
VII	B-202	224				N	0.00%	0.22%	0.00%	0.05%	0.07%
VII	B-203	224				N	0.00%	0.40%	0.18%	0.08%	0.14%
VII	B-204	224				N	0.00%	0.39%	0.18%	0.08%	0.14%
VII	T-201	224				N	0.00%	0.23%	0.18%	0.05%	0.08%
VII	T-202	224				N	0.00%	0.17%	0.00%	0.03%	0.06%
VII	T-203	224				N	0.00%	0.28%	0.00%	0.06%	0.10%
VII	T-204	224				N	0.00%	0.31%	0.00%	0.06%	0.11%
Group VII Subtotal				8 Tanks			0.00%	2.22%	0.70%	0.46%	0.78%

Sort on Radioactive Waste Type (SORWT) Model Results

SORWT Group	Tank No.	Primary Waste Type	Secondary Waste Type	Tertiary Waste Type	Other Waste Type	Watch List Status	% of Total Saltcake Volume	% of Total Sludge Volume	% of Total Supernate Volume	% of Total Interstitial Liquid	% of Total Waste Volume
VIII	B-107	1C	EB	CW	TBP	N	0.00%	1.32%	0.18%	0.19%	0.46%
VIII	B-108	1C	EB	CW	IX-TBP	N	0.00%	0.76%	0.00%	0.06%	0.26%
VIII	B-109	1C	EB	CW	IX	N	0.00%	1.02%	0.00%	0.13%	0.35%
VIII	BX-110	1C	EB-ITS	CW	IX	F	0.04%	1.52%	0.00%	0.24%	0.55%
VIII	BX-111	1C	EB-ITS	CW	IX	F	0.62%	0.55%	0.00%	0.00%	0.58%
VIII	BX-112	1C	EB	CW	IX	N	0.00%	1.32%	0.18%	0.11%	0.46%
Group VIII Subtotal				6 Tanks			0.66%	6.48%	0.35%	0.74%	2.66%
IX	TX-115	EB	R	CW	DW	N	2.77%	0.00%	0.00%	0.30%	1.77%
IX	U-102	EB	R			N	1.36%	0.35%	3.17%	2.01%	1.04%
IX	U-103	EB	R	MIX		G	1.83%	0.26%	2.29%	2.81%	1.30%
IX	U-106	EB	R	BL	PL	O	0.80%	0.21%	2.64%	1.09%	0.63%
IX	U-111	EB	R	1C		O	1.31%	0.21%	0.00%	1.95%	0.91%
Group IX Subtotal				5 Tanks			8.07%	1.02%	8.10%	8.17%	5.64%
X	C-107	1C	CW	SRS		N	0.00%	2.21%	0.00%	0.42%	0.76%
X	T-105	1C	CW	2C	BL-IX	N	0.00%	0.79%	0.00%	0.37%	0.27%
X	T-106	1C	CW	2C	MIX	N	0.00%	0.15%	0.35%	0.00%	0.06%
X	T-107	1C	CW	TBP		F	0.00%	1.38%	1.58%	0.21%	0.50%
X	U-110	1C	CW	R	LW	N	0.00%	1.50%	0.00%	0.24%	0.52%
Group X Subtotal				5 Tanks			0.00%	6.03%	1.94%	1.23%	2.11%
XI	A-101	DSSF	NCPLX	EVAP		G	4.11%	0.02%	0.00%	6.60%	2.64%
XI	A-102	DSSF	NCPLX	EVAP		N	0.10%	0.12%	0.70%	0.03%	0.11%
XI	A-103	DSSF	NCPLX	EVAP		N	0.00%	2.94%	0.88%	0.24%	1.03%
XI	AX-101	DSSF	NCPLX	EVAP		G	3.23%	0.02%	0.00%	5.11%	2.07%
Group XI Subtotal				4 Tanks			7.43%	3.11%	1.58%	11.98%	5.85%
XII	B-106	1C	TBP	HLO	MIX	N	0.00%	0.93%	0.18%	0.10%	0.32%
XII	BX-107	1C	TBP	CW	IX	N	0.00%	2.77%	0.18%	0.46%	0.96%
XII	C-110	1C	TBP	OWW	EB-IX	N	0.00%	1.50%	0.00%	0.11%	0.52%
XII	T-108	1C	TBP	EB	HLO	N	0.00%	0.35%	0.00%	0.00%	0.12%
Group XII Subtotal				4 Tanks			0.00%	5.56%	0.35%	0.67%	1.92%
XIII	C-108	TBP-F	1C	CW	OWW	F	0.00%	0.53%	0.00%	0.00%	0.18%
XIII	C-109	TBP-F	1C	CW	IX	F	0.00%	0.50%	0.70%	0.00%	0.18%
XIII	C-111	TBP-F	1C	CW	HS	F	0.00%	0.46%	0.00%	0.00%	0.16%
XIII	C-112	TBP-F	1C	CW	IX	F	0.00%	0.84%	0.00%	0.51%	0.29%
Group XIII Subtotal				4 Tanks			0.00%	2.32%	0.70%	0.51%	0.81%

Sort on Radioactive Waste Type (SORWT) Model Results

SORWT Group	Tank No.	Primary Waste Type	Secondary Waste Type	Tertiary Waste Type	Other Waste Type	Watch List Status	% of Total Saltcake Volume	% of Total Sludge Volume	% of Total Supernate Volume	% of Total Interstitial Liquid	% of Total Waste Volume
XIV	C-201	HS				N	0.00%	0.02%	0.00%	0.00%	0.01%
XIV	C-202	HS				N	0.00%	0.01%	0.00%	0.00%	0.00%
XIV	C-203	HS				N	0.00%	0.04%	0.00%	0.00%	0.01%
XIV	C-204	HS				N	0.00%	0.02%	0.00%	0.00%	0.01%
Group XIV Subtotal				4 Tanks			0.00%	0.09%	0.00%	0.00%	0.03%
XV	T-110	2C	224			G	0.00%	3.02%	0.53%	0.62%	1.05%
XV	T-111	2C	224	DW		O	0.00%	3.67%	0.35%	0.78%	1.27%
XV	T-112	2C	224	DW	MIX	N	0.00%	0.48%	1.23%	0.00%	0.19%
Group XV Subtotal				3 Tanks			0.00%	7.18%	2.11%	1.41%	2.50%
XVI	B-110	2C	5-6	FP	IX	N	0.00%	1.97%	0.18%	0.35%	0.68%
XVI	B-111	2C	5-6	FP	IX	N	0.00%	1.90%	0.18%	0.34%	0.66%
XVI	B-112	2C	5-6	FP	EB-ITS	N	0.00%	0.24%	0.53%	0.00%	0.09%
Group XVI Subtotal				3 Tanks			0.00%	4.11%	0.88%	0.69%	1.43%
XVII	T-101	CW	MIX	TBP-F	EVAP	F	0.00%	0.81%	0.18%	0.26%	0.28%
XVII	T-102	CW	MIX	IX		N	0.00%	0.15%	2.29%	0.00%	0.09%
XVII	T-103	CW	MIX			N	0.00%	0.19%	0.70%	0.00%	0.07%
Group XVII Subtotal				3 Tanks			0.00%	1.15%	3.17%	0.26%	0.45%
XVIII	U-201	CW				N	0.00%	0.03%	0.18%	0.00%	0.01%
XVIII	U-202	CW				N	0.00%	0.03%	0.18%	0.00%	0.01%
XVIII	U-203	CW				N	0.00%	0.02%	0.18%	0.00%	0.01%
Group XVIII Subtotal				3 Tanks			0.00%	0.08%	0.53%	0.00%	0.04%
XIX	BY-102	TBP	EB-ITS	CW	1C	N	1.48%	0.00%	0.00%	0.66%	0.94%
XIX	BY-109	TBP	EB-ITS	CW	MW	N	1.47%	0.67%	0.00%	1.25%	1.17%
Group XIX Subtotal				2 Tanks			2.95%	0.67%	0.00%	1.90%	2.12%
XX	C-103	SRS	SR-WASH	P	TBP-CW	O	0.00%	0.50%	23.42%	0.00%	0.54%
XX	C-106	SRS	SR-WASH	P	TBP	H	0.00%	1.58%	5.63%	0.26%	0.63%
Group XX Subtotal				2 Tanks			0.00%	2.08%	29.05%	0.26%	1.17%
XXI	T-109	TBP	EB	MIX		N	0.00%	0.47%	0.00%	0.00%	0.16%
XXI	TX-103	TBP	EB			N	0.00%	1.26%	0.00%	0.24%	0.43%
Group XXI Subtotal				2 Tanks			0.00%	1.73%	0.00%	0.24%	0.60%
XXII	TY-103	TBP	1C-F	CW	R-MIX	F	0.00%	1.30%	0.00%	0.08%	0.45%
XXII	TY-104	TBP	1C-F	DW	MIX-R	F	0.00%	0.35%	0.53%	0.19%	0.13%
Group XXII Subtotal				2 Tanks			0.00%	1.65%	0.53%	0.27%	0.58%

Sort on Radioactive Waste Type (SORWT) Model Results

SORWT Group	Tank No.	Primary Waste Type	Secondary Waste Type	Tertiary Waste Type	Other Waste Type	Watch List Status	% of Total Saltcake Volume	% of Total Sludge Volume	% of Total Supernate Volume	% of Total Interstitial Liquid	% of Total Waste Volume
XXIII	AX-102	CCPLX	DSSF	EVAP		N	0.13%	0.06%	0.53%	0.22%	0.11%
XXIII	AX-103	CCPLX	DSSF	EVAP		G	0.48%	0.02%	0.00%	0.58%	0.31%
Group XXIII Subtotal				2 Tanks			0.60%	0.07%	0.53%	0.80%	0.42%
XXIV	SX-113	R	DIA			N	0.00%	0.21%	0.00%	0.00%	0.07%
XXIV	U-104	R	DIA			N	0.00%	0.98%	0.00%	0.11%	0.34%
Group XXIV Subtotal				2 Tanks			0.00%	1.19%	0.00%	0.11%	0.41%
XXVA	A-104	SLUICE	P	H20	B	H	0.00%	0.23%	0.00%	0.00%	0.08%
XXVB	A-105	P	IX			H	0.00%	0.15%	0.00%	0.06%	0.05%
XXVC	A-106	CCPLX	NCPLX	EVAP	B	N	0.00%	1.01%	0.00%	0.11%	0.35%
XXVD	AX-104	EVAP	NCPLX	P		N	0.00%	0.06%	0.00%	0.00%	0.02%
XXVE	B-104	2C	EB	TBP	1C	N	0.30%	2.42%	0.18%	0.74%	1.03%
XXVF	C-102	CW	TBP	OWW		N	0.00%	3.40%	0.00%	0.59%	1.17%
XXVG	C-104	CW	OWW	SR-WAS	SRS	MX N	0.00%	2.37%	0.00%	0.18%	0.82%
XXVH	C-105	TBP	SR-WASH	CW	P	H	0.00%	1.21%	0.00%	0.18%	0.42%
XXVI	T-104	1C				N	0.00%	3.56%	0.53%	0.75%	1.23%
XXVJ	TX-101	R	MIX	MIX		N	0.00%	0.68%	0.53%	0.03%	0.24%
XXVK	TX-108	EB	DW			N	0.58%	0.00%	0.00%	0.00%	0.37%
XXVL	TY-101	1C-F	EB	TBP	R	F	0.00%	0.95%	0.00%	0.00%	0.33%
XXVM	TY-105	TBP				N	0.00%	1.86%	0.00%	0.00%	0.64%
XXVN	TY-106	TBP	DIA			N	0.00%	0.14%	0.00%	0.00%	0.05%
XXVO	U-204	R	2C	CW		N	0.00%	0.02%	0.18%	0.00%	0.01%
XXVP	U-112	UK				N	0.00%	0.36%	0.70%	0.00%	0.14%
Ungrouped Subtotal				16 Tanks			0.88%	18.40%	2.11%	2.64%	6.93%
Total Inventory							100%	100%	100%	100%	100%

Appendix B

Waste Types in Hanford Site Single-Shell Tanks

Waste Types in Hanford Site Single-Shell Tanks

This appendix summarizes available information that describes wastes in the Hanford Site single-shell tanks (SST). The complexity of the waste-generating processes, the waste transfers from generating facilities to SSTs, and the transactions between SSTs severely compromises the completeness and accuracy of the information contained in this appendix. These data, however, provide information to support tank categorization before actual characterization of SST waste.

The characterizations of waste types contained in this report were taken from a wide variety of sources. Compositions of the primary waste streams from two main extraction processes, bismuth phosphate ($BiPO_4$) and reduction oxidation (REDOX), as well as waste from the uranium extraction process at U Plant, were obtained from process flowsheets. For the plutonium-uranium extraction (PUREX) and B Plant waste fractionization processes, published reports of waste compositions were relied upon because of the complex process chemistry and several changes in flowsheets. The low-level waste and flush waste compositions are difficult to specify but can be assumed to be very dilute. In general, most low-level waste was sent to the cribs; only a small amount was sent to the SSTs. For the various campaigns to extract cesium and strontium (and in some cases other fission products), waste compositions were taken from process flowsheets when available. Some caution must be taken in evaluating the results because of several sources of error, including variability of the feed material, changes in process flowsheets, and the presence or absence of diluting streams such as wash wastes. Laboratory wastes from three laboratories operating at the Hanford Site also went into the SSTs; the composition of these wastes is unknown.

Not all of the named waste types have a unique point of origin. Some wastes result from evaporation of wastes already contained in SSTs, and other wastes are merely new names assigned to old wastes to reflect their suitability for further processing, including evaporation. During the early history of the Hanford Site, there was little interest in determining the composition of chemical waste streams, and little or no attempt was made to segregate wastes from different processes. The overriding concern during this period was to minimize waste volume to conserve space in the SSTs. To this end, from the early 1950s, waste in the SSTs was extensively subjected to evaporation. In the evaporators, supernatant liquids from the waste tanks were heated until a slurry was formed; this slurry was returned to the tanks, where a solid salt cake precipitated. Residual supernatant liquors were pumped to other tanks and re-evaporated. In another method, heaters were placed directly in the tanks and the wastes were evaporated without any transfers.

Because of the detection of leaks in several of the SSTs in the 1970s, it became necessary to reduce SST liquid wastes to a solid form or transfer them to the newly constructed double-shell tanks (DST). At this time, SST supernatant liquids were given designations according to the presence or absence of organic complexants and the suitability of the waste for further evaporation. For example, complexant concentrate (CC) waste was considered unsuitable for further evaporation at the SSTs because it was thought that the organic complexants might form a gel, making the waste difficult to pump. In contrast, evaporator feed (EF) was relatively dilute supernatant liquid that was suitable for evaporation. Terminal and residual liquors--waste types TL, HDRL, and RESD--should not be further evaporated at the SSTs because they would precipitate 1) fine aluminate solids that would settle and drain poorly or 2) deliquescent NaOH solids that would take up moisture from the air and redissolve. These waste types, designated double-shell slurry feed (DSSF), were pumped to the DSTs and then evaporated into a slurry. Because of the DSTs' secure construction, they were deemed suitable to accept liquids, suspended solids, and poorly draining slurries for indefinite storage.

WASTE DESCRIPTIONS

The following are brief descriptions and chemical compositions, where available, of 49 waste types discharged to the SSTs.

1. B. High-level waste from waste fractionization process at B Plant starting in 1967.

Approximate Composition

Element/isotope	mol/L
Al	0.079
Ba	0.000032
Ca	0.0001
Cr	0.002
$C_6H_5O_7$ (citrate)	0.12
Fe	0.029
Mn	0.00029
Na	1.29
Ni	0.002
^{106}Ru	0.000003
Pu	0.000001
NO_3	1.27
Tc	0.000048
U	0.0029
Zr	0.000048

2. B Plant Flush (BFSH). Flush water from the B Plant during the time of the $BiPO_4$ process in the 1950s.

3. BIX. This is a misprint for RIX.

4. BL. Low-level waste from the waste fractionization plant beginning in 1968.

Typical Composition

Element/isotope	mol/L
Al	0.55
$C_6H_5O_7$ (citrate)	0.92
Ca	0.000005
CO_3	2.61
Mn	0.0029
Na	5.55
Ni	0.0092
NO_3	5.28
Pb	0.014
Pu	0.00087
SiO_3	0.0029
U	0.37

5. BLEB. Evaporator bottoms where B Plant low-level waste was the feed material.

6. BNW. Laboratory waste from Pacific Northwest Laboratory.

7. CARB. Organic wash waste from the PUREX Plant before 1963, using sodium carbonate solution.

Approximate Composition

Element/isotope	mol/L
CO_3	0.21
Na	0.43
NO_3	0.07
UO_2	0.03

8. Complexant Concentrate (CCPL or CC). Contains a high concentration of organic complexants such as HEDTA, EDTA, and citric acid as a result of B Plant processing and subsequent evaporation. Any further concentration of this waste would cause the complexants to form a gel that would not be pumpable nor considered suitable for storage in SSTs. The given composition is an average of sampled tanks.

Average Composition

Element/isotope	mol/L
Al	0.38
Ba	0.0001
Ca	0.013
Cd	0.00062
Cl	0.05
CO_3	0.96
Cr	0.0046
Cu	0.00032
F	0.12
Fe	0.023
K	0.032
La	0.00065
Mg	0.0012
Mn	0.0016
Mo	0.003
Na	7.3
Ni	0.006
NO_2	0.78
NO_3	2.7
OH	0.36
Pb	0.0012
PO_4	0.026
Si	0.0031
SO_4	0.09
Zn	0.0006
Zr	0.0013

9. Cesium Feed (CF). Small quantities of this waste were put into Tank C-105 in 1976. It was a PUREX or PUREX sludge supernatant. For a typical composition, see waste type PSS.

10. Complexed Waste (CPLX). Dilute waste material containing relatively high concentrations of organic chelating agents such as EDTA and HEDTA from the B Plant waste fractionization process. This waste type is defined as containing at least 10 g/L organic material, or 100 mCi/g radionuclides. This is a later designation (post-1976) that does not reflect the bulk composition or point of origin of the waste, but merely re-labels all the waste in a tank according to the presence or absence of B Plant complexants.

Typical Composition
of Tank 102-AX

Element/isotope	mol/L
Al	0.1
CO_3	0.5
F	0.007
Na	2.7
NO_2	0.27
NO_3	0.72
OH	0.25
PO_4	0.014
SO_4	0.176

11. CW. Waste produced at the PUREX Plant from dissolution of zircaloy (after 1964) or aluminum fuel cladding. The zircaloy cladding was dissolved in an ammonium/fluoride, ammonium nitrate solution. The aluminum cladding was dissolved in a sodium nitrate/sodium hydroxide solution.

Approximate Composition -
Zircaloy Cladding

Element/isotope	mol/L
F	1.01
Na	1.4
NO_3	0.02
OH	0.37
Pu	0.0006
U	0.0008
ZrO_2	0.15

Aluminum Cladding

Element/isotope	mol/L
Al	1
Na	3.7
NO_2	0.9
NO_3	0.6
OH	1
Si	0.02

12. CWP. In 1963, some coating waste from the PUREX Plant was called CWP. See waste type CW.

13. CWR. REDOX process waste resulting from the dissolution of fuel element cladding. Both aluminum- and zircaloy-clad fuels were processed.

Approximate Composition of Aluminum Cladding Waste

Element/isotope	mol/L
Al	2.32
Na	5.9
NO_2	1.47
NO_3	1.07
OH	1
Pu	0.000004
U	0.0058

Approximate Composition of Zircaloy Cladding Waste

Element/isotope	mol/L
Al	0.21
F	2.25
Na	3.73
NO_2	0.17
NO_3	0.97
OH	1.39
P	0.000008
U	0.018
Zr	0.31

14. Diatomaceous earth (DE). SiO_2.

15. DSSF. Noncomplexed waste that has been concentrated in evaporators until the solution is nearly saturated with sodium aluminate. Further evaporation will yield a slurry that is not suitable for storage in SSTs. This is a general term for noncomplexed HDRL (Hanford defense residual liquor), including partially neutralized waste.

Typical Composition

Element/isotope	mol/L
Al	1.74
CO_3	0.21
F	0.06
Na	12.53
NO_2	2.62
NO_3	2.72
OH	3.43
PO_4	0.07

16. Decontamination Waste (DW). Wash solution from equipment decontamination efforts at the T Plant. This waste was mainly a dilute $NaNO_2$ solution, averaging 0.24 M $NaNO_2$.

17. Evaporator Bottoms (EB). Slurry product from the evaporators. This slurry precipitated a solid salt cake that was stored in SSTs.

Average Composition of
Sampled Salt Cake in
241-S Tank Farm

Element/isotope	Weight %
H_2O	12.8
$NaAlO_2$	1.9
Na_2CO_3	6.4
$NaNO_2$	1.8
$NaNO_3$	73.8
$Na_3(PO_4)_2$	1.5

18. Evaporator Feed (EF). This term designates various kinds of supernatant liquids whose composition depends on source location and whether they underwent prior concentration. In general, EF may be either dilute feed that has not yet been evaporated or concentrated feed that has been partially evaporated but requires additional evaporation to meet requirements for residual liquor.

Typical Composition of Dilute Feed

Element/isotope	mol/L
Al	0.4
CO_3	0.2
Na	4.5
NO_2	0.6
NO_3	2.3
OH	0.7
PO_4	0.03

Typical Composition of Concentrated Feed

Element/isotope	mol/L
Al	0.9
CO_3	0.23
Na	8.26
NO_2	1.6
NO_3	3.6
OH	1.7
PO_4	0.05

19. EVAP. This is a post-1976 designation for evaporator feed. For typical composition, see No. 18 Evaporator Feed (EF). With the exception of terminal liquors, which could not be further evaporated, and aging waste, which contained short-lived, high-heat fission products, any tank supernatant liquor could be designated evaporator feed.

20. Fission Products (FP) Waste. Waste produced at B Plant and Hot Semiworks during the 1960s in campaigns to isolate various fission products such as cerium and promethium.

21. Hanford Defense Residual Liquor. This is a late 1970s designation for terminal liquors remaining after waste evaporation, these including complexed and noncomplexed waste, partially neutralized wastes, and DSSF. Further evaporation of these wastes would cause precipitation of solids unsuitable for storage in SSTs. Composition is the same as No. 44 Terminal Liquor, TL.

22. Hanford Laboratory Operations (HLO). Laboratory waste from 300 Area.

23. HS. Waste from Hot Semiworks Plant, which ran several strontium extraction campaigns from 1955 until 1961. There were 50,000 gallons of dilute wastes discharged to tank farms. For approximate chemical composition see SSW, Strontium Semiworks Waste.

24. Water (H_2O). Filtered Hanford Site water (200 East Area) contains the following impurities in parts per million:

Filtered Hanford Site
200 East Water Impurities

Element/isotope	ppm
Ca	20-40
Cl	1-5
CO_2	0-2
Mg	4-5.5
SO_4	14-30
SiO_4	3-7.5

25. IWW. Concentrated, neutralized high-level waste from the PUREX process. This waste type only entered the tank farms in one occurrence and is probably equivalent to waste type P. It should actually be written as 1WW and is bottom waste from the No. 1 acid concentrator.

Approximate Composition

Element/isotope	mol/L
Fe	0.05
Na	5.37
NO_3	5.82
OH	5.37
Pu	0.000007
SO_4	0.1
U	0.0126

26. IX. Ion exchange waste from the cesium recovery process at the B Plant. Feed was PUREX supernatant. This includes column waste, column wash waste, and cesium purification waste.

Approximate Composition

Element/isotope	mol/L
CO_3	0.65
Na	3.9
NO_2	1.9
NO_3	0.49
SO_4	0.085

27. LW. Laboratory waste from 222-S Building.

28. MW. Metal waste from the $BiPO_4$ process. It was produced at the B and T Plants from the dissolution of uranium fuel elements.

Approximate Composition

Element/isotope	mol/L
CO_3	1.14
Na	3.53
NO_3	0.59
OH	1.16
PO_4	0.23
SO_4	0.24
U	0.25

29. N. Phosphate decontamination waste from N Reactor. After 1982 ion-exchange regeneration waste containing sodium sulfate was produced. The following composition is for post-1980 N Reactor waste; N Reactor waste produced during the time when the SSTs were active is assumed to be similar.

Approximate Composition of
Concentrated Phosphate Waste

Element/isotope	mol/L
Na	1.11
NO_2	0.014
OH	0.01
PO_4	0.36

30. Noncomplexed Waste (NCPL). A general term for supernatant liquids and saltwell liquors not identified as containing organic complexants. This term came into use after 1976 and does not reflect origin or composition of the waste, only its suitability for further treatment.

Estimated Composition

Element/isotope	mol/L
Al	1.5
CO_3	0.2
Na	10.6
NO_2	2.2
NO_3	3.3
PO_4	0.08

31. OWW. Organic solvent wash waste from the PUREX Plant, containing carbonate, permanganate, and nitrate.

Approximate Composition

Element/isotope	mol/L
CO_3	0.21
K	0.01
MnO_4	0.01
MnO_2	0.01
Na	0.27
NO_3	0.06
U	0.008

32. P. High-activity neutralized acid waste generated by the PUREX process.

Approximate Composition

Element/isotope	mol/L
Al	0.15
Fe	0.4
Na	1.4
NO_3	1.3
PO_4	0.02
SO_4	0.9

33. PL. Low-level waste from the PUREX Plant.

Approximate Composition

Element/isotope	mol/L
Na	0.0013
NO_3	0.0026
Np	5.0 E-7
Pu	3.2 E-6
U	0.0013

34. PNF. Waste used as feed for the partial neutralization campaigns conducted at the 242-S Evaporator during the late 1970s. Noncomplexed. For typical composition see No. 18, evaporator feed (EF).

35. PUREX Sludge Supernatant (PSS) Liquid. PUREX sludge supernatant liquid was produced by leaching PUREX sludge. This sludge, in underground storage, resulted from the neutralization of PUREX high-level waste and the removal of supernatant liquids.

Approximate Composition

Element/isotope	mol/L
Al	0.04
CO_3	0.24
Cr	0.002
Na	5.4
NO_3	4.2
NO_2	0.22
SO_4	0.25

36. R. High-level waste from the REDOX process. ≥ RSltCk (Agnew, 1996 LAUR-96-2…)

Approximate Composition

Element/isotope	mol/L
Al	1.2
Cr	0.177
Fe	0.016
Na	6.91
NO_3	4.83
OH	0.74
PU	7.7 E-7
SO_4	0.031
U	0.0014

37. RESD. A residual evaporator liquor. This is the same as HDRL, which in turn was formerly called TL. For composition see No. 44, Terminal Liquor (TL).

38. REDOX Ion Exchange (RIX) Waste. Waste produced at B Plant after extraction of cesium from REDOX supernatant liquid by ion exchange. This includes column waste, column wash waste, and cesium purification waste.

Approximate Composition

Element/isotope	mol/L
Al	0.6
Na	3.1
NO_3	1.97
NO_2	0.27
OH	0.69
SO_4	0.022

39. REDOX Supernatant (RSN). Supernatant liquor portion of waste generated by the REDOX process and found above sludge in underground storage tanks.

Approximate Composition

Element/isotope	mol/L
Al	0.59
Na	5.2
NO_2	0.18
NO_3	3.08
OH	1.26
SO_4	0.015

40. SIX. Waste resulting from the removal of cesium from PUREX sludge supernatant liquid (see waste type PSS) by ion exchange at the B Plant. The given composition includes column waste, wash waste, and cesium purification waste.

Approximate Composition

Element/isotope	mol/L
Al	0.027
CO_3	0.16
Cr	0.0013
Na	2.93
NO_2	0.4
NO_3	2.76
SO_4	0.16

41. Strontium Sludge (SRS). Sludge feed for the strontium extraction process at the B Plant. This waste type turned up during the mid-1970s and most likely originated largely from the PUREX process. Three compositions of PUREX sludges are given, two from sample analyses and one estimated from knowledge of essential material consumption and chemical behavior. The first waste composition is clearly labeled PUREX sludge but is not dated nor is a sampling method given. The third waste composition given here represents a homogenized core sample of the tank and may contain a variety of sludges. The one estimated composition contains less water than the actual compositions. The discrepancies between these three compositions reflect the difficulty of relying on a wide variety of sources to characterize highly variable waste types.

Composition of a Sampled Sludge from Tank 241-C-106

Element/isotope	mol/L
Al*	1.95
Ba	<0.04
Ca*	0.2
Fe*	1.78
Mg	0.09
Mn	0.55
Na	2.2
OH	5.74
Pu	0.00025
Si*	0.136

* Assuming Al present as $NaAlO_2$, Fe as $Fe(OH)_3$, Ca as $Ca(OH)_2$, and Si as Na_2SiO_3.

Composition of a Composite of Sampled Solids from Tank 241-C-106 Done in September 1976

Element/isotope	mol/L
Al	2.11
Ca	0.425
Fe	1.33
Mg	0.386
Na	7.27
P	0.13
Si	3.61
TOC	6.6 gm/L

PUREX Sludge Composition*

Element/isotope	mol/L
Al	3.87
Fe	2.75
Mn	0.8
Na	12.96
OH	8.25
PO_4	0.27
Si	4.14
Zr	1.1

* This is a theoretical PUREX sludge composition based on known consumption of essential materials and known solubility behavior of ionic species.

42. Strontium Semiworks Waste (SSW). Waste produced from the strontium extraction process at the strontium semiworks after 1961. Feed was typically PUREX high-level acid waste.

Approximate Composition

Element/isotope	mol/L
Ba	0.0002
Ca	0.0049
Ce	0.0017
$C_2H_3O_2$ (acetate)	1.34
Fe	0.03
K	0.078
Na	4.9
NO_3	2.1
OH	1.32
Pb	0.034
RE	0.0069
Sr	0.0005

43. <u>TBP</u>. Waste from the TBP uranium-extraction process at U Plant, composed of concentrated, neutralized aqueous effluents from the primary extraction column and from the solvent wash.

Approximate Composition

Element/isotope	mol/L
Cl	0.0025
Fe	0.03
Na	8.87
NO_3	7.35
OH	0.09
PO_4	0.3
Pu	6.7 E-7
SO_4	0.31
U	0.0061

44. <u>Terminal Liquor (TL)</u>. Terminal liquor produced by evaporators as a concentrated supernatant liquid decanted from the evaporator bottoms. Terminal liquor is defined as evaporator liquor that may not be evaporated further without producing solids that are unsatisfactory for storage in SSTs. These undesirable solids may be either deliquescent caustic salts, fine and poorly draining aluminate solids, or gelled organic complexants.

Typical Composition

Element/isotope	mol/L
Al	2.3
CO_3	0.2
Na	12.6
NO_2	3.0
NO_3	2.5
OH	4.4
PO_4	0.001

45. <u>1C</u>. First decontamination cycle waste from the $BiPO_4$ process at B and T Plants. This waste type consists of byproducts coprecipitated from a plutonium-containing solution. Coating waste from the removal of aluminum fuel element cladding was added and composed about 24% of this waste stream.

Approximate Composition

Element/isotope	mol/L
Al	0.38
Bi	0.012
Ce	0.00022
Cr	0.0016
F	0.19
Fe	0.025
Na	3.34
NO_2	0.28
NO_3	1.54
OH	0.28
PO_4	0.28
PU	0.000002
Si	0.034
SO_4	0.052

46. <u>2C</u>. Waste from the second decontamination cycle of the $BiPO_4$ process at B and T Plants and consisting of effluent remaining after precipitation of plutonium product.

Approximate Composition

Element/isotope	mol/L
Bi	0.0092
Cr	0.0025
F	0.22
Fe	0.023
Na	2.04
NO_3	1.27
PO_4	0.34
Si	0.037
SO_4	0.062

47. <u>224</u>. Waste from the final decontamination and concentration stage of the $BiPO_4$ process. In this stage, first the byproducts and finally the plutonium product are precipitated with lanthanum fluoride. This waste was largely sent into the ground through reverse flow wells and underground sumps.

Approximate Composition

Element/isotope	mol/L
Bi	0.0062
Cr	0.0009
F	0.31
$H_2C_2O_4$ (oxalate)	0.028
K	0.26
La	0.0014
Mn	0.0046
Na	1.75
NO_3	1.06
OH	0.59
PO_4	0.049

48. <u>5-6</u>. Waste from Tank 5-6 at B Plant. This is a very hot waste that collected in the bottom of Section 5 at B Plant due to boil-over during dissolving and neutralization during the $BiPO_4$ process.

49. Z. Waste discharged from the Plutonium Finishing Plant during the late 1970s. Waste from the Plutonium Reclamation Facility and the Remote Mechanical C Line was sent to evaporators and put in SSTs. At times, slag and crucibles from processing of plutonium metal were used as feed material for plutonium reclamation, changing the waste composition.

Approximate Composition Without Slag and Crucible Processing

Element/isotope	mol/L
Al	0.5
Ba	0.000003
Ca	0.00071
Cr	0.0014
Fe	0.0007
K	0.0007
Mg	0.000021
Mn	0.0007
Na	4
Ni	0.00057
Pb	0.00036
Sr	0.000021
OH	0.0001
Cl	0.041
F	0.047
NO_3	3.5
NO_2	0.014
PO_4	0.00014
SO_4	0.0014
TRU	0.00006
U	0.00001
TOC	3 g/L

Approximate Composition with
Slag and Crucible Processing
(where different from above)

Element/isotope	mol/L
Ca	0.014
Fe	0.0071
F	0.018
I	0.00016
NO_2	0.0065

Appendix C

Core Sample Analytical Data Tables Used in the SORWT Model Verification Study

Data Set Used in Verification Study

Group No.	Tank No.	Core No.	Composite No.	Sample No.	Al	BI	Cr	Fe	La	Mn
XII	C-110	37	1	Sample	1.36E+04	1.24E+04	4.75E+02	1.16E+04	7.98E+00	5.60E+01
XII	C-110	37	1	Duplicate	1.38E+04	1.30E+04	4.81E+02	1.15E+04	7.98E+00	4.82E+01
XII	C-110	37	2	Sample	1.40E+04	1.33E+04	4.74E+02	1.14E+04	7.91E+00	5.01E+01
XII	C-110	37	2	Duplicate	1.47E+04	1.28E+04	4.64E+02	1.17E+04	7.95E+00	4.64E+01
XII	C-110	38	1	Sample	1.43E+04	1.51E+04	4.86E+02	1.15E+04	8.00E+00	9.34E+01
XII	C-110	38	1	Duplicate	1.38E+04	1.57E+04	5.05E+02	1.11E+04	7.95E+00	5.21E+01
XII	C-110	39	1	Sample	1.49E+04	1.38E+04	4.27E+02	9.35E+03	7.96E+00	3.10E+01
XII	C-110	39	1	Duplicate	1.52E+04	1.42E+04	4.35E+02	9.72E+03	7.89E+00	3.28E+01
XII	C-110	39	2	Sample	1.46E+04	1.35E+04	4.22E+02	9.21E+03	7.98E+00	3.51E+01
XII	C-110	39	2	Duplicate	1.45E+04	1.02E+04	4.13E+02	8.99E+03	7.95E+00	8.45E+01
XII	BX-107	40	1	Sample	1.34E+04	2.13E+04	9.54E+02	1.07E+04	7.98E+00	6.51E+01
XII	BX-107	40	1	Duplicate	1.43E+04	2.25E+04	9.90E+02	1.13E+04	7.98E+00	6.05E+01
XII	BX-107	40	2	Sample	1.12E+04	1.93E+04	7.87E+02	8.35E+03	7.98E+00	4.99E+01
XII	BX-107	40	2	Duplicate	1.28E+04	2.19E+04	8.89E+02	9.39E+03	8.00E+00	5.89E+01
XII	BX-107	41	1	Sample	1.72E+04	2.82E+04	1.08E+03	1.34E+04	7.97E+00	6.52E+01
XII	BX-107	41	1	Duplicate	1.73E+04	2.80E+04	1.08E+03	1.32E+04	7.97E+00	8.16E+01
XII	BX-107	41	2	Sample	1.33E+04	1.89E+04	9.58E+02	1.05E+04	8.00E+00	6.60E+01
XII	BX-107	41	2	Duplicate	1.49E+04	1.83E+04	1.01E+03	1.17E+04	7.98E+00	6.92E+01
VII	B-201	26	1	Sample	1.23E+04	9.79E+04	3.25E+03	1.86E+04	1.45E+04	2.23E+04
VII	B-201	26	1	Duplicate	1.31E+04	1.05E+05	3.31E+03	1.87E+04	1.56E+04	2.33E+03
VII	B-201	26	2	Sample	1.04E+04	8.50E+04	2.87E+03	1.52E+04	1.26E+04	1.95E+04
VII	B-201	26	2	Duplicate	1.06E+04	8.91E+04	2.94E+03	1.62E+04	1.29E+04	2.08E+04
VII	B-201	27	1	Sample	1.17E+03	9.61E+04	3.48E+03	1.16E+04	1.46E+04	2.41E+04
VII	B-201	27	1	Duplicate	1.29E+03	1.00E+05	3.88E+03	1.24E+04	1.55E+04	2.59E+04
VII	B-201	27	2	Sample	1.00E+03	9.10E+04	3.56E+03	1.13E+04	1.40E+04	2.35E+04
VII	B-201	27	2	Duplicate	1.06E+03	9.49E+04	3.76E+03	1.13E+04	1.50E+04	2.42E+04
VII	B-202	24	1	Sampl	1.01E+03	3.34E+04	2.33E+03	6.55E+03	1.23E+04	1.14E+04
VII	B-202	24	1	Dupl	.	.	.	.	.	.
VII	B-202	24	1	Samp2	1.93E+03	2.76E+04	1.97E+03	1.01E+04	1.18E+04	1.29E+03
VII	B-202	24	1	Dup2	1.60E+03	2.72E+04	1.88E+03	9.04E+03	1.14E+04	8.00E+02
VII	B-202	24	2	Sample	1.62E+03	3.21E+04	2.45E+03	8.80E+03	1.28E+04	1.28E+04
VII	B-202	24	2	Duplicate	.	.	.	.	.	.
VII	B-202	24	2	Sample	.	.	.	.	.	.
VII	B-202	24	2	Duplicate	.	.	.	.	.	.
VII	B-202	25	1	Sample	2.55E+02	3.50E+04	2.78E+03	4.09E+03	1.45E+04	1.35E+04
VII	B-202	25	1	Duplicate	1.95E+02	3.66E+04	2.79E+03	3.63E+03	1.42E+04	7.54E+03
VII	B-202	25	2	Sampl	4.85E+02	3.18E+04	2.56E+03	4.91E+03	1.31E+04	1.25E+04
VII	B-202	25	2	Dupl	.	.	.	.	.	.
VII	B-202	25	2	Samp2	6.08E+02	3.32E+04	2.20E+03	4.88E+03	1.32E+04	1.22E+04
VII	B-202	25	2	Dup2	6.88E+02	3.32E+04	2.20E+03	5.32E+03	1.31E+04	1.20E+04
XVI	B-110	1	1	Sampl	4.13E+03	1.78E+04	7.38E+02	1.76E+04	7.15E+01	7.60E+01
XVI	B-110	1	1	Dupl	3.81E+03	1.82E+04	7.38E+02	1.74E+04	8.82E+01	7.10E+01
XVI	B-110	1	1	Samp2	5.86E+03	2.08E+04	7.57E+02	1.81E+04	7.44E+01	8.40E+01
XVI	B-110	1	1	Dup2	3.13E+03	1.93E+04	7.30E+02	1.75E+04	6.32E+01	8.10E+01
XVI	B-110	1	1	Samp3	1.19E+03	1.84E+04	8.18E+02	2.84E+04	8.60E+01	1.59E+02
XVI	B-110	1	1	Dup3	1.15E+03	1.74E+04	7.98E+02	1.80E+04	8.00E+01	9.10E+01
XVI	B-110	1	1	Samp4	1.16E+03	1.74E+04	8.15E+02	1.87E+04	6.26E+01	8.40E+01
XVI	B-110	1	1	Dup4	1.11E+03	1.73E+04	7.80E+02	1.80E+04	6.11E+01	7.30E+01
XVI	B-110	2	1	Sampl	1.98E+03	2.07E+04	8.98E+02	1.96E+04	3.09E+01	6.80E+01
XVI	B-110	2	1	Dupl	1.71E+03	2.03E+04	7.88E+02	1.78E+04	3.13E+01	6.30E+01
XVI	B-110	2	1	Samp2	1.79E+03	2.08E+04	8.23E+02	1.85E+04	2.84E+01	7.40E+01
XVI	B-110	2	1	Dup2	1.97E+03	2.17E+04	8.99E+02	1.90E+04	3.00E+01	6.70E+01
XVI	B-110	3	1	Sampl	6.95E+02	2.30E+04	8.14E+02	1.77E+04	7.42E+01	9.70E+01
XVI	B-110	3	1	Dupl	7.16E+02	2.03E+04	7.54E+02	1.70E+04	7.64E+01	6.80E+01
XVI	B-110	3	1	Samp2	7.68E+02	2.21E+04	8.11E+02	1.84E+04	6.46E+01	1.14E+02
XVI	B-110	3	1	Dup2	7.00E+02	2.30E+04	8.04E+02	1.82E+04	7.21E+01	7.40E+01
XVI	B-110	3	2	Sampl	6.44E+02	2.34E+04	7.59E+02	1.75E+04	6.87E+01	5.70E+01
XVI	B-110	3	2	Dupl	1.12E+03	2.26E+04	7.97E+02	1.76E+04	7.73E+01	6.10E+01
XVI	B-110	3	2	Samp2	1.27E+03	2.36E+04	8.44E+02	1.89E+04	7.68E+01	7.50E+01
XVI	B-110	3	2	Dup2	1.27E+03	1.98E+04	8.04E+02	1.78E+04	7.47E+01	7.70E+01
XVI	B-110	3	3	Sampl	1.23E+03	2.16E+04	8.34E+02	1.84E+04	6.83E+01	6.80E+01
XVI	B-110	3	3	Dupl	1.33E+03	2.04E+04	8.46E+02	1.85E+04	6.83E+01	1.14E+02
XVI	B-110	3	3	Samp2	6.77E+02	2.26E+04	7.71E+02	1.80E+04	7.22E+01	8.60E+01
XVI	B-110	3	3	Dup2	7.53E+02	2.24E+04	7.60E+02	1.77E+04	8.03E+01	1.24E+02
XVI	B-110	4	1	Sampl	1.15E+03	1.78E+04	8.54E+02	1.86E+04	9.70E+01	9.20E+01
XVI	B-110	4	1	Dupl	1.26E+03	1.84E+04	8.72E+02	1.89E+04	9.53E+01	1.03E+02
XVI	B-110	4	1	Samp2	1.20E+03	1.74E+04	8.51E+02	1.82E+04	9.01E+01	1.02E+02
XVI	B-110	4	1	Dup2	1.27E+03	1.83E+04	8.67E+02	2.06E+04	8.85E+01	1.14E+02
XVI	B-110	9	1	Sampl	4.05E+02	1.54E+04	7.53E+02	1.46E+04	1.23E+02	8.80E+01
XVI	B-110	9	1	Dupl	3.87E+02	1.48E+04	7.39E+02	1.46E+04	1.19E+02	9.30E+01
XVI	B-110	9	1	Samp2	3.62E+02	1.55E+04	7.53E+02	1.47E+04	1.30E+02	1.01E+02
XVI	B-110	9	1	Dup2	3.39E+02	1.44E+04	7.53E+02	1.44E+04	1.15E+02	9.10E+01
XVI	B-110	10	1	Sampl	1.35E+03	1.41E+04	7.83E+02	1.80E+04	6.92E+01	1.34E+02
XVI	B-110	10	1	Dupl	1.28E+03	1.47E+04	7.34E+02	1.72E+04	6.69E+01	1.23E+02
XVI	B-110	10	1	Samp2	1.21E+03	1.70E+04	7.71E+02	1.82E+04	6.48E+01	1.16E+02
XVI	B-110	10	1	Dup2	1.21E+03	1.72E+04	7.58E+02	1.89E+03	6.67E+01	1.11E+02
XVI	B-110	16	1	Sampl	1.43E+03	1.89E+04	7.84E+02	1.84E+04	8.63E+01	8.80E+01
XVI	B-110	16	1	Dupl	1.51E+03	1.95E+04	8.03E+02	1.86E+04	1.15E+02	1.03E+02
XVI	B-110	16	1	Samp2	1.49E+03	1.93E+04	7.84E+02	1.83E+04	7.69E+01	1.40E+02
XVI	B-110	16	1	Dup2	1.51E+03	1.99E+04	7.82E+02	1.82E+04	7.64E+01	1.76E+02
XVI	B-111	29	1	Sample	1.15E+03	2.06E+04	1.12E+03	1.69E+04	5.93E+01	1.07E+02
XVI	B-111	29	1	Duplicate	1.11E+03	2.00E+04	1.16E+03	1.68E+04	5.63E+01	1.21E+02
XVI	B-111	29	2	Sample	1.13E+03	2.00E+04	1.10E+03	1.67E+04	5.53E+01	1.05E+02
XVI	B-111	29	2	Duplicate	1.19E+03	2.02E+04	1.11E+03	1.71E+04	5.59E+01	1.12E+02
XVI	B-111	30	1	Sample	1.61E+03	2.04E+04	1.18E+03	8.83E+03	6.21E+01	1.11E+02
XVI	B-111	30	1	Duplicate	1.63E+03	2.04E+04	1.18E+03	1.88E+04	6.08E+01	1.09E+02
XVI	B-111	30	2	Sample	1.57E+03	1.93E+04	1.13E+03	1.80E+04	6.26E+01	1.18E+02
XVI	B-111	30	2	Duplicate	1.51E+03	2.07E+04	1.19E+03	1.87E+04	6.00E+01	1.03E+02
IV	S-104	42	1	Sample	1.16E+05	2.90E+01	2.53E+03	1.56E+03	8.00E+00	8.15E+02
IV	S-104	42	1	Duplicate	1.11E+05	2.90E+01	2.47E+03	1.45E+03	8.00E+00	1.09E+03
IV	S-104	42	2	Sample	1.19E+05	2.86E+01	2.62E+03	1.90E+03	7.89E+00	1.22E+03
IV	S-104	42	2	Duplicate	1.13E+05	2.88E+01	2.46E+03	1.63E+03	7.94E+00	1.13E+03
IV	S-104	43	1	Sample	1.19E+05	4.57E+01	2.30E+03	1.74E+03	9.94E+00	1.07E+03
IV	S-104	43	1	Duplicate	1.22E+05	4.55E+01	2.40E+03	1.81E+03	9.88E+00	9.90E+02
IV	S-104	43	2	Sample	1.22E+05	4.51E+01	2.30E+03	1.76E+03	9.80E+00	6.53E+02
IV	S-104	43	2	Duplicate	1.14E+05	4.49E+01	2.30E+03	1.69E+03	9.80E+00	5.83E+02
IV	S-104	44	1	Sample	1.15E+05	4.19E+01	2.10E+03	1.66E+03	1.04E+01	1.52E+03
IV	S-104	44	1	Duplicate	1.23E+05	4.25E+01	2.27E+03	1.85E+03	1.05E+01	1.96E+03
IV	S-104	44	2	Sample	1.17E+05	4.21E+01	2.20E+03	1.67E+01	1.04E+01	1.29E+03
IV	S-104	44	2	Duplicate	1.13E+05	4.22E+01	2.29E+03	1.86E+01	1.04E+01	1.48E+03
XV	T-111	31	1	Sample	6.56E+02	2.14E+04	1.92E+03	2.08E+04	3.75E+03	6.47E+03
XV	T-111	31	1	Duplicate	6.32E+02	2.05E+04	1.86E+03	2.02E+04	3.63E+03	6.29E+03
XV	T-111	31	2	Sample	7.06E+02	2.01E+04	1.73E+03	1.97E+04	3.45E+03	6.02E+03
XV	T-111	31	2	Duplicate	6.80E+02	2.02E+04	1.67E+03	1.95E+04	3.38E+03	5.86E+03
XV	T-111	33	1	Sample	4.85E+02	2.63E+04	1.76E+03	1.57E+04	4.45E+03	6.15E+03
XV	T-111	33	1	Duplicate	4.83E+02	2.66E+04	1.81E+03	1.62E+04	4.58E+03	6.29E+03
XV	T-111	33	2	Sample	4.59E+02	2.61E+04	1.82E+03	1.61E+04	4.78E+03	6.59E+03
XV	T-111	33	2	Duplicate	4.59E+02	2.73E+04	1.82E+03	1.61E+04	4.84E+03	6.59E+03

Group No.	Tank No.	Core No.	Composite No.	Sample No.	Na	Pb	Si	Zr	Cs-137	Sr-90
XII	C-110	37	1	Sample	8.10E+04	4.36E+02	7.53E+03	1.67E+02	1.54E+01	7.13E+00
XII	C-110	37	1	Duplicate	8.01E+04	4.61E+02	7.48E+03	1.72E+02	1.53E+01	7.21E+00
XII	C-110	37	2	Sample	8.58E+04	4.43E+02	7.54E+03	1.80E+02	1.51E+01	7.15E+00
XII	C-110	37	2	Duplicate	8.48E+04	4.24E+02	7.22E+03	1.76E+02	1.41E+01	6.50E+00
XII	C-110	38	1	Sample	8.06E+04	2.09E+02	7.86E+03	1.97E+02	1.91E+01	4.38E+00
XII	C-110	38	1	Duplicate	7.39E+04	2.15E+02	7.58E+03	2.01E+02	2.05E+01	4.26E+00
XII	C-110	39	1	Sample	8.92E+04	1.11E+02	6.43E+03	1.51E+02	2.39E+01	3.72E+00
XII	C-110	39	1	Duplicate	8.77E+04	1.18E+02	6.37E+03	1.56E+02	2.29E+01	2.59E+00
XII	C-110	39	2	Sample	8.68E+04	1.28E+02	6.28E+03	1.36E+02	2.41E+01	3.94E+00
XII	C-110	39	2	Duplicate	8.67E+04	1.26E+02	6.26E+03	1.33E+02	2.40E+01	3.55E+00
XII	BX-107	40	1	Sample	1.02E+05	3.54E+01	6.43E+03	1.81E+02	1.35E+01	9.76E+00
XII	BX-107	40	1	Duplicate	1.06E+05	5.45E+01	6.77E+03	1.97E+02	1.34E+01	1.02E+01
XII	BX-107	40	2	Sample	9.97E+04	6.56E+01	5.63E+03	7.90E+01	1.09E+01	7.71E+00
XII	BX-107	40	2	Duplicate	1.02E+05	6.48E+01	6.37E+03	5.34E+01	1.16E+01	8.79E+00
XII	BX-107	41	1	Sample	1.01E+05	1.23E+02	7.98E+03	1.73E+02	2.00E+01	1.18E+01
XII	BX-107	41	1	Duplicate	1.03E+05	7.58E+01	7.99E+03	6.92E+01	2.04E+01	1.20E+01
XII	BX-107	41	2	Sample	9.45E+04	1.01E+02	6.10E+03	1.35E+02	2.43E+01	8.74E+00
XII	BX-107	41	2	Duplicate	9.56E+04	7.51E+01	6.97E+03	1.97E+02	2.51E+01	9.96E+00
VII	B-201	26	1	Sample	5.40E+04	2.22E+03	5.53E+04	8.24E+01	9.90E-01	3.87E+00
VII	B-201	26	1	Duplicate	5.85E+04	2.24E+03	5.97E+04	7.70E+01	1.61E+00	5.18E+00
VII	B-201	26	2	Sample	5.38E+04	1.32E+03	4.49E+04	5.60E+01	6.16E-01	2.76E+00
VII	B-201	26	2	Duplicate	5.67E+04	1.36E+03	4.77E+04	5.20E+01	8.53E-01	2.22E+00
VII	B-201	27	1	Sample	3.60E+04	1.62E+03	6.95E+03	4.40E+01	4.63E-01	1.04E+00
VII	B-201	27	1	Duplicate	4.11E+04	1.96E+03	7.73E+03	4.50E+01	8.26E-01	1.33E+00
VII	B-201	27	2	Sample	3.79E+04	1.50E+03	7.31E+03	4.20E+01	4.53E-01	9.40E-01
VII	B-201	27	2	Duplicate	3.87E+04	1.55E+03	7.67E+03	4.40E+01	5.90E-01	8.30E-01
VII	B-202	24	1	Samp1	3.46E+04	7.55E+02	3.34E+03	6.40E+00	2.62E-02	3.90E+00
VII	B-202	24	1	Dup1	.	.	.	.	.	.
VII	B-202	24	1	Samp2	3.56E+04	7.77E+02	5.85E+03	3.90E+00	6.74E-02	7.37E+00
VII	B-202	24	1	Dup2	3.36E+04	7.15E+02	5.19E+03	4.00E+00	6.54E-02	6.05E+00
VII	B-202	24	2	Sample	3.96E+04	8.33E+02	4.78E+03	7.00E+00	2.74E-02	5.85E+00
VII	B-202	24	2	Duplicate	.	.	.	.	2.92E-02	1.88E+00
VII	B-202	24	2	Sample	.	.	.	.	.	.
VII	B-202	24	2	Duplicate	.	.	.	.	.	.
VII	B-202	25	1	Sample	3.88E+04	4.40E+02	1.20E+03	6.50E+00	3.52E-01	3.03E+00
VII	B-202	25	1	Duplicate	3.71E+04	4.39E+02	1.13E+03	6.90E+00	2.48E-01	3.04E+00
VII	B-202	25	2	Samp1	3.63E+04	7.12E+02	1.93E+03	6.40E+00	2.09E-02	2.66E+00
VII	B-202	25	2	Dup1	.	.	.	.	.	.
VII	B-202	25	2	Samp2	3.50E+04	3.34E+02	2.66E+03	4.00E+00	1.14E-02	2.36E+00
VII	B-202	25	2	Dup2	3.58E+04	3.41E+02	2.69E+03	4.00E+00	1.07E-02	2.72E+00
XVI	B-110	1	1	Samp1	1.06E+05	6.51E+02	1.36E+04	4.98E+01	1.44E+01	2.13E+02
XVI	B-110	1	1	Dup1	1.05E+05	6.57E+02	1.79E+04	6.13E+01	1.47E+01	2.36E+02
XVI	B-110	1	1	Samp2	1.18E+05	1.08E+03	2.39E+04	5.17E+01	1.50E+01	2.31E+02
XVI	B-110	1	1	Dup2	1.00E+05	8.56E+02	1.59E+04	4.39E+01	1.46E+01	1.90E+02
XVI	B-110	1	1	Samp3	1.01E+05	1.10E+03	9.48E+03	7.98E+02	.	.
XVI	B-110	1	1	Dup3	9.65E+04	1.13E+03	9.37E+03	3.38E+01	.	.
XVI	B-110	1	1	Samp4	9.84E+04	9.77E+02	9.50E+03	8.29E+02	.	.
XVI	B-110	1	1	Dup4	9.59E+04	9.20E+02	9.33E+03	3.44E+01	.	.
XVI	B-110	2	1	Samp1	9.80E+04	3.88E+02	1.04E+04	4.55E+02	1.50E+01	.
XVI	B-110	2	1	Dup1	9.14E+04	2.46E+02	9.37E+03	1.89E+01	1.51E+01	.
XVI	B-110	2	1	Samp2	9.44E+04	2.87E+02	9.78E+03	1.71E+01	1.49E+01	.
XVI	B-110	2	1	Dup2	9.80E+04	2.81E+02	1.01E+04	5.19E+02	1.53E+01	.
XVI	B-110	3	1	Samp1	9.21E+04	4.97E+01	9.15E+03	5.26E+01	1.46E+01	2.74E+01
XVI	B-110	3	1	Dup1	8.84E+04	5.11E+01	8.95E+03	5.42E+01	1.31E+01	2.64E+01
XVI	B-110	3	1	Samp2	9.52E+04	4.32E+01	9.58E+03	4.58E+01	1.39E+01	2.61E+01
XVI	B-110	3	1	Dup2	9.45E+04	4.83E+01	9.52E+03	5.12E+01	1.41E+01	2.59E+01
XVI	B-110	3	2	Samp1	9.19E+04	4.60E+02	8.99E+03	4.87E+01	1.34E+01	.
XVI	B-110	3	2	Dup1	9.04E+04	5.17E+02	9.01E+03	5.48E+01	1.36E+01	.
XVI	B-110	3	2	Samp2	9.48E+04	6.17E+02	9.56E+03	5.45E+01	1.37E+01	.
XVI	B-110	3	2	Dup2	9.16E+04	1.04E+03	9.15E+03	5.30E+01	1.36E+01	.
XVI	B-110	3	3	Samp1	9.49E+04	4.75E+02	9.55E+03	4.85E+01	1.31E+01	.
XVI	B-110	3	3	Dup1	9.49E+04	5.84E+02	9.69E+03	4.84E+01	1.31E+01	.
XVI	B-110	3	3	Samp2	9.22E+04	4.84E+02	9.03E+03	5.12E+01	1.41E+01	.
XVI	B-110	3	3	Dup2	9.27E+04	5.38E+02	8.93E+03	5.70E+01	1.42E+01	.
XVI	B-110	4	1	Samp1	1.07E+05	5.38E+02	9.21E+03	5.55E+02	1.67E+01	1.16E+02
XVI	B-110	4	1	Dup1	1.09E+05	6.03E+02	9.38E+03	5.46E+02	1.69E+01	1.37E+02
XVI	B-110	4	1	Samp2	1.06E+05	5.92E+02	9.12E+03	5.16E+02	1.64E+01	1.19E+02
XVI	B-110	4	1	Dup2	1.04E+05	9.05E+02	9.11E+03	5.07E+02	1.64E+01	1.92E+02
XVI	B-110	9	1	Samp1	9.24E+04	5.24E+02	8.39E+03	7.10E+01	1.37E+01	5.00E+01
XVI	B-110	9	1	Dup1	9.27E+04	5.07E+02	8.20E+03	6.87E+01	1.36E+01	5.00E+01
XVI	B-110	9	1	Samp2	9.15E+04	5.57E+02	8.17E+03	7.52E+01	1.41E+01	4.78E+01
XVI	B-110	9	1	Dup2	9.17E+04	4.92E+02	8.21E+03	6.67E+01	1.49E+01	4.64E+01
XVI	B-110	10	1	Samp1	9.37E+04	5.17E+02	8.93E+03	3.39E+01	1.49E+01	4.73E+01
XVI	B-110	10	1	Dup1	8.80E+04	5.09E+02	8.63E+03	3.27E+01	1.51E+01	7.75E+01
XVI	B-110	10	1	Samp2	9.39E+04	5.51E+02	8.96E+03	3.17E+01	1.47E+01	7.25E+01
XVI	B-110	10	1	Dup2	9.48E+04	4.93E+02	9.05E+03	3.26E+01	1.47E+01	7.43E+01
XVI	B-110	16	1	Samp1	9.57E+04	3.06E+02	1.01E+04	4.59E+01	1.40E+01	7.12E+00
XVI	B-110	16	1	Dup1	9.68E+04	4.08E+02	1.02E+04	6.11E+01	1.43E+01	6.44E+00
XVI	B-110	16	1	Samp2	9.25E+04	2.73E+02	1.01E+04	4.09E+01	1.42E+01	.
XVI	B-110	16	1	Dup2	9.29E+04	2.71E+02	1.00E+04	4.06E+01	1.43E+01	.
XVI	B-111	29	1	Sample	1.01E+05	1.90E+03	9.50E+03	2.20E+01	1.73E+02	3.37E+02
XVI	B-111	29	1	Duplicate	9.78E+04	1.80E+03	9.45E+03	1.90E+01	1.62E+02	2.79E+02
XVI	B-111	29	2	Sample	9.63E+04	1.74E+03	9.37E+03	1.90E+01	1.90E+02	2.94E+02
XVI	B-111	29	2	Duplicate	9.49E+04	1.49E+03	9.61E+03	2.20E+01	1.64E+02	3.04E+02
XVI	B-111	30	1	Sample	9.48E+04	1.88E+03	1.12E+04	2.07E+01	1.43E+02	1.69E+02
XVI	B-111	30	1	Duplicate	9.50E+04	1.92E+03	1.13E+04	2.03E+01	1.44E+02	1.75E+02
XVI	B-111	30	2	Sample	9.07E+04	1.82E+03	1.10E+04	2.09E+01	1.42E+02	2.07E+02
XVI	B-111	30	2	Duplicate	9.52E+04	1.93E+03	1.14E+04	2.00E+01	1.48E+02	2.19E+02
IV	S-104	42	1	Sample	1.24E+05	3.55E+01	1.03E+03	1.31E+01	6.75E+01	2.95E+02
IV	S-104	42	1	Duplicate	1.25E+05	3.55E+01	1.04E+03	8.63E+00	6.20E+01	2.81E+02
IV	S-104	42	2	Sample	1.16E+05	3.50E+01	1.18E+03	4.85E+00	6.61E+01	3.39E+02
IV	S-104	42	2	Duplicate	1.19E+05	3.52E+01	1.09E+03	1.25E+01	6.26E+01	3.10E+02
IV	S-104	43	1	Sample	1.19E+05	3.88E+01	1.23E+03	2.60E+01	6.02E+01	3.05E+02
IV	S-104	43	1	Duplicate	1.20E+05	3.85E+01	1.13E+03	2.83E+01	6.03E+01	3.00E+02
IV	S-104	43	2	Sample	1.16E+05	3.82E+01	2.31E+03	2.97E+01	5.83E+01	3.10E+02
IV	S-104	43	2	Duplicate	1.19E+05	3.81E+01	9.47E+02	3.79E+01	5.57E+01	3.45E+02
IV	S-104	44	1	Sample	1.14E+05	4.19E+01	1.44E+03	2.29E+01	6.31E+01	2.99E+02
IV	S-104	44	1	Duplicate	1.13E+05	4.25E+01	1.40E+03	2.03E+01	6.40E+01	3.56E+02
IV	S-104	44	2	Sample	1.15E+05	4.21E+01	1.57E+03	2.09E+01	6.39E+01	2.72E+02
IV	S-104	44	2	Duplicate	1.19E+05	4.22E+01	1.55E+03	2.94E+01	6.40E+01	3.03E+02
XV	T-111	31	1	Sample	4.01E+04	4.53E+02	6.04E+03	4.00E+00	2.11E-01	7.34E+00
XV	T-111	31	1	Duplicate	3.96E+04	4.27E+02	5.88E+03	4.01E+00	2.12E-01	6.97E+00
XV	T-111	31	2	Sample	3.94E+04	4.86E+02	5.09E+03	3.99E+00	2.38E-01	7.31E+00
XV	T-111	31	2	Duplicate	3.85E+04	4.82E+02	5.78E+03	3.99E+00	2.36E-01	7.55E+00
XV	T-111	33	1	Sample	3.36E+04	2.72E+02	5.39E+03	4.00E+00	1.12E-01	3.62E+00
XV	T-111	33	1	Duplicate	3.41E+04	2.62E+02	5.52E+03	3.99E+00	1.15E-01	3.67E+00
XV	T-111	33	2	Sample	3.52E+04	2.67E+02	5.41E+03	3.99E+00	1.04E-01	3.48E+00
XV	T-111	33	2	Duplicate	3.51E+04	2.72E+02	5.41E+03	4.00E+00	1.03E-01	3.37E+00

Group No.	Tank No.	Core No.	Composite No.	Sample No.	Pu-239/40	U	PO4	NO3	NO2	F
XII	C-110	37	1	Sample	5.58E-02	1.98E+03	3.71E+04	9.59E+04	2.81E+03	8.51E+03
XII	C-110	37	1	Duplicate	5.83E-02	2.05E+03	3.81E+04	9.69E+04	2.60E+03	8.77E+03
XII	C-110	37	2	Sample	6.17E-02	1.96E+03	4.15E+04	9.65E+04	2.84E+03	9.14E+03
XII	C-110	37	2	Duplicate	6.52E-02	2.05E+03	4.93E+04	9.14E+04	2.79E+03	9.37E+03
XII	C-110	38	1	Sample	7.65E-02	1.51E+03	1.89E+04	1.22E+05	5.42E+03	7.81E+03
XII	C-110	38	1	Duplicate	8.85E-02	1.27E+03	3.20E+04	1.10E+05	4.76E+03	8.59E+03
XII	C-110	39	1	Sample	1.35E-01	9.43E+02	1.47E+04	1.19E+05	1.23E+04	6.74E+03
XII	C-110	39	1	Duplicate	1.53E-01	1.08E+03	1.68E+04	1.22E+05	1.35E+04	7.06E+03
XII	C-110	39	2	Sample	5.18E-02	1.05E+03	1.96E+04	1.18E+05	1.24E+04	4.86E+03
XII	C-110	39	2	Duplicate	5.44E-02	1.17E+03	1.87E+04	1.17E+05	1.31E+04	4.33E+03
XII	BX-107	40	1	Sample	3.49E-02	1.56E+03	1.45E+04	1.45E+05	1.02E+04	8.91E+03
XII	BX-107	40	1	Duplicate	5.33E-02	2.07E+03	1.43E+04	1.39E+05	9.17E+03	8.11E+03
XII	BX-107	40	2	Sample	8.34E-02	1.86E+03	1.48E+04	1.46E+05	9.12E+03	8.50E+03
XII	BX-107	40	2	Duplicate	7.57E-02	2.18E+03	1.51E+04	1.53E+05	9.19E+03	8.33E+03
XII	BX-107	41	1	Sample	5.49E-02	2.82E+03	1.34E+04	1.23E+05	1.25E+04	9.04E+03
XII	BX-107	41	1	Duplicate	5.64E-02	2.82E+03	1.34E+04	1.29E+05	1.24E+04	8.72E+03
XII	BX-107	41	2	Sample	4.49E-02	2.29E+04	1.43E+04	1.28E+05	1.21E+03	1.09E+04
XII	BX-107	41	2	Duplicate	5.41E-02	2.52E+04	1.41E+04	1.31E+05	1.18E+03	1.10E+04
VII	B-201	26	1	Sample	7.66E-01	7.63E+02	1.00E+03	4.70E+04	9.00E+02	5.20E+03
VII	B-201	26	1	Duplicate	8.38E-01	8.60E+02	1.10E+03	5.00E+04	1.00E+03	5.90E+03
VII	B-201	26	2	Sample	6.67E-01	6.52E+02	1.00E+03	5.10E+04	1.00E+03	6.10E+03
VII	B-201	26	2	Duplicate	9.05E-01	7.02E+02	1.30E+03	5.90E+04	1.10E+03	7.20E+03
VII	B-201	27	1	Sample	1.40E+00	2.89E+02	1.40E+03	5.10E+04	8.00E+02	6.30E+03
VII	B-201	27	1	Duplicate	1.56E+00	3.21E+02	1.40E+03	4.90E+04	8.00E+02	5.90E+03
VII	B-201	27	2	Sample	1.44E+00	3.12E+02	1.36E+03	4.80E+04	7.20E+02	5.60E+03
VII	B-201	27	2	Duplicate	1.50E+00	3.23E+02	1.42E+03	4.90E+04	7.30E+02	5.80E+03
VII	B-202	24	1	Sampl	1.55E-01	1.71E+02	1.85E+03	6.29E+04	4.55E+02	5.95E+03
VII	B-202	24	1	Dupl	.	.	1.81E+03	6.61E+04	4.39E+02	6.13E+03
VII	B-202	24	1	Samp2	1.58E-01	5.39E+02	.	.	.	.
VII	B-202	24	1	Dup2	1.40E-01	5.05E+02	.	.	.	.
VII	B-202	24	2	Sample	1.18E-01	6.97E+02	1.69E+03	7.13E+04	4.46E+02	6.23E+03
VII	B-202	24	2	Duplicate	1.83E-01	1.19E+02	.	.	.	.
VII	B-202	24	2	Sample	.	.	2.22E+03	5.85E+04	7.48E+02	6.37E+03
VII	B-202	24	2	Duplicate	.	.	2.00E+03	5.52E+04	7.46E+02	6.08E+03
VII	B-202	25	1	Sample	2.50E-01	2.06E+02	2.73E+03	6.67E+04	5.80E+02	6.71E+03
VII	B-202	25	1	Duplicate	3.19E-01	2.32E+02	2.23E+03	6.02E+04	4.96E+02	5.98E+03
VII	B-202	25	2	Sampl	2.07E-01	3.37E+02	1.77E+03	5.13E+04	4.47E+02	5.90E+03
VII	B-202	25	2	Dupl	.	.	.	.	.	.
VII	B-202	25	2	Samp2	1.61E-01	2.12E+02	2.20E+03	6.12E+04	7.70E+02	6.50E+03
VII	B-202	25	2	Dup2	1.41E-01	2.11E+02	2.22E+03	6.12E+04	7.60E+02	6.57E+03
XVI	B-110	1	1	Sampl	1.09E-01	2.36E+02	2.42E+04	1.55E+05	9.85E+03	1.60E+03
XVI	B-110	1	1	Dupl	1.13E-01	2.40E+02	2.65E+04	1.68E+05	9.87E+03	1.70E+03
XVI	B-110	1	1	Samp2	1.16E-01	2.31E+02	.	.	.	.
XVI	B-110	1	1	Dup2	9.60E-02	2.33E+02	.	.	.	.
XVI	B-110	1	1	Samp3	.	.	.	.	.	.
XVI	B-110	1	1	Dup3	.	.	.	.	.	.
XVI	B-110	1	1	Samp4	.	.	.	.	.	.
XVI	B-110	1	1	Dup4	.	.	.	.	.	.
XVI	B-110	2	1	Sampl	.	2.27E+02	2.36E+04	1.66E+05	1.06E+04	1.71E+03
XVI	B-110	2	1	Dupl	.	2.32E+02	2.60E+04	1.74E+05	1.08E+04	1.77E+03
XVI	B-110	2	1	Samp2	.	2.29E+02	.	.	.	.
XVI	B-110	2	1	Dup2	.	2.21E+02	.	.	.	.
XVI	B-110	3	1	Sampl	1.41E-01	1.80E+02	2.36E+04	1.63E+05	9.24E+03	1.59E+03
XVI	B-110	3	1	Dupl	1.58E-01	1.75E+02	2.18E+04	1.62E+05	9.17E+03	1.36E+03
XVI	B-110	3	1	Samp2	1.09E-01	1.80E+02	.	.	.	.
XVI	B-110	3	1	Dup2	1.39E-01	1.81E+02	.	.	.	.
XVI	B-110	3	2	Sampl	.	.	.	.	.	.
XVI	B-110	3	2	Dupl	.	.	.	.	.	.
XVI	B-110	3	2	Samp2	.	.	.	.	.	.
XVI	B-110	3	2	Dup2	.	.	.	.	.	.
XVI	B-110	3	3	Sampl	.	.	.	.	.	.
XVI	B-110	3	3	Dupl	.	.	.	.	.	.
XVI	B-110	3	3	Samp2	.	.	.	.	.	.
XVI	B-110	3	3	Dup2	.	.	.	.	.	.
XVI	B-110	4	1	Sampl	1.12E-01	2.00E+02	2.76E+04	2.35E+05	1.23E+04	2.23E+03
XVI	B-110	4	1	Dupl	1.16E-01	2.17E+02	2.85E+04	2.26E+05	1.16E+04	2.29E+03
XVI	B-110	4	1	Samp2	1.09E-01	2.12E+02	.	.	.	.
XVI	B-110	4	1	Dup2	1.31E-01	2.33E+02	.	.	.	.
XVI	B-110	9	1	Sampl	9.23E-02	1.82E+02	2.42E+04	1.87E+05	9.03E+03	1.97E+03
XVI	B-110	9	1	Dupl	9.28E-02	1.76E+02	2.62E+04	1.89E+05	8.87E+03	2.04E+03
XVI	B-110	9	1	Samp2	9.68E-02	1.93E+02	.	.	.	.
XVI	B-110	9	1	Dup2	9.55E-02	1.77E+02	.	.	.	.
XVI	B-110	10	1	Sampl	7.12E-02	2.52E+02	2.46E+04	1.92E+05	1.12E+04	2.05E+03
XVI	B-110	10	1	Dupl	6.89E-02	2.72E+02	2.41E+04	1.80E+05	1.09E+04	1.99E+03
XVI	B-110	10	1	Samp2	1.12E-01	2.83E+02	.	.	.	.
XVI	B-110	10	1	Dup2	1.17E-01	2.82E+02	.	.	.	.
XVI	B-110	16	1	Sampl	1.15E-01	1.36E+02	2.36E+04	1.67E+05	1.03E+04	1.94E+03
XVI	B-110	16	1	Dupl	1.26E-01	1.48E+02	2.43E+04	1.70E+05	1.03E+04	2.01E+03
XVI	B-110	16	1	Samp2	.	.	.	.	.	.
XVI	B-110	16	1	Dup2	.	.	.	.	.	.
XVI	B-111	29	1	Sample	7.33E-02	2.07E+02	2.31E+04	7.50E+04	4.90E+04	1.50E+03
XVI	B-111	29	1	Duplicate	9.02E-02	2.04E+02	2.33E+04	7.50E+04	4.90E+04	1.50E+03
XVI	B-111	29	2	Sample	1.04E-01	2.04E+02	2.38E+04	7.50E+04	4.90E+04	1.60E+03
XVI	B-111	29	2	Duplicate	1.07E-01	2.08E+02	2.24E+04	7.70E+04	5.00E+04	1.50E+03
XVI	B-111	30	1	Sample	9.51E-02	1.88E+02	2.49E+04	8.80E+04	4.00E+04	1.60E+03
XVI	B-111	30	1	Duplicate	1.05E-01	1.84E+02	2.33E+04	8.70E+04	4.10E+04	1.60E+03
XVI	B-111	30	2	Sample	1.09E-01	1.89E+02	2.54E+04	8.90E+04	4.10E+04	1.60E+03
XVI	B-111	30	2	Duplicate	9.44E-02	1.95E+02	2.52E+04	9.00E+04	4.10E+04	1.60E+03
IV	S-104	42	1	Sample	1.37E-01	7.10E+03	1.10E+03	1.70E+05	2.84E+04	1.10E+02
IV	S-104	42	1	Duplicate	1.36E-01	6.51E+03	1.09E+03	1.97E+05	2.58E+04	1.09E+02
IV	S-104	42	2	Sample	1.57E-01	6.90E+03	1.10E+03	1.97E+05	2.61E+04	1.10E+02
IV	S-104	42	2	Duplicate	1.54E-01	7.27E+03	1.10E+03	2.00E+05	2.48E+04	1.20E+02
IV	S-104	43	1	Sample	2.96E-01	7.06E+03	1.08E+03	1.95E+05	2.98E+04	1.08E+02
IV	S-104	43	1	Duplicate	3.14E-01	6.52E+03	1.08E+03	1.89E+05	2.66E+04	1.08E+02
IV	S-104	43	2	Sample	3.85E-01	7.53E+03	1.09E+03	1.57E+05	2.04E+04	1.09E+02
IV	S-104	43	2	Duplicate	3.61E-01	7.51E+03	1.09E+03	1.77E+05	2.12E+04	1.09E+02
IV	S-104	44	1	Sample	3.65E-01	6.14E+03	.	.	.	.
IV	S-104	44	1	Duplicate	4.04E-01	6.21E+03	.	.	.	.
IV	S-104	44	2	Sample	3.66E-01	5.15E+03	2.19E+03	1.86E+05	2.48E+04	2.19E+02
IV	S-104	44	2	Duplicate	3.10E-01	6.32E+03	2.18E+03	1.95E+05	2.94E+04	2.18E+02
XV	T-111	31	1	Sample	1.41E-01	2.21E+03	1.67E+04	4.41E+04	1.10E+03	3.03E+03
XV	T-111	31	1	Duplicate	1.35E-01	2.40E+02	1.56E+04	4.45E+04	1.10E+03	3.14E+03
XV	T-111	31	2	Sample	1.37E-01	3.75E+03	1.77E+04	4.39E+04	1.10E+03	3.09E+03
XV	T-111	31	2	Duplicate	1.34E-01	4.00E+03	1.71E+04	4.36E+04	8.71E+02	3.16E+03
XV	T-111	33	1	Sample	1.29E-01	3.34E+03	1.35E+04	3.61E+04	7.04E+02	1.26E+03
XV	T-111	33	1	Duplicate	1.39E-01	3.01E+03	1.36E+04	3.76E+04	8.42E+02	1.47E+03
XV	T-111	33	2	Sample	1.42E-01	1.82E+03	1.50E+04	4.03E+04	7.04E+02	1.59E+03
XV	T-111	33	2	Duplicate	1.53E-01	2.07E+03	1.51E+04	3.98E+04	7.59E+02	1.67E+03

Group No.	Tank No.	Core No.	Composite No.	Sample No.	Cl	TOC	pH
XII	C-110	37	1	Sample	7.88E+02	5.00E+02	11
XII	C-110	37	1	Duplicate	8.06E+02	1.05E+03	11.07
XII	C-110	37	2	Sample	7.35E+02	1.09E+03	11.33
XII	C-110	37	2	Duplicate	6.61E+02	1.09E+03	11.29
XII	C-110	38	1	Sample	9.14E+02	.	10.7
XII	C-110	38	1	Duplicate	8.52E+02	.	10.86
XII	C-110	39	1	Sample	2.02E+03	5.28E+02	10.86
XII	C-110	39	1	Duplicate	2.02E+03	.	10.9
XII	C-110	39	2	Sample	1.11E+03	.	11.12
XII	C-110	39	2	Duplicate	1.10E+03	.	11.11
XII	BX-107	40	1	Sample	1.17E+03	7.00E+02	9.59
XII	BX-107	40	1	Duplicate	1.14E+03	7.00E+02	9.66
XII	BX-107	40	2	Sample	1.14E+03	5.50E+02	9.77
XII	BX-107	40	2	Duplicate	1.21E+03	5.50E+02	9.58
XII	BX-107	41	1	Sample	1.02E+03	5.00E+02	.
XII	BX-107	41	1	Duplicate	1.06E+03	5.50E+02	.
XII	BX-107	41	2	Sample	1.20E+03	7.96E+02	.
XII	BX-107	41	2	Duplicate	1.15E+03	9.97E+02	.
VII	B-201	26	1	Sample	1.70E+03	.	.
VII	B-201	26	1	Duplicate	1.80E+03	.	.
VII	B-201	26	2	Sample	1.80E+03	.	.
VII	B-201	26	2	Duplicate	2.00E+03	.	.
VII	B-201	27	1	Sample	1.60E+03	.	.
VII	B-201	27	1	Duplicate	1.50E+03	.	.
VII	B-201	27	2	Sample	1.50E+03	.	.
VII	B-201	27	2	Duplicate	1.50E+03	.	.
VII	B-202	24	1	Sampl	7.48E+02	3.14E+04	.
VII	B-202	24	1	Dupl	7.05E+02	3.32E+04	.
VII	B-202	24	1	Samp2	.	.	.
VII	B-202	24	1	Dup2	.	.	.
VII	B-202	24	2	Sample	1.35E+03	3.77E+03	.
VII	B-202	24	2	Duplicate	.	.	.
VII	B-202	24	2	Sample	7.17E+02	1.90E+03	.
VII	B-202	24	2	Duplicate	6.46E+02	2.20E+03	.
VII	B-202	25	1	Sample	1.04E+03	3.80E+03	.
VII	B-202	25	1	Duplicate	9.48E+02	3.36E+03	.
VII	B-202	25	2	Sampl	1.13E+03	3.65E+03	.
VII	B-202	25	2	Dupl	.	.	.
VII	B-202	25	2	Samp2	6.95E+02	2.10E+03	.
VII	B-202	25	2	Dup2	6.64E+02	2.30E+03	.
XVI	B-110	1	1	Sampl	1.05E+03	3.98E+02	8.24
XVI	B-110	1	1	Dupl	9.87E+02	4.39E+02	8.22
XVI	B-110	1	1	Samp2	.	.	.
XVI	B-110	1	1	Dup2	.	.	.
XVI	B-110	1	1	Samp3	.	.	.
XVI	B-110	1	1	Dup3	.	.	.
XVI	B-110	1	1	Samp4	.	.	.
XVI	B-110	1	1	Dup4	.	.	.
XVI	B-110	2	1	Sampl	1.05E+03	3.12E+02	8.99
XVI	B-110	2	1	Dupl	1.08E+03	3.28E+02	8.88
XVI	B-110	2	1	Samp2	.	.	.
XVI	B-110	2	1	Dup2	.	.	.
XVI	B-110	3	1	Sampl	1.05E+03	3.58E+02	7.57
XVI	B-110	3	1	Dupl	1.05E+03	3.00E+02	7.88
XVI	B-110	3	1	Samp2	.	.	.
XVI	B-110	3	1	Dup2	.	.	.
XVI	B-110	3	2	Sampl	.	.	.
XVI	B-110	3	2	Dupl	.	.	.
XVI	B-110	3	2	Samp2	.	.	.
XVI	B-110	3	2	Dup2	.	.	.
XVI	B-110	3	3	Sampl	.	.	.
XVI	B-110	3	3	Dupl	.	.	.
XVI	B-110	3	3	Samp2	.	.	.
XVI	B-110	3	3	Dup2	.	.	.
XVI	B-110	4	1	Sampl	1.50E+03	4.56E+02	.
XVI	B-110	4	1	Dupl	1.45E+03	3.96E+02	.
XVI	B-110	4	1	Samp2	.	.	.
XVI	B-110	4	1	Dup2	.	.	.
XVI	B-110	9	1	Sampl	1.23E+03	3.04E+02	8
XVI	B-110	9	1	Dupl	1.28E+03	2.98E+02	7.81
XVI	B-110	9	1	Samp2	.	.	.
XVI	B-110	9	1	Dup2	.	.	.
XVI	B-110	10	1	Sampl	1.30E+03	4.63E+02	7.88
XVI	B-110	10	1	Dupl	1.26E+03	4.21E+02	8.33
XVI	B-110	10	1	Samp2	.	.	.
XVI	B-110	10	1	Dup2	.	.	.
XVI	B-110	16	1	Sampl	1.43E+03	4.57E+02	8.12
XVI	B-110	16	1	Dupl	1.44E+03	4.07E+02	8.08
XVI	B-110	16	1	Samp2	.	.	.
XVI	B-110	16	1	Dup2	.	.	.
XVI	B-111	29	1	Sample	1.00E+03	6.80E+02	8.87
XVI	B-111	29	1	Duplicate	1.00E+03	8.20E+02	.
XVI	B-111	29	2	Sample	1.10E+03	6.70E+02	.
XVI	B-111	29	2	Duplicate	1.00E+03	5.60E+02	.
XVI	B-111	30	1	Sample	1.00E+03	1.62E+03	.
XVI	B-111	30	1	Duplicate	1.00E+03	1.59E+03	.
XVI	B-111	30	2	Sample	1.00E+03	1.32E+03	.
XVI	B-111	30	2	Duplicate	1.10E+03	1.34E+03	.
IV	S-104	42	1	Sample	3.22E+03	2.19E+03	10.17
IV	S-104	42	1	Duplicate	3.08E+03	2.38E+03	13.29
IV	S-104	42	2	Sample	3.13E+03	1.30E+03	13.32
IV	S-104	42	2	Duplicate	3.10E+03	1.30E+03	13.38
IV	S-104	43	1	Sample	3.14E+03	2.35E+03	12.91
IV	S-104	43	1	Duplicate	3.00E+03	2.06E+03	12.63
IV	S-104	43	2	Sample	2.95E+03	1.19E+03	13.08
IV	S-104	43	2	Duplicate	3.22E+03	1.09E+03	13.09
IV	S-104	44	1	Sample	.	.	.
IV	S-104	44	1	Duplicate	.	.	.
IV	S-104	44	2	Sample	3.26E+03	1.10E+03	13.07
IV	S-104	44	2	Duplicate	3.52E+03	1.10E+03	13.09
XV	T-111	31	1	Sample	4.66E+02	3.68E+03	11.65
XV	T-111	31	1	Duplicate	4.73E+02	3.30E+03	.
XV	T-111	31	2	Sample	4.75E+02	3.85E+03	.
XV	T-111	31	2	Duplicate	5.18E+02	4.12E+03	.
XV	T-111	33	1	Sample	3.62E+02	2.00E+03	.
XV	T-111	33	1	Duplicate	4.40E+02	2.00E+03	.
XV	T-111	33	2	Sample	4.23E+02	3.00E+03	.
XV	T-111	33	2	Duplicate	4.40E+02	3.00E+03	.

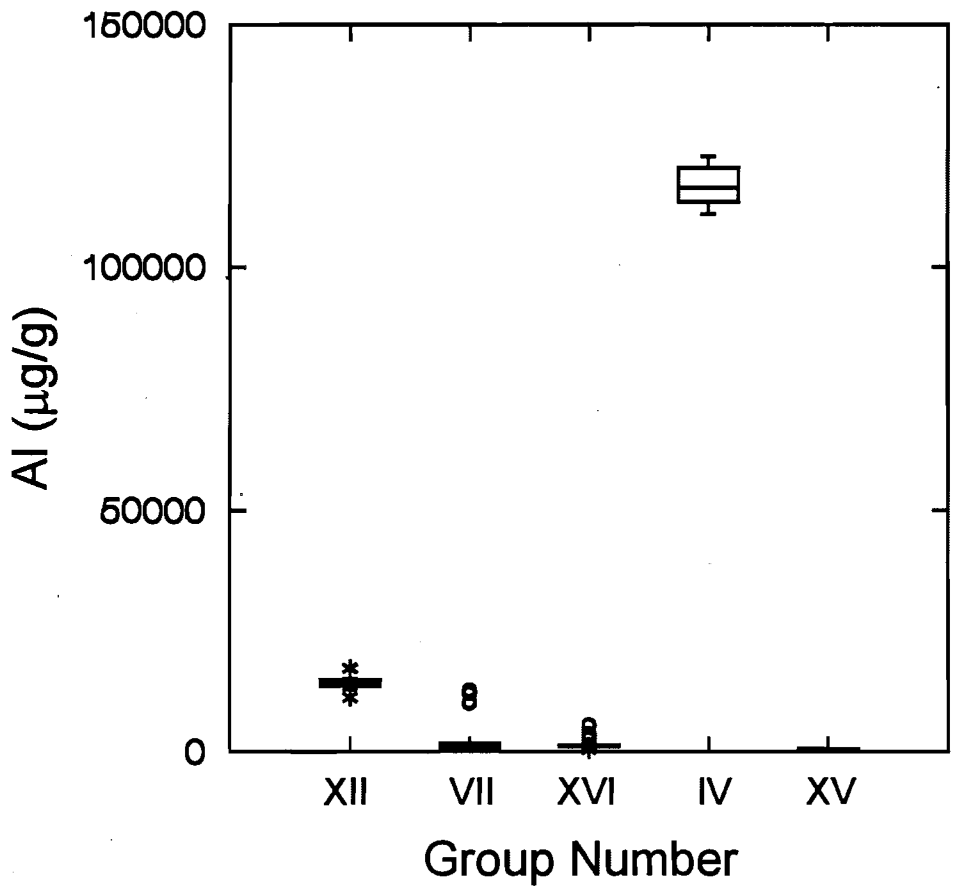
Data Set Used in Verification Study

Group No.	Tank No.	Density
XII	BX-107	1.47
XII	BX-107	1.45
XII	BX-107	1.4
XII	C-110	1.18
XII	C-110	1.21
XII	C-110	1
XII	C-110	1.34
XII	C-110	1.24
VII	B-201	1.25
VII	B-201	1.3
VII	B-201	1.4
VII	B-201	1.2
VII	B-201	1.2
VII	B-201	1.2
VII	B-201	1.3
VII	B-201	1.3
VII	B-201	1.3
VII	B-201	1.2
VII	B-201	1.2
VII	B-201	1.2
VII	B-201	1.2
VII	B-201	1.3
VII	B-201	1.3
VII	B-201	1.2
VII	B-201	1.3
VII	B-202	1.01
VII	B-202	1.02
VII	B-202	0.94
VII	B-202	1.35
VII	B-202	1.3
VII	B-202	1.1
VII	B-202	1.13
VII	B-202	0.87
VII	B-202	1.08
VII	B-202	1.02
VII	B-202	1.09
VII	B-202	1.08
VII	B-202	0.92
VII	B-202	1.08
VII	B-202	1.13
XVII	B-110	1.29
XVII	B-110	1.28
XVII	B-110	1.31
XVII	B-110	1.3
XVII	B-110	1.21
XVII	B-110	1.47
XVII	B-110	1.25
XVII	B-110	1.17
XVII	B-110	1.37
XVII	B-110	1.36
XVII	B-110	1.3
XVII	B-110	1.3
XVII	B-110	1.3
XVII	B-110	1.3
XVII	B-110	1.3
XVII	B-110	1.3
XVII	B-110	1.3
XVII	B-110	1.3
XVII	B-110	1.24
XVII	B-110	1.24
XVII	B-110	1.29
XVII	B-110	1.28
XVII	B-110	1.28
XVII	B-110	1.3
XVII	B-110	1.3
XVII	B-110	1.3
XVII	B-110	1.3
XVII	B-110	1.3
XVII	B-111	1.2
XVII	B-111	1.2
XVII	B-111	1.3
XVII	B-111	1.3
XVII	B-111	0.9
XVII	B-111	1.3
XVII	B-111	1.3
XVII	B-111	1
IV	S-104	1.64
XV	T-111	1.19
XV	T-111	1.28

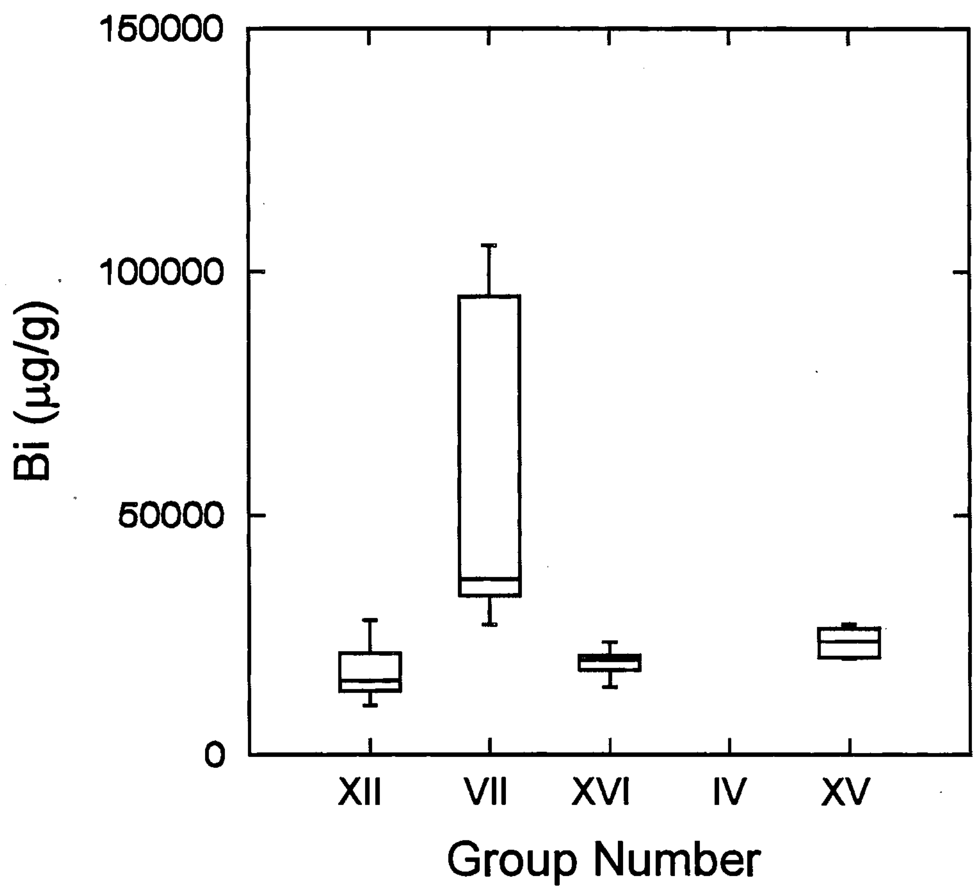
Appendix D

Box Plots of Core Sample Analytical Data Used in the SORWT Model Verification Study

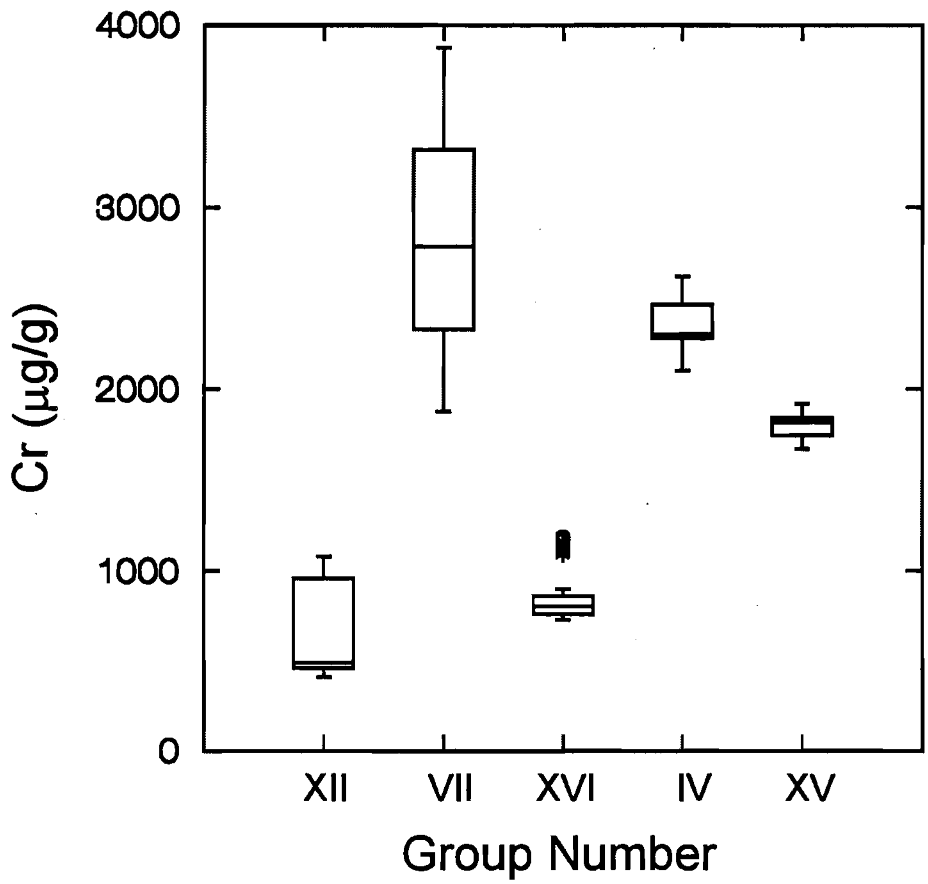
Box Plot of Al Concentrations in SORWT Groups



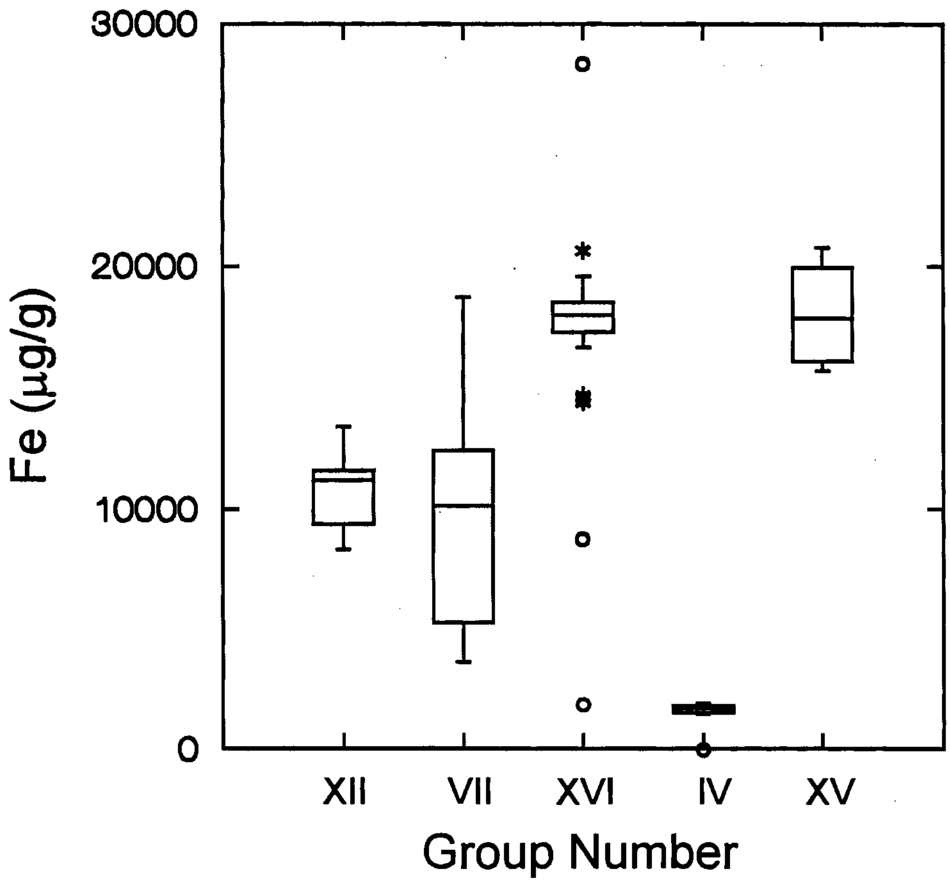
Box Plot of Bi Concentrations in SORWT Groups



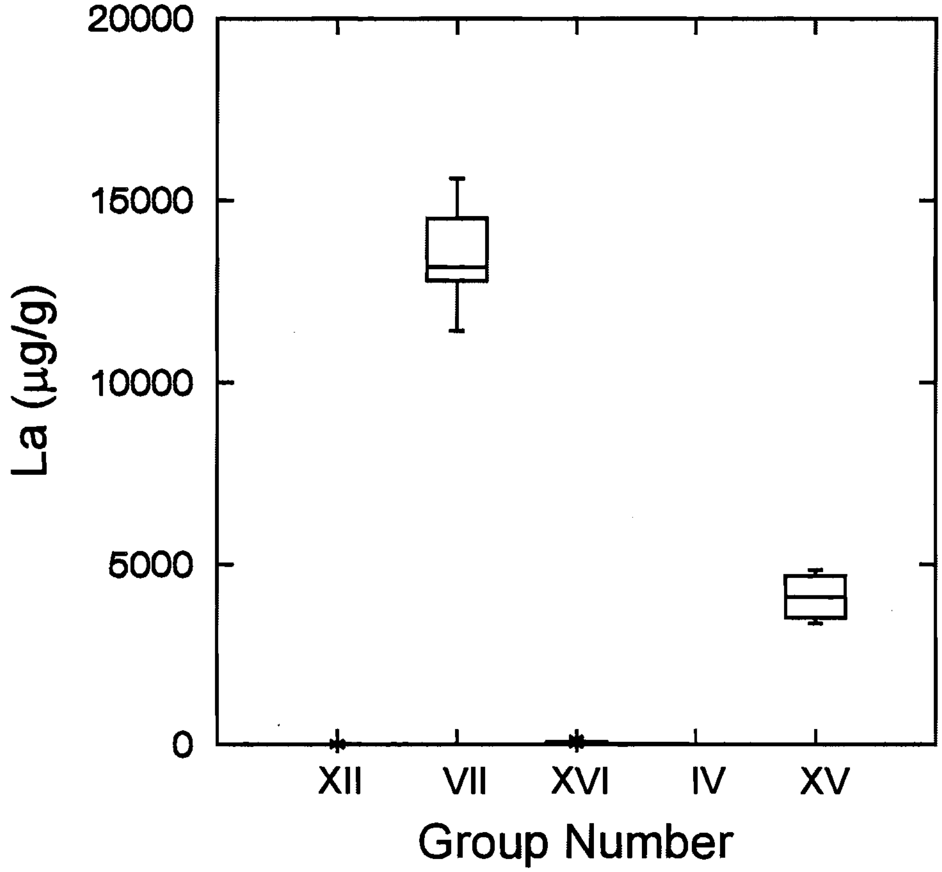
Box Plot of Cr Concentrations in SORWT Groups



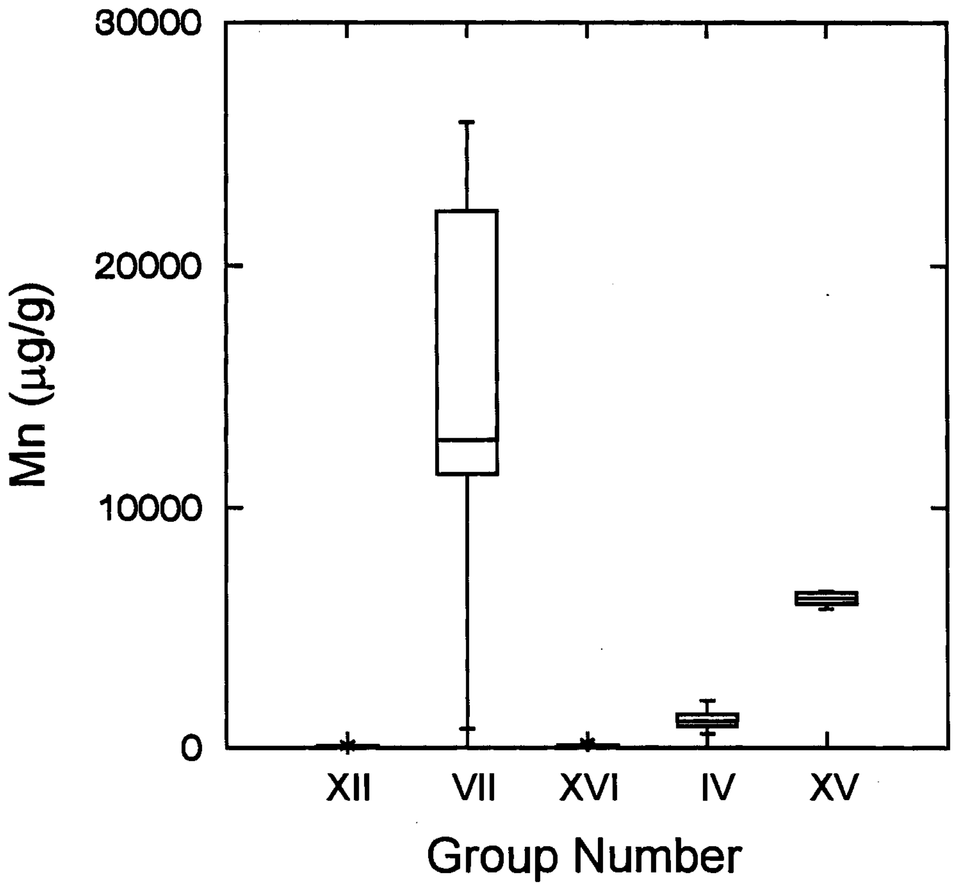
Box Plot of Fe Concentrations in SORWT Groups



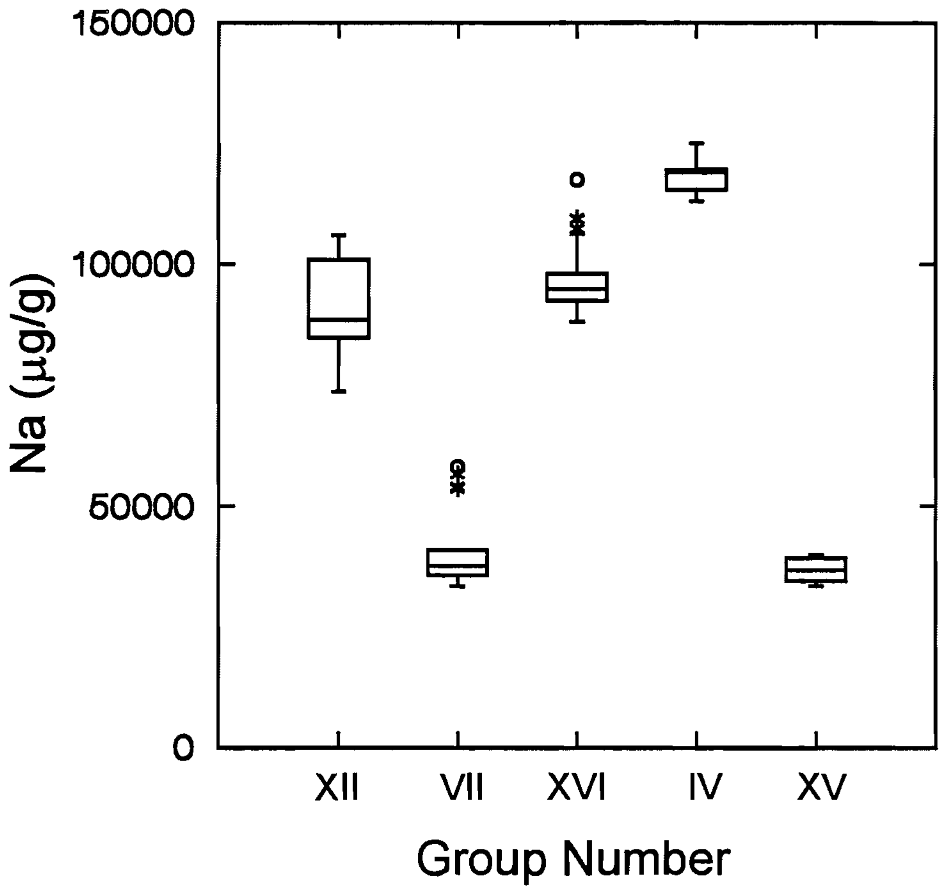
Box Plot of La Concentrations in SORWT Groups



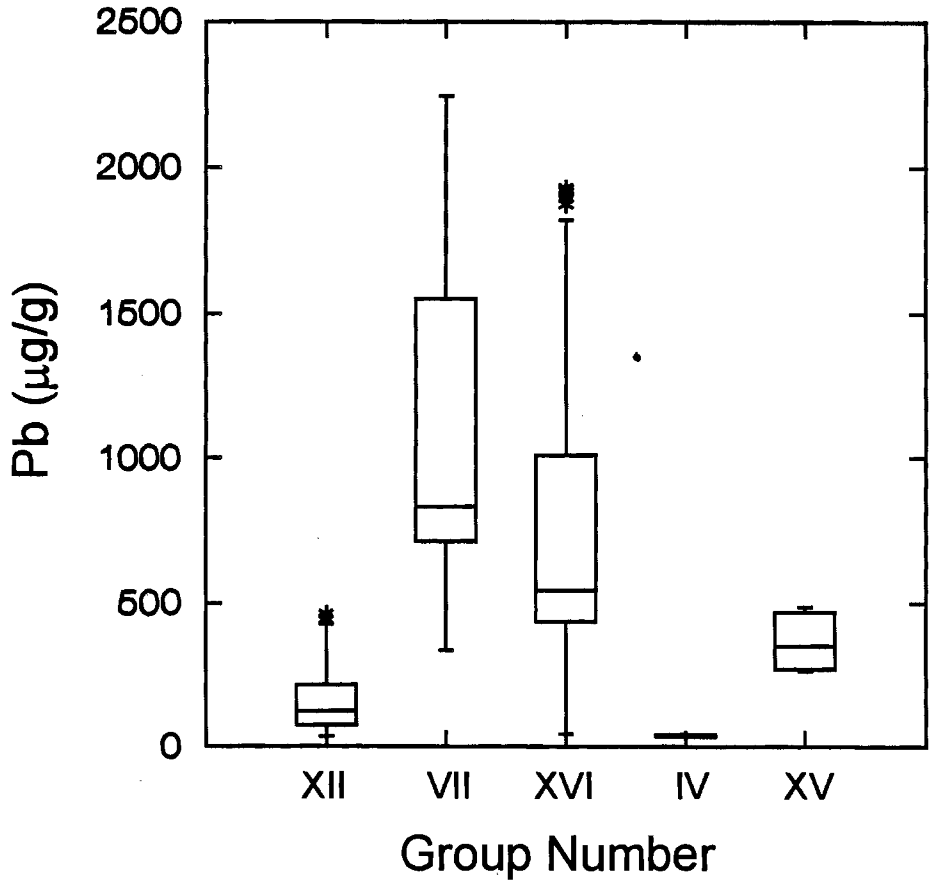
Box Plot of Mn Concentrations in SORWT Groups



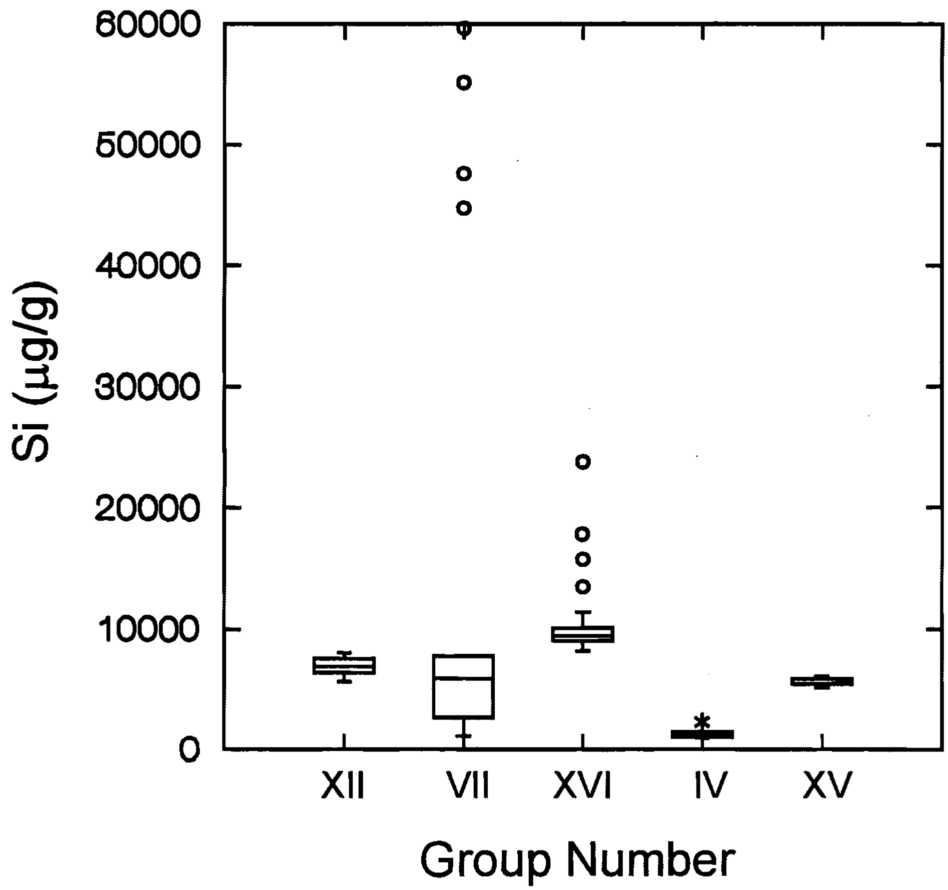
Box Plot of Na Concentrations in SORWT Groups



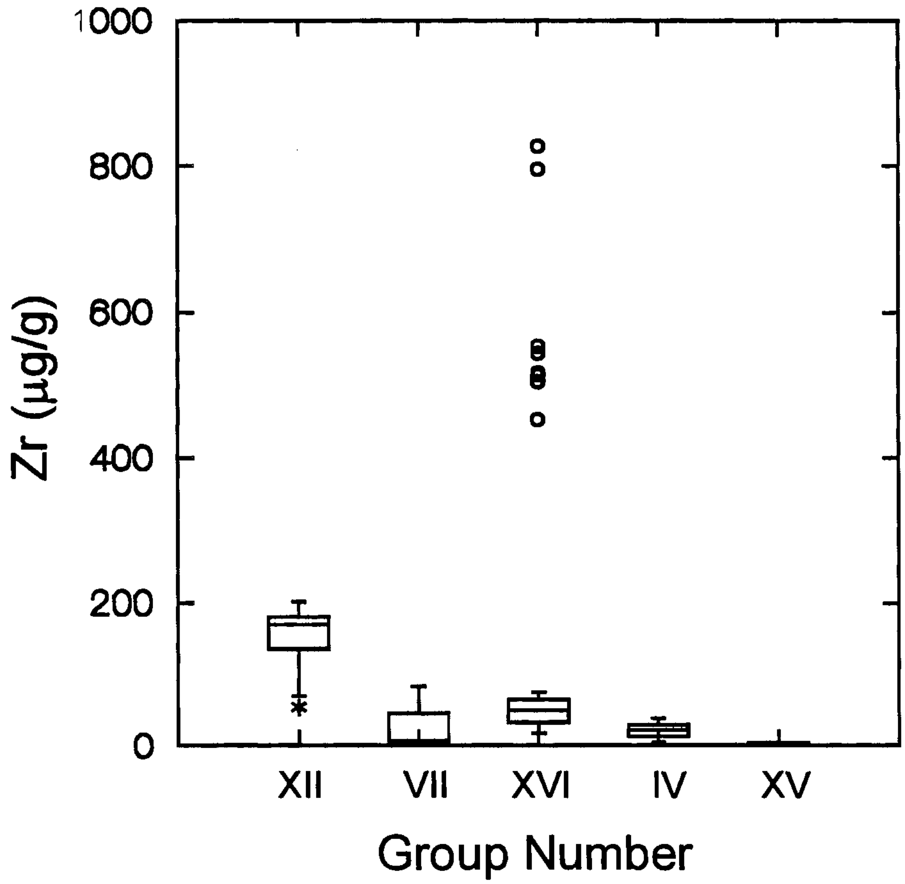
Box Plot of Pb Concentrations in SORWT Groups



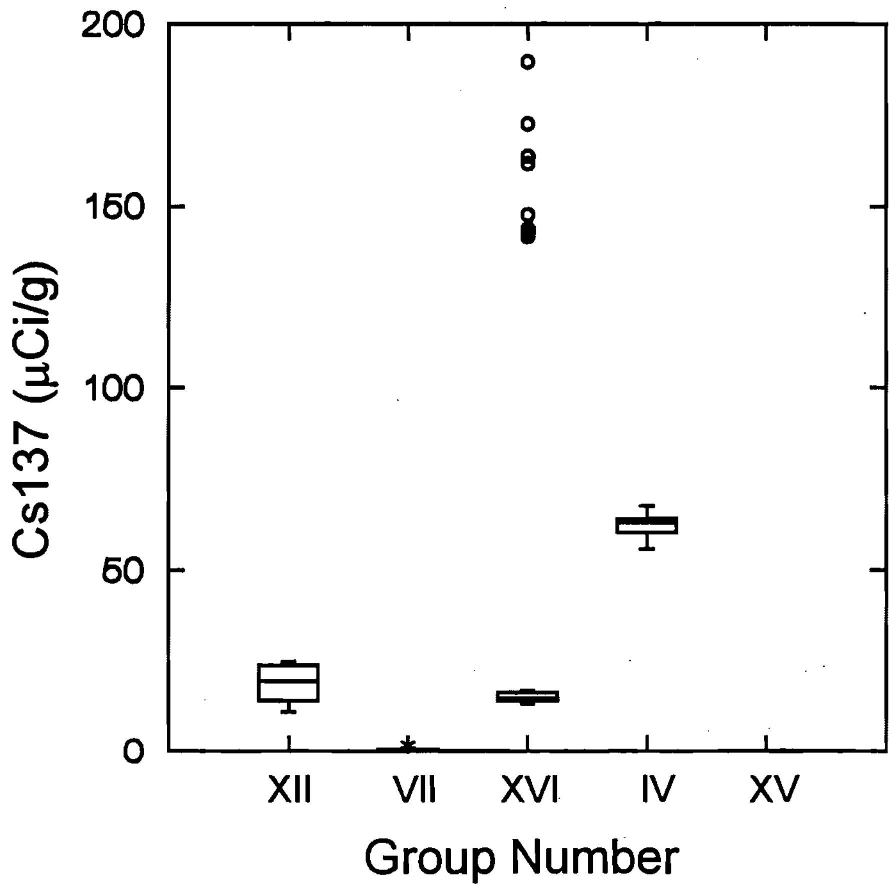
Box Plot of Si Concentrations in SORWT Groups



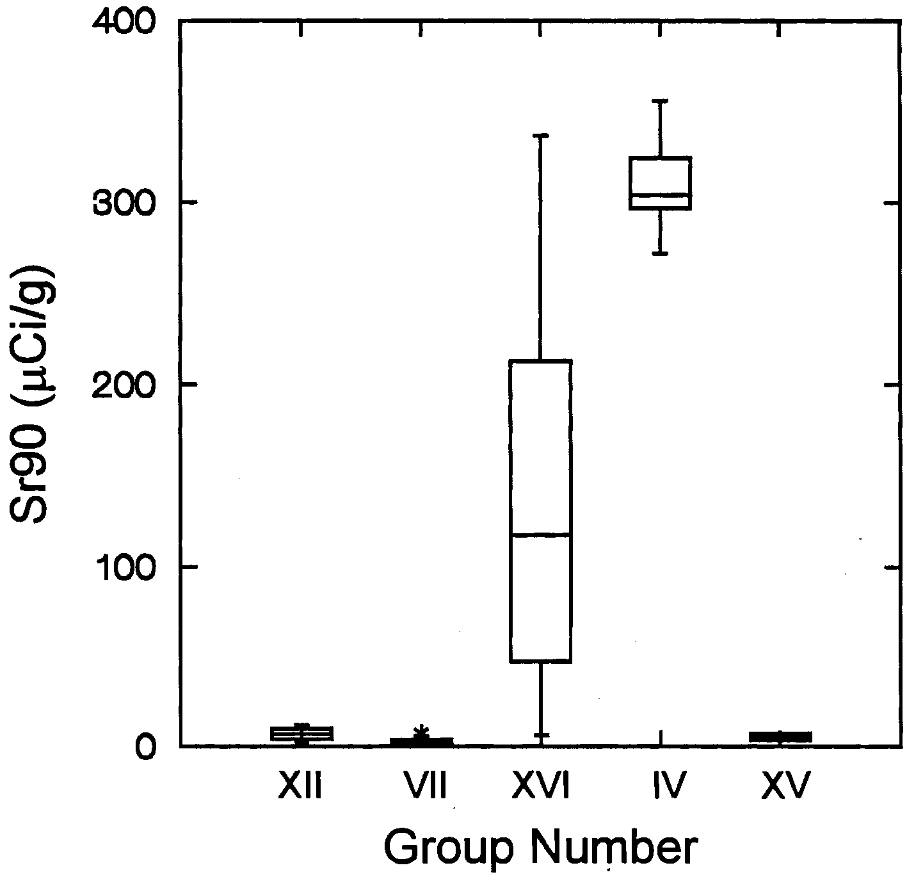
Box Plot of Zr Concentrations in SORWT Groups



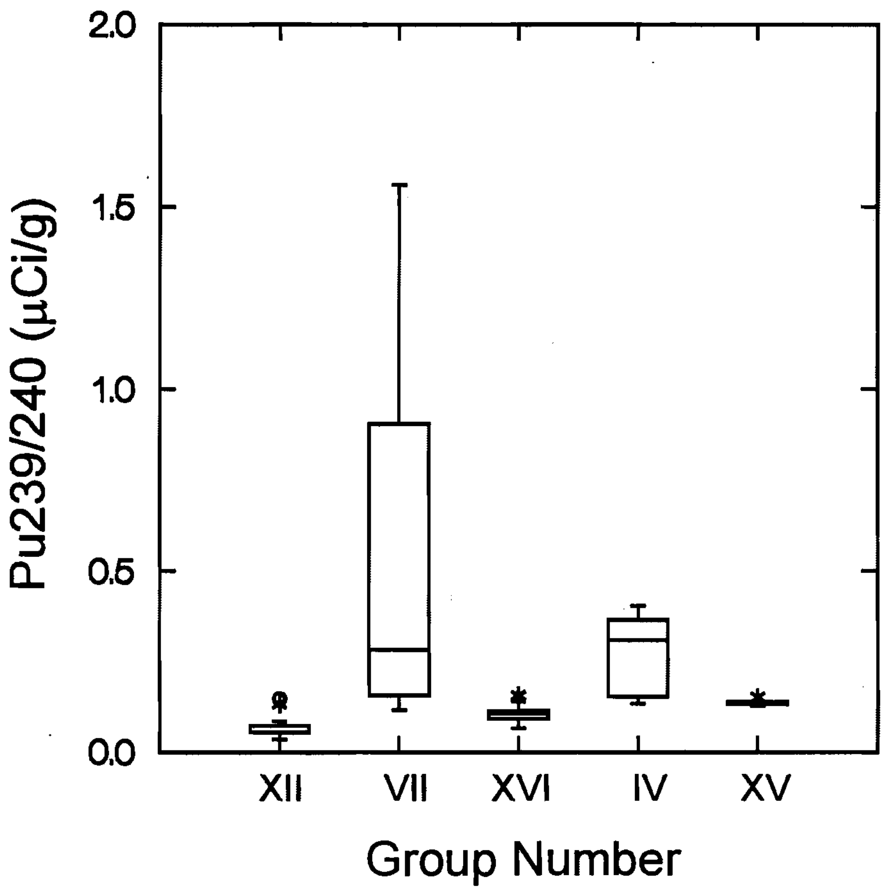
Box Plot of Cs137 Concentrations in SORWT Groups



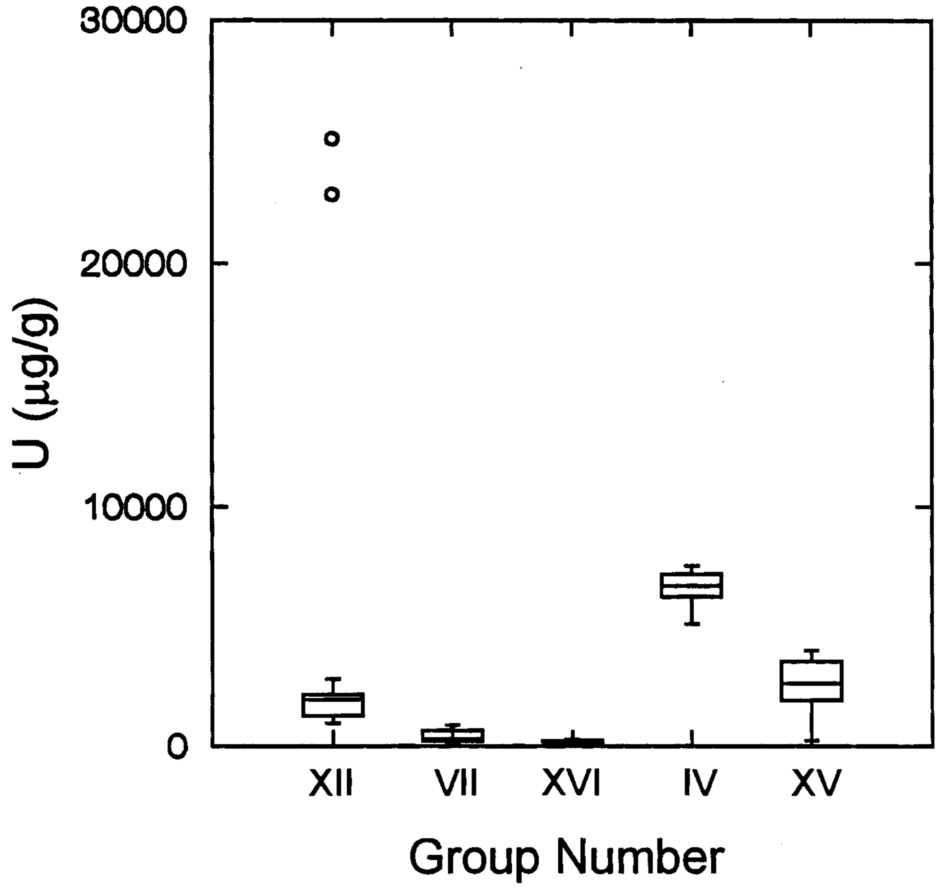
Box Plot of Sr90 Concentrations in SORWT Groups



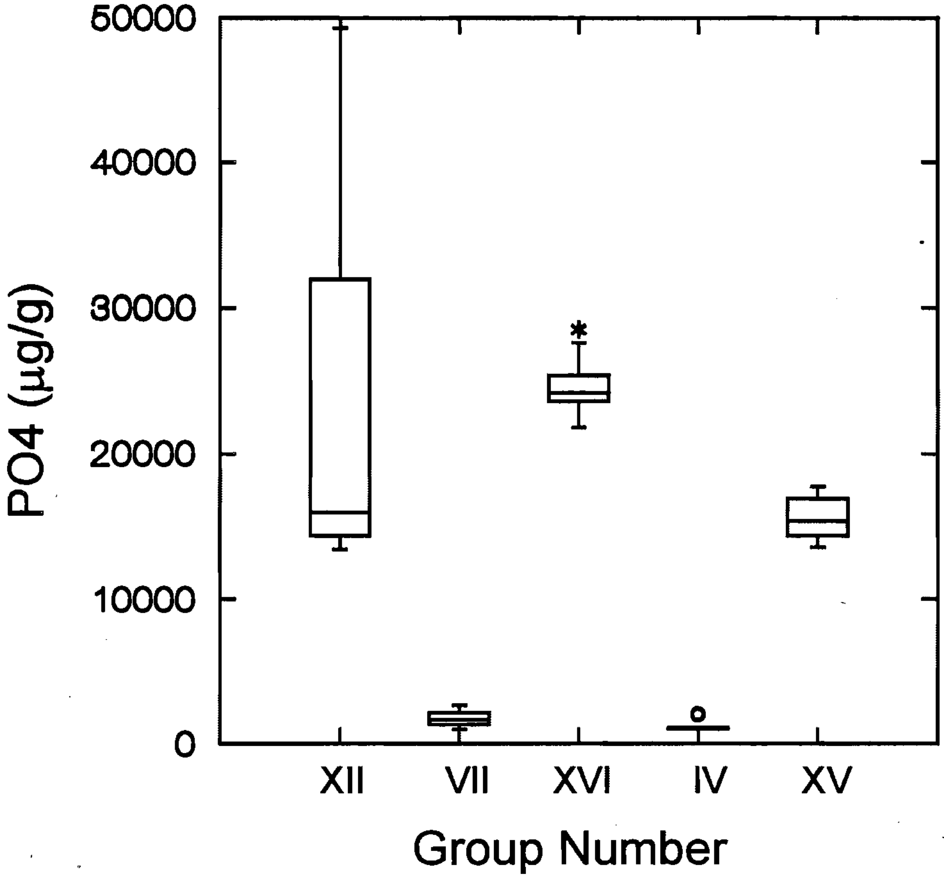
Box Plot of Pu239/240 Concentrations in SORWT Groups



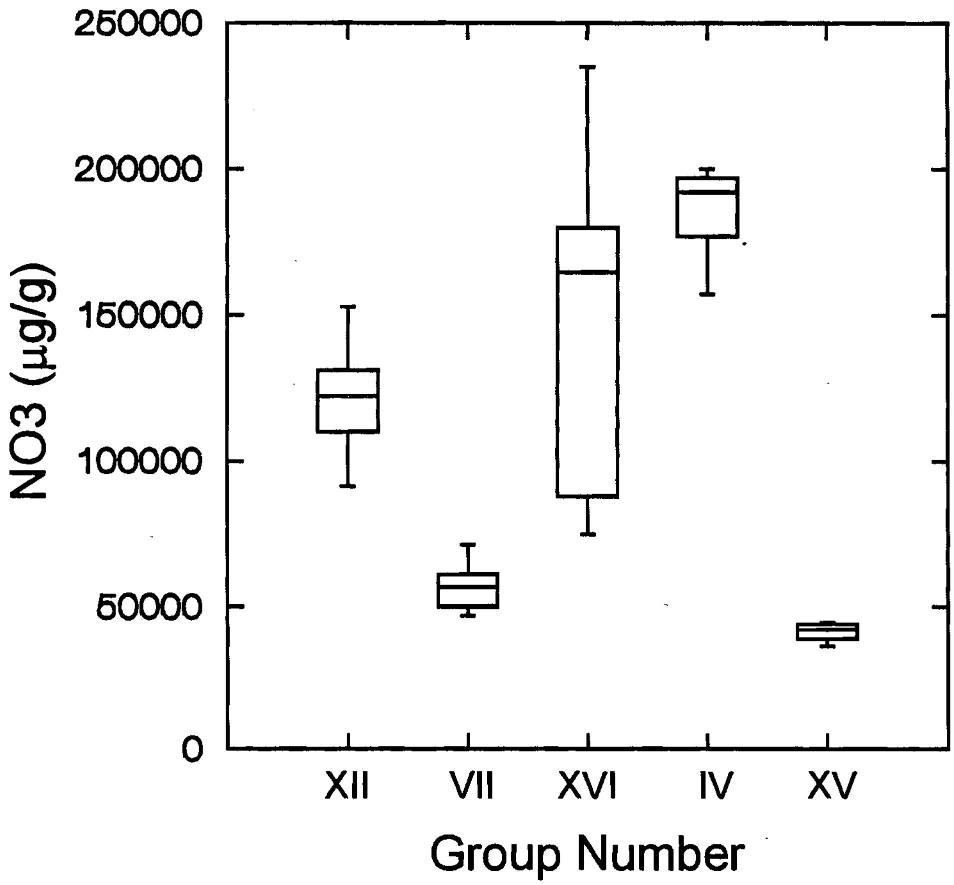
Box Plot of U Concentrations in SORWT Groups



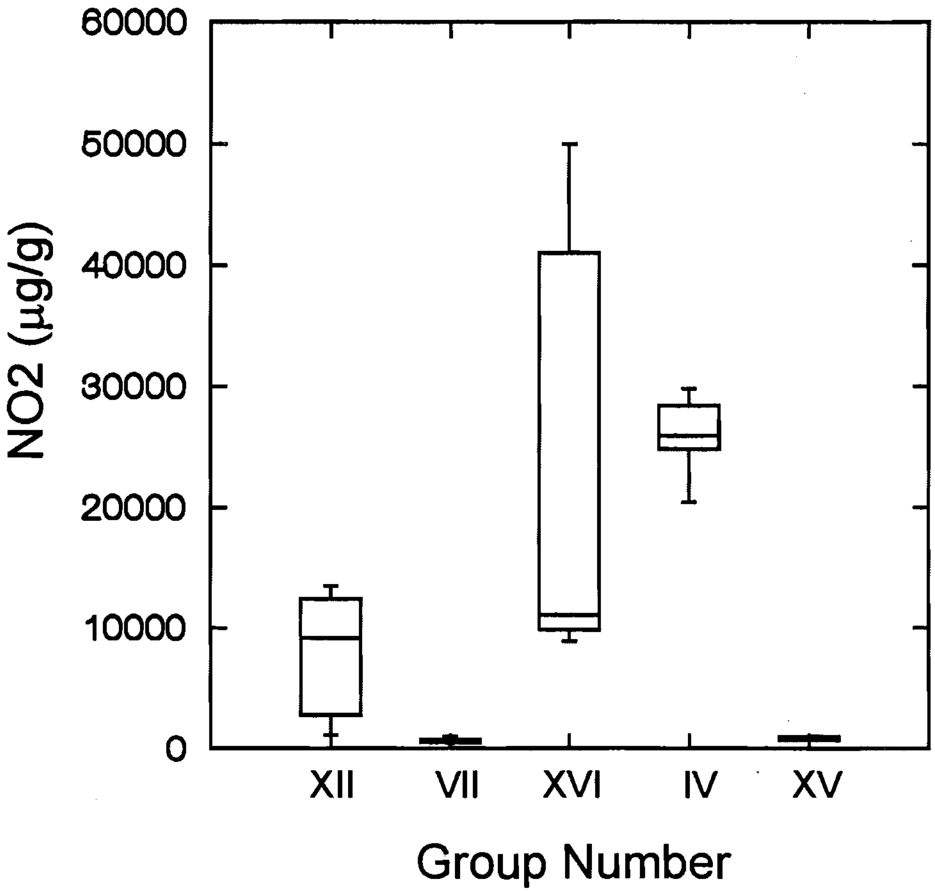
Box Plot of PO4 Concentrations in SORWT Groups



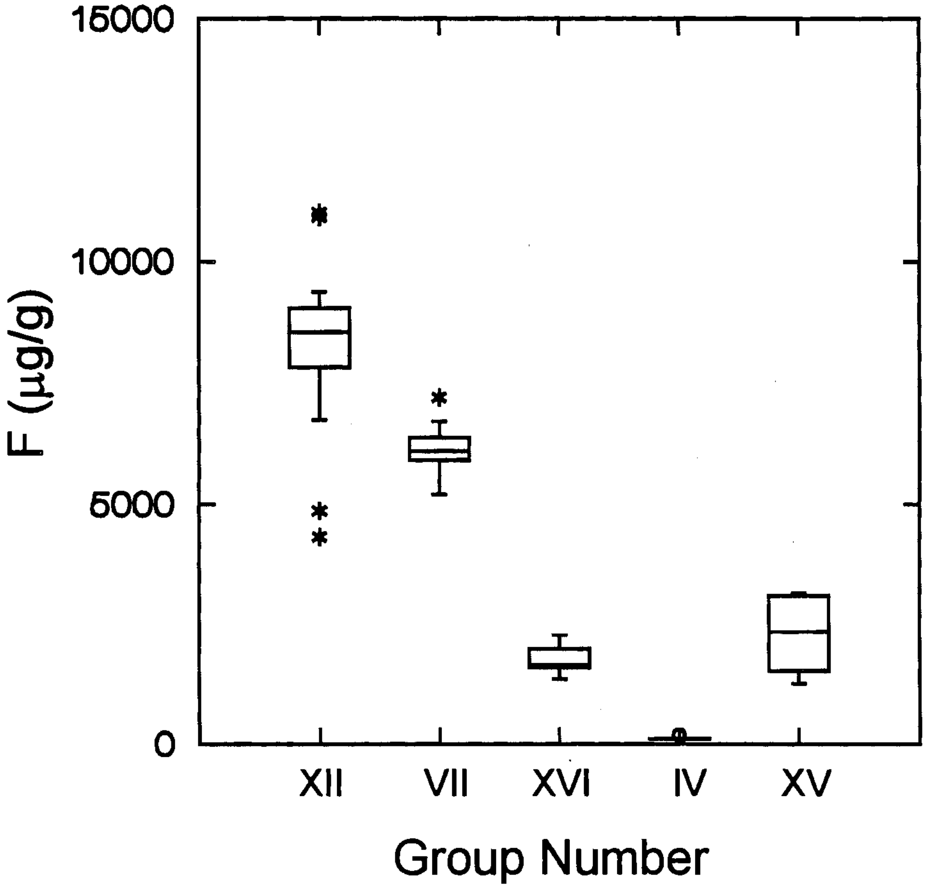
Box Plot of NO3 Concentrations in SORWT Groups



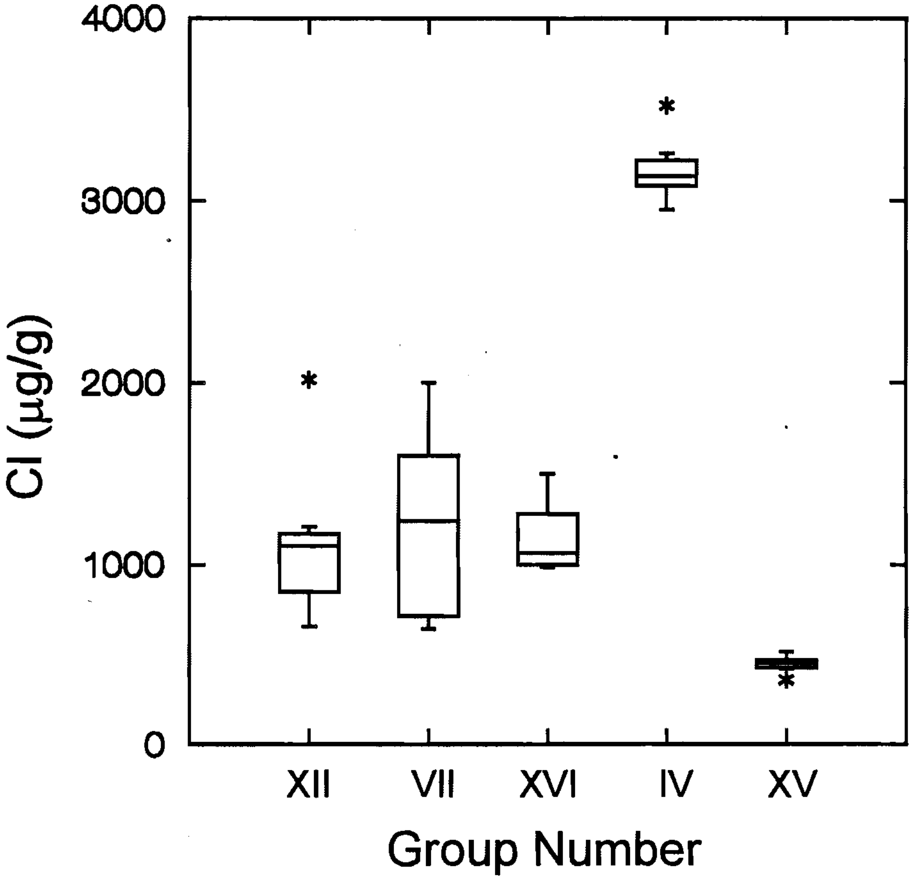
Box Plot of NO2 Concentrations in SORWT Groups



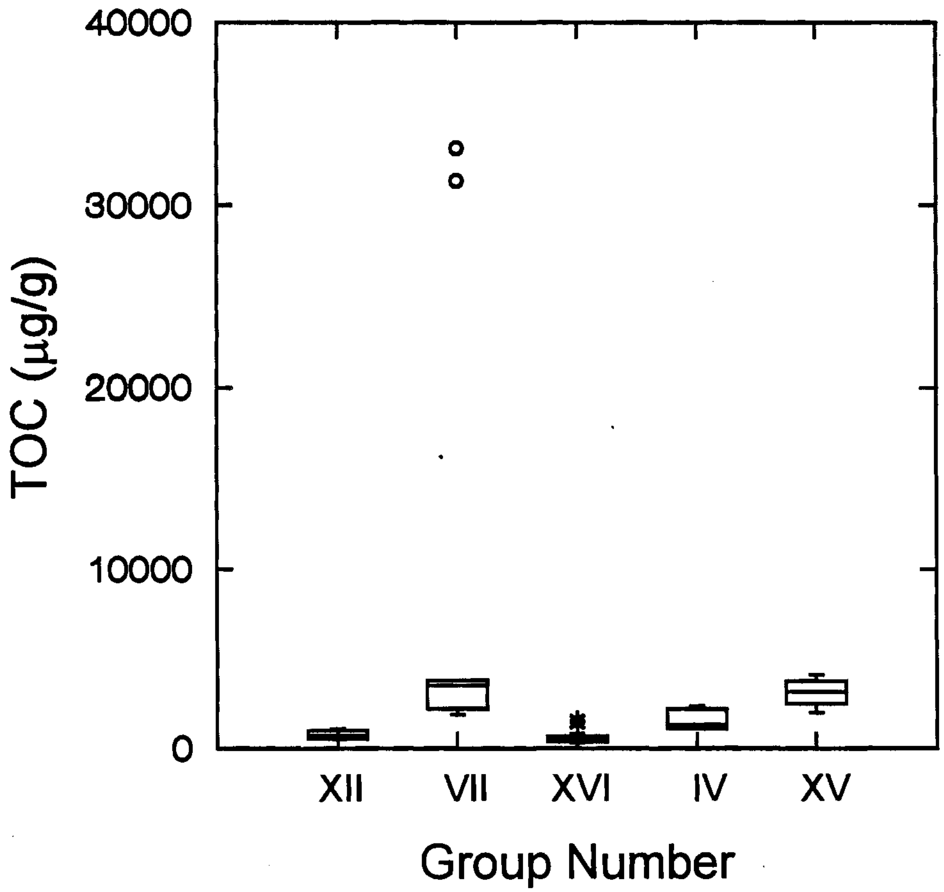
Box Plot of F Concentrations in SORWT Groups



Box Plot of Cl Concentrations in SORWT Groups



Box Plot of TOC Concentrations in SORWT Groups



Appendix E

ANOVA Results of Core Sample Analytical Data Used in the SORWT Model Verification Study

FRI 1/27/95 1:24:29 PM D:\SORWT\SORWTDAT.SYS
LEVELS ENCOUNTERED DURING PROCESSING ARE:
GROUPNO$

IV VII XII XV XVI

5 CASES DELETED DUE TO MISSING DATA.

DEP VAR: AL N: 103 MULTIPLE R: 0.998 SQUARED MULTIPLE R: 0.996

ANALYSIS OF VARIANCE

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE	F-RATIO	P
GROUPNO$	.137018E+12	4	.342544E+11	5514.853	0.000
ERROR	.608707E+09	98	6211300.211		

FRI 1/27/95 1:24:55 PM D:\SORWT\SORWTDAT.SYS
COL/
ROW GROUPNO$
1 IV
2 VII
3 XII
4 XV
5 XVI

USING LEAST SQUARES MEANS.

POST HOC TEST OF AL

USING MODEL MSE OF 6211300.211 WITH 98. DF.
MATRIX OF PAIRWISE MEAN DIFFERENCES:

	1	2	3	4	5
1	0.000				
2	-113510.000	0.000			
3	-102677.434	10832.566	0.000		
4	-116430.000	-2920.000	-13752.566	0.000	
5	-115575.229	-2065.229	-12897.795	854.771	0.000

TUKEY HSD MULTIPLE COMPARISONS.
MATRIX OF PAIRWISE COMPARISON PROBABILITIES:

	1	2	3	4	5
1	1.000				
2	0.000	1.000			
3	0.000	0.000	1.000		
4	0.000	0.056	0.000	1.000	
5	0.000	0.033	0.000	0.897	1.000

FRI 1/27/95 1:26:32 PM D:\SORWT\SORWTDAT.SYS
LEVELS ENCOUNTERED DURING PROCESSING ARE:
GROUPNO$

IV	VII	XII	XV	XVI

5 CASES DELETED DUE TO MISSING DATA.

DEP VAR: BI N: 103 MULTIPLE R: 0.805 SQUARED MULTIPLE R: 0.648

ANALYSIS OF VARIANCE

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE	F-RATIO	P
GROUPNO$	.329519E+11	4	.823799E+10	45.153	0.000
ERROR	.178796E+11	98	.182445E+09		

FRI 1/27/95 1:26:41 PM D:\SORWT\SORWTDAT.SYS
COL/
ROW GROUPNO$
1 IV
2 VII
3 XII
4 XV
5 XVI

USING LEAST SQUARES MEANS.

POST HOC TEST OF BI

USING MODEL MSE OF ************ WITH 98. DF.

MATRIX OF PAIRWISE MEAN DIFFERENCES:

	1	2	3	4	5
1	0.000				
2	61714.696	0.000			
3	17316.781	-44397.915	0.000		
4	23523.725	-38190.971	6206.944	0.000	
5	19315.017	-42399.679	1998.236	-4208.708	0.000

TUKEY HSD MULTIPLE COMPARISONS.
MATRIX OF PAIRWISE COMPARISON PROBABILITIES:

	1	2	3	4	5
1	1.000				
2	0.000	1.000			
3	0.008	0.000	1.000		
4	0.002	0.000	0.816	1.000	
5	0.000	0.000	0.984	0.925	1.000

FRI 1/27/95 1:28:10 PM D:\SORWT\SORWTDAT.SYS
LEVELS ENCOUNTERED DURING PROCESSING ARE:
GROUPNO$

IV	VII	XII	XV	XVI

5 CASES DELETED DUE TO MISSING DATA.

DEP VAR: CR N: 103 MULTIPLE R: 0.944 SQUARED MULTIPLE R: 0.891

ANALYSIS OF VARIANCE

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE	F-RATIO	P
GROUPNO$	.707020E+08	4	.176755E+08	199.780	0.000
ERROR	8670526.646	98	88474.762		

FRI 1/27/95 1:28:16 PM D:\SORWT\SORWTDAT.SYS
COL/
ROW GROUPNO$
1 IV
2 VII
3 XII
4 XV
5 XVI

USING LEAST SQUARES MEANS.

POST HOC TEST OF CR

USING MODEL MSE OF 88474.762 WITH 98. DF.
MATRIX OF PAIRWISE MEAN DIFFERENCES:

	1	2	3	4	5
1	0.000				
2	481.667	0.000			
3	-1668.333	-2150.000	0.000		
4	-554.583	-1036.250	1113.750	0.000	
5	-1499.438	-1981.104	168.896	-944.854	0.000

TUKEY HSD MULTIPLE COMPARISONS.
MATRIX OF PAIRWISE COMPARISON PROBABILITIES:

	1	2	3	4	5
1	1.000				
2	0.000	1.000			
3	0.000	0.000	1.000		
4	0.001	0.000	0.000	1.000	
5	0.000	0.000	0.248	0.000	1.000

```
 FRI 1/27/95 1:28:43 PM   D:\SORWT\SORWTDAT.SYS
LEVELS ENCOUNTERED DURING PROCESSING ARE:
GROUPNO$
 IV            VII           XII           XV            XVI

   5 CASES DELETED DUE TO MISSING DATA.


DEP VAR:      FE      N:      103  MULTIPLE R: 0.869  SQUARED MULTIPLE R: 0.755

                        ANALYSIS OF VARIANCE

SOURCE        SUM-OF-SQUARES   DF  MEAN-SQUARE     F-RATIO       P

GROUPNO$        .299271E+10    4  .748177E+09      75.346       0.000

ERROR           .973134E+09   98  9929936.716

 FRI 1/27/95 1:29:00 PM   D:\SORWT\SORWTDAT.SYS
COL/
ROW GROUPNO$
  1  IV
  2  VII
  3  XII
  4  XV
  5  XVI

USING LEAST SQUARES MEANS.

POST HOC TEST OF        FE


USING MODEL MSE OF  9929936.716 WITH     98. DF.
MATRIX OF PAIRWISE MEAN DIFFERENCES:

                      1            2            3            4            5

             1        0.000
             2     8731.872        0.000
             3     9387.892      656.020        0.000
             4    16613.725     7881.853     7225.833        0.000
             5    16062.329     7330.457     6674.438     -551.396        0.000

TUKEY HSD MULTIPLE COMPARISONS.
MATRIX OF PAIRWISE COMPARISON PROBABILITIES:

                      1            2            3            4            5

             1        1.000
             2        0.000        1.000
             3        0.000        0.972        1.000
             4        0.000        0.000        0.000        1.000
             5        0.000        0.000        0.000        0.991        1.000
```

FRI 1/27/95 1:29:25 PM D:\SORWT\SORWTDAT.SYS
LEVELS ENCOUNTERED DURING PROCESSING ARE:
GROUPNO$

IV	VII	XII	XV	XVI

5 CASES DELETED DUE TO MISSING DATA.

DEP VAR: LA N: 103 MULTIPLE R: 0.995 SQUARED MULTIPLE R: 0.989

ANALYSIS OF VARIANCE

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE	F-RATIO	P
GROUPNO$	.257985E+10	4	.644963E+09	2284.408	0.000
ERROR	.276686E+08	98	282332.659		

FRI 1/27/95 1:29:38 PM D:\SORWT\SORWTDAT.SYS
COL/
ROW GROUPNO$
1 IV
2 VII
3 XII
4 XV
5 XVI

USING LEAST SQUARES MEANS.

POST HOC TEST OF LA

USING MODEL MSE OF 282332.659 WITH 98. DF.
MATRIX OF PAIRWISE MEAN DIFFERENCES:

	1	2	3	4	5
1	0.000				
2	13582.117	0.000			
3	-1.445	-13583.562	0.000		
4	4098.087	-9484.029	4099.533	0.000	
5	64.190	-13517.927	65.635	-4033.898	0.000

TUKEY HSD MULTIPLE COMPARISONS.
MATRIX OF PAIRWISE COMPARISON PROBABILITIES:

	1	2	3	4	5
1	1.000				
2	0.000	1.000			
3	1.000	0.000	1.000		
4	0.000	0.000	0.000	1.000	
5	0.996	0.000	0.992	0.000	1.000

```
FRI 1/27/95 1:29:54 PM   D:\SORWT\SORWTDAT.SYS
LEVELS ENCOUNTERED DURING PROCESSING ARE:
GROUPNO$
 IV          VII          XII          XV          XVI

   5 CASES DELETED DUE TO MISSING DATA.
```

DEP VAR: MN N: 103 MULTIPLE R: 0.852 SQUARED MULTIPLE R: 0.725

ANALYSIS OF VARIANCE

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE	F-RATIO	P
GROUPNO$	.293853E+10	4	.734633E+09	64.674	0.000
ERROR	.111318E+10	98	.113590E+08		

```
FRI 1/27/95 1:30:05 PM   D:\SORWT\SORWTDAT.SYS
COL/
ROW GROUPNO$
  1  IV
  2  VII
  3  XII
  4  XV
  5  XVI
```

USING LEAST SQUARES MEANS.

POST HOC TEST OF MN

USING MODEL MSE OF 11359012.943 WITH 98. DF.
MATRIX OF PAIRWISE MEAN DIFFERENCES:

	1	2	3	4	5
1	0.000				
2	13358.387	0.000			
3	-1091.972	-14450.359	0.000		
4	5132.417	-8225.971	6224.389	0.000	
5	-1052.854	-14411.241	39.118	-6185.271	0.000

TUKEY HSD MULTIPLE COMPARISONS.
MATRIX OF PAIRWISE COMPARISON PROBABILITIES:

	1	2	3	4	5
1	1.000				
2	0.000	1.000			
3	0.907	0.000	1.000		
4	0.010	0.000	0.000	1.000	
5	0.869	0.000	1.000	0.000	1.000

```
 FRI 1/27/95 1:33:56 PM   D:\SORWT\SORWTDAT.SYS
LEVELS ENCOUNTERED DURING PROCESSING ARE:
GROUPNO$
 IV           VII           XII           XV            XVI

   5 CASES DELETED DUE TO MISSING DATA.


DEP VAR:      NA      N:     103  MULTIPLE R: 0.970  SQUARED MULTIPLE R: 0.940

                       ANALYSIS OF VARIANCE

SOURCE       SUM-OF-SQUARES   DF  MEAN-SQUARE     F-RATIO       P

GROUPNO$       .709272E+11    4  .177318E+11     385.204      0.000

ERROR          .451116E+10   98  .460323E+08

 FRI 1/27/95 1:34:29 PM   D:\SORWT\SORWTDAT.SYS
COL/
ROW GROUPNO$
  1  IV
  2  VII
  3  XII
  4  XV
  5  XVI

USING LEAST SQUARES MEANS.

POST HOC TEST OF        NA

USING MODEL MSE OF 46032257.982 WITH     98. DF.
MATRIX OF PAIRWISE MEAN DIFFERENCES:
```

	1	2	3	4	5
1	0.000				
2	-76885.941	0.000			
3	-27116.667	49769.275	0.000		
4	-81300.000	-4414.059	-54183.333	0.000	
5	-21891.188	54994.754	5225.479	59408.813	0.000

```
TUKEY HSD MULTIPLE COMPARISONS.
MATRIX OF PAIRWISE COMPARISON PROBABILITIES:
```

	1	2	3	4	5
1	1.000				
2	0.000	1.000			
3	0.000	0.000	1.000		
4	0.000	0.554	0.000	1.000	
5	0.000	0.000	0.049	0.000	1.000

FRI 1/27/95 1:34:47 PM D:\SORWT\SORWTDAT.SYS
LEVELS ENCOUNTERED DURING PROCESSING ARE:
GROUPNO$

IV	VII	XII	XV	XVI

5 CASES DELETED DUE TO MISSING DATA.

DEP VAR: PB N: 103 MULTIPLE R: 0.618 SQUARED MULTIPLE R: 0.381

ANALYSIS OF VARIANCE

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE	F-RATIO	P
GROUPNO$	.131325E+08	4	3283114.895	15.108	0.000
ERROR	.212966E+08	98	217312.653		

FRI 1/27/95 1:34:55 PM D:\SORWT\SORWTDAT.SYS
COL/
ROW GROUPNO$
1 IV
2 VII
3 XII
4 XV
5 XVI

USING LEAST SQUARES MEANS.

POST HOC TEST OF PB

USING MODEL MSE OF 217312.653 WITH 98. DF.
MATRIX OF PAIRWISE MEAN DIFFERENCES:

	1	2	3	4	5
1	0.000				
2	1085.904	0.000			
3	142.831	-943.074	0.000		
4	326.500	-759.404	183.669	0.000	
5	711.304	-374.600	568.474	384.804	0.000

TUKEY HSD MULTIPLE COMPARISONS.
MATRIX OF PAIRWISE COMPARISON PROBABILITIES:

	1	2	3	4	5
1	1.000				
2	0.000	1.000			
3	0.923	0.000	1.000		
4	0.543	0.002	0.886	1.000	
5	0.000	0.042	0.000	0.203	1.000

```
 FRI 1/27/95 1:40:59 PM   D:\SORWT\SORWTDAT.SYS
LEVELS ENCOUNTERED DURING PROCESSING ARE:
GROUPNO$
 IV           VII          XII          XV           XVI

   5 CASES DELETED DUE TO MISSING DATA.


DEP VAR:      SI      N:     103  MULTIPLE R: 0.431  SQUARED MULTIPLE R: 0.186

                       ANALYSIS OF VARIANCE

SOURCE        SUM-OF-SQUARES   DF  MEAN-SQUARE     F-RATIO       P

GROUPNO$        .169385E+10    4  .423462E+09       5.581       0.000

ERROR           .743582E+10   98  .758757E+08

 FRI 1/27/95 1:41:06 PM   D:\SORWT\SORWTDAT.SYS
COL/
ROW GROUPNO$
  1  IV
  2  VII
  3  XII
  4  XV
  5  XVI

USING LEAST SQUARES MEANS.

POST HOC TEST OF        SI


USING MODEL MSE OF 75875689.857 WITH     98. DF.
MATRIX OF PAIRWISE MEAN DIFFERENCES:

                      1           2           3           4           5

            1       0.000
            2   14321.760       0.000
            3    5606.361   -8715.399       0.000
            4    4238.583  -10083.176   -1367.778       0.000
            5    8846.979   -5474.781    3240.618    4608.396       0.000

TUKEY HSD MULTIPLE COMPARISONS.
MATRIX OF PAIRWISE COMPARISON PROBABILITIES:

                      1           2           3           4           5

            1       1.000
            2       0.000       1.000
            3       0.422       0.031       1.000
            4       0.823       0.061       0.996       1.000
            5       0.018       0.179       0.663       0.638       1.000
```

FRI 1/27/95 1:41:25 PM D:\SORWT\SORWTDAT.SYS
LEVELS ENCOUNTERED DURING PROCESSING ARE:
GROUPNO$

IV	VII	XII	XV	XVI

5 CASES DELETED DUE TO MISSING DATA.

DEP VAR: ZR N: 103 MULTIPLE R: 0.365 SQUARED MULTIPLE R: 0.133

ANALYSIS OF VARIANCE

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE	F-RATIO	P
GROUPNO$	338155.908	4	84538.977	3.764	0.007
ERROR	2201118.624	98	22460.394		

FRI 1/27/95 1:41:33 PM D:\SORWT\SORWTDAT.SYS
COL/
ROW GROUPNO$
1 IV
2 VII
3 XII
4 XV
5 XVI

USING LEAST SQUARES MEANS.

POST HOC TEST OF ZR

USING MODEL MSE OF 22460.394 WITH 98. DF.
MATRIX OF PAIRWISE MEAN DIFFERENCES:

	1	2	3	4	5
1	0.000				
2	7.705	0.000			
3	131.771	124.066	0.000		
4	-17.210	-24.916	-148.982	0.000	
5	112.542	104.837	-19.229	129.752	0.000

TUKEY HSD MULTIPLE COMPARISONS.
MATRIX OF PAIRWISE COMPARISON PROBABILITIES:

	1	2	3	4	5
1	1.000				
2	1.000	1.000			
3	0.136	0.112	1.000		
4	0.999	0.995	0.141	1.000	
5	0.145	0.104	0.990	0.165	1.000

FRI 1/27/95 1:41:51 PM D:\SORWT\SORWTDAT.SYS
LEVELS ENCOUNTERED DURING PROCESSING ARE:
GROUPNO$
IV VII XII XV XVI

8 CASES DELETED DUE TO MISSING DATA.

DEP VAR: CS137 N: 100 MULTIPLE R: 0.486 SQUARED MULTIPLE R: 0.236

ANALYSIS OF VARIANCE

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE	F-RATIO	P
GROUPNO$	42611.220	4	10652.805	7.339	0.000
ERROR	137887.504	95	1451.447		

FRI 1/27/95 1:41:59 PM D:\SORWT\SORWTDAT.SYS
COL/
ROW GROUPNO$
1 IV
2 VII
3 XII
4 XV
5 XVI

USING LEAST SQUARES MEANS.

POST HOC TEST OF CS137

USING MODEL MSE OF 1451.447 WITH 95. DF.
MATRIX OF PAIRWISE MEAN DIFFERENCES:

	1	2	3	4	5
1	0.000				
2	-61.905	0.000			
3	-43.775	18.130	0.000		
4	-62.142	-0.237	-18.367	0.000	
5	-21.670	40.235	22.105	40.472	0.000

TUKEY HSD MULTIPLE COMPARISONS.
MATRIX OF PAIRWISE COMPARISON PROBABILITIES:

	1	2	3	4	5
1	1.000				
2	0.000	1.000			
3	0.022	0.612	1.000		
4	0.005	1.000	0.788	1.000	
5	0.411	0.003	0.240	0.052	1.000

FRI 1/27/95 1:42:20 PM D:\SORWT\SORWTDAT.SYS
LEVELS ENCOUNTERED DURING PROCESSING ARE:
GROUPNO$

IV	VII	XII	XV	XVI

22 CASES DELETED DUE TO MISSING DATA.

DEP VAR: SR90 N: 86 MULTIPLE R: 0.872 SQUARED MULTIPLE R: 0.761

ANALYSIS OF VARIANCE

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE	F-RATIO	P
GROUPNO$	951095.029	4	237773.757	64.538	0.000
ERROR	298426.030	81	3684.272		

FRI 1/27/95 1:42:32 PM D:\SORWT\SORWTDAT.SYS
COL/
ROW GROUPNO$
1 IV
2 VII
3 XII
4 XV
5 XVI

USING LEAST SQUARES MEANS.

POST HOC TEST OF SR90

USING MODEL MSE OF 3684.272 WITH 81. DF.
MATRIX OF PAIRWISE MEAN DIFFERENCES:

	1	2	3	4	5
1	0.000				
2	-306.415	0.000			
3	-302.395	4.020	0.000		
4	-304.170	2.245	-1.775	0.000	
5	-176.147	130.268	126.248	128.023	0.000

TUKEY HSD MULTIPLE COMPARISONS.
MATRIX OF PAIRWISE COMPARISON PROBABILITIES:

	1	2	3	4	5
1	1.000				
2	0.000	1.000			
3	0.000	1.000	1.000		
4	0.000	1.000	1.000	1.000	
5	0.000	0.000	0.000	0.000	1.000

FRI 1/27/95 1:43:01 PM D:\SORWT\SORWTDAT.SYS
LEVELS ENCOUNTERED DURING PROCESSING ARE:
GROUPNO$

IV	VII	XII	XV	XVI

22 CASES DELETED DUE TO MISSING DATA.

DEP VAR: PU23940 N: 86 MULTIPLE R: 0.638 SQUARED MULTIPLE R: 0.407

ANALYSIS OF VARIANCE

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE	F-RATIO	P
GROUPNO$	3.558	4	0.890	13.915	0.000
ERROR	5.178	81	0.064		

FRI 1/27/95 1:43:07 PM D:\SORWT\SORWTDAT.SYS
COL/
ROW GROUPNO$
1 IV
2 VII
3 XII
4 XV
5 XVI

USING LEAST SQUARES MEANS.

POST HOC TEST OF PU23940

USING MODEL MSE OF .064 WITH 81. DF.
MATRIX OF PAIRWISE MEAN DIFFERENCES:

	1	2	3	4	5
1	0.000				
2	0.324	0.000			
3	-0.212	-0.536	0.000		
4	-0.143	-0.467	0.069	0.000	
5	-0.175	-0.499	0.037	-0.032	0.000

TUKEY HSD MULTIPLE COMPARISONS.
MATRIX OF PAIRWISE COMPARISON PROBABILITIES:

	1	2	3	4	5
1	1.000				
2	0.008	1.000			
3	0.172	0.000	1.000		
4	0.727	0.000	0.968	1.000	
5	0.263	0.000	0.988	0.998	1.000

```
 FRI 1/27/95 1:43:35 PM   D:\SORWT\SORWTDAT.SYS
LEVELS ENCOUNTERED DURING PROCESSING ARE:
GROUPNO$
 IV           VII          XII          XV           XVI

   18 CASES DELETED DUE TO MISSING DATA.


DEP VAR:       U      N:      90  MULTIPLE R: 0.600  SQUARED MULTIPLE R: 0.360

                       ANALYSIS OF VARIANCE

SOURCE       SUM-OF-SQUARES   DF  MEAN-SQUARE     F-RATIO       P

GROUPNO$       .509678E+09    4  .127419E+09      11.945      0.000

ERROR          .906692E+09   85  .106670E+08


 FRI 1/27/95 1:43:41 PM   D:\SORWT\SORWTDAT.SYS
COL/
ROW GROUPNO$
  1  IV
  2  VII
  3  XII
  4  XV
  5  XVI

USING LEAST SQUARES MEANS.

POST HOC TEST OF         U


USING MODEL MSE OF 10666968.923 WITH     85. DF.
MATRIX OF PAIRWISE MEAN DIFFERENCES:


                        1           2           3           4           5

            1         0.000
            2     -6271.056       0.000
            3     -2436.500    3834.556       0.000
            4     -4130.000    2141.056   -1693.500       0.000
            5     -6475.971    -204.915   -4039.471   -2345.971       0.000


TUKEY HSD MULTIPLE COMPARISONS.
MATRIX OF PAIRWISE COMPARISON PROBABILITIES:


                        1           2           3           4           5

            1         1.000
            2         0.000       1.000
            3         0.274       0.006       1.000
            4         0.052       0.538       0.740       1.000
            5         0.000       1.000       0.001       0.365       1.000
```

FRI 1/27/95 1:44:02 PM D:\SORWT\SORWTDAT.SYS
LEVELS ENCOUNTERED DURING PROCESSING ARE:
GROUPNO$

IV	VII	XII	XV	XVI

32 CASES DELETED DUE TO MISSING DATA.

DEP VAR: PO4 N: 76 MULTIPLE R: 0.878 SQUARED MULTIPLE R: 0.771

ANALYSIS OF VARIANCE

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE	F-RATIO	P
GROUPNO$	.800097E+10	4	.200024E+10	59.629	0.000
ERROR	.238169E+10	71	.335449E+08		

FRI 1/27/95 1:44:11 PM D:\SORWT\SORWTDAT.SYS
COL/
ROW GROUPNO$
1 IV
2 VII
3 XII
4 XV
5 XVI

USING LEAST SQUARES MEANS.

POST HOC TEST OF PO4

USING MODEL MSE OF 33544926.190 WITH 71. DF.
MATRIX OF PAIRWISE MEAN DIFFERENCES:

	1	2	3	4	5
1	0.000				
2	395.722	0.000			
3	20945.556	20549.833	0.000		
4	14227.500	13831.778	-6718.056	0.000	
5	23244.545	22848.823	2298.990	9017.045	0.000

TUKEY HSD MULTIPLE COMPARISONS.
MATRIX OF PAIRWISE COMPARISON PROBABILITIES:

	1	2	3	4	5
1	1.000				
2	1.000	1.000			
3	0.000	0.000	1.000		
4	0.000	0.000	0.060	1.000	
5	0.000	0.000	0.723	0.003	1.000

```
 FRI 1/27/95 1:44:43 PM   D:\SORWT\SORWTDAT.SYS
LEVELS ENCOUNTERED DURING PROCESSING ARE:
GROUPNO$
 IV            VII           XII           XV            XVI

   32 CASES DELETED DUE TO MISSING DATA.


DEP VAR:      NO3      N:       76  MULTIPLE R: 0.853  SQUARED MULTIPLE R: 0.727

                       ANALYSIS OF VARIANCE

SOURCE        SUM-OF-SQUARES   DF  MEAN-SQUARE     F-RATIO       P

GROUPNO$        .175964E+12    4  .439910E+11      47.380       0.000

ERROR           .659208E+11   71  .928463E+09

 FRI 1/27/95 1:44:52 PM   D:\SORWT\SORWTDAT.SYS
COL/
ROW GROUPNO$
  1  IV
  2  VII
  3  XII
  4  XV
  5  XVI

USING LEAST SQUARES MEANS.

POST HOC TEST OF       NO3


USING MODEL MSE OF ************ WITH     71. DF.
MATRIX OF PAIRWISE MEAN DIFFERENCES:


                      1           2           3           4           5

             1       0.000
             2  -129711.111       0.000
             3   -65038.889   64672.222       0.000
             4  -145062.500  -15351.389  -80023.611       0.000
             5   -41300.000   88411.111   23738.889  103762.500       0.000

TUKEY HSD MULTIPLE COMPARISONS.
MATRIX OF PAIRWISE COMPARISON PROBABILITIES:


                      1           2           3           4           5

             1       1.000
             2       0.000       1.000
             3       0.000       0.000       1.000
             4       0.000       0.760       0.000       1.000
             5       0.006       0.000       0.114       0.000       1.000
```

FRI 1/27/95 1:45:07 PM D:\SORWT\SORWTDAT.SYS
LEVELS ENCOUNTERED DURING PROCESSING ARE:
GROUPNO$

IV	VII	XII	XV	XVI

32 CASES DELETED DUE TO MISSING DATA.

DEP VAR: NO2 N: 76 MULTIPLE R: 0.739 SQUARED MULTIPLE R: 0.546

ANALYSIS OF VARIANCE

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE	F-RATIO	P
GROUPNO$	.812275E+10	4	.203069E+10	21.381	0.000
ERROR	.674339E+10	71	.949773E+08		

FRI 1/27/95 1:45:14 PM D:\SORWT\SORWTDAT.SYS
COL/
ROW GROUPNO$
1 IV
2 VII
3 XII
4 XV
5 XVI

USING LEAST SQUARES MEANS.

POST HOC TEST OF NO2

USING MODEL MSE OF 94977326.797 WITH 71. DF.
MATRIX OF PAIRWISE MEAN DIFFERENCES:

	1	2	3	4	5
1	0.000				
2	-25011.278	0.000			
3	-18091.667	6919.611	0.000		
4	-24832.750	178.528	-6741.083	0.000	
5	-2819.545	22191.732	15272.121	22013.205	0.000

TUKEY HSD MULTIPLE COMPARISONS.
MATRIX OF PAIRWISE COMPARISON PROBABILITIES:

	1	2	3	4	5
1	1.000				
2	0.000	1.000			
3	0.000	0.219	1.000		
4	0.000	1.000	0.485	1.000	
5	0.942	0.000	0.000	0.000	1.000

FRI 1/27/95 1:45:30 PM D:\SORWT\SORWTDAT.SYS
LEVELS ENCOUNTERED DURING PROCESSING ARE:
GROUPNO$

IV	VII	XII	XV	XVI

32 CASES DELETED DUE TO MISSING DATA.

DEP VAR: F N: 76 MULTIPLE R: 0.960 SQUARED MULTIPLE R: 0.921

ANALYSIS OF VARIANCE

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE	F-RATIO	P
GROUPNO$	.689270E+09	4	.172318E+09	206.385	0.000
ERROR	.592803E+08	71	834933.824		

FRI 1/27/95 1:45:43 PM D:\SORWT\SORWTDAT.SYS
COL/
ROW GROUPNO$

1	IV
2	VII
3	XII
4	XV
5	XVI

USING LEAST SQUARES MEANS.

POST HOC TEST OF F

USING MODEL MSE OF 834933.824 WITH 71. DF.
MATRIX OF PAIRWISE MEAN DIFFERENCES:

	1	2	3	4	5
1	0.000				
2	6002.444	0.000			
3	8128.556	2126.111	0.000		
4	2169.250	-3833.194	-5959.306	0.000	
5	1629.364	-4373.081	-6499.192	-539.886	0.000

TUKEY HSD MULTIPLE COMPARISONS.
MATRIX OF PAIRWISE COMPARISON PROBABILITIES:

	1	2	3	4	5
1	1.000				
2	0.000	1.000			
3	0.000	0.000	1.000		
4	0.000	0.000	0.000	1.000	
5	0.000	0.000	0.000	0.610	1.000

FRI 1/27/95 1:46:02 PM   D:\SORWT\SORWTDAT.SYS
LEVELS ENCOUNTERED DURING PROCESSING ARE:
GROUPNO$

IV	VII	XII	XV	XVI

32 CASES DELETED DUE TO MISSING DATA.

DEP VAR: CL   N: 76   MULTIPLE R: 0.926   SQUARED MULTIPLE R: 0.857

ANALYSIS OF VARIANCE

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE	F-RATIO	P
GROUPNO$	.414409E+08	4	.103602E+08	106.625	0.000
ERROR	6898701.915	71	97164.816		

FRI 1/27/95 1:46:06 PM   D:\SORWT\SORWTDAT.SYS
COL/
ROW GROUPNO$
1 IV
2 VII
3 XII
4 XV
5 XVI

USING LEAST SQUARES MEANS.

POST HOC TEST OF   CL

USING MODEL MSE OF   97164.816 WITH   71. DF.
MATRIX OF PAIRWISE MEAN DIFFERENCES:

	1	2	3	4	5
1	0.000				
2	-1937.389	0.000			
3	-2045.556	-108.167	0.000		
4	-2712.375	-774.986	-666.819	0.000	
5	-2009.409	-72.020	36.146	702.966	0.000

TUKEY HSD MULTIPLE COMPARISONS.
MATRIX OF PAIRWISE COMPARISON PROBABILITIES:

	1	2	3	4	5
1	1.000				
2	0.000	1.000			
3	0.000	0.835	1.000		
4	0.000	0.000	0.000	1.000	
5	0.000	0.950	0.996	0.000	1.000

FRI 1/27/95 1:46:34 PM D:\SORWT\SORWTDAT.SYS
LEVELS ENCOUNTERED DURING PROCESSING ARE:
GROUPNO$
IV VII XII XV XVI

45 CASES DELETED DUE TO MISSING DATA.

DEP VAR: TOC N: 63 MULTIPLE R: 0.520 SQUARED MULTIPLE R: 0.271

ANALYSIS OF VARIANCE

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE	F-RATIO	P
GROUPNO$	.520472E+09	4	.130118E+09	5.381	0.001
ERROR	.140262E+10	58	.241831E+08		

FRI 1/27/95 1:46:45 PM D:\SORWT\SORWTDAT.SYS
COL/
ROW GROUPNO$
1 IV
2 VII
3 XII
4 XV
5 XVI

USING LEAST SQUARES MEANS.

POST HOC TEST OF TOC

USING MODEL MSE OF 24183079.245 WITH 58. DF.
MATRIX OF PAIRWISE MEAN DIFFERENCES:

	1	2	3	4	5
1	0.000				
2	7162.000	0.000			
3	-867.462	-8029.462	0.000		
4	1512.750	-5649.250	2380.212	0.000	
5	-972.500	-8134.500	-105.038	-2485.250	0.000

TUKEY HSD MULTIPLE COMPARISONS.
MATRIX OF PAIRWISE COMPARISON PROBABILITIES:

	1	2	3	4	5
1	1.000				
2	0.016	1.000			
3	0.993	0.003	1.000		
4	0.966	0.124	0.818	1.000	
5	0.985	0.001	1.000	0.738	1.000

FRI 1/27/95 1:47:13 PM D:\SORWT\SORWTDAT.SYS
LEVELS ENCOUNTERED DURING PROCESSING ARE:
GROUPNO$
IV XII XV XVI

70 CASES DELETED DUE TO MISSING DATA.

DEP VAR: PH N: 38 MULTIPLE R: 0.939 SQUARED MULTIPLE R: 0.882

ANALYSIS OF VARIANCE

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE	F-RATIO	P
GROUPNO$	121.793	3	40.598	84.879	0.000
ERROR	16.262	34	0.478		

FRI 1/27/95 1:47:19 PM D:\SORWT\SORWTDAT.SYS
COL/
ROW GROUPNO$
1 IV
2 XII
3 XV
4 XVI

USING LEAST SQUARES MEANS.

POST HOC TEST OF PH

USING MODEL MSE OF .478 WITH 34. DF.
MATRIX OF PAIRWISE MEAN DIFFERENCES:

	1	2	3	4
1	0.000			
2	-2.172	0.000		
3	-1.153	1.019	0.000	
4	-4.582	-2.411	-3.429	0.000

TUKEY HSD MULTIPLE COMPARISONS.
MATRIX OF PAIRWISE COMPARISON PROBABILITIES:

	1	2	3	4
1	1.000			
2	0.000	1.000		
3	0.398	0.494	1.000	
4	0.000	0.000	0.000	1.000

```
MON 7/25/94 4:21:51 PM    D:\SORWT\DENSITY.SYS
 LEVELS ENCOUNTERED DURING PROCESSING ARE:
 GROUPNO$
  V             VI           XI            XIV           XV

    16 CASES DELETED DUE TO MISSING DATA.


 DEP VAR: DENSITY      N:       59  MULTIPLE R: 0.712  SQUARED MULTIPLE R: 0.507
```

ANALYSIS OF VARIANCE

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE	F-RATIO	P
GROUPNO$	0.645	4	0.161	13.893	0.000
ERROR	0.626	54	0.012		

```
MON 7/25/94 4:21:59 PM    D:\SORWT\DENSITY.SYS
 COL/
 ROW GROUPNO$
   1  V
   2  VI
   3  XI
   4  XIV
   5  XV

 USING LEAST SQUARES MEANS.

 POST HOC TEST OF  DENSITY


 USING MODEL MSE OF          .012 WITH     54. DF.
 MATRIX OF PAIRWISE MEAN DIFFERENCES:
```

	1	2	3	4	5
1	0.000				
2	0.554	0.000			
3	0.289	-0.265	0.000		
4	0.149	-0.405	-0.140	0.000	
5	0.185	-0.369	-0.104	0.036	0.000

```
 TUKEY HSD MULTIPLE COMPARISONS.
 MATRIX OF PAIRWISE COMPARISON PROBABILITIES:
```

	1	2	3	4	5
1	1.000				
2	0.000	1.000			
3	0.000	0.195	1.000		
4	0.357	0.027	0.566	1.000	
5	0.000	0.011	0.362	0.991	1.000

Appendix F

Descriptive Statistics of Core Sample Analytical Data Used in the SORWT Model Verification Study

FRI 1/27/95 2:10:58 PM D:\SORWT\SORWT_S.SYS

THE FOLLOWING RESULTS ARE FOR:
GROUPNO$ = IV

TOTAL OBSERVATIONS: 12

	AL	BI	CR	FE	LA
N OF CASES	12	12	12	12	12
MINIMUM	111000.000	28.600	2100.000	16.700	7.890
MAXIMUM	123000.000	45.700	2620.000	1900.000	10.500
RANGE	12000.000	17.100	520.000	1883.300	2.610
MEAN	117000.000	38.775	2353.333	1423.775	9.413
VARIANCE	.160000E+08	55.569	21515.152	446681.986	1.217
STANDARD DEV	4000.000	7.454	146.680	668.343	1.103
STD. ERROR	1154.701	2.152	42.343	192.934	0.318
SKEWNESS(G1)	0.151	-0.604	0.187	-1.655	-0.553
KURTOSIS(G2)	-1.263	-1.498	-0.620	0.956	-1.495
SUM	1404000.000	465.300	28240.000	17085.300	112.950
C.V.	0.034	0.192	0.062	0.469	0.117
MEDIAN	116500.000	42.150	2300.000	1675.000	9.840

	MN	NA	PB	SI	ZR
N OF CASES	12	12	12	12	12
MINIMUM	583.000	113000.000	35.000	947.000	4.850
MAXIMUM	1960.000	125000.000	42.500	2310.000	37.900
RANGE	1377.000	12000.000	7.500	1363.000	33.050
MEAN	1150.083	118250.000	38.625	1326.417	21.207
VARIANCE	149374.811	.136591E+08	8.682	139466.811	96.568
STANDARD DEV	386.490	3695.821	2.947	373.453	9.827
STD. ERROR	111.570	1066.892	0.851	107.806	2.837
SKEWNESS(G1)	0.449	0.425	0.118	1.550	-0.127
KURTOSIS(G2)	-0.160	-0.646	-1.486	2.009	-0.904
SUM	13801.000	1419000.000	463.500	15917.000	254.480
C.V.	0.336	0.031	0.076	0.282	0.463
MEDIAN	1110.000	119000.000	38.350	1205.000	21.900

	CS137	SR90	PU23940	U	PO4
N OF CASES	12	12	12	12	10
MINIMUM	55.700	272.000	0.136	5150.000	1080.000
MAXIMUM	67.500	356.000	0.404	7530.000	2190.000
RANGE	11.800	84.000	0.268	2380.000	1110.000
MEAN	62.308	309.583	0.282	6685.000	1310.000
VARIANCE	10.783	634.992	0.011	469627.273	212733.333
STANDARD DEV	3.284	25.199	0.105	685.294	461.230
STD. ERROR	0.948	7.274	0.030	197.827	145.854
SKEWNESS(G1)	-0.434	0.522	-0.457	-0.721	1.499
KURTOSIS(G2)	-0.307	-0.615	-1.483	0.081	0.249
SUM	747.700	3715.000	3.385	80220.000	13100.000
C.V.	0.053	0.081	0.373	0.103	0.352
MEDIAN	62.850	304.000	0.312	6710.000	1095.000

	NO3	NO2	F	CL	TOC
N OF CASES	10	10	10	10	10
MINIMUM	157000.000	20400.000	108.000	2950.000	1090.000
MAXIMUM	200000.000	29800.000	219.000	3520.000	2380.000
RANGE	43000.000	9400.000	111.000	570.000	1290.000
MEAN	186300.000	25730.000	132.000	3162.000	1606.000
VARIANCE	.198456E+09	9857888.889	2090.667	25306.667	315382.222
STANDARD DEV	14087.425	3139.728	45.724	159.081	561.589
STD. ERROR	4454.835	992.869	14.459	50.306	177.590
SKEWNESS(G1)	-1.003	-0.414	1.479	0.948	0.425
KURTOSIS(G2)	-0.216	-0.793	0.219	0.723	-1.667
SUM	1863000.000	257300.000	1320.000	31620.000	16060.000
C.V.	0.076	0.122	0.346	0.050	0.350
MEDIAN	192000.000	25950.000	109.500	3135.000	1300.000

THE FOLLOWING RESULTS ARE FOR:
GROUPNO$ = VII

TOTAL OBSERVATIONS: 22

	AL	BI	CR	FE	LA
N OF CASES	17	17	17	17	17
MINIMUM	195.000	27189.000	1875.000	3630.000	11424.000
MAXIMUM	13071.000	105375.000	3875.000	18712.000	15599.000
RANGE	12876.000	78186.000	2000.000	15082.000	4175.000
MEAN	3490.000	61753.471	2835.000	10155.647	13591.529
VARIANCE	.220602E+08	.106507E+10	390714.625	.244163E+08	1562411.890
STANDARD DEV	4696.825	32635.396	625.072	4941.290	1249.965
STD. ERROR	1139.147	7915.246	151.602	1198.439	303.161
SKEWNESS(G1)	1.265	0.156	0.130	0.344	-0.002
KURTOSIS(G2)	-0.268	-1.888	-1.146	-1.001	-1.043
SUM	59330.000	1049809.000	48195.000	172646.000	231056.000
C.V.	1.346	0.528	0.220	0.487	0.092
MEDIAN	1168.000	36591.000	2787.000	10138.000	13170.000

	MN	NA	PB	SI	ZR
N OF CASES	17	17	17	17	17
MINIMUM	800.000	33576.000	334.000	1130.000	3.900
MAXIMUM	25880.000	58510.000	2244.000	59723.000	82.400
RANGE	25080.000	24934.000	1910.000	58593.000	78.500
MEAN	14508.471	41364.059	1124.529	15648.176	28.912
VARIANCE	.694385E+08	.722929E+08	416589.015	.442815E+09	768.351
STANDARD DEV	8332.975	8502.523	645.437	21043.163	27.719
STD. ERROR	2021.043	2062.165	156.541	5103.717	6.723
SKEWNESS(G1)	-0.251	1.128	0.406	1.281	0.582
KURTOSIS(G2)	-1.113	-0.419	-1.119	-0.196	-1.050
SUM	246644.000	703189.000	19117.000	266019.000	491.500
C.V.	0.574	0.206	0.574	1.345	0.959
MEDIAN	12800.000	37896.000	833.000	5849.000	7.000

	CS137	SR90	PU23940	U	PO4
N OF CASES	18	18	18	18	18
MINIMUM	0.011	0.830	0.118	119.000	1000.000
MAXIMUM	1.610	7.370	1.560	860.000	2730.000
RANGE	1.599	6.540	1.442	741.000	1730.000
MEAN	0.403	3.168	0.606	413.944	1705.722
VARIANCE	0.200	3.555	0.296	53980.173	243377.624
STANDARD DEV	0.447	1.886	0.544	232.336	493.333
STD. ERROR	0.105	0.444	0.128	54.762	116.280
SKEWNESS(G1)	1.169	0.747	0.719	0.567	0.266
KURTOSIS(G2)	0.849	-0.340	-1.070	-1.094	-0.812
SUM	7.260	57.030	10.908	7451.000	30703.000
C.V.	1.109	0.595	0.897	0.561	0.289
MEDIAN	0.300	2.740	0.285	322.000	1730.000

	NO3	NO2	F	CL	TOC
N OF CASES	18	18	18	18	10
MINIMUM	47000.000	439.000	5200.000	646.000	1900.000
MAXIMUM	71300.000	1100.000	7200.000	2000.000	33200.000
RANGE	24300.000	661.000	2000.000	1354.000	31300.000
MEAN	56588.889	718.722	6134.444	1224.611	8768.000
VARIANCE	.547446E+08	42388.095	198802.614	216320.958	.154537E+09
STANDARD DEV	7398.958	205.884	445.873	465.103	12431.308
STD. ERROR	1743.951	48.527	105.093	109.626	3931.125
SKEWNESS(G1)	0.361	0.090	0.338	0.088	1.491
KURTOSIS(G2)	-1.060	-0.934	0.662	-1.461	0.253
SUM	1018600.000	12937.000	110420.000	22043.000	87680.000
C.V.	0.131	0.286	0.073	0.380	1.418
MEDIAN	56850.000	747.000	6090.000	1240.000	3505.000

THE FOLLOWING RESULTS ARE FOR:
GROUPNO$ = XII

TOTAL OBSERVATIONS: 18

	AL	BI	CR	FE	LA
N OF CASES	18	18	18	18	18
MINIMUM	11200.000	10200.000	413.000	8350.000	7.890
MAXIMUM	17300.000	28200.000	1080.000	13400.000	8.000
RANGE	6100.000	18000.000	667.000	5050.000	0.110
MEAN	14322.566	17355.556	685.000	10811.667	7.967
VARIANCE	1998942.011	.281097E+08	72523.882	1977720.588	0.001
STANDARD DEV	1413.839	5301.856	269.303	1406.315	0.029
STD. ERROR	333.245	1249.659	63.475	331.472	0.007
SKEWNESS(G1)	0.318	0.773	0.349	0.032	-1.312
KURTOSIS(G2)	0.908	-0.410	-1.693	-0.706	1.262
SUM	257806.190	312400.000	12330.000	194610.000	143.410
C.V.	0.099	0.305	0.393	0.130	0.004
MEDIAN	14300.000	15400.000	495.500	11200.000	7.980

	MN	NA	PB	SI	ZR
N OF CASES	18	18	18	18	18
MINIMUM	31.000	73900.000	35.400	5630.000	53.400
MAXIMUM	93.400	106000.000	461.000	7990.000	201.000
RANGE	62.400	32100.000	425.600	2360.000	147.600
MEAN	58.111	91133.333	181.456	6932.778	152.978
VARIANCE	299.810	.914647E+08	22577.901	531574.183	2032.682
STANDARD DEV	17.315	9563.718	150.259	729.091	45.085
STD. ERROR	4.081	2254.190	35.416	171.848	10.627
SKEWNESS(G1)	0.299	-0.084	1.039	0.006	-1.031
KURTOSIS(G2)	-0.482	-1.205	-0.570	-1.280	-0.042
SUM	1046.000	1640400.000	3266.200	124790.000	2753.600
C.V.	0.298	0.105	0.828	0.105	0.295
MEDIAN	57.450	88450.000	120.500	6870.000	169.500

	CS137	SR90	PU23940	U	PO4
N OF CASES	18	18	18	18	18
MINIMUM	10.900	2.590	0.035	943.000	13400.000
MAXIMUM	25.100	12.000	0.153	25200.000	49300.000
RANGE	14.200	9.410	0.118	24257.000	35900.000
MEAN	18.533	7.188	0.070	4248.500	22255.556
VARIANCE	23.805	8.643	0.001	.523516E+08	.135458E+09
STANDARD DEV	4.879	2.940	0.030	7235.439	11638.639
STD. ERROR	1.150	0.693	0.007	1705.409	2743.253
SKEWNESS(G1)	-0.087	0.034	1.695	2.462	1.160
KURTOSIS(G2)	-1.481	-1.166	2.096	4.147	-0.178
SUM	333.600	129.390	1.258	76473.000	400600.000
C.V.	0.263	0.409	0.432	1.703	0.523
MEDIAN	19.550	7.180	0.057	1970.000	15950.000

	NO3	NO2	F	CL	TOC
N OF CASES	18	18	18	18	13
MINIMUM	91400.000	1180.000	4330.000	661.000	500.000
MAXIMUM	153000.000	13500.000	11000.000	2020.000	1090.000
RANGE	61600.000	12320.000	6670.000	1359.000	590.000
MEAN	121261.111	7638.333	8260.556	1116.444	738.538
VARIANCE	.329647E+09	.211695E+08	2894146.732	137326.967	56825.103
STANDARD DEV	18156.190	4601.031	1701.219	370.577	238.380
STD. ERROR	4279.455	1084.473	400.981	87.346	66.115
SKEWNESS(G1)	-0.064	-0.131	-0.779	1.467	0.498
KURTOSIS(G2)	-0.837	-1.610	0.625	1.706	-1.417
SUM	2182700.000	137490.000	148690.000	20096.000	9601.000
C.V.	0.150	0.602	0.206	0.332	0.323
MEDIAN	122000.000	9145.000	8550.000	1105.000	700.000

THE FOLLOWING RESULTS ARE FOR:
GROUPNO$ = XV

TOTAL OBSERVATIONS: 8

	AL	BI	CR	FE	LA
N OF CASES	8	8	8	8	8
MINIMUM	459.000	20100.000	1670.000	15700.000	3380.000
MAXIMUM	706.000	27300.000	1920.000	20800.000	4840.000
RANGE	247.000	7200.000	250.000	5100.000	1460.000
MEAN	570.000	23562.500	1798.750	18037.500	4107.500
VARIANCE	11610.286	.106398E+08	6041.071	4794107.143	378107.143
STANDARD DEV	107.751	3261.874	77.724	2189.545	614.904
STD. ERROR	38.096	1153.247	27.480	774.121	217.401
SKEWNESS(G1)	0.087	-0.006	-0.158	0.078	0.012
KURTOSIS(G2)	-1.824	-1.905	-0.629	-1.851	-1.754
SUM	4560.000	188500.000	14390.000	144300.000	32860.000
C.V.	0.189	0.138	0.043	0.121	0.150
MEDIAN	558.500	23750.000	1815.000	17850.000	4100.000

	MN	NA	PB	SI	ZR
N OF CASES	8	8	8	8	8
MINIMUM	5860.000	33600.000	262.000	5090.000	3.990
MAXIMUM	6590.000	40100.000	486.000	6040.000	4.010
RANGE	730.000	6500.000	224.000	950.000	0.020
MEAN	6282.500	36950.000	365.125	5565.000	3.996
VARIANCE	69907.143	7311428.571	11061.268	96771.429	0.000
STANDARD DEV	264.400	2703.965	105.173	311.081	0.007
STD. ERROR	93.479	955.996	37.184	109.984	0.003
SKEWNESS(G1)	-0.257	-0.032	0.082	0.144	0.660
KURTOSIS(G2)	-1.128	-1.770	-1.892	-0.980	-0.739
SUM	50260.000	295600.000	2921.000	44520.000	31.970
C.V.	0.042	0.073	0.288	0.056	0.002
MEDIAN	6290.000	36850.000	349.500	5465.000	3.995

	CS137	SR90	PU23940	U	PO4
N OF CASES	8	8	8	8	8
MINIMUM	0.103	3.370	0.129	240.000	13500.000
MAXIMUM	0.238	7.550	0.153	4000.000	17700.000
RANGE	0.135	4.180	0.024	3760.000	4200.000
MEAN	0.166	5.414	0.139	2555.000	15537.500
VARIANCE	0.004	4.067	0.000	1513285.714	2408392.857
STANDARD DEV	0.063	2.017	0.007	1230.157	1551.900
STD. ERROR	0.022	0.713	0.003	434.926	548.679
SKEWNESS(G1)	0.059	0.012	0.786	-0.628	-0.019
KURTOSIS(G2)	-1.893	-1.969	0.273	-0.440	-1.280
SUM	1.331	43.310	1.110	20440.000	124300.000
C.V.	0.377	0.372	0.051	0.481	0.100
MEDIAN	0.163	5.320	0.138	2610.000	15350.000

	NO3	NO2	F	CL	TOC
N OF CASES	8	8	8	8	8
MINIMUM	36100.000	704.000	1260.000	362.000	2000.000
MAXIMUM	44500.000	1100.000	3160.000	518.000	4120.000
RANGE	8400.000	396.000	1900.000	156.000	2120.000
MEAN	41237.500	897.250	2301.250	449.625	3118.750
VARIANCE	.105827E+08	31437.071	753383.929	2100.839	630926.786
STANDARD DEV	3253.103	177.305	867.977	45.835	794.309
STD. ERROR	1150.146	62.687	306.876	16.205	280.831
SKEWNESS(G1)	-0.432	0.205	-0.050	-0.540	-0.374
KURTOSIS(G2)	-1.340	-1.651	-1.914	0.038	-1.144
SUM	329900.000	7178.000	18410.000	3597.000	24950.000
C.V.	0.079	0.198	0.377	0.102	0.255
MEDIAN	41950.000	856.500	2350.000	453.000	3150.000

THE FOLLOWING RESULTS ARE FOR:
GROUPNO$ = XVI

TOTAL OBSERVATIONS: 48

	AL	BI	CR	FE	LA
N OF CASES	48	48	48	48	48
MINIMUM	339.000	14093.000	730.000	1890.000	28.400
MAXIMUM	5860.000	23643.000	1193.000	28417.000	129.800
RANGE	5521.000	9550.000	463.000	26527.000	101.400
MEAN	1424.771	19353.792	853.896	17486.104	73.602
VARIANCE	971945.712	6088799.445	19302.819	.108591E+08	494.616
STANDARD DEV	985.873	2467.549	138.935	3295.318	22.240
STD. ERROR	142.299	356.160	20.053	475.638	3.210
SKEWNESS(G1)	2.658	-0.351	1.501	-1.906	0.398
KURTOSIS(G2)	8.235	-0.508	0.785	11.650	0.666
SUM	68389.000	928982.000	40987.000	839333.000	3532.900
C.V.	0.692	0.127	0.163	0.188	0.302
MEDIAN	1218.000	19852.500	803.500	17984.500	71.800

	MN	NA	PB	SI	ZR
N OF CASES	48	48	48	48	48
MINIMUM	57.000	88030.000	43.200	8171.000	17.100
MAXIMUM	176.000	117806.000	1927.000	23916.000	829.000
RANGE	119.000	29776.000	1883.800	15745.000	811.900
MEAN	97.229	96358.813	749.929	10173.396	133.749
VARIANCE	640.946	.340031E+08	301486.533	7224131.648	45812.918
STANDARD DEV	25.317	5831.216	549.078	2687.774	214.040
STD. ERROR	3.654	841.664	79.253	387.947	30.894
SKEWNESS(G1)	0.782	1.530	1.012	3.584	2.058
KURTOSIS(G2)	0.762	2.608	-0.051	13.898	2.853
SUM	4667.000	4625223.000	35996.600	488323.000	6419.940
C.V.	0.260	0.061	0.732	0.264	1.600
MEDIAN	95.000	94877.500	544.500	9467.500	49.250

	CS137	SR90	PU23940	U	PO4
N OF CASES	44	30	30	34	22
MINIMUM	13.050	6.441	0.069	136.000	21800.000
MAXIMUM	190.000	337.000	0.158	283.000	28500.000
RANGE	176.950	330.559	0.089	147.000	6700.000
MEAN	40.638	133.436	0.107	209.029	24554.545
VARIANCE	3194.437	10041.561	0.000	1181.423	2666406.926
STANDARD DEV	56.519	100.208	0.020	34.372	1632.914
STD. ERROR	8.521	18.295	0.004	5.895	348.138
SKEWNESS(G1)	1.710	0.418	0.297	0.289	0.719
KURTOSIS(G2)	1.040	-1.102	0.448	-0.100	0.133
SUM	1788.090	4003.088	3.215	7107.000	540200.000
C.V.	1.391	0.751	0.185	0.164	0.067
MEDIAN	14.685	117.550	0.109	205.500	24200.000

	NO3	NO2	F	CL	TOC
N OF CASES	22	22	22	22	22
MINIMUM	75000.000	8870.000	1360.000	987.000	298.000
MAXIMUM	235000.000	50000.000	2290.000	1500.000	1620.000
RANGE	160000.000	41130.000	930.000	513.000	1322.000
MEAN	145000.000	22910.455	1761.364	1152.591	633.500
VARIANCE	.273933E+10	.299707E+09	67031.385	30677.206	183095.595
STANDARD DEV	52338.641	17312.048	258.904	175.149	427.897
STD. ERROR	11158.636	3690.941	55.199	37.342	91.228
SKEWNESS(G1)	-0.141	0.632	0.533	0.811	1.402
KURTOSIS(G2)	-1.284	-1.499	-0.850	-0.851	0.473
SUM	3190000.000	504030.000	38750.000	25357.000	13937.000
C.V.	0.361	0.756	0.147	0.152	0.675
MEDIAN	164500.000	11050.000	1650.000	1065.000	447.500

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ALL Groups

TOTAL OBSERVATIONS: 108

	AL	BI	CR	FE	LA
N OF CASES	103	103	103	103	103
MINIMUM	195.000	28.600	413.000	16.700	7.890
MAXIMUM	123000.000	105375.000	3875.000	28417.000	15599.000
RANGE	122805.000	105346.400	3462.000	28400.300	15591.110
MEAN	17418.303	24079.187	1399.437	13281.304	2599.080
VARIANCE	.134928E+10	.498349E+09	778162.190	.388808E+08	.255639E+08
STANDARD DEV	36732.517	22323.726	882.135	6235.448	5056.078
STD. ERROR	3619.362	2199.622	86.919	614.397	498.190
SKEWNESS(G1)	2.307	2.418	1.022	-0.653	1.688
KURTOSIS(G2)	3.500	5.583	-0.026	-0.496	1.087
SUM	1794085.190	2480156.300	144142.000	1367974.300	267705.260
C.V.	2.109	0.927	0.630	0.469	1.945
MEDIAN	1492.000	20001.000	899.000	16100.000	68.700

	MN	NA	PB	SI	ZR
N OF CASES	103	103	103	103	103
MINIMUM	31.000	33576.000	35.000	947.000	3.900
MAXIMUM	25880.000	125000.000	2244.000	59723.000	829.000
RANGE	25849.000	91424.000	2209.000	58776.000	825.100
MEAN	3072.019	84304.971	599.653	9122.029	96.616
VARIANCE	.397227E+08	.739592E+09	337540.192	.895065E+08	24894.848
STANDARD DEV	6302.593	27195.444	580.982	9460.789	157.781
STD. ERROR	621.013	2679.647	57.246	932.199	15.547
SKEWNESS(G1)	2.350	-0.814	1.255	3.801	2.932
KURTOSIS(G2)	4.547	-0.629	0.637	15.609	8.581
SUM	316418.000	8683412.000	61764.300	939569.000	9951.490
C.V.	2.052	0.323	0.969	1.037	1.633
MEDIAN	111.000	93685.000	460.000	8171.000	45.000

	CS137	SR90	PU23940	U	PO4
N OF CASES	100	86	86	90	76
MINIMUM	0.011	0.830	0.035	119.000	1000.000
MAXIMUM	190.000	356.000	1.560	25200.000	49300.000
RANGE	189.989	355.170	1.525	25081.000	48300.000
MEAN	28.780	92.416	0.231	2129.900	14590.829
VARIANCE	1823.219	14700.248	0.103	.159143E+08	.138435E+09
STANDARD DEV	42.699	121.245	0.321	3989.269	11765.860
STD. ERROR	4.270	13.074	0.035	420.506	1349.637
SKEWNESS(G1)	2.337	0.984	3.010	3.934	0.434
KURTOSIS(G2)	4.690	-0.705	8.493	18.347	-0.393
SUM	2877.981	7947.818	19.875	191691.000	1108903.000
C.V.	1.484	1.312	1.387	1.873	0.806
MEDIAN	14.490	10.080	0.128	330.000	14900.000

	NO3	NO2	F	CL	TOC
N OF CASES	76	76	76	76	63
MINIMUM	36100.000	439.000	108.000	362.000	298.000
MAXIMUM	235000.000	50000.000	11000.000	3520.000	33200.000
RANGE	198900.000	49561.000	10892.000	3158.000	32902.000
MEAN	112950.000	12091.250	4178.816	1351.487	2416.317
VARIANCE	.322513E+10	.198215E+09	9980675.326	644527.906	.310176E+08
STANDARD DEV	56790.219	14078.890	3159.221	802.825	5569.344
STD. ERROR	6514.285	1614.959	362.387	92.090	701.671
SKEWNESS(G1)	0.290	1.366	0.362	1.357	5.018
KURTOSIS(G2)	-1.256	0.874	-1.181	0.911	24.326
SUM	8584200.000	918935.000	317590.000	102713.000	152228.000
C.V.	0.503	1.164	0.756	0.594	2.305
MEDIAN	103450.000	9170.000	3115.000	1100.000	1090.000

THE FOLLOWING RESULTS ARE FOR:
GROUPNO$ = IV

TOTAL OBSERVATIONS: 1

	DENSITY
N OF CASES	1
MINIMUM	1.640
MAXIMUM	1.640
RANGE	0.000
MEAN	1.640
VARIANCE	.
STANDARD DEV	.
STD. ERROR	.
SKEWNESS(G1)	.
KURTOSIS(G2)	.
SUM	1.640
C.V.	0.000
MEDIAN	1.640

THE FOLLOWING RESULTS ARE FOR:
GROUPNO$ = VII

TOTAL OBSERVATIONS: 32

	DENSITY
N OF CASES	32
MINIMUM	0.870
MAXIMUM	1.400
RANGE	0.530
MEAN	1.171
VARIANCE	0.018
STANDARD DEV	0.133
STD. ERROR	0.024
SKEWNESS(G1)	-0.474
KURTOSIS(G2)	-0.552
SUM	37.470
C.V.	0.114
MEDIAN	1.200

THE FOLLOWING RESULTS ARE FOR:
GROUPNO$ = XII

TOTAL OBSERVATIONS: 8

	DENSITY
N OF CASES	8
MINIMUM	1.000
MAXIMUM	1.470
RANGE	0.470
MEAN	1.286
VARIANCE	0.025
STANDARD DEV	0.159
STD. ERROR	0.056
SKEWNESS(G1)	-0.490
KURTOSIS(G2)	-0.739
SUM	10.290
C.V.	0.124
MEDIAN	1.290

THE FOLLOWING RESULTS ARE FOR:
GROUPNO$ = XV

TOTAL OBSERVATIONS: 2

	DENSITY
N OF CASES	2
MINIMUM	1.190
MAXIMUM	1.280
RANGE	0.090
MEAN	1.235
VARIANCE	0.004
STANDARD DEV	0.064
STD. ERROR	0.045
SKEWNESS(G1)	0.000
KURTOSIS(G2)	-2.000
SUM	2.470
C.V.	0.052
MEDIAN	1.235

THE FOLLOWING RESULTS ARE FOR:
GROUPNO$ = XVI

TOTAL OBSERVATIONS: 36

	DENSITY
N OF CASES	36
MINIMUM	0.900
MAXIMUM	1.470
RANGE	0.570
MEAN	1.271
VARIANCE	0.009
STANDARD DEV	0.094
STD. ERROR	0.016
SKEWNESS(G1)	-2.149
KURTOSIS(G2)	6.643
SUM	45.740
C.V.	0.074
MEDIAN	1.300

THE FOLLOWING RESULTS ARE FOR:
ALL GROUPS

TOTAL OBSERVATIONS: 79

	DENSITY
N OF CASES	79
MINIMUM	0.870
MAXIMUM	1.640
RANGE	0.770
MEAN	1.236
VARIANCE	0.018
STANDARD DEV	0.134
STD. ERROR	0.015
SKEWNESS(G1)	-0.513
KURTOSIS(G2)	1.073
SUM	97.610
C.V.	0.109
MEDIAN	1.280

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THE FOLLOWING RESULTS ARE FOR:
GROUPNO$ = IV

TOTAL OBSERVATIONS: 12

	PH
N OF CASES	10
MINIMUM	10.170
MAXIMUM	13.380
RANGE	3.210
MEAN	12.803
VARIANCE	0.903
STANDARD DEV	0.950
STD. ERROR	0.300
SKEWNESS(G1)	-2.420
KURTOSIS(G2)	4.322
SUM	128.030
C.V.	0.074
MEDIAN	13.085

THE FOLLOWING RESULTS ARE FOR:
GROUPNO$ = VII

TOTAL OBSERVATIONS: 22

	PH
N OF CASES	0
MINIMUM	.
MAXIMUM	.
RANGE	.
MEAN	.
VARIANCE	.
STANDARD DEV	.
STD. ERROR	.
SKEWNESS(G1)	.
KURTOSIS(G2)	.
SUM	.
C.V.	.
MEDIAN	.

THE FOLLOWING RESULTS ARE FOR:
GROUPNO$ = XII

TOTAL OBSERVATIONS: 18

	PH
N OF CASES	14
MINIMUM	9.580
MAXIMUM	11.330
RANGE	1.750
MEAN	10.631
VARIANCE	0.444
STANDARD DEV	0.666
STD. ERROR	0.178
SKEWNESS(G1)	-0.760
KURTOSIS(G2)	-1.135
SUM	148.840
C.V.	0.063
MEDIAN	10.880

THE FOLLOWING RESULTS ARE FOR:
GROUPNO$ = XV

TOTAL OBSERVATIONS: 8

	PH
N OF CASES	1
MINIMUM	11.650
MAXIMUM	11.650
RANGE	0.000
MEAN	11.650
VARIANCE	.
STANDARD DEV	.
STD. ERROR	.
SKEWNESS(G1)	.
KURTOSIS(G2)	.
SUM	11.650
C.V.	0.000
MEDIAN	11.650

THE FOLLOWING RESULTS ARE FOR:
GROUPNO$ = XVI

TOTAL OBSERVATIONS: 48

	PH
N OF CASES	13
MINIMUM	7.570
MAXIMUM	8.990
RANGE	1.420
MEAN	8.221
VARIANCE	0.197
STANDARD DEV	0.444
STD. ERROR	0.123
SKEWNESS(G1)	0.574
KURTOSIS(G2)	-0.778
SUM	106.870
C.V.	0.054
MEDIAN	8.120

THE FOLLOWING RESULTS ARE FOR:
ALL GROUPS

TOTAL OBSERVATIONS: 108

	PH
N OF CASES	38
MINIMUM	7.570
MAXIMUM	13.380
RANGE	5.810
MEAN	10.405
VARIANCE	3.731
STANDARD DEV	1.932
STD. ERROR	0.313
SKEWNESS(G1)	0.119
KURTOSIS(G2)	-1.296
SUM	395.390
C.V.	0.186
MEDIAN	10.780

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