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EVALUATION OF SOLIDIFICATION/STABILIZATION TREATMENT PROCESSES FOR MUNICIPAL WASTE COMBUSTION RESIDUES

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FOREWORD

Today's rapidly developing and changing technologies and industrial products and practices frequently carry with them the increased generation of solid and hazardous wastes. These materials, if improperly dealt with, can threaten both public health and the environment. Abandoned waste sites and accidental releases of toxic and hazardous substances to the environment also have important environmental and public health implications. The Risk Reduction Engineering Laboratory assists in providing an authoritative and defensible engineering basis for assessing and solving these problems. Its products support (i) policies, programs, and regulations of the U.S. Environmental Protection Agency, (ii) the permitting and other responsibilities of the State and local governments, and (iii) the needs of both large and small businesses in handling their wastes responsibly and economically.

This document provides results of evaluations conducted to determine the effectiveness of several solidification/stabilization (S/S) processes to treat air pollution control (APC) residues, combined ash and bottom ash from the combustion of municipal solid waste. Five different S/S technologies were evaluated. The untreated and treated residues, sampled from a modern state-of-art waste-to-energy plant, were subjected to a series of physical durability and chemical leaching tests. Results were used to provide a side-by-side comparison of the treatment processes and of the treated residue with untreated residues. The S/S processes as formulated and tested, generally did not physically decrease the potential for release of contaminants. One process, however, did significantly reduce the potential for Pb release as a result of chemical treatment. This report provides information useful in designing and evaluating S/S processes for treating municipal waste combustion (MWC) residue.

This document is intended for use by organizations and individuals concerned with the treatment and management of MWC residues.

ABSTRACT

The investigations described in this report, were carried out to provide a side-by-side comparison and evaluation of the effectiveness of solidification/stabilization (S/S) processes as treatment technologies for residues from municipal waste combustion (MWC). The experimental design of this program was a full factorial design for the evaluation of five S/S processes. The two experimental factors were the residue type to be treated and the S/S process. The experimental levels within the residue type factor were (i) bottom ash, (ii) air pollution control residue, and (iii) combined ash. The six experimental levels within the S/S process factors were (i) the untreated residue, (ii) a portland cement only control S/S process, and (iii - vi) four selected vendor S/S processes. Thus, two experimental factors at three and six experimental levels respectively, resulted in the evaluation of eighteen experimental cases.

Evaluation of each experimental case included analysis of chemical composition, physical properties, durability, and leaching characteristics. The testing included: moisture content, loss on ignition, bulk density, modified Proctor density, particle size density, permeability, specific surface area, porosity, cone penetrometer, unconfined compressive strength, pozzolanic activity, unconfined compressive strength after immersion, wet/dry, freeze/thaw, TCLP, availability leach test, distilled water leach test, acid neutralization capacity, and the monolithic leach test.

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TABLE OF CONTENTS

		page
	Cover Page	I
	Disclaimer	II
	Foreword	III
	Abstract	IV
	Table of Contents	V
	List of Tables	X
	List of Figures	XIII
	List of Acronyms and Definitions	XVI
	Acknowledgements	XVII
	Peer Reviewers	XVIII
1	Introduction	1
1.1	Background on Ash Management	1
1.2	Program Goals	1
1.3	Program Experimental Design	3
1.4	Vendor and Process Selection	5
1.5	Program Organization	6
2	Selection of Testing Methods and Protocols	10
2.1	Chemical Composition of Untreated Residues	10
2.1.1	Sample Analysis by Digestion and Extraction Techniques	10
2.1.2	Neutron Activation Analysis (NAA)	10
2.2	Physical Properties Analysis	11
2.2.1	Moisture Content	12
2.2.2	Loss on Ignition (LOI)	13
2.2.3	Bulk Density	13
2.2.4	Modified Proctor Density	13
2.2.5	Particle Size Distribution	14
2.2.6	Permeability	14
2.2.7	Specific Surface Area and Porosity	14
2.2.8	Cone Penetrometer	15
2.2.9	Unconfined Compressive Strength (UCS)	15

TABLE OF CONTENTS (continued)

2.2.10	Pozzolanic Activity	15
2.2.11	Unconfined Compressive Strength After Immersion	16
2.2.12	Freeze/Thaw Weathering	16
2.2.13	Wet/Dry Weathering	17
2.3	Leaching Tests Selected	18
2.3.1	Toxicity Characteristic Leaching Procedure (TCLP)	18
2.3.2	Availability Leach Test (ALT)	18
2.3.3	Distilled Water Leach Test (DWLT)	18
2.3.4	Acid Neutralization Capacity (ANC)	19
2.3.5	Monolith Leach Test	19
2.4	Data Presentation	20
2.5	Sample Preparation for Physical, Chemical and Leaching Analysis	20
3	Residue Sampling and preparation	35
3.1	Residue Sampling and Preparation	35
3.2	Untreated Residue Homogeneity	37
4	Process Descriptions and Economics	45
4.1	Process Descriptions	45
4.2	Process Economics for Solidification/Stabilization of MWC residues	46
5	Physical Properties of Untreated and Treated Residues	55
5.1	Moisture Content	55
5.2	Loss on Ignition	56
5.3	Bulk Density	56
5.4	Modified Proctor Density	58
5.5	Particle Size Distribution	58
5.6	Permeability	59
5.7	Pore Diameter and Surface Area	60
5.8	Cone Penetrometer	60
5.9	Unconfined Compressive Strength	60
5.10	Pozzolanic Activity	61
5.11	UCS After Immersion	62
5.12	Freeze/Thaw Weathering and Wet/Dry Weathering	62

TABLE OF CONTENTS (continued)

6		Results of Chemical Analysis of Untreated and Treated Residues	88
	6.1	Composition of Untreated Residues	88
	6.11	Elements, Anions and Indicator Parameters	88
	6.12	PCDDs and PCDFs	89
	6.2	Composition of Treated Residues and Vendor Additives	90
	6.2.1	Composition of Vendor Additives	90
	6.2.2	Composition of Treated Residues	90
	6.2.3	Comparison of SW-846 and Neutron Activation Analyses	91
	6.2.4	Analysis of Corrections for Process Dilution Effects	91
7		Leaching of Untreated and Treated Residues - Release Potential	117
	7.1	Data Reduction, Analysis and Presentation	117
	7.2	TCLP	119
	7.2.1	TCLP Extract pHs and Cadmium, Copper, Lead and Zinc Concentrations	119
	7.2.2	Species Release for TCLP	122
	7.3	Distilled Water Leach Test	125
	7.4	Availability Leach Test	129
	7.5	Acid Neutralization Capacity Leach Test	133
	7.6	Comparison of Magnitude and Consistency of Results from Tests for Leaching Potential	136
	7.6.1	Treated APC Residue	136
	7.6.2	Treated Bottom Ash	137
	7.6.3	Treated Combined Ash	137
	7.6.4	Release Potential Compared to Total Concentrations	138
	7.6.5	Summary of Leaching Potential Results by Treatment Process	139
8		Experimental Results and Modeled Leaching of Untreated and Treated Residues - Release Rate	196
	8.1	Data evaluation	196
	8.1.1	Mechanisms and intrinsic properties from monolith leach test	196
	8.1.2	Definition of Leaching Parameters	197
	8.1.3	Transport models for parameter estimation	200
	8.1.4	Determination of leaching mechanism from the cumulative release data.	202

	8.1.5	Diffusion Modelling Limitations	205
	8.2	Leaching Results and Discussion	205
	8.2.1	Data handling	205
	8.2.2	Monolith leach test release data	206
	8.2.3	Tortuosity	208
	8.2.4	Chemical Retention	209
	8.2.5	Effective Diffusion Coefficients	210
	8.3	Three dimensional diffusion model for Estimation of Release during Field Application	212
9		Summary and Conclusions	262
	9.1	Overall Conclusions	264
	9.2	Treatment Process Effectiveness	266
	9.2.1	Physical Properties	267
	9.2.2	Leaching Potential	268
	9.2.3	Leaching Release Rate	271
	9.3	Physical Properties and Durability Test Methods	273
	9.4	Leaching Tests	273
	9.5	Chemical Analysis	274
10		References	275
11		Appendices	278
		Table of Contents	278
		Explanation of Appendices	279
	A	**Results of Chemical Analysis of Untreated MWC Residues**	280
	A-1	Results of chemical analysis of untreated APC residue	282
	A-2	Results of chemical analysis of untreated bottom ash	290
	A-3	Results of chemical analysis of untreated combined ash	302
	B	**Summary Results of TCLP. DWLT and ALT for untreated and treated APC residues**	314
	B-1	Summary results of TCLP, DWLT and ALT for untreated and treated APC residues.	315

B-2 Summary results of TCLP, DWLT and ALT for untreated and treated bottom ash. 341

B-3 Summary results of TCLP, DWLT and ALT for untreated and treated combined ash 368

C **Summary of Monolith Leach Test Extract Concentrations and Data Analysis for Untreated and Treated MWC Residues** 394

C-1 Summary of monolith leach test extract concentrations and data analysis for untreated bottom ash and combined ash. 397

C-2 Summary of monolith leach test extract concentrations and data analysis for APC residue, bottom ash and combined ash treated by Process 1. 418

C-3 Summary of monolith leach test extract concentrations and data analysis for APC residue, bottom ash and combined ash treated by Process 2. 448

C-4 Summary of monolith leach test extract concentrations and data analysis for APC residue, bottom ash and combined ash treated by Process 3 478

C-5 Summary of monolith leach test extract concentrations and data analysis for APC residue, bottom ash and combined ash treated by Process 4. 508

C-6 Summary of monolith leach test extract concentrations and data analysis for APC residue, bottom ash and combined ash treated by WES Control Process. 529

LIST OF TABLES

		page
1.1	Technical Advisory Panel Members	8
2.1	Analysis of residues and additives	23
2.2	Elements analyzed by NAA and analysis detection limits	25
2.3	Comparison of NAA values with NIST Certified Standard Reference Material	26
2.4	Physical testing of untreated and treated MWC residues	27
2.5	Analysis of extracts from leaching tests	28
2.6	Particle size reductions required for chemical analysis and leaching tests	30
4.1	Quantities of process additives and water added per 100 lbs ash	49
4.2	Process dilution factors for each treatment process	50
4.3	Capital Improvement Costs for CREF Treatment Facility	51
4.4	Annual Operating Cost Details for CREF Treatment Facility	52
4.5	Annual Operating Cost Summary for CREF Treatment Facility	53
5.1	Comparison of physical properties, cure rate and durability	65
5.2	Comparison of physical properties, cure rate and durability	67
5.3	Comparison of physical properties, cure rate and durability	69
5.4	Moisture content and liquid added during the treatment process	71
5.5	Relative increases in residue specific volume resulting from treatment	72
5.6	Swelling and shrinkage % of untreated and treated residues	72
5.7	Percent finer material from sieve analysis	73
5.8	Relative weight loss of freeze/thaw and wet/dry test specimens	74
6.1	Comparison of chloride, sulfate and TDS results for untreated MWC residues	93
6.2	PCDD/PCDF assay results for untreated APC residue	94
6.3	PCDD/PCDF assay results for untreated bottom ash	95
6.4	PCDD/PCDF assay results for combined ash	96
6.5	Relative quantities of MWC residues and process additives in treated residues	97
6.6	Principal components in calcium-based process additives	98
6.7	Significant contributions from process additives to total treated residue composition	99
7.1	Leaching Test Liquid to Solid Ratios and Treatment Process Dilution Factors	141
7.2	Comparison of Selected Metal Concentration in Extraction Fluids 1 and 2	142
7.3	Relative categories of treatment effects	142
7.4	Summary of conclusions on treatment effects on contaminant release TCLP	143
7.5	Summary of conclusions on treatment effects on contaminant release by DWLT	144

7.6	Summary of conclusions on treatment effects on contaminant release by DWLT	145
7.7	Comparison of total dissolved solids released for the distilled water leach test	146
7.8	Summary of conclusions on treatment effects on contaminant release	147
7.9	Comparison of leaching test results for treated APC residue	148
7.10	Comparison of leaching test results for treated bottom ash	149
7.11	Comparison of leaching test results for treated combined ash	150
7.12	Fraction of total element present in treated residues released during availability leach test	151
8.1	Effective diffusion coefficients based on individual extract cycling time-intervals	213
8.2	Cumulative elemental and species release after 64 days leaching	214
8.3	Cumulative elemental and species release after 64 days leaching	215
8.4	Cumulative elemental and species release after 64 days leaching	216
8.5	Effective diffusion coefficients for several salts used to estimate tortuosity	217
8.6	Physical retardation (tortuosities) in products produced from waste materials	218
8.7	Estimated chemical retention values for untreated and treated MWC residues	219
8.8	Estimated chemical retention values for untreated and treated MWC residues	220
8.9	Estimated chemical retention values for untreated and treated MWC residues	221
8.10	Estimated effective diffusion coefficients for untreated and treated residues	222
8.11	Estimated effective diffusion coefficients for untreated and treated residues	223
8.12	Estimated effective diffusion coefficients for untreated and treated residues	224

LIST OF FIGURES

		page
1.1	Organization of USEPA Program for Utilization of Municipal Waste Combustor Residues	9
2.1	Configuration of monolith extraction test for compacted granular materials	31
2.2	Sample preparation for leaching tests and analysis	32
2.3	Effects of particle size reduction for analysis on total concentrations	33
2.4	Effects of particle size reduction for analysis on total concentrations	34
3.1	Typical mass burn municipal waste combustion facility schematic	38
3.2	Bottom ash collection and preparation	39
3.3	Combined ash collection and preparation	40
3.4	APC residue collection and preparation	41
3.5	Box plot neutron activation analysis results for homogenized, untreated APC residue	42
3.6	Box plot of neutron activation analysis results for homogenized, untreated bottom ash	43
3.7	Box plot of neutron activation analysis results for homogenized, untreated combined	44
4.1	Schematic process flow diagram for the Commerce Refuse to Energy MWC Facility	54
5.1	Modified proctor density compaction curves	75
5.2a	Particle size distribution of bottom ash prior to residue drying and crushing	76
5.2b	Particle size distribution of bottom ash after preparation	77
5.3a	Particle size distribution of combined ash prior to residue drying and crushing	78
5.3b	Particle size distribution of combined ash after preparation	79
5.4a	Particle size distribution of untreated APC residue	80
5.4b	Particle size distribution of APC residue treated by Process 4	81
5.5	BET cumulative pore surface area plot for untreated APC residue	82
5.6	BET cumulative pore surface area plot for untreated bottom ash	83
5.7	BET cumulative pore surface area plot for untreated combined ash	84
5.8	Unconfined compressive strength (UCS) as a function of cure time	85
5.9	UCS and UCS after immersion	86
5.10	Cumulative weight loss (percent eroded)	87
6.1	Comparison of box plots of neutron activation analysis results	100
6.2	Comparison of box plots of neutron activation analysis results	101
6.3	Untreated total composition by SW-846	102
6.4	Untreated total composition (page 2) by SW-846	103
6.5	Total Aluminum concentrations between NAA and SW-846 analysis methods	104

6.6	Total Cadmium concentrations between NAA and SW-846 analysis methods	105
6.7	Total Chromium concentrations between NAA and SW-846 analysis methods	106
6.8	Total Copper concentrations between NAA and SW-846 analysis methods	107
6.9	Total Chloride concentrations between NAA and SW-846 analysis methods	108
6.10	Total Zinc concentrations between NAA and SW-846 analysis methods	109
6.11	Calcium Total analysis by NAA	110
6.12	Potassium and Sodium Total analysis by Neutron Activation Analysis	111
6.13	Lead Total analysis by SW-846	112
6.14	A comparison of SW-846 and NAA results for Al and Cd	113
6.15	A comparison of SW-846 and NAA results for Cl and Cr	114
6.16	A comparison of SW-846 and NAA results for Cu and Zn	115
6.17	NAA corrected for process dilution (Chloride & Zinc)	116
7.1	TCLP extract pHs	152
7.2	Cadmium and copper concentrations in TCLP extracts	153
7.3	Lead and zinc concentrations in TCLP extracts	154
7.4	Aluminum and calcium release during TCLP extraction, corrected for process dilution	155
7.5	Cadmium and copper release during TCLP extraction, corrected for process dilution	156
7.6	Potassium and sodium release during TCLP extraction	157
7.7	Lead and zinc release during TCLP extraction, corrected of process dilution	158
7.8	Chloride and sulfate release during TCLP extraction, corrected for process dilution	159
7.9	Distilled water leach test extract pHs	160
7.10	Aluminum release during distilled water leach test, corrected for process dilution	161
7.11	Cadmium release during distilled water leach test, corrected for process dilution	162
7.12	Calcium release during distilled water leach test, corrected for process dilution	163
7.13	Copper release during distilled water leach test, corrected for process dilution	164
7.14	Lead release during distilled water leach test, corrected for process dilution	165
7.15	Potassium release during distilled water leach test, corrected for process dilution	166
7.16	Sodium release during distilled water leach test, corrected for process dilution	167
7.17	Zinc release during distilled water leach test, corrected for process dilution	168
7.18	Chloride release during distilled water leach test, corrected for process dilution	169
7.19	Sulfate release during the distilled water leach test, corrected for process dilution	170
7.20	Total dissolved solids release during the distilled water leach test	171

7.21	Total organic carbon release during the distilled water leach test	172
7.22	Aluminum and Calcium release during availability leach test	173
7.23	Cadmium and copper release during availability leach test	174
7.24	Potassium and sodium release during availability leach test	175
7.25	Lead and zinc release during availability leach test	176
7.26	Chloride and sulfate release during availability leach test	177
7.27	Untreated and treated APC residue pH titration curves from the acid neutralization	178
7.28	Untreated and treated bottom ash pH titration curves	179
7.29	Untreated and treated combined ash pH titration curves	180
7.30	Cadmium concentrations in acid neutralization capacity extracts as a function of pH	181
7.31	Cadmium (Cd) concentrations in acid neutralization capacity extracts	182
7.32	Cadmium (Cd) concentrations in acid neutralization capacity extracts	183
7.33	Chromium concentrations in acid neutralization capacity extracts as a function of pH	184
7.34	Chromium (Cr) concentrations in acid neutralization capacity extracts	185
7.35	Chromium (Cr) concentrations in acid neutralization capacity extracts	186
7.36	Copper (Cu) concentrations in acid neutralization capacity extracts	187
7.37	Copper (Cu) concentrations in acid neutralization capacity extracts	188
7.38	Copper (Cu) concentrations in acid neutralization capacity extracts	189
7.39	Lead (Pb) concentrations in acid neutralization capacity extracts as a function of pH	190
7.40	Lead (Pb) concentrations in acid neutralization capacity extracts as a function of pH	191
7.41	Lead (Pb) concentrations in acid neutralization capacity extracts as a function of pH	192
7.42	Zinc (Zn) concentrations in acid neutralization capacity extracts as a function of pH	193
7.43	Zinc (Zn) concentration in acid neutralization capacity extracts as a function of pH	194
7.44	Zinc (Zn) concentration in acid neutralization capacity extracts as a function f pH	195
8.1	A schematic example of monolith species release data illustrating diffusion	225
8.2	The effects of porewater pH on release of magnesium - APC/Process 1	226
8.3	Contaminant release during the monolith leach test - APC/Process 2	227
8.4	Contaminant release during the monolith leach test - APC/Process 3	228
8.5	Contaminant release during the monolith leach test - APC/WES Control	229
8.6	Contaminant release during the monolith leach test	230
8.7	Contaminant release during the monolith leach test	231
8.8	Contaminant release during the monolith leach test	232

8.9	Contaminant release during the monolith leach test	233
8.10	Contaminant release during the monolith leach test	234
8.11	Contaminant release during the monolith leach test	235
8.12	Contaminant release during the monolith leach test	236
8.13	Contaminant release during the monolith leach test	237
8.14	Contaminant release during the monolith leach test	238
8.15	Contaminant release during the monolith leach test	239
8.16	Contaminant release during the monolith leach test	240
8.17	Contaminant release during the monolith leach test	241
8.18	Contaminant release during the monolith leach test	242
8.19	Contaminant release during the monolith leach test	243
8.20	Comparison of tortuosities estimated from the monolith leaching test	244
8.21	Mechanisms of sodium release from bottom ash treated by Process 2	245
8.22	Standard deviation as a function of pD_e for all estimated pD_e	246
8.23	Relative contributions of free diffusion, tortuosity, and chemical retardation	247
8.24	Relative contributions of free diffusion, tortuosity, and chemical retardation	248
8.25	Relative contributions of free diffusion, tortuosity, and chemical retardation	249
8.26	Relative contributions of free diffusion, tortuosity, and chemical retardation	250
8.27	Relative contributions of free diffusion, tortuosity, and chemical retardation	251
8.28	Relative contributions of free diffusion, tortuosity, and chemical retardation	252
8.29	Relative contributions of free diffusion, tortuosity, and chemical retardation	253
8.30	Relative contributions of free diffusion, tortuosity, and chemical retardation	254
8.31	Relative contributions of free diffusion, tortuosity, and chemical retardation	255
8.32	Relative contributions of free diffusion, tortuosity, and chemical retardation	256
8.33	Relative contributions of free diffusion, tortuosity, and chemical retardation	257
8.34	Relative contributions of free diffusion, tortuosity, and chemical retardation	258
8.35	Relative contributions of free diffusion, tortuosity, and chemical retardation	259
8.36	Relative contributions of free diffusion, tortuosity, and chemical retardation	260
8.37	Cumulative contaminant release as a function of time and pD_e for typical construction	261

ACRONYMS AND DEFINITIONS

ALT	Availability Leach Test, also AVLT
ANS	American Nuclear Society
APC Residue	Air Pollution Control Residue
ASTM	American Society of Testings Materials
BET	Brunauer Emmett-Teller
BJH	Barrett, Joyner and Halenda
COD	Chemical Oxygen Demand
CREF	Commerce Refuse to Energy Facility
DI	Deionized Water
ds	dry solid
DWLT	Distilled Water Leach Test
ECN	Netherlands Energy Research Center
GFAA	Graphite Furnace Atomic Adsorption
ICP	Inductively Coupled Plasma
IHTWM	Institute for Hazardous and Toxic Waste Management
LOI	Loss on Ignition
MLT	Monolithic Leach Test
NAA	Neutron Activation Analysis
NIST	National Institute of Standards (Bureau of Standards)
ORD	Office of Research and Development
PCDD	Polychlorinated dibeno-dioxin
PCDF	Polychlorinated dibenzo-furan
PSR	Particle Size Reduction
RO	Reverse Osmosis
RREL	Research and Development, Risk Reduction Engineering Lab
S/S	Solidification/Stabilization
TCLP	Toxicity Characteristic Leaching Procedure
TDS	Total Dissolved Solids or Total Dissolvable Solids
TOC	Total Organic Carbon
UCS	Unconfined Compressive Strength
USEPA	United States Environmental Protection Agency
WES	Waterways Experiment Station

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NOTE

This report is organized by chapter with the text of each chapter presented first, followed by the tables and finally the figures for the particular chapter. This format was used to improve clarity of presentation.

EVALUATION OF SOLIDIFICATION/STABILIZATION TREATMENT PROCESSES FOR MUNICIPAL WASTE COMBUSTION RESIDUES

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The EPA's Science Advisory Board (SAB) Committee conducted a review of the program design, "Review of the ORD Municipal Waste Combustion Ash Solidification/Stabilization Research Program",Report of the Municipal Waste Combustion Ash Subcommittee, EPA-SAB-EEC-90-010, March 1990.

1. INTRODUCTION

1.1 BACKGROUND ON ASH MANAGEMENT

The proper management of Municipal Waste Combustion (MWC) residues is necessary to ensure that the use of combustion as a solid waste management method is protective of human health and the environment. The U.S. Environmental Protection Agency (USEPA) has developed an extensive array of regulations dealing with air emissions from MWC's. Although recent Federal regulations for Municipal Solid Waste landfills (Oct. 9, 1991) address the disposal of MWC residues, regulations specific to ash disposal generally remain the responsibility of individual states. Recently, the U.S. Congress has considered legislation that would require the USEPA to develop comprehensive national ash disposal, treatment, and utilization standards. In order to have the scientific data available to support possible future regulatory choices, the USEPA has initiated a number of studies on MWC ash, ash disposal facilities, and ash management practices. This study will add to that data base.

Municipal waste combustors generate two principal types of residues: (i) bottom ash, including ash or slag retained on the combustion grates and grate siftings collected from the primary combustion chamber, and (ii) air pollution control (APC) residues, including fly ash and acid gas scrubber residue, collected from air pollution control devices. Relatively small quantities of residues produced by the periodic cleaning of boiler and economizer tubes may be mixed either with the APC residues or the bottom ash depending on specific facility design. Bottom ash and APC residues typically are generated at nominal mass ratios of 9:1, respectively. APC residues typically contain higher concentrations of soluble salts and specific metals, such as cadmium, lead, mercury and zinc, than bottom ash. In addition, the physical properties of bottom ash and APC residues are significantly different. Currently, most MWC facilities in the United States mix bottom ash with APC residues for collection and disposal. This mixed residue stream is referred to as "combined ash." Separate management of bottom ash and APC residues is under consideration in many jurisdictions. This is most frequently considered to examine the potential for utilization or reduced disposal requirements for bottom ash which constitutes the majority of the residue stream but contains substantially lower concentrations of regulated metals and soluble salts. Separate management of bottom ash may result in the requirement of revising or developing new management strategies for the APC residues.

1.2 PROGRAM GOALS

The overall goal of this program is to provide credible data that can be used to plan and implement MWC residue management strategies. Because of various options available for the

management of MWC residues, USEPA Office of Research and Development (ORD) is investigating the treatment and utilization of the residues in several phases. The investigation described in this report was carried out to provide a side-by-side comparison and evaluation of the effectiveness of S/S technologies as treatment processes for bottom ash, APC residues and combined ash. The program was designed to emphasize evaluation of treatment technologies, rather than determine how ash characteristics are affected by municipal waste combustor designs, operating conditions, and waste input. Therefore, the residues included in this study were obtained from only one source. Furthermore, residue processing focused primarily on treatment for disposal, potentially with reduced disposal facility design constraints, with a secondary emphasis on treatment for utilization.

In addition to S/S, evaluation of vitrification is being carried out in follow up studies. Results of these evaluations will be presented in subsequent reports. The specific objectives of this investigation were:

1. To define residue sampling, preparation and characterization protocols to permit bench and pilot-scale demonstrations of S/S treatment processes with representative residues;
2. To carry out MWC residue S/S treatment process demonstrations under carefully controlled and monitored conditions;
3. To compare the effects of S/S treatment processes on fundamental physical and chemical properties of MWC residues;
4. To compare the effects of S/S treatment processes on leaching properties of MWC residues through laboratory procedures which include both Toxicity Characteristics Leaching Procedure (TCLP) [US EPA, 1986] and tests that permit estimation of contaminant releases from these materials over a prolonged period of time under diverse environmental conditions; and,
5. To evaluate the physical durability of S/S treated MWC products during aggressive environmental cycling.

Supplemental issues which were investigated during this investigation included:

1. What are the limitations of analytical procedures described in "USEPA Test Methods for Evaluating Solid Waste, SW-846, 3rd edition" when applied to untreated and treated MWC residues?
2. What are effects of size reduction and subsample size on the chemical composition of MWC residues?

Dependent upon available resources, future studies will investigate additional treatment options and will emphasize the environmental effects of utilization alternatives such as road construction material, building blocks, marine construction applications, and other commercial products. The resulting information will assist USEPA in providing technical guidance on the application of treatment and utilization technologies for MWC residue management, including as alternatives to landfilling and if residue treatment is prudent prior to landfilling or utilization.

1.3 PROGRAM EXPERIMENTAL DESIGN

The experimental design of this program was a full factorial design for the evaluation of five solidification/stabilization processes for MWC residues. The two experimental factors were the residue type to be treated and the S/S process. The experimental levels within the residue type factor were (i) bottom ash, (ii) APC residue, and (iii) combined ash. The six experimental levels within the S/S process factors were (i) the untreated residue, (ii) the WES Control S/S process, and (iii - vi) the four selected vendor S/S processes. Thus, two experimental factors at three and six experimental levels respectively, resulted in the evaluation of eighteen experimental cases. Each experimental case was evaluated in triplicate.

The three residue types used in this study were obtained during a single composite sampling event from a typical state-of-the-art mass burn municipal waste combustor incorporating a lime slurry spray drier (wet-dry) acid gas scrubber and a fabric filter particulate removal system. Each bulk residue sample was dried, size reduced, screened and homogenized prior to use in this program. Thus all process demonstrations, testing and evaluations were carried out on pre-processed residues to facilitate laboratory scale testing and direct treatment effect comparisons.

Five S/S processes were evaluated. Four of five of the processes were proprietary vendor applications of four different generic S/S process categories. The generic S/S process categories represented by the selected vendors were:

- S/S with Portland cement and polymeric additives or other proprietary additives (Process 1);
- S/S with Portland cement , soluble silicates and dry carbonaceous material (Process 2);
- S/S with cement kiln dust and proprietary additives (Process 3),
- S/S through addition of soluble phosphates (Process 4).

The fifth process used Type 1 Portland cement only (WES Control Process) The Type 1 Portland cements only (WES Control Process) was selected to provide a baseline comparison of the treatment effects of Portland cement without vendor additives.

Each experiment was evaluated in triplicate. Each experimental case was analyzed for chemical composition and tested for physical properties and durability, and leaching characteristics using a series of testing procedures (e.g.,. bulk density, wet/dry, freeze/thaw, TCLP, availability leach test, monolithic leach test, etc.). Details of the testing procedures are provided in the Section 2.2 of this report.

Prior to the process demonstration, each vendor received approximately 50 lb samples of each residue type to facilitate preliminary process testing and formula optimization. The vendors were provided a list of test and program objectives that were to be used to evaluate their process. The vendors were not provided specific performance criteria to which they should treat the residues. This was left to their discretion. Vendor process optimization may have focused on minimizing contaminants release based on TCLP, concurrently with minimization of cost, and not on maximizing the physical properties of the treated residue. This was probably because the primary focus of the demonstrations was treatment for disposal with secondary focus on residue utilization.

Treatment of each residue type using S/S processes were carried out by each selected vendor at the Army Corp of Engineers, Waterways Experiment Station (WES) Vicksburg, MS. Mixing of residues with process additives was accomplished using a paddle mixer (Hobart Model K 455S). Each process demonstration replicate consisted of the vendor carrying out the specified process to produce approximately 100 lb of treated residue while EPA representatives and US Army Corp of Engineer personnel observed. Test specimens of the resulting treated residue for subsequent testing were prepare WES personnel.

Additional components of the experimental design of this program included:

1. Parallel analysis of untreated and treated residues for elemental composition using procedures currently recommended under USEPA protocols (Test Methods for Evaluation Solid Waste, SW-846, 3rd Ed.) and neutron activation analysis (NAA) to investigate the limitations of the recommended protocols when applied to MWC residues;
2. Chemical analysis of the bottom ash and combined ash during size reduction and screening to indicate potential bias in the evaluations resulting from the residue preparation and homogenization procedures;
3. Multiple chemical analysis of all three residue types to test for residue homogeneity following residue preparation and homogenization procedures;

4. Analysis of all three types of untreated residues in triplicate for polychlorinated dibenzo-dioxins and furans (PCDDs and PCDFs) subsequent to residue preparation and homogenization procedures; and,
5. Testing of untreated residues for pozzolanic activity using standardized test methods.

1.4 VENDOR AND PROCESS SELECTION

A general "Invitation for Participation" in this program was issued during Spring 1989. This solicitation included a description of the program, including the program objectives and the testing methods to be employed during process evaluations. The solicitation also detailed information to be included in vendor responses. Twenty one responses which were categorized as S/S, vitrification and other technologies were received. The technical advisory panel met during July 1989 to evaluate the responses. Responses were ranked on the following basis:

1. Vendor experience - 25%;
2. Technical details of the proposed process - 25%;
3. Potential for process commercialization - 25%;
4. Process innovativeness - 10%;
5. Projected process economics - 10%; and,
6. The residue quantity required for process demonstration - 5%

The initial focus of the program was decided to be on S/S because of deficiencies in the proposals based on other technologies. Subsequently, vendors with vitrification technologies have responded to the TAP comments and are participating in the program. Within the general S/S category, responses included the following technologies:

1. S/S with portland cement and polymeric or other proprietary additives;
2. S/S with portland cement, soluble silicates and dry carbonaceous material;
3. S/S with cement kiln dust and proprietary additives; and,
4. S/S through addition of soluble phosphates.

The top ranked vendor within each of the above S/S categories was selected for participation in the program. Vendors not selected through this selection procedure were provided the option of participating if they were willing to pay all evaluation costs.

At the completion of the project, the selected commercial vendors reviewed the draft report. After reviewing the report, the commercial vendors were given the option of identifying their company

name or remaining anonymous. Those selecting to identify their company name and the associated process evaluated in this study are listed below.

Enreco	Process 1
Chemfix	Process 2
Wheelabrator	Process 4

The remaining commercial vendor elected to remain anonymous.

1.5. PROGRAM ORGANIZATION

This project was carried out as part of the USEPA Municipal Waste Innovative Technology Evaluation (MITE) Program. The basis of vendor participation as part of the MITE program, is that the process development costs and the costs associated with demonstration of a process are paid for by the vendor. Costs associated with evaluation of the technology are paid for by USEPA. In this program, process demonstration costs were paid for by each vendors carrying out its process while costs associated with MWC residue sampling and preparation and evaluation of treated residues was paid for by USEPA.

The activities in this program were carried out through the cooperation of numerous individuals and organizations (Figure 1.1). The USEPA project officer was Mr. Carlton Wiles, Chief, Municipal Waste Technology Section, Office of Research and Development, Risk Reduction Engineering Laboratory, Cincinnati, Ohio (USEPA-RREL). USEPA-RREL developed the initial program design and objectives and was responsible for overall program oversight. An important component of the program was the Technical Advisory Panel (TAP) formed as a peer review body to provide technical input and evaluation of the program design and results. The TAP was comprised of a wide spectrum of representatives having a direct interest in MWC management in order to have as broad input and consensus as practical (Table 1.1). TAP members included representatives from (i) state and federal regulatory agencies, (ii) Environmental Defense Fund, (iii) MWC facility designers and operators, (iv) highway and construction development authorities, (v) academic faculty with expertise in residue management, and (vi) foreign research and development/regulatory agencies with experience in MWC residue management. The TAP was coordinated by Dr. John Liskowitz, Professor and Director of the Institute for Hazardous and Toxic Waste Management (IHTWM) at New Jersey Institute of Technology (NJIT). This program also was reviewed during the design phase by the USEPA Science Advisory Board [US EPA-SAB-EEC-90-010, 1990].

Program Technical coordinator was Dr. David S. Kosson, Associate Professor, Department of Chemical and Biochemical Engineering at Rutgers, The State University of New Jersey. Technical coordination included responsibility for detailed project management such as protocol development, vendor coordination, analytical laboratory coordination, data management, etc. The Project Engineer was

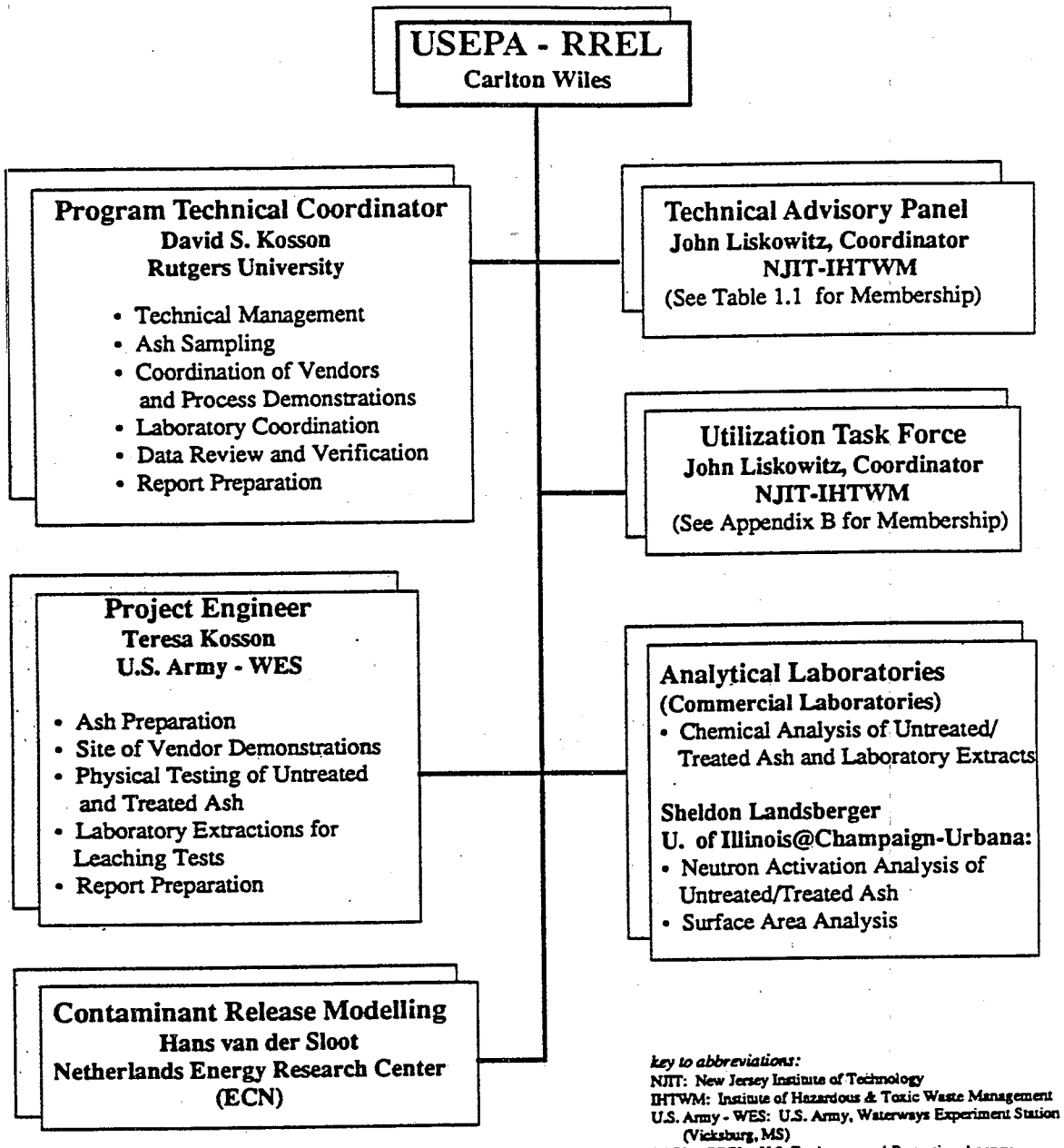
Ms. Teresa T. Kosson, Civil Engineer, U.S. Army Corps of Engineers, Waterways Experiment Station (WES), Vicksburg, MS. WES was the site for residue preparation, vendor demonstrations (except vitrification demonstrations), physical testing of untreated and treated residues, leaching test extractions and protocol development.

Mathematical modelling and estimation of diffusion parameters during leaching of untreated and treated residues was carried out under the direction of Dr. Hans van der Sloot at the Netherlands Energy Research Foundation, Petten, The Netherlands. Neutron activation analysis and BET surface area and pore structure analysis were carried out under the direction of Dr. Sheldon Landsberger, Associate Professor, Department of Nuclear Engineering, University of Illinois at Champaign-Urbana. Chemical analysis of untreated and treated residues, and leaching test extracts (except acid neutralization capacity extracts) was carried out by NUS Corporation (under the direction of Dr. Haia Roffman and Mr. Greg Zimmerman) and Versar Laboratories (under the direction of Ms. Janet Jaufman). Chemical analysis of acid neutralization capacity extracts was carried out at Rutgers University, Department of Chemical and Biochemical Engineering, by Mr. Ben Stuart.

Table 1.1. Technical Advisory Panel Members

Name	Title	Affiliation
Mr. Ken Afferton	Assistant Commissioner of Design and Right of Way	NJ Department of Transportation
Mr. John Cullinane	Engineer	U.S. Army Corp of Engineers Waterways Experiment Station
Mr. Jesse Connor	Senior Research Scientist, Stabilization	Chemical Waste Management, Inc.
Dr. Richard A. Denison	Senior Scientist	Environmental Defense Fund
Dr. T. Taylor Eighmy	Research Assistant Professor and Director, Environmental Research Group	University of New Hampshire
Mr. Keith Forrester, P.E.	WES-PHix Engineering Manager	Wheelabrator Environmental Systems Inc.
Ms. Judy L. Korn, P.E.	Civil Engineer	Los Angeles County Solid Waste Management Department
Dr. John W. Liskowitz	Distinguished Professor and Executive Director	NJIT, Institute for Hazardous and Toxic Waste Management
Dr. Parker D. Mathusa	Program Director	New York State Energy Research and Development Authority
Ms. Jocelyn Mullen	Consultant	Denver, Colorado
Dr. W. Clayton Ormsby	Supv. Research Chemist, Research Development and Technology	Federal Highway Administration (U.S. Department of Transportation)
Dr. Haia K. Roffman	Director of Risk Assessment and Toxicology	AWD Technologies, Inc.
Mr. Steve Sawell	Consultant	Compass Environmental Inc., Canada
Mr. David B. Sussman	Vice President, Environmental Affairs	Ogden Martin Systems, Inc.
Dr. Hans van der Sloot	Research Engineer	Netherlands Energy Research Foundation
Mr. Michael Winka	Environmental Specialist	State of New Jersey Department of Environmental Protection, Division of Solid Waste Management

ORGANIZATION OF USEPA PROGRAM FOR UTILIZATION OF MUNICIPAL WASTE COMBUSTOR RESIDUES



key to abbreviations:
NJIT: New Jersey Institute of Technology
IHTWM: Institute of Hazardous & Toxic Waste Management
U.S. Army - WES: U.S. Army, Waterways Experiment Station (Vicksburg, MS)
USEPA-RREL: U.S. Environmental Protection Agency, Risk Reduction Engineering Laboratory

2. SELECTION OF TESTING METHODS AND PROTOCOLS

2.1 CHEMICAL COMPOSITION OF UNTREATED RESIDUES

Process Additives and Treated Residues

All untreated residues, process additives and treated residues were analyzed for metals, anions and other parameters using traditional extraction/digestion techniques followed by either inductively coupled plasma (ICP), graphite furnace atomic absorption (GFAA) or ion chromatography analytical techniques, as appropriate. Wet chemical analyses were employed as appropriate. Metals and halogen analyses were also carried out using neutron activation analysis (NAA). NAA techniques were used where possible because of suspected limitations of the digestion/extraction techniques. Redundant analyses using both approaches were carried out for a limited number of species (e.g., Al, Cd, Cu, Cr, Zn, Cl, Br) to discern the suspected limitations. Each analysis was carried out once on each of three replicate samples from all untreated and treated residues. Additional analyses of untreated residues were carried out to determine the effects of particle size reduction on experimental results (see Chapter 3.3). Single analyses also were carried out on process additives. Analyses of process additives were limited because of assumed homogeneity of commercially prepared additives.

2.1.1 Sample Analysis by Digestion and Extraction Techniques

Untreated residues, process additives and treated residues were analyzed for chemical composition using methods recommended by USEPA testing protocols ("Test Methods for Evaluating Solid Wastes," SW-846, 3rd Ed., and "Methods for Chemical Analysis of Water and Wastes," EPA-600-79-020) and Standard Methods for the Examination of Water and Wastewater. Table 2.1 provides a summary of the analyses carried out and the analytical protocol employed.

2.1.2 Neutron Activation Analysis (NAA)

NAA was carried out on samples to assay for metals and halogens. NAA is a non-destructive analytical technique which permits direct analysis of true total concentrations. Table 2.2 presents the elements analyzed and the respective detection limits. Samples were prepared in triplicate and packaged in 1.5 ml polyethylene vials which were filled to the top to keep the same geometry consistent for counting procedures. All samples were analyzed using the 1.5 MW REIGA reactor at the University of Illinois. For short-lived NAA, a 10 second irradiation at a neutron flux of 4×12^{12} n cm^{-2} sec^{-1} (500 KW) followed by ten minute decay and a ten minute counting time was used to determine aluminum, calcium, chlorine, manganese, sodium and titanium. Silicon and indium were determined using short-lived

epithermal NAA with a flux of 2.1×10^{11} n cm^{-2} sec^{-1} at 500 KW for neutrons between 0.5 eV and 0.5 MeV and a flux of 4.5×10^{11} n cm^{-2} sec^{-1} at 500 KW for neutrons greater than 2.8 MeV. An irradiation time of 30 seconds followed by a decay time of eight minutes and a counting time of fifteen minutes was used. Cadmium, gold and molybdenum were determined employing medium-lived epithermal NAA and Compton suppression techniques. An irradiation of one hour at 1.5MW followed by a decay time of 6 - 8 days and a counting time of 3 hours was used. For antimony, arsenic, bromine, lanthanum, and samarium, thermal NAA was employed with an irradiation time of 1 hour at a flux of 3.3×10^{12} n cm^{-2} sec^{-1} at 1.5 MW, a decay time of 5 - 10 days and a counting time of one hour. The increased decay time was necessary to reduce the high activity levels from ^{82}Br and ^{24}Na radioisotopes. A further 3 - 4 week delay was used to determine cerium, cesium, chromium, cobalt, iron, mercury, rubidium, selenium, scandium, silver, tantalum, thorium and zinc.

An ORTEC high purity germanium detector was used for counting the gamma-ray spectra of the samples and standards. The detector, which has a 18% relative efficiency with an energy resolution of 1.9 keV for ^{60}Co photopeak at 1332 keV, is connected to an ORTEC ADCAM multichannel analyzer system. The Compton suppression system is comprised of a large NaI(Tl) detector surrounding the main germanium detector. The usual comparative method was used in the data evaluation employing in-house PC-based program codes. All deadtime (<30%) and pile-up corrections were done using a pulser.

Calibration and Quality Control was accomplished as follows:
Short-lived thermal and epithermal NAA calibration of the germanium detector was done using NIST 1632a trace elements in coal. Medium-lived and long-lived NAA calibration was performed using atomic absorption standard solutions. Quality control was assured by analyzing NIST 1633 fly ash. Results (Table 2.3) were in good agreement with the published NIST values or compilation values. All variations in flux were closely monitored with solid sulphur for short-lived NAA and NIST cobalt wire for medium and long-lived NAA.

2.2 PHYSICAL PROPERTIES ANALYSIS

Physical properties of the untreated and treated residues were analyzed to determine basic physical properties of the materials, curing rates and strength development, and the durability of the materials under simulated weathering conditions. The specific objectives of these analyses were to:

1. Obtain information to aid in the interpretation of chemical and leaching assays;
2. Estimate properties which affect waste disposal characteristics; or,

3. Provide preliminary information on treated residue stability during environmental exposure scenarios which may be encountered during disposal or utilization.

Performance criteria for evaluation of treated residues have not been established. The intent of gathering physical properties data was for comparison between untreated residues and the treatment processes. Specific performance goals were not provided to the Vendors for optimization of processes for demonstration. Table 2.4 summarizes the physical tests carried out, the objective of each test, and designates the physical forms of the treated residue for which the test was used. For classification purposes, untreated and treated residues were designated either as granular (e.g., "soil-like" or readily friable) or "monolithic" (e.g., formed a consolidated, stable mass). A material was classified as monolithic if after either vibratory or modified proctor compaction in unconfined compressive strength molds (2x2x2 in cubes) and subsequent curing, the material achieved a cone penetrometer index of greater than 100 psi. Samples which did not remain consolidated after curing or did not attain a cone penetrometer index of 100 psi were classified as granular. All untreated residues and one of the treated residues (Vendor 4, APC residue) were unconsolidated and classified as soil-like, while all other treated residues were monolithic. The subsequent paragraphs briefly describe the objective and method for each physical property analysis carried out.

2.2.1 Moisture Content

Moisture content of untreated and treated residues were carried out to determine initial and remaining free water in MWC residues before and after treatment and curing. All moisture reported moisture determinations were carried out on residue samples prepared specifically for use in this study and therefore are not representative of the "as disposed" characteristic of the residues. Moisture contents of residues as sampled from the MWC facility can best be estimated by the weight losses observed during the drying stage of residue preparation (see Section 3.1). Moisture content analyses were carried out at both 60°C and 105°C to differentiate loosely bound pore water within samples. The moisture content at 105°C of analytical samples was used to correct results of chemical analyses and leaching tests to a dry weight basis of the initial sample tested. Thus, moisture content was assayed on samples of each particle size (<9.5mm, <2mm and <300mm) employed for testing in this study. Moisture reported for bulk material is based on a particle size of less than 2 mm. Analyses were carried out according to the American Society of Testing and Materials (ASTM) Standard Method of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures (D 2261-80) [ASTM D2216, 1980)]. This method was conducted by drying ten grams of material at 60°C in a convection oven to constant weight. The same

sample is then dried to constant weight at 105°C. The moisture content of the sample was then calculated as the initial sample weight minus the dried sample weight divided by the initial sample weight.

2.2.2 Loss on Ignition (LOI)

LOI at 550°C of untreated and treated residues was carried out as an indicator of remaining uncombusted components within the residues and water of hydration. Although this is a standard analysis for MWC residues, data interpretation must be approached with caution. The change in mass of the sample may be the result of a combination of combustion of previously uncombusted components within the residues, loss of water of hydration or calcining (loss of carbonates). In general, the principal component of LOI on untreated bottom ash and combined ash is uncombusted components within the ash. The principal components of LOI in the untreated APC residue are uncombusted materials and to a lesser degree carbonates. A significant component of the LOI for treated residues may be either water of hydration or losses attributed to process additives. LOI analyses were carried out using a modification of APHA 16th Edition of Standard Methods, Method 209 D [Standard Methods, 1985]. This method was conducted on samples size reduced to less than 300 mm. Thirty grams were dried at 105°C to constant weight. The residue then was ignited at 550°C in a muffle furnace for 2 hours and the weight loss determined. Heating at 550°C was repeated until the weight loss was less than 4% of the previous weight loss. LOI is reported as the difference between the dry weight at 105°C and the residue weight after ignition at 550°C divided by the dry weight at 105°C.

2.2.3 Bulk Density

Bulk density was measured for monolithic treated residues to facilitate determination of volume changes resulting from treatment. Information on volume changes is useful for disposal or utilization calculations. Measurements for treated MWC residues were conducted by weighing a specimen of known volume. Two inch cubic test specimens were prepared and cured for 28 days in an environmental chamber at 98 percent relative humidity and 23°C. After 28 days of curing, the dimensions of the cube were measured and the weights of the test specimens obtained. Bulk density was calculated as the sample mass divided by the sample volume. Gross bulk density measurements of the untreated MWC residues were made to facilitate shipping estimates. Gross bulk density was determined by weighing the 55-gallon storage drums of the MWC residues, measuring the volume of the material in each drum and calculating the density by dividing the drum weight by the volume of the drum contents.

2.2.4 Modified Proctor Density

Modified Proctor Density was conducted to determine the density of granular untreated and treated residues after applying standard compaction conditions. This test also is useful for determining the optimum moisture content for maximum sample compaction and a resulting density for disposal or utilization calculations. Modified Proctor Density tests were carried out in accordance with ASTM Standard

Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10-lb Rammer and 18-in Drop (D 1557) [ASTM D155, 1978]. A series of at least six test specimens are prepared by adding water to yield moisture contents that vary by approximately 5 - 15 percent. The samples are compacted in a cylindrical mold (h = 4 in, d = 4 in) using a ten pound rammer with a vertical drop of 18 inches. Five equal layers are compacted with 25 blows per layer. Density determinations and moisture content determinations were made for each test specimen. The moisture content with the maximum density is the optimum moisture content.

2.2.5 Particle Size Distribution

Particle size distributions were determined on untreated residues after drying and screening to less than 2 inches and drying but prior to further particle size reduction. Particle size distributions also were determined on untreated residues after particle size reduction (less than 0.5 in) and homogenization, and on treated granular residues. Analyses were carried out using a modified version of ASTM Standard Practice for Dry Preparation of Soil Samples for Particle-Size Analysis and Determination for Soil Constants Dry Preparation (D 421) [ASTM D421, 1985]. Washing of samples during preparation was omitted because the residue had significant quantities of soluble salts which would have dissolved if washed as directed. A quantitative determination of the distribution of particle sizes larger than 75 micrometers was carried out by sieving samples and weighing the fractions retained on each sieve.

2.2.6 Permeability

Permeability was evaluated on treated residues to determine the relative contributions of convective contaminant transport, via percolation of water through the treated MWC residue, and diffusive transport of contaminants through the sample pore structure. Permeability was assayed using the "Falling Head Permeability Test" described in the U.S. Army Corp of Engineers Laboratory Soils Testing Manual EM 1110-1-1906,[U.S. Army Corp of Engineers, Engineer Manual, 1970]. A four inch cylindrical test specimen surrounded by a thin flexible rubber membrane was placed in a triaxial cell. Water flow at a pressure of 230 kPa was forced through the test specimen. The amount of water flowing through the test specimen was recorded periodically and hydraulic conductivity was calculated. Permeability then was calculated from the hydraulic conductivity.

2.2.7 Specific Surface Area and Porosity

Specific surface areas and pore-size distributions were estimated based on nitrogen gas adsorption isotherms. These properties were analyzed to aid in the interpretation of leaching release rate data through knowledge of untreated and treated residue pore structures. Nitrogen gas adsorption isotherms were determined for all materials with a volumetric vacuum apparatus (ASAP 2400, Micrometrics, Norcross, GA). All measurements were performed at the boiling point of liquid nitrogen (~77K) and utilized a molecular cross-sectional area of 0.162nm^2. The saturated equilibrium vapor

pressure of nitrogen (P_o) was measured every 90 minutes during the analysis. Prior to the determination of the adsorption isotherms, samples were out-gassed at 110°C under vacuum to remove any physisorbed species. Approximately 10 cm^3 of sample was used for each measurement.

The Brunauer Emmett-Teller (BET) [Brunauer, S. Emmett, et.a., 1938] gas adsorption method was used for the determination of surface area. A series of five points were measured over the P/P_o range of 0.05 - 0.25 on the N_2 adsorption isotherm for use in the BET calculations. The BET plots for all samples were linear over this range of P/P_o values. Mesopore volume and distributions were determined by the BJH [Barret, E.P. et al, 1951] calculation. Total pore volumes were determined at a P/P_o of 0.95. Samples were analyzed for micropore surface area and pore volume by the t-plot [Hallsey, G.J. 1948, and Hardins, W.D. et al., 1943] method.

2.2.8 Cone Penetrometer

Cone penetrometer measurements were used to determine the initial strength development of treated residues during curing. The cone index readings obtained are considered to be the index of the shearing resistance and are indicative of the capacity of the material to support movement of vehicular traffic. Cone penetrometer readings (cone index) were obtained in accordance with the Cone Penetrometer test method outlined in the "Materials Testing" U.S Army Technical Manual No.5-530 [U.S. Army Corp of Engineers, Technical Manual, 1989]. Cone penetrometer readings were obtained on prepared samples that had cured for 1 hour, 2 hours, 3 hours, 6 hours, 1 day, 2 days, and 3 days after the sarnple was prepared.

2.2.9 Unconfined Compressive Strength (UCS)

UCS is a direct measure of the strength required to fracture a monolithic test specimen and is indicative of the load bearing capacity. UCSs were determined using ASTM Compressive Strength of Hydraulic Cement Mortars Procedure (C 109) [ASTM C109, 1980)]. Laterally unconfined test specimens were axially loaded until failure using a Tinius Olsen Super L compression apparatus. UCS determinations were made on two inch cubed test specimens following 7, 14, 21 and 28 days of curing in an environmental chamber at 98 percent relative humidity and 23°C. A load was applied to the face of the test specimen that was in contact with the true plane surface of the mold. The UCS was calculated by dividing the measured force by the surface area to which it was applied.

2.2.10 Pozzolanic Activity

The pozzolanic activity index is indicative of the self-cementing potential of the material. This test was carried out on untreated residues (subsequent to residue preparation and homogenization) because of continuing debate in the literature over whether or not MWC residues exhibit significant pozzolanic activity. This debate is a consequence of field observations of apparent hardening and self-cementing

properties of combined ash [US EPA Draft, 1989]. Results of this testing were intended as an aid in interpretation of the treatment effects. These results may differ significantly from field observations of "as disposed" residues because of residue aging during shipping and preparation and the residue preparation and homogenization procedures.

Pozzolanic activity indices were determined using portland cement and lime. Pozzolanic Activity was determined using ASTM Pozzolanic Activity Index Determination (C 311) [ASTM C 311, 1980]. The pozzolanic activity index with portland cement procedure required preparation of a control mix of 26 percent type I portland cement and 73 percent sand. A test mix was prepared using 17 percent cement, 9 percent untreated MWC residue, and 73 percent sand. Water addition to the mixes varied as specified in the test method. Two inch cubic test specimens were prepared and cured for 1 day in a moist room at 23°C. The test specimens then were cured in a sealed mold at 55°C for six days. After curing, test specimens were cooled to room temperature and UCS was measured. The average UCS is reported as pozzolanic strength. The cubes were cured an additional 27 days in an air tight container. UCS determinations were made at the conclusion of the cure period. The pozzolanic activity index with portland cement was calculated by dividing the average compressive strength of the test mix cubes by the average compressive strength of the control mix cubes.

The pozzolanic activity index with lime procedure required preparation of a mix of approximately 75 percent sand, 8 percent lime, and 16 percent residue. Water addition was as specified in the test method.

2.2.11 Unconfined Compressive Strength After Immersion

The UCS after immersion assesses the effects of exposure to constant total immersion on the strength of a monolith. UCS after immersion measurements were carried out in accordance with a combination of ASTM Compressive Strength for Hydraulic Cement Mortars procedure (C109) [ASTM C109, 1980] and ASTM Standard Specification for Moisture Cabinets and Moist Rooms and Storage Cabinets of Testing Hydraulic Cements (C511) [ASTM C511, 1978]. Two inch cubic molds were prepared and cured for 28 days at 98 percent relative humidity and 23°C in an environmental chamber. Two test specimens were completely submerged in a dilute lime solution (0.10g lime /L distilled water) designed to mimic the natural pore water of wetted cement. After 24 hours of immersion, one test specimen was removed and the UCS was measured. The remaining test specimen was removed following 28 days of immersion and tested for UCS.

2.2.12 Freeze/Thaw Weathering

The Freeze/Thaw weathering test was selected to evaluate the effect of thermal cycling on the physical integrity and erosion of monolithic treated residues. The freeze/thaw weathering test was carried out in accordance with the draft ASTM C-666 and ASTM D560 [ASTM C666, 1980, ASTM D560, 1989]].

Resistance to rapid freeze/thaw. Cylindrical test specimens 4.5 cm diameter by 7.4 cm were subjected to twelve successive cycles of being submerged in water for 24 hours and then frozen at -20°C for 24 hours. Specimens serving as test controls were subjected to 24 hour cycles of being submerged in water followed by placement in an environmental chamber maintained at 20°C and 98 percent relative humidity. Common specimens served as test controls for both the freeze/thaw weathering test and the wet/dry weathering test. Results are reported as the cumulative percent weight loss, or percent eroded, of each test specimen.

2.2.13 Wet/Dry Weathering

The Wet/Dry weathering test was selected to evaluate the effect of varying moisture conditions on the physical integrity and erosion of monolithic treated residues. The Wet/Dry weathering test was carried out in accordance with the draft ASTM Wet/Dry Weathering Test [ASTM D559, 1989]. Cylindrical test specimens 4.5 cm diameter by 7.4 cm were subjected to twelve successive cycles of being submerged in water for twenty-four hours followed by drying in a nitrogen-purged oven for twenty-four hours at 60°C. Results are reported as the cumulative percent weight loss, or percent eroded, of each test specimen.

2.3 LEACHING TESTS SELECTED

The leaching properties tests were selected to provide a broad understanding of contaminant release under a variety of potential environmental conditions. Leaching tests were selected primarily to evaluate fundamental leaching properties rather than simulate specific environmental exposure scenarios. This approach permits the application of the leaching data obtained to the estimation of contaminant release over a wide variety of environmental conditions instead of only the particular exposure scenario tested. TCLP also was carried out on prepared untreated and treated residues for comparison purposes. Table 2.5 indicates the chemical analyses carried out on extracts obtained from each leach test. The leaching tests selected and the basis for selection of each test are discussed briefly in the following paragraphs.

Testing of untreated residues was carried out on samples after completion of the residue preparation and homogenization procedures (see Section 3.1) to permit comparison with the results obtained from treated residues. Therefore, results from testing of the untreated residues may not be indicative of the behavior of "as disposed" residues. which have not been mechanically processed. For example, removal of the non-crushable residue fractions greater than 9.5 mm may have resulted in increased concentrations of specific elements (e.g., lead and cadmium) in the processed residues used in this study.

Each vendor carried out its specific process one time on each of three aliquots of each type of preprocessed residue. All leach tests were carried out one time on prepared samples from each

process demonstration. Extracts were analyzed for the same list of metals and anions presented in Table 2.2. In addition, distilled water leach test (DWLT) extracts were analyzed for total dissolved solids (TDS), total organic carbon (TOC) and chemical oxygen demand (COD). Contaminant release results from all leach tests were back-calculated to mass released per mass of ash initially treated on a dry weight basis (e.g., mg/kg ash dry solid (ds)). This calculation corrects for variations in moisture content and dilution during processing and treatment. In addition, results of testing are presented in tabular form on the following bases:

1. Extract concentrations (mg/l or ug/l);
2. Release per unit mass of treated residue (mg/kg); and,
3. Release from treated residue per unit mass of untreated residue (mg/kg ash, ds).

2.3.1 Toxicity Characteristic Leaching Procedure (TCLP)

The TCLP was selected to be carried out to allow a comparison with a broad database of results obtained from testing of other materials. The TCLP was carried out in accordance with the method outlined in the 7 Nov 1986 Federal Register, Volume 40, Part 261 [US EPA, 1986]. This test is carried out on a sample crushed to less than 9.5 mm. Extraction is carried out at a 20:1 liquid to solid ratio using dilute acetic acid. The extraction solution is either buffered or unbuffered depending on the alkalinity of the material to be tested. Only a fixed quantity of acid is added for the extraction, and therefore the final pH of the extract is widely variable. Thus, metals concentrations observed in the extract often reflect the pH dependent solubility constraints of the specific element. The contaminant concentrations in the test leachate are compared with a published list of limits.

2.3.2 Availability Leach Test (ALT)

The Availability Leach Test was selected to assess the maximum amount of specific elements or species which could be released under an assumed "worst case" environmental scenario. This test was originally developed by the Netherlands Energy Research Center (ECN) [van der Sloot, H.A., et al, 1984]. The test is carried out on a sample crushed and size reduced to less than 300 µm. Two serial extractions are carried out, each at a 100:1 liquid to solid ratio, using distilled water. The pH is controlled to pH 7 during the first extraction and to pH 4 during the second extraction, using an automatic pH controller which delivers dilute nitric acid. Thus, the final extraction pH is controlled not the amount of acid used. The first and second extracts are combined for analysis. The very large liquid to solid ratio insures that the contaminant release is not constrained by its solubility at the final pH and the amount of contaminant extracted is the maximum amount which would be available at that pH. This test generally

extracts all species which are not tightly bound in a mineral or glassy matrix. The test does not provide information on the rate of contaminant release.

2.3.3 Distilled Water Leach Test (DWLT)

The Distilled Water Leach test (DWLT) was selected to assess the amount of specific elements or species which could be released under continued exposure to precipitation or nominally clean water percolation. Synthetic acid rain solutions were not selected as the extractant because the limited acidity of these extractants would have minimal impact on the extraction of untreated or treated MWC residues because of the residues' very high natural alkalinity. The DWLT was carried out in accordance with the sequential batch leaching test in the U.S. Army Corps of Engineers EL-87-9, US. [Environmental Laboratory, 1987]. The test is carried out on a sample crushed to less than 2.0 mm. Four serial extractions of the residue sample are carried out, each at a 10:1 liquid to solid ratio using distilled water as the extractant. No acid is added and no pH control is used. Thus, the natural buffering capacity of the material controls the final extract pH which was typically between pH 10 and 12 for the materials tested. The first and second extracts were combined for analysis, as were the third and fourth extracts. This test estimates the amount of contaminant released over prolonged exposure and provides limited information on the rate of contaminant release.

2.3.4 Acid Neutralization Capacity (ANC)

The Acid Neutralization Capacity (ANC) test was selected to assess the solubility of specific metals over a broad pH range [Test Methods for Solidified Waste Characterization, 1986]. The test was carried out on a sample crushed and size reduced to less than 300 μm Eleven separate extractions are carried out using separate size reduced subsamples at a liquid to solid ratio of 5:1. The low liquid to solid ratio results in the extraction being solubility constrained for some analytes. Each extraction receives a different amount of dilute nitric acid, varying from 0 to 12 meq/g dry untreated or treated residue, resulting in a broad range of final pHs. A titration curve also is obtained for each material tested.

2.3.5 Monolith Leach Test

The Monolith Leach Test was selected to assess the release rate of specific elements and species from untreated and treated MWC residues under diffusion controlled conditions. This would be the case under field conditions where the flow of infiltration or contacting water is predominantly around monolithic structures (e.g., blocks, other forms or low permeability compacted fill). The Monolith Leach Test was carried out based on a modification of the American Nuclear Society (ANS) American National Standard Measurement of the Leachability of Solidified Low-Level Radioactive Wastes by a Short-Term Test Procedure.(ANSI-16.1-1986). The test was carried out using a 4 cm diameter by 4 cm cylindrical, monolithic sample instead of the specified size test specimen. Treated residues were either vibrated or compacted using modified proctor compactive effort into PVC plastic molds immediately after being

treated. Samples were cured at 98% relative humidity and 20°C for 28 days prior to testing. Monolithic samples were extracted by contacting with 8.47 liters distilled water for up to 64 days. Contacting water was replaced with fresh distilled water at 1, 2, 4, 8, 16, 32 and 64 days and analyzed for metals and other species.

A new test method was developed for evaluation of compacted granular materials. Release rate data was obtained for untreated bottom ash and combined ash by compacting each ash at optimum moisture content, using modified proctor compactive effort, in 4 inch diameter by 4 inch cylindrical polyethylene molds. Specimens then were cured in the mold for 28 days at 24°C and 98 percent relative humidity. The exposed face of the specimen in each mold then was covered with a 22mm thick layer of 3mm diameter glass beads and contacted with 8.47 liters distilled water (Figure 2.1). Contacting water was replaced with fresh distilled water at 6 hours and 1, 2, 4, 8, 16 and 32 days.

Modeling of the release data in conjunction with the results of the availability leach test was used to determine effective diffusion coefficients, tortuosity and chemical retention factors for estimating long term species release rates (see Chapter 8).

2.4 DATA PRESENTATION

The complex series of chemical and leaching analyses carried out in this study resulted in the development of an extremely large data set. The complexity of data set was further increased because of the intrinsic variability associated with the MWC residues (e.g., typical standard deviations of approximately 20% of the mean value). Discussion and analysis of the data set in this report is facilitated to the greatest extent possible through the use of graphical representations. Standard data presentations employed include x-y data and line plots, bar graphs and box plots. The use of box plots permits observation of data variability and skewedness. Each box plot typically reflects all replicates within an observed variable. The central line within each shaded "box" represents the median of the data obtained for the particular element. The bottom and top of the shaded box represent the limits of the lower and upper fourths of the data set. Thus, the box encloses one quarter of the data points obtained below the median and one quarter of the data points obtained above the median. The lower and upper "whiskers" on each box represent the entire range of the data, excluding outliers. Data outliers are indicated by open circles. Outliers are defined as those data which are greater than or less than 1.5 times the distance between the lower and upper fourths from the median. For the cases where only three replicate analyses were obtained (e.g., Figures 2.3 and 2.4), the upper limit, central line and lower limit of the "box" each represent one of the replicate observations. This discussion is repeated for convenience prior to the first use of this data presentation format in Chapter 3.2.

2.5 SAMPLE PREPARATION FOR PHYSICAL, CHEMICAL AND LEACHING ANALYSIS

Particle size reduction (PSR) of test specimens was necessary for the leaching tests, several of the physical property tests, and chemical analysis of the solids. The particle size reductions required were less than 9.8 mm, less than 2mm, and less than 50 mesh (300mm). Table 2.6 briefly summarizes the required particle size for solids subjected to the leaching test and chemical analysis and the method of PSR. A summary of the PSR procedure is provided in Figure 2.2. First, a mortar and pestle was utilized to reduce the entire sample to <9.5mm. The mortar and pestle then were used to reduce the particle size to <2mm. The subsequent step employed a parallel plate, mechanical grinder (Bico Model UA 53) to reduce the material to pass through a 50 mesh (300 μm) screen.

A standardized criteria for particle size reduction was necessary to assure uniform sample preparation because many samples were not size reducible in entirety. The PSR criteria was as follows: 85% of the initial sample mass (~ 3kg) had to be reduced to less than 2mm. The 15% of initial sample mass that was non-reducible consisted of mainly ferrous particles and glass. Greater than 65% of the initial sample mass had to be reduced to less than 50 mesh. The materials rejected from the mechanical grinder were primarily unburnt paper material and ferrous particles.

During the PSR procedure, only ceramic surfaces (alumina) were allowed to contact the residue. To prevent cross-contamination between samples, the surfaces were cleaned and acid washed between uses according to the following sequence:

(i) scrub with soap and water to remove all apparent residue;
(ii) rinse with reverse osmosis (RO) water;
(iii) Soak in 2N HNO_3 for 4 hours;
(iv) rinse twice with RO water; and,
(v) rinse with distilled deionized water (DI).

A trial PSR procedure was carried out and the final rinse waters generated during cleaning were collected to verify that the cleaning procedure was adequate. The rinse waters were analyzed for lead, zinc, arsenic and cadmium. In all cases, the contaminant levels were below detection limits.

Bias resulting from the PSR protocol was evaluated by analyzing the greater than 2mm reject, less than 2 mm size reduced material and the less than 300 μm size reduced material from untreated bottom ash and combined ash. Metals were analyzed using SW-846 methods. Triplicate initial grab samples of each homogenized residue was size reduced according to the described protocol and the resulting fractions analyzed. Results for aluminum, cadmium, chromium copper, lead and zinc are presented in Figures 2.3 and 2.4. Slight enrichment of cadmium and zinc occurred in the analytical samples

as a result of rejection of the greater than 2 mm fraction, recognizing this fraction represented less than 15 percent of the initial residue sample. For example, the mean value for cadmium in the bottom ash less than 300 µm was 35 mg/kg while the estimate for the total mean, including correction for the reject fraction, was 30 mg/kg or a difference of 17% which was within the range of sampling and analysis variability. Similarly, the mean value for zinc in the bottom ash less than 300 µm fraction was 4730 mg/kg while the estimate for the total mean, including correction for the reject fraction, was 4120 mg/kg or a difference of 15%. Slight enrichment of copper (bottom ash only) and zinc also occurred in the analytical samples as a result of the size reduction to less than 300 µm.

Table 2.1. Analysis of residues and additives.

Parameter	Extraction Method	Analytical Method	Source	Detection Limits (mg/kg)
Arsenic	3050	7060	(1)	1.0
Cadmium	3050	7131	(1)	0.1
Mercury	3050	7471	(1)	0.1
Lead	3050	7421	(1)	0.5
Selenium	3050	7740	(1)	0.5
Silver	3050	6010	(1)	0.3
Aluminum	3050	6010	(1)	2.1
Boron	3050	6010	(1)	0.6
Barium	3050	6010	(1)	0.3
Beryllium	3050	6010	(1)	0.1
Chromium	3050	6010	(1)	0.9
Copper	3050	6010	(1)	0.9
Lithium	3050	6010	(1)	1.3
Nickel	3050	6010	(1)	1.8
Tin	3050	6010	(1)	5.5
Zinc	3050	6010	(1)	0.5
pH	—	9045	(1)	—
Anions by Ion Chromatography	—	EPA 300.1	(2)	—
Chloride	—	—	—	1.0
Fluoride	—	—	—	0.5
Nitrate	—	—	—	0.05
Nitrite	—	—	—	0.05
Orthophosphate	—	—	—	0.05
Sulfate	—	—	—	1.0

— = Not Applicable

Table 2.1. (continued)

Parameter	Extraction Method	Analytical Method	Source	Detection Limits (mg/kg)
Ammonia	—	EPA 350.3	(2)	0.15
COD	—	410.1 or 410.2	(3)	50 or 500
TOC	—	415.1 EPA CE-81-1 using combustion boat	(1)	100
Total Dissolved Solids	—	160.1	(2)	1,000
Dioxins/Furans	—	High resolution GC High resolution MS	—	—

—— = Not Applicable

Source:

1. "Test Methods for Evaluating Solid Wastes," SW846.
2. "Methods for Chemical Analysis of Water and Wastes," EPA-600-4-79-020.
3. "Standard Methods for the Examination of Water and Wastewater."

Table 2.2. Elements analyzed by NAA and analysis detection limits.

Element	Detection Limit (mg/kg)	
Aluminum	0.5	%
Antimony	0.2	ppm
Arsenic	0.5	ppm
Barium	20	ppm
Bromine	1	ppm
Cadmium	0.3	ppm
Calcium	300	ppm
Cesium	0.5	ppm
Chlorine	5	ppm
Chromium	1	ppm
Cobalt	0.2	ppm
Dysprosium	0.2	ppm
Gallium	5	ppm
Hafnium	0.2	ppm
Indium	0.1	ppm
Iodine	2	ppm
Iron	150	ppm
Potassium	600	ppm
Magnesium	0.1	%
Manganese	1	ppm
Molybdenum	2	ppm
Rubidium	2	ppm
Scandium	0.1	ppm
Selenium	0.2	ppm
Sodium	20	ppm
Silicon	1-3	%
Silver	2	ppm
Strontium	50	ppm
Thorium	0.2	ppm
Titanium	300	ppm
Uranium	1	ppm
Vanadium	5	ppm
Zinc	5	ppm

Note: all rare earths = less than 1 ppm

Table 2.3. Comparison of NAA values with NIST Certified Standard Reference Material 1633 Coal Fly Ash. All concentrations are in mg/kg unless specified otherwise, followed by the standard deviation.

Element	NAA Value	NIST Value*
Ag	0.44 ± 0.17	(0.30 ± 0.050)
Al	12.5 ± 2.0%	(12.6 ± 0.6%)
As	57.2 ± 0.7	61 ± 4
Au	6.4 ± 0.4 ng/g	(5.2 ± 2.6 ng/g)
Ba	2110 ± 170	(2665 ± 160)
Br	6.30 ± 0.35	(8.4 ± 2.2)
Ca	4.28 ± 0.27%	(4.65 ± 0.34%)
Cd	1.34 ± 0.20	(1.47 ± 0.15)
Ce	138 ± 2	(149 ± 10)
Cl	<200	(38 ± 13)
Co	37.3 ± 0.5	(38)
Cr	137 ± 2	131 ± 2
Cs	8.09 ± 0.15	(8.6 ± 0.6)
Fe	5.70 ± 0.08	(6.16 ± 0.27%)
Hg	<480 ng/g	140 ± 10 ng/g)
In	123 ± 13 ng/g	(220 ± 80 ng/g)
La	76 ± 1	(79 ± 5)
Mn	471 ± 8	493 ± 7
Mo	20.6 ± 0.3	(28 ± 5)
Na	3100 ± 110	(3130 ± 200)
Ni	99 ± 3	98 ± 3
Rb	106 ± 2	(112)
Sb	5.58 ± 0.08	(6.8 ± 0.7)
Sc	24.0 ± 0.3	(26 ± 3)
Se	9.8 ± 0.5	(9.4 ± 0.5)
Si	25.0 ± 1.0	(22.0 ± 1.0)
Sm	14.0 ± 0.2	(12.9 ± 1.5)
Sr	1230 ± 100	(1380 ± 100)
Ta	1.62 ± 0.04	(1.90 ± 0.14)
Th	21.9 ± 0.3	(24)
Ti	7100 ± 500	(7100 ± 500)
V	219 ± 6	214 ± 8
Zn	234 ± 4	210 ± 20

* Parentheses denote consensus values from Gladney et al. [National Bureau of Standards Report 260-111 U.S. Department of Commerce, 1987].

Table 2.4. Physical testing of untreated and treated MWC residues.

Analysis	Objective	Product Type Tested	Reference *
Basic Properties			
Moisture Content	Free water and correction of chemical analyses to dry weight basis	Monolithic or granular	ASTM D2261-80
Loss on Ignition	Residual organic matter, carbonate and water of hydration	Monolithic or granular	Standard Methods 209D
Bulk Density	Volume changes and transportation estimates	Monolithic or granular	See description in text
Particle Size Distribution	Gradation and classfication of granular material	granular only	ASTM D421
Permeability	Water percolation rates through treated residues	Monolithic or granular	U.S. Army Engineering Manual GM 1110-21906
Porosity and Surface Area	Internal pore structure and surface area for use with contaminant diffusion estimates	Monolithic or granular	BET Isotherm
Modified Proctor Density	Optimum moisture content for compaction and compacted density	granular only	ASTM D1557-78
Curing Rate and Strength Development			
Cone Penetrometer	Initial, short term strength development during curing	Monolithic or granular	U.S. Army Manual TMS-530/NAVFAC NO-330/AFM
Unconfined Compresive Strength (UCS)	Cure rate and long term strength development	Monolithic only	ASTM C-109
Pozzolanic Activity	Self-cementing properties of untreated residues	Granular only	ASTM C-311-80
Durability and Weathering Effects			
UCS after Immersion	Effect of weathering under saturated conditions on strength	Monolithic only	ASTM C-511-78 ASTM C-109
Freeze/Thaw Weathering	Product erosion during thermal cycling	Monolithic only	ASTM C-666-80
Wet/Dry Weathering	Product erosion during immersion cycling	Monolithic only	ASTM D559-89

* See Section 2.6 for Complete References

Table 2.5. Analysis of extracts from leaching tests.

Parameter	Analytical Method	Source	Detection Limits (µg/kg)
Arsenic	7060	(1)	10
Cadmium	7131	(1)	1
Mercury	7470	(1)	0.2
Lead	7421	(1)	5
Selenium	7740	(1)	5
Silver	6010	(1)	3
Aluminum	6010	(1)	21
Boron	6010	(1)	6
Barium	6010	(1)	3
Beryllium	6010	(1)	1
Calcium	6010	(1)	11
Cobalt	6010	(1)	7
Chromium	6010	(1)	9
Copper	6010	(1)	9
Iron	6010	(1)	7
Potassium	6010	(1)	2,000
Lithium	6010	(1)	13
Magnesium	6010	(1)	6
Manganese	6010	(1)	2
Molybdenum	6010	(1)	7
Sodium	6010	(1)	44
Nickel	6010	(1)	18
Antimony	6010	(1)	28
Silicon	6010	(1)	19
Strontium	6010	(1)	1
Tin	6010	(1)	55

Table 2.5. (continued)

Parameter	Analytical Method	Source	Detection Limits (µg/kg)
Titanium	6010	(1)	12
Vanadium	6010	(1)	4
Zinc	6010	(1)	5
pH	EPA 150.1	(2)	—
COD*	Low - EPA 410.2 Medium - EPA 410.1	(2)	5 mg/L 50 mg/L
TSS**	EPA 160.2	(2)	10 mg/L
TDS*	EPA 160.1	(2)	10 mg/L
TOC*	415.1 EPA 9060 using combustion boat	(1)	100
Anions by Ion Chromatography	EPA 300.1	(2)	—
Chloride	—	—	0.2 mg/L
Fluoride	—	—	0.1 mg/L
Nitrate	—	—	0.01 mg/L
Nitrite	—	—	0.01 mg/L
Orthophosphate	—	—	0.01 mg/L
Sulfate	—	—	0.2 mg/L

Source:

1. "Test Methods for Evaluating Solid Wastes," SW846, 3rd Edition.
2. "Methods for Chemical Analysis of Water and Wastes," EPA-600/4-79-020.

* Distilled Water Leach Test Only.

** Monolith Leach Test Only

Table 2.6. Particle size reductions required for chemical analysis and leaching tests.

Analysis	Particle Size Required
Solid Sample Analysis (untreated and treated residues)	
Metals	<300 µm
SW-846	<300 µm
Neutron Activation	<2 mm
COD, TOC	<2 mm
pH, TDS, NH_3, Anions,	<9.8 mm
Dioxins, Furans	
Leaching Tests	
TCLP	<9.8 mm
Distilled Water Leach Test	>2 mm
Availability Leach Test	<300 µm
Acid Neutralization Capacity Leach Test	<300 µm

Figure 2.1. Configuration of monolith extraction test for compacted granular materials.

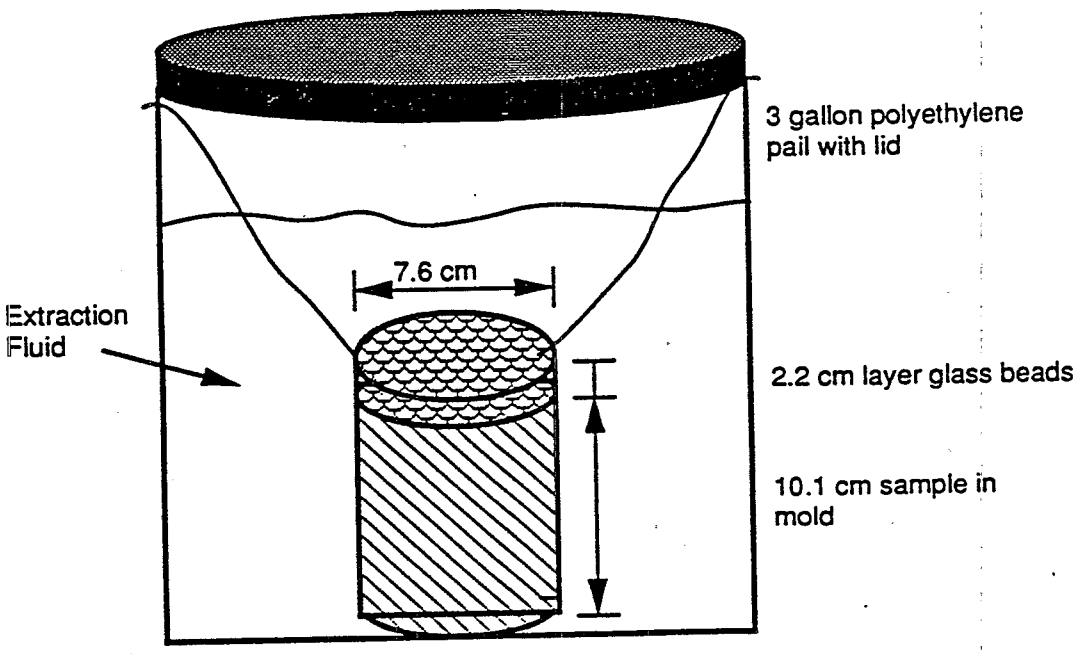


Figure 2.2. Sample preparation for leaching tests and analysis.

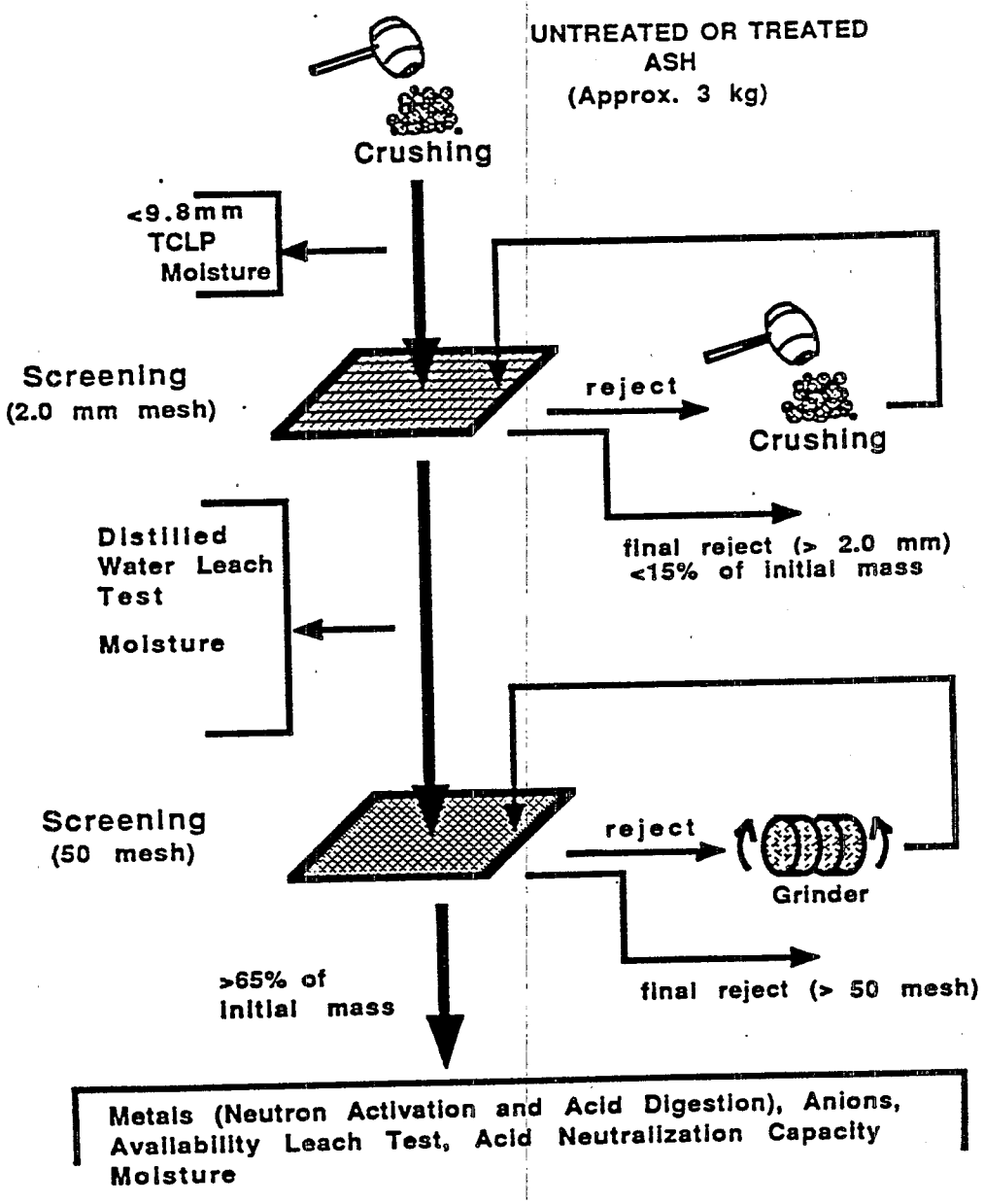
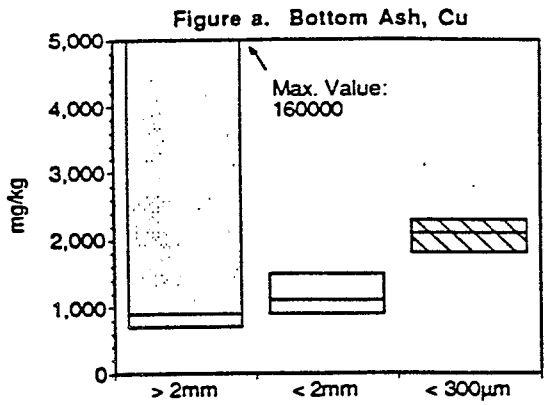
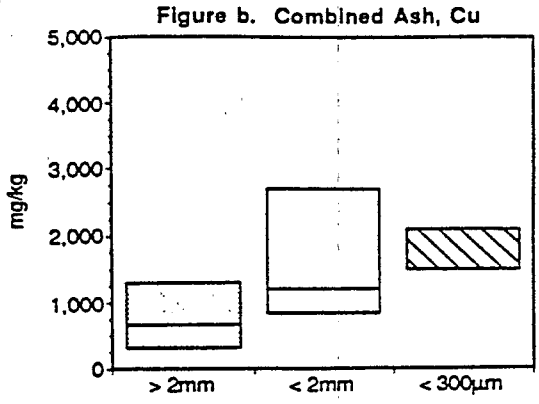
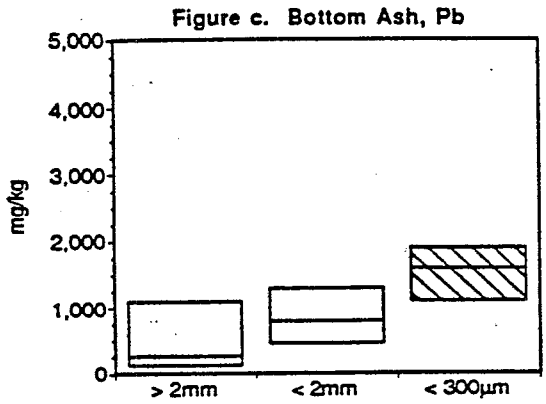
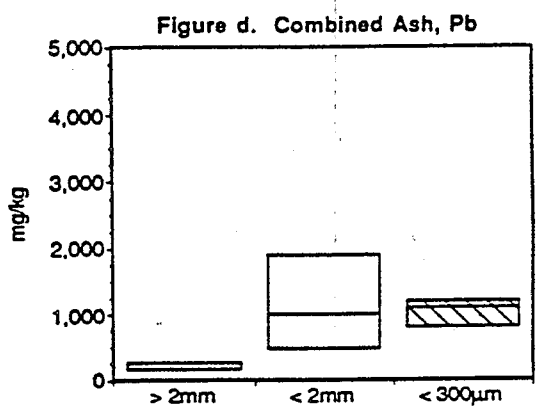


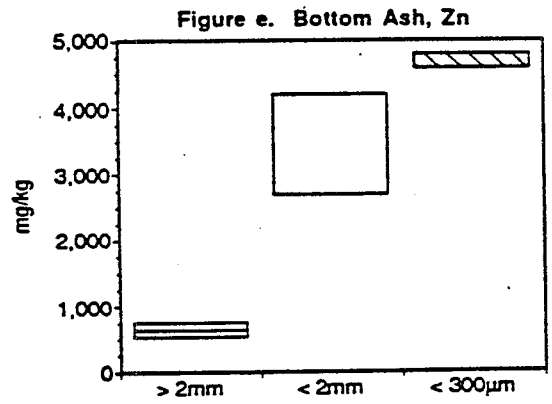
Figure 2.3. Effects of particle size reduction for analysis on total concentrations.











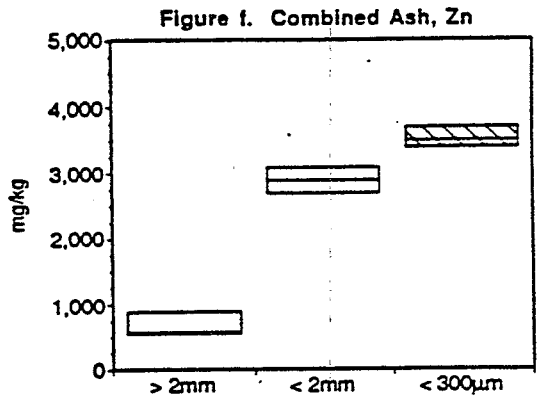
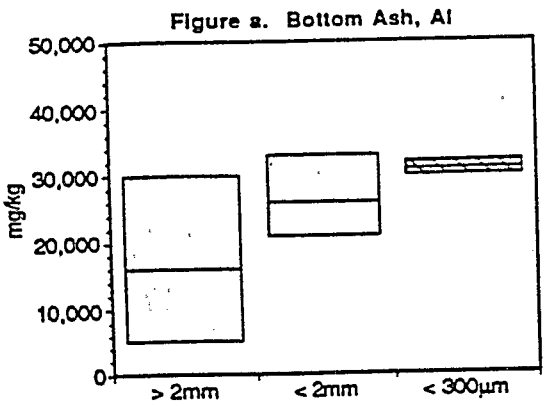
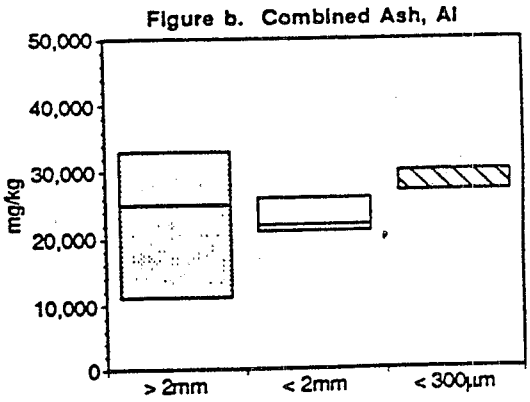
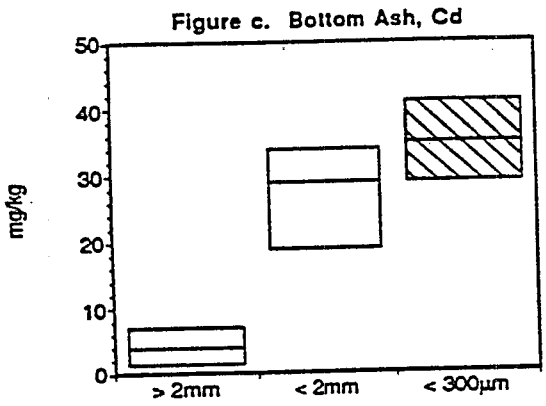
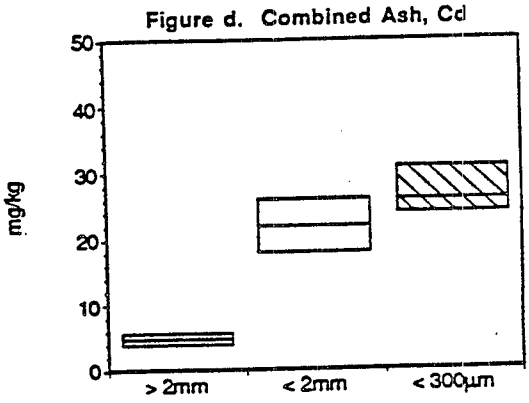


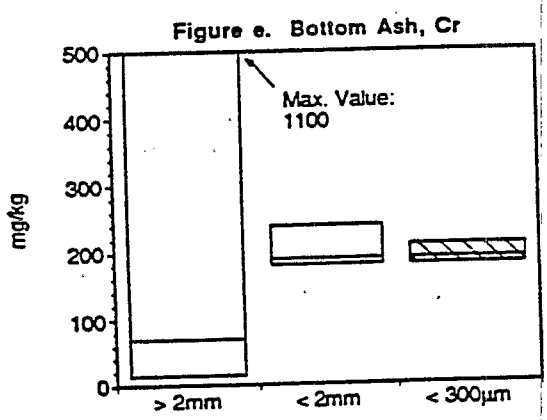
Figure 2.4. Effects of particle size reduction for analysis on total concentrations.

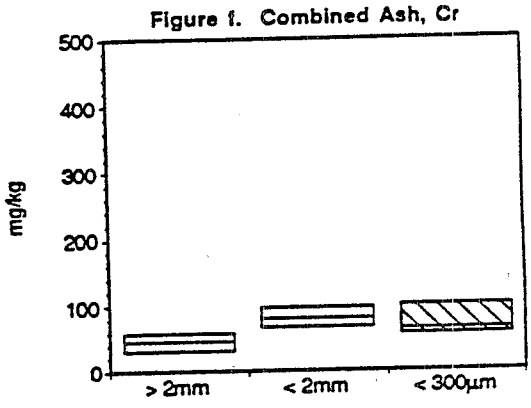












3. RESIDUE SAMPLING AND PREPARATION

3.1 RESIDUE SAMPLING AND PREPARATION

MWC residue used in this study was collected from a modern mass burn facility with a nominal capacity rating of 2,100 tons/day. The service area of the facility was primarily household waste with some commercial and non-hazardous industrial contributions. The MWC facility has the following process sequence: (i) primary combustor with movable grates, (ii) boiler and economizer, (iii) wet/dry scrubber (spray drier) with lime, and (iv) particulate recovery using baghouses (fabric filters). A generic flow diagram for this type of facility is presented in Figure 3.1. Residues from all of the boiler surfaces are included with the bottom ash stream, which is quenched after exiting from the primary combustor. This may have resulted in slightly elevated concentrations of cadmium and other volatile heavy metals in the bottom ash compared to MWC facilities where all of the boiler ash is included with the APC residue. APC residue generated is the mixed residuals from the acid gas scrubber and the baghouses. The facility includes three separate combustors and APC trains. APC residue from each process train is mixed with the bottom ash from that process train prior to combining the residues from all three process trains. Subsequent to combining the APC residue with the bottom ash from each process stream, residues from all three process trains are mixed, passed through a grizzly to remove materials larger than ten inches and trommelled to pass a 1.5 inch screen in conjunction with iron recovery. Combined ash passing the trommel then is accumulated in a bunker prior to disposal.

Bottom ash, APC residue, and combined ash were sampled in bulk (2-10 tons of each residue type) during two days of typical facility operation on September 14-16, 1989. Bottom ash and combined ash required processing prior to treatment demonstrations in order to facilitate laboratory scale testing. Figures 3.2 through 3.4 summarize MWC residue sampling and preparation. Bottom ash was sampled after quenching from the vibratory conveyor. Full stream cuts were taken at random intervals over approximately a six hour interval. Bottom ash was screened to pass a two inch square mesh during collection. Ash components that would not pass through the two inch mesh were weighed and discarded. The discarded materials were primarily large chunks of slug and metal, glass and wire tangles. A total of approximately 9,000 lbs (15,55-gallon drums) of screened bottom ash was collected.

APC residue was sampled through ports installed on the underside of the screw conveyor transporting the residue from each APC process train to the point of mixing with the bottom ash. The entire APC residue stream was collected from the facility's three APC trains at random intervals of several hours each during daytime operation over two days. The APC residue was screened during

collection to pass a 0.5 inch square mesh. Negligible amounts of material were collected on the screen and discarded. Approximately 4000 lbs (fifteen 55-gallon drums) of APC residue were collected.

Combined ash was collected from the storage bunker of material passing through the trommel. Bulk samples were randomly obtained from the storage pile using a front end loader. All combined ash sampled had been produced within two hours of sampling. Water appeared to be freely draining from the combined ash during sampling. Combined ash was screened to pass a two inch square mesh during collection. This was necessary because, although the combined ash nominally had passed through the 1.5 inch trommel, some particles had clumped together into larger aggregates. Reject material was weighed and discarded. Approximately 8,000 lbs (15, 55-gallon drums) of combined ash was sampled.

All MWC residues collected were placed in polyethylene lined 55-gallon drums, sealed and shipped to WES for further processing. After receipt at WES, bottom ash and combined ash had moisture contents ranging from 12-18 and 12-37 percent, respectively. Both bottom ash and combined ash were air dried at WES to a target of less than 10% moisture to facilitate subsequent particle size reduction, homogenization and storage for this experimental program. The MWC residue was spread into open air drying troughs (8 ft X 4 ft X 2 ft) to a depth of 18 inches. The residue in each trough was thoroughly mixed daily using heavy duty garden rakes and shovels to enhance air drying. At night and during inclement weather, the drying troughs were covered with portable roofs. During daylight hours, the troughs were left open to the atmosphere. The final moisture content of the bottom ash and combined ash was 11+/- 3 wt% and 10+/-2 wt%, respectively. Further reduction in residue moisture content was not possible because of the high humidity climate at WES (Mississippi). The APC residue collected had a moisture content of less than 5 percent and did not require drying.

Particle size reduction of bottom ash and combined ash to less than 0.5 inch was necessary to carry out the laboratory-scale process demonstrations. The residue was removed from the drying troughs and passed through one-half inch mesh screens. The material that passed the screen was collected in storage drums. The material retained on the screen was separated and classified as either crushable of non-crushable. The non-crushable materials were primarily metallic objects and were not used in this study. A commercial compaction hammer was used to reduce the particle size of the material classified as crushable. The material was spread into a one-half inch layer on a concrete surface and five passes with the compaction hammer were made over the surface of the residue. The material was re-sieved through the one-half inch screen. The material passing the screen was collected in storage drums and the material retained on the screen was recycled through the particle size reduction step. Residue not passing the one-half inch mesh screen after three cycles was classified non-crushable and not used in this study.

Homogenization of each residue type after particle size reduction was achieved using a 1,000 gallon, baffled tank as a mixing drum. Each residue was placed in the tank and mixed at a speed of 4 - 6 rotations per minute for five hours. The residue then was removed from the homogenization tank and placed in 55-gallon storage drums until testing.

3.2 UNTREATED RESIDUE HOMOGENEITY

Each untreated residue drum was sampled to assess the homogeneity of the resulting materials after residue size reduction to less than 0.5 in. A total of eleven grab samples of approximately 3 kg each were obtained for each residue type. Bottom ash and combined ash samples were further size reduced to less than 300 µm using the particle size reduction protocol described in Chapter 2.4. APC residue samples did not require further particle size reduction. Neutron activation analysis was carried out on random subsamples of the less than 300 µm size reduced samples to assay for metals and halogens.

Figures 3.5 through 3.7 present box plots of the results obtained from the neutron activation analyses. The use of box plots permits observation of data variability and skewedness. Each box plot presentation reflects all eleven replicates within a residue type. The central line within each shaded "box" represents the median of the data obtained for the particular element. The bottom and top of the shaded box represent the limits of the lower and upper fourths of the data set. Thus, the box encloses one quarter of the data points obtained below the median and one quarter of the data points obtained above the median. The lower and upper "whiskers" on each box represent the entire range of the data, excluding outliers. Data outliers are indicated by open circles. Outliers are defined as those data which are greater than or less than 1.5 times the distance between the lower and upper fourths from the median. Elements are ordered within figures according to increasing means and grouped by concentration orders of magnitude.

Manganese, copper, titanium, iron, aluminum and silicon in APC residue exhibited greater variability than other elements of similar concentration. These elements are present in APC residue primarily from physical entrainment of particles from the combustion zone in the combustion gases. Four of the eleven replicates for copper in APC residue were considered outliers. All halogen concentrations in APC residue had very limited variability. Iodine, cobalt, copper, chloride, iron and silicon in bottom ash had greater variability than other elements within the material of similar concentration. Those elements in combined ash which have significant concentration in APC residue exhibited greater variability in the combined ash. These elements include iodine, cadmium, bromine, zinc and calcium. Iron and zinc also exhibited greater variability in combined ash than other elements of similar concentration. This probably was the result of elemental metal being present in the municipal solid waste that was combusted.

Figure 3.1. Typical mass burn waste combustion facility schematic [L.A. County Sanitation].

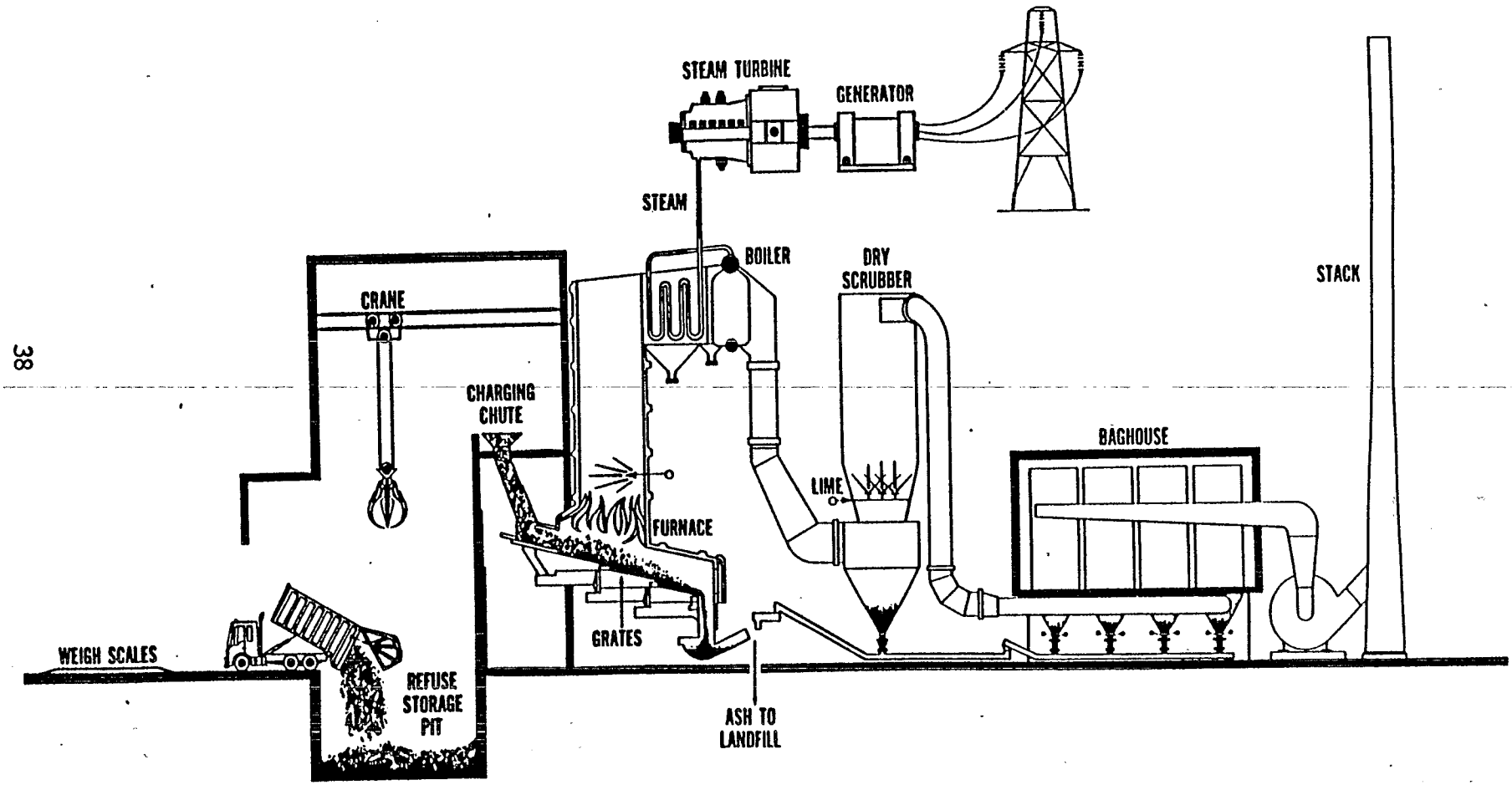


Figure 3.2. Bottom ash preparation.

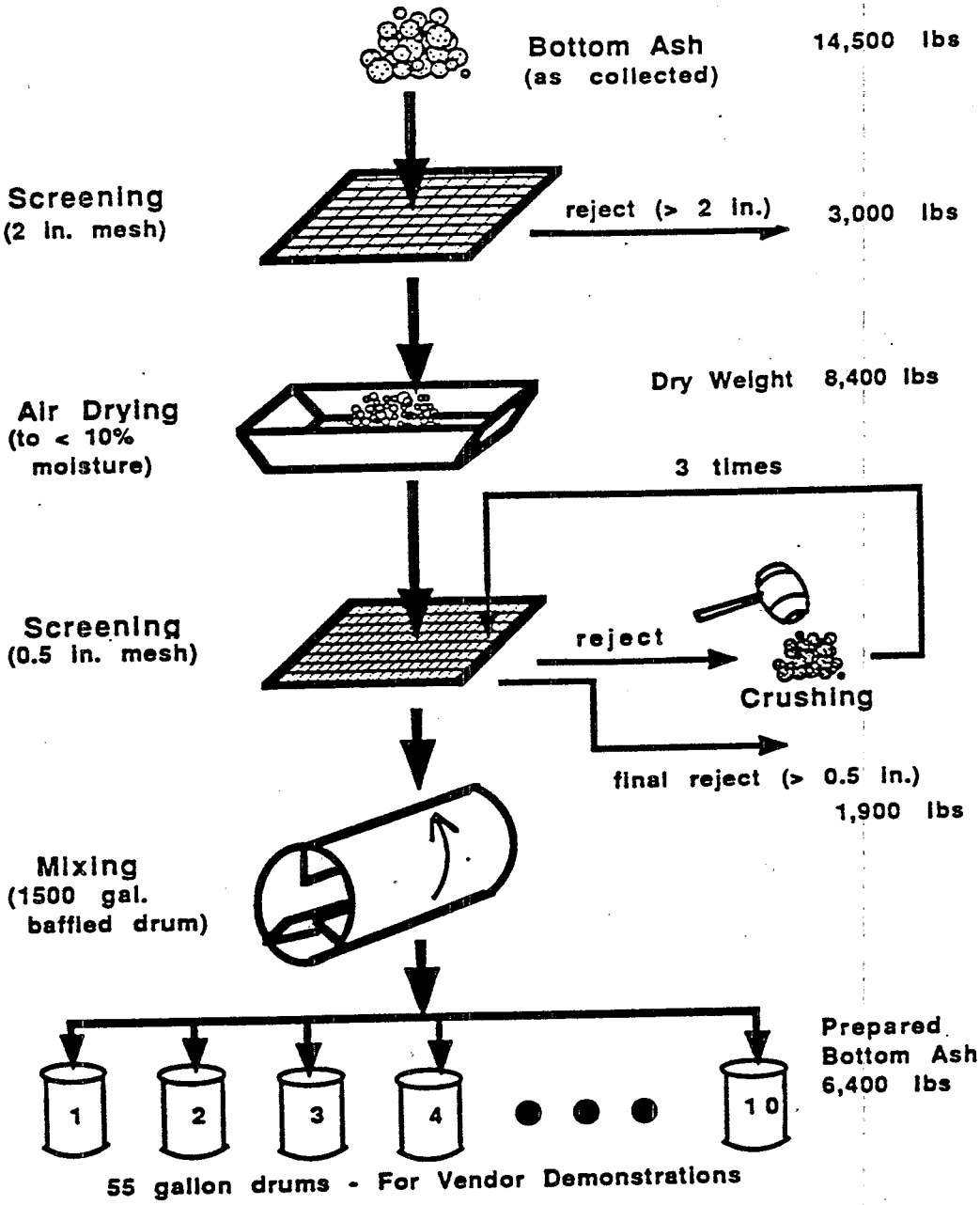


Figure 3.3. Combined ash preparation.

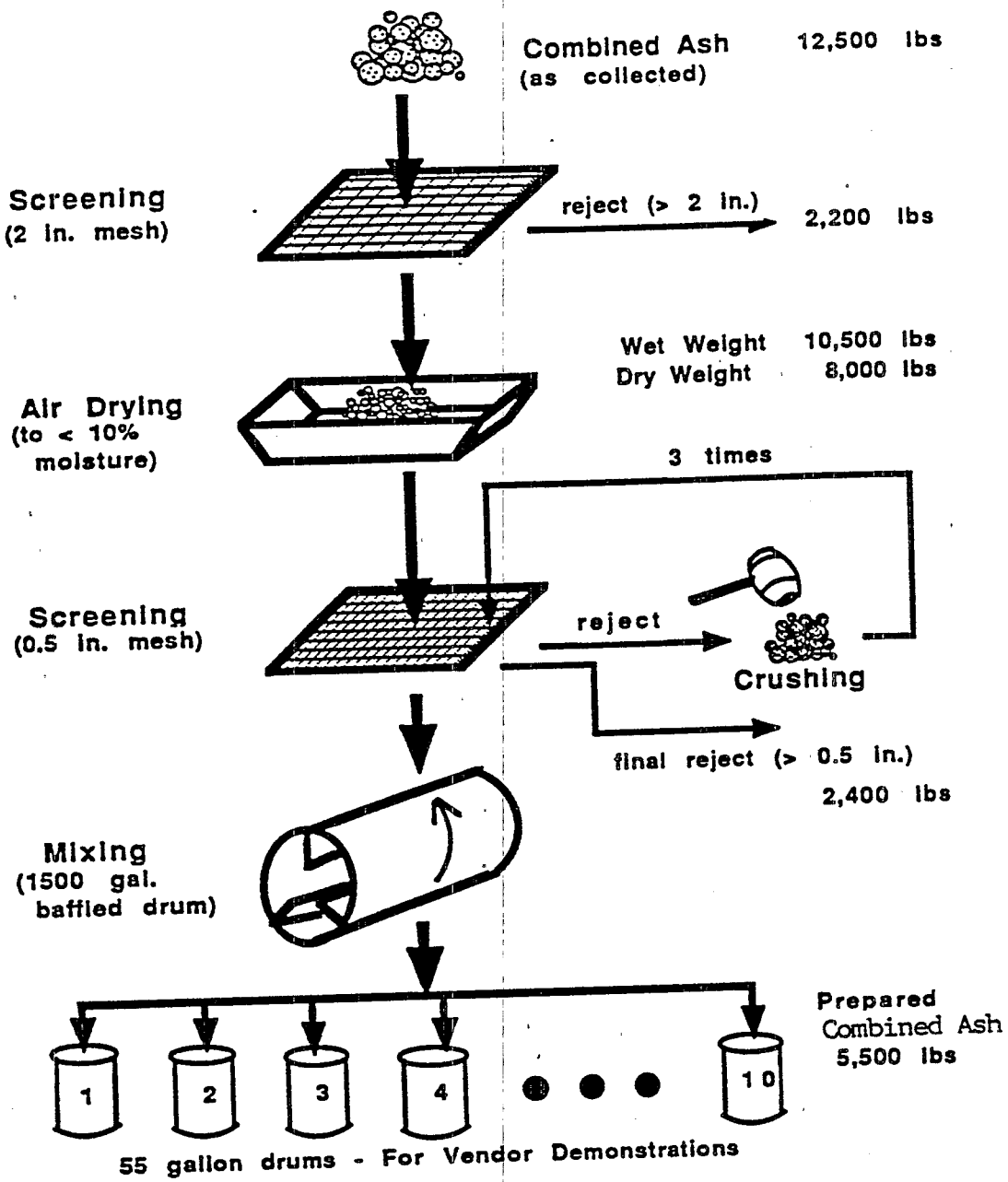


Figure 3.4. APC residue preparation.

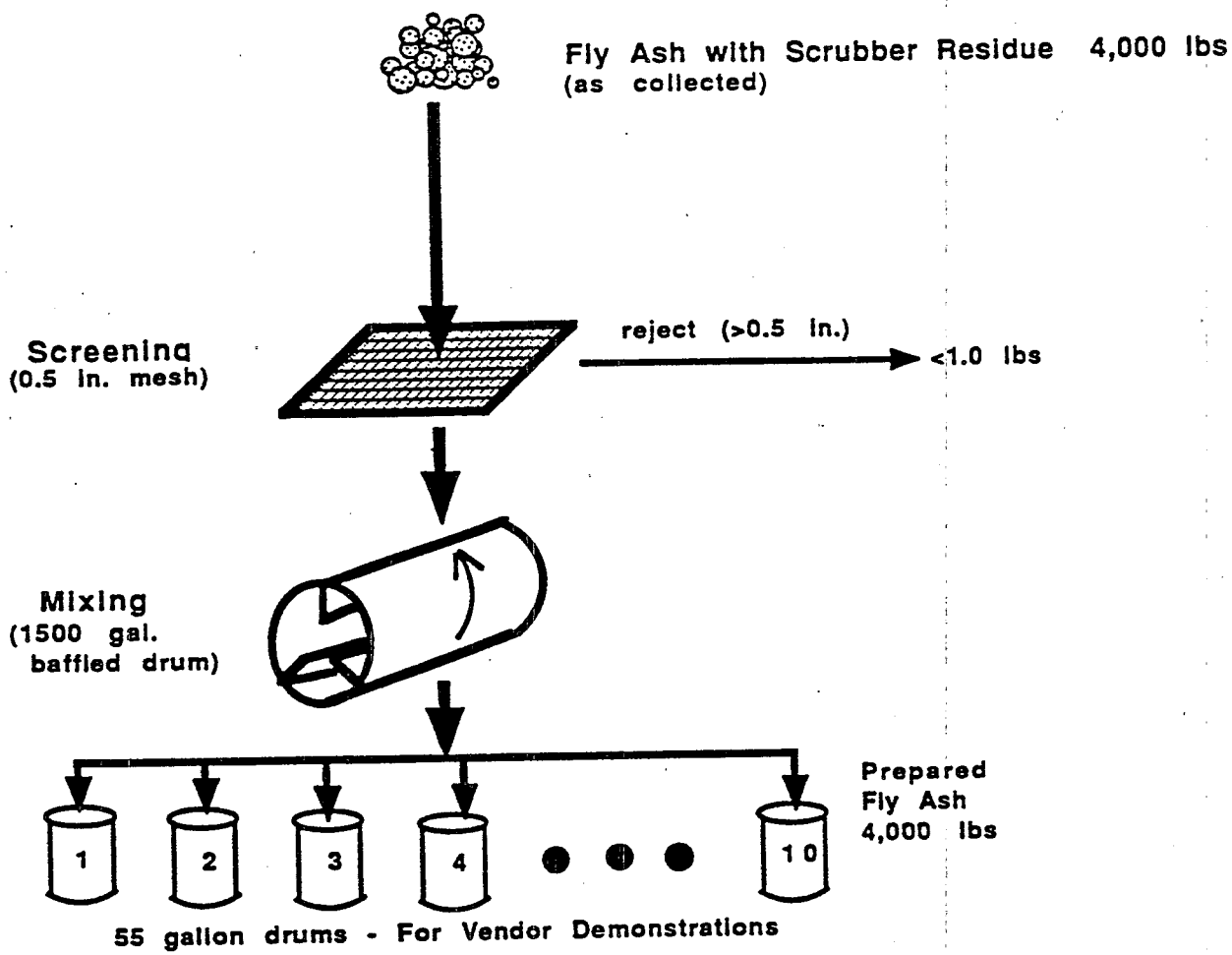


Figure 3:5. Box plot of neutron activation analysis results for homogenized, untreated APC residue (<300 µm, ground; 11 replicates).

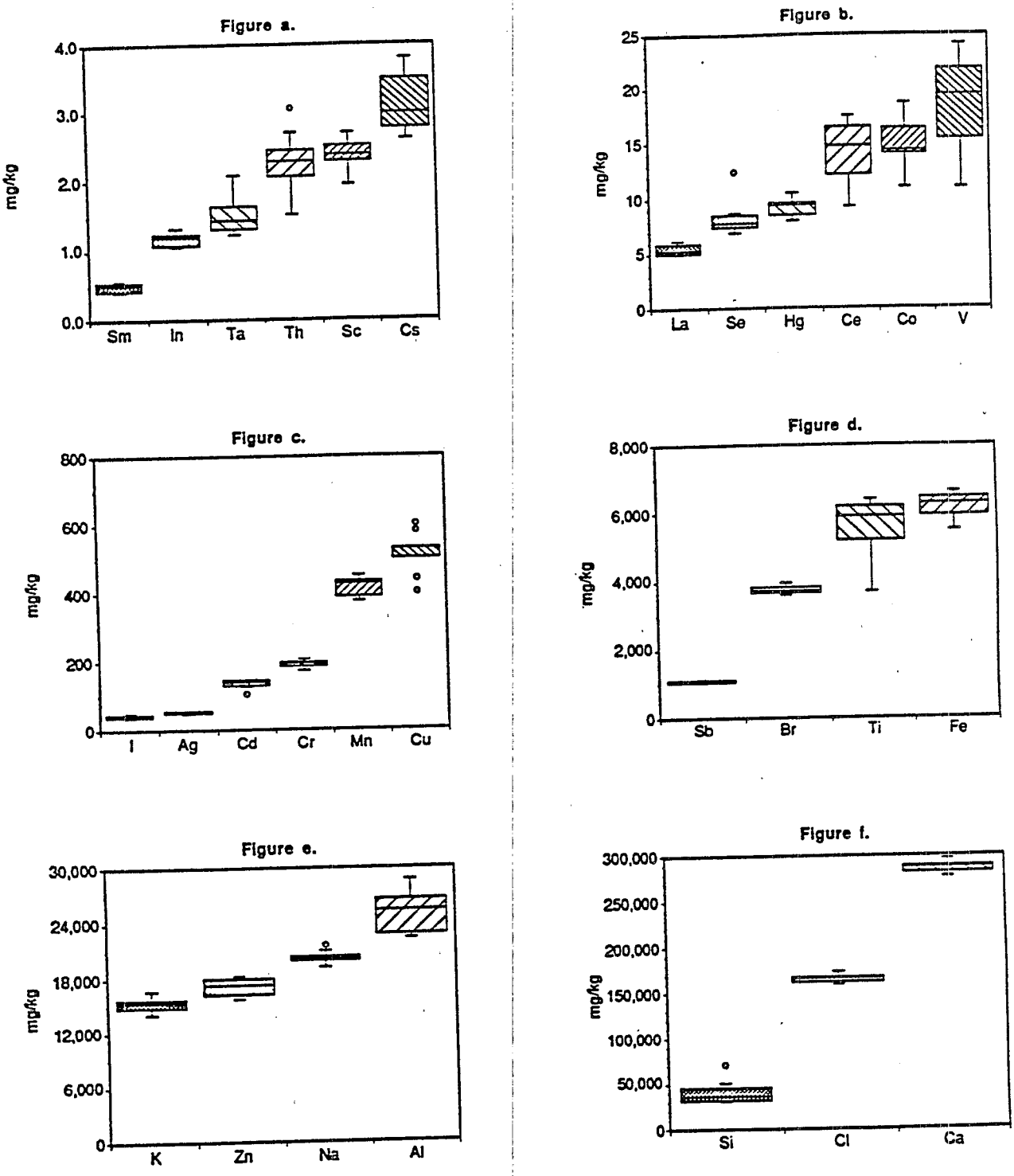
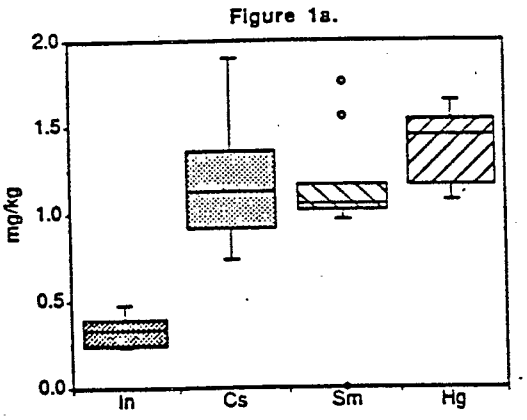
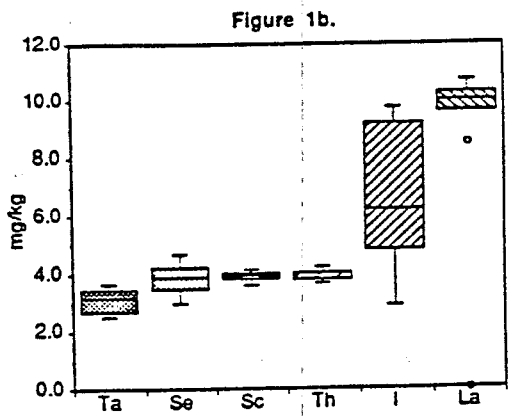
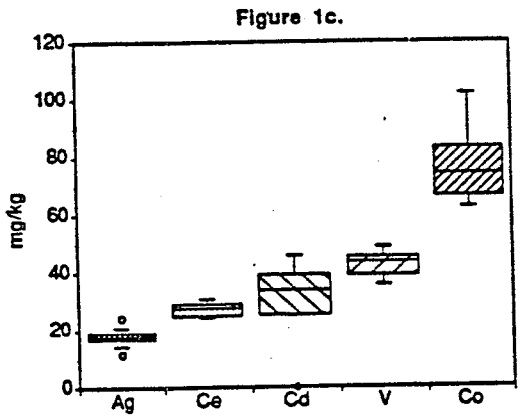
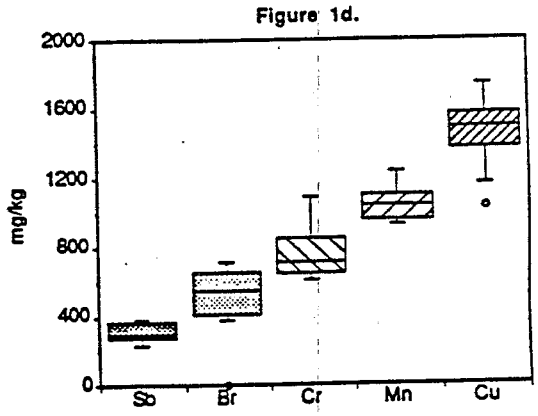


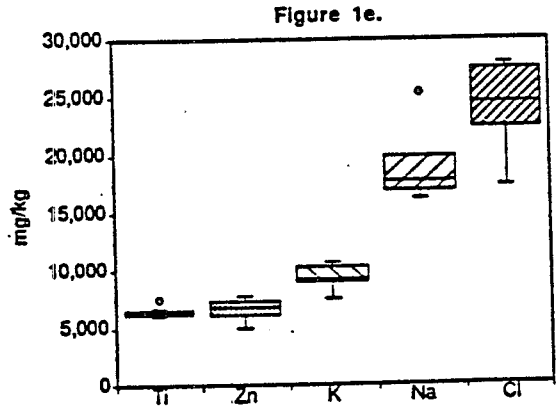
Figure 3.6. Box plot of neutron activation analysis results for homogenized, untreated bottom ash (<300 µm, ground; 11 replicates).











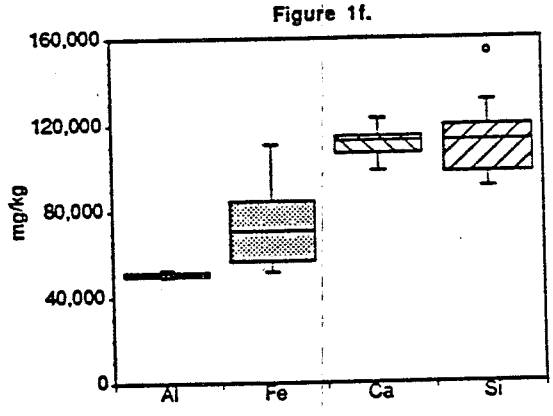
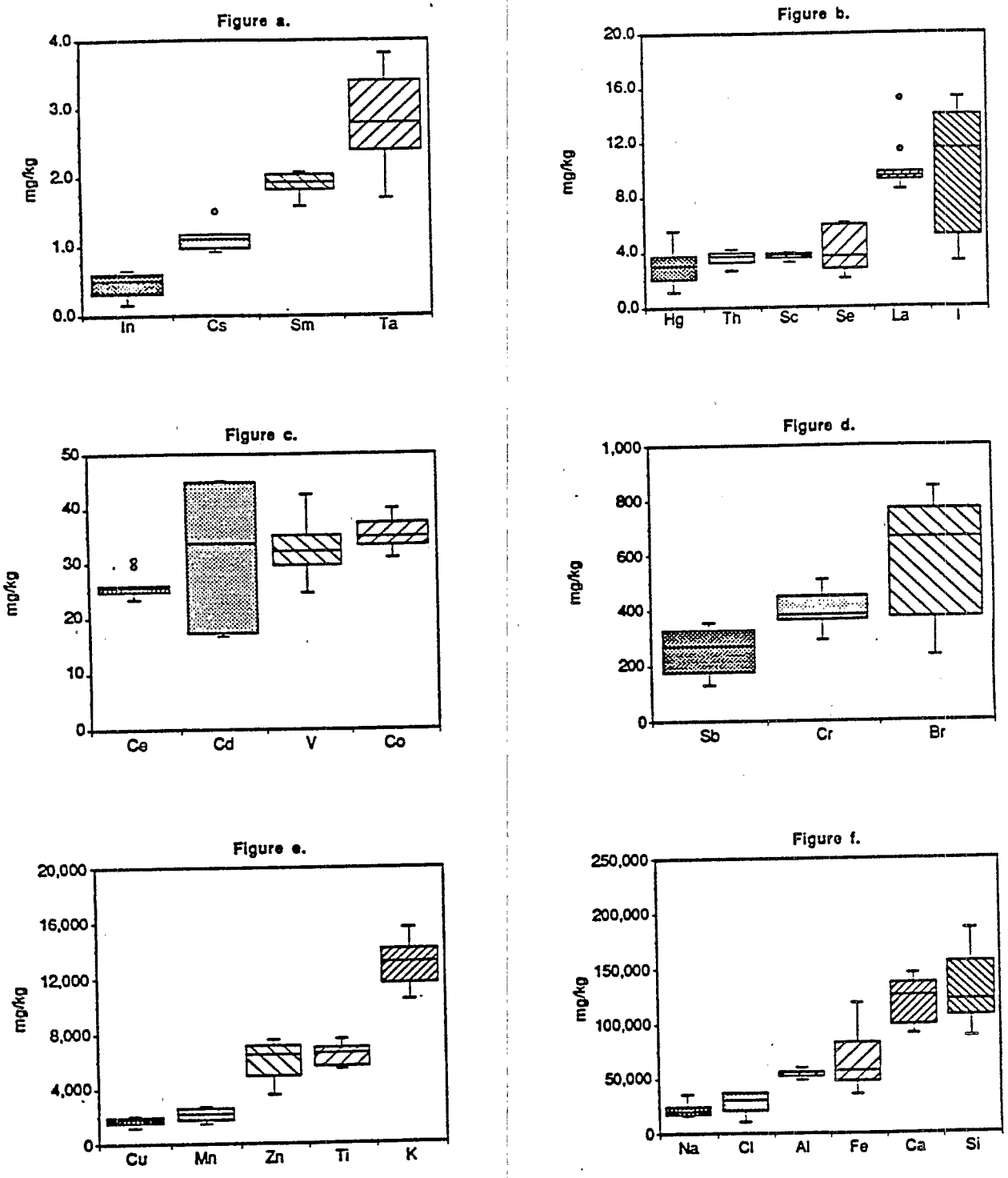


Figure 3.7. Box plot of neutron activation analysis results for homogenized, untreated combined ash (<300 µm, ground; 11 replicates).



4. PROCESS DESCRIPTIONS AND ECONOMICS

4.1 PROCESS DESCRIPTIONS

Five S/S treatment processes were selected for inclusion in this study. Treatment processes were selected to be representative of general classes of S/S process chemistries. The specific process carried out for demonstration was developed by the vendors selected to participate in this study. Only the vendors who requested to be identified are indicated in this report (see Section 1.4). The processes evaluated are summarized as follows:

Process 1 - This process used Portland cement (type I) and polymeric absorbents to carry out S/S. Vendor supplied information indicated that this process would produce a soil-like product and that approximately 1.7 tons of product would be produced per ton of ash treated. The vendor supplied information also indicated that MWC residue treatment costs would be approximately $30-40 per ton of residue treated.

Process 2 - This process used a combination of proprietary additives to carry our S/S. The process employed is of a general class of S/S processes which employ portland cement, dry carbonaceous material and additional soluble silicate reagents to immobilize inorganic contaminants. Vendor supplied information indicated that the treated materials would be soil-like and that a 20-30% volume increase would occur as a result of treatment.

Process 3 - This process used a waste pozzolan to carry out S/S. A wastewater (municipal landfill leachate from a landfill with no record of industrial waste disposal) was used in the process instead of potable water. This process had previously been carried out at full-scale with MWC residues from a different MWC facility than the one used in this study. Projected treatment cost information was proprietary.

Process 4 - This process patented by Wheelabrator Environmental Systems as WES-PHix used proprietary additives to react soluble phosphates with the MWC residues. This process did not include the addition of a traditional pozzolan or Portland cement. Vendor supplied information indicated that this process would produce a soil-like product and that minimal increases in residue volume or weight would occur. Modifications of this process have been implemented at full-scale at various MWC facilities.

WES Control - This process was used as a positive experimental control. The process employed Portland Cement, Type I only as a process additive to produce a monolith. The process was developed

based on varying cement and water additions until a nominal cone penetrometer greater than 100 psi and minimal leaching based on TCLP results was achieved.

The relative amounts of process additives and water additions were varied by vendor according to residue type. Vendors were supplied with test quantities of each residue type prior to process demonstrations. However, process vendors indicated that their processes were optimized around only one or a few of the evaluation tests to be carried out. Therefore, it is unlikely that any of the above processes were truly optimized for performance based on all of the evaluation parameters.

A summary of the relative quantities of MWC residue, process additives and water additions are provided for each process and residue type in Table 4.1. All process additives are lumped together for reporting purposes to preserve proprietary process information. The resulting process dilution factors, or the relative increase in MWC residue weight resulting from treatment, is presented in Table 4.2.

4.2. PROCESS ECONOMICS FOR SOLIDIFICATION/STABILIZATION OF MWC RESIDUES

A cost estimate for implementation of MWC residue treatment must include many factors, several of which will be based on unique local conditions at individual MWC facilities. The following is a summary and brief discussion of factors which ultimately would influence treatment costs:

a. Treatment Specifications - Treatment performance typically will be based on regulatory requirements or desired treated residue characteristics in the final disposal or utilization scenario. Such considerations will govern treatment process selection and operation. For example, at the Commerce Refuse to Energy Facility (CREF) located in Commerce, CA, treatment process selection was based on meeting leaching test requirements under the California Waste Extraction Test (WET) and also on potential for utilization of the treated residue as a landfill road construction material [ANS 16.1, 1986]. Thus, treatment decisions at CREF were based on both leaching test performance under a local leaching test and structural properties of the treated material. Currently, there are no Federal USEPA guidelines for MWC residue treatment or treatment process performance, but several state and local jurisdictions have implemented MWC residue guidelines which are highly variable from jurisdiction to jurisdiction. Where treatment is required, these state and local guidelines will determine the degree of treatment which is necessary.
b. Treatment Process Additives - Non-proprietary and proprietary process additives may contribute significantly to treatment costs depending on the nature, local availability and process loadings of specific treatment additives. Process additives also may substantially impact treatment costs by increasing the volume or weight of the residues requiring transportation and disposal.

c. Treatment Process Design - Different S/S processes may require varied preparation, feed rates, curing and other processing conditions.

d. Process Licensing Agreements - Use of proprietary treatment processes may include process licensing fees.

e. MWC Facility Improvements - Capital improvements will likely be necessary at any MWC facility implementing a residue treatment process. Capital improvements will mainly involve materials handling equipment, such as conveyors, screens, reagent storage tanks, particle size control, drying, storage silos, mixing equipment, casting forms, piping, etc.

f. Transportation to Disposal or Utilization Location - Where treatment process results in significantly increased quantities, an increase in overall treatment costs will occur if long distance transportation of the treated residues is required and/or disposal costs are high. This increase may heavily influence the selection of a treatment process.

g. Process Operation and Maintenance - Personnel, utilities and maintenance will be required to support a residue management process. The net amount expended for residue management may increase or decrease depending on the specific requirements of the treatment process relative to untreated residue management.

The very site specific nature of treatment process implementation and the proprietary nature of some of the treatment processes included in this study prevented the incorporation of comparative cost estimates in this study. However, as an example only of costs associated with S/S treatment of MWC residues, a summary of cost estimates for a treatment process implemented at the CREF is presented here [County Sanitation Districts of L.A. County, 1991, Korn, J.L. and Huitric, R.L., 1992]. It should be noted that actual costs associated with other processes could be significantly lower or higher and should be determined on a case by case basis.

The CREF is a mass burn MWC facility incorporating ammonia injection for NOx control, a lime slurry spray drier for acid gas scrubbing and fabric filter baghouses for particulate control. A schematic flow diagram of the CREF is provided in Figure 4.1. CREF operation results in the generation of approximately 35,000 tons per year of combined ash. A pilot study was carried out at CREF to evaluate S/S treatment options for the facility. The process selected for implementation includes the following process steps:

1. Separate collection of APC residue from bottom ash;
2. Separate silo storage of APC residue and Portland cement;
3. Screening of bottom ash to less than 1 inch nominal particle size;
4. Separation of ferrous materials from oversized (>1 inch) bottom ash fraction;

5. Mixing of APC residue, bottom ash, Portland cement and water batchwise in a standard rotating drum concrete mixing truck;
6. Forming of S/S residue blocks in modified 20 cubic yard roll-off containers at the MWC facility;
7. Setting of S/S residue blocks at ambient conditions for one to two days; and,
8. Transporting of treated residues to a local landfill (approximately 10 miles from the MWC facility) where the residues may be used as a landfill road construction material.

A self-cleaning vibratory finger screen was selected for bottom ash screening. Portland type II cement is added at between 8 and 12% by weight of the residue treated and moisture content of the mix is targeted at 25%. The ratio of APC residue to screened wet bottom ash incorporated in the treatment mixture is 15:70. Approximately 15% of the total residue stream is greater than 1 inch size and is not included in the treatment process. Ferrous scrap is recovered from the material greater than 1 inch in size and the remainder of it is landfilled directly.

Summaries of capital costs and annual operating costs along with additional specific assumptions are provided in Tables 4.3 through 4.5. Including an additional landfill tipping fee for disposal of the additional treated residue weight and annual debt service, the total treatment costs can be summarized as follows:

Annual operating cost/ton ash	$16.16
Landfill tipping fee/ton treated ash	$14.30
Debt service /ton ash	$8.74
Total ash management cost/ton ash	$39.20
Current ash management cost/ton	(21.95)
Additional cost of treatment/ton ash	$17.25

Note that this process does not include any substantial transportation costs or process technology licensing fees.

Table 4.1. Quantities of process additives and water added per 100 lbs ash for each treatment process.

	Additives [lbs]	Water [lbs]
APC Residue		
Process 1	11	90
Process 2	25	100
Process 3	50	85
Process 4	12	25
WES Control	30	90
Bottom Ash		
Process 1	11	10
Process 2	25	32
Process 3	50	28*
Process 4	6	11
WES Control	10	10
Combined Ash		
Process 1	11	20
Process 2	25	32
Process 3	50	30
Process 4	7	12
WES Control	10	20

* Waste water added.

Table 4.2. Process dilution factors for each treatment process.

	Process Dilution Factors (kg treated residue/kg untreated residue)		
	Bottom Ash	APC Residue	Combined Ash
Process 1	1.2	2.0	1.3
Process 2	1.6	2.2	1.6
Process 3	1.8	2.4	1.8
Process 4	1.2	1.4*	1.2
WES Control	1.2	2.2*	1.3*

* Based on Table 4.1.

Table 4.3. Capital Improvement Costs for CREF Ash Treatmemt Facility.

Item	Pre-Construction Cost Estimate
1. Capital Cost of Construction Equipment Costs	
Aggregate Belt Conveyor (25 LF)	20,000
Ash Cranes (2 required)	200,000
Fly Ash & Cement Silos, Screw Conveyor, Weigh Bin & Supports	200,000
Pneumatic Fly Ash Conveyor System	15,000
Dust Collection System	10,000
Total Equipment Procurement & Delivery	$445,000
2. Construction Costs	
Pavement Removal, Excavations & Backfill	75,000
Ash Pits	125,000
Load Out Deflector Plate	2,000
Aggregate Weigh Bin	20,000
Crane Monorail Girders	10,000
Building Columns	20,000
Building Foundations	26,000
Fly Ash Silo Foundations	18,000
Cement Silo Foundations	18,000
Vibrating Screen Foundations	6,000
Building Roofing, Siding Beams & Girts	100,000
Roll-up Doors	8,000
Building Floor Slab & Drive-Thru Slab	20,000
Tube Residue Downcomer Modifics & Screw Conveyors	35,000
Building Lighting	15,000
Ash Pipe Supports	8,000
Utility Relocations	30,000
Electrical Construction Including MCC	145,000
Paved Area for Storage of Roll-off Container (15,000 SF)	70,000
Roll-off Bins for Concrete (18 required)	72,000
Equipment Installation	150,000
SUBTOTAL CONSTRUCTION	$968,000
Equipment Procurement	445,000
Engineering Design	152,000
Construction Management and Permitting	50,000
Contingency @10%	180,000
TOTAL	$1,795,000

Note: Actual cost was $2,600,000.

Table 4.4. Annual Operating Cost Details for CREF Treatment Facility.

Item	Annual Cost	Note
Cement, Tons	$180,960	$58/Ton
R. Mix Trk/Drvr	104,000	$50/hr
Plant Operator	54,000	
Additional Maintenance	25,000	
Sub-Total	363,960	
Hauling Concrete	198,120	
Overs Disposal	0	Cost of transportation = revenue
Sub-Total (Operating Costs)	562,080	
Debt Service on Capital Cost	304,000	
SUBTOTAL	866,080	
Landfill Fee (if needed)	497,640	
GRAND TOTAL	1,363,720	$15.95/Ton

Note: All Capital and operating costs are presented in 1992 dollars.

Table 4.5. Annual Operating Cost Summary for CREF Treatment Facility.

Item	Annual Cost	Cost Per Ton of Refuse	of Ash[1]
Existing System	$685,107	$6.23	$21.95
Proposed System			$16.16
- Oper. Cost w/o Tipping Fee	$562,080	$5.11	$116.16
- L..F. Tipping Fee (if needed)	$497,640[2]	$3.79	$14.31

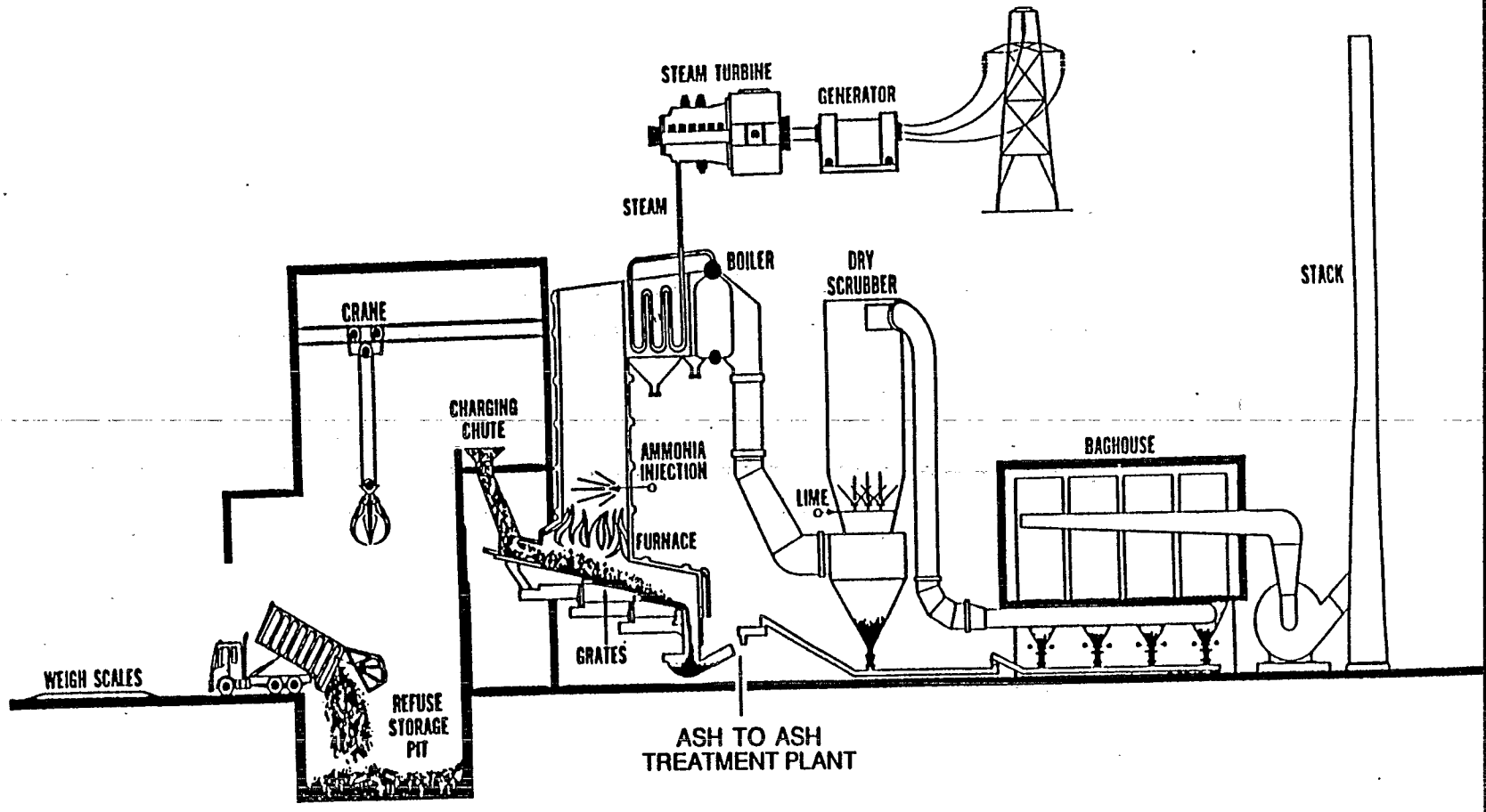
[1]Based on 34,777 tons of ash generated in 1990.

[2]Based on generating 31,200 tons of concrete in the proposed treatment system and a tipping fee of $15.95 per ton at the landfill.

Note: The above annual operating costs do not include debt service on the capital cost of implementing the proposed system. At a capital cost of $2,600,000 and a 10% interest rate for a 20 year payment period the annual debt service is estimated to be $304,000.

Annual debt service	= $304,000
Cost /Ton of Refuse	= $2.76 (110,000 tons of refuse)
Cost /Ton of Ash	= $8.74 (34,777 tons of ash)

Figure 4.1. Schematic process flow diagram for the Commerce Refuse to Energy MWC Facility (CREF) [County Sanitation Districts of LA County, 1991].



* This process flow diagram pre-dates the ash treatment process now in operation.

5. PHYSICAL PROPERTIES OF UNTREATED AND TREATED RESIDUES

Physical testing was carried out on the untreated and treated residue to determine basic physical properties, curing rate and strength development, and durability under simulated weathering conditions. Table 1 (Chapter 2.2) outlines the physical testing carried out on the residues. Side-by-side comparisons of the physical properties for the untreated residue and each of the treated residues were made.

Tables 5.1, 5.2 and 5.3 present the mean physical properties of the untreated and treated residues. Complete physical testing data is presented in Volume 2 of this report. The following sections discuss the results from each of the physical tests separately, including: moisture content, loss on ignition, bulk density, modified proctor density, particle size distribution, permeability, porosity and surface area, unconfined compressive strength, pozzolanic activity, UCS after immersion, freeze/thaw weathering and wet/dry weathering.

5.1 MOISTURE CONTENT

Moisture content was determined on untreated and treated residue with a maximum particle size of 9.8 mm. The untreated residue was collected from the storage barrels containing the material used during the process demonstrations. The test specimens were treated residue that had cured for 28 days and were sized reduced using a mortar and pestle only. Moisture content ranged from 0.3 to 33.3 percent at 60°C and from 0.9 to 35.2 percent at 105°C.

The liquid added during the treatment processes as a percentage of anhydrous material was calculated and compared to the moisture content measured on the treated material. The moisture content as a percent of anhydrous material was calculated as follows:

$$\% \text{ moisture} = \left[\frac{\text{Mass (wet)} - \text{Mass (dry)}}{\text{Mass (dry)}}\right] \times 100 \qquad \text{(Equation 5.1)}$$

The moisture content by weight of the treated anhydrous and hydrous material at 105°C was compared to the liquid added during treatment (as percent anhydrous material).For a well hydrated cement, the amount of water retained 105°C at is approximately 20 percent by weight of the anhydrous material, and for a completely hydrated cement about 25 percent [Lea, F.M., 1971]. This definition was expanded and the treated residues were classified using this classification category: (1) completely hydrated (>25%), (2) well hydrated (16 - 25%), (3) poorly hydrated (8-16%), and (4) very poorly hydrated (<8%). In addition, the moisture content (anhydrous at 105°C) had to be equal to or greater than the percent liquid added during treatment (as percent anhydrous) to be classified as well to completely hydrated. The poorly to very poorly hydrated residues were required to have a moisture content less

than the percent liquid added during treatment. Table 5.4 presents the anhydrous moisture content, the liquid added during the treatment process as percent of anhydrous material, and the degree of hydration for the treated and untreated residues.

According to the above criteria, Process 2 and Process 4 bottom ash and combined ash were well to completely hydrated. Moisture contents resulting from these processes exceeded the percent liquid added during treatment. This excess moisture indicated that there was adequate moisture to complete the setting reaction. Process 1 and the WES Control treated bottom ash and combined ash were poorly to very poorly hydrated. All three residues treated by Process 3 were poorly to very poorly hydrated and the percent liquid added during treatment was significantly larger than the moisture content of the materials. The deficit in moisture indicated that available water was depleted during the setting reaction and was chemically bound in the matrix. The APC residue treated by Processes 1, 2, 4 and the WES Control exceeded complete hydration; for all Processes but the WES Control, the moisture content exceeded the percent liquid added during treatment. The excess moisture was acquired during curing and illustrates the hydroscopic nature of the APC residue.

5.2 LOSS ON IGNITION

Loss on ignition (LOI) for the untreated bottom ash was 4.6 percent and ranged from 4.2 to 6.5 percent for the treated bottom ash. LOI for the untreated APC residue was 12 percent and ranged from 3.2 to 9.6 percent for the treated APC residues. LOI for the untreated combined ash was 6.3 percent and ranged from 2.9 to 7.4 percent for the treated combined ash. All of the treatment processes decreased LOIs in the APC residue. The bottom ash Process 4 treatment and combined ash Process 1 and Process 3 treatment decreased LOI from that of the untreated residue. Decreases in LOI can be attributed primarily to dilution effects.

5.3 BULK DENSITY

For the untreated material, gross bulk densities and compacted bulk densities were measured. Gross bulk densities were measured using dry, granular residue stored in 55-gallon storage drums. Untreated, compacted bulk density test specimens were prepared by mixing the residue with water to the optimum moisture content and compacted into molds using Modified Proctor energy. The untreated, gross bulk densities were compared to the untreated compacted bulk densities. The increase in density of the untreated ash was 28 percent for the bottom, 67 percent for the APC residue, and 32 percent for the combined.

Compacted bulk density measurements were made on the treated residues. If the treated residue was a flowable liquid, it was poured into the molds and vibrated to remove the air voids. Processes 2, 3, and 4 generated flowable products and were vibrated into the molds. If the treated

residue was viscous and not a flowable liquid, it was compacted into the molds to remove air voids using Modified Proctor energy. The Process 1 and WES Control test specimens were compacted into the molds. The test specimens were cured at 98% relative humidity and 20°C for 28 days prior to testing.

Compacted bulk densities of the untreated residue were compared to the treated residue bulk densities. The untreated residue bulk densities were greater than the treated residue bulk densities for each ash type with the exception of Process 4. The addition of the binder resulted in a decrease in bulk density if the binder was less dense than the residue. Conversely, as in the case of Process 4, when the additive was denser than the residue, bulk density increase with addition of the binder.

Changes in the volume of the residue varied by process and ash type. Increases in the volume of the residue after treatment will increase disposal costs if a landfill disposal option is selected. Volume change factors were calculated to quantify the volume changes as follows:

$$\frac{\hat{V}_t}{\hat{V}_u} = \left\langle \frac{\rho_u}{\rho_t} \right\rangle \times DF \qquad \text{(Equation 5.2)}$$

where:

$\hat{V}_t$ ≡ Specific volume of untreated residue in the treated product [m^3/kg ash]

$\hat{V}_u$ ≡ Specific volume of untreated residue [m^3/kg ash]

ρ_u ≡ Bulk density of untreated ash

ρ_t ≡ Bulk density of treated ash

DF ≡ Process dilution factor $\left\langle \frac{\text{Kg treated residue}}{\text{Kg untreated residue}} \right\rangle$

Table 5.5 presents the volume change factors resulting from application of the treatment processes. The residue volume increased by approximately two to three times for all residue types treated by Process 2 and 3. Process 1 and the WES Control process had the same volume change factors for the bottom ash and combined ash (1.2 and 1.5, respectively). Process 4 had the smallest effect on the specific volume.

The width and height dimensions of the test specimens were measured after 28 days' curing to estimate shrinkage or swelling. Volume instability, especially shrinkage, is a major weakness of mortars and concretes. The volume changes produce undesirable stresses in the mass that may cause cracking

[Popovics, S., 1979]. The volumes of the cured test specimens were compared to the nominal dimensions of the 2 inch cubic molds as follows:

$$S = \frac{V_f - V_i}{V_i} \times 100 \qquad \text{(Equation 5.3)}$$

S = Shrinkage (<0) or swelling (>0)
V_f = Final volume of test specimen
V_i = Volume of 2 inch cubic mold

Table 5.6 presents the shrinking and swelling of the test specimens during the 28 day cure time. Positive values indicate swelling and negative values shrinkage. The untreated, Process 4, and Process 1 APC residue test specimens had no shrinkage or swelling during curing. For the remaining treatment process, shrinkage or swelling varied by process and residue type. It is most likely that swelling was not observed during curing for the untreated residues because of aging of the residues during untreated residue preparation. However, it has been noted that untreated residues swell in field settings.

5.4 MODIFIED PROCTOR DENSITY

Modified Proctor density determinations were made only on granular materials which included the untreated residues and Process 4 APC residue. The moisture-density relationship curves are presented in Figure 5.1, wherein the dry density values of the granular materials are plotted as ordinates with corresponding moisture contents as abscissas. The moisture corresponding to the peak of the curve is the optimum moisture and the dry density of the sample at optimum moisture content is the maximum dry density. The optimum moistures were approximately 17 percent, 24 percent and 12 percent for the bottom ash, APC residue and combined ash, respectively, and 30 percent for the Process 4 APC residue. The maximum dry densities were 2100 kg/m^3, 1400 kg/m^3, and 2200 kg/m^3 for the bottom ash, APC residue and combined ash, respectively, and 1400 kg/m^3 for the Process 4 APC residue.

5.5 PARTICLE SIZE DISTRIBUTION

Particle size distribution analyses were performed only on granular materials. Particle size distribution analyses were carried out on the untreated bottom ash and the untreated combined ash before and after sample preparation (drying and particle size reduction to < 0.5 inches). Particle size distribution analyses were also carried out on the untreated APC residue and the Process 4 APC residue. Table 5.7 presents the particle size gradation as the percent finer material from sieve analysis.

The residues were classified into categories to assist in the evaluation of significant properties for engineering use according to ASTM Standard Method for Soil Classification (D2487). Prior to sample preparation, the bottom ash and combined were classified as a poorly graded gravel (GP). Following preparation, the bottom ash was classified as a well-graded sand with silt or as a gravely sand (SW-SM) and the combined ash was classified as a well graded gravels with silt (GW-GM). The untreated APC residues was classified as a silt (ML) and the Process 4 APC residue was classified as a poorly graded sand (SP).

Figure 5.2a presents the particle size distribution gradation curve for the bottom ash prior to sample preparation. Figure 5.2b presents the particle size distribution gradation curve for the bottom ash following sample preparation. Prior to sample preparation, approximately 50 percent of the bottom ash was less than 12.5 mm. After sample preparation, approximately 50 percent of the bottom ash was less than 2 mm.

Figure 5.3a presents the particle size distribution gradation curve for the combined ash prior to sample preparation. Figure 5.3b presents the particle size distribution gradation curve for the combined ash following sample preparation. Prior to sample preparation, approximately 50 percent of the combined ash was less than 25 mm. After sample preparation, approximately 50 percent of the combined ash was less than 3.35 mm. During combined ash processing, the bottom ash was quenched by complete water immersion, mixed with the APC residue, and then the combined ashes were trammeled. The available moisture and the trammeling resulted in particle cohesion. A comparison of the gradation curve of the untreated bottom ash and the combined ash show that between the range of 0.85 mm and 19.1 mm, 20 - 30 percent of the combined ash was larger than the bottom ash. This is attributable to particle cohesion.

Figures 5.4 a and 5.4 b present the particle size distribution gradation curve for the untreated APC residue and the Process 4 APC residue. The APC residue was stored until use in the study, requiring no pre-processing. The untreated APC residue exhibited very little gradation with over 98 percent of the material finer than 0.425 mm, and 77 percent finer than 0.075 (200 mesh). The Process 4 treatment increased particle size substantially. Only 42 percent of the treated APC residue passed the 0.3 mm opening, while 96 percent of the untreated APC residue remained finer.

5.6 PERMEABILITY

Tables 5.1, 5.2, and 5.3 present the average permeability data for each of the treated and untreated ash types. Monolithic test specimens were prepared by mixing the granular, untreated residue with water to optimum moisture content. To remove air voids, the mixtures were then vibrated

into the molds for 30 seconds or compacted into molds using modified proctor energy. Process 1 and WES Control were compacted into the molds and Processes 2, 3, and 4 produced flowable by-products that were vibrated into the molds. In general, permeabilities ranged from 6.8 E- 04 to 1.6 E-06 and permeabilities of the test specimens of treatment processes were only one order of magnitude less than the untreated test specimens. The Process 2 bottom ash and combined ash test specimens formed large fissures while curing and broke into four to six large pieces. A permeability reading was obtained on one (of three) Process 2 bottom ash test specimen which remained intact. No permeability readings were made for the combined ash treated by Process 2. There were no correlations in the permeabilities of test specimens that were compacted versus vibrated into the molds. There was no trend in the permeability data by process or by ash type.

5.7 PORE DIAMETER AND SURFACE AREA

The BET pore diameter and surface area data are listed in Tables 5.1, 5.2 and 5.3. Comparison of the untreated bottom ash with the treated bottom ash indicated a significant decrease in pore diameter and a significant increase in surface area as a result of treatment. The APC residue generally exhibited the same changes when treated. A notable exception was APC residue treated by Process 4. This process resulted in only a minimal increase in surface area. A comparison of the untreated combined ash with the treated residue indicated varying changes in the pore diameter as a result of treatment. Treatment consistently increased the surface area for the combined ash. Figures 5.5, 5.6, and 5.7 show the cumulative adsorption pore area plot for each of the untreated residues.

5.8 CONE PENETROMETER

Five cone index readings were obtained the first day followed by two single daily readings. The highest cone index readings for the untreated bottom and untreated combined ash were reached within the first six hours of curing, but then diminished to less than 10 psig by the end of the first day. The untreated APC residue acquired a final cone index reading of 285 psig. The treated bottom ash and treated combined ash test specimens reached the maximum obtainable cone index reading (750 psig) by the second day of curing. The APC residue for Processes 1, 2, 4 and WES Control had increasing cone index readings as curing progressed. The Process 3 APC residue reached the maximum cone index reading obtainable within 3 hours of curing.

5.9 UNCONFINED COMPRESSIVE STRENGTH

Figure 5.8 a compares UCS as a function of time for the untreated and treated bottom ash. The untreated bottom ash test specimens acquired negligible strength (<10 psi) at the onset and showed no

increase as cure time progressed. Bottom ash treated with the WES Control process exhibited the highest strength formation. Bottom ash treated using Process 1 acquired slightly less strength than the WES Control. The remaining process test specimens acquired only twenty percent of the highest strength of the WES Control test specimens. All treated bottom ash samples asymptotically approached maximum strength with time, indicating little potential for further strength development.

Figure 5.8 b compares UCS as a function of cure time for the untreated and treated APC residue. Process 4 was not tested because the treated residue was granular. The untreated APC residue test specimens initially acquired low strength (<10 psi) that decreased as cure time progressed. The APC residue treated with the WES Control process exhibited the highest strength formation. The UCS of APC residue treated using Processes 1, 2, and 3 were not significantly different from each other and were approximately one-third the UCS of the WES control test specimens. The UCS for Processes 1, 2, 3, and the untreated test specimens asymptotically approached a maximum strength with time indicating little potential for further strength development. Conversely, the UCS-cure time curve for the WES Control did not asymptotically approach a maximum strength by the 28th day, indicating a potential for further strength development.

The UCS of the untreated and treated combined ash is presented in Figure 5.8 c. The untreated combined ash initially acquired low strength and showed no strength increase with cure time. The WES Control resulted in the highest strength formation, but the strength decreased by approximately 250 psig as cure time progressed. Process 1, 2, and 3 acquired a 28-day UCS of approximately fifty percent of that acquired by the WES Control process and Process 4 test specimens acquired only about fifteen percent of the strength of the WES Control process. The Process 1, 2, 3, 4 and untreated test specimens UCS asymptotically approached a maximum strength with cure time, indicating little potential for further strength development. The UCS of combined ash treated using the WES Control Process only decreased with time indicating that strength loss would continue. This decrease may be attributed to increased dryness of the treated material as available water was depleted during the setting reaction. The addition of larger proportions of water in the S/S process should be investigated to provide improved strength formation.

5.10. POZZOLANIC ACTIVITY

The untreated ashes were tested for pozzolanic activity using cement and lime. Following one day of curing, the sample mixtures had not acquired sufficient strength to be extruded from the molds as specified by the test protocol. The test specimens were maintained in the molds for the entire curing period (7 days). At the end of the curing period, the bottom ash and combined ash test specimens had a thick and adhesive consistency and did not set. The APC residue test specimens set, but crumbled upon demolding, hence, no UCS information was obtainable. The MWC residues exhibited no inherent

pozzolanic activity with cement or lime. This result may have been a consequence of residue aging during the residue preparation process.

5.11 UCS AFTER IMMERSION

Figure 5.9 compares UCS and UCS after immersion for the treated residues only. All the untreated residue test specimens acquired minimal UCS after curing 28 days (<10 psi) and deteriorated from a free standing monolith to a granular or amorphous form after 24 hours of immersion. The Process 2 APC residue and Process 3 test specimens for all three ash types deteriorated from a free standing monolith to a granular form after 28 days of immersion. Concrete materials that are cured and then immersed for 24 hours typically exhibit a 20-40 percent decrease in UCS (Lea, F.M., 1971). Excluding Process 1 APC residue, after 24 hours of immersion a decrease in UCS was observed for every treatment process of all ash types. With the exception of Process 1 bottom ash, UCS increased with increasing immersion time for the treatment processes that withstood 28 days of immersion. The UCS after 28 days of immersion was similar to the 28 day UCS reading with no immersion for products which maintained physical integrity, and even exceeded the non-immersion UCS in several processes. Evaluation of UCS after longer immersion periods should be investigated to see if immersion continues to enhance or reduce the UCS.

5.12 FREEZE/THAW WEATHERING AND WET/DRY WEATHERING

Figure 5.10 presents the wet/dry and freeze/thaw weathering test results as the cumulative weight percent eroded at the conclusion of twelve successive weathering cycles. The cumulative weight percent eroded was obtained by drying and weighing the residual material which washed off the test specimen at the conclusion of a cycle. The same test control was used for both weathering tests and these results also are presented. The test control was subjected only to successive 24 hour wetting cycles and storage in moist conditions (98 percent relative humidity and 20°C), with no drying or freezing cycle. Comparison of the control data with the wet/dry data indicated the impact from the drying cycle and comparison of the control with the freeze/thaw data indicated the impact from the freezing cycle. Comparison of the control data and the test data was based on relative weight losses. Relative weight losses were calculated for wet/dry and freeze/thaw test specimens by subtracting the cumulative weight loss of the control test specimens from the cumulative weight loss of the test specimens:

Relative Weight Loss (%) = [cumulative weight loss of test specimen (%)] - [cumulative weight loss of the control test specimen (%)].

Small relative weight loss, compared to the cumulative weight loss, indicated that the material erosion was primarily the result of the wetting cycle with little impact from the freezing or drying cycle (i.e., similar performance by control test specimen and test specimen). Relative weight loss similar to the cumulative weight loss indicated that the material erosion was primarily the result of the freezing or drying cycle (i.e., the test control maintained high degree of integrity and was not affected by the wetting cycle). Negative relative weight loss indicated that the test control was less durable than the test specimen. In such cases, freezing or drying actually enhanced the durability of the sample. The mechanism which caused this result is unclear. Table 5.8 presents the relative weight loss eroded and the number of cycles the test specimens survived cycling. Test failure was declared when test specimens had diminished to particle sizes that could not be removed with the laboratory tongs.

Bottom Ash: Weathering test results for the treated bottom ash are presented in Figure 5.10. The Process 3 test control test specimen failed after five cycles, but the remaining treatment process test control specimens survived all twelve cycles and had less than 10 percent cumulative erosion. for the freeze/thaw test specimens, the relative weight loss was similar to the cumulative weight loss indicating that the material erosion primarily resulted from the wetting cycle. Process 3 freeze/thaw test specimens failed after five cycles and the Process 4 freeze/thaw test specimen and an 80 percent cumulative weight. Process 1,2, and the WES Control had cumulative weight losses of 16, 43, and 24 percent respectively. Process 1 and the WES control produced the most durable test specimens to freeze/thaw cycles.

Process 2 wet/dry test specimens failed after 7 cycles and had a 100 percent cumulative weight loss. Process 4 wet/dry test specimens had a 90 percent relative weight loss and lower relative weight loss indicating the process formulations are quite stable to wet/dry cycling. The negative relative weight loss of the WES control test specimen indicates that the wet/dry cycling actually enhanced the durability of the test specimens. The negative relative weight losses for the Process 3 wet./dry test specimens indicated the drying cycles enhance the durability of the test specimens but the large cumulative weight loss (80 percent) indicate that the test specimens are not very durable in wet/dry cycling.

APC Residue: Weathering test results for the treated APC residue are presented in Figure 5.10. The Process 2 and Process 3 test control test specimen had less than 38 percent cumulative erosion.

Process 2 and Process 3 freeze/thaw test specimens failed after five cycles as did the test control test specimens and Process 1 failed by test completion. The WES control test specimens performed better than the other treatment processes with a 53 percent cumulative weight loss. The large difference between relative weight loss and cumulative weight loss indicated that the material erosion for this process test specimen primarily resulted from the freezing cycle.

The wet/dry test specimens had cumulative weight losses ranging from 17 - 73 percent. The negative relative weight losses for Processes 1,2, and 3 (- 5, -27, and - 46 percent respectively) indicate that the wet/dry cycling actually enhanced the durability of the test specimens. The relative weight loss of the WES Control was only 0.8 percent indicating that the drying cycle had little effect on the durability of the test specimens. The cumulative weight losses are large meaning durability of the test specimens to wet/dry cycling are questionable.

Combined Ash: Weathering test results for the treated combined ash are presented in Figure 5.10. The Process 4 test control specimens failed after two cycles, but the remaining test control specimens had less than 8 percent cumulative erosion. Process 4 freeze/thaw also failed after two cycles. Process 2 and Process 3 freeze/thaw test specimens performed poorly with cumulative weight losses of 80 percent and 75 percent, respectively. The Process 1 and WES Control freeze/thaw test specimens had less than 20 percent cumulative weight loss. The cumulative weight loss for the Processes 1, 2, 3, and the WES Control freeze/thaw test specimens was small when compared with the relative weight loss. These results indicated that the material degradation resulted form the freezing cycle. The Process 1 test completed specimens performed well and are durable to freeze/thaw cycling.

Process 4 wet/dry test specimens failed after 2 cycles, but the remaining test specimens completed 12 cycles with between 3 and 42 percent cumulative weight loss. The differences in cumulative weight losses for the Process 1, 2, , and WES Control wet/dry specimens and the relative weight losses were small. These results indicated that the material erosion was primarily from the wetting cycle. The WES Control and Process 1 test specimens performed well and are durable in wet/dry cycling.

TABLE 5.1. Comparison of physical properties, cure rate and durability.

Bottom Ash

Process	Untreated	1	2	3	4	WES
Physical Properties						
BET Isotherm						
Average Pore Diameter (A^o)	342[1]	147	247	218	336	176
Surface Area (m^2/g)	3.2	29	23	16	12	23
Bulk Density (kg/m^3)	1950 (1400)[2]	1900	1200	1600	2100	1900
Modified Proctor Optimum Moisture (%)	16.6	na[3]	na	na	na	na
Maximum Dry Density (kg/m^3)	2111	na	na	na	na	na
Loss on Ignition (550°C, wt%)	4.6	4.8	6.5	5.1	4.2	6.2
Moisture (60°C, wt%)	8.9	5.6	21	3.2	15	9.4
(105°C, wt%)	9.4	6.4	22	3.5	16	10
Permeability (cm^2/s)	6.85E-04	6.49E-05	1.29E-04	2.62E-04	1.04E-05	1.61E-5

Process	Untreated	1	2	3	4	WES
Cure Rate (psig)						
Cone Penetrometer						
1 hour cure	50	205	148	750	348	239
2 hour cure	43	302	449	750	425	419
3 hour cure	39	523	608	750	406	406
6 hour cure	35	740	621	750	282	739
1 day cure	10	750	750	750	M[4]	750
2 day cure	10	750	750	750	M	750
3 day cure	10	750	750	750	M	750

1 - Reading obtained on one replicate only
2 - Bulk density for granular, non-compacted material
3 - Not applicable
4 - Reading not obtained
5 - Test specimens disintegrated from monolith to unconsolidated form during test.

TABLE 5.1. (continued) Comparison of physical properties, cure rate and durability.

Bottom Ash

Process	Untreated	1	2	3	4	WES
Durability						
UCS (psig)						
7 day cure	05	1051	189	120	68	653
14 day cure	08	965	158	178	56	640
21 day cure	04	1069	69	225	57	1128
28 day cure	06	1081	119	275	M	1152
UCS After Immersion						
24 hour immersion	D[5]	824	115	138	68	686
28 day immersion	D	432	149	D	197	1075
Weathering Tests (cum. erosion, wt%)						
Freeze/Thaw	na	15	43	100	80	28
Wet/Dry	na	2.3	100	80	100	1
Test Control	na	1.6	8	100	2	1

1 - Reading obtained on one replicate only
2 - Bulk density for granular, non-compacted material
3 - Not applicable
4 - Reading not obtained
5 - Test specimens disintegrated from monolith to granular form during test.

TABLE 5.2. Comparison of physical properties, cure rate and durability.

APC Residue

Process	Untreated	1	2	3	4	WES
Physical Properties						
BET Isotherm						
Average Pore Diameter (A^o)	449	348	232	254	334	210
Surface Area (m^2/g)	5.5	14	17	13	6.3	33
Bulk Density (kg/m^3)	1550 (540)[1]	1400	1200	1400	na[2]	1300
Modified Proctor						
Optimum Moisture (%)	23.6	na	na	na	30.5	na
Maximum Dry Density (kg/m^3)	1406	na	na	na	1430	na
Loss on Ignition (550^oC, wt%)	12	6.5	4.4	3.2	9.6	4.0
Moisture						
(60^oC, wt%)	0.3	35	34	5.5	28	33
(105^oC, wt%)	0.9	49	35	7.3	31	35
Permeability (cm^2/s)	5.93 E-5	2.92E-05	7.67E-06	4.07E-05	na	1.60E-06

Process	Untreated	1	2	3	4	WES
Cure Rate (psig)						
Cone Penetrometer						
1 hour cure	74	24	06	204	na	35
2 hour cure	158	32	19	597	na	45
3 hour cure	158	44	36	750	na	53
6 hour cure	233	78	48	750	na	75
1 day cure	269	197	96	750	na	447
2 day cure	275	218	138	750	na	425
3 day cure	285	240	150	750	na	739

1 - Bulk density for granular, non-compacted material
2 - Not applicable
3 - Test specimens disintegrated from monolith to unconsolidated form during test.

TABLE 5.2. (continued) Comparison of physical properties, cure rate and durability.

APC Residue

Process	Untreated	1	2	3	4	WES
Durability						
UCS (psig)						
7 day cure	11	151	X[3]	170	na	162
14 day cure	04	127	127	141	na	384
21 day cure	04	103	172	163	na	502
28 day cure	05	136	175	154	na	555
UCS After Immersion						
24 hour immersion	D[4]	157	14	55	na	255
28 day immersion	D	224	D	D	na	434
Weathering Tests (cum. erosion, wt%)						
Freeze/Thaw	na	100	100	100	na	53
Wet/Dry	na	21	72	54	na	15
Test Control	na	27	100	100	na	15

1 - Bulk density for granular, non-compacted material
2 - Not applicable
3 - Reading not obtained
4 - Test specimens disintegrated from monolith to granular form during test.

TABLE 5.3. Comparison of physical properties, cure rate and durability.

Combined Ash

Process	Untreated	1	2	3	4	WES
Physical Properties						
BET Isotherm						
Average Pore Diameter (A^o)	185	151	259	194	327	258
Surface Area (m^2/g)	10	24	20	15	12	12
Bulk Density (kg/m^3)	1920 (1300)[1]	1700	1300	1500	2000	1500
Modified Proctor						
Optimum Moisture (%)	12.2	na[2]	na	na	na	na
Maximum Dry Density (kg/m^3)	2161	na	na	na	na	na
Loss on Ignition (550^oC, wt%)	6.3	5.8	7.4	2.9	6.1	6.6
Moisture						
(60^oC, wt%)	8.2	7.6	18	2.6	15	9.1
(105^oC, wt%)	8.9	8.9	19	2.9	18	10
Permeability (cm^2/s)	2.19E-4	3.67E-5	M[3]	4.41E-04	2.39E-4	1.22E-04

Process	Untreated	1	2	3	4	WES
Cure Rate (psig)						
Cone Penetrometer						
1 hour cure	105	21	109	361	530	59
2 hour cure	118	37	465	750	602	169
3 hour cure	133	46	750	750	609	239
6 hour cure	130	115	750	750	750	277
1 day cure	10	717	750	750	750	722
2 day cure	10	750	750	750	750	750
3 day cure	10	750	750	750	750	750

1 - Bulk density for granular, non-compacted material
2 - Not applicable
3 - Test specimens cracked during curing
4 - Test specimens disintegrated from monolith to granular form during test.

TABLE 5.3. (continued) Comparison of physical properties, cure rate and durability.

Combined Ash

Process	Untreated	1	2	3	4	WES
Durability						
UCS (psig)						
7 day cure	09	239	244	120	148	679
14 day cure	08	241	255	178	52	582
21 day cure	08	258	103	225	65	514
28 day cure	07	252	228	275	83	441
UCS After Immersion						
24 hour immersion	D[4]	189	119	138	56	409
28 day immersion	D	291	152	D	176	51
Weathering Tests						
(cum. erosion, wt%)						
Freeze/Thaw	na	4.2	83	76	100	18
Wet/Dry	na	2.3	40	49	100	3.4
Test Control	na	2.0	5.9	5.2	100	1.7

1 - Bulk density for granular, non-compacted material
2 - Not applicable
3 - Test specimens cracked during curing
4 - Test specimens disintegrated from monolith to unconsolidated form during test.

Table 5.4 Moisture content and liquid added during the treatment process as percent of anhydrous material (%) and degree of hydration.

MOISTURE

Residue Type		Untreated	Process 1	Process 2	Process 3	Process 4	WES Control
APC Residue	(1)	1	54	53	11	39	40
	(2)	na	45	46	36	27	41
	(3)	na	C	C	P	C	C
Bottom	(1)	10	8	27	4	20	12
	(2)	na	8	24	16	12	8
	(3)	na	VP	C	VP	W	P
Combined	(1)	11	10	23	4	28	11
	(2)	na	15	22	16	12	15
	(3)	na	P	W	VP	C	P

(1) = Moisture content at 105°C as percent anhydrous material

(2) = Liquid added during treatment processes as percent anhydrous material

(3) = Degree of hydration

na = Not applicable

C = Completely hydrated (≥25%)

W = Well hydrated (16 - <25%)

P = Poorly hydrated (8 -16%)

VP = Very poorly hydrated (<8%)

Table 5.5. Relative increases in residue specific volume resulting from treatment (volume change factors).

Process	1	2	3	4	WES
APC Residue	2.2	2.8	2.3	na	2.6
Bottom	1.2	2.6	2.2	1.1	1.2
Combined	1.5	2.4	2.3	1.2	1.5

na = not applicable

Table 5.6. Swelling and shrinkage % of untreated and treated residues during the 28 day curing period.

Ash Type	Untreated	Process 1	Process 2	Process 3	Process 4	WES
APC Residue	0	0	-1.1	+2.9	0	+6.4
Bottom	0	+6.2	+13	+11	0	+4.9
Combined	0	+1.5	+9.2	+9.7	na	+5.2

na = not applicable

Table 5.7. Percent finer material from sieve analysis.

Opening (mm)	Untreated Bottom Ash as sampled	Untreated Bottom Ash After Preparation	Untreated APC Residue	Process 4 APC Residue	Untreated Combined Ash as sampled	Untreated Combined Ash After Preparation
37.500	100	100	100	100	100	100
25.000	84	100	100	100	48	100
19.100	74	100	100	100	40	100
12.500	53	100	100	100	28	100
9.500	42	96	100	100	26	92
6.350	31	79	100	100	18	66
4.350	27	70	100	100	16	55
3.350	25	62	100	98	15	51
2.000	21	46	99.8	91	13	36
1.180	18	35	99.6	83	11	28
0.850	21	30	99.5	77	10	24
0.600	13	25	99.1	69	9	21
0.425	11	21	98.2	68	7	19
0.300	9	36	96.2	42	6	16
0.212	7	15	93.3	17	5	13.7
0.150	6	13	90.1	5.2	4	11
0.106	5	11	86.3	1.6	3	9
0.075	2	8	77.2	1.1	2	7

Table 5.8. Relative weight loss of freeze/thaw and wet/dry test specimens.

	Freeze/Thaw			Wet/Dry			Control
	Cumulative Weight Loss (%)	Relative Weight Loss (%)	Number of Cycles Tested	Cumulative Weight Loss (%)	Relative Weight Loss (%)	Number of Cycles Tested	Number of Cycles Tested
APC Residue							
Process 1	100	100	12	22	-5	12	12
Process 2	100	100	5	73	-27	12	5
Process 3	100	100	5	54	-46	12	5
Process 4	na	na	na	na	na	na	na
WES Control	53	37	12	17	0.8	12	12
Bottom Ash							
Process 1	16	15	12	2	0.7	12	12
Process 2	43	35	12	100	100	7	12
Process 3	100	100	5	80	-20	12	5
Process 4	80	78	12	92	90	12	12
WES Control	29	24	12	2	-4	12	12
Combined Ash							
Process 1	4	2	12	3	0.3	12	12
Process 2	80	77	12	40	35	12	12
Process 3	76	70	12	42	36	12	12
Process 4	100	100	2	100	100	2	2
WES Control	18	16	12	4	2	12	12

na= not applicable

Figure 5.1. Modified proctor density compaction curves.

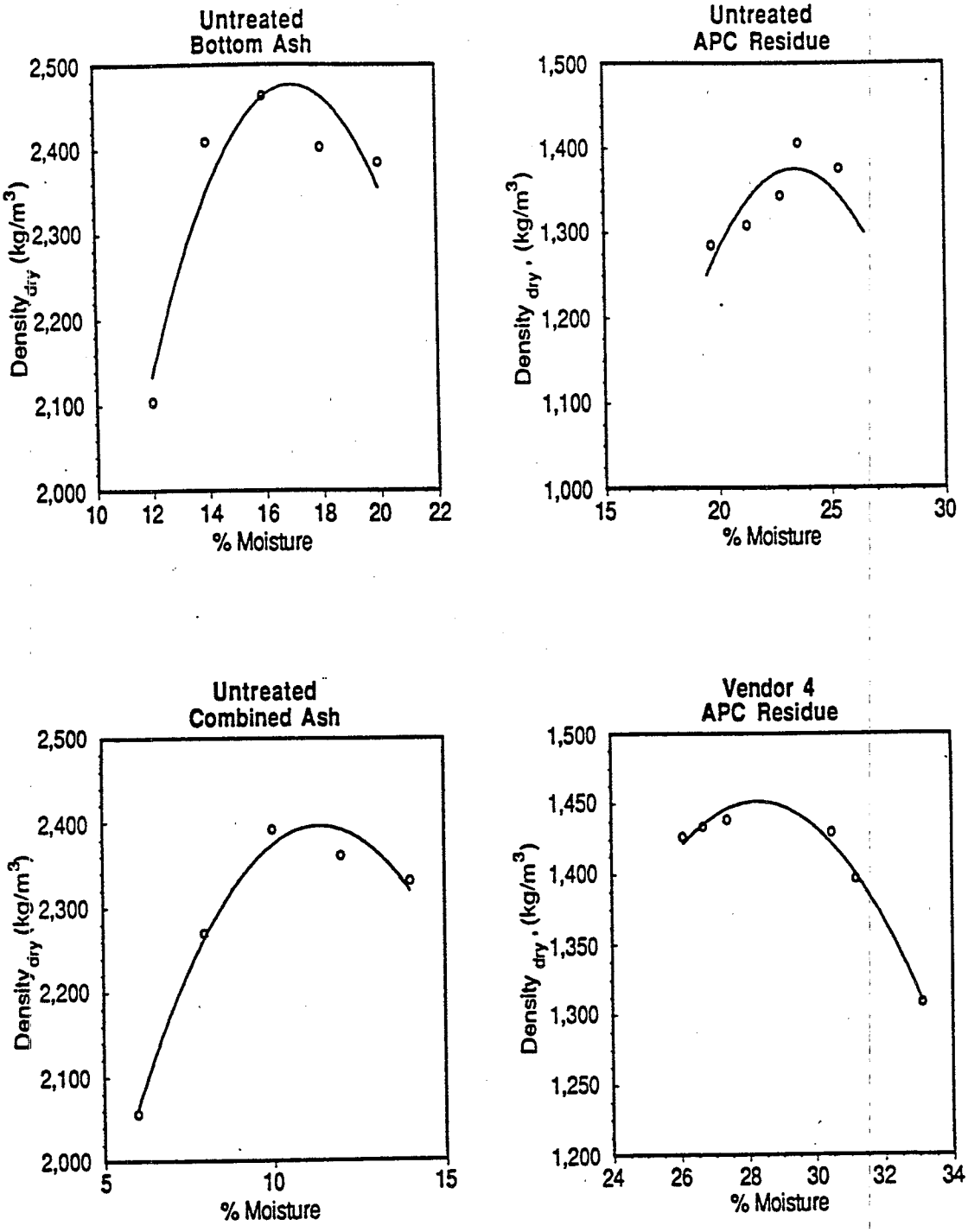


Figure 5.2a. Particle size distribution of bottom ash prior to residue drying and crushing for treatment process demonstrations.

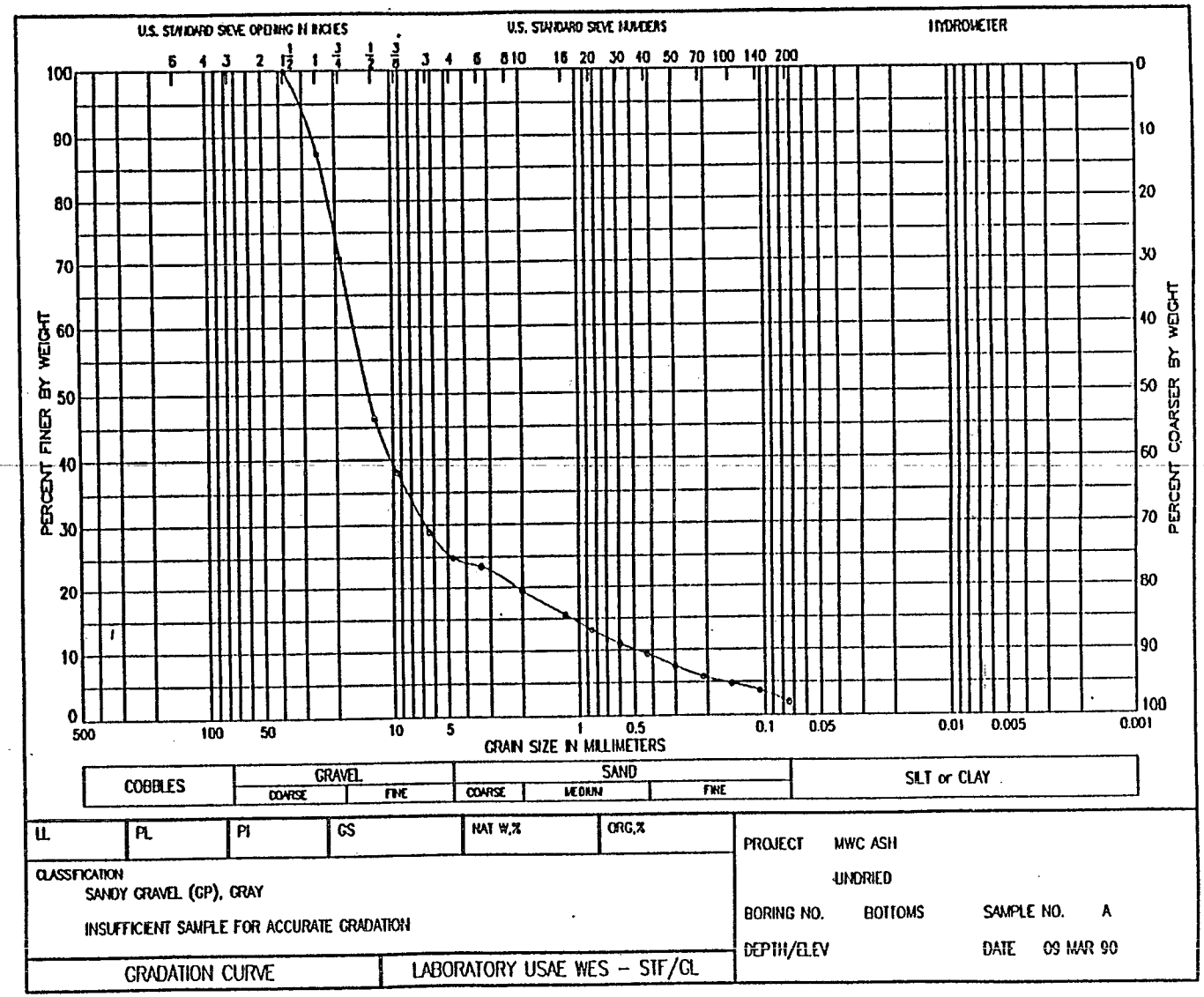


Figure 5.2b. Particle size distribution of bottom ash after preparation for treatment process demonstrations.

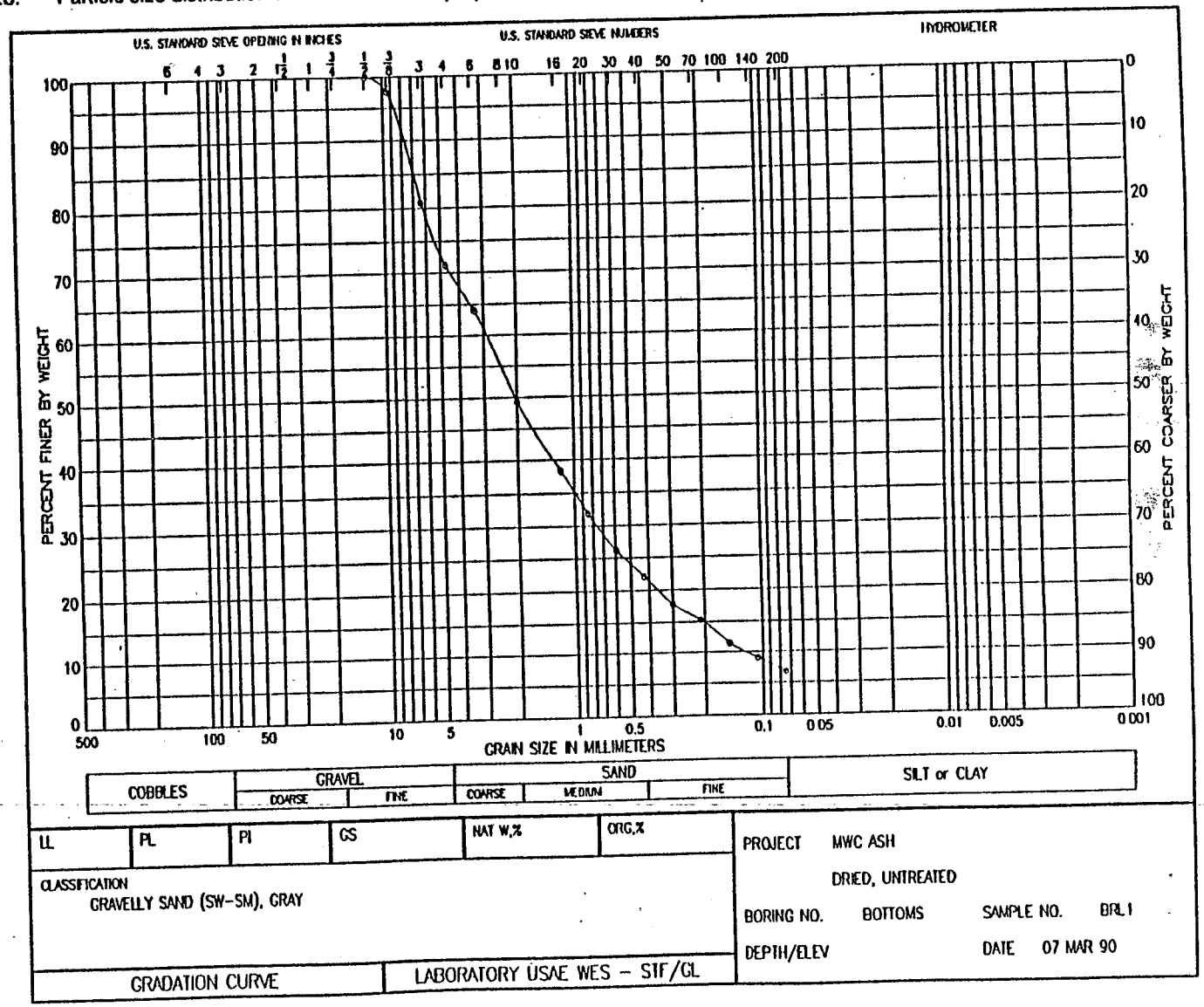


Figure 5.3a. Particle size distribution of combined ash prior to residue drying and crushing for treatment process demonstrations.

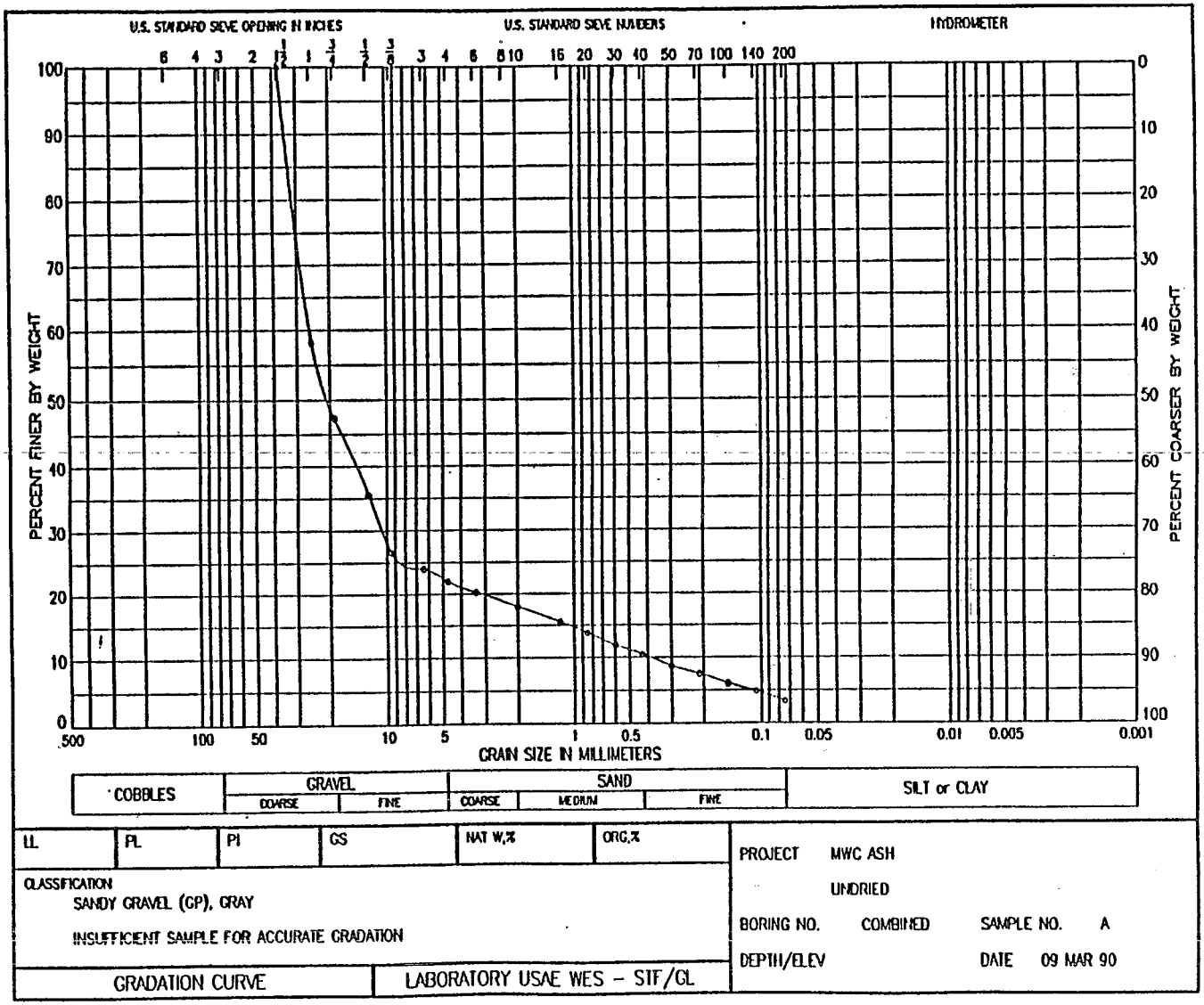


Figure 5.3b. Particle size distribution of combined ash after preparation for treatment process demonstrations.

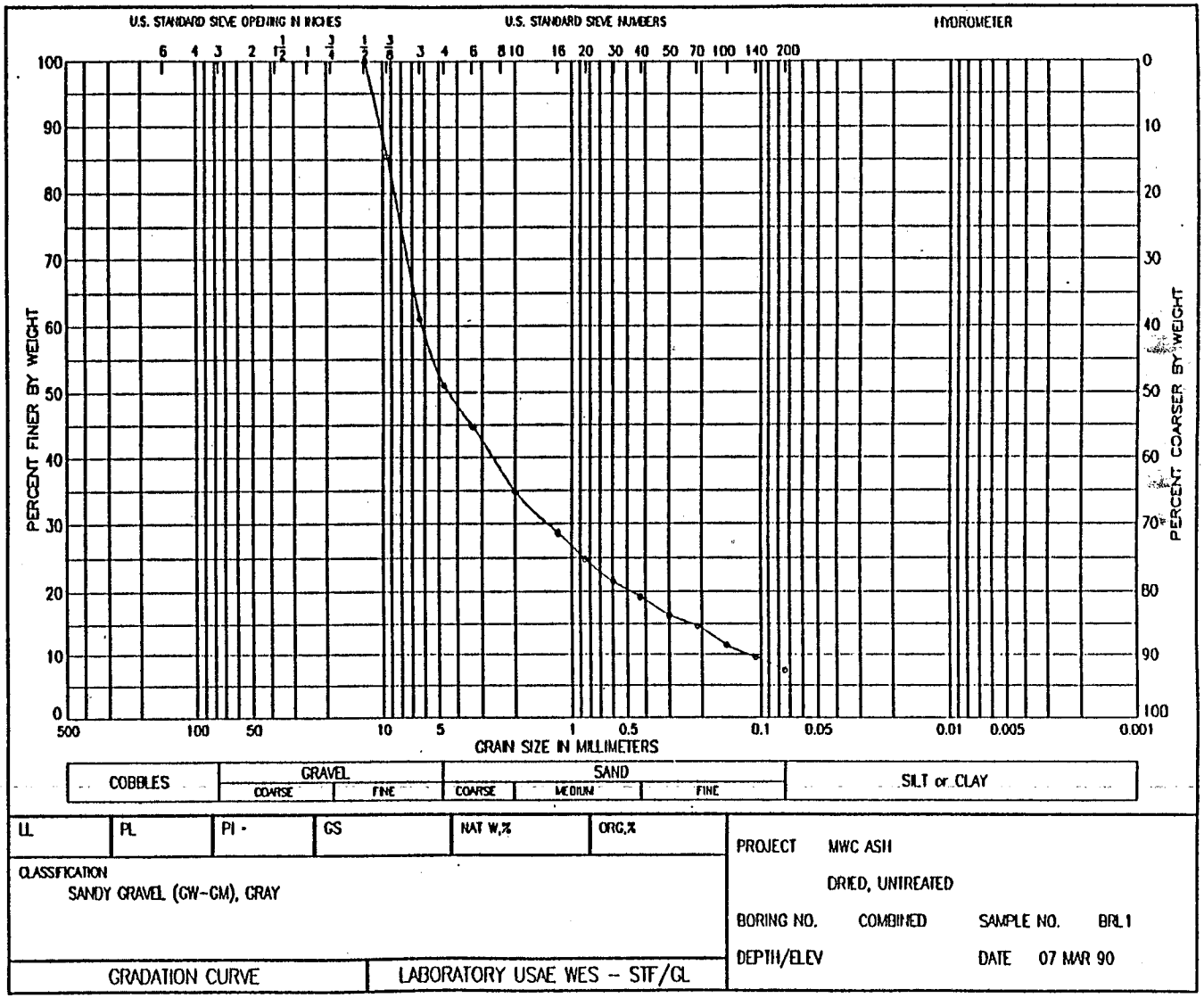


Figure 5.4a. Particle size distribution of untreated APC residue.

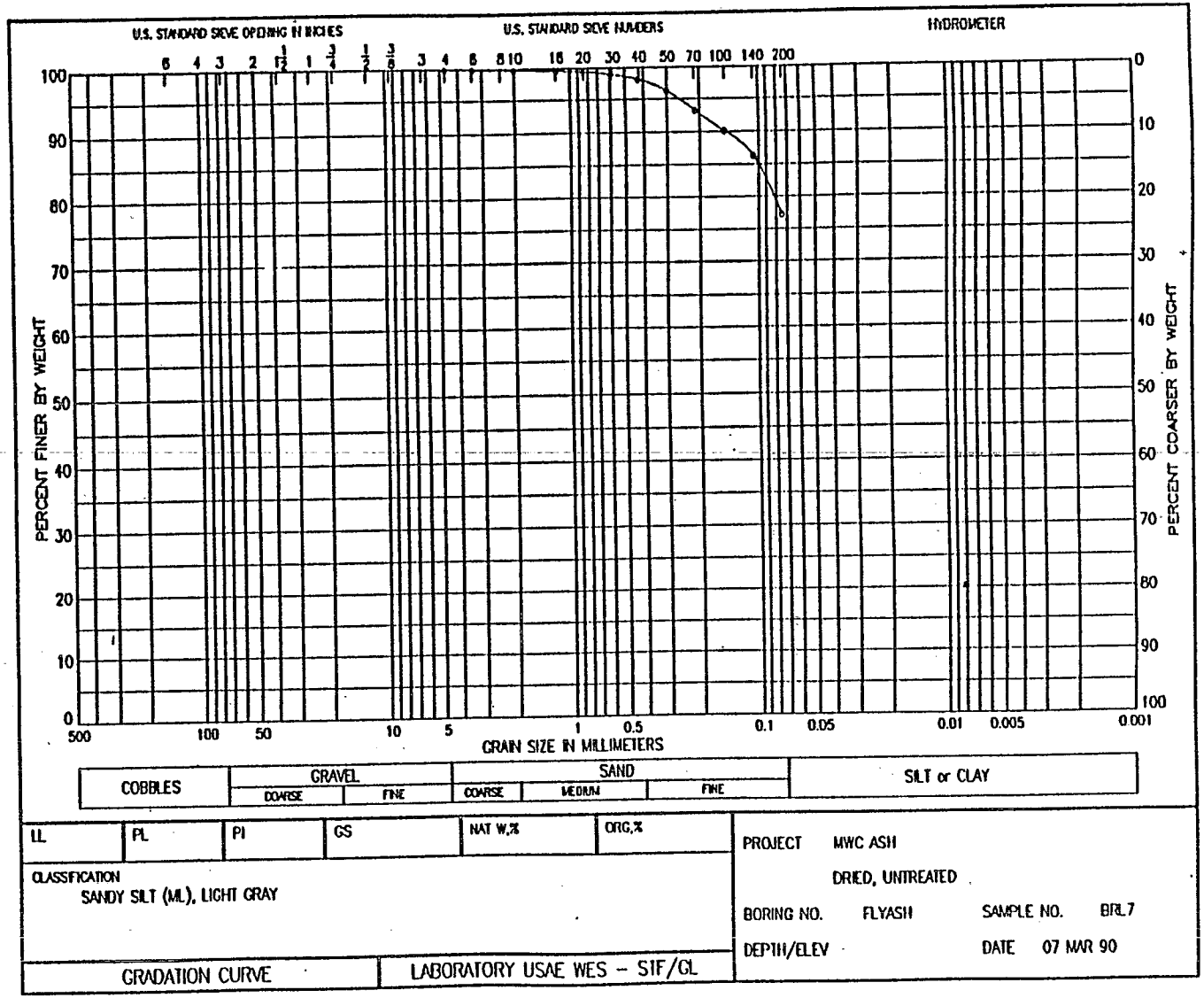


Figure 5.4b. Particle size distribution of APC residue treated by Process 4.

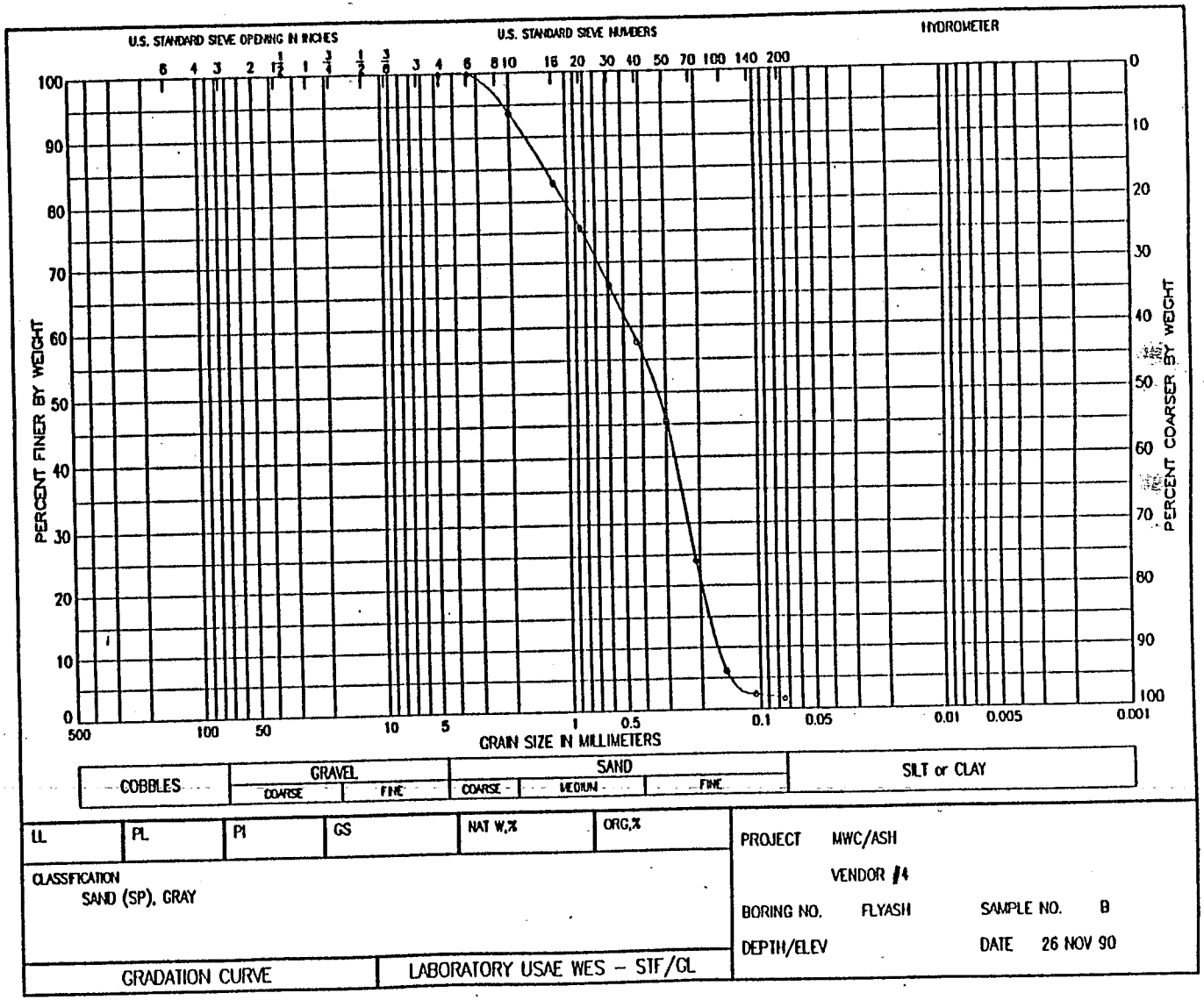


Figure 5.5. BET cumulative pore surface area plot for untreated APC residue.

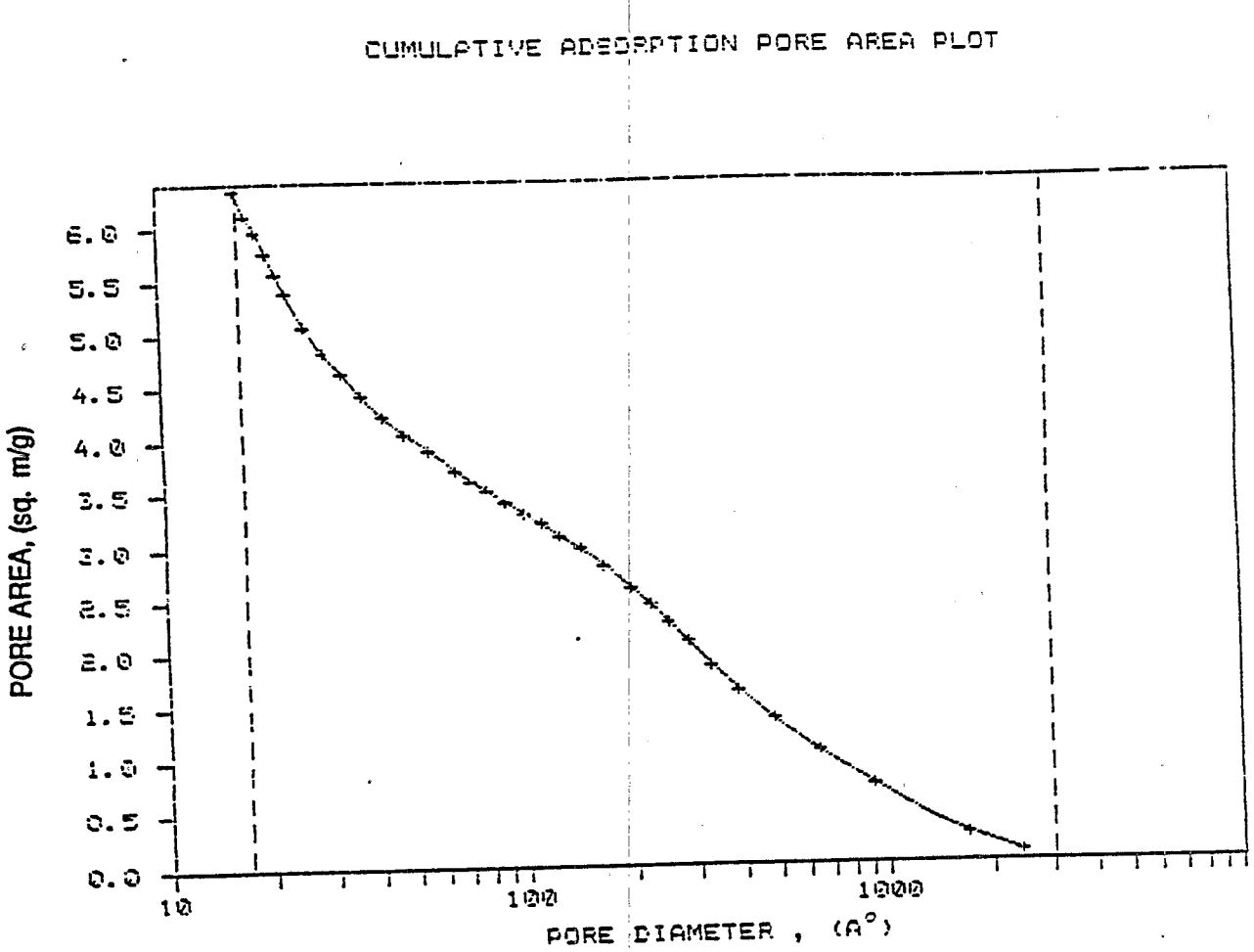


Figure 5.6. BET cumulative pore surface area plot for untreated bottom ash (prepared for treatment process demonstrations).

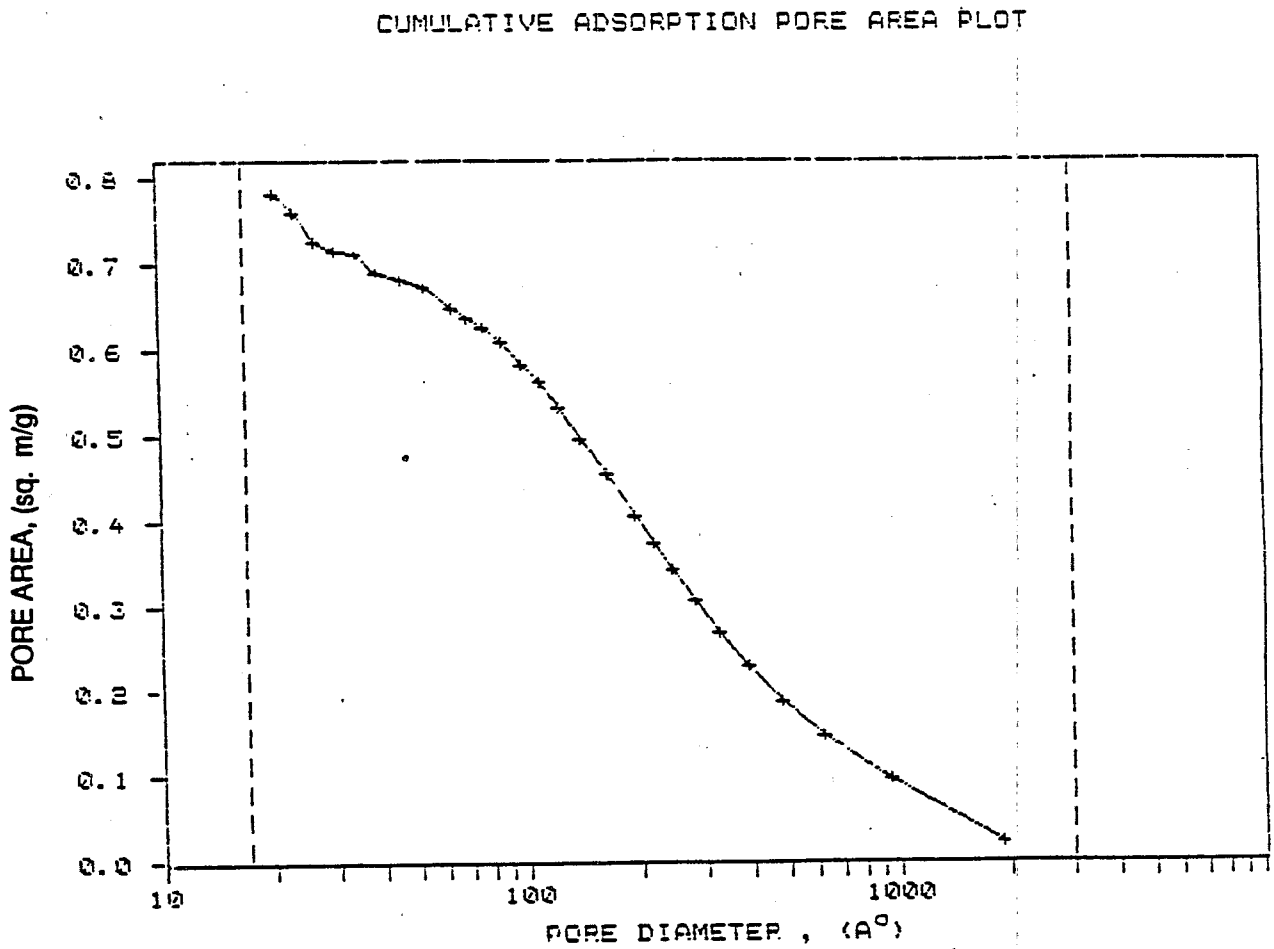


Figure 5.7. BET cumulative pore surface area plot for untreated combined ash (prepared for treatment process demonstrations).

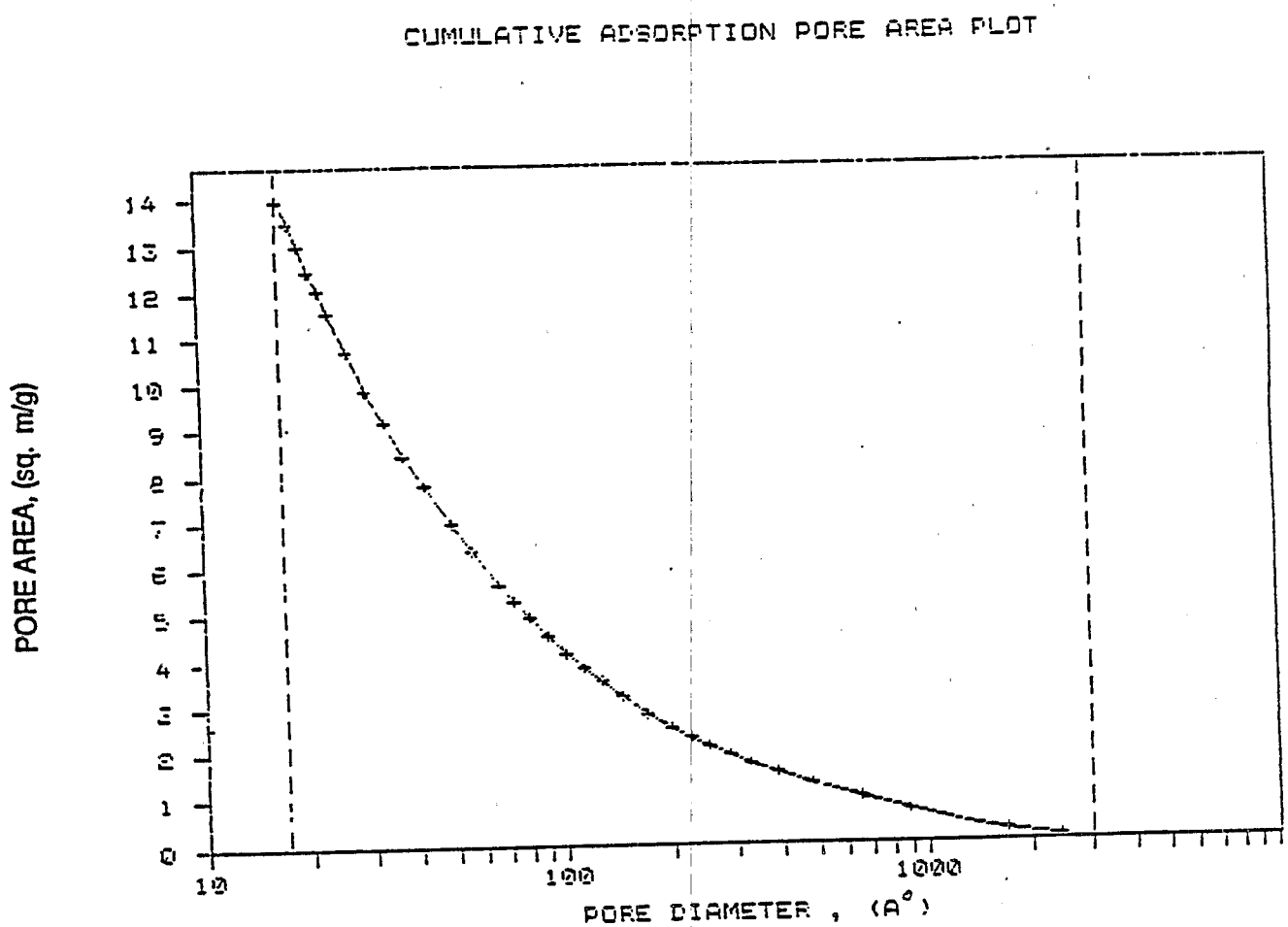


Figure 5.8. Unconfined compressive strength (UCS) as a function of cure time. (a) Bottom ash, (b) APC residue, (c) Combined ash.

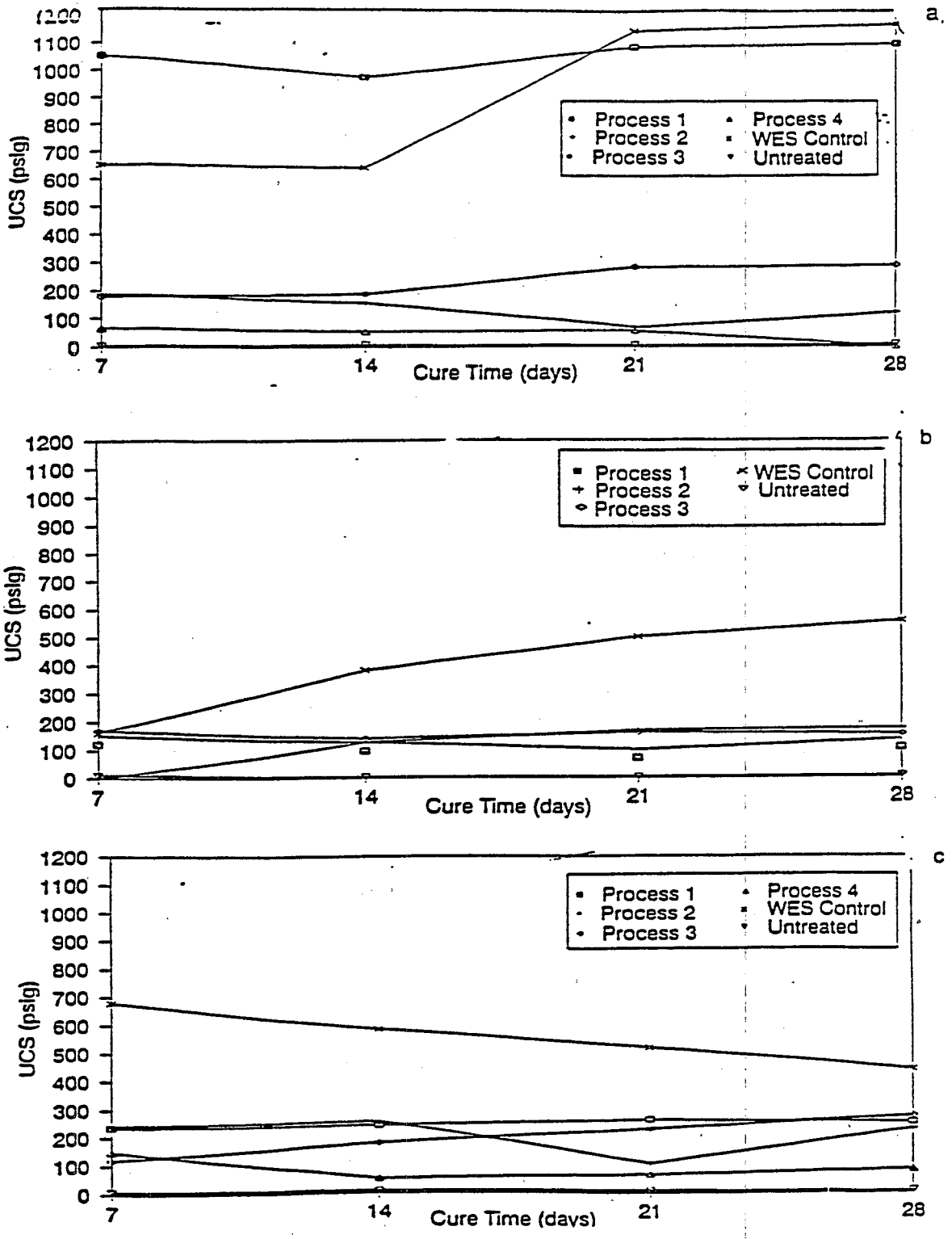


Figure 5.9. UCS and UCS after immersion. (a) Bottom ash, (b) APC residue, (c) Combined ash.

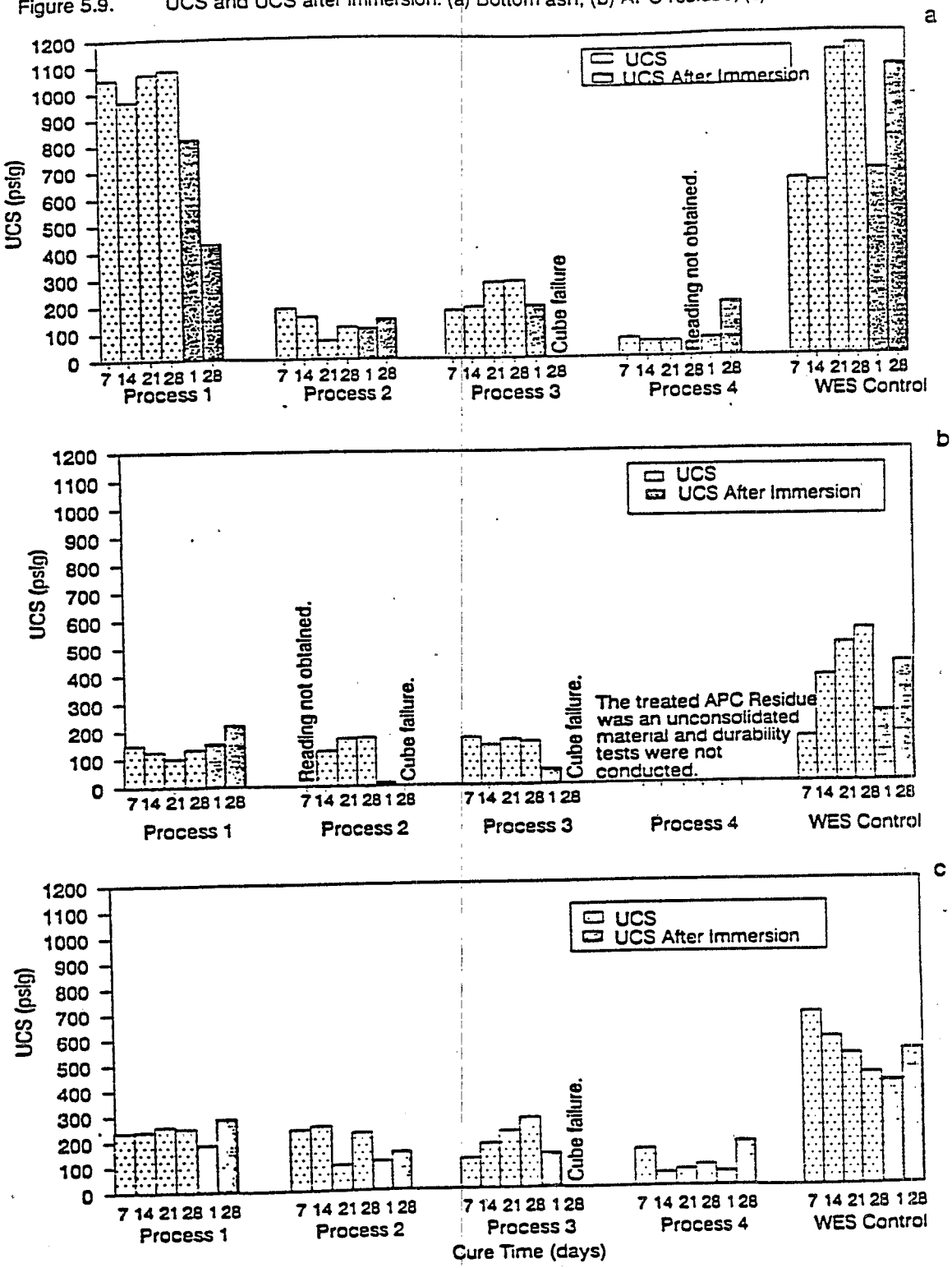
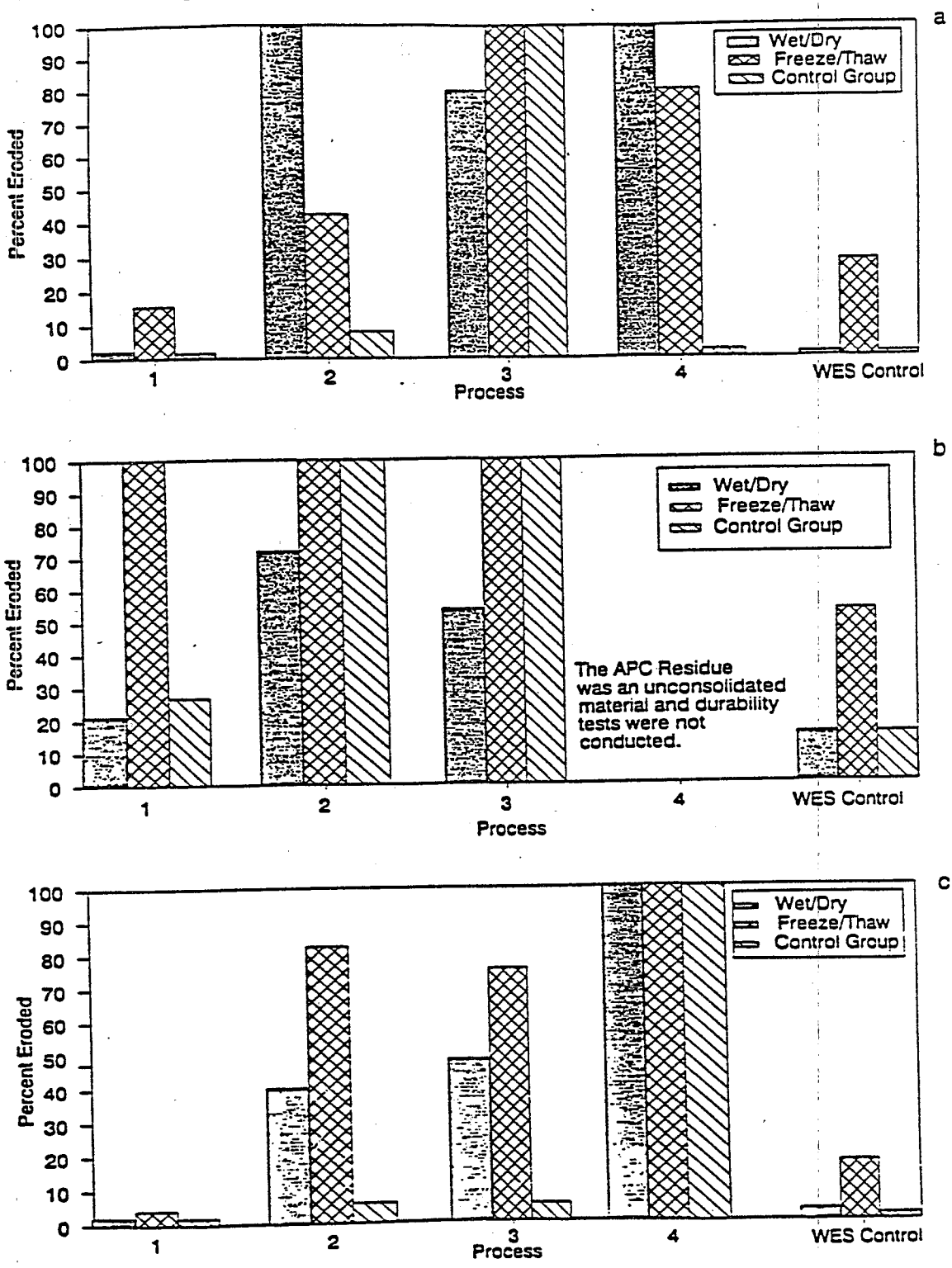


Figure 5.10. Cumulative weight loss (percent eroded) at the conclusion of wet/dry and freeze/thaw testing. (a) Bottom ash, (b) APC residue, (c) Combined ash.



6. RESULTS OF CHEMICAL ANALYSIS OF UNTREATED AND TREATED RESIDUES

6.1 COMPOSITION OF UNTREATED RESIDUES

Untreated residues were analyzed for specific elements of interest (e.g., principal components, trace metals of potential concern, or to expand the current MWC residue data base), anions and indicator parameters such as total organic carbon and total dissolvable solids. Several elements were analyzed both by USEPA recommended methods and by neutron activation analysis. This redundancy in analysis was carried out to examine the effectiveness of currently recommended methods on the complex MWC residue matrix. A complete list of chemical analyses and methods is presented in Chapter 2.1.

6.1.1 Elements, Anions and Indicator Parameters

NAA results for untreated residues, subsequent to residue preparation for this study, are initially presented in Figures 3.5 through 3.7 for discussion of residue homogeneity resulting from residue preparation procedures. Mean concentrations and coefficients of variation for these results are provided in Appendix A.1 through A.3. Elements analyzed are presented in order of increasing means and are grouped by relative concentrations for each residue type. A discussion of the box plot presentation format is provided in Chapter 2.4. These results indicate that the major elements, i.e., at concentrations greater than 1 wt %, present in the residues include potassium, zinc, sodium, aluminum, silicon, chloride and calcium for APC residue; potassium, chloride, aluminum, iron, calcium and silicon for bottom ash; and, potassium, sodium, chloride, aluminum, iron, calcium and silicon for combined ash.

Selected elements from the results presented in Figures 3.5 through 3.7 are regrouped to facilitate direct comparison of the composition of the different residue types and presented in Figures 6.1 and 6.2. These results are augmented in Figures 6.3 and 6.4 with the presentation of results from SW-846 analyses for selected elements and parameters not assayed for by NAA. Bromine, chloride, cadmium, potassium, zinc, arsenic, and tin were present in greater concentrations in the APC residue than either the bottom ash or combined ash. Aluminum, chromium, copper, iron, silicon, and nickel were present in lesser concentrations in APC residue than either the bottom ash or combined ash. These results are consistent with the metallic species exhibiting the greatest volatility during the combustion process being enriched in the APC residue. Sulfate, chloride, calcium and total dissolvable solids (TDS) were present in greater concentration in the APC residue than in the bottom or combined residue, with the exception of one outlier assay for sulfate in the bottom ash. These results are consistent with the functioning of the APC devices which recover acid gases from the combustion gases through neutralization with lime (calcium oxide) to form calcium sulfate and calcium chloride salts. No explanation is apparent for

TOC and COD to be the greatest in the combined ash. Significantly, the effect of APC residue on the chemical composition of combined ash is masked by the intrinsic heterogeneity of the residues and dilution effects. Thus, the mean values for most elements were not statistically differentiated between the bottom ash and combined ash used in this study. However, for most elements the variability associated with the combined ash composition was greater than that associated with either the bottom ash or APC residue. The APC residue had the greatest degree of homogeneity for most elements. This most likely results from the APC residue having the most uniform and finest particle size distribution (see Chapter 5.5). Combined ash most likely has the greatest degree of variability because of imperfect mixing during the blending of bottom ash with APC residue by the MWC facility.

Analysis of the total concentration of chloride, sulfate and total dissolvable solids (TDS) in the solid matrices of the untreated and treated residues was extremely difficult. Table 6.1 presents the originally assumed total assay (see Chapter 2.1), neutron activation, distilled water leach test and availability leach test results for the untreated residues. Chloride concentration was underestimated by the assumed total assay. The highest concentration results were obtained by the availability leach test for bottom ash and combined ash, and by the distilled water leach test for the APC residue. The APC residue results were most likely a reflection of the greater degree of solubility of the total matrix and the need for multiple extractions for complete release to the solution phase. The bottom ash and combined ash results are a consequence of the more aggressive nature of the availability leach test extractant (dilute nitric acid) and the more stable solid matrix of these residues.

Sulfate results varied by greater than one order of magnitude. The total assay and distilled water leach test results reflected the limited solubility of sulfate in alkaline aqueous solution at low liquid to solid ratios. This was because both the total assay and the distilled water leach test employed distilled water as the extractant for the alkaline residues. The liquid to solid ratio was 10 to 1 for the total assay and four serial extractions at 10 to 1 each, for the distilled water leach test.

The TDS results also were variable. It would be expected that the distilled water leach test results would be greater than or equal to the total assay. This was the case for the bottom ash and combined ash. The results for the APC residue were not statistically significantly different (.80 level) because of the high degree of variability associated with the distilled water leach test results.

6.1.2 PCDDs and PCDFs

APC residue, bottom ash and combined ash were assayed for PCDDs and PCDFs after residue preparation. These assays were carried out to address concerns over the potential for MWC residues to contain concentrations of these organic species which would be great enough to cause human health or environmental impacts. Each residue type was assayed in triplicate. Results of these assays and calculation of 2,3,7,8-TCDD toxicity equivalents (ug/g) are presented in Table 6.2 through 6.4. 2, 3, 7, 8 -

TCDD toxicity equivalents were calculated by the USEPA method [US EPA, 1987]. 2,3,7,8-TCDD toxicity equivalents ranged between 0.54 and 0.62, 0.01 and 0.06, and, 0.06 and 0.07 ng/g for APC residue, bottom ash and combined ash, respectively. These results were all below the currently recommended action limits for dioxins in residential soils. Nessel also has reported that PCDDs bind extremely tenaciously to incinerator APC residues making them not bioavailable (Nessel, 1992).

6.2 COMPOSITION OF TREATED RESIDUES AND VENDOR ADDITIVES

6.2.1 Composition of Vendor Additives

Processes evaluated during this study included the blending of proprietary and non-proprietary S/S additives with the MWC residues. Each process additive was sampled and analyzed for primary constituents and trace species of concern. These analyses were carried out to determine whether compositional changes and negative treatment effects (e.g., increased leaching) when observed were a consequence of process additives. Detailed analysis of vendor additives is not presented here in order to preserve the proprietary nature of the processes. A summary of the relative proportions of process additives for each process type and residue application is presented in Table 6.5. All processes, except Process 4 applied to APC residue and combined ash, included an additive which contained calcium as a principal constituent. These additives are listed as "Additive 1." Principal elemental components of each of these calcium based additives is presented in Table 6.6. In addition to the major elements which contribute to pozzolan formation (aluminum, calcium and silicon), iron, potassium, sodium and sulfate are present in some of these additives in significant proportions. The quantities added were considered great enough to potentially effect the gross composition and release characteristics of the treated products. This was considered the case when greater than 10% of the element in the treated residue resulted from addition of a process additive. The contribution of each of these elements to the total composition of the treated residue is summarized in Table 6.7. All processes except Process 4 applied to APC residue resulted in substantial additions of calcium relative to calcium content of the untreated residue. Greater than 50% of the sodium in all residue types treated by Process 2 resulted from addition of the process additives. Between 38 and 50% of the potassium in all residue types treated by Process 3 resulted from process additives. Furthermore, 12 and 13% of the sulfate in the treated bottom ash and combined ash (Process 3), respectively, resulted from the process additives. These contributions from process additives were reflected in the results from the leaching tests carried out on treated residues (refer to Chapter 7).

6.2.2 Composition of Treated Residues

Results of NAA and SW-846 analyses of treated residues for aluminum, cadmium, chromium, copper, chloride and zinc are presented in Figures 6.5 through 6.10. Results from both analytical

methods as well as for untreated residues are presented side by side for comparison (Refer to Chapter 2 for an explanation of the analytical methods employed). Results of NAA for calcium, potassium and sodium are presented in Figures 6.11 and 6.12 (SW-846 methods were not carried out on solid samples for these elements). Results of SW-846 analysis for lead are presented in Figure 6.13 (NAA can not be used for lead analysis). Results for aluminum, cadmium, chromium and copper indicate few discernable concentration differences between the untreated and treated residues. This is because of either the relatively similar elemental content of the process additives relative to the residues (aluminum), the relatively low total concentration of the element in both untreated and treated residues (cadmium, chromium, copper) and, or, the high degree of variability associated with the residue composition (bottom ash and combined ash: copper, chromium.). The specific exception to this was for aluminum in the APC residue treated by the WES Control (NAA), which indicated an unreasonably low concentration. The reason for this is unclear.

Chloride and zinc results most clearly reflected the dilution effects of the treatment processes on elements principally contained in the residues because of their relatively high concentrations and low variability in the residues (refer to Chapter 3.2). Calcium and potassium results clearly indicate the substantial quantity of these elements contributed by additives for Process 3 applied to bottom ash and combined ash (see Table 6.7). Sodium results for all three residue types show the substantial contribution of this element by Process 2 additives to the total composition.

6.2.3 Comparison of SW-846 and Neutron Activation Analyses

The ratio of SW-846 divided by NAA results multiplied by 100 are presented for each analysis of untreated and treated residue (aluminum, cadmium, chloride, chromium, copper and zinc) in Figures 6.14 through 6.16. SW-846 analyses generally underestimated the total elemental composition relative to NAA for aluminum, chromium and zinc. These results reflect the extent to which the listed elements are sequestered in the silicate matrix of the residue which is recalcitrant to nitric acid digestion. This effect is most severe for chromium where less than 40% recovery was achieved during the SW-846 digestion. This effect also most likely is occurring for lead because of its potential for incorporation in silicate matrices but could not be verified by NAA. Cadmium results reflect that it was not incorporated in a matrix recalcitrant to the nitric acid digestion. Chloride results reflect the difficulties associated with the total assay discussed in Chapter 6.2.1. Copper results most likely reflect both the high degree of copper content variability (Chapter 3.2) and incorporation into the silicate matrix.

6.2.4 Analysis of Corrections for Process Dilution Effects

Chloride and zinc concentrations from analysis of treated residues by NAA were used to estimate the accuracy of using calculated process dilution factors for correction of treated residue results (total and

leaching potential; typically [mg/kg ash]). This was accomplished by multiplying the measured concentration in the treated residue by the process dilution factor (Chapter 4) for the specific treatment process employed. Chloride and zinc were selected for this estimation because of their relatively low variability and significant concentration in untreated residues (see Chapter 3.2) and insignificant concentrations in the process additives. Results of the calculated concentrations for treated residues are presented in Figure 6.17. Untreated residue concentrations are presented for comparison. Ideal results would indicate that there was no difference between the corrected treated residue concentrations and the measured untreated residue concentrations. This was true for bottom ash and combined ash. APC residue treated by Process 1,2,3 and WES Control indicated that application of process dilution factors for these cases may result in overcompensation by approximately 30%. This effect was a consequence of the hydroscopic nature and high free moisture content of these treated residues.

Table 6.1. Comparison of chloride, sulfate and TDS results for untreated MWC residues based on total analysis, neutron activation analysis, distilled water leach test, and availability leach test.

	"Total"[1]	NAA[2]	DWLT[3]	ALT[4]
APC Residue				
Chloride	184,000	168,000	217,000	146,000
Sulfate	6,340	NA[5]	41,000	88,000
TDS	349,000	NA	289,000	NA
Bottom Ash				
Chloride	20,400	24,300	26,900	32,600
Sulfate	2,500	NA	1,160	29,300
TDS	34,700	NA	63,300	NA
Combined Ash				
Chloride	14,100	28,900	30,400	35,100
Sulfate	1,430	NA	2,300	37,200
TDS	48,300	NA	63,900	NA

[1]Total - USEPA method, see Chapter 2.1
[2]NAA - Neutron activation analysis
[3]DWLT - Distilled water leach test, extracts (1+2) + (3+4)
[4]ALT - Availability leach test
[5]NA - Not analyzed

Table 6.2. PCDD/PCDF assay results for untreated APC residue (ng/g and toxicity equivalents; "A", "B" and "C" refer to replicates).

		APC Residue					
PCDD/PCDF Homolog	Toxicity Equivalency Factor	Conc. (ng/g) A	Toxicity Equivalent A	Conc. (ng/g) B	Toxicity Equivalent B	Conc. (ng/g) C	Toxicity Equivalent C
2, 3, 7, 8-TCDD	1.00000	0.08500	0.08500	0.08600	0.08600	0.08400	0.08400
Other TCDD	0.01000	0.79200	0.00792	0.98200	0.00982	0.82500	0.00825
1, 2, 3, 7, 8-PCDD	0.50000	0.20200	0.10100	0.22300	0.11150	0.22800	0.11440
Other PCDD	0.00500	0.92500	0.00463	1.26400	0.00632	0.82200	0.00411
1, 2, 3, 4, 7, 8-HxCDD	0.04000	0.05100	0.00204	0.05900	0.00236	0.06000	0.00240
1, 2, 3, 6, 7, 8-HxCDD	0.04000	0.07800	0.00312	0.08600	0.00344	0.08200	0.00328
1, 2, 3, 7, 8, 9-HxCDD	0.04000	0.11900	0.00476	0.13900	0.00556	0.14300	0.00572
Other HxCDD	0.00040	0.57200	0.00023	0.67700	0.00027	0.65000	0.00026
1, 2, 3, 4, 6, 7, 8-HpCDD	0.00100	0.53000	0.00053	0.58100	0.00058	0.59900	0.00060
Other HpCDD	0.00001	0.49000	0.00000	0.53400	0.00001	0.55000	0.00001
OCDD	0.00000	0.91100	0.00000	0.74000	0.00000	0.79900	0.00000
2, 3, 7, 8-PCDF	0.10000	1.92300	0.19230	2.26200	0.22620	2.22900	0.22290
Other TCDF	0.00100	7.25500	0.00726	12.86700	0.01287	7.33700	0.00734
1, 2, 3, 7, 8-PCDF	0.10000	0.53600	0.05360	0.68900	0.06890	0.59700	0.05970
2, 3, 4, 7, 8-PCDF	0.10000	0.61300	0.06130	0.68400	0.06840	0.64800	0.06480
Other PCDF	0.00100	2.63600	0.00264	5.11000	0.00511	1.96200	0.00196
1, 2, 3, 4, 7, 8-HxCDF	0.01000	0.60000	0.00600	0.59100	0.00591	0.65900	0.00659
1, 2, 3, 6, 7, 8-HxCDF	0.01000	0.78600	0.00786	0.80500	0.00805	0.73800	0.00738
1, 2, 3, 7, 8, 9-HxCDF	0.01000	0.24700	0.00247	0.25100	0.00251	0.33700	0.00337
1, 2, 4, 6, 7, 8-HxCDF	0.01000	0.03200	0.00032	0.01800	0.00018	0.03900	0.00039
Other HxCDF	0.00010	0.58700	0.00006	1.09400	0.00011	0.11600	0.00001
1, 2, 3, 4, 6, 7, 8-HpCDF	0.00100	0.59900	0.00060	0.62900	0.00063	0.63500	0.00064
1, 2, 3, 4, 7, 8, 9-HpCDF	0.00100	0.05200	0.00005	0.06100	0.00006	0.06700	0.00007
Other HpCDF	0.00001	0.16200	0.00000	0.18100	0.00000	0.17800	0.00000
OCDF	0.00000	0.12900	0.00000	0.13000	0.00000	0.13200	0.00000
Total Toxicity Equivalent			0.54368		0.62479		0.599777

Table 6.3. PCDD/PCDF assay results for untreated bottom ash (ng/g and toxicity equivalents; "A", "B" and "C" refer to replicates).

		Bottom Ash					
PCDD/PCDF Homolog	Toxicity Equivalency Factor	Conc. (ng/g) A	Toxicity Equivalent A	Conc. (ng/g) B	Toxicity Equivalent B	Conc. (ng/g) C	Toxicity Equivalent C
2, 3, 7, 8-TCDD	1.00000	0.00700	0.00700	0.00000	0.00000	0.00800	0.00800
Other TCDD	0.01000	0.06300	0.00063	0.00700	0.00007	0.08600	0.00086
1, 2, 3, 7, 8-PCDD	0.50000	0.02300	0.01150	0.01000	0.00500	0.02500	0.01250
Other PCDD	0 00500	0.10000	0.00050	0.00000	0.00000	0.12200	0.00061
1, 2, 3, 4, 7, 8-HxCDD	0.04000	0.00800	0.00032	0.00500	0.00020	0.00700	0.00028
1, 2, 3, 6, 7, 8-HxCDD	0.04000	0.01500	0.00060	0.00800	0.00032	0.01800	0.00072
1, 2, 3, 7, 8, 9-HxCDD	0.04000	0.02400	0.00096	0.01000	0.00040	0.02200	0.00088
Other HxCDD	0.00040	0.13200	0.00005	0.04400	0.00002	0.11600	0.00005
1, 2, 3, 4, 6, 7, 8-HpCDD	0.00100	0.32000	0.00032	0.14700	0.00015	0.23900	0.00024
Other HpCDD	0.00001	0.36100	0.00000	0.17700	0.00000	0.26600	0.00000
OCDD	0.00000	2.97400	0.000000	1.54300	0.00000	1.92800	0.00000
2, 3, 7, 8-PCDF	0.10000	0.16600	0.01660	0.05200	0.00520	0.22200	0.02200
Other TCDF	0.00100	0.69100	0.00069	0.23600	0.00024	1.08300	0.00108
1, 2, 3, 7, 8-PCDF	0.10000	0.03700	0.00370	0.00900	0.00090	0.04900	0.00490
2, 3, 4, 7, 8-PCDF	0.10000	0.05200	0.00520	0.00900	0.00090	0.06900	0.00690
Other PCDF	0.00100	0.26700	0.00027	0.07000	0.00007	0.38800	0.00039
1, 2, 3, 4, 7, 8-HxCDF	0.01000	0.05100	0.00051	0.01000	0.00010	0.06500	0.00065
1, 2, 3, 6, 7, 8-HxCDF	0.01000	0.06400	0.00064	0.01100	0.00011	0.07200	0.00072
1, 2, 3, 7, 8, 9-HxCDF	0.01000	0.02300	0.00023	0.00700	0.00007	0.02900	0.00029
1, 2, 4, 6, 7, 8-HxCDF	0.01000	0.00700	0.00007	0.00000	0.00000	0.00300	0.00003
Other HxCDF	0.00010	0.09100	0.00001	0.01900	0.00000	0.09100	0.00001
1, 2, 3, 4, 6, 7, 8-HpCDF	0.00100	0.08300	0.00008	0.02300	0.00002	0.09000	0.00009
1, 2, 3, 4, 7, 8, 9-HpCDF	0.00100	0.00700	0.00001	0.00000	0.00000	0.00600	0.00001
Other HpCDF	0.00001	0.06000	0.00000	0.02500	0.00000	0.04600	0.00000
OCDF	0.00000	0.06200	0.00000	0.02600	0.00000	0.05300	0.00000
Total Toxicity Equivalent			0.04989		0.01377		0.06140

Table 6.4. PCDD/PCDF assay results for combined ash (ng/g and toxicity equivalents ; "A", "B" and "C" refer to replicates)

		Combined Ash					
PCDD/PCDF Homolog	Toxicity Equivalency Factor	Conc. (ng/g) A	Toxicity Equivalent A	Conc. (ng/g) B	Toxicity Equivalent B	Conc. (ng/g) C	Toxicity Equivalent C
2, 3, 7, 8-TCDD	1.00000	0.00800	0.00800	0.01000	0.01000	0.00700	0.00700
Other TCDD	0.01000	0.08900	0.00089	0.10000	0.00100	0.07900	0.00079
1, 2, 3, 7, 8-PCDD	0.50000	0.02400	0.01200	0.02400	0.01200	0.02000	0.01000
Other PCDD	0.00500	0.13500	0.00068	0.15500	0.00078	0.11000	0.00055
1, 2, 3, 4, 7, 8-HxCDD	0.04000	0.00700	0.00028	0.00700	0.00028	0.00800	0.00032
1, 2, 3, 6, 7, 8-HxCDD	0.04000	0.01400	0.00056	0.01200	0.00048	0.01200	0.00048
1, 2, 3, 7, 8, 9-HxCDD	0.04000	0.02200	0.00088	0.02000	0.00080	0.01900	0.00076
Other HxCDD	0.00040	0.10900	0.00004	0.10300	0.00004	0.09600	0.00004
1, 2, 3, 4, 6, 7, 8-HpCDD	0.00100	0.13900	0.00014	0.10200	0.00010	0.11900	0.00012
Other HpCDD	0.00001	0.12100	0.00000	0.09200	0.00000	0.10000	0.00000
OCDD	0.00000	0.35700	0.00000	0.22200	0.00000	0.26900	0.00000
2, 3, 7, 8-PCDF	0.10000	0.23000	0.02300	0.23600	0.02360	0.20500	0.02050
Other TCDF	0.00100	0.96900	0.00097	1.15500	0.00116	0.77800	0.00078
1, 2, 3, 7, 8-PCDF	0.10000	0.05000	0.00500	0.05500	0.00550	0.04800	0.00480
2, 3, 4, 7, 8-PCDF	0.10000	0.01300	0.00130	0.08000	0.00800	0.07200	0.00720
Other PCDF	0.00100	0.47400	0.00047	0.45600	0.00046	0.30300	0.00030
1, 2, 3, 4, 7, 8-HxCDF	0.01000	0.07300	0.00073	0.06800	0.00068	0.07100	0.00071
1, 2, 3, 6, 7, 8-HxCDF	0.01000	0.09500	0.00095	0.08200	0.00082	0.08700	0.00087
1, 2, 3, 7, 8, 9-HxCDF	0.01000	0.03800	0.00038	0.03300	0.00033	0.03100	0.00031
1, 2, 4, 6, 7, 8-HxCDF	0.01000	0.00300	0.00003	0.00400	0.00004	0.00300	0.00003
Other HxCDF	0.00010	0.10000	0.00001	0.11800	0.00001	0.04400	0.00000
1, 2, 3, 4, 6, 7, 8-HpCDF	0.00100	0.10500	0.00011	0.09600	0.00010	0.09700	0.00010
1, 2, 3, 4, 7, 8, 9-HpCDF	0.00100	0.00900	0.00001	0.01100	0.00001	0.00800	0.00001
Other HpCDF	0.00001	0.02900	0.00000	0.02600	0.00000	0.02900	0.00000
OCDF	0.00000	0.04300	0.00000	0.03700	0.00000	0.04300	0.00000
Total Toxicity Equivalent			0.05643		0.06618		0.05567

Table 6.5. Relative quantities of MWC residues and process additives in treated residues (% of treated residue as prepared).

Process	Ash	Additive 1	Additive 2	Additive 3	H_2O
APC Residue					
1	49.8	5[1]	0.5[1]	-	44.7
2	44.4	6.6[1]	2.3[2]	2.2[2,3]	44.4
3	42.6	21[4]	36[2,3]	-	-
4	75.8	9[2]	-	-	16.4
WES	45.4	13.6	-	-	40.9
Bottom Ash					
1	76	8[1]	0.8[2]	-	15.2
2	63.6	9.3[1]	3.4[2]	3.2[2,3]	20.5
3	56.2	28[4]	16[2,3]	-	-
4	85.1	4[2]	1[2,3]	-	9.6
WES	83	8.3	-	-	8.3
Combined Ash					
1	76	8[1]	0.8[2]	-	15.2
2	63.6	9.3[1]	3.4[2]	3.2[2,3]	20.5
3	55.5	28[4]	17[2,3]	-	-
4	85.1	4[2]	1[1]	-	9.6
WES	77.8	7.8	-	-	15.5

[1]Portland Cement, Type 1
[2]Proprietary Additive
[3]Liquid Additive
[4]Waste Pozzolan

Table 6.6 Principal components in calcium-based process additives (wt% ds).

	Process				
	1[1]	2[2]	3[2]	4[2]	WES[1]
Al	2.4	3.0	2.0	-	2.4
Ca	47.8	49.8	33.1	56	48.9
Fe	1.8	2.1	1.2	-	1.8
K	0.3	0.4	2.0	-	0.4
Si	7.0	7.0	4.4	-	6.8
Na	-	0.1	0.4	-	-
SO_4	0.8	-	1.0	-	0.8

(1)Portland cement, type 1
(2)Proprietary additive

Table 6.7. Significant contributions from process additives to total treated residue composition (% ds of element in treated residue contributed by process additives). Contributions greater than 10% of the total treated residue composition are indicated.

	% of Product from Additives				
	Process 1	Process 2	Process 3	Process 4	WES
APC Residue					
Al	15	22	42	-	34
Ca	14	20	36	-	34
Fe	25	33	25	-	47
K	-	-	38	-	-
Si	14	20	35	-	33
Na	-	55	-	-	-
SO_4	-	-	-	-	-
Bottom Ash					
Al	-	11	24	-	-
Ca	30	40	59	20	32
Fe	-	-	-	-	-
K	-	-	50	-	-
Si	-	-	16	-	-
Na	-	56	-	-	-
SO_4	-	-	13	-	-
Combined Ash					
Al	-	12	26	-	-
Ca	28	38	57	-	28
Fe	-	-	-	-	-
K	-	-	43	-	-
Si	-	-	14	-	-
Na	-	54	-	-	-
SO_4	-	-	12	-	-

Figure 6.1. Comparison of box plots of neutron activation analysis results for homogenized, untreated ash (<300 um, ground; 11 replicates, mg/kg ds).

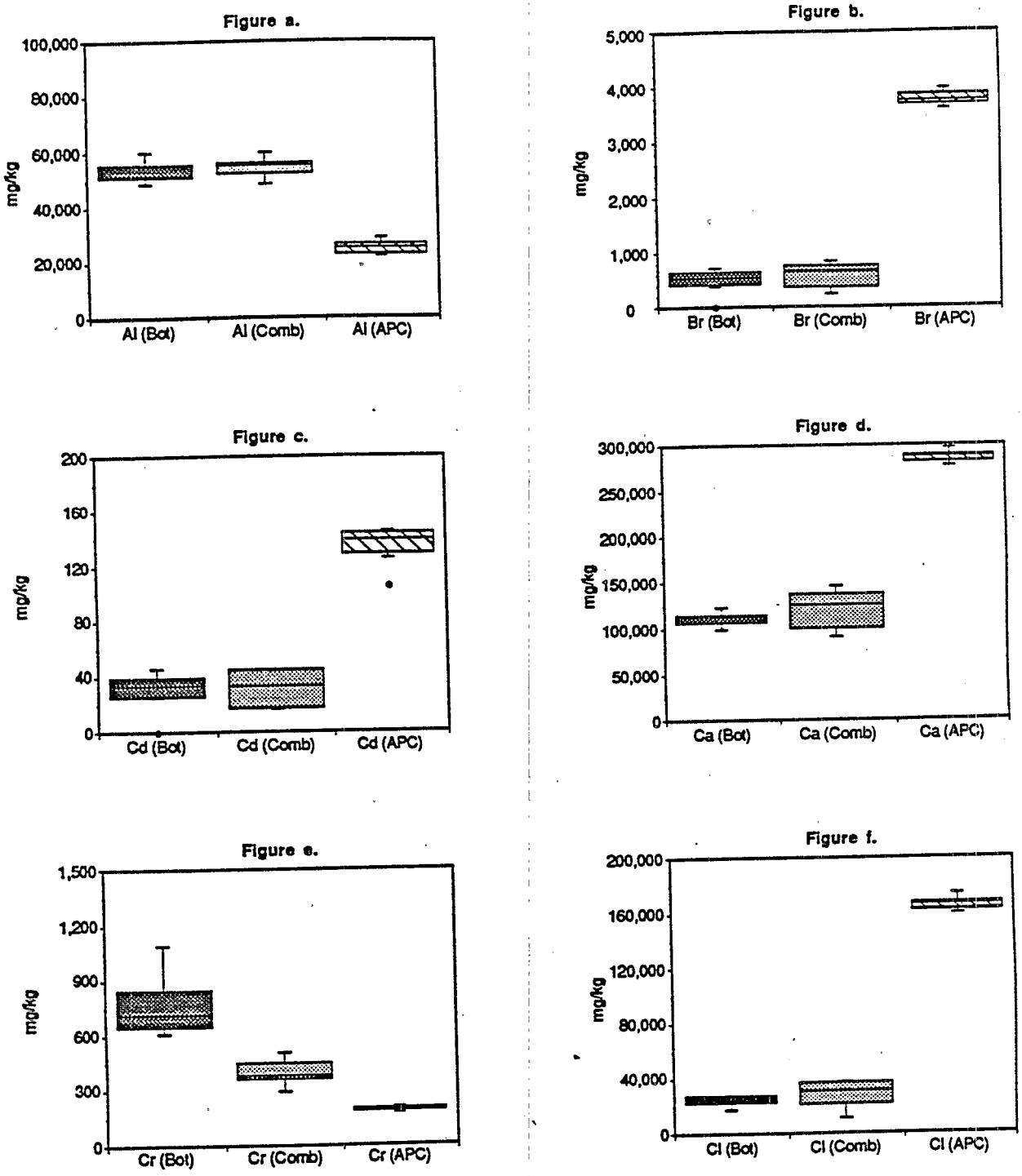
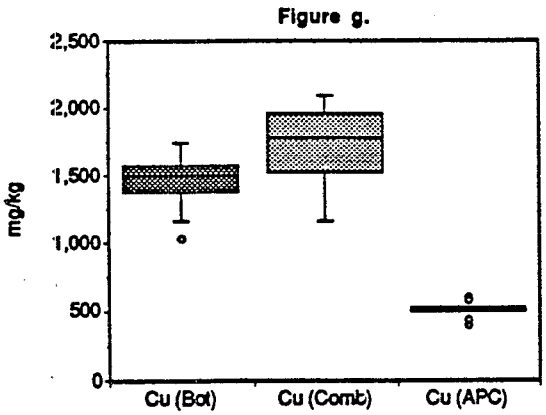
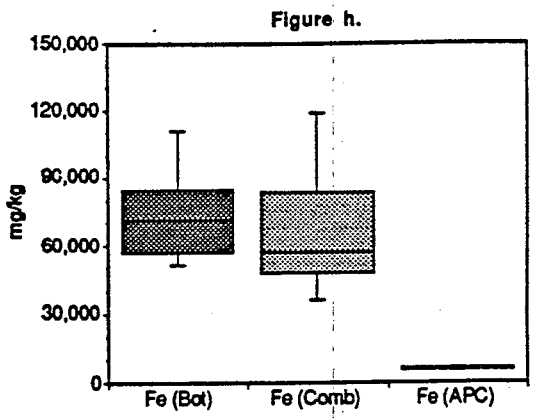
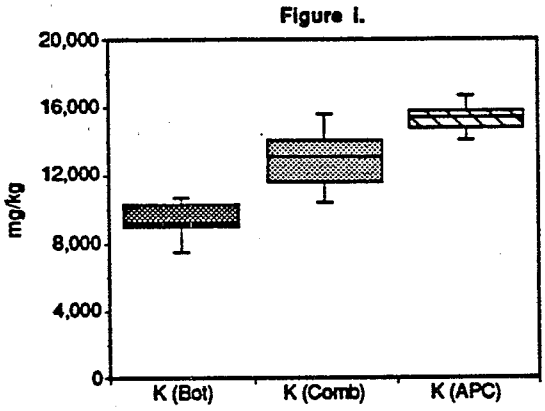
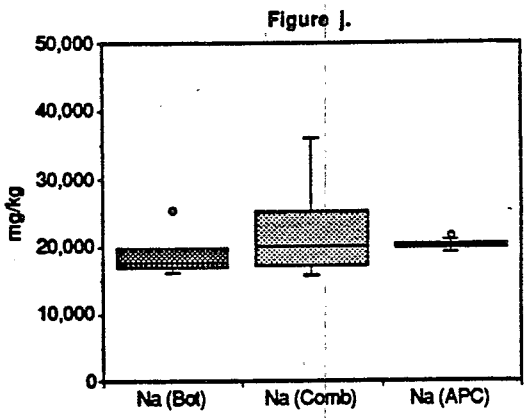


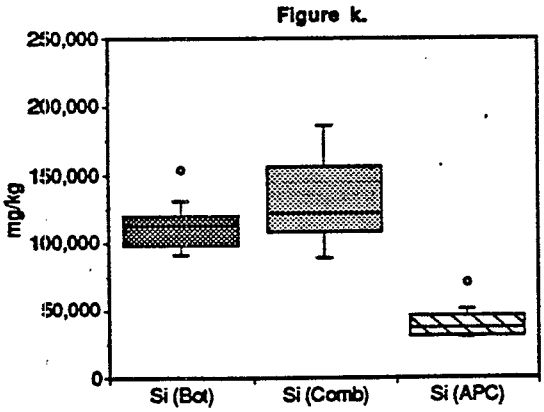
Figure 6.2. Comparison of box plots of neutron activation analysis results for homogenized, untreated ash (<300 um, ground; 11 replicates).











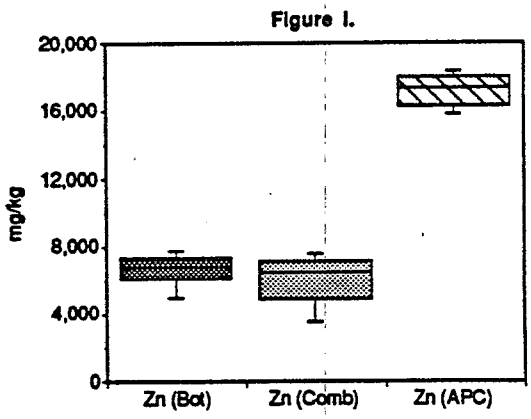


Figure 6.3. Untreated total composition by SW-846.

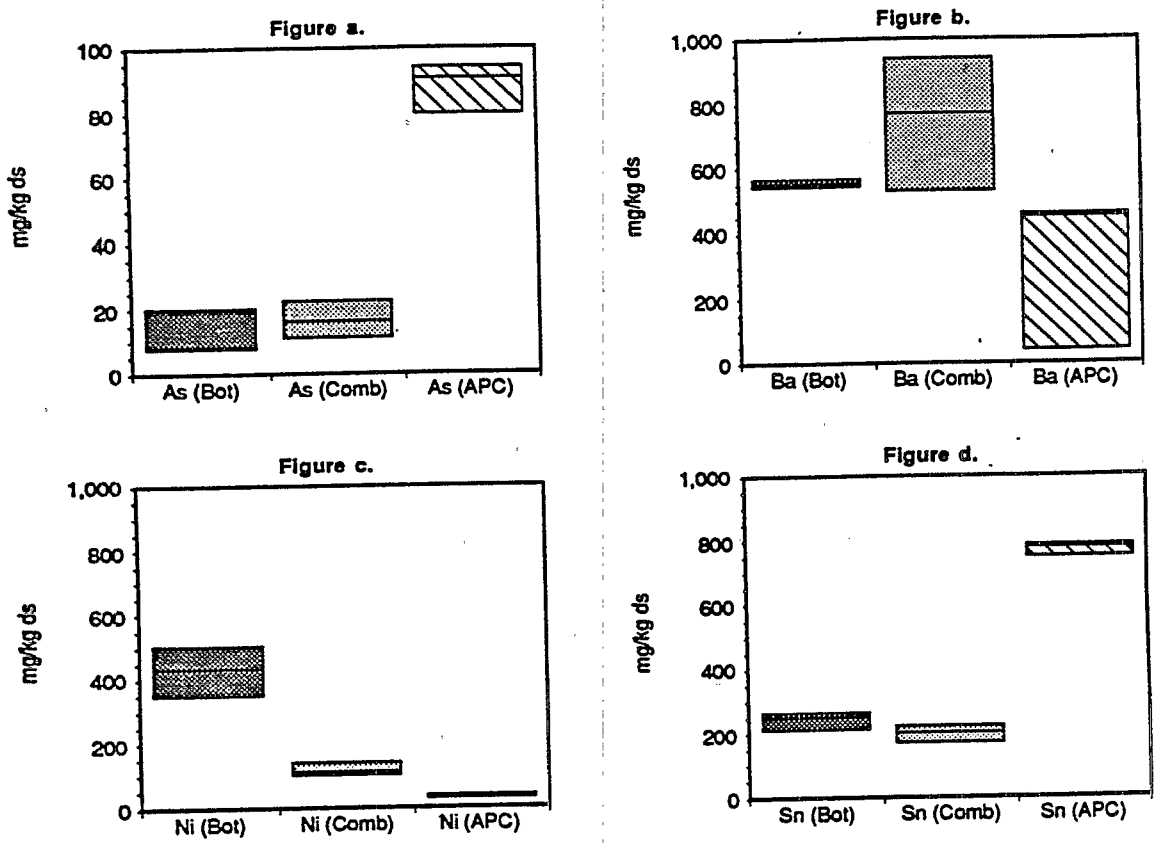


Figure 6.4. Untreated total composition (page 2) by SW-846.

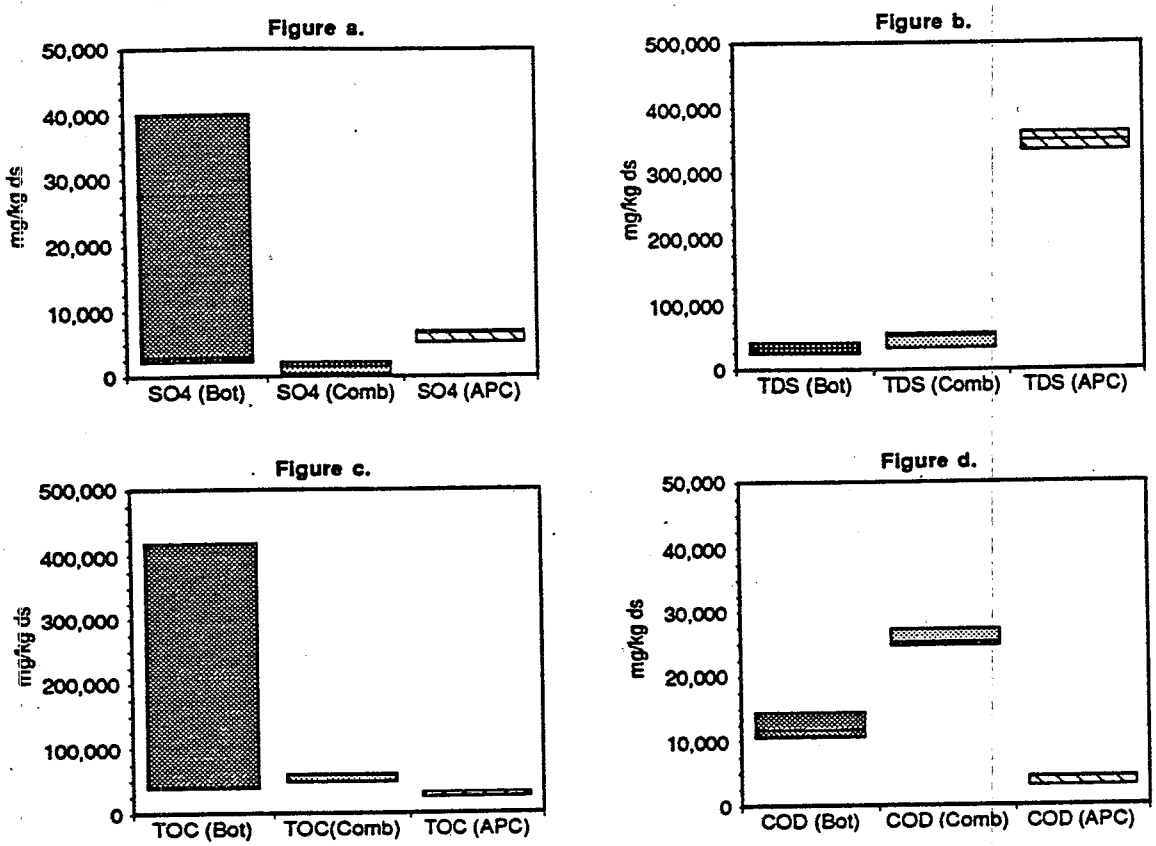
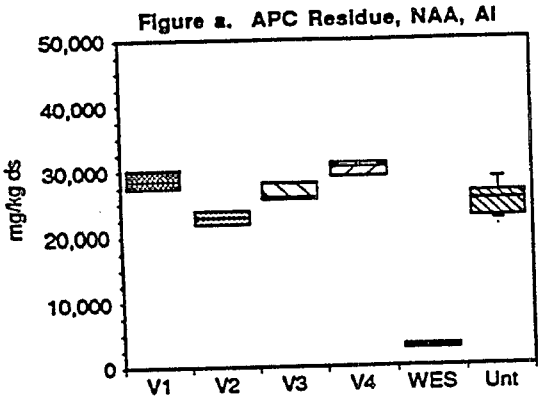
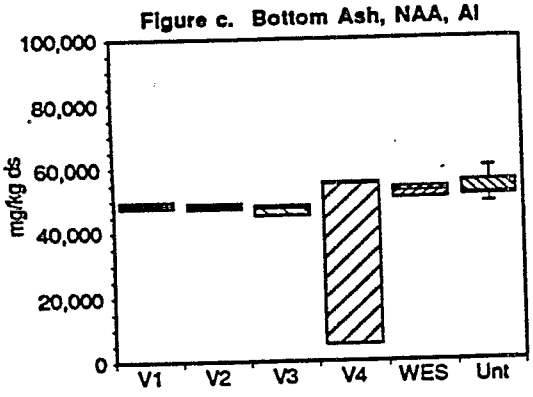
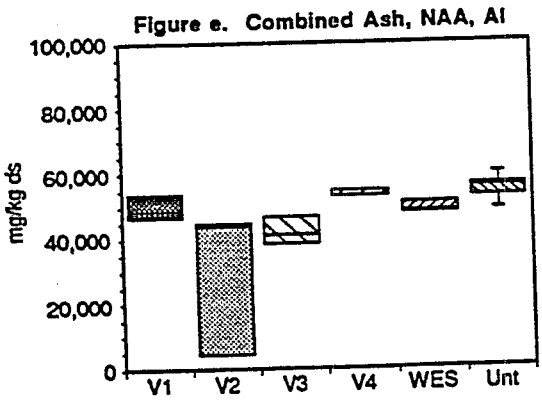


Figure 6.5. A comparison of total aluminum concentrations between NAA and SW-846 analysis methods.

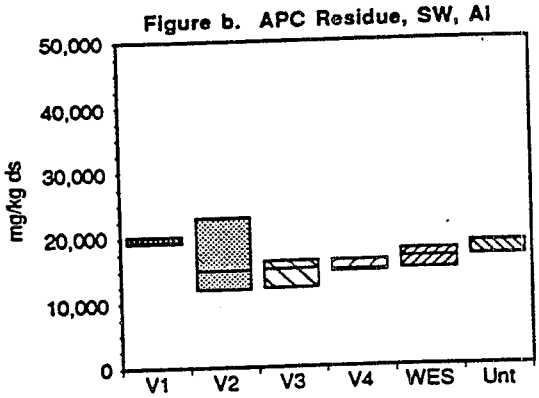
NAA

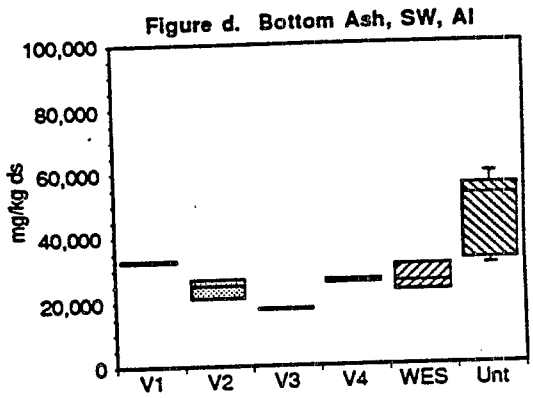






SW-846





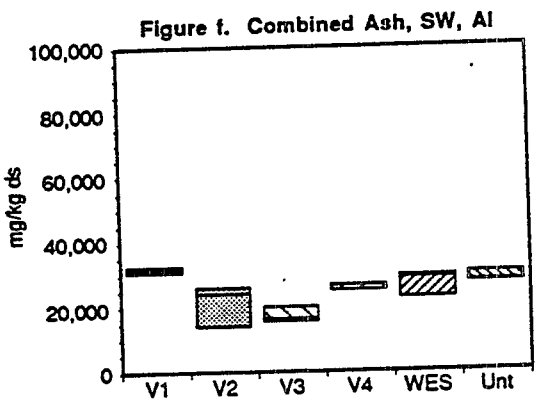
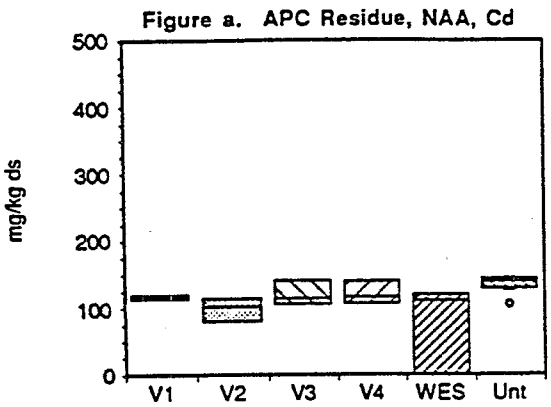
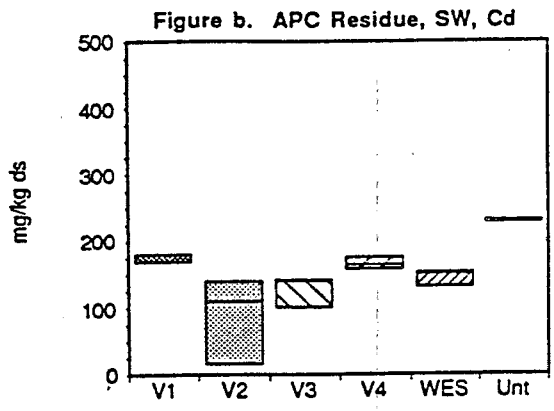


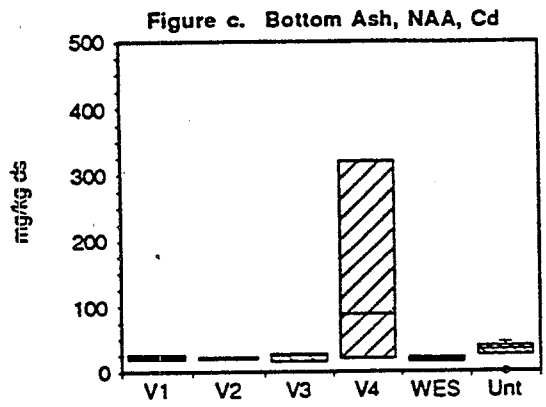
Figure 6.6. A comparison of total cadmium concentrations between NAA and SW-846 analysis methods.

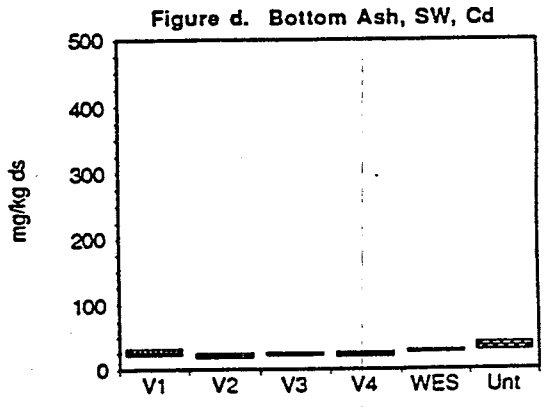
NAA

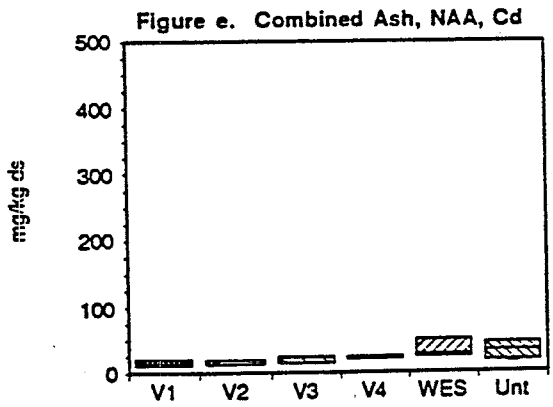
SW-846











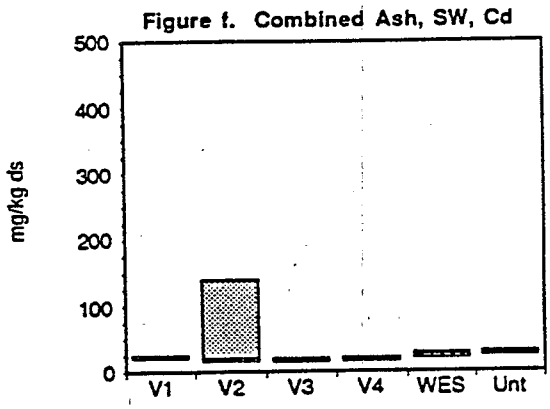
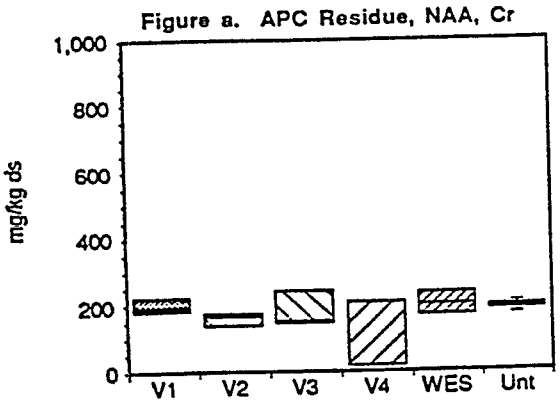
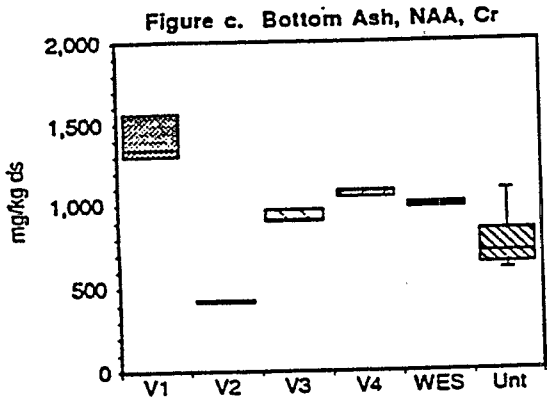
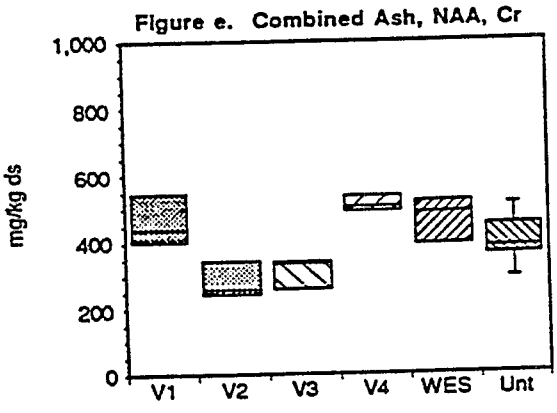


Figure 6.7. A comparison of total chromium concentrations between NAA and SW-846 analysis methods.

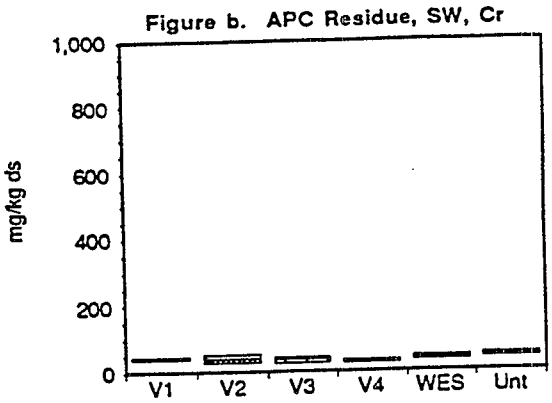
NAA

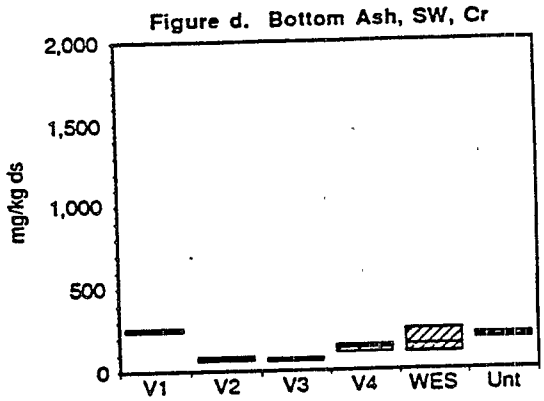






SW-846





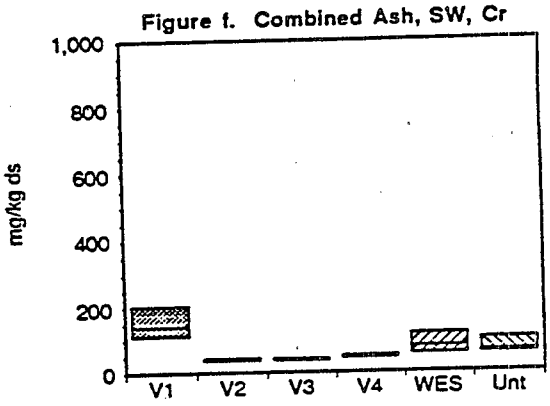
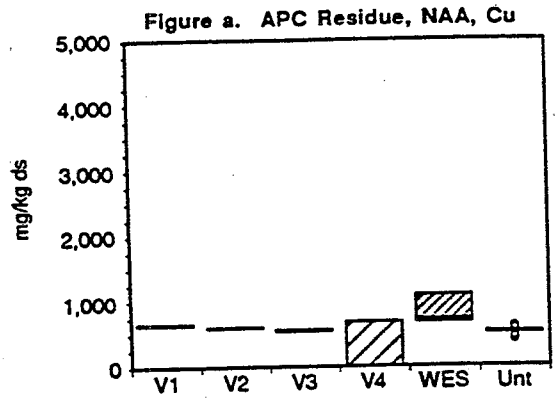
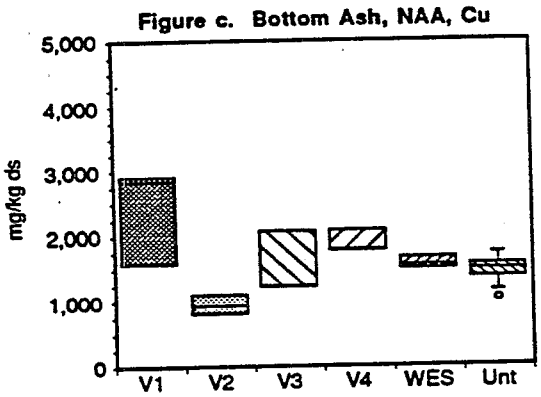
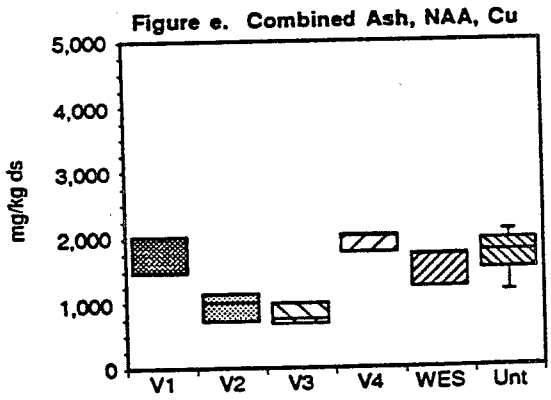


Figure 6.8. A comparison of total copper concentrations between NAA and SW-846 analysis methods.

NAA







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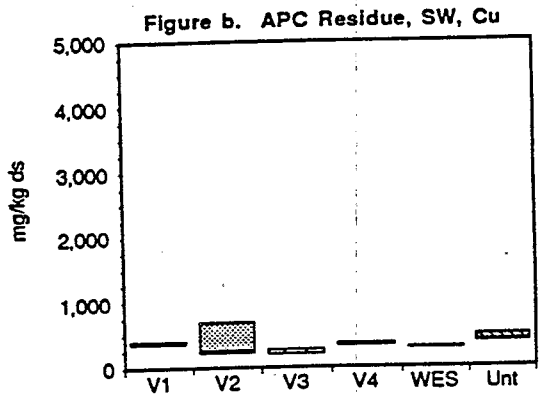
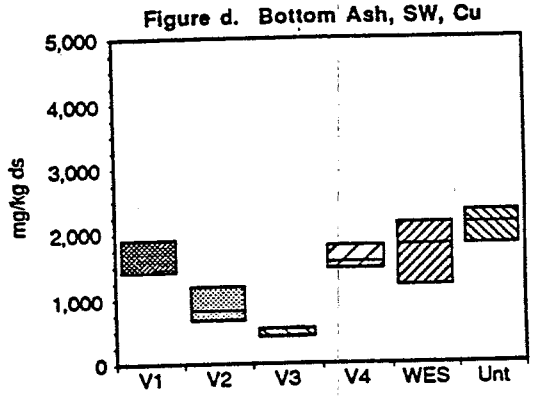




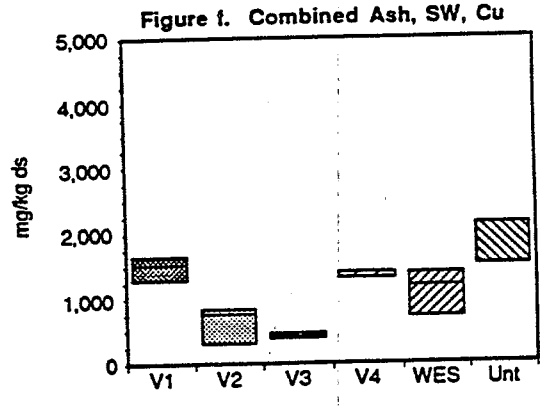


Figure 6.9. A comparison of total chloride concentrations between NAA and SW-846 analysis methods.

NAA

Figure a. APC Residue, NAA, Cl

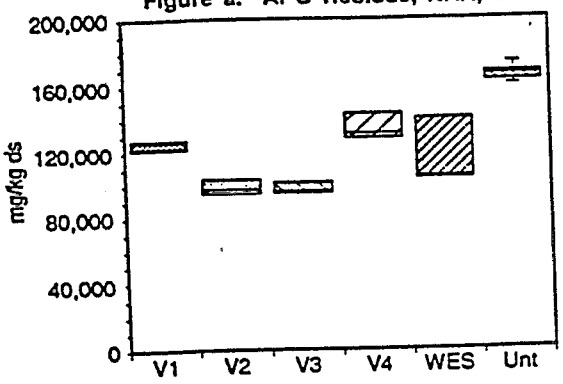


Figure c. Bottom Ash, NAA, Cl

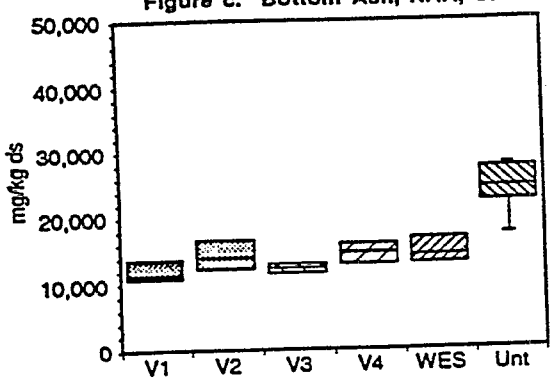
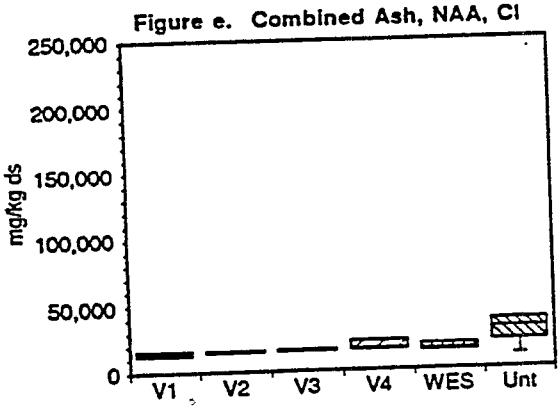


Figure e. Combined Ash, NAA, Cl



SW-846

Figure b. APC Residue, SW, Cl

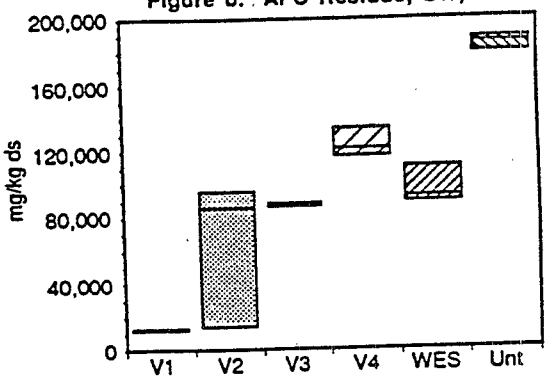


Figure d. Bottom Ash, SW, Cl

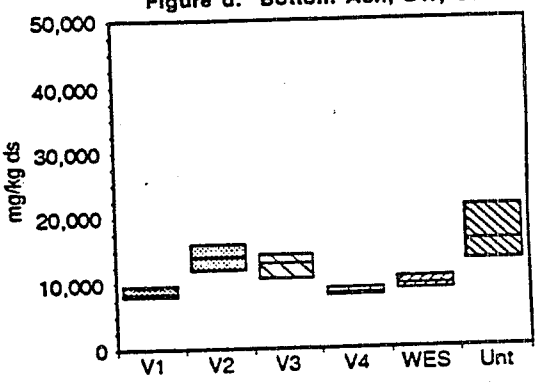


Figure f. Combined Ash, SW, Cl

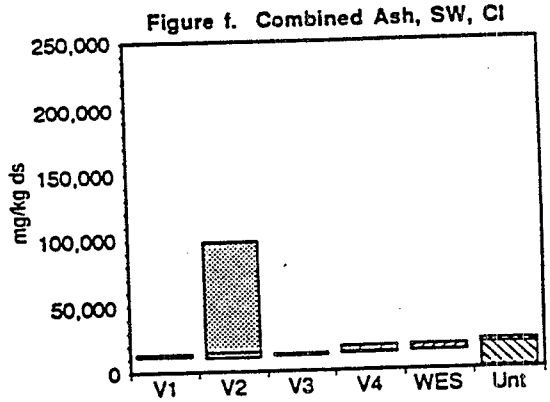


Figure 6.10. A comparison of total zinc concentrations between NAA and SW-846 analysis methods.

NAA

SW-846

Figure a. APC Residue, NAA, Zn

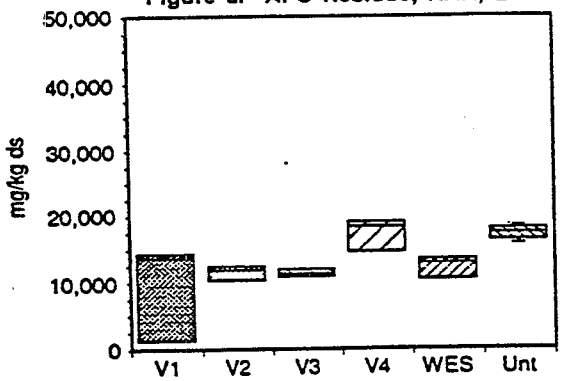


Figure b. APC Residue, SW, Zn

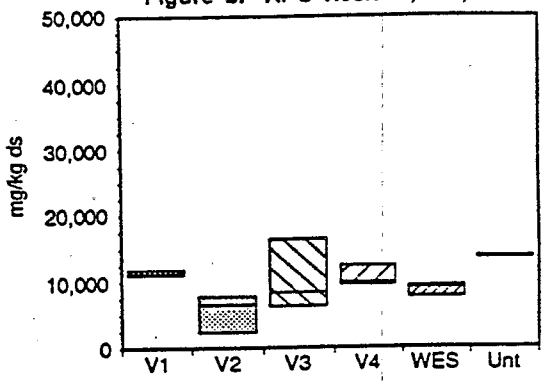


Figure c. Bottom Ash, NAA, Zn

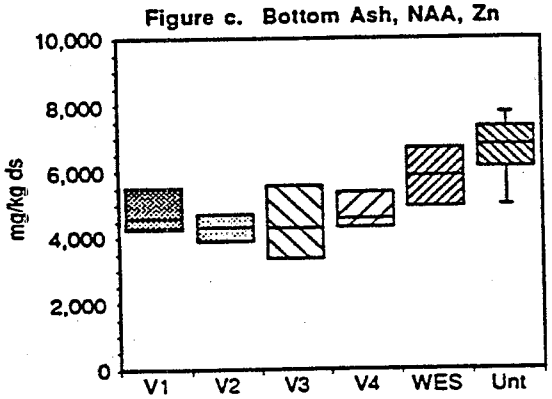


Figure d. Bottom Ash, SW, Zn

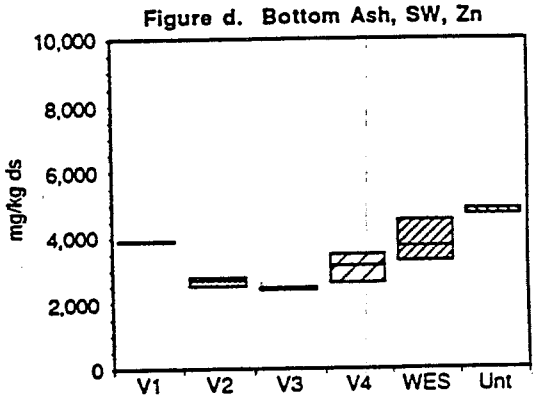


Figure e. Combined Ash, NAA, Zn

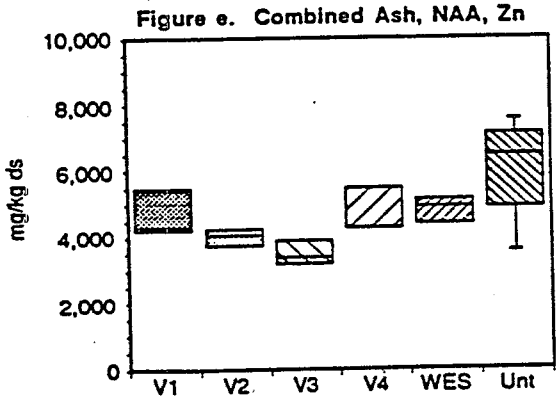


Figure f. Combined Ash, SW, Zn

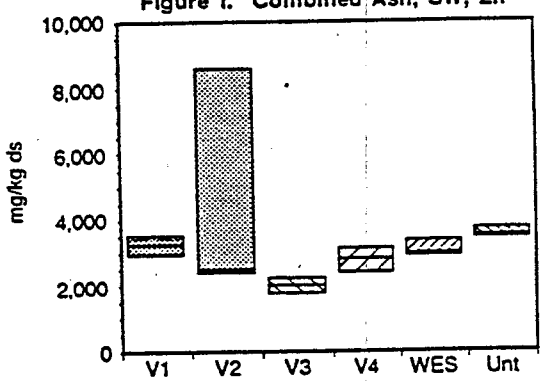


Figure 6.11. Calcium Total analysis by NAA.

Figure a. APC Residue, Ca

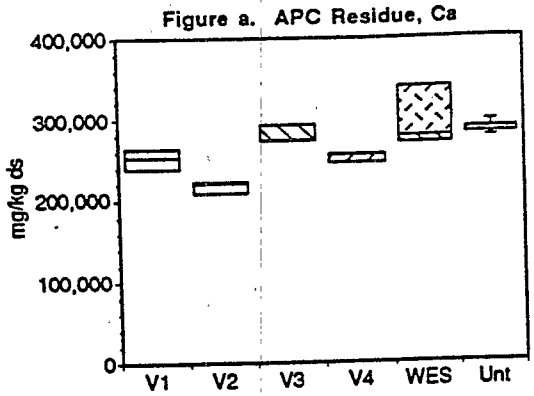


Figure b. Bottom Ash, Ca

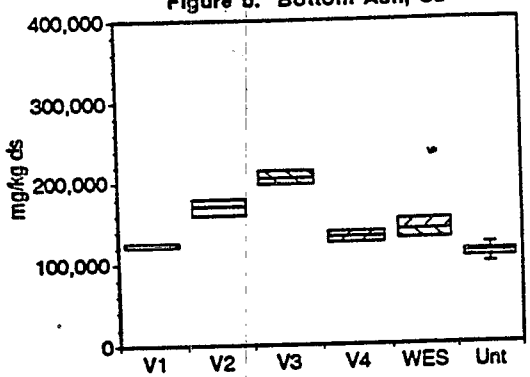


Figure c. Combined Ash, Ca

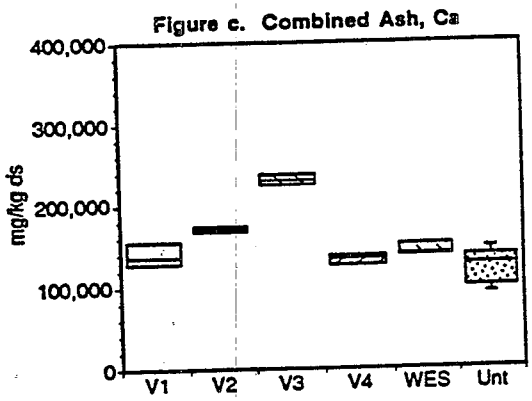


Figure 6.12. Potassium and sodium total analysis by neutron activation analysis.

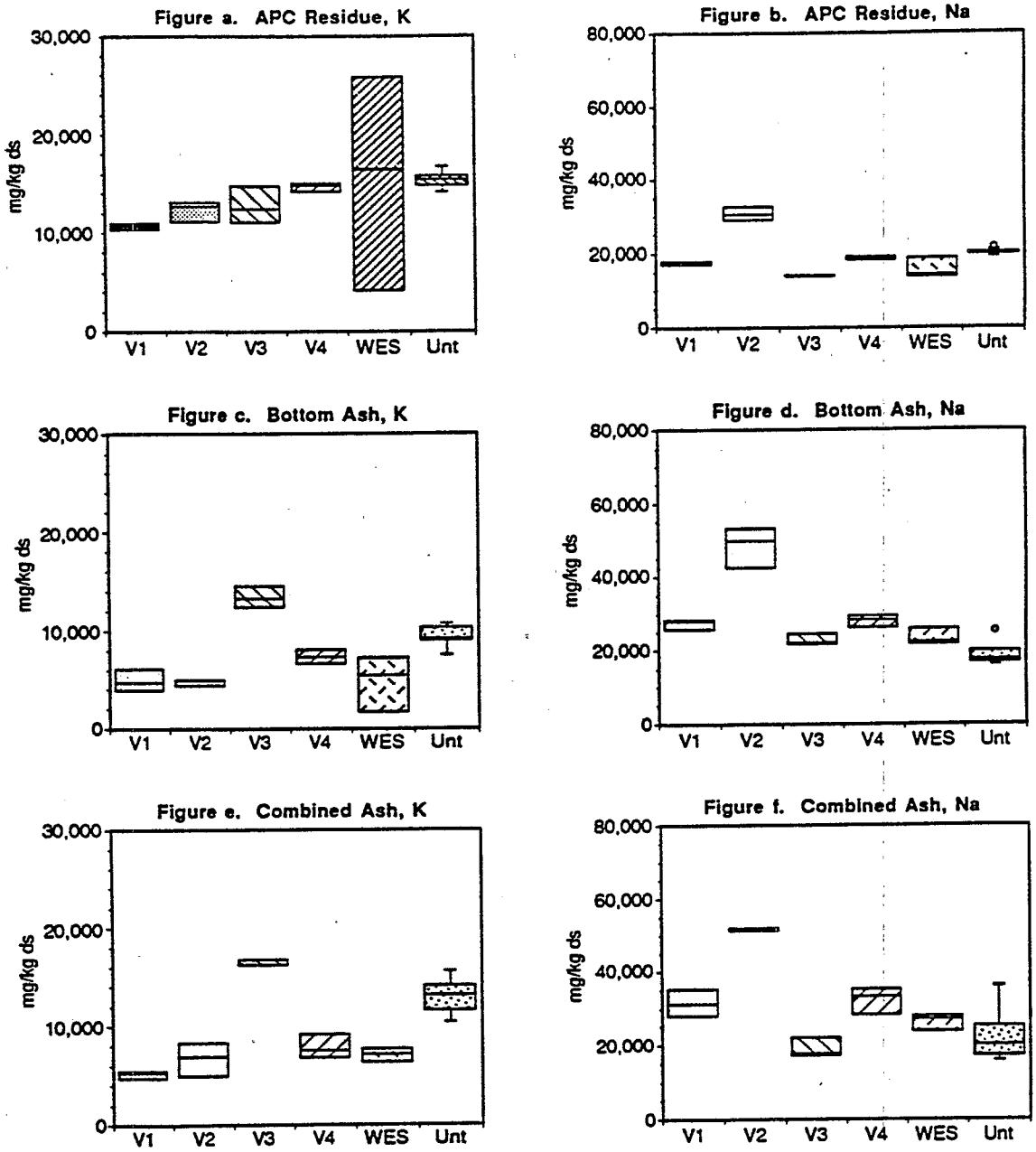


Figure 6.13. Lead total analysis by SW-846.

Figure a. APC Residue, Pb

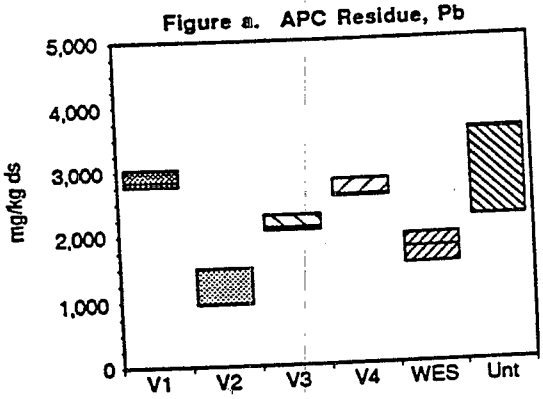


Figure b. Bottom Ash, Pb

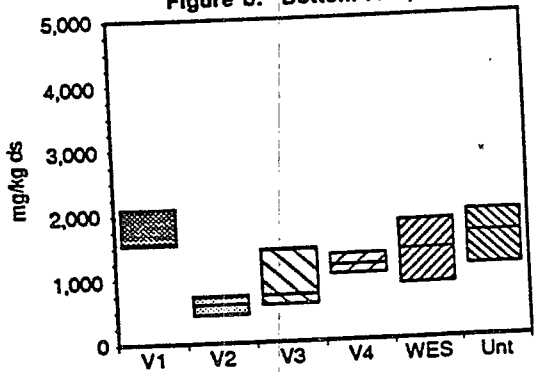


Figure c. Combined Ash, Pb

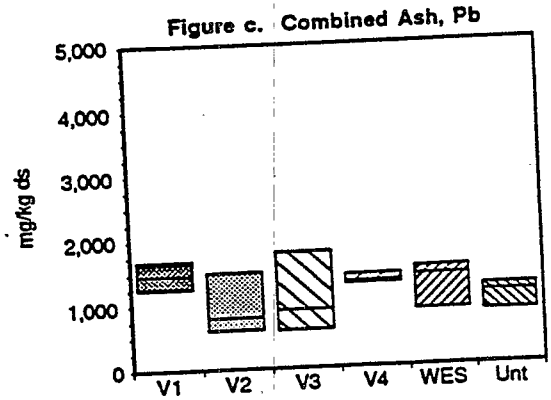
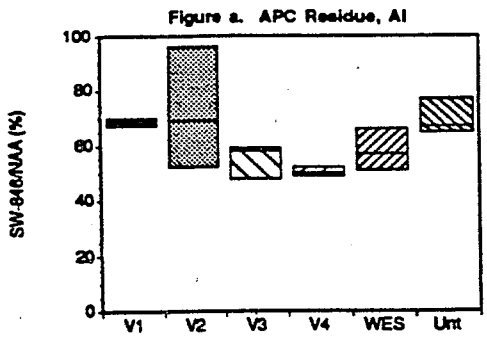
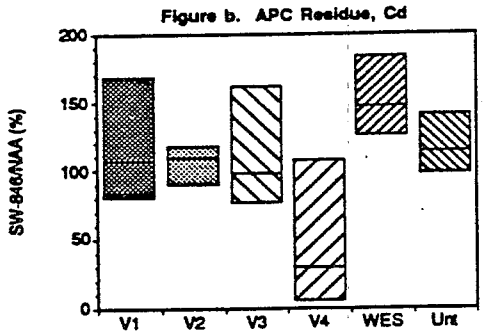
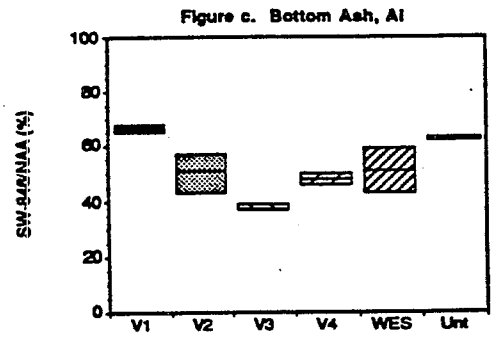
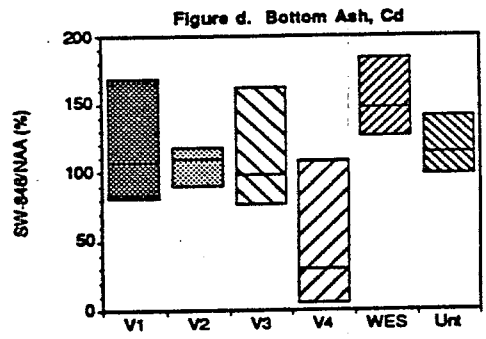


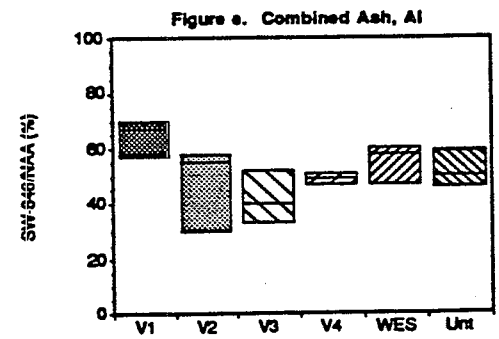
Figure 6.14. A comparison of SW-846 and NAA results for Al and Cd.











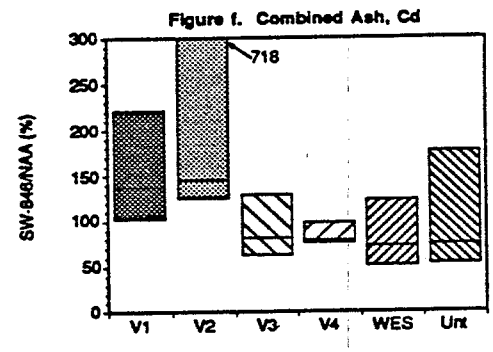
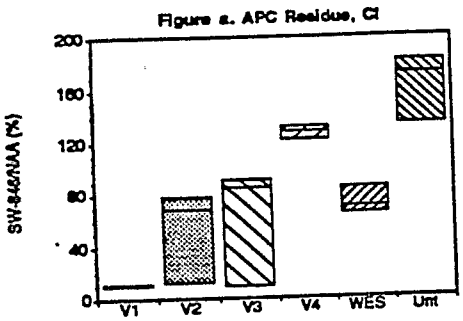
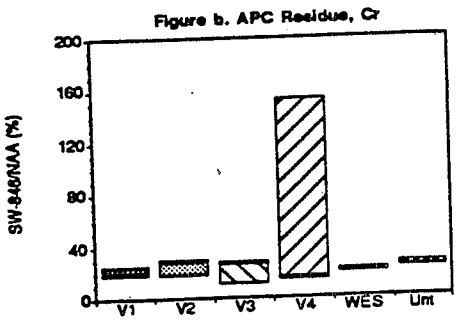
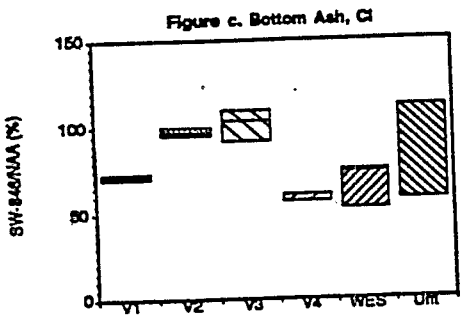
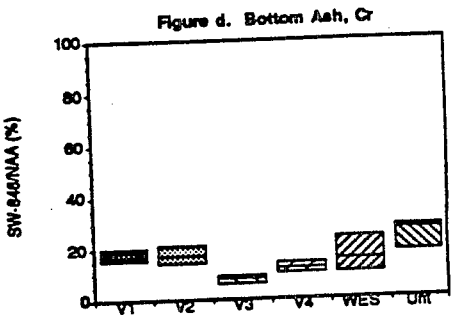


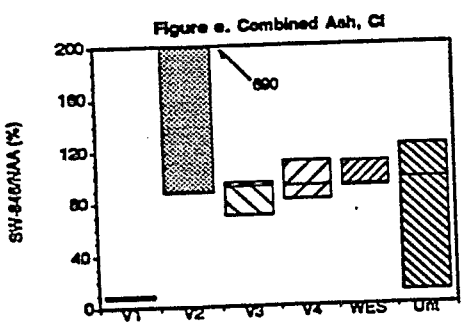
Figure 6.15. A comparison of SW-846 and NAA results for Cl and Cr.











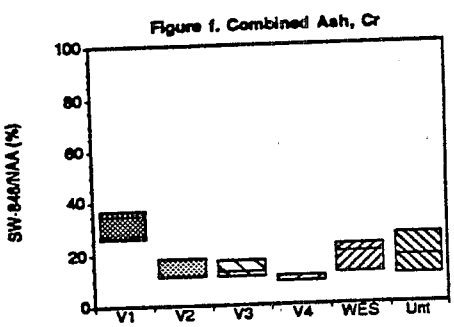


Figure 6.16. A comparison of SW-846 and NAA results for Cu and Zn.

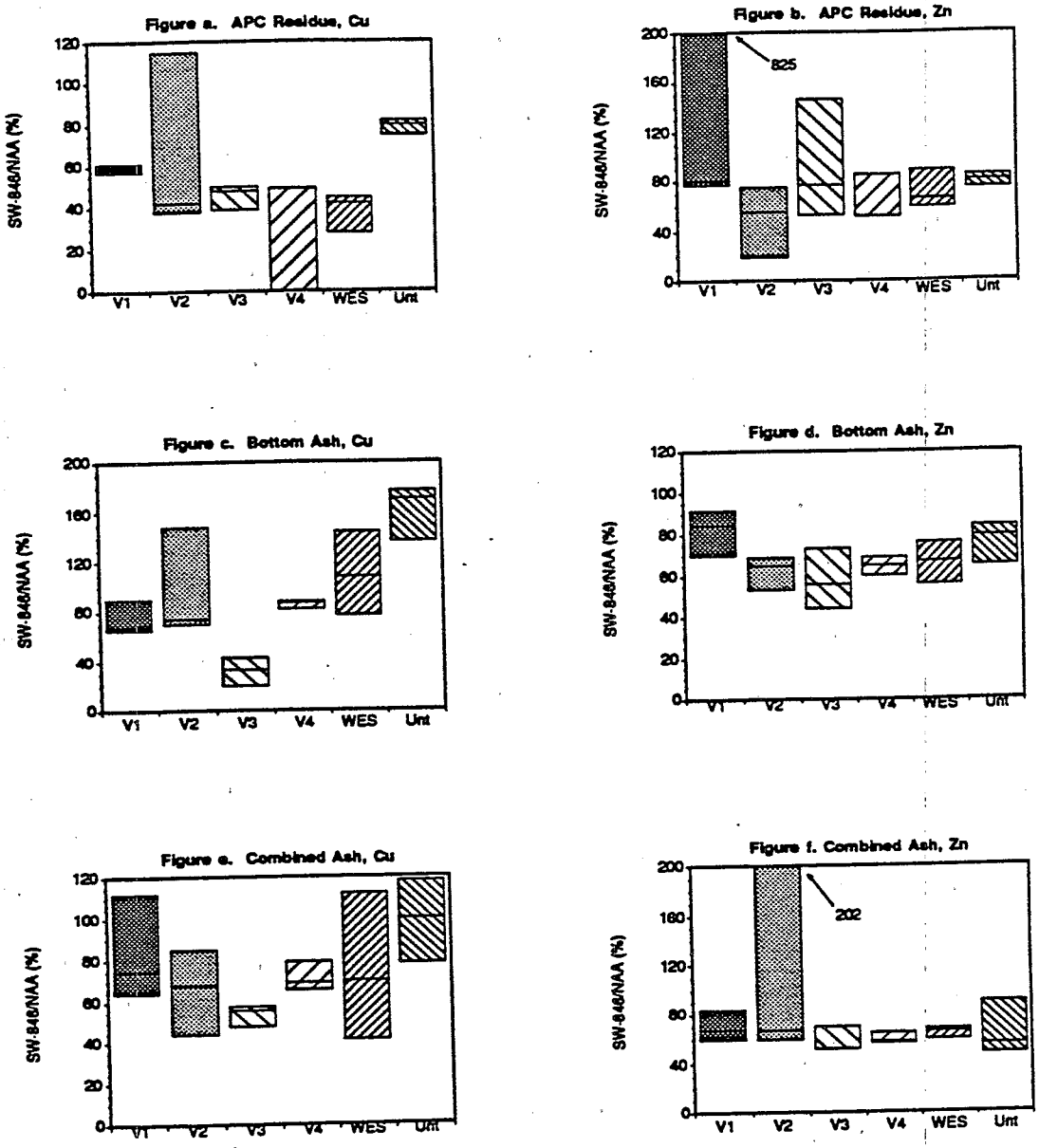
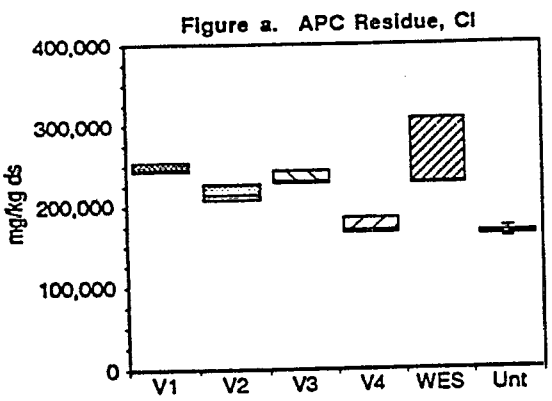
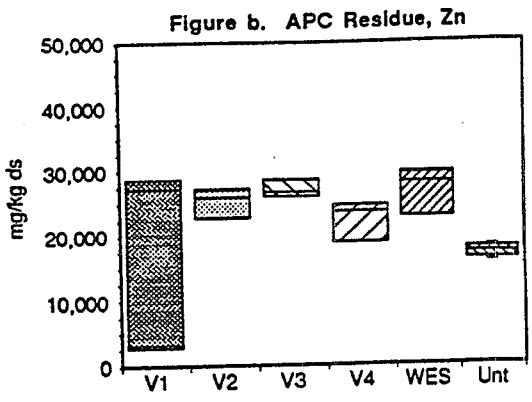
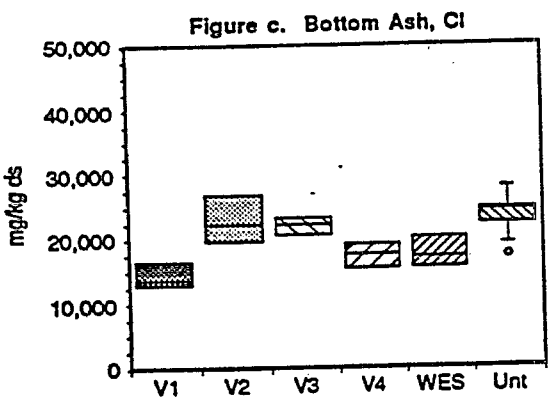
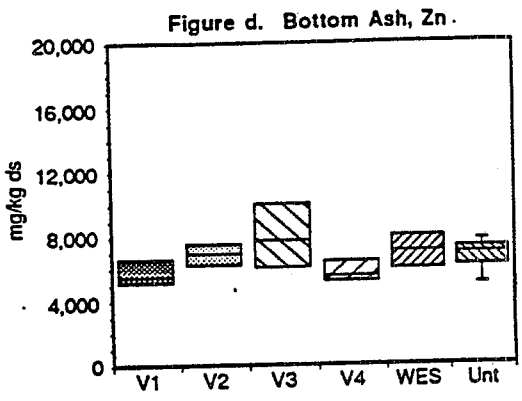


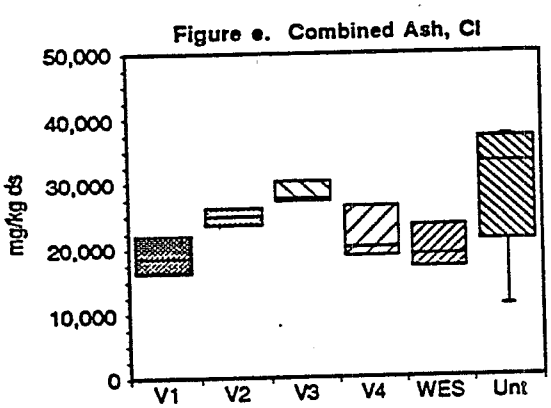
Figure 6.17. NAA corrected for process dilution (Chloride and Zinc).

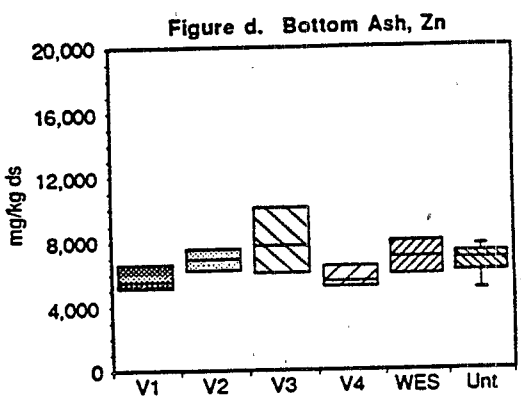












7.1 DATA REDUCTION, ANALYSIS AND PRESENTATION

Chemical analysis of extracts from laboratory leach tests generally results directly in the determination of an aqueous phase contaminant concentration. However, transformation of concentration data into element or species release, e.g., the mass of a particular element or species emitted from the solid matrix into the extract per unit mass of solid extracted, permits normalization and comparison of data obtained from several different leach tests. Comparison of treated residues to untreated residues is based on test results for the preprocessed untreated residues (refer to Chapter 3.1). The TCLP, distilled water leach test and the availability leach test are all intended to assess the potential for (or the maximum extent of) species release under different extremes of leaching conditions. However, each test employs different liquid to solid ratios and extraction conditions. Only the TCLP has a defined concentration basis for interpretation of resulting extract concentrations. Thus, data interpretation on an extract concentration basis is of limited usefulness. Use of additives for each treatment process and varying treated residue moisture contents also may result in dilution effects, further confounding direct comparison of extract concentration data. In order to provide more uniform data interpretation from these leaching tests, extract concentration data has been transformed to a basis of release per mass of MWC residue extracted. This has been accomplished through application of the following calculations:

$$R_{product} = [(C_{extract})(L:S\ ratio)]/(1-M_{product}) \qquad \text{(Equation 7.1)}$$

where:

$R_{product}$ = release per unit mass of treated residue [mg/kg];
$C_{extract}$ = species concentration measured in the leaching test extract [mg/l];
L:S Ratio = liquid to solid ratio employed for the leaching test [l/kg]; and,
$M_{product}$ = moisture content at 105 C of the treated residue [g/g].

$$R_{ash} = (R_{product})(DF) \qquad \text{(Equation 7.2)}$$

where:

R_{ash} = release per unit mass of untreated residue [mg/kg ash treated]; and,
DF = treatment process dilution factor [kg treated residue/kg untreated residue].

Tabulated results from leaching tests are provided in Appendix B.1 - B.3. Mean values of replicate data are presented on (i) an extract concentration basis, (ii) product (treated residue) release basis, and (iii) untreated residue release basis (corrected for process dilution). coefficients of variation for each analysis also are presented with each data set. Complete data sets including reporting of each replicate value, are provided in Volume 2 of this report.

The TCLP, DWLT and the ALT leaching data are interpreted on a release basis because these test results most frequently are viewed as the potential for release under the extreme conditions represented by the testing procedures. The ANC leach test and results are interpreted on concentration basis. The ANC data is presented on a concentration basis because the objective of the test was to determine the solubility of a variety of elements as a function of pH. The TCLP data for cadmium, copper, lead, and zinc also are presented on a concentration basis to allow a direct comparison between the untreated and treated ash, between the treatment processes, and where applicable, compare to the USEPA regulatory limits.

The acid neutralization capacity leach test is the principal exception to leaching data interpretation on a release basis. The ANC test was carried out at a low liquid to solid ratio (5:1) to facilitate determination of pH titration curves and saturated solution concentrations of a variety of elements as a function of pH. Therefore, it is most useful to present ANC data on a concentration basis. In addition, extract data also has been presented on a concentration basis for cadmium, copper, lead and zinc from TCLP extractions.

Detailed analysis of leaching data has been restricted to approximately 15 key elements and species considered to be indicative of the leaching behavior of the various groups of elements and species present. The following elements and species have been the focus of leaching data analysis:

Aluminum, calcium, potassium and sodium - principal cationic components of ash;
Chloride and sulfate - principal anionic components of ash;
Cadmium, copper, lead, zinc - potentially toxic metals present in significant leachable concentrations;
Total dissolved solids - indicative of overall leaching of salts; and,
Total organic carbon (TOC) - indicative of organic species leaching.

The most meaningful way to present and interpret the leaching data on a comparative basis is through graphical presentation. For TCLP, DWLT and the Availability leach test(ALT), this was accomplished through generation of box plots. Within each box plot, all three replicate data points for the untreated and each treated residue are presented. The extremes (bottom and top) of each "box" represent the minimum and maximum of the three replicate analyses. The intermediate horizontal line

represents the third replicate. Thus, both the relative release between untreated and treated residues as well as the variability within the data is presented. Release data for untreated and treated APC residue, bottom ash and combined ash were grouped on the same page for each element to permit comparison of release between MWC residue types. Whenever practical, the ranges for the y-axis were maintained constant within element groups to further facilitate comparison.

The liquid-to-solid ratios and process dilution factors are presented in Table 7.1. Summary tables are used to highlight differences between the untreated and treated residues. Residue treatment effects are grouped according to the categories described in Table 7.2. These categories were chosen to indicate important effects of the treatment processes in the presence of highly variable testing results are terms for release relative to the untreated residue and the treated residues. The 0.80 confidence interval was selected to accentuate treatment effects with a limited number of replicates. Thus, statistically, significant treatment effects at the 0.80 level represent effects that may warrant further investigation with more replication. Furthermore, results were grouped based on (i) increased or decreased release greater than a factor of 2 compared to the untreated residue and (ii) release compared to other treatment processes. The relative categories of treatment effects are defined as follows: "Decreased" release indicates a treatment effect significant at the 0.80 confidence level compared to the untreated residue. "Increased" release indicates a treatment effect significant at the 0.80 confidence level compared to the untreated residue. "Greatly decreased" release indicates release less than one half that of the untreated residue. "Greatly increased" release indicates release of more than twice that of the untreated residue. "Decreased release compared to other processes" indicates decreased release compared to other processes in addition to less than one-half of the untreated residue. "Increased release compared to other processes" indicates increased release compared to other processes in addition to greater than twice that of the untreated residue. When relative release is discussed in the text, the terminology will be italized.

Results of the ANC leaching test are presented graphically as titration curves (pH as a function of acid addition) and concentration as a function of pH curves. All replicate data is presented in each figure. Curves drawn on data plots are simple data interpolations provided to indicate general trends and are not regressed models. Figures are generally grouped by MWC residue type and titration curve or element to facilitate comparison of treatment effects.

7.2 TCLP

7.2.1 TCLP Extract pHs and Cadmium, Copper, Lead and Zinc Concentrations

The TCLP protocol requires that a pretest be performed to select the appropriate extraction fluid (Extraction Fluid 1 or Extraction Fluid 2) for the sample to be tested. This selection is based on the

acid neutralization capacity of the material to be tested. A fixed quantity of acetic acid is used in preparation of both extraction fluids. Extraction Fluid 1 is buffered with NaOH while Extraction fluid 2 is not buffered. Even following the extraction fluid selection procedure, the final extract pHs were widely variable from process to process and between MWC residue types, ranging between 5 and 12.

Extraction Fluid 2 was required for all cases except, (i) untreated bottom ash, (ii) Process 1 bottom ash, and (iii) Process 1 combined ash. TCLP extractions were carried out on the untreated MWC residues using both extraction fluids for comparison purposes. TCLP extractions on the treated residues employed only the required extraction fluid. .Table 7.2 compares untreated residue extraction results for TCLP Extraction Fluid 1 and Extraction Fluid 2. Extract concentrations for chromium, cadmium, copper, lead, zinc, and the corresponding extract pH for each case.

The APC residue exhibited a large buffering capacity. The final pHs for Extraction Fluid 1 and Extraction Fluid 2 were 11.91 and 11.88, respectively. According to the ANC data (See Section 7.5) , the APC residue metals addressed, except lead, are not mobile at pH greater than 8. Hence, the TCLP metal extract concentrations for both extraction fluids are several orders of magnitude lower than the total quantity detected in the APC residue. The endpoint pHs were similar for both Extraction Fluid 1 and Extraction Fluid 2 and consequently the metal concentrations were very similar.

For the bottom ash, the final extract pH for Extraction Fluid 1 and Extraction Fluid 2 were 7.79 and 5.24, respectively. According to the ANC data (See Section 7.5), cadmium, lead, copper and zinc become very mobile at a pH of 6 or less, and chromium at a pH of 7 or less. Extraction Fluid 2 results in a pH environment where the metals are very mobile, hence concentrations are much higher in the Extraction Fluid 2 extracts than in Extraction Fluid 1 extracts. Extraction Fluid 1 was the required extraction fluid according to the pretest criteria, indicating the metals were not very mobile.

The combined ash TCLP final extract pHs were 6.3 for Extraction Fluid 1 and 5.2 for Extraction Fluid 2. According to the ANC data for the combined ash (See Section 7.5), cadmium and zinc become very mobile at a pH of 6 or less; chromium and lead become very mobile at a pH of 5 or less. The mobility of copper is unclear from the ANC data. Extraction Fluid 2 results in a pH environment in which the metals were very mobile, hence concentrations were much higher in the Extraction Fluid 2 extracts than in Extraction Fluid 1 extracts.

From this data, it is apparent that the metal concentrations in the TCLP extracts strongly are function of the final extract pH. When comparing the effectiveness of treatment based on TCLP, the metal concentrations of the untreated material are compared to the treated material. However, these comparisons can be misleading because of the variable final extract pH.

TCLP extract pHs and extract cadmium and copper, and lead and zinc concentrations are presented in Figures 7.1, 7.2 and 7.3, respectively. The selected metal concentrations were generated during TCLP extraction using the required extration fluid. Note that TCLP results for untreated residues are for residues prior to processing and may not necessarily reflect the results which would be obtained on residues as sampled from the MWC facility (see Chapter 3.1). These results are for comparison with treated residue results. All untreated and treated bottom ash and combined ash samples passed all of the TCLP extract concentration criteria. The untreated APC residue failed the TCLP criteria for lead and mercury, but the treated APC residues passed TCLP criteria. Mercury most likely was lost from the APC residues either during treatment or sample preparation. Special sampling and preservation protocols for mercury containing samples were not followed.

Cadmium (Figure 7.2): Cadmium concentration results indicated that the untreated and all treated APC residues, except Process 4, were two orders of magnitude below the regulatory limit of 1000 µg/l. The relatively high cadmium concentration for Process 4 appears to be primarily a consequence of the equilibrium pH of the TCLP extract being approximately 7. At this pH, cadmium was appreciably soluble for residues treated by Process 4 (see ANC results, Chapter 7.5). Cadmium concentration results for bottom ash and combined ash were similar, indicating one to three orders of magnitude reduction for Processes 1 and 2. Process 3 resulted in a substantial decrease in cadmium concentration for both bottom ash and combined ash, but was much greater in the bottom ash. The WES Control process did not indicate any significant change in leachable cadmium concentration for either the treated bottom ash or combined ash.

Copper (Figure 7.2): Copper concentrations were similar for APC residues treated with Processes 2, 3,4 and the WES Control and somewhat lower than the untreated residue. Process 1 applied to the APC residue resulted in lower copper concentrations than the other processes. Processes 2, 3 and 4 applied to the bottom ash and combined ash resulted in lower copper concentrations than the untreated residue as well as decreased data variability. Process 1 resulted in lower copper concentrations than the other processes for bottom ash but similar concentrations for the combined ash. The WES Control process resulted in copper concentrations somewhat lower than the untreated residue for the bottom ash, but not for the combined ash.

Lead (Figure 7.3): The lead concentration for the untreated APC residue was greater than six times the regulatory limit. Lead concentrations were similar for APC residues treated by Processes 1, 2 and the WES Control and less than five percent of the untreated APC residue concentration. Process 3 displayed a high degree of variability when applied to the APC residue. Process 4 resulted in *the lowest* lead concentrations as compared to the untreated APC residues and the other process results. Lead

concentrations for bottom ash and combined ash treated by Processes 1, 2, 3 and 4 were similar and were much lower than *greatly decreased* compared to the untreated residues. These bottom ash and combined ash lead concentrations also were much lower than the treated APC residue concentrations for Processes 1, 2 and 3. The WES Control process resulted in increased lead concentrations for the bottom ash as compared to the untreated residue, but not for the combined ash.

Zinc (Figure 7.3): Zinc concentrations were similar for APC residues treated by Processes 1, 2, 3 and the WES Control and less than half of the untreated APC residue. APC residue treated by Process 4 resulted in a increased zinc concentration. Bottom ash and combined ash treated by Processes 1 and 2 resulted in decreased zinc concentrations by over two orders of magnitude as compared to the untreated residues. Processes 3 and 4 also resulted in greatly decreased zinc concentrations for bottom ash and combined ash, but not to the same extent as Processes 1 and 2. The WES Control did not result in a significant change for either bottom ash or combined ash compared to the untreated residues.

7.2.2 Species Release for TCLP

Figures 7.4 through 7.8 present release data on an untreated ash basis (corrected for process dilution) for aluminum and calcium, cadmium and copper, potassium and sodium, lead and zinc, and chloride and sulfate. Discussion is provided for each element in the following paragraphs.

Aluminum (Figure 7.4): Aluminum release was increased for APC residue and bottom ash by Processes 1, 2 and the WES Control as compared to the respective untreated residues. Processes 3 and 4 resulted in *greatly decreased* aluminum release for combined ash compared to the untreated residue. Aluminum release was similar within each process for both bottom and combined ash. Increasing aluminum release from APC residue to bottom ash to combined ash for untreated residues appears to be predominantly a response to extract pH, as pH decreases from almost 12 to 8 to 6.5, respectively.

Calcium (Figure 7.4): All processes appear to have increased calcium release for treated APC residue as compared to the untreated residue, although Processes 3 and 4 were not statistically different because of the high degree of data variability. The WES Control process resulted in over twice the calcium release as compared to the untreated APC residue. Also note that the release potential varied from 100,000 to over 300,000 mg/kg, representing up to the equivalent of 30 wt % of the untreated residue. Calcium release from bottom ash was *decreased* by Process 1, increased by Process 4, and *greatly increased* by Process 3. Calcium release from combined ash was changed only by Process 3, where it was *greatly increased.*

Cadmium (Figure 7.5): Cadmium release from untreated and all treated APC residues, except Process 4, was very low and approaching detection limits. APC residue treated by Process 4 resulted in release of more than 25 mg/kg ash treated, which was two orders of magnitude greater than the untreated residue. Processes 4 and the WES Control resulted in *greatly increased* cadmium release from bottom ash compared to the untreated residue. Processes 3 and 4 resulted in *decreased*, and Processes 1 and 2 *greatly decreased*, cadmium release compared to the untreated combined ash.

Copper (Figure 7.5): Copper release was approximately 2 mg/kg from both the untreated APC residue and the bottom ash, but approximately 70 mg/kg from the untreated combined ash. Process 1 applied to APC residue *decreased* release. The WES Control process applied to bottom ash *increased release* and exhibited a high degree of data variability. All other processes applied to APC residue and bottom ash did not have a significant treatment effect. Processes 1, 2, 3 and 4 all *decreased* release from combined ash compared to the untreated residue. The WES Control process applied to combined ash exhibited a high degree of data variability and a mean only slightly lower than that of the untreated material.

Potassium (Figure 7.6): Potassium release was *increased* by Processes 1 and 3 for APC residue compared to the untreated residue. All other treated APC residues were not significantly different from the untreated APC residue. Potassium release for the untreated residue was approximately 15,000 mg/kg, representing greater than 1 wt % of the untreated material. Potassium release was different for the treated bottom ash and combined ash, compared to the untreated residues, only for Process 3 where its release was *greatly increased*. *Increased* potassium release by Process 3, for all three residue types, was a reflection of the potassium content of one of the process additives. Potassium release was very similar for both bottom ash and combined ash, which was approximately one third the release from the APC residue, except for Process 3 and APC residue treated by Process 1.

Sodium (Figure 7.6): Sodium release from APC residue was *increased* by Process 1 and the WES Control,compared to the untreated residue. Processes 3, 4 and the WES Control had similar sodium release to the bottom ash, as did the untreated residue. Release from the untreated bottom ash, and bottom and combined ash treated by Process 1 must be corrected for the presence of sodium in the TCLP Extraction Fluid 1, which would result in an equivalent release of 30,000 mg/kg and 38,000 mg/kg for untreated and Process 1, respectively. Process 2 *greatly increased* release from the APC residue, bottom ash and the combined ash, as compared to the untreated residues. High sodium release reflects the presence of sodium in process additives for Process 2. Processes 1 and 2 resulted in *greatly increased* release from the combined ash.

Lead (Figure 7.7): Lead release from APC residue was *greatly decreased* by all treatment processes. Process 4 resulted in *substantially decreased* lead release from APC residue in comparison to the other treatment processes as well. Lead release from untreated and treated bottom ash was very low, except for the WES Control process, which resulted in *increased* lead release. Lead release from all of the treatment processes applied to combined ash was *greatly decreased* compared to the untreated residue, except for the WES Control, which resulted in no change from the untreated material. Lead release also was much greater from the untreated combined residue compared to the untreated bottom ash, which may be a result of either extract pH effects, the requirement of Extraction Fluid 1 for the untreated bottom ash, or the presence of APC residue in the combined ash.

Zinc (Figure 7.7): Zinc release from the APC residue was *greatly decreased* by all of the treatment processes except Process 4, which resulted in *greatly increased* zinc release. Zinc release from the bottom ash was very low for the untreated residue and residue treated using Processes 1, 2 and 3. Process 4 and the WES Control both resulted in *greatly increased* release from the bottom ash. Processes 3 and 4 resulted in decreased release of zinc from the combined ash, while Processes 1 and 2 resulted in *greatly decreased* release. The WES Control resulted in no change from the untreated combined ash.

Chloride (Figure 7.8): Chloride release from APC residue was *increased* by Processes 1 and 2. Note that chloride release ranged from 100,000 to over 250,000 mg/kg ash treated, which represented up to 25 wt % of the initial APC residue. Chloride release from the bottom ash and the combined ash was not changed significantly by any of the treatment processes. Chloride release for untreated and treated bottom ash and combined ash ranged from 0.6 to 2.8 wt % of the initial residues. Chloride release was not determined for the WES Control process.

Sulfate (Figure 7.8): Sulfate release from the APC residue was *increased* by Process 1 and *greatly increased* by Processes 3 and 4. Sulfate release from bottom ash was *increased* by Process 2 and *greatly increased* by Process 3. Sulfate release from bottom ash also was *greatly decreased* by Process 1. Sulfate release from combined ash was *decreased* by Process 1 and *greatly increased* by Process 3. Sulfate release for all three untreated residues ranged between 15,000 and 20,000 mg/kg or up to 2 wt %.

Conclusions from the TCLP release results are summarized in Table 7.4. Comparisons of results for treated residues to untreated residues are based on the TCLP extraction fluid indicated by the TCLP screening Test. Most treated residues required Extraction Fluid 2 while the bottom ash, Process 1 and 2 and the combined ash Process 1 required Extraction Fluid 1.In summary, the treatment processes applied to APC residue resulted in *decreased* or *greatly decreased* release of only lead and zinc, except for

Process 4, which resulted in *greatly decreased* release of lead but *increased* release of cadmium and zinc. Treatment processes applied to APC residue also resulted in *increased* or *greatly increased* release of salts including calcium, potassium, sodium, chloride and, or, sulfate. Treatment processes applied to bottom ash did not result in a significant *decrease* in the release potential of any of the heavy metals. However, release of heavy metals from untreated bottom ash was very limited. Processes 4 and the WES Control resulted in *greatly increased* release of cadmium and zinc when applied to bottom ash. The WES control process also resulted in *increased* release of copper and lead. Release of sodium was *greatly decreased* by Processes 3, 4 and the WES Control. Release of sulfate from bottom ash was greatly decreased by Process 1, increased by Process 2, and greatly increased by Process 3. Treatment of combined ash resulted in *decreased* or *greatly decreased* release of cadmium, copper, lead and zinc for all of the treatment processes except the WES Control. The WES Control did not have a significant effect on any of the species release when applied to combined ash. Processes 1 and 2 resulted in *greatly increased* release of sodium, while Process 3 resulted in *greatly increased* release of calcium, potassium and zinc. Please note these comparisons were made using untreated data generated from the required extraction fluid.

7.3 DISTILLED WATER LEACH TEST

Figures 7.9 through 7.21 present pH and release data from DWLT extracts 1 and 2, and extracts 3 and 4 on an untreated ash basis (corrected for process dilution) for aluminum, cadmium, calcium, copper, lead, potassium, sodium, lead, zinc, chloride, sulfate, TDS and TOC. Discussion is provided for each parameter or element in the following paragraphs:

pH (Figure 7.9): Extract pHs for all extracts from untreated and treated APC residue were alkaline with pH between 11.8 and 12.2, except for Process 4, which had a mean pH of approximately 11.5 for the first two extracts and 11.2 for the second two extracts. Extract pHs for untreated and treated bottom ash and combined ash were between 10.5 and 12.2. In general, the pH decreased slightly for the second two extracts within treatment processes for bottom and combined ashes, but not for APC residue. This was primarily a result of the much greater alkalinity of the APC residue.

Aluminum (Figure 7.10): Aluminum release from APC residue was *increased* by all treatment processes although it was at a very low level of less than 5 mg/kg ash treated. Release also *increased* from the second two extracts for Processes 2 and 4, although the level was still small. Aluminum release from bottom ash and combined ash followed similar trends within each process type. Release from untreated bottom ash and combined ash was approximately 800 and 1,400 mg/kg, respectively, which was several orders of magnitude greater than for the APC residue. Release was *increased* compared to untreated

residue for Process 2 applied to bottom ash but not for combined ash even though both release levels were similar. Release was *greatly decreased* by Processes 1, 3 and the WES Control. Release by Process 3 also was substantially less than by bottom ash and combined ash treated with the other processes. Generally, within treatment processes, aluminum release was at similar levels for both sets of extracts, except for Process 2, which resulted in *decreased* release during the second set of extracts as compared to the first set. Release levels observed from the DWLT for bottom ash and combined ash frequently were substantially higher than those observed from the TCLP.

Cadmium (Figure 7.11): Cadmium release for all untreated and treated residues for residue types and processes was near or below detection limits at 0.01 mg/kg ash treated. This is a direct result of the extract pHs being alkaline (pH>10) where cadmium is relatively insoluble (see ANC results, Chapter 7.5).

Calcium (Figure 7.12): Calcium release generally was substantially less during the second set of extractions as compared to the first set. Release from untreated and treated APC residue ranged between 40,000 and 150,000 mg/kg ash treated, or up to 15 wt % of the untreated material. Process 1 applied to APC residue resulted in an *increase* in release compared to the untreated residue, while Process 4 and the WES Control resulted in *decreased* release. Release from untreated and treated bottom ash and combined ash was similar, within each treatment process. Release from untreated bottom ash and combined ash was less than 10% of the amount released from untreated APC residue. Process 3 resulted in *increased* release during the first set of extracts while Process 2 resulted in a *greatly decreased* release during the first set of extracts. In general, the releases observed for calcium from the DWLT were less than that observed from the TCLP.

Copper (Figure 7.13): Copper release from all residue types and treatment processes was very low at less than 5 mg/kg ash treated, except for Process 2 applied to bottom ash and combined ash, where it was approximately 10 and 60 mg/kg ash treated, respectively. Processes 2, 3 and the WES Control decreased release, and Processes 1 and 4 *greatly decreased* release from APC residue. Process 2 *greatly increased* release from the bottom ash and the combined ash, compared to the untreated residues, for the first set of extracts. In general, copper release observed from the DWLT was less than or equal to release observed from the TCLP.

Lead (Figure 7.14): Lead release was approximately 700 mg/kg for the untreated APC residue, but less than 1 mg/kg for the untreated bottom ash and combined ash. Treatment processes 1, 2 and WES Control applied to the APC residue *greatly decreased* lead release compared to the untreated residue. Process 4 substantially decreased release compared to these processes. Release from untreated and treated APC residues were somewhat less during the second set of extracts, compared to the first set.

Processes 2 and WES Control, applied to bottom ash, *increased* lead release. Process 3 *greatly increased* lead release compared to the untreated residue. Processes 1 and WES Control, applied to the combined ash, increased lead release, and Processes 2 and 3 *greatly increased* release as compared to the untreated residue. Releases observed from the DWLT were frequently substantially greater than releases observed by the TCLP. This is most likely the result of the more alkaline extract pH and increased lead solubility from the amphoteric nature of lead (refer to Section 7.5).

Potassium (Figure 7.15): Potassium release was substantially greater from the first set of extracts compared to the second set (note the change in scales in Figure 7.15 b, d, f). Release from APC residue was *increased* by Process 2 and the WES Control and *greatly increased* by Processes 1 and 3, compared to the untreated residue. Release from APC residue was *decreased* by Process 4. Release from bottom ash and combined ash was similar and changed only by Process 3, by which it was *greatly increased*. The *greatly increased* release by Process 3 was likely the result of potassium in one of the process additives. Potassium releases from the DWLT were similar to those observed from the TCLP.

Sodium (Figure 7.16): Sodium release was much greater in the first set of extracts compared to the second set for all residue types and processes (note the change in scales in Figure 7.16). Release from untreated and treated APC residues ranged from approximately 10,000 to 55,000 mg/kg ash treated, or up to 5.5 wt % of the untreated residue. Sodium release from APC residue was *decreased* by Process 4 and *greatly increased* by Process 2, compared to the untreated residue. Sodium releases were similar for untreated and treated bottom ash and combined ash, except for Process 2. Release from bottom ash and combined ash was *greatly increased* by Process 2 in both sets of extracts, compared to the untreated residues, and ranged up to 8 wt % of the untreated residue. This was most likely the result of the sodium content of one of the process additives. Sodium release observed from the DWLT was similar to that observed from the TCLP except for those cases where TCLP extraction fluid 1 was required, which contains sodium hydroxide as a component of the extraction fluid.

Zinc (Figure 7.17): Zinc release from untreated APC residue, bottom ash and combined ash, was approximately 80, 1 and 1 mg/kg, respectively. Zinc release from the APC residue was *greatly decreased* by Processes 1, 2, 4 and the WES Control, compared to the untreated residue. Zinc release from bottom ash, treated by Process 2, was *increased* during the first set of extracts and exhibited a high degree of variability compared to the untreated residue. Zinc release also was by Process 2, applied to combined ash, during the first set of extracts. Zinc release observed from the DWLT was similar to release observed from the TCLP.

Chloride (Figure 7.18): Chloride release was much greater during the first set of extracts than the second set for all untreated and treated residues, except Process 1 applied to combined ash. Chloride release from untreated and treated APC residue ranged from 100,000 to 300,000 mg/kg ash treated, or up to 30 wt % of the untreated residue. Process 4 *greatly decreased* the chloride release, and the WES Control process *increased* release as compared to the untreated residue. Significant chloride release occurred during the second set of extractions for the APC residue. This was primarily a reflection of the extremely high initial chloride contents. Chloride release was similar for the bottom ash and combined ash within processes. Processes 1 and 4 *decreased* chloride release from bottom ash, and only Process 4 decreased chloride release from the combined ash. Chloride releases observed from the DWLT were similar to releases observed from the TCLP.

Sulfate (Figure 7.19): Sulfate release from treated APC residue was somewhat less during the second set of extracts as compared with the first set. Release from untreated APC residue was similar, at approximately 20,000 mg/kg, for both extract sets. Process 4 *decreased* sulfate release, and Processes 1, 2 and the WES Control *greatly decreased* release from APC residue during both sets of extractions. Process 3 *increased* sulfate release in the first set of extracts, but *decreased* release in the second set of extracts compared with the untreated APC residue. Release from untreated bottom ash and combined ash was similar, ranging between approximately 700 to 1,500 mg/kg, with release increasing somewhat from the first to the second set of extracts. Processes 1, 4 and the WES Control *greatly decreased* sulfate release in the first set of extracts. Process 2 *greatly increased* release in the first set of extracts, compared to the untreated residues, and Process 3 substantially *increased* sulfate release beyond that of Process 2. Sulfate release was *decreased* greatly in the second set of extracts by Processes 4 and WES Control, applied to bottom ash. Sulfate release was *decreased* either significantly or *greatly* in the second set of extracts by all processes applied to combined ash, except Process 3. In general, releases observed from the DWLT were less than releases observed from the TCLP.

TDS (Figure 7.20): TDS release was very high for all residue types and treatment processes and reflects total soluble salt release. Release from treated APC residue ranged up to almost 700,000 mg/kg ash treated, or up to the equivalent of 70 wt % of the untreated residue. Processes 1, 2, 3 and WES Control *increased* TDS release from APC residue in the first set of extracts compared to the untreated residue. TDS release from untreated and treated APC residues also was substantial during the second set of extracts, ranging up to 140,000 mg/kg treated residue. Release from untreated bottom ash and combined ash was approximately 50,000 mg/kg, or the equivalent of 5 wt % of the untreated residue. Processes 2 and 3 applied to bottom ash and combined ash both *greatly increased* release, ranging up to 190,000 and 120,000 mg/kg treated residue, respectively. Process 4 resulted in *decreased* release

from bottom ash, compared to the untreated residue. TDS releases from DWLT cannot be compared to releases from TCLP because of extractant matrix interference with TCLP.

TOC (Figure 7.21): TOC release was greatest from the combined ash at approximately 500 mg/kg ash and was approximately 200 and 20 mg/kg ash from the bottom ash and APC residue, respectively. No identification of the nature of the TOC release was carried out. Processes 1, 2, 3, and WES Control *increased* TOC release compared to the untreated residue. Process 2 *increased* TOC release from bottom ash in the first set of extracts, and Process 3 *greatly increased* release in the second set of extracts. Results from Process 4 applied to bottom ash were very scattered but suggested increased TOC release. Process 2 *greatly increased* TOC release from the combined ash, compared to the untreated residue. TOC releases were substantially less in the second set of extracts for bottom ash and combined ash but were still at significant levels.

Conclusions from the DWLT results are summarized in Tables 7.5 and 7.6. Processes 1, 2, 4 and the WES Control *decreased* or *greatly decreased*, copper, lead and zinc release from APC residue. Much greater lead releases were observed from the APC residue than from either the bottom ash or the combined ash. Lead release from bottom ash was *increased* or *greatly increased* by Processes 2, 3 and the WES Control compared to the untreated residue. Lead release from combined ash was *increased* or *greatly increased* by Processes 1, 2, 3 and the WES Control. Lead release observed from the DWLT was much greater than release observed from TCLP results. The DWLT indicated increased release for many cases which TCLP indicated *decreased* release compared to the untreated residues. Very high levels of TDS were released from all untreated and treated residues. A direct comparison of mean TDS releases from all of the untreated and treated residues is provided in Table 7.7. Between 15 and 32 % by weight of the untreated and treated APC residue was released as TDS. Between 4 and 13% by weight of the untreated and treated bottom ash and combined ash was released as TDS. Treatment processes applied to all three residue types, except Process 4 applied to APC residue, either did not change or *increased* TDS release as compared to the untreated residues. Process 4, applied to APC residue, resulted in decreased TDS release.

7.4 AVAILABILITY LEACH TEST

Figure 7.22 through 7.26 present the release from the availability leach test on an untreated residue basis (corrected for process dilution) for aluminum and calcium, cadmium and copper, potassium and sodium, lead and zinc, and chloride and sulfate. Discussion is provided for each parameter or element in the following paragraphs.

Aluminum (Figure 7.22): Aluminum release from all three residue types was similar within treatment processes. Release from all three untreated residues was approximately 5,000 mg/kg ash. Release from APC residue was *greatly decreased* by Process 4 and *greatly increased* by the WES Control, compared to the untreated residue. Release from the bottom ash was affected only by Process 4, which *decreased* release. Release from combined ash was *greatly decreased* by Process 4 and *increased* by Process 3. In general, aluminum release from the availability leach test was several orders of magnitude greater than that observed by either the TCLP or the DWLT, but only a small fraction (typ. less than 20 %) of the total aluminum content of the material.

Calcium (Figure 7.22): Calcium release was much greater from the APC residue than from the bottom ash or combined ash. Releases from untreated APC residue, bottom ash and combined ash were approximately 200,000, 75,000 and 75,000 mg/kg ash, respectively. Release from treated APC residue ranged up to almost 800,000 mg/kg untreated ash or the equivalent of 80 wt% of the untreated residue. Processes 1, 3, 4 and the WES Control *increased* release from APC residue, compared to the untreated residue. Release from bottom ash was altered only by Process 3, which *increased* release. Processes 1, 2, and 3 all *increased* release from combined ash, compared to the untreated residue. Release observed from the availability leach test typically was greater than twice that observed by the DWLT for the untreated and treated APC residues, and approximately an order of magnitude greater for the untreated and treated bottom ash and combined ash. Calcium release during the availability test typically was approximately two-thirds of the total calcium content of each residue.

Cadmium (Figure 7.23): Cadmium release was approximately four times greater for the untreated APC residue compared to both the untreated bottom ash and combined ash. Release from untreated APC residue was approximately 140 mg/kg while release from untreated bottom ash and combined ash was approximately 30 mg/kg. Processes 1 and 3 *increased* cadmium release compared to the untreated APC residue. Process 1, applied to bottom ash, was the only treatment that resulted in *decreased* cadmium release. Otherwise, there were no significant changes in cadmium release as a result of treatment of all three residue types. Cadmium release from the availability test was approximately all of the cadmium content of each residue and was much greater than release observed from either the TCLP or DWLT.

Copper (Figure 7.23): Copper release was highly variable and was similar for all three residues types, with greater data variability associated with the bottom ash and combined ash than with the APC residue. Release from the untreated APC residue, bottom ash and combined ash was approximately 200, 400 and 400 mg/kg ash, respectively. Process 3 *increased* and the WES Control process *greatly increased* copper release from APC residue compared to the untreated residue. Process 1 *decreased* copper release from bottom ash compared to the untreated residue. All other treatment effects were not

significant (.80 level). Copper release from the availability leach test was approximately ten times greater than release observed from the TCLP and 100 times greater than release observed from the DWLT. Copper release from the availability leach test represented less than 35% of the total content in APC residue, and less than 25% of the total content in bottom ash and combined ash.

Potassium (Figure 7.24): Potassium release was approximately 14,000, 4,000 and 6,000 mg/kg ash from untreated APC residue, bottom ash and combined ash, respectively. Potassium release from APC residue was *increased* by Process 1 and the WES Control, compared to untreated residue. Release was *greatly increased* by Process 3 for all residue types, compared to the respective untreated residues, most likely because of the high potassium content of one of the process additives. No other treatment effects were significant. Potassium release from the availability leach test was similar to that observed by the DWLT and slightly greater than that observed from the TCLP. Potassium release from the availability leach test was almost the entire potassium content of the APC residue, but less than half of the total content of the bottom ash and combined ash.

Sodium (Figure 7.24): Sodium release was approximately 18,000, 5,000 and 7,000 mg/kg from untreated APC residue, bottom ash and combined ash, respectively. Sodium release from APC residue was *increased* by Process 1, compared to the untreated residue. Process 2 *increased* sodium release from the APC residue and *greatly increased* release from the bottom ash and combined ash, most likely because of high sodium content in one of the process additives. Sodium release from residues treated by Process 2 also was highly variable, with release from each residue type ranging by greater than 20,000 mg/kg ash treated. No other treatment effects were significant (.80 level) for all three residue types. Sodium release from the availability leach test was similar to that observed from the DWLT and TCLP. Sodium release from the availability test was approximately 70 % of the total content of the APC residue, but only between 25 and 30% of the total content for the bottom ash and the combined ash.

Lead (Figure 7.25): Lead release was approximately 1,000, 500 and 500 mg/kg ash for untreated APC residue, bottom ash and combined ash, respectively. Lead release from APC residue was *increased* by Processes 2 and 3 and *greatly increased* by the WES Control process, compared to the untreated residue. Lead release may have been increased by these processes because of the highly alkaline nature of the S/S matrix. Lead release from APC residue was *greatly decreased* (by several orders of magnitude) by Process 4. Lead release from bottom ash was not changed by any of the treatment processes. High variability in release from the untreated bottom ash most likely masked any treatment effects. Release from the combined ash was *greatly decreased* by Process 4, compared to the untreated residue. All other treatment effects were not significant (.80 level). Lead release observed by the availability leach test was substantially greater than release observed by both TCLP and DWLT.

Lead release from the availability leach test was up to 35% of the total content for APC residue and approximately 50% of the total content for bottom ash and combined ash.

Zinc (Figure 7.25): Zinc release was approximately 8,000, 3,000 and 3,000 mg/kg ash for untreated APC residue, bottom ash and combined ash, respectively. Release from APC residue was *increased* by Process 3 and the WES Control. Release from bottom ash was *decreased* by Process 1, and release from combined ash was not changed significantly (.80 level) by any of the treatments. Zinc release from the availability leach test was several orders of magnitude greater than release observed by both the TCLP and DWLT. Zinc release by the availability leach test was less than 50% of the total content for all three residue types.

Chloride (Figure 7.26): Chloride release was approximately 150,000, 32,000 and 32,000 mg/kg ash from APC residue, bottom ash and combined ash, respectively. Release from APC residue was *increased* by the WES Control process compared to the untreated residue. Release from bottom ash was *decreased* by Processes 1 and 4. Release from the combined residue was not changed significantly (.80 level) by any of the treatment processes. Process 4 applied to combined ash, however, resulted in a high degree of scatter in the chloride release data, where two of the data replicated closely, and suggests *decreased* release. The third data point may be an outlier. Chloride releases from the availability leach test was similar to releases observed from the TCLP and substantially lower than releases observed from the DWLT. Releases observed by the availability leach test were approximately the total chloride content as determined by NAA, further substantiating analytical difficulties with the extraction method of total analysis.

Sulfate (Figure 7.26): Sulfate release was approximately 100,000 mg/kg ash from the APC residue and 30,000 mg/kg ash from both the bottom ash and the combined ash. Release from the APC residue was *greatly increased* by Process 3 and the WES Control process compared to the untreated residue. Release also was *greatly increased* by Process 3, applied to bottom ash and combined ash. This was probably the result of the significant sulfate content in one of the process additives. Release from bottom ash also was decreased by Process 1. Releases observed by the availability leach test were approximately one order of magnitude greater than that observed from the DWLT and substantially greater than observed by the TCLP. Sulfate release from the availability leach test was much greater than the content measured by total analysis, indicating substantial limitations of the total analysis used.

Conclusions from the availability leach test are summarized in Table 7.8. Only Process 4 resulted in decreased release from APC residue, which resulted in *greatly decreased* release of aluminum and lead. Processes 1 and 3 resulted in increased cadmium release from APC residue. Processes 1 and 3 resulted

in increased lead release, and the WES Control resulted in *greatly increased* lead release from the APC residue. All processes applied to APC residue resulted in *increased* or *greatly increased* release of salts. Process 1, applied to bottom ash, resulted in *decreased* release of cadmium, zinc, copper, chloride and sulfate. Process 4, applied to bottom ash, resulted in *decreased* release of aluminum and chloride. Processes 2 and 3, applied to bottom ash, resulted in *increased* and *greatly increased*, respectively, release of salts. Process 4, applied to combined ash, resulted in *greatly decreased* release of aluminum and lead. Processes 1, 2 and 3 all resulted in *increased* or *greatly increased* release of salts from combined ash. The WES Control process had no effect on release from either bottom ash or combined ash. These results suggest that under constant pH conditions, only Process 4, applied to APC residue and combined ash, and Process 1, applied to bottom ash, had positive treatment effects. The remaining process applications had either no effect or a negative treatment effect.

7.5 ACID NEUTRALIZATION CAPACITY LEACH TEST

Figures 7.27 through 7.44 present pH titration curves and cadmium, chromium, copper , lead and zinc extract concentration as a function of pH for untreated and treated MWC residues. Extract concentrations are indicative of solubility for metals as a function of pH except when extract concentrations increase to and maintain a constant concentration at acidic pH. This phenomena is indicative of complete solubilization of the available fraction of the metal. Horizontal lines on each of the figures are used to indicate detection limits. Discussion is provided for the titration curves and each of the metals concentrations curves are provided in the following paragraphs.

pH titration curves (Figures 7.27 - 7.29): A principal change between the untreated and treated residues which effects leaching properties is the matrix alkalinity and acid buffering capacity. Untreated APC residue required approximately 7 meq/g of acid to titrate to pH 7 while bottom ash and combined ash each required approximately 2 meq/g. This is in contrast to the addition of 1.98 meq/g of acetic acid added for the TCLP. Thus, the very high buffering capacity of the MWC residues clearly overwhelm the acid addition for many leach tests where the amount of acid, not the extraction pH, is the controlled variable. The greater amount of acid required to titrate the APC residue is a direct consequence of lime utilization during the acid gas scrubbing of combustion gases. Furthermore, the buffering capacity of APC residue and combined ash can be substantially influenced by the acid gas scrubber operation on the municipal waste combustor. Metals solubility, and hence release, is strongly affected by aqueous solution pH and therefore by residue buffering capacity.

Treatment of APC residue by Processes 1 and the WES Control did not significantly alter the buffering capacity of the residue. Processes 2 and 3 slightly increased the buffering capacity to 7.5 meq/g treated

residue. Process 4 decreased the buffering capacity of APC residue to 3 meq/g. All treatment processes increased the buffering capacity of bottom ash and combined ash. Titration curves for bottom ash and combined ash were similar within processes. Processes 1, 2, 3, 4 and WES Control increased buffering capacity (to pH 7) to 3, 9, 6, 2.5, and 4 meq/g treated residue, respectively. These changes in buffering capacity are directly responsible for the extract pHs observed from the TCLP and DWLT.

Cadmium (Figures 7.30 - 7.32): Cadmium extract concentration was a strong function of pH for all untreated and treated residues. Extract concentration from all untreated residues was below detection limits at pH greater than 10. As pH decreased from 10 to 6 for untreated APC residue, cadmium concentration increased from 0.03 mg/l to 30 mg/l. Extract concentration from untreated combined ash increased from 0.03 mg/l to approximately 4 mg/l as pH decreased from 9 to 6. Similarly, extract concentration from bottom ash increased from 0.03 mg/l to approximately 5 mg/l as pH decreased from 8 to 6. The difference in pH below which the extract concentrations began to increase for APC residue, combined ash and bottom ash was principally a result of chloride concentration in the extracts. High chloride concentrations tend to increase cadmium solubility through complexation. APC residue had the greatest chloride concentration while bottom ash had the lowest. Treatment of APC residue resulted in a change in the pH - concentration curve only for Processes 1, 4 and the WES Control. Processes 1 and WES Control shifted to pH 9 the pH below which extract concentrations increased. Process 4 shifted the pH at which the maximum cadmium concentration was attained from pH 6 to 4 but did not shift the pH below which the concentration begins to increase.

Chromium (Figure 7.33 - 7.35): Chromium extract concentration as a function of pH followed several characteristic patterns for untreated and treated residues. The differences in extraction behavior most likely can be attributed to different speciation of the chromium in the different untreated and treated residues. The first characteristic pattern was that indicated by the untreated and treated APC residue, except for treatment by Process 4. In this characteristic pattern, chromium concentration was less than the detection limit at pH 12 . At pH less than 12 and greater than 10, chromium concentration gradually increased from 0.1 mg/l to 0.4 mg/l. The extract concentration remained fairly constant at approximately a 4 mg/l at pH between 4 and 10. At pH less than 4, the extract concentration increased to a maximum of 4 mg/l at approximately pH 2. This characteristic pattern also was observed for bottom ash treated by Processes 3 and WES control, and combined ash treated by Processes 1, 3 and the WES control. The second characteristic pattern was typified by APC residue treated by Process 4. In this pattern, chromium concentration increased to a maximum of approximately 5 mg/l with decreasing pH. The slope of the concentration curve decreased substantially at pH less than 4. This pattern also was observed for bottom ash treated by Process 1 . The third pattern observed is typified by untreated

bottom ash. In this case, the extract concentration remained below the detection limit until the pH was less than a certain value. At pH less than that value, the extract concentration increased rapidly with decreasing pH. This pH was 6 for untreated bottom ash. This pattern also was observed for Bottom ash treated by Process 4 (at pH 6-8), untreated combined ash (at pH 4) and for combined ash treated by Process 4 (at pH 6-8). Process 2 applied to both bottom ash and combined ash resulted in considerable data scatter and may reflect a somewhat amphoteric behavior at pH greater than 11. In summary, treatment of APC residue resulted in a slight reduction in chromium solubility only for Process 4. Treatment of bottom ash and combined ash resulted in increased chromium solubility at neutral to slightly acidic pH for all treatment processes.

Copper (Figures 7.36 - 7.38): Copper extract concentrations for untreated and treated APC residue indicated concentrations increasing from below the detection limit (0.1 mg/l) to between 10 and 100 mg/l with decreasing pH. The characteristic pH below which this concentration increase was observed was 6 for untreated APC residue, 5 for Processes 1 and 2, and, 7 for Process 4 and the WES control. Untreated and treated bottom ash resulted in low extract concentrations at pH greater than 6-8 and highly scattered concentrations at pH less than 8. Generally the highest extract concentrations (up to 4 mg/l) at neutral to slightly acidic pH were observed for untreated and treated combined ash. Maximum extract concentrations were approximately 100 mg/l. No significant reductions in copper solubility were observed as a result of treatment of bottom ash or combined ash.

Lead (Figures 7.39 - 7.41): Lead extract concentrations for untreated APC residue exhibited a classic amphoteric behavior and were at a minimum of approximately 1 mg/l between pH 6 and 10. At pH decreasing below or increasing above this range, the extract concentration increased rapidly to up to 100 mg/l. All treatment processes decreased the extract concentration to at or below the detection limit (0.5 mg/l) between pH 5.5 and 10. Processes 2, 4 and the WES Control were most effective within this pH range and may have extended this reduction to slightly more acidic pHs. Process 4 also decreased the amphoteric behavior by reducing the extract solution pH to less than 12 when no acid was added. Untreated and treated bottom ash and combined ash did not exhibit amphoteric behavior because the most alkali pH observed was less than 11.5. All untreated and treated bottom ash and combined ash extracts attained a maximum concentration of approximately 200 mg/l at a pH of 2. The principal difference among responses was the pH below which lead concentration increased rapidly with decreasing pH. This pH typically was pH 6 for untreated APC residue and bottom ash and pH 5 for untreated and combined ash and treated residues. All extract concentrations for bottom ash and combined ash were at or below the detection limit at pHs greater than 6.

Zinc (Figures 7.42 - 7.44): Zinc extract concentrations exhibited similar behavior for all untreated and treated residues. At pH greater than 8 the extract concentrations were widely scattered between 0.1 mg/l and 10 mg/l for APC residue and between the detection limit (0.02 mg/l) and 0.1 mg/l for bottom ash and combined ash. This scatter extended to 1.0 mg/l for bottom ash and combined ash treated by Process 2. At pH less than 8, all extract concentrations increased rapidly with decreasing pH until a maximum concentration of approximately 1000 mg/l was attained at pH between 4 and 6, depending on treatment process. The only effects resulting from treatment were a decrease in the pH below which the extract concentrations increased and a change in the slope of the concentration curve. These effects were indicated only for Process 4 applied to APC residues.

7.6 COMPARISON OF MAGNITUDE AND CONSISTENCY OF RESULTS FROM TESTS FOR LEACHING POTENTIAL

Tables 7.9 through 7.11 provide summary comparisons of the results form the TCLP, DWLT and ALT. Most of the results from the different tests indicated similar trends in the treatment effects, however several important exceptions existed. In these cases, one or more leaching test indicated a *decrease* or *increase* in a particular species release while the remaining leaching tests indicated contrary results. Contrary results from the different leaching tests are discussed by residue type and element or species in the sections that follow.

7.6.1 Treated APC Residue

Aluminum: For Process 4, the ALT indicated *greatly decreased* release while the distilled water leach test indicated *increased* release and TCLP indicated no significant change. This result is a reflection of the the increased solubility aluminum species at lower pHs. Process 4 resulted in an end point pH between 11 and 11.8 for the DWLT, while the untreated residue and all other treated residues resulted in DWLT end point pHs of approximately 12 or greater. Thus, by comparison with the untreated APC residue, DWLT release increased. Result of the ALT indicated a substantial reduction in release most likely because of the formation of insoluble aluminum-phosphate mineral phases. Differences in end point pH were not a factor because the ALT was carried out at constant pH.

Calcium: For Process 4, the DWLT indicated a *decrease* in calcium release while the ALT indicated an *increase* in calcium release. The explanation for this result is unclear. The WES control process indicated *decreased* release for the DWLT while indicating *greatly increased* release for the TCLP and increased release for the ALT. Decreased release for the DWLT most likely reflects greater stability of the calcium in the portland cement matrix than in the untreated material at alkaline pH. Increased release at lower

pHs (ALT and TCLP) reflects the increase amount of calcium present in the treated matrix and the dissolution of the portland cement in acidic conditions.

Copper: For the WES control process, *decreased* release was indicated by the DWLT while greatly *increased* release was indicated by the ALT. This result most likely reflect increasing copper solubility with decreasing pH.

Lead: Processes 2, 3 and the WES Control indicated either *greatly decreased* release for the TCLP while indicating *increased* or *greatly increased* release for the ALT. These results generally reflect the amphoteric nature of lead (Figure 7.39). Lead solubility *greatly decreased* at pHs less than 12 until *greatly increasing* again at pHs less than 5. Treatment by Processes 2, 3 and the WES Control resulted in TCLP end point pHs less than 11.8 while untreated residue had a TCLP end point pH of approximately 12. Processes 2 and WES Control also indicated *greatly decreased* release for the DWLT. This is most likely indicative of respeciation of the lead within the treated matrix. Respeciation also may be indicated by the increased release at pH 4 by the ALT.

Zinc: Process 3 indicated *greatly decreased* release for TCLP while *increased* release for ALT. The *decreased* release for TCLP is a result of *decreased* zinc solubility at high pH. For this case, the TCLP end point pH was greater than 11.

Sulfate: Process 1 indicated *increased* release for the TCLP and *greatly decreased* release for the DWLT. Process 4 indicated *greatly increased* release for TCLP and *decreased* release for DWLT. The WES Control indicated *greatly decreased* release for DWLT and *greatly increased* release for ALT. The reasons for these conflicting results are not clear.

7.6.2 Treated Bottom Ash

Aluminum: Process 1 and WES Control indicated *greatly decreased* release for DWLT and *greatly increased* release for TCLP. *Decreased* release for the DWLT most likely is indicative of respeciation of the aluminum and incorporation into the cement matrix. *Increased* release for the TCLP most likely reflects increasing solubility with decreasing pH. The TCLP end-point pH for the untreated and treated bottom ash was approximately 8 and 5.5, respectively.

7.6.3 Treated Combined Ash

Calcium: For Process 2 the DWLT indicated *greatly decreased* calcium release while the ALT indicated an *increase* in calcium release. *Decreased* release for the DWLT most likely reflects decreased matrix

solubility at greater pHs. The endpoint DWLT pH for the residue treated by Process 2 and the untreated residue were approximately 12 and 10.8, respectively.

Copper: Process 2 indicated *decreased* release for TCLP and greatly *increased* release for DWLT. Process 2 showed slightly amphoteric behavior for copper (Fig. 7.38) and had a greater end point pH (ca. 12) than for the untreated residue (ca. 10.8).

Lead: Processes 1, 2,and 3 indicated *greatly decreased* release for the TCLP while indicating *greatly increased* release for the DWLT. These results generally reflect the amphoteric nature of lead as described above for APC residue.

7.6.4 Release Potential Compared to Total Concentrations

Table 7.12 presents for several elements a comparison of the fraction of that element present in the untreated residue that was released following treatment during the AVT. This comparison is presented to provide an indication of the extent of long term immobilization of these elements as a function of the treatment processes evaluated. The AVT was selected for this comparison because it provides for the most uniform extraction conditions of the leach tests carried out (e.g., constant final pH) and represents the most aggressive potential exposure scenario or "worst case." Chemical immobilization varied considerably by specific element, process applied and residue type treated.

Results for APC residue indicate that cadmium, calcium, chloride, sodium and potassium were not irreversibly chemically bound to an appreciable extent. This also was the case for copper, lead and zinc for APC residue treated by Processes 2, 3 and the WES Control. Aluminum, copper, lead and zinc were chemically bound to significant extent by Processes 1 and 4. Furthermore, almost complete chemical immobilization of lead occurred for APC residue treated by Process 4.

Results for bottom ash indicate that calcium and chloride were not irreversibly chemically bound to an appreciable extent. This also was the case for sodium and zinc for bottom ash treated by Process 2 and potassium treated by Process 3. Greater than approximately 80% of the aluminum, copper and lead was chemically immobilized by all of the processes in the treated bottom ash. Results for cadmium, potassium and zinc varied by process type between 49 and 91% retention for those processes with significant retention.

Results for combined ash indicate that calcium and chloride were not irreversibly chemically bound to an appreciable extent. This also was the case for sodium in combined ash treated by Process 2 and potassium treated by Processes 1, 2 and 3. Greater than 70% chemical immobilization of aluminum and copper was achieved by all processes applied to combined ash. Results for lead varied considerably

by process between no appreciable chemical retention (Process 3) to 96% retention *(Process 4)*. Limited to no appreciable chemical retention of cadmium was achieved except by Process 1.

7.6.5 Summary of Leaching Potential Results by Treatment Process

Table 7.8 through 7.10 provide a comparison of release results by Process type and element for each residue type.

APC residue:

- Process 1 resulted in no change to *greatly increased* release for aluminum, calcium, cadmium,potassium, sodium and chloride. No change to *greatly decreased* release was indicated for copper, lead and zinc.
- Process 2 resulted in no change to *greatly increased* release for aluminum, calcium, potassium, sodium and chloride. No change to *greatly decreased* release was indicated for copper, zinc and sulfate.
- Process 3 resulted in no change to *greatly increased* release for aluminum, calcium, cadmium, potassium and sulfate. No change to *greatly decreased* release was observed for copper only. Lead and zinc results were confounded by changes in end point extract pHs.
- Process 4 resulted in no change to *greatly increased* release for cadmium. No change to *greatly decreased* release was indicated for potassium, copper, sodium, and chloride. Substantial reductions in lead release was observed compared to all other processes tested. Aluminum, calcium, zinc and sulfate results were confounded.
- The WES Control resulted in no change to *greatly increased* release for aluminum, calcium, potassium, sodium and chloride. Copper, lead, zinc and sulfate results were confounded.

Bottom Ash:

- Process 1 resulted in no change to *decreased* release for calcium, cadmium, copper, chloride and zinc. Release was *decreased* to *greatly decreased* for sulfate. Aluminum had confounded results. There was no change in the release of potassium, sodium and lead.
- Process 2 resulted in no change to *greatly increased* release of aluminum, copper, lead, zinc and sulfate. Sodium release was *greatly increased* which was attributed to a process additive.
- Process 3 resulted in no change to *greatly increased* release for calcium, potassium, copper and lead. Potassium and sulfate release were *greatly increased* which was attributed to a process additive. No change in release was observed for aluminum, cadmium, sodium, chloride and zinc. No decreases in release were observed.
- Process 4 resulted in no change to *greatly increased* release for calcium, cadmium, and zinc. No change in release was observed for potassium, copper, sodium and lead. No change to *greatly decreased* release was observed for aluminum, chloride and sulfate.

- The WES Control resulted in no change to *greatly increased* release for cadmium, copper, lead and zinc. No change in release was observed for calcium, potassium, sodium and chloride. No change to *greatly decreased* release was observed for sulfate. Confounded results were observed for aluminum.

Combined Ash:

- Process 1 resulted in no change to *increased* release for calcium. No change to *greatly decreased* release was observed for aluminum, cadmium, copper, zinc, and sulfate. No change in release was observed for potassium, sodium and chloride. Confounded results were obtained for lead.
- Process 2 resulted in no change to *increased* release for cadmium and sulfate. *Greatly increased* release was observed for sodium and was attributed to a process additive. No change was observed for aluminum, potassium, and chloride. Confounded results were observed for copper, lead and zinc.
- Process 3 resulted in no change to *greatly increased* release for aluminum and calcium. *Greatly increased* release was observed for potassium and sulfate which were attributed to a process additive. No change in release was observed for sodium and chloride. No change to *decreased release* was observed for cadmium, copper and zinc. Confounded results were observed for lead.
- Process 4 resulted in no change to *greatly decreased* release for aluminum, calcium, cadmium, copper, lead, chloride, zinc and sulfate. No increases in release were observed. No change in release was observed for potassium and sodium.
- The WES Control resulted in no change to *increased release* for lead. No change in release was observed for cadmium, potassium, copper, sodium, chloride and zinc. No change to *greatly decreased* release was observed for aluminum, calcium and sulfate.

Table 7.1. Leaching Test Liquid to Solid Ratios and Treatment Process Dilution Factors.

Leach Test	Liquid to Solid Ratio (ml extractant/g extracted)
TCLP	20.1
DWLT	4 serial extractions at 10:1 each
Availability leach test	200:1
ANC	5:1

Process Dilution Factors (kg treated residue/kg untreated residue)

	Bottom Ash	APC Residue	Combined Ash
Process 1	1.2	2.0	1.3
Process 2	1.6	2.2	1.6
Process 3	1.8	2.4	1.8
Process 4	1.2	1.3	1.2
WES Control	1.2	2.2	1.2

Table 7.2. Comparison of selected metal concentrations in Extraction Fluid 1 and Extraction Fluid 2.

	APC Residue		Bottom Ash		Combined Ash	
mg/l	E.F.1*	E.F.2**	E.F.1	E.F.2	E.F.1	E.F.2
Cr	27	21	5	79	5	67
Cd	5	5	7	161	10	508
Cu	74	74	95	6437	373	2850
Pb	37033	32633	41	1995	41	2127
Zn	3987	4330	527	61300	270	39133
pH (S.U.)	11.91	11.88	7.79	5.24	6.3	5.2

* E.F.1 = Extraction Fluid 1
** E.F.2 = Extraction Fluid 2

Table 7.3. Relative categories of treatment effects.

Symbol		Category
(- 3)	=	Decreased release compared to other processes in addition to less than 1/2 that of the untreated residue;
--	=	Greatly decreased release (release of less than 1/2 that of the untreated residue);
-	=	Decreased release (significant at the 0.80 confidence level as compared to the untreated residue);
+	=	Increased release (significant at the 0.80 confidence level as compared to the untreated residue);
++	=	Greatly increased release (release of greater than twice that of the untreated residue); and,
(+ 3)	=	Increased release compared to other processes in addition to twice that of the untreated residue.

Table 7.4. Summary of conclusions on treatment effects on contaminant release by TCLP (refer to table 7.3 for key).

	APC Residue	Bottom Ash	Combined Ash
Process 1			
- -	Pb, Zn	SO_4	Cd, Pb, Zn
-	Cu	Ca	Cu, SO_4
+	Al, Ca, Cl, K, Na, SO_4		
++		Al	
Process 2			
- -	Pb, Zn		Cd, Pb, Zn
-			Cu
+	Al, Cl	SO_4	
++	Ca, Na	Al, Na	Na
Process 3			
- -	Pb, Zn		Pb
-			Cd, Cu, Zn
+	K		
++	SO_4	Ca, K, SO_4	Ca, K, SO_4
Process 4			
- -	Pb (-3)*		Pb
-			Cd, Cu, Zn
+		Ca	
++	Cd, Zn, SO_4	Cd, Zn	
WES Control			
- -	Pb, Zn		
-			
+	Na	Cu, Pb	
++	Al, Ca	Al, Cd, Zn	

Table 7.5. Summary of conclusions on treatment effects on contaminant release by DWLT Extracts 1 and 2 (refer to Table 7.3 for key).

	APC Residue	Bottom Ash	Combined Ash
Process 1			
- -	Cu, Pb, Zn, SO_4	Al, SO_4	Al, SO_4
-		Cl	Cu
+	Al, Ca, Na, TDS, TOC		Pb
++	K		
Process 2			
- -	Pb, Zn, SO_4		Ca
-	Cu	Ca	
+	Al, K, TDS, TOC	Al, Pb, Zn, TOC	Zn
++	Na	Cu, Na, SO_4(+3), TDS	Cu, Na, SO_4(+3)*, Pb, - TDS (+3), TOC
Process 3			
- -			
-	Cu		Cu
+	Al, SO_4, TDS, TOC	Ca, TDS	Ca
++	K,	K, Pb, SO_4	K, Pb(+3)*, SO_4, TDS
Process 4			
- -	Cu, Pb(-3)**, Zn, Cl	SO_4	SO_4
-	Ca, K, Na, SO_4	Cl, TDS	Ca, Cl
+	Al		
++			
WES Control			
- -	Pb, Zn, SO_4	Al, SO_4	Al, SO_4
-	Ca, Cu		Ca
+	Al, K, Cl, TDS, TOC	Pb	Pb
++			

Table 7.6. Summary of conclusions on treatment effects on contaminant release by DWLT Extracts 3 and 4 (refer to Table 7.3 for key).

	APC Residue	Bottom Ash	Combined Ash
Process 1			
- -	Pb, Zn, SO_4	Al	Al, SO_4
-	Cu	Cu	Cu
+	Cl, TOC	Ca	Ca
++			Cl
Process 2			
- -	Pb, Zn, SO_4	Al	Al, SO_4
-	Na		Cu
+	Al, TOC	Ca, K	K
++		Na	Na
Process 3			
- -		Al(+3)	Al(-3)
-	Cl, SO_4		Cu
+	TOC	Ca, K, Pb	K
++		TOC	
Process 4			
- -	Pb		
-	Ca, Cu, Zn, Cl, SO_4	SO_4	SO_4
+	Al	Ca	Al
++			
WES Control			
- -	Pb , Zn, SO_4	Al	Al, SO_4
-		SO_4	
+	Al, Cl, TOC	Ca	
++			

Table 7.7. Comparison of total dissolved solids released for the distilled water leach test (g released/kg ash, dry solid), and in parenthesis, the weight % of the material released.

	Bottom Ash	APC Residue	Combined Ash
Untreated	58 (6%)	289 (29%)	60 (6%)
Process 1	53 (4%)	640 (32%)	54 (4%)
Process 2	187 (12%)	565 (26%)	208 (13%)
Process 3	126 (7%)	578 (24%)	144 (8%)
Process 4	47 (4%)	194 (15%)	56 (5%)
WES Control	59 (5%)	671 (30%)	79 (6%)

Table 7.8. Summary of conclusions on treatment effects on contaminant release by availability leach test (refer to Table 7.3 for key).

	APC Residue	Bottom Ash	Combined Ash
Process 1			
- -			
-		Cd, Cu, Cl, SO_4, Zn	
+	Ca, Cd, K, Na		Ca
++			
Process 2			
- -			
-			
+	Na, Pb		Ca
++		Na	Na
Process 3			
- -			
-			
+	Al, Ca, Cd, Pb, Zn,	Ca, Cu	Al, Ca
++	K, SO_4	K, SO_4	K, SO_4
Process 4			
- -	Al, Pb		Al, Pb
-		Al, Cl	
+	Ca		
++			
WES Control			
- -			
-			
+	Ca, K, Zn		
++	Al, Cl, Cu, Pb, SO_4		

Table 7.9. Comparison of leaching test results for treated APC residue (refer to Table 7.3 for key).

	Process 1	Process 2	Process 3	Process 4	WES
Al					
TCLP:	+	+			++
DWLT:	+	+	+	+	+
AVLT:			+	- -	++
Cd					
TCLP:				++	
DWLT:					
AVLT:	+		+		
Cu					
TCLP:	-				
DWLT:	- -	-	-	- -	-
AVLT:					++
Pb					
TCLP:	- -	- -	- -	- - -	- -
DWLT:	- -	- -		- - -	- -
AVLT:		+	+	- -	+ +
Zn					
TCLP:	- -	- -	- -	++	- -
DWLT:	- -	- -		- -	- -
AVLT:			+		+

	Process 1	Process 2	Process 3	Process 4	WES
Ca					
	+	++			++
	+			-	-
	+		+	+	+
K					
	+		+		
	++	+	++	-	+
	+		++		+
Na					
	+	++			+
	+	++		-	
	+	+			
Cl					
	+	+			
				- -	+
					+ +
SO4					
	+		++	++	
	- -	- -	+	-	- -
			++		++

Note: DWLT indicated is for extracts 1 and 2 only.

Table 7.10. Comparison of leaching test results for treated bottom ash (refer to Table 7.3 for key).

	Process 1	Process 2	Process 3	Process 4	WES
Al					
TCLP:	++	++			++
DWLT:	- -	+			- -
AVLT:				-	
Cd					
TCLP:				++	++
DWLT:					
AVLT:	-				
Cu					
TCLP:					+
DWLT:		++			
AVLT:	-		+		
Pb					
TCLP:					+
DWLT:		+	++		+
AVLT:					
Zn					
TCLP:				++	++
DWLT:		+			
AVLT:	-				

	Process 1	Process 2	Process 3	Process 4	WES
Ca					
	-		++	+	
		-	+		
			+		
K					
			++		
			++		
			++		
Na					
		++			
		++			
		++			
Cl					
	-			-	
	-			-	
SO4					
	- -	+	++		
	- -	+++	++	- -	- -
	-		++		

Note: DWLT indicated is for extracts 1 and 2 only.

Table 7.11. Comparison of leaching test results for treated combined ash (refer to Table 7.3 for key).

	Process 1	Process 2	Process 3	Process 4	WES
Al					
TCLP:					
DWLT:	- -				- -
AVLT:			+	- -	
Cd					
TCLP:	- -	- -	-	-	
DWLT:					
AVLT:					
Cu					
TCLP:	-	-	-	-	
DWLT:	-	++	-		
AVLT:					
Pb					
TCLP:	- -	- -	- -	- -	
DWLT:	+	++	+++		+
AVLT:				- -	
Zn					
TCLP:	- -	- -	-	-	
DWLT:		+			
AVLT:					

	Process 1	Process 2	Process 3	Process 4	WES
Ca					
			++		
		- -	+	-	-
	+	+	+		
K					
			++		
			++		
			++		
Na					
		++			
		++			
		++			
Cl					
				-	
SO4					
	-		++		
	- -	+++	++	- -	- -
			++		

Note: DWLT indicated is for extracts 1 and 2 only.

Table 7.12. Fraction of total element present in treated residues released during the availability leach test.

	Total * (mg/kg ash)	Process 1 (%)	Process 2 (%)	Process 3 (%)	Process 4 (%)	WES Control (%)
APC Residue						
Aluminum	25,586	16	31	33	1	69
Cadmium	137	≥100†	≥100†	≥100†	87	≥100†
Calcium	290,725	≥100†	95	≥100†	85	≥100†
Chloride	90,325	≥100†	≥100†	≥100†	≥100†	≥100†
Copper	515	30	55	76	25	≥100†
Lead	2,969	40	72	76	0.1	≥100†
Sodium	20,467	≥100†	≥100†	≥100†	94	≥100†
Potassium	15,598	≥100†	≥100†	≥100†	≥100†	≥100†
Zinc	17,453	38	62	69	38	90
Bottom Ash						
Aluminum	51,749	5	10	11	1	9
Cadmium	35	23	29	46	49	51
Calcium	113,087	53	≥100†	≥100†	78	92
Chloride	24,301	61	≥100†	≥100†	71	≥100†
Copper	1,477	5	18	13	15	10
Lead	1,563	9	10	20	3	21
Sodium	19,777	17	≥100†	38	17	23
Potassium	9,510	21	48	≥100†	24	47
Zinc	6,793	10	≥100†	24	27	31
Combined Ash						
Aluminum	56,083	11	27	21	1	9
Cadmium	32	≥100†	63	63	81	75
Calcium	123,357	≥100†	≥100†	≥100†	85	≥100†
Chloride	28,922	55	≥100†	≥100†	≥100†	≥100†
Copper	1,734	14	23	22	14	19
Lead	1,054	24	47	≥100†	4	32
Sodium	21,678	32	≥100†	34	24	24
Potassium	13,245	52	57	≥100†	36	43
Zinc	6,172	27	41	32	35	34

* All total element concentrations are based on NAA results except lead, which is based on SW-846 results.

† Values nominally greater than 100% were calculated because of either contributions from process additives or correction for process dilution.

Figure 7.1. TCLP extract pHs.

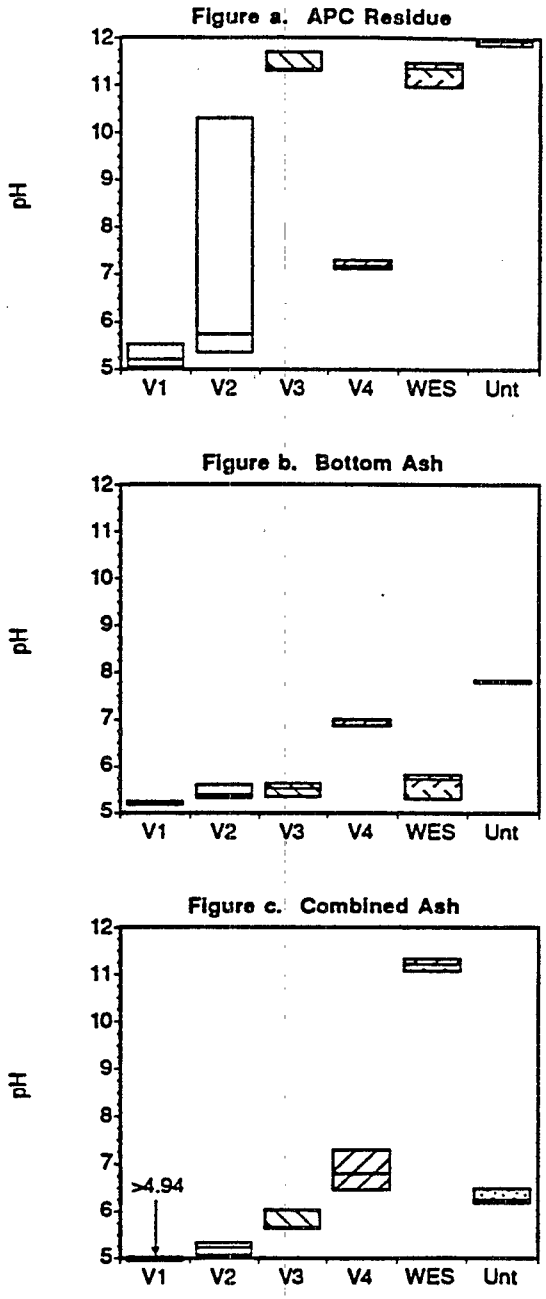
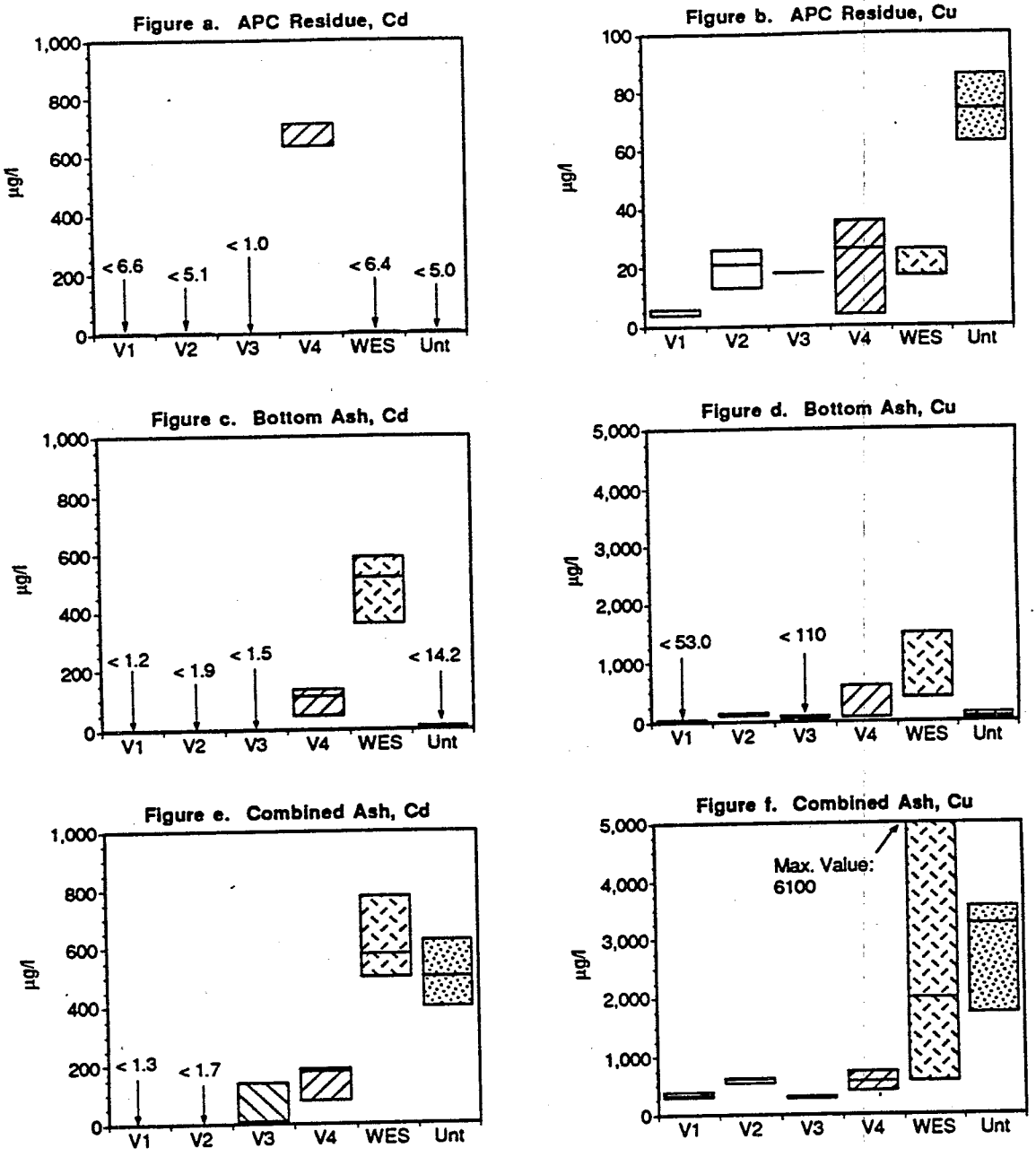
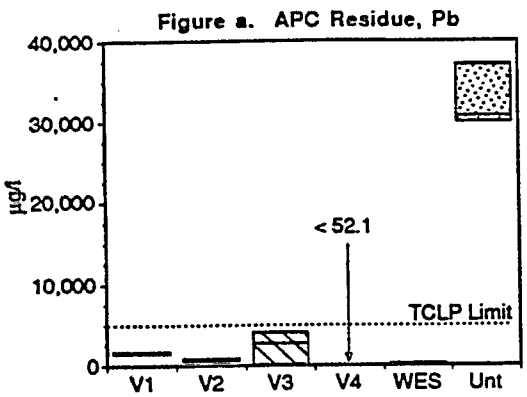


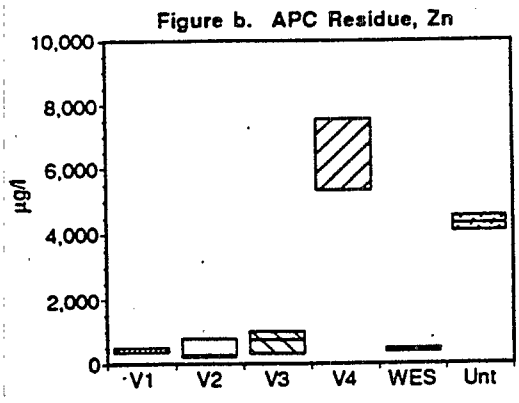
Figure 7.2. Cadmium and copper concentrations in TCLP extracts. Regulatory limit for cadmium concentration in TCLP extracts is 1000 µg/l.

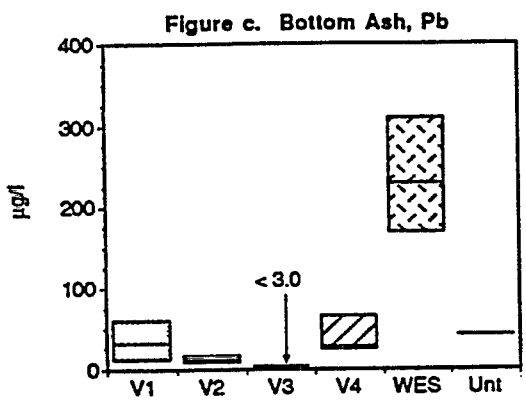


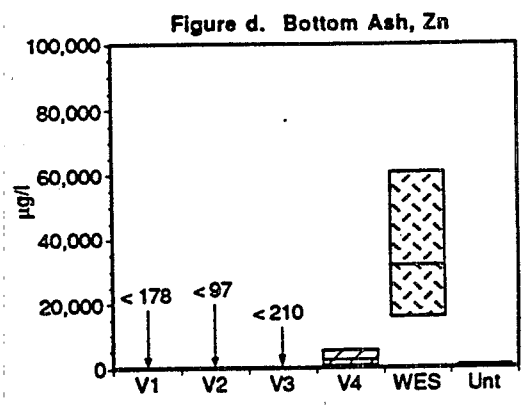
Note:
TCLP extraction fluid 2 was the required fluid for all cases except untreated bottom ash, and Process 1 applied to bottom ash and combined ash for which TCLP extraction fluid 1 was required.

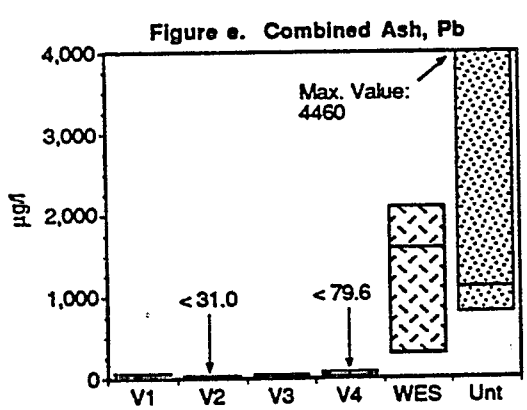
Figure 7.3. Lead and zinc concentrations in TCLP extracts. Regulatory limit for lead concentration in TCLP extracts is 5000 µg/l.

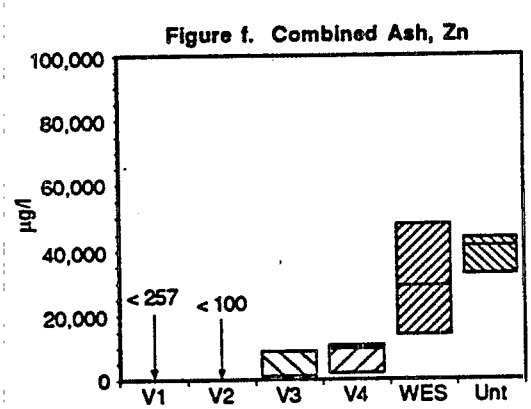






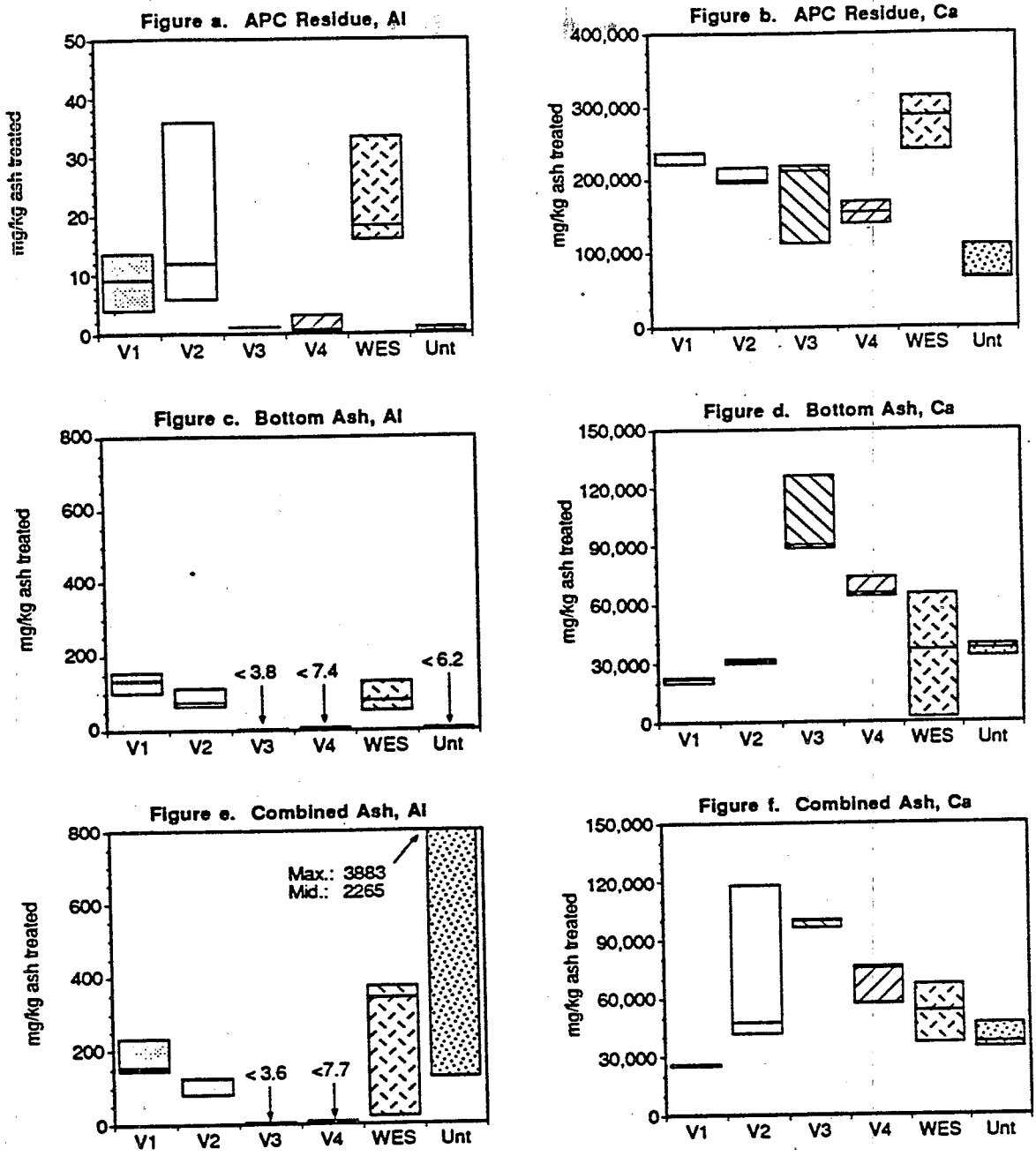






Note: TCLP extraction fluid 2 was the required fluid for all cases except untreated bottom ash, and Process 1 applied to bottom ash and combined ash for which TCLP extraction fluid 1 was required.

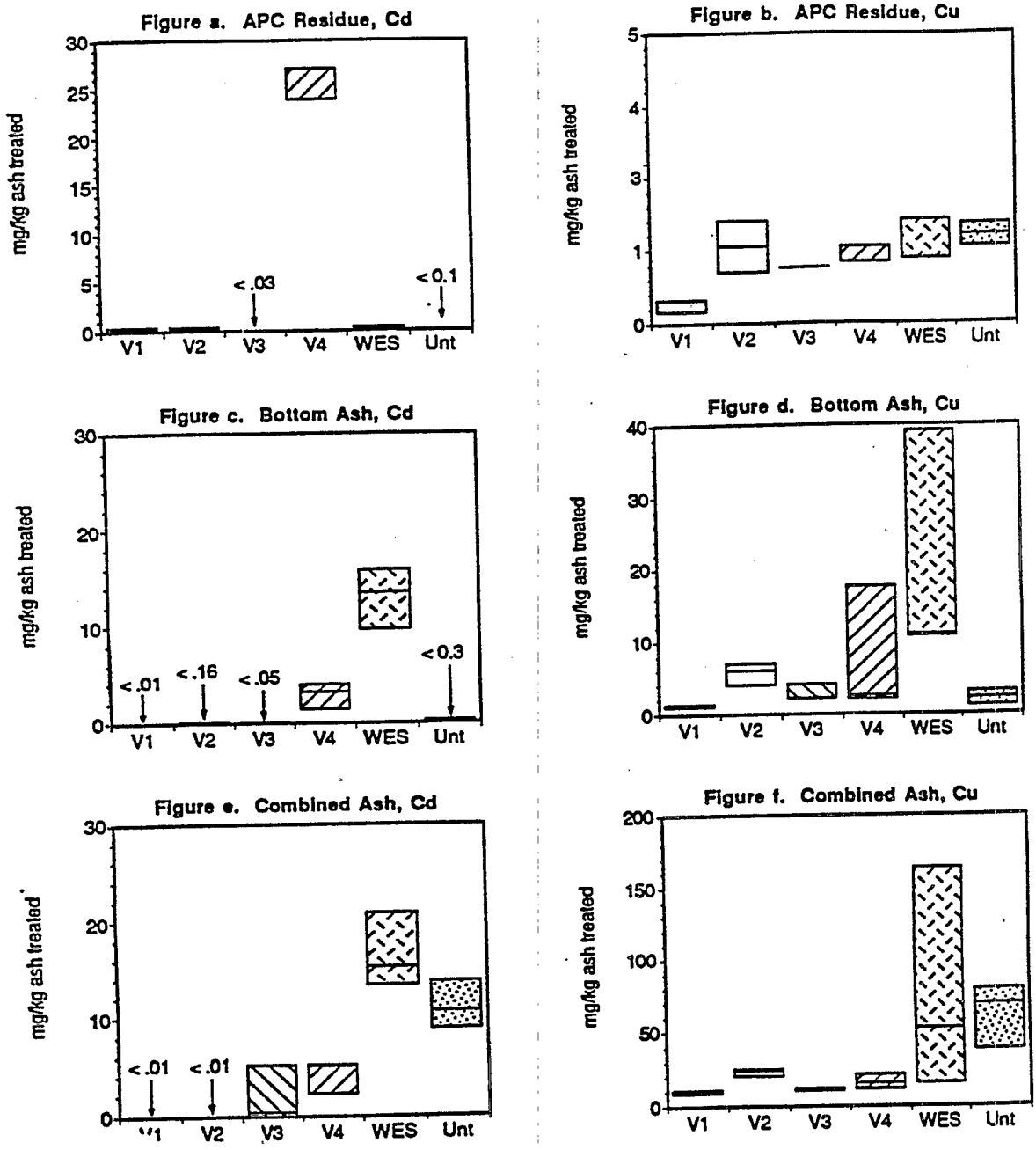
Figure 7.4. Aluminum and calcium release during TCLP extraction, corrected for process dilution.



Note:

TCLP Extraction Fluid 2 was the required extraction fluid for all cases except untreated Bottom Ash, and Process 1 Bottom Ash and Combined Ash for which TCLP Extraction Fluid 1 was required.

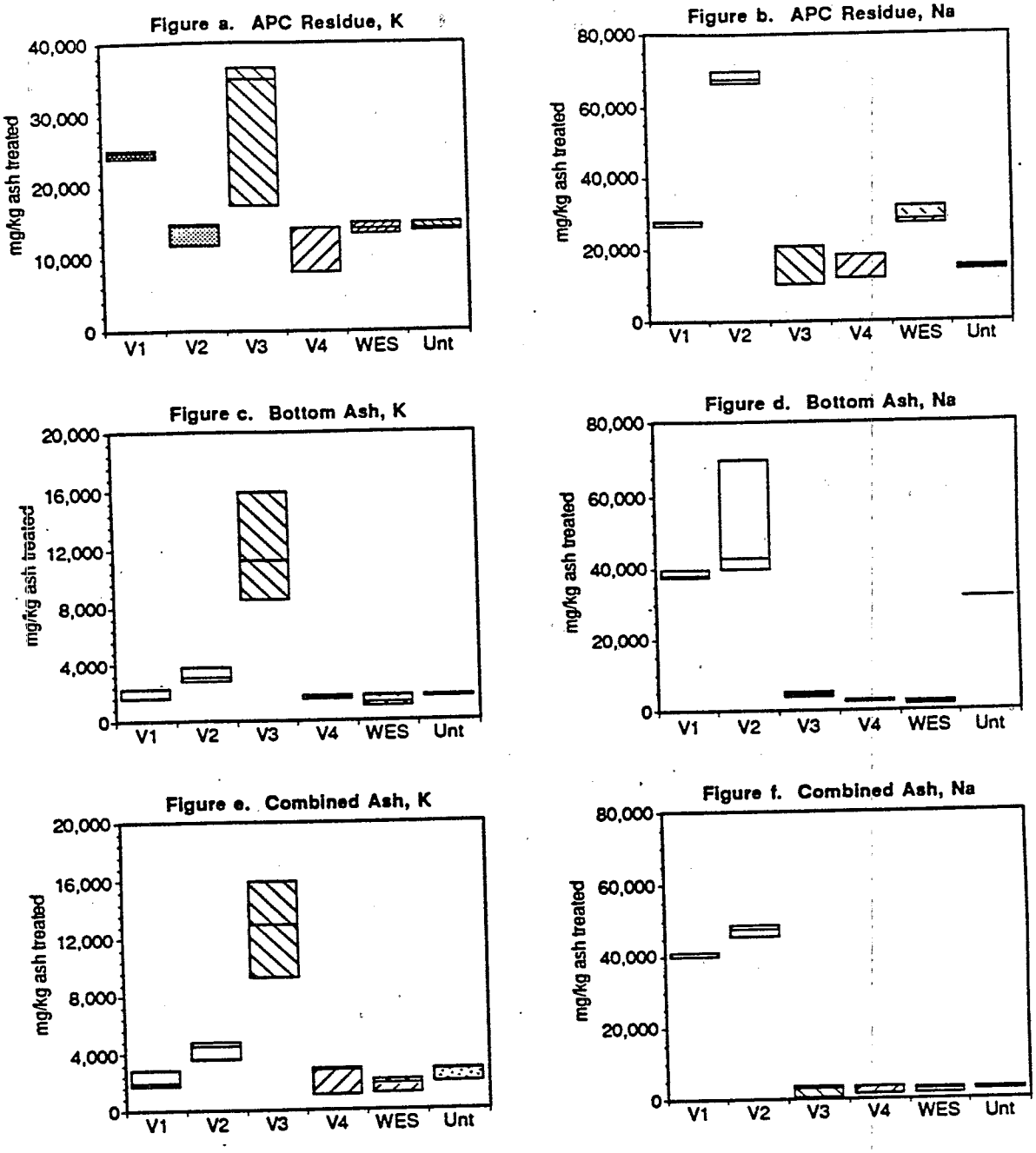
Figure 7.5. Cadmium and copper release during TCLP extraction, corrected for process dilution.



Note:

TCLP Extraction Fluid 2 was the required extraction fluid for all cases except untreated Bottom Ash, and Process 1 Bottom Ash and Combined Ash for which TCLP Extraction Fluid 1 was required.

Figure 7.6. Potassium and sodium release during TCLP extraction, corrected for process dilution.

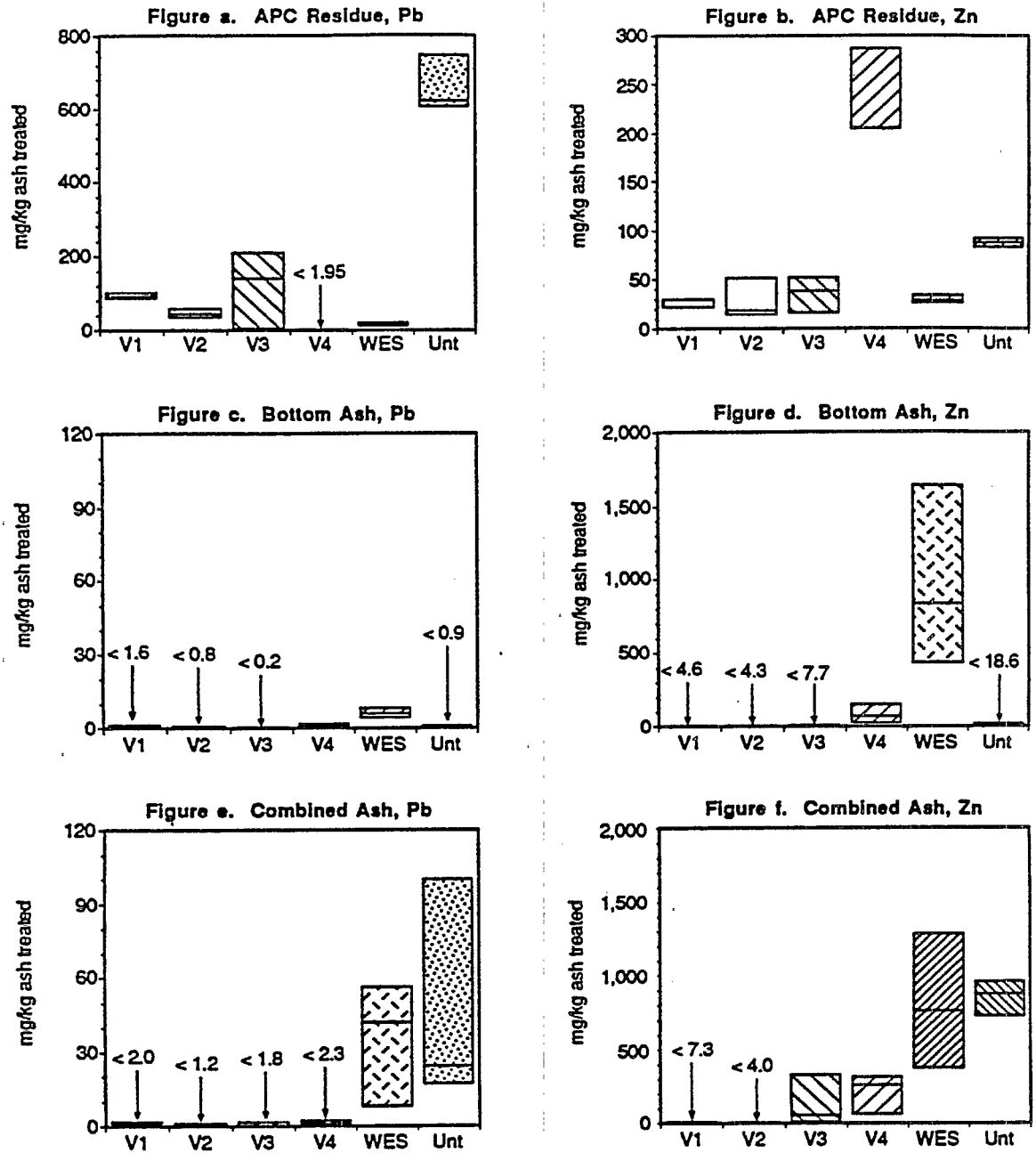


Notes:

1. TCLP extraction Fluid 2 was the required extraction Fluid for all cases except untreated Bottom Ash, and Process 1 Bottom Ash and Combined Ash for which TCLP Extraction Fluid 1 was required.

2. Sodium release from untreated Bottom Ash refelcts an equivalent release of 30,000 mg/kg resulting from the presence of sodium in the TCLP Extraction Fluid 1. Sodium release from bottom ash and combined ash treated by Process 1 reflects an equivalent release of 38,000 mg/kg resulting from the presence of sodium in the TCLP Extraction Fluid 1.

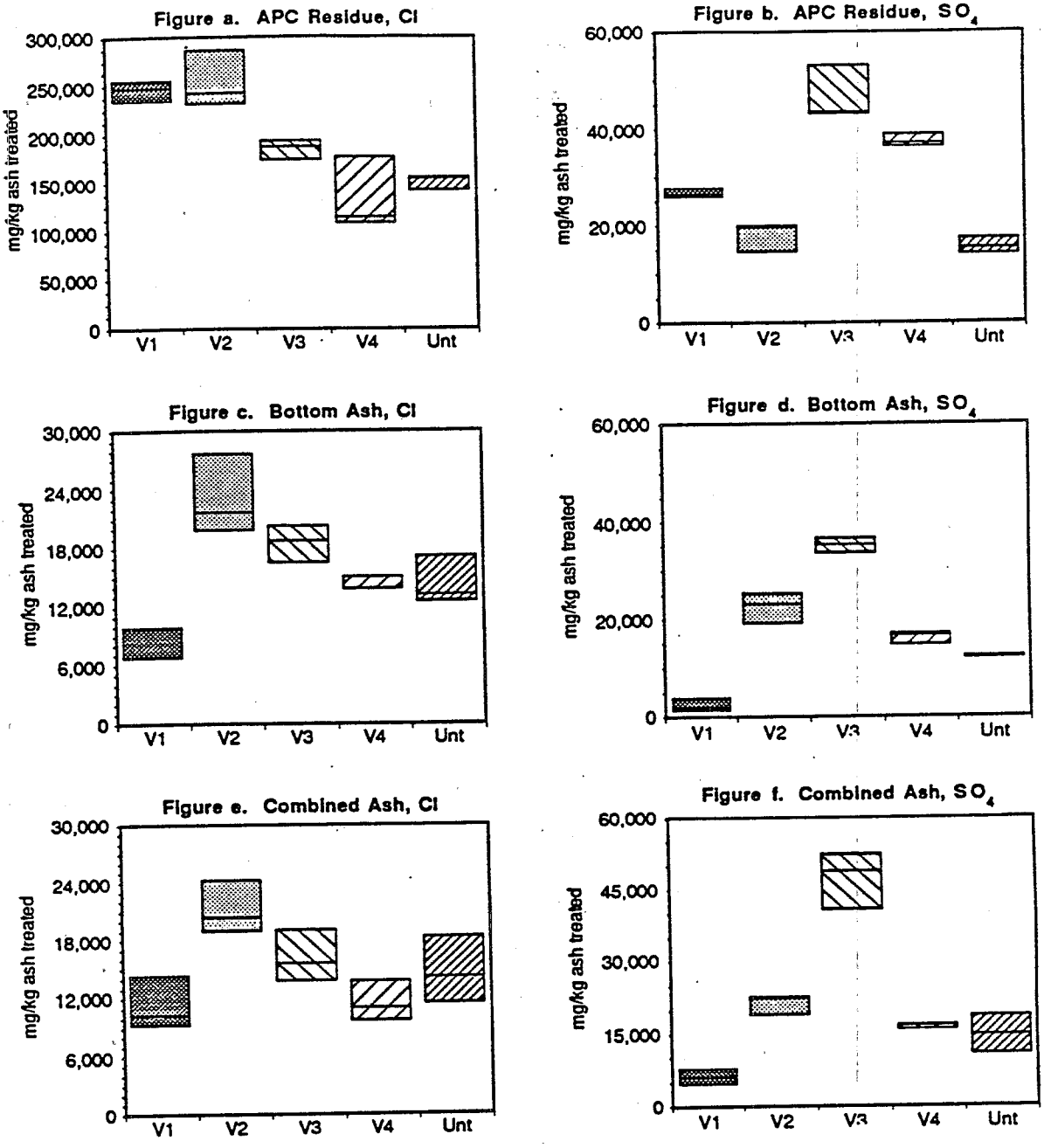
Figure 7.7. Lead and zinc release during TCLP extraction, corrected for process dilution.



Note:

TCLP Extraction Fluid 2 was the required extraction fluid for all cases except untreated Bottom Ash, and Process 1 Bottom Ash and Combined Ash for which TCLP Extraction Fluid 1 was required.

Figure 7.8. Chloride and sulfate release during TCLP extraction, corrected for process dilution.



Note:

TCLP Extraction Fluid 2 was the required extraction fluid for all cases except untreated Bottom Ash, and Process 1 Bottom Ash and Combined Ash for which TCLP Extraction Fluid 1 was required.

Figure 7.9. Distilled water leach test extract pHs.

Extracts 1 & 2

Figure a. APC Residue

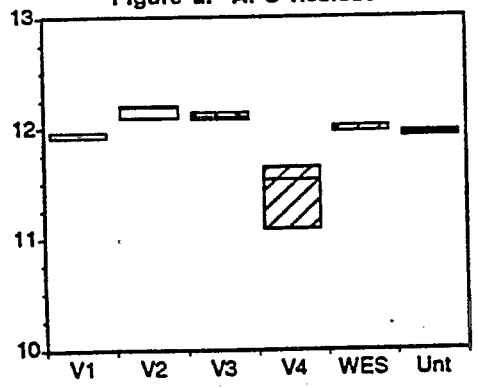


Figure c. Bottom Ash

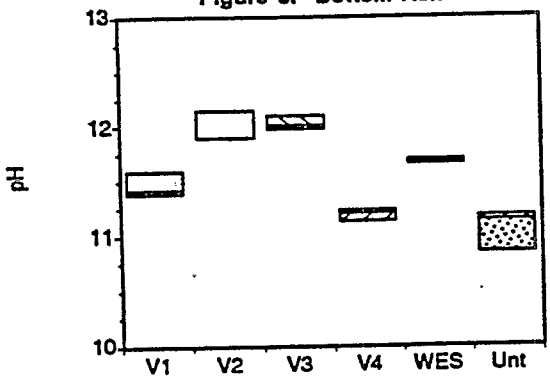
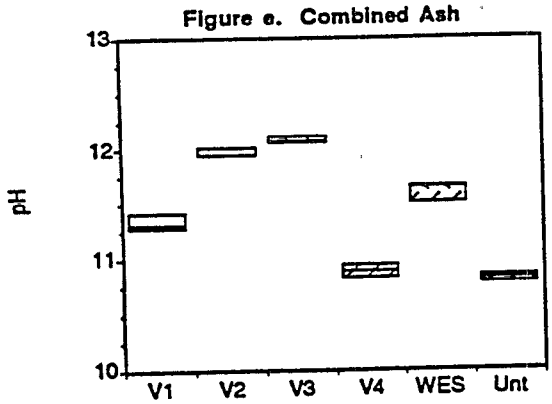


Figure e. Combined Ash



Extracts 3 & 4

Figure b. APC Residue

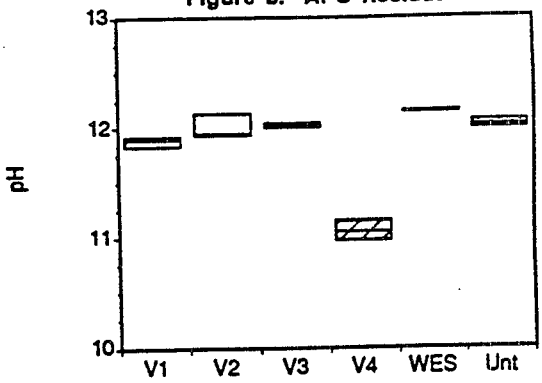


Figure d. Bottom Ash

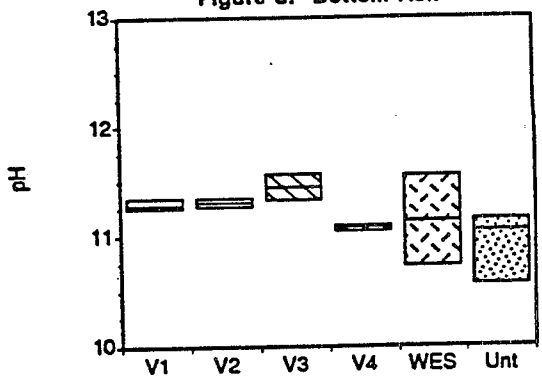


Figure f. Combined Ash

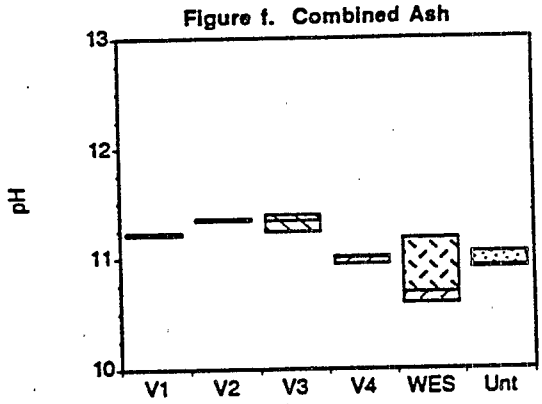


Figure 7.10. Aluminum release during distilled water leach test, corrected for process dilution.

Extracts 1 & 2

Figure a. APC Residue, Al

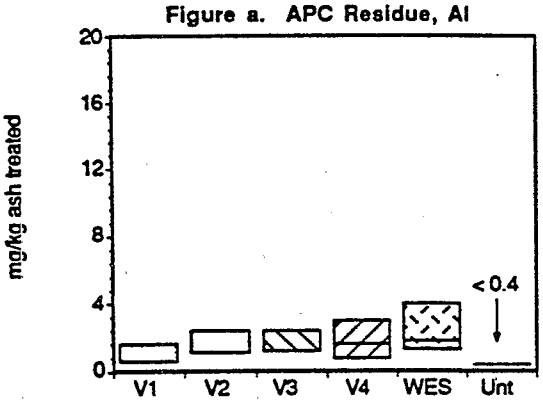


Figure c. Bottom Ash, Al

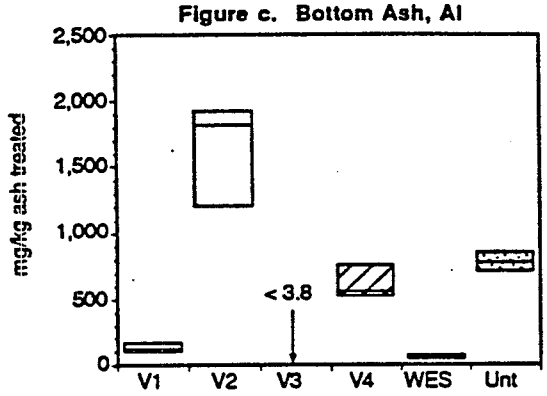
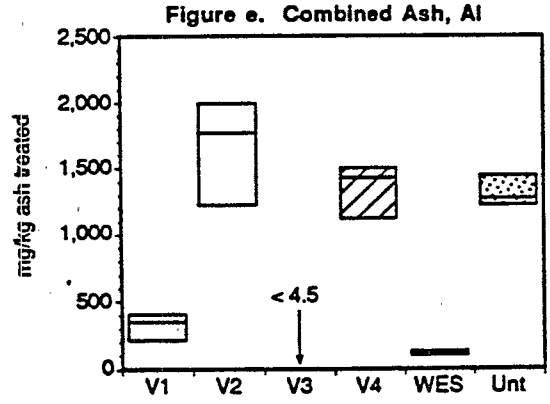


Figure e. Combined Ash, Al



Extracts 3 & 4

Figure b. APC Residue, Al

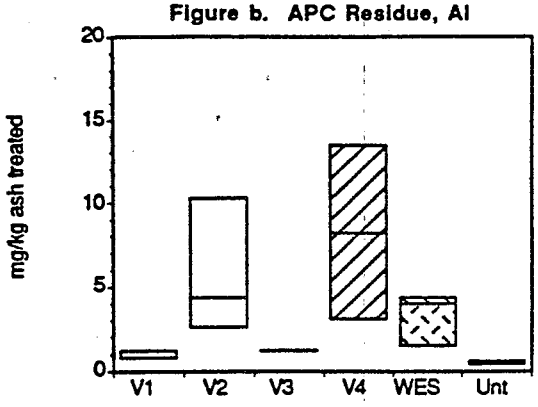


Figure d. Bottom Ash, Al

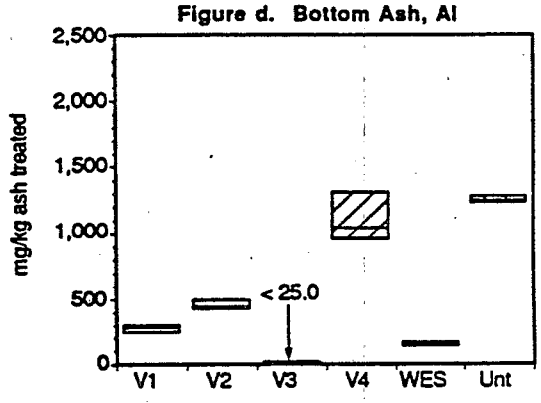


Figure f. Combined Ash, Al

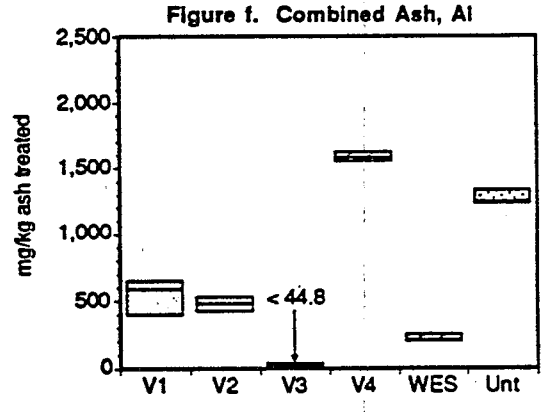


Figure 7.11. Cadmium release during distilled water leach test, corrected for process dilution.

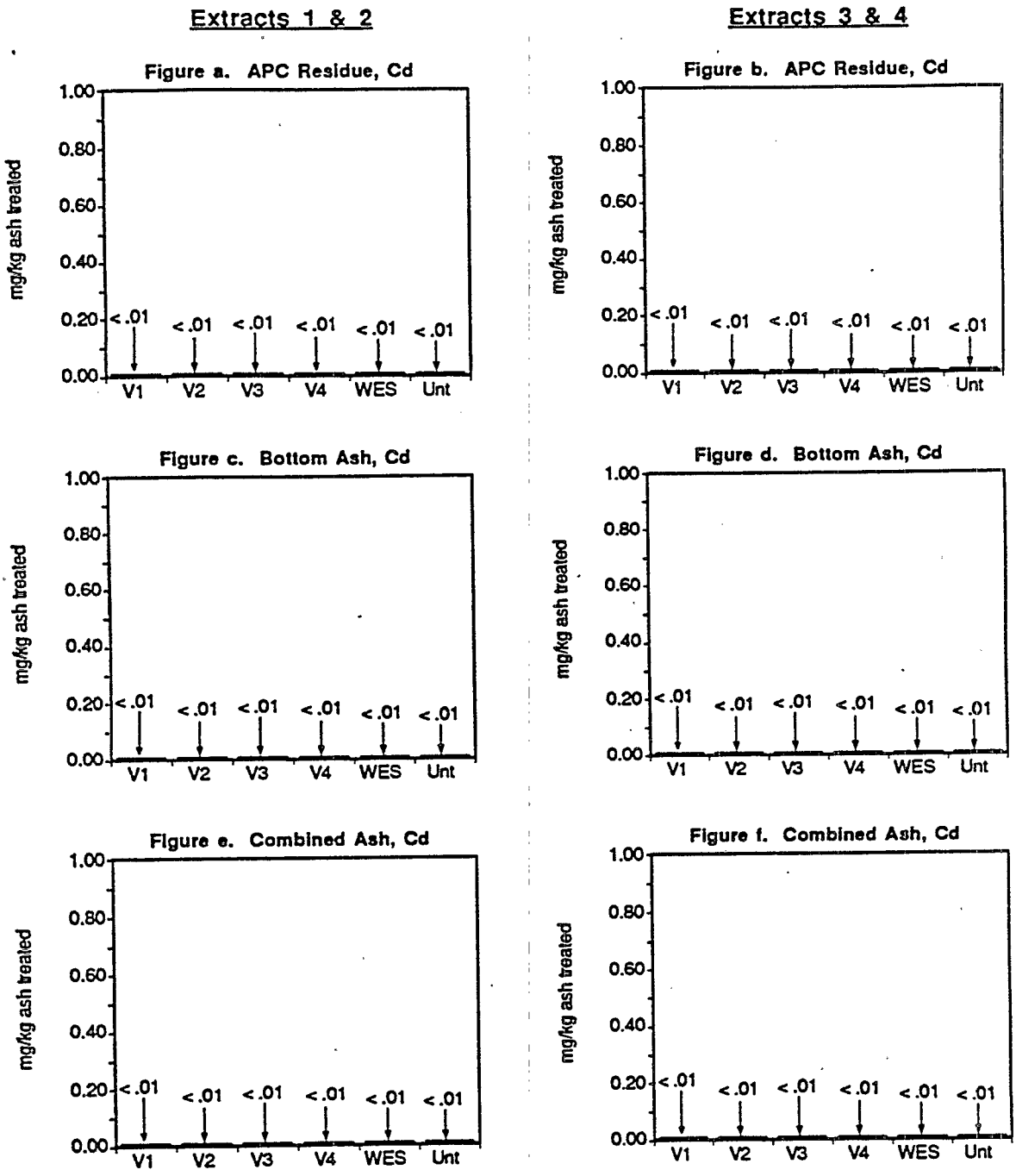
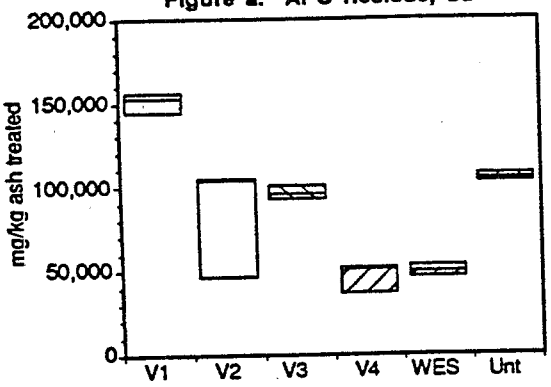


Figure 7.12. Calcium release during distilled water leach test, corrected for process dilution.

Extracts 1 & 2

Figure a. APC Residue, Ca



Extracts 3 & 4

Figure b. APC Residue, Ca

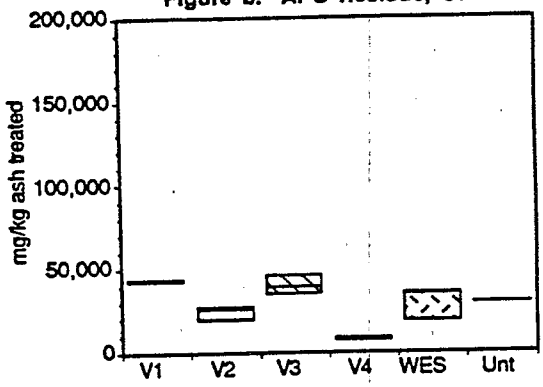


Figure c. Bottom Ash, Ca

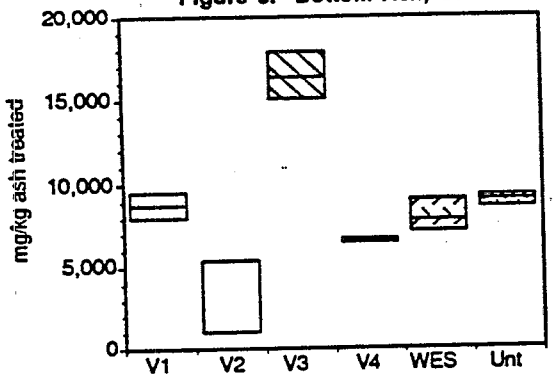


Figure d. Bottom Ash, Ca

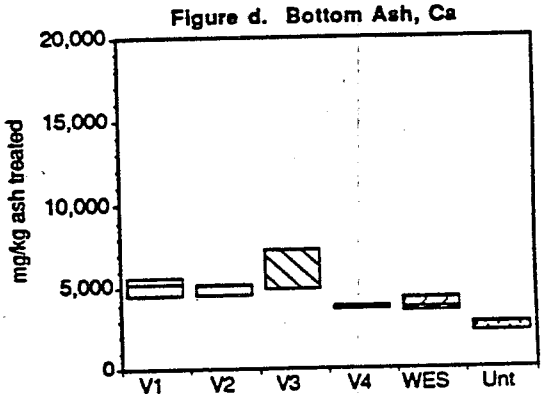


Figure e. Combined Ash, Ca

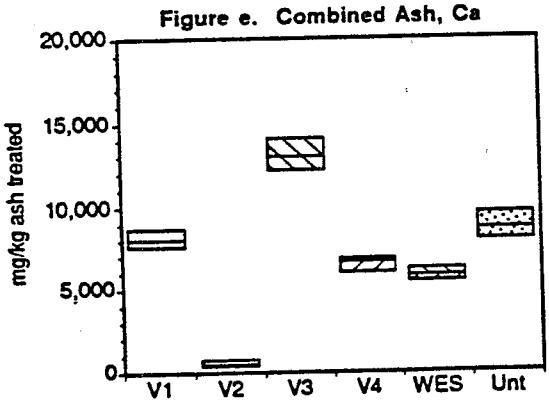


Figure f. Combined Ash, Ca

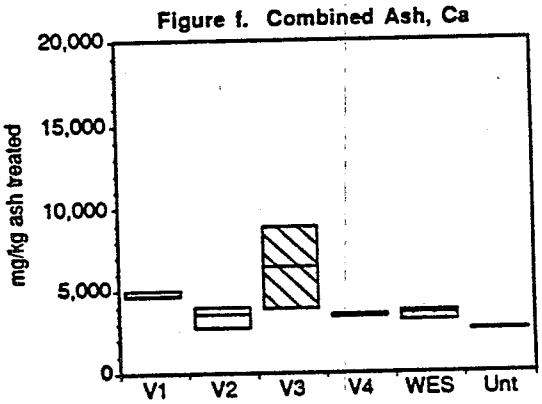


Figure 7.13. Copper release during distilled water leach test, corrected for process dilution.

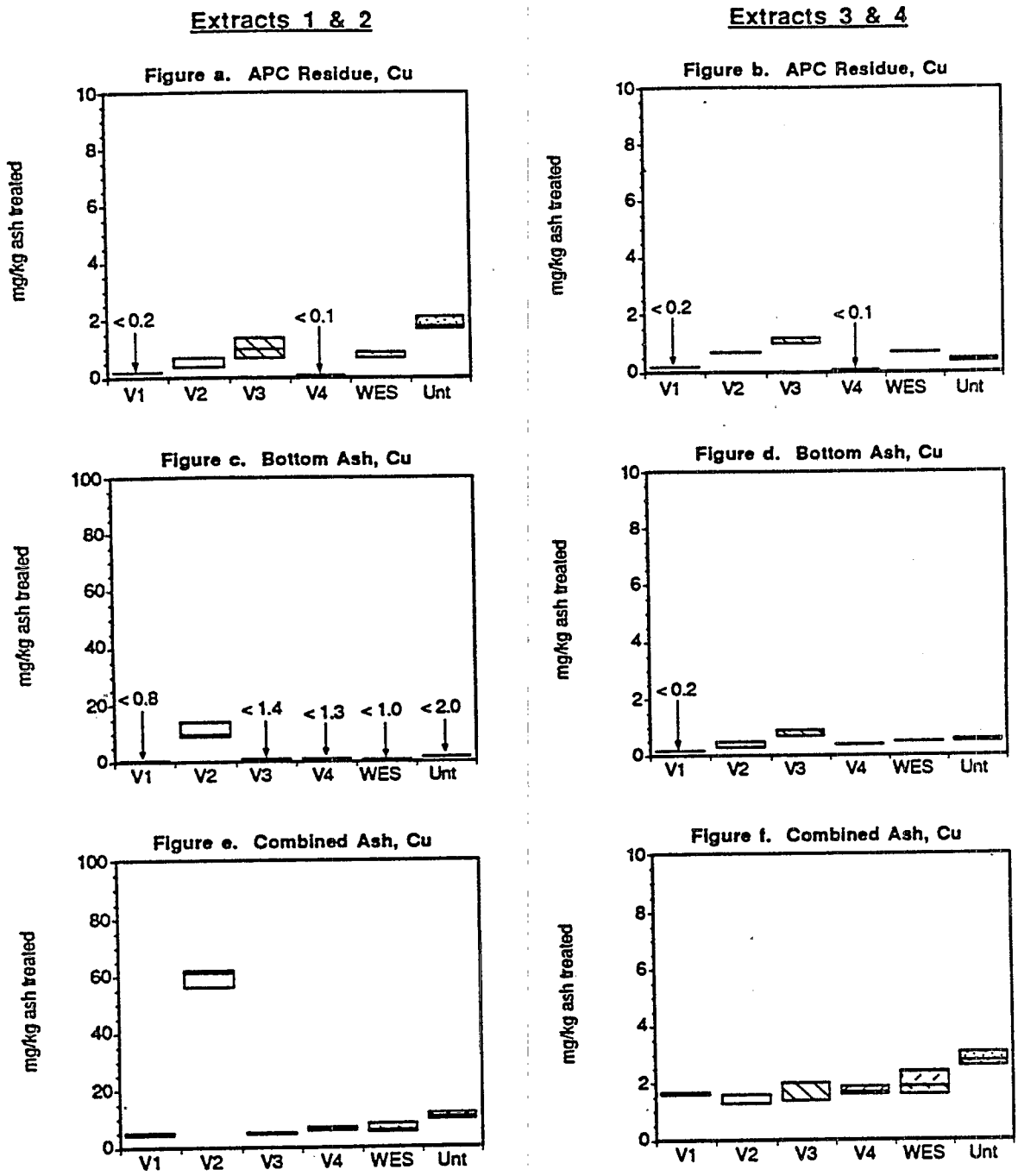


Figure 7.14. Lead release during distilled water leach test, *corrected for process dilution.*

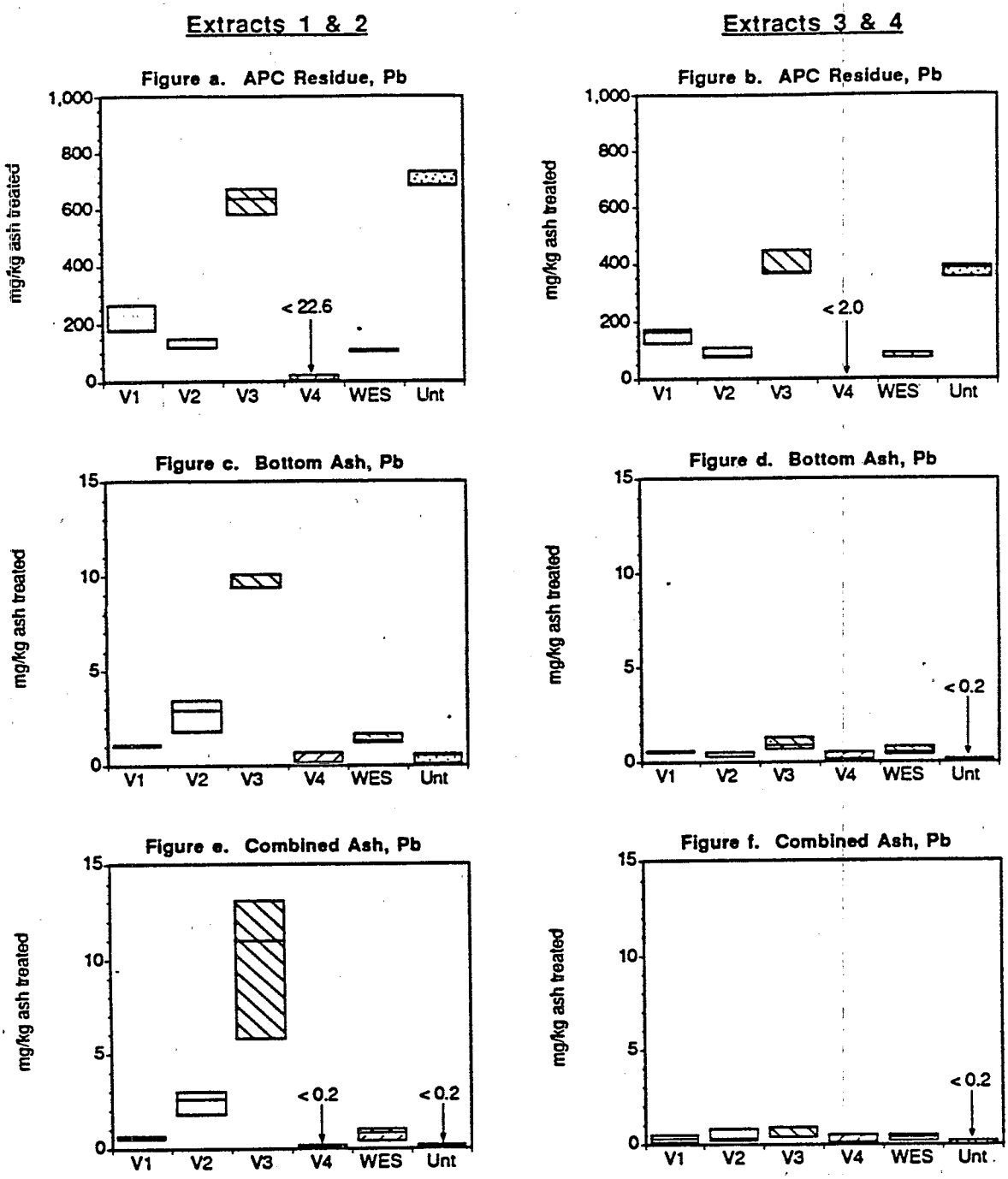
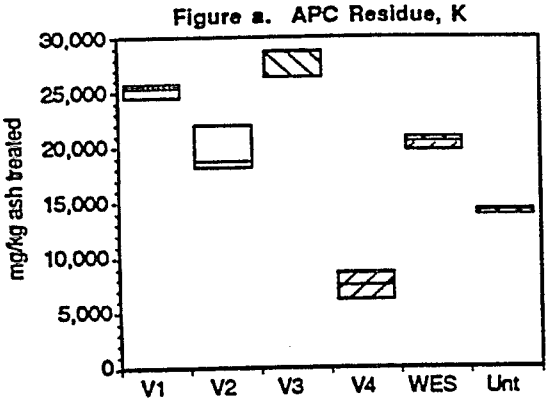


Figure 7.15. Potassium release during distilled water leach test, corrected for process dilution.

Extracts 1 & 2

Figure a. APC Residue, K



Extracts 3 & 4

Figure b. APC Residue, K

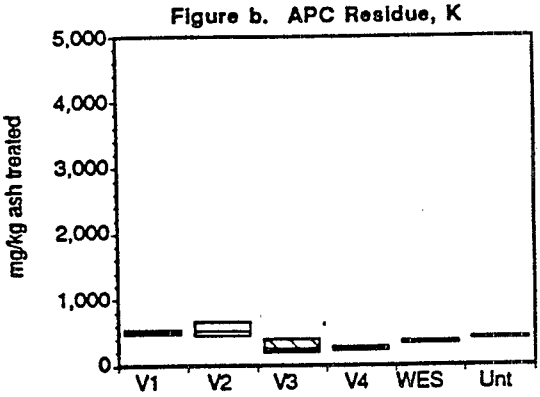


Figure c. Bottom Ash, K

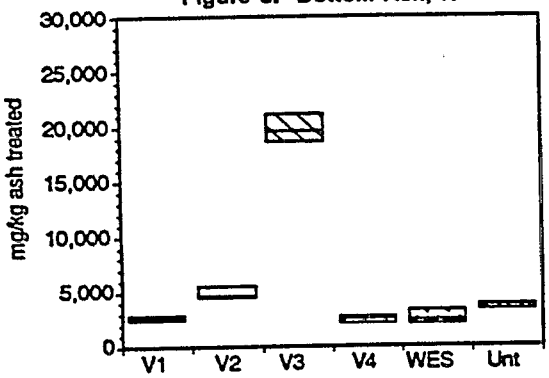


Figure d. Bottom Ash, K

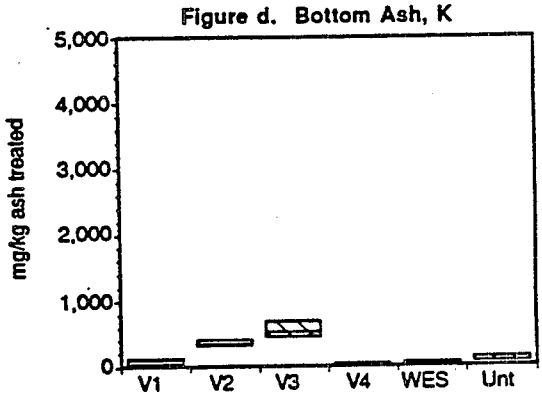


Figure e. Combined Ash, K

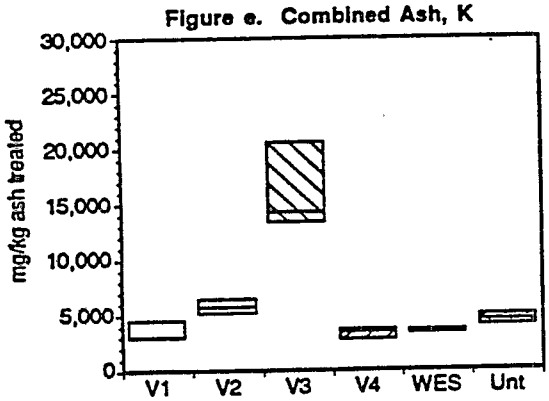


Figure f. Combined Ash, K

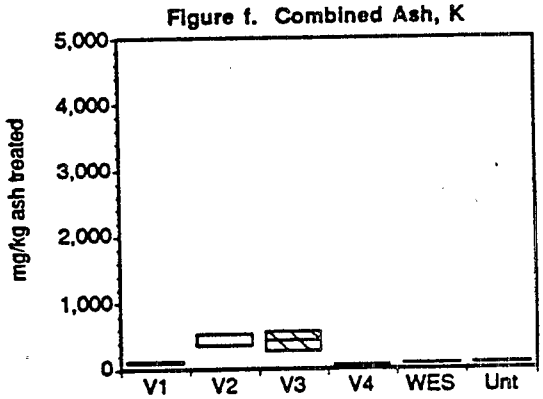


Figure 7.16. Sodium release during distilled water leach test, corrected for process dilution.

Extracts 1 & 2

Figure a. APC Residue, Na

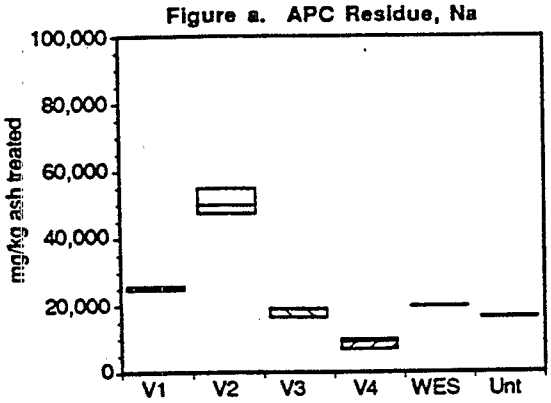


Figure c. Bottom Ash, Na

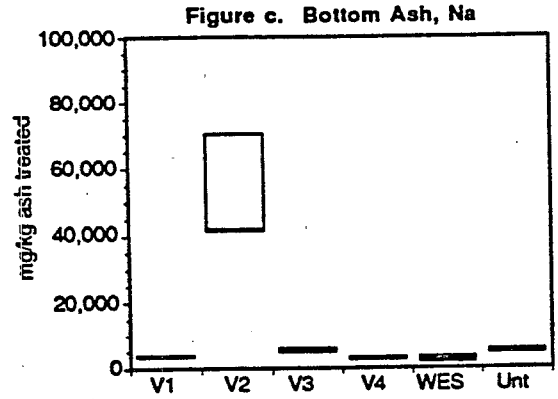
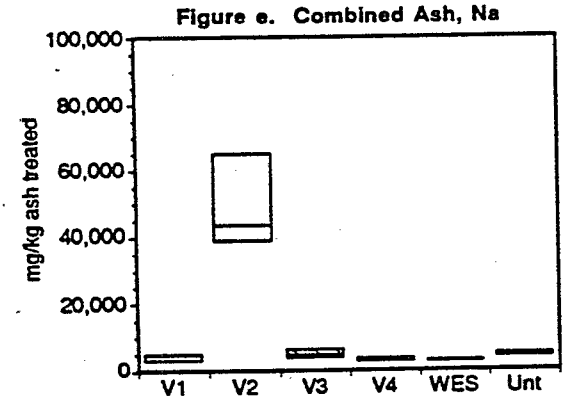


Figure e. Combined Ash, Na



Extracts 3 & 4

Figure b. APC Residue, Na

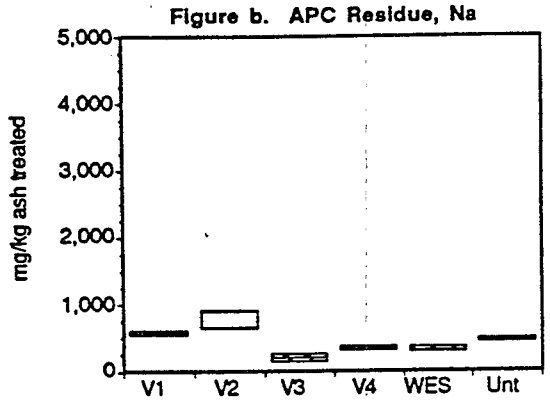


Figure d. Bottom Ash, Na

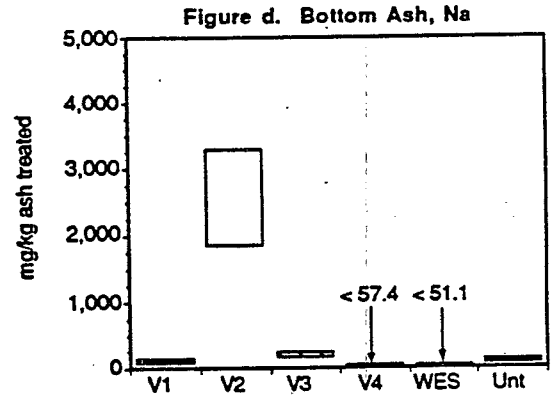


Figure f. Combined Ash, Na

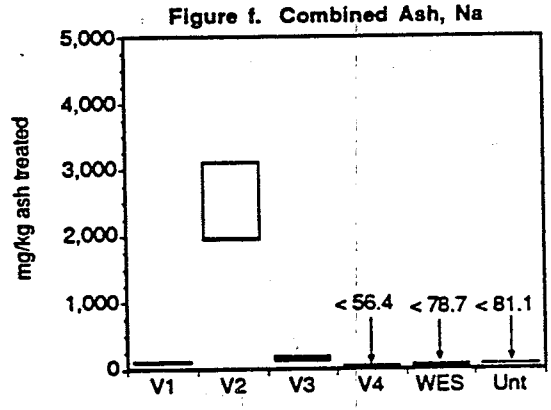


Figure 7.17. Zinc release during distilled water leach test, corrected for process dilution.

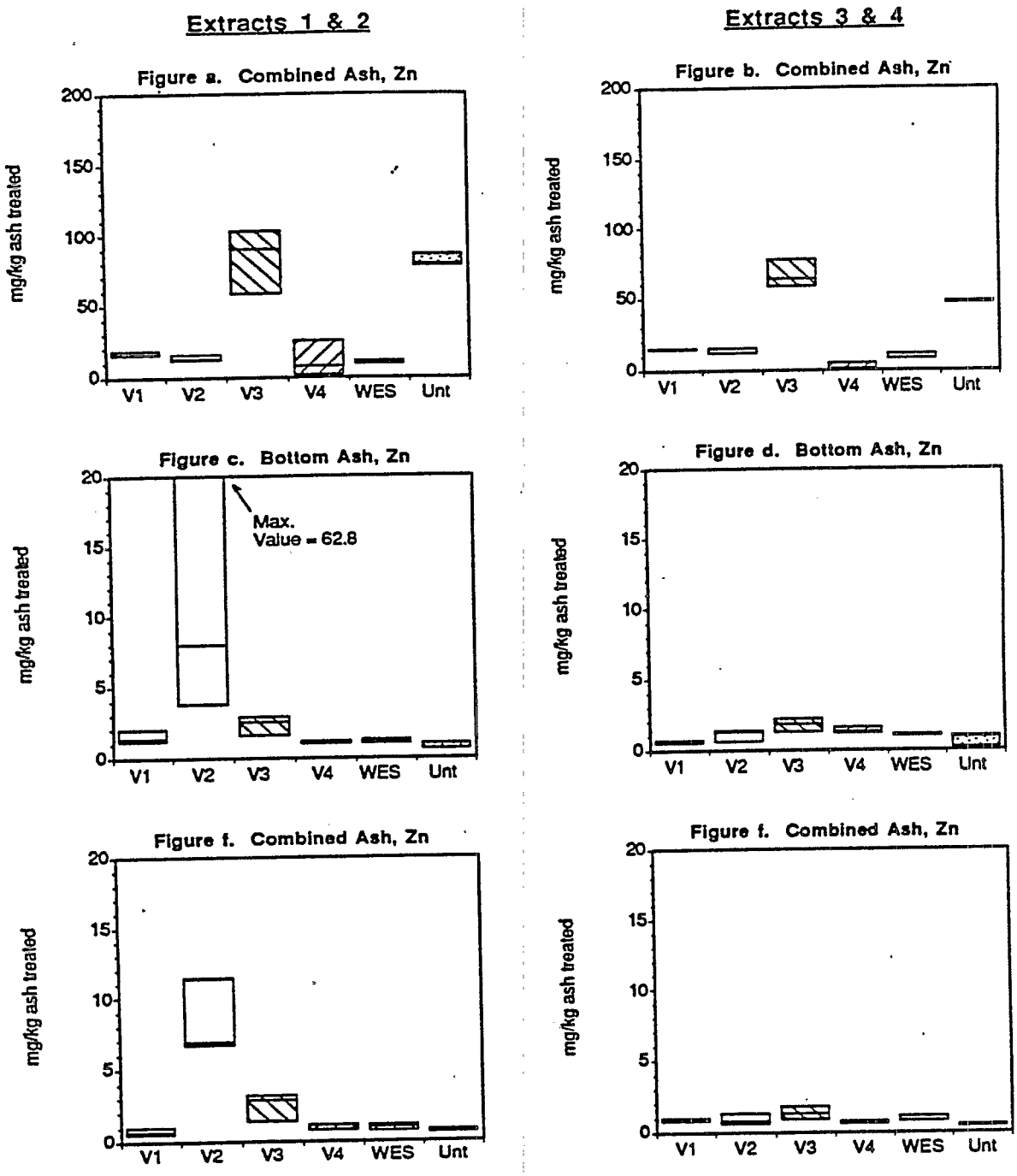


Figure 7.18. Chloride release during distilled water leach test, corrected for process dilution.

Extracts 1 & 2

Figure a. APC Residue, Cl

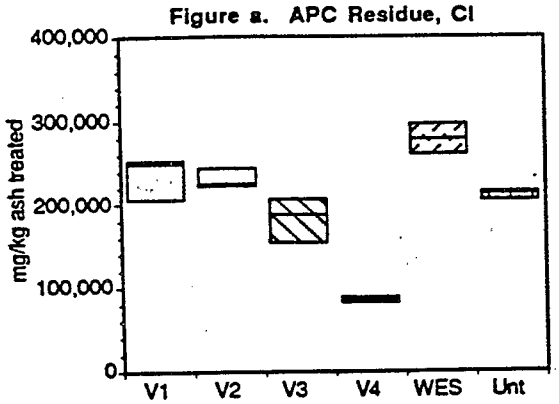


Figure c. Bottom Ash, Cl

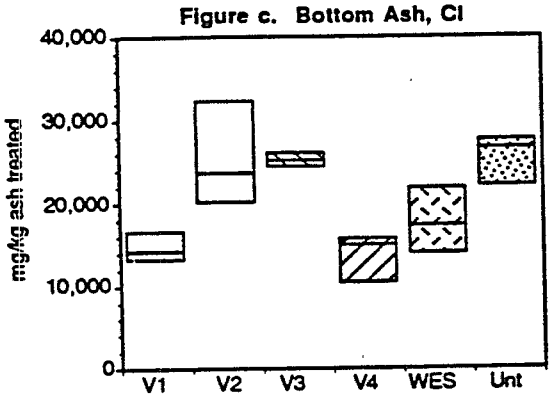
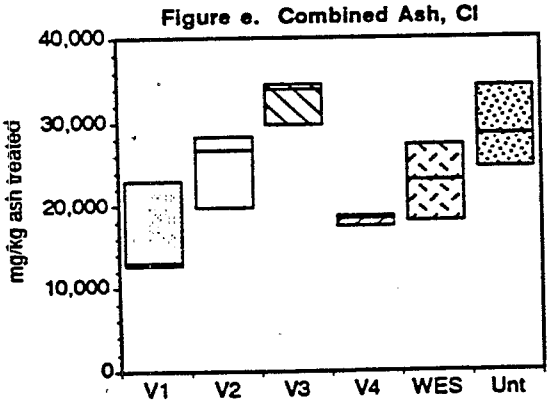


Figure e. Combined Ash, Cl



Extracts 3 & 4

Figure b. APC Residue, Cl

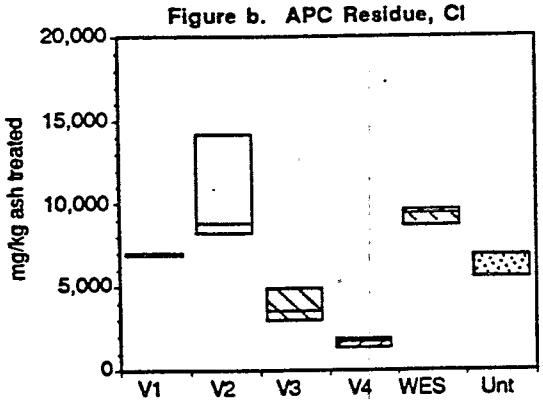


Figure d. Bottom Ash, Cl

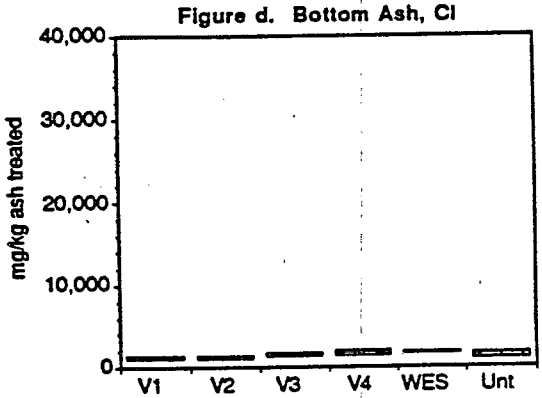


Figure f. Combined Ash, Cl

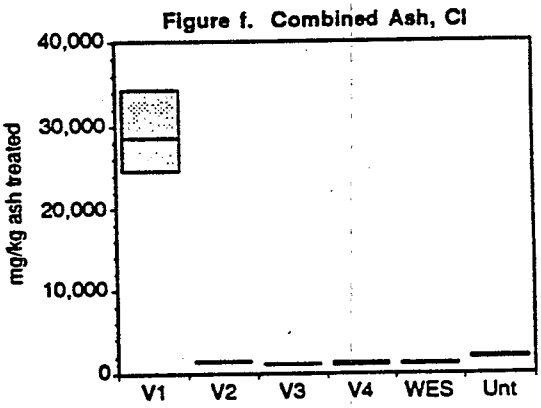


Figure 7.19. Sulfate release during distilled water leach test, corrected for process dilution.

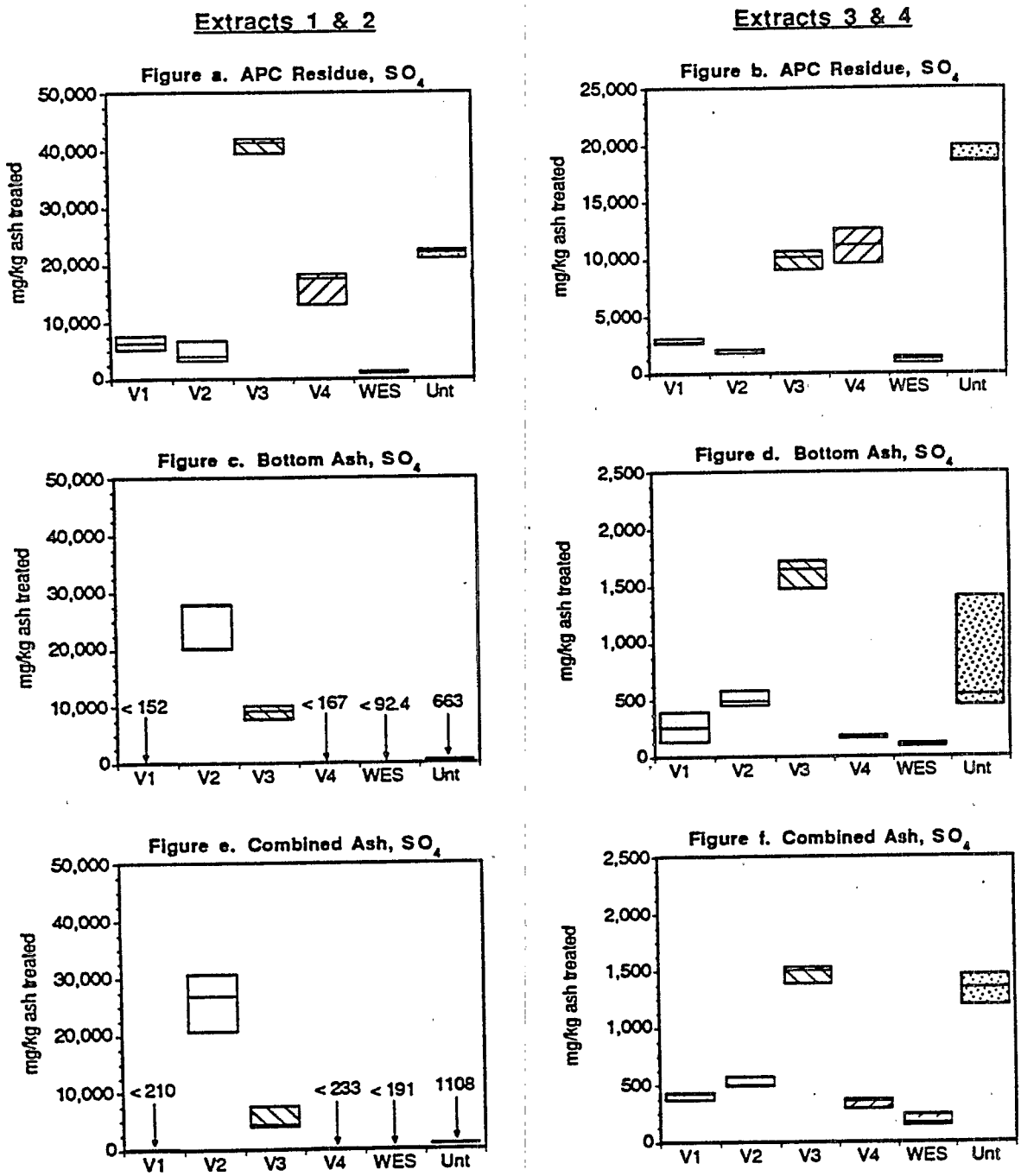


Figure 7.20. Total dissolved solids release during the distilled water leach test, *corrected for* process dilution.

Extracts 1 & 2

Figure a. APC Residue

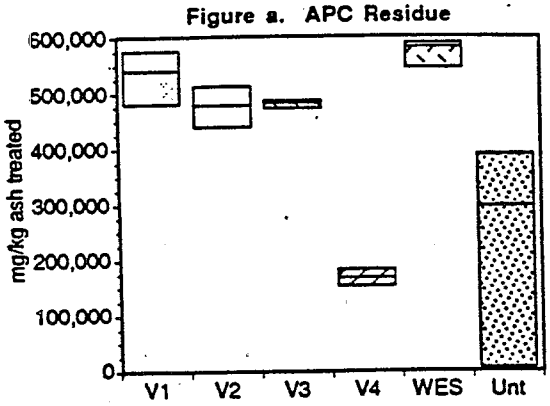


Figure c. Bottom Ash

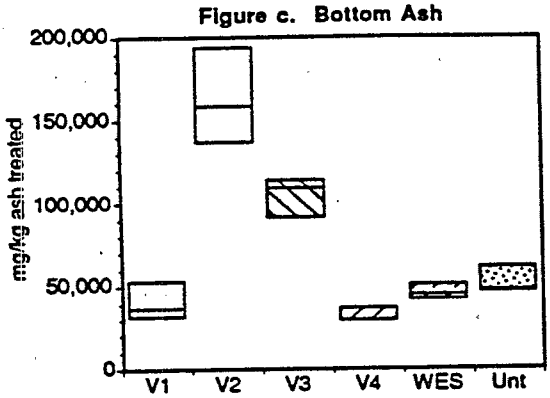
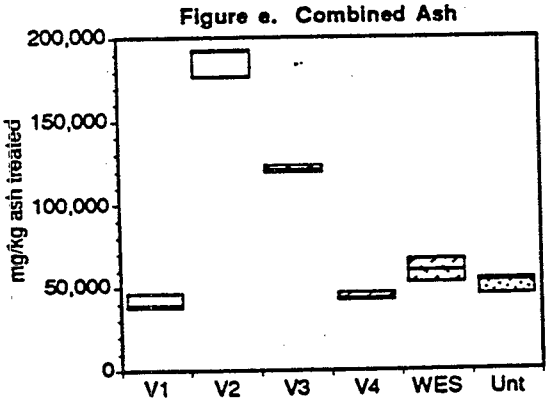


Figure e. Combined Ash



Extracts 3 & 4

Figure b. APC Residue

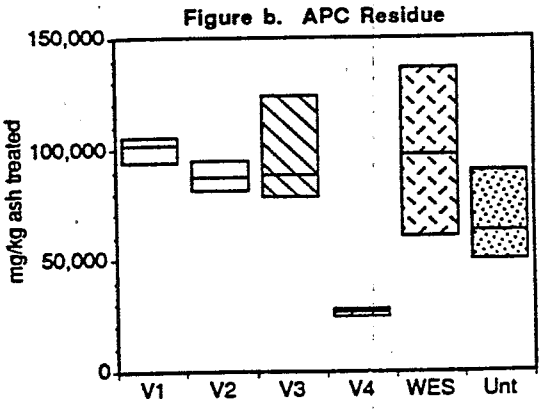


Figure d. Bottom Ash

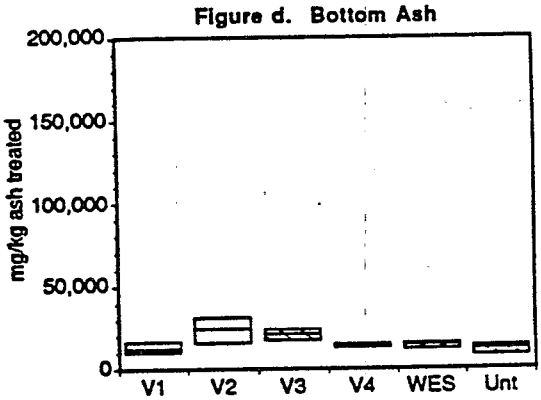


Figure f. Combined Ash

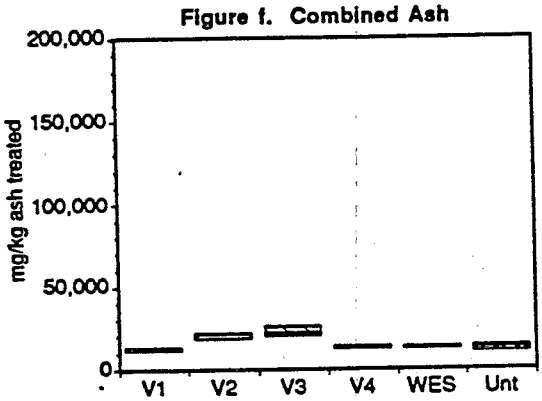


Figure 7.21. Total organic carbon release during the distilled water leach test, corrected for process dilution.

Extracts 1 & 2

Figure a. APC Residue

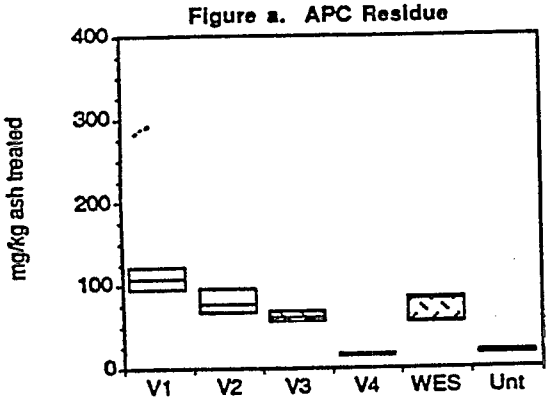


Figure c. Bottom Ash

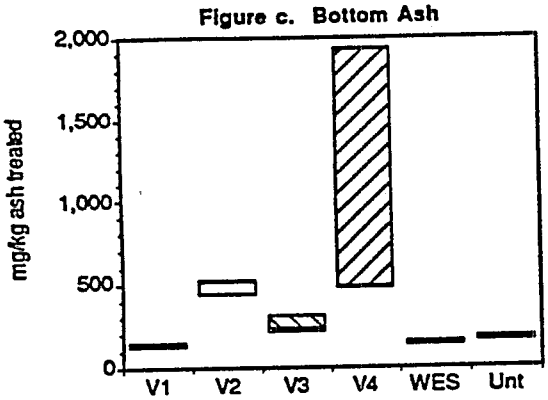
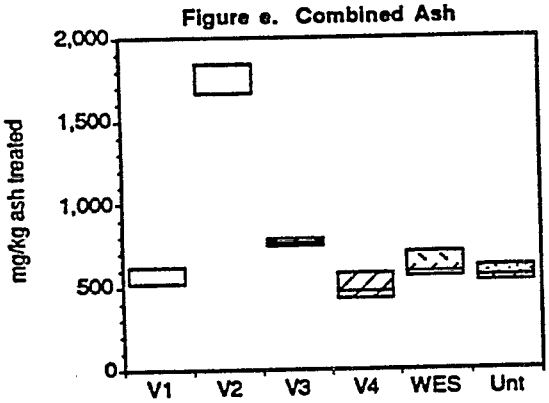


Figure e. Combined Ash



Extracts 3 & 4

Figure b. APC Residue

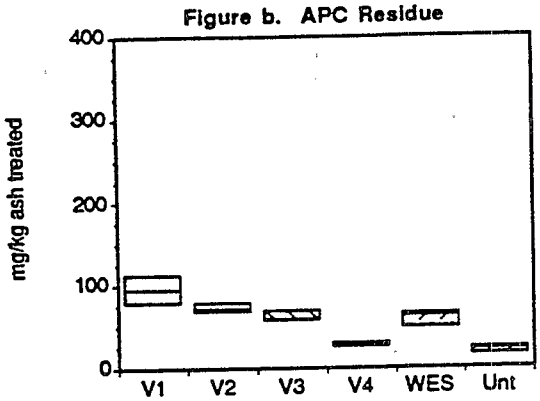


Figure d. Bottom Ash

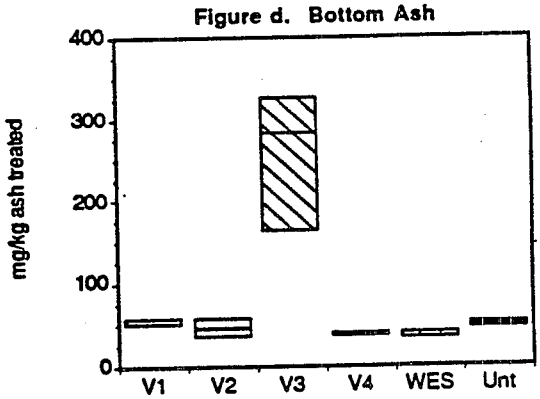


Figure f. Combined Ash

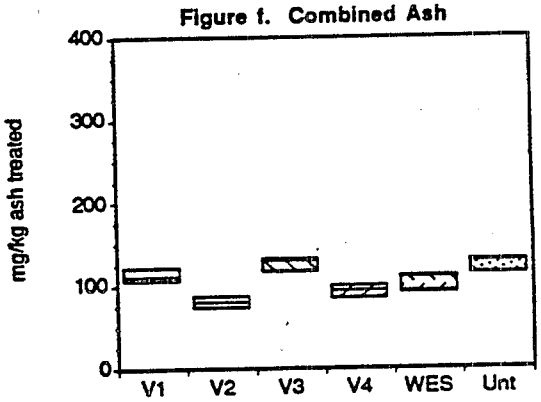
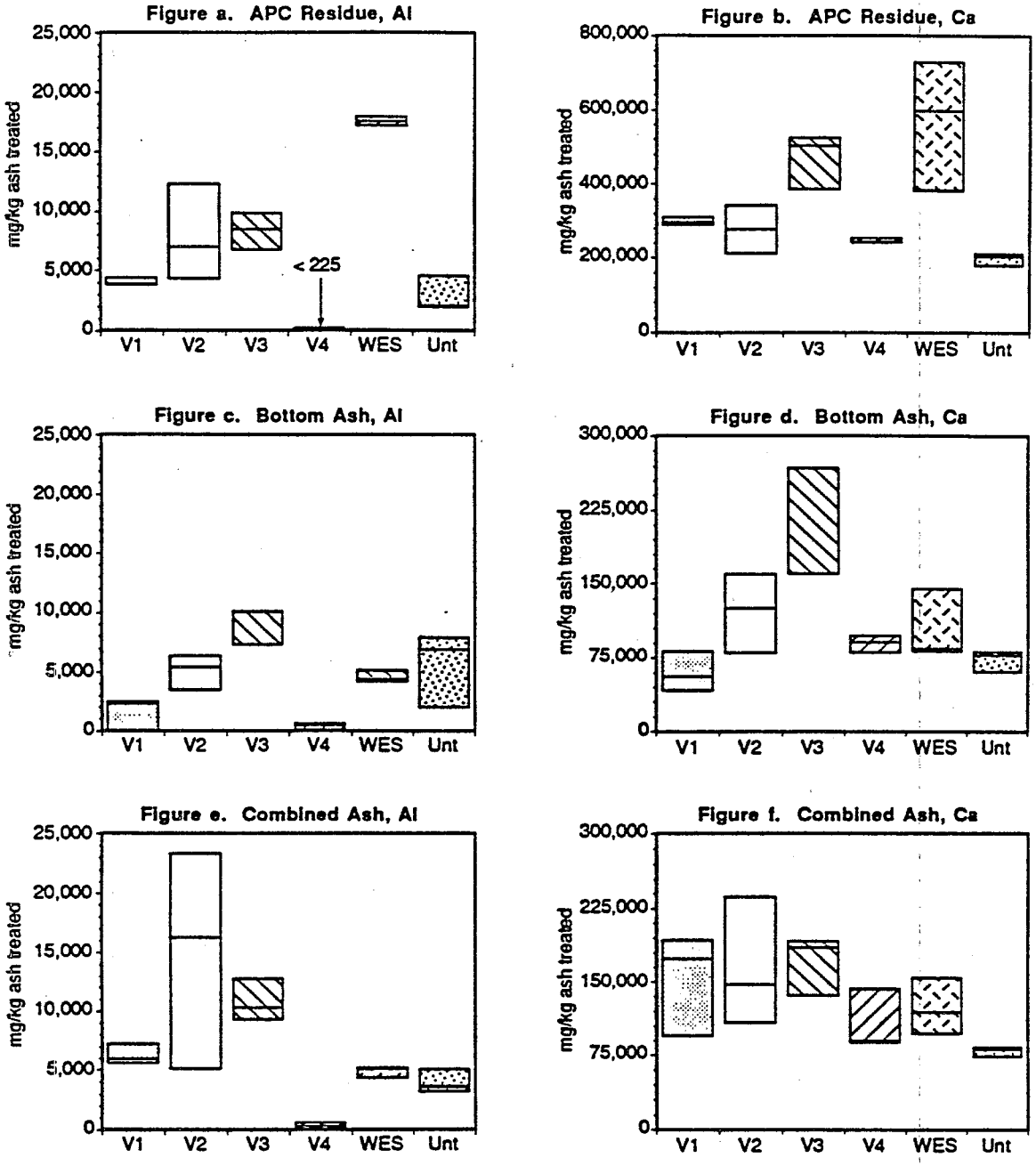


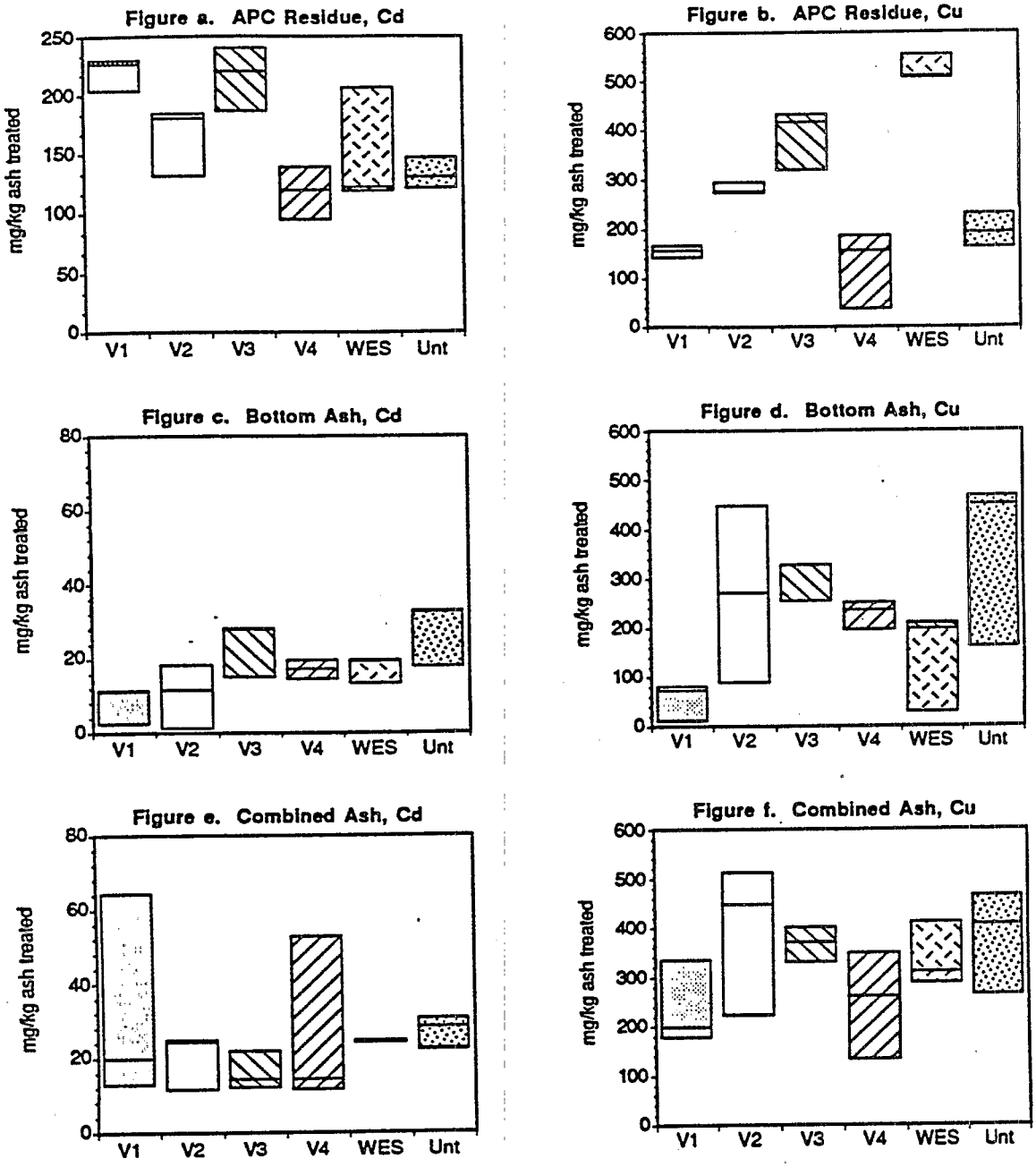
Figure 7.22. Aluminum and calcium release during availability leach test, *corrected for* process dilution.



Note:

Bottom Ash, Process 3, replicate C data was not included because of apparent analysis error.

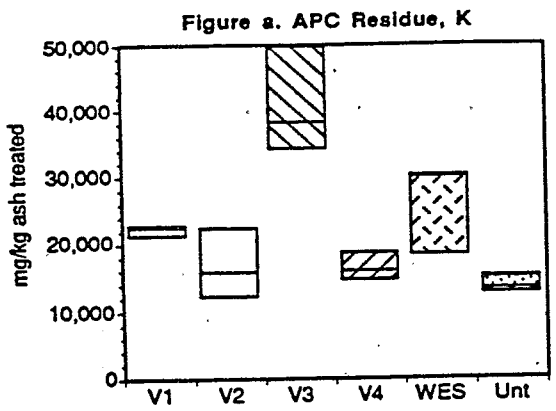
Figure 7.23. Cadmium and copper release during availability leach test, corrected for process dilution.

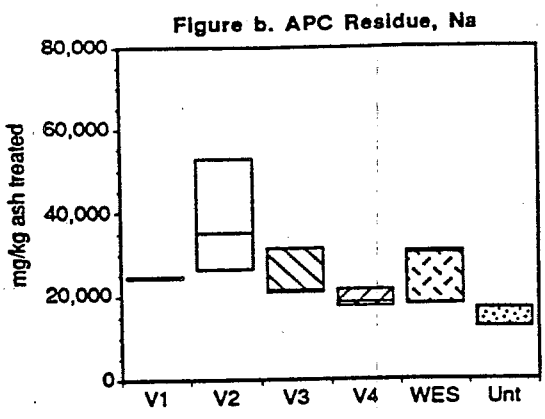


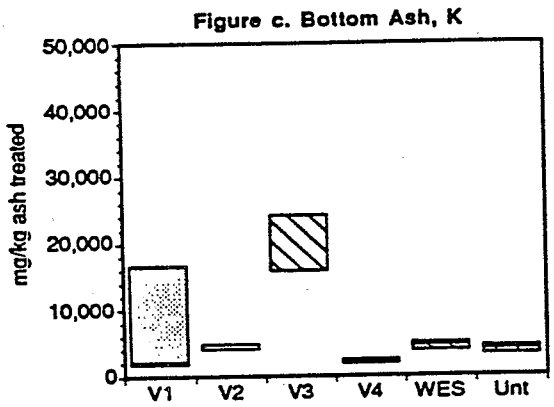
Note:

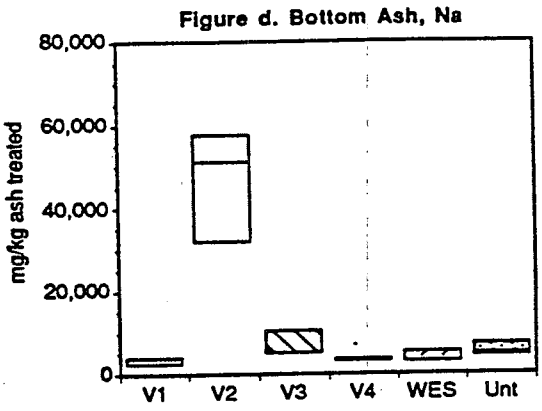
Bottom Ash, Process 3, replicate C data was not included because of apparent analysis error.

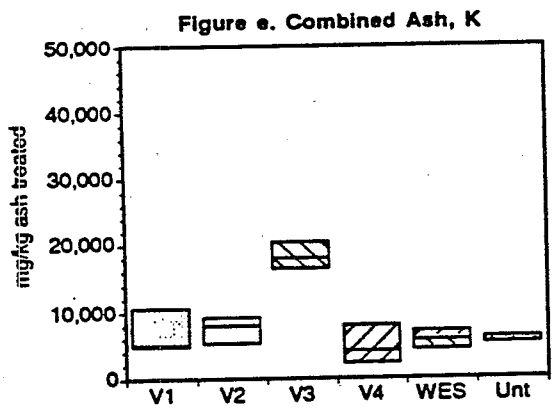
Figure 7.24. Potassium and sodium release during availability leach test, corrected for process dilution.

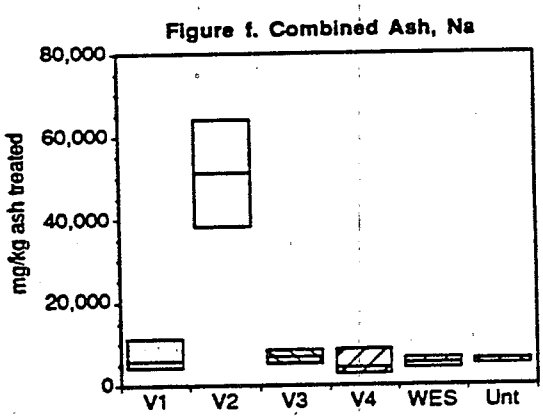








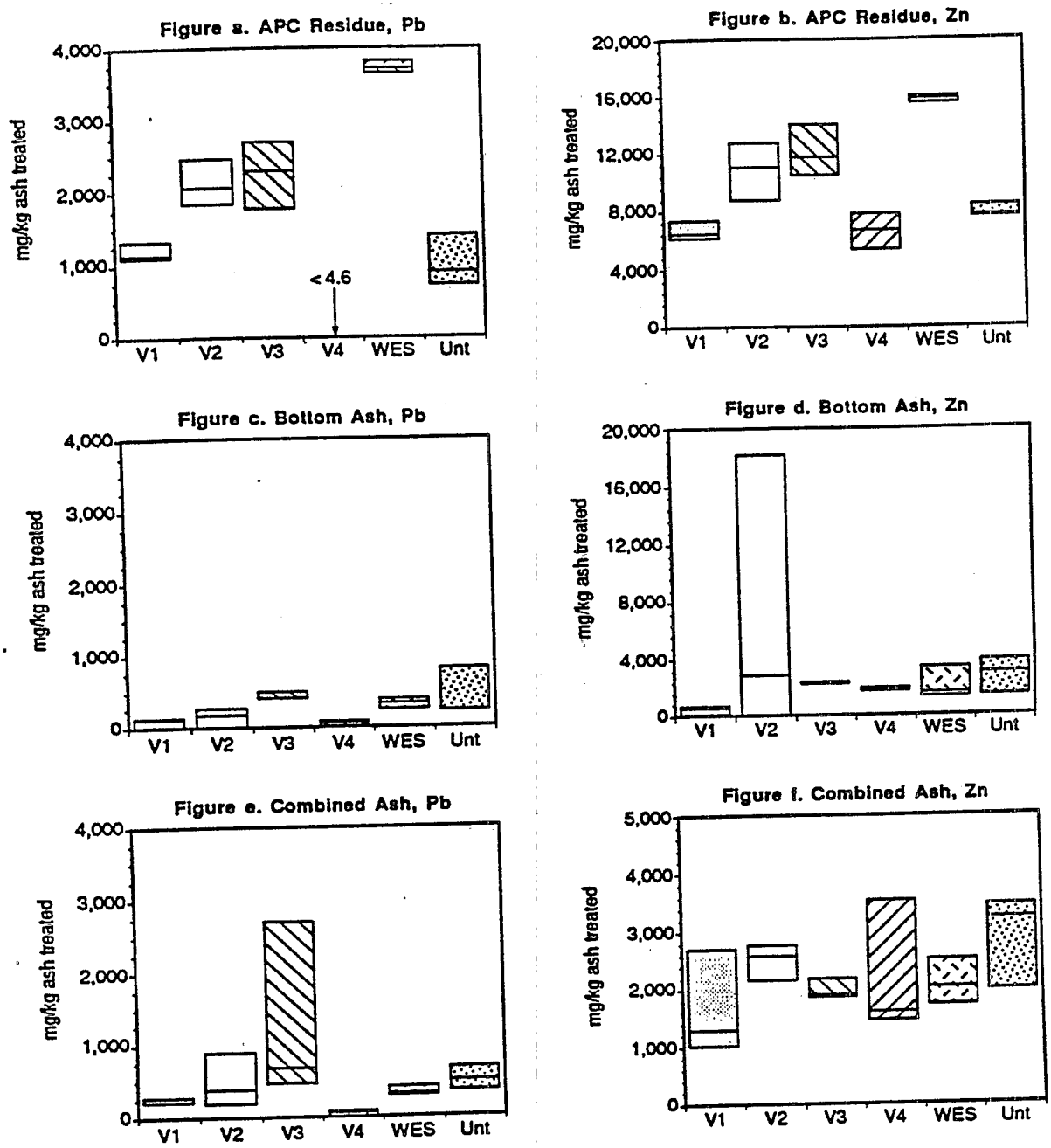




Note:

Bottom Ash, Process 3, replicate C data was not included because of apparent analysis error.

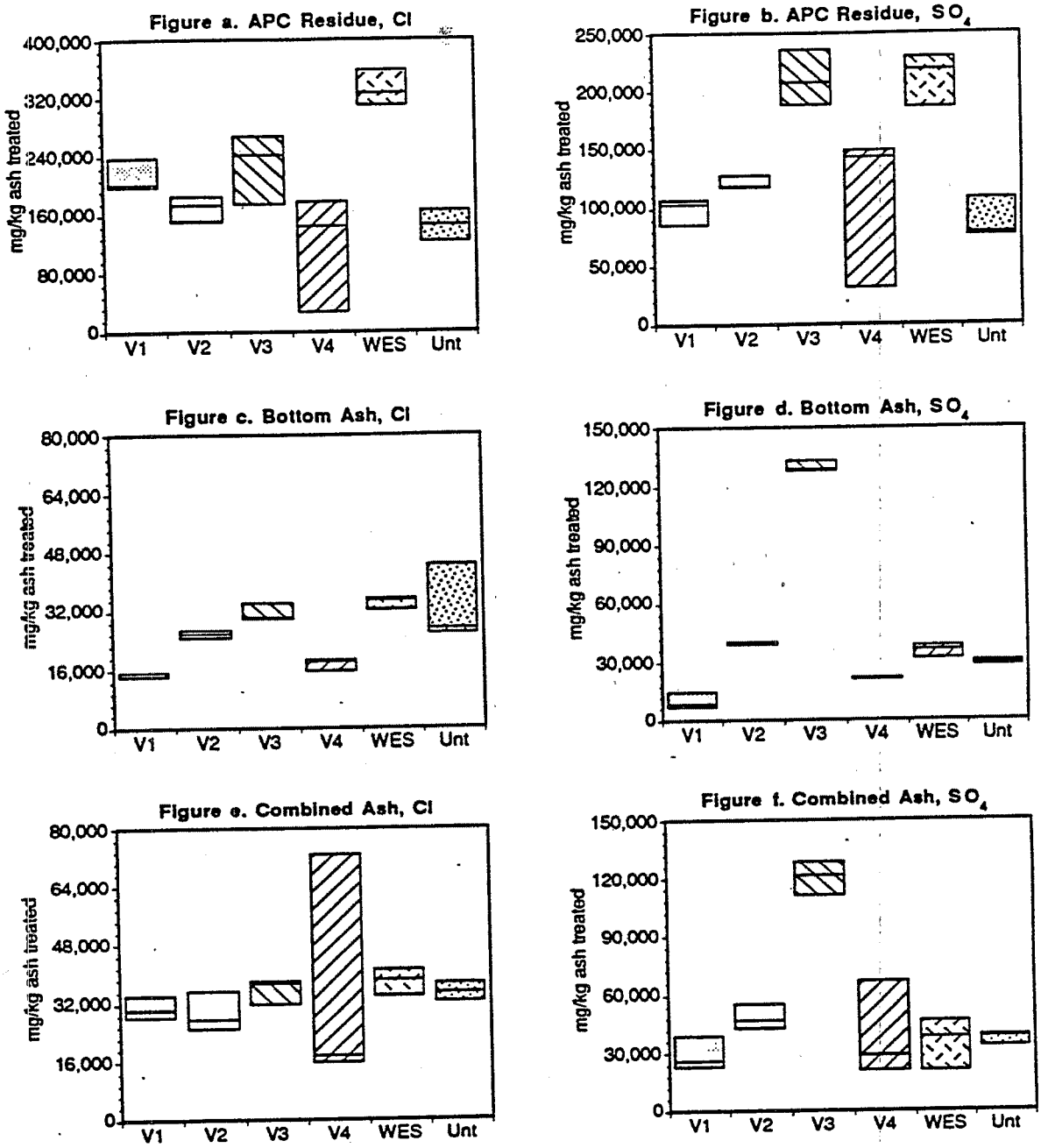
Figure 7.25. Lead and zinc release during availability leach test, corrected for process dilution.



Note:

Bottom Ash, Process 3, replicate C data was not included because of apparent analysis error.

Figure 7.26. Chloride and sulfate release during availability leach test, corrected for process dilution.



Note:

Bottom Ash, Process 3, replicate C data was not included because of apparent analysis error.

Figure 7.27. Untreated and treated APC residue pH titration curves from the acid neutralization leach test.

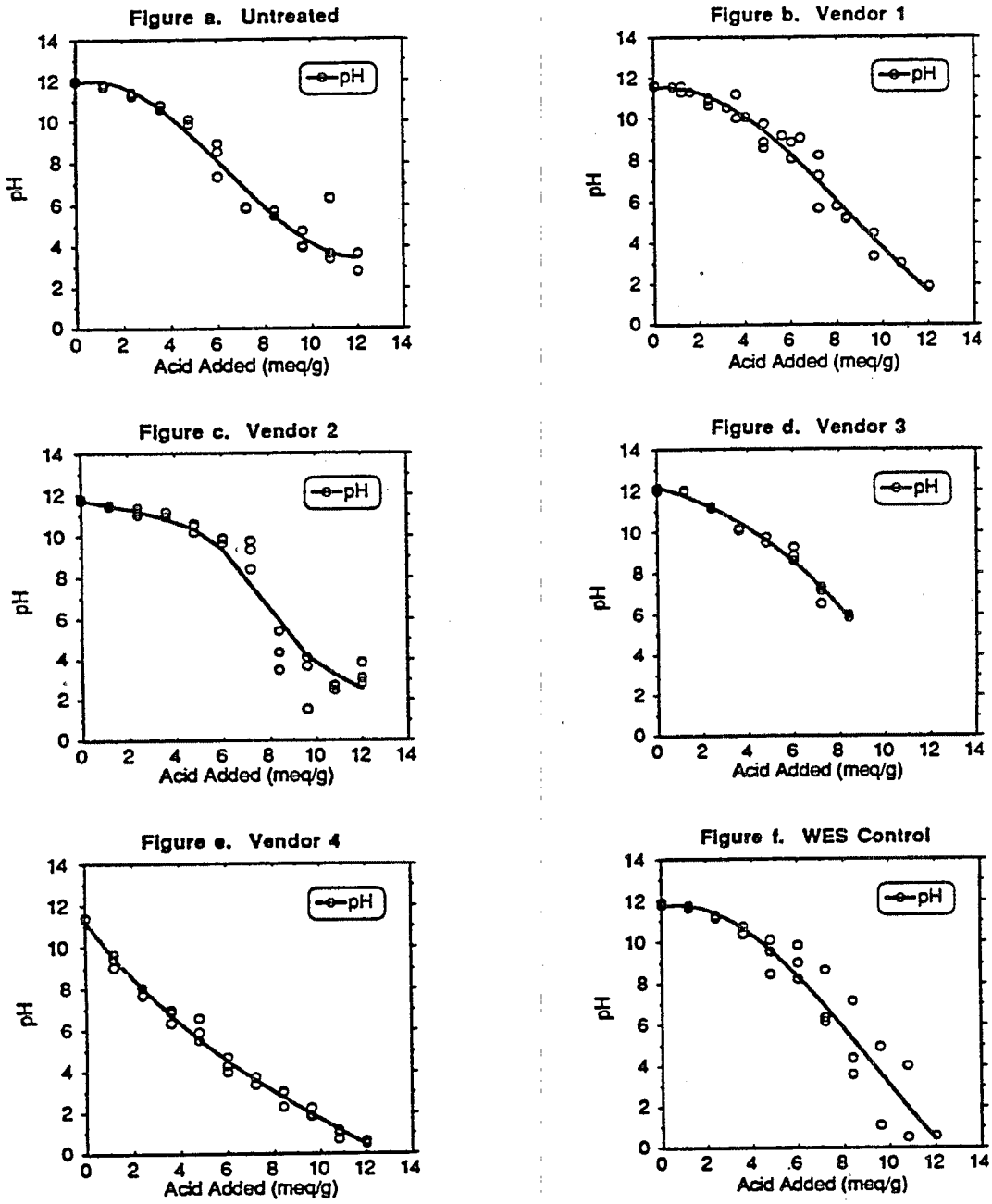
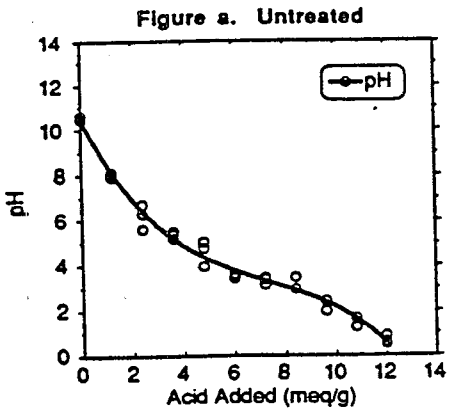
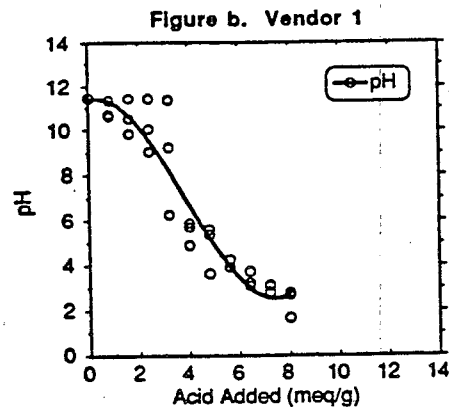
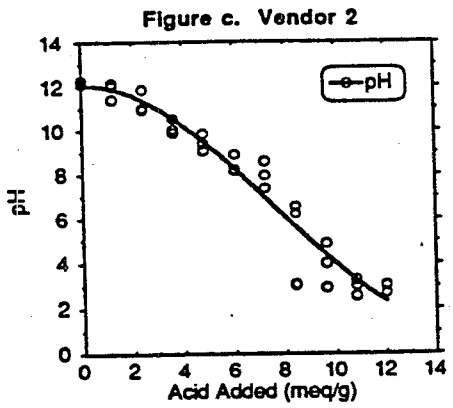
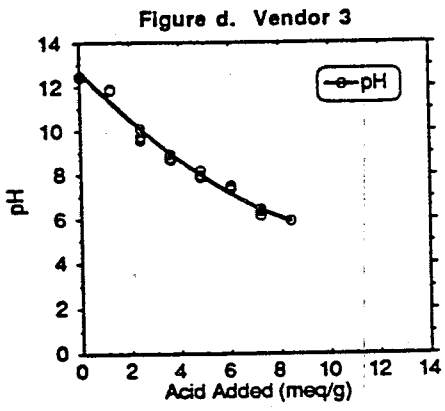


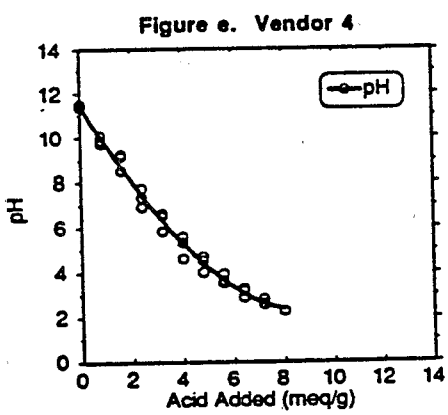
Figure 7.28. Untreated and treated bottom ash pH titration curves from the acid neutralization leach test.











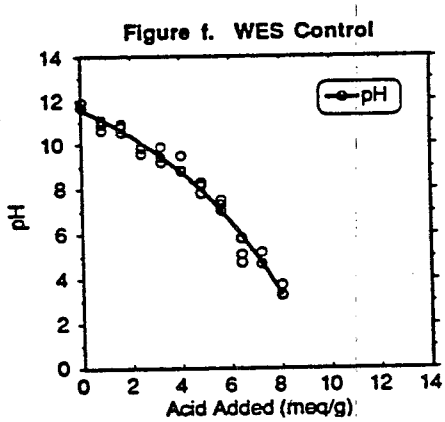


Figure 7.29. Untreated and treated combined ash pH titration curves from the acid neutralization leach test.

Figure a. Untreated

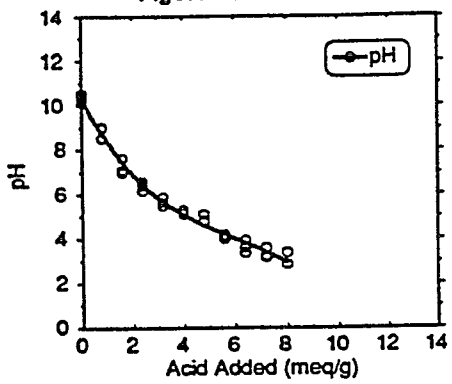


Figure b. Vendor 1

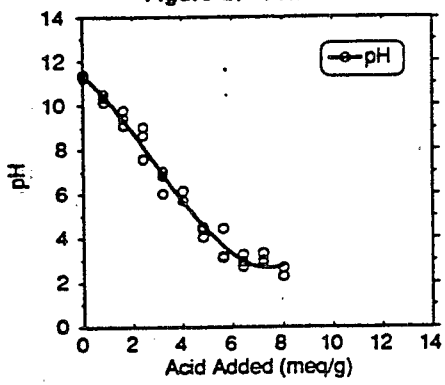


Figure c. Vendor 2

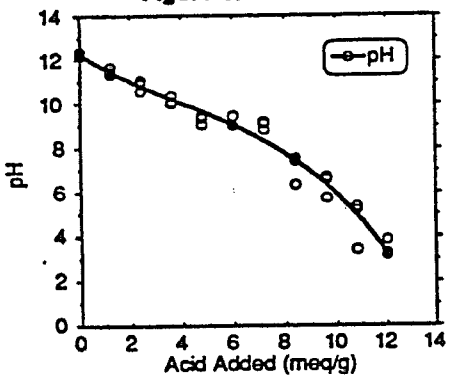


Figure d. Vendor 3

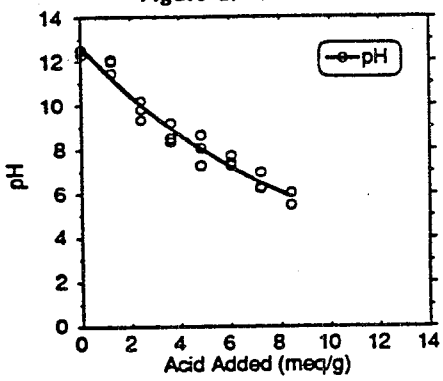


Figure e. Vendor 4

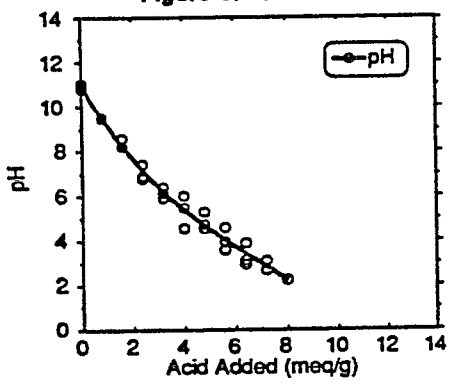


Figure f. WES Control

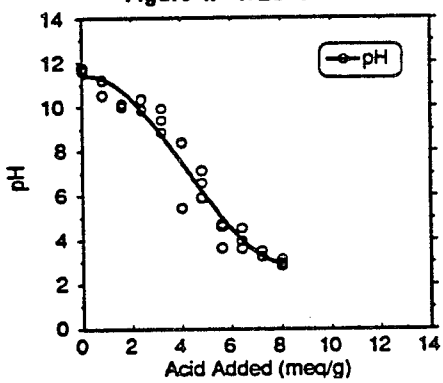
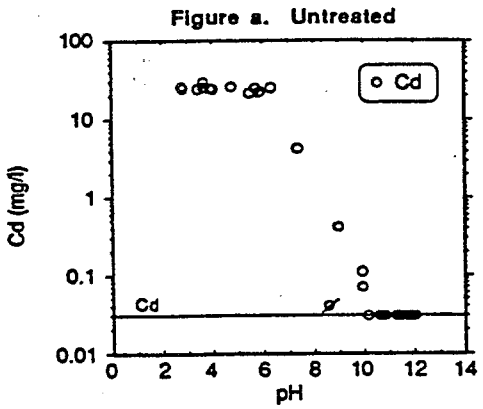
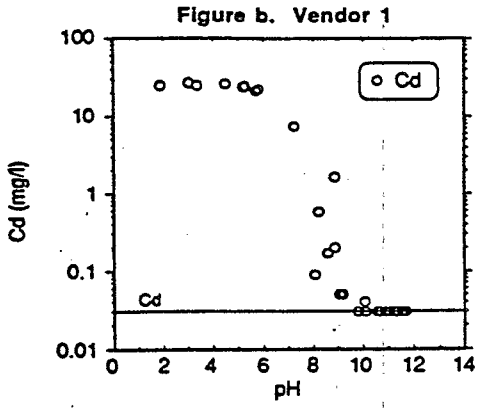
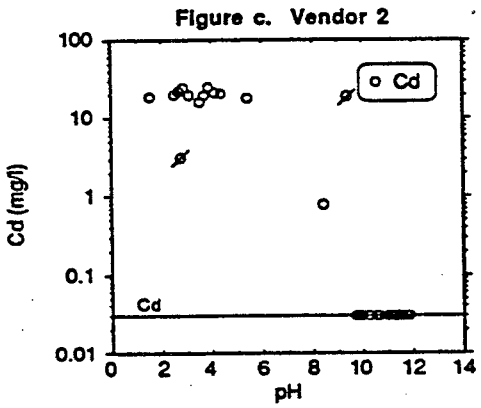
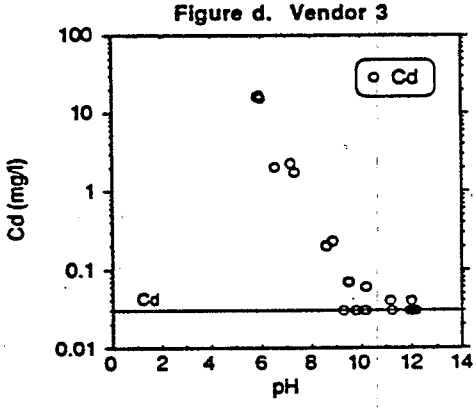


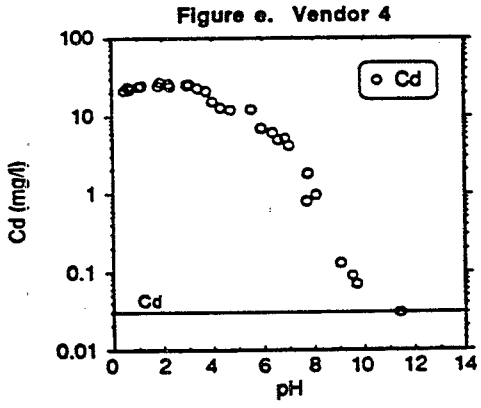
Figure 7.30. Cadmium concentrations in acid neutralization capacity extracts as a function of pH for untreated and treated APC residues.











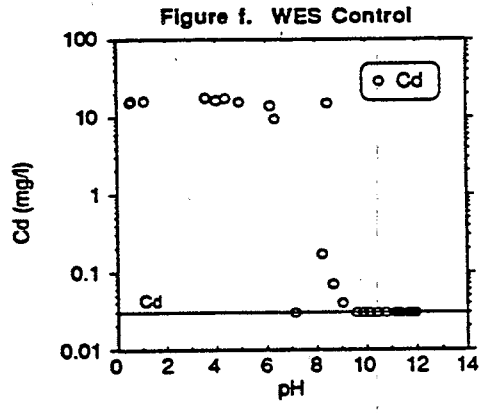


Figure 7.31. Cadmium (Cd) concentrations in acid neutralization capacity extracts as a function of pH for untreated and treated bottom ash.

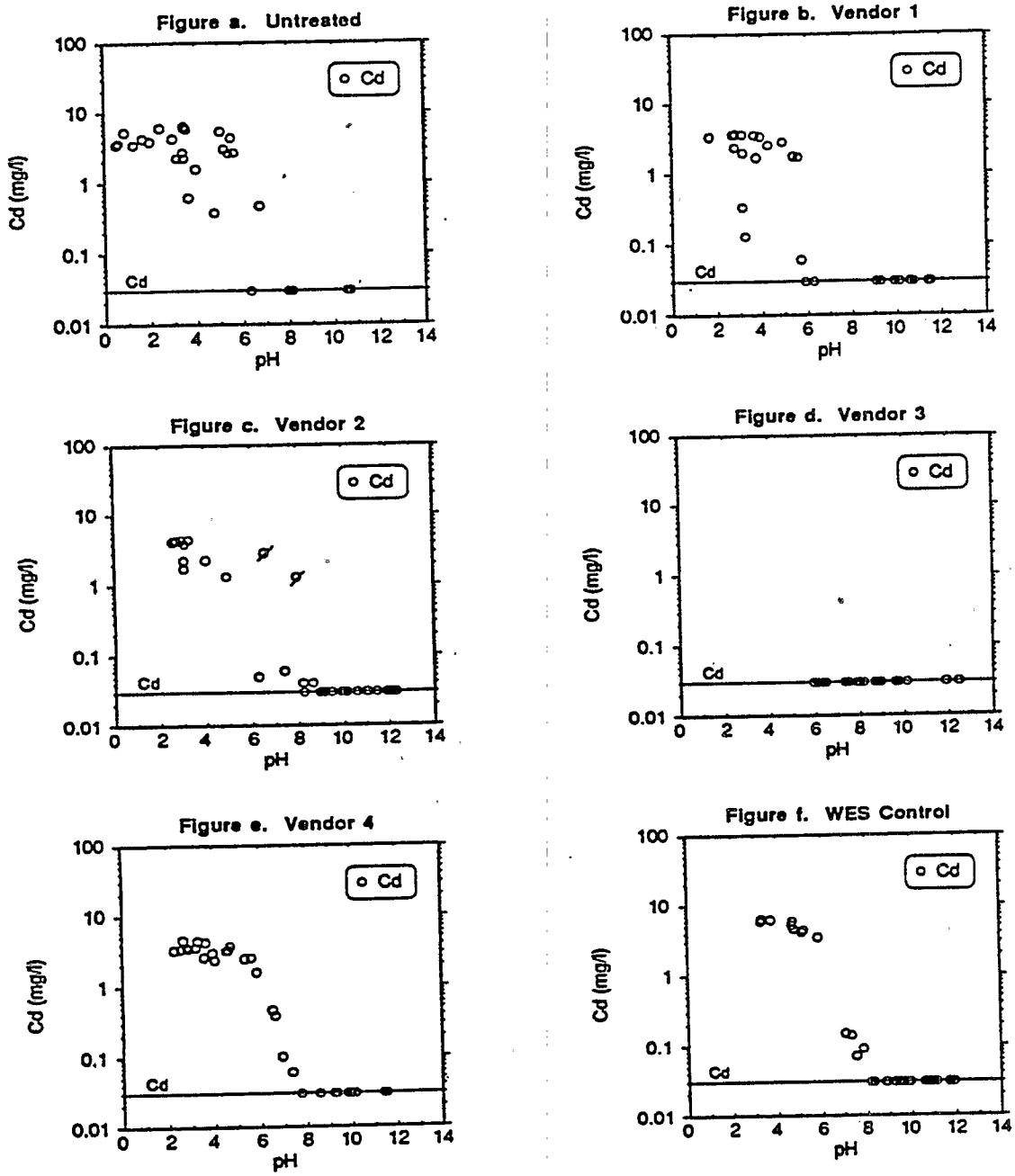


Figure 7.32. Cadmium (Cd) concentrations in acid neutralization capacity extracts as a function of pH for untreated and treated combined ash.

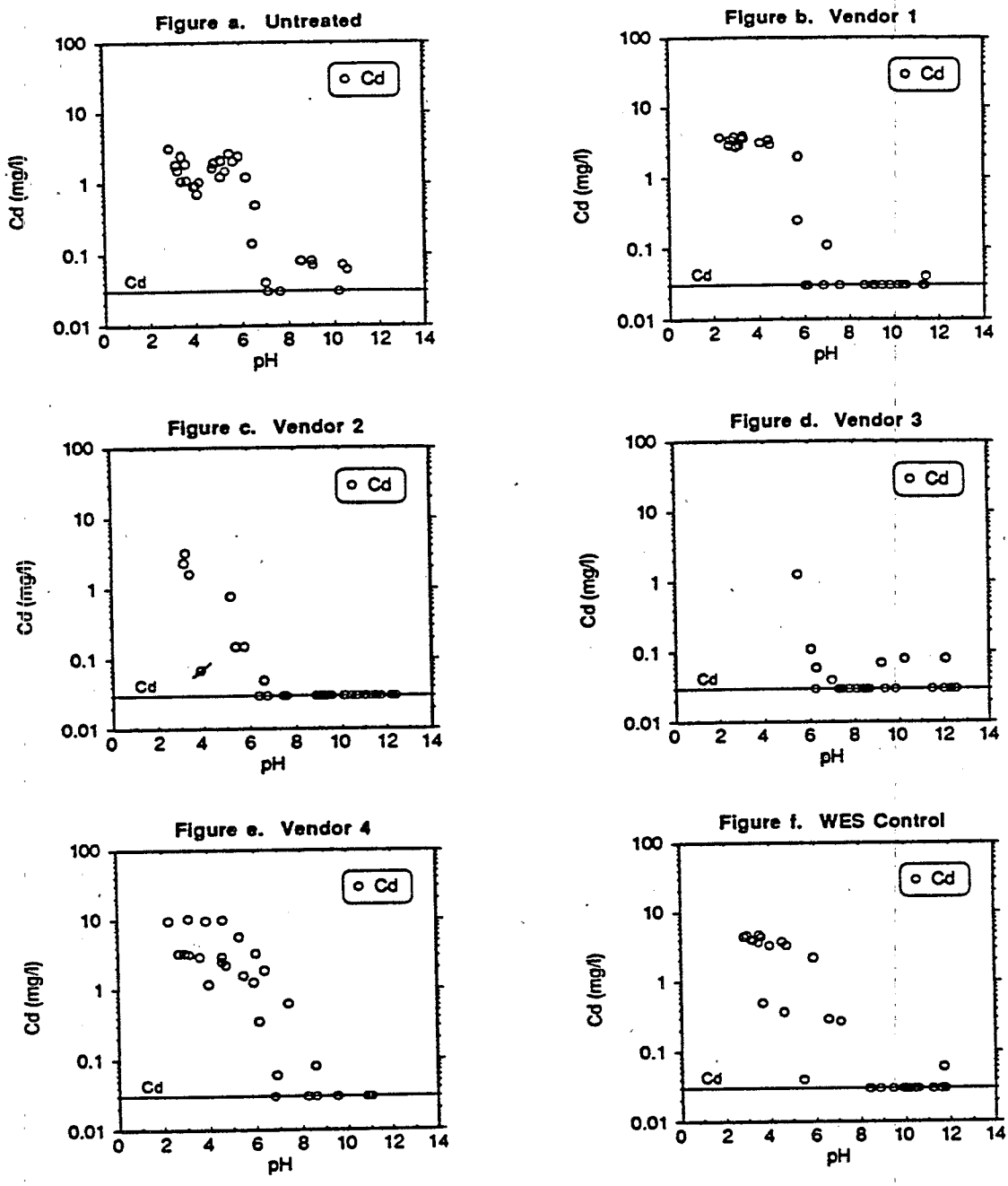
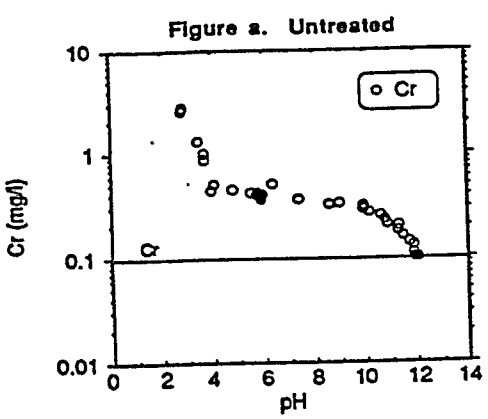
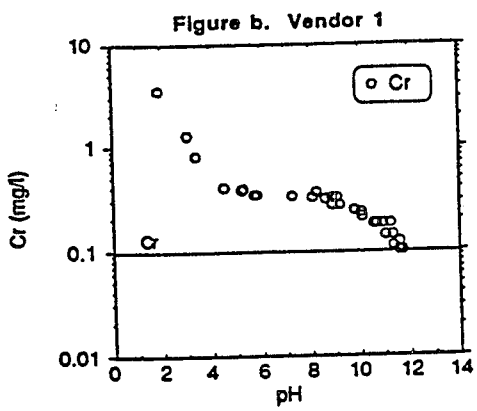
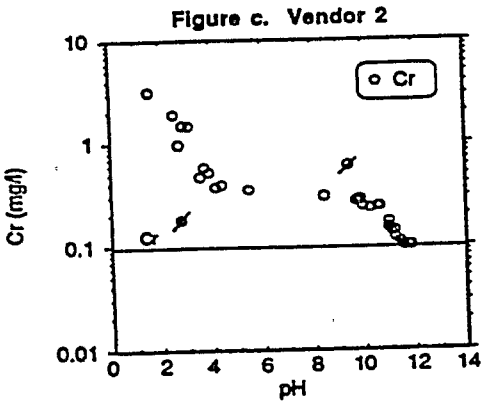
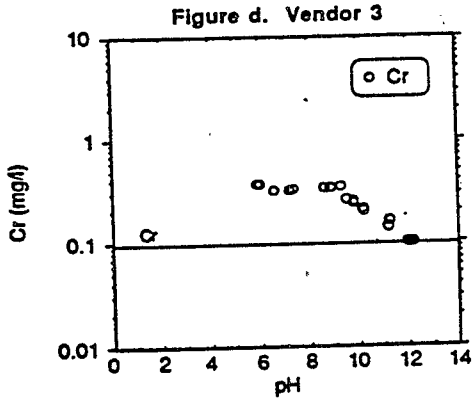


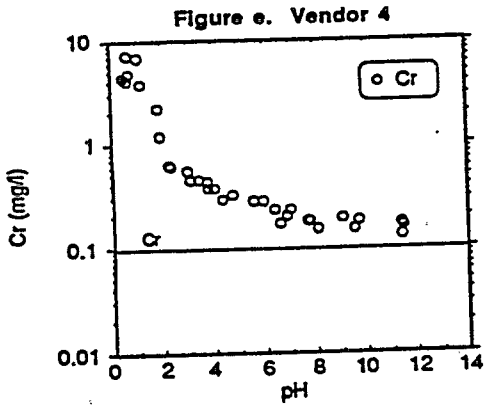
Figure 7.33. Chromium concentrations in acid neutralization capacity extracts as a function of pH for untreated and treated APC residues.











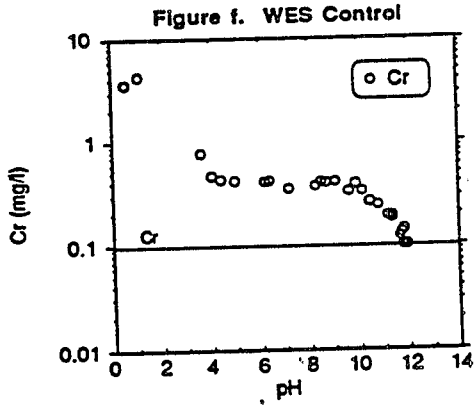


Figure 7.34. Chromium (Cr) concentrations in acid neutralization capacity extracts as a function of pH for untreated and treated bottom ash.

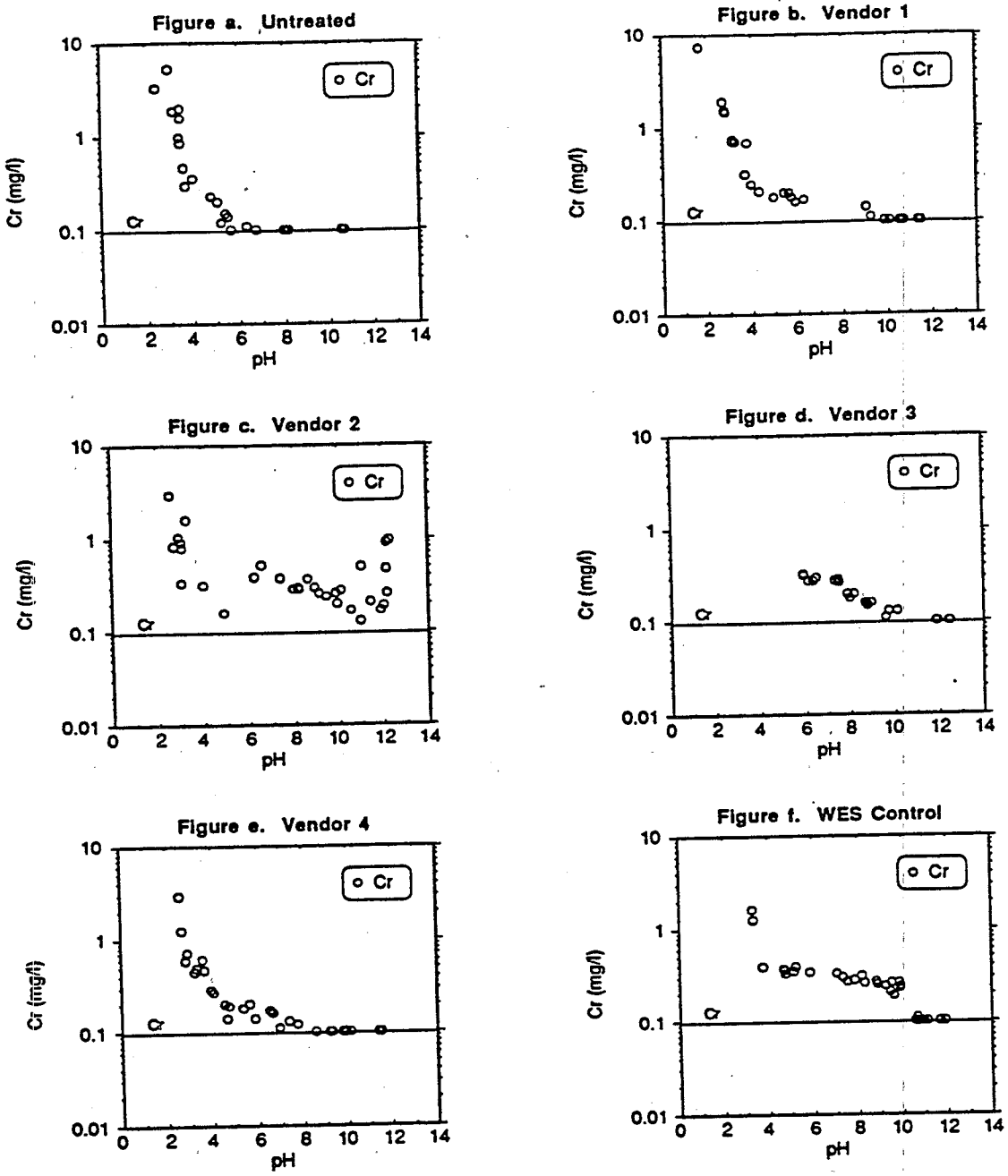
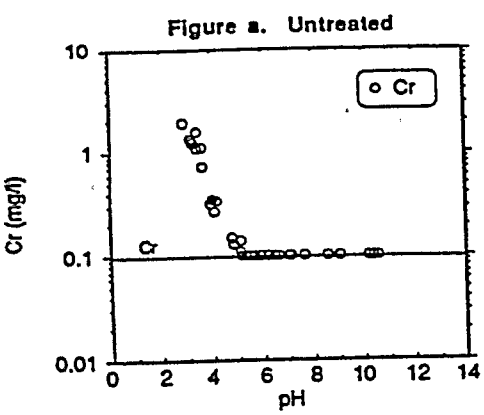
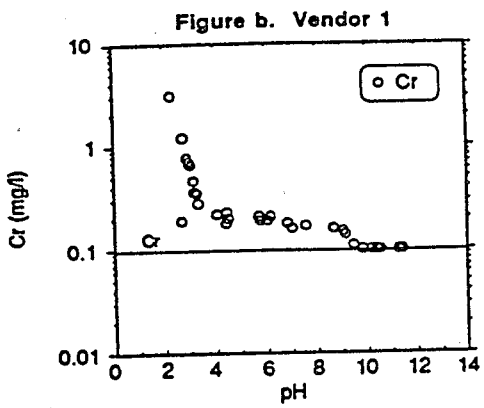
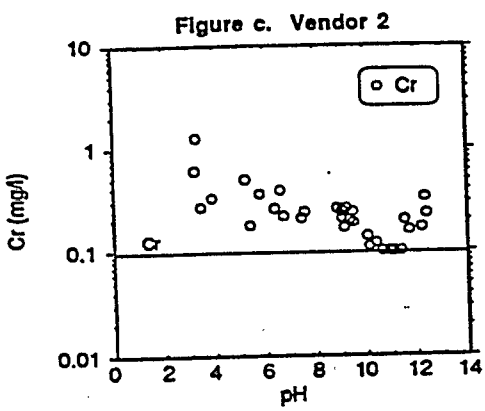
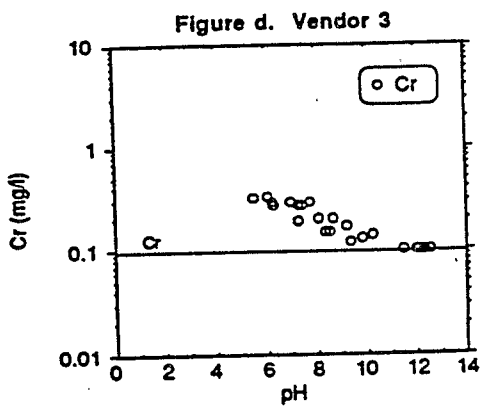


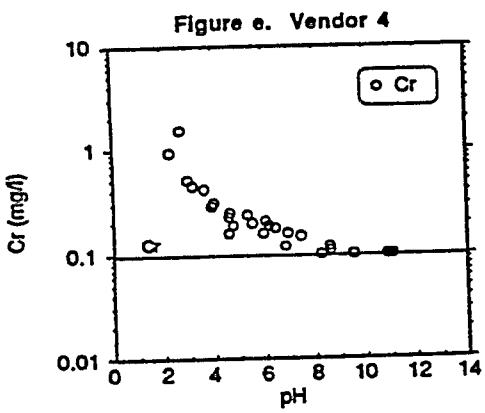
Figure 7.35. Chromium (Cr) concentrations in acid neutralization capacity extracts as a function of pH for untreated and treated combined ash.











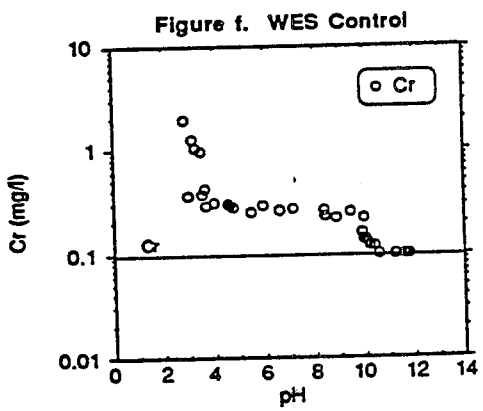
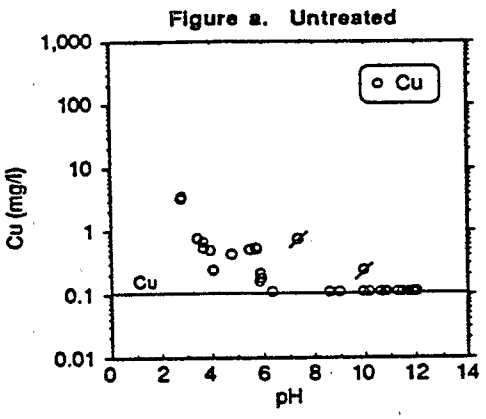
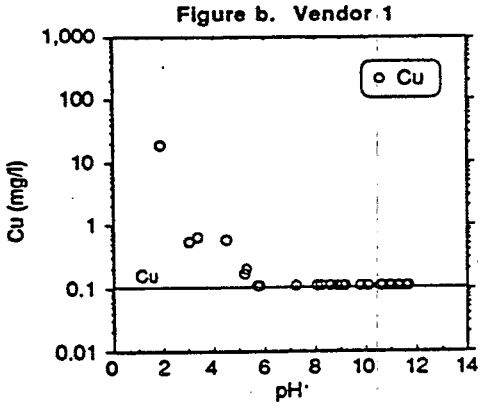
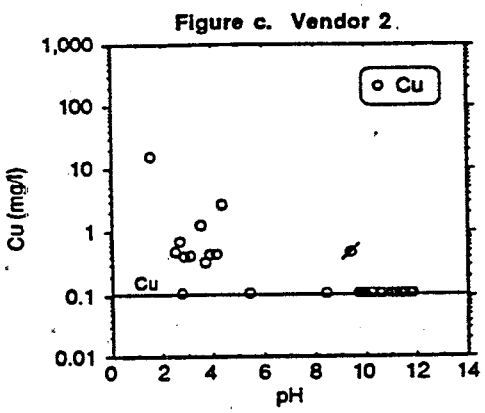
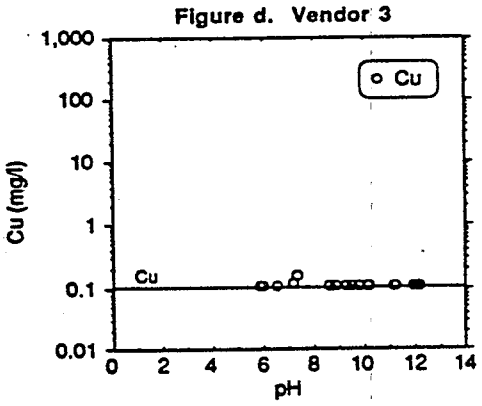


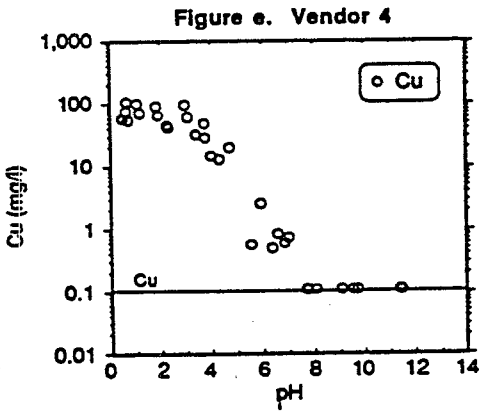
Figure 7.36. Copper (Cu) concentrations in acid neutralization capacity extracts as a function of pH for untreated and treated APC residues.











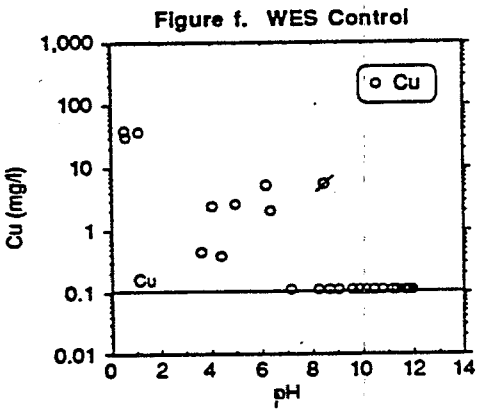


Figure 7.37. Copper (Cu) concentrations in acid neutralization capacity extracts as a function of pH for untreated and treated bottom ash.

Figure a. Untreated

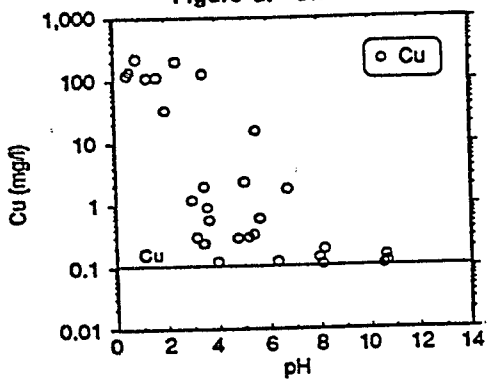


Figure b. Vendor 1

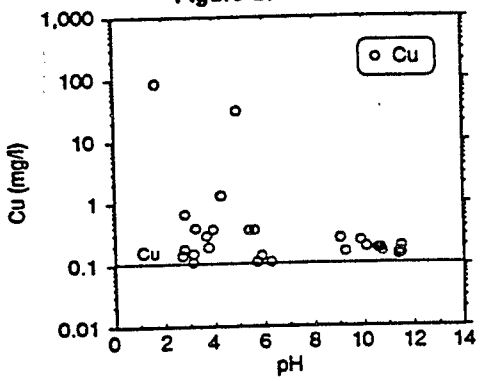


Figure c. Vendor 2

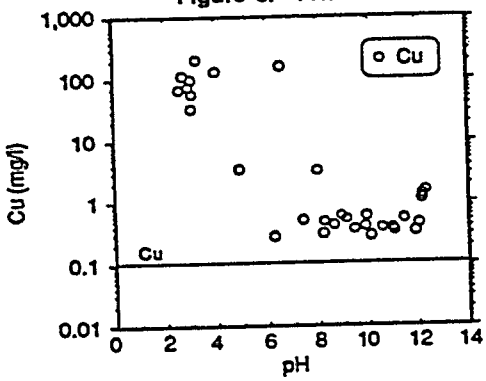


Figure d. Vendor 3

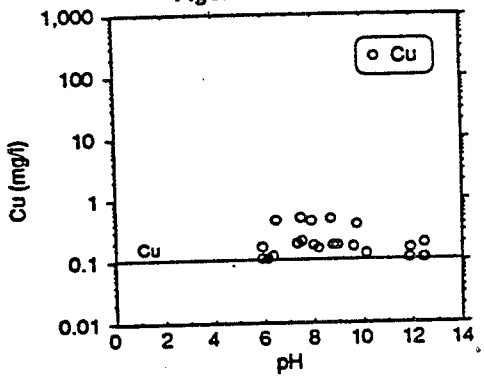


Figure e. Vendor 4

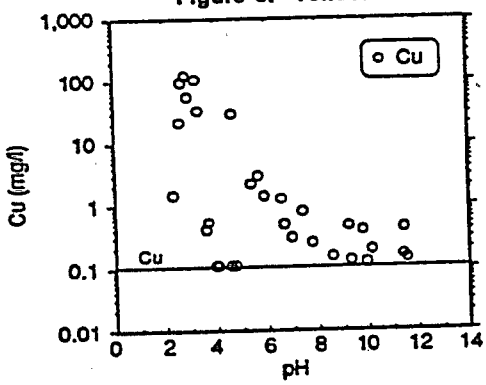


Figure f. WES Control

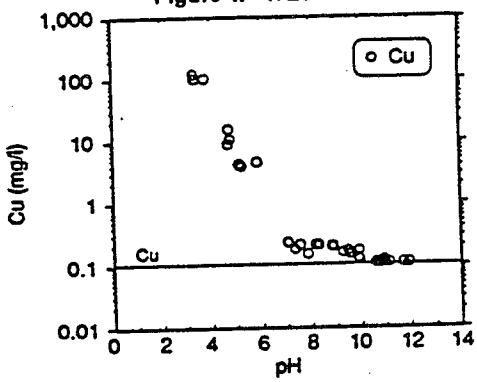


Figure 7.38. Copper (Cu) concentrations in acid neutralization capacity extracts as a function of pH for untreated and treated combined ash.

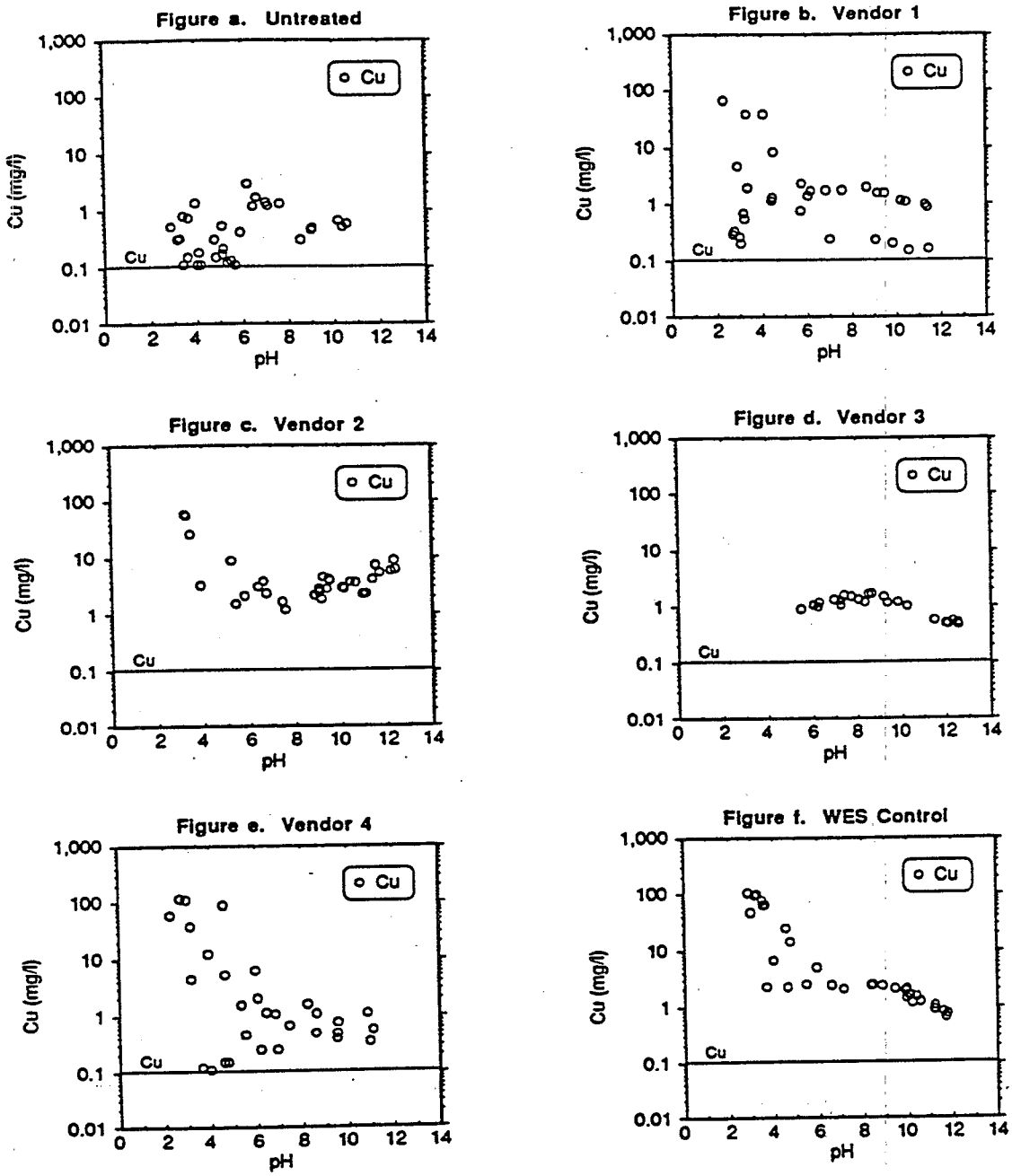
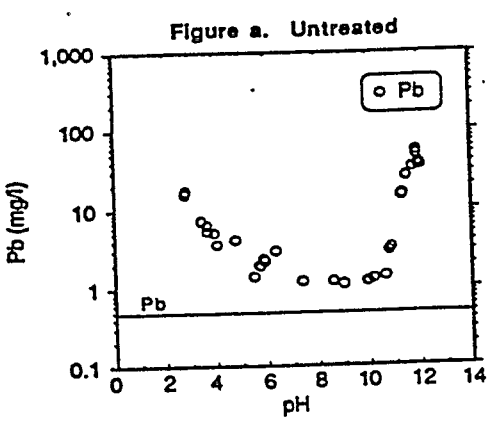
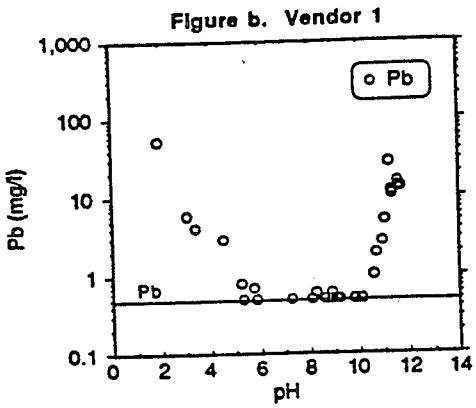
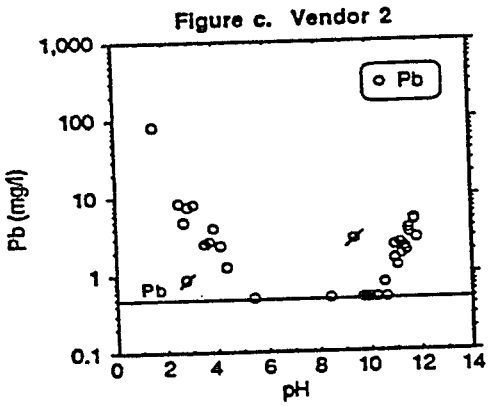
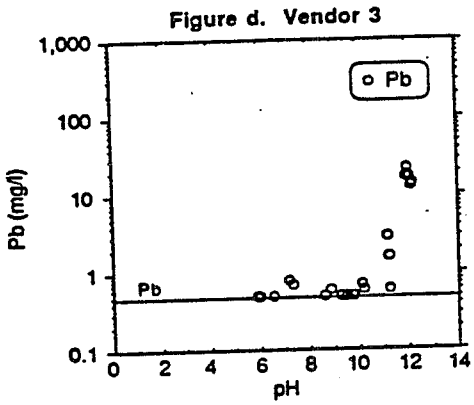


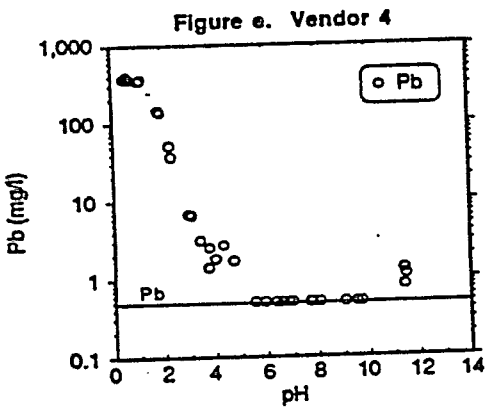
Figure 7.39. Lead (Pb) concentrations in acid neutralization capacity extracts as a function of pH for untreated and treated APC residues.











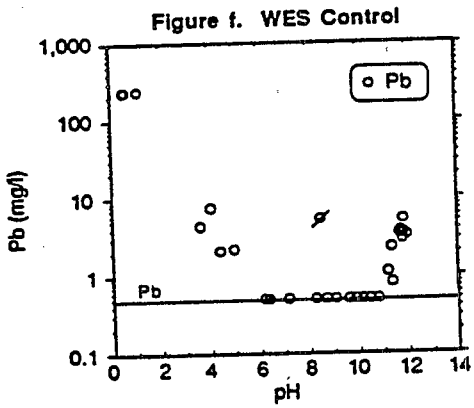


Figure 7.40. Lead (Pb) concentrations in acid neutralization capacity extracts as a function of pH for untreated and treated bottom ash.

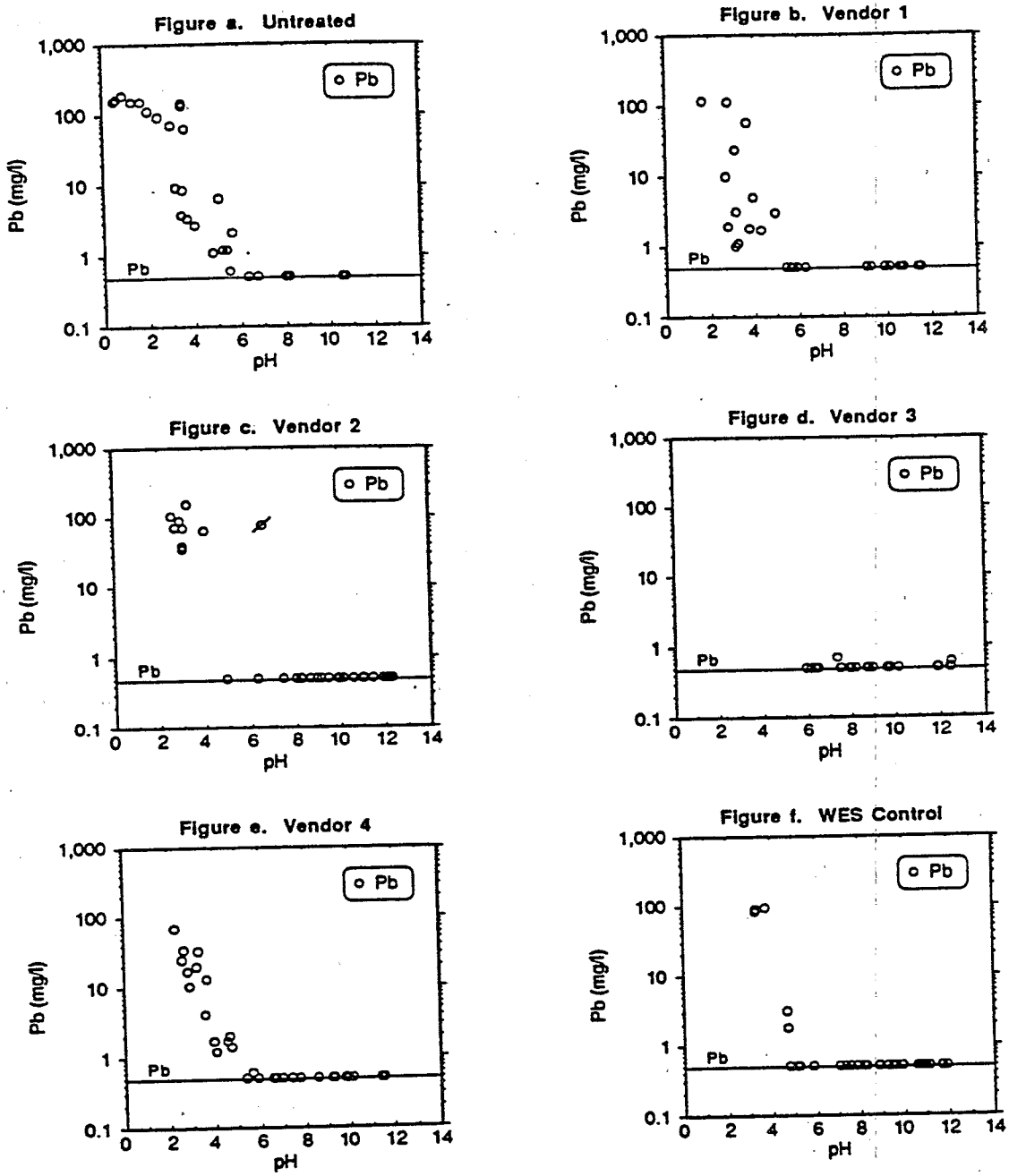
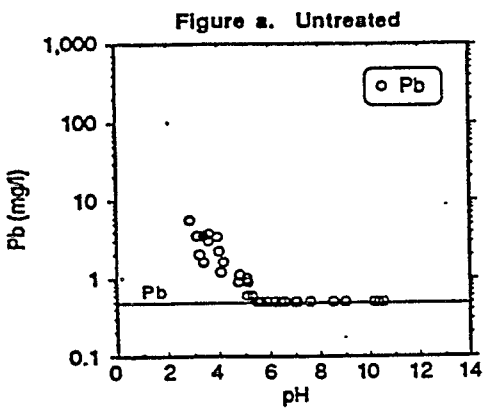
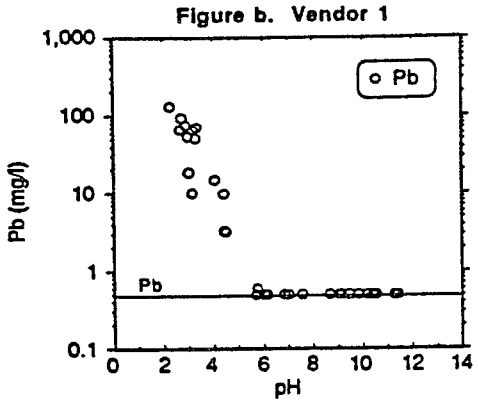
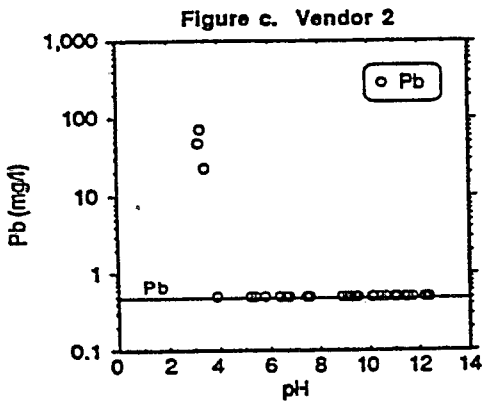
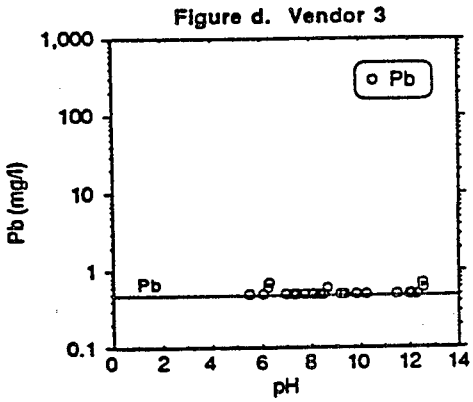


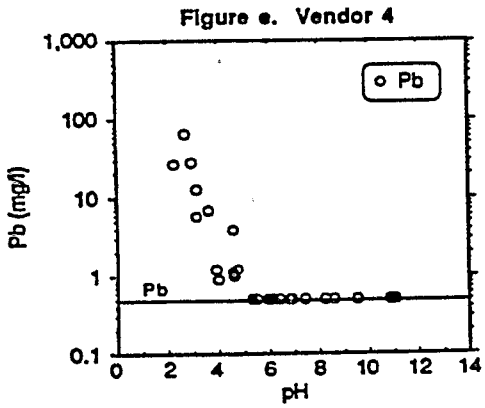
Figure 7.41. Lead (Pb) concentrations in acid neutralization capacity extracts as a function of pH for untreated and treated combined ash.











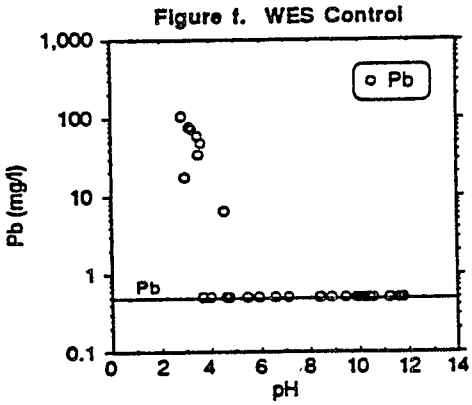
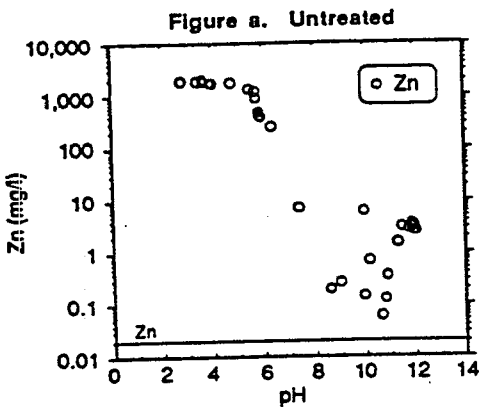
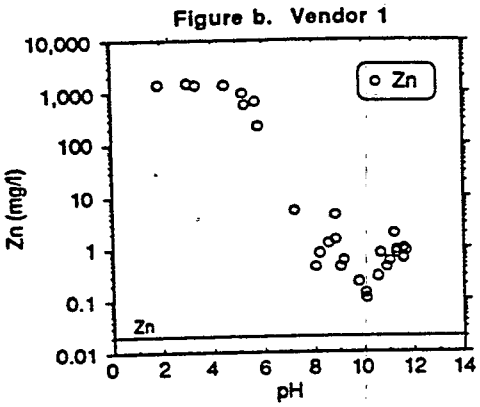
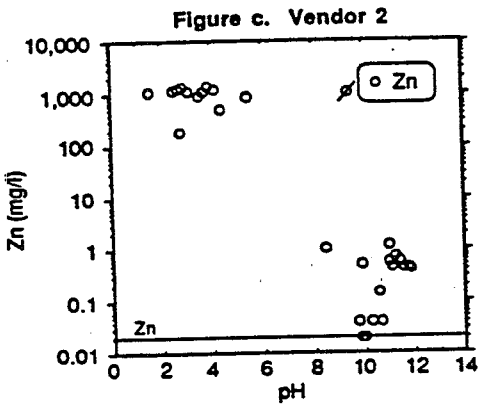
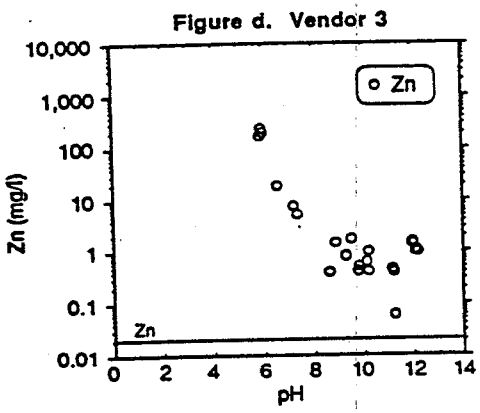


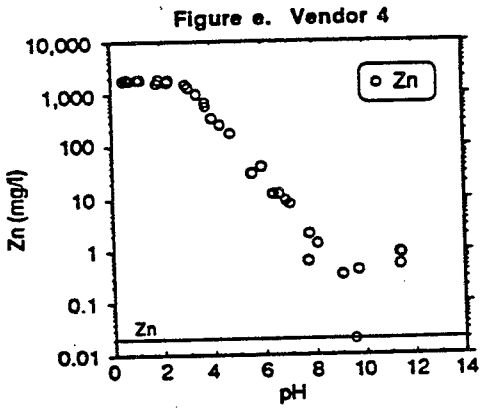
Figure 7.42. Zinc (Zn) concentrations in acid neutralization capacity extracts as a function of pH for untreated and treated APC residues.











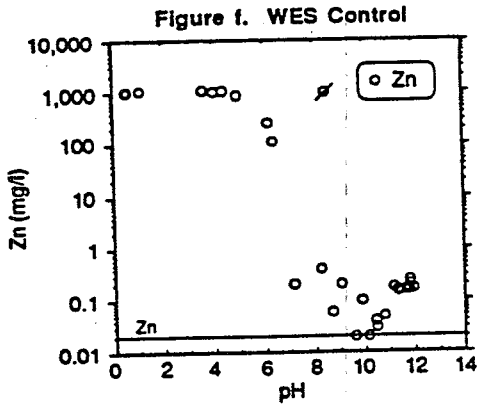


Figure 7.43. Zinc (Zn) concentrations in acid neutralization capacity extracts as a function of pH for untreated and treated bottom ash.

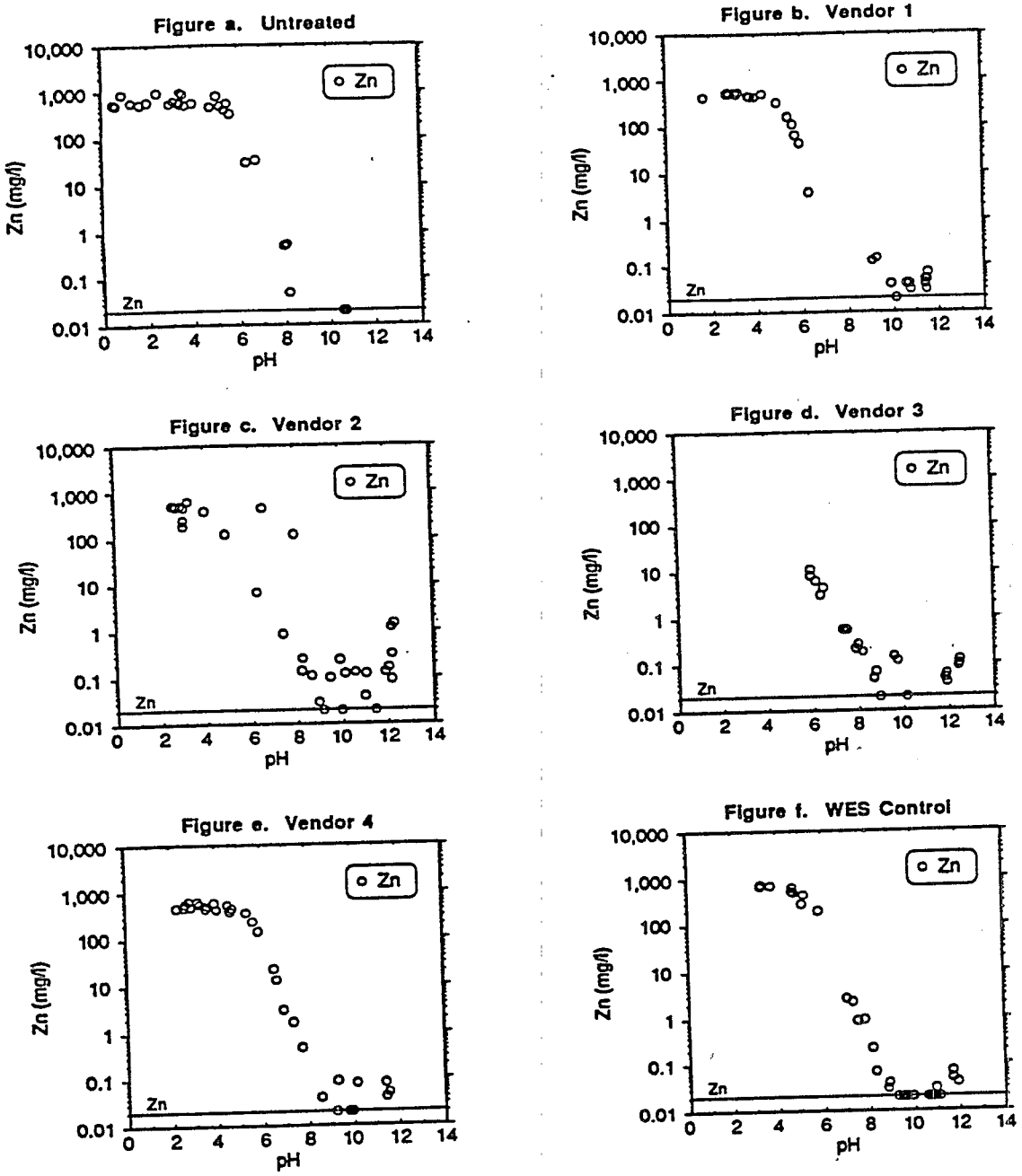
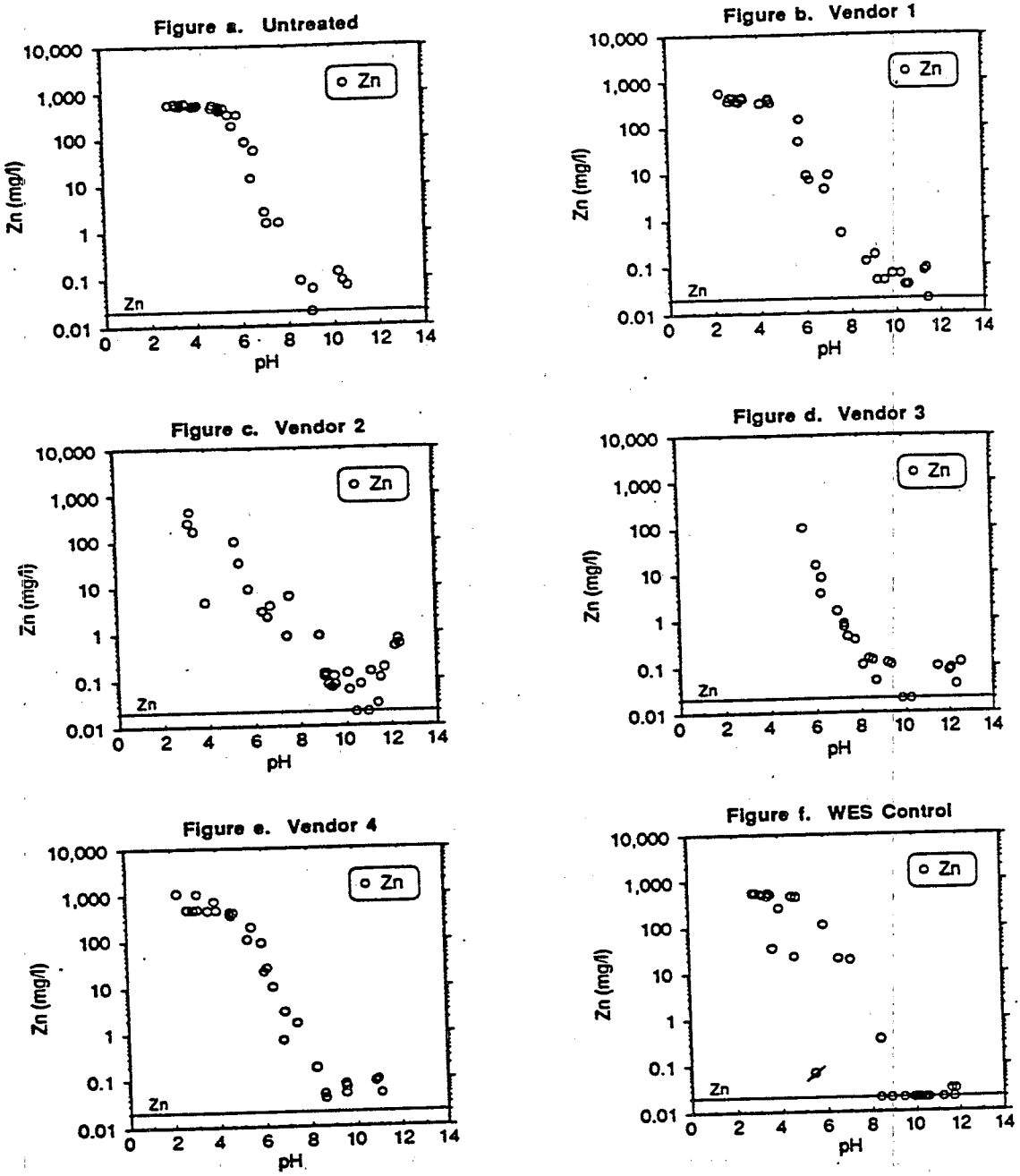


Figure 7.44. Zinc (Zn) concentrations in acid neutralization capacity extracts as a function of pH for untreated and treated combined ash.



8. EXPERIMENTAL RESULTS AND MODELED LEACHING OF UNTREATED AND TREATED RESIDUES - RELEASE RATE

8.1 DATA EVALUATION

8.1.1 Mechanisms and intrinsic properties from monolith leach test

The leaching behavior and release rates of species incorporated in monolithic stabilized MSW residues can be described by the following treatment effects:

- Availability, or the fraction of each element not tied up in silicate and poorly soluble mineral phases. The fraction which is bound in silicate and poorly soluble mineral phase is assumed to be environmentally not leachable. Availability defined in this report is the quantity of an element extracted during the availability leach test. This quantity often was substantially less than the total concentration of the element in the untreated or treated residue, but often substantially higher for treated than untreated residues.(see Chapters 2.3.5 and 7.4);
- Physical retention (tortuosity), which is derived from measuring the release rate of an inert component (one which does not chemically interact with the product matrix) from the product matrix. Physical retention is equivalent to tortuosity for cases where the monolith remains physically intact (e.g., no significant cracking or disintegration). In these cases, tortuosity is an approximation of the ratio of the actual mean path length a species travels from within the monolith to the monolith surface for release to the mean direct geometric path length. For cases where the monolith did not maintain physical integrity, the physical retention factor is a relative reference index for the degree of species retention within the S/S matrix by physical encapsulation at the micro-scale. Sodium was used as the non-interactive component for estimation of physical retention in this study ; and,
- Chemical retention, which is a function of each element's chemical interaction with the product matrix. This was derived from the measured release rate of a given component, its free mobility in water and the tortuosity as obtained from the inert component release rate.

Both physical retention and chemical retention were calculated from data obtained during the monolith leach test [van der Sloot, 1991, van der Sloot, et al., 1991, van der Sloot, et al., 1988]. The availability leach test provided quantification of the fraction of an element present in the material that was not bound up in low solubility mineral phases and that can potentially be released to the environment. Leaching mechanisms can be identified by plotting the release as a function of contact time. The following leaching mechanisms can be distinguished: dissolution, surface wash-off, matrix diffusion and depletion. An example of dissolution, matrix diffusion and depletion is presented in Figure 8.1. The following paragraphs discuss the observed response from each of these mechanisms.

Dissolution: The solubility of the product matrix or a large fraction of the matrix can be such that dissolution of material from the surface proceeds faster than diffusion through the pores of the matrix. This phenomenon has been observed in products containing very high gypsum loadings [van der Sloot, 1991]. In the case of high gypsum content, calcium sulfate solubility is relatively high, which results in an initial theoretical slope of +1 in the release-time plot (log-log). At longer time intervals, the slope decreases as the extract solution becomes saturated with respect to calcium sulfate.

Surface Wash-off: A material can be covered with a relatively soluble surface coating as a result of process conditions or condensation processes. This layer can dissolve rapidly during the initial phase of the monolith leaching experiment and is indicated by an initial slope of less than 0.35. In many cases, the subsequent release is diffusion controlled. This type of release is most common for slag type materials.

Diffusion: Leaching from most cement-based materials is controlled by diffusion through the solid matrix. Intrinsic leach parameters, including tortuosity, chemical retention and effective diffusion coefficients, can be derived allowing predictions about release at time scales considerably longer than the duration of the experiment.

Depletion: Depletion may occur in the later stages of leaching when the concentration of the species of interest within the center of the test specimen is reduced significantly by the cumulative effect of leaching. When this occurs, the initial boundary conditions and experimental assumptions are not met. Depletion may occur when the properties of the material being tested are not known in advance. As indicated above, a slope less than 0.35 in the early stages of leaching indicates surface wash-off, while a slope less than 0.35 after release in accordance with a slope 0.5 is an indication of depletion. This is verified easily by comparing the cumulative release data with the maximum release quantity obtained from the availability leach test. When more than 50% of the available mass present in the test specimen is leached, significant depletion can be expected to have occurred.

8.1.2 Definition of Leaching Parameters

The ion flux through the geometrical surface area of the product is described by Fick's second law under diffusion controlled conditions:

$$\frac{\delta C}{\delta t} = D_L \frac{\delta^2 C}{\delta x^2} \qquad \text{(Equation 8.1)}$$

with D_L the overall leach constant with dimensions of a diffusion coefficient and C is the species concentration.

In case of one-dimensional diffusion, the property DL can be obtained from:

$$D_L = \frac{f^2 D_o}{R\tau} \qquad \text{(Equation 8.2)}$$

with D_L the overall leach constant in m^2/s; f, the availability factor, is defined as the leachable concentration divided by the total concentration for each element in the material (-); D_o is the free mobility of the component in water (m^2/s); R is the chemical retention factor (-); and, τ is the physical retention or tortuosity factor (-).

The chemical retention reflects the retention of the release of a component relative to release of an inert species by chemical interactions of the diffusing ion with the product matrix. The porewater composition and the porewater pH are important factors in this respect. In other work, relations between porewater pH and retention values have been established. In a number of cases, these relations are strictly based on the solubility as a function of pH of the specific species. Figure 8.2 illustrates the effect of porewater pH on the release of magnesium [van der Sloot, et al.,1988]. The element Mg is an example where the solubility of magnesium decreases proportionally with an increasing pH. Thus, the retention value increases proportionally with the increasing pH. Reactive surface sites also may affect the diffusivity of components in the pore solution. Chemical retention factors may range from 1 to more than 1,000,000, where a value of 1 reflects no chemical retention during the leaching process. The wide range of chemical retention factors reflects that substantial reductions in release rates can be obtained by chemical modifications. Measures taken to modify the chemical retention of specific components can result in the increased mobilization of other matrix components. Multiparameter screening is necessary to insure that no adverse effects have been introduced.

The physical retention or tortuosity reflects the extended path length of a diffusing ion in the pore structure of a product. Values may range from 1 to 10 for stabilized materials and up to 1000 and higher for very dense concrete and bitumious mixes with water repellant properties. A tortuosity value of 1 reflects no physical retention during the leaching process.

The significance of the availability test for the judgement of the maximum leachability of a given component from waste materials is best illustrated by release data obtained for one of the products in this study, where depletion of a very soluble component occurs, and the maximum leachable quantity, as determined by the availability leach test, is approached (Figure 8.3). The data obtained during the monolith leach test are expressed as (mg element leached per m^2 surface area) as a function of time. The availability leach test results are recalculated to the same units by taking the size and shape of the specimens into account. These figures indicate that the release of sodium, chloride, potassium and bromide asymtotically approached the release limit dictated by the availability leach test. Similar

observations also have been made in column leaching experiments, indicating the practical significance of this test method as a screening tool for ultimate release at the very long term. A more complete discussion of release data from the monolith leach test for sodium, chloride, potassium and bromide is provided in Chapter 8.2.

D_L equals the effective diffusion coefficient for f = 1 because the 'driving force' for diffusion is determined by the leachable (available fraction) and not the total amount of each element in the material. By transforming these parameters to log-values by means of pD = - log D, a new relation is obtained indicating the individual contributions, free mobility, chemical retention and tortuosity, to the release of components:

$$pD_L = pD_o + 2pf - pR - p\tau \qquad \text{(Equation 8.3)}$$

After correction for the leachable fraction, or availability factor, (f) an effective diffusion coefficient (D_e) is obtained.The available concentration of a particular species is used for estimation of pDe instead of the total concentration and an availability factor used for estimation of pD_L. The effective diffusion coefficient, D_e, will be used in subsequent descriptions of release from waste forms:

$$pD_e = pD_o - pR - p\tau \qquad \text{(Equation 8.4)}$$

The general equation for the effective diffusion coefficient as a function of the physical retention (tortuosity) and chemical interaction is:

$$D_e = D_{o,x}\left(\frac{1}{R\tau}\right) \qquad \text{(Equation 8.5)}$$

where:

D_e is the effective diffusion coefficient of component x in the product, in m^2/s;

$D_{o,x}$ is the diffusion coefficient of component x in water, in m^2/s;

R is the chemical retention factor of component x in the product (-); and,

τ is the physical retention in the product (-)

For the calculation of the tortuosity, an ion should be chosen, which does not interact with the matrix (R equals 1). In many cases, sodium is an appropriate choice. The tortuosity of the product can be calculated with the formula:

$$\tau = \frac{D_{Na}}{D_{e,Na}}$$ (Equation 8.6)

where:

τ is the tortuosity of the product;

D_{Na} is the diffusion coefficient of Na in water (pD_{Na} = 8.88 at 22 °C) in m^2/s; and,

$D_{e,Na}$ is the effective diffusion coefficient of Na in the product in m^2/s

The chemical retention factor (R) for the component of interest then is calculated from:

$$R = \frac{D_x}{D_{e,x}\tau}$$ (Equation 8.7)

where:

R is the chemical retention factor (-);

D_x is the diffusion coefficient for component x in water, in m^2/s;

$D_{e,x}$ is the effective diffusion coefficient for component x in the product, in m^2/s; and,

τ is the tortuosity of the product (-).

The larger the pD_e, the slower the release from the material. Measures to improve the environmental quality of products containing secondary materials can be targeted at any of the three release rate factors f, R and τ. Changes in processing parameters generally can lead to a denser product and, consequently, influence the physical retention factor. However, within one category of materials, the range in tortuosity is relatively small. This implies that changes in chemical properties, which influence both R and f, have a greater effect on ultimate release rates.

8.1.3 Transport models for parameter estimation

A. Semi-infinite linear diffusion model

A one dimensional diffusion model can be applied for parameter estimation based on data obtained from both monolithic specimens and compacted granular material as long as the boundary conditions for the use of the one-dimensional model are fulfilled. The main conditions are:

- no depletion during the duration of the test; and
- extractant replacement cycles are frequent enough to ensure that the concentration gradient between the solid being leached and the extractant is maximized (e.g., the species concentration in the extract is dilute).

- Monolithic samples maintain physical integrity (e.g., no cracking or disintegration) during testing. For cases where the physical integrity of the monolith was not maintained, estimated values of physical retention and chemical retention should be regarded as relative indexes and not be used for extrapolation and estimation of releases over longer time intervals or different physical geometries. Cases where sample physical integrity was not maintained, represent a failure of the S/S matrix to retain its initial physical properties.

The diffusion model used for the interpretation of the monolith leach test results can be derived from the equation presented by Crank for the diffusion from a product with semi-infinite dimensions, in which the initial concentration is uniformly distributed in the product and the concentration on the surface between the product and the leachate is constant in time [Crank, J., 1975]:

$$\frac{C - C_1}{C_o - C_1} = \text{erf}\left\{\frac{x}{2\sqrt{D_e t}}\right\} \qquad \text{(Equation 8.8)}$$

where:

$C = C_{(x,t)}$ and is the concentration as a function of location within the solid test specimen and time;

C_1 is a constant concentration at x=0 (test specimen surface);

C_o is the initial concentration (at t=0) in the product which must be uniformly distributed;

D_e is the effective diffusion coefficient (m^2/s);

t is time(s); and,

x is the distance from the surface (m, positive values).

In the monolith leach test, the surface concentration only will be constant as long as no depletion occurs and the mean concentration in the solution does not deviate significantly from zero. These requirements are met by using a product for which the smallest dimension is greater than 5 cm, preventing depletion within the time frame of the experiment, 64 days in most cases, and by refreshing the leachate at regular time intervals. Laboratory experiments coupled with model estimations have indicated that use of the boundary condition $C_1=0$ for $t>0$ is appropriate for this study. The diffusion equation derived from Equation (8.8) for this boundary condition is:

$$D_e = \frac{\pi B_t^2}{4t\,(U_{max} d)^2} \qquad \text{(Equation 8.9)}$$

where:

D_e is the effective diffusion coefficient for component x in the product, in m^2/s;

B_t is the cumulative release of the component in mg/m^2;

t is the contact time in seconds;

U_{max} is the maximum leachable quantity in mg/kg; and,

d is the bulk density of the product, in kg/m^3

B. Granular compacted material

The model as described above for a monolithic specimen can be applied to release from compacted granular material contained in a mold and covered with glass beads. The glass bead layer provides a uniform surface area to which the release is normalized (See Chapter 2.3.5). The glass beads cause a slight time-lag in the release because of the diffusion path through the beads before actual release to the overlying solution occurs. A comparison between the release with and without a glass bead cover was carried out using ^{22}Na solution mixed with sand. The release of ^{22}Na was measured as a function of time applying the same liquid renewal intervals as described in Chapter 2.3.5. The results of these measurements for the two conditions are provided in Table 8.1. The variability in the Na^{22} release data for the case without glass beads was larger than the case with glass beads. This indicates better experimental control over sampling the overlying solution in the case with a buffer layer formed by the glass beads. In the release data from the experiment with glass beads, only the first extraction cycle indicates a lag time. All the subsequent data are on a slope of 0.5, indicating diffusion controlled release. The measured effective diffusion coefficients (pD_e) for the experiments with and without beads were 9.22 +/- 0.11 and 9.23 +/- 0.22, respectively. Similar values for sodium mobility in sand have been measured using diffusion tube experiments [van der Sloot, et al.,1989., van der Sloot, et.al., 1991, van der Sloot, et.al., 1988 , de Groot, et.al.,1990]. In a diffusion tube, the tracer is allowed to diffuse from a labeled segment into an unlabeled segment. Slicing of the tube contents after a given time period allows quantification of the effective diffusion coefficient. The diffusion tube method also resulted in effective diffusion coefficients for sodium (9.20 +/- 0.10) similar to those obtained from the compacted granular material method.

8.1.4 Determination of leaching mechanism from the cumulative release data.

For the determination of the leaching mechanism, the logarithm of the cumulative release has been plotted versus the logarithm of time. Rearranging Equation 8.9 yields:

$$B_t = u_{max} d\sqrt{(4 D_e t/\pi)} \qquad \text{(Equation 8.10)}$$

and after transformation to logarithm:

$$\log (B_t) = 1/2 \log (t) + \log \{\mu_{max} d\sqrt{4D_e/\pi}\} \qquad \text{(Equation 8.11)}$$

The release of each component per time interval can be calculated from the monolith leach test results with the formula:

$$B_i = \frac{c_i V_i}{1000\ A} \qquad \text{(Equation 8.12)}$$

where :

B_i is the release during period i, expressed in mg/m^2;

c_i is the extract concentration of the component in the ith period, expressed in mg/l;

V_i is the volume of the contact solution, in liters; and,

A is the geometrical surface area of the specimen in m^2.

The measured release from previous periods is summed to obtain the measured cumulative release. This implies that deviations in a given period accumulate in the subsequent periods, which may hamper interpretation. The cumulative release until the ith period can be calculated only from the release in the ith period, assuming diffusion control in the ith and previous time periods. These values can be used to check whether the release is diffusion controlled. If the measured and calculated cumulative releases are equal, the release is controlled by diffusion. The calculated cumulative release used for all N periods can be derived from:

$$B_{t,i} = B_i \frac{\sqrt{t_i}}{\sqrt{t_i} - \sqrt{t_{i-1}}} \qquad \text{for i =1 to N} \qquad \text{(Equation 8.13)}$$

where:

$B_{t,i}$ is the cumulative release of the component through period i, in mg/m^2;

t_i is the contact time after the period i in seconds; and,

t_i-1 is the contact time after the period (i-1) in seconds.

After plotting the logarithm of the calculated cumulative release ($B_{t,i}$) against the logarithm of the time (t_i) for i=1 to N, the slope of the relation over the complete time interval and three time intervals segments can be determined:

Interval 0 (total range)	-	leaching extracts 1 to 8;
Interval 1 (initial leach range)	-	leaching extracts 1 to 3;
Interval 2 (intermediate range)	-	leaching extracts 3 to 6; and,
Interval 3 (last range)	-	leaching extracts 5 to 8.

The mechanism of leaching during each interval can be derived from the slope of the data from the respective interval. Components dissolving from the surface (slope $\geq\equiv 0.8$), short initial release of surface deposited components (initial stage slope $< \equiv 0.4$) and diffusion controlled release (slope $\equiv 0.5$) can be distinguished. The meaning of the change in the slopes at different time-intervals is summarized below:

	SLOPE		
Leaching Interval	≤0.35	0.38-0.65	≥0.65
Initial	Surface wash-off	Diffusion	Lag time/dissolution
Intermediate	Depletion	Diffusion	Dissolution
Last	Depletion	Diffusion	Dissolution

Only in the cases where the slope is approximately 0.5, can effective diffusion coefficient be calculated. When the slope in the entire plot is 0.5 +/- 0.1 and the slope in the last range is less than 0.6, data from all leaching extracts can be used for the calculation of the effective diffusion coefficient. If this is not the case, only those intervals in which the slope is 0.5 +/- 0.1 can be used for calculation of D_e. The effective diffusion coefficient (D_e) for the component of interest then is calculated from each period using only those data points for which the slope is 0.5 +/- 0.1 with a deviation of less than 50% by:

$$D_{e,i,x} = \frac{\pi B_i^2}{4(u_{max}\, d)^2 \sqrt{t_i} - \sqrt{t_{i-1}}} \qquad \text{(Equation 8.14)}$$

where:

$D_{e,i,x}$ is the effective diffusion coefficient of component x calculated from the release in period i, in m^2/s;

B_i is the release in period i in mg/m^2;

d is the bulk density of the product, in kg/m^3;

U_{max} is the maximum leachable quantity in mg/kg;

t_i is the contact time until period i in s; and,

t_{i-1} is the contact time until period i-1 in s.

After expressing the effective diffusion coefficient in the negative logarithm, $pD_e,i,x = - \log (D_e,i,x)$, the mean effective diffusion coefficient and standard deviation for component x can be calculated.

8.1.5 Diffusion Modelling Limitations

Data analysis of monolith leach test results based on diffusion modelling has limitations in several cases for this study. One data analysis limitation was for the cases where the physical integrity of the monolithic sample was not maintained. Loss of physical integrity manifested itself in several ways. Some samples developed a network of fractures through the samples. Other samples flaked and eroded at the surface. Diffusion model parameters (e.g., tortuosity, chemical retention and effective diffusion coefficients) for these cases were determined to provide a first order of magnitude estimate of relative contaminant retention by the treatment processes. Often for these cases, contaminant release may have been controlled by the rate of dissolution of the matrix, not pore diffusion processes. Low values for tortuosity (e.g. less than 5) also are indicative of poor physical performance of the monolith samples. In these cases, resulting parameter estimates should be used only for comparative purposes and not for extrapolation of contaminant release rates.

The second data analysis limitation resulted from extremely slow contaminant release rates. These cases typically are indicated by effective diffusion coefficients greater than pDe of 14. In these cases, the slow rate of release may be controlled by limited solubility of mineral phases in the pore water solution. Results may be further confounded by analytical method errors at or near method detection limits. For these cases, extrapolation of contaminant release rates based on estimated parameters should be considered conservative because the extrapolation would result in over estimation of anticipated actual release.

8.2 LEACHING RESULTS AND DISCUSSION

8.2.1 Data handling

The data for estimation of leaching parameters from the monolith leach test were transferred to ECN for data processing. A number of inconsistencies were noted during the evaluation, which will appear only in a comparison of interrelated information as carried out in this study. There are some obvious relations between total concentration, availability and actual release that need to be fulfilled. Expressed in the same units, the sequence of the concentrations in increasing order should be actual release, availability and total. This condition was not fulfilled due to analytical problems in some cases. In particular, a number of discrepancies between total and available concentrations exists for the anions (chloride, bromide, sulfate and nitrate). Whenever the total was less than the availability, the availability

was used in the calculations. In a few cases, only availability data were available (e.g., TDS). In those situations, the total has been assumed to be at least equal to the availability.

· The relationship between the individual data points of the monolith leach test also is fixed within certain limits. The choice of the time intervals dictates the concentrations measured in the leachate in case of diffusion controlled leaching. Deviations may occur because of measurements close to the detection limit (large standard deviations), contamination, or because of day to day variation in the analytical methods. The latter should be minimal, but in practice should not be overlooked.

In the series of analyses, one very obvious error was noted in all day 8 data for Process 2. The data in several elements were at least a factor of 10 out of range as compared to all other intervals measured. The reason for the discrepancy is not clear, but viewing all the other data points, a consistent pattern is indicated. The day 8 data have been omitted from the calculation and an estimated value was used to obtain meaningful results.

8.2.2 Monolith leach test release data

Knowledge of the physical integrity of the monolith test specimens during leaching is crucial to proper interpretation of leaching data and use of estimated physical retention, chemical retention and effective diffusion coefficient values. The following cases did not maintain physical integrity (e.g., exhibited substantial fracturing or erosion of the monolith test specimen) during monolith leach testing:

Bottom ash - Processes 2, 3

APC residue - Processes 1, 2 and 3

Combined ash - Process 2 and 3

Summary data and parameter estimation for all test cases is presented in Appendix C. Figures 8.3 through 8.18 present the mean cumulative release data for sodium, chloride, cadmium, copper, lead and zinc as obtained from the monolith leach test applied to untreated and treated residues. Data is not presented for untreated APC residue and APC residue treated by Process 4 because the method for testing compacted granular material was developed specifically for this study and it was decided to verify the test method on untreated bottom ash and combined ash prior to testing the applicable APC residue cases. Comparable testing of untreated APC residue and APC residue treated by Process 4 currently is in progress and will be presented in a subsequent report. Results from the monolith leach test on a release basis are presented in the units of release per unit surface area leached (e.g., mg/m^2). This is because the sample surface area contacting the leaching fluid, not the total sample mass, is the variable which controls the quantity of a species released when diffusing from a solidified monolith. The total concentration and the available concentration (from the availability leach test) were transformed to a release per unit area basis and are presented in each figure. The quantity indicated as the total

concentration is based on the acid digestion (SW-846) results. The predicted cumulative release based on the estimated effective diffusion coefficient and a one dimensional model also is presented.

In general, the data from the monolith leach test are consistent with the data from the total analysis and the availability leach test. Total concentration was the greatest value, availability was somewhat less than the total concentration, and the cumulative monolith release did not exceed either the total concentration or the available concentration. Several notable exceptions exist. Sodium release from the treated APC residues observed by the monolith leach test exceeded the available concentration but approached the total concentration for Process 2. Sodium release exceeded both the total and available concentrations for Process 3, and slightly exceeded both total and available concentrations for the WES Control process. This is most likely attributable to analytical errors associated with the measurement of sodium in extracts containing very high concentrations of total salts. Sodium release also significantly exceeded the available concentration for combined ash treated by Process 3. Sodium release was reasonable predicted by the diffusion model except after depletion started to occur (e.g., see sodium release from APC residue treated by Process 3 where depletion occurred after day 16 (Figure 8.5)).

Chloride release exceeded both the total and available concentrations for the treated APC residues. In addition, the available concentration was greater than the total concentration for most cases (all residue types). This indicates severe shortcomings of the total analysis method. Releases which exceeded the available concentrations were most likely the result of analytical errors associated with quantifying high chloride concentrations in extracts. Release data from most cases indicated chloride depletion. Some cases indicated very rapid chloride depletion (e.g., see chloride release from APC residue treated by Process 2 where depletion occurred after day 4 (Figure 8.4)). Chloride release was reasonably predicted by the diffusion model except where rapid depletion occurred.

Cadmium release was a small fraction of the available concentration for all cases and depletion was not observed. Effective diffusion coefficients were very high (e.g., pDe greater than 14) for all cases. Several cases existed where cadmium concentrations in the monolith leach test extract were below detection limits (bottom ash : untreated, Process 4; combined ash: untreated, Process 3, Process 4) indicating effective diffusion coefficients greater than pDe equal to 16. Cadmium release was reasonable predicted by the diffusion model when extract concentrations were above detection limits.

Copper , lead and zinc release was typical of diffusion controlled release for most cases. A few cases suggested initial surface wash off followed by negligible release (bottom ash treated by the WES Control process (copper, lead and zinc), combined ash treated by Process 1 (zinc), Process 3 (lead and zinc) and the WES Control process (lead and zinc). Very high effective diffusion coefficients with pDe greater than 16 was indicated for these cases. The diffusion model reasonable predicted release for all other cases.

Tables 8.2 through 8.4 present the cumulative release observed from the monolith leach test samples after 64 days of leaching. Values for the untreated bottom ash and combined ash are estimated release after 64 days based on releases observed after 32 days. All results indicate that the principal species released were soluble salts including calcium, potassium, sodium, bromine, chloride and sulfate. Lead and cadmium release was much greater from the APC residue than from the bottom ash or combined ash.

8.2.3 Tortuosity

The physical retention (tortuosity) in the s/s matrix can be derived as indicated in Chapter 8.1 from the mobility of sodium in the various stabilized products. This is valid under the condition that the release is diffusion controlled. Sodium and several other salts are virtually non-reactive in a stabilized matrix [van der Sloot,et al. 1985]. Table 8.5 provides a comparison of mobility data for sodium, potassium, lithium, chloride, bromide and nitrate. Figure 8.19 presents typical release curves for these species from treated APC residue. The lower limit for mobility is 8.88, which is the free mobility for sodium in water [Li, et al.,1974]. Several general trends among the treated residues are apparent. The nitrate data were poor because of analytical detection limits, which limits the conclusions that can be drawn for this component. Apparently, lithium was not a very good indicator for tortuosity, since the lithium mobilities in bottom ash and combined ash are significantly lower (pDe higher) than the other alkali earth elements and the halogens. No free mobility value was available for TDS because it is a lumped parameter. When the sodium value for free mobility was used to approximate the TDS free mobility, the agreement between TDS and the alkali elements release generally was good. The physical retention (tortuosity) data are presented graphically in Figure 8.20 for the three residues types. The standard deviations are provided as error bars (approximately .80 confidence intervals) to aid in the interpretation of the data. The tortuosity values for cement stabilized products ranged between 1 and 15. Strikingly, the tortuosity was higher in the untreated material and the material from the phosphate addition process (Process 4). This observation is consistent with the behavior other salts. Since the release of the salts is mostly diffusion controlled in cement-based products, it appears that the porosity in the stabilized matrices was higher than the untreated material or phosphoric acid treated material. This result was directly correlated with the compacted dry density of the materials, for which the untreated and Process 4 treated residues was the greatest. In general, the physical retention achieved by the treatment processes was relatively poor.

A comparison of tortuosities in a variety of matrices is provided in Table 8.6 [Versluijs, et al., 1990 and van der Sloot, et al, 1985]. A comparison with data from the Mammoet project [Versluijs, et al., 1990] and older data on stabilized MSW bottom ash [van der Sloot, et al.,1985] can be made. The high

tortuosity values for asphalt concrete (τ = 2000 - 50000) are caused by the hydrophobic nature of bituminous mixtures, which results in only a partial wetting of the material. Small pores may not be wetted at all. In contrast, the stabilized coal ash has a relatively low tortuosity (τ= 5 - 20). Within one category of materials, the tortuosity factor is often correlated with density and strength of the product. This implies that improvement of technical product quality is associated with an improvement in environmental quality.

In some cases, the mobility values approached or were essentially the same as the lower limit theoretical value of 8.88. This was the case for the treated APC residue and Process 3 applied to all three residue types. Substantial depletion of the constituents occurred over the testing period for these materials. In addition, these products showed significant physical deterioration during the leaching test. These materials might have been acceptable based on a short term test (24 hours), while the long term testing indicated stability problems. The following mechanism of release was observed from the processed APC residues: Diffusion was the predominant mechanism in the initial phase (24-48 hr). The porosity of the product increased substantially as more soluble salt was leached (~ 30% of the total mass was soluble), which resulted in a reduction in tortuosity to no physical retention (τ = 1), and consequently to an increase in the release rate. This was reflected by an increase in the slope of the release-time plot. This process continued until the leachable constituent was depleted, which was indicated by a subsequent decrease in the slope of the release-time plot until a negative slope was reached. In Figure 8.21 this mechanism is indicated in the sodium data for bottom ash treated by Process 2. The release data were based on the individual time intervals, assuming diffusion controlled release during the preceding period. The tortuosity decreased dramatically after 48 hours of contact with water. A material sensitive to these types of changes cannot be considered durable and therefore should be tested as a granular waste. Clearly, the salts were not retained at all.

8.2.4 Chemical Retention

The chemical retention values are derived from the effective diffusion coefficients as indicated in Chapter 8.1. It is important to reiterate that the chemical retention values reflect the chemical interactions of the fraction of a particular species which is available for leaching. Tables 8.7 through 8.9 present the retention values for the different elements in the untreated and treated residues. At low mobilities (pD_e values greater than 13) the errors in the retention values, expressed as percentage error or as absolute values, can be substantial. However, a deviation by a factor of 2 at a retention value of 1,000,000 still indicates quite considerable retention. At high mobilities (low pD_e), much smaller deviations were observed (approximately 10 - 15 %). In Figure 8.22 the standard deviation in the mobility is presented

as a function of the pDe value. Several data were outside the range of acceptable deviations. Either detection limit problems or depletion of constituents occurred in these situations.

Chemical retention values indicate that the elements with the greatest extent of chemical interaction were aluminum, cadmium, magnesium, silicon and zinc for untreated and treated APC residue; cadmium, calcium, copper, iron , lead, magnesium, sulfate and zinc for untreated and treated bottom ash and combined ash. Cadmium chemical retention was several orders of magnitude greater in treated APC residue than in untreated or treated bottom ash and combined ash. Lead chemical retention was much greater in untreated and treated bottom ash and combined ash than treated APC residue. As stated previously, these results reflect the pH dependent solubility of the metals and the pH of the monolith pore water. Chemical retention was limited or negligible for most other species.

8.2.5 Effective Diffusion Coefficients

The effective diffusion coefficients and standard deviations derived from the semi-infinite diffusion model are listed in Tables 8.10 through 8.12. Figures 8.23 through 8.30 provide a comparison, within each untreated or treated residue, of the effective diffusion coefficients of the most important elements analyzed. Each figure indicates the relative contribution of free mobility, physical retention and chemical retention to the effective diffusion coefficient. The effect of species availability on the effective diffusion coefficient also is indicated by presentation of the estimated effective diffusion coefficient based on the total concentration of the species. The effective diffusion coefficient would have been substantially underestimated (pDe would be too high) if it was based on total concentration for many species (e.g., aluminum, barium, chromium, copper, nickel, lead and zinc). This may lead to underestimation of the actual rate of release. These figures also indicate that the effective diffusion coefficient is very similar to the free mobility of the particular species unless substantial chemical retention occurs.

Figures 8.31 through 8.36 provide a side by side comparison of the effective diffusion coefficients for aluminum, calcium, cadmium, copper, potassium, sodium, lead, zinc, chloride and sulfate. Again, each figure indicates the relative contribution of free mobility, physical retention and chemical retention to the effective diffusion coefficient. Significant differences amongst processes and other specific observations are discussed, organized by residue type and element, in the paragraphs that follow.

A. Bottom ash - In a comparison of the behavior of the different elements in the untreated versus the processed materials the following differences are observed:

Al : Process 2 and 4 exhibited high mobility compared to the other processes. In Process 4, this appears to have been caused by a significant decrease in availability due to the formation of

alumino phosphates. Verification of this hypothesis is needed. In Process 2, this may have been caused by the high concentration of silicates added. In comparison with the untreated, aluminum mobilities for all processes are higher.

Ba : The mobility of barium was reduced ($BaSO_4$ solubility control) due to the high mobility of sulfate in Process 2.

Ca : The Ca was affected similarly to Ba by the high mobility of sulfate in Process 2. In comparison with the untreated material, there is either no appreciable change in Ca or a slight decrease in Ba.

Cd : With the exception of Process 4, the mobility of Cd is significantly reduced in all processes.

Cl : In comparison with the untreated material, Cl mobility was increased in Process 2 and 3. The same applies for Na and K.

Cu : The mobility of Cu in Process 2 was significantly increased in comparison with the untreated residue and the other processes.

Pb : The mobility of Pb for Process 2 and 3 was approximately one to two orders greater in the treated residues compared to the untreated residues.

Sr : High sulfate affected the mobility of Sr similarly to Ba and Ca in Process 2.

SO_4: The mobility of sulfate in Process 2 was significantly increased by the addition of soluble silicates. The mechanism is unclear at present. Since ettringite is an important cementitious phase in these type of stabilized materials, it is conceivable that the formation of ettringite is suppressed by the silicate addition. This needs to be verified. Sulfate was strongly retained in the untreated material.

Zn : In Processes 4 and 5 the mobility of Zn was decreased by about one order of magnitude.

B. Combined ash - The same comments for bottom ash apply for Al, Ba, Ca, Sr and sulfate. Mg mobility was reduced in the different processes, mainly due to the higher pH in the products. The Cd mobility in Process 3 Combined Ash was increased. The change in Cu mobility in Process 2 was less pronounced than in the bottom ash. In Process 4 Combined Ash, the Pb mobility was slightly increased, but the availability was substantially reduced. The net emission was therefore considerably reduced.

C. APC residue - Since data on untreated residues are not available for the APC residue, conclusions about positive or negative treatment effects can not be drawn. In general, the differences between the processes were small. In comparison with the bottom and combined ash, the mobility for a number of components (Ba, Ca, Li, Sr) was significantly higher. The mobility of Pb in the APC products was several orders of magnitude greater than in the bottom ash and combined ash products. The Cu mobility for APC residue in Process 1 is significantly higher , as compared to the other processes.

8.3 THREE DIMENSIONAL DIFFUSION MODEL FOR ESTIMATION OF RELEASE DURING FIELD APPLICATION

An important advantage of the monolith leach test is the option to use the intrinsic leach properties derived from the test data for prediction of release under conditions other than those studied in the laboratory. Many factors effect the translation of laboratory results to prediction of field behavior. Field environmental conditions that are important include residue aging, contact with infiltration and precipitation frequency, temperature cycles, direct abrasion or erosion and the specific application scenario. Thus, estimates of field releases must be carefully derived. Residue preparation effects, the limited number of residues investigated and the idealized treatment scenarios investigated also must be considered when using the data developed in this study to predict field behavior. However, simplified models can be used to indicate relative releases and provide order of magnitude or limit case assessments.

The leach parameters obtained from the monolith leach test can be used to predict the release of contaminants during a given time period for a variety of application geometries. A simple one-dimensional diffusion model, assuming a constant source, can be used for a first approximation. This approach is valid as long as the concentration in the material has not decreased substantially, avoiding species depletion. However, long-term predictions have to take into account the limited source strength (fraction available for leaching). The simple 1-dimensional model can be extended to correct for the available fraction on the long term leaching. Nevertheless, a 3-dimensional diffusion model enables one to take actual dimensions into account, so differences in leaching from a product with a cubic versus a flat rectangular shape can be described. With the 3-D model, release from only one side of the material also can be modeled.

A 3 -dimensional model is based on the analytical solution of the linear diffusion from a parallelepiped, which initially is at a constant concentration, to an infinite region outside with an initial concentration of zero. [Carlslow and Jaeger, (1980)]. The diffusion profile is calculated in all three dimensions according to the equation:

$$c(x,y,z,t) = \frac{1}{8} C \left[\operatorname{erf}\frac{a-x}{2\sqrt{Dt}} + \operatorname{erf}\frac{a+x}{2\sqrt{Dt}} \right] \left[\operatorname{erf}\frac{b-y}{2\sqrt{Dt}} + \operatorname{erf}\frac{b+y}{2\sqrt{Dt}} \right] \left[\operatorname{erf}\frac{c-z}{2\sqrt{Dt}} + \operatorname{erf}\frac{c+z}{2\sqrt{Dt}} \right]$$

(Equation 8.15)

(Carslow and Jaeger, 1980, Chapter II, paragraph 2.2. eq.10)

where:

$c(x,y,z,t)$ = concentration at location x at time t;

C = initial concentration in parallelepiped;

a, b, c	=	parallelepiped dimensions;
x, y, z	=	location coordinates;
D	=	effective diffusion coefficient;
t	=	time; and,
erf ( )	=	standard error function.

After integration of the profiles, the amount leached out as a function of time can be calculated.

In all cases, a good definition of the boundary conditions is needed to make a proper judgement. The cumulative release, expressed as fraction of the total leachable quantity (R_{max}), can be calculated using the 3-D model for different product configurations and bulk applications based on the effective diffusion coefficient measured under well-defined boundary conditions. The relative release from standard sizes with dimensions of 10x10x10 cm and 15x15x45 cm were calculated as a function of time for different effective diffusion coefficients ranging from pD_e=9 to pD_e=15 (pD_e = -log D_e, D_e in m^2/s). The release-time curves are provided in Figure 8.37. Between blocks of increasing size, the difference is largely a shift of the release-time curves for a given pD_e to a longer time-scale. It takes longer to reach the maximum leachable quantity, but the leachable quantity may ultimately be reached unless the chemistry or other release controlling factors change. A significant shift in the release-time curve is apparent for the roadbase simulation. For a base of 15 cm thickness, 50% of the highly mobile components (pD_e=9) will be leached from the slab in less than about one year, assuming permanent contact with water. a 45 cm thick slab will reach the same level of relative release in about 6 years. Translation of lab data to field conditions further involves corrections for the ambient temperature and degree of contact with water.

Table 8.1. Effective diffusion coefficients based on individual extract cycling time-intervals.

Time (hr)	Without Glass Beads	With Glass Beads
24	9.26	11.20
48	8.85	9.30
96	9.34	9.21
192	9.37	9.13
384	9.08	9.10
864	9.45	9.35
mean:	9.23	9.22*
standard deviation:	0.22	0.11*

* 24 hr data omitted

Table 8.2. Cumulative elemental and species release after 64 days leaching, using the monolith leach test. Testing was not carried out for untreated APC residue and APC residue treated by Process 4 (granular product). All release values are in units of [mg/m^2].

Ash type: **APC RESIDUE**

Release	Untreated	Process 1	Process 2	Process 3	Process 4	WES
Aluminum		300	420	1,200		170
Barium		2,500	4,800	1,900		6,300
Bromine		71,000	170,000	180,000		160,000
Cadmium		0.40	1.5	5.2		0.50
Calcium		1,400,000	2,400,000	3,600,000		2,900,000
Chloride		3,500,000	7,100,000	8,400,000		7,200,000
Copper		75	9.9	22		8.8
Iron		190	69	150		51
Lead		1200	1,600	6,800		340
Lithium		230	660	630		570
Magnesium		120	73	270		150
Nickel		11	9.6	11		9.4
Nitrate		830	830	730		920
Potassium		400,000	850,000	1,400,000		960,000
Silicon		1,300	1,200	1100		950
Sodium		380,000	1,900,000	940,000		900,000
Strontium		3,900	16,000	10,000		11,000
Sulfate		28,000	49,000	420,000		24,000
Zinc		170	350	1,000		110
Standard Deviation						
Aluminum		31	150	700		19
Barium		140	38	91		110
Bromine		4,300	16,000	2,300		9,100
Cadmium		0	0.52	1.9		0.10
Calcium		83,000	180,000	88,000		110,000
Chloride		200,000	160,000	170,000		390,000
Copper		88	3.6	5.5		1.4
Iron		150	11	75		20
Lead		260	470	210		39
Lithium		16	45	45		35
Magnesium		58	38	110		78
Nickel		1.9	NA	1.2		0.14
Nitrate		250	120	36		160
Potassium		100,000	40,000	35,000		59,000
Silicon		93	83	240		76
Sodium		18,000	580,000	30,000		180,000
Strontium		190	1,500	330		550
Sulfate		610	15,000	8,900		3,600
Zinc		85	61	110		34

NA = Not Analyzed.

Table 8.3. Cumulative elemental and species release after 64 days leaching, using the monolith leach test. Values reported for untreated residues are 32 day release values transformed to provide estimates of release after 64 days for comparison purposes. All release values are in units of [mg/m^2].

Ash type: **BOTTOM Ash**

Release	Untreated	Process 1	Process 2	Process 3	Process 4	WES
Aluminum	2,400	3,900	79,000	3,700	9,000	5,300
Barium	500	110	12	270	300	370
Bromine	14,000	8,600	14,000	20,000	6,300	14,000
Cadmium	ND	0.40	0.60	0.70	NA	0.83
Calcium	190,000	60,000	6,800	97,000	82,000	110,000
Chloride	960,000	440,000	1,000,000	1,400,000	290,000	780,000
Chromium	62	7.6	92	8.9	9.0	NA
Copper	64	8.6	2,200	58	20	28
Iron	390	310	200	81	80	270
Lead	25	6.7	29	43	6.6	10
Lithium	49	28	140	360	25	66
Magnesium	1,000	300	120	120	130	260
Nickel	ND	10	15	13	NA	10
Nitrate	270	590	530	180	210	500
Potassium	190,000	120,000	250,000	1,000,000	61,000	260,000
Silicon	4,100	3,500	9,800	4,800	1,100	3,100
Sodium	240,000	170,000	2,200,000	340,000	77,000	260,000
Strontium	1,600	510	83	1,200	460	1,300
Sulfate	3,300	12,000	960,000	210,000	7,300	11,000
Zinc	150	23	99	27	32	85
Standard Deviation						
Aluminum	560	220	6,700	340	2,900	94
Barium	49	5.5	1.0	56	64	60
Bromine	1,400	1,400	860	3,100	580	820
Cadmium		0	0.20	0.42	NA	0.058
Calcium	12,000	9,900	760	34,000	9,500	6,400
Chloride	27,000	67,000	87,000	250,000	25,000	30,000
Chromium	1.4	0.64	11	2.0	2.7	NA
Copper	1.6	0.21	130	29	3.5	3.0
Iron	110	120	30	41	17	150
Lead	11	4.6	6.7	20	2.8	2.2
Lithium	NA	7.4	19	27	4.6	0.71
Magnesium	320	85	39	35	10	23
Nickel	NA	0.99	1	1.7	NA	1.1
Nitrate	87	88	78	26	37	38
Potassium	8,900	23,000	7,300	84,000	14,000	3,900
Silicon	26	150	1,400	260	53	130
Sodium	5,900	31,000	34,000	11,000	17,000	5,700
Strontium	68	110	8.5	290	64	21
Sulfate	NA	4,200	120,000	23,000	2,900	1,200
Zinc	25	5.0	14	2.9	0	97

NA = Not Analyzed.

Table 8.4. Cumulative elemental and species release after 64 days leaching, using the monolith leach test. Values reported for untreated residues are 32 day release values transformed to provide estimates of release after 64 days for comparison purposes. All release values are in units of [mg/m^2].

Ash type: **COMBINED Ash**

Release	Untreated	Process 1	Process 2	Process 3	Process 4	WES
Aluminum	3,400	4,500	53,000	6,300	16,000	7,200
Barium	680	190	6.8	200	580	890
Bromine	13,000	7,900	17,000	13,000	6,000	14,000
Cadmium	NA	0.40	0.53	NA	NA	0.87
Calcium	210,000	77,000	6,300	49,000	120,000	180,000
Chloride	1,100,000	560,000	820,000	1,200,000	380,000	900,000
Chromium	67	16	130	9.2	NA	8.8
Copper	130	67	280	160	100	110
Iron	570	310	280	71	85	210
Lead	14	10	34	22	6.6	11
Lithium	59	20	130	210	30	92
Magnesium	1,800	540	110	180	110	320
Nickel	110	17	12	17	NA	12
Nitrate	180	460	1,300	130	120	290
Potassium	280,000	160,000	170,000	940,000	82,000	310,000
Silicon	5,400	2,300	12,000	4,500	1,000	2,600
Sodium	260,000	170,000	1,800,000	280,000	79,000	260,000
Strontium	1,800	660	69	610	640	1,700
Sulfate	6,700	28,000	760,000	130,000	15,000	13,000
Zinc	95	39	130	24	36	34
Standard Deviation						
Aluminum	1,700	99	24,000	400	4,100	350
Barium	120	15	0.84	32	51	55
Bromine	1,200	400	3,200	1700	1,900	730
Cadmium	NA	NA	0.15	NA	NA	0.12
Calcium	41,000	7,800	910	2,900	18,000	22,000
Chloride	75,000	44,000	81,000	120,000	130,000	53,000
Chromium	14	12	27	0.31	NA	2.8
Copper	18	19	99	6.1	3.2	14
Iron	340	110	62	15	34	94
Lead	5.0	1.7	8.3	2.9	0.54	6.0
Lithium	NA	NA	20	40	2.3	3.5
Magnesium	1,400	90	75	46	31	230
Nickel	NA	8.4	2.1	2.6	NA	2.3
Nitrate	44	39	550	12	18	27
Potassium	41,000	5,800	44,000	62,000	31,000	13,000
Silicon	2,700	250	1,700	190	200	400
Sodium	39,000	5,800	730,000	24,000	30,000	9,900
Strontium	310	110	21	73	210	250
Sulfate	2,600	1,100	400,000	30,000	1,600	2,100
Zinc	13	26	57	2.9	11	6.4

NA - Not Analyzed.

Table 8.5. Effective diffusion coefficients for several salts used to estimate tortuosity.

APC Residue

pD_e	Untreated	Process 1	Process 2	Process 3	Process 4	WES
Bromine	NA	10.14	9.12	9.31	NA	8.62
Chloride	NA	9.64	9.03	8.95	NA	9.29
Lithium	NA	9.76	8.90	8.96	NA	8.89
Nitrate	NA	9.78	9.67	9.69	NA	9.37
Potassium	NA	9.46	9.01	8.81	NA	8.65
Sodium	NA	9.56	9.15	8.77	NA	8.70
TDS	NA	10.25	9.41	9.41	NA	9.59

Bottom ash

pD_e	Untreated	Process 1	Process 2	Process 3	Process 4	WES
Bromine	10.05	10.06	9.50	8.69	10.39	9.59
Chloride	10.50	10.40	9.64	8.93	10.70	10.45
Lithium	11.93	12.00	10.64	9.61	11.42	11.14
Nitrate	11.37	9.35	10.76	8.81	11.61	10.23
Potassium	10.12	9.71	9.28	9.07	10.19	9.79
Sodium	10.24	9.96	9.73	9.27	10.39	9.84
TDS	NA	10.17	9.63	9.53	10.30	9.72

Combined ash

pD_e	Untreated	Process 1	Process 2	Process 3	Process 4	WES
Bromine	9.91	9.92	9.36	9.01	11.22	9.28
Chloride	10.52	10.50	9.91	9.44	10.79	10.35
Lithium	11.69	12.07	10.67	10.22	11.64	10.71
Nitrate	10.36	7.68	9.57	8.75	11.07	9.22
Potassium	10.18	9.75	9.94	9.26	10.73	9.56
Sodium	10.26	9.87	9.71	9.43	11.08	9.40
TDS	NA	9.95	10.02	9.58	10.52	9.71

NA - Not Analyzed.

Table 8.6. Physical retardation (tortuosities) in products produced from waste materials.

Material	Physical retardation factor
Unconsolidated granular waste	2.5
Stabilized coal fly ash	10 - 30
Stabilized incinerator bottom ash	40
Calcium silicate block	70 - 100
Light weight concrete	220
Concrete	340
Fly ash concrete	400 - 900
Bituminous concrete	2,000 - 10,000

Table 8.7. Estimated chemical retention values for untreated and treated MWC residues based on diffusion modelling of the monolith leach test results. All values are in dimensionless units.

Ash type: **APC RESIDUE**

Retention	Untreated	Process 1	Process 2	Process 3	Process 4	WES
Aluminum		49,000	530,000	15,000,000		72,000,000
Barium		2.8	1.9	30		8.5
Bromine		6.0	1.9	11		.4
Cadmium		34,000,000	21,000,000	13,000,000		270,000,000
Calcium		8.4	14	22		210
Chloride		1.9	1.2	2.5		6.2
Copper		3300	2,700,000	160,000		11,000,000
Iron		220	39,000	2,600		11,000,000
Lead		230	400	300		180,000
Lithium		1.6	0.6	1.6		1.6
Magnesium		3,000,000	9,000,000	22,000,000		120,000,000
Nickel		1100	3,000	1,200		33,000
Nitrate		2.7	5.1	17		7.4
Potassium		1.3	1.3	1.8		1.5
Silicon		24,000	120,000	480,000		19,000,000
Sodium		1.0	1.0	1.0		1.0
Strontium		1.2	1.5	6.0		2.8
Sulfate		6,800	12,000	560		200,000
Zinc		980,000	1,200,000	240,000		110,000,000
Standard Deviation						
Aluminum		15,000	480,000	25,000,000		61,000,000
Barium		0.73	1.3	9		6.3
Bromine		0.52	1.9	9.8		0.77
Cadmium		8,400,000	20,000,000	6,500,000		270,000,000
Calcium		0.42	6.1	9.4		42
Chloride		0.30	0.44	1.2		2.4
Copper		4600	3,200,000	120,000		7,700,000
Iron		150	67,000	4,000		6,500,000
Lead		140	1,300	330		130,000
Magnesium		1,400,000	8,800,000	17,000,000		170,000,000
Nickel		1600	NA	11,00		33,000
Nitrate		1.5	2.7	17		4.2
Potassium		0.097	0.77	0.24		0.69
Sodium		0	0	0		0
Sulfate		2,800	4,400	510		240,000
Zinc		730,000	320,000	110,000		65,000,000

NA = Not Analyzed.

Table 8.8. Estimated chemical retention values for untreated and treated MWC residues based on diffusion modelling of the monolith leach test results. All values are in dimensionless units.

Ash type: **BOTTOM Ash**

Retention	Untreated	Process 1	Process 2	Process 3	Process 4	WES
Aluminum	4,500	210	2.9	6,800	0.57	1,200
Barium	95	220	40,000	290	70	510
Bromine	1.0	2.0	1.4	0.55	1.6	0.90
Cadmium	NA	170,000	200,000	350,000	NA	130,000
Calcium	200	1,900	60,000	17,000	470	27,00
Chloride	2.9	4.7	1.4	1.1	3.5	6.4
Chromium	140	240	9.1	5,900	NA	1,000
Copper	32,000	46,000	18	75,000	42,000	73,000
Iron	6,300	20,000	5,600	520,000	8,200	15,000
Lead	3,100,000	1,000,000	21,000	93,000	320,000	2,800,000
Lithium	49	110	8.1	2.2	10.7	20
Magnesium	29,000	70,000	460,000	20,000,000	1,500,000	440,000
Nickel	NA	33,000	1,500	1,600	NA	820
Nitrate	30	0.36	22	0.54	27	6.9
Potassium	1.2	0.91	0.60	1.1	1.0	1.5
Silicone	10,000	450	280	2,800	4,000	14,000
Sodium	1.0	1.0	1.0	1.0	1.0	1.0
Strontium	11	16	19,000	160	23	39
Sulfate	150,000	4,600	2.2	5,700	6,700	55,000
Zinc	400,000	270,000	3,400,000	2,300,000	2,300,000	33,000,000
Standard Deviation						
Aluminum	5,200	300	2.6	9,900	0.58	730
Barium	70	160	16,000	300	28	320
Bromine	0.36	0.38	1.1	0.26	0.67	0.31
Cadmium	NA	160,000	280,000	410,000	NA	85,000
Calcium	120	850	9,300	24,000	130	2,100
Chloride	0.80	2.5	0.78	1.3	1.7	1.9
Chromium	240	190	2.6	3,600	NA	640
Copper	32,000	53,000	20	85,000	16,000	57,000
Iron	5,700	31,000	4,400	700,000	4,700	12,000
Lead	5,000,000	1,100,000	20,000	99,000	280,000	1,700,000
Magnesium	34,000	12,000	700,000	18,000,000	340,000	320,000
Nickel	NA	45,000	1,300	1,700	NA	410
Nitrate	23	0.088	22	0.24	15	5.8
Potassium	0.34	0.16	0.23	0.59	0.22	0.30
Sodium	0	0	0	0	0	0
Sulfate	NA	3,000	1.1	5,100	2,900	11,000
Zinc	560,000	280,000	5,600,000	1,900,000	700,000	1,6000,000

NA = Not Analyzed.

Table 8.9. Estimated chemical retention values for untreated and treated MWC residues based on diffusion modelling of the monolith leach test results. All values are in dimensionless units.

Ash type: **COMBINED Ash**

Retention	Untreated	Process 1	Process 2	Process 3	Process 4	WES
Aluminum	870	710	82	2,700	.017	1,400
Barium	52	440	290,000	360	16	250
Bromine	.74	1.8	.70	.64	12	1.2
Cadmium	NA	93,000	1,400,000	NA	NA	950,000
Calcium	190	4,200	9,000	2,300	73	2,800
Chloride	3.0	6.6	3.6	1.6	1.6	14
Chromium	.74	240	8.6	14,000	NA	1,000
Copper	16,000	8,800	2,300	5,300	960	26,000
Iron	170,000	1,800	350,000	3,900,000	11,000	61,000
Lead	1,200,000	2,900,000	1,600,000	620,000,000	97,000	40,000,000
Lithium	26	160	9.1	6.3	3.6	20
Magnesium	2,000	150,000	2,700,000	5,500,000	280,000	1,900,000
Nickel	2.5	300	730	680	NA	6,300
Nitrate	3.2	.024	1.2	.54	2.0	1.7
Potassium	1.3	1.4	2.8	1.1	.87	2.4
Silicon	930	6,000	1,800	13,000	2,800	160,000
Sodium	1.0	1.0	1.0	1.0	1.0	1.0
Strontium	12	30	87,000	510	4.5	69
Sulfate	120,000	1,300	5.4	2,800	980	48,000
Zinc	380,000	11,000,000	3,800,000	20,000,0000	1,400,000	110,000,000
Standard Deviation						
Aluminum	160	260	70	1,100	.013	190
Barium	43	210	230,000	250	13	150
Bromine	.30	.73	.11	.35	20	.27
Cadmium	NA	NA	1,400,000	NA	NA	1,400,000
Calcium	75	2100	53,000	1,800	49	190
Chloride	1.3	1.4	4.0	.48	1.9	1.8
Chromium	.73	400	4.9	5,000	NA	690
Copper	12,000	5,300	2100	3,500	1,300	12,000
Iron	250,000	2,300	580,000	2,700,000	7,700	46,000
Lead	940,000	3,600,000	1,000,000	1,100,000,000	150,000	27,000,000
Magnesium	65,000	170,000	1,200,000	1,100,000	160,000	1,100,000
Nickel	NA	290	99	670	NA	7,600
Nitrate	4.0	.036	.76	.44	2.1	2.0
Potassium	.06	.69	.92	.36	.55	.66
Sodium	0	0	0	0	0	0
Sulfate	87,000	570	3.7	3,200	1,200	32,000
Zinc	140,000	850,000	6,300,000	310,000,000	2,000,000	42,000,000

NA = Not Analyzed.

Table 8.10. Estimated effective diffusion coefficients for untreated and treated residues based on diffusion modelling of the monolith leach test results. All values are in units of [- log (m^2/s)].

Ash type: APC RESIDUE

pDe	Untreated	Process1	Process 2	Process 3	Process 4	WES
Aluminum		14.66	15.07	14.85		16.89
Barium		10.16	9.53	10.24		9.68
Bromine		10.14	9.12	9.31		8.62
Cadmium		>17.35	16.58	16.11		>17.21
Calcium		10.71	10.48	10.30		11.24
Chloride		9.64	9.03	8.95		9.29
Copper		>12.27	>15.35	>14.09		>15.80
Iron		12.10	12.81	11.93		15.96
Lead		11.97	12.76	11.20		13.96
Lithium		9.76	8.90	8.96		8.89
Magnesium		16.27	16.23	16.29		16.70
Nickel		12.39	13.48	12.00		3.51
Nitrate		9.78	9.67	9.69		9.37
Potassium		9.46	9.01	8.81		8.65
Silicon		14.19	14.49	14.70		16.23
Sodium		9.56	9.15	8.77		8.70
Strontium		9.80	9.47	9.70		9.30
Sulfate		13.42	13.27	11.45		13.40
Zinc		15.67	15.42	14.31		16.87
Other Assays						
TDS		10.25	9.41	9.41		9.59
TOC		13.63	13.59	12.42		13.11
Standard Deviation						
Aluminum		.24	.34	.67		.40
Barium		.16	.08	.34		.10
Bromine		.10	.51	.49		.12
Cadmium		.37	.42	1.15		.51
Calcium		.09	.45	.40		.19
Chloride		.09	.58	.63		.11
Copper		NA	NA	.55		NA
Iron		.27	.44	.71		.50
Lead		.09	.54	.49		.27
Lithium		.10	.48	.49		.07
Magnesium		.55	.86	1.02		.74
Nitrate		.37	.31	.48		.21
Potassium		.09	.39	.49		.13
Silicon		.17	.28	.46		.17
Sodium		.08	.44	.35		.07
Strontium		.07	.54	.38		.08
Sulfate		.11	.66	.14		.10
Zinc		.10	.38	.39		.53
Other Assays						
TDS		.48	.62	1.36		1.22
TOC		.15	.31	.68		37

NA = Not Analyzed.

Table 8.11. Estimated effective diffusion coefficients for untreated and treated residues based on diffusion modelling of the monolith leach test results. All values are in units of [- log (m^2/s)].

Ash type: **BOTTOM Ash**

pDe	Untreated	Process 1	Process 2	Process 3	Process 4	WES
Aluminum	14.06	12.00	10.50	11.96	10.30	13.27
Barium	12.30	12.38	14.47	11.70	12.38	12.65
Bromine	10.05	10.06	9.50	8.69	10.39	9.59
Cadmium	NA	>15.31	>14.79	>14.80	NA	>15.16
Calcium	12.68	13.44	14.72	13.29	13.28	13.41
Chloride	10.50	10.40	9.64	8.93	10.70	10.45
Chromium	11.73	12.55	10.99	13.27	NA	13.09
Copper	>14.76	14.39	10.85	14.10	15.18	14.70
Iron	14.20	14.00	13.65	13.93	14.53	13.81
Lead	16.17	15.21	13.78	12.87	15.34	16.34
Lithium	11.93	12.00	10.64	9.61	11.42	11.14
Magnesium	14.66	15.07	15.20	16.73	16.83	15.64
Nickel	NA	14.26	12.81	12.57	NA	13.06
Nitrate	11.37	9.35	10.76	8.81	11.61	10.23
Potassium	10.12	9.71	9.28	9.07	10.19	9.79
Silicon	14.49	12.86	12.42	12.97	14.24	14.24
Sodium	10.24	9.96	9.73	9.27	10.39	9.84
Strontium	11.50	11.35	14.21	11.66	11.96	11.63
Sulfate	15.62	13.61	10.06	12.75	14.23	14.62
Zinc	15.71	15.39	15.40	15.48	16.93	17.50
Other Assays						
TDS	10.50	10.17	9.63	9.53	10.30	9.72
TOC	NA	13.96	11.85	13.29	13.36	12.43
Standard Deviation						
Aluminum	.09	.16	.30	.24	.09	.20
Barium	.08	.09	.32	.37	.16	.14
Bromine	.17	.15	.26	.77	.14	.14
Cadmium	NA	.10	.93	NA	NA	.61
Calcium	.06	.16	.26	.94	.11	.11
Chloride	.16	.13	.16	.45	.15	.13
Chromium	NA	.43	.24	NA	NA	.58
Copper	.51	.36	.34	.51	.22	.99
Iron	.19	.15	.25	.22	.19	.25
Lead	.09	.85	.27	.49	.25	1.16
Lithium	NA	NA	.48	.29	.27	.19
Magnesium	.72	.60	1.10	1.09	.70	.61
Nickel	NA	NA	.43	.33	.65	NA
Nitrate	.36	.14	.15	.40	.26	.16
Potassium	.07	.16	.28	.56	.12	.10
Silicon	.12	.10	.37	.12	.17	.15
Sodium	.08	.09	.40	.58	.13	.23
Strontium	.07	.10	.62	.46	.14	.08
Sulfate	NA	.16	.17	.17	.19	.12
Zinc	.18	.16	.27	.38	.29	.32
Other Assays						
TDS	.16	.33	.50	.68	.30	.44
TOC	NA	.22	.75	.65	.38	.67

NA - Not Analyzed.

Table 8.12. Estimated effective diffusion coefficients for untreated and treated residues based on diffusion modelling of the monolith leach test results. All values are in units of [- log (m^2/s)].

Ash type: **COMBINED Ash**

pDe	Untreated	Process 1	Process 2	Process 3	Process 4	WES
Aluminum	13.63	13.13	11.71	13.28	9.66	12.97
Barium	12.04	12.63	15.10	12.05	12.24	11.90
Bromine	9.91	9.92	9.36	9.01	11.22	9.28
Cadmium	NA	>15.01	>15.94	NA	NA	>15.11
Calcium	12.75	13.67	14.77	12.93	13.05	13.07
Chloride	10.52	10.50	9.91	9.44	10.79	10.35
Chromium	10.35	11.88	10.88	13.88	NA	12.67
Copper	14.57	13.93	13.07	13.30	13.93	13.98
Iron	15.22	12.84	14.23	16.21	15.22	14.28
Lead	16.31	16.13	15.93	16.08	15.28	17.05
Lithium	11.69	12.07	10.67	10.22	11.64	10.71
Magnesium	15.01	15.08	16.40	16.44	16.73	15.89
Nickel	11.02	12.32	13.13	12.38	NA	13.24
Nitrate	10.36	7.68	9.57	8.75	11.07	9.22
Potassium	10.18	9.75	9.94	9.26	10.73	9.56
Silicon	13.48	13.65	12.96	13.55	14.52	14.61
Sodium	10.26	9.87	9.71	9.43	11.08	9.40
Strontium	11.45	11.57	14.75	12.24	11.83	11.34
Sulfate	15.27	13.02	10.42	12.74	13.87	14.03
Zinc	16.01	17.09	15.54	17.12	17.01	17.60
Other Assays						
TDS	10.50	9.95	10.02	9.58	10.52	9.71
TOC	12.89	13.32	12.29	12.12	13.43	12.45
Standard Deviation						
Aluminum	.19	.10	.35	.15	.16	.09
Barium	.08	.08	.23	.48	.12	.19
Bromine	.12	.13	.32	.30	.17	.15
Cadmium	NA	.21	NA	NA	NA	NA
Calcium	.09	.07	.32	.58	.07	.11
Chloride	.21	.13	.26	.29	.15	.12
Chromium	NA	.71	.22	NA	NA	NA
Copper	.17	.31	.35	.18	.09	.16
Iron	.21	.28	.41	.46	.54	.15
Lead	.37	.33	.66	.13	.51	NA
Lithium	NA	.24	.31	13	NA	NA
Magnesium	1.06	.56	1.15	.76	.39	.70
Nickel	NA	NA	75	NA	NA	NA
Nitrate	.60	.52	.18	.29	.22	.20
Potassium	.08	.08	.25	.32	.10	.20
Silicon	.06	.16	.42	.08	.15	.15
Sodium	.09	.10	.24	.27	.12	.15
Strontium	.09	.14	.59	.62	.06	.15
Sulfate	.17	.20	.30	.07	.12	NA
Zinc	.35	.41	.34	.33	.17	.13
Other Assays						
TDS	0.25	24	.69	.43	.43	.82
TOC	NA	.15	.46	.66	.16	.50

NA - Not Analyzed.

Figure 8.1. A schematic example of monolith species release data illustrating diffusion, dissolution and depletion leaching mechanisms.

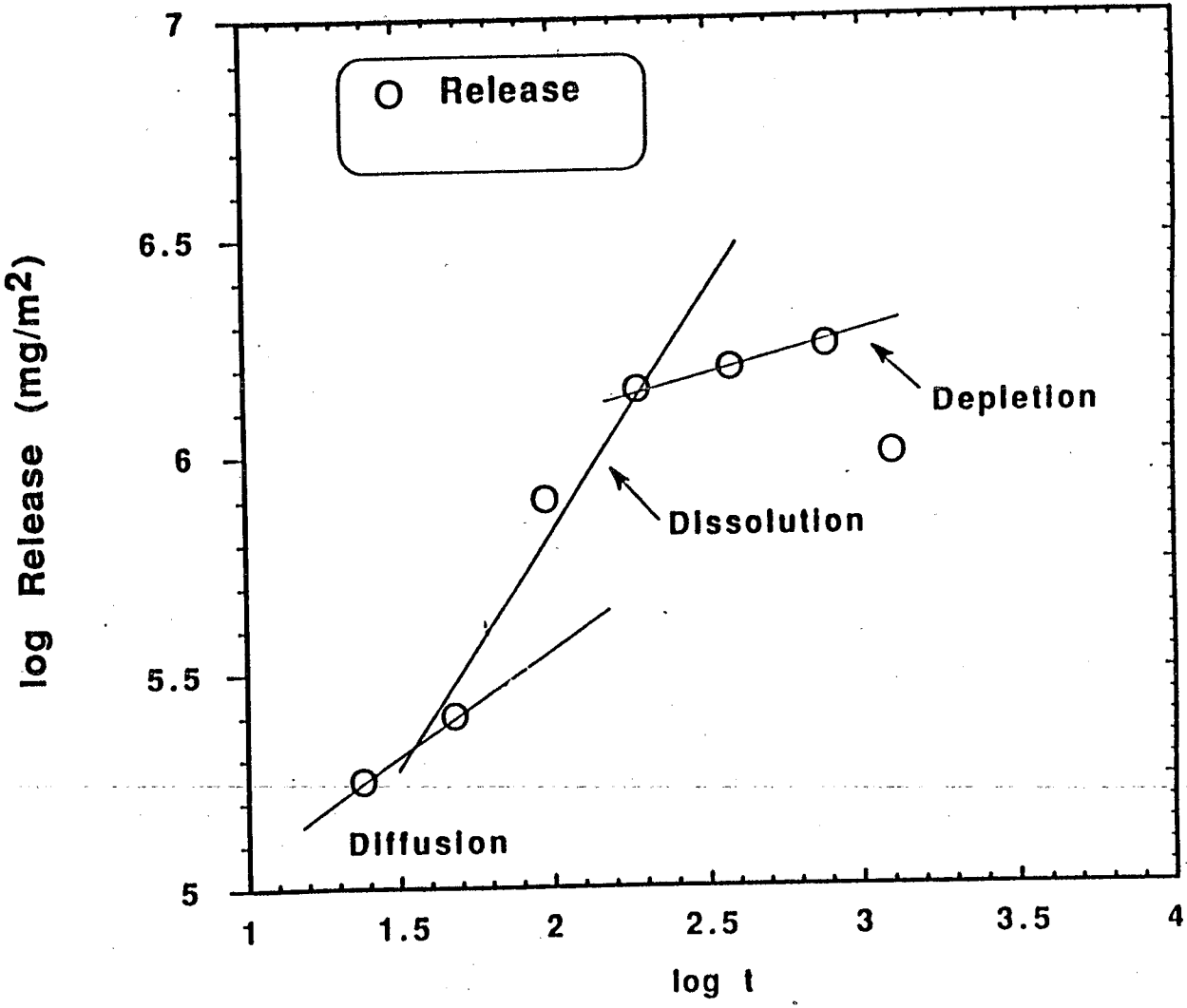


Figure 8.2. The effects of porewater pH on release of magnesium from a solidified/stabilized matrix.

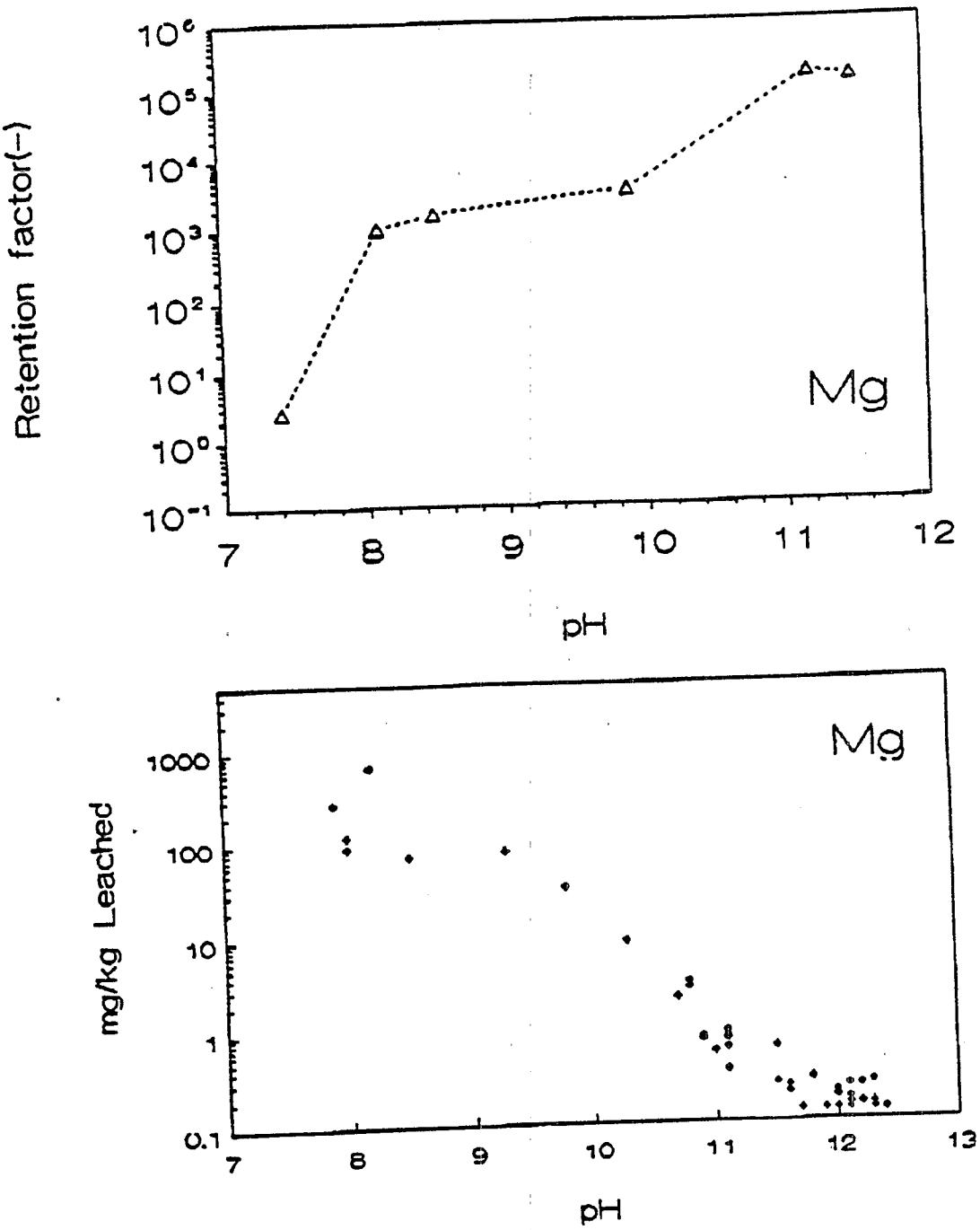


Figure 8.3. Contaminant release during the monolith leach test compared to the total and available contaminant content.

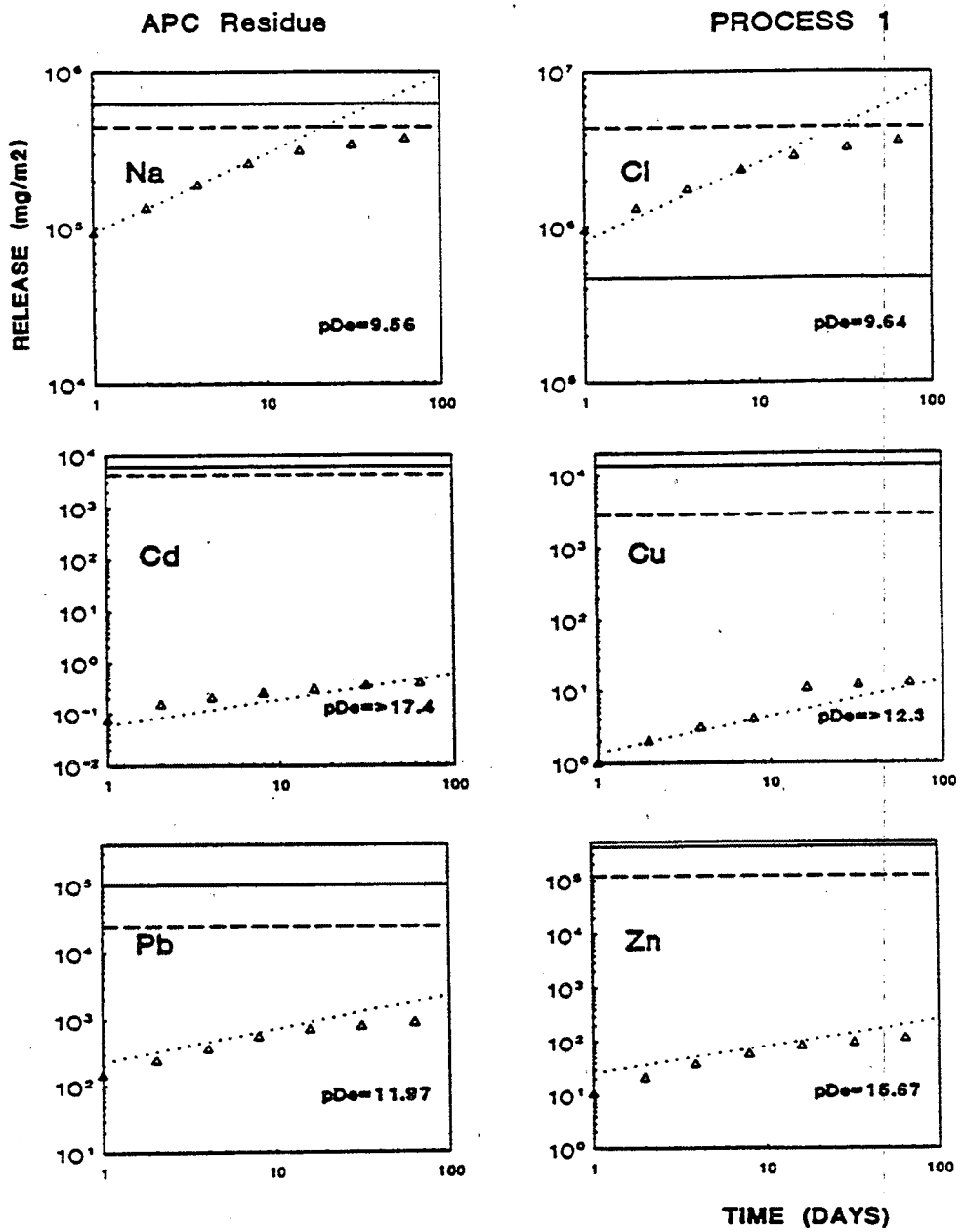


Figure 8.4. Contaminant release during the monolith leach test compared to the total and available contaminant content.

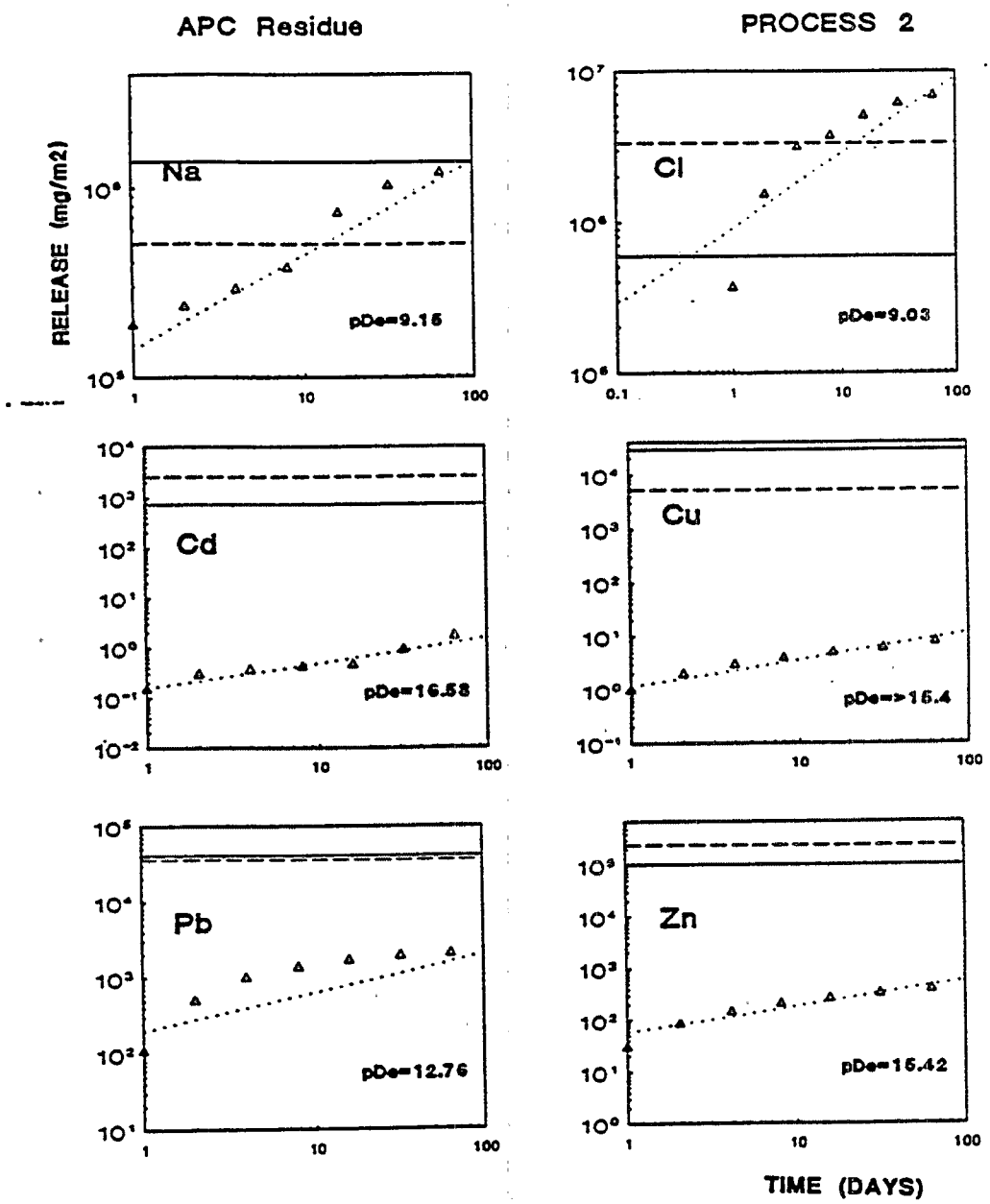


Figure 8.5. Contaminant release during the monolith leach test compared to the total and available contaminant content.

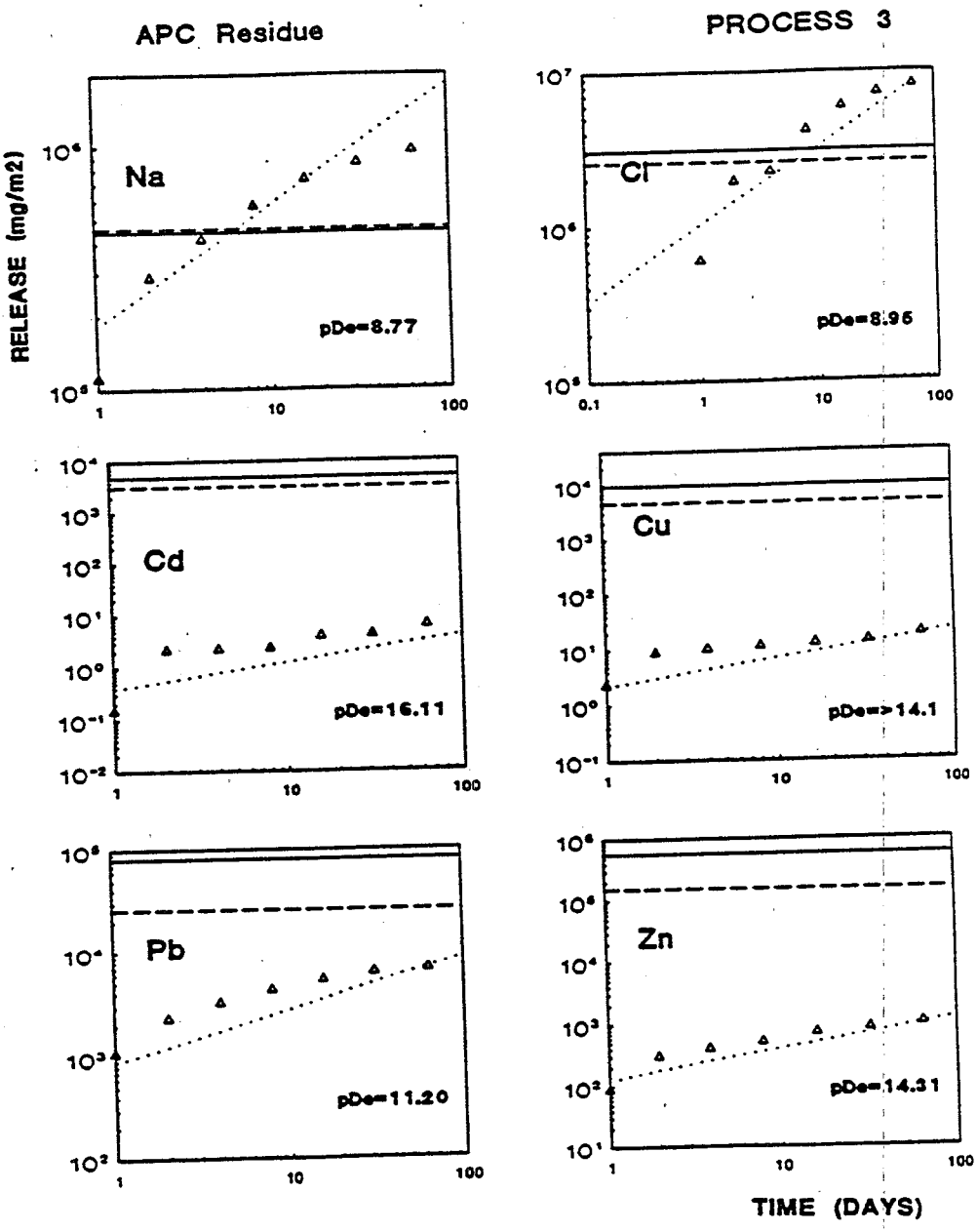
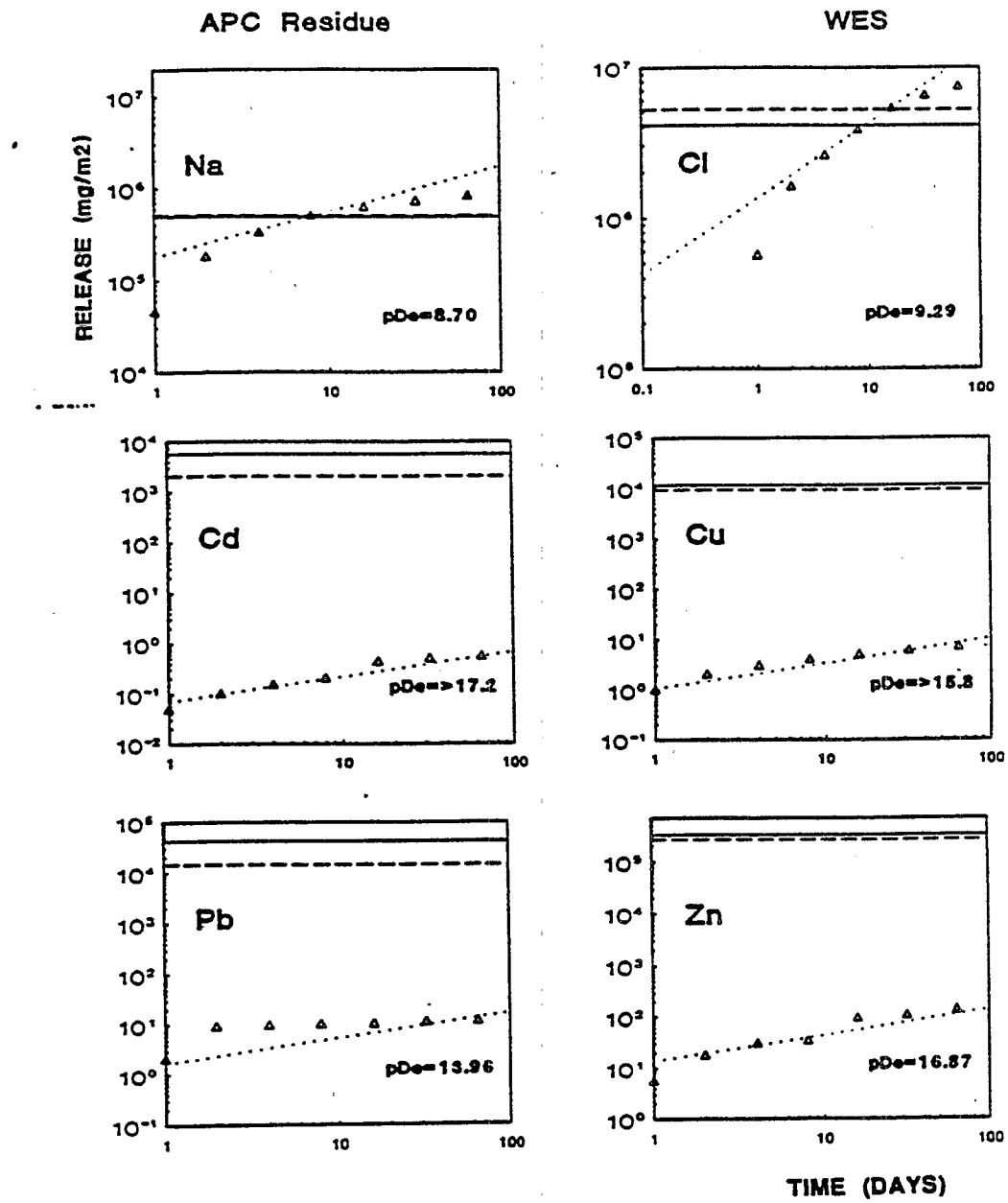


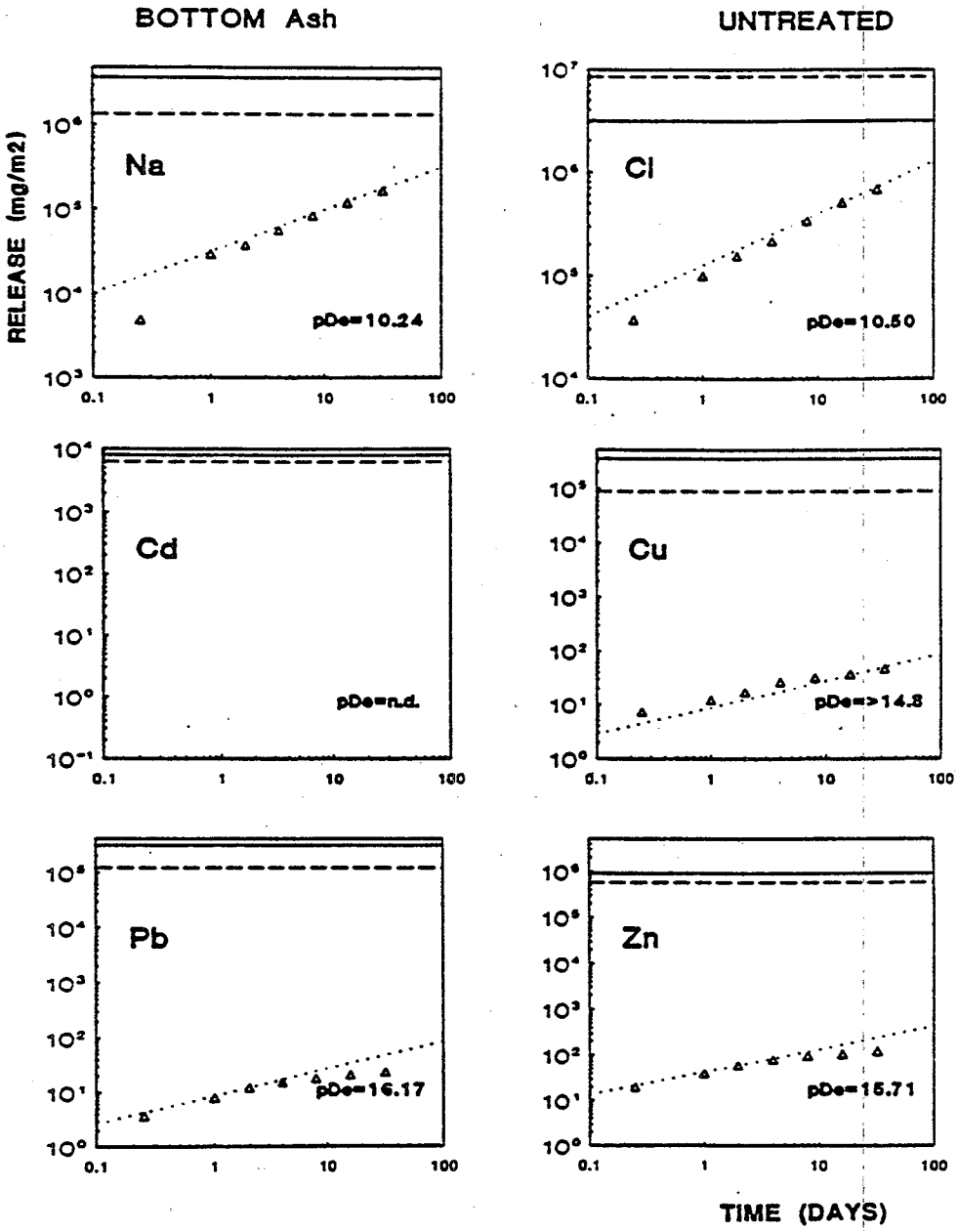
Figure 8.6. Contaminant release during the monolith leach test compared to the total and available contaminant content.



Legend:

- Δ Δ — Monolith leach test data
- ..... — Diffusion based leaching model
- — — — Availability (transformed from availability leach test)
- ——— Total (transformed from total chemical analysis)

Figure 8.7. Contaminant release during the monolith leach test compared to the total and available contaminant content.



Legend:

- Δ Δ — Monolith leach test data
- ..... — Diffusion based leaching model
- — — — Availability (transformed from availability leach test)
- ——— Total (transformed from total chemical analysis)

Figure 8.8. Contaminant release during the monolith leach test compared to the total and available contaminant content.

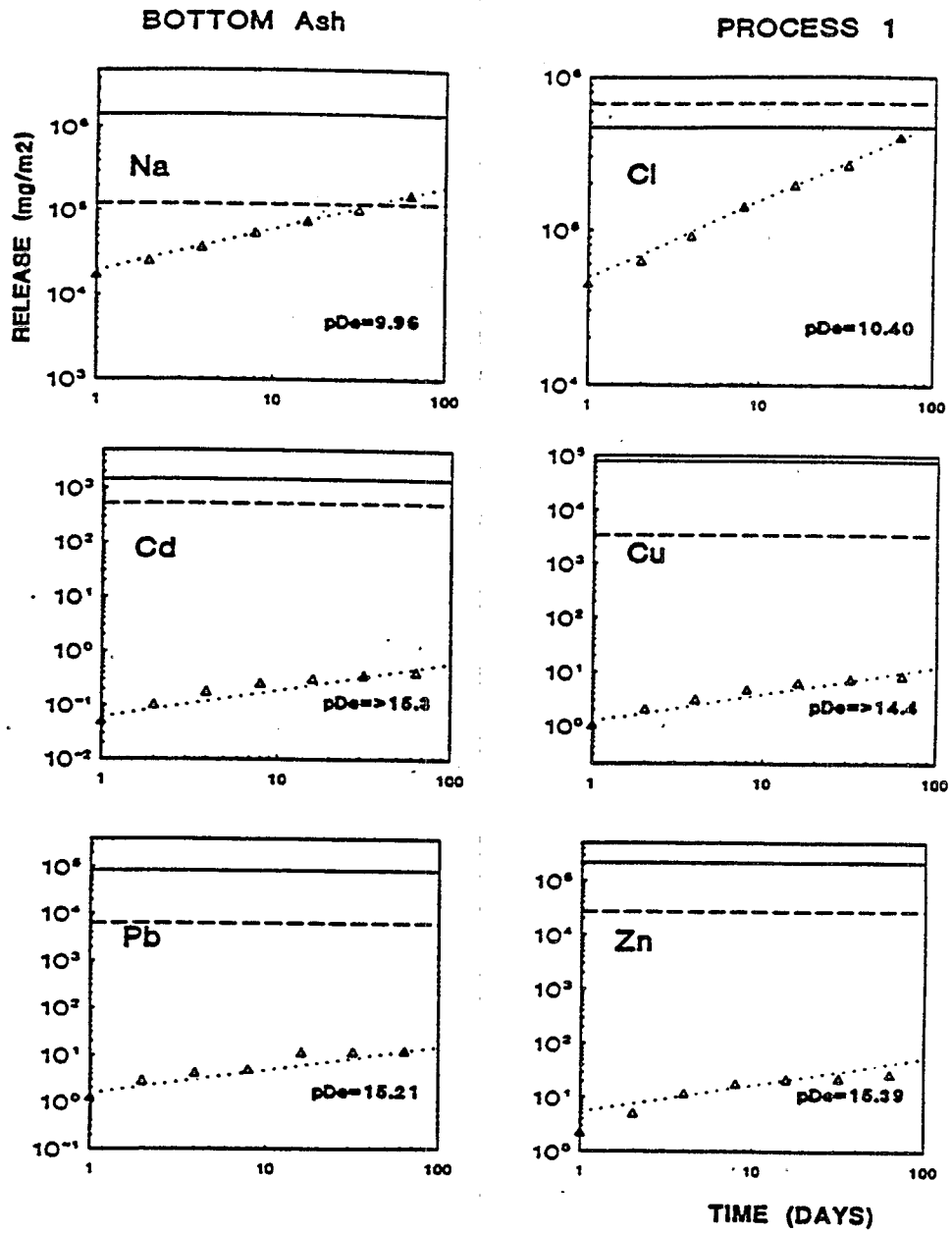


Figure 8.9. Contaminant release during the monolith leach test compared to the total and available contaminant content.

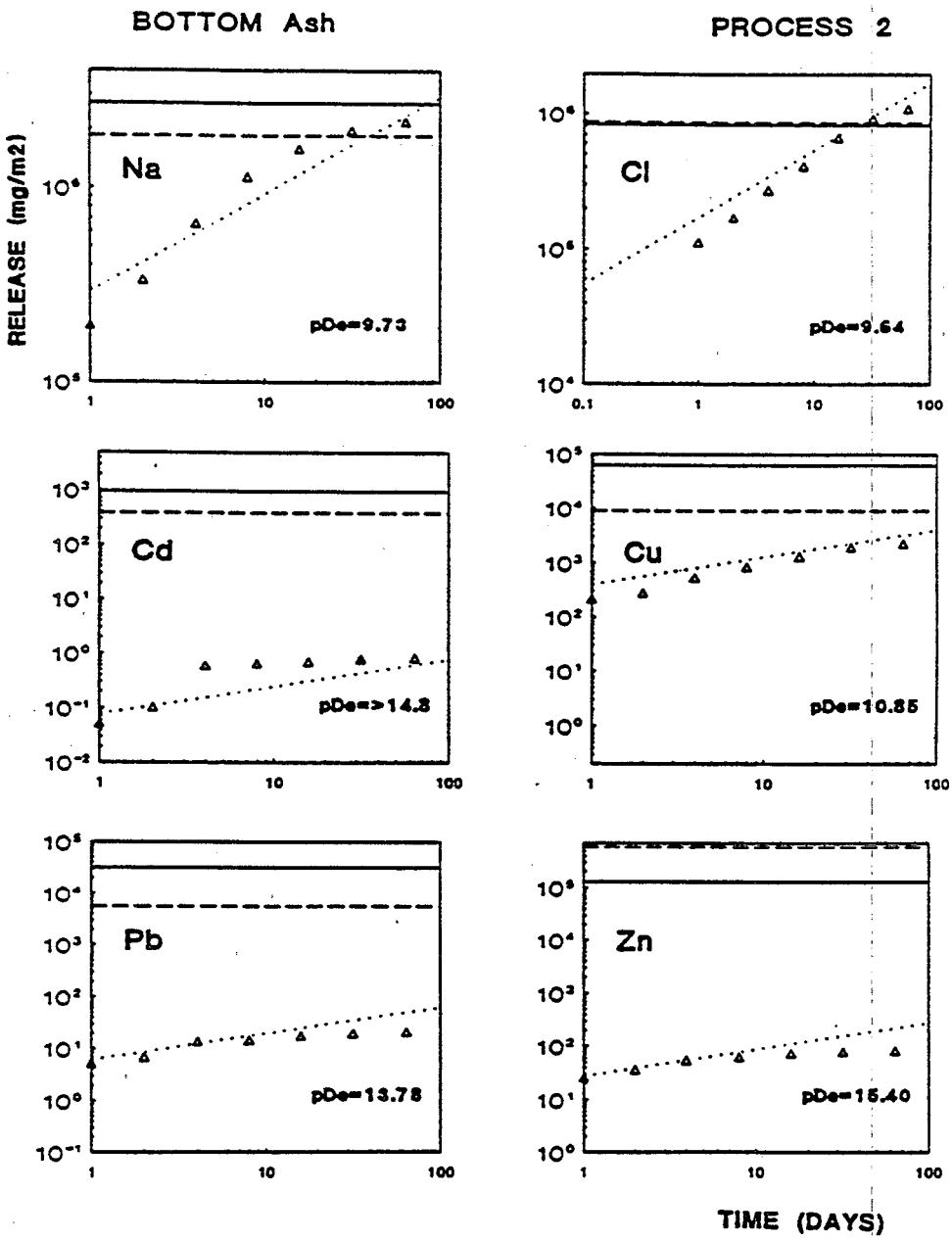


Figure 8.10. Contaminant release during the monolith leach test compared to the total and available contaminant content.

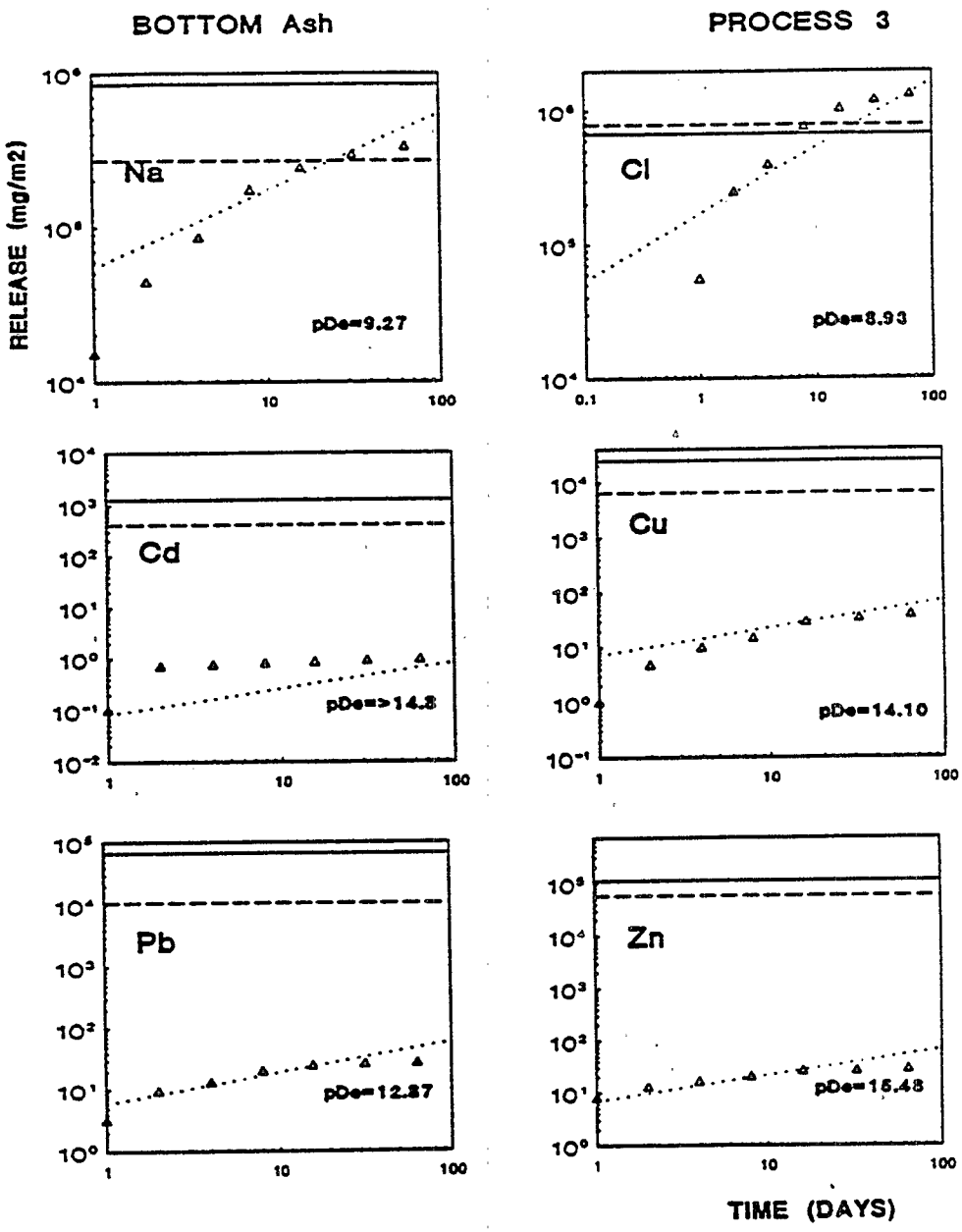
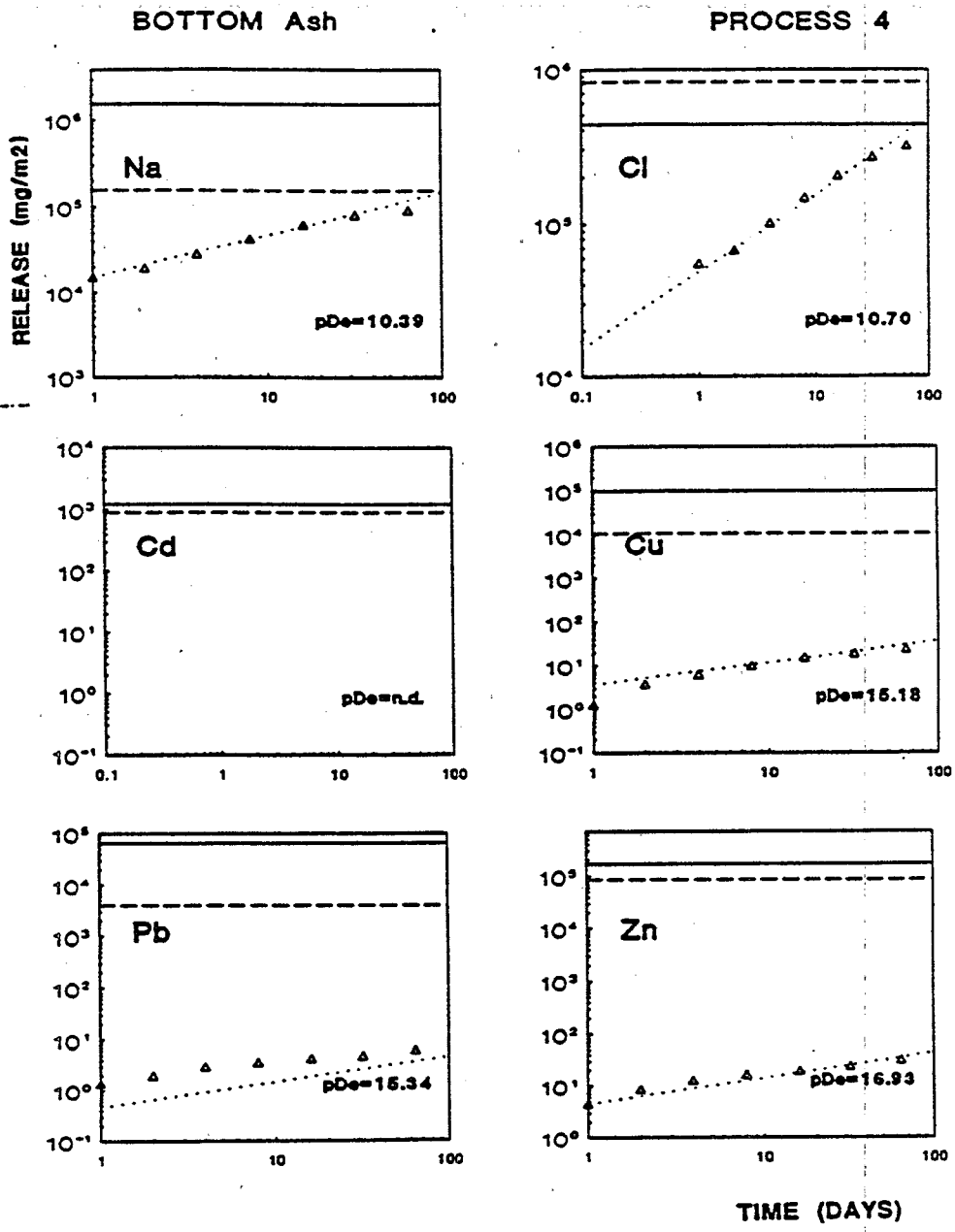


Figure 8.11. Contaminant release during the monolith leach test compared to the total and available contaminant content.



Legend:

- Δ Δ Monolith leach test data
- ..... Diffusion based leaching model
- — — — Availability (transformed from availability leach test)
- ——— Total (transformed from total chemical analysis)

Figure 8.12. Contaminant release during the monolith leach test compared to the total and available contaminant content.

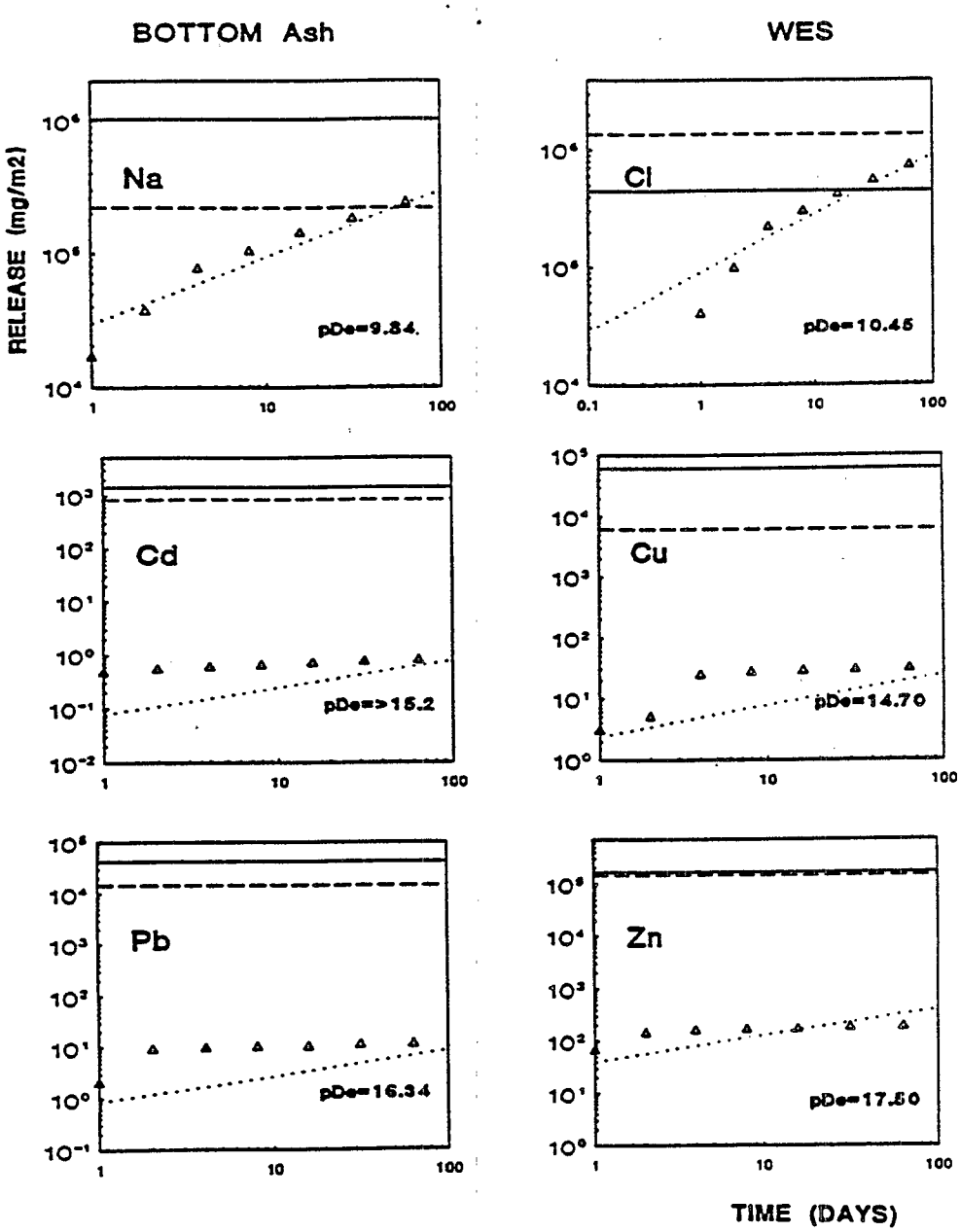
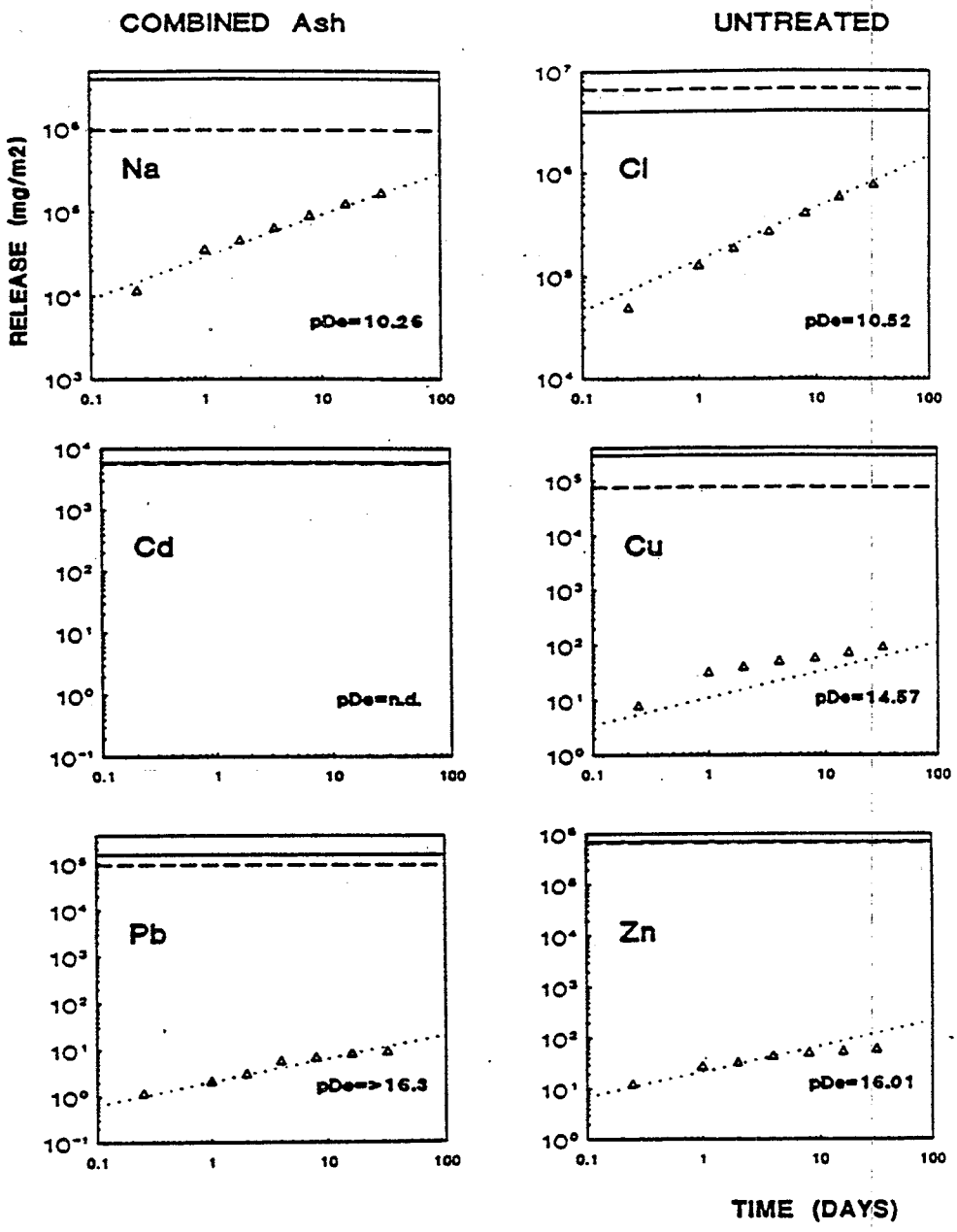


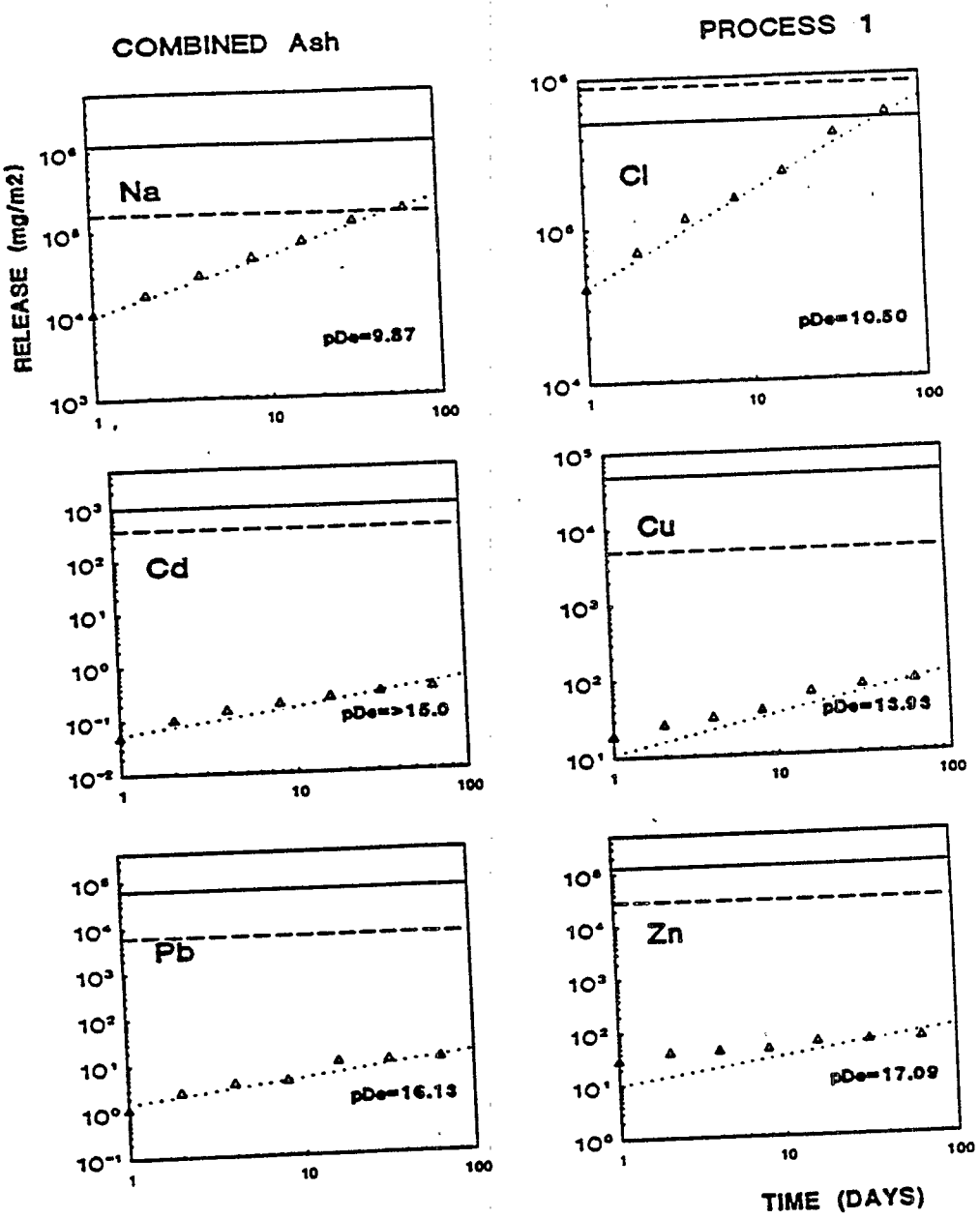
Figure 8.13. Contaminant release during the monolith leach test compared to the total and available contaminant content.



Legend:

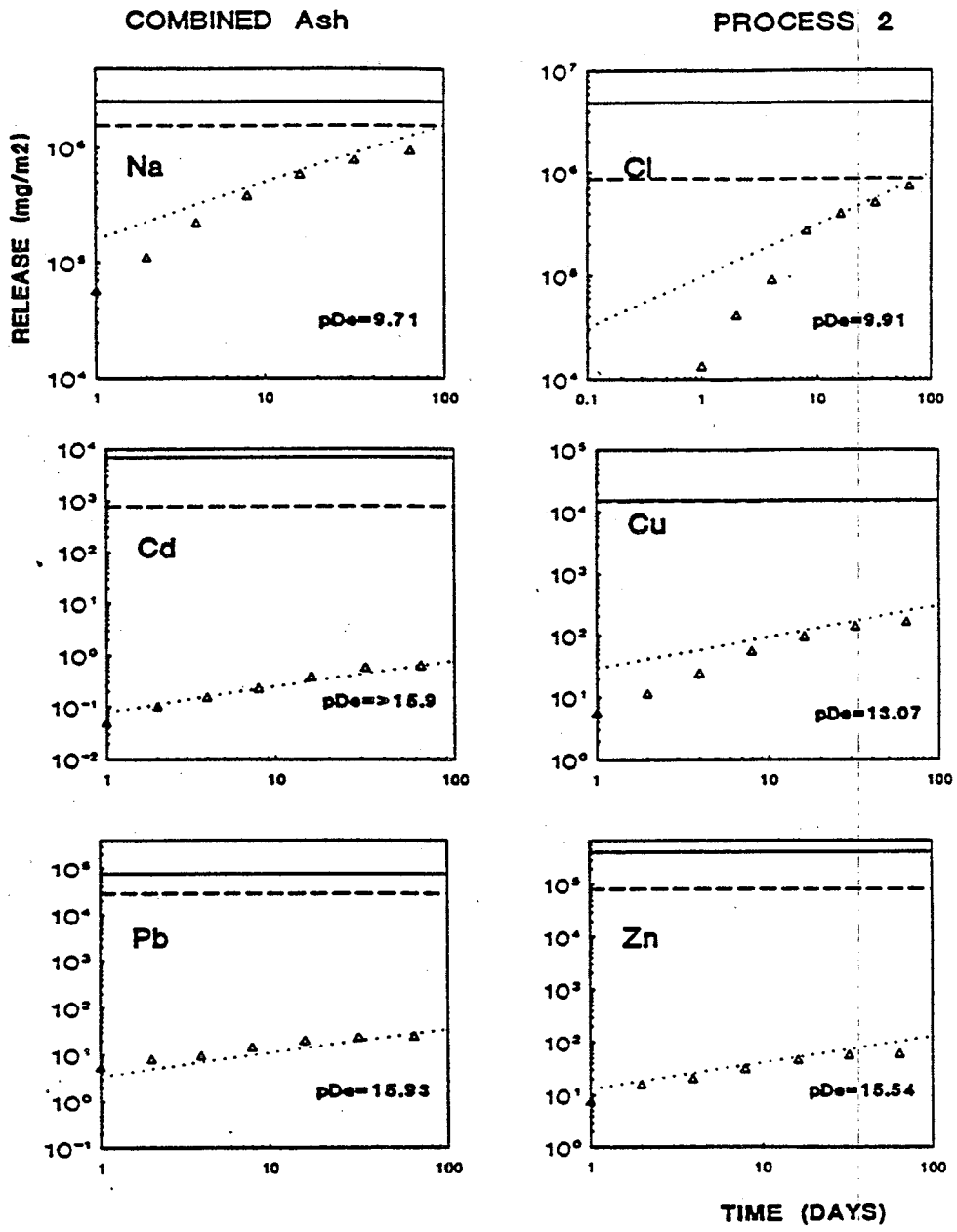
- Δ Δ — Monolith leach test data
- ..... — Diffusion based leaching model
- — — — Availability (transformed from availability leach test)
- ——— Total (transformed from total chemical analysis)

Figure 8.14. Contaminant release during the monolith leach test compared to the total and available contaminant content.



Legend:
- Δ Δ Monolith leach test data
- ..... Diffusion based leaching model
- — — — Availability (transformed from availability leach test)
- ——— Total (transformed from total chemical analysis)

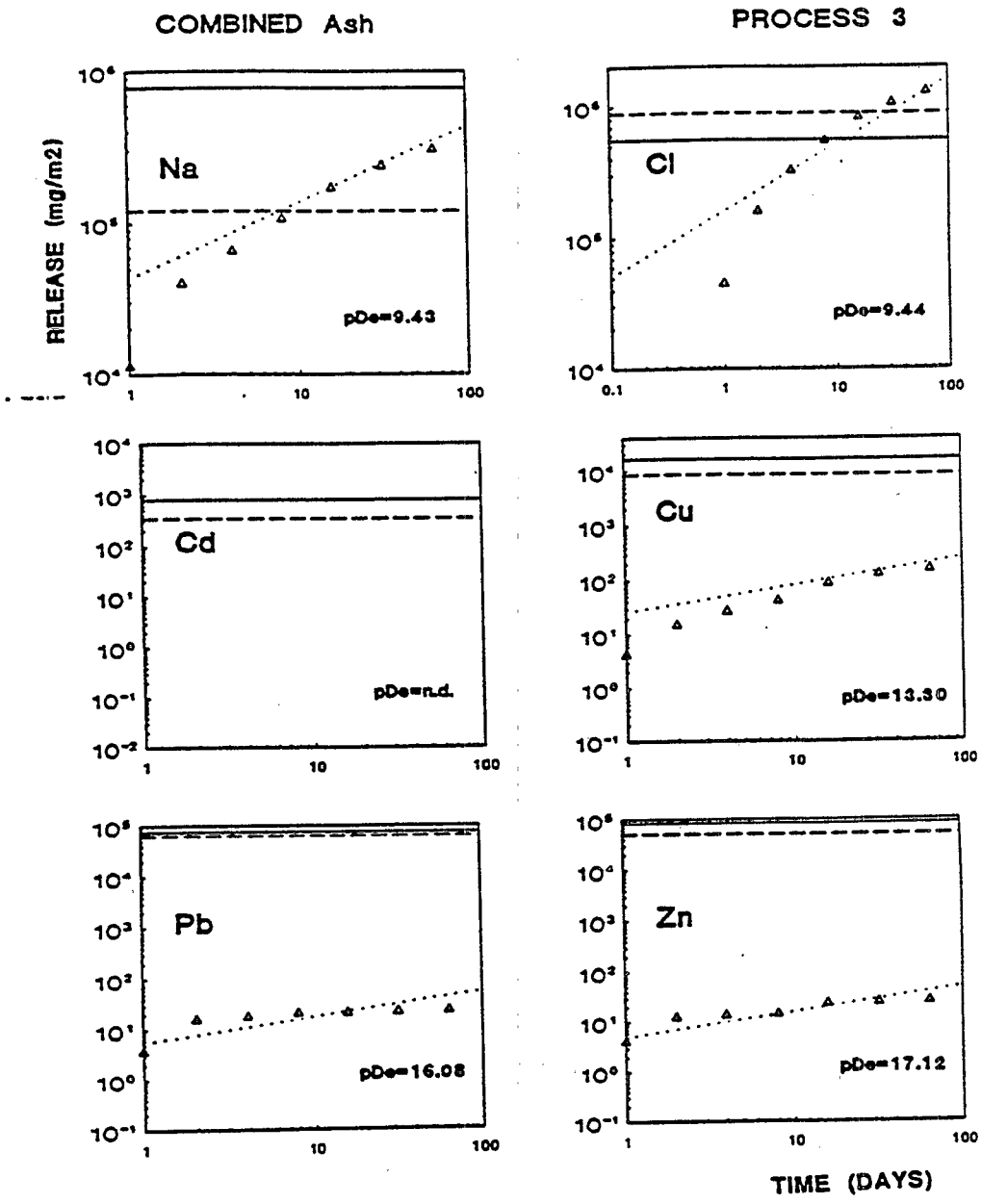
Figure 8.15. Contaminant release during the monolith leach test compared to the total and available contaminant content.



Legend:

- Δ Δ — Monolith leach test data
- ..... — Diffusion based leaching model
- — — — Availability (transformed from availability leach test)
- ——— Total (transformed from total chemical analysis)

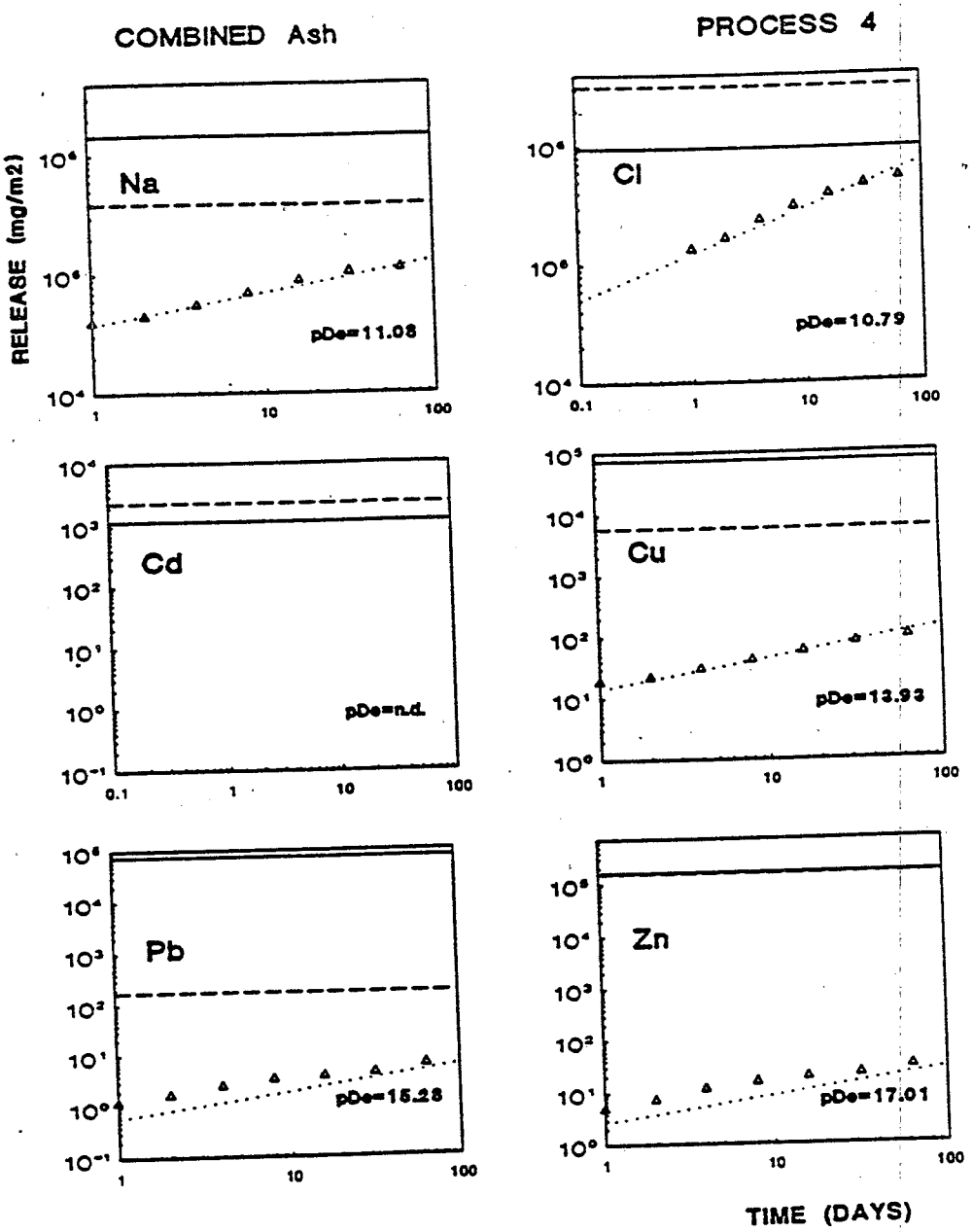
Figure 8.16. Contaminant release during the monolith leach test compared to the total and available contaminant content.



Legend:

- Δ Δ — Monolith leach test data
- ..... — Diffusion based leaching model
- — — — Availability (transformed from availability leach test)
- ——— Total (transformed from total chemical analysis)

Figure 8.17. Contaminant release during the monolith leach test compared to the total and available contaminant content.



Legend:

- Δ Δ — Monolith leach test data
- ..... — Diffusion based leaching model
- — — — Availability (transformed from availability leach test)
- ——— Total (transformed from total chemical analysis)

Figure 8.18. Contaminant release during the monolith leach test compared to the total and available contaminant content.

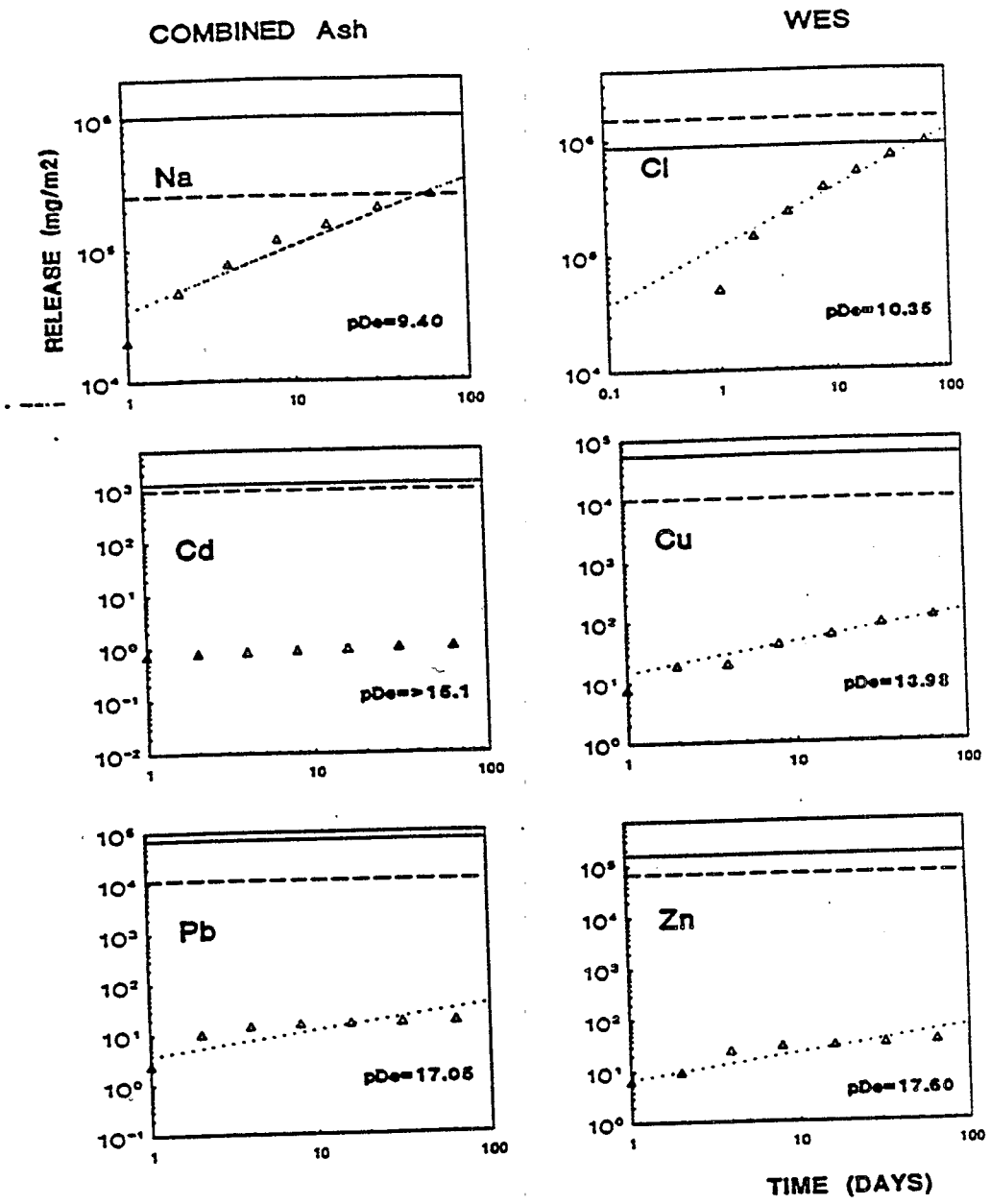


Figure 8.19. Contaminant release during the monolith leach test compared to the total and available contaminant content.

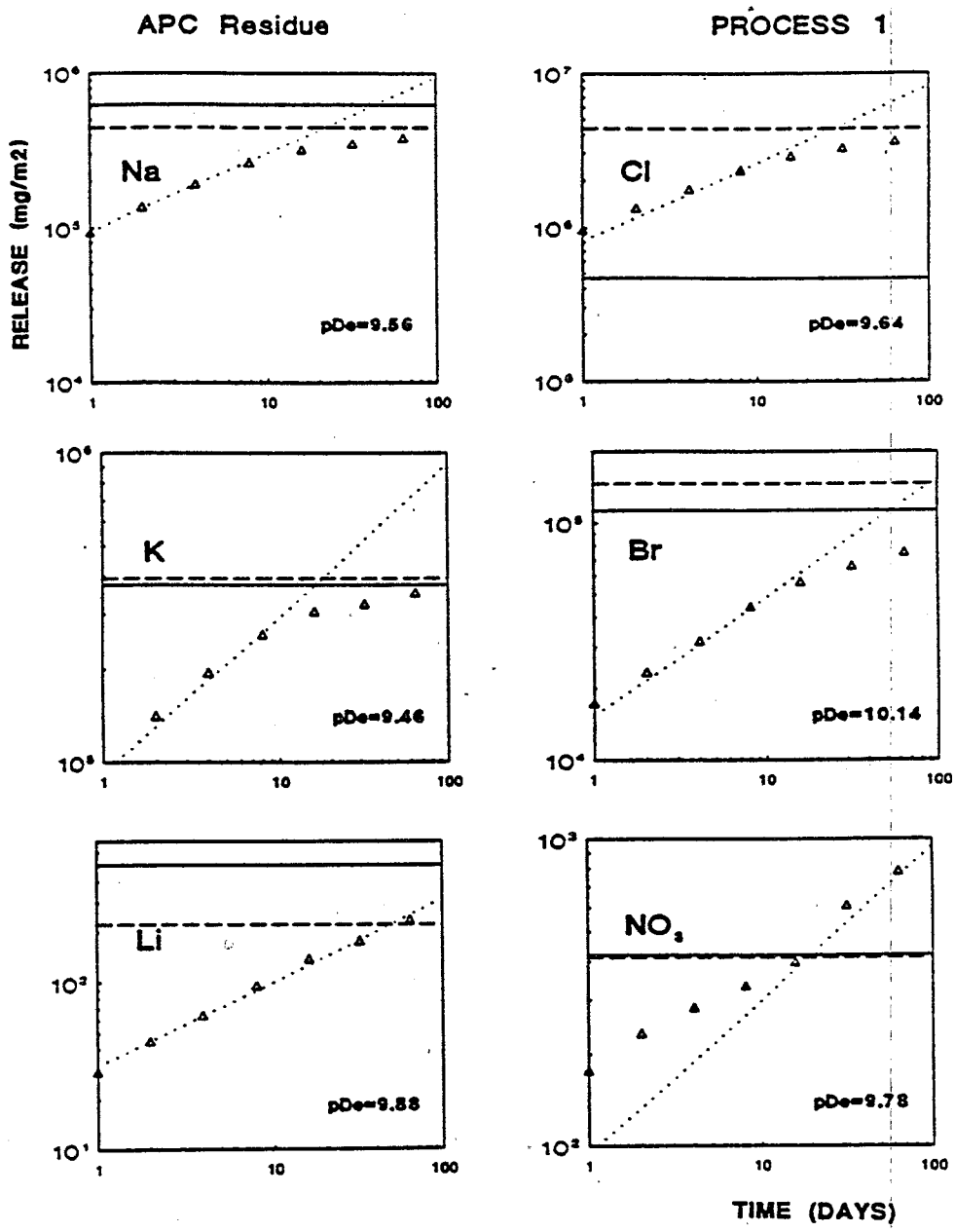


Figure 8.20. Comparison of tortuosities estimated from the monolith leaching test. Error bars indicate .80 confidence intervals.

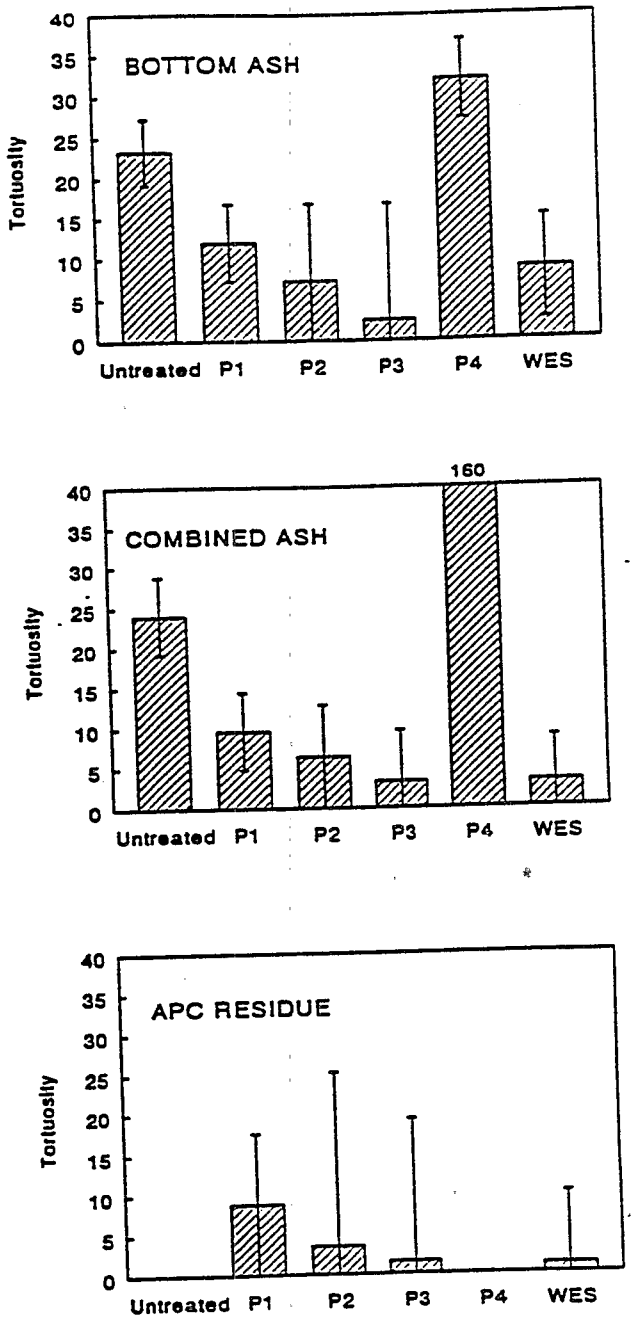


Figure 8.21. Mechanisms of sodium release from bottom ash treated by Process 2.

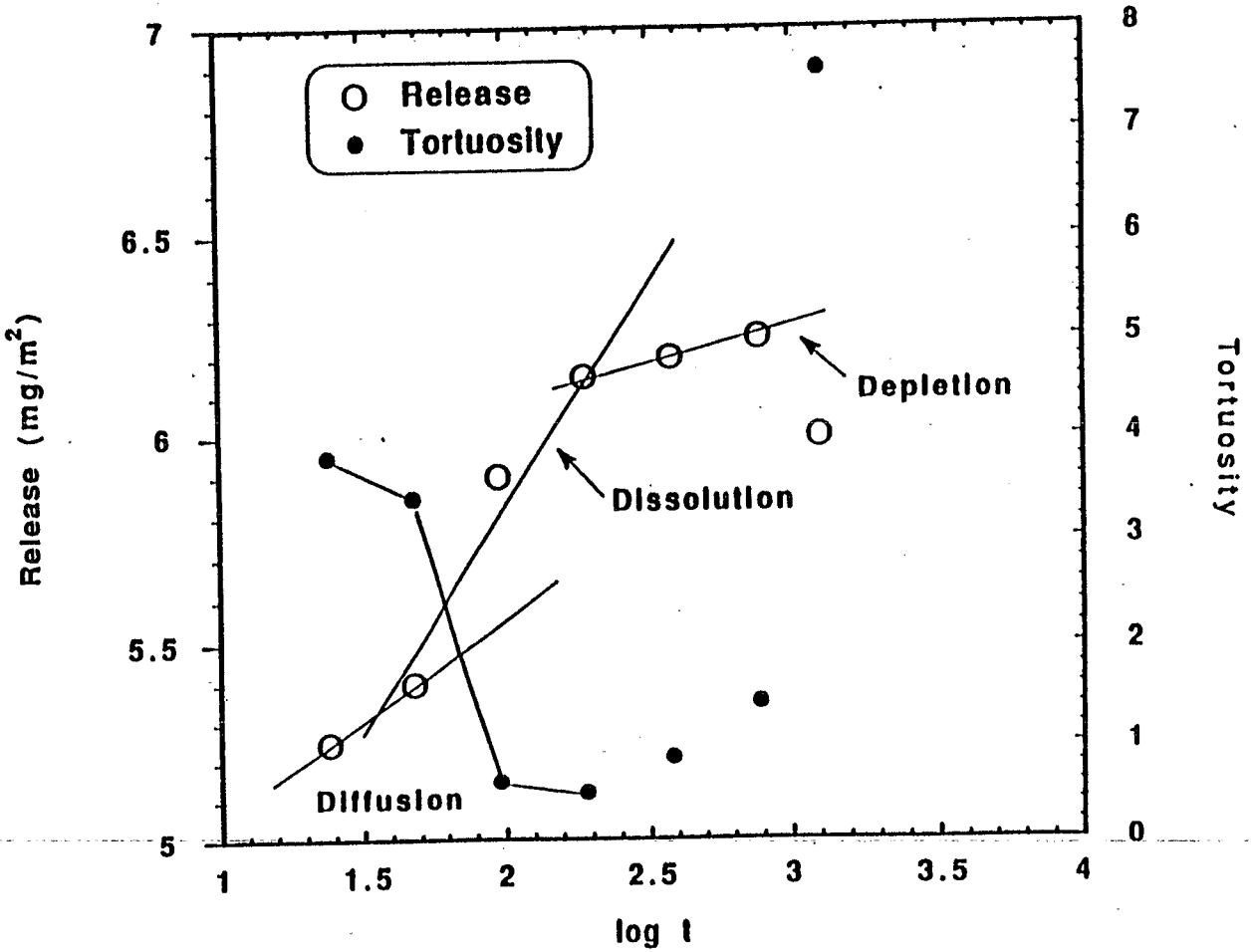


Figure 8.22. Standard deviation as a function of pD_e for all estimated pD_e.

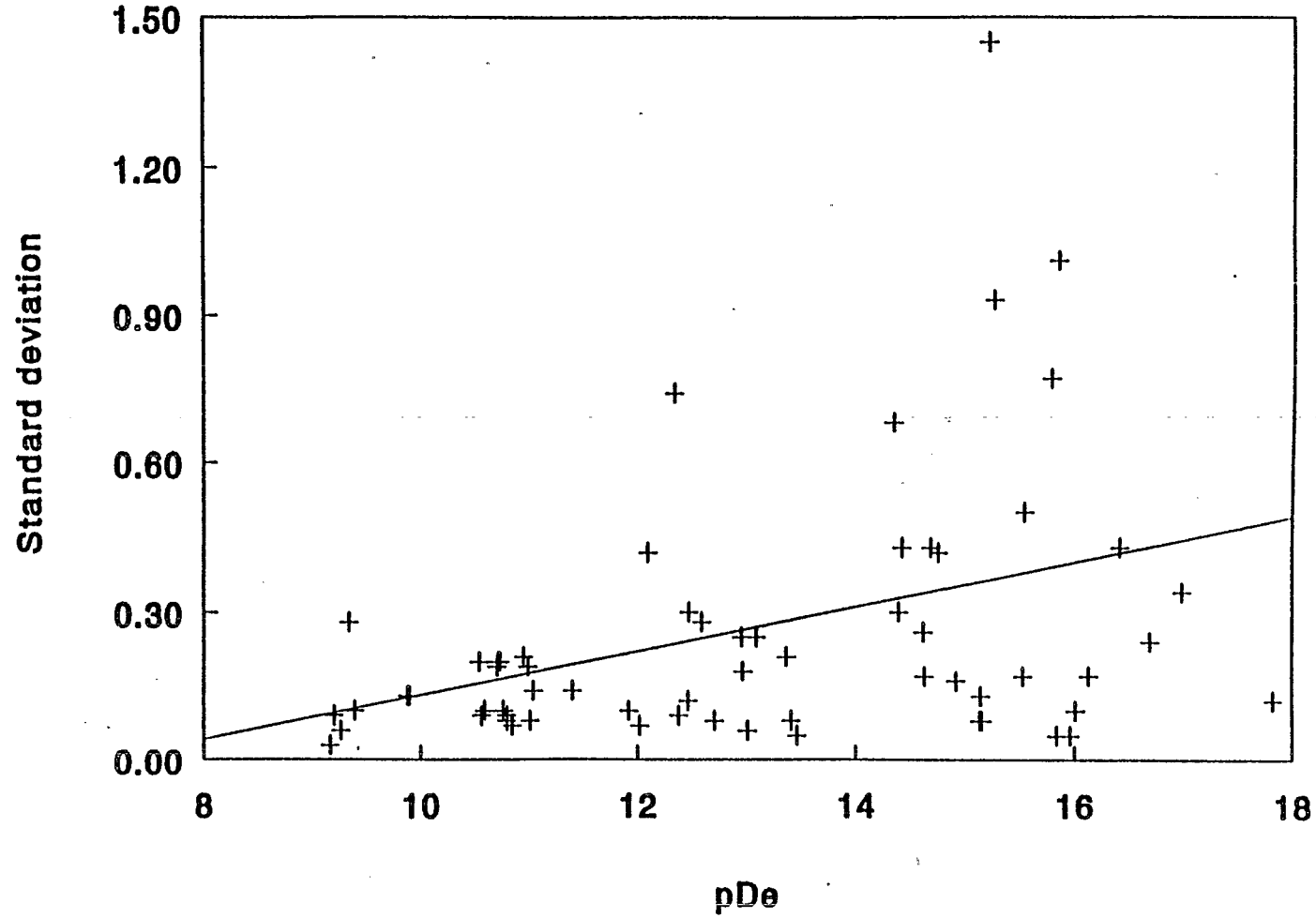


Figure 8.23. Relative contributions of free diffusion, tortuosity, and chemical retardation to the effective diffusion coefficient and the effect of availability (comparison of elements).

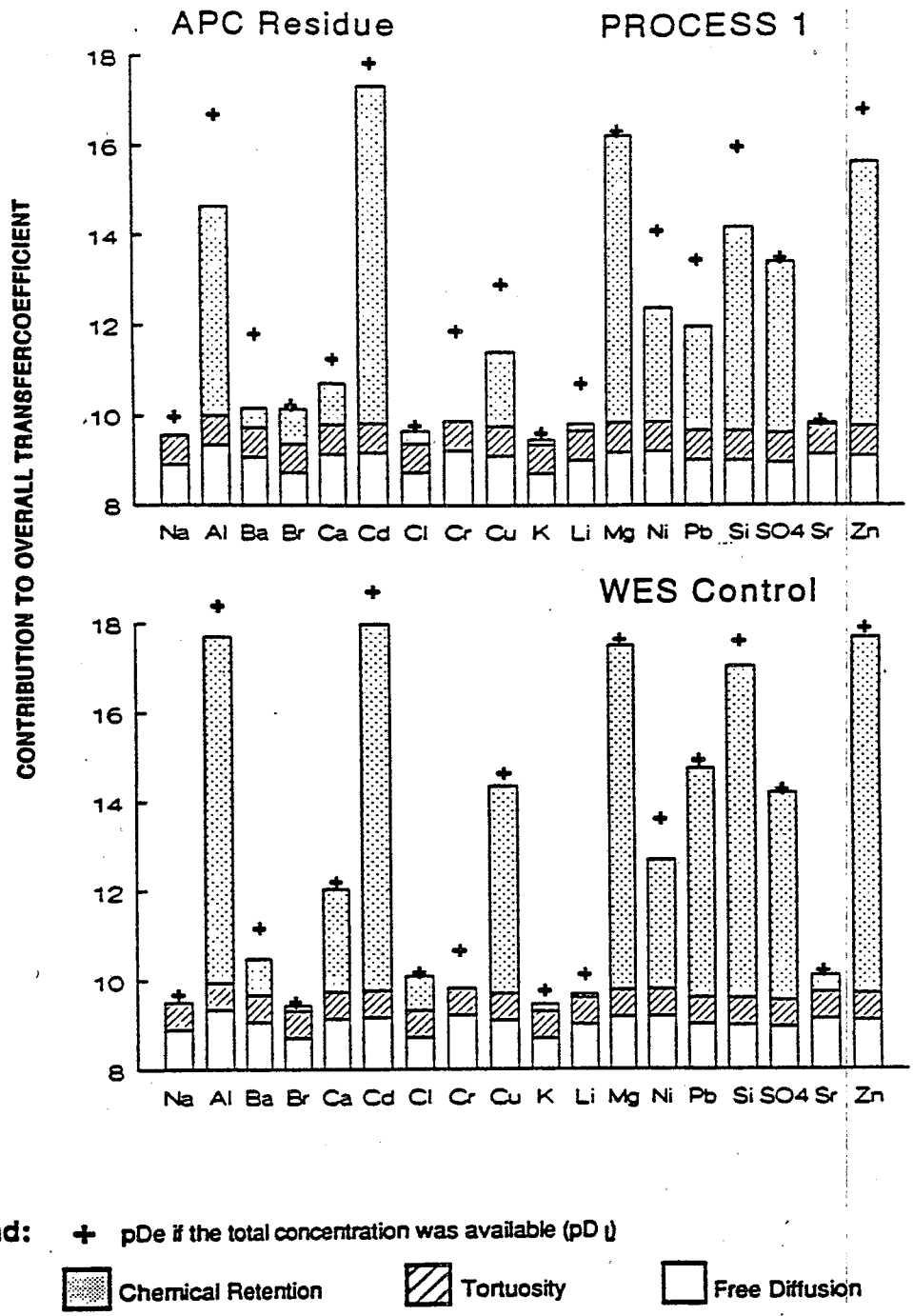


Figure 8.24. Relative contributions of free diffusion, tortuosity, and chemical retardation to the effective diffusion coefficient and the effect of availability (comparison of elements).

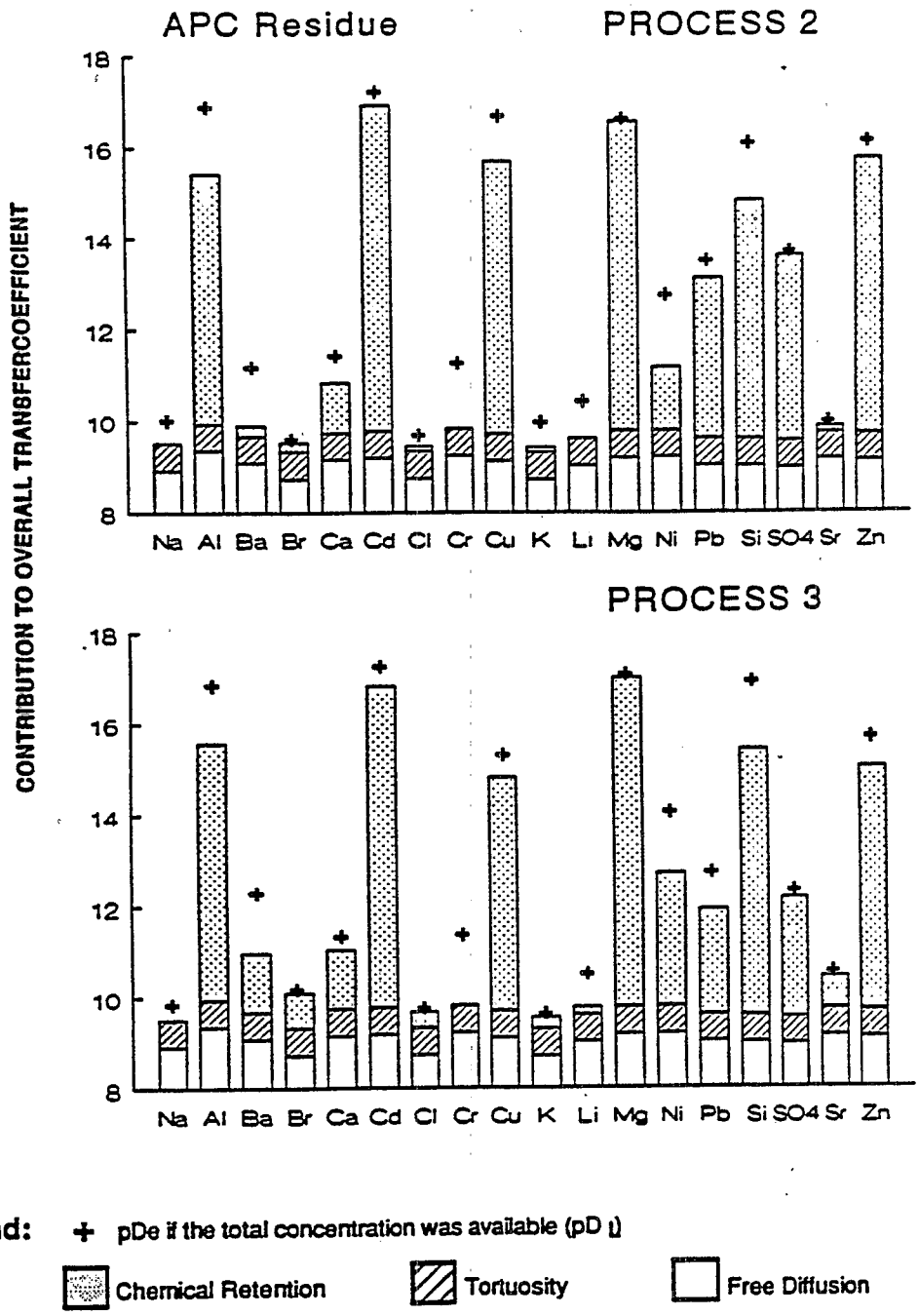


Figure 8.25. Relative contributions of free diffusion, tortuosity, and chemical retardation to the effective diffusion coefficient and the effect of availability (comparison of elements).

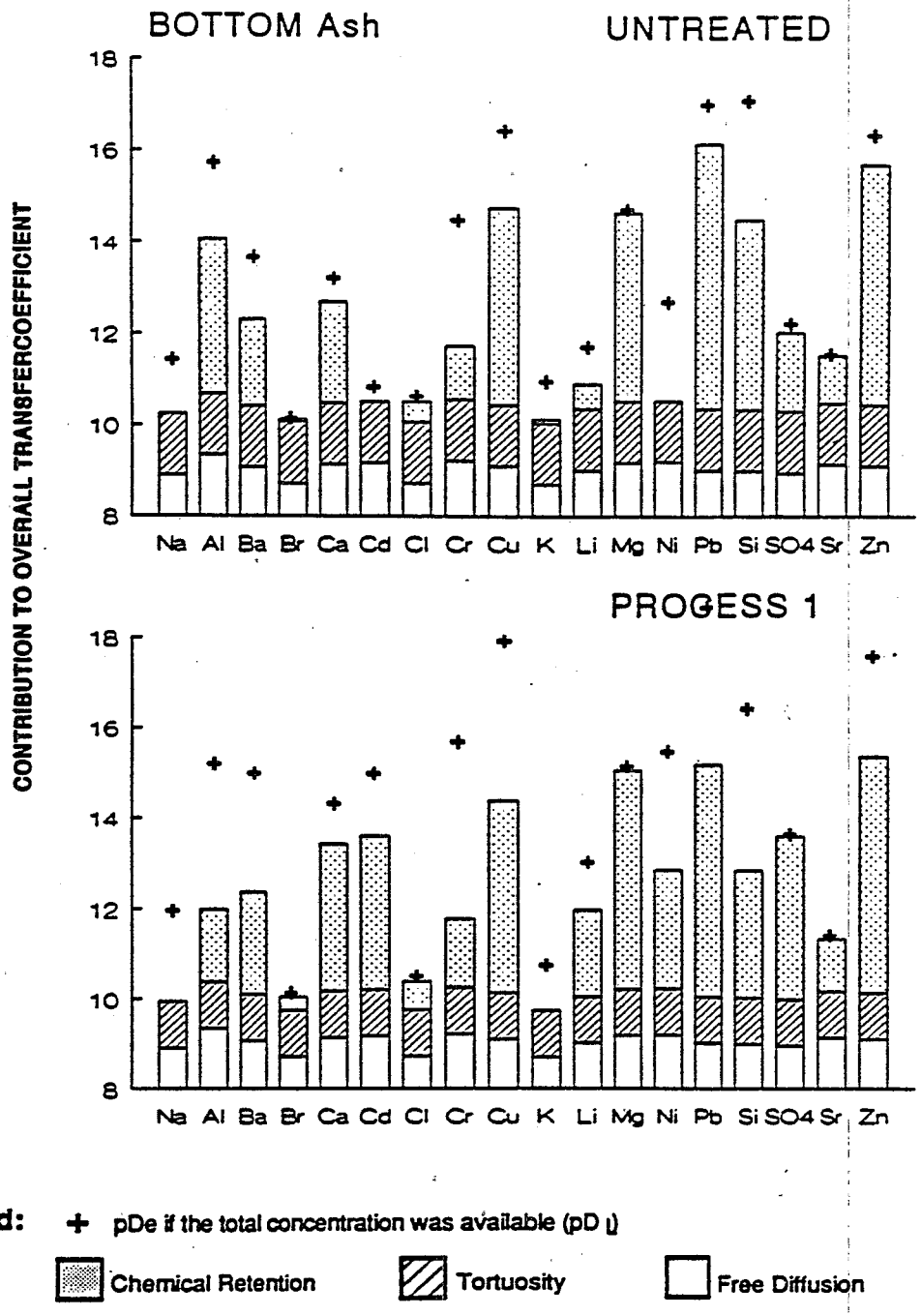


Figure 8.26. Relative contributions of free diffusion, tortuosity, and chemical retardation to the effective diffusion coefficient and the effect of availability (comparison of elements).

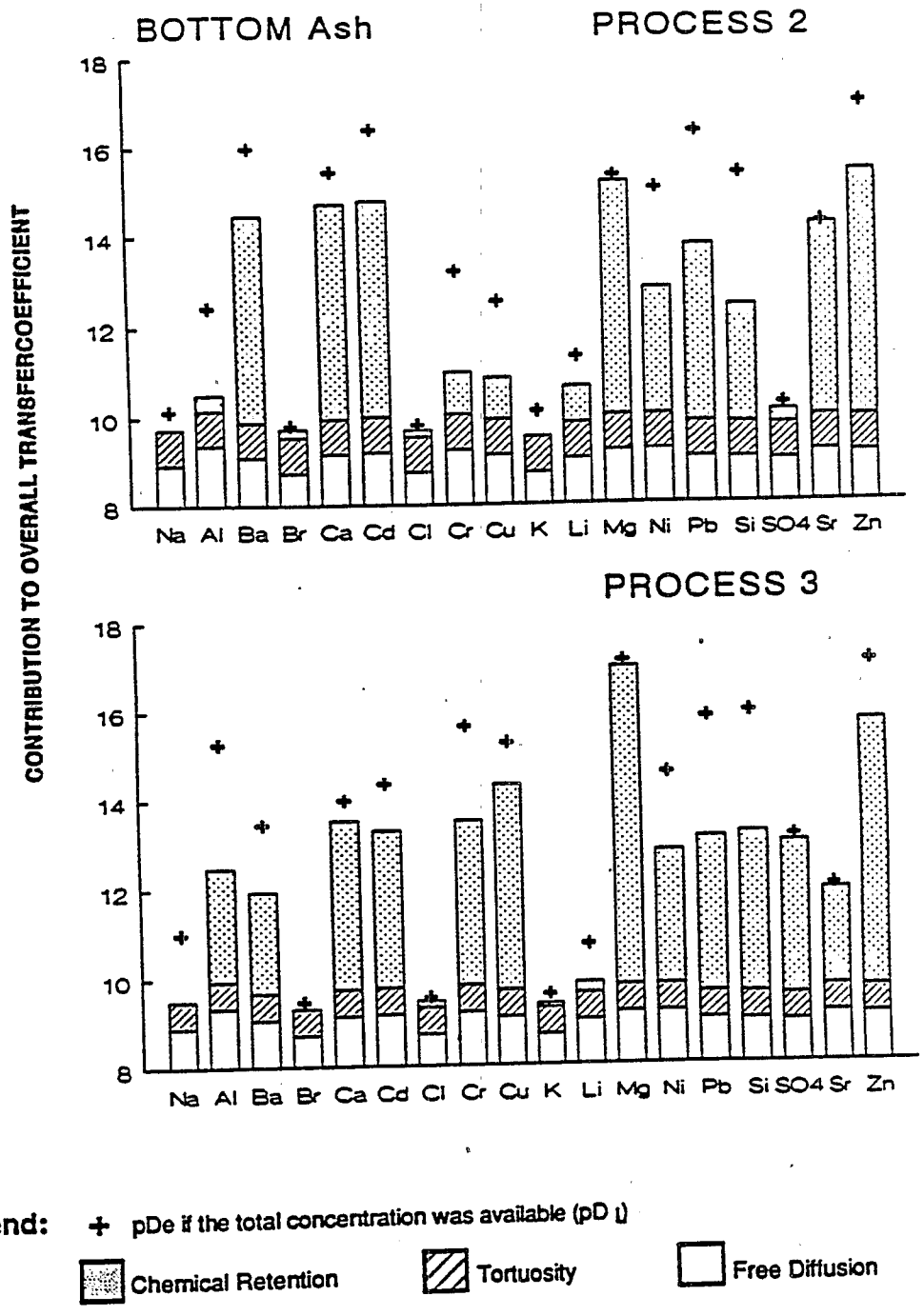


Figure 8.27. Relative contributions of free diffusion, tortuosity, and chemical retardation to the effective diffusion coefficient and the effect of availability (comparison of elements).

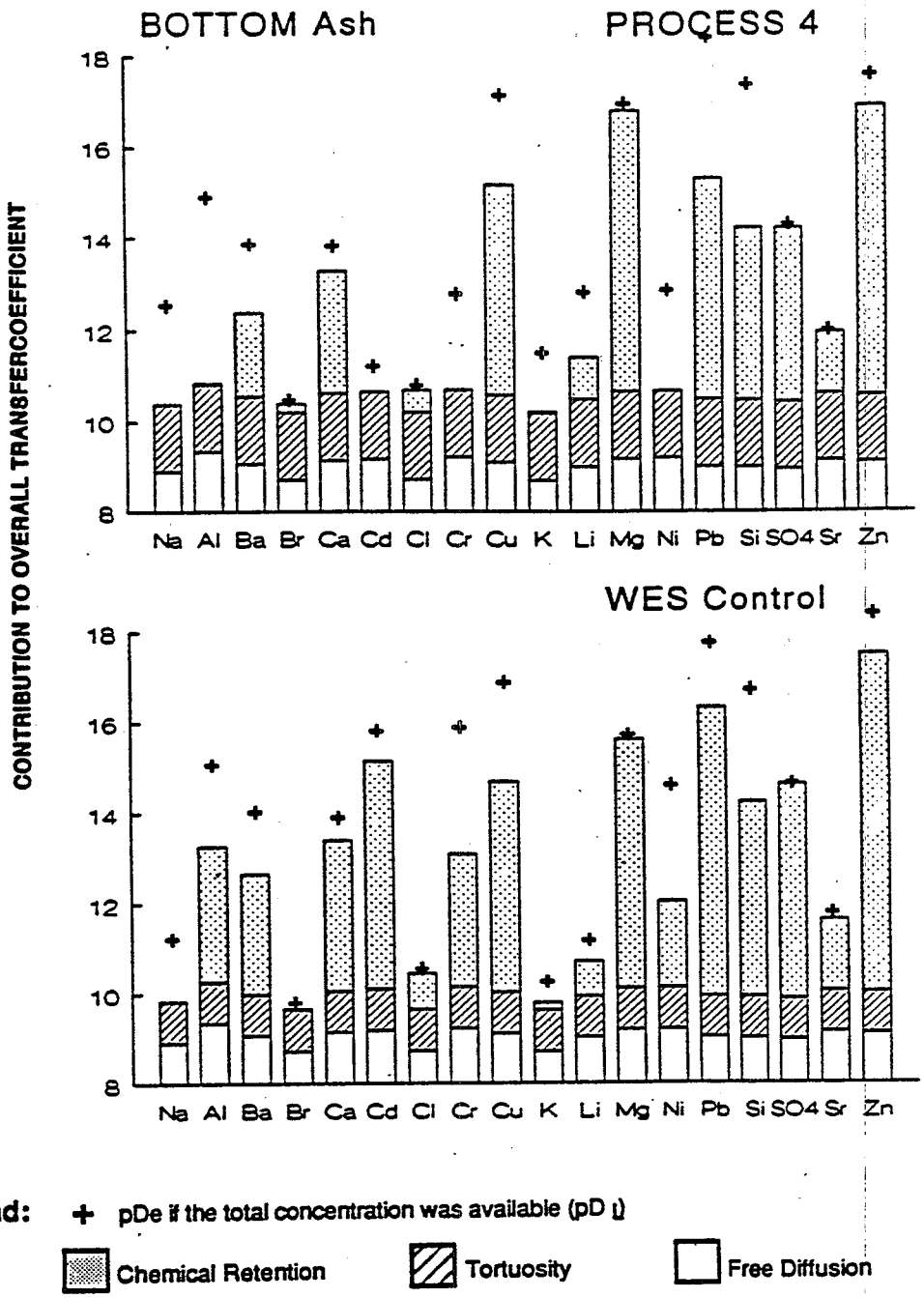


Figure 8.28. Relative contributions of free diffusion, tortuosity, and chemical retardation to the effective diffusion coefficient and the effect of availability (comparison of elements).

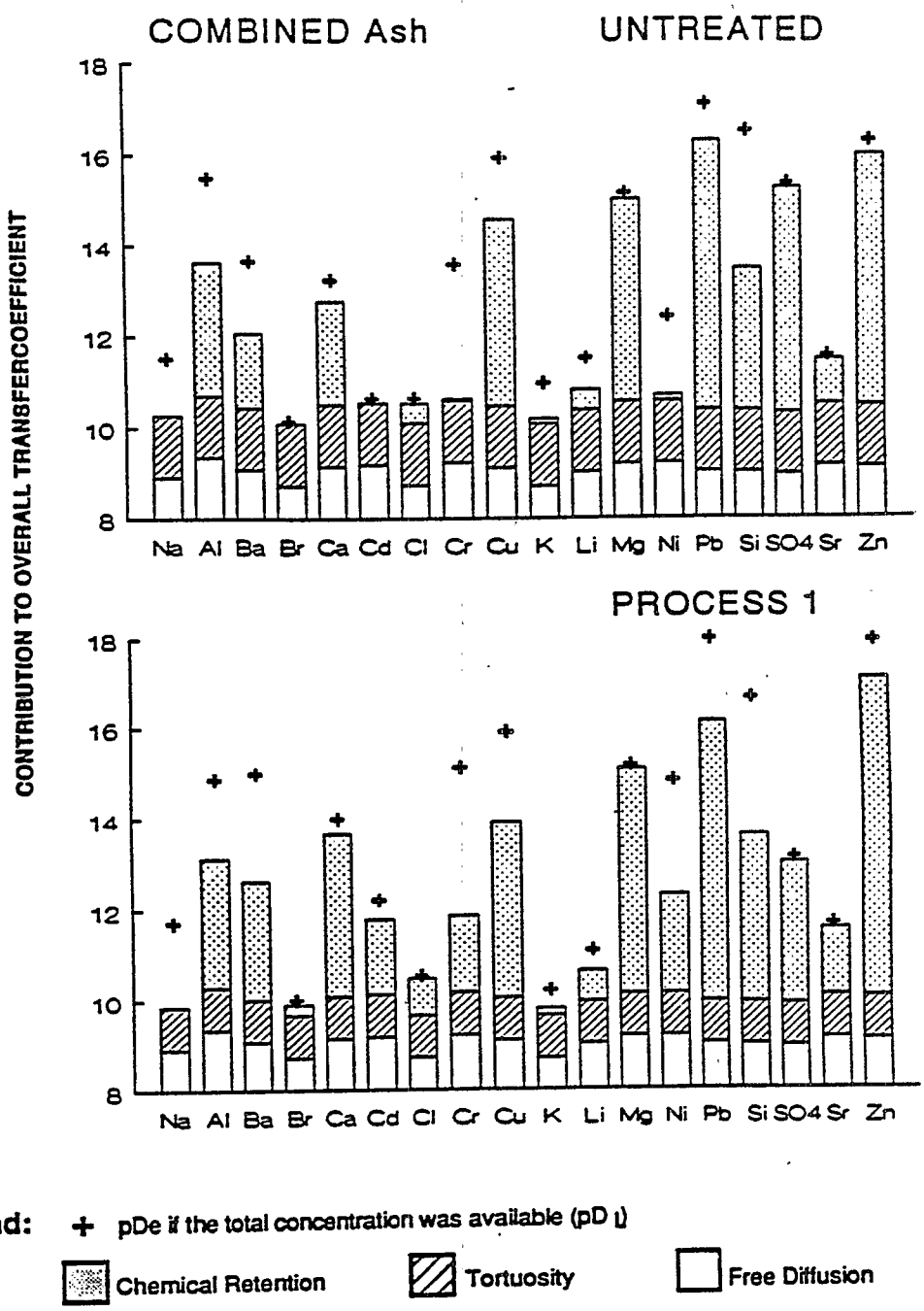


Figure 8.29. Relative contributions of free diffusion, tortuosity, and chemical retardation to the effective diffusion coefficient and the effect of availability (comparison of elements).

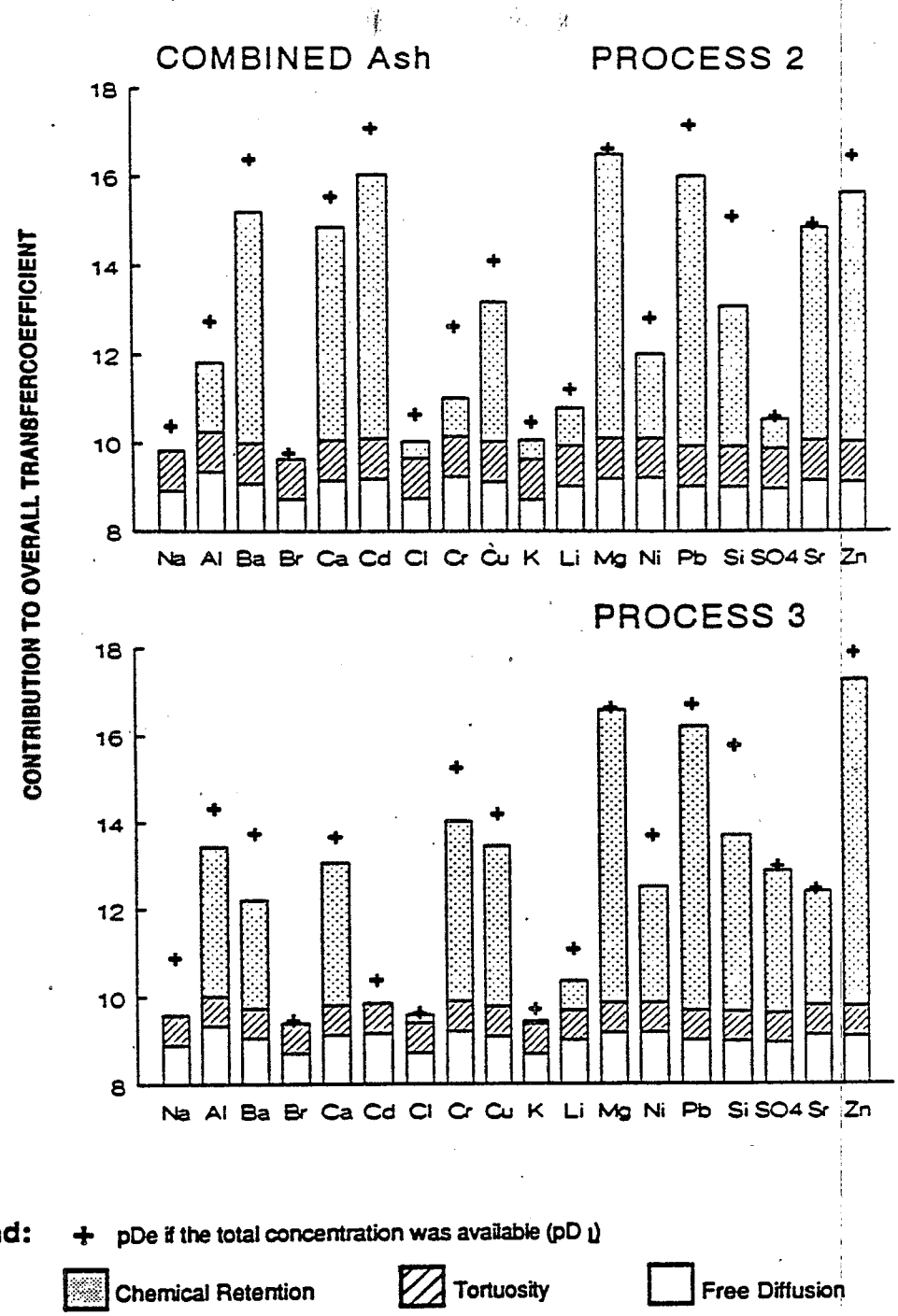


Figure 8.30. Relative contributions of free diffusion, tortuosity, and chemical retardation to the effective diffusion coefficient and the effect of availability (comparison of elements).

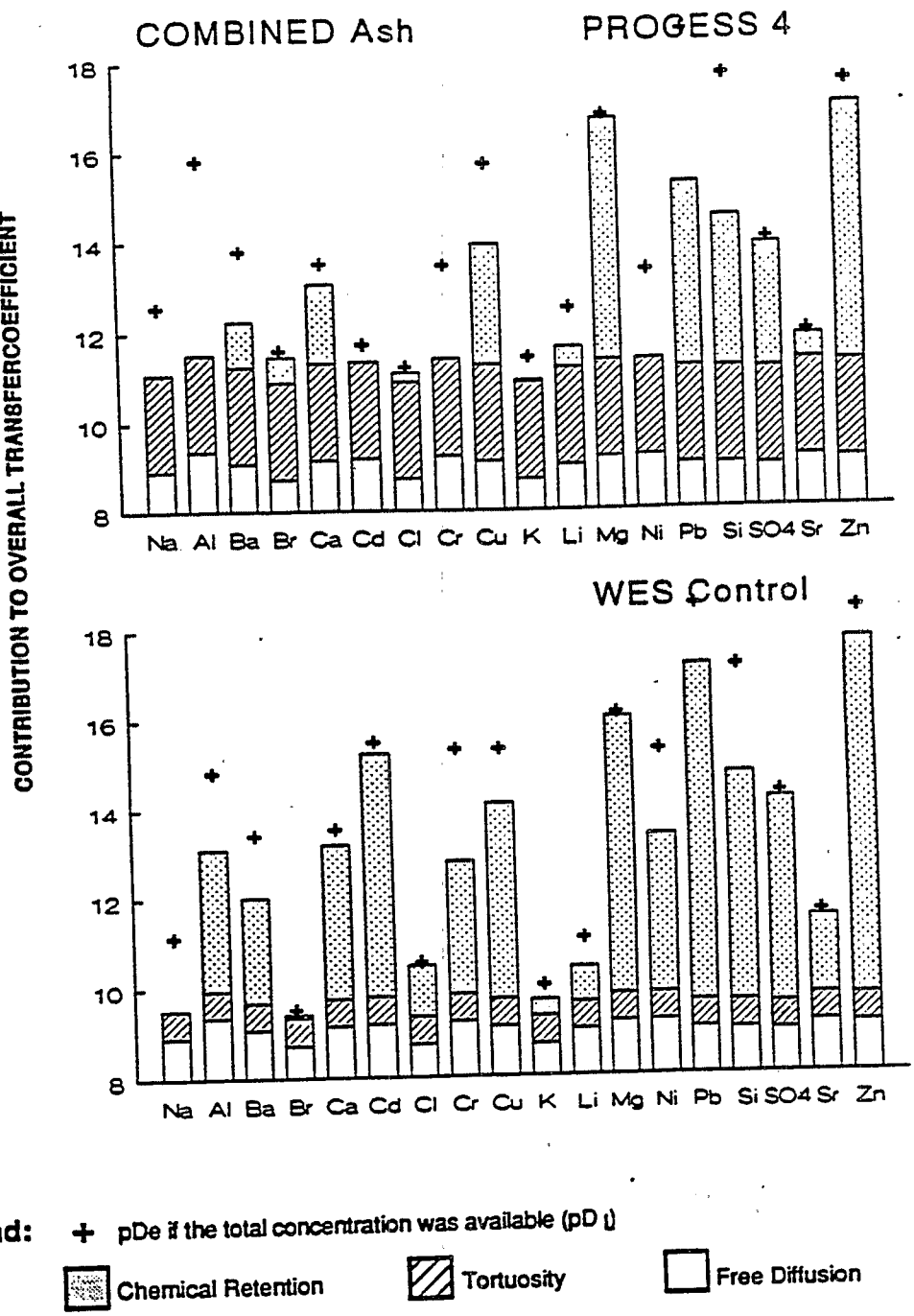


Figure 8.31. Relative contributions of free diffusion, tortuosity, and chemical retardation to the effective diffusion coefficient and the effect of availability (comparison of treatment processes (0= untreated; 5 = WES)).

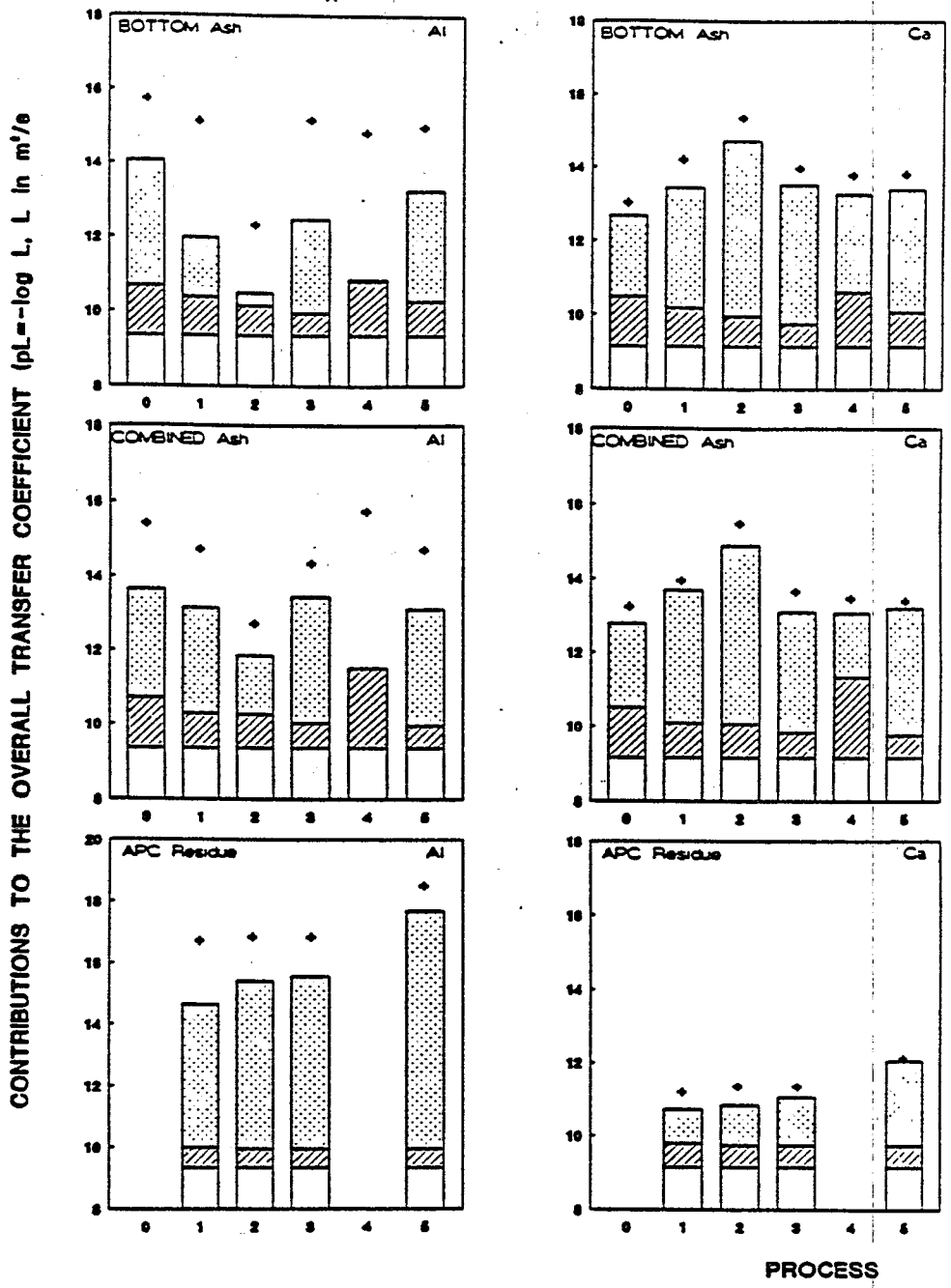


Figure 8.32. Relative contributions of free diffusion, tortuosity, and chemical retardation to the effective diffusion coefficient and the effect of availability (comparison of treatment processes (0= untreated; 5 = WES)).

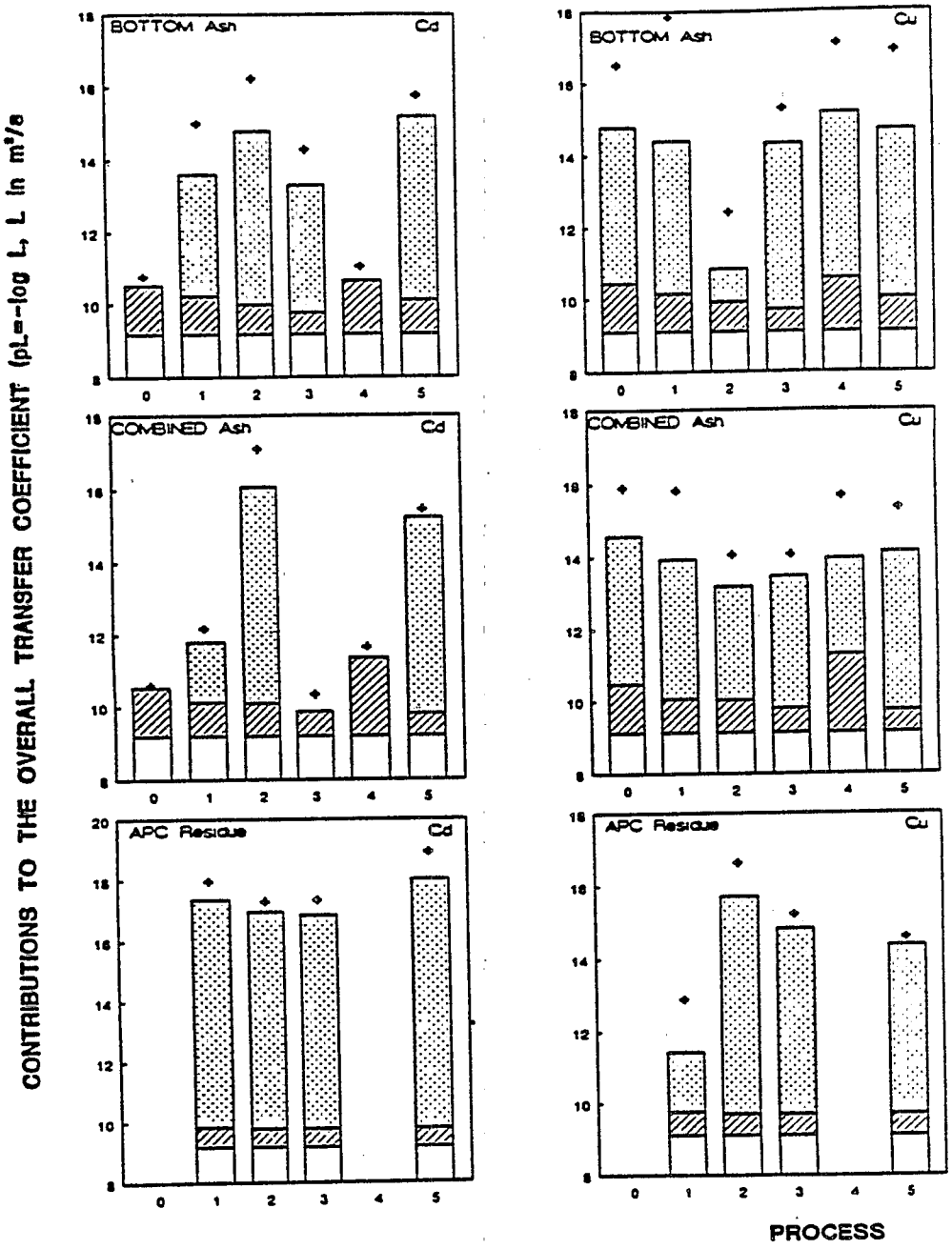


Figure 8.33. Relative contributions of free diffusion, tortuosity, and chemical retardation to the effective diffusion coefficient and the effect of availability (comparison of treatment processes (0= untreated; 5 = WES)).

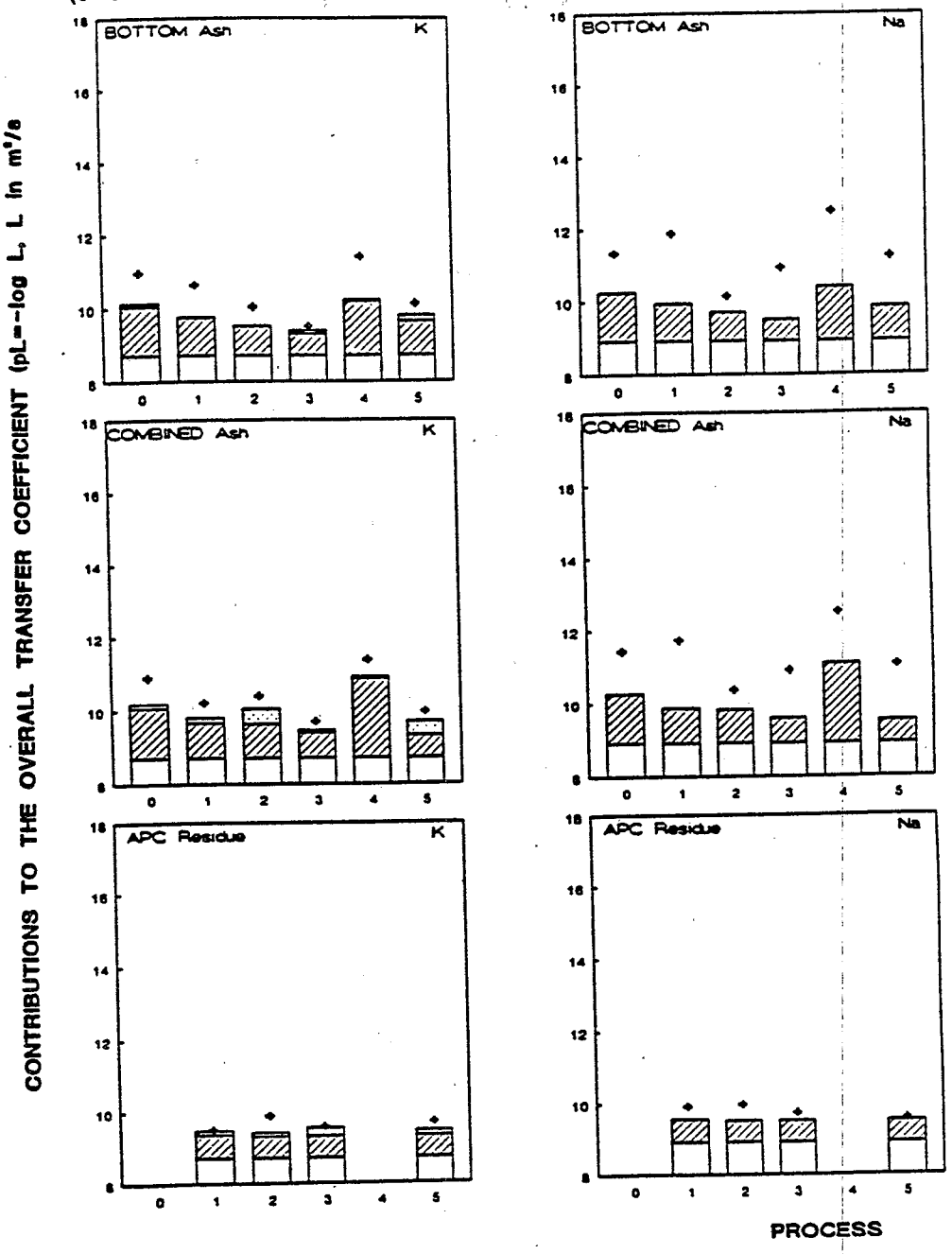


Figure 8.34. Relative contributions of free diffusion, tortuosity, and chemical retardation to the effective diffusion coefficient and the effect of availability (comparison of treatment processes (0= untreated; 5 = WES)).

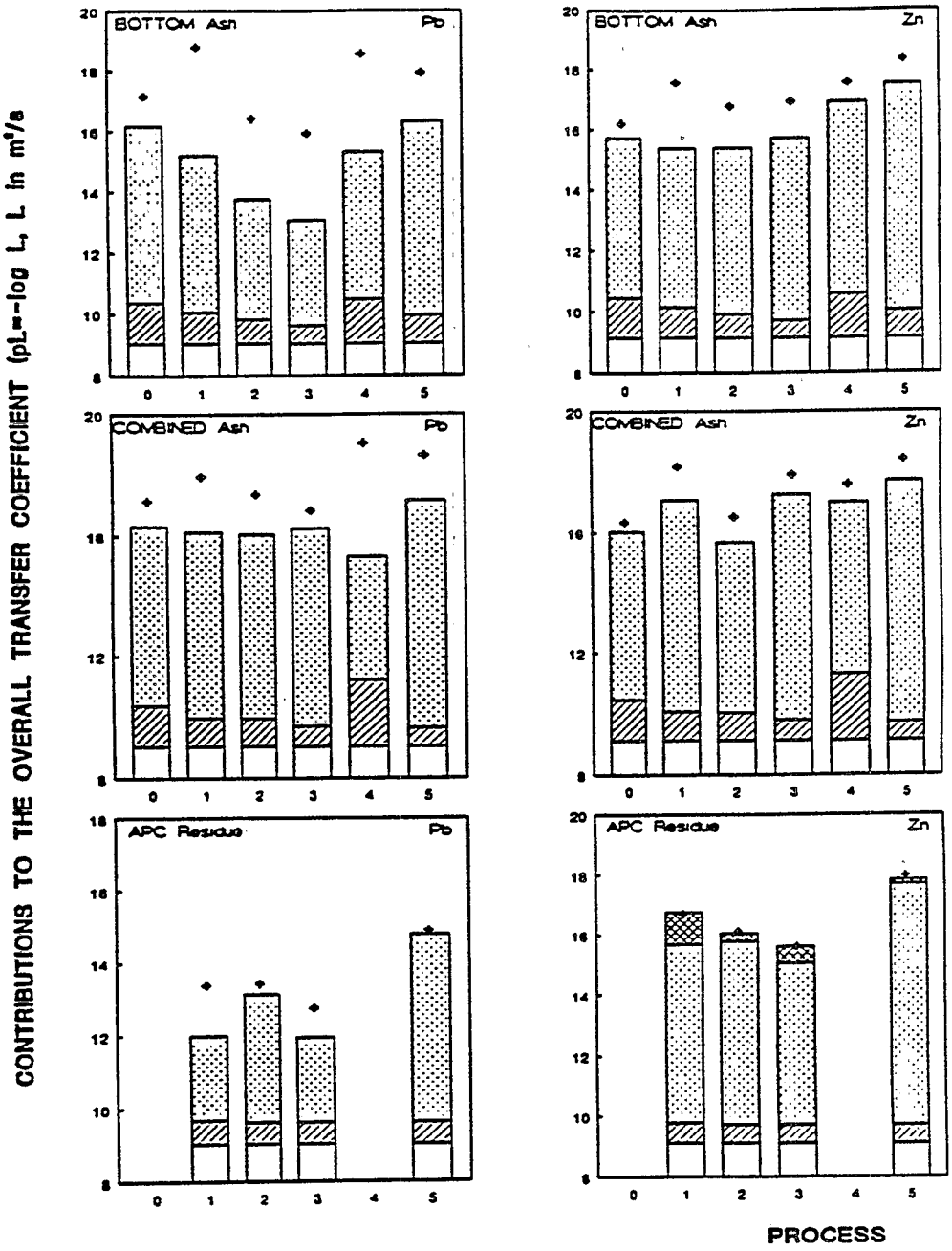


Figure 8.35. Relative contributions of free diffusion, tortuosity, and chemical retardation to the effective diffusion coefficient and the effect of availability (comparison of treatment processes (0= untreated; 5 = WES)).

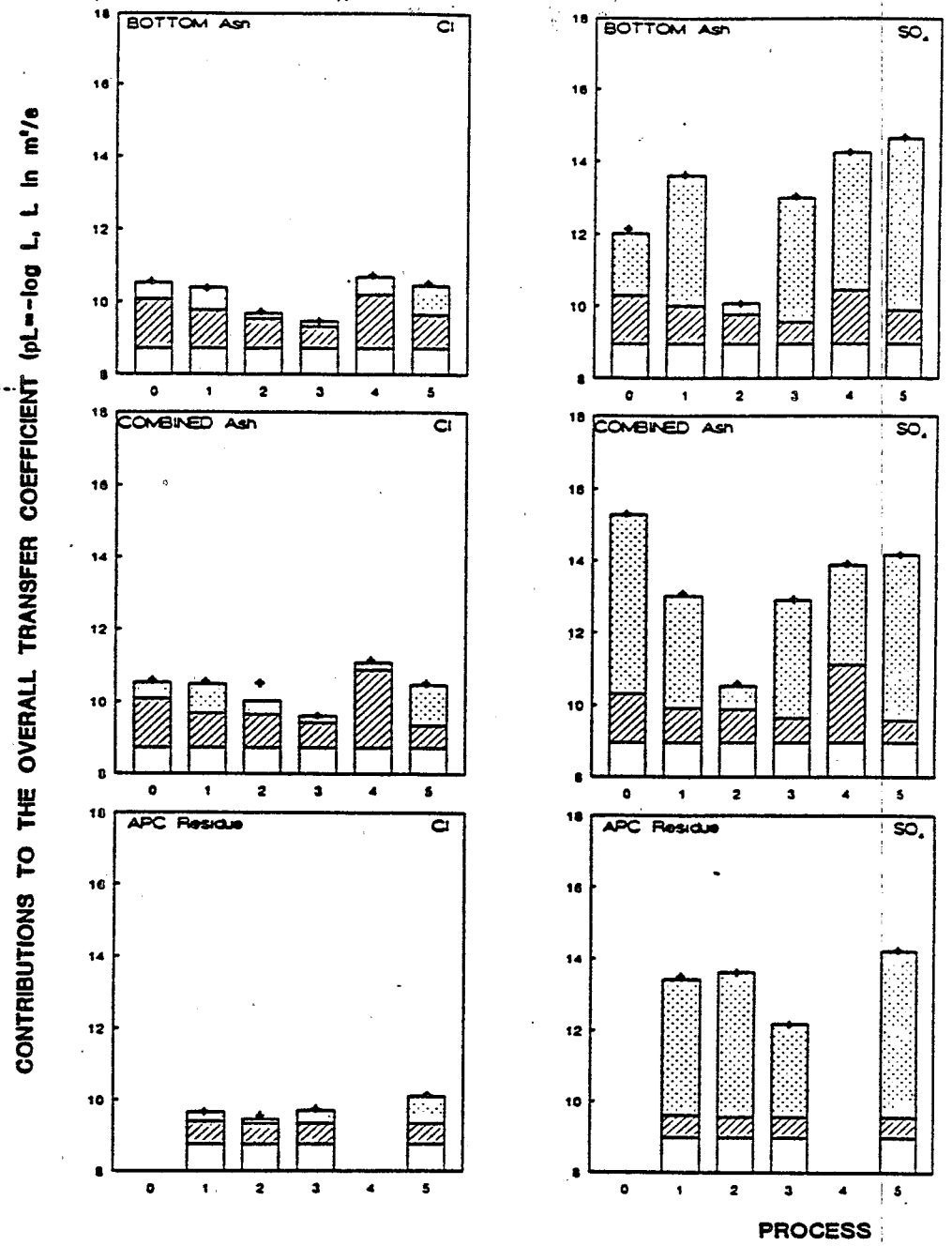


Figure 8.36. Relative contributions of free diffusion, tortuosity, and chemical retardation to the effective diffusion coefficient and the effect of availability (comparison of treatment processes (0= untreated; 5 = WES)).

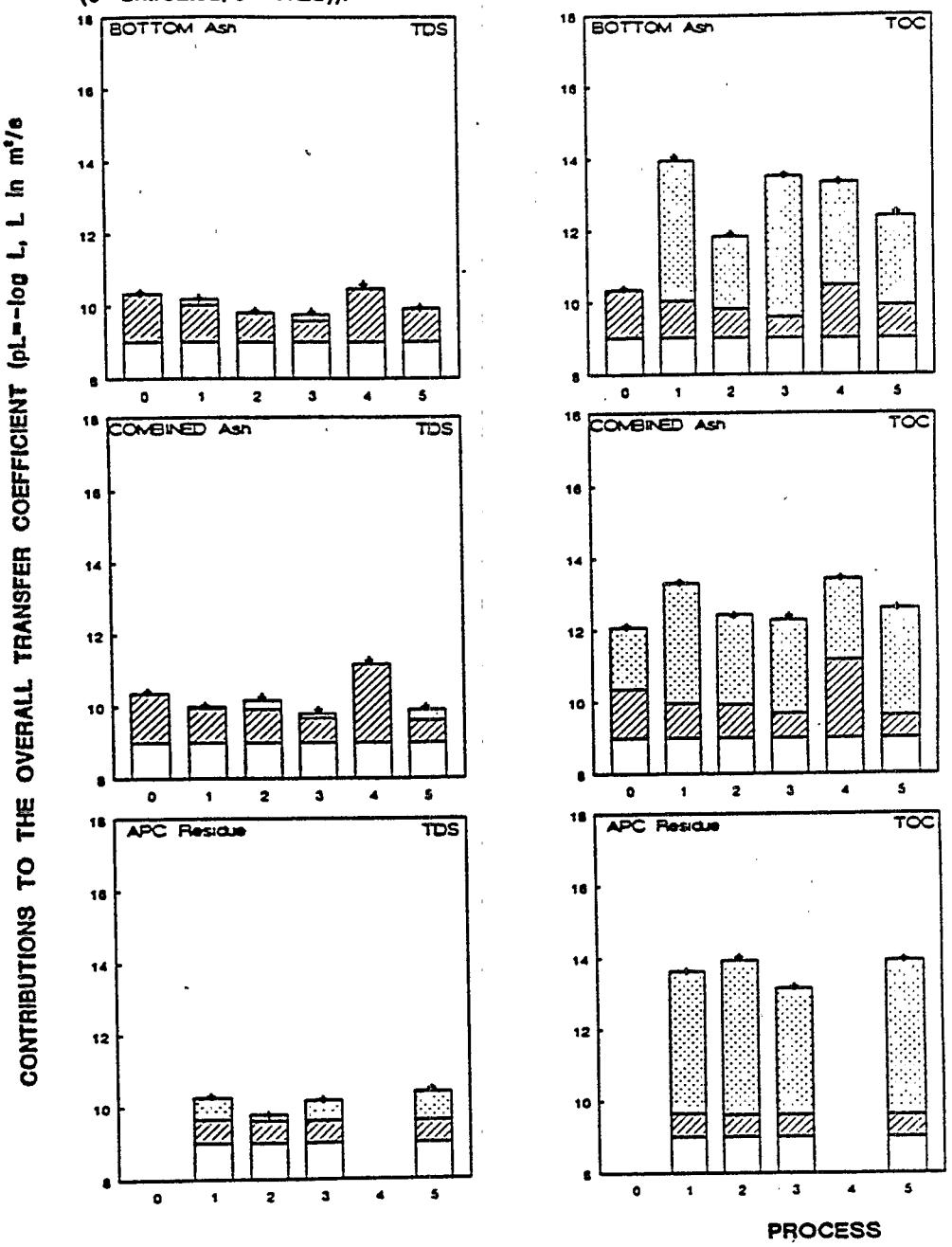
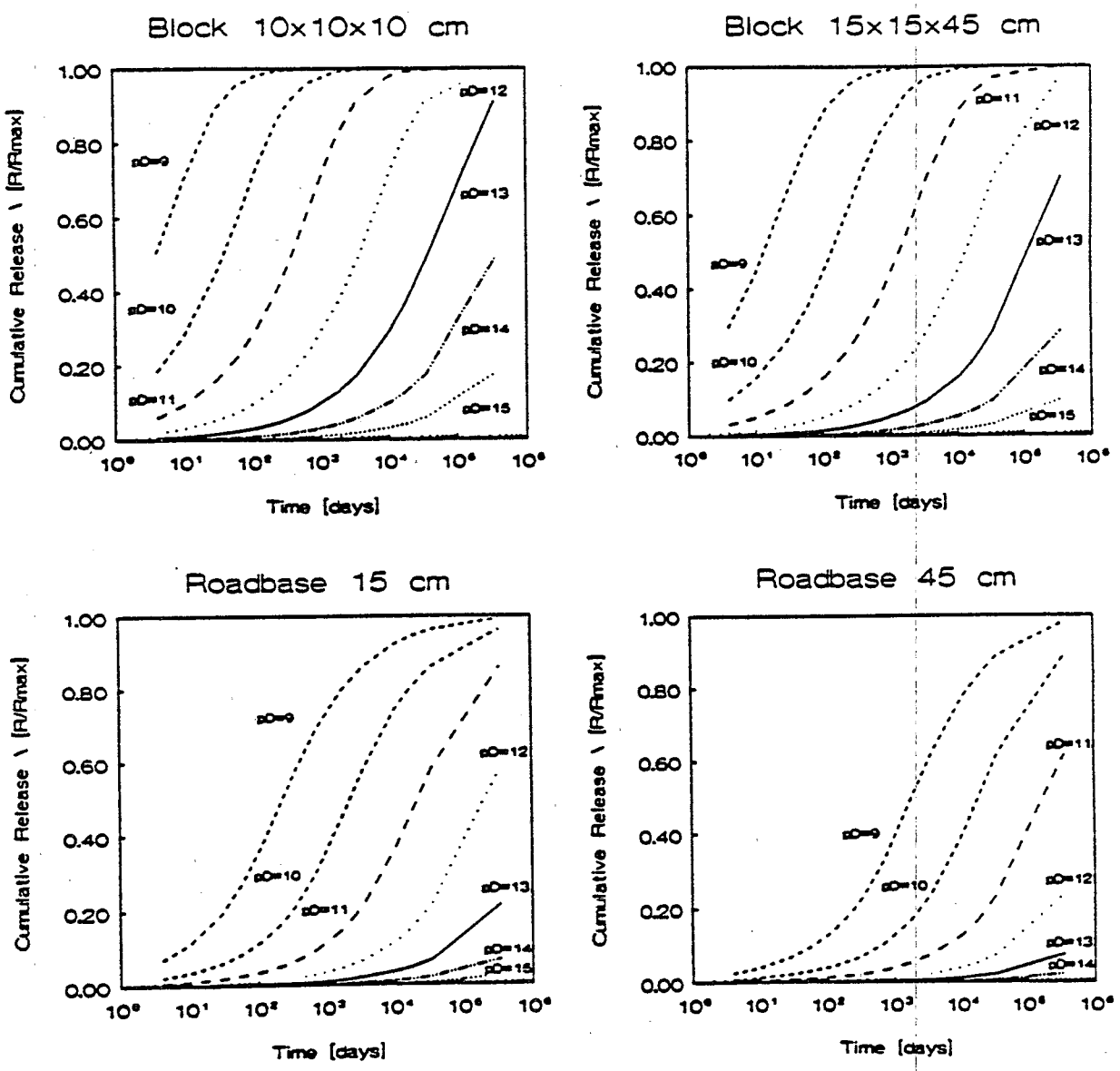


Figure 8.37. Cumulative contaminant release as a function of time and pD_e for typical construction applications. (Note 10^4 days ≡ 27 yrs.).



9. SUMMARY AND CONCLUSIONS

The objective of this study was to provide credible data on the effectiveness of the selected S/S processes for treatment of MWC bottom ash, APC residue, and combined ash. The study was conducted to provide a side-by-side comparison and evaluation of the effectiveness of MWC S/S technologies for treating bottom ash, APC residues and combined ash. The study emphasized evaluation of the S/S treatment technologies, rather than how ash characteristics are affected by municipal waste combustor designs, operating conditions, and waste input. Therefore, the number of different residues included in the study was limited to bottom ash, APC residue, and combined ash from a single mass burn MWC facility.

The specific objectives of this study were to:

1. Define residue sampling, preparation and characterization protocols to permit bench and pilot-scale demonstrations of S/S treatment processes with representative residues.

2. Carry out MWC residue S/S treatment process demonstrations under carefully controlled and monitored conditions;

3. Compare the effects of the S/S treatment processes on the fundamental physical and chemical properties of MWC residues;

4. Compare the effects of the S/S processes on leaching properties of MWC residues through laboratory procedures which included the TCLP and other tests that permit estimation of contaminant release potential and release rate over a prolonged period of time and under diverse environmental conditions; and,

5. Evaluate the physical durability of the treated MWC residues during aggressive environmental cycling tests.

The experimental design of this program was a full factorial design for the evaluation of five solidification/stabilization processes for MWC residues. The two experimental factors were the residue type to be treated and the S/S process. The experimental levels within the residue type factor were (i) bottom ash, (ii) APC residue, and (iii) combined ash. The six experimental levels within the S/S process factors were (i) the untreated residue, (ii) the WES Control S/S process, and (iii - vi) the four selected

vendor S/S processes. Thus, two experimental factors at three and six experimental levels respectively, resulted in the evaluation of eighteen experimental cases. Each experimental case was evaluated in triplicate.

The three residue types used in this study were obtained during a single composite sampling event from a typical state-of-the-art mass burn municipal waste combustor incorporating a lime slurry spray drier (wet-dry) acid gas scrubber and a fabric filter particulate removal system. Each bulk residue sample was dried, size reduced, screened and homogenized prior to use in this program. Thus all process demonstrations, testing and evaluations were carried out on pre-processed residues to facilitate laboratory-scale testing and direct treatment effect comparisons.

Five S/S processes were evaluated. Four of five of the processes were proprietary vendor applications of four different generic S/S process categories. The generic S/S process categories represented by the selected vendors were:

- S/S with Portland cement and proprietary polymeric additives (Process 1);
- S/S with Portland cement, soluble silicates and dry carbonaceous material (Process 2);
- S/S with cement kiln dust and proprietary additives (Process 3),
- S/S through addition of soluble phosphates (Process 4).

The fifth process used Type 1 Portland cement only (WES Control Process). The WES Control Process was selected to provide a baseline comparison of the treatment effects of Portland cement without vendor additives. Each experiment was evaluated in triplicate. Each experimental case was analyzed for chemical composition and tested for physical properties and durability, and leaching characteristics using a series of testing procedures (e.g.. bulk density, wet/dry, freeze/thaw, TCLP, availability leach test, monolithic leach test, etc.). Details of the testing procedures are provided in Section 2.2 of this report.

Prior to the process demonstration, each vendor received approximately 50 lb samples of each residue type to facilitate preliminary process testing and formula optimization. The vendors were provided a list of test and program objectives that were to be used to evaluate their process. The vendors were not provided specific performance criteria to which they should treat the residues. This was left to their discretion. Vendor process optimization may have focused on minimizing contaminants release based on TCLP, concurrently with minimization of cost, and not on maximizing the physical properties of the treated residue. This was probably because the primary focus of the demonstrations

was treatment for disposal with secondary focus on residue utilization. Each process demonstration replicate consisted of the vendor carrying out the specified process to produce approximately 100 lb of treated residue while EPA representatives and US Army Corp of Engineer personnel observed.

Conclusions are summarized and discussed in the following sections. Overall conclusions present the general inferences deduced from the study. The treatment process effectiveness of each residue type is discussed and conclusions are made based on the results of the physical properties, durability testing and the leaching potential and the leaching release rate. Conclusions are made on the physical and durability test methods, the leaching test methods, and the methods used for chemical analysis.

9.1 OVERALL CONCLUSIONS

The overall conclusions are based on all aspects of the study and are as follows:

- Based on comparison of untreated residues with treated residues, the S/S processes evaluated generally did not decrease the potential for release of target contaminants. The phosphate process, however did reduce the potential for Pb to be released.

- Whether the MWC residues were treated or not, release potential for metals (lead, cadmium, zinc, etc.) typically was significantly less than the total concentration present in the residues.

- Release rates of the elements were very low for compacted granular untreated bottom ash and combined ash. Release rates also were very low from bottom ash and combined ash treated by processes that produced physically durable specimens.

- The S/S processes evaluated did not successfully treat the residues to reduce the potential for release of TDS and soluble salts. Whether the MWC residues were treated or not, the release potential and release rates were high for TDS and the salts of calcium, sodium, potassium, chloride, and sulfate. The total amounts of these constituents released typically approached the total concentration in the MWC residues. In the case of the APC residues, the treatment processes increased the release potential of the salts.

- The high concentration and ultimate fate of soluble salts in MWC residues should be carefully considered in the design of treatment processes, utilization and disposal of the residues.

- Based on results from the program, APC residues have the least potential for utilization in applications requiring structurally durable products. The physical retention values for the treated APC residues indicated limited or no physical retention. The major contaminant release from the

APC residue were salts (Na, K, Ca, Cl, SO_4). *In excess of 30 percent of the total mass dissolved due to the release of salts.*

- The use of proprietary additives in the S/S processes evaluated did not enhance the strength of the treated residues. The WES Control process produced test specimens with unconfined compressive strengths greater than or equal to those processes with proprietary additives.

- Evaluation of S/S process design, performance, and treatment efficiency should be based on a matrix of several testing protocols. No single test, such as TCLP, can provide all the information required to evaluate contaminant release potential, contaminant release rate, and physical durability. An appropriate test matrix to evaluate S/S processes should include tests which will address these factors.

- TCLP was not a good indicator of release from untreated and treated residues for several reasons. Variable end-point pH for the extraction resulted in wide variation in estimated metals release because of pH dependent solubility constraints. The low liquid to solid ratio for the TCLP (20:1) also may have resulted in solubility limitations for many elements of concern. Finally, TCLP does not provide for determination of the total release of soluble salts and anions.

- Most processes evaluated in this study most likely were developed based on a limited number of testing procedures. Variations in Portland cement based and other S/S technologies will influence the degree of durability and chemical leaching potential. Therefore, substantial improvements in S/S process optimization may be obtainable by optimizing process design based on results of multiple test criteria.

- The Portland cement based processes can be formulated to produce S/S test specimens of MWC bottom and combined residues with high structural integrity and increased resistance to weathering. These type processes, if properly designed, are likely to be successful in producing monolithic products with physical properties acceptable for various utilization options. This does not mean, however, that the chemical characteristics also would be acceptable. Physical durability or possessing a monolithic structure does not ensure acceptable performance with respect to contaminant release.

- The release rate of most potentially toxic metals will be very slow to negligible for S/S treated MWC residues.

- The unconsolidated, granular nature of the ash material required that a useful method for estimating diffusion controlled release from compacted granular materials be developed. Such a

method was developed for this evaluation. The application of a modified monolith leach test to determine intrinsic leaching properties for granular materials has been proven to be very consistent, and data are comparable with results from other types of diffusion measurements. The tortuosity data obtained in the experimental setup are consistent with diffusion measurements using radiotracers.

- The most durable test specimens to the cyclic weathering tests and the immersion tests were those with the highest UCS. Thus UCS may be used as a preliminary indicator of durability.

- The monolithic leach test (MLT) for construction materials and stabilized products provides intrinsic information on long term leaching effects and usefulness in relation to product quality. The MLT also provides useful information for product quality improvement. By focusing on the controlling parameter requiring adjustment, initial estimates of release rates and fluxes for varied application scenarios can be obtained. The release mechanisms (dissolution, wash-off and diffusion) can be distinguished. The distinction between physical retention and chemical retention can be made for cases where diffusion is the controlling release mechanism. Existing regulatory tests do not provide such useful information.

- Physical retention was directly correlated with the compacted dry densities of the material for the bottom and combined ashes. The test specimens with the greater densities had more physical retention.

- The USEPA recommended methods of chemical analysis (SW-846) were not comparable in many cases to the neutron activation chemical analysis for total elemental concentrations. The USEPA method results indicated significantly lower elemental concentrations than the NAA methods suggesting that only partial analytical recoveries occurred. This discrepancy warrants further investigation into the chemical analysis methods to investigate and develop more applicable methods for similar type solid matrices.

9.2 TREATMENT PROCESS EFFECTIVENESS

The treatment process effectiveness was evaluated based on the physical properties, the leaching potential and the leaching release rate data. The data generated when testing the treated residues were compared to each other and to the data generated when the untreated residue was tested.

9.2.1 Physical Properties

The physical properties were evaluated using a range of testing protocols that resulted in empirical values for strength parameters and information on the durability of the test specimens when subjected to a range of cyclic environmental conditions.

- S/S with Portland cement, polymeric additives, and other proprietary additives (Process 1 and the WES Control) produced the treated residue with the highest UCS and the best performance on the UCS after 28 days of immersion in water, wet/dry weathering, and freeze/thaw weathering. The treatment processes required compaction during molding of the test specimens using a Proctor compaction energy. This indicates that the treated residues can be prepared in such a manner that increases strength and durability.

- The treated APC residues exhibited poor performance in all of the durability tests including UCS after immersion, wet/dry weathering, and freeze/thaw weathering. In several cases, the monolith samples degraded to an unconsolidated form. The APC residues contained high levels of sulfates and the formulations included large percentages of liquid additives. Thus, APC residues treated with the processes tested have the least potential for utilization in application requiring structural durability. Process 1 and WES Control combined ash test specimens developed less than one-half the UCS developed by the bottom ash test specimens and only slightly more UCS than the APC residue test specimens. Hence, it appears that the presence of APC residue in the combined ash may adversely affect the strength of the treated residues.

- The Process 4 vendor claimed the treatment process was formulated to produce an unconsolidated product with little structural integrity and this was reflected in the performance of the test specimens during the strength and durability testing. Process 3 bottom ash and combined ash test specimens performed poorly on the strength and durability testing as compared to the performance of the Process 1 and WES Control test specimens. These test specimens exhibited almost twice the amount of swelling of Process 1 and the WES Control bottom ash and combined ash test specimens. This behavior could be attributed to the additives used in the formulation that resulted in the swelling and weakening of the structural integrity of the treated residues.

- Process 3 included no Portland cement. The formulation and the test specimens for all three residue types performed poorly. All of the APC residue treatment processes (excluding Process 4 which was unconsolidated and not tested) and the bottom and combined ash treatment Processes 2 and 4, performed poorly during the durability tests. Process 1 and the WES Control bottom and combined ash test specimens performed better on the durability testing and

acquired higher UCS's than any of the other treatment process test specimens. These test specimens were compacted into the molds during sample preparation and were poorly, to very poorly hydrated after 28 days of curing. The correlation between these parameters and strength formation and durability warrant further investigation.

9.2.2 Leaching Potential

The TCLP, AVLT, and the DWLT are all intended to assess the maximum extent of species release, or the leaching potential, under varying environmental conditions.

- Process additives contributed substantially to the release of calcium, sodium, potassium, and sulfate in several of the test specimens for the TCLP, DWLT, and/or the AVLT. For example, Process 3 additives had high concentrations of potassium and sulfate. Potassium and sulfate release potentials in the TCLP, DWLT, and the AVLT were one to two orders of magnitude higher than the release potentials measured in the untreated residues for all three residues treated using Process 3 additives. A similar increase in release is noted for aluminum in the WES Control test specimens which used Portland cement with high concentrations of aluminum.

- The calculated process dilution factors provided accurate correction for the dilution effects of process additives used to treat bottom ash and combined ash. The calculated process dilution factors for the APC residue may result in the over estimation of release potential by up to 30 percent. The APC residue was very hydroscopic during curing and this absorbed water could not be accurately accounted for in the dilution factor calculations.

- In designing a S/S treatment process for MWC residues, leaching of total salts and dissolution of the untreated and treated residue must be considered. In this study, up to 32 weight percent, 12 weight percent, and 13 weight percent for the treated APC residue, bottom ash, and combined ash, respectively, dissolved in distilled water during serial extractions. The DWLT leachate TDS release potential was two to three times higher in the treated residues than the untreated leachates. This indicated that treatment of the residues increased the release potential of the total salts.

- Leaching tests which define a fixed quantity of acid to be added instead of the extract pH are subject to wide variations in test results which primarily reflect the alkalinity of the solidified/stabilized matrix being tested.

The increased and decreased leaching potential according to the TCLP, DWLT, and AVLT were used to determine the treatment process efficiency from a leaching potential perspective. The concentrations of aluminum, cadmium, copper, lead, zinc, calcium, potassium, sodium, chloride, and sulfate

in the leachates generated from the untreated residues were compared to that of the treated residues. The results varied widely from ash type to ash type and by leaching test and are presented in the following sections by ash type.

APC Residue

- Process 1 - For aluminum, calcium, cadmium, potassium, sodium and chloride, the leaching potential changes ranged from no change to an increase of two orders of magnitude due to treatment. For copper, lead and zinc, leaching potential changes ranged from no change to a decrease by one to two orders of magnitude. For sulfate, the leaching potential changes varied according to leaching test and ranged from no change to increase or decrease.

- Process 2 - For aluminum, calcium, potassium, sodium and chloride, the leaching potential changes ranged from no change to an increase of two orders of magnitude due to treatment. For copper, zinc, and sulfate, the leaching potential changes ranged from no change to a decrease of two orders of magnitude. For lead, the leaching potential changes varied according to leaching test and ranged from an increase to a decrease. For cadmium, there was no change in the leaching potential due to treatment.

- Process 3 - For aluminum, calcium, cadmium, potassium and sulfate, the leaching potential changes ranged from no change to an increase of one order of magnitude due to treatment. For copper only, the leaching potential changes ranged from no change to an increase of two orders of magnitude due to treatment. For lead and zinc, the leaching potential changes varied according to leaching test and ranged from an increase to a decrease. For sodium and chloride, there was no change in the leaching potential due to treatment.

- Process 4 - For cadmium, the leaching potential changes ranged from no change to an increase of two orders of magnitude due to treatment. For potassium, copper, sodium, and chloride, the leaching potential changes ranged from no change to a decrease of two orders of magnitude due to treatment. For aluminum, calcium, zinc, and sulfate, the leaching potential changes varied according to leaching test and ranged from an increase to a decrease. The leaching potential for lead was reduced by two to three orders of magnitude which is a substantial reduction when compared to the other treatment processes.

- Portland cement only (WES Control) - For aluminum, cadmium, potassium, sodium and chloride the leaching potential changes ranged from no change to an increase of two orders of magnitude

due to treatment. For calcium, copper, lead, zinc and sulfate , the leaching potential changes varied according to leaching test and ranged from an increase to a decrease.

Bottom Ash

- Process 1 - For calcium, cadmium, copper, chloride and zinc, the leaching potential changes ranged from no change to a decrease by one order of magnitude. For sulfate, the leaching potential changes decreased by one to two orders of magnitude. For aluminum, the leaching potential changes varied according to leaching test and ranged from no change to increase or decrease. There was no change in the leaching potential for potassium, sodium and lead.

- Process 2 - For aluminum, copper, lead, zinc, sodium, and sulfate, the leaching potential changes ranged from no change to an increase of two orders of magnitude due to treatment. The increased sodium release is likely attributable to additives. For calcium, the leaching potential changes varied according to leaching test and ranged from no change to a decrease. For cadmium, potassium, and chloride, there was no change in the leaching potential due to treatment.

- Process 3 - For calcium, copper, lead, potassium and sulfate, the leaching potential changes ranged from no change to an increase of two orders of magnitude due to treatment. The increased potassium and sulfate release is likely attributable to additives. For aluminum, cadmium, sodium, chloride and zinc, there was no change in the leaching potential due to treatment. There were no decreases in leaching potential observed for this process.

- Process 4 - For calcium, cadmium and zinc, the leaching potential changes ranged from no change to an increase of two orders of magnitude due to treatment. For aluminum, chloride, and sulfate, the leaching potential changes decreased by one to two orders of magnitude. There were no changes in leaching potential observed for potassium, copper, sodium and lead.

- WES Control - For cadmium, copper, lead and zinc, the leaching potential changes ranged from no change to an increase of two orders of magnitude due to treatment. For sulfate, the leaching potential changes varied from no change to a reduction of two orders of magnitude. For aluminum, the leaching potential changes varied according to leaching test and ranged from an increase to a decrease. For calcium potassium, sodium, and chloride, there was no change in the leaching potential due to treatment.

Combined Ash

- Process 1 - For aluminum, cadmium, copper, sulfate and zinc, the leaching potential changes ranged from no change to a decrease by one order of magnitude. For calcium, the leaching potential changes varied according to leaching test and ranged from no change to an increase of an order of magnitude. For lead, the leaching potential changes varied according to leaching test and ranged from no change to increase or decrease. There was no change in potential for potassium, sodium and chloride.

- Process 2 - For sodium and sulfate, the leaching potential changes ranged from no change to an increase of two orders of magnitude due to treatment. The increased sodium release is likely attributable to additives. For cadmium, the leaching potential changes varied according to leaching test and ranged from no change to a decrease of two orders of magnitude. For calcium, copper, lead, and zinc, the leaching potential changes varied according to leaching test and ranged from no change to increase or decrease. For aluminum, potassium, and chloride, there was no change in the leaching potential due to treatment.

- Process 3 - For aluminum, calcium, potassium and sulfate, the leaching potential changes ranged from no change to an increase of two orders of magnitude due to treatment. The increased potassium and sulfate release is likely attributable to additives. For cadmium, copper and zinc, the leaching potential changes ranged from no change to a decrease in leaching potential by one order of magnitude. For lead, the leaching potential changes varied according to leaching test and ranged from an increase to a decrease. For sodium and chloride, there was no change in the leaching potential due to treatment.

- Process 4 - For aluminum, calcium, cadmium, copper, lead, chloride, zinc and sulfate, the leaching potential changes ranged from no change to a decrease in leaching potential by two orders of magnitude. For potassium and chloride, there was no change in the leaching potential due to treatment.

- WES Control - For aluminum, calcium, and sulfate, the leaching potential changes ranged from no change to a decrease in leaching potential by two orders of magnitude. For lead, the leaching potential changes range from no change to an increase of one order of magnitude. For cadmium, potassium, copper, sodium, chloride and zinc there was no change in the leaching potential due to treatment.

9.2.3 Leaching Release Rate

The release rate is a function of availability, physical retention, and chemical retention. The following conclusions on the leaching release rate have been made on based on these parameters.

- The physical retention in the solidified/stabilized APC residues for all of the vendor processes and for Process 3, all ash types, was limited or nonexistent. The physical retention values for these materials approached or were essentially the same as the theoretical lower limit of 1, or no physical retention. Only minor physical retention was observed for the solidified/stabilized bottom ash and combined ashes. The physical retention of the untreated bottom and the untreated combined ash was greater than for the treated ashes. Process 4 indicated a higher physical retention than any of the other treatment processes. Physical retention obtained by the treatment processes tested was poor in comparison to physical retention values achieved by construction materials, S/S coal ash and S/S incineration bottom ash reported in other studies.

- The chemical retention in the untreated bottom and combined ash often was greater than in the treated material. The retention values for individual elements in the products from the different processes are consistent. This indicates systematic trends dictated by the major element chemistry in the product matrices, which does not appear to be greatly different between the different vendor processes, except Process 4. A few typical differences were observed. In Process 2, the addition of process additives resulted in increased mobility of the aluminum and sulfate. The mobilities of barium, calcium and strontium were significantly decreased as a consequence of the higher sulfate mobility. It appears that in Process 3 the highest pH levels are occurring in the porewater, based on the sensitivity of magnesium mobility to pH. The higher Mg retention in Process 4 also may be attributed to the formation of new mineral phases. In Process 4, an increase in the aluminum release was noted, which may indicate the mobilization and subsequent precipitation of alumna phosphates.

- The S/S bottom ash and combined ash resulted in less physical retention than the compacted untreated residues except for Process 4. Physical retention was directly correlated with the compacted dry densities of the materials, with greater densities resulting in greater physical retention.

- The major contaminants released from APC residue were salts. In view of the high salt content in APC residue of up to 30 percent of the total mass, the release of salts will proceed rather rapidly and leave large voids. This will increase matrix porosity and reduce physical retention. The release of salts ultimately will lead to the deterioration of the material. The stabilized APC

residue after leaching was highly porous. The release pattern initially reflects (24 - 28 hr.) diffusion control, then the voids open up due to loss of mass by dissolution, and ultimately the release levels off through depletion of leachable salt. Clearly, the stabilized APC residues can not be regarded as truly stabilized matrices. All APC products showed either breakdown of product matrix or substantial wear during the testing period of 2 months. In view of the high salt leaching, attention should be focused on the release of these apparently constituents.

- The release rate of most potentially toxic metals will be very slow to negligible for S/S treated MWC residues which maintain physical durability. However, the release of elements such as sodium, potassium and chloride will be very rapid even when physical durability is maintained.

9.3 PHYSICAL PROPERTIES AND DURABILITY TEST METHODS

The conclusions based on the methods used to determine the physical properties and the durability of the treated and untreated residues are the following:

- The UCS after immersion test with a 28 day immersion period is useful for assessment of structural durability in exposed utilization applications. Processes for which products disintegrated or resulted in decreasing strength may not satisfy structural requirements in these applications. Processes resulting in stable or increasing strengths should be evaluated further.
- The freeze/thaw weathering test was the most aggressive of the durability tests applied in this study.
- Permeability could not be correlated to the strength or durability of the test specimens.
- The correlation between degree of hydration, strength formation, and durability warrant further investigation
- Physical retention was directly correlated with the compacted dry densities of the materials, for the bottom and combined ashes. The test specimens with the greater densities had more physical retention. The APC residues had little or no physical retention due to the release of salts. The large salt release resulted in increased porosity and led to the deterioration of the samples.

9.4 LEACHING TESTS

The conclusions based on the leaching test methods used to determine the leaching potential and the leaching release rate of the treated and untreated residues are:

- Results obtained from any single leaching test do not clearly define either the potential for contaminant release or the rate of release.

- Leaching tests which define a fixed quantity of acid to be added instead of defining the extract pH are subject to wide variations in test results which primarily reflect the alkalinity of the S/S matrix being tested.

- Effective diffusion coefficients estimated based on total species concentration in the solid phase instead of available species concentration may result in underestimation of the diffusion coefficient by up to two orders of magnitude. This may lead to underestimating the actual rate of release.

9.5 CHEMICAL ANALYSIS

- PCDDs and PCDFs were present in extremely low concentrations in all untreated residues tested and therefore should not be a health risk concern in the treated residues evaluated in this study.

- *Analysis of total chloride, sulfate and dissolvable solids in solid untreated and treated residues using the SW-846 methods was not consistent. Improved analytical methods are needed for these matrices.*

- Analysis of total elemental composition of the untreated and treated residues for metals resulted in underestimation of the concentration of several elements because of incomplete acid digestion techniques. The SW-846 acid digestion was not sufficient for the dissolution of elemental species from a silicate matrix. SW-846 digestion methods need to be improved as applied to these matrices to obtain true total estimates. This is particularly important in the determination of elemental mass balances. This effect was most pronounced for chromium, aluminum and zinc. Similar effects may be present for lead, but were not verified.

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11. APPENDICES

Table of Contents

			Page
APPENDIX A	**RESULTS OF CHEMICAL ANALYSIS OF UNTREATED MWC RESIDUES.**		280
	APPENDIX A.1	Results of chemical analysis of untreated APC residue.	282
	APPENDIX A.2	Results of chemical analysis of untreated bottom ash.	290
	APPENDIX A.3	Results of chemical analysis of untreated combined ash.	302
APPENDIX B	**SUMMARY RESULTS OF TCLP, DWLT AND AVLT FOR UNTREATED AND TREATED MWC RESIDUES**		314
	APPENDIX B.1	Summary results of TCLP, DWLT and AVLT for untreated and treated APC residues.	315
	APPENDIX B.2	Summary results of TCLP, DWLT and AVLT for untreated and treated bottom ash.	341
	APPENDIX B.3	Summary results of TCLP, DWLT and AVLT for untreated and treated combined ash.	368
APPENDIX C	**SUMMARY OF MONOLITH LEACH TEST EXTRACT CONCENTRATIONS AND DATA ANALYSIS FOR UNTREATED AND TREATED MWC RESIDUES.**		394
	APPENDIX C.1	Summary of monolith leach test extract concentrations and data analysis for untreated bottom ash and combined ash.	397
	APPENDIX C.2	Summary of monolith leach test extract concentrations and data analysis for APC residue, bottom ash and combined ash treated by Process 1.	418
	APPENDIX C.3	Summary of monolith leach test extract concentrations and data analysis for APC residue, bottom ash and combined ash treated by Process 2.	448
	APPENDIX C.4	Summary of monolith leach test extract concentrations and data analysis for APC residue, bottom ash and combined ash treated by Process 3.	478
	APPENDIX C.5	Summary of monolith leach test extract concentrations and data analysis for APC residue, bottom ash and combined ash treated by Process 4.	508
	APPENDIX C.6	Summary of monolith leach test extract concentrations and data analysis for APC residue, bottom ash and combined ash treated by WES Control Process.	529

EXPLANATION OF APPENDICES

1. The "ds" notation indicates that results have been corrected to a dry weight basis.

2. The coefficient of variation (CV) for replicated data are tabulated.

3. The footnote notation and the meaning of each are listed as follows:

   u - Undetected. The detection limits are indicated in the table

   A - U(1 of 3) Indicates that 1 of the 3 replicates analyzed resulted in an undetected value. The Detection limit value was used for calculation of the mean value.

   B - U(2 of 3) Indicates that 2 of the 3 replicates analyzed resulted in an undetected value. The detection limit value was used for calculation of the mean value.

   NA - Not Analyzed

4. Results from leaching tests are tabulated on three separate bases:

   (1) Concentration in extract from leaching test, which is reported with units of either ug/l or mg/l.

   (2) Release basis which reports the mass of particular species reported released from the mass of sample extracted, either untreated or treated residue. These are reported with units of mg/kg ds and have been corrected to adry wieght basis.

   (3) Release based on untreated residue. The release is corrected for process dilution during treatment. These are reported in units of mag/kg ash or mag/kg ash treated.

Appendix A - Results of chemical analysis of untreated MWC residues.

List of Tables:

Table Number	Description
APC Residue (Appendix A.1)	
A.1-1	Solids by SW-846, <300µm fraction, Set 1 [mg/kg] (see Note 1)
A.1-2	Solids by SW-846, <300µm fraction, Set 1, corrected to dry solid basis [mg/kg d.s.] (see Note 1)
A.1-3	Solids by SW-846, <300µm fraction, Set 2 [mg/kg] (see Note 1)
A.1-4	Solids by SW-846, <300µm fraction, Set 2, corrected to dry solid basis [mg/kg d.s.] see Note 1)
A.1-5	NAA, <300mm fraction [mg/kg d.s.] (see Note 1)
A.1-6	NAA Summary, <300µm fraction, [mg/kg] and corrected to dry solid basis [mg/kg d.s.] (see Note 2)
Bottom Ash (Appendix A.2)	
A.2-1	Reject fraction (>2mm) from particle size reduction, Set 1 (see Note 3)
A.2-2	<2mm fraction from particle size reduction, Set 1 (see Note 3)
A.2-3	<300µm fraction from particle size reduction, Set 1 (see Note 3)
A.2-4	<300µm fraction from particle size reduction corrected to dry solid basis, Set 1 (see Note 3)
A.2-5	Reject fraction (72 mm) from particle size reduction, Set 2 (see Note 3)
A.2-6	<2mm fraction from particle size reduction, Set 2 (see Note 3)
A.2-7	<300µm fraction from particle size reduction (see Note 3)
A.2-8	<300µm fraction from particle size reduction, corrected to dry solid basis, Set 2 (see Note 3)
A.2-9	NAA, <300µm fraction [mg/kg] (see Note 2)
A.2-10	NAA summary, <300µm fraction [mg/kg d.s.] (see Note 2)

Table Number	Description
	Combined Ash (Appendix A.3)
A.3-1	Reject fraction (>2mm) from particle size reduction, Set 1 (see Note 3)
A.3-2	<2mm fraction from particle size reduction, Set 1 (see Note 3)
A.3-3	<300µm fraction from particle size reduction, Set 1 (see Note 3)
A.3-4	<300µm fraction from particle size reduction corrected to dry solid basis, Set 1 (see Note 3)
A.3-5	Reject fraction (72 mm) from particle size reduction, Set 2 (see Note 3)
A.3-6	<2mm fraction from particle size reduction, Set 2 (see Note 3)
A.3-7	<300µm fraction from particle size reduction (see Note 3)
A.3-8	<300µm fraction from particle size reduction, corrected to dry solid basis, Set 2 (see Note 3)
A.3-9	NAA, <300µm fraction [mg/kg] (see Note 2)
A.3-10	NAA summary, <300µm fraction [mg/kg d.s.] (see Note 2)

Notes:

1. All of the untreated APC residue passed through a 300µm mesh with minimal effort. Analysis was carried out on 3 grab samples from randomly selected 55 gallon drums of the APC residue after homogenization (See Chapter 3.1) for Set 1. An additional 3 grab samples from randomly selected drums was analyzed for Set 2.
2. NAA was carried out on one grab sample from each of the 55 gallon drums indicated by the sample identifier. All samples were size reduced to <300µm prior to NAA.
3. These analyses were carried out on the residue particle size fractions resulting from the particle size reduction procedure described in Chapter 2.5. Analysis was carried out on bottom ash and combined ash grab samples from randomly selected 55 gal drums after residue preparation (see Chapter 3.1) for Set 1 and an additional 3 grab samples from different drums for Set 2.

Appendix A. 1.

Results of chemical analysis of untreated APC residue

PROCESS: Untreated, Set 1
ASH TYPE: APC Residue, <300 um
ASSAY: Solids by SW-846

A. 1-1

	A	B	C	X	C.V.
Metals (mg/kg)					
Aluminum	13500.0	13200.0	12100.0	12933.3	0.06
Antimony	NA	NA	NA	NA	
Arsenic	29.8	59.6	34.4	41.3	0.39
Barium	353.0	348.0	342.0	347.7	0.02
Beryllium	U	U	U	U	
Boron	179.0	180.0	176.0	178.3	0.01
Cadmium	192.0	184.0	189.0	188.3	0.02
Calcium	NA	NA	NA	NA	
Chromium	38.3	38.3	39.3	38.6	0.01
Cobalt	NA	NA	NA	NA	
Copper	354.0	337.0	347.0	346.0	0.02
Iron	NA	NA	NA	NA	
Lead	2880.0	2770.0	2830.0	2826.7	0.02
Lithium	12.5	12.0	11.6	12.0	0.04
Magnesium	NA	NA	NA	NA	
Manganese	NA	NA	NA	NA	
Mercury	41.6	47.9	41.4	43.6	0.08
Molybdenum	NA	NA	NA	NA	
Nickel	26.0	25.0	24.0	25.0	0.04
Potassium	NA	NA	NA	NA	
Selenium	3.3	ND	3.0	3.2	0.07
Silicon	NA	NA	NA	NA	
Silver	42.3	40.6	42.0	41.6	0.02
Sodium	NA	NA	NA	NA	
Strontium	NA	NA	NA	NA	
Tin	580.0	561.0	582.0	574.3	0.02
Titanium	NA	NA	NA	NA	
Vanadium	NA	NA	NA	NA	
Zinc	2820.0	2680.0	3100.0	2866.7	0.07
Anions (mg/kg)					
Bromide	4880.0	5090.0	5130.0	5033.3	0.03
Fluoride	18.8	18.7	18.9	18.8	0.01
Chloride	177000.0	170000.0	180000.0	175666.7	0.03
Sulfate	6660.0	6310.0	5120.0	6030.0	0.13
Nitrogen Species:					
Nitrite	0.10	0.10	0.11	0.10	0.06
Nitrate	26.2	28.6	29.6	28.1	0.06
Ammonia	2.4	2.1	2.0	2.2	0.10
Phosphorous	2100.0	2200.0	1160.0	1680.0	0.34
Other Assays (mg/kg)					
pH (S.U.)					
TDS(Extract)	319000.0	332000.0	347000.0	332666.7	0.04
COD	24600.0	31200.0	25400.0	27066.7	0.13
TOC	4260.0	4320.0	2950.0	3843.3	0.20
TS (%)	99.00	99.40	99.00	99.13	0.00

File: Unt Flv Sol.<300um/Set1 U=undetected,A=U(1of3),B=U(2of3),NA=not analyzed

PROCESS: Untreated, Set 1
ASH TYPE: APC Residue, <300 um
ASSAY: Solids by SW-846

A. 1-2

	A	B	C	X	C.V.
Metals (mg/kg de)					
Aluminum	14180.7	13924.1	12656.9	13587.2	0.06
Antimony	NA	NA	NA	NA	
Arsenic	31.3	62.9	36.0	43.4	0.39
Barium	370.8	367.1	357.7	365.2	0.02
Beryllium	0.0 U	U	U	U	
Boron	188.0	189.9	184.1	187.3	0.02
Cadmium	201.7	194.1	197.7	197.8	0.02
Calcium	NA	NA	NA	NA	
Chromium	40.2	40.4	41.1	40.6	0.01
Cobalt	NA	NA	NA	NA	
Copper	371.8	355.5	363.0	363.4	0.02
Iron	NA	NA	NA	NA	
Lead	3025.2	2921.9	2960.3	2969.1	0.02
Lithium	13.1	12.7	12.1	12.6	0.04
Magnesium	NA	NA	NA	NA	
Manganese	NA	NA	NA	NA	
Mercury	43.7	50.5	43.3	45.8	0.09
Molybdenum	NA	NA	NA	NA	
Nickel	27.3	26.4	25.1	26.3	0.04
Potassium	NA	NA	NA	NA	
Selenium	3.5	3.0 U	3.1	3.2 A	0.07
Silicon	NA	NA	NA	NA	
Silver	44.4	42.8	43.9	43.7	0.02
Sodium	NA	NA	NA	NA	
Strontium	NA	NA	NA	NA	
Tin	609.2	591.8	608.8	603.3	0.02
Titanium	NA	NA	NA	NA	
Vanadium	NA	NA	NA	NA	
Zinc	2962.2	2827.0	3242.7	3010.6	0.07
Anions (mg/kg de)					
Bromide	5126.1	5369.2	5366.1	5287.1	0.03
Fluoride	19.7	19.7	19.8	19.7	0.00
Chloride	185924.4	179324.9	188284.5	184511.3	0.03
Sulfate	6995.8	6656.1	5355.6	6335.9	0.14
Nitrogen Species:					
Nitrite	0.11	0.11	0.12	0.11	0.05
Nitrate	27.5	30.2	31.0	29.6	0.06
Ammonia	2.5	2.2	2.1	2.3	0.10
Phosphorous	2205.9	2320.7	1213.4	1767.0	0.34
Other Assays (mg/kg de)					
pH (S.U.)					
TDS(Extract)	335084.0	350211.0	362970.7	349421.9	0.04
COD	25840.3	32911.4	26569.0	28440.3	0.14
TOC	4474.8	4557.0	3085.8	4039.2	0.20
TS (%)	99.00	99.40	99.30	99.23	0.00

File: Unt.Fly Sol.<300um/Set1 U=undetected,A=U(1of3),B=U(2of3),NA=not analyzed

PROCESS: Untreated, Set 2
ASH TYPE: APC Residue, <300 um
ASSAY: Solids by SW-846

A. 1-3

	A	B	C	X	C.V.
Metals (mg/kg)					
Aluminum	18000.0	16000.0	18000.0	17333.3	0.07
Antimony	0.0	0.0	0.0	NA	
Arsenic	76.0	86.0	90.0	84.0	0.09
Barium	430.0	40.0	440.0	303.3	0.75
Beryllium	1.6	1.5	1.8 U	U	
Boron	NA	NA	NA	NA	
Cadmium	220.0	220.0	220.0	220.0	0.00
Calcium	NA	NA	NA	NA	
Chromium	44.0	38.0	48.0	43.3	0.12
Cobalt	NA	NA	NA	NA	
Copper	380.0	370.0	470.0	406.7	0.14
Iron	NA	NA	NA	NA	
Lead	2100.0	3400.0	3400.0	2966.7	0.25
Lithium	12.0	12.0	14.0	12.7	0.09
Magnesium	NA	NA	NA	NA	
Manganese	NA	NA	NA	NA	
Mercury	74.0	60.0	76.0	70.0	0.12
Molybdenum	NA	NA	NA	NA	
Nickel	32.0	28.0	38.0	32.7	0.15
Potassium	NA	NA	NA	NA	
Selenium	5.0 U	5.0 U	5.0	5.0	0.00
Silicon	NA	NA	NA	NA	
Silver	16.0	15.0	14.0	15.0	0.07
Sodium	NA	NA	NA	NA	
Strontium	NA	NA	NA	NA	
Tin	740.0	710.0	750.0	733.3	0.03
Titanium	NA	NA	NA	NA	
Vanadium	NA	NA	NA	NA	
Zinc	13000.0	13000.0	13000.0	13000.0	0.00
Anions (mg/kg)					
Bromide	NA	NA	NA	NA	
Fluoride	NA	NA	NA	NA	
Chloride	NA	NA	NA	NA	
Sulfate	NA	NA	NA	NA	
Nitrogen Species:					
Nitrite	NA	NA	NA	NA	
Nitrate	NA	NA	NA	NA	
Ammonia	NA	NA	NA	NA	
Phosphorous	NA	NA	NA	NA	
Other Assays (mg/kg)					
pH (S.U.)	NA	NA	NA	NA	
TDS(Extract)	NA	NA	NA	NA	
COD	NA	NA	NA	NA	
TOC	NA	NA	NA	NA	
TS (%)					

File: Unt Fly Ash <300um\Set2\r U=undetected A=U(1of3) B=U(2of3),NA=not analyzed

PROCESS: Untreated, Set 2
ASH TYPE: APC Residue, <300 um
ASSAY: Solids by SW-846

	A	B	C	X	C.V.
Metals (mg/kg ds)					
Aluminum	18907.6	16877.6	18828.5	18204.6	0.06
Antimony	NA	NA	NA	NA	
Arsenic	79.8	90.7	94.1	88.2	0.08
Barium	451.7	42.2	460.3	318.0	0.75
Beryllium	1.7 U	U	U	U	
Boron	NA	NA	NA	NA	
Cadmium	231.1	232.1	230.1	231.1	0.00
Calcium	NA	NA	NA	NA	
Chromium	46.2	40.1	50.2	45.5	0.11
Cobalt	NA	NA	NA	NA	
Copper	399.2	390.3	491.6	427.0	0.13
Iron	NA	NA	NA	NA	
Lead	2205.9	3586.5	3556.5	3116.3	0.25
Lithium	12.6	12.7	14.6	13.3	0.09
Magnesium	NA	NA	NA	NA	
Manganese	NA	NA	NA	NA	
Mercury	77.7	63.3	79.5	73.5	0.12
Molybdenum	NA	NA	NA	NA	
Nickel	33.6	29.5	39.7	34.3	0.15
Potassium	NA	NA	NA	NA	
Selenium	5.3	3.0 U	5.2	4.5 A	0.29
Silicon	NA	NA	NA	NA	
Silver	16.8	15.8	14.6	15.8	0.07
Sodium	NA	NA	NA	NA	
Strontium	NA	NA	NA	NA	
Tin	777.3	748.9	784.5	770.3	0.02
Titanium	NA	NA	NA	NA	
Vanadium	NA	NA	NA	NA	
Zinc	13655.5	13713.1	13598.3	13655.6	0.00
Anions (mg/kg ds)					
Bromide	NA	NA	NA	NA	
Fluoride	NA	NA	NA	NA	
Chloride	NA	NA	NA	NA	
Sulfate	NA	NA	NA	NA	
Nitrogen Species:					
Nitrite	NA	NA	NA	NA	
Nitrate	NA	NA	NA	NA	
Ammonia	NA	NA	NA	NA	
Phosphorous	NA	NA	NA	NA	
Other Assays (mg/kg ds)					
pH (S.U.)					
TDS(Extract)	NA	NA	NA	NA	
COD	NA	NA	NA	NA	
TOC	NA	NA	NA	NA	
TS (%)					

File: Unt.Fly Sol.<300um/Set2/r U=undetected,A=U(1of3),B=U(2of3),NA=not analyzed

A. 1-4

PROCESS: Untreated
ASH TYPE: APC Residue
ASSAY: Solids by Neutron Activation

Units: mg/kg

	<300 μ m, ground					
Drum #	1	2	4	5	6	7
Aluminum	26300	25820	24300	23600	22800	26700
Antimony	1120	1040	1110	1080	1080	1050
Bromine	3830	3680	3860	3720	3740	3610
Cadmium	139	135	144	144	140	105
Calcium	282000	278000	288000	297000	286000	277000
Cerium	14.7	17.4	11.7	13.2	16.5	16.3
Cesium	2.89	2.72	3.47	3.79	3.49	3.74
Chlorine	163000	160000	169000	174000	167000	160000
Chromium	198	185	196	189	205	194
Cobalt	14.3	14.1	13.7	14.3	16.3	15.3
Copper	500 U	520	600 U	500 U	400 U	440
Indium	1.27	1.20	1.18	1.06	1.14	1.32
Iodine	47.8	45.7	41.1	37.2	40.5	50.7
Iron	5940	6140	6450	6280	6610	6330
Lanthanum	6.18	5.93	5.21	5.02	5.16	6.11
Maganese	436	377	428	453	436	414
Mercury	10.1	9.43	9.81	9.46	8.24	10.5
Potassium	15500	14100	16100	15400	15400	15300
Samarium	0.565	0.553	0.419	0.411	0.517	0.544
Scandium	2.62	2.38	2.38	2.41	2.31	2.70
Selenium	7.36 U	7.07 U	8.41	7.72 U	7.98 U	7.78 U
Silicon	71000	33000	37000	41000	30000 U	31000
Silver	50.1	50.3	55.8	55.9	55.8	53.1
Sodium	21000	20000	20200	21600	19200	19900
Tantalum	1.27 U	1.65	1.31 U	1.46 U	1.37 U	1.23
Thorium	3.06	2.71	1.53	2.29	2.07	2.32
Titanium	6100	5200	5300	5300	6400	6400
Vanadium	17.4	20.5	15.4 U	11.0	11.6 U	19 4
Zinc	16800	16200	18100	18300	18000	17100

A. 1-5

PROCESS: Untreated
ASH TYPE: APC Residue
ASSAY: Solids by Neutron Activation

Units: mg/kg

	<300 μ m, ground				
Drum #	8	9	10	12	15
Aluminum	26600	22800	26600	22300	25400
Antimony	1040	1080	1070	1100	1110
Bromine	3630	3750	3760	3970	3950
Cadmium	126	144	145	129	134
Calcium	291000	285000	289000	288000	289000
Cerium	16.2	13.5	9.23	12.1	16.4
Cesium	3.18	2.98	2.86	2.76	2.60
Chlorine	167000	168000	164000	167000	167000
Chromium	207	190	186	173	196
Cobalt	18.6	17.2	11.0	15.2	14.0
Copper	580	530	510	500 U	500
Indium	1.23	1.07	1.08	1.20	1.24
Iodine	40.2	34.6	41.3	37.6	39.1
Iron	6630	6260	5700	5500	6460
Lanthanum	5.65	5.03	5.28	4.98	5.85
Maganese	436	390	448	411	381
Mercury	9.51	8.49	8.96	7.96	9.28
Potassium	15300	14800	15800	14600	16700
Samarium	0.526	0.402	0.447	0.444	0.499
Scandium	2.52	2.18	2.29	1.96	2.43
Selenium	8.53 U	8.69	7.63 U	6.85 U	12.4
Silicon	46000	35000	51000	30000 U	44000
Silver	54.3	52.4	47.7	49.9	54.3
Sodium	20400	19300	20400	20400	20200
Tantalum	2.09	1.54	1.31	1.94	1.44
Thorium	2.45	2.03	2.30	2.18	2.24
Titanium	4800	3700	6000	6200	5900
Vanadium	24.1	22.6	21.8	18.9	19.8
Zinc	17800	17300	15800	16300	17400

[illegible]

A. 1-5

PROCESS: Untreated
ASH TYPE: APC Residue
ASSAY: Solids by Neutron Activa

Units: mg/kg

<300 m ,ground		
	x	st.dev/x
Aluminum	25202	0.09
Antimony	1080	0.03
Bromine	3773	0.03
Cadmium	135	0.09
Calcium	285364	0.02
Cerium	14.29	0.18
Cesium	3.13	0.14
Chlorine	166000	0.02
Chromium	192.64	0.05
Cobalt	14.91	0.13
Copper	507.27	0.11
Indium	1.18	0.07
Iodine	41.44	0.12
Iron	6211	0.06
Lanthanum	5.49	0.08
Magenese	419.18	0.06
Mercury	9.23	0.08
Potassium	15364	0.05
Samarium	0.48	0.13
Scandium	2.38	0.09
Selenium	8.22	0.18
Silicon	40818	0.30
Silver	53	0.05
Sodium	20160	0.03
Tantalum	1.51	0.19
Thorium	2.29	0.17
Titanium	5573	0.15
Vanadium	18.41	0.23
Zinc	17191	0.05

A. 1-5

PROCESS: Untreated
ASH TYPE: Fly Ash
ASSAY: Solids by Neutron Activation

	X (mg/kg)	X (mg/kg ds)	C.V.
Metals			
Aluminum	25202.0	25585.8	0.09
Antimony	1080.0	1096.4	0.03
Arsenic	NA	NA	
Barium	NA	NA	
Beryllium	NA	NA	
Boron	NA	NA	
Cadmium	135.0	137.1	0.09
Calcium	286364.0	290724.9	0.02
Chromium	192.6	195.6	0.05
Cobalt	14.9	15.1	0.13
Copper	507.3	515.0	0.11
Iron	6211.0	6305.6	0.06
Lead	NA	NA	
Lithium	NA	NA	
Magnesium	NA	NA	
Manganese	419.2	425.6	0.06
Mercury	9.2	9.4	0.08
Molybdenum	NA	NA	
Nickel	NA	NA	
Potassium	15364.0	15598.0	0.05
Selenium	8.2	8.3	0.18
Silicon	40818.0	41439.6	0.30
Silver	53.0	53.8	0.05
Sodium	20160.0	20467.0	0.03
Strontium	NA	NA	
Tin	NA	NA	
Titanium	5573.0	5657.9	0.15
Vanadium	18.4	18.7	0.23
Zinc	17191.0	17452.8	0.05
Anions (mg/l)			
Bromide	3773.0	3830.5	0.03
Fluoride	NA	NA	
Chloride	166000.0	168527.9	0.02
Sulfate	NA	NA	
Nitrogen Species:			
Nitrite	NA	NA	
Nitrate	NA	NA	
Ammonia	NA	NA	
Phosphorous	NA	NA	
Other Assays (mg/l)			
pH (S.U.)	NA	NA	
TDS	NA	NA	
COD	NA	NA	
TOC	NA	NA	

File:UntFly/NAA/Summary

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

A. 1-6

Appendix A.2.

Results of chemical analysis of untreated bottom ash.

PROCESS: Untreated, Set 1
ASH TYPE: Bottom Ash, >2mm
ASSAY: Solids by SW-846

A. 2-1

	A	B	C	X	C.V.
Metals (mg/kg)					
Aluminum	25400.0	24400.0	18900.0	22900.0	0.15
Antimony	NA	NA	NA		
Arsenic	12.2	21.2	9.1	14.2	0.44
Barium	609.0	473.0	261.0	447.7	0.39
Beryllium	ND	ND	ND		
Boron	142.0	138.0	128.0	136.0	0.05
Cadmium	33.7	42.4	27.7	34.6	0.21
Calcium	NA	NA	NA		
Chromium	107.0	149.0	91.5	115.8	0.26
Cobalt	NA	NA	NA		
Copper	1470.0	1450.0	1130.0	1350.0	0.14
Iron	NA	NA	NA		
Lead	1080.0	1490.0	839.0	1136.3	0.29
Lithium	8.8	9.4	8.1	8.8	0.07
Magnesium	NA	NA	NA		
Manganese	NA	NA	NA		
Mercury	5.0	6.4	5.5	5.6	0.13
Molybdenum	NA	NA	NA		
Nickel	250.0	228.0	159.0	212.3	0.22
Potassium	NA	NA	NA		
Selenium	1.0	1.0	ND	1.0	0.01
Silicon	NA	NA	NA		
Silver	11.5	13.2	8.5	11.1	0.22
Sodium	NA	NA	NA		
Strontium	NA	NA	NA		
Tin	135.0	199.0	108.0	147.3	0.32
Titanium	NA	NA	NA		
Vanadium	NA	NA	NA		
Zinc	3350.0	4530.0	4350.0	4076.7	0.16
Anions (mg/kg)					
Bromide	NA	NA	NA		
Fluoride	NA	NA	NA		
Chloride	NA	NA	NA		
Sulfate	NA	NA	NA		
Nitrogen Species:					
Nitrite	NA	NA	NA		
Nitrate	NA	NA	NA		
Ammonia	NA	NA	NA		
Phosphorous	NA	NA	NA		
Other Assays (mg/kg)					
pH (S.U.)	NA	NA	NA		
TDS	NA	NA	NA		
COD	NA	NA	NA		
TOC	NA	NA	NA		
TS (%)	99.80	99.90	99.90	99.90	0.00

File: Unt.Bot.Sol.>2mm/Set1 U=undetected,A=U(1of3),B=U(2of3),NA=not analyzed,ND=not detected

PROCESS: Untreated, Set 1
ASH TYPE: Bottom Ash, <2mm
ASSAY: Solids by SW-846

A. 2-2

	A	B	C	X	C.V.
Metals (mg/kg)					
Aluminum	24500.0	23600.0	14300.0	20800.0	0.27
Antimony	NA	NA	NA		
Arsenic	8.9	11.8	15.3	12.0	0.27
Barium	350.0	424.0	240.0		
Beryllium	ND	ND	ND		
Boron	165.0	144.0	111.0	140.0	0.19
Cadmium	33.8	41.9	27.5	34.4	0.21
Calcium	NA	NA	NA		
Chromium	110.0	150.0	86.5	115.5	0.28
Cobalt	NA	NA	NA		
Copper	901.0	1420.0	1720.0	1347.0	0.31
Iron	NA				
Lead	1430.0	1330.0	1530.0	1430.0	0.07
Lithium	8.9	9.6	5.9	8.1	0.24
Magnesium	NA	NA	NA		
Manganese	NA	NA	NA		
Mercury	4.6	6.4	4.0	5.0	0.25
Molybdenum	NA				
Nickel	211.0	245.0	674.0	376.7	0.69
Potassium	NA	NA	NA		
Selenium	ND	ND	ND		
Silicon	NA	NA	NA		
Silver	7.7	10.1	6.2	8.0	0.25
Sodium	NA	NA	NA		
Strontium	NA	NA	NA		
Tin	172.0	167.0	98.7	145.9	0.28
Titanium	NA	NA	NA		
Vanadium	NA	NA	NA		
Zinc	3910.0	4540.0	2850.0	3766.7	0.23
Anions (mg/kg)					
Bromide	NA	NA	NA		
Fluoride	NA	NA	NA		
Chloride	NA	NA	NA		
Sulfate	NA	NA	NA		
Nitrogen Species:					
Nitrite	NA	NA	NA		
Nitrate	NA	NA	NA		
Ammonia	NA	NA	NA		
Phosphorous	NA	NA	NA		
Other Assays (mg/kg)					
pH (S.U.)	NA	NA	NA		
TDS	NA	NA	NA		
COD	NA	NA	NA		
TOC	NA	NA	NA		
TS (%)	99.20	99.10	99.10		

File: Unt.Bot.Sol.<2mm/Set1 U=undetected,A=U(1of3),B=U(2of3),NA=not analyzed,ND=not detected

PROCESS: Untreated, Set 1
ASH TYPE: Bottom Ash, <300um
ASSAY: Solids by SW-846

A. 2-3

	A	B	C	X	C.V.
Metals (mg/kg)					
Aluminum	24300.0	24900.0	27500.0	25566.7	0.07
Antimony	NA	NA	NA	NA	
Arsenic	8.2	15.5	17.9	13.9	0.36
Barium	498.0	456.0	314.0	422.7	0.23
Beryllium	U	U	U	U	
Boron	127.0	165.0	26.6	106.2	0.67
Cadmium	30.5	24.8	26.6	27.3	0.11
Calcium	NA	NA	NA	NA	
Chromium	104.0	159.0	17.3	93.4	0.76
Cobalt	NA	NA	NA	NA	
Copper	1000.0	1770.0	1290.0	1353.3	0.29
Iron	NA	NA	NA	NA	
Lead	901.0	1440.0	1030.0	1123.7	0.25
Lithium	8.8	9.7	8.4	9.0	0.07
Magnesium	NA	NA	NA	NA	
Manganese	NA	NA	NA	NA	
Mercury	5.1	3.8	3.8	4.2	0.18
Molybdenum	NA	NA	NA	NA	
Nickel	197.0	308.0	356.0	287.0	0.28
Potassium	NA	NA	NA	NA	
Selenium	U	U	U	U	
Silicon	NA	NA	NA	NA	
Silver	8.5	7.9	6.2	7.5	0.16
Sodium	NA	NA	NA	NA	
Strontium	NA	NA	NA	NA	
Tin	143.0	152.0	152.0	149.0	0.03
Titanium	NA	NA	NA	NA	
Vanadium	NA	NA	NA	NA	
Zinc	3660.0	2950.0	4070.0	3560.0	0.16
Anions (mg/kg)					
Bromide	401.00	285.00	180.00	288.67	0.38
Fluoride	0.50 U	0.50 U	0.50 U	0.50 U	0.00
Chloride	23200.00	18600.00	18233.00	20011.00	0.14
Sulfate	60.50	49.10	145.00	84.87	0.62
Nitrogen Species:					
Nitrite	4.19	1.87	1.07	2.38	0.68
Nitrate	5.28	2.27	1.41	2.99	0.68
Ammonia	6.67	9.66	9.11	8.48	0.19
Phosphorous	3900.00	2320.00	2470.00	2395.00	0.36
Other Assays (mg/kg)					
pH (S.U.)	10.54	10.53	10.32	10.43	0.01
TDS	42700.00	35100.00	24400.00	34066.67	0.27
COD	40000.00	3900.00	41900.00	28600.00	0.75
TOC	14500.00	11700.00	10500.00	12233.33	0.17
TS (%)	86.70	87.20	87.90	87.27	0.01

File: Unt. Bot. Sol.<300um/Set1 U=undetected,A=U(1of3),B=U(2of3),NA=not analyzed

PROCESS: Untreated, Set 1
ASH TYPE: Bottom Ash, <300um
ASSAY: Solids by SW-846

A. 2-4

	A	B	C	X	C.V.
Metals (mg/kg ds)					
Aluminum	24670.1	25279.2	28205.1	26051.5	0.07
Antimony	NA	NA	NA	NA	
Arsenic	8.3	15.7	18.4	14.1	0.37
Barium	505.6	462.9	322.1	430.2	0.22
Beryllium	0.0 U	0.0 U	0.0 U	0.0 U	
Boron	128.9	167.5	27.3	107.9	0.67
Cadmium	31.0	25.2	27.3	27.8	0.11
Calcium	NA	NA	NA	NA	
Chromium	105.6	161.4	17.7	94.9	0.76
Cobalt	NA	NA	NA	NA	
Copper	1015.2	1797.0	1323.1	1378.4	0.29
Iron	NA	NA	NA	NA	
Lead	914.7	1461.9	1056.4	1144.4	0.25
Lithium	8.9	9.8	8.6	9.1	0.07
Magnesium	NA	NA	NA	NA	
Manganese	NA	NA	NA	NA	
Mercury	5.2	3.9	3.9	4.3	0.17
Molybdenum	NA	NA	NA	NA	
Nickel	200.0	312.7	365.1	292.6	0.29
Potassium	NA	NA	NA	NA	
Selenium	0.0 U	0.0 U	0.0 U	0.0 U	
Silicon	NA	NA	NA	NA	
Silver	8.6	8.0	6.4	7.7	0.15
Sodium	NA	NA	NA	NA	
Strontium	NA	NA	NA	NA	
Tin	145.2	154.3	155.9	151.8	0.04
Titanium	NA	NA	NA	NA	
Vanadium	NA	NA	NA	NA	
Zinc	3715.7	2994.9	4174.4	3628.3	0.16
Anions (mg/kg ds)					
Bromide	407.1	289.3	184.6	293.7	0.38
Fluoride	0.51 U	0.51 U	0.51 U	0.51 U	0.01
Chloride	23553.3	18883.2	18700.5	20379.0	0.13
Sulfate	61.4	49.8	148.7	86.7	0.62
Nitrogen Species:					
Nitrite	4.3	1.9	1.1	2.4	0.68
Nitrate	5.4	2.3	1.4	3.0	0.68
Ammonia	6.8	9.8	9.3	8.6	0.19
Phosphorous	3959.4	2355.3	2533.3	2444.3	0.36
Other Assays (mg/kg ds)					
pH (S.U.)	10.54	10.53	10.32	10.43	0.01
TDS	43350.3	35634.5	25025.6	34670.1	0.27
COD	40609.1	3959.4	42974.4	29181.0	0.75
TOC	14720.8	11878.2	10769.2	12456.1	0.16
TS (%)	86.7	87.2	87.9	87.3	0.01

File: Unt. Bot. Sol.<300um/Set1 U=undetected,A=U(1of3),B=U(2of3),NA=not analyzed

PROCESS: Untreated Ash, Set 2
ASH TYPE: Bottom Ash, >2mm
ASSAY: Solids by SW-846

FIELD SAMPLE:
A=H127951, B=H127952
C=H127953

A. 2-5

	A	B	C	X	C.V.
Metals (mg/kg)					
Aluminum	5100.0	30000.0	16000.0	17033.3	0.73
Antimony	NA	NA	NA		
Arsenic	43.0	26.0	33.0	34.0	0.25
Barium	140.0	380.0	490.0	336.7	0.53
Beryllium	45.0	29.0	1.6	25.2	0.87
Boron	NA	NA	NA		
Cadmium	7.1	1.4	3.9	4.1	0.69
Calcium	NA	NA	NA		
Chromium	15.0	1100.0	70.0	395.0	1.55
Cobalt	NA	NA	NA		
Copper	160000.0	900.0	700.0	53866.7	1.71
Iron	NA	NA	NA		
Lead	260.0	1100.0	130.0	496.7	1.06
Lithium	4.0	27.0	6.0	12.3	1.03
Magnesium	NA	NA	NA		
Manganese	NA	NA	NA		
Mercury	0.5	0.4	0.5	0.5	0.12
Molybdenum	NA	NA	NA		
Nickel	57.0	660.0	120.0	279.0	1.19
Potassium	NA	NA	NA		
Selenium	5.0 U	5.0 U	5.0 U	5.0 U	0.00 U
Silicon	NA	NA	NA		
Silver	3.5	2.8	3.3	3.2	0.11
Sodium	NA	NA	NA		
Strontium	NA	NA	NA		
Tin	580.0	33.0	30.0	214.3	1.48
Titanium	NA	NA	NA		
Vanadium	NA	NA	NA		
Zinc	530.0	760.0	630.0	640.0	0.18
Anions (mg/kg)					
Bromide	NA	NA	NA		
Fluoride	NA	NA	NA		
Chloride	NA	NA	NA		
Sulfate	NA	NA	NA		
Nitrogen Species:					
Nitrite	NA	NA	NA		
Nitrate	NA	NA	NA		
Ammonia	NA	NA	NA		
Phosphorous	NA	NA	NA		
Other Assays (mg/kg)					
pH (S.U.)	NA	NA	NA		
TDS	NA	NA	NA		
COD	NA	NA	NA		
TOC	NA	NA	NA		
TS (%)	99.20	99.10	99.10		

File: Unt.Bot.Solids>2mm/2 U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

PROCESS: Untreated, Set 2
ASH TYPE: Bottom Ash, <2mm mesh
ASSAY: Solids by SW-846

FIELD SAMPLE:
A=H127995, B=H127996
C=H127997

A. 2-6

	A	B	C	X	C.V.
Metals (mg/kg)					
Aluminum	21000.0	26000.0	33000.0	26666.7	0.23
Antimony	NA	NA	NA		
Arsenic	18.0	22.0	16.0	18.7	0.16
Barium	380.0	400.0	610.0	463.3	0.27
Beryllium	40.0	46.0	55.0	47.0	0.16
Boron	NA	NA	NA		
Cadmium	19.0	29.0	34.0	27.3	0.28
Calcium	NA	NA	NA		
Chromium	190.0	180.0	240.0	203.3	0.16
Cobalt	NA	NA	NA		
Copper	900.0	1100.0	1500.0	1166.7	0.26
Iron	NA	NA	NA		
Lead	460.0	800.0	1300.0	853.3	0.50
Lithium	8.0	8.0	10.0	8.7	0.13
Magnesium	NA	NA	NA		
Manganese	NA	NA	NA		
Mercury	3.0	7.2	7.0	5.7	0.41
Molybdenum	NA	NA	NA		
Nickel	350.0	360.0	460.0	390.0	0.16
Potassium	NA	NA	NA		
Selenium	5.0 U	5.0 U	5.0 U	5.0 U	0.00 U
Silicon	NA	NA	NA		
Silver	4.9	5.7	5.1	5.2	0.08
Sodium	NA	NA	NA		
Strontium	NA	NA	NA		
Tin	160.0	180.0	280.0	206.7	0.31
Titanium	NA	NA	NA		
Vanadium	NA	NA	NA		
Zinc	2700.0	4200.0	4200.0	3700.0	0.23
Anions (mg/kg)					
Bromide	NA	NA	NA		
Fluoride	NA	NA	NA		
Chloride	NA	NA	NA		
Sulfate	NA	NA	NA		
Nitrogen Species:					
Nitrite	NA	NA	NA		
Nitrate	NA	NA	NA		
Ammonia	NA	NA	NA		
Phosphorous	NA	NA	NA		
Other Assays (mg/kg)					
pH (S.U.)	NA	NA	NA		
TDS	NA	NA	NA		
COD	NA	NA	NA		
TOC	NA	NA	NA		
TS (%)	99.20	99.10	99.10	99.10	0.00

File: Unt.Bot.Solids<2mm

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

PROCESS: Untreated, Set 2
ASH TYPE: Bottom Ash, < 300 µm
ASSAY: Solids by SW-846

FIELD SAMPLE
A=H127986, B=H127987
C=H127988

A. 2-7

	A	B	C	X	C.V.
Metals (mg/kg)					
Aluminum	31000.0	32000.0	30000.0	31000.0	0.03
Antimony	NA	NA	NA	NA	
Arsenic	20.0	7.5	19.0	15.5	0.45
Barium	560.0	540.0	530.0	543.3	0.03
Beryllium	21.0	27.0	24.0	24.0	0.13
Boron	NA	NA	NA	NA	
Cadmium	41.0	29.0	35.0	35.0	0.17
Calcium	NA	NA	NA	NA	
Chromium	180.0	210.0	190.0	193.3	0.08
Cobalt	NA	NA	NA	NA	
Copper	1800.0	2300.0	2100.0	2066.7	0.12
Iron	NA	NA	NA	NA	
Lead	1600.0	1100.0	1900.0	1533.3	0.26
Lithium	10.0	8.0	8.0	8.7	0.13
Magnesium	NA	NA	NA	NA	
Manganese	NA	NA	NA	NA	
Mercury	6.7	4.8	6.3	5.9	0.17
Molybdenum	NA	NA	NA	NA	
Nickel	500.0	430.0	340.0	423.3	0.19
Potassium	NA	NA	NA	NA	
Selenium	5.0 U	5.0 U	5.0 U	5.0 U	0.00 U
Silicon	NA	NA	NA	NA	
Silver	2.2	1.6	8.0	3.9	0.90
Sodium	NA	NA	NA	NA	
Strontium	NA	NA	NA	NA	
Tin	250.0	210.0	260.0	240.0	0.11
Titanium	NA	NA	NA	NA	
Vanadium	NA	NA	NA	NA	
Zinc	4800.0	4800.0	4600.0	4733.3	0.02
Anions (mg/kg)					
Bromide	320.00	200.00	260.00	260.00	0.23
Fluoride	NA	NA	NA	NA	
Chloride	16000.00	13000.00	21000.00	16666.67	0.24
Sulfate	2900.00	2200.00	39000.00	14700.00	1.43
Nitrogen Species:					
Nitrite	NA	NA	NA	NA	
Nitrate	39.00	15.00	31.00	28.33	0.43
TKN	200.00	210.00	260.00	223.33	0.14
Phosphorous	0.50 U	0.50 U	0.50 U	0.50 U	0.00 U
Other Assays (mg/kg)					
pH (S.U.)	9.94	10.26	9.77	10.02	0.02
TDS	NA	NA	NA	NA	
COD	NA	NA	NA	NA	
TOC	NA	NA	NA	NA	
TS (%)	99.50	99.50	99.50	99.50	0.00

File:Unt.Bot.Solids<300um/2 U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

PROCESS: Untreated, Set 2
ASH TYPE: Bottom Ash, <300um
ASSAY: Solids by SW-846

FIELD SAMPLE
A=H127986, B=H127987
C=H127988

A. 2-8

	A	B	C	X	C.V.
Metals (mg/kg ds)					
Aluminum	31472.1	32487.3	30769.2	31576.2	0.03
Antimony	NA	NA	NA	NA	
Arsenic	20.3	7.6	19.5	15.8	0.45
Barium	568.5	548.2	543.6	553.4	0.02
Beryllium	21.3	27.4	24.6	24.4	
Boron	NA	NA	NA	NA	
Cadmium	41.6	29.4	35.9	35.7	0.17
Calcium	NA	NA	NA	NA	
Chromium	182.7	213.2	194.9	196.9	0.08
Cobalt	NA	NA	NA	NA	
Copper	1827.4	2335.0	2153.8	2105.4	0.12
Iron	NA	NA	NA	NA	
Lead	1624.4	1116.8	1948.7	1563.3	0.27
Lithium	10.2	8.1	8.2	8.8	0.13
Magnesium	NA	NA	NA	NA	
Manganese	NA	NA	NA	NA	
Mercury	6.8	4.9	6.5	6.0	0.17
Molybdenum	NA	NA	NA	NA	
Nickel	507.6	436.5	348.7	431.0	0.18
Potassium	NA	NA	NA	NA	
Selenium	5.1 U	5.1 U	5.1 U	5.1 U	
Silicon	NA	NA	NA	NA	
Silver	2.2	1.6	8.2	4.0	0.90
Sodium	NA	NA	NA	NA	
Strontium	NA	NA	NA	NA	
Tin	253.8	213.2	266.7	244.6	0.11
Titanium	NA	NA	NA	NA	
Vanadium	NA	NA	NA	NA	
Zinc	4873.1	4873.1	4717.9	4821.4	0.02
Anions (mg/kg ds)					
Bromide	324.9	203.0	266.7	264.9	0.23
Fluoride	NA	NA	NA	NA	
Chloride	16243.7	13198.0	21538.5	16993.4	0.25
Sulfate	2944.2	2233.5	40000.0	15059.2	1.43
Nitrogen Species:					
Nitrite	NA	NA	NA	NA	
Nitrate	39.6	15.2	31.8	28.9	0.43
TKN	203.0	213.2	266.7	227.6	0.15
Phosphorous	0.5 U	0.5 U	0.5 U	0.5 U	0.01
Other Assays (mg/kg ds)					
pH (S.U.)	9.94	10.26	9.77	10.02	0.02
TDS	NA	NA	NA	NA	
COD	NA	NA	NA	NA	
TOC	NA	NA	NA	NA	
TS (%)	99.5	99.5	99.5	99.5	0.00

File:Unt.Bot.Solids<300um/2 U=undetected, A=U(1of3), B=U(2of3), NA=not analyzed

PROCESS: Untreated
ASH TYPE: Bottom Ash
ASSAY: Solids by Neutron Activation

Units: mg/kg

	<300 μ m, ground					
DRUM #	1	2	3	4	5	6
Aluminum	49600	52700	49400	53000	50600	51100
Antimony	340	274	240	289	299	230
Bromine	659	524	411	525	548	377
Cadmium	38.4	29.9	25.5	33.8	32.9	25.3
Calcium	123000	107000	99400	112000	113000	98900
Cerium	25.1	28.2	31.0	27.8	30.3	29.0
Cesium	0.808	1.90	0.958	0.913	0.738 U	1.27
Chlorine	28000	22800	19200	22400	24200	17300
Chromium	646	778	1090	850	715	1000
Cobalt	62.7	80.0	83.3	74.7	92.7	102
Copper	1030	1370	1580	1490	1570	1740
Indium	0.245	0.311	0.235	0.239	0.341	0.232
Iodine	9.19	4.97	5.00	4.61	6.21	2.88 U
Iron	51300	78900	98500	84700	75800	111000
Lanthanum	8.48	10.3	9.61	10.1	10.5	9.88
Maganese	926	1020	1040	1100	1090	1240
Mercury	1.62	1.08	1.12	1.42	1.43	1.17
Potassium	7490	9200	8700	9600	10300	9000
Samarium	1.02	1.06	1.17	1.04	1.10	1.06
Scandium	3.62	3.88	3.93	4.15	4.02	3.89
Selenium	4.19	3.88	3.48	3.14 U	4.68	4.02
Silicon	91000	120000	131000	120000	113000	154000
Silver	18.6	17.5	14.2	16.6	19.1	11.5
Sodium	16200	19800	25400	19900	17700	25400
Tantalum	3.11	2.68	3.23	2.54	3.47	3.23
Thorium	3.88	4.03	4.08	4.22	3.80	4.02
Titanium	6400	6000	6000	6500	6600	6200
Vanadium	35.8	43.2	43.6	45.3	43.9	48.7
Zinc	7550	6140	5640	6580	6790	4990
[illegible]	1	2	3	4	5	6

A. 2-9

PROCESS: Untreated
ASH TYPE: Bottom Ash
ASSAY: Solids by Neutron Activation

Units: mg/kg

	<300 μ m, ground				
DRUM #	8	10	11	12	15
Aluminum	51100	51300	51600	51300	49000
Antimony	295	335	372	369	384
Bromine	567	653	ND	652	716
Cadmium	35.6	39.2	ND	42.0	45.8
Calcium	113000	120000	114000	110000	115000
Cerium	26.3	25.7	24.8	26.2	24.4
Cesium	1.36	1.33	1.07	1.13	1.40
Chlorine	24700	27500	24700	24500	28000
Chromium	734	610	685	612	705
Cobalt	70.7	74.3	66.4	67.1	65.3
Copper	1470	1570	1530	1490	1160
Indium	0.375	0.391	0.474	0.330	0.400
Iodine	6.63	9.60	4.83	6.67	9.77
Iron	71000	56800	70100	66700	56100
Lanthanum	9.71	10.7	ND	10.2	10.0
Maganese	1050	956	1150	1000	951
Mercury	1.50	1.65	1.50	1.45	1.54
Potassium	9200	9190	9060	10700	10600
Samarium	1.02	0.988	ND	1.76	1.56
Scandium	4.11	3.85	3.83	3.93	3.67
Selenium	2.97	3.67 U	3.48 U	4.22	4.57
Silicon	117000	112000	108000	98000	97000
Silver	18.4	21.0	24.4	17.7	16.8
Sodium	16900	16900	18200	17300	17300
Tantalum	3.19	3.13	2.51	3.66	3.46
Thorium	4.03	3.97	3.68	3.81	4.03
Titanium	6700	6600	7500	6600	6400
Vanadium	39.0	41.6	38.8	43.4	45.4
Zinc	7340	7050	6540	7210	7770

[illegible]

	8	10	11	12	15

A. 2-9

PROCESS: Untreated
ASH TYPE: Bottom Ash
ASSAY: Solids by Neutron Activation

Units: mg/kg

<300	m, ground	
	x	c.v
Aluminum	50973	0.02
Antimony	311.55	0.17
Bromine	563.20	0.20
Cadmium	34.64	0.19
Calcium	111391	0.07
Cerium	27.35	0.08
Cesium	1.17	0.28
Chlorine	23936	0.14
Chromium	765.91	0.20
Cobalt	76.29	0.16
Copper	1455	0.14
Indium	0.32	0.25
Iodine	6.40	0.36
Iron	74627	0.24
Lanthanum	9.95	0.06
Maganese	1048	0.09
Mercury	1.41	0.14
Potassium	9357	0.10
Samarium	1.18	0.23
Scandium	3.91	0.04
Selenium	3.85	0.14
Silicon	114636	0.15
Silver	17.8	0.19
Sodium	19480	0.17
Tantalum	3.11	0.12
Thorium	3.96	0.04
Titanium	6500	0.06
Vanadium	42.61	0.03
Zinc	6891	0.13

A. 2-9

PROCESS: Untreated
ASH TYPE: Bottom
ASSAY: Solids by Neutron Activation

A. 2-10

	x (mg/kg)	x (mg/kg ds)	C.V.
Metals			
Aluminum	50973.0	51749.2	0.02
Antimony	311.6	316.3	0.17
Arsenic	NA	NA	
Barium	NA	NA	
Beryllium	NA	NA	
Boron	NA	NA	
Cadmium	34.6	35.2	0.19
Calcium	111391.0	113087.3	0.07
Chromium	765.9	777.6	0.20
Cobalt	76.3	77.5	0.16
Copper	1455.0	1477.2	0.14
Iron	74627.0	75763.5	0.24
Lead	NA	NA	
Lithium	NA	NA	
Magnesium	NA	NA	
Manganese	1048.0	1064.0	0.09
Mercury	1.4	1.4	0.14
Molybdenum	NA	NA	
Nickel	NA	NA	
Potassium	9367.0	9509.6	0.10
Selenium	3.9	3.9	0.14
Silicon	114636.0	116381.7	0.15
Silver	17.8	18.1	0.19
Sodium	19460.0	19776.6	0.17
Strontium	NA	NA	
Tin	NA	NA	
Titanium	6500.0	6599.0	0.06
Vanadium	42.6	43.3	0.08
Zinc	6691.0	6792.9	0.13
Anions (mg/l)			
Bromide	563.2	571.8	0.20
Fluoride	NA	NA	
Chloride	23936.0	24300.5	0.14
Sulfate	NA	NA	
Nitrogen Species:			
Nitrite	NA	NA	
Nitrate	NA	NA	
Ammonia	NA	NA	
Phosphorous	NA	NA	
Other Assays (mg/l)			
pH (S.U.)	NA	NA	
TDS	NA	NA	
COD	NA	NA	
TOC	NA	NA	

File:Unt.Bot/NAA/Summary

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

Appendix A.3.

Results of chemical analysis of untreated combined ash.

PROCESS: Untreated, Set 1
ASH TYPE: Combined Ash, >2mm
ASSAY: Solids by SW-846

A. 3-1

	A	B	C	X	C.V.
Metals (mg/kg)					
Aluminum	28500.0	28000.0	17100.0	24533.3	0.26
Antimony	NA	NA	NA		
Arsenic	7.7	18.3	15.9	14.0	0.40
Barium	701.0	904.0	543.0	716.0	0.25
Beryllium	ND	ND	ND		
Boron	183.0	154.0	165.0	167.3	0.09
Cadmium	31.5	39.1	20.5	30.4	0.31
Calcium	NA	NA	NA		
Chromium	69.7	73.5	101.0	81.4	0.21
Cobalt	NA	NA	NA		
Copper	1360.0	1030.0	3620.0	2003.3	0.70
Iron	NA	NA	NA		
Lead	1080.0	1580.0	1230.0	1296.7	0.20
Lithium	11.0	11.7	7.4	10.0	0.23
Magnesium	NA	NA	NA		
Manganese	NA	NA	NA		
Mercury	10.3	12.9	10.3	11.2	0.13
Molybdenum	NA	NA	NA		
Nickel	60.5	87.3	251.0	132.9	0.78
Potassium	NA	NA	NA		
Selenium	1.2	ND	ND	1.2	
Silicon	NA	NA	NA		
Silver	17.9	9.7	3.9	10.5	0.67
Sodium	NA	NA	NA		
Strontium	NA	NA	NA		
Tin	151.0	192.0	293.0	212.0	0.34
Titanium	NA	NA	NA		
Vanadium	NA	NA	NA		
Zinc	3610.0	4320.0	2460.0	3463.3	0.27
Anions (mg/kg)					
Bromide	NA	NA	NA	NA	NA
Fluoride	NA	NA	NA	NA	NA
Chloride	NA	NA	NA	NA	NA
Sulfate	NA	NA	NA	NA	NA
Nitrogen Species:					
Nitrite	NA	NA	NA	NA	NA
Nitrate	NA	NA	NA	NA	NA
Ammonia	NA	NA	NA	NA	NA
Phosphorous	NA	NA	NA	NA	NA
Other Assays (mg/kg)					
pH (S.U.)	NA	NA	NA	NA	NA
TDS	NA	NA	NA	NA	NA
COD	NA	NA	NA	NA	NA
TOC	NA	NA	NA	NA	NA
TS (%)	99.80	99.60	99.80	NA	NA

File: Unt.Comb.Sol.>2mm/Set1 U=undetected,AsU(1of3),BaU(2of3),NA=not analyzed,ND=not detected

PROCESS: Untreated, Set 1
ASH TYPE: Combined, <2mm
ASSAY: Solids by SW-846

A. 3-2

	A	B	C	X	C.V.
Metals (mg/kg)					
Aluminum	25200.0	27080.0	18900.0	23726.7	0.18
Antimony	NA	NA	NA		
Arsenic	16.7	11.5	10.4	12.9	0.26
Barium	675.0	899.0	541.0		
Beryllium	ND	ND	ND		
Boron	206.0	166.0	128.0	166.7	0.23
Cadmium	25.3	28.9	23.6	25.9	0.10
Calcium	NA	NA	NA		
Chromium	68.5	95.8	57.1	73.8	0.27
Cobalt	NA	NA	NA		
Copper	1640.0	1500.0	915.0	1351.7	0.28
Iron	NA	NA	NA		
Lead	1190.0	1360.0	876.0	1142.0	0.22
Lithium	10.2	11.2	9.0	10.1	0.11
Magnesium	NA	NA	NA		
Manganese	NA	NA	NA		
Mercury	10.9	12.5	7.2	10.2	0.27
Molybdenum	NA	NA	NA		
Nickel	78.0	109.0	49.0	78.7	0.38
Potassium	NA	NA	NA		
Selenium	ND	ND	ND		
Silicon	NA	NA	NA		
Silver	8.0	6.4	11.0	8.5	0.28
Sodium	NA	NA	NA		
Strontium	NA	NA	NA		
Tin	148.0	151.0	109.0	136.0	0.17
Titanium	NA	NA	NA		
Vanadium	NA	NA	NA		
Zinc	3850.0	4100.0	2900.0	3616.7	0.18
Anions (mg/kg)					
Bromide	NA	NA	NA		
Fluoride	NA	NA	NA		
Chloride	NA	NA	NA		
Sulfate	NA	NA	NA		
Nitrogen Species:					
Nitrite	NA	NA	NA		
Nitrate	NA	NA	NA		
Ammonia	NA	NA	NA		
Phosphorous	NA	NA	NA		
Other Assays (mg/kg)					
pH (S.U.)					
TDS	NA	NA	NA		
COD	NA	NA	NA		
TOC	NA	NA	NA		
TS (%)	NA	NA	NA		

File: Unt.Comb.Sol.<2mm/Set1 U=undetected,A=U(1of3),B=U(2of3),NA=not analyzed,ND=not detected

PROCESS: Untreated, Set 1
ASH TYPE: Combined, <300 um
ASSAY: Solids by SW-846

A. 3-3

	A	B	C	X	C.V.
Metals (mg/kg)					
Aluminum	22700.0	25700.0	31000.0	26466.7	0.16
Antimony	NA	NA	NA	NA	
Arsenic	15.4	13.4	13.8	14.2	0.07
Barium	718.0	889.0	608.0	738.3	0.19
Beryllium	U	U	U	U	
Boron	122.0	157.0	173.0	150.7	0.17
Cadmium	26.3	37.5	25.2	29.7	0.23
Calcium	NA	NA	NA	NA	
Chromium	64.6	72.8	68.9	68.8	0.06
Cobalt	NA	NA	NA	NA	
Copper	751.0	1030.0	810.0	863.7	0.17
Iron	NA	NA	NA	NA	
Lead	956.0	1660.0	905.0	1173.7	0.36
Lithium	11.3	11.1	9.9	10.8	0.07
Magnesium	NA	NA	NA	NA	
Manganese	NA	NA	NA	NA	
Mercury	9.1	14.4	11.6	11.7	0.23
Molybdenum	NA	NA	NA	NA	
Nickel	13.5	93.3	158.0	88.3	0.82
Potassium	NA	NA	NA	NA	
Selenium	U	1.2	U	1.2 U	
Silicon	NA	NA	NA	NA	
Silver	5.8	7.1	4.5	5.8	0.22
Sodium	NA	NA	NA	NA	
Strontium	NA	NA	NA	NA	
Tin	134.0	170.0	109.0	137.7	0.22
Titanium	NA	NA	NA	NA	
Vanadium	NA	NA	NA	NA	
Zinc	3150.0	4410.0	2650.0	3403.3	0.27
Anions (mg/kg)					
Bromide	306.00	345.00	186.00	279.00	0.30
Fluoride	0.60 U	0.60 U	0.60 U	0.60 U	
Chloride	29600.00	29600.00	15300.00	24833.33	0.33
Sulfate	360.00	386.00	748.00	498.00	0.44
Nitrogen Species:					
Nitrite	0.44	0.48	0.48	0.47	0.05
Nitrate	0.66	0.50	0.37	0.51	0.28
Ammonia	12.20	13.50	15.70	13.80	0.13
Phosphorous	2060.00	2140.00	2930.00	2535.00	0.19
Other Assays (mg/kg)					
pH (S.U.)	10.40	10.39	10.32	10.36	0.00
TDS(Extract)	55900.00	52400.00	34100.00	47466.67	0.25
COD	68200.00	62300.00	63900.00	64800.00	0.05
TOC	22400.00	22600.00	25600.00	23533.33	0.08
TS (%)	90.60	89.10	93.60	91.35	0.03

File: Unt.Comb.Sol.<300/Set1 U=undetected,A=U(1of3),B=U(2of3),NA=not analyzed

PROCESS: Untreated, Set 1
ASH TYPE: Combined, <300 um
ASSAY: Solids by SW-846

A. 3-4

	A	B	C	X	C.V.
Metals (mg/kg ds)					
Aluminum	23139.7	26171.1	31440.2	26917.0	0.16
Antimony	NA	NA	NA	NA	
Arsenic	15.7	13.6	14.0	14.4	0.08
Barium	731.9	905.3	616.6	751.3	0.19
Beryllium	0.0 U	0.0 U	0.0 U	0.0 U	
Boron	124.4	159.9	175.5	153.2	0.17
Cadmium	26.8	38.2	25.6	30.2	0.23
Calcium	NA	NA	NA	NA	
Chromium	65.9	74.1	69.9	70.0	0.06
Cobalt	NA	NA	NA	NA	
Copper	765.5	1048.9	821.5	878.6	0.17
Iron	NA	NA	NA	NA	
Lead	974.5	1690.4	917.8	1194.3	0.36
Lithium	11.5	11.3	10.0	11.0	0.07
Magnesium	NA	NA	NA	NA	
Manganese	NA	NA	NA	NA	
Mercury	9.3	14.7	11.8	11.9	0.23
Molybdenum	NA	NA	NA	NA	
Nickel	13.8	95.0	160.2	89.7	0.82
Potassium	NA	NA	NA	NA	
Selenium	0.0 U	1.2	0.0 U	0.4 B	
Silicon	NA	NA	NA	NA	
Silver	5.9	7.2	4.6	5.9	0.23
Sodium	NA	NA	NA	NA	
Strontium	NA	NA	NA	NA	
Tin	136.6	173.1	110.5	140.1	0.22
Titanium	NA	NA	NA	NA	
Vanadium	NA	NA	NA	NA	
Zinc	3211.0	4490.8	2687.6	3463.2	0.27
Anions (mg/kg ds)					
Bromide	311.93	351.32	188.64	283.96	0.30
Fluoride	0.61 U	0.61 U	0.61 U	0.61 U	
Chloride	30173.29	30142.57	15517.24	25277.70	0.33
Sulfate	366.97	393.08	758.62	506.22	0.43
Nitrogen Species:					
Nitrite	0.45	0.49	0.49	0.47	0.05
Nitrate	0.67	0.51	0.38	0.52	0.29
Ammonia	12.44	13.75	15.92	14.04	0.13
Phosphorous	2099.90	2179.23	2971.60	2575.41	0.19
Other Assays (mg/kg ds)					
pH (S.U.)	10.40	10.39	10.32	10.36	0.00
TDS(Extract)	56982.67	53360.49	34584.18	48309.11	0.25
COD	75275.94	69921.44	68269.23	71155.54	0.05
TOC	24724.06	25364.76	27350.43	25813.08	0.05
TS (%)	90.60	89.10	93.60	91.35	0.03

File: Unt.Comb.Sol.<300/Set1 U=undetected,A=U(1of3),B=U(2of3),NA=not analyzed

PROCESS: Untreated Ash, Set 2
ASH TYPE: Bottom Ash, >2mm
ASSAY: Solids by SW-846

FIELD SAMPLE
A=H127951, B=H127952
C=H127953

A. 3-5

	A	B	C	X	C.V.
Metals (mg/kg)					
Aluminum	5100.0	30000.0	16000.0	17033.3	0.73
Antimony	NA	NA	NA		
Arsenic	43.0	26.0	33.0	34.0	0.25
Barium	140.0	380.0	490.0	336.7	0.53
Beryllium	45.0	29.0	1.6	25.2	0.87
Boron	NA	NA	NA		
Cadmium	7.1	1.4	3.9	4.1	0.69
Calcium	NA	NA	NA		
Chromium	15.0	1100.0	70.0	395.0	1.55
Cobalt	NA	NA	NA		
Copper	160000.0	900.0	700.0	53866.7	1.71
Iron	NA	NA	NA		
Lead	260.0	1100.0	130.0	496.7	1.06
Lithium	4.0	27.0	6.0	12.3	1.03
Magnesium	NA	NA	NA		
Manganese	NA	NA	NA		
Mercury	0.5	0.4	0.5	0.5	0.12
Molybdenum	NA	NA	NA		
Nickel	57.0	660.0	120.0	279.0	1.19
Potassium	NA	NA	NA		
Selenium	5.0 U	5.0 U	5.0 U	5.0 U	0.00 U
Silicon	NA	NA	NA		
Silver	3.5	2.8	3.3	3.2	0.11
Sodium	NA	NA	NA		
Strontium	NA	NA	NA		
Tin	580.0	33.0	30.0	214.3	1.48
Titanium	NA	NA	NA		
Vanadium	NA	NA	NA		
Zinc	530.0	760.0	630.0	640.0	0.18
Anions (mg/kg)					
Bromide	NA	NA	NA		
Fluoride	NA	NA	NA		
Chloride	NA	NA	NA		
Sulfate	NA	NA	NA		
Nitrogen Species:					
Nitrite	NA	NA	NA		
Nitrate	NA	NA	NA		
Ammonia	NA	NA	NA		
Phosphorous	NA	NA	NA		
Other Assays (mg/kg)					
pH (S.U.)	NA	NA	NA		
TDS	NA	NA	NA		
COD	NA	NA	NA		
TOC	NA	NA	NA		
TS (%)	99.20	99.10	99.10		

File: Unt.Bot.Solids>2mm/2 U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

PROCESS: Untreated - Set 2
ASH TYPE: Combined, <2mm
ASSAY: Solids by SW-846

FIELD SAMPLE
A=H127991, B=H127992
C=H127993

A. 3-6

	A	B	C	X	C.V.
Metals (mg/kg)					
Aluminum	26000.0	22000.0	21000.0	23000.0	0.12
Antimony	NA	NA	NA		
Arsenic	21.0	11.0	12.0	14.7	0.38
Barium	1100.0	800.0	640.0	846.7	0.28
Beryllium	20.0	21.0	21.0	20.7	0.03
Boron	NA	NA	NA		
Cadmium	26.0	22.0	18.0	22.0	0.18
Calcium	NA	NA	NA		
Chromium	97.0	67.0	81.0	81.7	0.18
Cobalt	NA	NA	NA		
Copper	1200.0	840.0	2700.0	1580.0	0.62
Iron	NA	NA	NA		
Lead	1900.0	1000.0	480.0	1126.7	0.64
Lithium	8.0	7.0	10.0	8.3	0.18
Magnesium	NA	NA	NA		
Manganese	NA	NA	NA		
Mercury	6.6	7.1	4.2	6.0	0.26
Molybdenum	NA	NA	NA		
Nickel	9.4	81.0	150.0	80.1	0.88
Potassium	NA	NA	NA		
Selenium	5.0 U	5.0 U	5.0 U	5.0 U	0.00 U
Silicon	NA	NA	NA		
Silver	3.5	4.0	3.1	3.5	0.13
Sodium	NA	NA	NA		
Strontium	NA	NA	NA		
Tin	140.0	130.0	150.0	140.0	0.07
Titanium	NA	NA	NA		
Vanadium	NA	NA	NA		
Zinc	2700.0	3100.0	2900.0	2900.0	0.07
Anions (mg/kg)					
Bromide	NA	NA	NA		
Fluoride	NA	NA	NA		
Chloride	NA	NA	NA		
Sulfate	NA	NA	NA		
Nitrogen Species:					
Nitrite	NA	NA	NA		
Nitrate	NA	NA	NA		
Ammonia	NA	NA	NA		
Phosphorous	NA	NA	NA		
Other Assays (mg/kg)					
pH (S.U.)	NA	NA	NA		
TDS	NA	NA	NA		
COD	NA	NA	NA		
TOC	NA	NA	NA		
TS (%)	99.80	99.60	99.80		

File: Unt.Comb.Solids<2mm,Set2 U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

PROCESS: Untreated - Set 2
ASH TYPE: Combined, <300 um
ASSAY: Solids by SW-846

FIELD SAMPLE:
A=H128037, B=H127989
C=H127990

A. 3-7

	A		B		C		X	C.V.
Metals (mg/kg)								
Aluminum	27000.0		27000.0		30000.0		28000.0	0.06
Antimony	NA		NA		NA		NA	
Arsenic	16.0		22.0		11.0		16.3	0.34
Barium	920.0		520.0		760.0		733.3	0.27
Beryllium	21.0		15.0		22.0		19.3	0.20
Boron	NA		NA		NA		NA	
Cadmium	31.0		24.0		26.0		27.0	0.13
Calcium	NA		NA		NA		NA	
Chromium	57.0		64.0		100.0		73.7	0.31
Cobalt	NA		NA		NA		NA	
Copper	1500.0		2100.0		1500.0		1700.0	0.20
Iron	NA		NA		NA		NA	
Lead	810.0		1200.0		1100.0		1036.7	0.20
Lithium	8.0		9.0		9.0		8.7	0.07
Magnesium	NA		NA		NA		NA	
Manganese	NA		NA		NA		NA	
Mercury	11.0		11.0		7.2		9.7	0.23
Molybdenum	NA		NA		NA		NA	
Nickel	110.0		99.0		140.0		116.3	0.18
Potassium	NA		NA		NA		NA	
Selenium	5.0	U	5.0	U	5.0	U	5.0	0.00
Silicon	NA		NA		NA		NA	
Silver	6.8		4.7		6.0		5.8	0.18
Sodium	NA		NA		NA		NA	
Strontium	NA		NA		NA		NA	
Tin	200.0		220.0		170.0		196.7	0.13
Titanium	NA		NA		NA		NA	
Vanadium	NA		NA		NA		NA	
Zinc	3700.0		3400.0		3500.0		3533.3	0.04
Anions (mg/kg)								
Bromide	220.00		180.00		240.00		213.33	0.14
Fluoride	NA		NA		NA		NA	
Chloride	21000.00		1600.00		19000.00		13866.67	0.77
Sulfate	510.00		1500.00		2200.00		1403.33	0.61
Nitrogen Species:								
Nitrite	NA		NA		NA		NA	
Nitrate	9.60		10.00		4.60		8.07	0.37
TKN	270.00		52.00		430.00		250.67	0.76
Phosphorous	0.05	U	0.05	U	0.05	U	0.05	0.00
Other Assays (mg/kg)								
pH (S.U.)	10.49		10.10		10.17		10.14	0.02
TDS	NA		NA		NA		NA	
COD	54000.00		44000.00		57000.00		51666.67	0.13
TOC	12000.00		NA		8500.00		10250.00	0.24
TS (%)	90.60		89.10		93.60		91.35	0.03

File:Unt.Comb.Solids<300/Set2 U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

PROCESS: Untreated, Set 2
ASH TYPE: Combined, <300 um
ASSAY: Solids by SW-846

FIELD SAMPLE
A=H128037, B=H127989
C=H127990

A. 3-8

	A	B	C	X	C.V.
Metals (mg/kg ds)					
Aluminum	27522.9	27494.9	30426.0	28481.3	0.06
Antimony	NA	NA	NA	NA	
Arsenic	16.3	22.4	11.2	16.6	0.34
Barium	937.8	529.5	770.8	746.0	0.28
Beryllium	21.4	15.3	22.3		
Boron	NA	NA	NA	NA	
Cadmium	31.6	24.4	26.4	27.5	0.13
Calcium	NA	NA	NA	NA	
Chromium	58.1	65.2	101.4	74.9	0.31
Cobalt	NA	NA	NA	NA	
Copper	1529.1	2138.5	1521.3	1729.6	0.20
Iron	NA	NA	NA	NA	
Lead	825.7	1222.0	1115.6	1054.4	0.19
Lithium	8.2	9.2	9.1	8.8	0.06
Magnesium	NA	NA	NA	NA	
Manganese	NA	NA	NA	NA	
Mercury	11.2	11.2	7.3	9.9	0.23
Molybdenum	NA	NA	NA	NA	
Nickel	112.1	100.8	142.0	118.3	0.18
Potassium	NA	NA	NA	NA	
Selenium	5.1 U	5.1 U	5.1 U	5.1	
Silicon	NA	NA	NA	NA	
Silver	6.9	4.8	6.1	5.9	0.18
Sodium	NA	NA	NA	NA	
Strontium	NA	NA	NA	NA	
Tin	203.9	224.0	172.4	200.1	0.13
Titanium	NA	NA	NA	NA	
Vanadium	NA	NA	NA	NA	
Zinc	3771.7	3462.3	3549.7	3594.6	0.04
Anions (mg/kg ds)					
Bromide	224.26	183.30	243.41	216.99	0.14
Fluoride	NA	NA	NA	NA	
Chloride	21406.73	1629.33	19269.78	14101.94	0.77
Sulfate	519.88	1527.49	2231.24	1426.20	0.60
Nitrogen Species:					
Nitrite	NA	NA	NA	NA	
Nitrate	9.79	10.18	4.67	8.21	0.37
Ammonia	275.23	52.95	436.11	254.76	0.76
Phosphorous	0.05 U	0.05 U	0.05 U	0.05	0.00
Other Assays (mg/kg ds)					
pH (S.U.)	10.49	10.10	10.17	10.14	0.02
TDS(Extract)	NA	NA	NA	NA	
COD	59602.65	49382.72	60897.44	56627.60	0.11
TOC	13245.03	NA	9081.20	11163.11	0.26
TS (%)	90.60	89.10	93.60	91.35	0.03

File:Unt.Comb.Solids<300/Set2 U=undetected,A=U(1of3),B=U(2of3),NA=not analyzed

PROCESS: Untreated
ASH TYPE: Combined Ash
ASSAY: Solids by Neutron Activation

Units: mg/kg

	<300 μ m, ground				
Drum #	1	2	3	4	5
Aluminum	55300	60000	51500	55900	55600
Antimony	132	294	245	301	177
Bromine	267	733	597	769	401
Cadmium	18.0	45.1	35.4	45.0	16.9
Calcium	91700	137000	116000	136000	121000
Cerium	30.7	25.9	25.3	24.8	25.7
Cesium	1.17	1.50	0.936	0.962	1.18
Chlorine	14400	37400	28300	35900	28500
Chromium	509	363	382	384	450
Cobalt	40.0	37.5	31.0	33.3	35.2
Copper	1960	1820	1520	1540	2060
Indium	0.214	0.589	0.422	0.646	0.504
Iodine	3.79	14.0	10.3	14.0	10.5
Iron	119000	50100	64200	50100	73300
Lanthanum	9.84	9.62	9.16	9.44	15.2
Maganese	1540	1740	2390	2730	2360
Mercury	1.12	3.21	2.64	5.57	2.88
Potassium	11500	14600	13400	14000	12900
Samarium	2.07	2.08	1.76	1.93	1.94
Scandium	3.99	3.93	3.80	3.79	3.98
Selenium	2.09 U	3.20	4.64	2.79 U	2.60
Silicon	178000	108000	125000	109000	156000
Silver	7.22	12.9	9.95	10.3	12.6
Sodium	32100	19100	21200	17200	22900
Tantalum	2.61	3.41	3.61	2.47	2.98
Thorium	3.96	4.07	3.91	3.93	4.25
Titanium	5600	6600	7000	7100	6600
Vanadium	33.6	32.5	24.7	31.6	42.7
Zinc	4200	7140	6420	7570	6350
Unt.Comb.NAA	1	2	3	4	5

A. 3-9

PROCESS: Untreated
ASH TYPE: Combined Ash
ASSAY: Solids by Neutron Activation

Units: mg/kg

	<300 μ m, ground				
Drum #	6	7	9	13	15
Aluminum	55800	48800	56400	59400	52600
Antimony	355	327	175	351	130
Bromine	850	732	372	840	235
Cadmium	45.0	32.0	17.3	41.6	16.7
Calcium	146000	131000	99800	143000	91100
Cerium	24.3	23.4	26.0	25.5	29.5
Cesium	1.01 U	0.909 U	1.08	1.12	1.17
Chlorine	37300	33200	21200	37100	11000
Chromium	291	307	416	363	467
Cobalt	34.3	35.1	34.8	37.7	31.9
Copper	1160	1340	1770	1790	2090
Indium	0.506	0.499	0.301	0.598	0.147
Iodine	15.3	12.8	5.27	12.5	3.33 U
Iron	35900	41300	83400	47700	107000
Lanthanum	9.28	8.54	9.43	9.68	11.4
Maganese	1730	2600	2030	2680	1460
Mercury	3.75	3.67	2.04	4.74	1.13
Potassium	15600	12100	11600	14100	10400
Samarium	1.93	1.58	1.82	2.01	2.04
Scandium	3.47	3.29	3.59	3.79	3.73
Selenium	6.03 U	6.15	4.18	6.11 U	3.09 U
Silicon	102000	89000	154000	119000	186000
Silver	14.5	13.2	10.6	12.6	9.37
Sodium	16180	15800	25200	18100	36100
Tantalum	3.46	2.05	2.39	1.69	3.15
Thorium	3.05	2.69	3.29	3.47	3.39
Titanium	6600	5900	5500	7600	5400
Vanadium	28.8	31.0	35.2	29.6	38.1
Zinc	6620	6550	4920	7340	3560

Unt.Comb. NAA/300pg2

6	7	9	13	15

A. 3-9

PROCESS: Untreated
ASH TYPE: Combined Ash
ASSAY: Solids by Neutron Activation

Units: mg/kg

<300 m, ground		
	x	st.dev/x
Aluminum	55130	0.06
Antimony	248.7	0.36
Bromine	579.6	0.41
Cadmium	31.3	0.41
Calcium	121260	0.17
Cerium	26.11	0.09
Cesium	1.10	0.16
Chlorine	28430	0.34
Chromium	393.2	0.17
Cobalt	35.08	0.08
Copper	1705	0.18
Indium	0.44	0.38
Iodine	10.18	0.44
Iron	67200	0.42
Lanthanum	10.16	0.19
Maganese	2126	0.23
Mercury	3.08	0.47
Potassium	13020	0.12
Samarium	1.92	0.08
Scandium	3.74	0.06
Selenium	4.09	0.38
Silicon	132600	0.25
Silver	11200	0.00
Sodium	21309	0.32
Tantalum	2.60	0.24
Thorium	3.60	0.14
Titanium	6390	0.12
Vanadium	32.82	0.15
Zinc	6067	0.23

UntLComb.NAA/300/pg.3

A. 3-9

PROCESS: Untreated
ASH TYPE: Combined Ash
ASSAY: Solids by Neutron Activation

A. 3-10

	x (mg/kg)	x (mg/kg ds)	C.V.
Metals			
Aluminum	55130.0	56083.4	0.06
Antimony	248.7	253.0	0.36
Arsenic	NA	NA	
Barium	NA	NA	
Beryllium	NA	NA	
Boron	NA	NA	
Cadmium	31.3	31.8	0.41
Calcium	121260.0	123357.1	0.17
Chromium	393.2	400.0	0.17
Cobalt	35.1	35.7	0.08
Copper	1705.0	1734.5	0.18
Iron	67200.0	68362.2	0.42
Lead	NA	NA	
Lithium	NA	NA	
Magnesium	2126.0	2162.8	
Manganese	NA	NA	0.23
Mercury	3.1	3.1	0.47
Molybdenum	NA	NA	
Nickel	NA	NA	
Potassium	13020.0	13245.2	0.12
Selenium	4.1	4.2	0.38
Silicon	132600.0	134893.2	0.25
Silver	NA	NA	
Sodium	21309.0	21677.5	0.32
Strontium	NA	NA	
Tin	NA	NA	
Titanium	NA	NA	0.12
Vanadium	32.6	33.4	0.15
Zinc	6067.0	6171.9	0.23
Anions (mg/l)			
Bromide	579.6	589.6	0.41
Fluoride	NA	NA	
Chloride	28430.0	28921.7	0.34
Sulfate	NA	NA	
Nitrogen Species:			
Nitrite	NA	NA	
Nitrate	NA	NA	
Ammonia	NA	NA	
Phosphorous	NA	NA	
Other Assays (mg/l)			
pH (S.U.)	NA	NA	
TDS	NA	NA	
COD	NA	NA	
TOC	NA	NA	

Unt.Comb./NAA/Summary

Appendix B. Summary results of TCLP, DWLT and AVLT for untreated and treated MWC residues.

Contents:

	Table Number:			
	TCLP	DWLT (Ext. 1+2)	DWLT (Ext. 3+4	AVLT
APC Residue (Appendix B.1)				
Extract Concentration [1]	B.1-1	-	-	-
Release [2]	B.1-2	B.1-5	B.1-8	B.1-11
Release [3]	B.1-3	B.1-6	B.1-9	B.1-12
C.V.[4]	B.1-4	B.1-7	B.1-10	B.1-13
Bottom Ash (Appendix B.2)				
Extract Concentration [1]	B.2-1	-	-	-
Release [2]	B.2-2	B.2-5	B.2-8	B.2-11
Release [3]	B.2-3	B.2-6	B.2-9	B.2-12
C.V.[4]	B.2-4	B.2-7	B.2-10	B.2-13
Combined Ash (Appendix B.3)				
Extract Concentration [1]	B.3-1	-	-	-
Release [2]	B.3-2	B.3-5	B.3-8	B.3-11
Release [3]	B.3-3	B.3-6	B.3-9	B.3-12
C.V.[4]	B.3-4	B.3-7	B.3-10	B.3-13

[1]Extract concentrations - mean values of 3 replicates [µg/l or mg/l]

[2]Release on a treated residue basis - mean values of 3 replicates [mg/kgg d.s.]

[3]Release on an untreated residue basis (corrected for process dilution) - mean values of 3 replicates[mg/kg ash]

[4]C.V. - coefficients of variation for replicate assays

Appendix B.1.

Summary results of TCLP, DWLT and AVLT for untreated and treated APC residues.

B. 1-1

Comparison of extract concentrations for TCLP on untreated and treated MWC residues (ug/l).

LEACH TEST: TCLP ASH TYPE: APC Residue

	Process 1 (Ext. 2)	Process 2 (Ext. 2)	Process 3 (Ext. 2)	Process 4 (Ext. 2)	WES Control (Ext. 2)	Untreated (Ext. 1)	Untreated (Ext. 2)	Reg. Limits
Metals (ug/l)								
Aluminum	145	266	21 U	38 A	333	44 A	42 A	
Antimony	14 U	40 U	40 U	426 A	40 U	25 B	23 B	
Arsenic	3 U	10 U	10 U	21	10 U	3 U	3 U	5000
Barium	729	1367	843	403 A	1500	1317	1600	100000
Beryllium	1 U	4	2 U	1 U	2	1 U	1 U	
Boron	134	NA	NA	2364 A	NA	674	974	
Cadmium	3	3	1 U	450 A	4	5 B	5 U	1000
Calcium	3780000	3000000	3500000	2723437	4166667	4516667	4033333	
Chromium	3 U	16	9 B	3 U	20	27	21	5000
Cobalt	3 U	7 U	7 U	9 A	7 U	5 U	5 U	
Copper	5 B	20	16	22 A	23	74	74	
Iron	42	106	10 A	15 B	147	56	60	
Lead	1523	670	2267	35	240	37033	32633	5000
Lithium	176	190	113	80 A	163	154	153	
Magnesium	113	260	143	83003	413	105	54	
Manganese	2 B	5 B	4 U	449 A	5 B	6 A	2 U	
Mercury	37	54	6	22	10	259	232	200
Molybdenum	3 U	210	307	194 A	233	294	276	
Nickel	5 U	20 A	20 U	23 A	20 B	11 U	11 U	
Potassium	402667	203333	573333	198997	210000	709000	712667	
Selenium	30 U	5 U	5 U	21 U	5 U	20 U	20 U	1000
Silicon	733	1600	1167	7674 A	2500	269	269	
Silver	4 U	7 U	7 U	4 U	7 U	6	4 A	5000
Sodium	446667	1000000	333333	265672 A	433333	2190000	726333	
Strontium	3660	7867	4767	1624	5233	3457	3663	
Tin	10 U	55 U	55 U	11 B	55 U	17 U	17 U	
Titanium	2 U	12 U	12 U	2 U	12 U	1 U	1 U	
Vanadium	3 U	8 A	9 A	7 A	8 A	3 U	3 U	
Zinc	402	420	690	4314	433	3987	4330	

U=undetected, detection limit indicated; A=U(1 of 3); B=U(2 of 3); NA= not analyzed

TCLP/SumCompEx/Fly

Comparison of extract concentrations for TCLP on untreated and treated MWC residues (mg/l), (continued).

LEACH TEST: TCLP **ASH TYPE:** APC Residue

	Process 1 (Ext. 2)	Process 2 (Ext. 2)	Process 3 (Ext. 2)	Process 4 (Ext. 2)	WES Control (Ext. 2)	Untreated (Ext. 1)	Untreated (Ext. 2)	Reg. Limits
Anions (mg/l)								
Bromide	100	96	86	95	NA	225	222	
Fluoride	NA	NA	NA	NA	NA	5	4	
Chloride	4003	3743	3577	3553	NA	8137	7497	
Sulfate	435	266	902	1000	NA	883	770	
Nitrogen Species:								
Nitrite	NA	NA	NA	NA	NA	0	0	
Nitrate	448	NA	117	17	NA	26	26	
Ammonia	NA	NA	NA	NA	NA	NA	NA	
Phosphorous	1	1 B	NA	1	NA	0 B	0 U	
Other Assays (mg/l)								
pH (S.U.)	5.14	8.03	11.51	7.16	11.23	11.91	11.88	
TDS	NA	NA	NA	NA	NA	NA	NA	
COD	NA	NA	NA	NA	NA	NA	NA	
TOC	NA	NA	NA	NA	NA	NA	NA	

U=undetected, detection limit indicated; A=U(1 of 3); B=U(2 of 3); NA= not analyzed

TCLP/SumCompEx/Fly

Comparison of species release for leaching tests on untreated and treated MWC residues (mg released/kg, dry solid).

LEACH TEST: TCLP **ASH TYPE:** APC Residue

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated *	Total (SW-846)	Total (NAA)
Metals (mg/kg ds)								
Aluminum	4	8	0 U	1 A	10	1 A	13587	25586
Antimony	0 U	1 U	1 U	12 A	1 U	0 B	NA	1096
Arsenic	0 U	0 U	0 U	1	0 U	0 U	43	NA
Barium	22	42	18	12 A	47	32	365	NA
Beryllium	0.0 U	0.1	0.0 U	0.0 U	0.1	0.0 U	U	NA
Boron	4.1	NA	NA	69.2 A	NA	19.7	187.3	NA
Cadmium	0	0	0 U	13 A	0	0 U	198	137
Calcium	116081	92714	75546	79719	127665	81391	NA	290725
Chromium	0 U	1	0 B	0 U	1	0	41	196
Cobalt	0 U	0 U	0 U	0 A	0 U	0 U	NA	15
Copper	0 B	1	0	1 A	1	1	363	515
Iron	1	3	0 A	0 B	5	1	NA	6306
Lead	47	21	49	1	7	658	2969	NA
Lithium	5	6	2	2 A	5	3	13	NA
Magnesium	3	8	3	2429	13	1	NA	NA
Manganese	0 B	0 B	0 U	13 A	0 B	0 U	NA	426
Mercury	1.13	1.66	0.18	0.64	0.30	4.69	45.84	9.37
Molybdenum	0 U	6	7	6 A	7	6	NA	NA
Nickel	0 U	1 A	0 U	1 A	1 B	0 U	26	NA
Potassium	12366	6267	12374	5826	6469	14377	NA	15598
Selenium	1 U	0 U	0 U	1 U	0 U	0 U	3 A	8
Silicon	23	49	25	225 A	77	6	NA	41440
Silver	0 U	0 U	0 U	0 U	0 U	0 A	44	54
Sodium	13779	30893	7195	7780 A	13300	14653	NA	20467
Strontium	119	242	103	48	162	74	NA	NA
Tin	0 U	2 U	1 U	0 B	2 U	0 U	603	NA
Titanium	0 U	0 U	0 U	0 U	0 U	0 U	NA	5658
Vanadium	0 U	0 A	0 A	0 A	0 A	0 U	NA	19
Zinc	12	13	15	126	13	87	3011	17453

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed * Ext 2

File:TCLP/Fly.sum.

Comparison of species release for leaching tests on untreated and treated MWC residues (mg released/kg, dry solid), (continued).

B. 1-2

LEACH TEST: TCLP **ASH TYPE: APC Residue**

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated *	Total (SW-846)	Total (NAA)
Anions (mg/kg ds)								
Bromide	3058	2959	1862	2745	NA	4472	5287	3830
Fluoride	NA	NA	NA	NA	NA	87	20	NA
Chloride	122964	115412	77144	102726	NA	151239	184511	168528
Sulfate	13366	8221	19442	28848	NA	15528	6336	NA
Nitrogen Species:								
Nitrite	NA	NA	NA	NA	NA	2	0	NA
Nitrate	13742	NA	2530	NA	NA	573	30	NA
Ammonia	NA	NA	NA	NA	NA	NA	2	NA
Phosphorous	31	33 B	NA	29	NA	0 U	1767	NA
Other Assays (mg/kg ds								
pH (S.U.)	5.14	8.03	11.51	7.2	11.23	11.9		NA
TDS	NA	NA	NA	NA	NA	NA	349421.91	NA
COD	NA	NA	NA	NA	NA	NA	28440.26	NA
TOC	NA	NA	NA	NA	NA	NA	4039.18	NA

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed * Ext. 2

File:TCLP/Fly.sum.

Comparison of species release for leaching tests on untreated and treated MWC residues (mg released/kg ash treated).

LEACH TEST: TCLP ASH TYPE: APC Residue

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Metals (mg/kg ash, ds)								
Aluminum	9	18	1 U	1 A	23	1 A	13587	25586
Antimony	1 U	3 U	2 U	16 A	3 U	0 B	NA	1096
Arsenic	0 U	1 U	1 U	1	1 U	0 U	43	NA
Barium	45	93	44	15 A	103	32	365	NA
Beryllium	0.1 U	0.2	0.1 U	0.037498 U	0.2	0.0 U	0.0 U	NA
Boron	8.2	#VALUE!	#VALUE!	89.92141 A	#VALUE!	19.7	187.3	NA
Cadmium	0	0	0 U	17 A	0	0 U	198	137
Calcium	232163	203970	161311	103634	280863	61391	NA	290725
Chromium	0 U	1	0 B	0 U	1	0	41	196
Cobalt	0 U	0 U	0 U	0 A	0 U	0 U	NA	15
Copper	0 B	1	1	1 A	2	1	363	515
Iron	3	7	1 A	1 B	10	1	NA	6306
Lead	94	45	118	1	16	658	2969	NA
Lithium	11	13	6	3 A	11	3	13	NA
Magnesium	7	18	7	3158	28	1	NA	NA
Manganese	0 B	0 B	0 U	17 A	0 B	0 U	NA	426
Mercury	2.3	3.7	0.4	0.630732	0.6	4.7	45.8	9
Molybdenum	0 U	14	16	7 A	16	6	NA	NA
Nickel	0 U	1 A	1 U	1 A	1 B	0 U	26	NA
Potassium	24731	13788	29698	7574	14232	14377	NA	15598
Selenium	2 U	0 U	0 U	1 U	0 U	0 U	3 A	8
Silicon	45	108	60	292 A	170	6	NA	41440
Silver	0 U	1 U	0 U	0 U	1 U	0 A	44	54
Sodium	27557	67964	17268	10114 A	29261	14653	NA	20467
Strontium	238	533	247	62	356	74	NA	NA
Tin	1 U	4 U	3 U	0 B	4 U	0 U	603	NA
Titanium	0 U	1 U	1 U	0 U	1 U	0 U	NA	5658
Vanadium	0 U	1 A	0 A	0 A	1 A	0 U	NA	19
Zinc	25	28	36	164	29	87	3011	17453

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:TCLP/Fly.sum.

Comparison of species release for leaching tests on untreated and treated MWC residues (mg released/kg ash treated), (continued).

LEACH TEST: TCLP ASH TYPE: APC Residue

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Anions (mg/kg ash ds)								
Bromide	6117	6510	4470	3568	NA	4472	5287	3830
Fluoride	NA	NA	NA	NA	NA	87	20	NA
Chloride	245927	253905	185145	133544	NA	151239	184511	168528
Sulfate	26732	18085	46662	37503	NA	15528	6336	NA
Nitrogen Species:								
Nitrite	NA	NA	NA	NA	NA	2	0	NA
Nitrate	27484	NA	6072	NA	NA	573	30	NA
Ammonia	NA	NA	NA	NA	NA	NA	2	NA
Phosphorous	61	72 B	NA	37	NA	0 U	1767	NA
Other Assays (mg/kg ds)								
pH (S.U.)	5.14	8.03	11.51	7.16	11.23	11.88	10.02	
TDS	NA	NA	NA	NA	NA	NA	349421.91	NA
COD	NA	NA	NA	NA	NA	NA	28440.26	NA
TOC	NA	NA	NA	NA	NA	NA	4039.18	NA

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:TCLP/Fly.sum.

Comparison of coefficients of variation for species release from leaching tests on untreated and treated MWC residues.

LEACH TEST: TCLP **ASH TYPE:** APC Residue

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated*	Total (SW-846)	Total (NAA)
Metals								
Aluminum	0.53	0.89	0.01 U	1.04 A	0.42	0.45 A	0.06	0.09
Antimony	0.01 U	0.02 U	0.01 U	0.84 A	0.05 U	0.06 B	NA	0.03
Arsenic	0.01 U	0.02 U	0.01 U	0.25	0.05 U	0.00 U	0.39	NA
Barium	0.08	0.16	0.12	0.89 A	0.39	0.16	0.02	NA
Beryllium	0.01 U	0.05	0.01 U	0.03 U	0.36	0.00 U	NA U	NA
Boron	0.06	NA	NA	0.87 A	NA	0.12	0.02	NA
Cadmium	0.96	0.63	0.01 U	0.87 A	0.62	0.00 U	0.02	0.09
Calcium	0.04	0.05	0.32	0.88	0.13	0.32	NA	0.02
Chromium	0.01 U	0.09	0.03 B	0.03 U	0.19	0.26	0.01	0.05
Cobalt	0.01 U	0.02 U	0.01 U	0.59 A	0.05 U	0.00 U	NA	0.13
Copper	0.26 B	0.31	0.01	0.74 A	0.20	0.15	0.02	0.11
Iron	0.67	0.92	0.50 A	1.27 B	0.33	0.19	NA	0.06
Lead	0.08	0.26	0.88	0.43	0.29	0.12	0.02	NA
Lithium	0.04	0.07	0.26	0.84 A	0.04	0.10	0.04	NA
Magnesium	0.60	0.64	0.21	0.87	0.36	0.11	NA	NA
Manganese	0.26 B	0.33 B	0.01 U	0.87 A	0.45 B	0.00 U	NA	0.06
Mercury	0.15	0.49	0.13	0.11	0.05	0.13	0.09	0.08
Molybdenum	0.01 U	0.06	0.04	0.85 A	0.07	0.03	NA	NA
Nickel	0.01 U	0.05 A	0.01 U	0.69 A	0.05 B	0.00 U	0.04	NA
Potassium	0.03	0.12	0.36	0.93	0.06	0.04	NA	0.05
Selenium	0.01 U	0.02 U	0.01 U	0.75 U	0.05 U	0.00 U	0.07 A	0.18
Silicon	0.20	0.37	0.55	0.87 A	0.18	0.27	NA	0.30
Silver	0.01 U	0.02 U	0.01 U	0.03 U	0.05 U	0.25 A	0.02	0.05
Sodium	0.03	0.02	0.35	0.92 A	0.06	0.04	NA	0.03
Strontium	0.02	0.12	0.04	0.89	0.14	0.06	NA	NA
Tin	0.01 U	0.02 U	0.01 U	0.11 B	0.05 U	0.00 U	0.02	NA
Titanium	0.01 U	0.02 U	0.01 U	0.03 U	0.05 U	0.00 U	NA	0.15
Vanadium	0.01 U	0.16 A	0.25 A	0.53 A	0.14 A	0.00 U	NA	0.23
Zinc	0.19	0.70	0.50	0.90	0.13	0.05	0.07	0.05

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed *Ext. 2

File:CV/TCLP/FLY/SUM.

Comparison of coefficients of variation for species release from leaching tests on untreated and treated MWC residues (continued).

LEACH TEST: TCLP — ASH TYPE: APC Residue

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated *	Total (SW-846)	Total (NAA)
Anions								
Bromide	0.01	0.18	0.14	0.16	NA	0.04	0.03	0.03
Fluoride	NA	NA	NA	NA	NA	0.19	0.00	NA
Chloride	0.04	0.11	0.05	0.28	NA	0.05	0.03	0.02
Sulfate	0.04	0.17	0.12	0.03	NA	0.11	0.14	NA
Nitrogen Species:								
Nitrite	NA	NA	NA	NA	NA	0.36	0.05	NA
Nitrate	0.14	NA	0.64	NA	NA	0.16	0.06	NA
Ammonia	NA	NA	NA	NA	NA	NA	0.10	NA
Phosphorous	0.01	0.09	NA	0.03	NA	0.00 U	0.34	NA
Other Assays								
pH (S.U.)	0.05	0.34	0.02	0.01	0.02	0.01		NA
TDS	NA	NA	NA	NA	NA	NA	0.04	NA
COD	NA	NA	NA	NA	NA	NA	0.14	NA
TOC	NA	NA	NA	NA	NA	NA	0.20	NA

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

* Ext. 2

File:CV/TCLP/FLY/SUM.

B. 1-4

Comparison of species release for leaching tests on untreated and treated MWC residues (mg released/kg, dry solid).

LEACH TEST: DWLT, Extracts 1 + 2 **ASH TYPE:** APC Residue

	Process 1	Process 2	Process 3	Process 4	WES Control	WES Untreated	Total (SW-846)	Total (NAA)
Metals (mg/kg ds)								
Aluminum	0 B	1 B	1 B	1	1	0 U	13587	25586
Antimony	0 U	1 U	1 U	0 U	1 U	0 U	NA	1096
Arsenic	0 U	0 U	0 U	0 U	1 U	0 U	43	NA
Barium	58	69	20	13	141	63	365	NA
Beryllium	0.0 U	0.1 A	0.1	0.0 U	0.1	0.0 U	U	NA
Boron	3.2	NA	NA	NA	NA	13.5	187.3	NA
Cadmium	0 U	0 U	0 U	0 B	0 U	0	198	137
Calcium	75580	38755	40247	35849	22584	104907	NA	290725
Chromium	0 U	0 A	0	0	0	0 U	41	196
Cobalt	0 U	0 U	0 U	0 U	0 U	0 U	NA	15
Copper	0 U	0 U	0	0 U	0	2	363	515
Iron	5 A	0 B	0 U	0	1	0 U	NA	6306
Lead	104	63	263	7	49	700	2969	NA
Lithium	5	5	3	1	4 B	4	13	NA
Magnesium	2 A	1	1	1	1	0 A	NA	NA
Manganese	0 U	0 U	0 U	0 U	0 U	0 U	NA	426
Mercury	1.48	1.64	0.01	0.00 U	0.80 B	0.10	45.84	9.37
Molybdenum	0 U	4	4	5	3	0 U	NA	NA
Nickel	0 U	1 U	0 U	0 U	1 U	0 U	26	NA
Potassium	12609	8942	11637	5703	9278	14166	NA	15598
Selenium	1 U	0 U	0 U	1 U	0 U	1 U	3 A	8
Silicon	6	10	8	20	16	1 A	NA	41440
Silver	0 U	0 U	0 U	0 U	0 U	0 U	44	54
Sodium	12709	23150	7614	6864	8997	16569	NA	20467
Strontium	122	208	100	43	171	106	NA	NA
Tin	0 U	1 U	1 U	0 U	2 U	0 U	603	NA
Titanium	0 U	0 U	0 U	0 U	0 U	0 U	NA	5658
Vanadium	0 U	0	0	0 U	0	0 U	NA	19
Zinc	9	6	35	9	5	81	3011	17453

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:DWLT.Fly/Sum 1+2

Comparison of species release for leaching tests on untreated and treated MWC residues (mg released/kg, dry solid), (continued).

LEACH TEST: DWLT, Extracts 1 + 2 ASH TYPE: APC Residue

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Anions (mg/kg ds)								
Bromide	2562	2515	1754	1389	2363	5259	5287	3830
Fluoride	NA	NA	NA	NA	NA	64	20	NA
Chloride	117991	105014	76199	65830	126718	211168	184511	168528
Sulfate	3221	2137	17101	12613	558	21929	6336	NA
Nitrogen Species:								
Nitrite	NA	NA	NA	NA	NA	1 B	0	NA
Nitrate	75	13	22	41	93	43	30	NA
Ammonia	NA	NA	NA	NA	NA	NA	2	NA
Phosphorous	15 U	26	22 U	21	45 U	0 U	1767	NA
Other Assays (mg/kg ds								
pH (S.U.)	11.14	12.09	12.11	11.6	12.00	11.9		NA
TDS	266216.68	216812.74	200435.23	129320.9	260170.03	231032.1	349421.91	NA
COD	5001.44	4407.59	1320.91 A	3077.0	5031.80	8216.6	28440.26	NA
TOC	54.18	36.18	25.84	12.22	33.74	18.6	4039.18	NA

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:DWLT.Fly/Sum 1+2

Comparison of species release for leaching tests on untreated and treated MWC residues (mg released/kg ash treated).

LEACH TEST: DWLT, Extracts 1 + 2 **ASH TYPE:** APC Residue

	Process 1	Process 2	Process 3	Process 4	WES - Control	Untreated	Total (SW-846)	Total (NAA)
Metals (mg/kg ash, ds)								
Aluminum	1 B	2 B	2 B	2	2	0 U	13587	25586
Antimony	1 U	2 U	2 U	0 U	2 U	0 U	NA	1096
Arsenic	0 U	1 U	1 U	0 U	2 U	0 U	43	NA
Barium	117	151	47	17	309	63	365	NA
Beryllium	0.1 U	0.1 A	0.1	0.0 U	0.2	0.0 U	0.0 U	NA
Boron	6.5	NA	NA	NA	NNA	13.5	187.3	NA
Cadmium	0 U	0 U	0 U	0 B	0 U	0	198	137
Calcium	151160	85260	96592	46604	49685	104907	NA	290725
Chromium	0 U	1 A	1	1	1	0 U	41	196
Cobalt	0 U	0 U	0 U	0 U	1 U	0 U	NA	15
Copper	0 U	1 U	1	0 U	1	2	363	515
Iron	10 A	0 B	0 U	1	3	0 U	NA	6306
Lead	209	139	632	9	107	700	2969	NA
Lithium	11	10	8	2	8 B	4	13	NA
Magnesium	3 A	2	2	2	1	0 A	NA	NA
Manganese	0 U	0 U	0 U	0 U	0 U	0 U	NA	426
Mercury	3.0	3.6	0.0	0.0 U	1.8 B	0.1	45.8	9
Molybdenum	0 U	8	10	8	7	0 U	NA	NA
Nickel	0 U	1 U	1 U	0 U	1 U	0 U	26	NA
Potassium	25217	19673	27929	7414	20412	14166	NA	15598
Selenium	1 U	0 U	0 U	1 U	0 U	1 U	3 A	8
Silicon	13	22	18	26	35	1 A	NA	41440
Silver	0 U	0 U	0 U	0 U	0 U	0 U	44	54
Sodium	25417	50930	18275	8923	19794	16569	NA	20467
Strontium	244	457	241	55	375	106	NA	NA
Tin	1 U	3 U	3 U	0 U	3 U	0 U	603	NA
Titanium	0 U	1 U	1 U	0 U	1 U	0 U	NA	5658
Vanadium	0 U	1	1	0 U	0	0 U	NA	19
Zinc	18	14	84	12	10	81	3011	17453

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:DWLT.Fly/Sum 1+2

Comparison of species release for leaching tests on untreated and treated MWC residues (mg released/kg ash treated), (continued).

LEACH TEST: DWLT, Extracts 1 + 2 **ASH TYPE:** APC Residue

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Anions (mg/kg ash ds)								
Bromide	5124	5533	4210	1806	5199	5259	5287	3830
Fluoride	NA	NA	NA	NA	NA	64	20	NA
Chloride	235981	231031	182877	85579	278779	211168	184511	168528
Sulfate	6443	4702	41044	16397	1227	21929	6336	NA
Nitrogen Species:								
Nitrite	NA	NA	NA	NA	NA	1 B	0	NA
Nitrate	149	29	53	54	205	43	30	NA
Ammonia	NA	NA	NA	NA	NA	NA	2	NA
Phosphorous	30 U	58	52 U	27	99 U	0 U	1767	NA
Other Assays (mg/kg ds)								
pH (S.U.)	11.14	12.09	12.11	11.6	12.00	11.9	10.02	NA
TDS	532437.36	476988.02	481044.55	168117.1	572374.08	231032.1	349421.91	NA
COD	10002.88	9696.70	3170.20 A	4000.1	11069.97	8216.6	28440.26	NA
TOC	108.36	79.59	62.02	15.89	74.23	18.6	4039.18	NA

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:DWLT.Fly/Sum 1+2

Comparison of coefficients of variation for species release from leaching tests on untreated and treated MWC residues.

LEACH TEST: DWLT, Extracts 1 + 2 **ASH TYPE:** Bottom Ash

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Metals								
Aluminum	0.27	0.23	0.37	0.21	0.25	0.09	0.03	0.02
Antimony	0.02 U	0.18	0.00 U	0.00	0.01 U	0.02 U	NA	0.17
Arsenic	0.02 U	1.16 B	0.00 U	0.00 B	0.01 U	0.02 U	0.45	NA
Barium	0.20	0.08	0.06	0.16	0.09	0.29	0.02	NA
Beryllium	0.79 B	0.10 B	0.00 U	0.00 B	0.18	0.98 A	NA	NA
Boron	0.12	NA	NA	NA	NA	0.31	NA	NA
Cadmium	0.05 B	0.07 U	0.00 U	0.00 U	0.01 U	0.75 A	0.17	0.19
Calcium	0.09	1.01	0.08	0.02	0.12	0.04	NA	0.07
Chromium	0.02 U	0.52	0.43	0.00	0.13 B	0.02 U	0.08	0.20
Cobalt	0.26 B	0.07 U	0.00 U	0.00 U	0.15 B	0.09 B	NA	0.16
Copper	0.23	0.25	0.30	0.05	0.02	0.09	0.12	0.14
Iron	0.67	0.22	0.00 U	0.37	0.80	0.59 B	NA	0.24
Lead	0.07	0.31	0.05	0.82	0.15	0.59	0.27	NA
Lithium	0.07	0.28	0.05	0.04	0.01	0.27	0.13	NA
Magnesium	0.69	0.32	0.30	0.41	0.38	0.75	NA	NA
Manganese	0.89 B	0.07 U	0.00 U	0.00 U	0.01 U	0.83 A	NA	0.09
Mercury	0.58 U	0.15	0.00 U	0.08	0.87 B	0.29 B	0.17	0.14
Molybdenum	1.17	0.18	0.43	0.39	0.04	0.03 U	NA	NA
Nickel	0.40 B	0.07 U	0.00 U	0.00 U	0.01 U	0.02 B	0.18	NA
Potassium	0.08	0.11	0.06	0.12	0.24	0.07	NA	0.10
Selenium	0.02 U	0.13	0.00 U	0.00	0.01 U	0.02 U	NA U	0.14
Silicon	0.18	0.19	0.73	0.19	0.11	0.09	NA	0.15
Silver	0.02 U	0.07 U	0.00 U	0.00 U	0.01 U	0.02 U	0.90	0.19
Sodium	0.06	0.33	0.12	0.12	0.28	0.11	NA	0.17
Strontium	0.20	0.53	0.02	0.14	0.07	0.07	NA	NA
Tin	0.27 B	0.07 U	0.00 U	0.00 U	0.01 U	0.02 U	0.11	NA
Titanium	0.73 B	0.07 U	0.00 U	0.08 U	0.01 U	0.11	NA	0.06
Vanadium	0.24 B	0.44	0.16	0.00	0.16	0.03 B	NA	0.08
Zinc	0.31	1.32	0.28	0.13	0.19	0.30	0.02	0.13

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:CV/DWLT/Bot. 1+2

Comparison of species release for leaching tests on untreated and treated MWC residues (mg released/kg ash treated), (continued).

LEACH TEST: DWLT, Extracts 1+2 ASH TYPE: Bottom Ash

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Anions (mg/kg ash ds)								
Bromide	296	562	410	246	404	424	294	572
Fluoride	NA	NA	NA	NA	NA	3 B	1 U	NA
Chloride	14725	25442	25366	13516	17791	25536	20379	24301
Sulfate	109	25330	9036	144	88	352	87	NA
Nitrogen Species:								
Nitrite	NA	NA	NA	NA	NA	2	2	NA
Nitrate	2777	49	37	22	30	16	3	NA
Ammonia	NA	NA	NA	NA	NA	NA	9	NA
Phosphorous	26 U	44	104 B	24	25 U	1	2444	NA
Other Assays (mg/kg ds)								
pH (S.U.)	11.14	11.14	12.30	11.1	11.14	11.2	10.43	NA
TDS	40717.52	163100.19	105112.55	34086.2	46049.34	52122.3	34670.14	NA
COD	490.77	1632.04	1519.99	245.8	375.76	679.6	29180.96	NA
TOC	138.54	495.23	253.83	952.84	144.97	169.4	12456.07	NA

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:DWLT.bot.sum/1+2

Comparison of species release for leaching tests on untreated and treated MWC residues (mg released/kg ash treated).

LEACH TEST: DWLT, Extracts 1+2 ASH TYPE: Bottom Ash

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Metals (mg/kg ash, ds)								
Aluminum	133	1652	3	612	59	787	31576	51749
Antimony	0 U	4	2 U	0	1 U	0 U	NA	316
Arsenic	0 U	1 B	0 U	0 B	0 U	0 U	16	NA
Barium	35	2	23	23	51	26	553	NA
Beryllium	0.0 B	0.1 B	0.1 U	0.023671 B	0.1	0.1 A	24.4	NA
Boron	NA	NA	NA	#VALUE!	NA	0.5	NA	NA
Cadmium	0 B	0 U	0 U	0 U	0 U	0 A	36	35
Calcium	8769	2478	16448	6446	8025	8996	NA	113087
Chromium	0 U	6	0	0	0 B	0 U	197	778
Cobalt	0 B	0 U	0 U	0 U	0 B	0 B	NA	77
Copper	1	11	1	1	1	2	2105	1477
Iron	1	1	0 U	0	1	0 B	NA	75763
Lead	1	3	10	0	1	0	1563	NA
Lithium	2	5	5	1	1	1	9	NA
Magnesium	1	1	1	0	0	1	NA	NA
Manganese	0 B	0 U	0 U	0 U	0 U	0 A	NA	1064
Mercury	0.0 U	0.0	0.0 U	0.004971	0.0 B	0.0 B	6.0	1
Molybdenum	2	29	20	9	6	0 U	NA	NA
Nickel	0 B	1 U	1 U	0 U	1 U	0 B	431	NA
Potassium	2699	4945	19850	2379	2564	3613	NA	9510
Selenium	0 U	0	0 U	0	0 U	0 U	5 U	4
Silicon	32	542	28	13	39	10	NA	116382
Silver	0 U	0 U	0 U	0 U	0 U	0 U	4	18
Sodium	3792	51250	5710	3093	2702	5090	NA	19777
Strontium	46	17	111	28	61	56	NA	NA
Tin	0 B	2 U	2 U	0 U	1 U	0 U	245	NA
Titanium	0 B	1 U	0 U	0 U	0 U	1	NA	6599
Vanadium	0 B	5	0	0	0	0 B	NA	43
Zinc	2	25	2	1	1	1	4821	6793

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:DWLT.bot.sum/1+2

Comparison of species release for leaching tests on untreated and treated MWC residues (mg released/kg, dry solid), (continued).

LEACH TEST: DWLT, Extracts 1+2 ASH TYPE: Bottom Ash

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Anions (mg/kg ds)								
Bromide	247	351	228	208	336	424	294	572
Fluoride	NA	NA	NA	NA	NA	3 B	1 U	NA
Chloride	12270	15901	14092	11454	14826	25536	20379	24301
Sulfate	90	15831	5021	122	73	352	87	NA
Nitrogen Species:								
Nitrite	NA	NA	NA	NA	NA	2	2	NA
Nitrate	2314	30	21	18	25	16	3	NA
Ammonia	NA	NA	NA	NA	NA	NA	9	NA
Phosphorous	22 U	28	58 B	20	21 U	1	2444	NA
Other Assays (mg/kg ds								
pH (S.U.)	11.14	11.14	12.30	11.1	11.14	11.2	10.43	NA
TDS	33931.27	101937.62	58395.86	28886.61	38374.45	52122.3	34870.14	NA
COD	408.98	1020.02	844.44	208.3	313.13	679.6	29180.96	NA
TOC	115.45	309.52	141.02	807.49	120.81	169.4	12456.07	NA

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:DWLT.bot.sum/1+2

Comparison of species release for leaching tests on untreated and treated MWC residues (mg released/kg, dry solid).

LEACH TEST: DWLT, Extracts 1+2 ASH TYPE: Bottom Ash

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Metals (mg/kg ds)								
Aluminum	111	1033	1	519	49	787	31576	51749
Antimony	0 U	2	1 U	0	1 U	0 U	NA	316
Arsenic	0 U	1 B	0 U	0 B	0 U	0 U	16	NA
Barium	29	1	13	20	42	26	553	NA
Beryllium	0.0 B	0.0 B	0.0 U	0.0 B	0.0	0.1 A	24.4	NA
Boron	1.0	NA	NA	NA	NA	0.5	NA	NA
Cadmium	0 B	0 U	0 U	0 U	0 U	0 A	36	35
Calcium	7308	1549	9136	5463	6687	8996	NA	113087
Chromium	0 U	4	0	0	0 B	0 U	197	778
Cobalt	0 B	0 U	0 U	0 U	0 B	0 B	NA	77
Copper	1	7	1	1	1	2	2105	1477
Iron	1	1	0 U	0	0	0 B	NA	75763
Lead	1	2	5	0	1	0	1563	NA
Lithium	2	3	3	1	1	1	9	NA
Magnesium	1	0	0	0	0	1	NA	NA
Manganese	0 B	0 U	0 U	0 U	0 U	0 A	NA	1064
Mercury	0.01 U	0.01	0.00 U	0.00	0.01 B	0.01 B	6.05	1.43
Molybdenum	2	18	11	8	5	0 U	NA	NA
Nickel	0 B	1 U	0 U	0 U	0 U	0 B	431	NA
Potassium	2249	3091	11028	2018	2153	3613	NA	9510
Selenium	0 U	0	0 U	0	0 U	0 U	5 U	4
Silicon	27	339	16	11	32	10	NA	116382
Silver	0 U	0 U	0 U	0 U	0 U	0 U	4	18
Sodium	3160	32031	3172	2621	2251	5090	NA	19777
Strontium	38	11	62	24	51	56	NA	NA
Tin	0 B	2 U	1 U	0 U	1 U	0 U	245	NA
Titanium	0 B	0 U	0 U	0 U	0 U	1	NA	6599
Vanadium	0 B	3	0	0	0	0 B	NA	43
Zinc	1	15	1	1	1	1	4821	6793

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:DWLT.bot.sum/1+2

Comparison of coefficients of variation for species release from leaching tests on untreated and treated MWC residues (continued).

LEACH TEST: TCLP ASH TYPE: Bottom Ash

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Anions								
Bromide	0.94 A	0.09	0.15	0.11	0.15	NA	0.23	0.20
Fluoride	NA	NA	NA	NA	0.05	NA	NA	NA
Chloride	0.20	0.18	0.10	0.05	0.17	NA	0.25	0.14
Sulfate	0.52	0.13	0.04	0.08	0.16	NA	1.43	NA
Nitrogen Species:								
Nitrite	NA	NA	NA	NA	0.15	NA	NA	NA
Nitrate	0.12	NA	0.18	NA	0.46	NA	0.43	NA
Ammonia	NA	NA	NA	NA	NA	NA	0.15	NA
Phosphorous	0.01 U	0.12 U	NA	0.02	2.93 A	NA	0.01 U	NA
Other Assays								
pH (S.U.)	0.01	0.03	0.03	0.01	0.00		0.02	NA
TDS	NA	NA	NA	NA	NA	NA	NA	NA
COD	NA	NA	NA	NA	NA	NA	NA	NA
TOC	NA	NA	NA	NA	NA	NA	NA	NA

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:CV/TCLP/Bot. Sum.

B. 2-4

Comparison of coefficients of variation for species release from leaching tests on untreated and treated MWC residues.

LEACH TEST: TCLP ASH TYPE: Bottom Ash

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Metals								
Aluminum	0.21	0.31	0.17	0.31	0.44	0.93	0.03	0.02
Antimony	0.01 U	0.12 U	0.10	0.11	1.52 B	0.56	NA	0.17
Arsenic	0.01 U	0.12 U	0.01 U	0.18 B	0.02 U	1.00 A	0.45	NA
Barium	0.21	0.29	0.01	0.04	0.30	0.27	0.02	NA
Beryllium	0.71 B	0.61	0.01 U	0.02 U	0.11	0.02 U	NA	NA
Boron	0.18	NA	NA	0.03	NA	0.12	NA	NA
Cadmium	0.55	0.40 A	0.11	0.47	0.24	0.12	0.17	0.19
Calcium	0.07	0.04	0.21	0.08	0.90	0.09	NA	0.07
Chromium	0.01 U	0.63	0.04	0.02 U	0.31	0.75	0.08	0.20
Cobalt	0.01 U	0.12 U	0.09 B	0.32	0.13	0.41	NA	0.16
Copper	0.08	0.28	0.36	1.20	0.80	0.87	0.12	0.14
Iron	0.54	0.59	0.45	0.44	0.73	1.19	NA	0.24
Lead	0.69	0.44	0.01	0.62	0.30	0.65	0.27	NA
Lithium	0.16	0.20	0.05	0.65	0.26	0.14	0.13	NA
Magnesium	0.48	0.57	0.10	0.03	0.11	0.18	NA	NA
Manganese	0.62 B	0.26 B	0.09	0.74	0.12	1.16	NA	0.09
Mercury	0.01 U	0.12 A	0.24 B	0.02 U	0.41 B	0.81 A	0.17	0.14
Molybdenum	0.01 U	0.17	0.22	0.47	0.43	0.94	NA	NA
Nickel	0.04 B	0.12 U	1.36	0.34	1.19	0.26	0.18	NA
Potassium	0.20	0.16	0.31	0.08	0.28	0.18	NA	0.10
Selenium	0.35 U	0.12 U	0.06 A	0.02 U	0.02 U	0.02 U	NA U	0.14
Silicon	0.16	0.54	0.23	0.53	0.30	0.43	NA	0.15
Silver	0.01 U	0.12 U	0.01 U	0.02 U	0.02 U	0.02 U	0.90	0.19
Sodium	0.03	0.32	0.17	0.11	0.27	0.16	NA	0.17
Strontium	0.12	0.31	0.02	0.06	0.08	0.09	NA	NA
Tin	0.01 U	0.12 U	0.01 U	0.02 U	0.02 U	0.02 U	0.11	NA
Titanium	1.02 B	0.50 A	0.01 U	0.02 U	0.51 A	1.19 A	NA	0.06
Vanadium	0.55 B	0.31	0.14	0.18 B	0.32 A	0.02 U	NA	0.06
Zinc	0.20	0.47	0.35	0.79	0.63	0.29	0.02	0.13

undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

V/TCLP/Bot. Sum.

B. 2-3

Comparison of species release for leaching tests on untreated and treated MWC residues (mg released/kg, dry solid).

LEACH TEST: TCLP — ASH TYPE: Bottom Ash

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (HAA)
Metals (mg/kg dc)								
Aluminum	109	53	2	5	74	5	31578	51749
Antimony	0 U	1 U	4	4	8 B	3	NA	316
Arsenic	0 U	0 U	0 U	0 B	0 U	0.07 U	16	NA
Barium	12	3	6	15	13	10	553	NA
Beryllium	0.0 B	0.1	0.0 U	0.0 U	0.1	0.0 B	24.4	NA
Boron	1.2	NA	NA	35.7	NA	24.6	NA	NA
Cadmium	0	0 A	0	2	11	0.26	36	35
Calcium	18227	19398	56606	56582	28976	23118	NA	113087
Chromium	0 U	4	0	0 U	0	0.12 B	197	776
Cobalt	0 U	0 U	0 B	1	4	0.15 B	NA	77
Copper	1	4	2	6	17	2	2105	1477
Iron	3	3	0	1	50	1	NA	75763
Lead	1	0	0	1	5	1	1563	NA
Lithium	1	4	3	2	1	1 U	9	NA
Magnesium	7	46	1712	1610	2454	675	NA	NA
Manganese	0 B	0 B	4	48	90	7	NA	1064
Mercury	0.00 U	0.01 A	0.00 B	0.00 U	0.01 B	0.01	6.05	1.43
Molybdenum	0 U	16	12	11	5	6	NA	NA
Nickel	0 B	1 U	4	4	95	1	431	NA
Potassium	1536	2011	6626	1397	1132	1732	NA	9510
Selenium	1 U	0 U	0 A	1 U	0 U	0.30 U	5 U	4
Silicon	59	165	62	227	414	38	NA	116382
Silver	0 U	0 U	0 U	0 U	0 U	0.07 U	4	16
Sodium	32082	31832	2486	2237	1788	32186	NA	19777
Strontium	31	117	66	50	52	39	NA	NA
Tin	0 U	1 U	1 U	0 U	1 U	0.36 U	245	NA
Titanium	0 B	1 A	0 U	0 U	1 A	0.03 B	NA	6599
Vanadium	0 B	1	0	0 B	0 A	0.07 B	NA	43
Zinc	3	2	3	70	810	12	4821	6793

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:TCLP/bot.sum

Comparison of species release for leaching tests on untreated and treated MWC residues (mg released/kg ash treated).

LEACH TEST: TCLP ASH TYPE: Bottom Ash

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Metals (mg/kg ash, ds)								
Aluminum	131	84	3	6	89	5	31576	51749
Antimony	0 U	2 U	8	4	9 B	3	NA	316
Arsenic	0 U	0 U	0 U	0 B	0 U	0.07 U	16	NA
Barium	15	5	10	16	15	10	553	NA
Beryllium	0.0 B	0.1	0.1 U	0.0 U	0.1	0.04 B	24.4	NA
Boron	NA	NA	NA	NA	NA	24.6	NA	NA
Cadmium	0	0 A	0	3	13	0	36	35
Calcium	21673	31036	101690	66766	34771	23116	NA	113087
Chromium	0 U	6	1	0 U	0	0.12 B	197	776
Cobalt	0 U	0 U	0 B	1	4	0.15 B	NA	77
Copper	1	6	3	7	20	2	2105	1477
Iron	4	5	1	1	60	1	NA	75763
Lead	1	1	0	1	6	1	1563	NA
Lithium	1	6	5	3	2	1 U	9	NA
Magnesium	9	73	3082	1899	2944	675	NA	NA
Manganese	0 B	0 B	7	57	109	7	NA	1064
Mercury	0.0 U	0.0 A	0.0 B	0.0 U	0.0 B	0.01	6.0	1
Molybdenum	0 U	25	21	13	5	6	NA	NA
Nickel	0 B	1 U	7	4	114	1	431	NA
Potassium	1645	3218	11930	1648	1359	1732	NA	9510
Selenium	1 U	0 U	0 A	1 U	0 U	0.30 U	5 U	4
Silicon	71	265	112	267	497	38	NA	116382
Silver	0 U	0 U	0 U	0 U	0 U	0.07 U	4	16
Sodium	38498	50932	4475	2639	2146	32166	NA	19777
Strontium	38	187	156	59	62	39	NA	NA
Tin	0 U	2 U	2 U	0 U	1 U	0.36 U	245	NA
Titanium	0 B	1 A	0 U	0 U	1 A	0.03 B	NA	6599
Vanadium	0 B	1	1	0 B	0 A	0.07 B	NA	43
Zinc	4	3	6	82	972	12	4821	6793

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:TCLP/bot.sum

B. 2-2

Comparison of species release for leaching tests on untreated and treated MWC residues (mg released/kg, dry solid), (continued).

LEACH TEST: TCLP — ASH TYPE: Bottom Ash

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Anions (mg/kg ds)								
Bromide	518 A	441	313	334	NA	338	294	572
Fluoride	NA	NA	NA	NA	NA	12	1 U	NA
Chloride	7373	14447	10339	11939	NA	13124	20379	24301
Sulfate	2065	14138	19599	13460	NA	12487	87	NA
Nitrogen Species:								
Nitrite	NA	NA	NA	NA	NA	1	2	NA
Nitrate	6926	NA	5018	NA	NA	1177	3	NA
Ammonia	NA	NA	NA	NA	NA	NA	9	NA
Phosphorous	21 U	26 U	NA	24	NA	3 A	2444	NA
Other Assays (mg/kg ds								
pH (S.U.)	5.22	5.51	5.45	6.9	5.78	7.8	10.43	NA
TDS	NA	NA	NA	NA	NA	NA	34670.14	NA
COD	NA	NA	NA	NA	NA	NA	29180.96	NA
TOC	NA	NA	NA	NA	NA	NA	12456.07	NA

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed ds= dry solid

File:TCLP/bot.sum.

Comparison of species release for leaching tests on untreated and treated MWC residues (mg released/kg, dry solid).

LEACH TEST: TCLP **ASH TYPE: Bottom Ash**

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Metals (mg/kg ds)								
Aluminum	109	53	2	5	74	841	31576	51749
Antimony	0 U	1 U	4	4	8 B	1	NA	316
Arsenic	0 U	0 U	0 U	0 B	0 U	0 A	16	NA
Barium	12	3	6	15	13	15	553	NA
Beryllium	0.0 B	0.1	0.0 U	0.0 U	0.1	0.0 U	24.4	NA
Boron	1.2	NA	NA	35.7	NA	31.6	NA	NA
Cadmium	0	0 A	0	2	11	15	36	35
Calcium	18227	19398	56606	56582	28976	36609	NA	113087
Chromium	0 U	4	0	0 U	0	2	197	778
Cobalt	0 U	0 U	0 B	1	4	4	NA	77
Copper	1	4	2	6	17	143	2105	1477
Iron	3	3	0	1	50	476	NA	75763
Lead	1	0	0	1	5	44	1563	NA
Lithium	1	4	3	2	1	2	9	NA
Magnesium	7	46	1712	1610	2454	2746	NA	NA
Manganese	0 B	0 B	4	48	90	267	NA	1064
Mercury	0.00 U	0.01 A	0.00 B	0.00 U	0.01 B	0.02 A	6.05	1.43
Molybdenum	0 U	16	12	11	5	1	NA	NA
Nickel	0 B	1 U	4	4	95	33	431	NA
Potassium	1536	2011	6628	1397	1132	1683	NA	9510
Selenium	1 U	0 U	0 A	1 U	0 U	0 U	5 U	4
Silicon	59	165	62	227	414	625	NA	116382
Silver	0 U	0 U	0 U	0 U	0 U	0 U	4	18
Sodium	32082	31832	2486	2237	1788	2596	NA	19777
Strontium	31	117	88	50	52	54	NA	NA
Tin	0 U	1 U	1 U	0 U	1 U	0 U	245	NA
Titanium	0 B	1 A	0 U	0 U	1 A	1 A	NA	6599
Vanadium	0 B	1	0	0 B	0 A	0 U	NA	43
Zinc	3	2	3	70	810	1354	4821	6793

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:TCLP/bot.sum.

Comparison of extract concentrations for TCLP on untreated and treated MWC residues (mg/l), (continued).

LEACH TEST: TCLP ASH TYPE: BOTTOM

	Process 1 (Ext. 1)	Process 2 (Ext. 1)	Process 3 (Ext. 2)	Process 4 (Ext. 2)	WES Control (Ext. 2)	Untreated (Ext. 1)	Untreated (Ext. 2)	Reg. Limits
Anions (mg/l)								
Bromide	24 A	17	15	14	NA	15	15	
Fluoride	NA	NA	NA	NA	NA	1	1	
Chloride	345	559	499	500	NA	651	596	
Sulfate	96	547	946	563	NA	551	567	
Nitrogen Species:								
Nitrite	NA	NA	NA	NA	NA	0	0	
Nitrate	325	NA	242	33	NA	33	53	
Ammonia	NA	NA	NA	NA	NA	NA		
Phosphorous	1 U	1 U	NA	1	NA	0 B	0 A	
Other Assays (mg/l)								
pH (S.U.)	5.22	5.51	5.45	6.87	5.78	7.79	5.24	
TDS	NA	NA	NA	NA	NA	NA	NA	
COD	NA	NA	NA	NA	NA	NA	NA	
TOC	NA	NA	NA	NA	NA	NA	NA	

U=undetected, detection limit indicated; A=U(1 of 3); B=U(2 of 3); NA= not analyzed

TCLP/SumCompEx/Bottom

B. 2-1

Comparison of extract concentrations for TCLP on untreated and treated MWC residues (ug/l).

LEACH TEST: TCLP **ASH TYPE:** BOTTOM

	Process 1 (Ext. 1)	Process 2 (Ext. 1)	Process 3 (Ext. 2)	Process 4 (Ext. 2)	WES Control (Ext. 2)	Untreated (Ext. 1)	Untreated (Ext. 2)	Reg. Limits
Metals (ug/l)								
Aluminum	5067	2033	84	217	3333	214	37680	
Antimony	14 U	40 U	203	151	347 B	150	52	
Arsenic	3 U	10 U	10 U	3 B	10 U	3 U	8 A	5000
Barium	571	113	280	626	573	458	690	100000
Beryllium	2 B	3	2 U	1 U	3	2 B	1 U	
Boron	56	NA	NA	1493	NA	1103	1433	
Cadmium	1	2 A	1	99	490	12	698	1000
Calcium	854000	760000	2733333	2366667	1296667	1036667	1660000	
Chromium	3 U	133	16	3 U	17	5 B	79	5000
Cobalt	3 U	7 U	7 B	25	167	7 B	161	
Copper	49	137	76	254	770	95	6437	
Iron	142	122	15	48	2280	41	21289	
Lead	35	12	3 U	39	237	41 U	1995	5000
Lithium	51	157	137	103	63	48	68	
Magnesium	337	1863	62667	67367	110000	30267	124667	
Manganese	6 B	4 B	177	2000	4067	307	11967	
Mercury	0 U	0 A	0 B	0 U	0 B	0	1 A	200
Molybdenum	3 U	607	557	449	203	347	52	
Nickel	5 B	20 U	187	154	4233	34	1480	
Potassium	72133	78000	320000	58533	50667	77667	76400	
Selenium	25 U	5 U	5 A	30 U	5 U	13 U	20 U	1000
Silicon	2763	6200	3000	9427	18667	1697	28167	
Silver	4 U	7 U	7 U	4 U	7 U	3 U	3 U	5000
Sodium	1503333	1233333	120000	93767	80000	1443333	117833	
Strontium	1467	4500	4233	2080	2333	1743	2457	
Tin	10 U	55 U	55 U	10 U	55 U	17 U	17 U	
Titanium	5 B	20 A	12 U	2 U	25 A	1 B	26 A	
Vanadium	4 B	22	15	3 B	8 A	3 B	3 U	
Zinc	151	73	160	2888	36333	527	61300	

U=undetected, detection limit indicated; A=U(1 of 3); B=U(2 of 3); NA= not analyzed

TCLP/SumCompEx/Bottom

Appendix B.2 Summary results of TCLP, DWLT and AVLT for untreated and treated bottom ash.

List of Tables:

	Table Number:			
	TCLP	DWLT (Ext. 1+2)	DWLT (Ext. 3+4	AVLT
APC Residue (Appendix B.1)				
Extract Concentration [1]	B.1-1	-	-	-
Release [2]	B.1-2	B.1-5	B.1-8	B.1-11
Release [3]	B.1-3	B.1-6	B.1-9	B.1-12
C.V.[4]	B.1-4	B.1-7	B.1-10	B.1-13
Bottom Ash (Appendix B.2)				
Extract Concentration [1]	B.2-1	-	-	-
Release [2]	B.2-2	B.2-5	B.2-8	B.2-11
Release [3]	B.2-3	B.2-6	B.2-9	B.2-12
C.V.[4]	B.2-4	B.2-7	B.2-10	B.2-13
Combined Ash (Appendix B.3)				
Extract Concentration [1]	B.3-1	-	-	-
Release [2]	B.3-2	B.3-5	B.3-8	B.3-11
Release [3]	B.3-3	B.3-6	B.3-9	B.3-12
C.V.[4]	B.3-4	B.3-7	B.3-10	B.3-13

[1]Extract concentrations - mean values of 3 replicates [µg/l or mg/l]

[2]Release on a treated residue basis - mean values of 3 replicates [mg/kgg d.s.]

[3]Release on an untreated residue basis (corrected for process dilution) - mean values of 3 replicates[mg/kg ash]

[4]C.V. - coefficients of variation for replicate assays

B. 1-13 Comparison of coefficients of variation for species release from leaching tests on untreated and treated MWC residues (continued).

LEACH TEST: Availability **ASH TYPE:** APC Residue

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Anions								
Bromide	0.09	0.10 A	0.09 A	0.44	0.01 U	0.14	0.03	0.03
Fluoride	NA	NA	NA	NA	NA	NA	0.00	NA
Chloride	0.10	0.10	0.21	0.68	0.08	0.15	0.03	0.02
Sulfate	0.12	0.04	0.11	0.61	0.11	0.20	0.14	NA
Nitrogen Species:								
Nitrite	NA	NA	NA	NA	NA	NA	0.05	NA
Nitrate	NA	NA	NA	NA	NA	NA	0.06	NA
Ammonia	NA	NA	NA	NA	NA	NA	0.10	NA
Phosphorous	0.33	0.00	0.01	0.26	0.37 B	1.71 A	0.34	NA
Other Assays								
pH (S.U.)	0.00	0.00	0.00	0.00	0.00	0.00		NA
TDS	NA	NA	NA	NA	NA	NA	0.04	NA
COD	NA	NA	NA	NA	NA	NA	0.14	NA
TOC	NA	NA	NA	NA	NA	NA	0.20	NA

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:CV/AVAIL/FLY/SUM.

Comparison of coefficients of variation for species release from leaching tests on untreated and treated MWC residues.

LEACH TEST: Availability ASH TYPE: APC Residue

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Metals								
Aluminum	0.08	0.51	0.18	0.55	0.02	0.50	0.06	0.09
Antimony	0.11	1.17	0.31	0.11	0.25	0.37		0.03
Arsenic	0.18	1.37 A	0.40	0.06	0.47	0.29	0.39	NA
Barium	0.08	0.29	0.22	0.05	0.01	0.21	0.02	NA
Beryllium	0.22	0.00 U	0.13 B	0.00 U	0.08	0.42 A	NA U	NA
Boron	NA	NA	NA	NA	NA	NA	0.02	NA
Cadmium	0.08	0.18	0.12	0.19	0.33	0.10	0.02	0.09
Calcium	0.04	0.24	0.16	0.03	0.31	0.08	NA	0.02
Chromium	0.36	0.43	0.23	0.00 U	0.02	0.45	0.01	0.05
Cobalt	0.22 B	0.11	0.05	0.21	0.14	0.28 B	NA	0.13
Copper	0.08	0.04	0.16	0.62	0.05	0.17	0.02	0.11
Iron	0.37	1.64	0.76	0.69	0.40	1.37	NA	0.06
Lead	0.10	0.15	0.20	0.07	0.02	0.35	0.02	NA
Lithium	0.21	0.22	0.01	0.05	0.23	0.25	0.04	NA
Magnesium	0.10	0.26	0.20	0.02	0.32	0.28	NA	NA
Manganese	0.10	0.33	0.13	0.08	0.01	0.16	NA	0.06
Mercury	0.29	0.96	0.29	0.06	0.57	0.38	0.09	0.08
Molybdenum	0.37	0.45	0.28	0.09	0.03	0.06	NA	NA
Nickel	0.29	0.36	0.31	0.07	0.16	0.13	0.04	NA
Potassium	0.03	0.30	0.20	0.13	0.26	0.09	NA	0.05
Selenium	0.01 U	0.00 U	0.01 U	0.00 U	0.01 U	0.00 U	0.07 A	0.18
Silicon	0.08	0.20	0.19	0.09	0.08	0.26	NA	0.30
Silver	0.01 U	0.00 U	0.22 B	0.00 U	0.01 U	0.24 A	0.02	0.05
Sodium	0.01	0.35	0.24	0.11	0.28	0.18	NA	0.03
Strontium	0.10	0.24	0.13	0.04	0.03	0.03	NA	NA
Tin	0.01 U	0.71 B	0.01 U	0.00 U	0.55 B	0.00 U	0.02	NA
Titanium	0.01 U	1.68 B	0.27 B	0.00 U	0.42	0.68 B	NA	0.15
Vanadium	0.31	1.02	0.01 B	0.02 B	0.81	0.26 B	NA	0.23
Zinc	0.09	0.18	0.15	0.19	0.01	0.05	0.07	0.05

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:CV/AVAIL/FLY/SUM.

Comparison of species release for leaching tests on untreated and treated MWC residues (mg released/kg ash treated), (continued).

LEACH TEST: Availability ASH TYPE: APC Residue

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated		Total (SW-846)	Total (NAA)
Anions (mg/kg ash ds)									
Bromide	8197	9017	9836	5328	9017	5712		4099	4099
Fluoride	NA	NA	NA	NA	NA	NA		NA	NA
Chloride	180651	198716	216781	117423	198716	145669		90325	90325
Sulfate	166602	183262	199923	108291	183262	88055		83301	83301
Nitrogen Species:									
Nitrite	NA	NA	NA	NA	NA	NA		NA	NA
Nitrate	NA	NA	NA	NA	NA	NA		NA	NA
Ammonia	NA	NA	NA	NA	NA	NA		NA	NA
Phosphorous	29183	32101	35020	18969	32101	284	A	14592	14592
Other Assays (mg/kg ds)									
pH (S.U.)	4.00	4.00	4.00	4.0	4.00	4.0		10.02	
TDS	NA	NA	NA	NA	NA	NA		NA	NA
COD	NA	NA	NA	NA	NA	NA		NA	NA
TOC	NA	NA	NA	NA	NA	NA		NA	NA

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:Avail.Fly/sum./2

Comparison of species release for leaching tests on untreated and treated MWC residues (mg released/kg ash treated).

LEACH TEST: Availability ASH TYPE: APC Residue

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Metals (mg/kg ash, ds)								
Aluminum	4061	7920	8415	151	17597	2920	13587	25586
Antimony	77	169	116	126	332	111	NA	1096
Arsenic	9	24 A	19	61	31	14	43	NA
Barium	149	216	177	46	372	92	365	NA
Beryllium	1.2	0.7 U	0.9 B	0.266676 U	2.3	0.5 A	0.0 U	NA
Boron	NA	NA	NA	NA	NA	NA	187.3	NA
Cadmium	220	166	216	119	150	133	198	137
Calcium	300322	277200	470391	246124	569605	198223	NA	290725
Chromium	10	20	17	1 U	37	6	41	196
Cobalt	3 B	9	8	2	9	2 B	NA	15
Copper	156	262	389	128	524	197	363	515
Iron	37	1279	117	20	1847	30	NA	6306
Lead	1195	2127	2261	4	3723	1008	2969	NA
Lithium	11	12	16	8	16	5	13	NA
Magnesium	8285	6013	14747	7439	15007	4273	NA	NA
Manganese	77	147	186	94	305	64	NA	426
Mercury	4.7	2.5	10.7	22.50113	3.6	17.2	45.6	9
Molybdenum	18	14	27	17	37	11	NA	NA
Nickel	11	13	16	5	25	4	26	NA
Potassium	22266	16667	40865	16568	26358	13798	NA	15598
Selenium	2 U	2 U	3 U	8 U	3 U	1 U	3 A	8
Silicon	9917	17600	16474	7618	42655	4202	NA	41440
Silver	3 U	3 U	3 B	1 U	4 U	2 A	44	54
Sodium	24458	38133	24544	19176	26364	14012	NA	20467
Strontium	276	567	631	188	534	169	NA	NA
Tin	22 U	41 B	29 U	3 U	49 B	12 U	603	NA
Titanium	5 U	194 B	8 B	1 U	203	4 B	NA	5658
Vanadium	4	8	3 B	1 B	11	2 B	NA	19
Zinc	6658	10853	12094	6639	15782	7913	3011	17453

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:Avail.Fly/sum./2

Comparison of species release for leaching tests on untreated and treated MWC residues (mg released/kg, dry solid), (continued).

LEACH TEST: Availability **ASH TYPE:** APC Residue

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated		Total (SW-846)	Total (NAA)
Anions (mg/kg ds)									
Bromide	4099	4099	4099	4099	4099	5712		4099	4099
Fluoride	NA	NA	NA	NA	NA	NA		NA	NA
Chloride	90325	90325	90325	90325	90325	145669		90325	90325
Sulfate	83301	83301	83301	83301	83301	88055		83301	83301
Nitrogen Species:									
Nitrite	NA	NA	NA	NA	NA	NA		NA	NA
Nitrate	NA	NA	NA	NA	NA	NA		NA	NA
Ammonia	NA	NA	NA	NA	NA	NA		NA	NA
Phosphorous	14592	14592	14592	14592	14592	284	A	14592	14592
Other Assays (mg/kg ds									
pH (S.U.)	4.00	4.00	4.00	4.0	4.00	4.0		4.00	4.00
TDS	NA	NA	NA	NA	NA	NA		NA	NA
COD	NA	NA	NA	NA	NA	NA		NA	NA
TOC	NA	NA	NA	NA	NA	NA		NA	NA

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:Avail.Fly/sum:/2

Comparison of species release for leaching tests on untreated and treated MWC residues (mg released/kg, dry solid).

LEACH TEST: Availability ASH TYPE: APC Residue

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Metals (mg/kg ds)								
Aluminum	2030	3600	3506	116	7998	2920	13587	25586
Antimony	39	77	48	97	151	111	NA	1098
Arsenic	5	11 A	8	47	14	14	43	NA
Barium	75	98	74	35	169	92	365	NA
Beryllium	0.6	0.3 U	0.4 B	0.2 U	1.1	0.5 A	U	NA
Boron	NA	NA	NA	NA	NA	NA	187.3	NA
Cadmium	110	75	90	91	68	133	198	137
Calcium	150161	126000	195996	189326	256911	198223	NA	290725
Chromium	5	9	7	1 U	17	6	41	196
Cobalt	2 B	4	3	2	4	2 B	NA	15
Copper	78	126	162	98	238	197	363	515
Iron	18	581	49	15	839	30	NA	6306
Lead	598	967	942	3	1692	1008	2969	NA
Lithium	5	5	7	6	7	5	13	NA
Magnesium	4142	2733	6144	5722	6821	4273	NA	NA
Manganese	39	67	77	72	139	64	NA	426
Mercury	2.36	1.14	4.46	17.31	1.65	17.22	45.84	9.37
Molybdenum	9	6	11	13	17	11	NA	NA
Nickel	6	6	7	4	12	4	26	NA
Potassium	11143	7667	17027	12745	11981	13798	NA	15598
Selenium	1 U	1 U	1 U	6 U	1 U	1 U	3 A	8
Silicon	4958	8000	6864	5860	19388	4202	NA	41440
Silver	2 U	1 U	1 B	1 U	2 U	2 A	44	54
Sodium	12229	17333	10227	14751	11983	14012	NA	20467
Strontium	138	267	263	145	243	169	NA	NA
Tin	11 U	19 B	12 U	2 U	22 B	12 U	603	NA
Titanium	2 U	68 B	3 B	0 U	92	4 B	NA	5658
Vanadium	2	4	1 B	1 B	5	2 B	NA	19
Zinc	3329	4933	5039	5107	7173	7913	3011	17453

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:Avail.Fly/sum./2

Comparison of coefficients of variation for species release from leaching tests on untreated and treated MWC residues (continued).

LEACH TEST: DWLT, Extracts 3 + 4 — ASH TYPE: APC Residue

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Anions								
Bromide	0.02	0.16	0.14	0.17	0.03	0.06	0.03	0.03
Fluoride	NA	NA	NA	NA	NA	0.07	0.00	NA
Chloride	0.01	0.31	0.26	0.16	0.06	0.11	0.03	0.02
Sulfate	0.08	0.09	0.08	0.14	0.21	0.04	0.14	NA
Nitrogen Species:								
Nitrite	NA	NA	NA	NA	NA	0.49 B	0.05	NA
Nitrate	1.05	0.14	0.87	0.26	0.61	0.65	0.06	NA
Ammonia	NA	NA	NA	NA	NA	NA	0.10	NA
Phosphorous	0.01 U	0.58 B	0.02	0.00	0.00 U	0.00 U	0.34	NA
Other Assays								
pH (S.U.)	0.04	0.01	0.00	0.02	0.00	0.00		NA
TDS	0.06	0.07	0.25	0.06	0.39	0.12	0.04	NA
COD	0.04 A	0.60	0.53	0.00	0.50	0.02	0.14	NA
TOC	0.18	0.07	0.10	0.07	0.15	0.20	0.20	NA

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:CV/DWLT/Fly/Sum/3+4

Comparison of coefficients of variation for species release from leaching tests on untreated and treated MWC residues.

LEACH TEST: DWLT, Extracts 3 + 4 ASH TYPE: APC Residue

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Metals								
Aluminum	0.17	0.72	0.02 U	0.62	0.46	0.17 B	0.06	0.09
Antimony	0.01 U	0.06 U	0.02 U	0.00 U	0.00 U	0.00 U	NA	0.03
Arsenic	0.01 U	0.06 U	0.02 U	0.00 U	0.49 U	0.20 B	0.39	NA
Barium	0.02	0.17	0.10	0.25	0.07	0.06	0.02	NA
Beryllium	0.01 U	0.40	0.02 U	0.00 U	0.06	0.00 U	NA U	NA
Boron	0.13	NA	NA	NA	NA	0.04	0.02	NA
Cadmium	1.19 B	0.06 U	0.02 U	0.22	0.00 U	0.19	0.02	0.09
Calcium	0.01	0.17	0.14	0.10	0.32	0.00	NA	0.02
Chromium	0.01 U	0.06 U	0.02 U	0.18	0.00	0.00 U	0.01	0.05
Cobalt	0.01 U	0.02	0.13 A	0.00 U	0.06 U	0.00 U	NA	0.13
Copper	0.01 U	0.10	0.19	0.00 U	0.12	0.06	0.02	0.11
Iron	1.40 B	0.13	0.02	0.75	0.14	0.65	NA	0.06
Lead	0.17	0.20	0.12	1.41	0.13	0.06	0.02	NA
Lithium	0.07	0.23 B	0.27 B	0.03	0.23 B	0.11	0.04	NA
Magnesium	0.36	0.41	0.20	0.44	0.18	0.31	NA	NA
Manganese	0.01 U	0.06 U	0.00 B	0.00 U	0.00 U	0.00 U	NA	0.06
Mercury	0.02	0.17	0.19	0.00 U	0.10 B	0.11	0.09	0.08
Molybdenum	0.06	0.39	0.15	0.09	0.27	0.02	NA	NA
Nickel	0.01 U	0.06 U	0.02 U	0.11 B	0.00 U	0.00 U	0.04	NA
Potassium	0.06	0.20	0.36	0.10	0.06	0.05	NA	0.05
Selenium	0.05 B	0.06 U	0.02 U	0.00 U	0.00 U	0.00 U	0.07 A	0.18
Silicon	0.13	0.39	0.09	0.36	0.12	0.36	NA	0.30
Silver	0.01 U	0.06 U	0.02 U	0.00 U	0.00 U	0.00 U	0.02	0.05
Sodium	0.05	0.20	0.26	0.09	0.11	0.04	NA	0.03
Strontium	0.03	0.18	0.14	0.03	0.05	0.06	NA	NA
Tin	0.01 U	0.34 B	0.02 U	0.00 U	0.00 U	0.00 U	0.02	NA
Titanium	0.01 U	0.06 U	0.02 U	0.03	0.00 U	0.05	NA	0.15
Vanadium	0.01 U	0.25	0.02 U	0.00 U	0.30	0.00 U	NA	0.23
Zinc	0.02	0.15	0.15	1.14	0.20	0.01	0.07	0.05

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:CV/DWLT/Fly/Sum/3+4

Comparison of species release for leaching tests on untreated and treated MWC residues (mg released/kg ash treated), (continued).

LEACH TEST: DWLT, Extracts 3 + 4 **ASH TYPE:** APC Residue

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Anions (mg/kg ash ds)								
Bromide	248	343	122	70	366	189	5287	3830
Fluoride	NA	NA	NA	NA	NA	60	20	NA
Chloride	6928	10437	3808	1665	9238	6437	184511	168528
Sulfate	2876	2041	10040	11226	1221	19073	6336	NA
Nitrogen Species:								
Nitrite	NA	NA	NA	NA	NA	0 B	0	NA
Nitrate	43	61	33	12	35	35	30	NA
Ammonia	NA	NA	NA	NA	NA	NA	2	NA
Phosphorous	61 U	119 B	52 U	27	62 U	0 U	1767	NA
Other Assays (mg/kg ds)								
pH (S.U.)	11.14	12.34	12.03	11.3	12.15	12.0	10.02	NA
TDS	100427	88111	97246	26356	98314	57936	349422	NA
COD	578	2312	419	205	573	370	28440	NA
TOC	96	73	62	28	59	21	4039	NA

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:DWLT.Fly/Sum 3 + 4

Comparison of species release for leaching tests on untreated and treated MWC residues (mg released/kg ash treated).

LEACH TEST: DWLT, Extracts 3 + 4 ASH TYPE: APC Residue

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Metals (mg/kg ash, ds)								
Aluminum	1	6	1 U	8	3	0 B	13587	25586
Antimony	1 U	2 U	2 U	0 U	2 U	0 U	NA	1096
Arsenic	0 U	1 U	1 U	0 U	1 U	0 B	43	NA
Barium	76	59	59	5	47	14	365	NA
Beryllium	0.1 U	0.2	0.1 U	0.0 U	0.2	0.0 U	0.0 U	NA
Boron	3.7	NA	NA	NA	NA	12.6	187.3	NA
Cadmium	0 B	0 U	0 U	0	0 U	0	198	137
Calcium	43572	24456	40563	7883	30123	29780	NA	290725
Chromium	0 U	1 U	0 U	1	1	0 U	41	196
Cobalt	0 U	0	0 A	0 U	0 U	0 U	NA	15
Copper	0 U	1	1	0 U	1	0	363	515
Iron	1 B	1	0	1	1	0	NA	6306
Lead	155	90	396	1	80	379	2969	NA
Lithium	1	1 B	1 B	1	1 B	0	13	NA
Magnesium	1	1	1	3	1	1	NA	NA
Manganese	0 U	0 U	0 B	0 U	0 U	0 U	NA	426
Mercury	1.0	1.2	0.0	0.0 U	0.6 B	1.9	45.6	9
Molybdenum	2	5	2	2	2	2	NA	NA
Nickel	0 U	1 U	1 U	0 B	1 U	0 U	26	NA
Potassium	505	552	287	260	355	424	NA	15598
Selenium	0 B	0 U	0 U	1 U	0 U	1 U	3 A	8
Silicon	21	98	25	73	34	3	NA	41440
Silver	0 U	0 U	0 U	0 U	0 U	0 U	44	54
Sodium	572	748	211	356	330	475	NA	20467
Strontium	20	36	17	11	24	14	NA	NA
Tin	1 U	4 B	3 U	0 U	3 U	0 U	603	NA
Titanium	0 U	1 U	1 U	1	1 U	1	NA	5658
Vanadium	0 U	1	0 U	0 U	1	0 U	NA	19
Zinc	15	13	67	2	9	48	3011	17453

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:DWLT.Fly/Sum 3 + 4

Comparison of species release for leaching tests on untreated and treated MWC residues (mg released/kg, dry solid), (continued).

LEACH TEST: DWLT, Extracts 3 + 4 **ASH TYPE:** APC Residue

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Anions (mg/kg ds)								
Bromide	124	156	51	54	166	189	5287	3830
Fluoride	NA	NA	NA	NA	NA	60	20	NA
Chloride	3464	4744	1587	1280	4199	6437	184511	168528
Sulfate	1438	928	4183	8636	555	19073	6336	NA
Nitrogen Species:								
Nitrite	NA	NA	NA	NA	NA	0 B	0	NA
Nitrate	21	28	14	9	16	35	30	NA
Ammonia	NA	NA	NA	NA	NA	NA	2	NA
Phosphorous	30 U	54 B	22 U	21	28 U	0 U	1767	NA
Other Assays (mg/kg ds								
pH (S.U.)	11.14	12.34	12.03	11.3	12.15	12.0		NA
TDS	50213.37	40050.33	40519.12	20274.1	44667.98	57935.7	349421.91	NA
COD	289.08 A	1050.95	174.61	157.6	260.56	370.2	28440.26	NA
TOC	47.84	33.21	25.79	21.88	26.79	21.0	4039.18	NA

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:DWLT.Fly/Sum 3 + 4

Comparison of species release for leaching tests on untreated and treated MWC residues (mg released/kg, dry solid).

LEACH TEST: DWLT, Extracts 3 + 4 ASH TYPE: APC Residue

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Metals (mg/kg ds)								
Aluminum	1	3	0 U	6	2	0 B	13587	25586
Antimony	0 U	1 U	1 U	0 U	1 U	0 U	NA	1096
Arsenic	0 U	0 U	0 U	0 U	0 U	0 B	43	NA
Barium	38	27	25	4	21	14	365	NA
Beryllium	0.0 U	0.1	0.0 U	0.0 U	0.1	0.0 U	U	NA
Boron	1.9	NA	NA	NA	NA	12.6	187.3	NA
Cadmium	0 B	0 U	0 U	0	0 U	0	198	137
Calcium	21786	11116	16901	6084	13692	29780	NA	290725
Chromium	0 U	0 U	0 U	0	0	0 U	41	196
Cobalt	0 U	0	0 A	0 U	0 U	0 U	NA	15
Copper	0 U	0	0	0 U	0	0	363	515
Iron	1 B	0	0	0	0	0	NA	6306
Lead	78	41	165	1	37	379	2969	NA
Lithium	1	0 B	0 B	0	0 B	0	13	NA
Magnesium	1	0	0	2	0	1	NA	NA
Manganese	0 U	0 U	0 B	0 U	0 U	0 U	NA	426
Mercury	0.50	0.56	0.01	0.00 U	0.28 B	1.67	45.64	9.37
Molybdenum	1	2	1	1	1	2	NA	NA
Nickel	0 U	1 U	0 U	0 B	1 U	0 U	26	NA
Potassium	252	251	120	200	161	424	NA	15598
Selenium	0 B	0 U	0 U	1 U	0 U	1 U	3 A	8
Silicon	10	45	10	56	16	3	NA	41440
Silver	0 U	0 U	0 U	0 U	0 U	0 U	44	54
Sodium	286	340	88	274	150	475	NA	20467
Strontium	10	16	7	8	11	14	NA	NA
Tin	0 U	2 B	1 U	0 U	2 U	0 U	603	NA
Titanium	0 U	0 U	0 U	0	0 U	1	NA	5658
Vanadium	0 U	0	0 U	0 U	0	0 U	NA	19
Zinc	8	6	28	2	4	48	3011	17453

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File.DWLT.Fly/Sum 3 + 4

Comparison of coefficients of variation for species release from leaching tests on untreated and treated MWC residues (continued).

LEACH TEST: DWLT, Extracts 1 + 2 ASH TYPE: APC Residue

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Anions								
Bromide	0.10	0.07	0.12	0.12	0.13	0.03	0.03	0.03
Fluoride	NA	NA	NA	NA	NA	0.10	0.00	NA
Chloride	0.11	0.05	0.15	0.04	0.06	0.03	0.03	0.02
Sulfate	0.19	0.40	0.03	0.18	0.21	0.03	0.14	NA
Nitrogen Species:								
Nitrite	NA	NA	NA	NA	NA	1.30 B	0.05	NA
Nitrate	0.49	0.51	0.23	1.24	0.62	0.32	0.06	NA
Ammonia	NA	NA	NA	NA	NA	NA	0.10	NA
Phosphorous	1.14 U	0.06	0.02	0.00	0.43	0.00 U	0.34	NA
Other Assays								
pH (S.U.)	0.04	0.00	0.00	0.03	0.00	0.00		NA
TDS	0.09	0.08	0.02	0.09	0.04	0.86	0.04	NA
COD	0.74	0.16	0.83	0.11	0.55	0.18	0.14	NA
TOC	0.18	0.18	0.10	0.06	0.22	0.09	0.20	NA

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:CV/DWLT.Fly/Sum 1+2

Comparison of coefficients of variation for species release from leaching tests on untreated and treated MWC residues.

LEACH TEST: DWLT, Extracts 1 + 2 ASH TYPE: APC Residue

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Metals								
Aluminum	0.57 B	0.45 B	0.52 B	0.63	0.61	0.00 U	0.06	0.09
Antimony	0.01 U	0.06 U	0.02 U	0.00 U	0.00 U	0.00 U	NA	0.03
Arsenic	0.01 U	0.06 U	0.02 U	0.00 U	0.32 U	0.00 U	0.39	NA
Barium	0.08	0.19	0.08	0.28	0.06	0.06	0.02	NA
Beryllium	0.01 U	0.37 A	0.21	0.00 U	0.09	0.00 U	NA U	NA
Boron	0.09	NA	NA	NA	NA	0.04	0.02	NA
Cadmium	0.01 U	0.06 U	0.02 U	0.09 B	0.14 U	0.30	0.02	0.09
Calcium	0.04	0.39	0.04	0.16	0.07	0.02	NA	0.02
Chromium	0.01 U	0.09 A	0.16	0.37	0.13	0.00 U	0.01	0.05
Cobalt	0.01 U	0.06 U	0.02 U	0.00 U	0.11 U	0.00 U	NA	0.13
Copper	0.01 U	0.06 U	0.36	0.00 U	0.17	0.11	0.02	0.11
Iron	1.58 A	0.22 B	0.02 U	0.06	0.60	0.00 U	NA	0.06
Lead	0.23	0.11	0.07	1.23	0.03	0.04	0.02	NA
Lithium	0.03	0.13	0.05	0.04	0.08 B	0.02	0.04	NA
Magnesium	1.60 A	0.54	0.06	0.62	0.05	0.74 A	NA	NA
Manganese	0.01 U	0.06 U	0.02 U	0.00 U	0.00 U	0.00 U	NA	0.06
Mercury	0.07	0.09	0.53	0.00 U	0.16 B	0.19	0.09	0.08
Molybdenum	0.01 U	0.16	0.07	0.06	0.09	0.00 U	NA	NA
Nickel	0.01 U	0.06 U	0.02 U	0.00 U	0.00 U	0.00 U	0.04	NA
Potassium	0.03	0.10	0.05	0.17	0.03	0.02	NA	0.05
Selenium	0.74 U	0.06 U	0.02 U	0.00 U	0.00 U	0.00 U	0.07 A	0.18
Silicon	0.65	0.19	0.45	0.72	0.05	0.75 A	NA	0.30
Silver	0.01 U	0.06 U	0.02 U	0.00 U	0.00 U	0.00 U	0.02	0.05
Sodium	0.03	0.08	0.08	0.18	0.00	0.01	NA	0.03
Strontium	0.03	0.13	0.03	0.15	0.06	0.01	NA	NA
Tin	0.01 U	0.06 U	0.02 U	0.00 U	0.00 U	0.00 U	0.02	NA
Titanium	0.01 U	0.06 U	0.02 U	0.00 U	0.00 U	0.00 U	NA	0.15
Vanadium	0.01 U	0.11	0.16	0.00 U	0.27	0.00 U	NA	0.23
Zinc	0.09	0.15	0.28	1.07	0.09	0.06	0.07	0.05

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:CV/DWLT.Fly/Sum 1+2

Comparison of coefficients of variation for species release from leaching tests on untreated and treated MWC residues (continued).

B. 2-7

LEACH TEST: DWLT, Extracts 1 + 2 **ASH TYPE:** Bottom Ash

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Anions								
Bromide	0.17	0.21	0.01	0.22	0.21	0.16	0.23	0.20
Fluoride	NA	NA	NA	NA	NA	0.22 B	NA	NA
Chloride	0.12	0.25	0.03	0.21	0.22	0.12	0.25	0.14
Sulfate	0.35	0.18	0.13	0.21	0.08	0.77	1.43	NA
Nitrogen Species:								
Nitrite	NA	NA	NA	NA	NA	0.35	NA	NA
Nitrate	1.67	0.17	0.63	0.56	0.85	0.22	0.43	NA
Ammonia	NA	NA	NA	NA	NA	NA	0.15	NA
Phosphorous	0.02 U	0.07	1.05 B	0.00	0.01 U	0.12	0.01 U	NA
Other Assays								
pH (S.U.)	0.04	0.04	0.00	0.04	0.04	0.02	0.02	NA
TDS	0.27	0.18	0.12	0.13	0.10	0.16	NA	NA
COD	0.16	0.03	0.67	0.86	0.68	0.04	NA	NA
TOC	0.09	0.09	0.20	0.86	0.07	0.07	NA	NA

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:CV/DWLT/Bot. 1+2

Comparison of species release for leaching tests on untreated and treated MWC residues (mg released/kg, dry solid).

LEACH TEST: DWLT, Extracts 3 + 4 ASH TYPE: Bottom Ash

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Metals (mg/kg ds)								
Aluminum	230	285	12	920	134	1255	31576	51749
Antimony	0 U	1 U	1 U	0 U	1 U	1 B	NA	316
Arsenic	0 U	0 U	0 U	0 U	0 U	0 U	16	NA
Barium	12	4	11	10	16	5	553	NA
Beryllium	0.0 B	0.1	0.0 U	0.0 U	0.1	0.0 U	24.4	NA
Boron	0.7	NA	NA	NA	NA	0.7	NA	NA
Cadmium	0 B	0	0 U	0 U	0 U	0 U	36	35
Calcium	4249	3092	3171	3156	3241	2651	NA	113087
Chromium	0 U	0	0 B	0 U	0 A	0 U	197	778
Cobalt	0 U	0 U	0	0 U	0 A	0 U	NA	77
Copper	0	0 B	0	0	0	1	2105	1477
Iron	0	0	0 A	0	0	1	NA	75763
Lead	0	0	1	0	0	0	1563	NA
Lithium	0	1	1	0	0 U	0	9	NA
Magnesium	0	0 A	0	1	0	1	NA	NA
Manganese	0 B	0 U	0 U	0 U	0 U	0 U	NA	1064
Mercury	0.00 U	0.01 U	0.00 U	0.00 U	0.00 U	0.00 B	6.05	1.43
Molybdenum	5	0	3	5	3	4	NA	NA
Nickel	0 B	1 U	0 U	0 U	0 U	0 U	431	NA
Potassium	81	225	310	37	48	91	NA	9510
Selenium	0 U	0 U	0 U	0 U	0 U	0 U	5 U	4
Silicon	29	71	66	8	27	10	NA	116382
Silver	0 U	0 U	0 U	0 U	0 U	0 U	4	18
Sodium	101	1461	106	45	42	96	NA	19777
Strontium	9	36	17	5	9	7	NA	NA
Tin	1 B	2 U	1 U	0 B	1 U	0 U	245	NA
Titanium	0 B	0 U	0 U	0 A	0 U	1	NA	6599
Vanadium	0 U	0	0	0 U	0 B	0 U	NA	43
Zinc	0	1	1	1	1	1	4821	6793

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:DWLT.bot.sum/3+4

Comparison of species release for leaching tests on untreated and treated MWC residues (mg released/kg, dry solid), (continued).

LEACH TEST: DWLT, Extracts 3 + 4 **ASH TYPE:** Bottom Ash

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Anions (mg/kg ds)								
Bromide	24	22	20	29	31	35	294	572
Fluoride	NA	NA	NA	NA	NA	2 U	1 U	NA
Chloride	1003	711	781	1417	1415	1418	20379	24301
Sulfate	221	319	899	144	88	805	87	NA
Nitrogen Species:								
Nitrite	NA	NA	NA	NA	NA	0	2	NA
Nitrate	10	139	38	18	18	28	3	NA
Ammonia	NA	NA	NA	NA	NA	NA	9	NA
Phosphorous	22	28	23 U	20	21 U	1	2444	NA
Other Assays (mg/kg ds								
pH (S.U.)	11.14	11.14	11.94	11.1	11.14	11.1	10.43	NA
TDS	10461.39	14746.02	11452.49	11360.92	11209.74	11224.2	34670.14	NA
COD	117.23	140.53	33.17	100.3	67.96	135.6	29180.96	NA
TOC	44.21	29.31	143.55	32.16	30.29	49.3	12456.07	NA

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:DWLT.bot.sum/3+4

Comparison of species release for leaching tests on untreated and treated MWC residues (mg released/kg ash treated).

Draft 3/11/91

LEACH TEST: DWLT, Extracts 3 + 4 ASH TYPE: Bottom Ash

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Metals (mg/kg ash, ds)								
Aluminum	276	455	21	1086	161	1255	31576	51749
Antimony	0 U	2 U	2 U	0 U	1 U	1 B	NA	316
Arsenic	0 U	0 U	0 U	0 U	0 U	0 U	16	NA
Barium	14	6	20	11	19	5	553	NA
Beryllium	0.0 B	0.1	0.1 U	0.0 U	0.1	0.0 U	24.4	NA
Boron	NA	NA	NA	NA	NA	0.7	NA	NA
Cadmium	0 B	0	0 U	0 U	0 U	0 U	36	35
Calcium	5099	4947	5707	3724	3869	2651	NA	113087
Chromium	0 U	1	0 B	0 U	0 A	0 U	197	778
Cobalt	0 U	0 U	0	0 U	0 A	0 U	NA	77
Copper	0	0 B	1	0	0	1	2105	1477
Iron	0	0	0 A	0	0	1	NA	75763
Lead	1	0	1	0	1	0	1563	NA
Lithium	0	2	1	0	0 U	0	9	NA
Magnesium	1	0 A	1	1	0	1	NA	NA
Manganese	0 B	0 U	0 U	0 U	0 U	0 U	NA	1064
Mercury	0.0 U	0.0 U	0.0 U	0.0 U	0.0 U	0.0 B	6.0	1
Molybdenum	5	1	5	6	4	4	NA	NA
Nickel	0 B	1 U	1 U	0 U	1 U	0 U	431	NA
Potassium	98	360	557	43	57	91	NA	9510
Selenium	0 U	0 U	0 U	0 U	0 U	0 U	5 U	4
Silicon	35	114	118	10	33	10	NA	116382
Silver	0 U	0 U	0 U	0 U	0 U	0 U	4	18
Sodium	121	2338	190	53	51	96	NA	19777
Strontium	11	57	30	6	11	7	NA	NA
Tin	1 B	2 U	2 U	0 B	1 U	0 U	245	NA
Titanium	0 B	1 U	0 U	1 A	0 U	1	NA	6599
Vanadium	0 U	1	0	0 U	0 B	0 U	NA	43
Zinc	1	1	2	1	1	1	4821	6793

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:DWLT.bot.sum/3+4

Comparison of species release for leaching tests on untreated and treated MWC residues (mg released/kg ash treated), (continued).

LEACH TEST: DWLT, Extracts 3 + 4 ASH TYPE: Bottom Ash

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Anions (mg/kg ash ds)								
Bromide	29	35	36	35	37	35	294	572
Fluoride	NA	NA	NA	NA	NA	2 U	NA U	NA
Chloride	1204	1137	1405	1672	1699	1418	20379	24301
Sulfate	265	511	1619	170	106	805	87	NA
Nitrogen Species:						0		
Nitrite	NA	NA	NA	NA	NA	0	NA	NA
Nitrate	12	223	69	21	21	28	3	NA
Ammonia	NA	NA	NA	NA	NA	NA	9	NA
Phosphorous	26	44	41 U	24	25 U	1	2444	NA
Other Assays (mg/kg ds)								
pH (S.U.)	11.14	11.14	11.94	11.1	11.14	11.1	10.02	NA
TDS	12553.67	23593.64	20614.48	13405.88	13451.68	11224.2	34670.14	NA
COD	140.67	224.65	59.70	118.4	81.56	135.6	29180.96	NA
TOC	53.05	46.90	258.38	37.95	36.35	49.3	12456.07	NA

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:DWLT.bot.sum/3+4

Comparison of coefficients of variation for species release from leaching tests on untreated and treated MWC residues.

LEACH TEST: DWLT, Extracts 3+4 ASH TYPE: Bottom Ash

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Metals								
Aluminum	0.10	0.08	0.21	0.17	0.10	0.02	0.03	0.02
Antimony	0.02 U	0.07 U	0.00 U	0.00 U	0.01 U	0.16 B	NA	0.17
Arsenic	0.02 U	0.07 U	0.00 U	0.00 U	0.01 U	0.02 U	0.45	NA
Barium	0.33	0.14	0.17	0.05	0.08	0.37	0.02	NA
Beryllium	0.27 B	0.07	0.00 U	0.00 U	0.16	0.02 U	NA	NA
Boron	0.43	NA	NA	NA	NA	0.19	NA	NA
Cadmium	0.13 B	0.16	0.00 U	0.00 U	0.01 U	0.98 U	0.17	0.19
Calcium	0.11	0.07	0.24	0.03	0.11	0.12	NA	0.07
Chromium	0.02 U	0.10	0.03 B	0.00 U	0.05 A	0.02 U	0.08	0.20
Cobalt	0.02 U	0.07 U	0.17	0.00 U	0.08 A	0.02 U	NA	0.16
Copper	0.03	0.11 B	0.15	0.05	0.03	0.08	0.12	0.14
Iron	0.52	0.17	0.14 A	0.25	0.09	1.08	NA	0.24
Lead	0.12	0.23	0.26	0.56	0.45	0.75	0.27	NA
Lithium	0.18	0.31	0.17	0.20	0.01 U	0.25	0.13	NA
Magnesium	0.35	0.31 A	0.68	0.23	0.27	0.14	NA	NA
Manganese	0.16 B	0.07 U	0.00 U	0.00 U	0.01 U	0.02 U	NA	0.09
Mercury	0.02 U	0.07 U	0.00 U	0.00 U	0.01 U	0.07 B	0.17	0.14
Molybdenum	0.32	0.15	0.21	0.30	0.07	0.25	NA	NA
Nickel	0.30 B	0.07 U	0.00 U	0.00 U	0.01 U	0.02 U	0.18	NA
Potassium	0.40	0.11	0.22	0.10	0.10	0.41	NA	0.10
Selenium	0.02 U	0.07 U	0.00 U	0.00 U	0.01 U	0.02 U	NA U	0.14
Silicon	0.24	0.11	0.10	0.25	0.08	0.19	NA	0.15
Silver	0.02 U	0.07 U	0.00 U	0.00 U	0.01 U	0.02 U	0.90	0.19
Sodium	0.27	0.35	0.24	0.09	0.01	0.25	NA	0.17
Strontium	0.16	0.26	0.16	0.08	0.09	0.08	NA	NA
Tin	1.22 B	0.07 U	0.00 U	0.05 B	0.01 U	0.02 U	0.11	NA
Titanium	0.10 B	0.07 U	0.00 U	0.13 A	0.01 U	0.16	NA	0.06
Vanadium	0.02 U	0.23	0.06	0.00 U	0.02 B	0.02 U	NA	0.08
Zinc	0.26	0.35	0.26	0.17	0.07	0.59	0.02	0.13

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:CV/DWLT/Bot. 3+4

Comparison of coefficients of variation for species release from leaching tests on untreated and treated MWC residues (continued).

LEACH TEST: DWLT, Extracts 3+4 **ASH TYPE:** Bottom Ash

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Anions								
Bromide	0.16	0.30	0.20	0.13	0.10	0.15	0.23	0.20
Fluoride	NA	NA	NA	NA	NA	0.02 U	NA	NA
Chloride	0.13	0.14	0.16	0.19	0.04	0.23	0.25	0.14
Sulfate	0.49	0.13	0.08	0.07	0.17	0.66	1.43	NA
Nitrogen Species:								
Nitrite	NA	NA	NA	NA	NA	0.07	NA	NA
Nitrate	0.65	0.82	1.00	0.84	0.52	0.74	0.43	NA
Ammonia	NA	NA	NA	NA	NA	NA	0.15	NA
Phosphorous	0.02	0.07	0.00	0.00	0.01	0.19	0.01 U	NA
Other Assays								
pH (S.U.)	0.04	0.04	0.00	0.04	0.04	0.03	0.02	NA
TDS	0.26	0.33	0.16	0.09	0.14	0.26	NA	NA
COD	0.08	0.07	0.14	0.00	0.61	0.28	NA	NA
TOC	0.08	0.22	0.33	0.06	0.10	0.07	NA	NA

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:CV/DWLT/Bot. 3+4

Comparison of species release for leaching tests on untreated and treated MWC residues (mg released/kg, dry solid).

LEACH TEST: Availability ASH TYPE: Bottom Ash

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Metals (mg/kg ds)								
Aluminum	2006	3200	3243	348	3624	5641	31576	51749
Antimony	9 U	13	16	9	14 A	29 B	NA	316
Arsenic	2 B	2 B	9 A	1 A	3	10 A	16	NA
Barium	34	64 A	55	90	112	141	553	NA
Beryllium	0.6	0.3 U	0.4 B	0.2 U	0.5 A	0.7	24.4	NA
Boron	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	7	6	9	14	15	28	36	35
Calcium	49754	76000	113229	74733	86520	73360	NA	113087
Chromium	3	6	5 A	1 U	7	13	197	778
Cobalt	2	3 A	3	4	3	8	NA	77
Copper	64	169	110	190	121	360	2105	1477
Iron	268	327	198	297	153	2679	NA	75763
Lead	110	93	170	46	272	422	1563	NA
Lithium	3 U	6	6	3	4 A	4	9	NA
Magnesium	1715	1533	3800	3087	3728	3606	NA	NA
Manganese	41	117	141	131	119	219	NA	1064
Mercury	0.04 U	0.07 B	0.05 U	0.07 B	0.04 B	0.05 A	6.05	1.43
Molybdenum	13	31	20	14	14	14	NA	NA
Nickel	9 A	12	14	27	17	49	431	NA
Potassium	1693	2667	11236	1901	3757	3937	NA	9510
Selenium	1 U	1 U	1 U	3 U	1 U	1 U	5 U	4 U
Silicon	2666	5913	4923	3333	7586	7403	NA	116382
Silver	2 U	1 U	2 U	1 U	2 U	2 U	4	18
Sodium	2678	29333	4121	2760	3760	5634	NA	19777
Strontium	45	363	276	86	149	162	NA	NA
Tin	12 U	11 U	13 U	2 U	12 U	14 B	245	NA
Titanium	4 B	2 U	3 U	0 U	6 A	90 B	NA	6599
Vanadium	2 B	3	4	1 B	1 U	4 B	NA	43
Zinc	557	4410	910	1559	1777	2781	4821	6793

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:Avail.Bot.sum/r

Comparison of species release for leaching tests on untreated and treated MWC residues (mg released/kg, dry solid), (continued).

B. 2-11

LEACH TEST: Availability **ASH TYPE:** Bottom Ash

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Anions (mg/kg ds)								
Bromide	1080 U	2000 U	4740	2000	5414 U	6786 U	265	572
Fluoride	NA	NA	NA	NA	NA		NA	NA
Chloride	12269	16153	17519	14653	28713	32580	16993	24301
Sulfate	8580	24733	72443	18073	29462	29343	15059	NA
Nitrogen Species:								
Nitrite	NA	NA	NA	NA	NA	NA	NA	NA
Nitrate	NA	NA	NA	NA	NA	NA	29	NA
Ammonia	NA	NA	NA	NA	NA	NA	228	NA
Phosphorous	290 B	200 U	235	200	215 U	204 B	1 U	NA
Other Assays (mg/kg ds)								
pH (S.U.)	4.00	4.00	4.00	4.0	4.00	4.0	10.02	NA
TDS	NA	NA	NA	NA	NA	NA	NA	NA
COD	NA	NA	NA	NA	NA	NA	NA	NA
TOC	NA	NA	NA	NA	NA	NA	NA	NA

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:Avail.Bot.sum/r

Comparison of species release for leaching tests on untreated and treated MWC residues (mg released/kg ash treated).

LEACH TEST: Availability ASH TYPE: Bottom Ash

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Metals (mg/kg ash, ds)								
Aluminum	2408	5120	5838	411	4588	5641	31576	51749
Antimony	10 U	20	29	10	16 A	29 B	NA	316
Arsenic	3 B	4 B	16 A	1 A	4	10 A	16	NA
Barium	41	103 A	99	107	134	141	553	NA
Beryllium	0.7	0.5 U	0.7 B	0.2 U	0.6 A	0.7	24.4	NA
Boron	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	8	10	16	17	18	28	36	35
Calcium	59705	121600	203812	88185	103624	73360	NA	113087
Chromium	4	10	9 A	1 U	8	13	197	778
Cobalt	2	5 A	6	5	4	6	NA	77
Copper	77	270	198	225	145	360	2105	1477
Iron	321	523	357	350	183	2679	NA	75763
Lead	133	150	306	54	326	422	1563	NA
Lithium	3 U	10	10	4	5 A	4	9	NA
Magnesium	2058	2453	6840	3642	4474	3606	NA	NA
Manganese	49	188	254	154	143	219	NA	1064
Mercury	0.1 U	0.1 B	0.1 U	0.1 B	0.1 B	0.1 A	6.0	1
Molybdenum	15	50	36	16	17	14	NA	NA
Nickel	11 A	20	26	32	21	49	431	NA
Potassium	2031	4587	20225	2243	4509	3937	NA	9510
Selenium	1 U	2 U	2 U	4 U	1 U	1 U	5 U	4 U
Silicon	3202	9461	8662	3933	9104	7403	NA	116382
Silver	2 U	2 U	3 U	1 U	2 U	2 U	4	18
Sodium	3454	46933	7417	3280	4512	5634	NA	19777
Strontium	54	581	496	101	178	162	NA	NA
Tin	14 U	18 U	23 U	3 U	14 U	14 B	245	NA
Titanium	5 B	4 U	5 U	0 U	7 A	90 B	NA	6599
Vanadium	2 B	4	7	1 B	2 U	4 B	NA	43
Zinc	668	7056	1639	1839	2133	2781	4821	6793

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:Avail.Bot.sum/r

Comparison of species release for leaching tests on untreated and treated MWC residues (mg released/kg ash treated), (continued).

LEACH TEST: Availability **ASH TYPE:** Bottom Ash

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Anions (mg/kg ash ds)								
Bromide	1296 U	3200 U	8532	2360	6497 U	6786 U	265	572
Fluoride	NA	NA	NA	NA	NA	NA	NA	NA
Chloride	14723	25845	31534	17291	34455	32580	16993	24301
Sulfate	10296	39573	130398	21327	35354	29343	15059	NA
Nitrogen Species:								
Nitrite	NA	NA	NA	NA	NA	NA	NA	NA
Nitrate	NA	NA	NA	NA	NA	NA	29	NA
Ammonia	NA	NA	NA	NA	NA	NA	228	NA
Phosphorous	348 B	320 U	424	236	258 U	204 B	1 U	NA
Other Assays (mg/kg ds)								
pH (S.U.)	4.00	4.00	4.00	4.0	4.00	4.0	10.02	NA
TDS	NA	NA	NA	NA	NA	NA	NA	NA
COD	NA	NA	NA	NA	NA	NA	NA	NA
TOC	NA	NA	NA	NA	NA	NA	NA	NA

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:Avail.Bot.sum/r

Comparison of coefficients of variation for species release from leaching tests on untreated and treated MWC residues.

LEACH TEST: Availability — ASH TYPE: Bottom Ash

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Metals								
Aluminum	0.06	0.29	0.69	0.66	0.11	0.56	0.03	0.02
Antimony	0.02 U	0.21	0.18	0.30	0.32 A	1.24 B	NA	0.17
Arsenic	0.16 B	0.16 B	0.63 A	0.16 A	0.26	0.91 A	0.45	NA
Barium	0.30	0.85 A	0.51	0.10	0.18	0.51	0.02	NA
Beryllium	0.25	0.00 U	0.13 B	0.00 U	0.49 A	0.35	NA	NA
Boron	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	0.61	0.83	0.68	0.15	0.21	0.31	0.17	0.19
Calcium	0.34	0.33	0.28	0.10	0.34	0.15	NA	0.07
Chromium	0.37	0.38	0.52 A	0.00 U	0.09	0.90	0.08	0.20
Cobalt	0.15	0.56 A	0.16	0.43	0.23	0.56	NA	0.16
Copper	0.08	0.66	0.84	0.13	0.69	0.48	0.12	0.14
Iron	0.15	0.31	0.94	0.11	0.67	1.32	NA	0.24
Lead	0.03	0.91	0.87	0.69	0.22	0.82	0.27	NA
Lithium	0.02 U	0.00	0.26	0.82	0.24 A	0.01	0.13	NA
Magnesium	0.21	0.61	0.38	0.04	0.56	0.46	NA	NA
Manganese	0.13	0.89	0.72	0.25	0.28	0.54	NA	0.09
Mercury	0.02 U	0.69 B	0.01 U	0.70 B	0.01 B	0.21 A	0.17	0.14
Molybdenum	0.63	0.22	0.13	0.21	0.53	0.79	NA	NA
Nickel	0.66 A	0.58	0.35	0.29	0.45	0.63	0.18	NA
Potassium	0.09	0.08	0.20	0.11	0.13	0.15	NA	0.10
Selenium	0.02 U	0.00 U	0.01 U	0.65 U	0.01 U	0.01 U	NA U	0.14
Silicon	0.43	0.71	0.64	0.08	0.14	0.60	NA	0.15
Silver	0.02 U	0.00 U	0.01 U	0.00 U	0.01 U	0.01 U	0.90	0.19
Sodium	0.21	0.28	0.37	0.04	0.27	0.23	NA	0.17
Strontium	0.16	0.44	0.28	0.15	0.10	0.33	NA	NA
Tin	0.02 U	0.00 U	0.01 U	0.30 U	0.01 U	0.37 B	0.11	NA
Titanium	0.54 B	0.00 U	0.01 U	0.00 U	0.64 A	1.68 B	NA	0.06
Vanadium	0.34 B	0.37	0.73	0.25 B	0.01 U	1.09 B	NA	0.08
Zinc	0.20	1.39	0.73	0.06	0.53	0.46	0.02	0.13

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:CV/Avail/Bot.Sum.

Comparison of coefficients of variation for species release from leaching tests on untreated and treated MWC residues (continued).

LEACH TEST: Availability **ASH TYPE:** Bottom Ash

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Anions								
Bromide	0.02 U	0.00 U	0.01	0.00	0.01 U	0.43 U	0.23	0.20
Fluoride	NA	NA	NA	NA	NA	NA	NA	NA
Chloride	0.04	0.04	0.08	0.09	0.05	0.32	0.25	0.14
Sulfate	0.40	0.02	0.02	0.02	0.09	0.05	1.43	NA
Nitrogen Species:								
Nitrite	NA	NA	NA	NA	NA	NA	NA	NA
Nitrate	NA	NA	NA	NA	NA	NA	0.43	NA
Ammonia	NA	NA	NA	NA	NA	NA	0.15	NA
Phosphorous	0.28 B	0.00 U	0.01	0.00	0.01 U	3.44 B	0.01 U	NA
Other Assays								
pH (S.U.)	0.00	0.00	0.00	0.00	0.00	0.00	0.02	NA
TDS	NA	NA	NA	NA	NA	NA	NA	NA
COD	NA	NA	NA	NA	NA	NA	NA	NA
TOC	NA	NA	NA	NA	NA	NA	NA	NA

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:CV/Avail/Bot.Sum.

Appendix B.3.

Summary results of TCLP, DWLT and AVLT for untreated and treated combined ash.

B. 3-1

Comparison of extract concentrations for TCLP on untreated and treated MWC residues (ug/l).

LEACH TEST: TCLP — ASH TYPE: Combined

	Process 1 (Ext. 1)	Process 2 (Ext. 2)	Process 3 (Ext. 2)	Process 4 (Ext. 2)	WES Control (Ext. 2)	Untreated (Ext. 1)	Untreated (Ext. 2)	Reg. Limits
Metals (ug/l)								
Aluminum	6207	2800	73	192	9267	356	94893	
Antimony	14 B	40 U	157	97	40 U	96	26 A	
Arsenic	3 U	10 U	10 U	3 U	13 B	3 U	13 A	5000
Barium	548	180	250	499	500	408	911	100000
Beryllium	1 B	3	2 U	1 U	3	1 U	1 U	
Boron	107	NA	NA	1657	NA	1067	1553	
Cadmium	1	2	51	149	620	10	508	1000
Calcium	903000	1733333	2666667	2463333	1966667	1020667	1803333	
Chromium	3 U	78	14 A	3 U	24	5 U	67	5000
Cobalt	3 U	6	10 A	38	61	5 U	105	
Copper	337	590	307	572	2690	373	2650	
Iron	339	133	19	49	3067	86	32662	
Lead	59	16	20 A	43	1333	41 U	2127	5000
Lithium	44	157	120	145	67	30	62	
Magnesium	699	2133	86667	79367	105667	26600	93100	
Manganese	25	7	793	6233	7467	425	9527	
Mercury	0 U	1	1	0 B	1 A	0 A	1	200
Molybdenum	3 U	187	183	90	18 B	90	14	
Nickel	6 B	23 A	82	145	293	12 B	484	
Potassium	76633	108000	343333	80133	66000	114333	116800	
Selenium	30 U	5 U	5 U	30 U	5 U	11 U	20 U	1000
Silicon	3047	4067	8500	16770	30667	1489	33033	
Silver	4 U	7 U	7 U	4 U	7 U	3 U	3 U	5000
Sodium	1416667	1200000	64000	99033	93333	1483333	127333	
Strontium	1500	4233	4000	2477	2367	1760	2750	
Tin	10 U	55 U	55 U	10 U	55 U	17 U	17 U	
Titanium	11	19 A	12 U	2 U	29 A	12	46	
Vanadium	3 U	23	20	3 U	7	3 U	3 U	
Zinc	229	85	3463	7567	30333	270	39133	

U=undetected, detection limit indicated; A=U(1 of 3); B=U(2 of 3); NA= not analyzed

TCLP/SumCompEx/Comb.

Comparison of extract concentrations for TCLP on untreated and treated MWC residues (mg/l), (continued).

B. 3-1

LEACH TEST: TCLP **ASH TYPE:** Combined

	Process 1 (Ext. 1)	Process 2 (Ext. 2)	Process 3 (Ext. 2)	Process 4 (Ext. 2)	WES Control (Ext. 2)	Untreated (Ext. 1)	Untreated (Ext. 2)	Reg. Limits
Anions (mg/l)								
Bromide	29 U	17	12	11	NA	12	14	
Fluoride	NA	NA	NA	NA	NA	1	0	
Chloride	398	540	437	407	NA	645	670	
Sulfate	220	543	1277	585	NA	592	673	
Nitrogen Species:								
Nitrite	NA	NA	NA	NA	NA	0	0	
Nitrate	482	NA	261	27	NA	46	80	
Ammonia	NA	NA	NA	NA	NA	NA	NA	
Phosphorous	1 U	1 U	NA	1	NA	0	1	
Other Assays (mg/l)								
pH (S.U.)	5.02	5.21	5.65	6.88	11.21	6.34	5.19	
TDS	NA	NA	NA	NA	NA	NA	NA	
COD	NA	NA	NA	NA	NA	NA	NA	
TOC	NA	NA	NA	NA	NA	NA	NA	

U=undetected, detection limit indicated; A=U(1 of 3); B=U(2 of 3); NA= not analyzed

TCLP/SumCompEx/Comb.

B. 3-2

Comparison of species release for leaching tests on untreated and treated MWC residues (mg released/kg, dry solid).

LEACH TEST: TCLP — ASH TYPE: Combined Ash

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Metals (mg/kg ds)								
Aluminum	136	69	2	5	206	2091	28461	56083
Antimony	0 B	1 U	3	2	1 U	1 A	NA	253
Arsenic	0 U	0 U	0 U	0 U	0 B	0 A	17	NA
Barium	12	4	5	12	11	20	746	NA
Beryllium	0.0 B	0.1	0.0 U	0.0 U	0.1	0.0 U		NA
Boron	2.3	NA	NA	39.1	NA	34.0	NA	NA
Cadmium	0	0	1	4	14	11	27	32
Calcium	19828	43199	54926	58210	43840	39589	NA	123357
Chromium	0 U	2	0 A	0 U	1	1	75	400
Cobalt	0 U	0	0 A	1	1	2	NA	36
Copper	7	15	6	13	64	63	1730	1734
Iron	7	3	0	1	68	716	NA	68362
Lead	1	0	0 A	1	30	47	1054	NA
Lithium	1	4	2	3	1	1	9	NA
Magnesium	15	53	1785	1871	2354	2039	NA	2163
Manganese	1	0	16	146	166	208	NA	NA
Mercury	0.00 U	0.02	0.02	0.01 B	0.01 A	0.02	9.91	3.13
Molybdenum	0 U	5	4	2	0 B	0	NA	NA
Nickel	0 B	1 A	2	3	7	11	118	NA
Potassium	1687	2668	7071	1909	1471	2558	NA	13245
Selenium	1 U	0 U	0 U	1 U	0 U	0 U	5	4
Silicon	87	100	175	390	681	725	NA	134893
Silver	0 U	0 U	0 U	0 U	0 U	0 U	6	NA
Sodium	31106	29591	1319	2357	2081	2793	NA	21678
Strontium	33	104	82	59	53	60	NA	NA
Tin	0 U	1 U	1 U	0 U	1 U	0 U	200	NA
Titanium	0	0 A	0 U	0 U	1 A	1	NA	NA
Vanadium	0 U	1	0	0 U	0	0 U	NA	33
Zinc	5	2	71	177	675	858	3595	6172

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:TCLP/Comb.Sum.

B. 3-2

Comparison of species release for leaching tests on untreated and treated MWC residues (mg released/kg, dry solid), (continued).

LEACH TEST: TCLP **ASH TYPE:** Combined Ash

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Anions (mg/kg ds)								
Bromide	638 U	415	244	269	NA	300	217	590
Fluoride	NA	NA	NA	NA	NA	8	NA U	NA
Chloride	8765	13294	9008	9615	NA	14705	14102	28922
Sulfate	4815	13398	26294	13768	NA	14760	1426	NA
Nitrogen Species:								
Nitrite	NA	NA	NA	NA	NA	1	NA	NA
Nitrate	10578	NA	5375	NA	NA	1748	8	NA
Ammonia	NA	NA	NA	NA	NA	NA	255	NA
Phosphorous	22 U	25 U	NA	24	NA	27	0	NA
Other Assays (mg/kg ds								
pH (S.U.)	5.02	5.21	5.65	6.9	11.21	5.2	10.14	NA
TDS	NA	NA	NA	NA	NA	NA	NA	NA
COD	NA	NA	NA	NA	NA	NA	56627.60	NA
TOC	NA	NA	NA	NA	NA	NA	11163.11	NA

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:TCLP/Comb.Sum.

Comparison of species release for leaching tests on untreated and treated MWC residues (mg released/kg ash treated).

LEACH TEST: TCLP — ASH TYPE: Combined Ash

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Metals (mg/kg ash, db)								
Aluminum	177	110	3	5	247	2091	28481	56083
Antimony	0 B	2 U	6	3	1 U	1 A	NA	253
Arsenic	0 U	0 U	0 U	0 U	0 B	0 A	17	NA
Barium	16	7	9	14	13	20	746	NA
Beryllium	0.0 B	0.1	0.1 U	0.0 U	0.1	0.0 U	0.0	NA
Boron	3.0	NA	NA	46.2	NA	34.0	NA	NA
Cadmium	0	0	2	4	17	11	27	32
Calcium	25776	69116	98867	68668	52608	39589	NA	123357
Chromium	0 U	3	1 A	0 U	1	1	75	400
Cobalt	0 U	0	0 A	1	2	2	NA	36
Copper	10	23	11	16	77	63	1730	1734
Iron	10	5	1	1	82	716	NA	68362
Lead	2	1	1 A	1	36	47	1054	NA
Lithium	1	6	4	4	2	1	9	NA
Magnesium	20	85	3213	2208	2825	2039	NA	2163
Manganese	1	0	29	172	199	208	NA	NA
Mercury	0.0 U	0.0	0.0	0.0 B	0.0 A	0.0	9.9	3
Molybdenum	0 U	7	7	3	0 B	0	NA	NA
Nickel	0 B	1 A	3	4	8	11	118	NA
Potassium	2193	4269	12728	2253	1766	2558	NA	13245
Selenium	1 U	0 U	0 U	1 U	0 U	0 U	5	4
Silicon	87	161	315	460	817	725	NA	134693
Silver	0 U	0 U	0 U	0 U	0 U	0 U	6	NA
Sodium	40438	47345	2374	2781	2498	2793	NA	21678
Strontium	43	167	146	69	63	60	NA	NA
Tin	0 U	2 U	2 U	0 U	1 U	0 U	200	NA
Titanium	0	1 A	0 U	0 U	1 A	1	NA	NA
Vanadium	0 U	1	1	0 U	0	0 U	NA	33
Zinc	7	3	128	209	810	858	3595	6172

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:TCLP/Comb.Sum.

Comparison of species release for leaching tests on untreated and treated MWC residues (mg released/kg ash treated), (continued).

B. 3-3

LEACH TEST: TCLP **ASH TYPE: Combined Ash**

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Anions (mg/kg ash ds)								
Bromide	830 U	665	439	317	NA	300	217	590
Fluoride	NA	NA	NA	NA	NA	8	NA U	NA
Chloride	11394	21270	16214	11346	NA	14705	14102	28922
Sulfate	6259	21436	47330	16246	NA	14760	1426	NA
Nitrogen Species:								
Nitrite	NA	NA	NA	NA	NA	1	NA	NA
Nitrate	13751	NA	9676	NA	NA	1748	8	NA
Ammonia	NA	NA	NA	NA	NA	NA	255	NA
Phosphorous	29 U	39 U	NA	28	NA	27	0	NA
Other Assays (mg/kg ds)								
pH (S.U.)	5.02	5.21	5.65	6.88	11.21	5.19	10.02	
TDS	NA	NA	NA	NA	NA	NA	NA	NA
COD	NA	NA	NA	NA	NA	NA	58627.60	NA
TOC	NA	NA	NA	NA	NA	NA	11163.11	NA

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:TCLP/Comb.Sum.

Comparison of coefficients of variation for species release from leaching tests on untreated and treated MWC residues.

LEACH TEST: TCLP ASH TYPE: Combined Ash

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Metals								
Aluminum	0.27	0.23	0.28	0.62	0.79	0.90	0.06	0.06
Antimony	0.02 B	0.03 U	0.24	0.10	0.01 U	0.22 A	NA	0.36
Arsenic	0.01 U	0.03 U	0.00 U	0.04 U	0.23 B	0.75 A	0.34	NA
Barium	0.24	0.19	0.17	0.22	0.10	0.54	0.28	NA
Beryllium	0.12 B	0.67	0.00 U	0.04 U	0.18	0.02 U	NA	NA
Boron	0.55	NA	NA	0.17	NA	0.14	NA	NA
Cadmium	0.10	0.13	1.51	0.40	0.23	0.22	0.13	0.41
Calcium	0.02	0.61	0.02	0.15	0.29	0.17	NA	0.17
Chromium	0.01 U	0.12	0.43 A	0.04 U	0.54	0.84	0.31	0.17
Cobalt	0.01 U	0.05	0.46 A	0.56	0.21	0.79	NA	0.08
Copper	0.14	0.11	0.07	0.31	1.00	0.34	0.20	0.18
Iron	0.21	0.41	0.46	0.79	0.79	0.85	NA	0.42
Lead	0.21	0.81	1.34 A	0.79	0.70	0.97	0.19	NA
Lithium	0.10	0.07	0.17	0.79	0.24	0.23	0.06	NA
Magnesium	0.12	0.79	0.16	0.10	0.17	0.30	NA	NA
Manganese	0.31	0.29	0.65	0.14	0.09	0.32	NA	0.23
Mercury	0.01 U	0.54	0.47	0.78 B	0.68 A	0.74	0.23	0.47
Molybdenum	0.01 U	0.07	0.03	0.37	1.08 B	0.11	NA	NA
Nickel	0.71 B	0.10 A	0.32	0.14	0.26	0.32	0.18	NA
Potassium	0.28	0.14	0.26	0.45	0.28	0.20	NA	0.12
Selenium	0.01 U	0.03 U	0.00 U	0.04 U	0.01 U	0.02 U	NA U	0.38
Silicon	0.11	0.19	0.64	0.45	0.49	0.47	NA	0.25
Silver	0.01 U	0.03 U	0.00 U	0.04 U	0.01 U	0.02 U	0.18	NA
Sodium	0.02	0.03	0.72	0.40	0.33	0.13	NA	0.32
Strontium	0.15	0.02	0.07	0.15	0.02	0.27	NA	NA
Tin	0.01 U	0.03 U	0.00 U	0.04 U	0.01 U	0.02 U	0.13	NA
Titanium	0.52	0.32 A	0.00 U	0.04 U	0.69 A	0.86	NA	0.12
Vanadium	0.01 U	0.27	0.16	0.04 U	0.11	0.02 U	NA	0.15
Zinc	0.16	0.28	1.35	0.63	0.56	0.14	0.04	0.23

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:CV/TCLP/Comb.sum.

Comparison of coefficients of variation for species release from leaching tests on untreated and treated MWC residues (continued).

LEACH TEST: TCLP **ASH TYPE:** Combined Ash

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Anions								
Bromide	0.64 U	0.28	0.03	0.20	NA	0.22	0.14	0.41
Fluoride	NA	NA	NA	NA	NA	0.25	NA	NA
Chloride	0.24	0.13	0.16	0.18	NA	0.23	0.77	0.34
Sulfate	0.26	0.09	0.12	0.03	NA	0.27	0.60	NA
Nitrogen Species:								
Nitrite	NA	NA	NA	NA	NA	0.53	NA	NA
Nitrate	0.04	NA	0.25	NA	NA	0.66	0.37	NA
Ammonia	NA	NA	NA	NA	NA		0.76	NA
Phosphorous	0.01 U	0.03 U	NA	0.04	NA	0.55	0.00 U	NA
Other Assays								
pH (S.U.)	0.01	0.03	0.04	0.06	0.01	0.07	0.02	NA
TDS	NA	NA	NA	NA	NA	NA	NA	NA
COD	NA	NA	NA	NA	NA	NA	0.11	NA
TOC	NA	NA	NA	NA	NA	NA	0.26	NA

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:CV/TCLP/Comb.sum.

Comparison of species release for leaching tests on untreated and treated MWC residues (mg released/kg, dry solid).

LEACH TEST: DWLT, Extracts 1 + 2 ASH TYPE: Combined Ash

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Metals (mg/kg ds)								
Aluminum	251	1041	2	1127	98	1315	26481	56083
Antimony	0 U	1 B	1 U	0 U	1 U	0 U	NA	253
Arsenic	0 U	3	0 U	0 U	0 U	0 U	17	NA
Barium	50	1	19	34	56	32	746	NA
Beryllium	0.0 U	0.1	0.0 A	0.0 U	0.1	0.0 U		NA
Boron	0.6	NA	NA	NA	NA	0.4	NA	NA
Cadmium	0 U	0 U	0 U	0 U	0 U	0 A	27	32
Calcium	6248	328	7294	5418	4661	8785	NA	123357
Chromium	0 U	3	0 B	0 U	0 B	0 B	75	400
Cobalt	0 U	0 B	0 U	0 U	0	0 U	NA	36
Copper	4	37	3	5	5	11	1730	1734
Iron	0	1	0 U	0	0	1 B	NA	66362
Lead	0	2	5	0	1	0	1054	NA
Lithium	1	2	3	1	1	1	9	NA
Magnesium	0	0 B	1	1	0	1	NA	2163
Manganese	0 U	0 U	0 U	0 U	0 U	0 B	NA	NA
Mercury	0.00 U	0.02	0.01 B	0.01 A	0.00 U	0.00 U	9.91	3.13
Molybdenum	0 U	7	2	1	1	0 U	NA	NA
Nickel	0	1 U	0 B	0 B	0 U	0 B	116	NA
Potassium	2723	3653	8945	2791	2944	4526	NA	13245
Selenium	0 U	0	0 U	0 U	0 U	0 U	5	4
Silicon	28	229	24	6	41	6	NA	134693
Silver	0 U	0 U	0 U	0 U	0 U	0 U	6	NA
Sodium	3047	30747	2857	2671	2585	4678	NA	21678
Strontium	37	9	57	25	58	66	NA	NA
Tin	0 U	2 U	1 U	0 U	1 U	0 U	200	NA
Titanium	0 U	0 U	0 U	0	0 U	1	NA	NA
Vanadium	0 U	4	0	0 U	0	0 U	NA	33
Zinc	1	5	1	1	1	1	3595	6172

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:DWLT.comb.sum/1+2

Comparison of species release for leaching tests on untreated and treated MWC residues (mg released/kg, dry solid), (continued).

LEACH TEST: DWLT, Extracts 1 + 2 **ASH TYPE:** Combined Ash

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Anions (mg/kg ds)								
Bromide	216	265	285	218	289	297	217	590
Fluoride	NA	NA	NA	NA	NA	2 U	NA U	NA
Chloride	12501	15568	18214	15183	18988	29194	14102	28922
Sulfate	147	16330	2965	168	115	959	1426	NA
Nitrogen Species:								
Nitrite	NA	NA	NA	NA	NA	1	NA	NA
Nitrate	10	12	49	100	78	26	8	NA
Ammonia	NA	NA	NA	NA	NA	NA	255	NA
Phosphorous	22 U	28	23 U	20	21 U	2	0	NA
Other Assays (mg/kg ds								
pH (S.U.)	11.14	11.14	12.10	11.2	11.59	10.8	10.14	NA
TDS	31529.24	117135.51	67465.13	36836.78	49833.72	51210.4	NA	NA
COD	1960.07	3043.59	497.20 A	1314.3	2012.03	2298.5	56627.60	NA
TOC	427.56	1115.95	426.50	410.03	515.16	571.2	11163.11	NA

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:DWLT.comb.sum/1+2

Comparison of species release for leaching tests on untreated and treated MWC residues (mg released/kg ash treated).

LEACH TEST: DWLT, Extracts 1 + 2 ASH TYPE: Combined Ash

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Metals (mg/kg ash, ds)								
Aluminum	327	1666	4	1330	116	1315	28481	56083
Antimony	0 U	2 B	2 U	0 U	1 U	0 U	NA	253
Arsenic	0 U	4	0 U	0 U	0 U	0 U	17	NA
Barium	65	2	35	40	68	32	746	NA
Beryllium	0.0 U	0.1	0.1 A	0.023791 U	0.1	0.0 U	0.0	NA
Boron	1.0	NA	NA	#VALUE!	NA	0.4	NA	NA
Cadmium	0 U	0 U	0 U	0 U	0 U	0 A	27	32
Calcium	8123	526	13130	6394	5857	8785	NA	123357
Chromium	0 U	5	0 B	0 U	0 B	0 B	75	400
Cobalt	0 U	0 B	0 U	0 U	0	0 U	NA	36
Copper	5	60	5	6	7	11	1730	1734
Iron	0	1	0 U	1	1	1 B	NA	68362
Lead	1	2	10	0	1	0	1054	NA
Lithium	2	4	5	1	1	1	9	NA
Magnesium	0	0 B	1	1	0	1	NA	2163
Manganese	0 U	0 U	0 U	0 U	0 U	0 B	NA	NA
Mercury	0.0 U	0.0	0.0 B	0.007776 A	0.0 U	0.0 U	9.9	3
Molybdenum	0 U	11	4	2	2	0 U	NA	NA
Nickel	0	1 U	1 B	0 B	1 U	0 B	118	NA
Potassium	3540	5845	16100	3293	3532	4526	NA	13245
Selenium	0 U	0	0 U	0 U	0 U	0 U	5	4
Silicon	37	367	43	7	49	6	NA	134693
Silver	0 U	0 U	0 U	0 U	0 U	0 U	6	NA
Sodium	3962	49195	5142	3388	3102	4678	NA	21676
Strontium	46	14	103	30	70	66	NA	NA
Tin	0 U	2 U	2 U	0 U	1 U	0 U	200	NA
Titanium	0 U	1 U	0 U	0	0 U	1	NA	NA
Vanadium	0 U	6	0	0 U	0	0 U	NA	33
Zinc	1	8	3	1	1	1	3595	6172

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:DWLT.comb.sum/1+2

Comparison of species release for leaching tests on untreated and treated MWC residues (mg released/kg ash treated), (continued).

LEACH TEST: DWLT, Extracts 1 + 2 **ASH TYPE:** Combined Ash

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Anions (mg/kg ash ds)								
Bromide	281	424	513	258	347	297	217	590
Fluoride	NA	NA	NA	NA	NA	2 U	NA U	NA
Chloride	16251	24909	32785	17916	22786	29194	14102	28922
Sulfate	192	26128	5338	198	138	959	1426	NA
Nitrogen Species:								
Nitrite	NA	NA	NA	NA	NA	1	NA	NA
Nitrate	13	20	88	118	93	26	8	NA
Ammonia	NA	NA	NA	NA	NA	NA	255	NA
Phosphorous	29 U	44	41 U	24	26 U	2	0	NA
Other Assays (mg/kg ds)								
pH (S.U.)	11.14	11.14	12.10	11.2	11.59	10.8	10.14	
TDS	40988.01	187416.82	121437.24	43467.4	59800.46	51210.4	NA	NA
COD	2548.09	4869.74	894.95 A	1550.8	2414.44	2298.5	56627.60	NA
TOC	555.83	1785.53	767.69	483.84	618.19	571.2	11163.11	NA

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:DWLT.comb.sum/1+2

Comparison of coefficients of variation for species release from leaching tests on untreated and treated MWC residues.

LEACH TEST: DWLT, Extracts 1 + 2 ASH TYPE: Combined Ash

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Metals								
Aluminum	0.30	0.24	0.22	0.15	0.12	0.09	0.06	0.06
Antimony	0.01 U	0.15 B	0.01 U	0.01 U	0.02 U	0.02 U	NA	0.36
Arsenic	0.01 U	0.44	0.01 U	0.01 U	0.02 U	0.02 U	0.34	NA
Barium	0.31	0.42	0.15	0.07	0.67	0.06	0.28	NA
Beryllium	0.01 U	0.29	0.16 A	0.01 U	0.02	0.02 U	NA	NA
Boron	0.36	NA	NA	NA	NA	0.23	NA	NA
Cadmium	0.01 U	0.01 U	0.01 U	0.01 U	0.02 U	1.21 A	0.13	0.41
Calcium	0.07	0.37	0.07	0.07	0.06	0.09	NA	0.17
Chromium	0.01 U	0.11	0.06 B	0.01 U	0.31 B	0.62 B	0.31	0.17
Cobalt	0.01 U	0.34 B	0.01 U	0.01 U	0.17	0.02 U	NA	0.08
Copper	0.08	0.05	0.05	0.10	0.25	0.10	0.20	0.18
Iron	0.03	0.45	0.01 U	0.62	0.16	1.57 B	NA	0.42
Lead	0.11	0.27	0.38	0.27	0.44	0.59	0.19	NA
Lithium	0.01	0.29	0.07	0.16	0.10	0.12	0.06	NA
Magnesium	0.31	0.01 B	0.16	0.99	0.09	0.72	NA	NA
Manganese	0.01 U	0.01 U	0.01 U	0.01 U	0.02 U	0.57 B	NA	0.23
Mercury	0.01 U	0.01	0.87 B	0.48 A	0.02 U	0.02 U	0.23	0.47
Molybdenum	0.01 U	0.06	0.11	0.09	0.08	0.02 U	NA	NA
Nickel	0.38	0.01 U	0.01 B	0.09 B	0.02 U	0.33 B	0.18	NA
Potassium	0.25	0.11	0.24	0.13	0.04	0.10	NA	0.12
Selenium	0.01 U	0.24	0.01 U	0.01 U	0.02 U	0.02 U	NA U	0.36
Silicon	0.06	0.66	0.21	0.20	0.07	0.19	NA	0.25
Silver	0.01 U	0.01 U	0.01 U	0.01 U	0.02 U	0.02 U	0.16	NA
Sodium	0.26	0.28	0.24	0.14	0.02	0.10	NA	0.32
Strontium	0.06	0.30	0.14	0.14	0.12	0.10	NA	NA
Tin	0.01 U	0.01 U	0.01 U	0.01 U	0.02 U	0.02 U	0.13	NA
Titanium	0.01 U	0.01 U	0.01 U	0.12	0.02 U	0.04	NA	0.12
Vanadium	0.01 U	0.12	0.11	0.01 U	0.24	0.02 U	NA	0.15
Zinc	0.32	0.32	0.36	0.19	0 20	0.15	0.04	0 23

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:CV/DWLT/Comb. 1+2

Comparison of coefficients of variation for species release from leaching tests on untreated and treated MWC residues (continued).

LEACH TEST: DWLT, Extracts 1 + 2 **ASH TYPE:** Combined Ash

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Anions								
Bromide	0.21	0.20	0.18	0.04	0.10	0.14	0.14	0.41
Fluoride	NA	NA	NA	NA	NA	0.02 U	NA	NA
Chloride	0.36	0.18	0.08	0.04	0.20	0.17	0.77	0.34
Sulfate	0.09	0.20	0.37	0.19	0.34	0.14	0.60	NA
Nitrogen Species:								
Nitrite	NA	NA	NA	NA	NA	0.18	NA	NA
Nitrate	0.64	0.29	0.28	0.95	0.16	1.39	0.37	NA
Ammonia	NA	NA	NA	NA	NA	NA	0.76	NA
Phosphorous	0.01 U	0.01	0.01 U	0.01	0.02 U	0.45	0.00 U	NA
Other Assays								
pH (S.U.)	0.04	0.04	0.00	0.01	0.01	0.00	0.02	NA
TDS	0.11	0.05	0.02	0.05	0.12	0.11	NA	NA
COD	0.20	0.05	0.82 A	0.09	0.42	0.10	0.11	NA
TOC	0.10	0.06	0.03	0.16	0.13	0.08	0.26	NA

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:CV/DWLT/Comb. 1+2

Comparison of species release for leaching tests on untreated and treated MWC residues (mg released/kg, dry solid).

LEACH TEST: DWLT, Extracts 3 + 4 ASH TYPE: Combined Ash

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Metals (mg/kg ds)								
Aluminum	419	301	19	1323	185	1274	28481	56083
Antimony	0 U	1 U	1 U	0 U	1 U	1 B	NA	253
Arsenic	0 U	0 U	0 U	0 U	0 U	0 U	17	NA
Barium	20	5	14	13	26	9	746	NA
Beryllium	0.0 B	0.1	0.0 U	0.0 U	0.1	0.0 U		NA
Boron	0.9	NA	NA	NA	NA	0.7	NA	NA
Cadmium	0 U	0 U	0 U	0	0 U	0 U	27	32
Calcium	3701	2153	3578	2903	2940	2597	NA	123357
Chromium	0 U	0	0 B	0 U	0	0 B	75	400
Cobalt	0 U	0 U	0 U	0 U	0 U	0 U	NA	36
Copper	1	1	1	1	2	3	1730	1734
Iron	0	1	0 B	1	0	0 A	NA	66362
Lead	0	0 A	0	0	0	0	1054	NA
Lithium	0	1	1	0	0 B	0	9	NA
Magnesium	0	0	0	0	0	2	NA	2163
Manganese	0 U	0 U	0 U	0 U	0 U	0 U	NA	NA
Mercury	0.01 U	0.01	0.00 U	0.00 U	0.01 B	0.01 B	9.91	3.13
Molybdenum	1	0 B	1	1	1	1	NA	NA
Nickel	0 U	1 U	0 U	0 U	0 U	0 U	118	NA
Potassium	78	263	238	45	69	83	NA	13245
Selenium	0 U	0 U	0 U	0 U	0 U	0 U	5	4
Silicon	26	80	71	8	32	10	NA	134893
Silver	0 U	0 U	0 U	0 U	0 U	0 U	6	NA
Sodium	85	1465	90	45	57	79	NA	21678
Strontium	10	32	15	5	12	10	NA	NA
Tin	0	2 U	1 U	4 A	1 U	0 U	200	NA
Titanium	0 U	0 U	0 U	0	0 U	1	NA	NA
Vanadium	0 U	0	0 U	0 U	0	0 U	NA	33
Zinc	1	1	1	1	1	0	3595	6172

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:DWLT.comb.sum/3 + 4

Comparison of species release for leaching tests on untreated and treated MWC residues (mg released/kg, dry solid), (continued).

LEACH TEST: DWLT, Extracts 3 + 4 ASH TYPE: Combined Ash

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Anions (mg/kg ds)								
Bromide	21	16	16	16	29	28	217	590
Fluoride	NA	NA	NA	NA	NA	2 U	NA U	NA
Chloride	1079	687	635	944	1619	1176	14102	28922
Sulfate	316	327	824	288	157	1340	1426	NA
Nitrogen Species:								
Nitrite	NA	NA	NA	NA	NA	0 U	NA	NA
Nitrate	12	9	14	27	24	14	8	NA
Ammonia	NA	NA	NA	NA	NA	NA	255	NA
Phosphorous	22 U	28	23 U	20	21 U	1	0	NA
Other Assays (mg/kg ds								
pH (S.U.)	11.14	11.14	11.29	11.4	10.88	11.0	10.14	NA
TDS	9738.65	12811.89	12588.68	11022.29	10929.40	12662.0	NA	NA
COD	236.44	137.06	112.94 A	189.5	337.43	355.8	56627.60	NA
TOC	87.16	50.55	70.64	77.64	82.49	119.9	11163.11	NA

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:DWLT.comb.sum/3 + 4

Comparison of species release for leaching tests on untreated and treated MWC residues (mg released/kg ash treated).

LEACH TEST: DWLT, Extracts 3 + 4 ASH TYPE: Combined Ash

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Metals (mg/kg ash, ds)								
Aluminum	545	481	34	1561	222	1274	28481	56083
Antimony	0 U	2 U	2 U	0 U	1 U	1 B	NA	253
Arsenic	0 U	0 U	0 U	0 U	0 U	0 U	17	NA
Barium	26	8	25	16	31	9	746	NA
Beryllium	0.0 B	0.1	0.1 U	0.0 U	0.1	0.0 U	0.0	NA
Boron	1.1	NA	NA	NA	NA	0.7	NA	NA
Cadmium	0 U	0 U	0 U	0	0 U	0 U	27	32
Calcium	4811	3445	6441	3426	3528	2597	NA	123357
Chromium	0 U	1	1 B	0 U	0	0 B	75	400
Cobalt	0 U	0 U	0 U	0 U	0 U	0 U	NA	36
Copper	2	1	2	2	2	3	1730	1734
Iron	0	1	0 B	1	0	0 A	NA	68362
Lead	0	0 A	1	0	0	0	1054	NA
Lithium	0	2	1	0	0 B	0	9	NA
Magnesium	1	1	1	1	0	2	NA	2163
Manganese	0 U	0 U	0 U	0 U	0 U	0 U	NA	NA
Mercury	0.0 U	0.0	0.0 U	0.0 U	0.0 B	0.0 B	9.9	3
Molybdenum	1	0 B	2	1	1	1	NA	NA
Nickel	0 U	1 U	1 U	0 U	1 U	0 U	118	NA
Potassium	102	420	429	53	83	83	NA	13245
Selenium	0 U	0 U	0 U	0 U	0 U	0 U	5	4
Silicon	33	127	127	10	38	10	NA	134893
Silver	0 U	0 U	0 U	0 U	0 U	0 U	6	NA
Sodium	110	2344	162	53	69	79	NA	21678
Strontium	13	51	26	6	14	10	NA	NA
Tin	1	2 U	2 U	5 A	1 U	0 U	200	NA
Titanium	0 U	1 U	0 U	1	0 U	1	NA	NA
Vanadium	0 U	0	0 U	0 U	0	0 U	NA	33
Zinc	1	1	1	1	1	0	3595	6172

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:DWLT.comb.sum/3 + 4

Comparison of species release for leaching tests on untreated and treated MWC residues (mg released/kg ash treated), (continued).

LEACH TEST: DWLT, Extracts 3 + 4 **ASH TYPE:** Combined Ash

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Anions (mg/kg ash ds)								
Bromide	27	25	30	19	35	28	217	590
Fluoride	NA	NA	NA	NA	NA	2 U	NA U	NA
Chloride	1403	1099	1143	1113	1943	1176	14102	28922
Sulfate	411	524	1482	340	188	1340	1426	NA
Nitrogen Species:								
Nitrite	NA	NA	NA	NA	NA	0 U	NA	NA
Nitrate	16	14	25	32	29	14	8	NA
Ammonia	NA	NA	NA	NA	NA	NA	255	NA
Phosphorous	29 U	44	41 U	24	26 U	1	0	NA
Other Assays (mg/kg ds)								
pH (S.U.)	11.14	11.14	11.29	11.38	10.88	10.97	10.02	NA
TDS	12660.24	20499.02	22659.62	13006.3	13115.28	12662.0	NA	NA
COD	307.37	219.30	203.29 A	223.6	404.92	355.8	56627.60	NA
TOC	113.30	80.87	127.16	91.61	98.98	119.9	11163.11	NA

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:DWLT.comb.sum/3 + 4

Comparison of coefficients of variation for species release from leaching tests on untreated and treated MWC residues.

LEACH TEST: DWLT, Extracts 3 + 4 ASH TYPE: Combined Ash

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Metals								
Aluminum	0.24	0.08	0.29	0.02	0.11	0.04	0.06	0.06
Antimony	0.01 U	0.07 U	0.01 U	0.01 U	0.02 U	0.30 B	NA	0.36
Arsenic	0.01 U	0.07 U	0.01 U	0.01 U	0.02 U	0.02 U	0.34	NA
Barium	0.35	0.14	0.25	0.08	0.15	0.04	0.26	NA
Beryllium	0.28 B	0.07	0.01 U	0.01 U	0.07	0.02 U	NA	NA
Boron	0.52	NA	NA	NA	NA	0.12	NA	NA
Cadmium	0.01 U	0.16	0.01 U	0.99	0.02 U	0.02 U	0.13	0.41
Calcium	0.04	0.07	0.39	0.03	0.10	0.02	NA	0.17
Chromium	0.01 U	0.10	0.56 B	0.01 U	0.29	0.02 B	0.31	0.17
Cobalt	0.01 U	0.07 U	0.44 U	0.01 U	0.02 U	0.02 U	NA	0.08
Copper	0.04	0.11 B	0.17	0.08	0.19	0.10	0.20	0.18
Iron	0.10	0.17	0.17 B	0.60	0.34	1.21 A	NA	0.42
Lead	0.55	0.23	0.45	0.99	0.44	0.88	0.19	NA
Lithium	0.12	0.31	0.33	0.23	0.28 B	0.06	0.06	NA
Magnesium	0.19	0.31 A	0.40	0.11	0.26	1.00	NA	NA
Manganese	0.01 U	0.07 U	0.01 U	0.01 U	0.02 U	0.02 U	NA	0.23
Mercury	0.42 U	0.07 U	0.01 U	0.01 U	0.23 B	0.43 B	0.23	0.47
Molybdenum	0.20	0.15	0.39	0.17	0.08	0.13	NA	NA
Nickel	0.01 U	0.07 U	0.01 U	0.01 U	0.02 U	0.02 U	0.18	NA
Potassium	0.20	0.11	0.35	0.25	0.07	0.13	NA	0.12
Selenium	0.01 U	0.07 U	0.01 U	0.01 U	0.02 U	0.02 U	NA U	0.38
Silicon	0.15	0.11	0.14	0.20	0.09	0.21	NA	0.25
Silver	0.01 U	0.07 U	0.01 U	0.01 U	0.02 U	0.02 U	0.18	NA
Sodium	0.12	0.35	0.25	0.04	0.21	0.02	NA	0.32
Strontium	0.09	0.26	0.14	0.15	0.07	0.09	NA	NA
Tin	0.62	0.07 U	0.01 U	1.64 A	0.02 U	0.02 U	0.13	NA
Titanium	0.01 U	0.07 U	0.01 U	0.11	0.02 U	0.10	NA	0.12
Vanadium	0.01 U	0.23	0.01 U	0.01 U	0.22	0.02 U	NA	0.15
Zinc	0.16	0.35	0.33	0.12	0.16	0.16	0.04	0.23

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File.CV/DWLT/Comb. 3+4

Comparison of coefficients of variation for species release from leaching tests on untreated and treated MWC residues (continued).

LEACH TEST: DWLT, Extracts 3 + 4 **ASH TYPE:** Combined Ash

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Anions								
Bromide	0.00	0.30	0.26	0.03	0.09	0.11	0.14	0.41
Fluoride	NA	NA	NA	NA	NA	0.02 U	NA	NA
Chloride	0.06	0.14	0.15	0.09	0.06	0.23	0.77	0.34
Sulfate	0.08	0.13	0.05	0.13	0.28	0.10	0.60	NA
Nitrogen Species:								
Nitrite	NA	NA	NA	NA	NA	0.02 U	NA	NA
Nitrate	0.82	0.82	1.00	1.26	0.77	0.85	0.37	NA
Ammonia	NA	NA	NA	NA	NA	NA	0.76	NA
Phosphorous	0.01	0.07	0.01 U	0.01	0.02 U	0.39	0.00 U	NA
Other Assays								
pH (S.U.)	0.04	0.04	0.01	0.00	0.03	0.01	0.02	NA
TDS	0.07	0.33	0.12	0.04	0.03	0.14	NA	NA
COD	0.01	0.07	0.35 A	0.10	0.55	0.05	0.11	NA
TOC	0.07	0.22	0.07	0.08	0.11	0.08	0.26	NA

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:CV/DWLT/Comb. 3+4

Comparison of species release for leaching tests on untreated and treated MWC residues (mg released/kg, dry solid).

LEACH TEST: Availability ASH TYPE: Combined Ash

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Metals (mg/kg ds)								
Aluminum	4832	9333	6645	288	4255	4000	31538	56083
Antimony	10 B	11 B	19 A	17	9 B	8 U	NA	253
Arsenic	3	11	6 A	7	3	6	16	NA
Barium	96	158	85	117	155	130	553	NA
Beryllium	0.6	0.3 U	0.4 U	0.2 U	0.6	0.6		NA
Boron	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	25	13	11	22	20	27	36	32
Calcium	118413	102667	105254	89201	103280	79348	NA	123357
Chromium	4	10	11	1 U	5	3	197	400
Cobalt	2	5	4	2	4	3	NA	36
Copper	183	247	217	207	281	380	2102	1734
Iron	143	2307	2485	586	153	674	NA	68362
Lead	196	307	755	39	281	502	1559	NA
Lithium	3 B	7	6	5	4 A	4	9	NA
Magnesium	4032	2767	4272	3366	3753	4746	NA	2163
Manganese	184	293	324	265	303	678	NA	NA
Mercury	0.21 A	1.49 A	0.07 A	0.40	0.09	0.06 B	6.04	3.13
Molybdenum	3	3 A	6	5	9	2 B	NA	NA
Nickel	11	17	12	13	14	19	431	NA
Potassium	5258	4733	10919	4032	4767	5832	NA	13245
Selenium	1 U	1 U	1 U	3 U	1 U	1 B	5	4
Silicon	5405	13200	9469	4117	7204	4338	NA	134893
Silver	2 U	1 U	2 U	1 U	2 U	2 B	4	NA
Sodium	5403	32000	4111	4373	4406	5764	NA	21678
Strontium	100	427	285	106	161	158	NA	NA
Tin	12 U	11 U	13 U	2 U	12 U	11 U	244	NA
Titanium	3 U	148 B	103 A	0 U	3 U	2 U	NA	NA
Vanadium	2 B	5 A	10	1 U	1 U	1 U	NA	33
Zinc	1289	1573	1101	1839	1751	2902	4815	6172

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:Avail.Comb.sum/r

Comparison of species release for leaching tests on untreated and treated MWC residues (mg released/kg, dry solid), (continued).

LEACH TEST: Availability **ASH TYPE:** Combined Ash

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Anions (mg/kg ds)								
Bromide	1080 U	2000 U	4749 U	2268	3584 U	6786 U	284	590
Fluoride	NA	NA	NA	NA	NA		1 U	NA
Chloride	12269	18440	19935	29638	31620	32580	25278	28922
Sulfate	8580	30533	66971	32625	29621	29343	506	NA
Nitrogen Species:								
Nitrite	NA	NA	NA	NA	NA	NA	0	NA
Nitrate	NA	NA	NA	NA	NA	NA	1	NA
Ammonia	NA	NA	NA	NA	NA	NA	14	NA
Phosphorous	290 B	200 B	319 B	203	215 U	204 B	2575	NA
Other Assays (mg/kg ds								
pH (S.U.)	4.00	4.00	4.00	4.0	4.00	4.0	10.36	NA
TDS	NA	NA	NA	NA	NA	NA	48309.11	NA
COD	NA	NA	NA	NA	NA	NA	71155.54	NA
TOC	NA	NA	NA	NA	NA	NA	25813.08	NA

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:Avail.Comb.sum/r

Comparison of species release for leaching tests on untreated and treated MWC residues (mg released/kg ash treated).

LEACH TEST: Availability ASH TYPE: Combined Ash

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Metals (mg/kg ash, ds)								
Aluminum	6282	14933	11961	340	5106	4000	26481	56083
Antimony	13 B	18 B	34 A	21	11 B	6 U	NA	253
Arsenic	4	16	11 A	9	4	6	17	NA
Barium	125	253	154	138	166	130	746	NA
Beryllium	0.6	0.5 U	0.6 U	0.2398 U	0.7	0.6		NA
Boron	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	32	20	20	26	24	27	27	32
Calcium	153937	164267	189456	105257	123936	79348	NA	123357
Chromium	5	16	19	1 U	6	3	75	400
Cobalt	3	6	7	2	4	3	NA	36
Copper	238	395	390	244	337	360	1730	1734
Iron	165	3691	4473	692	183	674	NA	68362
Lead	255	491	1356	46	337	502	1054	NA
Lithium	4 B	12	11	6	5 A	4	9	NA
Magnesium	5241	4427	7690	3972	4504	4746	NA	2163
Manganese	239	468	584	312	363	678	NA	NA
Mercury	0.3 A	2.4 A	0.1 A	0.467264	0.1	0.1 B	9.9	3
Molybdenum	4	5 A	15	6	11	2 B	NA	NA
Nickel	14	28	22	15	16	19	118	NA
Potassium	6835	7573	19654	4757	5720	5832	NA	13245
Selenium	1 U	2 U	2 U	4 U	1 U	1 B	5	4
Silicon	7027	21120	17080	4858	8645	4336	NA	134893
Silver	2 U	2 U	3 U	1 U	2 U	2 B	6	NA
Sodium	7024	51200	7400	5161	5287	5764	NA	21676
Strontium	130	683	513	125	194	158	NA	NA
Tin	15 U	18 U	24 U	2 U	14 U	11 U	200	NA
Titanium	3 U	237 B	186 A	0 U	3 U	2 U	NA	NA
Vanadium	2 B	9 A	17	1 U	2 U	1 U	NA	33
Zinc	1675	2517	1981	2170	2101	2902	3595	6172

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:Avail.Comb.sum/r

B. 3-12 Comparison of species release for leaching tests on untreated and treated MWC residues (mg released/kg ash treated), (continued).

LEACH TEST: Availability **ASH TYPE:** Combined Ash

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Anions (mg/kg ash ds)								
Bromide	1404 U	3200 U	8548 U	2677	4301 U	6786 U	217	590
Fluoride	NA	NA	NA	NA	NA	0	NA U	NA
Chloride	15950	29504	35883	34972	37944	32580	14102	28922
Sulfate	11154	48853	120547	38498	35545	29343	1426	NA
Nitrogen Species:								
Nitrite	NA	NA	NA	NA	NA	NA	NA	NA
Nitrate	NA	NA	NA	NA	NA	NA	8	NA
Ammonia	NA	NA	NA	NA	NA	NA	255	NA
Phosphorous	376 B	320 B	575 B	239	258 U	204 B	0	NA
Other Assays (mg/kg ds)								
pH (S.U.)	4.00	4.00	4.00	4.0	4.00	4.0	10.14	
TDS	NA	NA	NA	NA	NA	NA	NA	NA
COD	NA	NA	NA	NA	NA	NA	56627.60	NA
TOC	NA	A	NA	A	NA	NA	11163.11	NA

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:Avail.Comb.sum/r

Comparison of coefficients of variation for species release from leaching tests on untreated and treated MWC residues.

LEACH TEST: Availability — ASH TYPE: Combined Ash

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Metals								
Aluminum	0.14	0.62	0.12	0.81	0.13	0.24	0.06	0.06
Antimony	0.21 B	0.46 B	0.10 A	1.07	0.02 B	0.00 U	NA	0.36
Arsenic	0.38	1.00	1.05 A	1.53	0.17	0.93	0.34	NA
Barium	0.14	0.70	0.01	0.65	0.26	0.29	0.26	NA
Beryllium	0.26	0.00 U	0.01 U	0.01 U	0.25	0.09	NA	NA
Boron	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	0.86	0.37	0.22	0.88	0.01	0.16	0.13	0.41
Calcium	0.34	0.40	0.02	0.29	0.23	0.07	NA	0.17
Chromium	0.20	0.89	0.25	0.01 U	0.14	0.38	0.31	0.17
Cobalt	0.24	0.32	0.06	0.22	0.03	0.32	NA	0.08
Copper	0.36	0.38	0.04	0.43	0.20	0.27	0.20	0.18
Iron	0.57	1.61	0.74	0.60	0.23	1.13	NA	0.42
Lead	0.13	0.74	0.86	0.81	0.20	0.32	0.19	NA
Lithium	0.26 B	0.31	0.21	0.53	0.23 A	0.00	0.06	NA
Magnesium	0.57	0.49	0.09	0.20	0.17	0.24	NA	NA
Manganese	0.57	0.69	0.16	0.19	0.21	0.35	NA	0.23
Mercury	1.00 A	1.47 A	0.58 A	1.41	0.27	0.58 B	0.23	0.47
Molybdenum	0.26	0.76 A	0.16	0.27	0.18	0.18 B	NA	NA
Nickel	0.29	0.34	0.28	0.23	0.36	0.51	0.16	NA
Potassium	0.48	0.26	0.07	0.60	0.24	0.08	NA	0.12
Selenium	0.01 U	0.00 U	0.01 U	0.85 U	0.01 U	0.11 B	NA U	0.38
Silicon	0.22	0.63	0.21	0.22	0.25	0.27	NA	0.25
Silver	0.01 U	0.00 U	0.01 U	0.01 U	0.01 U	0.29 B	0.18	NA
Sodium	0.52	0.25	0.26	0.60	0.23	0.10	NA	0.32
Strontium	0.34	0.40	0.15	0.13	0.25	0.06	NA	NA
Tin	0.01 U	0.00 U	0.01 U	0.01 U	0.01 U	0.00 U	0.13	NA
Titanium	0.01 U	1.70 B	0.84 A	0.01 U	0.01 U	0.00 U	NA	0.12
Vanadium	0.27 B	1.20 A	0.71	0.01 U	0.01 U	0.00 U	NA	0.15
Zinc	0.54	0.12	0.09	0.53	0.19	0.27	0.04	0.23

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:CV/Avail. Comb. Sum.

B. 3-13 Comparison of coefficients of variation for species release from leaching tests on untreated and treated MWC residues (continued).

LEACH TEST: Availability **ASH TYPE:** Combined Ash

	Process 1	Process 2	Process 3	Process 4	WES Control	Untreated	Total (SW-846)	Total (NAA)
Anions								
Bromide	0.57 U	0.00 U	0.01 U	0.18	0.43 U	0.51 U	0.14	0.41
Fluoride	NA	NA	NA	NA	NA	NA	NA	NA
Chloride	0.10	0.18	0.09	0.91	0.09	0.07	0.77	0.34
Sulfate	0.29	0.13	0.07	0.62	0.37	0.08	0.60	NA
Nitrogen Species:								
Nitrite	NA	NA	NA	NA	NA	NA	NA	NA
Nitrate	NA	NA	NA	NA	NA	NA	0.37	NA
Ammonia	NA	NA	NA	NA	NA	A	0.76	NA
Phosphorous	0.01 U	1.91 B	0.30 B	7.15	0.00 U	0.80 B	0.00 U	NA
Other Assays								
pH (S.U.)	0.00	0.00	0.00	0.00	0.00	0.00	0.02	NA
TDS	NA	NA	NA	NA	NA	NA	NA	NA
COD	NA	NA	NA	NA	NA	NA	0.11	NA
TOC	NA	NA	NA	NA	NA	NA	0.26	NA

U=undetected, A=U(1 of 3), B=U(2 of 3), NA= not analyzed

File:CV/Avail. Comb. Sum.

Appendix C. Summary of monolith leach test extract concentrations and data analysis for untreated and treated MWC residues.

List of Tables:

Table Number	Product Code	Description
Appendix C.1. Untreated Bottom Ash and Combined Ash		
C.1-1	VOXL	Untreated, blank
C.1-2	VOBA	Untreated, Bottom Ash, Replicate A
C.1-3	VOBB	Untreated, Bottom Ash, Replicate B
C.1-4	VOBC	Untreated, Bottom Ash, Replicate C
C.1-5	VOCA	Untreated, Combined Ash, Replicate A
C.1-6	VOCB	Untreated, Combined Ash, Replicate B
C.1-7	VOCC	Untreated, Combined Ash, Replicate C
Appendix C.2 Process 1		
C.2-1	V1XL	Process 1, blank
C.2-2	V1FA	Process 1, APC Residue, Replicate A
C.2-3	V1FB	Process 1, APC Residue, Replicate B
C.2-4	V1FC	Process 1, APC Residue, Replicate C
C.2-5	V1BA	Process 1, Bottom Ash, Replicate A
C.2-6	V1BB	Process 1, Bottom Ash, Replicate B
C.2-7	V1BC	Process 1, Bottom Ash, Replicate C
C.2-8	V1CA	Process 1, Combined Ash, Replicate A
C.2-9	V1CB	Process 1, Combined Ash, Replicate B
C.2-10	V1CC	Process 1, Combined Ash, Replicate C

Appendix C.3

Process 2

C.3-1	V2XL	Process 2, blank
C.3-2	V2FA	Process 2, APC Residue, Replicate A
C.3-3	V2FB	Process 2, APC Residue, Replicate B
C.3-4	V2FC	Process 2, APC Residue, Replicate C
C.3-5	V2BA	Process 2, Bottom Ash, Replicate A
C.3-6	V2BB	Process 2, Bottom Ash, Replicate B
C.3-7	V2BC	Process 2, Bottom Ash, Replicate C
C.3-8	V2CA	Process 2, Combined Ash, Replicate A
C.3-9	V2CB	Process 2, Combined Ash, Replicate B
C.3-10	V2CC	Process 2, Combined Ash, Replicate C

Appendix C.4

Process 3

C.4-1	V3XL	Process 3, blank
C.4-2	V3FA	Process 3, APC Residue, Replicate A
C.4-3	V3FB	Process 3, APC Residue, Replicate B
C.4-4	V3FC	Process 3, APC Residue, Replicate C
C.4-5	V3BA	Process 3, Bottom Ash, Replicate A
C.4-6	V3BB	Process 3, Bottom Ash, Replicate B
C.4-7	V3BC	Process 3, Bottom Ash, Replicate C
C.4-8	V3CA	Process 3, Combined Ash, Replicate A
C.4-9	V3CB	Process 3, Combined Ash, Replicate B
C.4-10	V3CC	Process 3, Combined Ash, Replicate C

Appendix C.5

Process 4

C.5-1	V4XL	Process 4, blank
C.5-2	V4BA	Process 4, Bottom Ash, Replicate A
C.5-3	V4FB	Process 4, Bottom Ash, Replicate B
C.5-4	V4BC	Process 4, Bottom Ash, Replicate C
C.5-5	V4CA	Process 4, Combined Ash, Replicate A
C.5-6	V4CB	Process 4, Combined Ash, Replicate B
C.5-7	V4CC	Process 4, Combined Ash, Replicate C

Appendix C.6

WES Control Process

C.6-1	V9XL	WES, blank
C.6-2	V9FA	WES, APC Residue, Replicate A
C.6-3	V9FB	WES, APC Residue, Replicate B
C.6-4	V9FC	WES, APC Residue, Replicate C
C.6-5	V9BA	WES, Bottom Ash, Replicate A
C.6-6	V9BB	WES, Bottom Ash, Replicate B
C.6-7	V9BC	WES, Bottom Ash, Replicate C
C.6-8	V9CA	WES, Combined Ash, Replicate A
C.6-9	V9CB	WES, Combined Ash, Replicate B
C.6-10	V9CC	WES, Combined Ash, Replicate C

Appendix C.1. Summary of monolith leach test extract concentrations and data analysis for untreated bottom ash and combined ash.

All
Productcode: VOXL

Surf.area: .0081 m^2 Bulk Density : 1000 kg/m^3 3 October 1991
Weight : 1 kg Extraction volume: 6.49 L

Concentration in µg/L Time (days)	K	Na	Li	Br	Cl	NO3	SO4	Al	B	Ba
.25		87.30				30		33.10	10	< 1
1		70.90				< 10		96.50	8.20	< 1
2		67.30				< 10		120	< 8	< 1
4		133				< 10		57.20	19.10	1.30
8		130				< 10		114	13.20	2.50
16		118				< 10		23.30	11.60	< 1
32		45.80				< 10		31.60	< 8	< 1
pD_e (-log[m^2/s]) :	-	-	-	-	-	-	-	-	-	-
Standard deviation :	-	-	-	-	-	-	-	-	-	-
Used data points :	-	-	-	-	-	-	-	-	-	-
Slope :	-	(.2)	-	-	-	-	-	(.1)	-	-
Std.Dev. of slope :		(.14)						(.23)		
Deviat.slope=1 (3 fases):		≈ - -						+ - -	≈ - -	? + ?
Wash-off(mg/m^2),Diss/Lag:										
Total Concentrat.(mg/kg):	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
Availability (mg/kg):	(.00)	(.00)	-	-	(.00)	-	(.00)	-	-	(.00)
Availability perc. (%):	(20)	(20)	-	-	(20)	-	(100)	-	-	(20)
Mean factor above DTL :	-	-	-	-	-	-	-	-	-	-
Max.Cum.release (mg/m^2):	(.0)	(.0)	-	-	(.0)	-	(.0)	-	-	(.0)
Cum.release 32d. (mg/m^2):	-	-	-	-	-	-	-	-	-	-
Leaching-perc. 32d. (%):	-	-	-	-	-	-	-	-	-	-
Mean factor above DTL :	-	-	-	-	-	-	-	-	-	-
Cum.release calc. 1D 32d:	-	-	-	-	-	-	-	-	-	-
Cum.release calc. 3D 32d:	-	-	-	-	-	-	-	-	-	-
(mg/m^2)	Tortuosity (Na):		0	range:	- -					
Chemical Retention R:	-	-	-	-	-	-	-	-	-	-
$R_{range-min}$:	-	-	-	-	-	-	-	-	-	-
$R_{range-max}$:	-	-	-	-	-	-	-	-	-	-

All
Productcode: VOXL

Surf.area .0081 m^2 Bulk Density 1000 kg/m^3 (continued)
Weight 1 kg Extraction volume 6.49 L

Concentration in µg/L Time (days)	Ca	Cd	Cr	Cu	Fe	Mg	Ni	Pb	Si	Sr	Zn
.25	54.60		< 6		27.60	85.30		< 1	185		4
1	81.10		7.40		85.20	333		9.10	398		9.60
2	112		< 6		97.40	375		< 1	501		7.90
4	77.60		< 6		46.50	128		< 1	417		3.40
8	342		6.40		92.90	269		< 1	549		11.30
16	200		< 6		22	26.10		< 1	173		12
32	34.30		< 6		15.90	79.60		< 1	385		3.60
pD_e $(-\log[m^2/s])$:	-	-	-	-	-	-	-	-	-	-	-
Standard deviation :	-	-	-	-	-	-	-	-	-	-	-
Used data points :	-	-	-	-	-	-	-	-	-	-	-
Slope :	(.3)	-	-	-	(.1)	(.0)	-	-	(.3)	-	(.3)
Std.Dev. of slope :	(.24)				(.25)	(.29)			(.18)		(.18)
Deviat.slope=½ (3 fases):	+ ≈ -		? ? ?		+ - -	+ - -			+ - -		+ ≈ -
Wash-off(mg/m^2),Diss/Lag:											
Total Concentrat.(mg/kg):	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
Availability (mg/kg):	(.00)	(.00)	(.00)	(.00)	-	-	(.00)	(.00)	-	-	(.00)
Availability perc. (%):	(90)	(80)	(10)	(25)	-	-	(20)	(10)	-	-	(40)
Mean factor above DTL :	-	-	-	-	-	-	-	-	-	-	-
Max.Cum.release (mg/m^2):	(.0)	(.0)	(.0)	(.0)	-	-	(.0)	(.0)	-	-	(.0)
Cum.release 32d. (mg/m^2):	-	-	-	-	-	-	-	-	-	-	-
Leaching-perc. 32d. (%):	-	-	-	-	-	-	-	-	-	-	-
Mean factor above DTL :	-	-	-	-	-	-	-	-	-	-	-
Cum.release calc. 1D 32d:	-	-	-	-	-	-	-	-	-	-	-
Cum.release calc. 3D 32d: (mg/m^2)	-	-	-	-	-	-	-	-	-	-	-
Chemical Retention R:	-	-	-	-	-	-	-	-	-	-	-
$R_{range-min}$:	-	-	-	-	-	-	-	-	-	-	-
$R_{range-max}$:	-	-	-	-	-	-	-	-	-	-	-

All

Productcode: VOXL

Concentration in µg/L Time (days)	TDS	Na	TOC
.25	14000	87.30	930
1	< 30	70.90	650
2	< 30	67.30	580
4	< 30	133	n.a.
8	< 30	130	n.a.
16	< 30	118	n.a.
32	10000	45.80	n.a.
pD_e (-log[m^2/s]) :	-	-	-
Standard deviation :	-	-	-
Used data points :	-	-	-
Slope :	-	(.2)	-
Std.Dev. of slope :		(.14)	
Deviat.slope=½ (3 fases):	? ? ?	* - -	- ? ?
Wash-off(mg/m^2),Diss/Lag:			
Total Concentrat.(mg/kg):	.000	.000	.000
Availability (mg/kg):	(.00)	(.00)	(.00)
Availability perc. (%):	(100)	(20)	(100)
Mean factor above DTL :	-	-	-
Max.Cum.release (mg/m^2):	(.0)	(.0)	(.0)
Cum.release 32d. (mg/m^2):	-	-	-
Leaching-perc. 32d. (%):	-	-	-
Mean factor above DTL :	-	-	-
Cum.release calc. 1D 32d:	-	-	-
Cum.release calc. 3D 32d:	-	-	-
(mg/m^2)	Tortuosity	0	
Chemical Retention R:	-	-	-
$R_{range-min}$:	-	-	-
$R_{range-max}$:	-	-	-

Bottom Ash
Productcode: V08A

Surf.area: .0065 m^2 Bulk Density : 2137 kg/m^3 3 October 1991
Weight : 1.24 kg Extraction volume: 6.49 L

Concentration in µg/L Time (days)	K	Na	Li	Br	Cl	NO3	SO4	Al	B	Ba
.25	4700	4870		600	37600	120	< 22	99.40	13.80	7.60
1	19200	25000		1030	63200	50	< 22	155	12.70	40.10
2	7260	8190		900	56800	20	< 22	105	< 8	13.30
4	14900	20200		970	61200	20	< 22	297	< 8	42.20
8	20600	27400		2170	124000	20	600	329	11.40	52.40
16	29200	37700		2770	172000	< 10	790	499	22.70	75.60
32	35500	46100		2880	175000	20	880	605	8.70	88.20
pD_e (-log[m^2/s]) :	9.64	9.80	-	9.50	10.19	11.23	> 15.0	13.65	-	12.20
Standard deviation :	.07	.08	-	.20	.14	.30	1.28	.12	-	.11
Used data points :	4 - 7	4 - 7	-	4 - 7	2 - 7	3 - 5	1 - 7	4 - 7	-	4 - 7
Slope :	.43	.40	-	.51	.49	.00	-	.37	-	.37
Std.Dev. of slope :	.03	.03		.18	.06	.00		.06		.04
Deviat.slope=½ (3 fases):	+ + ≈	+ + ≈		+ + −	+ ≈ −	− − −	? + +	+ + ≈	≈ + ≈	+ + ≈
Wash-off(mg/m^2),Diss/Lag:	≈	≈		(Lag)	(Lag)	135.6	(Lag)	(Lag)		(Lag)
Total Concentrat.(mg/kg):	9367	19480	10.15	324.9	16244	39.59	2944	31472	.000	568.5
Availability (mg/kg):	4467	7107	< 4.06	324.9	44670	39.59	28020	7919	-	223.4
Availability perc. (%):	47.69	36.48	< 40.00	100.00	275.00	100.00	951.72	25.16	-	39.29
Mean factor above DTL :	45	237	(DTL)	6	447	40	280	1584	-	64
Max.Cum.release (mg/m^2):	852166	1355797	< 774.5	61981	8521662	7553	5345354	1510702	-	42618
Cum.release 32d. (mg/m^2):	131158	169199	-	11303	688739	260	< 2354	2086	-	319
Leaching-perc. 32d. (%):	15.4	12.5	-	18.2	8.1	3.4	< .04	.1	-	.7
Mean factor above DTL :	25	807	-	3.2	197	3.7	15	27	-	46
Cum.release calc. 1D 32d:	136163	179558	-	11607	717518	193	< 1733	2376	-	355
Cum.release calc. 3D 32d:	608686	860162	-	48208	3849141	1179	< 11476	15306	-	2213
(mg/m^2)	Tortuosity (Na):		8	range:	6 - 9					
Chemical Retention R:	1.1	1.0	-	.77	3.8	39	149447	2619	-	175
$R_{range-min}$:	.94	.83	-	.49	2.7	19	7905	1982	-	136
$R_{range-max}$:	1.3	1.2	-	1.2	5.2	77	2825235	3462	-	224
pD_e for R=1 will be ≥				9.6		9.6				
Availability(%) becomes ≥				114.0		16.1				

Bottom Ash — Surf.area .0065 m^2 — Bulk Density 2137 kg/m^3 — (continued)
Productcode: V08A — Weight 1.24 kg — Extraction volume 6.49 L

Concentration in µg/L Time (days)	Ca	Cd	Cr	Cu	Fe	Mg	Ni	Pb	Si	Sr	Zn
.25	3400		< 6	7.40	52.10	108		3.70	262	26.60	19.80
1	19900		< 6	< 5	37	127		4.30	504	156	20.30
2	6100		< 6	< 5	38.80	86.60		4.10	241	46.10	20.30
4	17100		< 6	9.60	53.30	113		3.20	284	134	20.40
8	21600		< 6	< 5	35.20	93		2.60	388	171	16.80
16	33000		< 6	< 5	38.60	77.20		2.90	556	246	10
32	41000		6.70	9.60	95.50	405		2.70	662	298	15.30
pD_e (-log[m^2/s]) :	11.81	-	> 12.7	> 14.3	13.48	> 13.5	-	14.85	13.93	> 11.2	14.80
Standard deviation :	.06	-	-	.50	.24	.43	-	.13	.08	.09	.10
Used data points :	4 - 7	-	1 - 7	1 - 7	5 - 7	1 - 7	-	1 - 3	4 - 7	4 - 7	1 - 3
Slope :	.44	-	-	-	.72	.37	-	.64	.42	.40	.59
Std.Dev. of slope :	.04				.34	.12		.02	.04	.03	.06
Deviat.slope=½ (3 fases):	+ + ≈			? ? ?	≈ − +	≈ − +		+ − −	+ ≈ ≈	+ + ≈	≈ − −
Wash-off(mg/m^2),Diss/Lag:	≈		(Lag)	(Lag)	45.82	?≈		≈	?≈	≈	≈
Total Concentrat.(mg/kg):	111391	41.62	182.7	1827	74627	.000	507.6	1624	114636	.000	4873
Availability (mg/kg):	60914	32.49	26.40	467.0	670.0	(2639.6)	71.07	640.0	11777	(223.4)	3046
Availability perc. (%):	54.68	78.06	14.45	25.56	.90	#VALUE!	14.00	39.40	10.27	#VALUE!	62.50
Mean factor above DTL :	1218	162	13	234	670	-	18	640	589	-	1523
Max.Cum.release (mg/m^2):	11620517	6198	5036	89089	127815	(503554)	13558	122092	2246689	(42618)	581083
Cum.release 32d. (mg/m^2):	141881	-	< 43	< 47	350	1008	-	23	2893	1076	123
Leaching-perc. 32d. (%):	1.2	-	< .9	< .05	.3	.2	-	.02	.1	2.5	.02
Mean factor above DTL :	1015	-	(DTL)	(DTL)	10	144	-	3.3	19	77	9
Cum.release calc. 1D 32d:	152435	-	< 23	< 63	244	< 957	-	48	2573	< 1161	242
Cum.release calc. 3D 32d: (mg/m^2)	957786	-	< 151	< 428	1571	< 6058	-	313	16592	< 6867	1564
Chemical Retention R:	61	-	414	22190	2554	2576	-	86037	-	-	64673
$R_{range-min}$:	52	-	-	7052	1459	954	-	64319	-	-	51227
$R_{range-max}$:	70	-	-	69817	4472	6955	-	115090	-	-	81649

pD_e for R=1 will be ≥
Availability(%) becomes ≥

Bottom Ash
Productcode: VOBA

Concentration in µg/L Time (days)	TDS	Na	TOC
.25	86000	4870	1110
1	131000	25000	900
2	87000	8190	660
4	121000	20200	670
8	246000	27400	n.a.
16	304000	37700	640
32	335000	46100	n.a.
pD_e (-log[m^2/s]) :	-	9.80	-
Standard deviation :	-	.08	-
Used data points :	-	4 - 7	-
Slope :	(.5)	.40	(.3)
Std.Dev. of slope :	(.05)	.03	(.05)
Deviat.slope=½ (3 fases):	+ + -	+ + =	- - ?
Wash-off(mg/m^2),Diss/Lag:	69555	=	227
Total Concentrat.(mg/kg):	.000	19480	.000
Availability (mg/kg):	(.00)	7107	(.00)
Availability perc. (%):	(100)	36.48	(100)
Mean factor above DTL :	-	237	-
Max.Cum.release (mg/m^2):	(.0)	1355797	(.0)
Cum.release 32d. (mg/m^2):	-	169199	-
Leaching-perc. 32d. (%):	-	12.5	-
Mean factor above DTL :	-	807	-
Cum.release calc. 1D 32d:	-	179558	-
Cum.release calc. 3D 32d:	-	860162	-
(mg/m^2)	Tortuosity	8	
Chemical Retention R:	-	1.0	-
$R_{range-min}$:	-	.83	-
$R_{range-max}$:	-	1.2	-

Bottom Ash
Productcode: V08B

Surf.area: .0061 m^2 Bulk Density : 2359 kg/m^3 3 October 1991
Weight : 1.28 kg Extraction volume: 6.49 L

Concentration in µg/L Time (days)	K	Na	Li	Br	Cl	NO3	SO4	Al	B	Ba
.25	6180	7370		630	47900	40		77	11.60	11
1	19000	23500		930	68900	30		70.50	< 8	36.90
2	10500	12400		820	61400	20		145	< 8	24.10
4	12900	16300		650	48500	< 10		176	19.90	38.70
8	23000	28100		1540	117000	< 10		256	8.40	64.90
16	27100	32000		2200	159000	< 10		386	< 8	80.40
32	36300	44200		2420	163000	< 10		466	9.70	109
pD_e (-log[m^2/s]) :	9.59	9.58	-	9.34	9.75	10.03	-	12.73	-	11.33
Standard deviation :	.09	.08	-	.20	.21	.13	-	.06	-	.07
Used data points :	3 - 7	3 - 7	-	1 - 7	2 - 6	2 - 3	-	3 - 6	-	4 - 7
Slope :	.47	.46	-	.53	.49	.19	-	.48	-	.48
Std.Dev. of slope :	.05	.05		.06	.13	?		.05		.06
Deviat.slope=i (3 fases):	+ = -	+ = -		+ = -	+ = -	- ? ?		+ = =	? - -	+ = =
Wash-off(mg/m^2),Diss/Lag:	=	=		=	=	17.21		(Lag)		(Lag)
Total Concentrat.(mg/kg):	9367	19480	8.12	203.1	13198	15.23	2234	32487	.000	548.2
Availability (mg/kg):	4061	4873	< 4.06	203.1	25787	15.23	29239	2030	-	87.31
Availability perc. (%):	43.35	25.02	< 50.00	100.00	195.38	100.00	1309.1	6.25	-	15.93
Mean factor above DTL :	41	162	(DTL)	4	258	15	292	406	-	25
Max.Cum.release (mg/m^2):	852144	1022531	< 851.9	42618	5411043	3196	6135397	425967	-	18321
Cum.release 32d. (mg/m^2):	143610	174347	-	9778	708261	< 138	-	1677	-	388
Leaching-perc. 32d. (%):	16.9	17.1	-	22.9	13.1	< 4.3	-	.4	-	2.1
Mean factor above DTL :	26	780	-	2.6	190	1.9	-	20	-	52
Cum.release calc. 1D 32d:	144053	174664	-	9601	761455	324	-	1936	-	418
Cum.release calc. 3D 32d: (mg/m^2)	627200	756929	-	35846	3565439	1666	-	12346	-	2565
	Tortuosity (Na):		5	range:	4 - 6					
Chemical Retention R:	1.6	1.0	-	.88	2.2	4.1	-	522	-	39
$R_{range-min}$:	1.3	.82	-	.56	1.4	3.0	-	455	-	33
$R_{range-max}$:	2.0	1.2	-	1.4	3.6	5.5	-	598	-	46
pD_e for R=1 will be ≥				9.4		9.4				
Availability(%) becomes ≥				106.3		49.6				

Bottom Ash — Surf.area .0061 m² — Bulk Density 2359 kg/m³ (continued)
Productcode: V08B — Weight 1.28 kg — Extraction volume 6.49 L

Concentration in µg/L Time (days)	Ca	Cd	Cr	Cu	Fe	Mg	Ni	Pb	Si	Sr	Zn
.25	5570		6.20	5.70	42.20	110		4.30	309	48.60	10.90
1	16700		< 6	7.40	28.20	80.20		1.90	781	153	10.20
2	9050		< 6	< 5	52.80	220		1.70	446	81.80	9.40
4	12500		< 6	< 5	44.80	23.30		< 1	494	113	18.20
8	20400		< 6	< 5	51.20	27.90		6.30	188	184	25.30
16	25800		< 6	< 5	35.70	60.60		2.40	266	216	12
32	36700		< 6	9.60	23.40	66.70		1.70	270	305	10.70
pD_e (-log[m^2/s]) :	12.25	-	> 9.9	> 13.6	13.40	> 14.1	-	15.24	13.42	> 10.8	14.75
Standard deviation :	.05	-	-	.42	.28	.93	-	.05	.17	.07	.05
Used data points :	3 - 7	-	1 - 7	1 - 7	1 - 5	1 - 7	-	2 - 3	5 - 7	3 - 7	1 - 3
Slope :	.51	-	-	-	.46	.04	-	.61	.26	.47	.51
Std.Dev. of slope :	.03				.14	.20		?	.14	.04	.05
Deviat.slope=½ (3 fases):	+ ≈ ≈			+ ? ?	+ - -	+ - +		- - -	+ - -	+ ≈ ≈	≈ - -
Wash-off(mg/m^2),Diss/Lag:	≈		(Lag)	?≈	≈	≈110.3		2.39	?≈	≈	≈
Total Concentrat.(mg/kg):	111391	29.44	213.2	2335	74627	.000	436.6	1117	114636	.000	4873
Availability (mg/kg):	81218	17.87	< 3.05	162.4	1056	(2639.6)	13.81	450.0	2843	(136.0)	1401
Availability perc. (%):	72.91	60.70	< 1.43	6.96	1.41	#VALUE!	3.16	40.30	2.48	#VALUE!	28.75
Mean factor above DTL :	1624	89	(DTL)	81	1056	-	3	450	142	-	701
Max.Cum.release (mg/m^2):	17042466	3750	< 640.0	34077	221587	(553883)	2898	94426	596564	(28538)	293980
Cum.release 32d. (mg/m^2):	134822	-	< 45	< 45	296	626	-	21	2930	1172	103
Leaching-perc. 32d. (%):	.8	-	< 7.0	< .1	.1	.1	-	.02	.5	4.1	.04
Mean factor above DTL :	905	-	(DTL)	(DTL)	8	84	-	2.8	18	79	7
Cum.release calc. 1D 32d:	134626	-	< 75	< 60	469	< 549	-	24	1223	< 1178	130
Cum.release calc. 3D 32d: (mg/m^2)	852498	-	< 374	< 366	3006	< 3347	-	153	7845	< 7044	837
Chemical Retention R:	278	-	1.0	6061	3460	15770	-	355262	-	-	95467
$R_{range-min}$:	249	-	-	2302	1828	1855	-	318607	-	-	85727
$R_{range-max}$:	311	-	-	15958	6549	134047	-	396133	-	-	106314

pD_e for R=1 will be ≥
Availability(%) becomes ≥

Bottom Ash
Productcode:

Concentration in µg/L Time (days)	VOBB TDS	VOBB Na	VOBB TOC
.25	97000	7370	1000
1	145000	23500	930
2	106000	12400	630
4	134000	16300	580
8	227000	28100	n.a.
16	290000	32000	540
32	308000	44200	n.a.

pD_e (-log[m^2/s]) :	-	9.58	-
Standard deviation :	-	.08	-
Used data points :	-	3 - 7	-
Slope :	(.5)	.46	(.3)
Std.Dev. of slope :	(.04)	.05	(.09)
Deviat.slope=½ (3 fases):	+ ≈ -	+ ≈ -	≈ - ?
Wash-off(mg/m^2),Diss/Lag:	59862	≈	27[illegible] 11 978 - [illegible]
Total Concentrat.(mg/kg):	.000	19480	.000
Availability (mg/kg):	(.00)	4873	(.00)
Availability perc. (%):	(100)	25.02	(100)
Mean factor above DTL :	-	162	-
Max.Cum.release (mg/m^2):	(.0)	1022531	(.0)
Cum.release 32d. (mg/m^2):	-	174347	-
Leaching-perc. 32d. (%):	-	17.1	-
Mean factor above DTL :	-	780	-
Cum.release calc. 1D 32d:	-	174664	-
Cum.release calc. 3D 32d: (mg/m^2)	-	756929	-
	Tortuosity	5	
Chemical Retention R:	-	1.0	-
$R_{range-min}$:	-	.82	-
$R_{range-max}$:	-	1.2	-

Bottom Ash — Surf.area: .0065 m^2 — Bulk Density : 2165 kg/m^3 — 3 October 1991
Productcode: VOBC — Weight : 1.27 kg — Extraction volume: 6.49 L

Concentration in µg/L Time (days)	K	Na	Li	Br	Cl	NO3	SO4	Al	B	Ba
.25	7100	8210	< 5	780	57100	50		82.80	< 8	11.80
1	19900	24500	< 5	1080	80800	30		78.50	11.40	41.90
2	11600	13800	< 5	720	51500	20		112	< 8	28.80
4	16100	19700	< 5	690	53500	20		176	8.20	45.30
8	20600	24600	< 5	1800	120000	20		211	16.40	55.30
16	27800	32000	< 5	2080	148000	20		263	< 8	76.10
32	36500	43500	5.30	2280	160000	20		368	< 8	101
pD_e (-log[m^2/s]) :	9.34	9.55	> 11.3	9.52	9.77	11.06	-	13.99	-	11.56
Standard deviation :	.09	.10	-	.20	.19	.64	-	.11	-	.08
Used data points :	3 - 7	3 - 7	1 - 7	1 - 7	2 - 6	1 - 7	-	3 - 7	-	3 - 7
Slope :	.41	.40	-	.48	.45	.06	-	.40	-	.44
Std.Dev. of slope :	.01	.02		.06	.11	.02		.04		.03
Deviat.slope=1 (3 fases):	+ ≈ ≈	+ ≈ ≈		≈ ≈ -	≈ ≈ -	- - -		+ ≈ ≈	? + ?	+ ≈ ≈
Wash-off(mg/m^2),Diss/Lag:	≈	≈	(Lag)	≈	≈	46.24		(Lag)		(Lag)
Total Concentrat.(mg/kg):	9367	19480	8.21	266.7	21538	31.79	40000	30769	.000	543.6
Availability (mg/kg):	3282	4923	< 4.10	266.7	27282	31.79	30769	6974	-	112.8
Availability perc. (%):	35.04	25.27	< 49.94	100.00	126.67	100.00	76.92	22.67	-	20.75
Mean factor above DTL :	33	164	(DTL)	5	273	32	308	1395	-	32
Max.Cum.release (mg/m^2):	641252	961878	< 801.1	52109	5330483	6211	6011789	1362612	-	22039
Cum.release 32d. (mg/m^2):	139385	166054	< 35	9415	669868	180	-	1289	-	360
Leaching-perc. 32d. (%):	21.7	17.3	< 4.4	18.1	12.6	2.9	-	.09	-	1.6
Mean factor above DTL :	27	792	(DTL)	2.7	192	2.6	-	17	-	52
Cum.release calc. 1D 32d:	141887	168822	< 18	9448	719643	190	-	1428	-	382
Cum.release calc. 3D 32d:	538645	728032	< 116	40103	3450619	1162	-	9308	-	2405
(mg/m^2)	Tortuosity (Na):		4	range:	3 - 5					
Chemical Retention R:	1.0	1.0	-	1.4	2.6	47	-	10367	-	71
$R_{range-min}$:	.82	.80	-	.92	1.7	11	-	8030	-	59
$R_{range-max}$:	1.2	1.3	-	2.3	4.0	206	-	13385	-	85
pD_e for R=1 will be ≥				9.4		9.4				
Availability(%) becomes ≥				83.3		14.6				

Bottom Ash — Surf.area .0065 m^2 — Bulk Density 2165 kg/m^3 (continued)
Productcode: V0BC — Weight 1.27 kg — Extraction volume 6.49 L

Concentration in µg/L Time (days)	Ca	Cd	Cr	Cu	Fe	Mg	Ni	Pb	Si	Sr	Zn
.25	6080		< 7.80	< 5	41.60	159		1.40	365	55.40	10.50
1	17200		< 6	< 5	18.10	42.20		1.70	567	164	8.50
2	10100		< 6	7.40	38.30	146		< 1	407	93	10.90
4	14600		< 6	< 5	26.30	58.50		< 1	386	134	5.10
8	16800		< 6	< 5	42.60	138		1.10	659	159	17.10
16	24800		< 6	12.30	17.30	25.70		1.90	256	214	27.40
32	35500		< 6	5.20	< 5	32.40		< 1	275	298	8.60
pD_e (-log[m^2/s]) :	12.20	-	> 10.7	> 14.6	13.93	> 14.6	-	> 16.6	14.31	> 10.7	15.76
Standard deviation :	.08	-	-	.77	.08	1.01	-	.12	.17	.10	.34
Used data points :	3 - 7	-	1 - 7	1 - 7	4 - 5	1 - 7	-	5 - 6	6 - 7	3 - 7	1 - 6
Slope :	.44	-	-	-	.70	-.04	-	(.8)	.10	.40	.49
Std.Dev. of slope :	.03				?	.20		?	?	.02	.13
Deviat.slope=½ (3 fases):	+ ≈ ≈			? ≈ -	≈ - -	≈ - -		+ + +	+ - -	+ ≈ ≈	≈ ≈ -
Wash-off(mg/m^2),Diss/Lag:	≈		(Lag)	(Lag)	11.62	≈101.2		≈1.62	?≈	≈	≈
Total Concentrat.(mg/kg):	111391	35.90	194.9	2154	74627	.000	348.7	1949	114636	.000	4718
Availability (mg/kg):	77949	32.82	10.26	451.3	1231	(5538.5)	61.54	820.5	7590	(125.1)	3897
Availability perc. (%):	69.98	91.42	5.27	20.95	1.65	#VALUE!	17.65	42.11	6.62	#VALUE!	82.61
Mean factor above DTL :	1559	164	5	226	1231	-	15	821	379	-	1949
Max.Cum.release (mg/m^2):	15230035	6413	2005	88177	240518	(1082138)	12024	160313	1482969	(24443)	761414
Cum.release 32d. (mg/m^2):	124888	-	< 44	< 45	189	601	-	< 9.1	2911	1116	88
Leaching-perc. 32d. (%):	.8	-	< 2.2	< .05	.08	.06	-	< .01	.2	4.6	.01
Mean factor above DTL :	893	-	(DTL)	(DTL)	5	86	-	(DTL)	19	80	6
Cum.release calc. 1D 32d:	126295	-	< 88	< 47	271	< 534	-	< 8.3	1076	< 1132	104
Cum.release calc. 3D 32d: (mg/m^2)	810497	-	< 549	< 300	1769	< 3680	-	< 55	7019	< 6693	681
Chemical Retention R:	266	-	7.7	68186	12843	67075	-	8890502	-	-	1053076
$R_{range-min}$:	222	-	-	11472	10601	6513	-	6700506	-	-	477383
$R_{range-max}$:	320	-	-	405289	15561	690758	-	11796276	-	-	2323018

pD_e for R=1 will be ≥
Availability(%) becomes ≥

Bottom Ash
Productcode:

Concentration in µg/L Time (days)	VOBC TDS	VOBC Na	VOBC TOC
.25	110000	8210	1140
1	175000	24500	970
2	106000	13800	710
4	114000	19700	680
8	200000	24600	640
16	255000	32000	720
32	348000	43500	n.a.

pD_e (-log[m^2/s]) :	-	9.56	-
Standard deviation :	-	.10	-
Used data points :	-	3 - 7	-
Slope :	(.5)	.40	(.3)
Std.Dev. of slope :	(.05)	.02	(.07)
Deviat.slope=½ (3 fases):	+ ≈ ≈	+ ≈ ≈	≈ - -
Wash-off(mg/m^2),Diss/Lag:		≈	
	60619		708 10 769-7.1.
Total Concentrat.(mg/kg):	.000	19480	.000
Availability (mg/kg):	(.00)	4923	(.00)
Availability perc. (%):	(100)	25.27	(100)
Mean factor above DTL :	-	164	-
Max.Cum.release (mg/m^2):	(.0)	947305	(.0)
Cum.release 32d. (mg/m^2):	-	163538	-
Leaching-perc. 32d. (%):	-	17.3	-
Mean factor above DTL :	-	792	-
Cum.release calc. 1D 32d:	-	166264	-
Cum.release calc. 3D 32d: (mg/m^2)	-	711261	-
	Tortuosity	4	
Chemical Retention R:	-	1.0	-
$R_{range-min}$:	-	.80	-
$R_{range-max}$:	-	1.3	-

Combined Ash
Productcode: VOCA

Surf.area: .0065 m^2 Bulk Density : 2127 kg/m^3 3 October 1991
Weight : 1.22 kg Extraction volume: 6.49 L

Concentration in µg/L Time (days)	K	Na	Li	Br	Cl	NO3	SO4	Al	B	Ba
.25	13200	11800		560	50400	30	< 500	84.30	15.80	11.50
1	26100	24500		830	79600	50	< 500	85.70	11.60	36.40
2	12400	10500		620	59100	30	< 500	135	< 8	22.60
4	21200	19300		940	86100	< 10	< 500	241	< 8	46.90
8	29700	26700		1700	136000	< 10	560	293	10.60	66.50
16	40100	35200		1920	177000	< 10	790	469	< 8	102
32	48200	43800		2180	185000	< 10	870	514	< 8	131
pD_e (-log[m^2/s]) :	9.51	9.58	-	9.38	9.86	9.32	> 14.7	13.02	-	11.74
Standard deviation :	.09	.10	-	.13	.12	.22	.13	.11	-	.04
Used data points :	3 - 7	3 - 7	-	2 - 7	2 - 7	1 - 3	1 - 7	3 - 7	-	4 - 7
Slope :	.48	.50	-	.47	.44	.63	-	.48	-	.51
Std.Dev. of slope :	.05	.06		.05	.04	.21		.06		.03
Deviat.slope=½ (3 fases):	+ ≈ -	+ ≈ ≈		+ ≈ -	+ ≈ -	+ ? ?	? + +	+ ≈ ≈	- ? ?	+ + ≈
Wash-off(mg/m^2),Diss/Lag:	≈	?≈		≈	≈	≈	(Lag)	(Lag)		(Lag)
Total Concentrat.(mg/kg):	13020	21309	8.15	224.3	21407	9.79	519.9	27523	.000	937.8
Availability (mg/kg):	5301	5097	< 4.08	224.3	35091	9.79	38742	3262	-	171.3
Availability perc. (%):	40.71	23.92	< 50.06	100.00	163.93	100.00	7452.2	11.85	-	18.26
Mean factor above DTL :	53	170	(DTL)	4	351	10	387	652	-	49
Max.Cum.release (mg/m^2):	994957	956668	< 765.8	42099	6586311	1838	7271575	612252	-	32152
Cum.release 32d. (mg/m^2):	190606	171536	-	8737	772010	< 150	< 4214	1819	-	416
Leaching-perc. 32d. (%):	19.2	17.9	-	20.8	11.7	< 8.2	< .06	.3	-	1.3
Mean factor above DTL :	36	818	-	2.5	221	2.1	(DTL)	24	-	60
Cum.release calc. 1D 32d:	185959	165166	-	9115	818265	428	< 3507	2023	-	461
Cum.release calc. 3D 32d: (mg/m^2)	768736	709206	-	34757	3966230	1560	< 22047	12833	-	2855
	Tortuosity (Na):		5	range:	4 - 6					
Chemical Retention R:	1.4	1.0	-	.98	2.9	.79	114734	1009	-	100
$R_{range-min}$:	1.1	.79	-	.73	2.2	.47	85830	788	-	92
$R_{range-max}$:	1.7	1.3	-	1.3	3.9	1.3	153372	1292	-	110
pD_e for R=1 will be ≥				9.4		9.4				
Availability(%) becomes ≥				101.1		112.7				

409

Combined Ash Surf.area .0065 m^2 Bulk Density 2127 kg/m^3 (continued)
Productcode: VOCA Weight 1.22 kg Extraction volume 6.49 L

Concentration in µg/L Time (days)	Ca	Cd	Cr	Cu	Fe	Mg	Ni	Pb	Si	Sr	Zn
.25	8430			8.20	59	59.50		1.20	341	74.40	13
1	18600			25.40	15.40	45.60		< 1	574	165	16
2	7880			8.20	38.30	119		< 1	306	69.50	5.80
4	14400			11.20	37.70	121		2.80	421	131	12
8	18700			7.20	20.30	21.40		< 1	176	173	6.10
16	28100			15.60	19.90	37.50		1.40	254	247	4.40
32	35900			20.10	30.50	124		< 1	442	320	5.40
pD_e (-log[m^2/s]) :	12.24	-	-	14.22	13.59	> 15.0	-	> 15.7	13.55	> 10.9	15.49
Standard deviation :	.09	-	-	.19	.17	.82	-	.60	.11	.10	.31
Used data points :	3 - 7	-	-	5 - 7	5 - 7	4 - 7	-	1 - 6	5 - 7	3 - 7	1 - 4
Slope :	.53	-	-	.74	.29	.09	-	-	.66	.53	.35
Std.Dev. of slope :	.05			.22	.19	.69			.08	.06	.18
Deviat.slope=½ (3 fases):	+ ≈ ≈			+ - +	- - -	+ - +		? - ?	≈ - +	+ ≈ ≈	- - -
Wash-off(mg/m^2),Diss/Lag:	?≈			?≈	54.60	≈48.09		(Lag)	?≈	≈	?≈
Total Concentrat.(mg/kg):	121260	31.60	58.10	1529	67200	.000	112.1	825.7	132600	.000	3772
Availability (mg/kg):	83588	30.58	< 2.45	407.8	346.6	(5096.8)	18.76	489.3	3874	(167.2)	3466
Availability perc. (%):	68.93	96.77	< 4.22	26.67	.52	#VALUE!	16.73	59.26	2.92	#VALUE!	91.89
Mean factor above DTL :	1672	153	(DTL)	204	347	-	5	489	194	-	1733
Max.Cum.release (mg/m^2):	15688825	5740	< 459.8	76541	65054	(956630)	3521	91838	727120	(31382)	650542
Cum.release 32d. (mg/m^2):	131807	-	-	96	221	527	-	< 9.4	2510	1178	63
Leaching-perc. 32d. (%):	.8	-	-	.1	.3	.06	-	< .01	.3	3.8	.01
Mean factor above DTL :	943	-	-	2.7	6	75	-	(DTL)	16	84	4.5
Cum.release calc. 1D 32d:	125822	-	-	63	111	< 338	-	< 14	1303	< 1129	125
Cum.release calc. 3D 32d: (mg/m^2)	790309	-	-	403	709	< 2054	-	< 88	8297	< 6973	798
Chemical Retention R:	275	-	-	27845	5402	126807	-	1061336	-	-	518312
$R_{range-min}$:	225	-	-	17779	3675	19136	-	265332	-	-	254978
$R_{range-max}$:	337	-	-	43610	7941	840281	-	4245380	-	-	1053611

pD_e for R=1 will be ≥
Availability(%) becomes ≥

Combined Ash
Productcode: VOCA

Concentration in µg/L Time (days)	TDS	Na	TOC
.25	130000	11800	1570
1	143000	24500	1830
2	105000	10500	1300
4	162000	19300	1560
8	235000	26700	1880
16	302000	35200	1860
32	361000	43800	1160

pD_e $(-\log[m^2/s])$:	-	9.58	> 12.3
Standard deviation :	-	.10	.11
Used data points :	-	3 - 7	1 - 4
Slope :	(.5)	.50	(.4)
Std.Dev. of slope :	(.02)	.06	(.07)
Deviat.slope=½ (3 fases):	¤ ¤ -	+ ¤ ¤	¤ - -
Wash-off(mg/m^2),Diss/Lag:	6 7960	?¤	¤ 753 -Avail
Total Concentrat.(mg/kg):	.000	21309	13245
Availability (mg/kg):	(.00)	5097	(13245.0)
Availability perc. (%):	(100)	23.92	(100)
Mean factor above DTL :	-	170	-
Max.Cum.release (mg/m^2):	(.0)	956668	(2485985)
Cum.release 32d. (mg/m^2):	-	171536	11143
Leaching-perc. 32d. (%):	-	17.9	.4
Mean factor above DTL :	-	818	-
Cum.release calc. 1D 32d:	-	165166	< 17682
Cum.release calc. 3D 32d:	-	709206	< 117647
(mg/m^2)	Tortuosity	5	
Chemical Retention R:	-	1.0	481
$R_{range-min}$:	-	.79	371
$R_{range-max}$:	-	1.3	624

411

Combined Ash
Productcode: VOCB

Surf.area: .0069 m^2 Bulk Density : 2055 kg/m^3 3 October 1991
Weight : 1.26 kg Extraction volume: 6.49 L

Concentration in µg/L Time (days)	K	Na	Li	Br	Cl	NO3	SO4	Al	B	Ba
.25	13200	12200		< 500	33200	30	< 500	41.10	10.30	19.60
1	23100	21100		850	74500	< 10	< 500	230	< 8	42.70
2	15000	12800		750	70800	< 10	< 500	112	< 8	31.60
4	17500	15200		1000	89200	20	< 500	206	18	44.20
8	32900	30300		1640	128000	< 10	< 500	326	< 8	90.10
16	40700	36000		1970	176000	< 10	< 500	425	21.30	114
32	49300	44500		2260	186000	< 10	570	368	< 8	140
pD_e ($-\log[m^2/s]$) :	9.63	9.74	-	9.15	9.76	> 10.5	> 15.1	13.13	-	11.22
Standard deviation :	.11	.12	-	.06	.05	.79	-	.17	-	.12
Used data points :	3 - 7	3 - 7	-	1 - 6	2 - 6	1 - 7	1 - 7	2 - 6	-	2 - 7
Slope :	.47	.48	-	-	.49	-	-	.49	-	.54
Std.Dev. of slope :	.06	.07			.03			.10		.05
Deviat.slope=½ (3 fases):	+ ≈ −	+ ≈ −		+ ≈ −	+ ≈ −	? ? ?		+ + −	? ≈ ?	+ + −
Wash-off(mg/m^2),Diss/Lag:	≈	≈		(Lag)	(Lag)	≈8.71	(Lag)	(Lag)		(Lag)
Total Concentrat.(mg/kg):	13020	21209	9.16	183.3	1629	10.18	1527	27495	.000	529.5
Availability (mg/kg):	6110	6110	< 4.07	183.3	32587	10.18	33605	3666	-	97.76
Availability perc. (%):	46.93	28.81	< 44.43	100.00	2000.0	100.00	2200.0	13.33	-	18.46
Mean factor above DTL :	61	204	(DTL)	4	326	10	336	733	-	28
Max.Cum.release (mg/m^2):	1115739	1115739	< 743.2	33472	5950670	1859	6136565	669443	-	17852
Cum.release 32d. (mg/m^2):	180309	161874	-	8437	712677	< 94	< 3358	1607	-	454
Leaching-perc. 32d. (%):	16.2	14.5	-	25.2	12.0	< 5.1	< .05	.2	-	2.5
Mean factor above DTL :	37	820	-	2.6	216	(DTL)	(DTL)	22	-	69
Cum.release calc. 1D 32d:	180082	159496	-	9431	825734	< 114	< 1830	1928	-	464
Cum.release calc. 3D 32d:	799494	742201	-	30167	3882652	< 624	< 11745	12328	-	2822
(mg/m^2)	Tortuosity (Na):		7	range:	5 - 9					
Chemical Retention R:	1.3	1.0	-	.40	1.6	7.8	205607	910	-	21
$R_{range-min}$:	.98	.76	-	.35	1.4	1.3	-	618	-	16
$R_{range-max}$:	1.6	1.3	-	.45	1.8	47	-	1341	-	28
pD_e for R=1 will be ≥				9.5						
Availability(%) becomes ≥				158.9						

Combined Ash
Productcode: VOCB

Surf.area .0069 m^2 Bulk Density 2055 kg/m^3 (continued)
Weight 1.26 kg Extraction volume 6.49 L

Concentration in µg/L Time (days)	Ca	Cd	Cr	Cu	Fe	Mg	Ni	Pb	Si	Sr	Zn
.25	9350		< 6	6.60	16.50	58	< 12	1.40	231	88	8.50
1	16300		7.20	5.70	127	464	< 12	< 1	970	151	7.40
2	9790		< 6	< 5	31.70	119	< 12	< 1	257	88.60	3.20
4	10600		< 6	11.20	76.90	170	< 12	< 1	345	101	29.50
8	22900		< 6	10.40	16.90	12.10	< 12	< 1	512	213	9.90
16	30000		< 6	17.20	30.90	24.30	< 12	< 1	439	262	4.90
32	38000		< 6	24.40	37.40	145	< 12	< 1	344	329	2.40
pD_e (-log[m^2/s]) :	12.11	-	> 9.4	13.61	14.65	> 14.1	> 10.4	> 15.3	12.63	> 10.8	15.29
Standard deviation :	.14	-	-	.15	.11	1.29	-	-	.03	.13	.60
Used data points :	3 - 7	-	1 - 7	4 - 7	5 - 7	1 - 7	1 - 7	1 - 7	3 - 5	3 - 7	1 - 5
Slope :	.54	-	-	.41	.57	.03	-	-	.50	.52	.55
Std.Dev. of slope :	.08			.12	.17	.34			.04	.08	.30
Deviat.slope=½ (3 fases):	+ ≈ ≈			≈ + +	+ − ≈	+ − +			+ − −	+ ≈ −	− − −
Wash-off(mg/m^2),Diss/Lag:	≈		(Lag)	≈	?≈	?≈	(Lag)	(Lag)	?≈	≈	≈
Total Concentrat.(mg/kg):	121260	24.44	65.17	2138	67200	.000	100.8	1222	132600	.000	3462
Availability (mg/kg):	73320	22.40	< 2.00	264.8	1344	(3462.3)	9.16	346.2	3462	(148.7)	1996
Availability perc. (%):	60.46	91.65	< 3.07	12.38	2.00	#VALUE!	9.09	28.33	2.61	#VALUE!	57.65
Mean factor above DTL :	1466	112	(DTL)	132	1344	-	2	346	173	-	998
Max.Cum.release (mg/m^2):	13388870	4090	< 365.2	48355	245426	(632246)	1673	63219	632191	(27154)	364487
Cum.release 32d. (mg/m^2):	128803	-	< 41	76	317	933	< 79	< 7.0	2914	1159	62
Leaching-perc. 32d. (%):	1.0	-	< 11.2	.2	.1	.1	< 4.7	< .01	.5	4.3	.02
Mean factor above DTL :	978	-	(DTL)	2.3	10	142	(DTL)	(DTL)	20	88	4.7
Cum.release calc. 1D 32d:	124246	-	< 77	80	122	< 602	< 109	< 15	3240	< 1124	87
Cum.release calc. 3D 32d: (mg/m^2)	783651	-	< 299	515	786	< 3820	< 620	< 96	20617	< 6703	560
Chemical Retention R:	141	-	.23	4725	43709	11942	2.5	283912	-	-	229606
$R_{range-min}$:	102	-	-	3334	33743	607	-	-	-	-	57082
$R_{range-max}$:	194	-	-	6697	56619	235097	-	-	-	-	923556

pD_e for R=1 will be ≥
Availability(%) becomes ≥

Combined Ash
Productcode: VOCB

Concentration in µg/L Time (days)	TDS	Na	TOC
.25	66000	12200	1460
1	157000	21100	1690
2	152000	12800	1520
4	134000	15200	1420
8	252000	30300	1880
16	334000	36000	2280
32	348000	44500	1460
pD_e (-log[m^2/s]) :	-	9.74	-
Standard deviation :	-	.12	-
Used data points :	-	3 - 7	-
Slope :	(.6)	.48	(.5)
Std.Dev. of slope :	(.09)	.07	(.11)
Deviat.slope=1 (3 fases):	+ * -	+ * -	+ - -
Wash-off(mg/m^2),Diss/Lag:	6465	*	675
Total Concentrat.(mg/kg):	.000	21209	.000
Availability (mg/kg):	(.00)	6110	(.00)
Availability perc. (%):	(100)	28.81	(100)
Mean factor above DTL :	-	204	-
Max.Cum.release (mg/m^2):	(.0)	1115739	(.0)
Cum.release 32d. (mg/m^2):	-	161874	-
Leaching-perc. 32d. (%):	-	14.5	-
Mean factor above DTL :	-	820	-
Cum.release calc. 1D 32d:	-	159496	-
Cum.release calc. 3D 32d:	-	742201	-
(mg/m^2)	Tortuosity	7	
Chemical Retention R:	-	1.0	-
$R_{range-min}$:	-	.76	-
$R_{range-max}$:	-	1.3	-

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Combined Ash — Surf.area: .0057 m^2 — Bulk Density : 2512 kg/m^3 — 3 October 1991
Productcode: VOCC — Weight : 1.26 kg — Extraction volume: 6.49 L

Concentration in µg/L Time (days)	K	Na	Li	Br	Cl	NO3	SO4	Al	B	Ba
.25	16800	15400	< 5	< 500	32800	30	< 500	109	12.80	26.90
1	26200	24100	< 5	1070	89200	30	< 500	280	10.20	63.50
2	14600	12600	< 5	< 500	25300	30	< 500	265	< 8	36.70
4	21400	20200	< 5	520	44800	< 10	< 500	355	10.40	59.50
8	34300	30800	< 5	1870	146000	< 10	1110	1040	11.10	86.10
16	40200	36000	< 5	1950	180000	< 10	1210	567	11.80	100
32	52700	48500	7	2380	202000	< 10	1710	737	16.40	134
pD_e (-log[m^2/s]) :	9.59	9.68	> 11.1	9.41	10.13	> 9.5	> 14.2	12.95	-	11.37
Standard deviation :	.08	.09	-	.20	.39	.88	.13	.32	-	.10
Used data points :	3 - 7	3 - 7	1 - 7	5 - 7	2 - 7	1 - 7	1 - 7	2 - 7	-	3 - 7
Slope :	.46	.47	-	.17	.57	-	-	.45	-	.45
Std.Dev. of slope :	.05	.05		.07	.17			.14		.05
Deviat.slope=i (3 fases):	≈ ≈ —	≈ ≈ —		? + —	≈ + —	≈ ? ?	? + +	+ ≈ —	— ≈ —	+ ≈ —
Wash-off(mg/m^2),Diss/Lag:	?≈	?≈	(Lag)	(Lag)	≈	≈33.72	(Lag)	(Lag)		≈
Total Concentrat.(mg/kg):	13020	21209	9.13	243.4	19270	4.67	2231	30426	.000	770.8
Availability (mg/kg):	6085	6085	< 4.06	243.4	37525	4.67	39351	5071	-	121.7
Availability perc. (%):	46.74	28.69	< 44.47	100.00	194.74	100.00	1763.6	16.67	-	15.79
Mean factor above DTL :	61	203	(DTL)	5	375	5	394	1014	-	35
Max.Cum.release (mg/m^2):	1345105	1345105	< 897.5	53804	8295000	1032	8698642	1120958	-	26902
Cum.release 32d. (mg/m^2):	234779	213601	< 42	10008	819903	< 148	< 6866	3818	-	577
Leaching-perc. 32d. (%):	17.5	15.9	< 4.7	18.6	9.9	< 14.3	< .08	.3	-	2.1
Mean factor above DTL :	39	893	(DTL)	2.5	206	1.9	1.7	44	-	72
Cum.release calc. 1D 32d:	230089	207941	< 27	11297	762413	< 197	< 7253	4015	-	590
Cum.release calc. 3D 32d:	990607	934023	< 161	43808	3973197	< 802	< 46851	25390	-	3588
(mg/m^2)	Tortuosity (Na):		6	range:	5 - 7					
Chemical Retention R:	1.3	1.0	-	.83	4.3	.94	30769	688	-	34
$R_{range-min}$:	1.1	.82	-	.53	1.7	.12	22772	329	-	28
$R_{range-max}$:	1.6	1.2	-	1.3	11	7.2	41576	1439	-	43
pD_e for R=1 will be ≥				9.5		9.5				
Availability(%) becomes ≥				109.5		103.2				

Combined Ash — Surf.area .0057 m^2 — Bulk Density 2512 kg/m^3 — (continued)
Productcode: VOCC — Weight 1.26 kg — Extraction volume 6.49 L

Concentration in µg/L Time (days)	Ca	Cd	Cr	Cu	Fe	Mg	Ni	Pb	Si	Sr	Zn
.25	12100		< 6	< 5	30.80	91.10		1.90	327	110	6.40
1	20500		6.50	5.70	69.10	233		< 1	619	178	14.30
2	10500		< 6	6.60	75.10	278		1.50	498	89.80	7
4	15800		< 6	9.60	29.70	35.70		1.30	264	145	12.60
8	24300		11.40	21.60	372	1440		1.70	2030	214	20
16	31300		< 6	15.60	13.80	23.50		1.50	317	263	4.60
32	44100		< 6	22.70	10.90	52.60		3.60	1270	368	4.20
pD_e (-log[m^2/s]) :	12.08	-	> 10.1	14.08	15.61	> 14.2	-	16.12	12.46	> 10.8	15.45
Standard deviation :	.05	-	.03	.25	.36	1.45	-	.29	.02	.07	.19
Used data points :	3 - 7	-	1 - 7	1 - 7	6 - 7	1 - 7	-	2 - 7	2 - 3	3 - 7	2 - 5
Slope :	.51	-	-	-	-.34	.06	-	.39	.46	.49	.46
Std.Dev. of slope :	.03				?	.40		.11	?	.04	.17
Deviat.slope=½ (3 fases):	≈ ≈ ≈		? ? ?	+ ≈ −	+ − −	+ − −		− ≈ ≈	+ − −	≈ ≈ ≈	+ − −
Wash-off(mg/m^2),Diss/Lag:	?≈		(Lag)	(Lag)	?≈	?≈		.884	(Lag)	?≈	≈
Total Concentrat.(mg/kg):	121260	26.37	101.4	1521	67200	.000	142.0	1116	132600	.000	3550
Availability (mg/kg):	81136	28.40	4.06	466.5	1542	(5679.5)	28.40	669.4	5680	(158.2)	3245
Availability perc. (%):	66.91	107.70	4.00	30.67	2.29	#VALUE!	20.00	60.00	4.28	#VALUE!	91.43
Mean factor above DTL :	1623	142	2	233	1542	-	7	669	284	-	1623
Max.Cum.release (mg/m^2):	17935326	6278	897.5	103121	340863	(1255468)	6278	147973	1255579	(34971)	717316
Cum.release 32d. (mg/m^2):	180581	-	< 55	99	685	2452	-	14	6063	1557	79
Leaching-perc. 32d. (%):	1.0	-	< 6.1	.10	.2	.2	-	.01	.5	4.5	.01
Mean factor above DTL :	1133	-	(DTL)	2.5	17	308	-	1.8	35	98	5
Cum.release calc. 1D 32d:	173691	-	< 86	100	57	< 1085	-	14	7859	< 1502	144
Cum.release calc. 3D 32d: (mg/m^2)	1084155	-	< 441	637	361	< 6762	-	87	49412	< 8632	918
Chemical Retention R:	151	-	1.3	16156	458418	16972	-	2157179	-	-	379010
$R_{range-min}$:	136	-	1.2	9131	201146	601	-	1112496	-	-	243670
$R_{range-max}$:	168	-	1.4	28585	1044748	479588	-	4182866	-	-	589521
pD_e for R=1 will be ≥											
Availability(%) becomes ≥											

Combined Ash
Productcode:

Concentration in µg/L Time (days)	VOCC TDS	Na	TOC
.25	68000	15400	1480
1	193000	24100	1850
2	92000	12600	930
4	118000	20200	1000
8	279000	30800	2030
16	351000	36000	2250
32	378000	48500	1520
pD_e (-log[m^2/s]) :	-	9.68	> 12.2
Standard deviation :	-	.09	.29
Used data points :	-	3 - 7	1 - 4
Slope :	(.6)	.47	(.3)
Std.Dev. of slope :	(.09)	.05	(.14)
Deviat.slope=½ (3 fases):	+ + -	≈ ≈ -	≈ ≈ -
Wash-off(mg/m^2),Diss/Lag:	1591	?≈	?≈
Total Concentrat.(mg/kg):	.000	21209	9081
Availability (mg/kg):	(.00)	6085	9081
Availability perc. (%):	(100)	28.69	100.00
Mean factor above DTL :	-	203	-
Max.Cum:release (mg/m^2):	(.0)	1345105	< 2007379
Cum.release 32d. (mg/m^2):	-	213601	12593
Leaching-perc. 32d. (%):	-	15.9	.6
Mean factor above DTL :	-	893	-
Cum.release calc. 1D 32d:	-	207941	< 16394
Cum.release calc. 3D 32d: (mg/m^2)	-	934023	< 104350
Tortuosity		6	
Chemical Retention R:	-	1.0	292
$R_{range-min}$:	-	.82	149
$R_{range-max}$:	-	1.2	572

417

Appendix C.2. Summary of monolith leach test extract concentrations and data analysis for APC residue, bottom ash and combined ash treated by Process 1.

All
Productcode: V1XL

Surf.area: .0324 m^2 Bulk Density : 1000 kg/m^3 1 October 1991
Weight : 1 kg Extraction volume: 8.47 L

Concentration in µg/L Time (days)	K	Na	Li	Br	Cl	NO3	SO4	Al	B	Ba
1	< 400	92.30	< 3			70		< 11	7.70	2.10
2	< 400	71.40	< 3			30		13.60	4.40	1.20
4	3930	4320	< 3			< 10		< 11	11.60	12.40
8	530	623	< 3			< 10		< 11	5	2.50
16	< 400	718	< 3			< 10		< 11	22.80	< 1
32	1470	686	< 3			< 10		21	< 4	15.90
64	< 400	58	< 3			20		< 11	8.20	1.20
pD_e (-log[m^2/s]) :	-	-	-	-	-	-	-	-	-	-
Standard deviation :	-	-	-	-	-	-	-	-	-	-
Used data points :	-	-	-	-	-	-	-	-	-	-
Slope :	-	(.3)	-	-	-	-	-	-	(.2)	-
Std.Dev. of slope :		(.53)							(.21)	
Deviat.slope=½ (3 fases):	? - ?	+ - -				= ? ?		? ? ?	+ = -	+ - -
Wash-off(mg/m^2),Diss/Lag:										
Total Concentrat.(mg/kg):	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
Availability (mg/kg):	(.00)	(.00)	-	-	(.00)	-	(.00)	-	-	(.00)
Availability perc. (%):	(20)	(20)	-	-	(20)	-	(100)	-	-	(20)
Mean factor above DTL :	-	-	-	-	-	-	-	-	-	-
Max.Cum.release (mg/m^2):	(.0)	(.0)	-	-	(.0)	-	(.0)	-	-	(.0)
Cum.release 64d. (mg/m^2):	-	-	-	-	-	-	-	-	-	-
Leaching-perc. 64d. (%):	-	-	-	-	-	-	-	-	-	-
Mean factor above DTL :	-	-	-	-	-	-	-	-	-	-
Cum.release calc. 1D 64d:	-	-	-	-	-	-	-	-	-	-
Cum.release calc. 3D 64d:	-	-	-	-	-	-	-	-	-	-
(mg/m^2)	Tortuosity (Na):		0	range:	-					
Chemical Retention R:	-	-	-	-	-	-	-	-	-	-
$R_{range-min}$:	-	-	-	-	-	-	-	-	-	-
$R_{range-max}$:	-	-	-	-	-	-	-	-	-	-

Productcode: V1XL

Surf.area .0324 m^2 | Bulk Density 1000 kg/m^3 | (continued)
Weight 1 kg | Extraction volume 6.47 L

Concentration in µg/L Time (days)	Ca	Cd	Cr	Cu	Fe	Mg	Ni	Pb	Si	Sr	Zn
1	336	< .2	< 3		< 5	4.50		1.60	128	< 2	4.10
2	218	.30	< 3		5.40	4.70		1.30	97.90	< 2	4.70
4	16300	< .2	< 3		5.20	5.40		< 1	105	41.90	2.90
8	2610	< .2	< 3		10.40	4		< 1	50.20	4.70	< 2
16	249	< .2	3.10		78.40	25		20.10	250	3	8.40
32	4490	< .2	< 3		< 5	2.10		2.70	137	10.90	< 2
64	< 20	< .2	< 3		16.60	2.30		1.40	102	< 2	6
pD_e ($-\log[m^2/s]$) :	-	-	-	-	-	-	-	-	-	-	-
Standard deviation :	-	-	-	-	-	-	-	-	-	-	-
Used data points :	-	-	-	-	-	-	-	-	-	-	-
Slope :	-	-	-	-	-	(.1)	-	-	(.2)	-	-
Std.Dev. of slope :						(.28)			(.16)		
Deviat.slope=½ (3 fases):	+ - +				+ + -	+ - -		+ - -	+ - -	? - +	+ ≈ -
Wash-off(mg/m^2),Diss/Lag:											
Total Concentrat.(mg/kg):	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
Availability (mg/kg):	(.00)	(.00)	(.00)	(.00)	-	-	(.00)	(.00)	-	-	(.00)
Availability perc. (%):	(90)	(80)	(10)	(25)	-	-	(20)	(10)	-	-	(40)
Mean factor above DTL :	-	-	-	-	-	-	-	-	-	-	-
Max.Cum.release (mg/m^2):	(.0)	(.0)	(.0)	(.0)	-	-	(.0)	(.0)	-	-	(.0)
Cum.release 64d. (mg/m^2):	-	-	-	-	-	-	-	-	-	-	-
Leaching-perc. 64d. (%):	-	-	-	-	-	-	-	-	-	-	-
Mean factor above DTL :	-	-	-	-	-	-	-	-	-	-	-
Cum.release calc. 1D 64d:	-	-	-	-	-	-	-	-	-	-	-
Cum.release calc. 3D 64d: (mg/m^2)	-	-	-	-	-	-	-	-	-	-	-
Chemical Retention R:	-	-	-	-	-	-	-	-	-	-	-
$R_{range-min}$:	-	-	-	-	-	-	-	-	-	-	-
$R_{range-max}$:	-	-	-	-	-	-	-	-	-	-	-

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Productcode: V1XL

Concentration in µg/L Time (days)	TDS	Na	TOC
1	36000	92.30	n.a.
2	24000	71.40	n.a.
4	44000	4320	n.a.
8	11000	623	910
16	71000	718	n.a.
32	< 30	686	n.a.
64	< 30	58	n.a.

pD_e (-log[m^2/s]) :	-	-	-
Standard deviation :	-	-	-
Used data points :	-	-	-
Slope :	-	(.3)	-
Std.Dev. of slope :		(.53)	
Deviat.slope=½ (3 fases):	+ - ?	+ - -	
Wash-off(mg/m^2),Diss/Lag:			
Total Concentrat.(mg/kg):	.000	.000	.000
Availability (mg/kg):	(.00)	(.00)	(.00)
Availability perc. (%):	(100)	(20)	(100)
Mean factor above DTL :	-	-	-
Max.Cum.release (mg/m^2):	(.0)	(.0)	(.0)
Cum.release 64d. (mg/m^2):	-	-	-
Leaching-perc. 64d. (%):	-	-	-
Mean factor above DTL :	-	-	-
Cum.release calc. 1D 64d:.	-	-	-
Cum.release calc. 3D 64d:	-	-	-
(mg/m^2)	Tortuosity	0	
Chemical Retention R:	-	-	-
$R_{range-min}$:	-	-	-
$R_{range-max}$:	-	-	-

APC-Residue
Productcode: V1FA

Surf.area: .0324 m^2 Bulk Density : 1445 kg/m^3 1 October 1991
Weight : 1.19 kg Extraction volume: 8.47 L

Concentration in µg/L Time (days)	K	Na	Li	Br	Cl	NO3	SO4	Al	B	Ba
1	379000	360000	114	66600	3720000	680	19700	95	70.20	648
2	163000	165000	58.50	23700	1430000	220	9970	66.70	39.40	378
4	207000	208000	74.90	31700	1610000	190	11300	148	31.90	565
8	245000	275000	123	48000	2260000	190	14400	171	39.90	1250
16	180000	212000	161	46600	2120000	250	14800	385	78.40	2190
32	71200	114000	152	37000	1400000	810	21000	237	43.40	2240
64	110000	130000	236	36000	1330000	680	20400	172	30.50	2640
pD_e (-log[m^2/s]) :	8.89	8.98	9.32	9.59	9.08	8.91	12.76	14.21	-	9.46
Standard deviation :	.11	.07	.16	.08	.14	.39	.12	.46	-	.24
Used data points :	1 - 4	1 - 4	1 - 7	1 - 4	1 - 4	1 - 7	1 - 4	1 - 7	-	2 - 7
Slope :	.38	.45	.44	.43	.33	.34	.41	.46	(.1)	.59
Std.Dev. of slope :	.05	.05	.05	.05	.04	.11	.09	.16	(.11)	.10
Deviat.slope=± (3 fases):	≈ - -	≈ - -	≈ - -	≈ - -	- - -	- + +	≈ - -	+ - -	- - -	+ + -
Wash-off(mg/m^2),Diss/Lag:	≈	≈	≈	≈	≈	101.5	≈	(Lag)		(Lag)
Total Concentrat.(mg/kg):	10200	16990	13.74	3071	12727	11.21	4990	19091	.000	417.2
Availability (mg/kg):	10707	12121	6.06	3980	118990	11.21	52121	2222	-	72.73
Availability perc. (%):	104.97	71.34	44.10	129.61	934.92	100.00	1044.5	11.64	-	17.43
Mean factor above DTL :	107	404	2	80	1190	11	521	444	-	21
Max.Cum.release (mg/m^2):	393251	445185	222.6	146179	4370312	411.7	1914321	81610	-	2671
Cum.release 64d. (mg/m^2):	354276	382719	240	75707	3625892	789	29167	333	-	2591
Leaching-perc. 64d. (%):	90.1	86.0	108	51.8	83.0	192	1.5	.4	-	97.0
Mean factor above DTL :	484	6971	26	83	3963	43	32	17	-	1416
Cum.release calc. 1D 64d:	738945	754071	254	122964	6551302	757	41761	336	-	2610
Cum.release calc. 3D 64d:	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	-	#VALUE!
(mg/m^2)	Tortuosity (Na):		1	range:	1 - 1					
Chemical Retention R:	1.3	1.0	-	6.2	1.9	1.2	5397	62601	-	2.1
	1.0	.86	-	5.2	1.4	.50	4112	21705	-	1.2
$R_{range-min}$:	1.7	1.2	-	7.4	2.7	3.0	7085	180551	-	3.6
$R_{range-max}$:										
pD_e for R=1 will be ≥						8.8				
Availability(%) becomes ≥						90.7				

APC-Residue
Productcode: V1FA

Surf.area .0324 m^2 Bulk Density 1445 kg/m^3 (continued)
Weight 1.19 kg Extraction volume 8.47 L

Concentration in µg/L Time (days)	Ca	Cd	Cr	Cu	Fe	Mg	Ni	Pb	Si	Sr	Zn
1	905000	.30		< 4	672	249	< 5	574	489	2620	42.60
2	531000	.30		< 4	220	141	5.40	367	567	1370	40.40
4	712000	< .2		< 4	27.40	33.60	< 5	483	274	1780	62.50
8	1050000	< .2		< 4	36.60	46.70	< 5	771	510	2750	84.40
16	909000	< .2		27.20	148	136	13.20	654	808	2630	102
32	695000	< .2		< 4	166	75.40	< 5	319	1090	1760	47.50
64	681000	< .2		< 4	80.80	36.30	< 5	385	1240	2020	69.30
pD_e (-log[m^2/s]) :	10.12	> 16.9	-	> 13.0	11.18	> 15.4	> 11.3	11.68	13.71	> 9.3	14.96
Standard deviation :	.14	.51	-	-	.49	.92	.09	.05	.32	.10	.08
Used data points :	1 - 4	1 - 7	-	1 - 7	3 - 7	1 - 7	1 - 7	2 - 4	1 - 7	1 - 4	2 - 5
Slope :	.64	-	-	-	.53	-.10	-	.54	.46	.59	.44
Std.Dev. of slope :	.09				.30	.17		.08	.11	.06	.06
Deviat.slope=i (3 fases):	+ - -	+ ? ?			- + -	- ≈ -	? ? ?	+ - -	≈ + -	+ - -	+ - -
Wash-off(mg/m^2),Diss/Lag:	≈	≈		(Lag)	210.3	≈71.90	(Lag)	(Lag)	≈	≈	(Lag)
Total Concentrat.(mg/kg):	237000	168.7	39.49	372.7	7570	.000	32.63	2758	44285	.000	11111
Availability (mg/kg):	145455	113.1	7.07	78.79	26.26	(4444.4)	6.06	666.7	5051	(141.4)	3232
Availability perc. (%):	61.37	67.06	17.90	21.14	.35	#VALUE!	18.57	24.18	11.40	#VALUE!	29.09
Mean factor above DTL :	2909	566	3	39	26	-	2	667	253	-	1616
Max.Cum.release (mg/m^2):	5342329	4154	259.7	2894	964.5	(163236)	222.6	24487	185515	(5193)	118706
Cum.release 64d. (mg/m^2):	1433365	< .4	-	< 13	353	188	< 11	929	1301	3903	117
Leaching-perc. 64d. (%):	26.8	< .01	-	< .4	36.6	.1	< 4.9	3.8	.7	75.2	.10
Mean factor above DTL :	39164	(DTL)	-	1.8	39	103	(DTL)	508	32	1066	32
Cum.release calc. 1D 64d:	2418123	< .78	-	< 49	129	< 169	< 25	1839	1348	< 6394	205
Cum.release calc. 3D 64d: (mg/m^2)	#VALUE!	#VALUE!	-	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Chemical Retention R:	8.3	43543615	-	6502	85	1420520	114	392	-	-	616265
$R_{range-min}$:	6.0	13601216	-	-	27	169726	93	347	-	-	517741
$R_{range-max}$:	12	139402715	-	-	262	11888996	140	443	-	-	733538

pD_e for R=1 will be ≥
Availability(%) becomes ≥

APC-Residue
Productcode: V1FA

Concentration in µg/L Time (days)	TDS	Na	TOC
1	4950000	360000	1430
2	2170000	165000	1050
4	2770000	208000	1010
8	4270000	275000	1680
16	3360000	212000	1200
32	3050000	114000	1000
64	2570000	130000	2870

pD_e (-log[m^2/s]) :	> 9.6	8.98	> 13.2
Standard deviation :	.54	.07	.21
Used data points :	1 - 7	1 - 4	1 - 4
Slope :	.13	.45	(.6)
Std.Dev. of slope :	.08	.05	(.18)
Deviat.slope=½ (3 fases):	¤ - -	¤ - -	+ - +
Wash-off(mg/m^2),Diss/Lag:	¤635173	¤	¤
Total Concentrat.(mg/kg):	228282	16990	8080
Availability (mg/kg):	228283	12121	8081
Availability perc. (%):	100.00	71.34	100.01
Mean factor above DTL :	-	404	-
Max.Cum.release (mg/m^2):	< 8384468	445185	< 296802
Cum.release 64d. (mg/m^2):	6049253	382719	2677
Leaching-perc. 64d. (%):	72.1	86.0	.9
Mean factor above DTL :	110190	6971	-
Cum.release calc. 1D 64d:	< 6752996	754071	< 3946
Cum.release calc. 3D 64d: (mg/m^2)	< 6850110	429750	< 6298
	Tortuosity	1	
Chemical Retention R:	3.6	1.0	13249
$R_{range-min}$:	1.1	.86	8147
$R_{range-max}$:	12	1.2	21547

APC-Residue
Productcode: V1FB

Surf.area: .0324 m^2 Bulk Density : 1481 kg/m^3 2 October 1991
Weight : 1.22 kg Extraction volume: 8.47 L

Concentration in µg/L Time (days)	K	Na	Li	Br	Cl	NO3	SO4	Al	B	Ba
1	432000	411000	128	53800	3650000	1610	16800	124	87.60	776
2	181000	184000	62.50	29100	1580000	230	10800	118	34	442
4	216000	218000	83	32200	1780000	240	12200	154	41.70	630
8	233000	265000	127	37100	2430000	130	11800	164	38.30	1320
16	160000	190000	138	39800	1800000	320	15500	196	48.20	2090
32	675000	106000	152	35000	1300000	900	22000	266	59.80	2170
64	107000	124000	237	37000	1210000	740	18500	162	35.80	2380
pD_e ($-\log[m^2/s]$) :	8.83	8.90	9.24	9.51	8.91	9.38	12.95	14.04	-	9.52
Standard deviation :	.08	.08	.10	.16	.11	.63	.04	.10	-	.20
Used data points :	1 - 3	1 - 3	1 - 5	1 - 4	1 - 4	1 - 7	4 - 6	4 - 6	-	2 - 6
Slope :	.39	.43	.48	.39	.37	.23	.45	.35	(.1)	.63
Std.Dev. of slope :	.08	.11	.06	.12	.05	.18	.03	.05	(.06)	.09
Deviat.slope=$\frac{1}{2}$ (3 fases):	≈ ≈ −	≈ − −	≈ − ≈	≈ − −	≈ − −	− + +	+ − −	+ − −	≈ − −	+ + −
Wash-off(mg/m^2),Diss/Lag:	≈	≈	≈	≈	≈	322.2	?≈	≈		(Lag)
Total Concentrat.(mg/kg):	10700	17630	14.10	3126	13585	22.37	5148	20327	.000	454.6
Availability (mg/kg):	11440	12257	6.13	3350	100919	22.37	43105	1941	-	81.72
Availability perc. (%):	106.92	69.53	43.48	107.19	742.86	100.00	837.30	9.55	-	17.98
Mean factor above DTL :	114	409	2	67	1009	22	431	388	-	23
Max.Cum.release (mg/m^2):	430765	461529	230.8	126142	3800036	842.3	1623090	73087	-	3077
Cum.release 64d. (mg/m^2):	523885	391607	242	69015	3594522	1090	28129	310	-	2564
Leaching-perc. 64d. (%):	122	84.8	105	54.7	94.6	129	1.7	.4	-	83.3
Mean factor above DTL :	716	7133	26	75	3929	60	31	15	-	1401
Cum.release calc. 1D 64d:	860273	853358	288	115492	6980180	898	28392	365	-	2796
Cum.release calc. 3D 64d:	421199	448886	213	107223	3694076	751	45856	594	-	2608
(mg/m^2)	Tortuosity (Na):		1	range:	1 - 1					
Chemical Retention R:	1.4	1.0	-	6.3	1.5	4.3	10002	50615	-	2.9
$R_{range-min}$:	1.1	.84	-	4.3	1.2	1.0	9203	40538	-	1.8
$R_{range-max}$:	1.7	1.2	-	9.1	2.0	18	10870	63197	-	4.5
pD_e for R=1 will be ≥						8.7				
Availability(%) becomes ≥						48.2				

APC-Residue
Productcode: V1FB

Surf.area .0324 m^2
Weight 1.22 kg

Bulk Density 1481 kg/m^3
Extraction volume 8.47 L

(continued)

Concentration in µg/L Time (days)	Ca	Cd	Cr	Cu	Fe	Mg	Ni	Pb	Si	Sr	Zn
1	1220000	.30			113	66.20	< 5	925	358	3070	48.20
2	600000	.30			55.30	37	< 5	724	393	1580	69.60
4	773000	< .2			16.80	54.50	< 5	856	432	1950	61.70
8	965000	< .2			11.50	46.20	< 5	1020	571	2800	69.40
16	849000	< .2			21.40	53.50	< 5	769	886	2470	73.90
32	837000	< .2			33.90	81	5.20	850	1540	1690	117
64	630000	< .2			18.30	35	< 5	410	1060	1820	61.40
pD_e (-log[m^2/s]) :	10.08	> 16.6	-	-	11.76	> 15.8	> 12.7	11.13	13.58	> 9.2	15.35
Standard deviation :	.08	.54	-	-	.07	.53	-	.15	.13	.08	.17
Used data points :	1 - 4	1 - 7	-	-	5 - 6	1 - 7	1 - 7	2 - 4	2 - 6	1 - 4	4 - 5
Slope :	.47	-	-	-	.66	.17	-	.25	.50	.52	.09
Std.Dev. of slope :	.07				?	.11		.00	.08	.07	?
Deviat.slope=½ (3 fases):	≈ - -	+ ? ?			- ≈ -	+ - -		+ - -	+ + -	≈ - -	+ - -
Wash-off(mg/m^2),Diss/Lag:	≈	≈			36.85	≈8.22	(Lag)	(Lag)	(Lag)	≈	≈
Total Concentrat.(mg/kg):	249000	181.8	44.43	391.2	6800	.000	39.02	3044	29249	.000	11849
Availability (mg/kg):	149132	102.2	4.70	83.76	15.53	(4290.1)	7.15	572.0	5312	(149.1)	3677
Availability perc. (%):	59.89	56.18	10.58	21.41	.23	#VALUE!	18.32	18.79	18.16	#VALUE!	31.03
Mean factor above DTL :	2983	511	2	42	16	-	2	572	266	-	1839
Max.Cum.release (mg/m^2):	5615464	3848	177.0	3154	584.8	(161541)	269.2	21538	200020	(5614)	138455
Cum.release 64d. (mg/m^2):	1535580	< .4	-	-	71	98	< 9.2	1452	1370	4021	131
Leaching-perc. 64d. (%):	27.3	< .01	-	-	12.1	.06	< 3.4	6.7	.7	71.6	.09
Mean factor above DTL :	41957	(DTL)	-	-	8	54	(DTL)	793	34	1099	36
Cum.release calc. 1D 64d:	2684906	< .98	-	-	40	< 109	< 6.6	3064	1685	< 7084	152
Cum.release calc. 3D 64d: (mg/m^2)	3337860	< 1.6	-	-	63	< 173	< 10	4620	2734	< 5239	248
Chemical Retention R:	8.9 28675036		-	-	380	4005011	2958	130	-	-	1816157
$R_{range-min}$:	7.3 8244748		-	-	323	1170104	-	92	-	-	1215849
$R_{range-max}$:	11 99731084		-	-	446	13708278	-	185	-	-	2712857

pD_e for R=1 will be ≥
Availability(%) becomes ≥

425

APC-Residue
Productcode: V1FB

Concentration in µg/L Time (days)	TDS	Na	TOC
1	5560000	411000	1360
2	2440000	184000	750
4	3100000	218000	820
8	4210000	265000	1360
16	3360000	190000	1190
32	2780000	106000	2000
64	2610000	124000	2510
pD_e (-log[m^2/s]) :	> 9.7	8.90	> 12.9
Standard deviation :	.58	.08	.12
Used data points :	1 - 7	1 - 3	1 - 4
Slope :	.09	.43	(.5)
Std.Dev. of slope :	.08	.11	(.10)
Deviat.slope=½ (3 fases):	= - -	= - -	= = =
Wash-off(mg/m^2),Diss/Lag:	=888594	=	=
Total Concentrat.(mg/kg):	245148	17630	4800
Availability (mg/kg):	245148	12257	4801
Availability perc. (%):	100.00	69.53	100.02
Mean factor above DTL :	-	409	-
Max.Cum.release (mg/m^2):	< 9230881	461529	< 180778
Cum.release 64d. (mg/m^2):	6289759	391607	2612
Leaching-perc. 64d. (%):	68.1	84.8	1.4
Mean factor above DTL :	114571	7133	-
Cum.release calc. 1D 64d:	< 7003163	853358	< 3226
Cum.release calc. 3D 64d:	< 7154699	448886	< 5403
(mg/m^2)	Tortuosity	1	
Chemical Retention R:	4.8	1.0	8765
$R_{range-min}$:	1.3	.84	6688
$R_{range-max}$:	18	1.2	11487

APC-Residue
Productcode: V1FC

Surf.area: .0324 m^2 Bulk Density : 1396 kg/m^3 2 October 1991
Weight : 1.15 kg Extraction volume: 8.47 L

Concentration in µg/L Time (days)	K	Na	Li	Br	Cl	NO3	SO4	Al	B	Ba
1	410000	387000	127	54200	3760000	220	15500	96.70	62.40	678
2	162000	164000	56.30	27500	1480000	100	10800	73.80	29	367
4	187000	189000	71.30	31900	1470000	160	12300	108	32	503
8	217000	245000	104	41400	1870000	120	16100	140	40.60	1100
16	143000	175000	98.80	40800	1700000	300	15000	238	59.70	1900
32	54400	85800	129	31000	1100000	690	18000	225	50.40	1900
64	102000	117000	234	32000	1130000	710	19800	154	76	2490
pD_e (-log[m^2/s]) :	8.86	8.99	> 8.9	9.53	9.14	9.26	12.75	13.94	-	9.70
Standard deviation :	.12	.12	.04	.10	.07	.09	.19	.07	-	.02
Used data points :	1 - 3	1 - 4	1 - 4	1 - 4	3 - 4	1 - 3	1 - 4	2 - 5	-	2 - 3
Slope :	.32	.35	.48	.44	.35	.66	.57	.54	(.3)	.45
Std.Dev. of slope :	.06	.04	.03	.08	?	.01	.16	.05	(.04)	?
Deviat.slope=½ (3 fases):	- - -	≈ - -	≈ - +	≈ - -	- - -	+ + +	+ - -	+ ≈ -	≈ - -	+ + -
Wash-off(mg/m^2),Diss/Lag:	≈	≈	≈	≈	489936	≈	≈	(Lag)		≈
Total Concentrat.(mg/kg):	10400	17200	12.92	3097	12103	11.69	5046	19179	.000	424.6
Availability (mg/kg):	11282	12308	< 4.10	3692	99487	11.69	53744	1928	-	69.74
Availability perc. (%):	108.48	71.56	< 31.73	119.21	822.03	100.00	1065.0	10.05	-	16.42
Mean factor above DTL :	113	410	(DTL)	74	995	12	537	386	-	20
Max.Cum.release (mg/m^2):	400441	436858	< 145.5	131043	3531174	414.9	1907580	68432	-	2475
Cum.release 64d. (mg/m^2):	333415	356263	214	67655	3270361	601	28103	271	-	2337
Leaching-perc. 64d. (%):	83.3	81.6	147	51.6	92.6	145	1.5	.4	-	94.4
Mean factor above DTL :	456	6490	23	74	3574	33	31	13	-	1277
Cum.release calc. 1D 64d:	776519	727245	< 267	116982	4977488	510	42145	383	-	1824
Cum.release calc. 3D 64d:	390803	421014	< 142	110363	3334371	383	67898	623	-	1918
(mg/m^2)	Tortuosity (Na):		1	range:	1 - 2					
Chemical Retention R:	1.2	1.0	-	5.4	2.1	2.6	5083	32645	-	3.5
$R_{range-min}$:	.90	.75	-	4.2	1.8	2.1	3308	27959	-	3.4
$R_{range-max}$:	1.5	1.3	-	6.8	2.5	3.3	7808	38117	-	3.7
pD_e for R=1 will be ≥						8.8				
Availability(%) becomes ≥						61.7				

427

APC-Residue — Surf.area .0324 m^2 — Bulk Density 1396 kg/m^3 — (continued)
Productcode: V1FC — Weight 1.15 kg — Extraction volume 8.47 L

Concentration in µg/L Time (days)	Ca	Cd	Cr	Cu	Fe	Mg	Ni	Pb	Si	Sr	Zn
1	1170000	.40		< 4	22.90	34	7.10	688	358	2880	41.80
2	551000	< .2		< 4	< 5	20.80	< 5	507	356	1400	40.80
4	677000	< .2		< 4	13.90	32	< 5	617	436	1700	54.70
8	940000	< .2		< 4	13.70	31.20	< 5	868	565	2570	83.50
16	812000	< .2		501	88.70	78	16	846	869	2290	700
32	522000	< .2		< 4	332	44.10	6.10	407	966	1380	47.80
64	572000	< .2		< 4	74.80	68.40	< 5	437	983	1770	62.40
pD_e (-log[m^2/s]) :	10.13	> 16.7	-	> 10.3	11.56	> 15.8	> 11.4	11.29	13.49	> 9.1	14.89
Standard deviation :	.06	.12	-	-	.22	.30	.57	.08	.04	.06	.03
Used data points :	1 - 4	1 - 7	-	1 - 7	3 - 4	1 - 7	1 - 7	2 - 4	3 - 5	1 - 4	2 - 4
Slope :	.47	-	-	-	-.02	.42	-	.39	.50	.51	.52
Std.Dev. of slope :	.05				?	.10		.06	.07	.06	.05
Deviat.slope=½ (3 fases):	≈ - -				- + -	+ - -	? - -	+ - -	+ ≈ -	≈ - -	+ - -
Wash-off(mg/m^2),Diss/Lag:	≈	≈		(Lag)	≈	≈	(Lag)	(Lag)	(Lag)	≈	(Lag)
Total Concentrat.(mg/kg):	258000	169.2	39.79	402.1	8210	.000	40.00	2841	33333	.000	11077
Availability (mg/kg):	155897	114.9	3.49	71.79	13.54	(3692.3)	< 3.90	553.9	4513	(123.1)	3077
Availability perc. (%):	60.43	67.88	8.77	17.86	.16	#VALUE!	< 9.75	19.49	13.54	#VALUE!	27.78
Mean factor above DTL :	3118	574	2	36	14	-	(DTL)	554	226	-	1538
Max.Cum.release (mg/m^2):	5533381	4078	123.9	2548	480.6	(131054)	< 138.4	19660	160184	(4369)	109215
Cum.release 64d. (mg/m^2):	1370885	< .4	-	< 137	144	81	< 13	1142	1185	3657	270
Leaching-perc. 64d. (%):	24.8	< .01	-	< 5.4	30.0	.06	< 9.4	5.8	.7	83.7	.2
Mean factor above DTL :	37457	(DTL)	-	19	16	44	(DTL)	624	29	999	74
Cum.release calc. 1D 64d:	2499690	< .92	-	< 894	41	< 85	< 15	2312	1510	< 6400	204
Cum.release calc. 3D 64d: (mg/m^2)	3157059	< 1.5	-	< 1248	64	< 140	< 22	3534	2429	< 4150	332
Chemical Retention R:	8.1	29382226	-	14	198	3501121	124	155	-	-	509027
$R_{range-min}$:	7.0	22515357	-	-	119	1766378	33	130	-	-	470646
$R_{range-max}$:	9.3	38343395	-	-	330	6939541	460	184	-	-	550539

pD_e for R=1 will be ≥
Availability(%) becomes ≥

APC-Residue

Productcode: V1FC

Concentration in µg/L Time (days)	TDS	Na	TOC
1	4890000	387000	1000
2	2200000	164000	640
4	2610000	189000	680
8	3150000	245000	1260
16	3200000	175000	1000
32	2400000	85800	1000
64	2450000	117000	2200
pD_e (-log[m^2/s]) :	> 9.7	8.99	> 13.0
Standard deviation :	.55	.12	.18
Used data points :	1 - 7	1 - 4	1 - 4
Slope :	.10	.35	(.6)
Std.Dev. of slope :	.07	.04	(.14)
Deviat.slope=½ (3 fases):	≈ - -	≈ - -	+ - ≈
Wash-off(mg/m^2),Diss/Lag:	≈824177	≈	≈
Total Concentrat.(mg/kg):	222564	17200	4461
Availability (mg/kg):	(222564.0)	12308	4462
Availability perc. (%):	(100)	71.56	100.01
Mean factor above DTL :	-	410	-
Max.Cum.release (mg/m^2):	(7899648)	436858	< 158373
Cum.release 64d. (mg/m^2):	5463673	356263	2034
Leaching-perc. 64d. (%):	69.2	81.6	1.3
Mean factor above DTL :	99524	6490	-
Cum.release calc. 1D 64d:	< 6111707	727245	< 2688
Cum.release calc. 3D 64d:	< 6122883	421014	< 4223
(mg/m^2)	Tortuosity	1	
Chemical Retention R:	3.8	1.0	7853
$R_{range-min}$:	1.1	.75	5133
$R_{range-max}$:	13	1.3	12014

Bottom Ash
Productcode: V1BA

Surf.area: .0324 m^2 Bulk Density : 2185 kg/m^3 1 October 1991
Weight : 1.80 kg Extraction volume: 8.47 L

Concentration in µg/L Time (days)	K	Na	Li	Br	Cl	NO3	SO4	Al	B	Ba
1	53200	68100	< 4	2570	173000	100	16800	1110	92.40	18
2	26400	31300	< 4	1350	71100	90	3280	858	41.70	15.70
4	38200	45200	5.90	2010	110000	110	2450	1550	41.30	27.70
8	57700	71300	11	3380	189000	100	3220	2260	59.50	46.60
16	66000	80900	14.80	4100	206000	180	3560	2470	86.30	53.30
32	71700	108000	29.50	12000	260000	670	5800	2600	98.20	83.60
64	145000	194000	48.40	9190	537000	680	9620	3120	169	146
pD_e (-log[m^2/s]) :	9.04	9.21	> 11.4	9.35	9.90	8.59	12.67	12.39	-	11.98
Standard deviation :	.14	.09	.51	.28	.13	.27	.11	.30	-	.15
Used data points :	1 - 7	1 - 7	1 - 7	1 - 7	1 - 7	1 - 5	3 - 7	1 - 7	-	2 - 7
Slope :	.48	.51	-	.65	.53	.54	.48	.49	(.4)	.60
Std.Dev. of slope :	.05	.03		.07	.04	.17	.07	.10	(.03)	.04
Deviat.slope=½ (3 fases):	+ - ≈	≈ ≈ +	? + +	+ + ≈	≈ ≈ +	+ + +	- ≈ +	+ - -	- ≈ ≈	+ ≈ +
Wash-off(mg/m^2),Diss/Lag:	≈	≈	(Lag)	(Lag)	≈	≈	3875	(Lag)		(Lag)
Total Concentrat.(mg/kg):	4300	26140	12.38	130.3	8393	2.14	41.91	33116	.000	561.4
Availability (mg/kg):	1390	2172	< 4.00	130.3	12096	2.14	5820	2085	-	34.74
Availability perc. (%):	32.32	8.31	< 32.31	100.00	144.11	100.00	13886.3	6.30	-	6.19
Mean factor above DTL :	14	72	(DTL)	3	121	2	58	417	-	10
Max.Cum.release (mg/m^2):	77222	120667	< 222.2	7239	672000	118.9	323333	115833	-	1930
Cum.release 64d. (mg/m^2):	119783	156538	31	9045	404181	505	11693	3652	-	102
Leaching-perc. 64d. (%):	155	130	14.0	125	60.1	425	3.6	3.2	-	5.3
Mean factor above DTL :	164	2851	3.9	10	442	28	13	181	-	56
Cum.release calc. 1D 64d:	122193	155835	< 24	7969	391436	313	7775	3862	-	103
Cum.release calc. 3D 64d:	74022	112313	< 36	6509	456182	118	12513	6063	-	163
(mg/m^2)	Tortuosity (Na):		2	range:	2 - 2					
Chemical Retention R:	1.1	1.0	-	2.1	7.5	.34	2582	554	-	404
$R_{range-min}$:	.77	.81	-	1.1	5.6	.18	1982	279	-	286
$R_{range-max}$:	1.5	1.2	-	4.0	10	.65	3364	1100	-	571
pD_e for R=1 will be ≥				9.0		9.1				
Availability(%) becomes ≥				68.7		170.6				

Bottom Ash — Surf.area .0324 m^2 — Bulk Density 2185 kg/m^3 — (continued)
Productcode: V1BA — Weight 1.80 kg — Extraction volume 8.47 L

Concentration in µg/L Time (days)	Ca	Cd	Cr	Cu	Fe	Mg	Ni	Pb	Si	Sr	Zn
1	21200	< .2	< 3	< 4	145	189		5	848	52.80	8.90
2	15600	< .2	< 3	< 4	46	48.60		6.30	985	45.30	10.80
4	27300	.30	5.40	4.20	48.10	73.10		5.20	1690	94.80	26.80
8	28900	.30	3.90	6.20	184	138		2.90	2480	208	23.60
16	27000	< .2	< 3	6.10	910	142		25.50	2690	287	14.70
32	31200	< .2	5.90	4.20	305	109		< 1	2330	396	4.20
64	53100	< .2	< 3	< 4	103	241		1.80	2190	728	16.60
pD_e (-log[m^2/s]) :	12.48	> 14.9	> 12.1	> 14.4	12.96	> 14.4	-	15.21	12.47	> 10.6	14.62
Standard deviation :	.30	.16	.42	.43	.25	.30	-	1.45	.12	.10	.26
Used data points :	1 - 7	1 - 7	1 - 7	1 - 7	1 - 3	1 - 7	-	4 - 7	2 - 5	4 - 7	2 - 4
Slope :	.40	-	-	-	.09	.34	-	-	.49	.59	.56
Std.Dev. of slope :	.09				.01	.07			.11	.07	.43
Deviat.slope=½ (3 fases):	+ - ≈	? + ?	? - ?	? ≈ -	- + -	- - ≈		+ + -	+ - -	+ + +	+ - -
Wash-off(mg/m^2),Diss/Lag:	≈	(Lag)	(Lag)	(Lag)	9.35	≈17.18		?≈	(Lag)	(Lag)	(Lag)
Total Concentrat.(mg/kg):	116800	26.06	237.8	1422	127800	.000	377.9	1531	140480	.000	3887
Availability (mg/kg):	34745	9.34	4.34	60.80	238.9	(1389.8)	7.82	112.9	3257	(36.92)	477.7
Availability perc. (%):	29.75	35.84	1.83	4.27	.19	#VALUE!	2.07	7.38	2.32	#VALUE!	12.29
Mean factor above DTL :	695	47	2	30	239	-	2	113	163	-	239
Max.Cum.release (mg/m^2):	1930278	518.9	241.1	3378	13272	(77211)	434.4	6272	180944	(2051)	26539
Cum.release 64d. (mg/m^2):	53408	< .4	< 7.1	< 8.5	455	246	-	12	3454	474	28
Leaching-perc. 64d. (%):	2.8	< .08	< 2.9	< .3	3.4	.3	-	.2	1.9	23.1	.1
Mean factor above DTL :	1459	(DTL)	(DTL)	(DTL)	50	134	-	7	86	130	8
Cum.release calc. 1D 64d:	58097	< .94	< 11	< 11	230	< 253	-	8.1	5480	< 544	68
Cum.release calc. 3D 64d: (mg/m^2)	93192	< 1.6	< 18	< 18	371	< 414	-	13	8789	< 756	110
Chemical Retention R:	1094	276366	373	104296	2960	82429	-	767947	-	-	163967
$R_{range-min}$:	549	190725	140	38324	1676	41615	-	26974	-	-	89569
$R_{range-max}$:	2180	400462	992	283836	5229	163270	-	21863404	-	-	300164

pD_e for R=1 will be ≥
Availability(%) becomes ≥

Bottom Ash
Productcode: V1BA

Concentration in µg/L Time (days)	TDS	Na	TOC
1	346000	68100	2190
2	120000	31300	1230
4	171000	45200	1430
8	375000	71300	2670
16	450000	80900	2350
32	556000	108000	1000
64	1030000	194000	2090

pD_e (-log[m^2/s]) :	> 9.7	9.21	> 13.4
Standard deviation :	.16	.09	.15
Used data points :	1 - 7	1 - 7	1 - 4
Slope :	.57	.51	(.6)
Std.Dev. of slope :	.04	.03	(.10)
Deviat.slope=½ (3 fases):	¤ ¤ ¤	¤ ¤ +	¤ – –
Wash-off(mg/m^2),Diss/Lag:	¤	¤	¤
Total Concentrat.(mg/kg):	18675	26140	10076
Availability (mg/kg):	18675	2172	(10076.0)
Availability perc. (%):	100.00	8.31	(100)
Mean factor above DTL :	-	72	-
Max.Cum.release (mg/m^2):	< 1037500	120667	(559778)
Cum.release 64d. (mg/m^2):	796807	156538	3388
Leaching-perc. 64d. (%):	76.8	130	.6
Mean factor above DTL :	14514	2851	-
Cum.release calc. 1D 64d:	< 748240	155835	< 5593
Cum.release calc. 3D 64d:	< 804149	112313	< 9449
(mg/m^2)	Tortuosity	2	
Chemical Retention R:	2.6	1.0	13637
$R_{range-min}$:	1.8	.81	9570
$R_{range-max}$:	3.8	1.2	19430

Bottom Ash — Surf.area: .0324 m^2 — Bulk Density : 2064 kg/m^3 — 1 October 1991

Productcode: V1BB — Weight : 1.70 kg — Extraction volume: 8.47 L

Concentration in µg/L Time (days)	K	Na	Li	Br	Cl	NO3	SO4	Al	B	Ba
1	52700	68400	< 4	2620	170000	120	16700	1120	97.30	17.80
2	62100	80000	5.60	3700	220000	150	30200	2000	89.80	30.20
4	3400	41500	< 4	1910	104000	90	2240	1720	40.40	40.20
8	56700	70700	8.10	3060	171000	120	2730	2540	67.30	60.70
16	63400	77700	14.80	3840	208000	190	2840	2620	104	83.80
32	59200	90500	26.30	5500	240000	770	4000	2630	102	86.60
64	103000	139000	12.50	6440	388000	760	6390	2820	156	112
pD_e ($-\log[m^2/s]$) :	9.25	9.50	> 11.6	9.51	9.91	8.81	13.06	11.85	-	11.82
Standard deviation :	.24	.11	.46	.05	.08	.05	.17	.03	-	.03
Used data points :	4 - 7	3 - 5	1 - 7	3 - 6	3 - 5	3 - 5	3 - 7	3 - 4	-	2 - 5
Slope :	.25	.45	.60	.49	.50	.54	.36	.56	(.3)	.50
Std.Dev. of slope :	.13	.18	.15	.05	.13	.07	.07	?	(.10)	.02
Deviat.slope=½ (3 fases):	- + ≈	≈ ≈ ≈	? + -	+ ≈ ≈	≈ ≈ ≈	+ + +	- - ≈	+ - -	- ≈ -	+ ≈ -
Wash-off(mg/m^2),Diss/Lag:	?≈	?≈	≈	?≈	?≈	?≈	?≈	(Lag)		(Lag)
Total Concentrat.(mg/kg):	3700	26500	11.76	147.3	7860	2.97	34.00	32521	.000	596.4
Availability (mg/kg):	1589	3178	< 4.00	147.3	12860	2.97	7479	1928	-	44.49
Availability perc. (%):	42.95	11.99	< 34.01	100.00	163.61	100.00	21996.5	5.93	-	7.46
Mean factor above DTL :	16	106	(DTL)	3	129	3	75	386	-	13
Max.Cum.release (mg/m^2):	83373	166747	< 209.9	7729	674753	155.8	392417	101160	-	2334
Cum.release 64d. (mg/m^2):	104699	148434	20	7077	392391	575	17018	4039	-	113
Leaching-perc. 64d. (%):	126	89.0	9.5	91.6	58.2	369	4.3	4.0	-	4.8
Mean factor above DTL :	143	2704	2.7	8	429	31	19	201	-	62
Cum.release calc. 1D 64d:	102711	154220	< 18	7078	390420	321	6041	6275	-	150
Cum.release calc. 3D 64d:	76901	142240	< 27	6570	456072	153	9767	9890	-	236
(mg/m^2)	Tortuosity (Na):		4	range:	3 - 5					
Chemical Retention R:	.90	1.0	-	1.6	3.9	.29	3231	82	-	144
$R_{range-min}$:	.52	.77	-	1.4	3.3	.26	2160	77	-	136
$R_{range-max}$:	1.6	1.3	-	1.8	4.6	.32	4834	87	-	153
pD_e for R=1 will be ≥	9.3			9.3		9.3				
Availability(%) becomes ≥	45.2			79.8		186.0				

Bottom Ash
Productcode: V1BB

Surf.area .0324 m^2 Bulk Density 2064 kg/m^3 (continued)
Weight 1.70 kg Extraction volume 8.47 L

Concentration in µg/L Time (days)	Ca	Cd	Cr	Cu	Fe	Mg	Ni	Pb	Si	Sr	Zn
1	20900	< .2	7.20	< 4	69.60	224	10.80	4.20	931	51.30	10.40
2	37100	.30	4.10	< 4	112	290	< 5	7.30	845	99.20	14
4	27000	.40	< 3	< 4	18	60.20	< 5	2.30	1750	96.20	8.60
8	30500	< .2	< 3	< 4	17.70	72	< 5	1.40	2380	209	15.30
16	31800	< .2	3.90	8.10	25.10	59	6.30	1.50	2560	299	16
32	27300	< .2	6.50	< 4	131	99	< 5	< 1	2410	341	4.50
64	35500	< .2	< 3	< 4	499	155	< 5	1.60	2090	510	22.70
pD_e (-log[m^2/s]) :	13.17	> 14.5	> 11.8	> 14.2	14.52	> 14.5	> 12.9	15.97	12.50	> 10.9	15.46
Standard deviation :	.05	.04	.44	-	.00	.81	.43	.17	.17	.09	.14
Used data points :	6 - 7	1 - 7	1 - 7	1 - 7	4 - 5	1 - 7	1 - 7	4 - 5	2 - 5	4 - 7	3 - 5
Slope :	.38	-	-	-	.50	.02	-	.10	.52	.41	.45
Std.Dev. of slope :	?				?	.18		?	.15	.05	.22
Deviat.slope=½ (3 fases):	+ - -	+ ? ?	+ + +		- + +	- - +	? ? ?	≈ - -	+ - -	+ ≈ ≈	+ - -
Wash-off(mg/m^2),Diss/Lag:	?≈	(Lag)	≈.888	(Lag)	?≈	?≈	≈	?≈	(Lag)	(Lag)	≈
Total Concentrat.(mg/kg):	114500	21.82	260.6	1917	132700	.000	404.7	1568	137460	.000	3930
Availability (mg/kg):	46610	9.53	3.39	67.80	296.6	(1652.5)	15.89	108.1	3390	(48.73)	635.6
Availability perc. (%):	40.71	43.68	1.30	3.54	.22	#VALUE!	3.93	6.89	2.47	#VALUE!	16.17
Mean factor above DTL :	932	48	2	34	297	-	4	108	169	-	318
Max.Cum.release (mg/m^2):	2445586	500.0	177.9	3557	15562	(86705)	833.7	5672	177870	(2557)	33349
Cum.release 64d. (mg/m^2):	54924	< .4	< 8.0	< 8.4	228	251	< 11	5.05	3390	420	24
Leaching-perc. 64d. (%):	2.2	< .08	< 4.5	< .2	1.5	.3	< 1.3	.09	1.9	16.4	.07
Mean factor above DTL :	1501	(DTL)	(DTL)	(DTL)	25	137	(DTL)	2.8	84	115	7
Cum.release calc. 1D 64d:	33043	< 1.5	< 12	< 14	45	< 242	< 16	3.1	5202	< 485	32
Cum.release calc. 3D 64d:	53475	< 2.4	< 18	< 23	73	< 414	< 25	5.0	8346	< 697	53
(mg/m^2)											
Chemical Retention R:	2785	53271	98	33032	54951	58161	1204	2241130	-	-	581965
$R_{range-min}$:	2473	49014	35	-	54739	9014	449	1513495	-	-	424632
$R_{range-max}$:	3136	57898	273	-	55164	375284	3228	3318586	-	-	797593

pD_e for R=1 will be ≥
Availability(%) becomes ≥

Bottom Ash
Productcode: V1BB

Concentration in µg/L Time (days)	TDS	Na	TOC
1	290000	68400	2180
2	567000	80000	2390
4	76000	41500	1290
8	326000	70700	2640
16	399000	77700	2250
32	446000	90500	1000
64	768000	139000	1740

pD_e (-log[m^2/s]) :	> 9.6	9.50	> 13.2
Standard deviation :	.61	.11	.40
Used data points :	1 - 7	3 - 5	1 - 4
Slope :	.40	.45	(.5)
Std.Dev. of slope :	.21	.18	(.36)
Deviat.slope=½ (3 fases):	- + =	= = =	= - -
Wash-off(mg/m^2),Diss/Lag:	?=	?=	=
Total Concentrat.(mg/kg):	16949	26500	9544
Availability (mg/kg):	16949	3178	9544
Availability perc. (%):	100.00	11.99	100.00
Mean factor above DTL :	-	106	-
Max.Cum.release (mg/m^2):	< 889299	166747	< 500765
Cum.release 64d. (mg/m^2):	750798	148434	3527
Leaching-perc. 64d. (%):	84.4	89.0	.7
Mean factor above DTL :	13676	2704	-
Cum.release calc. 1D 64d:	< 726247	154220	< 6410
Cum.release calc. 3D 64d: (mg/m^2)	< 726557	142240	< 10626
	Tortuosity	4	
Chemical Retention R:	1.0	1.0	4262
$R_{range-min}$:	.26	.77	1708
$R_{range-max}$:	4.3	1.3	10634

Bottom Ash
Productcode: V1BC

Surf.area: .0324 m^2 Bulk Density : 2052 kg/m^3 1 October 1991
Weight : 1.69 kg Extraction volume: 8.47 L

Concentration in µg/L Time (days)	K	Na	Li	Br	Cl	NO3	SO4	Al	B	Ba
1	63300	84600	9.50	< 500	141000	170	2712	2140	94.30	29.90
2	29400	38200	5.60	1740	99700	70	4090	1170	54.90	21.30
4	45600	59000	5.10	3020	154000	80	3970	1940	53.20	35.80
8	62200	75700	< 5	3060	171000	120	2730	2230	46.20	39.10
16	79100	98100	12.60	5130	237000	200	3430	2620	81.40	59.50
32	139000	213000	36.70	13000	590000	1000	8100	2570	125	94.50
64	156000	217000	54.60	10700	573000	960	8560	2760	154	129
pD_e (-log[m^2/s]) :	9.02	9.35	> 11.3	9.53	9.59	8.86	13.30	9.97	-	11.54
Standard deviation :	.09	.07	.46	.12	.18	.09	.19	.15	-	.08
Used data points :	1 - 7	1 - 5	1 - 7	2 - 5	2 - 7	1 - 5	4 - 7	1 - 5	-	2 - 7
Slope :	.52	.50	.70	.47	.54	.48	.62	.51	(.4)	.51
Std.Dev. of slope :	.03	.04	.13	.11	.08	.05	.15	.09	(.06)	.04
Deviat.slope=½ (3 fases):	+ ≈ ≈	+ ≈ ≈	≈ + +	+ + ≈	+ + +	- + +	+ - +	+ - -	≈ ≈ ≈	+ ≈ ≈
Wash-off(mg/m^2),Diss/Lag:	≈	≈	≈	(Lag)	(Lag)	≈	?≈	≈		(Lag)
Total Concentrat.(mg/kg):	5600	23690	12.38	192.8	9693	3.25	50.38	32421	.000	629.8
Availability (mg/kg):	1796	3286	< 4.00	192.8	11851	3.25	12443	194.3	-	24.10
Availability perc. (%):	32.08	13.87	< 32.31	100.00	122.26	100.00	24697.3	.60	-	3.83
Mean factor above DTL :	18	110	(DTL)	4	119	3	124	39	-	7
Max.Cum.release (mg/m^2):	93680	171399	< 208.6	10057	618154	169.5	649033	10135	-	1257
Cum.release 64d. (mg/m^2):	150212	205371	34	9712	513873	680	8782	4034	-	107
Leaching-perc. 64d. (%):	160	120	16.3	96.6	83.1	401	1.4	39.8	-	8.5
Mean factor above DTL :	205	3741	3.8	11	562	37	10	200	-	58
Cum.release calc. 1D 64d:	150278	188911	< 25	9049	517698	329	7577	5453	-	112
Cum.release calc. 3D 64d:	89932	154148	< 37	8494	507645	165	12275	6534	-	174
(mg/m^2)	Tortuosity (Na):		3	range:	2 - 3					
Chemical Retention R:	.76	1.0	-	2.3	2.6	.46	7979	1.6	-	106
$R_{range-min}$:	.62	.86	-	1.8	1.8	.37	5146	1.1	-	88
$R_{range-max}$:	.92	1.2	-	3.0	4.0	.57	12370	2.2	-	127
pD_e for R=1 will be ≥	9.1			9.2		9.2				
Availability(%) becomes ≥	36.9			65.8		147.3				

Bottom Ash — Surf.area .0324 m^2 — Bulk Density 2052 kg/m^3 — (continued)
Productcode: V1BC — Weight 1.69 kg — Extraction volume 8.47 L

Concentration in µg/L Time (days)	Ca	Cd	Cr	Cu	Fe	Mg	Ni	Pb	Si	Sr	Zn
1	39200			< 4	613	476	< 5	4.40	983	107	12.30
2	21800			< 4	193	126	< 5	1.30	1990	73.40	14.60
4	33900			4.20	76.90	75.70	< 5	2.60	1970	139	6.50
8	32400			< 4	21.50	82.50	< 5	< 1	1830	224	9.40
16	33600			7.10	18.60	57.70	6.60	< 1	2610	364	10.90
32	53000			6.30	18.50	453	< 5	< 1	2410	657	4.50
64	58900			< 4	58	241	< 5	< 1	2250	848	11.20
pD_e (-log[m^2/s]) :	12.86	-	-	> 12.7	12.74	> 14.5	> 14.5	> 12.7	11.80	> 10.8	14.28
Standard deviation :	.14	-	-	.29	.22	.69	-	.93	.01	.12	.09
Used data points :	4 - 6	-	-	1 - 7	5 - 6	1 - 7	1 - 7	1 - 7	4 - 5	3 - 5	3 - 5
Slope :	.35	-	-	-	-.01	.20	-	-	.51	.69	.37
Std.Dev. of slope :	.17				?	.19			?	.00	.09
Deviat.slope=⅓ (3 fases):	+ - ≈			? + ≈	- - +	- + +		≈ ? ?	+ - -	+ + +	≈ - -
Wash-off(mg/m^2),Diss/Lag:	3753			(Lag)	205.8	≈100.5	(Lag)	≈.830	≈	(Lag)	?≈
Total Concentrat.(mg/kg):	115000	31.76	259.6	1906	120300	.000	363.6	2103	123150	.000	3910
Availability (mg/kg):	67908	2.04	< 1.97	9.86	23.90	(2103.0)	(72.73)	3.07	1358	(50.38)	111.7
Availability perc. (%):	59.05	6.42	< .76	.52	.02	#VALUE!	(20)	.15	1.10	#VALUE!	2.86
Mean factor above DTL :	1358	10	(DTL)	5	24	-	-	3	68	-	56
Max.Cum.release (mg/m^2):	3542115	106.4	< 102.8	514.3	1247	(109694)	(3794)	160.1	70834	(2628)	5826
Cum.release 64d. (mg/m^2):	71315	-	-	< 8.8	261	395	< 9.6	< 3.2	3671	631	18
Leaching-perc. 64d. (%):	2.0	-	-	< 1.7	20.9	.4	< .3	< 2.0	5.2	24.0	.3
Mean factor above DTL :	1949	-	-	(DTL)	29	216	(DTL)	1.7	91	172	4.9
Cum.release calc. 1D 64d:	68978	-	-	< 11	28	< 333	< 12	< 3.9	4639	< 567	22
Cum.release calc. 3D 64d: (mg/m^2)	111261	-	-	< 19	45	< 524	< 18	< 6.0	7296	< 794	36
Chemical Retention R:	1904	-	-	1557	1293	69996	64771	1586	-	-	54355
$R_{range-min}$:	1390	-	-	807	786	14425	-	188	-	-	43731
$R_{range-max}$:	2608	-	-	3003	2127	339660	-	13374	-	-	67561

pD_e for R=1 will be ≥
Availability(%) becomes ≥

Bottom Ash
Productcode: V1BC

Concentration in µg/L Time (days)	TDS	Na	TOC
1	415000	84600	2540
2	263000	38200	1400
4	349000	59000	1840
8	390000	75700	2310
16	460000	98100	2560
32	1100000	213000	2000
64	1110000	217000	2110
pD_e (-log[m^2/s]) :	> 9.4	9.35	> 13.4
Standard deviation :	.18	.07	.11
Used data points :	1 - 7	1 - 5	1 - 4
Slope :	.50	.50	(.5)
Std.Dev. of slope :	.06	.04	(.10)
Deviat.slope=½ (3 fases):	+ = +	+ = =	+ - -
Wash-off(mg/m^2),Diss/Lag:	=	=	=
Total Concentrat.(mg/kg):	19167	23690	11610
Availability (mg/kg):	19168	3286	(11610.0)
Availability perc. (%):	100.00	13.87	(100)
Mean factor above DTL :	-	110	-
Max.Cum.release (mg/m^2):	< 999812	171399	(605583)
Cum.release 64d. (mg/m^2):	1068423	205371	3859
Leaching-perc. 64d. (%):	107	120	.6
Mean factor above DTL :	19462	3741	-
Cum.release calc. 1D 64d:	< 1069187	188911	< 6158
Cum.release calc. 3D 64d:	< 885573	154148	< 10222
(mg/m^2)	Tortuosity	3	
Chemical Retention R:	.87	1.0	9589
$R_{range-min}$:	.57	.86	7446
$R_{range-max}$:	1.3	1.2	12349

Combined Ash | Surf.area: .0324 m^2 | Bulk Density : 1469 kg/m^3 | 1 October 1991
Productcode: V1CA | Weight : 1.21 kg | Extraction volume: 8.47 L

Concentration in µg/L Time (days)	K	Na	Li	Br	Cl	NO3	SO4	Al	B	Ba
1	48900	42000	22.40	1910	161000	60	30300	2740	141	64.10
2	30500	27200	10.70	540	114000	80	2790	1450	60.20	38
4	56100	49400	< 4	2540	172000	60	10100	1860	77.80	55.30
8	66500	70700	< 4	3100	158000	40	8000	2030	53.20	72.50
16	103000	103000	27.30	4740	298000	190	12100	2860	146	124
32	166000	209000	29.50	11000	690000	630	26000	3110	171	176
64	165000	193000	51.40	7860	553000	540	23900	3590	124	225
pD_e (-log[m^2/s]) :	9.25	9.29	-	9.16	9.81	> 6.7	12.37	12.36	-	11.78
Standard deviation :	.11	.15	-	.23	.23	.65	.24	.14	-	.07
Used data points :	2 - 6	3 - 7	-	3 - 7	2 - 7	1 - 7	3 - 7	1 - 5	-	2 - 7
Slope :	.58	.55	-	.51	.52	.80	.42	.42	(.3)	.53
Std.Dev. of slope :	.05	.09		.14	.10	.18	.14	.07	(.09)	.03
Deviat.slope=½ (3 fases):	+ ≈ −	+ + ≈	+ + +	+ + ≈	+ + ≈	+ + +	− ≈ ≈	+ − −	≈ ≈ −	+ ≈ ≈
Wash-off(mg/m^2),Diss/Lag:	(Lag)	(Lag)		(Lag)	(Lag)	(Opl)	4124	≈		(Lag)
Total Concentrat.(mg/kg):	5465	31213	12.57	176.0	13661	.340	46.23	32568	.000	1443
Availability (mg/kg):	3930	4367	-	176.0	23362	< .340	20131	4585	-	80.79
Availability perc. (%):	71.91	13.99	-	100.00	171.01	< 100.00	43545.3	14.08	-	5.60
Mean factor above DTL :	39	146	-	4	234	(DTL)	201	917	-	23
Max.Cum.release (mg/m^2):	146769	163089	-	6573	872470	< 12.70	751806	171230	-	3017
Cum.release 64d. (mg/m^2):	166263	181504	-	8284	561007	418	29590	4611	-	197
Leaching-perc. 64d. (%):	113	111	-	126	64.3	3292	3.9	2.7	-	6.5
Mean factor above DTL :	227	3306	-	9	613	23	32	229	-	108
Cum.release calc. 1D 64d:	181956	192316	-	8985	564142	< 282	25608	5923	-	202
Cum.release calc. 3D 64d: (mg/m^2)	135549	149049	-	6177	630565	< 13	40982	9476	-	318
	Tortuosity (Na):		2	range:	2 - 3					
Chemical Retention R:	1.4	1.0	-	1.1	5.1	.00	1073	429	-	214
$R_{range-min}$:	1.1	.70	-	.68	3.0	.00	622	312	-	183
$R_{range-max}$:	1.9	1.4	-	1.9	8.5	.02	1851	591	-	250
pD_e for R=1 will be ≥				9.1						
Availability(%) becomes ≥				93.5						

Combined Ash
Productcode: V1CA

Surf.area .0324 m^2 Bulk Density 1469 kg/m^3 (continued)
Weight 1.21 kg Extraction volume 8.47 L

Concentration in µg/L Time (days)	Ca	Cd	Cr	Cu	Fe	Mg	Ni	Pb	Si	Sr	Zn
1	43100		58.70	74.80	536	657	38.80	4.60	871	154	119
2	24400		18.90	28.30	198	226	11.10	5.30	791	94	42.30
4	34600		< 3	23.90	123	83.80	< 5	5.20	1020	146	9.50
8	34800		< 3	25	130	71.80	< 5	1.70	1240	213	9.20
16	37500		22.70	104	371	260	31.70	24.10	1410	391	59.50
32	66300		4.80	51	32.80	787	< 5	< 1	1430	794	3.80
64	85400		< 3	35.20	295	362	< 5	2.80	1040	1130	16
pD_e ($-\log[m^2/s]$) :	13.14	-	10.54	12.96	11.07	> 14.0	> 10.9	14.86	12.96	> 10.9	16.53
Standard deviation :	.10	-	1.18	.55	.50	.68	.18	.70	.26	.14	.67
Used data points :	4 - 7	-	1 - 7	1 - 7	2 - 4	1 - 7	1 - 7	1 - 4	3 - 6	2 - 5	6 - 7
Slope :	.47	-	-	.21	-.30	.28	-	.10	.16	.67	2.07
Std.Dev. of slope :	.09			.14	.22	.21		.57	.04	.05	?
Deviat.slope=1 (3 fases):	+ - =		- - -	- = -	- - -	- + -	- ? ?	+ + -	+ - -	+ + +	- - -
Wash-off(mg/m^2),Diss/Lag:	?=		13.01	11.16	99.21	=140.6	=2.37	?=	=	(Lag)	40.70
Total Concentrat.(mg/kg):	136393	25.79	139.9	1301	103169	.000	145.4	1683	161735	.000	3541
Availability (mg/kg):	148472	10.04	3.93	137.6	91.70	(2620.1)	8.73	165.9	4148	(76.42)	786.0
Availability perc. (%):	108.86	38.93	2.81	10.58	.09	#VALUE!	6.01	9.86	2.56	#VALUE!	22.20
Mean factor above DTL :	2969	50	2	69	92	-	2	166	207	-	393
Max.Cum.release (mg/m^2):	5544788	375.0	146.8	5139	3425	(97849)	326.0	6196	154910	(2854)	29354
Cum.release 64d. (mg/m^2):	85249	-	< 30	89	441	640	< 27	12	2040	764	68
Leaching-perc. 64d. (%):	1.5	-	< 20.4	1.7	12.9	.7	< 8.3	.2	1.3	26.8	.2
Mean factor above DTL :	2329	-	5	12	48	350	3	7	51	209	19
Cum.release calc. 1D 64d:	78261	-	41	89	524	< 536	< 64	12	2682	< 552	8.3
Cum.release calc. 3D 64d: (mg/m^2)	126621	-	57	144	786	< 830	< 89	19	4332	< 778	14
Chemical Retention R:	4148	-	8.6	2937	32	24595	19	287655	-	-	11202702
$R_{range-min}$:	3265	-	.56	831	9.9	5191	12	57603	-	-	2394629
$R_{range-max}$:	5270	-	131	10383	100	116538	29	1436476	-	-	52409188

pD_e for R=1 will be ≥
Availability(%) becomes ≥

Combined Ash
Productcode: V1CA

Concentration in µg/L Time (days)	TDS	Na	TOC
1	287000	42000	4720
2	133000	27200	2610
4	390000	49400	3970
8	477000	70700	4470
16	681000	103000	2930
32	1240000	209000	3000
64	1130000	193000	3660

pD_e (-log[m^2/s]) :	> 9.4	9.29	> 12.7
Standard deviation :	.32	.15	.14
Used data points :	1 - 7	3 - 7	1 - 4
Slope :	.66	.55	(.6)
Std.Dev. of slope :	.08	.09	(.12)
Deviat.slope=½ (3 fases):	+ ≈ ≈	+ + ≈	+ − −
Wash-off(mg/m^2),Diss/Lag:	(Lag)	(Lag)	≈
Total Concentrat.(mg/kg):	25245	31213	14316
Availability (mg/kg):	25246	4367	14317
Availability perc. (%):	100.00	13.99	100.01
Mean factor above DTL :	-	146	-
Max.Cum.release (mg/m^2):	< 942829	163089	< 534678
Cum.release 64d. (mg/m^2):	1134039	181504	6630
Leaching-perc. 64d. (%):	120	111	1.2
Mean factor above DTL :	20657	3306	-
Cum.release calc. 1D 64d:	< 1037837	192316	< 12010
Cum.release calc. 3D 64d:	< 835101	149049	< 20064
(mg/m^2)	Tortuosity	2	
Chemical Retention R:	.94	1.0	2250
$R_{range-min}$:	.45	.70	1628
$R_{range-max}$:	1.9	1.4	3108

Combined Ash
Productcode: V1CB

Surf.area: .0324 m^2
Weight : 1.22 kg

Bulk Density : 1481 kg/m^3
Extraction volume: 8.47 L

1 October 1991

Concentration in µg/L Time (days)	K	Na	Li	Br	Cl	NO3	SO4	Al	B	Ba
1	46300	39100	6.70	1800	157000	50	21800	1590	110	49.90
2	30600	28100	5	1280	106000	110	7800	1280	38.50	36.30
4	59700	58200	< 5	2390	161000	50	9130	2270	75.30	72.90
8	65100	70300	5.90	2940	197000	40	6960	2070	51.50	77.60
16	97500	95500	8.90	3880	272000	120	11400	2850	122	85.10
32	147000	183000	28.60	8900	900000	740	25000	3060	172	145
64	161000	186000	15.60	7420	492000	760	22800	3770	184	180
pD_e (-log[m^2/s]) :	8.92	9.33	> 11.5	9.40	10.00	> 6.7	12.37	12.74	-	12.16
Standard deviation :	.10	.12	.03	.10	.07	.79	.15	.15	-	.10
Used data points :	3 - 6	3 - 6	3 - 5	2 - 5	2 - 5	1 - 7	1 - 3	4 - 6	-	4 - 7
Slope :	.45	.54	.51	.51	.44	.85	.26	.28	(.4)	.44
Std.Dev. of slope :	.08	.11	.05	.09	.04	.22	.02	.10	(.07)	.08
Deviat.slope-i (3 fases):	+ ≈ ≈	+ ≈ ≈	+ + ≈	+ + ≈	+ + ≈	+ + +	- ≈ ≈	+ - -	+ ≈ -	+ - ≈
Wash-off(mg/m^2),Diss/Lag:	(Lag)	(Lag)	≈	(Lag)	(Lag)	≈	≈	≈		(Lag)
Total Concentrat.(mg/kg):	4731	35376	12.04	186.0	13978	.310	111.8	30860	.000	865.6
Availability (mg/kg):	2700	4600	< 4.30	186.0	26452	< .310	30108	5591	-	105.4
Availability perc. (%):	57.07	13.00	< 35.71	100.00	189.23	< 100.00	26922.6	18.12	-	12.17
Mean factor above DTL :	27	153	(DTL)	4	265	(DTL)	301	1118	-	30
Max.Cum.release (mg/m^2):	101667	173210	< 161.9	7004	996032	< 11.67	1133696	210525	-	3969
Cum.release 64d. (mg/m^2):	158734	172589	20	7479	597344	489	27420	4415	-	169
Leaching-perc. 64d. (%):	156	99.6	12.4	107	60.0	4189	2.4	2.1	-	4.3
Mean factor above DTL :	217	3144	2.3	8	653	27	30	219	-	92
Cum.release calc. 1D 64d:	183394	195209	< 15	7296	522071	< 282	38826	4682	-	172
Cum.release calc. 3D 64d:	98690	156649	< 23	6205	631096	< 12	62137	7543	-	274
(mg/m^2)	Tortuosity (Na):		3	range:	2 - 3					
Chemical Retention R:	.62	1.0	-	1.8	7.1	.00	969	948	-	468
$R_{range-min}$:	.50	.75	-	1.4	6.1	.00	693	679	-	371
$R_{range-max}$:	.78	1.3	-	2.3	8.2	.02	1357	1325	-	591
pD_e for R=1 will be ≥	9.1			9.1						
Availability(%) becomes ≥	72.2			74.5						

Combined Ash — Surf.area .0324 m^2 — Bulk Density 1481 kg/m^3 — (continued)
Productcode: V1CB — Weight 1.22 kg — Extraction volume 8.47 L

Concentration in µg/L Time (days)	Ca	Cd	Cr	Cu	Fe	Mg	Ni	Pb	Si	Sr	Zn
1	35700		12.40	29.90	194	237	< 5	5.70	1400	117	32.50
2	23400		4.10	16.60	49.20	93.50	< 5	1.50	664	88.30	12.40
4	38800		3.80	29.10	65	70.30	< 5	1.70	1280	165	10.60
8	32700		< 3	31.20	48.70	66.20	< 5	1.10	1460	201	4.30
16	28900		3.20	35.20	34	101	< 5	24.50	1480	254	12.40
32	47400		14.80	56.20	177	874	14.40	< 1	1600	522	21.60
64	59800		< 3	20.40	429	406	< 5	3.60	1770	773	21.50
pD_e (-log[m^2/s]) :	13.36	-	> 11.0	13.65	12.57	> 15.1	> 12.4	15.59	13.21	> 11.4	16.52
Standard deviation :	.07	-	.29	.17	.04	.57	-	.14	.08	.15	.15
Used data points :	5 - 7	-	1 - 3	1 - 6	2 - 3	1 - 7	1 - 7	2 - 3	1 - 2	3 - 7	5 - 7
Slope :	.52	-	.03	.48	.40	.52	-	.18	.70	.58	.40
Std.Dev. of slope :	.11		.08	.07	?	.20		?	?	.08	.23
Deviat.slope=½ (3 fases):	+ - ≈		- ≈ +	+ - -	- ≈ +	- + +		- + -	+ - -	+ ≈ +	- ≈ ≈
Wash-off(mg/m^2),Diss/Lag:	5759		≈1.01	≈	21.13	≈21.14	(Lag)	.683	≈	(Lag)	7.74
Total Concentrat.(mg/kg):	127526	20.65	112.9	1527	102688	.000	125.8	1247	164662	.000	2946
Availability (mg/kg):	133333	49.46	< 3.01	258.1	236.6	(6666.7)	14.62	215.1	6452	(139.8)	2086
Availability perc. (%):	104.55	239.52	< 2.67	16.90	.23	#VALUE!	11.62	17.24	3.92	#VALUE!	70.80
Mean factor above DTL :	2667	247	(DTL)	129	237	-	4	215	323	-	1043
Max.Cum.release (mg/m^2):	5020564	1862	< 113.3	9719	8909	(251030)	550.5	8099	242946	(5264)	78547
Cum.release 64d. (mg/m^2):	69721	-	12	57	261	483	< 12	10	2524	554	30
Leaching-perc. 64d. (%):	1.4	-	10.6	.6	2.9	.2	< 2.2	.1	1.0	10.5	.04
Mean factor above DTL :	1905	-	2.2	8	29	264	(DTL)	5	63	151	8
Cum.release calc. 1D 64d:	54820	-	< 19	76	240	< 355	< 18	6.8	3133	< 573	23
Cum.release calc. 3D 64d: (mg/m^2)	88854	-	< 28	123	386	< 601	< 29	11	5073	< 844	37
Chemical Retention R:	6331	-	21	13282	928	337165	599	1397736	-	-	9804232
$R_{range-min}$:	5421	-	11	9016	843	89797	-	1021970	-	-	6886493
$R_{range-max}$:	7395	-	41	19565	1022	1265963	-	1911667	-	-	13958189

pD_e for R=1 will be ≥
Availability(%) becomes ≥

Combined Ash
Productcode: V1CB

Concentration in µg/L Time (days)	TDS	Na	TOC
1	< 30	39100	4080
2	< 30	28100	2680
4	< 30	58200	4110
8	< 30	70300	4980
16	529000	95500	2460
32	1100000	183000	3000
64	1110000	186000	3080
pD_e (-log[m^2/s]) :	> 9.3	9.33	> 12.7
Standard deviation :	.18	.12	.21
Used data points :	1 - 7	3 - 6	1 - 4
Slope :	-	.54	(.7)
Std.Dev. of slope :		.11	(.14)
Deviat.slope=½ (3 fases):	? + +	+ ¤ ¤	+ - -
Wash-off(mg/m^2),Diss/Lag:	(Lag)	(Lag)	¤
Total Concentrat.(mg/kg):	25806	35376	13010
Availability (mg/kg):	25806	4600	13011
Availability perc. (%):	100.00	13.00	100.01
Mean factor above DTL :	-	153	-
Max.Cum.release (mg/m^2):	< 971707	173210	< 489920
Cum.release 64d. (mg/m^2):	< 716060	172589	6376
Leaching-perc. 64d. (%):	< 73.7	99.6	1.3
Mean factor above DTL :	13043	3144	-
Cum.release calc. 1D 64d:	< 1091091	195209	< 12081
Cum.release calc. 3D 64d:	< 886211	156649	< 18385
(mg/m^2)	Tortuosity	3	
Chemical Retention R:	.82	1.0	1705
$R_{range-min}$:	.54	.75	1055
$R_{range-max}$:	1.3	1.3	2757

Combined Ash Surf.area: .0324 m^2 Bulk Density : 1590 kg/m^3 1 October 1991
Productcode: V1CC Weight : 1.31 kg Extraction volume: 8.47 L

Concentration in µg/L Time (days)	K	Na	Li	Br	Cl	NO3	SO4	Al	B	Ba
1	41000	34600	5	1650	149000	60	29400	2460	95.60	41.60
2	27900	24500	< 4	1150	85000	40	9060	1410	44.90	27.20
4	54700	51000	5.10	2150	147000	40	10300	2210	76	55.30
8	66800	70400	< 4	2700	193000	50	8170	2100	76.40	63
16	95900	96200	8.10	3970	265000	140	9980	2840	89.10	110
32	146000	189000	35	10000	540000	900	22000	2950	148	194
64	160000	187000	51.40	8520	572000	610	19300	3210	149	252
pD_e (-log[m^2/s]) :	9.27	9.17	-	9.40	9.88	> 7.8	12.52	12.49	-	12.13
Standard deviation :	.06	.03	-	.10	.13	.19	.19	.03	-	.11
Used data points :	3 - 6	3 - 5	-	2 - 5	3 - 7	1 - 4	4 - 7	4 - 5	-	3 - 5
Slope :	.48	.46	-	.57	.54	.45	.49	.44	(.4)	.50
Std.Dev. of slope :	.05	.00		.08	.07	.17	.17	?	(.05)	.18
Deviat.slope=½ (3 fases):	+ ≈ ≈	+ + ≈	≈ + +	+ + ≈	+ + ≈	≈ + +	- ≈ ≈	+ - -	+ - ≈	+ + ≈
Wash-off(mg/m^2),Diss/Lag:	(Lag)	(Lag)		(Lag)	(Lag)	≈	6435	≈		(Lag)
Total Concentrat.(mg/kg):	5297	28075	13.71	162.0	11879	.570	142.6	32613	.000	1566
Availability (mg/kg):	3672	3240	-	162.0	21814	< .570	17732	4320	-	101.5
Availability perc. (%):	69.32	11.54	-	100.00	183.64	< 100.00	12439.3	13.25	-	6.48
Mean factor above DTL :	37	108	-	3	218	(DTL)	177	864	-	29
Max.Cum.release (mg/m^2):	148467	131000	-	6550	881986	< 23.05	716942	174667	-	4104
Cum.release 64d. (mg/m^2):	154839	170629	-	7879	510030	481	28288	4491	-	194
Leaching-perc. 64d. (%):	104	130	-	120	57.8	2087	3.9	2.6	-	4.7
Mean factor above DTL :	212	3108	-	9	557	26	31	223	-	106
Cum.release calc. 1D 64d:	179550	177139	-	6812	530684	< 146	20475	5185	-	183
Cum.release calc. 3D 64d: (mg/m^2)	136432	122903	-	5800	610933	< 23	32875	8320	-	292
	Tortuosity (Na):		2	range:	2 - 2					
Chemical Retention R:	2.0	1.0	-	2.6	7.7	.07	2007	767	-	634
$R_{range-min}$:	1.7	.94	-	2.1	5.8	.04	1299	720	-	496
$R_{range-max}$:	2.3	1.1	-	3.3	10	.10	3102	817	-	811
pD_e for R=1 will be ≥				9.0						
Availability(%) becomes ≥				62.0						

Combined Ash
Productcode: V1CC

Surf.area .0324 m^2
Weight 1.31 kg

Bulk Density 1590 kg/m^3
Extraction volume 8.47 L

(continued)

Concentration in µg/L Time (days)	Ca	Cd	Cr	Cu	Fe	Mg	Ni	Pb	Si	Sr	Zn
1	37500	< .2	< 3	25.80	256	229	< 5	5.20	670	98.40	18.30
2	22200	.40	< 3	11.60	71.40	243	< 5	< 1	932	65.50	8.60
4	33900	< .2	< 3	29.10	20.50	68.60	< 5	1.10	1250	120	3.80
8	29900	< .2	< 3	29.10	19.40	78.20	< 5	1.20	1370	158	2.50
16	33700	< .2	< 3	32.20	294	88.30	< 5	2.50	1720	346	13.90
32	56100	< .2	9.40	49.90	125	768	18.30	20	1680	702	8.80
64	75900	< .2	4	29.60	109	383	< 5	1.60	1590	1020	17
pD_e (-log[m^2/s]) :	12.71	> 14.4	> 12.3	13.37	13.09	> 14.4	> 11.9	16.13	12.97	> 10.7	16.42
Standard deviation :	.08	–	.74	.21	.25	.68	–	.17	.18	.19	.43
Used data points :	4 - 7	1 - 7	1 - 7	1 - 6	3 - 4	1 - 7	1 - 7	3 - 5	2 - 5	5 - 7	3 - 7
Slope :	.48	–	–	.52	-.08	.40	–	.59	.28	.78	.61
Std.Dev. of slope :	.07			.09	?	.23		.27	.04	.14	.25
Deviat.slope=¼ (3 fases):	+ – ≈		? ? ≈	+ – –	– + –	– + +		– + –	+ – –	+ + +	– + –
Wash-off(mg/m^2),Diss/Lag:	?≈	(Lag)	(Lag)	≈	75.01	?≈	(Lag)	.695	(Lag)	(Opl)	4.75
Total Concentrat.(mg/kg):	155675	20.95	204.1	1652	83135	.000	228.9	1469	128778	.000	3251
Availability (mg/kg):	73434	15.33	4.54	153.4	99.35	(2807.8)	9.72	207.3	5616	(84.23)	993.5
Availability perc. (%):	47.17	73.17	2.22	9.28	.12	#VALUE!	4.25	14.12	4.36	#VALUE!	30.56
Mean factor above DTL :	1469	77	2	77	99	–	2	207	281	–	497
Max.Cum.release (mg/m^2):	2969091	619.8	183.6	6202	4017	(113525)	393.0	8382	227067	(3406)	40169
Cum.release 64d. (mg/m^2):	75603	< .4	< 7.4	54	234	486	< 13	8.52	2408	656	19
Leaching-perc. 64d. (%):	2.5	< .06	< 4.0	.9	5.8	.4	< 3.3	.1	1.1	19.3	.05
Mean factor above DTL :	2066	(DTL)	(DTL)	7	26	266	(DTL)	4.7	60	179	5
Cum.release calc. 1D 64d:	68317	< 2.0	< 6.5	67	60	< 394	< 23	3.8	3865	< 793	13
Cum.release calc. 3D 64d:	110020	< 3.3	< 11	108	97	< 608	< 36	6.1	6244	< 1138	21
(mg/m^2)											
Chemical Retention R:	2052	92791	705	10108	4371	80329	272	7017422	–	–	11343934
$R_{range-min}$:	1695	–	129	6229	2476	16696	–	4728488	–	–	4193715
$R_{range-max}$:	2485	–	3855	16403	7714	386498	–	10414367	–	–	30685164

pD_e for R=1 will be ≥
Availability(%) becomes ≥

Combined Ash
Productcode: V1CC

Concentration in µg/L Time (days)	TDS	Na	TOC
1	218000	34600	4020
2	259000	24500	2230
4	331000	51000	3560
8	425000	70400	4610
16	538000	96200	3850
32	1110000	189000	3000
64	1120000	187000	3980
pD_e (-log[m^2/s]) :	> 9.4	9.17	> 12.8
Standard deviation :	.32	.03	.16
Used data points :	1 - 7	3 - 5	1 - 4
Slope :	.62	.46	(.7)
Std.Dev. of slope :	.10	.00	(.09)
Deviat.slope=½ (3 fases):	+ ≈ ≈	+ + ≈	+ − −
Wash-off(mg/m^2),Diss/Lag:	(Lag)	(Lag)	≈
Total Concentrat.(mg/kg):	23218	28075	12527
Availability (mg/kg):	23218	3240	(12527.0)
Availability perc. (%):	100.00	11.54	(100)
Mean factor above DTL :	-	108	-
Max.Cum.release (mg/m^2):	< 938752	131000	(506493)
Cum.release 64d. (mg/m^2):	1045940	170629	6601
Leaching-perc. 64d. (%):	111	130	1.3
Mean factor above DTL :	19052	3108	-
Cum.release calc. 1D 64d:	< 1002375	177139	< 10878
Cum.release calc. 3D 64d:	< 831490	122903	< 16963
(mg/m^2)	Tortuosity	2	
Chemical Retention R:	1.3	1.0	3236
$R_{range-min}$:	.62	.94	2261
$R_{range-max}$:	2.8	1.1	4631

447

Appendix C.3. Summary of monolith leach test extract concentrations and data analysis for APC residue, bottom ash and combined ash treated by Process 2.

All
Productcode: V2XL

Surf.area: .0324 m^2 Weight : 1 kg
Bulk Density : 1000 kg/m^3 Extraction volume: 8.47 L
2 October 1991

Concentration in µg/L Time (days)	K	Na	Li	Br	Cl	NO3	SO4	Al	B	Ba
1	1020	709	< 3		< 500	< 10	< 500	< 11	< 4	1.50
2	989	477	< 3		< 500	< 10	< 500	48.70	< 4	< 1
4	715	126	< 3		< 500	40	< 500	21.50	7.90	< 1
8	2160	1590	4.80		< 500	< 10	< 500	25.60	6.80	17.80
16	1560	2720	< 3		5500	50	5300	< 11	142	7
32	478	110	< 3		< 500	< 10	< 500	14	< 4	< 1
64	676	52	< 3		< 500	30	< 500	< 11	61	< 1
pD_e (-log[m^2/s]) :	-	-	-	-	-	-	-	-	-	-
Standard deviation :	-	-	-	-	-	-	-	-	-	-
Used data points :	-	-	-	-	-	-	-	-	-	-
Slope :	(.1)	(-.2)	-	-	-	-	-	-	-	-
Std.Dev. of slope :	(.20)	(.43)								
Deviat.slope-½ (3 fases):	+ - -	- - -				? + -		≈ - ?	? + -	? - ?
Wash-off(mg/m^2),Diss/Lag:										
Total Concentrat.(mg/kg):	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
Availability (mg/kg):	(.00)	(.00)	-	-	(.00)	-	(.00)	-	-	(.00)
Availability perc. (%):	(20)	(20)	-	-	(20)	-	(100)	-	-	(20)
Mean factor above DTL :	-	-	-	-	-	-	-	-	-	-
Max.Cum.release (mg/m^2):	(.0)	(.0)	-	-	(.0)	-	(.0)	-	-	(.0)
Cum.release 64d. (mg/m^2):	-	-	-	-	-	-	-	-	-	-
Leaching-perc. 64d. (%):	-	-	-	-	-	-	-	-	-	-
Mean factor above DTL :	-	-	-	-	-	-	-	-	-	-
Cum.release calc. 1D 64d:	-	-	-	-	-	-	-	-	-	-
Cum.release calc. 3D 64d:	-	-	-	-	-	-	-	-	-	-
(mg/m^2)	Tortuosity (Na):		0	range:	- -					
Chemical Retention R:	-	-	-	-	-	-	-	-	-	-
$R_{range-min}$:	-	-	-	-	-	-	-	-	-	-
$R_{range-max}$:	-	-	-	-	-	-	-	-	-	-

All
Productcode: V2XL

Surf.area .0324 m^2
Weight 1 kg

Bulk Density 1000 kg/m^3
Extraction volume 8.47 L

(continued)

Concentration in µg/L Time (days)	Ca	Cd	Cr	Cu	Fe	Mg	Ni	Pb	Si	Sr	Zn
1	552		< 3		8.40	20.20			98.40	2.60	8.50
2	358		< 3		181	97.20			124	< 2	8.90
4	24.10		< 3		< 5	1.20			314	< 2	< 2
8	6350		< 3		< 5	11.10			119	19.40	< 2
16	2980		< 3		5.50	3.40			348	19.10	< 2
32	60.80		6.60		6.40	1.60			97.10	4.90	< 2
64	29.40		< 3		< 5	1.80			15200	< 2	5.20
pD_e ($-\log[m^2/s]$) :	-	-	-	-	-	-	-	-	-	-	-
Standard deviation :	-	-	-	-	-	-	-	-	-	-	-
Used data points :	-	-	-	-	-	-	-	-	-	-	-
Slope :	(-.2)	-	-	-	-	(-.6)	-	-	(.9)	-	-
Std.Dev. of slope :	(.65)					(.38)			(.41)		
Deviat.slope=½ (3 fases):	- - -				+ + +	- - -			+ - +	? - -	+ ? ?
Wash-off(mg/m^2),Diss/Lag:											
Total Concentrat.(mg/kg):	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
Availability (mg/kg):	(.00)	(.00)	(.00)	(.00)	-	-	(.00)	(.00)	-	-	(.00)
Availability perc. (%):	(90)	(80)	(10)	(25)	-	-	(20)	(10)	-	-	(40)
Mean factor above DTL :	-	-	-	-	-	-	-	-	-	-	-
Max.Cum.release (mg/m^2):	(.0)	(.0)	(.0)	(.0)	-	-	(.0)	(.0)	-	-	(.0)
Cum.release 64d. (mg/m^2):	-	-	-	-	-	-	-	-	-	-	-
Leaching-perc. 64d. (%):	-	-	-	-	-	-	-	-	-	-	-
Mean factor above DTL :	-	-	-	-	-	-	-	-	-	-	-
Cum.release calc. 1D 64d:	-	-	-	-	-	-	-	-	-	-	-
Cum.release calc. 3D 64d: (mg/m^2)	-	-	-	-	-	-	-	-	-	-	-
Chemical Retention R:	-	-	-	-	-	-	-	-	-	-	-
$R_{range-min}$:	-	-	-	-	-	-	-	-	-	-	-
$R_{range-max}$:	-	-	-	-	-	-	-	-	-	-	-

All
Productcode: V2XL

Concentration in µg/L Time (days)	TDS	Na	TOC
1	< 30	709	
2	42000	477	
4	107000	126	
8	< 30	1590	
16	< 30	2720	
32	< 30	110	
64	< 30	52	

pD_e (-log[m^2/s]) :	-	-	-
Standard deviation :	-	-	-
Used data points :	-	-	-
Slope :	-	(-.2)	-
Std.Dev. of slope :		(.43)	
Deviat.slope=½ (3 fases):	+ ? ?	- - -	
Wash-off(mg/m^2),Diss/Lag:			
Total Concentrat.(mg/kg):	.000	.000	.000
Availability (mg/kg):	(.00)	(.00)	(.00)
Availability perc. (%):	(100)	(20)	(100)
Mean factor above DTL :	-	-	-
Max.Cum.release (mg/m^2):	(.0)	(.0)	(.0)
Cum.release 64d. (mg/m^2):	-	-	-
Leaching-perc. 64d. (%):	-	-	-
Mean factor above DTL :	-	-	-
Cum.release calc. 1D 64d:	-	-	-
Cum.release calc. 3D 64d:	-	-	-
(mg/m^2)	Tortuosity	0	
Chemical Retention R:	-	-	-
$R_{range-min}$:	-	-	-
$R_{range-max}$:	-	-	-

APC-Residue
Productcode: V2FA

Surf.area: .0324 m^2 Bulk Density : 1663 kg/m^3 2 October 1991
Weight : 1.37 kg Extraction volume: 8.47 L

Concentration in µg/L Time (days)	K	Na	Li	Br	Cl	NO3	SO4	Al	B	Ba
1	299000	732000	122	36400	1440000	290	25900	330	70.80	479
2	695000	184000	410	117000	4520000	350	58200	175	98.60	1180
4	790000	219000	543	168000	6320000	400	69900	72.50	80.50	1700
8	337000	335000	226	30800	2330000	410	50000	115	39.90	3000
16	499000	1420000	463	120000	5000000	390	26000	663	198	3680
32	470000	1130000	530	94200	4140000	500	13200	147	35.70	4690
64	353000	703000	432	68100	2790000	400	8490	748	51	3590
pD_e (-log[m^2/s]) :	8.42	8.75	> 8.1	8.51	8.77	9.51	12.65	13.91	-	9.08
Standard deviation :	.19	.42	.68	.01	.26	.35	1.18	.61	-	.09
Used data points :	4 - 6	1 - 7	1 - 7	2 - 3	4 - 5	2 - 5	1 - 7	1 - 7	-	2 - 5
Slope :	.24	.47	.40	.52	1.10	.05	-.19	.41	(.1)	.57
Std.Dev. of slope :	.19	.14	.23	?	?	.04	.27	.21	(.22)	.07
Deviat.slope=½ (3 fases):	+ - -	- + -	+ - -	+ - -	+ - -	+ - -	+ - -	- ≈ -	+ - -	+ ≈ -
Wash-off(mg/m^2),Diss/Lag:	?≈	42475	≈	(Lag)	?≈	≈	?≈	45.51		(Lag)
Total Concentrat.(mg/kg):	11100	32700	12.00	160.0	14000	30.00	23000	23000	.000	570.0
Availability (mg/kg):	5600	12000	< 4.00	4880	79400	30.00	58200	2000	-	102.0
Availability perc. (%):	50.45	36.70	< 33.33	3050.0	567.14	100.00	253.04	8.70	-	17.89
Mean factor above DTL :	56	400	(DTL)	98	794	30	582	400	-	29
Max.Cum.release (mg/m^2):	236790	507407	< 169.1	206346	3357346	1269	2460926	84568	-	4313
Cum.release 64d. (mg/m^2):	900068	1234685	713	165871	6938080	716	65797	588	-	4789
Leaching-perc. 64d. (%):	380	243	422	80.4	207	56.4	2.7	.7	-	111
Mean factor above DTL :	1230	22490	130	181	7583	39	72	29	-	2617
Cum.release calc. 1D 64d:	766070	1114319	< 743	595243	7245687	1161	60416	489	-	6513
Cum.release calc. 3D 64d: (mg/m^2)	235449	498744	< 169	204719	3297179	1079	97207	795	-	4111
Tortuosity (Na):			1	range:	0 - 2					
Chemical Retention R:	.74	1.0	-	.89	1.6	8.2	7164	53209	-	1.5
$R_{range-min}$:	.47	.38	-	.87	.88	3.7	471	13051	-	1.2
$R_{range-max}$:	1.2	2.6	-	.91	2.9	19	108883	216929	-	1.8
pD_e for R=1 will be ≥	8.5			8.6		8.6				
Availability(%) becomes ≥	58.8			3229.7		34.8				

APC-Residue
Productcode: V2FA

Surf.area .0324 m^2 Bulk Density 1663 kg/m^3 (continued)
Weight 1.37 kg Extraction volume 8.47 L

Concentration in µg/L Time (days)	Ca	Cd	Cr	Cu	Fe	Mg	Ni	Pb	Si	Sr	Zn
1	693000	.60		< 4	35.20	40.80		436	935	4490	120
2	1740000	.60		< 4	31.80	26.90		1570	556	11400	221
4	2140000	.30		< 4	22.30	< 1		1950	338	15200	244
8	1360000	< .2		< 4	20	274		1500	829	10000	250
16	1620000	< .2		< 4	30	< 1		1250	559	10000	235
32	1430000	1.80		< 4	27.50	6.60		912	317	9200	261
64	821000	3.20		7.60	71.40	90.90		535	1320	6320	258
pD_e ($-\log[m^2/s]$) :	9.82	15.67	-	> 15.2	11.56	> 15.4	-	12.13	13.97	> 9.2	14.87
Standard deviation :	.29	.42	-	-	.41	1.37	-	.41	.37	.76	.53
Used data points :	4 - 6	1 - 7	-	1 - 7	1 - 7	1 - 7	-	5 - 6	1 - 5	1 - 7	1 - 7
Slope :	.04	-	-	-	.30	-	-	-.45	.26	.20	.32
Std.Dev. of slope :	.12				.11			?	.18	.23	.17
Deviat.slope=½ (3 fases):	+ - -	≈ ≈ +			≈ - +	+ - +		+ - -	- - +	+ - -	+ - -
Wash-off(mg/m^2),Diss/Lag:	?≈	≈		(Lag)	?≈	≈		?≈	?≈	?≈	≈
Total Concentrat.(mg/kg):	223000	17.00	52.00	690.0	7990	.000	77.00	960.0	15037	.000	2400
Availability (mg/kg):	96000	60.00	5.80	126.0	18.20	(2000.0)	< 5.60	840.0	7400	(340.0)	5800
Availability perc. (%):	43.05	352.94	11.15	18.26	.23	#VALUE!	< 7.27	87.50	49.21	#VALUE!	241.67
Mean factor above DTL :	1920	300	3	63	18	-	(DTL)	840	370	-	2900
Max.Cum.release (mg/m^2):	4059259	2537	245.2	5328	769.6	(84568)	< 236.8	35519	312901	(14377)	245247
Cum.release 64d. (mg/m^2):	2562959	1.80	-	< 8.3	62	115	-	2131	1269	17413	415
Leaching-perc. 64d. (%):	63.1	.07	-	< .2	8.1	.1	-	6.0	.4	121	.2
Mean factor above DTL :	70029	4.9	-	(DTL)	7	63	-	1165	32	4758	113
Cum.release calc. 1D 64d:	2616912	1.9	-	< 6.8	66	< 88	-	1603	1691	< 18914	468
Cum.release calc. 3D 64d: (mg/m^2)	2929011	3.1	-	< 11	103	< 141	-	2550	2750	< 13417	762
Chemical Retention R:	6.9	4514305	-	1898041	345	2336790	-	1827	-	-	849032
$R_{range-min}$:	3.5	1733910	-	-	133	98850	-	717	-	-	249006
$R_{range-max}$:	13	11753173	-	-	896	55241043	-	4659	-	-	2894935

pD_e for R=1 will be ≥
Availability(%) becomes ≥

APC-Residue
Productcode: V2FA

Concentration in µg/L Time (days)	TDS	Na	TOC
1	2280000	732000	1400
2	7290000	184000	1510
4	12100000	219000	1400
8	< 30	335000	2000
16	9450000	1420000	2000
32	7810000	1130000	3150
64	5680000	703000	3630
pD_e (-log[m^2/s]) :	> 8.9	8.75	> 12.9
Standard deviation :	.83	.42	.34
Used data points :	1 - 7	1 - 7	1 - 4
Slope :	-	.47	(.7)
Std.Dev. of slope :		.14	(.28)
Deviat.slope=$\frac{1}{2}$ (3 fases):	+ - -	- + -	+ ≈ ≈
Wash-off(mg/m^2),Diss/Lag:	≈	42475	≈
Total Concentrat.(mg/kg):	173000	32700	6100
Availability (mg/kg):	(173000.0)	12000	(6100.0)
Availability perc. (%):	(100)	36.70	(100)
Mean factor above DTL :	-	400	-
Max.Cum.release (mg/m^2):	(7315123)	507407	(257932)
Cum.release 64d. (mg/m^2):	11661943	1234685	3945
Leaching-perc. 64d. (%):	159	243	1.5
Mean factor above DTL :	212429	22490	-
Cum.release calc. 1D 64d:	< 13622980	1114319	< 4872
Cum.release calc. 3D 64d:	< 7115457	498744	< 7709
(mg/m^2)	Tortuosity	1	
Chemical Retention R:	1.1	1.0	11036
$R_{range-min}$:	.17	.38	5035
$R_{range-max}$:	7.6	2.6	24186

APC-Residue
Productcode: V2FB

Surf.area: .0324 m^2 Bulk Density : 1518 kg/m^3 2 October 1991
Weight : 1.25 kg Extraction volume: 8.47 L

Concentration in µg/L Time (days)	K	Na	Li	Br	Cl	NO3	SO4	Al	B	Ba
1	319000	754000	121	72500	3070000	290	16200	96.20	36.80	769
2	506000	1360000	277	102000	4270000	310	19600	89	43.30	1370
4	552000	1400000	377	103000	4320000	390	19000	116	50.40	1860
8	325000	1310000	200	130800	2330000	410	16760	134	72.20	2750
16	545000	1600000	495	140000	5700000	690	27000	329	125	4250
32	518000	1280000	548	103000	4730000	550	25600	232	44.80	4270
64	392000	812000	458	80300	3300000	460	16100	180	36.70	3340
pD_e (-log[m^2/s]) :	8.24	8.47	8.26	8.89	8.15	8.85	12.68	14.91	-	9.15
Standard deviation :	.50	.51	.38	.55	.74	.15	.37	.13	-	.11
Used data points :	1 - 6	1 - 6	2 - 6	1 - 3	1 - 2	2 - 5	1 - 6	2 - 4	-	2 - 6
Slope :	.34	.38	.24	1.14	2.25	.35	.38	.30	(.2)	.45
Std.Dev. of slope :	.21	.22	.17	.65	?	.09	.16	.05	(.20)	.06
Deviat.slope=½ (3 fases):	+ - -	+ - -	+ - -	+ - -	+ - -	+ - -	+ - -	+ ≈ -	+ - -	+ ≈ -
Wash-off(mg/m^2),Diss/Lag:	≈	≈	(Lag)	≈	≈	(Lag)	≈	(Lag)		(Lag)
Total Concentrat.(mg/kg):	13100	30600	10.00	1900	96000	17.00	6400	12000	.000	250.0
Availability (mg/kg):	7200	26000	6.00	4260	69200	17.00	53800	5600	-	124.0
Availability perc. (%):	54.96	84.97	60.00	224.21	72.08	100.00	840.63	46.67	-	49.60
Mean factor above DTL :	72	867	2	85	692	17	538	1120	-	35
Max.Cum.release (mg/m^2):	277778	1003086	231.5	164352	2669753	655.9	2075617	216049	-	4784
Cum.release 64d. (mg/m^2):	825302	2226251	647	191255	7246556	810	36667	307	-	4865
Leaching-perc. 64d. (%):	297	222	280	116	271	124	1.8	.1	-	102
Mean factor above DTL :	1127	40552	118	209	7920	44	40	15	-	2659
Cum.release calc. 1D 64d:	1098074	3063066	897	306219	11765201	1291	49654	398	-	6654
Cum.release calc. 3D 64d: (mg/m^2)	276900	996365	231	159938	2663623	641	79884	648	-	4508
	Tortuosity (Na):		0	range:	0 - 1					
Chemical Retention R:	.95	1.0	-	4.1	.73	3.4	14587	1015963	-	3.3
$R_{range-min}$:	.30	.31	-	1.2	.13	2.4	6157	758408	-	2.6
$R_{range-max}$:	3.0	3.3	-	15	4.1	4.9	34561	1360984	-	4.3
pD_e for R=1 will be ≥	8.3				8.3	8.3				
Availability(%) becomes ≥	56.2				84.2	53.9				

APC-Residue
Productcode: V2FB

Surf.area .0324 m^2 Bulk Density 1518 kg/m^3 (continued)
Weight 1.25 kg Extraction volume 8.47 L

Concentration in µg/L Time (days)	Ca	Cd	Cr	Cu	Fe	Mg	Ni	Pb	Si	Sr	Zn
1	632000	< .2		< 4	18.90	11.10	< 5	288	714	4740	74.40
2	995000	< .2		15.20	36.80	10.90	< 5	539	550	7990	113
4	1250000	< .2		< 4	19.30	< 1	< 5	649	686	9440	108
8	1270000	.30		< 4	57.80	105	< 5	1130	775	4400	237
16	1770000	.40		< 4	21.30	< 1	< 5	1310	502	11500	262
32	1620000	1.80		19.10	74.20	21.70	< 5	981	501	10100	289
64	962000	< .2		< 4	18.40	< 1	6.70	< 1	517	6830	135
pD_e (-log[m^2/s]) :	9.88	> 16.4	-	> 13.6	11.28	> 16.0	> 12.9	12.19	13.94	> 8.8	14.82
Standard deviation :	.43	.57	-	.71	.64	.97	-	.64	.24	.52	.43
Used data points :	1 - 6	1 - 7	-	1 - 7	1 - 5	1 - 7	1 - 7	1 - 4	1 - 4	1 - 6	1 - 6
Slope :	.52	-	-	-	.45	-	-	1.15	.60	.42	.67
Std.Dev. of slope :	.19				.38			.36	.20	.23	.17
Deviat.slope=i (3 fases):	+ - -	? + +		? ? ?	+ ≈ -	+ - ?		+ - -	+ - -	+ - -	+ ≈ -
Wash-off(mg/m^2),Diss/Lag:	≈	(Lag)		(Lag)	≈	(Lag)	(Lag)	(Opl)	≈	≈	(Lag)
Total Concentrat.(mg/kg):	221000	110.0	30.00	230.0	7340	.000	21.00	1500	40154	.000	6500
Availability (mg/kg):	126000	82.00	13.20	134.0	16.80	(2800.0)	8.20	1120	9800	(240.0)	5000
Availability perc. (%):	57.01	74.55	44.00	58.26	.23	#VALUE!	39.05	74.67	24.41	#VALUE!	76.92
Mean factor above DTL :	2520	410	6	67	17	-	2	1120	490	-	2500
Max.Cum.release (mg/m^2):	4861111	3164	509.3	5170	648.1	(108025)	316.4	43210	378086	(9259)	192901
Cum.release 64d. (mg/m^2):	2221806	< .9	-	< 14	64	< 40	< 9.6	1280	1110	14378	319
Leaching-perc. 64d. (%):	45.7	< .03	-	< .3	9.9	< .04	< 3.0	3.0	.3	155	.2
Mean factor above DTL :	60707	2.5	-	1.9	7	22	(DTL)	699	28	3929	87
Cum.release calc. 1D 64d:	2915234	< 1.1	-	< 43	78	< 55	< 6.0	1814	2111	< 18429	390
Cum.release calc. 3D 64d: (mg/m^2)	3359256	< 1.7	-	< 69	118	< 90	< 9.5	2890	3431	< 9075	634
Chemical Retention R:	15 43830958		-	85930	346	18943082	13421	4080	-	-	1464387
$R_{range-min}$:	5.7 11898835		-	16710	80	2053098	-	928	-	-	547524
$R_{range-max}$:	42 161457222		-	441885	1493	174779904	-	17942	-	-	3916596

pD_e for R=1 will be ≥
Availability(%) becomes ≥

APC-Residue
Productcode: V2FB

Concentration in µg/L Time (days)	TDS	Na	TOC
1	4580000	754000	1130
2	7020000	1360000	1140
4	8510000	1400000	1150
8	< 30	1310000	1000
16	10700000	1600000	2000
32	8970000	1280000	2720
64	6630000	812000	3600
pD_e (-log[m^2/s]) :	> 8.7	8.47	> 12.9
Standard deviation :	.61	.51	.37
Used data points :	1 - 7	1 - 6	1 - 4
Slope :	-	.38	(.5)
Std.Dev. of slope :		.22	(.33)
Deviat.slope=½ (3 fases):	+ - -	+ - -	+ = =
Wash-off(mg/m^2),Diss/Lag:	=	=	=
Total Concentrat.(mg/kg):	176000	30600	4700
Availability (mg/kg):	(176000.0)	26000	(4700.0)
Availability perc. (%):	(100)	84.97	(100)
Mean factor above DTL :	-	867	-
Max.Cum.release (mg/m^2):	(6790123)	1003086	(181327)
Cum.release 64d. (mg/m^2):	12132499	2226251	3330
Leaching-perc. 64d. (%):	179	222	1.8
Mean factor above DTL :	221000	40552	-
Cum.release calc. 1D 64d:	< 15373141	3063066	< 3446
Cum.release calc. 3D 64d:	< 6691972	996365	< 5419
(mg/m^2)	Tortuosity	0	
Chemical Retention R:	1.5	1.0	21078
$R_{range-min}$:	.37	.31	9073
$R_{range-max}$:	6.0	3.3	48970

APC-Residue
Productcode: V2FC

Surf.area: .0324 m^2 Bulk Density : 1639 kg/m^3 2 October 1991
Weight : 1.35 kg Extraction volume: 8.47 L

Concentration in µg/L Time (days)	K	Na	Li	Br	Cl	NO3	SO4	Al	B	Ba
1	303000	754000	123	41700	1850000	290	11600	136	37.70	765
2	559000	1470000	301	106000	4560000	580	19900	112	58.40	1480
4	646000	1680000	416	121000	5190000	470	21200	87	46	2210
8	346000	1351000	231	64200	2580000	480	27220	127	62.70	3220
16	524000	1490000	463	120000	5600000	760	30000	40	136	4150
32	530000	1180000	517	99100	4710000	600	31400	82.20	64	4090
64	303000	633000	351	68700	2770000	490	30000	797	41.20	2560
pD_e (-log[m^2/s]) :	8.57	8.44	8.48	8.16	8.39	8.84	12.66	14.58	-	8.56
Standard deviation :	.56	.58	.58	.86	.85	.49	.44	.27	-	.04
Used data points :	1 - 6	1 - 6	1 - 6	1 - 3	1 - 3	1 - 6	1 - 6	1 - 4	-	2 - 5
Slope :	.33	.34	.58	1.65	1.63	.44	.52	.47	(.3)	.50
Std.Dev. of slope :	.23	.24	.25	.84	.83	.22	.20	.25	(.19)	.04
Deviat.slope=½ (3 fases):	+ - -	+ - -	+ - -	+ - -	+ - -	+ - -	+ - -	≈ - +	+ - -	+ - -
Wash-off(mg/m^2),Diss/Lag:	≈	≈	≈	≈	≈	≈	≈	≈		(Lag)
Total Concentrat.(mg/kg):	12700	29100	12.00	1500	86000	15.00	4700	15000	.000	300.0
Availability (mg/kg):	10200	24000	6.00	1500	84800	15.00	54000	3200	-	68.00
Availability perc. (%):	80.31	82.47	50.00	100.00	98.60	100.00	1148.9	21.33	-	22.67
Mean factor above DTL :	102	800	2	30	848	15	540	640	-	19
Max.Cum.release (mg/m^2):	425000	1000000	250.0	62500	3533333	625.0	2250000	133333	-	2833
Cum.release 64d. (mg/m^2):	839419	2237230	628	162263	7126302	959	44786	361	-	4830
Leaching-perc. 64d. (%):	198	224	251	260	202	153	2.0	.3	-	170
Mean factor above DTL :	1147	40752	114	177	7789	52	49	18	-	2639
Cum.release calc. 1D 64d:	1145104	3134513	753	272176	11817941	1244	54741	356	-	7719
Cum.release calc. 3D 64d: (mg/m^2)	420924	993792	248	62352	3515161	611	88072	579	-	2807
	Tortuosity (Na):		0	range:	0 - 1					
Chemical Retention R:	2.2	1.0	-	.80	1.3	3.6	14860	509815	-	.92
$R_{range-min}$:	.60	.26	-	.11	.19	1.1	5375	272557	-	.84
$R_{range-max}$:	7.8	3.8	-	5.8	9.4	11	41080	953602	-	1.0
pD_e for R=1 will be ≥				8.3		8.3				8.6
Availability(%) becomes ≥				112.0		53.1				23.7

457

APC-Residue
Productcode: V2FC

Surf.area .0324 m^2 Bulk Density 1639 kg/m^3 (continued)
Weight 1.35 kg Extraction volume 8.47 L

Concentration in µg/L Time (days)	Ca	Cd	Cr	Cu	Fe	Mg	Ni	Pb	Si	Sr	Zn
1	655000	1.20		< 4	58	65.70		432	647	4740	108
2	1270000	.40		< 4	103	< 1		1000	704	9270	143
4	1530000	< .2		< 4	12.50	< 1		995	475	11800	129
8	1450000	< .2		< 4	20.20	76.90		195	752	10000	132
16	1620000	< .2		< 4	9.40	< 1		1240	346	10800	177
32	1550000	.80		4.10	34.40	< 1		946	400	9670	233
64	811000	3.80		< 4	75.70	102		425	1070	5400	233
pD_e (-log[m^2/s]) :	9.94	15.90	-	> 15.4	13.78	> 15.5	-	12.18	13.74	> 8.6	14.76
Standard deviation :	.74	.45	-	-	.46	.33	-	.76	.36	.55	.35
Used data points :	1 - 3	1 - 7	-	1 - 7	3 - 7	1 - 7	-	1 - 6	1 - 4	1 - 5	1 - 6
Slope :	1.50	-	-	-	.60	-	-	.37	.54	.60	.44
Std.Dev. of slope :	.71				.27			.33	.33	.33	.15
Deviat.slope=½ (3 fases):	+ - -	- ? +			- - +	? ? ?		+ - -	+ - +	+ - -	+ - -
Wash-off(mg/m^2),Diss/Lag:	(Opl)	≈		(Lag)	?≈	(Lag)		?≈	≈	≈	≈
Total Concentrat.(mg/kg):	209000	140.0	39.00	260.0	10380	.000	25.00	1500	50041	.000	7800
Availability (mg/kg):	156000	84.00	7.80	124.0	146.0	(3400.0)	(5.00)	940.0	6800	(220.0)	4000
Availability perc. (%):	74.64	60.00	20.00	47.69	1.41	#VALUE!	(20)	62.67	13.59	#VALUE!	51.28
Mean factor above DTL :	3120	420	4	62	146	-	-	940	340	-	2000
Max.Cum.release (mg/m^2):	6500000	3500	325.0	5167	6083	(141667)	(208)	39167	283333	(9167)	166667
Cum.release 64d. (mg/m^2):	2322976	< 1.8	-	< 7.3	82	< 65	-	1368	1149	16124	302
Leaching-perc. 64d. (%):	35.7	< .05	-	< .1	1.3	< .05	-	3.5	.4	176	.2
Mean factor above DTL :	63471	4.9	-	(DTL)	9	36	-	748	29	4406	83
Cum.release calc. 1D 64d:	3633730	2.0	-	< 5.2	41	< 134	-	1662	1984	< 24869	364
Cum.release calc. 3D 64d: (mg/m^2)	4297800	3.3	-	< 8.6	66	< 214	-	2648	3222	< 9071	593
Chemical Retention R:	19	15564094	-	6247381	116412	5786770	-	4209	-	-	1319200
$R_{range-min}$:	3.4	5555475	-	-	40678	2711123	-	727	-	-	585322
$R_{range-max}$:	102	43604010	-	-	333145	12351604	-	24369	-	-	2973214

pD_e for R=1 will be ≥
Availability(%) becomes ≥

458

APC-Residue
Productcode: V2FC

Concentration in µg/L Time (days)	TDS	Na	TOC
1	3200000	754000	1090
2	7590000	1470000	1020
4	7750000	1680000	1330
8	< 30	1351000	1000
16	10400000	1490000	2000
32	8060000	1180000	2750
64	5460000	633000	3620
pD_e (-log[m^2/s]) :	> 8.8	8.44	> 13.2
Standard deviation :	.71	.58	.37
Used data points :	1 - 7	1 - 6	1 - 4
Slope :	-	.34	(.5)
Std.Dev. of slope :		.24	(.33)
Deviat.slope=$\frac{1}{3}$ (3 fases):	+ - -	+ - -	+ ≈ ≈
Wash-off(mg/m^2),Diss/Lag:	≈	≈	≈
Total Concentrat.(mg/kg):	160000	29100	6300
Availability (mg/kg):	(160000.0)	24000	(6300.0)
Availability perc. (%):	(100)	82.47	(100)
Mean factor above DTL :	-	800	-
Max.Cum.release (mg/m^2):	(6666667)	1000000	(262500)
Cum.release 64d. (mg/m^2):	11099891	2237230	3349
Leaching-perc. 64d. (%):	166	224	1.3
Mean factor above DTL :	202191	40752	-
Cum.release calc. 1D 64d:	< 13672084	3134513	< 3444
Cum.release calc. 3D 64d:	< 6533854	993792	< 5570
(mg/m^2)	Tortuosity	0	
Chemical Retention R:	1.9	1.0	46588
$R_{range-min}$:	.37	.26	20072
$R_{range-max}$:	9.7	3.8	108136

459

Bottom Ash
Productcode: V2BA

Surf.area: .0324 m^2
Weight : 1.69 kg

Bulk Density : 2052 kg/m^3
Extraction volume: 8.47-L

2 October 1991

Concentration in µg/L Time (days)	K	Na	Li	Br	Cl	NO3	SO4	Al	B	Ba
1	79100	682000	30.70	5890	433000	20	391000	1490	99.90	7.40
2	36400	297000	20.50	3570	228000	170	190000	7590	50.90	5.20
4	120000	937000	73.40	5000	398000	340	264000	27000	71.90	9.40
8	169000	1590000	43.90	10600	526000	460	407000	32800	118	10
16	227000	1680000	123	11000	1000000	510	950000	56100	179	5.80
32	227000	1850000	160	13500	1010000	590	1060000	87600	371	3.70
64	128000	1130000	119	7420	665000	270	703000	64500	503	3.80
pD_e (-log[m^2/s]) :	8.54	9.11	10.04	9.30	9.04	10.02	9.59	10.31	-	14.01
Standard deviation :	.17	.44	.37	.16	.14	.20	.23	.35	-	.15
Used data points :	3 - 6	1 - 7	2 - 7	2 - 6	2 - 6	3 - 6	1 - 6	2 - 7	-	2 - 3
Slope :	.32	.49	.50	.50	.56	.25	.68	.61	(.7)	.85
Std.Dev. of slope :	.08	.15	.16	.10	.08	.04	.06	.15	(.03)	?
Deviat.slope=½ (3 fases):	+ - -	+ - -	+ = -	+ = -	+ = -	+ - -	+ + -	+ = -	+ + +	+ - -
Wash-off(mg/m^2),Diss/Lag:	(Lag)	(Lag)	(Lag)	(Lag)	(Lag)	(Lag)	(Lag)	(Lag)		(Opl)
Total Concentrat.(mg/kg):	4400	42400	8.00	320.0	16000	37.00	17000	21000	.000	670.0
Availability (mg/kg):	2600	28000	6.00	320.0	16780	37.00	25200	4000	-	110.0
Availability perc. (%):	59.09	66.04	75.00	100.00	104.88	100.00	148.24	19.05	-	16.42
Mean factor above DTL :	26	933	2	6	168	37	252	800	-	31
Max.Cum.release (mg/m^2):	135617	1460494	313.0	16691	875253	1930	1314444	208642	-	5738
Cum.release 64d. (mg/m^2):	257891	2134754	149	14896	1113648	617	1036529	72434	-	12
Leaching-perc. 64d. (%):	190	146	47.6	89.2	127	32.0	78.9	34.7	-	.2
Mean factor above DTL :	352	38886	27	16	1217	34	1133	3598	-	7
Cum.release calc. 1D 64d:	381677	2135969	156	19584	1376572	989	1094988	76150	-	30
Cum.release calc. 3D 64d:	134468	1386305	191	15237	838385	1204	1077075	101172	-	48
(mg/m^2)	Tortuosity (Na):		2	range:	1 - 4					
Chemical Retention R:	.43	1.0	-	2.4	1.3	12	2.8	5.9	-	55322
$R_{range-min}$:	.29	.36	-	1.7	.95	7.4	1.6	2.6	-	39095
$R_{range-max}$:	.64	2.8	-	3.4	1.8	18	4.7	13	-	78282
pD_e for R=1 will be ≥	8.9			8.9		8.9				
Availability(%) becomes ≥	89.9			64.7		29.3				

460

Bottom Ash — Surf.area .0324 m^2 — Bulk Density 2052 kg/m^3 — (continued)
Productcode: V2BA — Weight 1.69 kg — Extraction volume 8.47 L

Concentration in µg/L Time (days)	Ca	Cd	Cr	Cu	Fe	Mg	Ni	Pb	Si	Sr	Zn
1	3850	< .2	36.40	813	226	238	< 5	20.30	3130	29.90	99.60
2	3580	< .2	12.90	239	82.70	65.20	< 5	6	2280	29.50	41.50
4	5270	1.90	35.50	997	61.90	< 1	< 5	26.70	6180	75.60	69.60
8	5000	< .2	14.90	1223	160	185	17.10	2.60	2000	80	29.30
16	2230	< .2	63.30	1680	101	< 1	11.10	11.70	9180	40.80	41.40
32	1460	.30	92.50	2530	81.80	< 1	8.70	6.70	4880	26.70	21.40
64	1300	< .2	62.70	1140	53.30	< 1	< 5	5.70	3910	10.70	12.90
pD_e (-log[m^2/s]) :	14.12	> 14.2	10.37	10.32	12.99	> 14.1	> 12.6	13.54	12.93	> 14.5	16.29
Standard deviation :	.02	1.77	.39	.07	.30	.19	.60	.51	.58	1.00	.09
Used data points :	2 - 3	1 - 7	1 - 7	3 - 6	1 - 4	1 - 7	1 - 7	1 - 3	1 - 7	1 - 7	1 - 3
Slope :	.56	-	.51	.45	.34	-	-	1.08	.32	-.01	.63
Std.Dev. of slope :	?		.13	.05	.24			.62	.18	.26	.07
Deviat.slope=½ (3 fases):	+ - -	? - ?	+ + -	+ ≈ -	- - -	- ? ?	? ≈ -	+ - -	+ - -	+ - -	+ - -
Wash-off(mg/m^2),Diss/Lag:	(Lag)	(Lag)	≈	(Lag)	16.30	≈	(Lag)	(Opl)	≈	≈	≈
Total Concentrat.(mg/kg):	180000	18.00	59.00	1200	39200	.000	77.00	600.0	96799	.000	2500
Availability (mg/kg):	78000	7.20	4.40	170.0	420.0	(1660.0)	16.20	108.0	9000	(500.0)	11400
Availability perc. (%):	43.33	40.00	7.46	14.17	1.07	#VALUE!	21.04	18.00	9.30	#VALUE!	456
Mean factor above DTL :	1560	36	2	85	420	-	4	108	450	-	5700
Max.Cum.release (mg/m^2):	4068519	375.6	229.5	8867	21907	(86586)	845.0	5633	469444	(26080)	594630
Cum.release 64d. (mg/m^2):	5932	< .8	83	2254	200	< 129	< 15	21	8250	77	83
Leaching-perc. 64d. (%):	.1	< .2	36.2	25.4	.9	< .1	< 1.8	.4	1.8	.3	.01
Mean factor above DTL :	162	2.2	15	308	22	70	1.6	11	205	21	23
Cum.release calc. 1D 64d:	18441	< 1.6	78	3203	364	< 425	< 21	50	8403	< 74	221
Cum.release calc. 3D 64d: (mg/m^2)	29989	< 2.5	105	4265	577	< 655	< 36	81	13565	< 125	361
Chemical Retention R:	61869	63276	9.0	10	4107	47170	1764	21218	-	-	9885113
$R_{range-min}$:	58458	1069	3.7	9.0	2080	30221	447	6532	-	-	8090254
$R_{range-max}$:	65478	3745408	22	12	8108	73623	6965	68925	-	-	12078170

pD_e for R=1 will be ≥
Availability(%) becomes ≥

Bottom Ash
Productcode: V2BA

Concentration in µg/L Time (days)	TDS	Na	TOC
1	2060000	682000	23100
2	1230000	297000	10300
4	2220000	937000	20700
8	< 30	1590000	5000
16	5210000	1680000	60000
32	5920000	1850000	76000
64	3520000	1130000	31400

pD_e (-log[m^2/s]) :	> 8.8	9.11	> 11.4
Standard deviation :	.36	.44	.67
Used data points :	1 - 7	1 - 7	1 - 4
Slope :	-	.49	(-.0)
Std.Dev. of slope :		.15	(.49)
Deviat.slope=½ (3 fases):	+ ≈ -	+ - -	+ + -
Wash-off(mg/m^2),Diss/Lag:	≈	(Lag)	≈2010
Total Concentrat.(mg/kg):	55500	42400	7000
Availability (mg/kg):	(55500.0)	28000	(7000.0)
Availability perc. (%):	(100)	66.04	(100)
Mean factor above DTL :	-	933	-
Max.Cum.release (mg/m^2):	(2894907)	1460494	(365123)
Cum.release 64d. (mg/m^2):	5270230	2134754	59212
Leaching-perc. 64d. (%):	182	146	16.2
Mean factor above DTL :	96000	38886	-
Cum.release calc. 1D 64d:	< 5992346	2135969	< 39127
Cum.release calc. 3D 64d:	< 2837235	1386305	< 58547
(mg/m^2)	Tortuosity	2	
Chemical Retention R:	.41	1.0	152
$R_{range-min}$:	.18	.36	32
$R_{range-max}$:	.93	2.8	719

4432

Bottom Ash
Productcode: V2BB

Surf.area: .0324 m^2
Weight : 1.65 kg

Bulk Density : 2003 kg/m^3
Extraction volume: 8.47 L

2 October 1991

Concentration in µg/L Time (days)	K	Na	Li	Br	Cl	NO3	SO4	Al	B	Ba
1	89700	749000	34.20	1780	126000	90	129000	18300	95.30	5.20
2	62000	540000	35.30	2830	181000	180	166000	18000	34.30	6.50
4	142000	1230000	87.30	8870	518000	260	486000	40600	81.20	11.90
8	185000	1850000	43.10	12600	566000	430	582000	50000	69.70	10
16	204000	1680000	121	8600	910000	390	940000	78100	161	4.90
32	168000	1450000	142	10000	1010000	450	1060000	71700	367	2.30
64	100000	887000	110	6320	474000	200	552000	51400	526	1.20
pD_e (-log[m^2/s]) :	8.95	9.22	9.86	8.35	8.86	9.90	9.25	9.66	-	> 13.7
Standard deviation :	.53	.54	.33	.39	.14	.16	.10	.46	-	.51
Used data points :	1 - 7	1 - 7	2 - 6	2 - 6	3 - 6	2 - 5	3 - 6	1 - 7	-	1 - 4
Slope :	.33	.33	.45	.36	.36	.41	.41	.53	(.7)	.90
Std.Dev. of slope :	.16	.17	.20	.22	.08	.13	.07	.16	(.07)	.37
Deviat.slope=½ (3 fases):	+ - -	+ - -	+ ≈ -	+ - -	+ ≈ -	+ - -	+ ≈ -	+ - -	+ + +	+ - -
Wash-off(mg/m^2),Diss/Lag:	≈	≈	(Lag)	(Lag)	(Lag)	(Lag)	(Lag)	(Lag)		(Opt)
Total Concentrat.(mg/kg):	4900	53200	14.00	110.0	12000	30.00	18000	27000	.000	350.0
Availability (mg/kg):	3000	36000	6.00	110.0	15480	30.00	24600	2200	-	(70.00)
Availability perc. (%):	61.22	67.67	42.86	100.00	129.00	100.00	136.67	8.15	-	(20)
Mean factor above DTL :	30	1200	2	2	155	30	246	440	-	-
Max.Cum.release (mg/m^2):	152778	1833333	305.6	5602	788333	1528	1252778	112037	-	(3565)
Cum.release 64d. (mg/m^2):	248532	2192266	150	13332	989474	523	1023458	85772	-	11
Leaching-perc. 64d. (%):	163	120	49.1	238	126	34.2	81.7	76.6	-	.3
Mean factor above DTL :	340	39933	27	15	1081	29	1119	4261	-	6
Cum.release calc. 1D 64d:	266643	2336900	188	19458	1529480	894	1546731	86704	-	< 25
Cum.release calc. 3D 64d:	147890	1702288	214	5576	769385	1040	1156072	88886	-	< 43
(mg/m^2)	Tortuosity (Na):		2	range:	1 - 7					
Chemical Retention R:	.85	1.0	-	.21	.66	6.8	.95	1.0	-	23102
$R_{range-min}$:	.25	.29	-	.08	.48	4.7	.75	.34	-	7083
$R_{range-max}$:	2.9	3.5	-	.51	.91	9.8	1.2	2.9	-	75345
pD_e for R=1 will be ≥	9.0			9.0	9.0	9.1	9.3			
Availability(%) becomes ≥	66.3			219.7	158.9	38.3	139.9			

Bottom Ash
Productcode: V28B

Surf.area .0324 m^2 Bulk Density 2003 kg/m^3 (continued)
Weight 1.65 kg Extraction volume 8.47 L

Concentration in µg/L Time (days)	Ca	Cd	Cr	Cu	Fe	Mg	Ni	Pb	Si	Sr	Zn
1	3640	.30	28.50	862	125	117	< 5	28.60	3360	31.90	96.80
2	5710	< .2	22	556	77.80	23.60	6.30	25.60	3500	59.80	81.50
4	6920	< .2	54.30	1310	99.10	< 1	8	42.20	7420	98.70	127
8	6000	< .2	10	1800	122	131	9.80	6.50	8000	90	12
16	2930	.30	72	1850	99.30	< 1	13.20	14	8420	38.70	50.30
32	1350	< .2	87.10	1560	62.30	< 1	11	3.80	4060	24.20	11.50
64	1430	< .2	72.20	746	47.90	12	7.20	5.60	3380	12.70	14
pD_e $(-\log[m^2/s])$:	14.14	> 13.3	10.61	9.58	12.82	> 14.3	> 11.2	12.23	10.56	> 13.0	13.54
Standard deviation :	.52	.42	.10	.59	.11	1.35	.12	.03	.43	.70	.09
Used data points :	1 - 4	1 - 7	5 - 6	1 - 7	2 - 4	1 - 7	2 - 5	6 - 7	1 - 5	1 - 5	6 - 7
Slope :	.78	-	.27	.29	.32	-	.35	.56	.74	.47	.28
Std.Dev. of slope :	.43		?	.18	.01		.02	?	.22	.43	?
Deviat.slope=½ (3 fases):	+ - -	? ? ?	+ ≈ -	+ - -	+ - -	- ? ?	+ - -	+ - -	+ - -	+ - -	+ - -
Wash-off(mg/m^2),Diss/Lag:	≈	≈	(Lag)	≈	≈	=18.80	(Lag)	13.30	(Opl)	≈	44.23
Total Concentrat.(mg/kg):	159900	24.00	87.00	660.0	45100	.000	140.0	440.0	123236	.000	2700
Availability (mg/kg):	75000	.780	9.00	56.00	340.0	(540.0)	< 4.20	2.40	1140	(190.0)	30.00
Availability perc. (%):	46.90	3.25	10.34	8.48	.75	#VALUE!	< 3.00	.55	.93	#VALUE!	1.11
Mean factor above DTL :	1500	4	4	28	340	-	(DTL)	2	57	-	15
Max.Cum.release (mg/m^2):	3819444	39.72	458.3	2852	17315	(27500)	< 213.9	122.2	58056	(9676)	1528
Cum.release 64d. (mg/m^2):	7315	< .4	90	2270	166	< 75	16	33	9971	93	103
Leaching-perc. 64d. (%):	.2	< 1.0	19.6	79.6	1.0	< .3	7.6	27.0	17.2	1.0	6.7
Mean factor above DTL :	200	(DTL)	16	310	18	41	1.7	18	248	25	28
Cum.release calc. 1D 64d:	16929	< .44	119	2405	350	< 101	< 27	4.9	15844	< 162	13
Cum.release calc. 3D 64d: (mg/m^2)	27538	< .75	168	2349	564	< 165	< 43	7.8	22197	< 258	22
Chemical Retention R:	49153	7155	12	1.5	2114	64108	53	781	-	-	13390
$R_{range-min}$:	14826	2705	9.4	.38	1656	2860	40	737	-	-	10833
$R_{range-max}$:	162962	18927	15	5.6	2698	1436805	69	828	-	-	16551

pD_e for R=1 will be ≥
Availability(%) becomes ≥

464

Bottom Ash
Productcode: V28B

Concentration in µg/L Time (days)	TDS	Na	TOC
1	864000	749000	20000
2	864000	540000	12100
4	3280000	1230000	32400
8	< 30	1850000	6000
16	4990000	1680000	65000
32	4580000	1450000	56500
64	3010000	887000	23600
pD_e (-log[m^2/s]) :	> 9.1	9.22	> 10.8
Standard deviation :	.62	.54	.74
Used data points :	1 - 7	1 - 7	1 - 4
Slope :	-	.33	(.2)
Std.Dev. of slope :		.17	(.63)
Deviat.slope=½ (3 fases):	+ - -	+ - -	+ ≈ -
Wash-off(mg/m^2),Diss/Lag:	(Lag)	≈	≈
Total Concentrat.(mg/kg):	64000	53200	4300
Availability (mg/kg):	(64000.0)	36000	(4300.0)
Availability perc. (%):	(100)	67.67	(100)
Mean factor above DTL :	-	1200	-
Max.Cum.release (mg/m^2):	(3259259)	1833333	(218981)
Cum.release 64d. (mg/m^2):	4597858	2192266	56362
Leaching-perc. 64d. (%):	141	120	25.7
Mean factor above DTL :	83753	39933	-
Cum.release calc. 1D 64d:	< 4834645	2336900	< 45999
Cum.release calc. 3D 64d:	< 3096123	1702288	< 66124
(mg/m^2)	Tortuosity	2	
Chemical Retention R:	.60	1.0	30
$R_{range-min}$:	.15	.29	5.5
$R_{range-max}$:	2.5	3.5	165

Bottom Ash
Productcode: V2BC

Surf.area: .0324 m^2
Weight : 1.70 kg

Bulk Density : 2064 kg/m^3
Extraction volume: 8.47 L

2 October 1991

Concentration in µg/L Time (days)	K	Na	Li	Br	Cl	NO3	SO4	Al	B	Ba
1	83700	724000	27.30	5490	367000	< 10	387000	15800	154	7.10
2	44600	390000	20.50	2920	194000	30	182000	11800	68.30	6.50
4	134000	1210000	61.50	5570	374000	190	339000	36800	78.30	10.90
8	182000	1810000	42.30	11600	520000	320	529000	43500	68.70	10
16	211000	1630000	72.80	9000	870000	370	900000	75500	185	6.30
32	174000	1470000	124	9640	686000	410	822000	72200	359	3.30
64	102000	928000	95.50	12100	610000	440	7140	50200	507	5
pD_e (-log[m^2/s]) :	8.55	9.05	10.22	9.05	9.21	10.56	9.55	9.75	-	13.84
Standard deviation :	.11	.40	.29	.30	.24	.16	.22	.10	-	.37
Used data points :	3 - 5	1 - 6	2 - 7	1 - 6	1 - 6	3 - 6	1 - 6	3 - 5	-	1 - 4
Slope :	.33	.59	.43	.54	.58	.35	.62	.52	(.6)	.75
Std.Dev. of slope :	.07	.17	.13	.13	.10	.10	.07	.16	(.09)	.28
Deviat.slope=½ (3 fases):	+ - -	+ - -	+ ≈ -	+ - -	+ - -	+ ≈ -	+ ≈ -	+ ≈ -	≈ + +	+ - -
Wash-off(mg/m^2),Dias/Lag:	(Lag)	(Lag)	(Lag)	(Lag)	(Lag)	(Lag)	(Lag)	(Lag)		(Opl)
Total Concentrat.(mg/kg):	5000	49700	12.00	200.0	14000	46.00	21000	25000	.000	330.0
Availability (mg/kg):	3000	32000	6.00	200.0	16200	46.00	24400	3400	-	80.00
Availability perc. (%):	60.00	64.39	50.00	100.00	115.71	100.00	116.19	13.60	-	24.24
Mean factor above DTL :	30	1067	2	4	162	46	244	680	-	23
Max.Cum.release (mg/m^2):	157407	1679012	314.8	10494	850000	2414	1280247	178395	-	4198
Cum.release 64d. (mg/m^2):	243460	2133708	116	14723	946601	463	827692	79942	-	13
Leaching-perc. 64d. (%):	155	127	36.8	140	111	19.2	64.7	44.8	-	.3
Mean factor above DTL :	333	38867	21	16	1035	25	905	3971	-	7
Cum.release calc. 1D 64d:	435840	2612232	127	16374	1100054	658	1122816	124816	-	26
Cum.release calc. 3D 64d:	156010	1606279	165	10043	791427	922	1070932	134636	-	43
(mg/m^2)	Tortuosity (Na):		1	range:	1 - 3					
Chemical Retention R:	.51	1.0	-	1.5	2.2	47	2.8	1.8	-	42669
$R_{range-min}$:	.39	.40	-	.76	1.3	32	1.7	1.5	-	18394
$R_{range-max}$:	.65	2.5	-	3.1	3.9	67	4.7	2.3	-	98980
pD_e for R=1 will be ≥	8.8			8.9		8.9				
Availability(%) becomes ≥	84.4			80.8		14.6				

Bottom Ash — Surf.area .0324 m^2 — Bulk Density 2064 kg/m^3 (continued)
Productcode: V2BC — Weight 1.70 kg — Extraction volume 8.47 L

Concentration in µg/L Time (days)	Ca	Cd	Cr	Cu	Fe	Mg	Ni	Pb	Si	Sr	Zn
1	3740	< .2	50	683	234	266	< 5	16.40	3500	29.90	102
2	4450	< .2	16.70	379	143	156	< 5	15.40	4000	39.90	56.30
4	7330	< .2	57.20	1240	137	< 1	6.20	15.80	8070	82.90	152
8	6000	< .2	60	1420	46.20	98.40	< 5	23	8250	80	50
16	3130	< .2	69.30	1770	117	< 1	13.40	30.80	10300	39.40	42.10
32	1380	1	86.70	1550	88.20	5.40	12.30	15.50	4590	23.70	12.20
64	1430	< .2	59.20	769	101	50.10	< 5	6	3600	11	7
pD_e (-log[m^2/s]) :	14.11	> 15.0	10.18	10.86	13.35	> 15.4	12.77	13.76	11.96	> 13.3	14.58
Standard deviation :	.09	.35	.27	.32	.38	1.72	.27	.14	.17	.24	.53
Used data points :	2 - 3	1 - 7	1 - 6	2 - 6	5 - 7	1 - 7	5 - 6	2 - 5	2 - 5	2 - 3	1 - 4
Slope :	.72	-	.54	.46	-.11	-	-.12	.35	.41	1.05	.37
Std.Dev. of slope :	?		.12	.20	.17		?	.08	.14	?	.47
Deviat.slope=½ (3 fases):	+ - -		+ - -	+ - -	≈ - -	+ - +	? + +	+ - -	+ - -	+ - -	+ - -
Wash-off(mg/m^2),Diss/Lag:	(Opl)	(Lag)	(Lag)	(Lag)	75.93	≈87.14	(Lag)	(Lag)	(Lag)	(Opl)	≈
Total Concentrat.(mg/kg):	171000	25.00	72.00	820.0	48600	.000	150.0	730.0	114163	.000	2800
Availability (mg/kg):	100000	11.40	5.60	280.0	220.0	(2400.0)	17.00	170.0	7600	(400.0)	1800
Availability perc. (%):	58.48	45.60	7.78	34.15	.45	#VALUE!	11.33	23.29	6.66	#VALUE!	64.29
Mean factor above DTL :	2000	57	3	140	220	-	4	170	380	-	900
Max.Cum.release (mg/m^2):	5246914	598.1	293.8	14691	11543	(125926)	892.0	8920	398765	(20988)	94444
Cum.release 64d. (mg/m^2):	7179	< .6	104	2042	226	151	< 14	32	11061	80	110
Leaching-perc. 64d. (%):	.1	< .1	35.4	13.9	2.0	.1	< 1.6	.4	2.8	.4	.1
Mean factor above DTL :	196	1.6	19	279	25	83	1.5	17	275	22	30
Cum.release calc. 1D 64d:	24248	< .95	124	2849	128	< 127	19	61	21726	< 244	254
Cum.release calc. 3D 64d: (mg/m^2)	39436	< 1.6	160	4173	207	< 209	31	99	34383	< 397	413
Chemical Retention R:	67354	517700	6.6	41	10457	1259691	2667	39703	-	-	214544
$R_{range-min}$:	54288	231295	3.5	19	4363	24242	1447	28746	-	-	63613
$R_{range-max}$:	83565	1158750	12	87	25065	65457456	4915	54837	-	-	723580

pD_e for R=1 will be ≥
Availability(%) becomes ≥

467

Bottom Ash
Productcode: V2BC

Concentration in µg/L Time (days)	TDS	Na	TOC
1	2050000	724000	24600
2	1080000	390000	12700
4	< 30	1210000	22400
8	< 30	1810000	2000
16	5090000	1630000	62000
32	4700000	1470000	51200
64	1200000	928000	1810
pD_e (-log[m^2/s]) :	> 9.2	9.05	> 11.6
Standard deviation :	.71	.40	1.11
Used data points :	1 - 7	1 - 6	1 - 4
Slope :	-	.59	(-.5)
Std.Dev. of slope :		.17	(.75)
Deviat.slope=½ (3 fases):	+ + -	+ - -	+ + -
Wash-off(mg/m^2),Diss/Lag:	≈	(Lag)	≈3767
Total Concentrat.(mg/kg):	61500	49700	7800
Availability (mg/kg):	(61500.0)	32000	(7800.0)
Availability perc. (%):	(100)	64.39	(100)
Mean factor above DTL :	-	1067	-
Max.Cum.release (mg/m^2):	(3226852)	1679012	(409259)
Cum.release 64d. (mg/m^2):	3691263	2133708	46195
Leaching-perc. 64d. (%):	114	127	11.3
Mean factor above DTL :	67238	38867	-
Cum.release calc. 1D 64d:	< 4227152	2612232	< 33973
Cum.release calc. 3D 64d:	< 3011373	1606279	< 52747
(mg/m^2)	Tortuosity	1	
Chemical Retention R:	1.2	1.0	287
$R_{range-min}$:	.23	.40	22
$R_{range-max}$:	5.9	2.5	3736

Combined Ash
Productcode: V2CA

Surf.area: .0324 m^2 Bulk Density : 1955 kg/m^3 2 October 1991
Weight : 1.61 kg Extraction volume: 8.47 L

Concentration in µg/L Time (days)	K	Na	Li	Br	Cl	NO3	SO4	Al	B	Ba
1	24900	220000	12.50	1120	51300	140	28300	3510	96.20	4
2	23600	208000	17.10	2030	108000	180	82200	4840	79.70	4.60
4	51900	428000	51.60	3480	195000	330	133000	12300	94.10	3.50
8	86000	620000	70.20	13600	699000	240	260800	15000	61.40	4
16	102000	785000	95.50	10000	480000	850	330000	23500	298	3.90
32	103000	753000	86.50	7800	432000	800	327000	22600	292	< 1
64	81600	652000	86	11900	858000	180	14200	18200	372	1.80
pD_e (-log[m^2/s]) :	9.76	9.63	10.33	9.21	9.51	9.59	10.29	12.08	-	15.47
Standard deviation :	.22	.20	.03	.42	.38	.29	.18	.22	-	.45
Used data points :	2 - 5	2 - 6	3 - 5	2 - 7	2 - 7	2 - 6	2 - 6	2 - 6	-	1 - 3
Slope :	.71	.46	.44	.45	.51	.57	.53	.54	(.6)	.79
Std.Dev. of slope :	.14	.12	.00	.19	.17	.17	.11	.13	(.12)	.68
Deviat.slope=½ (3 fases):	+ - -	+ - -	+ - -	+ - -	+ ≈ ≈	+ ≈ -	+ ≈ -	+ - -	+ + -	+ - -
Wash-off(mg/m^2),Diss/Lag:	(Opl)	(Lag)	(Lag)	(Lag)	(Lag)	(Lag)	(Lag)	(Lag)		≈
Total Concentrat.(mg/kg):	5000	51900	10.00	220.0	98000	24.00	8000	14000	.000	320.0
Availability (mg/kg):	5000	32000	10.00	220.0	17360	24.00	27000	14600	-	280.0
Availability perc. (%):	100.00	61.66	100.00	100.00	17.71	100.00	337.50	104.29	-	87.50
Mean factor above DTL :	50	1067	3	4	174	24	270	2920	-	80
Max.Cum.release (mg/m^2):	248457	1590123	496.9	10932	862642	1193	1341667	725494	-	13914
Cum.release 64d. (mg/m^2):	123652	958365	110	13053	738066	711	307299	26129	-	5.96
Leaching-perc. 64d. (%):	49.8	60.3	22.1	119	85.6	59.6	22.9	3.6	-	.04
Mean factor above DTL :	169	17457	20	14	807	39	336	1298	-	3.3
Cum.release calc. 1D 64d:	171880	1273171	177	14189	788148	999	500948	34465	-	13
Cum.release calc. 3D 64d:	186380	1280955	237	10184	732628	980	662290	54744	-	22
(mg/m^2)	Tortuosity (Na):		5	range:	3 - 8					
Chemical Retention R:	2.1	1.0	-	.59	1.2	1.3	4.1	105	-	475603
$R_{range-min}$:	1.3	.63	-	.22	.49	.66	2.7	63	-	169980
$R_{range-max}$:	3.6	1.6	-	1.5	2.8	2.6	6.3	175	-	1330737
pD_e for R=1 will be ≥	9.4		#VALUE!	9.4		9.5				
Availability(%) becomes ≥	68.3			130.7		87.4				

Combined Ash — Surf.area .0324 m^2 — Bulk Density 1955 kg/m^3 — (continued)
Productcode: V2CA — Weight 1.61 kg — Extraction volume 8.47 L

Concentration in µg/L Time (days)	Ca	Cd	Cr	Cu	Fe	Mg	Ni	Pb	Si	Sr	Zn
1	4560	< .2	30.80	22	57.80	65.40	< 5	21	1690	13.80	30
2	6160	< .2	27.60	22	58.90	41.40	< 5	10.40	3800	56.50	31.10
4	2560	< .2	54.30	49.60	52.80	4.60	< 5	5.50	8430	67.30	18.10
8	4900	.30	60	123	324	139	9.40	19.20	9000	50	43.30
16	4710	.60	91.80	153	264	83.70	16.80	21.50	9640	35.90	58.40
32	2720	.80	91.30	169	178	66.10	< 5	13	5180	26.60	44
64	1080	< .2	70.80	95.40	24	14.90	< 5	4.70	3270	12.40	11
pD_e ($-\log[m^2/s]$) :	14.61	> 15.3	11.00	13.09	15.91	> 16.2	> 12.7	15.44	12.84	> 13.3	15.22
Standard deviation :	.60	.16	.12	.22	.39	1.09	.14	.45	.21	.11	.32
Used data points :	1 - 3	1 - 7	2 - 5	3 - 6	1 - 3	1 - 7	1 - 7	3 - 6	2 - 5	2 - 3	2 - 5
Slope :	.47	-	.53	.56	.82	.16	-	.39	.41	.25	.40
Std.Dev. of slope :	1.00		.11	.19	.56	.34		.40	.18	?	.28
Deviat.slope=½ (3 fases):	≈ − −	? + ≈	+ − −	+ ≈ −	+ ≈ −	− + −	? + ?	− ≈ −	+ − −	+ − −	≈ ≈ −
Wash-off(mg/m^2),Diss/Lag:	≈	(Lag)	(Lag)	(Lag)	≈	≈13.35	(Lag)	3.29	(Lag)	(Lag)	≈
Total Concentrat.(mg/kg):	175000	140.0	37.00	316.0	51300	.000	20.00	1500	114163	.000	8600
Availability (mg/kg):	109000	15.60	19.60	320.0	6600	(4000.0)	24.00	560.0	22000	(460.0)	1620
Availability perc. (%):	62.29	11.14	52.97	101.27	12.87	#VALUE!	120.00	37.33	19.27	#VALUE!	18.84
Mean factor above DTL :	2180	78	9	160	6600	-	6	560	1100	-	810
Max.Cum.release (mg/m^2):	5416358	775.2	974.0	15901	327963	(198765)	1193	27827	1093210	(22858)	80500
Cum.release 64d. (mg/m^2):	6977	< .7	112	166	251	109	< 13	25	10721	69	62
Leaching-perc. 64d. (%):	.1	< .09	11.5	1.0	.08	.05	< 1.1	.09	1.0	.3	.08
Mean factor above DTL :	191	1.9	20	23	27	60	(DTL)	14	266	19	17
Cum.release calc. 1D 64d:	13943	< .94	161	238	189	< 83	< 27	28	21798	< 262	104
Cum.release calc. 3D 64d: (mg/m^2)	22700	< 1.5	240	385	309	< 134	< 45	45	35147	< 433	169
Chemical Retention R:	57489	237085	11	1827	1022524	1945663	659	494640	-	-	247416
$R_{range-min}$:	14316	163617	8.6	1106	415623	156981	473	174761	-	-	119344
$R_{range-max}$:	230855	343543	15	3019	2515634	24115098	918	1400022	-	-	512926

pD_e for R=1 will be ≥
Availability(%) becomes ≥

Combined Ash
Productcode: V2CA

Concentration in µg/L Time (days)	TDS	Na	TOC
1	65000	220000	3880
2	411000	208000	3730
4	1310000	428000	4660
8	< 30	620000	18000
16	2320000	785000	8000
32	2440000	753000	8410
64	2280000	652000	6010
pD_e (-log[m^2/s]) :	> 10.1	9.63	> 12.0
Standard deviation :	1.14	.20	.61
Used data points :	1 - 7	2 - 6	1 - 4
Slope :	-	.46	(1.2)
Std.Dev. of slope :		.12	(.22)
Deviat.slope=½ (3 fases):	+ - ≈	+ - -	+ - -
Wash-off(mg/m^2),Diss/Lag:	(Lag)	(Lag)	(Lag)
Total Concentrat.(mg/kg):	82000	51900	7300
Availability (mg/kg):	(82000.0)	32000	(7300.0)
Availability perc. (%):	(100)	61.66	(100)
Mean factor above DTL :	-	1067	-
Max.Cum.release (mg/m^2):	(4074691)	1590123	(362747)
Cum.release 64d. (mg/m^2):	2307299	958365	13774
Leaching-perc. 64d. (%):	56.6	60.3	3.8
Mean factor above DTL :	42029	17457	-
Cum.release calc. 1D 64d:	< 1802044	1273171	< 18436
Cum.release calc. 3D 64d:	< 2374375	1280955	< 29997
(mg/m^2)	Tortuosity	5	
Chemical Retention R:	2.7	1.0	203
$R_{range-min}$:	.19	.63	49
$R_{range-max}$:	37	1.6	833

Combination
Productcode: V2CB

Surf.area: .0324 m^2 Bulk Density : 1991 kg/m^3 2 October 1991
Weight : 1.64 kg Extraction volume: 8.47 L

Concentration in µg/L Time (days)	K	Na	Li	Br	Cl	NO3	SO4	Al	B	Ba
1	21100	262000	5.70	2820	134000	270	161000	3670	71.70	2.50
2	46800	556000	28.40	5950	260000	430	273000	13200	54.60	5.20
4	131000	1520000	97.20	7150	356000	670	342000	41100	81.80	6.90
8	150000	1200000	61.50	12700	664000	1210	693000	35000	60.90	5
16	170000	1900000	56.60	15000	870000	1400	1100000	26100	148	< 1
32	163000	2080000	191	16400	754000	1500	995000	74700	454	1.90
64	84500	1160000	107	6040	404000	940	551000	45800	469	3.10
pD_e (-log[m^2/s]) :	8.94	8.56	9.98	8.28	9.29	8.70	9.59	11.13	-	14.27
Standard deviation :	.29	.25	.44	.15	.19	.15	.18	.41	-	.04
Used data points :	2 - 6	2 - 6	2 - 7	2 - 6	2 - 6	2 - 6	2 - 6	2 - 7	-	2 - 3
Slope :	.40	.41	.35	.40	.44	.47	.54	.32	(.7)	.41
Std.Dev. of slope :	.17	.14	.18	.07	.11	.09	.11	.16	(.10)	?
Deviat.slope=½ (3 fases):	+ − −	+ − −	+ − ≈	+ ≈ −	+ ≈ −	+ ≈ −	+ ≈ −	+ − ≈	+ + +	+ − +
Wash-off(mg/m^2),Diss/Lag:	(Lag)	(Lag)	(Lag)	(Lag)	(Lag)	(Lag)	(Lag)	(Lag)		(Lag)
Total Concentrat.(mg/kg):	6900	51500	9.00	140.0	11000	20.00	21000	26000	.000	620.0
Availability (mg/kg):	3400	24000	6.00	140.0	22200	20.00	35000	10200	-	132.0
Availability perc. (%):	49.28	46.60	66.67	100.00	201.82	100.00	166.67	39.23	-	21.29
Mean factor above DTL :	34	800	2	3	222	20	350	2040	-	38
Max.Cum.release (mg/m^2):	172099	1214815	303.7	7086	1123704	1012	1771605	516296	-	6681
Cum.release 64d. (mg/m^2):	200352	2268601	143	17269	899807	1678	1075742	62628	-	6.69
Leaching-perc. 64d. (%):	116	187	47.1	244	80.1	166	60.7	12.1	-	.1
Mean factor above DTL :	274	41324	26	19	983	92	1176	3111	-	3.7
Cum.release calc. 1D 64d:	304385	3332402	162	26723	1328221	2372	1486626	73305	-	25
Cum.release calc. 3D 64d: (mg/m^2)	166785	1203748	195	7060	1027504	998	1456162	110543	-	41
	Tortuosity (Na):		0	range:	0 - 1					
Chemical Retention R:	3.8	1.0	-	.81	8.2	2.0	9.6	138	-	359546
$R_{range-min}$:	2.0	.56	-	.58	5.3	1.4	6.3	53	-	328567
$R_{range-max}$:	7.5	1.8	-	1.1	13	2.8	15	358	-	393445
pD_e for R=1 will be ≥				8.4		8.4				
Availability(%) becomes ≥				110.8		71.4				

Combination
Productcode: V2CB

Surf.area .0324 m^2 Bulk Density 1991 kg/m^3 (continued)
Weight 1.64 kg Extraction volume 8.47 L

Concentration in µg/L Time (days)	Ca	Cd	Cr	Cu	Fe	Mg	Ni	Pb	Si	Sr	Zn
1	1600	< .2	19.60	20.60	18.30	5.20		4.90	1720	3.90	22
2	3310	< .2	43	90.90	247	545		12.40	5710	26.90	117
4	6410	.30	121	276	210	< 1		73.70	13000	74.50	313
8	2500	< .2	100	109	46.80	77.50		10.20	6000	15	21.50
16	1300	.30	61.30	141	72.60	< 1		18.80	6140	17.40	35.70
32	2270	.50	170	510	146	61.60		9.40	6120	26.60	44.90
64	2800	< .2	109	173	136	13.70		12.70	6410	19.50	41.70
pD_e (-log[m^2/s]) :	13.93	> 14.9	9.93	12.42	13.34	> 15.2	-	15.07	12.86	> 15.3	15.80
Standard deviation :	.19	.31	.43	.50	.18	1.98	-	.48	.78	.09	.07
Used data points :	2 - 3	1 - 7	2 - 6	2 - 6	4 - 7	1 - 7	-	4 - 7	1 - 7	4 - 6	4 - 6
Slope :	.95	-	.30	.40	.56	-	-	-.01	.36	.41	.53
Std.Dev. of slope :	?		.23	.30	.16			.24	.26	.11	.12
Deviat.slope=½ (3 fases):	+ - ≈	? + +	+ - ≈	+ - -	+ - ≈	+ - -		+ - -	+ - -	+ - -	+ - -
Wash-off(mg/m^2),Diss/Lag:	(Opl)	(Lag)	(Lag)	(Lag)	?≈	?≈		?≈	≈	?≈	?≈
Total Concentrat.(mg/kg):	167000	17.00	46.00	850.0	38600	.000	55.00	600.0	82074	.000	2500
Availability (mg/kg):	68000	7.20	7.80	280.0	240.0	(1300.0)	14.20	240.0	12200	(580.0)	1740
Availability perc. (%):	40.72	42.35	16.96	32.94	.62	#VALUE!	25.82	40.00	14.86	#VALUE!	69.60
Mean factor above DTL :	1360	36	4	140	240	-	4	240	610	-	870
Max.Cum.release (mg/m^2):	3441975	364.4	394.8	14173	12148	(65802)	718.8	12148	617531	(29358)	88074
Cum.release 64d. (mg/m^2):	5278	< .5	163	345	229	184	-	37	11790	48	156
Leaching-perc. 64d. (%):	.2	< .1	41.3	2.4	1.9	.3	-	.3	1.9	.2	.2
Mean factor above DTL :	144	(DTL)	30	47	25	101	-	20	293	13	43
Cum.release calc. 1D 64d:	19556	< .71	223	458	136	< 89	-	18	11975	< 34	58
Cum.release calc. 3D 64d: (mg/m^2)	31787	< 1.1	263	734	220	< 141	-	30	19319	< 55	95
Chemical Retention R:	138524	1060137	11	4596	31863	2183680	-	2512827	-	-	11077136
$R_{range-min}$:	88811	513752	4.3	1456	21101	22901	-	839633	-	-	9381723
$R_{range-max}$:	216067	2187614	30	14504	48113	208224503	-	7520311	-	-	13078934

pD_e for R=1 will be ≥
Availability(%) becomes ≥

Combination
Productcode: V2CB

Concentration in µg/L Time (days)	TDS	Na	TOC
1	1060000	262000	5000
2	1420000	556000	6240
4	2840000	1520000	9850
8	< 30	1200000	15000
16	6060000	1900000	25000
32	6240000	2080000	29400
64	3880000	1160000	16000

pD_e (-log[m^2/s]) :	> 9.0	8.56	> 11.3
Standard deviation :	.55	.25	.53
Used data points :	1 - 7	2 - 6	1 - 4
Slope :	-	.41	(1.1)
Std.Dev. of slope :		.14	(.25)
Deviat.slope=i (3 fases):	+ - -	+ - -	+ = -
Wash-off(mg/m^2),Diss/Lag:	(Lag)	(Lag)	(Lag)
Total Concentrat.(mg/kg):	69500	51500	4500
Availability (mg/kg):	(69500.0)	24000	(4500.0)
Availability perc. (%):	(100)	46.60	(100)
Mean factor above DTL :	-	800	-
Max.Cum.release (mg/m^2):	(3517901)	1214815	(227778)
Cum.release 64d. (mg/m^2):	5620533	2268601	27839
Leaching-perc. 64d. (%):	160	187	12.2
Mean factor above DTL :	102381	41324	-
Cum.release calc. 1D 64d:	< 6019021	3332402	< 25736
Cum.release calc. 3D 64d: (mg/m^2)	< 3387299	1203748	< 40693
	Tortuosity	0	
Chemical Retention R:	2.1	1.0	481
$R_{range-min}$:	.59	.56	143
$R_{range-max}$:	7.5	1.8	1614

474

Combination
Productcode: V2CC

Surf.area: .0324 m^2 Bulk Density : 1967 kg/m^3 2 October 1991
Weight : 1.62 kg Extraction volume: 8.47 L

Concentration in µg/L Time (days)	K	Na	Li	Br	Cl	NO3	SO4	Al	B	Ba
1	70900	807000	25	3820	194000	430	185000	16900	159	4.90
2	45100	517000	31.90	3700	168000	390	165000	14700	79.90	4.60
4	117000	1330000	48.30	11100	484000	800	439000	38900	132	5.40
8	198000	1600000	51.10	9080	500000	910	725000	46900	51.40	6.58
16	142000	1770000	136	28000	770000	1400	780000	63900	419	4.40
32	122000	1460000	148	11600	609000	1460	692000	54700	475	2.30
64	71800	867000	117	6470	391000	890	422000	34600	557	< 1
pD_e (-log[m^2/s]) :	9.32	9.14	9.91	8.79	9.11	8.63	9.59	10.12	-	13.77
Standard deviation :	.33	.36	.20	.45	.29	.15	.31	.52	-	.11
Used data points :	2 - 5	1 - 6	2 - 6	2 - 6	2 - 6	2 - 6	2 - 6	1 - 7	-	2 - 3
Slope :	.57	.54	.59	.46	.44	.46	.50	.46	(.6)	.23
Std.Dev. of slope :	.30	.16	.11	.27	.18	.09	.19	.18	(.16)	?
Deviat.slope=½ (3 fases):	+ - -	+ - -	+ + -	+ - -	+ - -	+ - -	+ - -	+ - -	+ + -	+ - -
Wash-off(mg/m^2),Diss/Lag:	(Lag)	(Lag)	(Lag)	(Lag)	(Lag)	(Lag)	(Lag)	(Lag)		(Lag)
Total Concentrat.(mg/kg):	8300	52100	12.00	250.0	15000	18.00	23000	24000	.000	530.0
Availability (mg/kg):	5800	40000	6.00	250.0	15760	18.00	29600	3200	-	62.00
Availability perc. (%):	69.88	76.78	50.00	100.00	105.07	100.00	128.70	13.33	-	11.70
Mean factor above DTL :	58	1333	2	5	158	18	296	640	-	18
Max.Cum.release (mg/m^2):	290000	2000000	300.0	12500	788000	900.0	1480000	160000	-	3100
Cum.release 64d. (mg/m^2):	200457	2183116	146	19285	814584	1642	890919	70740	-	7.63
Leaching-perc. 64d. (%):	69.1	109	48.7	154	103	182	60.2	44.2	-	.2
Mean factor above DTL :	274	39767	27	21	890	90	974	3514	-	4.2
Cum.release calc. 1D 64d:	331330	2809701	175	26231	1143459	2264	1237860	72463	-	21
Cum.release calc. 3D 64d: (mg/m^2)	263119	1887520	204	12258	747167	890	1214759	91441	-	34
	Tortuosity (Na):		2	range:	1 - 4					
Chemical Retention R:	2.4	1.0	-	.69	1.4	.45	2.5	3.6	-	29322
$R_{range-min}$:	1.1	.44	-	.25	.73	.31	1.2	1.1	-	22533
$R_{range-max}$:	5.2	2.3	-	1.9	2.8	.64	5.1	12	-	38157
pD_e for R=1 will be ≥				9.0		9.0				
Availability(%) becomes ≥				120.4		149.6				

475

Combination
Productcode: V2CC

Surf.area .0324 m^2 Bulk Density 1967 kg/m^3 (continued)
Weight 1.62 kg Extraction volume 8.47 L

Concentration in µg/L Time (days)	Ca	Cd	Cr	Cu	Fe	Mg	Ni	Pb	Si	Sr	Zn
1	3430	< .2	31.10	132	115	30.80	< 5	20.30	3900	24.90	101
2	4710	< .2	14.50	89.40	469	13.60	< 5	17.70	4780	42.50	103
4	7390	< .2	57.90	244	99.40	< 1	< 5	81.50	11600	97.60	227
8	3700	< .2	88	82.20	280	58.20	9.60	4.40	11680	112	94
16	3880	.30	96.80	326	228	28.80	< 5	20.60	12000	33.30	71.30
32	1390	.30	108	268	82.30	< 1	< 5	5	5810	17.20	21.60
64	1140	< .2	83.10	111	51.20	< 1	< 5	5.80	4180	11.10	12.10
pD_e ($-\log[m^2/s]$) :	13.96	> 15.9	> 9.9	11.91	11.63	> 16.0	> 12.3	15.48	11.40	> 13.8	13.80
Standard deviation :	.06	.21	.07	.45	.70	.40	-	.12	.25	1.18	.60
Used data points :	2 - 3	1 - 7	1 - 2	1 - 6	3 - 6	1 - 7	1 - 7	6 - 7	2 - 5	1 - 7	1 - 3
Slope :	.65	-	.67	.51	-.11	-	-	.21	.40	-.08	1.47
Std.Dev. of slope :	?		?	.20	.47			?	.22	.31	.19
Deviat.slope=½ (3 fases):	+ - -	? + +	+ - -	+ - -	+ - -	≈ - ?		+ - -	+ - -	+ - -	+ - -
Wash-off(mg/m^2),Diss/Lag:	(Lag)	(Lag)	≈	≈	?≈	≈	(Lag)	8.92	(Lag)	?≈	(Opl)
Total Concentrat.(mg/kg):	171000	21.00	43.00	770.0	39100	.000	48.00	800.0	94929	.000	2400
Availability (mg/kg):	92000	15.20	< 2.40	140.0	80.00	(3000.0)	13.60	120.0	5400	(240.0)	1360
Availability perc. (%):	53.80	72.38	< 5.58	18.18	.20	#VALUE!	28.33	15.00	5.69	#VALUE!	56.67
Mean factor above DTL :	1840	76	(DTL)	70	80	-	3	120	270	-	680
Max.Cum.release (mg/m^2):	4600000	760.0	< 120.0	7000	4000	(150000)	680.0	6000	270000	(12000)	68000
Cum.release 64d. (mg/m^2):	6703	< .4	125	327	346	< 35	< 10	41	14104	89	165
Leaching-perc. 64d. (%):	.1	< .05	104	4.7	8.7	< .02	< 1.5	.7	5.2	.7	.2
Mean factor above DTL :	183	(DTL)	23	45	38	19	(DTL)	22	350	24	45
Cum.release calc. 1D 64d:	25048	< .45	< 69	405	321	< 76	< 24	5.7	28188	< 76	447
Cum.release calc. 3D 64d: (mg/m^2)	40715	< .72	< 82	640	501	< 125	< 40	9.3	43396	< 128	725
Chemical Retention R:	39556	3028653	2.9	376	163	4073338	799	1677596	-	-	29313
$R_{range-min}$:	34152	1855194	2.4	133	32	1634933	-	1267606	-	-	7446
$R_{range-max}$:	45815	4944358	3.4	1064	821	10148476	-	2220191	-	-	115394

pD_e for R=1 will be ≥
Availability(%) becomes ≥

Combination
Productcode: V2CC

Concentration in µg/L Time (days)	TDS	Na	TOC
1	1040000	807000	5870
2	911000	517000	6160
4	3320000	1330000	11900
8	< 30	1600000	11000
16	4760000	1770000	19000
32	4370000	1460000	21400
64	3070000	867000	13500
pD_e (-log[m^2/s]) :	> 9.2	9.14	> 11.7
Standard deviation :	.56	.36	.46
Used data points :	1 - 7	1 - 6	1 - 4
Slope :	-	.54	(.9)
Std.Dev. of slope :		.16	(.31)
Deviat.slope=½ (3 fases):	+ - -	+ - -	+ - -
Wash-off(mg/m^2),Diss/Lag:	(Lag)	(Lag)	(Lag)
Total Concentrat.(mg/kg):	72500	52100	7200
Availability (mg/kg):	(72500.0)	40000	(7200.0)
Availability perc. (%):	(100)	76.78	(100)
Mean factor above DTL :	-	1333	-
Max.Cum.release (mg/m^2):	(3625000)	2000000	(360000)
Cum.release 64d. (mg/m^2):	4567272	2183116	23222
Leaching-perc. 64d. (%):	126	109	6.5
Mean factor above DTL :	83195	39767	-
Cum.release calc. 1D 64d:	< 4978651	2809701	< 25907
Cum.release calc. 3D 64d:	< 3382933	1887520	< 41557
(mg/m^2)	Tortuosity	2	
Chemical Retention R:	.85	1.0	311
$R_{range-min}$:	.23	.44	108
$R_{range-max}$:	3.1	2.3	897

477

Appendix C.4. Summary of monolith leach test extract concentrations and data analysis for APC residue, bottom ash and combined ash treated by Process 3.

All
Productcode: V3XL

Surf.area: .0324 m^2 Bulk Density : 1000 kg/m^3 2 October 1991
Weight : 1 kg Extraction volume: 8.47 L

Concentration in µg/L Time (days)	K	Na	Li	Br	Cl	NO3	SO4	Al	B	Ba
1	696	70	< 3			40	55000000	79.80	11	< 1
2	1230	60.70	5.10			< 10	< 500	11.40	< 6	< 1
4	804	42	< 3			< 10	< 500	< 11	< 6	< 1
8	< 400	< 27	< 3			< 10	< 500	< 11	8.60	< 1
16	< 400	667	< 3			< 10	< 500	< 11	6.90	1.20
32	< 400	64.10	< 3			< 10	< 500	24.10	7.60	< 1
64	1440	< 27	< 3			20	< 500	< 11	< 6	< 1
pD_e (-log[m^2/s]) :	-	-	-	-	-	-	-	-	-	-
Standard deviation :	-	-	-	-	-	-	-	-	-	-
Used data points :	-	-	-	-	-	-	-	-	-	-
Slope :	-	-	-	-	-	-	-	-	-	-
Std.Dev. of slope :										
Deviat.slope=½ (3 fases):	+ ? ?	≈ ≈ -				? ? ?		- ? ?	? ≈ -	
Wash-off(mg/m^2),Diss/Lag:										
Total Concentrat.(mg/kg):	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
Availability (mg/kg):	(.00)	(.00)	-	-	(.00)	-	(.00)	-	-	(.00)
Availability perc. (%):	(20)	(20)	-	-	(20)	-	(100)	-	-	(20)
Mean factor above DTL :	-	-	-	-	-	-	-	-	-	-
Max.Cum.release (mg/m^2):	(.0)	(.0)	-	-	(.0)	-	(.0)	-	-	(.0)
Cum.release 64d. (mg/m^2):	-	-	-	-	-	-	-	-	-	-
Leaching-perc. 64d. (%):	-	-	-	-	-	-	-	-	-	-
Mean factor above DTL :	-	-	-	-	-	-	-	-	-	-
Cum.release calc. 1D 64d:	-	-	-	-	-	-	-	-	-	-
Cum.release calc. 3D 64d: (mg/m^2)	-	-	-	-	-	-	-	-	-	-
	Tortuosity (Na):		0	range:	- -					
Chemical Retention R:	-	-	-	-	-	-	-	-	-	-
$R_{range-min}$:	-	-	-	-	-	-	-	-	-	-
$R_{range-max}$:	-	-	-	-	-	-	-	-	-	-

All
Productcode: V3XL

Surf.area .0324 m^2 Bulk Density 1000 kg/m^3 (continued)
Weight 1 kg Extraction volume 8.47 L

Concentration in µg/L Time (days)	Ca	Cd	Cr	Cu	Fe	Mg	Ni	Pb	Si	Sr	Zn
1	82.70	< .2	< 3	13.10	17.20	11.50	< 5	4.40	358	4.30	5.80
2	101	37.30	< 3	< 4	6.80	4.50	5.60	3.90	121	3.80	6.80
4	21.50	< .2	< 3	< 4	< 5	< 1	14.30	< 1	139	< 2	< 2
8	< 20	< .2	< 3	< 4	< 5	2.60	< 5	< 1	94.80	< 2	2.30
16	3160	< .2	< 3	< 4	< 5	5.60	< 5	< 1	< 22	8.80	< 2
32	38.90	< .2	4.70	< 4	< 5	2.40	< 5	5.50	51.30	< 2	3.10
64	75	< .2	< 3	< 4	13.50	4.90	< 5	< 1	91.90	< 2	< 2
pD_e (-log[m^2/s]) :	-	-	-	-	-	-	-	-	-	-	-
Standard deviation :	-	-	-	-	-	-	-	-	-	-	-
Used data points :	-	-	-	-	-	-	-	-	-	-	-
Slope :	-	-	-	-	-	-	-	-	-	-	-
Std.Dev. of slope :											
Deviat.slope=i (3 fases):	- + -				≈ ? ?	≈ - -	+ ? ?	+ ? ?	- - +	+ ? ?	+ - ?
Wash-off(mg/m^2),Diss/Lag:											
Total Concentrat.(mg/kg):	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
Availability (mg/kg):	(.00)	(.00)	(.00)	(.00)	-	-	(.00)	(.00)	-	-	(.00)
Availability perc. (%):	(90)	(80)	(10)	(25)	-	-	(20)	(10)	-	-	(40)
Mean factor above DTL :	-	-	-	-	-	-	-	-	-	-	-
Max.Cum.release (mg/m^2):	(.0)	(.0)	(.0)	(.0)	-	-	(.0)	(.0)	-	-	(.0)
Cum.release 64d. (mg/m^2):	-	-	-	-	-	-	-	-	-	-	-
Leaching-perc. 64d. (%):	-	-	-	-	-	-	-	-	-	-	-
Mean factor above DTL :	-	-	-	-	-	-	-	-	-	-	-
Cum.release calc. 1D 64d:	-	-	-	-	-	-	-	-	-	-	-
Cum.release calc. 3D 64d: (mg/m^2)	-	-	-	-	-	-	-	-	-	-	-
Chemical Retention R:	-	-	-	-	-	-	-	-	-	-	-
$R_{range-min}$:	-	-	-	-	-	-	-	-	-	-	-
$R_{range-max}$:	-	-	-	-	-	-	-	-	-	-	-

ALL
Productcode: V3XL

Concentration in µg/L Time (days)	TDS	Na	TOC
1	17000	70	n.a.
2	40000	60.70	n.a.
4	< 30	42	n.a.
8	< 30	< 27	n.a.
16	< 30	667	n.a.
32	< 30	64.10	510
64	64000	< 27	520
pD_e (-log[m^2/s]) :	-	-	-
Standard deviation :	-	-	-
Used data points :	-	-	-
Slope :	-	-	-
Std.Dev. of slope :			
Deviat.slope=i (3 fases):	+ ? ?	= = -	? ? +
Wash-off(mg/m^2),Diss/Lag:			
Total Concentrat.(mg/kg):	.000	.000	.000
Availability (mg/kg):	(.00)	(.00)	(.00)
Availability perc. (%):	(100)	(20)	(100)
Mean factor above DTL :	-	-	-
Max.Cum.release (mg/m^2):	(.0)	(.0)	(.0)
Cum.release 64d. (mg/m^2):	-	-	-
Leaching-perc. 64d. (%):	-	-	-
Mean factor above DTL :	-	-	-
Cum.release calc. 1D 64d:	-	-	-
Cum.release calc. 3D 64d:	-	-	-
(mg/m^2)	Tortuosity	0	
Chemical Retention R:	-	-	-
$R_{range-min}$:	-	-	-
$R_{range-max}$:	-	-	-

Fly Ash
Productcode: V3FA

Surf.area: .0324 m^2 Bulk Density : 1375 kg/m^3 2 October 1991
Weight : 1.13 kg Extraction volume: 8.47 L

Concentration in µg/L Time (days)	K	Na	Li	Br	Cl	NO3	SO4	Al	B	Ba
1	746000	431000	217	51700	2330000	270	87800	124	70.30	518
2	1060000	683000	417	115000	5210000	340	218000	613	116	831
4	780000	500000	277	100000	1200000	530	120000	< 11	85.60	694
8	880000	605000	358	140000	7400000	430	270000	< 11	120	833
16	961000	633000	428	120000	6800000	510	450000	956	121	1010
32	641000	468000	456	90600	5230000	480	401000	127	55.80	980
64	475000	392000	463	65000	3170000	270	97400	2540	38.90	2280
pD_e (-log[m^2/s]) :	8.47	8.43	8.27	8.05	8.43	9.27	10.78	13.55	-	9.42
Standard deviation :	.21	.20	.11	.25	.71	.62	.25	1.17	-	.14
Used data points :	3 - 5	3 - 5	3 - 5	3 - 5	1 - 7	1 - 7	3 - 6	1 - 7	-	3 - 5
Slope :	.15	.17	.31	.13	.33	.22	.60	-	(.0)	.27
Std.Dev. of slope :	.01	.06	.03	.20	.23	.17	.21		(.20)	.00
Deviat.slope=½ (3 fases):	+ - -	+ - -	+ - -	+ - -	≈ + -	+ - -	+ ≈ -	+ - +	+ - -	+ - ≈
Wash-off(mg/m^2),Dias/Lag:	?≈	≈	≈	≈	?≈	≈	(Lag)	?≈		≈
Total Concentrat.(mg/kg):	20800	12710	15.30	1749	87432	19.67	5355	16393	.000	338.8
Availability (mg/kg):	20765	13115	6.56	1749	73224	19.67	78689	2842	-	59.02
Availability perc. (%):	99.83	103.18	42.88	100.00	83.75	100.00	1469.4	17.33	-	17.42
Mean factor above DTL :	208	437	2	35	732	20	787	568	-	17
Max.Cum.release (mg/m^2):	726134	458620	229.4	61161	2560580	687.8	2751686	99382	-	2064
Cum.release 64d. (mg/m^2):	1449050	970390	684	178367	8192895	740	429826	1146	-	1868
Leaching-perc. 64d. (%):	200	212	298	292	320	108	15.6	1.2	-	90.5
Mean factor above DTL :	1980	17676	125	195	8954	40	470	57	-	1021
Cum.release calc. 1D 64d:	2197558	1455097	881	300176	8119227	827	587009	870	-	2110
Cum.release calc. 3D 64d: (mg/m^2)	721151	455874	229	61059	2545224	631	850794	1412	-	1819
	Tortuosity (Na):		0	range:	0 - 1					
Chemical Retention R:	1.8	1.0	-	.64	1.5	10.0	198	48531	-	6.7
$R_{range-min}$:	1.1	.63	-	.36	.29	2.4	112	3251	-	4.9
$R_{range-max}$:	2.9	1.6	-	1.2	7.9	42	349	724487	-	9.2
pD_e for R=1 will be ≥				8.2		8.3				
Availability(%) becomes ≥				124.7		31.7				

Fly Ash
Productcode: V3FA

Surf.area .0324 m^2 Bulk Density 1375 kg/m^3 (continued)
Weight 1.13 kg Extraction volume 8.47 L

Concentration in µg/L Time (days)	Ca	Cd	Cr	Cu	Fe	Mg	Ni	Pb	Si	Sr	Zn
1	1320000	.60		9.60	27.40	28.30	< 5	4270	340	3650	366
2	2140000	8.30		26.50	174	394	< 5	4930	943	5950	858
4	1690000	< .2		< 5	< 5	26.10	8.20	3770	286	4770	406
8	2190000	.40		< 5	10.90	27.60	< 5	4110	318	5670	479
16	2730000	6.50		< 5	170	359	< 5	4160	1020	7000	841
32	2320000	.80		< 5	29	59.30	< 5	3540	312	6610	525
64	1880000	8.10		18.10	235	411	6.50	1940	1690	6270	683
pD_e (-log[m^2/s]) :	9.73	15.45	-	> 13.7	11.11	> 15.6	> 11.6	10.57	14.06	> 9.0	13.79
Standard deviation :	.09	1.36	-	1.01	1.18	1.18	.99	.37	.60	.13	.38
Used data points :	3 - 5	1 - 7	-	1 - 7	1 - 7	1 - 7	1 - 7	4 - 6	4 - 7	3 - 5	3 - 7
Slope :	.35	.53	-	-	-	.54	- -	-.11	.55	.28	.16
Std.Dev. of slope :	.02	.47				.41		.07	.55	.02	.12
Deviat.slope=½ (3 fases):	+ - -	+ + -		+ ? ?	+ + -	+ + -	? ? ?	+ - -	+ - =	+ - -	+ - -
Wash-off(mg/m^2),Diss/Lag:	=	?=		?=	?=	?=	(Lag)	?=	?=	=	?=
Total Concentrat.(mg/kg):	251000	142.1	42.62	273.2	8060	.000	32.79	2295	39863	.000	16393
Availability (mg/kg):	218579	91.80	5.46	133.3	24.04	(6994.5)	< 4.59	743.2	5683	(240.4)	4372
Availability perc. (%):	87.08	64.61	12.81	48.80	.30	#VALUE!	< 14.00	32.38	14.26	#VALUE!	26.67
Mean factor above DTL :	4372	459	3	67	24	-	(DTL)	743	284	-	2186
Max.Cum.release (mg/m^2):	7643519	3210	190.9	4661	840.7	(244592)	< 160.5	25989	198730	(8407)	152885
Cum.release 64d. (mg/m^2):	3730460	6.51	-	< 19	170	341	< 10	6985	1283	10436	1087
Leaching-perc. 64d. (%):	48.8	.2	-	< .4	20.2	.1	< 6.2	26.9	.6	124	.7
Mean factor above DTL :	101929	18	-	2.1	19	186	(DTL)	3817	32	2851	297
Cum.release calc. 1D 64d:	5457639	3.2	-	< 35	122	< 201	< 13	7009	965	< 14493	1012
Cum.release calc. 3D 64d: (mg/m^2)	5831164	5.2	-	< 56	183	< 330	< 21	9839	1570	< 8095	1645
Chemical Retention R:	12	5564374	-	113047	256	7870355	785	107	-	-	147017
$R_{range-min}$:	9.5	242455	-	11045	17	515481	80	46	-	-	61749
$R_{range-max}$:	15	127702844	-	1157072	3887	120164398	7748	249	-	-	350029
pD_e for R=1 will be ≥											
Availability(%) becomes ≥											

Fly Ash
Productcode: V3FA

Concentration in µg/L Time (days)	TDS	Na	TOC
1	4160000	431000	n.a.
2	8930000	683000	2000
4	9170000	500000	n.a.
8	10400000	605000	1000
16	12100000	633000	1000
32	9690000	468000	1710
64	6620000	392000	1840
pD_e (-log[m^2/s]) :	> 8.5	8.43	> 12.7
Standard deviation :	.64	.20	.85
Used data points :	1 - 7	3 - 5	1 - 4
Slope :	.28	.17	-
Std.Dev. of slope :	.20	.06	
Deviat.slope=⅓ (3 fases):	+ - -	+ - -	? + =
Wash-off(mg/m^2),Diss/Lag:	=	=	(Lag)
Total Concentrat.(mg/kg):	166120	12710	5901
Availability (mg/kg):	166120	13115	5902
Availability perc. (%):	100.00	103.18	100.01
Mean factor above DTL :	-	437	-
Max.Cum.release (mg/m^2):	< 5809073	458620	< 206388
Cum.release 64d. (mg/m^2):	15964904	970390	#VALUE!
Leaching-perc. 64d. (%):	275	212	#VALUE!
Mean factor above DTL :	290810	17676	-
Cum.release calc. 1D 64d:	< 17615349	1455097	< 5049
Cum.release calc. 3D 64d: (mg/m^2)	< 5765464	455874	< 7745
	Tortuosity	0	
Chemical Retention R:	.89	1.0	13729
$R_{range-min}$:	.20	.63	1933
$R_{range-max}$:	3.9	1.6	97518

Fly Ash
Productcode: V3FB

Surf.area: .0324 m^2 Bulk Density : 1331 kg/m^3 2 October 1991
Weight : 1.10 kg Extraction volume: 8.47 L

Concentration in µg/L Time (days)	K	Na	Li	Br	Cl	NO3	SO4	Al	B	Ba
1	617000	365000	166	49800	2260000	190	81200	291	81.50	459
2	957000	624000	378	113000	5120000	430	212000	74.30	71	779
4	903000	567000	309	100000	5900000	460	210000	21.40	91.40	820
8	787000	490000	228	120000	4800000	350	190000	69.10	109	702
16	856000	564000	328	120000	5300000	440	310000	34	126	903
32	676000	496000	462	96000	5220000	480	468000	29.30	55.80	1090
64	514000	425000	471	68800	3500000	280	107000	1230	30.10	2340
pD_e (-log[m^2/s]) :	8.01	7.91	8.47	9.03	8.32	9.31	11.02	15.99	-	9.87
Standard deviation :	.81	.63	.51	.62	.81	.66	.09	.56	-	.45
Used data points :	1 - 2	1 - 3	1 - 7	1 - 4	1 - 3	1 - 7	4 - 6	3 - 6	-	1 - 6
Slope :	2.40	1.20	.37	.89	1.58	.26	.65	.03	(.0)	.44
Std.Dev. of slope :	?	.77	.17	.49	.79	.20	.03	.39	(.19)	.20
Deviat.slope=½ (3 fases):	+ - -	+ - -	+ - -	+ - -	+ - -	+ - -	+ ≈ -	- - +	+ - -	+ - +
Wash-off(mg/m^2),Diss/Lag:	≈	≈	?≈	≈	(Opl)	?≈	≈	82.42		≈
Total Concentrat.(mg/kg):	11400	13130	15.18	1952	88937	19.52	5206	15184	.000	303.7
Availability (mg/kg):	14317	8677	6.51	5249	111714	19.52	98698	4121	-	91.11
Availability perc. (%):	125.59	66.08	42.89	268.89	125.61	100.00	1895.8	27.14	-	30.00
Mean factor above DTL :	143	289	2	105	1117	20	987	824	-	26
Max.Cum.release (mg/m^2):	484303	293518	220.2	177559	3778967	660.3	3338673	139402	-	3082
Cum.release 64d. (mg/m^2):	1388139	923073	612	174524	8391574	688	412573	457	-	1854
Leaching-perc. 64d. (%):	287	314	278	98.3	222	104	12.4	.3	-	60.2
Mean factor above DTL :	1896	16814	111	191	9171	38	451	23	-	1013
Cum.release calc. 1D 64d:	2497031	1694876	670	283112	13704144	762	539234	74	-	1875
Cum.release calc. 3D 64d:	483604	293215	219	170339	3763598	600	804116	121	-	2148
(mg/m^2)	Tortuosity (Na):		0	range:	0 - 0					
Chemical Retention R:	2.0	1.0	-	20	3.9	36	1144	43769650	-	62
$R_{range-min}$:	.31	.23	-	4.8	.61	7.9	925	11994803	-	22
$R_{range-max}$:	13	4.3	-	85	25	163	1416	159717698	-	174
pD_e for R=1 will be ≥						7.8				
Availability(%) becomes ≥						16.7				

Fly Ash — Surf.area .0324 m^2 — Bulk Density 1331 kg/m^3 — (continued)
Productcode: V3FB — Weight 1.10 kg — Extraction volume 8.47 L

Concentration in µg/L Time (days)	Ca	Cd	Cr	Cu	Fe	Mg	Ni	Pb	Si	Sr	Zn
1	1120000	3.90		20.80	75.60	138	< 5	3360	517	2980	429
2	1940000	1.50		13.40	29.20	74.50	9.60	4570	348	5220	558
4	2000000	< .2		13.10	< 5	25	12.40	4470	329	5290	510
8	1700000	2.50		< 5	35.60	113	< 5	3210	498	4450	480
16	2380000	.30		< 5	< 5	31.40	< 5	3690	623	5930	497
32	2430000	< .2		< 5	7.10	6.90	< 5	3710	176	6830	510
64	2050000	3.10		8.20	92.20	137	< 5	2170	710	6680	455
pD_e (-log[m^2/s]) :	9.62	15.41	-	13.58	12.05	> 15.8	> 10.8	10.86	14.13	> 9.2	13.66
Standard deviation :	.62	1.06	-	.21	.04	1.14	.06	.70	.17	.55	.43
Used data points :	2 - 7	1 - 7	-	1 - 3	1 - 2	1 - 7	1 - 7	1 - 7	1 - 5	1 - 4	1 - 4
Slope :	.05	-	-	.55	.40	-.04	-	.09	.46	.71	.57
Std.Dev. of slope :	.05			.34	?	.31		.16	.10	.48	.39
Deviat.slope=i (3 fases):	+ - -	≈ - +		≈ ? ?	≈ - +	- - +	+ ? ?	+ - -	≈ - -	+ - -	+ - -
Wash-off(mg/m^2),Diss/Lag:	≈	.929		≈	≈	≈36.80	(Lag)	?≈	≈	≈	≈
Total Concentrat.(mg/kg):	252000	141.0	37.96	271.2	8160	.000	23.86	2061	36341	.000	8351
Availability (mg/kg):	160521	78.09	8.68	180.0	91.11	(4772.2)	6.29	1128	8243	(303.7)	5857
Availability perc. (%):	63.70	55.38	22.87	66.40	1.12	#VALUE!	26.36	54.74	22.68	#VALUE!	70.13
Mean factor above DTL :	3210	390	4	90	91	-	2	1128	412	-	2928
Max.Cum.release (mg/m^2):	5429970	2642	293.6	6089	3082	(161430)	212.8	38157	278837	(10273)	198126
Cum.release 64d. (mg/m^2):	3560537	3.06	-	< 18	65	137	< 12	6583	837	9772	899
Leaching-perc. 64d. (%):	65.6	.1	-	< .3	2.1	.08	< 5.6	17.3	.3	95.1	.5
Mean factor above DTL :	97286	8	-	2	7	75	(DTL)	3597	21	2670	246
Cum.release calc. 1D 64d:	4389893	2.7	-	52	153	< 107	< 46	7432	1256	< 13664	1537
Cum.release calc. 3D 64d: (mg/m^2)	4392618	4.4	-	84	242	< 173	< 64	10879	2041	< 9587	2494
Chemical Retention R:	30	16839829	-	295956	7215	39928676	362	678	-	-	354911
$R_{range-min}$:	9.2	1479601	-	184282	6536	2910354	318	135	-	-	131246
$R_{range-max}$:	100	191659716	-	475303	7965	547802386	411	3410	-	-	959738

pD_e for R=1 will be ≥
Availability(%) becomes ≥

Fly Ash
Productcode: V3FB

Concentration in µg/L Time (days)	TDS	Na	TOC
1	4570000	365000	n.a.
2	9620000	624000	2000
4	9980000	567000	n.a.
8	8100000	490000	1000
16	10300000	564000	1000
32	10700000	496000	1440
64	7890000	425000	1630

pD_e ($-\log[m^2/s]$) :	> 8.5	7.91	> 11.2
Standard deviation :	.60	.63	.85
Used data points :	1 - 7	1 - 3	1 - 4
Slope :	.29	1.20	-
Std.Dev. of slope :	.18	.77	
Deviat.slope=½ (3 fases):	+ - -	+ - -	? + ≈
Wash-off(mg/m^2),Diss/Lag:	?≈	≈	(Lag)
Total Concentrat.(mg/kg):	173535	13130	1193
Availability (mg/kg):	173536	8677	(1193.0)
Availability perc. (%):	100.00	66.08	(100)
Mean factor above DTL :	-	289	-
Max.Cum.release (mg/m^2):	< 5870230	293518	(40356)
Cum.release 64d. (mg/m^2):	15988432	923073	#VALUE!
Leaching-perc. 64d. (%):	272	314	#VALUE!
Mean factor above DTL :	291238	16814	-
Cum.release calc. 1D 64d:	< 17911584	1694876	< 5049
Cum.release calc. 3D 64d:	< 5826162	293215	< 8026
(mg/m^2)	Tortuosity	0	
Chemical Retention R:	2.9	1.0	1739
$R_{range-min}$:	.74	.23	245
$R_{range-max}$:	12	4.3	12351

Fly Ash — Surf.area: .0324 m^2 — Bulk Density : 1470 kg/m^3 — 2 October 1991
Productcode: V3FC — Weight : 1.21 kg — Extraction volume: 8.47 L

Concentration in µg/L Time (days)	K	Na	Li	Br	Cl	NO3	SO4	Al	B	Ba
1	616000	344000	154	39600	2340000	490	69600	340	68.30	459
2	1060000	690000	436	112000	5170000	480	219000	336	116	961
4	805000	504000	272	97000	5800000	540	220000	540	92.80	812
8	949000	606000	208	140000	6000000	540	260000	850	169	998
16	881000	587000	393	140000	6200000	600	400000	1160	84.90	1120
32	584000	422000	423	78400	4380000	37	376000	1488	41	1070
64	415000	341000	418	59000	2740000	210	81400	2390	43.50	2300
pD_e (-log[m^2/s]) :	8.15	8.17	8.34	9.04	8.29	8.69	10.75	13.22	-	9.63
Standard deviation :	.51	.24	.84	.72	.64	.32	.08	.34	-	.50
Used data points :	1 - 4	3 - 5	1 - 3	1 - 4	1 - 4	1 - 5	3 - 5	1 - 7	-	1 - 6
Slope :	.68	.11	1.30	1.06	.96	.43	.43	.68	(.0)	.45
Std.Dev. of slope :	.45	.09	1.14	.53	.49	.19	.11	.08	(.22)	.22
Deviat.slope=$\frac{1}{4}$ (3 fases):	+ - -	+ - -	+ - -	+ - -	+ - -	+ - -	+ - -	+ ≈ ≈	+ - -	+ - ≈
Wash-off(mg/m^2),Diss/Lag:	≈	≈	≈	≈	(Opl)	≈	(Lag)	(Lag)		≈
Total Concentrat.(mg/kg):	9900	12660	11.11	1778	86667	16.67	5222	12222	.000	255.6
Availability (mg/kg):	16000	8889	6.67	4667	101111	16.67	86667	3556	-	71.11
Availability perc. (%):	161.62	70.21	60.04	262.50	116.67	100.00	1659.6	29.09	-	27.83
Mean factor above DTL :	160	296	2	93	1011	17	867	711	-	20
Max.Cum.release (mg/m^2):	598025	332240	249.3	174436	3779180	623.1	3239313	132911	-	2658
Cum.release 64d. (mg/m^2):	1388139	913401	602	174106	8530127	757	425069	1857	-	2018
Leaching-perc. 64d. (%):	232	275	241	99.8	226	121	13.1	1.4	-	75.9
Mean factor above DTL :	1896	16638	110	190	9323	41	465	92	-	1103
Cum.release calc. 1D 64d:	2624890	1423508	883	275174	14147993	1475	716684	1702	-	2124
Cum.release calc. 3D 64d: (mg/m^2)	596638	331412	248	167151	3765193	614	1033904	2757	-	2140
	Tortuosity (Na):		0	range:	0 - 0					
Chemical Retention R:	1.5	1.0	-	11	2.0	4.7	336	41334	-	20
$R_{range-min}$:	.47	.57	-	2.2	.45	2.2	281	18807	-	6.3
$R_{range-max}$:	4.9	1.7	-	60	8.8	9.9	402	90845	-	63
pD_e for R=1 will be ≥						8.0				
Availability(%) becomes ≥						46.2				

Fly Ash — Surf.area .0324 m^2 — Bulk Density 1470 kg/m^3 — (continued)
Productcode: V3FC — Weight 1.21 kg — Extraction volume 8.47 L

Concentration in µg/L Time (days)	Ca	Cd	Cr	Cu	Fe	Mg	Ni	Pb	Si	Sr	Zn
1	988000	2.40		30.10	92.40	152	9.80	2720	691	2850	412
2	2180000	5.50		22.80	99.70	223	< 5	5240	615	6030	721
4	1800000	< .2		< 5	< 5	17.70	< 5	4180	243	4850	462
8	2210000	.30		< 5	< 5	20.80	< 5	4100	416	5890	516
16	2680000	8		21.90	353	434	< 5	4430	917	6680	950
32	2120000	< .2		< 5	51.80	23.50	< 5	3320	190	6290	484
64	1810000	6.70		17.40	200	343	< 5	2290	1640	5800	625
pD_e (-log[m^2/s]) :	9.76	15.66	-	13.20	10.82	> 15.7	> 11.8	10.36	14.12	> 9.1	13.68
Standard deviation :	.61	1.51	-	.37	.79	1.23	-	.56	.69	.50	.54
Used data points :	1 - 4	1 - 7	-	1 - 2	1 - 7	1 - 7	1 - 7	1 - 4	1 - 7	1 - 6	1 - 6
Slope :	.85	.20	-	1.37	-	.25	-	.68	.27	.44	.32
Std.Dev. of slope :	.49	.50		?		.41		.49	.21	.22	.22
Deviat.slope=½ (3 fases):	+ - -	+ + -		+ ? -	+ - -	- ≈ -		+ - -	- - ≈	+ - -	+ - -
Wash-off(mg/m^2),Diss/Lag:	≈	?≈		≈	?≈	?≈	(Lag)	≈	?≈	≈	?≈
Total Concentrat.(mg/kg):	264000	101.1	27.78	211.1	9560	.000	22.22	2111	25513	.000	6333
Availability (mg/kg):	208889	100.0	7.33	173.3	31.11	(6666.7)	8.67	956.6	6667	(244.4)	4889
Availability perc. (%):	79.12	98.90	26.39	82.10	.33	#VALUE!	39.02	45.26	26.13	#VALUE!	77.19
Mean factor above DTL :	4178	500	3	87	31	-	2	956	333	-	2444
Max.Cum.release (mg/m^2):	7807549	3738	274.0	6477	1163	(249178)	324.1	35717	249189	(9135)	182734
Cum.release 64d. (mg/m^2):	3604456	6.09	-	< 28	211	317	< 10.	6870	1232	10036	1090
Leaching-perc. 64d. (%):	46.2	.2	-	< .4	18.1	.1	< 3.1	19.2	.5	110	.6
Mean factor above DTL :	98486	17	-	3.2	23	173	(DTL)	3754	31	2742	298
Cum.release calc. 1D 64d:	5343719	2.9	-	85	235	< 188	< 20	12348	1130	< 12810	1383
Cum.release calc. 3D 64d: (mg/m^2)	5824416	4.7	-	138	343	< 300	< 33	16593	1838	< 8678	2245
Chemical Retention R:	23	16712318	-	67830	239	17066410	2360	118	-	-	205381
$R_{range-min}$:	5.8	513344	-	28886	39	1014944	-	33	-	-	59775
$R_{range-max}$:	94	544082858	-	159275	1471	286973816	-	430	-	-	705669

pD_e for R=1 will be ≥
Availability(%) becomes ≥

Fly Ash
Productcode: V3FC

Concentration in µg/L Time (days)	TDS	Na	TOC
1	2310000	344000	n.a.
2	9040000	690000	n.a.
4	9020000	504000	2000
8	9720000	606000	1000
16	11500000	587000	1000
32	7030	422000	1380
64	6070000	341000	1900
pD_e (-log[m^2/s]) :	> 9.5	8.17	> 11.6
Standard deviation :	2.58	.24	.64
Used data points :	1 - 7	3 - 5	1 - 4
Slope :	-.39	.11	-
Std.Dev. of slope :	.79	.09	
Deviat.slope=½ (3 fases):	+ - -	+ - -	? ¤ ¤
Wash-off(mg/m^2),Diss/Lag:	?¤	¤	(Lag)
Total Concentrat.(mg/kg):	162222	12660	1333
Availability (mg/kg):	162222	8889	1333
Availability perc. (%):	100.00	70.21	100.02
Mean factor above DTL :	-	296	-
Max.Cum.release (mg/m^2):	< 6063298	332240	< 49823
Cum.release 64d. (mg/m^2):	12461103	913401	#VALUE!
Leaching-perc. 64d. (%):	206	275	#VALUE!
Mean factor above DTL :	226986	16638	-
Cum.release calc. 1D 64d:	< 5596507	1423508	< 4245
Cum.release calc. 3D 64d:	< 5178402	331412	< 6421
(mg/m^2)	Tortuosity	0	
Chemical Retention R:	18	1.0	2065
$R_{range-min}$:	.05	.57	475
$R_{range-max}$:	6683	1.7	8983

Bottom Ash
Productcode: V3BA

Surf.area: .0324 m^2 Bulk Density : 1637 kg/m^3 2 October 1991
Weight : 1.51 kg Extraction volume: 8.47 L

Concentration in µg/L Time (days)	K	Na	Li	Br	Cl	NO3	SO4	Al	B	Ba
1	245000	58300	41.30	2610	214000	80	69700	293	50.90	42.70
2	440000	112000	62.70	8900	746000	20	130000	556	42	94.30
4	592000	162000	122	6100	570000	60	110000	780	29.80	96.50
8	949000	342000	203	18000	1400000	80	130000	2370	142	128
16	429000	268000	300	17000	1100000	140	89000	3570	45	321
32	582000	194000	309	9150	660000	260	86100	3430	48.40	128
64	397000	144000	274	8500	466000	100	103000	3190	63.70	70.30
pD_e (-log[m^2/s]) :	8.77	8.73	9.16	8.42	8.96	> 8.4	11.23	12.52	-	11.19
Standard deviation :	.62	.22	.13	.74	.80	.41	.31	.18	-	.24
Used data points :	1 - 5	2 - 5	3 - 6	1 - 7	1 - 7	1 - 7	2 - 4	4 - 6	-	2 - 5
Slope :	.63	.49	.46	.43	.33	.53	-.00	.27	(.3)	.57
Std.Dev. of slope :	.37	.20	.11	.25	.27	.14	.14	.19	(.17)	.21
Deviat.slope=½ (3 fases):	+ - -	+ - -	+ ≈ -	+ - -	+ - -	+ + -	+ - -	+ + -	≈ - -	+ - -
Wash-off(mg/m^2),Diss/Lag:	(Lag)	(Lag)	(Lag)	≈	≈	≈	(Lag)	(Lag)		(Lag)
Total Concentrat.(mg/kg):	11000	18140	12.02	120.2	14423	1.20	1923	18029	.000	300.5
Availability (mg/kg):	13462	5769	7.21	120.2	16827	< 1.20	74038	4087	-	67.31
Availability perc. (%):	122.38	31.80	59.98	100.00	116.67	< 100.00	3850.0	22.67	-	22.40
Mean factor above DTL :	135	192	2	2	168	(DTL)	740	817	-	19
Max.Cum.release (mg/m^2):	628642	269398	336.7	5613	785779	< 56.04	3457392	190853	-	3143
Cum.release 64d. (mg/m^2):	949999	334696	343	18367	1347880	193	187647	3709	-	230
Leaching-perc. 64d. (%):	151	124	102	327	172	344	5.4	1.9	-	7.3
Mean factor above DTL :	1298	6097	62	20	1473	11	205	184	-	126
Cum.release calc. 1D 64d:	1345794	606230	465	18138	1351815	< 177	438981	5486	-	417
Cum.release calc. 3D 64d: (mg/m^2)	617113	265099	317	5581	759646	< 56	667463	8805	-	633
	Tortuosity (Na):		1	range:	0 - 1					
Chemical Retention R:	1.8	1.0	-	.75	2.6	.73	281	2264	-	199
$R_{range-min}$:	.42	.61	-	.14	.41	.28	137	1495	-	116
$R_{range-max}$:	7.4	1.7	-	4.1	17	1.9	577	3427	-	342
pD_e for R=1 will be ≥				8.5						
Availability(%) becomes ≥				115.8						

Bottom Ash Surf.area .0324 m^2 Bulk Density 1837 kg/m^3 (continued)
Productcode: V3BA Weight 1.51 kg Extraction volume 8.47 L

Concentration in µg/L Time (days)	Ca	Cd	Cr	Cu	Fe	Mg	Ni	Pb	Si	Sr	Zn
1	38800		3.50	< 4	253	194	< 5	12.60	775	203	31.60
2	77900		< 3	14.90	32.90	106	10.60	24.60	1200	491	19.30
4	59900		< 3	19.40	< 5	22.10	5.70	13.90	1610	521	13.70
8	43300		< 3	19.30	41.10	6.90	< 5	27.50	3700	678	15
16	56200		6.30	56.30	92.60	93.20	< 5	17.50	4290	1280	23.90
32	6540		6.80	20.20	30	31.40	< 5	4.60	1890	271	< 2
64	3750		8	20.50	35.60	140	< 5	4.50	3950	170	8
pD_e ($-\log[m^2/s]$) :	13.60	-	12.33	13.55	14.37	> 16.1	> 11.6	14.14	12.56	> 11.1	15.48
Standard deviation :	1.51	-	.18	.46	.11	1.06	.59	.35	.19	.15	.33
Used data points :	1 - 7	-	1 - 7	2 - 6	6 - 7	1 - 7	1 - 7	3 - 5	2 - 5	2 - 5	1 - 5
Slope :	-.43	-	-	.24	.25	.09	-	.17	.67	.45	.24
Std.Dev. of slope :	.31			.23	?	.31		.47	.13	.13	.13
Deviat.slope=½ (3 fases):	+ - -		? + +	+ - -	- - -	- ¤ -	+ ? ?	+ - -	+ - -	+ - -	- ¤ -
Wash-off(mg/m^2),Diss/Lag:	?¤		(Lag)	(Lag)	68.61	¤58.12	(Lag)	¤	(Lag)	(Lag)	?¤
Total Concentrat.(mg/kg):	178600	21.63	56.49	528.9	91200	.000	87.74	1442	83220	.000	2404
Availability (mg/kg):	149038	15.63	5.05	141.8	218.8	(5288.5)	8.65	228.4	5529	(312.5)	1250
Availability perc. (%):	83.45	72.26	8.94	26.82	.24	#VALUE!	9.86	15.83	6.64	#VALUE!	52.00
Mean factor above DTL :	2981	78	2	71	219	-	2	228	276	-	625
Max.Cum.release (mg/m^2):	6959707	729.9	235.8	6622	10217	(246960)	403.9	10666	258191	(14593)	58372
Cum.release 64d. (mg/m^2):	74868	-	< 8.8	40	128	155	< 11	28	4553	945	30
Leaching-perc. 64d. (%):	1.1	-	< 3.7	.6	1.3	.06	< 2.7	.3	1.8	6.5	.05
Mean factor above DTL :	2046	-	1.6	5	16	85	(DTL)	15	113	258	8
Cum.release calc. 1D 64d:	57460	-	8.4	58	35	< 114	< 33	48	7065	< 2061	55
Cum.release calc. 3D 64d: (mg/m^2)	93253	-	13	94	56	< 187	< 52	77	11347	< 3227	90
Chemical Retention R:	44151	-	1923	42276	233205	12662893	390	196355	-	-	3636703
$R_{range-min}$:	1366	-	1266	14761	181967	1102990	99	88059	-	-	1699846
$R_{range-max}$:	1426547	-	2920	121078	298869	145376547	1532	437839	-	-	7780473

pD_e for R=1 will be ≥
Availability(%) becomes ≥

Bottom Ash
Productcode: V3BA

Concentration in µg/L Time (days)	TDS	Na	TOC
1	544000	58300	2000
2	2050000	112000	5000
4	1490000	162000	4000
8	2940000	342000	8000
16	2240000	268000	7000
32	1670000	194000	6210
64	1270000	144000	3400
pD_e (-log[m^2/s]) :	> 8.9	8.73	> 12.8
Standard deviation :	.77	.22	.70
Used data points :	1 - 7	2 - 5	1 - 4
Slope :	.32	.49	(1.1)
Std.Dev. of slope :	.25	.20	(.47)
Deviat.slope=½ (3 fases):	+ - -	+ - -	+ - -
Wash-off(mg/m^2),Diss/Lag:	¤	(Lag)	¤
Total Concentrat.(mg/kg):	39663	18140	13221
Availability (mg/kg):	39663	5769	13221
Availability perc. (%):	100.00	31.80	100.00
Mean factor above DTL :	-	192	-
Max.Cum.release (mg/m^2):	< 1852164	269398	< 617388
Cum.release 64d. (mg/m^2):	3190367	334696	9309
Leaching-perc. 64d. (%):	172	124	1.5
Mean factor above DTL :	58114	6097	-
Cum.release calc. 1D 64d:	< 3319547	606230	< 13210
Cum.release calc. 3D 64d:	< 1801609	265099	< 20677
(mg/m^2)	Tortuosity	1	
Chemical Retention R:	1.3	1.0	9029
$R_{range-min}$:	.22	.61	1817
$R_{range-max}$:	7.6	1.7	44876

492

Bottom Ash
Productcode: V388

Surf.area: .0324 m^2 Bulk Density : 1952 kg/m^3 2 October 1991
Weight : 1.61 kg Extraction volume: 8.47 L

Concentration in µg/L Time (days)	K	Na	Li	Br	Cl	NO3	SO4	Al	B	Ba
1	362000	87300	107	3680	137000	70	106000	350	36.50	72.80
2	992000	281000	147	7010	685000	60	177000	362	32.10	123
4	901000	239000	183	20000	1500000	< 10	250000	592	32.60	94.80
8	599000	211000	136	12000	830000	50	120000	1650	166	74.50
16	586000	182000	235	11000	670000	110	76000	2450	64.80	289
32	451000	145000	276	7300	543000	140	59800	3290	33	411
64	317000	115000	279	6740	350000	140	107000	4230	88.40	209
pD_e (-log[m^2/s]) :	8.21	8.62	8.99	7.99	8.12	> 8.3	12.68	13.31	-	11.58
Standard deviation :	.68	.81	.39	.99	.27	.58	.14	.34	-	.50
Used data points :	1 - 5	1 - 7	1 - 7	1 - 3	2 - 3	1 - 7	6 - 7	2 - 7	-	1 - 7
Slope :	.42	.15	.42	2.11	1.13	.51	.84	.74	(.4)	.53
Std.Dev. of slope :	.41	.23	.13	.34	?	.20	?	.09	(.21)	.17
Deviat.slope=1 (3 fases):	+ - -	+ - -	+ - -	+ - -	+ - -	+ + -	+ - -	+ + =	+ - -	+ + -
Wash-off(mg/m^2),Diss/Lag:	=	?=	=	(Opl)	(Opl)	?=	?=	(Opl)		=
Total Concentrat.(mg/kg):	12400	21010	14.10	103.0	10656	.710	3279	17564	.000	234.2
Availability (mg/kg):	8899	2810	4.68	103.0	19063	< .710	71897	5621	-	74.94
Availability perc. (%):	71.77	13.38	33.19	100.00	178.90	< 100.00	2192.9	32.00	-	32.00
Mean factor above DTL :	89	94	2	2	191	(DTL)	719	1124	-	21
Max.Cum.release (mg/m^2):	441654	139459	232.3	5112	946090	< 35.24	3568221	278968	-	3719
Cum.release 64d. (mg/m^2):	1100054	329467	356	17706	1232594	152	234180	3379	-	333
Leaching-perc. 64d. (%):	249	236	153	346	130	431	6.6	1.2	-	9.0
Mean factor above DTL :	1503	6001	65	19	1347	8	256	168	-	182
Cum.release calc. 1D 64d:	1807466	355531	389	26883	4303603	< 136	84904	3215	-	314
Cum.release calc. 3D 64d: (mg/m^2)	440395	137894	224	5105	944114	< 35	136659	5209	-	489
	Tortuosity (Na):		1	range:	0 - 3					
Chemical Retention R:	.62	1.0	-	.36	.48	.62	10276	18078	-	631
$R_{range-min}$:	.13	.15	-	.04	.26	.17	7368	8341	-	197
$R_{range-max}$:	3.0	6.5	-	3.5	.89	2.4	14333	39184	-	2020
pD_e for R=1 will be ≥	8.4			8.4	8.4					
Availability(%) becomes ≥	91.1			166.3	258.4					

Bottom Ash Surf.area .0324 m^2 Bulk Density 1952 kg/m^3 (continued)
Productcode: V3BB Weight 1.61 kg Extraction volume 8.47 L

Concentration in µg/L Time (days)	Ca	Cd	Cr	Cu	Fe	Mg	Ni	Pb	Si	Sr	Zn
1	88500	.40	4.50	15.40	57.50	186	< 5	46.30	857	465	28.80
2	139000	2.40	< 3	35.30	43.40	99	7.80	69.40	1220	945	28.30
4	88400	< .2	5.40	34.60	13.80	23.80	22	40.30	1640	793	13.90
8	28100	< .2	< 3	25	16.20	1.50	< 5	17.30	3010	573	< 2
16	93300	< .2	< 3	19.10	17.40	17.60	< 5	38.30	3810	1500	11.60
32	50700	< .2	3.90	7.20	10.70	6.80	< 5	32.60	4630	1030	4.60
64	33500	< .2	4	28.50	32.80	87.40	< 5	4.30	4250	396	7.70
pD_e (-log[m^2/s]) :	12.45	> 13.7	> 12.8	14.05	15.02	> 16.5	> 11.8	13.66	12.99	> 11.3	15.32
Standard deviation :	.93	1.64	.65	.88	.43	1.58	.42	.69	.10	.52	.49
Used data points :	1 - 7	1 - 7	1 - 7	1 - 7	3 - 7	1 - 7	1 - 7	1 - 5	2 - 6	1 - 6	1 - 3
Slope :	-.06	-	-	.09	.19	-.22	-	.10	.51	.46	.36
Std.Dev. of slope :	.20			.24	.19	.44		.35	.06	.23	.80
Deviat.slope=i (3 fases):	+ - -	+ ? ?	+ - +	+ - -	- - ¤	- - +	+ ? ?	+ - -	+ ¤ -	+ - -	¤ - -
Wash-off(mg/m^2),Diss/Lag:	?¤	?¤	¤	?¤	21.05	¤64.86	(Lag)	?¤	(Lag)	¤	¤
Total Concentrat.(mg/kg):	169100	25.80	77.30	409.8	82900	.000	92.50	585.5	89111	.000	2459
Availability (mg/kg):	88993	8.43	7.03	182.7	374.7	(3747.1)	17.10	281.0	7728	(327.9)	1335
Availability perc. (%):	52.63	32.67	9.09	44.58	.45	#VALUE!	18.49	48.00	8.67	#VALUE!	54.29
Mean factor above DTL :	1780	42	3	91	375	-	4	281	386	-	667
Max.Cum.release (mg/m^2):	4416690	418.4	348.9	9067	18596	(185967)	848.7	13946	383538	(16274)	66256
Cum.release 64d. (mg/m^2):	136330	< 1.0	< 7.0	43	50	110	< 14	65	5076	1491	25
Leaching-perc. 64d. (%):	3.1	< .2	< 2.0	.5	.3	.06	< 1.6	.5	1.3	9.2	.04
Mean factor above DTL :	3725	2.7	(DTL)	6	5	60	1.5	36	126	407	7
Cum.release calc. 1D 64d:	137448	< 3.2	< 7.5	45	30	< 54	< 56	108	6418	< 2011	75
Cum.release calc. 3D 64d: (mg/m^2)	220349	< 5.0	< 12	73	49	< 88	< 88	175	10173	< 2907	123
Chemical Retention R:	3988	60465	6793	171079	1316574	41069376	778	83885	-	-	3221166
$R_{range-min}$:	473	1379	1527	22767	489048	1072710	293	17214	-	-	1044603
$R_{range-max}$:	33654	2650330	30225	1285578	3544371	157236664	2066	408773	-	-	9932872

pD_e for R=1 will be ≥
Availability(%) becomes ≥

Bottom Ash
Productcode: V3BB

Concentration in µg/L Time (days)	TDS	Na	TOC
1	937000	87300	2000
2	1330000	281000	3000
4	3320000	239000	6000
8	1910000	211000	5000
16	1730000	182000	4000
32	1470000	145000	9580
64	1000000	115000	5230

pD_e (-log[m^2/s]) :	> 9.1	8.62	> 12.9
Standard deviation :	.76	.81	.61
Used data points :	1 - 7	1 - 7	1 - 4
Slope :	.18	.23	(1.0)
Std.Dev. of slope :	.22	.23	(.41)
Deviat.slope=½ (3 fases):	+ - -	+ - -	+ - -
Wash-off(mg/m^2),Diss/Lag:	=	?=	(Lag)
Total Concentrat.(mg/kg):	42505	21010	12693
Availability (mg/kg):	42506	2810	12693
Availability perc. (%):	100.00	13.38	100.00
Mean factor above DTL :	-	94	-
Max.Cum.release (mg/m^2):	< 2109557	139459	< 629949
Cum.release 64d. (mg/m^2):	3057827	329467	9100
Leaching-perc. 64d. (%):	145	236	1.4
Mean factor above DTL :	55700	6001	-
Cum.release calc. 1D 64d:	< 3252016	355531	< 11440
Cum.release calc. 3D 64d:	< 2003967	137894	< 18827
(mg/m^2)	Tortuosity	1	
Chemical Retention R:	2.2	1.0	16087
$R_{range-min}$:	.39	.15	3922
$R_{range-max}$:	13	6.5	65989

Bottom Ash
Productcode: V38C

Surf.area: .0324 m^2 Bulk Density : 1893 kg/m^3 2 October 1991
Weight : 1.66 kg Extraction volume: 8.47 L

Concentration in µg/L Time (days)	K	Na	Li	Br	Cl	NO3	SO4	Al	B	Ba
1	285000	74800	112	3560	276000	70	87300	378	39.90	60.20
2	497000	141000	135	10500	1010000	50	148000	564	24.10	116
4	813000	221000	161	24000	1700000	140	190000	1000	28.30	124
8	843000	300000	191	17000	1300000	80	110000	2440	174	96.90
16	788000	263000	260	15000	1100000	130	83000	3330	73.30	235
32	577000	201000	353	10300	709000	160	80700	4320	41	207
64	368000	138000	297	8860	456000	140	104000	3490	68.30	97.10
pD_e (-log[m^2/s]) :	8.43	8.66	8.90	7.86	7.91	> 7.9	12.53	8.25	-	10.54
Standard deviation :	.63	.79	.34	.93	.28	.39	.06	.30	-	.48
Used data points :	1 - 4	1 - 3	1 - 7	1 - 4	2 - 4	1 - 7	6 - 7	2 - 7	-	1 - 6
Slope :	1.07	1.67	.46	1.33	.18	.41	.37	.57	(.4)	.58
Std.Dev. of slope :	.41	.59	.12	.61	.33	.13	?	.13	(.20)	.21
Deviat.slope=½ (3 fases):	+ - -	+ - -	+ ≈ -	+ - -	+ - -	+ - -	+ - -	+ + -	+ - -	+ - -
Wash-off(mg/m^2),Diss/Lag:	(Opl)	(Opl)	≈	(Opl)	(Lag)	(Lag)	?≈	(Lag)		≈
Total Concentrat.(mg/kg):	10500	18880	11.82	118.2	13002	.800	2719	17731	.000	248.2
Availability (mg/kg):	11348	3783	4.73	118.2	16667	< .800	71395	22.93	-	22.93
Availability perc. (%):	108.07	20.03	40.02	100.00	128.18	< 100.00	2626.1	.13	-	9.24
Mean factor above DTL :	113	126	2	2	167	(DTL)	714	5	-	7
Max.Cum.release (mg/m^2):	546035	182028	227.6	5687	801971	< 38.49	3435333	1103	-	1103
Cum.release 64d. (mg/m^2):	1090382	349989	394	23324	1712561	201	209920	4058	-	245
Leaching-perc. 64d. (%):	200	192	173	410	214	522	6.1	368	-	22.2
Mean factor above DTL :	1490	6375	72	25	1872	11	229	202	-	134
Cum.release calc. 1D 64d:	1743501	444632	423	34710	4665901	< 216	97239	4300	-	309
Cum.release calc. 3D 64d: (mg/m^2)	542821	179721	221	5682	801162	< 38	156088	1099	-	431
	Tortuosity (Na):		1	range:	0 - 3					
Chemical Retention R:	.94	1.0	-	.25	.27	.27	6667	.15	-	53
$R_{range-min}$:	.22	.16	-	.03	.14	.11	5846	.07	-	17
$R_{range-max}$:	4.0	6.1	-	2.1	.51	.66	7603	.29	-	158
pD_e for R=1 will be ≥	8.5			8.5	8.5			9.1		
Availability(%) becomes ≥	111.7			201.4	247.1			.3		

496

Bottom Ash — Surf.area .0324 m^2 — Bulk Density 1893 kg/m^3 — (continued)
Productcode: V3BC — Weight 1.56 kg — Extraction volume 8.47 L

Concentration in µg/L Time (days)	Ca	Cd	Cr	Cu	Fe	Mg	Ni	Pb	Si	Sr	Zn
1	58500	< .2	< 6	9.60	77.90	120	< 5	23.90	824	331	18.10
2	103000	< .2	< 6	29.90	73.10	59.90	7.80	39	1210	664	21.80
4	68800	< .2	< 6	58.60	17.30	19.50	18.60	22	1730	763	14.40
8	24200	< .2	< 6	64.30	24.20	< 1	< 5	30.60	2790	518	14
16	36800	< .2	< 6	74.40	12.20	6.30	< 5	8.70	3720	957	14.10
32	10800	< .2	< 6	73.90	19.30	33.90	< 5	5.30	4280	471	8.60
64	4720	< .2	7.10	42.10	25.40	89.60	6.90	4.90	3650	237	4.90
pD_e (-log[m^2/s]) :	12.02	> 14.7	> 12.9	12.90	10.61	> 15.8	> 12.5	> 9.0	11.57	> 10.8	13.82
Standard deviation :	.63	-	-	.26	.05	1.05	1.09	.61	.09	.74	.48
Used data points :	1 - 3	1 - 7	1 - 7	2 - 6	5 - 7	1 - 7	1 - 7	1 - 3	2 - 6	1 - 3	1 - 5
Slope :	1.00	-	-	.30	.53	-	-	.83	.47	1.49	.22
Std.Dev. of slope :	.92			.10	.08			.95	.05	.74	.24
Deviat.slope=½ (3 fases):	+ - -			+ - -	- - ≈	- - +	+ ? ?	+ - -	+ ≈ -	+ - -	+ - -
Wash-off(mg/m^2),Diss/Lag:	≈	(Lag)	(Lag)	(Lag)	35.42	≈33.82	(Lag)	≈	(Lag)	(Opl)	?≈
Total Concentrat.(mg/kg):	174000	24.82	73.29	425.5	104400	.000	91.02	732.9	88018	.000	2482
Availability (mg/kg):	101655	3.31	(7.33)	161.5	1.84	(2364.1)	17.73	< 1.18	1513	(186.8)	146.6
Availability perc. (%):	58.42	13.34	(10)	37.95	.00	#VALUE!	19.48	< .16	1.72	#VALUE!	5.90
Mean factor above DTL :	2033	17	-	81	2	-	4	(DTL)	76	-	73
Max.Cum.release (mg/m^2):	4891363	159.3	(353)	7771	88.54	(113754)	853.1	< 56.78	72801	(8988)	7054
Cum.release 64d. (mg/m^2):	80209	< .4	< 11	92	65	86	< 14	35	4759	1030	25
Leaching-perc. 64d. (%):	1.6	< .3	< 3.1	1.2	73.4	.08	< 1.6	61.6	6.5	11.5	.4
Mean factor above DTL :	2192	(DTL)	(DTL)	13	7	47	1.5	19	118	281	7
Cum.release calc. 1D 64d:	250016	< .36	< 6.3	145	23	< 77	< 25	< 92	6250	< 1849	45
Cum.release calc. 3D 64d: (mg/m^2)	396352	< .60	< 11	234	32	< 122	< 40	< 55	9720	< 2714	74
Chemical Retention R:	1357	639757	8960	10973	47	6961107	3502	1.8	-	-	92657
$R_{range-min}$:	319	-	-	6067	42	618519	288	.44	-	-	30381
$R_{range-max}$:	5771	-	-	19845	53	78343602	42635	7.1	-	-	282584

pD_e for R=1 will be ≥
Availability(%) becomes ≥

Bottom Ash
Productcode: V3BC

Concentration in µg/L Time (days)	TDS	Na	TOC
1	742000	74800	2000
2	2470000	141000	8000
4	3180000	221000	9000
8	2770000	300000	10000
16	2120000	263000	10000
32	1740000	201000	11100
64	1260000	138000	4520
pD_e (-log[m^2/s]) :	> 8.8	8.66	> 12.4
Standard deviation :	.84	.79	.90
Used data points :	1 - 7	1 - 3	1 - 4
Slope :	.21	1.67	(1.2)
Std.Dev. of slope :	.26	.59	(.63)
Deviat.slope=1 (3 fases):	+ - -	+ - -	+ - -
Wash-off(mg/m^2),Diss/Lag:	*	(Opl)	(Lag)
Total Concentrat.(mg/kg):	39952	18880	11820
Availability (mg/kg):	39953	3783	11820
Availability perc. (%):	100.00	20.03	100.00
Mean factor above DTL :	-	126	-
Max.Cum.release (mg/m^2):	< 1922430	182028	< 568746
Cum.release 64d. (mg/m^2):	3733597	349989	14279
Leaching-perc. 64d. (%):	194	192	2.5
Mean factor above DTL :	68010	6375	-
Cum.release calc. 1D 64d:	< 3925434	444632	< 19240
Cum.release calc. 3D 64d:	< 1884131	179721	< 29989
(mg/m^2)	Tortuosity	1	
Chemical Retention R:	1.2	1.0	4256
$R_{range-min}$:	.17	.16	537
$R_{range-max}$:	8.0	6.1	33750

4698

Combined Ash
Productcode: V3CA

Surf.area: .0324 m^2 Bulk Density : 1652 kg/m^3 2 October 1991
Weight : 1.36 kg Extraction volume: 6.47 L

Concentration in µg/L Time (days)	K	Na	Li	Br	Cl	NO3	SO4	Al	B	Ba
1	227000	44200	102	1520	177000	40	21000	654	54.40	72.80
2	443000	113000	11.80	4140	453000	40	33700	1440	22.10	223
4	392000	102000	91.50	6600	640000	30	31000	1350	22.50	172
8	513000	163000	106	10000	840000	70	28000	2410	154	161
16	806000	249000	173	14000	1100000	80	47000	5030	97.60	178
32	786000	261000	228	10800	918000	130	110000	7030	86.40	42.80
64	684000	260000	253	10900	879000	60	134000	6980	152	27.20
pD_e (-log[m^2/s]) :	8.48	8.51	9.14	8.34	8.66	> 8.2	12.38	12.52	-	11.44
Standard deviation :	.15	.22	.12	.22	.06	.21	.24	.21	-	.15
Used data points :	3 - 6	3 - 7	3 - 7	2 - 6	2 - 5	2 - 6	3 - 7	2 - 7	-	4 - 5
Slope :	.37	.34	.40	.39	.42	.48	.62	.56	(.6)	.14
Std.Dev. of slope :	.10	.10	.05	.12	.02	.13	.13	.09	(.15)	?
Deviat.slope=½ (3 fases):	+ ≈ −	+ ≈ −	+ ≈ −	+ − −	+ − −	+ + −	+ + +	+ + −	− ≈ −	+ − −
Wash-off(mg/m^2),Diss/Lag:	(Lag)	(Lag)	(Lag)	(Lag)	(Lag)	(Lag)	(Lag)	(Lag)		?≈
Total Concentrat.(mg/kg):	14000	18470	11.96	143.5	13158	.930	909.1	15550	.000	406.7
Availability (mg/kg):	10048	2871	4.78	143.5	21100	< .930	71531	5742	-	86.12
Availability perc. (%):	71.77	15.54	39.97	100.00	160.36	< 100.00	7868.4	36.92	-	21.18
Mean factor above DTL :	100	96	2	3	211	(DTL)	715	1148	-	25
Max.Cum.release (mg/m^2):	422078	120600	200.8	6028	886330	< 39.07	3004744	241199	-	3618
Cum.release 64d. (mg/m^2):	1006727	311665	252	15152	1308929	118	105797	6508	-	229
Leaching-perc. 64d. (%):	239	258	126	251	148	302	3.5	2.7	-	6.3
Mean factor above DTL :	1375	6677	46	17	1431	6	116	323	-	125
Cum.release calc. 1D 64d:	1268275	347863	281	21148	2159779	< 155	101738	6878	-	359
Cum.release calc. 3D 64d:	419120	119649	189	6001	875028	< 39	162869	11043	-	555
(mg/m^2)	Tortuosity (Na):		0	range:	0 - 1					
Chemical Retention R:	1.5	1.0	-	1.0	2.1	.76	6497	3780	-	584
$R_{range-min}$:	1.1	.60	-	.62	1.8	.47	3758	2334	-	412
$R_{range-max}$:	2.1	1.7	-	1.7	2.5	1.2	11233	6120	-	827
pD_e for R=1 will be ≥				8.3						
Availability(%) becomes ≥				98.1						

499

Combined Ash
Productcode: V3CA

Surf.area .0324 m^2 Bulk Density 1652 kg/m^3 (continued)
Weight 1.36 kg Extraction volume 8.47 L

Concentration in µg/L Time (days)	Ca	Cd	Cr	Cu	Fe	Mg	Ni	Pb	Si	Sr	Zn
1	31200		< 3	17.30	32.90	51.80	< 5	15.20	1050	287	17
2	72200		< 3	44.80	76.20	87.40	< 5	48.50	1620	731	33.60
4	37500		< 3	45.70	< 5	13.70	35.90	9.20	1690	534	5.20
8	20700		< 3	60.70	18.50	11.60	< 5	10.80	2640	411	< 2
16	10800		11.80	178	168	176	16.60	< 1	4110	397	37.30
32	1560		< 3	165	14	125	< 5	2.40	3770	135	5.60
64	4170		7.20	103	17.90	414	< 5	5.10	1460	156	4
pD_e (-log[m^2/s]) :	12.37	-	> 13.0	12.68	15.34	> 15.5	> 10.9	17.90	12.70	> 12.1	17.45
Standard deviation :	.75	-	.30	.25	.06	.91	.90	.25	.11	1.04	.42
Used data points :	1 - 3	-	6 - 7	2 - 6	6 - 7	1 - 7	1 - 7	6 - 7	2 - 5	1 - 7	6 - 7
Slope :	1.02	-	(1.2)	.57	.35	.68	-	1.09	.47	-.09	-.49
Std.Dev. of slope :	1.13		?	.15	?	.30		?	.10	.24	?
Deviat.slope=½ (3 fases):	+ - -		? ? -	+ + -	+ - -	- + +	? - ?	¤ - +	+ ¤ -	+ - -	- - -
Wash-off(mg/m^2),Diss/Lag:	¤		¤	(Lag)	?¤	?¤	(Lag)	?¤	(Lag)	?¤	?¤
Total Concentrat.(mg/kg):	189000	19.14	37.08	394.7	59600	.000	39.47	1794	97027	.000	2033
Availability (mg/kg):	102871	8.13	7.66	205.7	358.9	(3827.8)	8.37	1507	7177	(334.9)	1220
Availability perc. (%):	54.43	42.48	20.66	52.12	.60	#VALUE!	21.21	84.00	7.40	#VALUE!	60.00
Mean factor above DTL :	2057	41	4	103	359	-	2	1507	359	-	610
Max.Cum.release (mg/m^2):	4321217	341.5	321.8	8641	15076	(160791)	351.6	63303	301478	(14068)	51248
Cum.release 64d. (mg/m^2):	46567	-	< 8.9	161	87	230	< 20	24	4272	693	27
Leaching-perc. 64d. (%):	1.1	-	< 2.8	1.9	.6	.1	< 5.7	.04	1.4	4.9	.05
Mean factor above DTL :	1272	-	(DTL)	22	10	126	2.2	13	106	189	7
Cum.release calc. 1D 64d:	147124	-	< 5.0	206	17	< 144	< 62	3.7	7009	< 689	5.0
Cum.release calc. 3D 64d: (mg/m^2)	235502	-	< 8.6	332	27	< 243	< 96	6.1	11286	< 1040	8.2
Chemical Retention R:	4265	-	16611	9309	3555761	5536811	139	186561073	-	-	554595293
$R_{range-min}$:	758	-	8235	5202	3083217	685838	18	104888032	-	-	211086072
$R_{range-max}$:	24015	-	33504	16658	4100728	44698983	1105	331830364	-	-	145711148

pD_e for R=1 will be ≥
Availability(%) becomes ≥

Combined Ash
Productcode: V3CA

Concentration in µg/L Time (days)	TDS	Na	TOC
1	542000	44200	2000
2	1120000	113000	5000
4	1340000	102000	7000
8	1730000	163000	10000
16	2260000	249000	20000
32	2360000	261000	17100
64	2230000	260000	7310

pD_e (-log[m^2/s]) :	> 9.0	8.51	> 11.9
Standard deviation :	.49	.22	.78
Used data points :	1 - 7	3 - 7	1 - 4
Slope :	.51	.34	(1.3)
Std.Dev. of slope :	.17	.10	(.45)
Deviat.slope=½ (3 fases):	+ - -	+ ¤ -	+ ¤ -
Wash-off(mg/m^2),Diss/Lag:	¤	(Lag)	(Lag)
Total Concentrat.(mg/kg):	43779	18470	6698
Availability (mg/kg):	43780	2871	6699
Availability perc. (%):	100.00	15.54	100.01
Mean factor above DTL :	-	96	-
Max.Cum.release (mg/m^2):	< 1839030	120600	< 281399
Cum.release 64d. (mg/m^2):	3027764	311665	17884
Leaching-perc. 64d. (%):	165	258	6.4
Mean factor above DTL :	55152	5677	-
Cum.release calc. 1D 64d:	< 3168145	347863	< 16067
Cum.release calc. 3D 64d:	< 1770756	119649	< 26018
(mg/m^2)	Tortuosity	0	
Chemical Retention R:	2.3	1.0	2083
$R_{range-min}$:	.73	.60	346
$R_{range-max}$:	7.1	1.7	12532

Combined Ash
Productcode: V3CB

Surf.area: .0324 m^2 Bulk Density : 1673 kg/m^3 2 October 1991
Weight : 1.38 kg Extraction volume: 8.47 L

Concentration in µg/L Time (days)	K	Na	Li	Br	Cl	NO3	SO4	Al	B	Ba
1	241000	48800	25.40	1930	188000	40	39500	641	35.30	72.50
2	431000	107000	28.50	4560	464000	40	41200	1170	30.10	199
4	353000	91700	95.90	5100	530000	20	33000	1450	33.40	135
8	456000	140000	97.30	6000	630000	130	32000	2330	143	129
16	670000	199000	95.60	11000	790000	50	62000	4580	53.10	129
32	705000	229000	240	9040	848000	130	102000	6290	89.90	51
64	526000	209000	235	8590	676000	120	137000	6100	104	26.40
pD_e (-log[m^2/s]) :	8.83	9.16	9.61	8.64	9.08	> 7.6	12.22	12.79	-	11.31
Standard deviation :	.47	.47	.24	.54	.56	.48	.28	.17	-	.83
Used data points :	1 - 7	1 - 7	3 - 7	1 - 7	1 - 7	1 - 7	1 - 7	2 - 7	-	1 - 3
Slope :	.39	.63	.39	.63	.47	.53	.51	.55	(.5)	1.33
Std.Dev. of slope :	.15	.16	.13	.18	.19	.16	.09	.07	(.16)	1.09
Deviat.slope=½ (3 fases):	+ ≈ −	+ ≈ −	+ ≈ +	+ − −	+ − −	≈ + +	+ ≈ ≈	+ + −	+ − ≈	+ − −
Wash-off(mg/m^2),Diss/Lag:	≈	≈	(Lag)	(Lag)	≈	≈	≈	(Lag)		≈
Total Concentrat.(mg/kg):	14200	14540	14.17	116.9	11806	.380	2597	20071	.000	566.7
Availability (mg/kg):	11334	4723	7.08	116.9	17804	< .380	67532	7084	-	85.01
Availability perc. (%):	79.82	32.48	49.96	100.00	150.80	< 100.00	2600.0	35.29	-	15.00
Mean factor above DTL :	113	157	2	2	178	(DTL)	675	1417	-	24
Max.Cum.release (mg/m^2):	482045	200873	301.1	4972	757220	< 16.16	2872194	301289	-	3616
Cum.release 64d. (mg/m^2):	884122	267825	214	12083	1078618	139	116776	5898	-	194
Leaching-perc. 64d. (%):	183	133	71.1	243	142	860	4.1	2.0	-	5.4
Mean factor above DTL :	1208	4879	39	13	1179	8	128	293	-	106
Cum.release calc. 1D 64d:	967762	276090	247	12360	1141446	< 130	116136	6318	-	419
Cum.release calc. 3D 64d: (mg/m^2)	471491	188943	245	4912	721631	< 16	185205	10183	-	641
Tortuosity (Na):			2	range:	1 - 5					
Chemical Retention R:	.75	1.0	-	.47	1.3	.04	1034	1587	-	97
$R_{range-min}$:	.25	.34	-	.14	.35	.01	549	1075	-	14
$R_{range-max}$:	2.2	2.9	-	1.6	4.6	.13	1950	2344	-	656
pD_e for R=1 will be ≥	9.0			9.0						
Availability(%) becomes ≥	92.2			145.8						

Combined Ash Surf.area .0324 m^2 Bulk Density 1673 kg/m^3 (continued)
Productcode: V3CB Weight 1.38 kg Extraction volume 8.47 L

Concentration in µg/L Time (days)	Ca	Cd	Cr	Cu	Fe	Mg	Ni	Pb	Si	Sr	Zn
1	37900		< 5	18.70	75.40	30.60	10.60	16.40	996	276	9.10
2	77600		< 5	41	36.40	21	14.30	31.30	1410	617	18.80
4	34300		< 5	47.90	6.50	11	16.30	5.80	1780	417	8.40
8	17500		< 5	60.70	21.80	4.20	< 5	11.10	2780	337	15
16	16100		< 5	147	73.40	87.30	< 5	< 1	4170	394	18.80
32	1660		< 5	170	16.80	91.20	5.20	3.50	4340	124	7.50
64	2750		< 5	115	25.10	283	< 5	4.30	2300	125	5
pD_e ($-\log[m^2/s]$) :	12.36	-	> 13.7	12.79	16.26	> 16.3	12.12	14.11	13.10	> 11.6	15.59
Standard deviation :	.72	-	-	.18	.85	.91	.95	.94	.11	.34	.51
Used data points :	1 - 3	-	1 - 7	2 - 6	1 - 7	1 - 7	1 - 7	1 - 2	2 - 6	3 - 5	1 - 5
Slope :	.81	-	-	.57	.07	.79	-	2.70	.45	-.04	.53
Std.Dev. of slope :	1.15			.10	.22	.28		?	.06	.15	.31
Deviat.slope=½ (3 fases):	+ - -			+ + -	- ≈ -	- + +	+ - ?	- - +	+ ≈ -	+ - -	+ - -
Wash-off(mg/m^2),Diss/Lag:	≈		(Lag)	(Lag)	18.91	≈	?≈	≈	(Lag)	?≈	≈
Total Concentrat.(mg/kg):	202000	20.07	43.68	425.0	48300	.000	43.68	897.3	77272	.000	2243
Availability (mg/kg):	106257	12.28	12.28	222.0	3542	(4486.4)	14.40	377.8	10626	(259.7)	1039
Availability perc. (%):	52.60	61.19	28.11	52.22	7.33	#VALUE!	32.97	42.11	13.75	#VALUE!	46.32
Mean factor above DTL :	2125	61	6	111	3542	-	4	378	531	-	519
Max.Cum.release (mg/m^2):	4519202	522.3	522.3	9442	150644	(190810)	612.4	16068	451933	(11045)	44190
Cum.release 64d. (mg/m^2):	49097	-	< 9.1	157	67	138	< 16	19	4647	599	22
Leaching-perc. 64d. (%):	1.1	-	< 1.7	1.7	.04	.07	< 2.6	.1	1.0	5.4	.05
Mean factor above DTL :	1341	-	(DTL)	21	7	75	1.7	10	115	164	6
Cum.release calc. 1D 64d:	156088	-	< 3.7	198	58	< 75	28	74	6644	< 962	37
Cum.release calc. 3D 64d: (mg/m^2)	249731	-	< 6.3	319	95	< 115	44	120	10746	< 1424	60
Chemical Retention R:	941	-	17781	2735	6685331	6560900	466	69417	-	-	1730480
$R_{range-min}$:	180	-	-	1801	943112	807440	52	8001	-	-	533688
$R_{range-max}$:	4912	-	-	4156	4738951	953310981	4157	602228	-	-	5611072

pD_e for R=1 will be ≥
Availability(%) becomes ≥

Combined Ash
Productcode: V3CB

Concentration in µg/L Time (days)	TDS	Na	TOC
1	591000	48800	2000
2	1490000	107000	6000
4	1240000	91700	6000
8	1400000	140000	11000
16	1740000	199000	15000
32	2130000	229000	17100
64	1890000	209000	7360
pD_e (-log[m^2/s]) :	> 9.1	9.16	> 11.3
Standard deviation :	.52	.47	.81
Used data points :	1 - 7	1 - 7	1 - 4
Slope :	.42	.53	(1.3)
Std.Dev. of slope :	.18	.16	(.49)
Deviat.slope-½ (3 fases):	+ - -	+ ≈ -	+ ≈ -
Wash-off(mg/m^2),Diss/Lag:	≈	≈	(Lag)
Total Concentrat.(mg/kg):	45572	14540	3187
Availability (mg/kg):	45573	4723	3188
Availability perc. (%):	100.00	32.48	100.02
Mean factor above DTL :	-	157	-
Max.Cum.release (mg/m^2):	< 1938259	200873	< 135588
Cum.release 64d. (mg/m^2):	2739940	267825	16851
Leaching-perc. 64d. (%):	141	133	12.4
Mean factor above DTL :	49910	4879	-
Cum.release calc. 1D 64d:	< 2972320	276090	< 16571
Cum.release calc. 3D 64d: (mg/m^2)	< 1841243	188943	< 24223
	Tortuosity	2	
Chemical Retention R:	.66	1.0	103
$R_{range-min}$:	.20	.34	16
$R_{range-max}$:	2.2	2.9	663

Combined Ash Surf.area: .0324 m^2 Bulk Density : 1709 kg/m^3 2 October 1991
Productcode: V3CC Weight : 1.41 kg Extraction volume: 8.47 L

Concentration in µg/L Time (days)	K	Na	Li	Br	Cl	NO3	SO4	Al	B	Ba
1	298000	65800	25.40	2120	222000	50	69600	944	30.80	96.40
2	497000	104000	16.90	4540	459000	30	77900	1370	23.50	149
4	413000	110000	82.80	5400	570000	30	86000	1630	37	102
8	455000	143000	43.40	6800	640000	90	70000	2730	148	92.20
16	750000	219000	154	12000	1000000	60	43000	4210	77.50	126
32	643000	212000	165	8360	749000	90	121000	7230	76.90	44.10
64	483000	193000	175	8200	622000	110	152000	7290	115	25.20
pD_e (-log[m^2/s]) :	8.67	8.83	10.10	8.25	8.78	> 8.6	11.81	12.72	-	11.59
Standard deviation :	.42	.14	.65	.11	.14	.26	.47	.13	-	.47
Used data points :	1 - 6	2 - 5	1 - 7	2 - 5	2 - 5	1 - 7	1 - 7	2 - 7	-	1 - 5
Slope :	.47	.36	.75	.45	.35	.46	.32	.55	(.6)	.36
Std.Dev. of slope :	.19	.08	.15	.09	.07	.09	.14	.05	(.16)	.28
Deviat.slope=½ (3 fases):	+ - -	+ - -	+ ≈ -	+ - -	+ - -	≈ ≈ ≈	+ - +	+ + ≈	+ - -	+ - -
Wash-off(mg/m^2),Diss/Lag:	≈	(Lag)	(Opl)	(Lag)	(Lag)	≈	?≈	(Lag)		≈
Total Concentrat.(mg/kg):	13700	14890	11.85	118.5	11848	1.09	876.8	16588	.000	450.2
Availability (mg/kg):	11374	4739	7.11	118.5	20900	< 1.09	61848	7109	-	85.31
Availability perc. (%):	83.02	31.83	60.00	100.00	176.40	< 100.00	7054.0	42.86	-	18.95
Mean factor above DTL :	114	158	2	2	209	(DTL)	618	1422	-	24
Max.Cum.release (mg/m^2):	494278	205942	309.0	5150	908247	< 47.37	2687716	308934	-	3707
Cum.release 64d. (mg/m^2):	925165	273654	173	12397	1114171	120	161950	6641	-	166
Leaching-perc. 64d. (%):	187	133	56.0	241	123	253	6.0	2.1	-	4.5
Mean factor above DTL :	1264	4985	32	14	1218	7	177	330	-	91
Cum.release calc. 1D 64d:	1192619	413002	144	20081	1920387	< 124	174568	7060	-	311
Cum.release calc. 3D 64d: (mg/m^2)	487799	201423	181	5133	891022	< 47	274752	11370	-	484
	Tortuosity (Na):		1	range:	1 - 1					
Chemical Retention R:	1.1	1.0	-	.41	1.4	.84	853	2845	-	397
$R_{range-min}$:	.42	.72	-	.32	1.0	.46	288	2101	-	134
$R_{range-max}$:	2.9	1.4	-	.52	1.9	1.5	2528	3852	-	1176
pD_e for R=1 will be --- ≥				8.6						
Availability(%) becomes ≥				156.8						

Combined Ash — Surf.area .0324 m^2 — Bulk Density 1709 kg/m^3 — (continued)
Productcode: V3CC — Weight 1.41 kg — Extraction volume 8.47 L

Concentration in µg/L Time (days)	Ca	Cd	Cr	Cu	Fe	Mg	Ni	Pb	Si	Sr	Zn
1	56900		< 5	39.20	71.70	178	9.60	27.50	918	298	29.60
2	73300		< 5	63.40	51.30	96.20	< 5	42.60	1460	484	26.10
4	38400		5	69.60	< 5	28.80	16.90	8.10	1980	399	3.60
8	19900		< 5	72.80	19	16.30	< 5	8.60	2740	332	5
16	6600		< 5	139	35.40	34.20	< 5	< 1	4480	270	7.20
32	1970		< 5	161	26.50	67.80	< 5	< 1	3740	150	11.20
64	3140		6.30	101	12.90	247	12.60	3.50	1830	168	2.70
pD_e (-log[m^2/s]) :	12.25	-	> 13.1	12.63	15.22	> 15.7	> 12.3	14.42	13.04	> 11.3	16.51
Standard deviation :	.54	-	.59	.20	.34	.81	.74	.89	.06	.60	.04
Used data points :	1 - 3	-	1 - 7	2 - 5	1 - 2	1 - 7	1 - 7	1 - 4	2 - 5	1 - 3	3 - 6
Slope :	.60	-	-	.35	1.29	.21	-	-.21	.53	1.10	.54
Std.Dev. of slope :	.89			.14	?	.25		.63	.05	.79	.03
Deviat.slope=½ (3 fases):	+ - -		? ? ?	+ = -	+ + -	- = +	+ ? ?	- - ?	+ - -	+ - -	- = -
Wash-off(mg/m^2),Diss/Lag:	=		(Lag)	(Lag)	=	=46.19	(Lag)	?=	(Lag)	=	12.24
Total Concentrat.(mg/kg):	195000	15.40	42.65	473.9	47500	.000	47.39	592.4	89328	.000	1777
Availability (mg/kg):	106635	(12.32)	12.32	222.8	3555	(4502.4)	14.45	379.2	10664	(260.7)	1043
Availability perc. (%):	54.68	(80)	28.89	47.00	7.48	#VALUE!	30.49	64.00	11.94	#VALUE!	58.67
Mean factor above DTL :	2133	-	6	111	3555	-	4	379	533	-	521
Max.Cum.release (mg/m^2):	4634015	(535)	535.4	9682	154489	(195660)	628.0	16479	463423	(11329)	45325
Cum.release 64d. (mg/m^2):	52339	-	< 9.5	169	58	175	< 15	24	4483	549	22
Leaching-perc. 64d. (%):	1.1	-	< 1.8	1.7	.04	.09	< 2.4	.1	1.0	4.8	.05
Mean factor above DTL :	1430	-	(DTL)	23	6	96	1.6	13	111	150	6
Cum.release calc. 1D 64d:	182091	-	< 8.1	245	197	< 136	< 24	53	7328	< 1295	13
Cum.release calc. 3D 64d:	290641	-	< 13	395	321	< 235	< 37	86	11847	< 2024	21
(mg/m^2)											
Chemical Retention R:	1548	-	8512	3992	1311988	4383692	1430	302230	-	-	30797807
$R_{range-min}$:	449	-	2165	2535	605665	677358	259	39157	-	-	27791727
$R_{range-max}$:	5331	-	33471	6285	2842020	28370145	7879	2332743	-	-	34129039

pD_e for R=1 will be ≥
Availability(%) becomes ≥

Combined Ash
Productcode: V3CC

Concentration in µg/L Time (days)	TDS	Na	TOC
1	639000	65800	3000
2	1120000	104000	7000
4	1360000	110000	8000
8	1460000	143000	11000
16	2030000	219000	19000
32	1960000	212000	14800
64	1700000	193000	6830
pD_e (-log[m^2/s]) :	> 8.9	8.83	> 11.4
Standard deviation :	.48	.14	.69
Used data points :	1 - 7	2 - 5	1 - 4
Slope :	.42	.36	(1.1)
Std.Dev. of slope :	.13	.08	(.46)
Deviat.slope=i (3 fases):	+ - -	+ - -	+ - -
Wash-off(mg/m^2),Diss/Lag:	≈	(Lag)	(Lag)
Total Concentrat.(mg/kg):	36729	14890	4383
Availability (mg/kg):	36730	4739	4384
Availability perc. (%):	100.00	31.83	100.02
Mean factor above DTL :	-	158	-
Max.Cum.release (mg/m^2):	< 1596168	205942	< 190515
Cum.release 64d. (mg/m^2):	2684519	273654	18203
Leaching-perc. 64d. (%):	168	133	9.6
Mean factor above DTL :	48900	4985	-
Cum.release calc. 1D 64d:	< 2926805	413002	< 20479
Cum.release calc. 3D 64d:	< 1552601	201423	< 30549
(mg/m^2)	Tortuosity	1	
Chemical Retention R:	.98	1.0	284
$R_{range-min}$:	.32	.72	58
$R_{range-max}$:	3.0	1.4	1396

Appendix C.5. Summary of monolith leach test extract concentrations and data analysis for APC residue, bottom ash and combined ash treated by Process 4.

All
Productcode: V4XL

Surf.area: .0324 m^2 Bulk Density : 1000 kg/m^3 2 October 1991
Weight : 1 kg Extraction volume: 8.47 L

Concentration in µg/L Time (days)	K	Na	Li	Br	Cl	NO3	SO4	Al	B	Ba
1		84.90				20		< 11	< 8	< 1
2		68.90				30		23.60	< 8	< 1
4		< 30				20		< 11	< 8	1.20
8		< 30				30		< 11	< 8	1.20
16		38.70				50		< 11	8.80	< 1
32		< 30				50		43.70	< 8	< 1
64		192				< 10		32.80	33.20	< 1
pD_e (-log[m^2/s]) :	-	-	-	-	-	-	-	-	-	-
Standard deviation :	-	-	-	-	-	-	-	-	-	-
Used data points :	-	-	-	-	-	-	-	-	-	-
Slope :	-	-	-	-	-	-	-	-	-	-
Std.Dev. of slope :										
Deviat.slope=½ (3 fases):		+ ? +				+ = -		? ? +	? ? +	? + ?
Wash-off(mg/m^2),Diss/Lag:										
Total Concentrat.(mg/kg):	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
Availability (mg/kg):	(.00)	(.00)	-	-	(.00)	-	(.00)	-	-	(.00)
Availability perc. (%):	(20)	(20)	-	-	(20)	-	(100)	-	-	(20)
Mean factor above DTL :	-	-	-	-	-	-	-	-	-	-
Max.Cum.release (mg/m^2):	(.0)	(.0)	-	-	(.0)	-	(.0)	-	-	(.0)
Cum.release 64d. (mg/m^2):	-	-	-	-	-	-	-	-	-	-
Leaching-perc. 64d. (%):	-	-	-	-	-	-	-	-	-	-
Mean factor above DTL :	-	-	-	-	-	-	-	-	-	-
Cum.release calc. 1D 64d:	-	-	-	-	-	-	-	-	-	-
Cum.release calc. 3D 64d: (mg/m^2)	-	-	-	-	-	-	-	-	-	-
	Tortuosity (Na):		0	range:	- -					
Chemical Retention R:	-	-	-	-	-	-	-	-	-	-
$R_{range-min}$:	-	-	-	-	-	-	-	-	-	-
$R_{range-max}$:	-	-	-	-	-	-	-	-	-	-

All
Productcode: V4XL

Surf.area .0324 m^2 Bulk Density 1000 kg/m^3 (continued)
Weight 1 kg Extraction volume 8.47 L

Concentration in µg/L Time (days)	Ca	Cd	Cr	Cu	Fe	Mg	Ni	Pb	Si	Sr	Zn
1	< 20				< 5	< 1			149		< 2
2	< 20				49	2.80			99.40		< 2
4	35.80				5.70	3			< 22		3.60
8	31.50				14.20	3.80			206		4
16	29.50				< 5	16.40			101		3.50
32	< 20				26.40	113			283		3.50
64	89.80				41.60	42.10			629		14
pD_e (-log[m^2/s]) :	-	-	-	-	-	-	-	-	-	-	-
Standard deviation :	-	-	-	-	-	-	-	-	-	-	-
Used data points :	-	-	-	-	-	-	-	-	-	-	-
Slope :	-	-	-								
Std.Dev. of slope :											
Deviat.slope=½ (3 fases):	? + =				- = +	+ + +			+ + +		? = +
Wash-off(mg/m^2),Diss/Lag:											
Total Concentrat.(mg/kg):	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
Availability (mg/kg):	(.00)	(.00)	(.00)	(.00)	-	-	(.00)	(.00)	-	-	(.00)
Availability perc. (%):	(90)	(80)	(10)	(25)	-	-	(20)	(10)	-	-	(40)
Mean factor above DTL :	-	-	-	-	-	-	-	-	-	-	-
Max.Cum.release (mg/m^2):	(.0)	(.0)	(.0)	(.0)	-	-	(.0)	(.0)	-	-	(.0)
Cum.release 64d. (mg/m^2):	-	-	-	-	-	-	-	-	-	-	-
Leaching-perc. 64d. (%):	-	-	-	-	-	-	-	-	-	-	-
Mean factor above DTL :	-	-	-								
Cum.release calc. 1D 64d:	-	-	-	-	-	-	-	-	-	-	-
Cum.release calc. 3D 64d: (mg/m^2)	-	-	-	-	-	-	-	-	-	-	-
Chemical Retention R:	-	-	-	-	-	-	-	-	-	-	-
$R_{range-min}$:	-	-	-	-	-	-	-	-	-	-	-
$R_{range-max}$:	-	-	-	-	-	-	-	-	-	-	-

All

Productcode:	V4XL		
Concentration in µg/L Time (days)	TDS	Na	TOC
1	< 30	84.90	n.a.
2	< 30	68.90	2360
4	< 30	< 30	1150
8	< 30	< 30	600
16	22000	38.70	500
32	< 30	< 30	n.a.
64	< 30	192	n.a.
pD_e (-log[m^2/s]) :	-	-	-
Standard deviation :	-	-	-
Used data points :	-	-	-
Slope :	-	-	-
Std.Dev. of slope :			
Deviat.slope-½ (3 fases):		+ ? +	+ - ?
Wash-off(mg/m^2).Diss/Lag:			
Total Concentrat.(mg/kg):	.000	.000	.000
Availability (mg/kg):	(.00)	(.00)	(.00)
Availability perc. (%):	(100)	(20)	(100)
Mean factor above DTL :	-	-	-
Max.Cum.release (mg/m^2):	(.0)	(.0)	(.0)
Cum.release 64d. (mg/m^2):	-	-	-
Leaching-perc. 64d. (%):	-	-	-
Mean factor above DTL :	-	-	-
Cum.release calc. 1D 64d:	-	-	-
Cum.release calc. 3D 64d: (mg/m^2)	-	-	-
	Tortuosity	0	
Chemical Retention R:	-	-	-
$R_{range-min}$:	-	-	-
$R_{range-max}$:	-	-	-

Bottom Ash | Surf.area: .0324 m^2 | Bulk Density : 2149 kg/m^3 | 2 October 1991

Productcode: V4BA | Weight : 1.77 kg | Extraction volume: 8.47 L

Concentration in µg/L Time (days)	K	Na	Li	Br	Cl	NO3	SO4	Al	B	Ba
1	57000	58400	8.10	4330	212000	270	1050	2320	32.90	133
2	16600	16700	5.20	2990	46900	100	880	1230	8.70	41.90
4	32500	35600	< 5	2510	129000	100	2370	3020	16.40	88.30
8	47200	56600	12	3420	178000	80	4380	6230	19	148
16	59800	77400	17.60	4220	224000	90	7040	10200	30.50	210
32	52200	74700	32.50	4820	250000	130	13200	11700	47.10	243
64	22000	39800	29.10	4070	185000	100	11100	10700	42.10	172
pD_e (-log[m^2/s]) :	9.45	9.66	> 10.7	9.58	10.10	11.13	13.31	9.76	-	11.79
Standard deviation :	.13	.18	.25	.23	.24	.30	.22	.09	-	.19
Used data points :	1 - 5	1 - 5	1 - 7	1 - 5	1 - 5	4 - 7	3 - 7	4 - 6	-	1 - 6
Slope :	.52	.61	-	.37	.56	.15	.60	.45	(.4)	.60
Std.Dev. of slope :	.08	.09		.12	.14	.12	.12	.15	(.05)	.07
Deviat.slope=½ (3 fases):	≈ - -	≈ ≈ -	+ + ≈	≈ - -	≈ - -	- - -	+ + -	+ + -	≈ ≈ -	≈ ≈ -
Wash-off(mg/m^2),Diss/Lag:	≈	≈	(Lag)	≈	≈	70.63	(Lag)	(Lag)		≈
Total Concentrat.(mg/kg):	8000	28170	10.66	207.2	7928	19.11	242.5	26761	.000	486.9
Availability (mg/kg):	2020	2880	< 2.06	207.2	15180	19.11	18160	430.0	-	84.20
Availability perc. (%):	25.25	10.22	< 19.32	100.00	191.48	100.00	7490.2	1.61	-	17.29
Mean factor above DTL :	20	96	(DTL)	4	152	19	182	86	-	24
Max.Cum.release (mg/m^2):	110352	157333	< 112.5	11319	829278	1044	992074	23491	-	4600
Cum.release 64d. (mg/m^2):	75106	93902	29	6891	320213	227	10462	11868	-	271
Leaching-perc. 64d. (%):	68.1	59.7	25.8	60.9	38.6	21.7	1.1	50.5	-	5.9
Mean factor above DTL :	55	1710	3.2	8	350	12	11	590	-	148
Cum.release calc. 1D 64d:	108077	120909	< 28	9554	387065	148	11418	16172	-	304
Cum.release calc. 3D 64d:	95956	124408	< 38	9326	484440	223	18498	17577	-	479
(mg/m^2)	Tortuosity (Na):		6	range:	4 - 9					
Chemical Retention R:	.99	1.0	-	1.3	4.1	42	3991	.46	-	93
$R_{range-min}$:	.73	.66	-	.75	2.4	21	2390	.37	-	61
$R_{range-max}$:	1.3	1.5	-	2.2	7.2	85	6665	.57	-	143
pD_e for R=1 will be ≥	9.5			9.5		9.5		10.1		
Availability(%) becomes ≥	25.4			88.5		15.4		2.4		

Bottom Ash — Surf.area .0324 m^2 — Bulk Density 2149 kg/m^3 — (continued)
Productcode: V4BA — Weight 1.77 kg — Extraction volume 8.47 L

Concentration in µg/L Time (days)	Ca	Cd	Cr	Cu	Fe	Mg	Ni	Pb	Si	Sr	Zn
1	32400			< 5	57.50	11.40		5.30	< 22	168	17.30
2	14200			9.50	22.20	8.10		2.40	< 22	54.30	15.60
4	32000			9.60	30.70	14.20		3.80	312	125	16.20
8	46300			14	41.60	19.50		2.50	780	229	15.60
16	65800			21.40	38.80	103		2.50	1080	377	10.60
32	83500			14.60	90	205		1.90	1150	491	19.40
64	70300			18.80	83.70	180		5.50	1010	424	28.70
pD_e (-log[m^2/s]) :	12.56	-	-	14.56	13.83	> 16.1	-	15.50	13.62	> 11.2	16.19
Standard deviation :	.04	-	-	.37	.19	.79	-	.34	.30	.07	.44
Used data points :	3 - 6	-	-	2 - 7	1 - 7	1 - 7	-	5 - 7	1 - 7	4 - 6	1 - 7
Slope :	.47	-	-	.21	.40	1.05	-	.57	-	.55	.27
Std.Dev. of slope :	.03			.08	.05	.11		.56		.10	.11
Deviat.slope-½ (3 fases):	+ ▪ -			+ - -	▪ ▪ ▪	+ + ▪		+ - ▪	? + -	+ + -	+ - +
Wash-off(mg/m^2),Diss/Lag:	(Lag)			(Lag)	▪	(Opl)		1.35	(Lag)	(Lag)	?▪
Total Concentrat.(mg/kg):	125800	22.43	131.8	1811	119300	.000	287.7	1177	115523	.000	3159
Availability (mg/kg):	76000	16.44	(13.18)	197.4	284.0	(3140.0)	29.80	74.20	3200	(82.60)	1576
Availability perc. (%):	60.41	73.29	(10)	10.90	.24	#VALUE!	10.36	6.30	2.77	#VALUE!	49.89
Mean factor above DTL :	1520	82	-	99	284	-	7	74	160	-	788
Max.Cum.release (mg/m^2):	4151852	898.1	(720)	10784	15515	(171537)	1628	4054	174815	(4512)	86096
Cum.release 64d. (mg/m^2):	90059	-	-	24	95	141	-	6.25	1144	488	32
Leaching-perc. 64d. (%):	2.2	-	-	.2	.6	.08	-	.2	.7	10.8	.04
Mean factor above DTL :	2461	-	-	2.6	10	77	-	3.4	28	133	9
Cum.release calc. 1D 64d:	113391	-	-	30	99	< 79	-	3.7	1408	< 622	36
Cum.release calc. 3D 64d:	182129	-	-	48	160	< 130	-	6.1	2285	< 897	59
(mg/m^2)											
Chemical Retention R:	471	-	-	49671	7750	1489865	-	533633	-	-	2173738
$R_{range-min}$:	426	-	-	21285	4982	243819	-	245118	-	-	793373
$R_{range-max}$:	520	-	-	115913	12056	9103863	-	1161744	-	-	5955757
pD_e for R=1 will be ≥											
Availability(%) becomes ≥											

Bottom Ash
Productcode: V4BA

Concentration in µg/L Time (days)	TDS	Na	TOC
1	352000	58400	1790
2	194000	16700	2190
4	298000	35600	2260
8	388000	56600	2490
16	446000	77400	2120
32	507000	74700	1680
64	431000	39800	1110
pD_e (-log[m^2/s]) :	> 9.6	9.66	> 12.7
Standard deviation :	.30	.18	.40
Used data points :	1 - 7	1 - 5	1 - 4
Slope :	.34	.61	(.7)
Std.Dev. of slope :	.08	.09	(.34)
Deviat.slope=½ (3 fases):	+ - -	= = -	+ - -
Wash-off(mg/m^2),Diss/Lag:	=	=	=
Total Concentrat.(mg/kg):	16197	28170	5513
Availability (mg/kg):	16197	2880	(5513.0)
Availability perc. (%):	100.00	10.22	(100)
Mean factor above DTL :	-	96	-
Max.Cum.release (mg/m^2):	< 884836	157333	(301173)
Cum.release 64d. (mg/m^2):	683874	93902	3566
Leaching-perc. 64d. (%):	77.3	59.7	1.2
Mean factor above DTL :	12457	1710	-
Cum.release calc. 1D 64d:	< 760607	120909	< 6769
Cum.release calc. 3D 64d: (mg/m^2)	< 722911	124408	< 11302
	Tortuosity	6	
Chemical Retention R:	.65	1.0	954
$R_{range-min}$:	.32	.66	382
$R_{range-max}$:	1.3	1.5	2383

Bottom Ash
Productcode: V488

Surf.area: .0324 m^2
Weight : 1.75 kg

Bulk Density : 2125 kg/m^3
Extraction volume: 8.47 L

2 October 1991

Concentration in µg/L Time (days)	K	Na	Li	Br	Cl	NO3	SO4	Al	B	Ba
1	55300	58800	< 5	4890	235000	160	930	1750	17.50	155
2	15800	16700	< 5	1210	59600	90	750	1080	< 8	39.40
4	22400	24900	< 5	1960	99800	70	1500	2080	10.70	68
8	34700	40500	< 5	3240	152000	80	4380	3830	12.60	123
16	43100	53100	9.50	3110	155000	70	3960	5690	25.80	152
32	42400	61400	23.50	4100	204000	110	7690	9660	30.90	255
64	20600	37400	24.10	3470	152000	80	6300	10400	42.60	207
pD_e (-log[m^2/s]) :	9.52	9.81	> 10.3	10.00	10.30	11.08	13.66	10.32	-	11.89
Standard deviation :	.05	.14	.24	.16	.15	.31	.28	.10	-	.17
Used data points :	2 - 5	1 - 6	1 - 7	2 - 6	2 - 6	3 - 5	3 - 7	4 - 7	-	1 - 6
Slope :	.50	.43	-	.42	.42	-.00	.50	.51	-	.55
Std.Dev. of slope :	.04	.05		.08	.08	.11	.17	.09		.07
Deviat.slope=½ (3 fases):	- - -	- ≈ -	? + +	- - -	- - -	- - -	+ + -	+ + ≈	- + ≈	- + -
Wash-off(mg/m^2),Diss/Lag:	4272	≈	(Lag)	478.0	21954	32.69	(Lag)	(Lag)		≈
Total Concentrat.(mg/kg):	6600	29500	10.32	224.5	8347	22.65	489.0	25651	.000	428.9
Availability (mg/kg):	1662	2680	< 1.16	224.5	15620	22.65	17760	528.0	-	85.60
Availability perc. (%):	25.18	9.08	< 11.24	100.00	187.14	100.00	3632.1	2.06	-	19.96
Mean factor above DTL :	17	89	(DTL)	4	156	23	178	106	-	24
Max.Cum.release (mg/m^2):	89769	144753	< 62.65	12126	843673	1223	959259	28519	-	4623
Cum.release 64d. (mg/m^2):	61251	76544	< 20	5746	276425	173	6669	9016	-	261
Leaching-perc. 64d. (%):	68.2	52.9	< 31.9	47.4	32.8	14.1	.7	31.6	-	5.6
Mean factor above DTL :	45	1394	2.2	6	302	9	7	448	-	143
Cum.release calc. 1D 64d:	80977	94056	< 22	6317	311466	185	7443	10268	-	274
Cum.release calc. 3D 64d: (mg/m^2)	75887	104898	< 31	7650	412784	277	12082	13680	-	433
	Tortuosity (Na):		8	range:	6 - 11					
Chemical Retention R:	.83	1.0	-	2.4	4.7	27	6278	1.2	-	83
$R_{range-min}$:	.74	.72	-	1.7	3.4	13	3292	.95	-	56
$R_{range-max}$:	.93	1.4	-	3.5	6.6	54	11973	1.5	-	122
pD_e for R=1 will be ≥	9.6			9.6		9.7				
Availability(%) becomes ≥	27.6			64.6		19.4				

514

Bottom Ash — Surf.area .0324 m^2 — Bulk Density 2125 kg/m^3 (continued)
Productcode: V4BB — Weight 1.75 kg — Extraction volume 8.47 L

Concentration in µg/L	Ca	Cd	Cr	Cu	Fe	Mg	Ni	Pb	Si	Sr	Zn
Time (days)											
1	35400			5.40	55.30	7.20		4.60	< 22	174	15.80
2	12800			6.80	21.80	17.20		< 1	< 22	45	8.50
4	24400			7.40	78.30	10		2.10	453	83.90	13.90
8	40500			8.10	9.70	11.50		1.60	524	166	14.50
16	34200			12.90	11.10	36.80		1.50	702	228	9.60
32	62600			11.10	25.30	101		1.90	1150	380	14.80
64	63300			12.30	121	281		2.50	1260	394	46.30
pD_e ($-\log[m^2/s]$) :	12.82	-	-	14.73	13.66	> 16.3	-	15.56	13.64	> 11.5	16.22
Standard deviation :	.18	-	-	.19	.03	.83	-	.08	.12	.21	.36
Used data points :	1 - 7	-	-	2 - 5	1 - 2	1 - 7	-	5 - 7	1 - 7	1 - 7	1 - 7
Slope :	.46	-	-	.29	.43	1.01	-	.37	-	.59	.39
Std.Dev. of slope :	.06			.09	?	.17		.02		.06	.12
Deviat.slope=½ (3 fases):	+ ≈ ≈			+ - -	+ - +	+ + +		- - ≈	? + ≈	≈ + ≈	+ - +
Wash-off(mg/m^2),Dias/Lag:	≈			(Lag)	≈	(Opl)		.773	(Lag)	≈	≈
Total Concentrat.(mg/kg):	132900	19.64	149.3	1473	111300	.000	296.6	1022	116068	.000	2615
Availability (mg/kg):	67000	14.28	(14.93)	210.0	272.0	(3160.0)	33.20	52.20	3160	(74.40)	1458
Availability perc. (%):	50.41	72.71	(10)	14.26	.24	#VALUE!	11.19	5.11	2.72	#VALUE!	55.75
Mean factor above DTL :	1340	71	-	105	272	-	8	52	158	-	729
Max.Cum.release (mg/m^2):	3618827	771.3	(806)	11343	14691	(170679)	1793	2819	170679	(4019)	78750
Cum.release 64d. (mg/m^2):	71420	-	-	17	84	121	-	3.97	1080	385	32
Leaching-perc. 64d. (%):	2.0	-	-	.1	.6	.07	-	.1	.6	9.6	.04
Mean factor above DTL :	1951	-	-	1.9	9	66	-	2.2	27	105	9
Cum.release calc. 1D 64d:	73524	-	-	26	113	< 60	-	2.4	1343	< 355	32
Cum.release calc. 3D 64d: (mg/m^2)	118524	-	-	42	183	< 103	-	4.0	2181	< 578	52
Chemical Retention R:	608	-	-	53023	3801	1802721	-	438860	-	-	1641294
$R_{range-min}$:	400	-	-	33962	3544	267214	-	365234	-	-	712967
$R_{range-max}$:	924	-	-	82781	4077	12161806	-	527326	-	-	3778360

pD_e for R=1 will be ---- ≥
Availability(%) becomes ≥

Bottom Ash
Productcode: V4BB

Concentration in µg/L Time (days)	TDS	Na	TOC
1	328000	58800	2010
2	198000	16700	2130
4	290000	24900	2230
8	264000	40500	2250
16	396000	53100	1530
32	466[illegible]	61400	1730
64	370[illegible]	37400	970

pD_e ($-\log[m^2/s]$) :	> 9.8	9.81	> 12.9
Standard deviation :	.33	.14	.35
Used data points :	1 - 7	1 - 6	1 - 4
Slope :	.31	.43	(.6)
Std.Dev. of slope :	.08	.05	(.32)
Deviat.slope=½ (3 fases):	+ - -	- = -	+ - -
Wash-off(mg/m^2),Diss/Lag:	?=	=	=
Total Concentrat.(mg/kg):	18236	29500	6683
Availability (mg/kg):	18236	2680	6683
Availability perc. (%):	100.00	9.08	100.00
Mean factor above DTL :	-	89	-
Max.Cum.release (mg/m^2):	< 984969	144753	< 360965
Cum.release 64d. (mg/m^2):	604402	76544	3359
Leaching-perc. 64d. (%):	61.4	52.9	.9
Mean factor above DTL :	11010	1394	-
Cum.release calc. 1D 64d:	< 676680	94056	< 6724
Cum.release calc. 3D 64d: (mg/m^2)	< 718337	104898	< 10788
	Tortuosity	8	
Chemical Retention R:	.73	1.0	993
$R_{range-min}$:	.34	.72	440
$R_{range-max}$:	1.6	1.4	2244

Bottom Ash Surf.area: .0324 m^2 Bulk Density : 1991 kg/m^3 2 October 1991
Productcode: V4BC Weight : 1.64 kg Extraction volume: 8.47 L

Concentration in µg/L Time (days)	K	Na	Li	Br	Cl	NO3	SO4	Al	B	Ba
1	19200	19200	< 5	4070	178000	210	560	248	< 8	57.50
2	13800	14500	< 5	1590	75000	60	720	810	20.40	61.40
4	21200	23400	< 5	2390	111000	130	1250	1340	10.30	96.20
8	32900	39100	10.80	3720	173000	90	2100	2550	11.30	176
16	39300	51300	12.40	4200	197000	140	3000	4100	20.50	255
32	36400	55600	27.60	4460	203000	170	5280	6820	29.10	427
64	17000	28800	32.20	3240	128000	130	5080	6970	29.20	369
pD_e (-log[m^2/s]) :	**9.79**	**9.90**	**11.48**	**9.79**	**9.91**	**10.83**	**13.94**	**9.02**	-	**11.66**
Standard deviation :	.20	.13	.16	.07	.07	.28	.14	.13	-	.19
Used data points :	2 - 6	2 - 6	1 - 7	1 - 5	1 - 5	1 - 5	3 - 7	4 - 7	-	2 - 7
Slope :	.37	.50	-	.49	.50	.30	.54	.51	-	.57
Std.Dev. of slope :	.09	.08		.04	.04	.12	.08	.12		.08
Deviat.slope=½ (3 fases):	+ - -	+ ≈ -	? + +	≈ - -	≈ - -	≈ - -	+ + ≈	+ + ≈	+ ≈ -	+ + -
Wash-off(mg/m^2),Diss/Lag:	(Lag)	(Lag)	(Lag)	≈	≈	13.52	(Lag)	(Lag)		(Lag)
Total Concentrat.(mg/kg):	7300	26250	10.63	248.8	9178	31.70	706.1	26680	.000	509.5
Availability (mg/kg):	2020	2780	5.78	248.8	13160	31.70	18300	87.20	-	101.0
Availability perc. (%):	27.67	10.59	54.37	100.00	143.39	100.00	2591.6	.33	-	19.82
Mean factor above DTL :	20	93	2	5	132	32	183	17	-	29
Max.Cum.release (mg/m^2):	102247	140716	292.6	12594	666123	1605	926296	4414	-	5112
Cum.release 64d. (mg/m^2):	47003	60623	< 26	6188	278412	243	4703	5970	-	377
Leaching-perc. 64d. (%):	46.0	43.1	< 8.9	49.1	41.8	15.1	.5	135	-	7.4
Mean factor above DTL :	34	1104	2.8	7	304	13	5	297	-	206
Cum.release calc. 1D 64d:	67601	82749	28	8371	386095	323	5207	7087	-	395
Cum.release calc. 3D 64d: (mg/m^2)	74835	96087	43	9245	450753	471	8464	4238	-	618
	Tortuosity (Na):		10	range:	7 - 13					
Chemical Retention R:	1.3	1.0	-	1.2	1.6	12	9796	.05	-	40
$R_{range-min}$:	.80	.75	-	1.0	1.3	6.4	7085	.04	-	26
$R_{range-max}$:	2.0	1.3	-	1.4	1.8	23	13545	.07	-	62
pD_e for R=1 will be ≥				9.7		9.7		10.3		
Availability(%) becomes ≥				91.1		28.6		1.5		

Bottom Ash
Productcode: V4BC

Surf.area .0324 m^2
Weight 1.64 kg

Bulk Density 1991 kg/m^3
Extraction volume 8.47 L

(continued)

Concentration in µg/L Time (days)	Ca	Cd	Cr	Cu	Fe	Mg	Ni	Pb	Si	Sr	Zn
1	15600			< 5	10.30	< 1		5.30	< 22	73.50	4.90
2	19500			7.50	14.80	6.80		4.30	< 22	68.20	15.30
4	30900			8.80	25.10	18.20		5	387	117	20.80
8	48100			11	25.20	16.10		5.70	594	222	24.60
16	49100			12	20.80	34.90		4.50	999	329	13.80
32	69800			17.20	10.80	20		5.90	1080	533	15.90
64	86900			16.40	127	386		6	1430	574	25.80
pD_e (-log[m^2/s]) :	12.66	-	-	14.47	14.29	> 16.2	-	13.14	13.64	> 11.4	16.57
Standard deviation :	.12	-	-	.16	.33	.80	-	.36	.11	.15	.09
Used data points :	2 - 6	-	-	3 - 6	2 - 5	1 - 7	-	4 - 7	1 - 7	3 - 7	5 - 7
Slope :	.43	-	-	.30	.15	-	-	.06	-	.59	.45
Std.Dev. of slope :	.06			.05	.17			.10		.08	.14
Deviat.slope=½ (3 fases):	+ ≈ ≈			+ - -	+ - +	+ - +		+ - -	? + -	+ + ≈	+ - ≈
Wash-off(mg/m^2),Diss/Lag:	(Lag)			(Lag)	(Lag)	(Lag)		?≈	(Lag)	(Lag)	?≈
Total Concentrat.(mg/kg):	139100	26.28	107.3	1565	113500	.000	247.7	1434	104018	.000	3490
Availability (mg/kg):	81200	12.06	(10.73)	163.8	334.0	(2960.0)	18.24	11.56	3640	(99.60)	1642
Availability perc. (%):	58.38	45.89	(10)	10.47	.29	#VALUE!	7.36	.81	3.50	#VALUE!	47.04
Mean factor above DTL :	1624	60	-	82	334	-	5	12	182	-	821
Max.Cum.release (mg/m^2):	4110123	610.4	(543)	8291	16906	(149827)	923.3	585.1	184247	(5041)	83114
Cum.release 64d. (mg/m^2):	83628	-	-	20	61	126	-	9.59	1185	501	32
Leaching-perc. 64d. (%):	2.0	-	-	.2	.4	.08	-	1.6	.6	9.9	.04
Mean factor above DTL :	2285	-	-	2.2	7	69	-	5	29	137	9
Cum.release calc. 1D 64d:	100367	-	-	25	63	< 61	-	8.2	1451	< 543	22
Cum.release calc. 3D 64d: (mg/m^2)	161479	-	-	41	103	< 101	-	13	2355	< 808	37
Chemical Retention R:	345	-	-	23809	13197	1123785	-	1345	-	-	3022902
$R_{range-min}$:	259	-	-	16329	6173	176822	-	591	-	-	2453075
$R_{range-max}$:	458	-	-	34714	28212	7142185	-	3062	-	-	3725094

pD_e for R=1 will be ≥
Availability(%) becomes ≥

Bottom Ash
Productcode: V4BC

Concentration in µg/L Time (days)	TDS	Na	TOC
1	210000	19200	1230
2	142000	14500	2250
4	342000	23400	2310
8	287000	39100	2270
16	397000	51300	1820
32	508000	55600	2140
64	303000	28800	1440
pD_e (-log[m^2/s]) :	> 9.8	9.90	> 12.7
Standard deviation :	.41	.13	.56
Used data points :	1 - 7	2 - 6	1 - 4
Slope :	.39	.50	(.8)
Std.Dev. of slope :	.13	.08	(.46)
Deviat.slope=½ (3 fases):	+ - -	+ ≈ -	+ - -
Wash-off(mg/m^2),Diss/Lag:	≈	(Lag)	≈
Total Concentrat.(mg/kg):	18054	26250	4924
Availability (mg/kg):	18054	2780	4925
Availability perc. (%):	100.00	10.59	100.01
Mean factor above DTL :	-	93	-
Max.Cum.release (mg/m^2):	< 913844	140716	< 249290
Cum.release 64d. (mg/m^2):	572248	60623	3519
Leaching-perc. 64d. (%):	62.6	43.1	1.4
Mean factor above DTL :	10424	1104	-
Cum.release calc. 1D 64d:	< 617493	82749	< 6097
Cum.release calc. 3D 64d:	< 666466	96087	< 9355
(mg/m^2)	Tortuosity	10	
Chemical Retention R:	.62	1.0	472
$R_{range-min}$:	.24	.75	131
$R_{range-max}$:	1.6	1.3	1696

519

Combined Ash
Productcode: V4CA

Surf.area: .0324 m^2 Bulk Density : 2052 kg/m^3 2 October 1991
Weight : 1.69 kg Extraction volume: 8.47 L

Concentration in µg/L Time (days)	K	Na	Li	Br	Cl	NO3	SO4	Al	B	Ba
1	174000	155000	5.20	7610	531000	130	5070	5680	32.60	598
2	22800	18700	< 5	1840	123000	40	2360	1490	12.60	85.60
4	47500	42500	< 5	4000	278000	60	5510	3890	46.30	192
8	61100	56400	13.20	3730	259000	30	7020	6210	20.30	268
16	74700	77200	18.30	4480	304000	60	10900	10600	37	377
32	51300	63000	35.20	5020	303000	90	16100	15600	47.40	493
64	16800	23800	28.40	4380	225000	30	14700	1500	40.60	400
pD_e (-log[m^2/s]) :	10.16	10.37	11.07	11.73	10.77	10.18	13.79	8.53	-	11.74
Standard deviation :	.11	.19	.15	.26	.23	.19	.05	.28	-	.04
Used data points :	3 - 5	2 - 5	4 - 6	3 - 5	2 - 5	4 - 6	3 - 6	1 - 2	-	3 - 6
Slope :	.33	.65	.71	.08	.38	.79	.53	-.16	(.3)	.46
Std.Dev. of slope :	.02	.13	.14	.11	.19	.12	.04	?	(.12)	.02
Deviat.slope=i (3 fases):	- - -	- - -	? + -	≈ - -	≈ - -	- - -	+ ≈ -	+ + -	+ - -	- ≈ -
Wash-off(mg/m^2),Diss/Lag:	24637	22518	(Opl)	659.5	50080	27.24	(Lag)	≈		61.35
Total Concentrat.(mg/kg):	9000	27900	10.81	334.4	18145	4.39	875.6	26809	.000	862.4
Availability (mg/kg):	6667	7299	4.59	2752	60754	4.39	55861	64.22	-	180.0
Availability perc. (%):	74.07	26.16	42.46	823.18	334.83	100.00	6379.5	.24	-	20.87
Mean factor above DTL :	67	243	2	55	608	4	559	13	-	51
Max.Cum.release (mg/m^2):	347754	380719	239.4	143546	3168959	229.0	2913737	3350	-	9389
Cum.release 64d. (mg/m^2):	117168	114136	29	8120	528852	115	16119	11756	-	631
Leaching-perc. 64d. (%):	33.7	30.0	12.1	5.7	16.7	50.2	.6	351	-	6.7
Mean factor above DTL :	85	2079	3.2	9	578	6	18	584	-	345
Cum.release calc. 1D 64d:	151663	129489	36	10244	683849	97	19269	9453	-	664
Cum.release calc. 3D 64d: (mg/m^2)	193296	174525	55	16061	989336	125	31299	3322	-	1041
Tortuosity (Na):			29	range:	19 - 44					
Chemical Retention R:	.97	1.0	-	35	3.8	.92	2368	.01	-	16
$R_{range-min}$:	.76	.65	-	19	2.3	.59	2106	.00	-	15
$R_{range-max}$:	1.2	1.5	-	64	6.4	1.4	2663	.01	-	17
pD_e for R=1 will be ≥	10.2					10.2		10.8		
Availability(%) becomes ≥	75.1					104.4		3.3		

Combined Ash Surf.area .0324 m^2 Bulk Density 2052 kg/m^3 (continued)
Productcode: V4CA Weight 1.69 kg Extraction volume 8.47 L

Concentration in µg/L Time (days)	Ca	Cd	Cr	Cu	Fe	Mg	Ni	Pb	Si	Sr	Zn
1	82600			75.30	32.50	40.30		5	337	618	20.40
2	16300			14.20	29.10	12		1.90	< 22	93.20	9.60
4	41500			33.10	26.60	16.30		3.30	407	228	17.80
8	61900			47.90	23.30	25		3.40	569	351	16.90
16	89800			61.80	6.20	41.40		1.70	606	580	13.60
32	126000			85.90	9.60	86.30		2.10	776	789	11.50
64	108000			73.60	80	209		7.70	730	724	33.60
pD_e $(-\log[m^2/s])$:	12.64	-	-	12.86	13.88	> 16.3	-	13.00	14.12	> 11.1	17.13
Standard deviation :	.03	-	-	.05	.87	.36	-	.08	.17	.10	.32
Used data points :	3 - 6	-	-	3 - 6	1 - 7	1 - 7	-	5 - 6	3 - 6	3 - 6	5 - 7
Slope :	.53	-	-	.45	.14	.70	-	.30	.29	.61	.65
Std.Dev. of slope :	.01			.02	.25	.09		?	.05	.04	.52
Deviat.slope=½ (3 fases):	≈ ≈ -			- ≈ -	+ - +	- + +		≈ - +	+ ≈ -	- + -	+ - +
Wash-off(mg/m^2),Diss/Lag:	≈			≈	?≈	≈		1.30	(Lag)	≈	3.96
Total Concentrat.(mg/kg):	135500	22.02	46.08	1407	90300	.000	94.39	1427	156839	.000	3150
Availability (mg/kg):	119062	44.04	(4.61)	112.5	150.7	(4138.6)	9.60	3.28	5138	(120.3)	2956
Availability perc. (%):	87.87	200.00	(10)	8.00	.17	#VALUE!	10.17	.23	3.28	#VALUE!	93.85
Mean factor above DTL :	2381	220	-	56	151	-	2	3	257	-	1478
Max.Cum.release (mg/m^2):	6210333	2297	(240)	5868	7861	(215871)	500.7	171.1	268001	(6275)	154186
Cum.release 64d. (mg/m^2):	137533	-	-	102	54	112	-	6.56	901	884	32
Leaching-perc. 64d. (%):	2.2	-	-	1.7	.7	.05	-	3.8	.3	14.1	.02
Mean factor above DTL :	3758	-	-	11	6	61	-	3.6	22	242	9
Cum.release calc. 1D 64d:	155870	-	-	114	47	< 83	-	2.8	1220	< 929	22
Cum.release calc. 3D 64d: (mg/m^2)	250649	-	-	184	77	< 130	-	4.5	1983	< 1388	36
Chemical Retention R:	109	-	-	195	1692	410510	-	325	-	-	3657486
$R_{range-min}$:	102	-	-	175	226	178283	-	268	-	-	1733916
$R_{range-max}$:	117	-	-	216	12673	945230	-	393	-	-	7715025

pD_e for R=1 will be ≥
Availability(%) becomes ≥

Combined Ash
Productcode: V4CA

Concentration in µg/L Time (days)	TDS	Na	TOC
1	1060000	155000	7720
2	297000	18700	3730
4	516000	42500	4860
8	570000	56400	5270
16	607000	77200	4920
32	665000	63000	5730
64	501000	23800	3740
pD_e (-log[m^2/s]) :	> 9.8	10.37	> 12.7
Standard deviation :	.47	.19	.13
Used data points :	1 - 7	2 - 5	1 - 4
Slope :	.17	.65	(.4)
Std.Dev. of slope :	.06	.13	(.10)
Deviat.slope=½ (3 fases):	= - -	- - -	= - -
Wash-off(mg/m^2),Diss/Lag:	=144149	22518	=
Total Concentrat.(mg/kg):	34760	27900	14169
Availability (mg/kg):	34760	7299	14169
Availability perc. (%):	100.00	26.16	100.00
Mean factor above DTL :	-	243	-
Max.Cum.release (mg/m^2):	< 1813099	380719	< 739062
Cum.release 64d. (mg/m^2):	1102146	114136	9403
Leaching-perc. 64d. (%):	60.8	30.0	1.3
Mean factor above DTL :	20076	2079	-
Cum.release calc. 1D 64d:	< 1200023	129489	< 16277
Cum.release calc. 3D 64d: (mg/m^2)	< 1322291	174525	< 27734
	Tortuosity	29	
Chemical Retention R:	.22	1.0	195
$R_{range-min}$:	.07	.65	145
$R_{range-max}$:	.64	1.5	262

Combined Ash
Productcode: V4CB

Surf.area: .0324 m^2 Bulk Density : 1967 kg/m^3 2 October 1991
Weight : 1.62 kg Extraction volume: 8.47 L

Concentration in µg/L Time (days)	K	Na	Li	Br	Cl	NO3	SO4	Al	B	Ba
1	107000	94500	8.10	5120	345000	80	2900	4710	14.80	446
2	18200	15900	< 5	1100	71200	30	1880	2190	13.40	112
4	25500	23500	9.60	2310	136000	30	4850	5050	14.60	200
8	30900	31700	15.60	2600	162000	40	7560	8480	21.60	288
16	27300	28600	14.50	2600	160000	40	11400	12200	28.80	305
32	18300	21400	40.80	2810	148000	190	18100	20100	80.50	387
64	8160	9860	18.60	2420	114000	< 10	16400	18900	38	285
pD_e (-log[m^2/s]) :	10.04	10.11	> 10.6	10.07	9.85	10.59	12.74	9.03	-	11.72
Standard deviation :	.08	.02	.19	.17	.13	.19	.10	.12	-	.15
Used data points :	2 - 4	2 - 4	3 - 5	2 - 4	2 - 4	3 - 5	3 - 6	3 - 6	-	2 - 6
Slope :	.38	.50	.30	.62	.59	.21	.63	.65	(.6)	.42
Std.Dev. of slope :	.06	.04	.23	.26	.20	.12	.01	.03	(.12)	.08
Deviat.slope=½ (3 fases):	- - -	- - -	+ + -	- - -	- - -	- + +	+ + -	+ + -	+ + -	- - -
Wash-off(mg/m^2),Diss/Lag:	17398	14476	(Lag)	441.7	35470	12.54	(Lag)	(Lag)		39.73
Total Concentrat.(mg/kg):	7400	32700	11.61	277.0	13646	6.96	412.4	26578	.000	904.3
Availability (mg/kg):	3462	3523	< 2.38	277.0	13320	6.96	17821	270.9	-	167.0
Availability perc. (%):	46.79	10.77	< 20.50	100.00	97.61	100.00	4321.0	1.02	-	18.47
Mean factor above DTL :	35	117	(DTL)	6	133	7	178	54	-	48
Max.Cum.release (mg/m^2):	173100	176150	< 119.0	13850	666000	348.0	891050	13545	-	8350
Cum.release 64d. (mg/m^2):	61528	58940	29	4957	297025	110	16493	18725	-	529
Leaching-perc. 64d. (%):	35.5	33.5	24.4	35.8	44.6	31.6	1.9	138	-	6.3
Mean factor above DTL :	45	1074	3.2	5	325	6	18	930	-	289
Cum.release calc. 1D 64d:	86731	81373	< 33	6699	414835	92	19799	21491	-	600
Cum.release calc. 3D 64d: (mg/m^2)	106322	102132	< 44	8299	470934	129	31887	12987	-	941
	Tortuosity (Na):		16	range:	15 - 16					
Chemical Retention R:	1.4	1.0	-	1.4	.84	4.4	387	.03	-	29
$R_{range-min}$:	1.1	.95	-	.94	.62	2.8	307	.02	-	20
$R_{range-max}$:	1.6	1.1	-	2.1	1.1	6.8	488	.04	-	41
pD_e for R=1 will be ≥				9.9	9.9	9.9		10.5		
Availability(%) becomes ≥				84.4	106.5	47.7		5.8		

Combined Ash
Productcode: V4CB

Surf.area .0324 m^2 Bulk Density 1967 kg/m^3 (continued)
Weight 1.62 kg Extraction volume 8.47 L

Concentration in µg/L Time (days)	Ca	Cd	Cr	Cu	Fe	Mg	Ni	Pb	Si	Sr	Zn
1	55200			52.20	162	63.80		10.40	317	318	33.20
2	19600			17.60	68.60	10.90		2.10	< 22	85.50	17.10
4	41000			32.40	20.60	16.20		4	277	161	19.20
8	62500			49.30	57.10	34.30		4.50	580	266	21.60
16	72800			58.40	19.30	64.40		1.70	611	322	15.20
32	98900			82.50	7.80	31.40		1.70	1930	465	11.70
64	77500			76.90	131	303		2.70	950	398	67.40
pD_e (-log[m^2/s]) :	12.30	-	-	13.70	14.56	> 15.9	-	15.65	13.80	> 11.3	15.35
Standard deviation :	.09	-	-	.10	.62	.56	-	.15	.18	.07	.11
Used data points :	3 - 6	-	-	1 - 6	3 - 5	1 - 7	-	5 - 7	3 - 5	3 - 6	1 - 3
Slope :	.40	-	-	.51	-.05	.61	-	.33	.57	.49	.49
Std.Dev. of slope :	.05			.04	.88	.19		.19	.29	.06	.19
Deviat.slope=½ (3 fases):	+ ¤ -			¤ ¤ -	- - +	- ¤ +		- - -	¤ + -	¤ ¤ -	¤ - +
Wash-off(mg/m^2),Diss/Lag:	(Lag)			¤	47.65	¤3.61		2.83	(Lag)	¤	¤
Total Concentrat.(mg/kg):	132100	18.53	53.36	1405	85800	.000	121.2	1293	157396	.000	2811
Availability (mg/kg):	75153	12.08	(5.34)	291.2	523.4	(3075.4)	15.36	64.15	3544	(103.9)	1342
Availability perc. (%):	56.89	65.19	(10)	20.72	.61	#VALUE!	12.68	4.96	2.25	#VALUE!	47.75
Mean factor above DTL :	1503	60	-	146	523	-	4	64	177	-	671
Max.Cum.release (mg/m^2):	3757650	604.0	(267)	14560	26170	(153770)	768.0	3208	177200	(5195)	67100
Cum.release 64d. (mg/m^2):	111757	-	-	97	122	137	-	7.08	1225	527	48
Leaching-perc. 64d. (%):	3.0	-	-	.7	.5	.09	-	.2	.7	10.1	.07
Mean factor above DTL :	3054	-	-	11	13	75	-	3.9	30	144	13
Cum.release calc. 1D 64d:	139128	-	-	107	71	< 89	-	2.5	1165	< 601	74
Cum.release calc. 3D 64d: (mg/m^2)	222273	-	-	174	116	< 145	-	4.1	1892	< 928	121
Chemical Retention R:	93	-	-	2513	15190	335416	-	270204	-	-	111351
$R_{range-min}$:	75	-	-	2000	3627	91374	-	189874	-	-	85914
$R_{range-max}$:	115	-	-	3158	63609	1231245	-	384520	-	-	144319

pD_e for R=1 will be ≥
Availability(%) becomes ≥

Combined Ash
Productcode: V4CB

Concentration in µg/L Time (days)	TDS	Na	TOC
1	604000	94500	5740
2	242000	15900	2250
4	336000	23500	5160
8	373000	31700	5050
16	336000	28600	4230
32	381000	21400	4070
64	341000	9860	3240
pD_e (-log[m^2/s]) :	> 9.9	10.11	> 13.0
Standard deviation :	.48	.02	.19
Used data points :	1 - 7	2 - 4	1 - 4
Slope :	.15	.50	(.6)
Std.Dev. of slope :	.05	.04	(.16)
Deviat.slope=½ (3 fases):	= - -	- - -	+ - -
Wash-off(mg/m^2),Diss/Lag:	=80429	14476	=
Total Concentrat.(mg/kg):	27189	32700	16191
Availability (mg/kg):	27189	3523	16191
Availability perc. (%):	100.00	10.77	100.00
Mean factor above DTL :	-	117	-
Max.Cum.release (mg/m^2):	< 1359450	176150	< 809550
Cum.release 64d. (mg/m^2):	683090	58940	7775
Leaching-perc. 64d. (%):	50.2	33.5	1.0
Mean factor above DTL :	12443	1074	-
Cum.release calc. 1D 64d:	< 764792	81373	< 13377
Cum.release calc. 3D 64d:	< 925794	102132	< 21587
(mg/m^2)	Tortuosity	16	
Chemical Retention R:	.55	1.0	638
$R_{range-min}$:	.18	.95	412
$R_{range-max}$:	1.7	1.1	987

Combined Ash
Productcode: V4CC

Surf.area: .0324 m^2 Bulk Density : 2003 kg/m^3 2 October 1991
Weight : 1.65 kg Extraction volume: 8.47 L

Concentration in µg/L Time (days)	K	Na	Li	Br	Cl	NO3	SO4	Al	B	Ba
1	126000	114000	6.90	6600	440000	210	2620	5830	11.60	478
2	19600	16000	< 5	1360	85200	70	2030	1840	< 8	104
4	30700	28900	9	2120	134000	70	3900	6100	12.80	266
8	30700	30800	15.60	2120	133000	60	5640	7890	15.40	289
16	26700	30400	19.40	2360	144000	50	8960	12400	24.10	353
32	13900	18100	49.10	2260	128000	50	14800	20100	40.10	445
64	5850	7600	22.90	1730	84700	40	13700	18400	34.30	313
pD_e (-log[m^2/s]) :	10.21	10.97	11.50	10.05	9.97	10.63	13.28	9.60	-	11.46
Standard deviation :	.15	.13	.09	.16	.16	.35	.06	.09	-	.18
Used data points :	2 - 4	2 - 4	3 - 5	2 - 4	2 - 4	6 - 7	3 - 5	3 - 6	-	3 - 5
Slope :	.32	.47	.55	.32	.32	-.32	.60	.58	-	.20
Std.Dev. of slope :	.19	.22	.14	.18	.19	?	.04	.05		.05
Deviat.slope=½ (3 fases):	- - -	- - -	+ + -	- - -	- - -	- - -	+ + -	+ ≈ -	≈ + -	≈ - -
Wash-off(mg/m^2),Dise/Lag:	21379	18686	(Lag)	926.9	64756	64.81	(Lag)	(Lag)		≈
Total Concentrat.(mg/kg):	6720	35000	10.69	261.1	12802	3.67	443.6	25000	.000	841.7
Availability (mg/kg):	4500	10000	7.50	261.1	14839	3.67	24194	528.2	-	153.4
Availability perc. (%):	66.96	28.57	70.16	100.00	115.91	100.00	5454.5	2.11	-	18.23
Mean factor above DTL :	45	333	3	5	148	4	242	106	-	44
Max.Cum.release (mg/m^2):	229167	509259	381.9	13297	755690	186.9	1232102	26899	-	7812
Cum.release 64d. (mg/m^2):	66257	64257	33	4849	300345	144	13502	18969	-	588
Leaching-perc. 64d. (%):	28.9	12.6	8.6	36.5	39.7	77.0	1.1	70.5	-	7.5
Mean factor above DTL :	48	1170	3.6	5	328	8	15	942	-	321
Cum.release calc. 1D 64d:	94377	86539	35	6528	410358	47	14691	22215	-	758
Cum.release calc. 3D 64d:	122036	128489	55	8053	490280	67	23801	21964	-	1173
(mg/m^2)	Tortuosity (Na):		116	range:	85 - 157					
Chemical Retention R:	.27	1.0	-	.18	.15	.64	182	.02	-	2.1
$R_{range-min}$:	.19	.74	-	.13	.10	.29	157	.01	-	1.4
$R_{range-max}$:	.39	1.4	-	.26	.21	1.4	211	.02	-	3.2
pD_e for R=1 will be ≥	10.8			10.8	10.8	10.8		11.4		
Availability(%) becomes ≥	128.3			232.9	299.8	124.9		16.9		

Combined Ash — Surf.area .0324 m^2 — Bulk Density 2003 kg/m^3 (continued)
Productcode: V4CC — Weight 1.65 kg — Extraction volume 8.47 L

Concentration in µg/L Time (days)	Ca	Cd	Cr	Cu	Fe	Mg	Ni	Pb	Si	Sr	Zn
1	59200			64.40	105	15.50		5.80	< 22	338	16.20
2	17300			17	38.70	10		5.30	206	75.70	18
4	47600			39	16.20	13.90		3.10	329	192	15.20
8	52900			44.90	19.10	16		2.30	597	224	16.70
16	66400			59.30	34.90	37.30		1.90	729	315	13.20
32	86400			90.20	17.60	85.20		2.10	770	462	11
64	65200			79.30	73.20	111		2.50	660	383	14.80
pD_e (-log[m^2/s]) :	12.42	-	-	13.44	15.43	> 16.2	-	15.39	13.83	> 11.3	16.76
Standard deviation :	.09	-	-	.15	.11	.39	-	.18	.15	.02	.03
Used data points :	4 - 6	-	-	2 - 6	3 - 5	1 - 7	-	5 - 7	2 - 6	4 - 6	6 - 7
Slope :	.35	-	-	.54	.55	.77	-	.20	.50	.52	.43
Std.Dev. of slope :	.01			.09	.18	.06		.03	.09	.02	?
Deviat.slope=½ (3 fases):	+ - -			≈ ≈ -	- - ≈	+ + +		≈ - -	+ ≈ -	≈ ≈ -	+ - -
Wash-off(mg/m^2),Dias/Lag:	≈			≈	27.70	(Opl)		2.42	(Lag)	≈	?≈
Total Concentrat.(mg/kg):	124500	16.33	45.97	1331	99800	.000	91.03	1321	137926	.000	2419
Availability (mg/kg):	73387	9.58	(4.60)	217.7	1085	(2883.1)	12.76	50.60	3669	(93.35)	1218
Availability perc. (%):	59.95	58.67	(10)	16.36	1.09	#VALUE!	14.02	3.83	2.66	#VALUE!	50.33
Mean factor above DTL :	1468	48	-	109	1085	-	3	51	183	-	609
Max.Cum.release (mg/m^2):	3737301	487.9	(234)	11087	55255	(146825)	649.8	2577	186847	(4754)	62028
Cum.release 64d. (mg/m^2):	103261	-	-	103	80	76	-	6.01	866	520	27
Leaching-perc. 64d. (%):	2.8	-	-	.9	.1	.05	-	.2	.5	10.9	.04
Mean factor above DTL :	2821	-	-	11	9	42	-	3.3	22	142	7
Cum.release calc. 1D 64d:	119960	-	-	110	56	< 58	-	2.7	1184	< 570	14
Cum.release calc. 3D 64d (mg/m^2):	192206	-	-	179	91	< 99	-	4.4	1924	< 849	22
Chemical Retention R:	17	-	-	186	15027	96646	-	20035	-	-	387759
$R_{range-min}$:	14	-	-	132	11545	39520	-	13152	-	-	361368
$R_{range-max}$:	20	-	-	263	19560	236345	-	30520	-	-	416078

pD_e for R=1 will be ≥
Availability(%) becomes ≥

Combined Ash
Productcode: V4CC

Concentration in µg/L Time (days)	TDS	Na	TOC
1	757000	114000	7770
2	260000	16000	3800
4	325000	28900	4710
8	325000	30800	4290
16	343000	30400	4920
32	377000	31000	4340
64	312000	27600	3440
pD_e (-log[m^2/s]) :	> 10.0	10.97	> 12.7
Standard deviation :	.54	.13	.21
Used data points :	1 - 7	2 - 4	1 - 4
Slope :	.09	.47	(.3)
Std.Dev. of slope :	.03	.22	(.14)
Deviat.slope=½ (3 fases):	- - -	- - -	- - -
Wash-off(mg/m^2),Diss/Lag:	=123798	18686	=
Total Concentrat.(mg/kg):	30241	35000	13709
Availability (mg/kg):	30242	10000	13710
Availability perc. (%):	100.00	28.57	100.00
Mean factor above DTL :	-	333	-
Max.Cum.release (mg/m^2):	< 1540102	509259	< 698194
Cum.release 64d. (mg/m^2):	705572	64257	8697
Leaching-perc. 64d. (%):	45.8	12.6	1.2
Mean factor above DTL :	12852	1170	-
Cum.release calc. 1D 64d:	< 770033	86539	< 15437
Cum.release calc. 3D 64d:	< 972869	128489	< 26200
(mg/m^2)	Tortuosity	116	
Chemical Retention R:	.09	1.0	48
$R_{range-min}$:	.03	.74	29
$R_{range-max}$:	.32	1.4	79

Appendix C. 6. Summary of monolith leach test extract concentrations and data analysis for APC residue, bottom ash and combined ash treated by WES Control Process.

All
Productcode: V9XL

Surf.area: .0324 m^2
Weight : 1 kg

Bulk Density : 1000 kg/m^3
Extraction volume: 8.47 L

2 October 1991

Concentration in µg/L Time (days)	K	Na	Li	Br	Cl	NO3	SO4	Al	B	Ba
1	2340	1990	< 3		< 500	40		19.50	< 4	13.90
2	< 422	610	< 3		< 500	< 10		25.70	13.70	1.90
4	2900	1890	< 3		610	< 10		124	4.60	8
8	1930	1650	5.60		< 500	< 10		32	9.30	14.40
16	2650	5010	3.20		< 500	< 10		19.20	< 4	13.90
32	1410	100	< 3		< 500	50		22.50	4.80	< 1
64	2570	34.70	< 3		< 500	30		39.30	32.10	1.80
pD_e (-log[m^2/s]) :	-	-	-	-	-	-	-	-	-	-
Standard deviation :	-	-	-	-	-	-	-	-	-	-
Used data points :	-	-	-	-	-	-	-	-	-	-
Slope :	(.3)	(-.6)	-	-	-	-	-	(.2)	-	-
Std.Dev. of slope :	(.18)	(.45)						(.26)		
Deviat.slope=½ (3 fases):	+ - -	+ - -	? + ?			? ? +		+ - ≈	- - +	≈ ≈ -
Wash-off(mg/m^2),Diss/Lag:										
Total Concentrat.(mg/kg):	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
Availability (mg/kg):	(.00)	(.00)	-	-	(.00)	-	(.00)	-	-	(.00)
Availability perc. (%):	(20)	(20)	-	-	(20)	-	(100)	-	-	(20)
Mean factor above DTL :	-	-	-	-	-	-	-	-	-	-
Max.Cum.release (mg/m^2):	(.0)	(.0)	-	-	(.0)	-	(.0)	-	-	(.0)
Cum.release 64d. (mg/m^2):	-	-	-	-	-	-	-	-	-	-
Leaching-perc. 64d. (%):	-	-	-	-	-	-	-	-	-	-
Mean factor above DTL :	-	-	-	-	-	-	-	-	-	-
Cum.release calc. 1D 64d:	-	-	-	-	-	-	-	-	-	-
Cum.release calc. 3D 64d:	-	-	-	-	-	-	-	-	-	-
(mg/m^2)	Tortuosity (Na):		0	range:	- -					
Chemical Retention R:	-	-	-	-	-	-	-	-	-	-
$R_{range-min}$:	-	-	-	-	-	-	-	-	-	-
$R_{range-max}$:	-	-	-	-	-	-	-	-	-	-

All
Productcode: V9XL

Surf.area .0324 m^2 Bulk Density 1000 kg/m^3 (continued)
Weight 1 kg Extraction volume 8.47 L

Concentration in µg/L Time (days)	Ca	Cd	Cr	Cu	Fe	Mg	Ni	Pb	Si	Sr	Zn
1	6480		< 3	6	7.60	1.20	< 5		111	20	15.40
2	346		5.40	< 4	72.60	27.90	< 5		356	3.20	< 2
4	1220		< 3	< 4	36.40	81.70	< 5		122	10.60	9.60
8	4990		< 3	< 4	< 5	2.60	< 5		162	19.90	3.10
16	5440		5.80	< 4	244	88.40	< 5		104	39.20	< 2
32	42.40		11.10	8.60	14.90	3.80	6.90		117	2.50	8.60
64	108		8.60	< 4	17.90	30.10	< 5		252	< 2	6
pD_e ($-\log[m^2/s]$) :	-	-	-	-	-	-	-	-	-	-	-
Standard deviation :	-	-	-	-	-	-	-	-	-	-	-
Used data points :	-	-	-	-	-	-	-	-	-	-	-
Slope :	(-.6)	-	-	-	-	(.5)	-	-	(.2)	-	-
Std.Dev. of slope :	(.50)					(.57)			(.21)		
Deviat.slope=½ (3 fases):	- - -		? + +	? ? ?	+ - -	+ - -			+ - +	≈ - -	- - -
Wash-off(mg/m^2),Diss/Lag:											
Total Concentrat.(mg/kg):	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
Availability (mg/kg):	(.00)	(.00)	(.00)	(.00)	-	-	(.00)	(.00)	-	-	(.00)
Availability perc. (%):	(90)	(80)	(10)	(25)	-	-	(20)	(10)	-	-	(40)
Mean factor above DTL :	-	-	-	-	-	-	-	-	-	-	-
Max.Cum.release (mg/m^2):	(.0)	(.0)	(.0)	(.0)	-	-	(.0)	(.0)	-	-	(.0)
Cum.release 64d. (mg/m^2):	-	-	-	-	-	-	-	-	-	-	-
Leaching-perc. 64d. (%):	-	-	-	-	-	-	-	-	-	-	-
Mean factor above DTL :	-	-	-	-	-	-	-	-	-	-	-
Cum.release calc. 1D 64d:	-	-	-	-	-	-	-	-	-	-	-
Cum.release calc. 3D 64d: (mg/m^2)	-	-	-	-	-	-	-	-	-	-	-
Chemical Retention R:	-	-	-	-	-	-	-	-	-	-	-
$R_{range-min}$:	-	-	-	-	-	-	-	-	-	-	-
$R_{range-max}$:	-	-	-	-	-	-	-	-	-	-	-

All

Productcode:	V9XL		
Concentration in µg/L	TDS	Na	TOC
Time (days)			
1	< 30	1990	650
2	19000	610	560
4	27000	1890	n.a.
8	32000	1650	n.a.
16	< 30	5010	n.a.
32	< 30	100	1090
64	< 30	34.70	n.a.
pD_e (-log[m^2/s]) :	-	-	-
Standard deviation :	-	-	-
Used data points :	-	-	-
Slope :	-	(-.6)	-
Std.Dev. of slope :		(.45)	
Deviat.slope=½ (3 fases):	+ - ?	+ - -	+ ? ?
Wash-off(mg/m^2),Diss/Lag:			
Total Concentrat.(mg/kg):	.000	.000	.000
Availability (mg/kg):	(.00)	(.00)	(.00)
Availability perc. (%):	(100)	(20)	(100)
Mean factor above DTL :	-	-	-
Max.Cum.release (mg/m^2):	(.0)	(.0)	(.0)
Cum.release 64d. (mg/m^2):	-	-	-
Leaching-perc. 64d. (%):	-	-	-
Mean factor above DTL :	-	-	-
Cum.release calc. 1D 64d:	-	-	-
Cum.release calc. 3D 64d:	-	-	-
(mg/m^2)	Tortuosity	0	
Chemical Retention R:	-	-	-
$R_{range-min}$:	-	-	-
$R_{range-max}$:	-	-	-

APC-Residue
Productcode: V9FA

Surf.area: .0324 m^2 Bulk Density : 1457 kg/m^3 2 October 1991
Weight : 1.20 kg Extraction volume: 8.47 L

Concentration in µg/L Time (days)	K	Na	Li	Br	Cl	NO3	SO4	Al	B	Ba
1	248000	178000	67.10	48600	2190000	330	6360	98	64.60	927
2	675000	530000	256	81800	4050000	570	9270	106	34.90	2910
4	656000	581000	264	87800	3780000	1040	6740	174	41	3150
8	887000	715000	393	118000	4830000	700	10600	61.90	59.80	4500
16	686000	480000	506	112000	5800000	400	55100	102	84.60	2230
32	362000	399000	348	92700	4360000	580	12600	77.90	54.70	4420
64	365000	395000	463	100000	3740000	530	5270	93.70	36.60	6190
pD_e (-log[m^2/s]) :	8.13	8.29	8.40	8.10	8.72	8.78	11.47	16.24	-	9.63
Standard deviation :	.03	.09	.14	.21	.12	.33	.07	.36	-	.17
Used data points :	3 - 4	3 - 4	2 - 5	3 - 5	3 - 5	2 - 4	3 - 4	5 - 7	-	5 - 7
Slope :	.44	.30	.35	.18	.31	.15	.65	-.06	(.2)	.74
Std.Dev. of slope :	?	?	.07	.14	.03	.42	?	.19	(.12)	.14
Deviat.slope=½ (3 fases):	+ - -	+ - -	+ - -	+ - -	+ - -	+ - -	+ ≈ -	+ - -	≈ - -	+ - +
Wash-off(mg/m^2),Diss/Lag:	(Lag)	(Lag)	(Lag)	(Lag)	(Lag)	(Lag)	≈	?≈		≈
Total Concentrat.(mg/kg):	18500	13400	9.79	1545	110955	33.71	7163	16783	.000	349.7
Availability (mg/kg):	13706	13986	8.39	1545	140979	33.71	7100	7832	-	167.8
Availability perc. (%):	74.09	104.37	85.70	100.00	127.06	100.00	99.12	46.67	-	48.00
Mean factor above DTL :	137	466	3	31	1410	34	71	1566	-	48
Max.Cum.release (mg/m^2):	507630	518000	310.7	57222	5221444	1249	262963	290074	-	6215
Cum.release 64d. (mg/m^2):	1014047	856934	601	167544	7515818	1085	27695	187	-	6360
Leaching-perc. 64d. (%):	200	165	193	293	144	86.9	10.5	.06	-	102
Mean factor above DTL :	739	15610	109	183	8214	59	30	9	-	3476
Cum.release calc. 1D 64d:	2290003	1934962	1022	265298	11943447	2663	25375	114	-	4968
Cum.release calc. 3D 64d:	506543	516069	309	57109	5141833	1226	39239	187	-	5003
(mg/m^2)	Tortuosity (Na):		0	range:	0 - 0					
Chemical Retention R:	1.1	1.0	-	1.00	4.1	4.4	1341	33138389	-	15
$R_{range-min}$:	1.0	.82	-	.61	3.1	2.1	1154	14580176	-	10
$R_{range-max}$:	1.2	1.2	-	1.6	5.3	9.3	1559	75318213	-	22
pD_e for R=1 will be ≥				8.1		8.1				
Availability(%) becomes ≥				100.1		47.7				

APC-Residue
Productcode: V9FA

Surf.area .0324 m^2 Bulk Density 1457 kg/m^3 (continued)
Weight 1.20 kg Extraction volume 8.47 L

Concentration in µg/L Time (days)	Ca	Cd	Cr	Cu	Fe	Mg	Ni	Pb	Si	Sr	Zn
1	516000	< .2			39.40	31.20	6.50	128	324	1520	22
2	1710000	< .2			20.50	21.80	< 5	345	521	4930	48.60
4	1730000	< .2			41.10	77.60	< 5	296	462	5400	50.20
8	1960000	< .2			10	310	< 5	164	817	7610	15.70
16	1940000	.90			9.70	< 1	< 5	342	266	13400	240
32	1780000	.30			35.40	113	< 5	165	692	6270	44.90
64	1960000	< .2			35.50	214	< 5	< 1	728	7060	123
pD_e (-log[m^2/s]) :	10.85	> 16.3	-	-	15.83	> 15.8	> 12.6	13.90	15.48	> 8.7	16.20
Standard deviation :	.15	.89	-	-	.42	.74	-	.47	.26	.12	.79
Used data points :	6 - 7	1 - 7	-	-	5 - 7	1 - 7	1 - 7	4 - 6	5 - 7	2 - 5	1 - 7
Slope :	.14	-	-	-	.94	-	-	.00	.73	.48	.53
Std.Dev. of slope :	?				.54			.61	.38	.11	.27
Deviat.slope=½ (3 fases):	+ - -	? - -			+ - +	+ - +		+ - -	+ - +	+ - -	+ - -
Wash-off(mg/m^2),Diss/Lag:	?=	(Lag)			10.52	(Lag)	(Lag)	?=	?=	(Lag)	=
Total Concentrat.(mg/kg):	243000	153.9	41.96	307.7	7380	.000	30.77	1958	41486	.000	8951
Availability (mg/kg):	271329	55.94	16.50	251.8	1231	(7552.5)	13.43	1734	18462	(240.6)	7273
Availability perc. (%):	111.66	36.36	39.32	81.82	16.68	#VALUE!	43.65	88.57	44.50	#VALUE!	81.25
Mean factor above DTL :	5427	280	28	126	1231	-	3	1734	923	-	3636
Max.Cum.release (mg/m^2):	10049222	2072	611.1	9326	45593	(279722)	497.4	64222	683778	(8911)	269370
Cum.release 64d. (mg/m^2):	3031423	< .6	-	-	50	201	< 9.5	377	996	12075	142
Leaching-perc. 64d. (%):	30.2	< .03	-	-	.1	.07	< 1.9	.6	.1	136	.05
Mean factor above DTL :	82829	1.6	-	-	5	110	(DTL)	206	25	3299	39
Cum.release calc. 1D 64d:	1982554	< .78	-	-	29	< 187	< 14	375	646	< 21674	111
Cum.release calc. 3D 64d: (mg/m^2)	2898306	< 1.2	-	-	47	< 300	< 21	609	1053	< 8782	182
Chemical Retention R:	213 53044884		-	-	1824451316597574		9608	316179	-	-	52183980
$R_{range-min}$:	150 6871188		-	-	6986609 2993643		-	106392	-	-	8451634
$R_{range-max}$:	304 409501224		-	-	4764289492021474		-	939630	-	-	322206054

pD_e for R=1 will be ≥
Availability(%) becomes ≥

APC-Residue
Productcode: V9FA

Concentration in µg/L Time (days)	TDS	Na	TOC
1	3620000	178000	2560
2	7460000	530000	1350
4	7360	581000	1750
8	9170000	715000	1640
16	< 30	480000	2000
32	7480000	399000	2570
64	7710000	395000	3610
pD_e (-log[m^2/s]) :	> 9.7	8.29	> 12.1
Standard deviation :	2.29	.09	.19
Used data points :	1 - 7	3 - 4	1 - 4
Slope :	-	.30	(.4)
Std.Dev. of slope :		?	(.15)
Deviat.slope=½ (3 fases):	- + +	+ - -	+ - ≈
Wash-off(mg/m^2),Diss/Leg:	?≈	(Lag)	≈
Total Concentrat.(mg/kg):	171348	13400	3370
Availability (mg/kg):	171348	13986	3371
Availability perc. (%):	100.00	104.37	100.02
Mean factor above DTL :	-	466	-
Max.Cum.release (mg/m^2):	< 6346222	518000	< 124852
Cum.release 64d. (mg/m^2):	9266648	856934	4047
Leaching-perc. 64d. (%):	146	165	3.2
Mean factor above DTL :	168797	15610	-
Cum.release calc. 1D 64d:	< 4734991	1934962	< 5543
Cum.release calc. 3D 64d:	< 4918849	516069	< 9230
(mg/m^2)	Tortuosity	0	
Chemical Retention R:	20	1.0	5778
$R_{range-min}$:	.11	.82	3731
$R_{range-max}$:	3953	1.2	8948

APC-Residue Surf.area: .0324 m^2 Bulk Density : 1445 kg/m^3 2 October 1991
Productcode: V9FB Weight : 1.19 kg Extraction volume: 8.47 L

Concentration in µg/L Time (days)	K	Na	Li	Br	Cl	NO3	SO4	Al	B	Ba
1	209000	145000	43.50	33700	1670000	210	6080	80.80	48.20	889
2	575000	435000	189	86400	3550000	370	9670	77.20	48.60	2650
4	641000	558000	283	80000	3720000	370	8780	119	42.30	3390
8	862000	727000	374	126000	5840000	660	10600	40	52	4500
16	678000	1590000	425	98900	5370000	150	27600	100	46.60	2780
32	395000	421000	357	99900	4270000	690	12600	51.70	40.30	4600
64	309000	336000	363	83200	3230000	510	5290	102	34.30	5000
pD_e (-log[m^2/s]) :	7.64	7.78	8.06	7.96	8.54	8.71	13.50	16.37	-	8.84
Standard deviation :	.13	.08	.03	.07	.13	.15	.10	.36	-	.07
Used data points :	2 - 4	2 - 4	2 - 4	3 - 4	2 - 4	2 - 4	3 - 4	4 - 7	-	2 - 4
Slope :	.29	.37	.49	.66	.36	.42	.27	.31	(.1)	.38
Std.Dev. of slope :	.08	.01	.05	?	.17	.24	?	.30	(.12)	.02
Deviat.slope=½ (3 fases):	+ - -	+ - -	+ - -	+ - -	+ - -	+ - +	+ - -	+ - -	+ - -	+ - =
Wash-off(mg/m^2),Diss/Lag:	(Lag)	(Lag)	(Lag)	(Lag)	(Lag)	(Lag)	=	?=		(Lag)
Total Concentrat.(mg/kg):	13060	10100	9.51	1495	89674	19.02	203.8	14946	.000	326.1
Availability (mg/kg):	8424	8152	5.43	1495	148370	19.02	84783	8152	-	168.5
Availability perc. (%):	64.50	80.71	57.10	100.00	165.45	100.00	41600.9	54.55	-	51.67
Mean factor above DTL :	84	272	2	30	1484	19	848	1630	-	48
Max.Cum.release (mg/m^2):	309400	299410	199.4	54909	5449392	698.6	3113944	299410	-	6189
Cum.release 64d. (mg/m^2):	959149	1101100	532	158969	7228256	774	21076	149	-	6224
Leaching-perc. 64d. (%):	310	368	267	290	133	111	.7	.05	-	101
Mean factor above DTL :	699	20057	97	174	7900	42	23	7	-	3401
Cum.release calc. 1D 64d:	2436154	2002470	969	301514	15196786	1602	28962	102	-	12254
Cum.release calc. 3D 64d:	309273	299210	199	54843	5402010	688	46974	166	-	6048
(mg/m^2)	Tortuosity (Na):		0	range:	0 - 0					
Chemical Retention R:	1.2	1.0	-	2.3	8.8	12	462905	143137702	-	7.9
$R_{range-min}$:	.85	.84	-	2.0	6.5	8.6	370110	61966683	-	6.7
$R_{range-max}$:	1.6	1.2	-	2.7	12	17	578967	330635769	-	9.3
pD_e for R=1 will be ---≥						7.6				
Availability(%) becomes ≥						28.6				

APC-Residue
Productcode: V9FB

Surf.area .0324 m^2 Bulk Density 1445 kg/m^3 (continued)
Weight 1.19 kg Extraction volume 8.47 L

Concentration in µg/L Time (days)	Ca	Cd	Cr	Cu	Fe	Mg	Ni	Pb	Si	Sr	Zn
1	445000	< .2		4.10	57.20	26.80		85.40	515	1290	17.20
2	1410000	< .2		< 4	32.30	19.30		192	515	4200	28.40
4	1720000	< .2		< 4	20.70	36.40		255	478	5580	42.80
8	2190000	< .2		< 4	41	380		270	981	7640	38.70
16	1530000	< .2		11.10	< 5	< 1		230	307	11000	136
32	1840000	.30		6.30	19.40	61.90		222	497	6520	43.80
64	1630000	< .2		< 4	96.60	169		< 1	524	5890	99.50
pD_e (-log[m^2/s]) :	10.40	> 16.8	-	> 15.2	14.87	> 15.5	-	13.15	15.75	> 8.8	16.23
Standard deviation :	.28	.16	-	.44	.77	.87	-	.16	.13	.04	.54
Used data points :	5 - 7	1 - 7	-	1 - 7	6 - 7	1 - 7	-	2 - 4	5 - 7	2 - 5	4 - 7
Slope :	.05	-	-	-	2.32	-	-	.25	.39	.46	.25
Std.Dev. of slope :	.13				?			.09	.18	.02	.45
Deviat.slope=½ (3 fases):	+ - -			? ≈ ≈	- - +	+ - +		+ - -	+ - ≈	+ - -	+ - -
Wash-off(mg/m^2),Diss/Lag:	?≈	(Lag)		(Lag)	15.27	(Lag)		(Lag)	?≈	(Lag)	(Lag)
Total Concentrat.(mg/kg):	205000	131.8	35.33	298.9	7100	.000	25.82	1766	34096	.000	7609
Availability (mg/kg):	173913	54.35	17.12	231.0	652.2	(4347.8)	9.78	1658	21196	(250.0)	7065
Availability perc. (%):	84.84	41.24	48.46	77.27	9.19	#VALUE!	37.88	93.85	62.16	#VALUE!	92.86
Mean factor above DTL :	3478	272	29	115	652	-	2	1658	1060	-	3533
Max.Cum.release (mg/m^2):	6387545	1996	628.8	8484	23954	(159688)	359.2	60896	778495	(9182)	259486
Cum.release 64d. (mg/m^2):	2814184	< .4	-	< 9.8	71	182	-	328	998	11011	106
Leaching-perc. 64d. (%):	44.1	< .02	-	< .1	.3	.1	-	.5	.1	120	.04
Mean factor above DTL :	76893	(DTL)	-	(DTL)	8	99	-	179	25	3009	29
Cum.release calc. 1D 64d:	2097537	< .41	-	< 11	46	< 141	-	844	544	< 20000	104
Cum.release calc. 3D 64d: (mg/m^2)	2846047	< .68	-	< 18	75	< 242	-	1366	887	< 8999	169
Chemical Retention R:	247 574960788		-	168045146454824	30207680		-	179480	-	-	178745514
$R_{range-min}$:	128 396790658		-	6099118	1088403	4068729	-	123264	-	-	51906387
$R_{range-max}$:	474 833134301		-	463004133828062222472471			-	261334	-	-	615530392

pD_e for R=1 will be ≥
Availability(%) becomes ≥

APC-Residue
Productcode: V9FB

Concentration in µg/L Time (days)	TDS	Na	TOC
1	3920000	145000	1200
2	6940000	435000	1900
4	8020000	558000	1250
8	10000000	727000	1640
16	< 30	1590000	2000
32	7810000	421000	2800
64	6830000	336000	2350
pD_e (-log[m^2/s]) :	> 8.6	7.78	> 13.1
Standard deviation :	.65	.08	.48
Used data points :	1 - 7	2 - 4	1 - 4
Slope :	-	.37	(.6)
Std.Dev. of slope :		.01	(.43)
Deviat.slope=½ (3 fases):	+ - ¤	+ - -	+ ¤ -
Wash-off(mg/m^2),Diss/Lag:	¤	(Lag)	¤
Total Concentrat.(mg/kg):	157608	10100	8288
Availability (mg/kg):	157609	8152	(8288.0)
Availability perc. (%):	100.00	80.71	(100)
Mean factor above DTL :	-	272	-
Max.Cum.release (mg/m^2):	< 5788726	299410	(304405)
Cum.release 64d. (mg/m^2):	11376995	1101100	3435
Leaching-perc. 64d. (%):	197	368	1.1
Mean factor above DTL :	207238	20057	-
Cum.release calc. 1D 64d:	< 15229801	2002470	< 4592
Cum.release calc. 3D 64d: (mg/m^2)	< 5728309	299210	< 7241
	Tortuosity	0	
Chemical Retention R:	5.3	1.0	160426
$R_{range-min}$:	1.2	.84	53021
$R_{range-max}$:	23	1.2	485407

APC-Residue
Productcode: V9FC

Surf.area: .0324 m^2 Bulk Density : 1361 kg/m^3 2 October 1991
Weight : 1.12 kg Extraction volume: 8.47 L

Concentration in µg/L Time (days)	K	Na	Li	Br	Cl	NO3	SO4	Al	B	Ba
1	323000	238000	103	48400	2040000	370	7890	127	39.50	1650
2	533000	405000	188	60100	2730000	490	9540	111	40.50	2690
4	591000	514000	258	69800	3140000	560	10100	95.70	38.60	3340
8	601930	500000	360	111000	5000000	610	11900	32	9.30	3440
16	729000	500000	538	102000	5540000	450	24900	98.10	41.10	3710
32	380000	418000	350	96800	4290000	480	13500	37.70	64.60	4790
64	271000	314000	363	83300	3080000	500	6930	164	54	5050
pD_e (-log[m^2/s]) :	8.38	8.22	8.41	7.99	8.80	8.81	13.43	16.26	-	8.77
Standard deviation :	.21	.07	.02	.09	.13	.21	.17	.61	-	.08
Used data points :	3 - 5	2 - 3	2 - 5	2 - 4	2 - 5	2 - 4	3 - 5	5 - 7	-	2 - 3
Slope :	.15	.34	.50	.44	.37	.16	.65	.37	(.3)	.31
Std.Dev. of slope :	.07	?	.02	.13	.07	.02	.24	1.01	(.19)	?
Deviat.slope=½ (3 fases):	+ - -	+ - -	+ - -	+ - -	+ - -	+ - -	+ - -	+ - =	+ = -	+ - -
Wash-off(mg/m^2),Diss/Lag:	(Lag)	(Lag)	(Lag)	(Lag)	(Lag)	(Lag)	(Lag)	43.33		(Lag)
Total Concentrat.(mg/kg):	11900	10460	13.81	1519	92541	27.62	151.9	17956	.000	386.7
Availability (mg/kg):	13812	13812	8.29	1519	163260	27.62	104420	8011	-	171.3
Availability perc. (%):	116.07	132.05	60.03	100.00	176.42	100.00	68728.9	44.62	-	44.29
Mean factor above DTL :	138	460	3	30	1633	28	1044	1602	-	49
Max.Cum.release (mg/m^2):	477878	477878	286.8	52556	5648594	955.6	3612803	277171	-	5927
Cum.release 64d. (mg/m^2):	896390	755242	565	149375	6749858	905	22158	174	-	6449
Leaching-perc. 64d. (%):	188	158	197	284	119	94.7	.6	.06	-	109
Mean factor above DTL :	653	13757	103	163	7377	49	24	9	-	3524
Cum.release calc. 1D 64d:	1609866	1937095	935	276665	11784888	1968	36380	107	-	12728
Cum.release calc. 3D 64d:	475471	476476	285	52485	5537351	936	58986	174	-	5819
(mg/m^2)	Tortuosity (Na):		0	range:	0 - 0					
Chemical Retention R:	2.3	1.0	-	.91	5.8	5.6	145067	40843768	-	2.5
$R_{range-min}$:	1.4	.86	-	.75	4.3	3.5	98016	9947998	-	2.1
$R_{range-max}$:	3.8	1.2	-	1.1	7.7	8.9	214702	167693375	-	3.0
pD_e for R=1 will be ≥				8.0		8.1				
Availability(%) becomes ≥				104.7		42.4				

APC-Residue — Surf.area .0324 m^2 — Bulk Density 1361 kg/m^3 (continued)
Productcode: V9FC — Weight 1.12 kg — Extraction volume 8.47 L

Concentration in µg/L Time (days)	Ca	Cd	Cr	Cu	Fe	Mg	Ni	Pb	Si	Sr	Zn
1	796000	< .2		< 4	26.40	23	< 5	176	665	2310	36.40
2	1330000	< .2		< 4	17.10	19.90	< 5	211	701	4000	35.20
4	1610000	< .2		< 4	14.70	34.50	< 5	223	467	5230	42.90
8	2250000	< .2		< 4	< 5	2.60	< 5	15.90	162	7000	35
16	1830000	.60		6	< 5	< 1	< 5	306	263	13000	35
32	1910000	.40		< 4	12.50	31.80	< 5	214	502	6400	34.10
64	1570000	< .2		< 4	39.80	107	5.40	< 1	553	5360	69.70
pD_e (-log[m^2/s]) :	10.66	> 16.7	-	> 15.2	15.37	> 17.0	> 13.3	13.04	15.66	> 8.7	16.37
Standard deviation :	.19	.46	-	-	.50	.94	-	.18	.16	.10	.44
Used data points :	5 - 6	1 - 7	-	1 - 7	6 - 7	1 - 7	1 - 7	2 - 3	4 - 7	2 - 5	1 - 7
Slope :	.06	-	-	-	1.67	-	-	.08	.62	.55	.28
Std.Dev. of slope :	?				?			?	.11	.09	.11
Deviat.slope=½ (3 fases):	+ - -	? + +			≈ - +	+ - +		+ ≈ -	+ - ≈	+ - -	+ - ≈
Wash-off(mg/m^2),Diss/Lag:	≈	(Lag)		(Lag)	7.19	?≈	(Lag)	(Lag)	269.6	(Lag)	?≈
Total Concentrat.(mg/kg):	196000	151.9	45.58	303.9	6480	.000	30.39	1519	25306	.000	9254
Availability (mg/kg):	331492	93.92	#N/A!	232.0	635.4	(8563.5)	11.33	1685	18508	(237.6)	7182
Availability perc. (%):	169.13	61.82	#N/A!	76.36	9.80	#VALUE!	37.28	110.91	73.14	#VALUE!	77.61
Mean factor above DTL :	6630	470	#N/A!	116	635	-	3	1685	925	-	3591
Max.Cum.release (mg/m^2):	11469214	3250	#VALUE!	8027	21984	(296287)	392.0	58299	640354	(8221)	248488
Cum.release 64d. (mg/m^2):	2952998	< .5	-	< 7.8	32	57	< 9.3	300	866	11319	75
Leaching-perc. 64d. (%):	25.7	< .02	-	< .10	.1	.02	< 2.4	.5	.1	138	.03
Mean factor above DTL :	80686	(DTL)	-	(DTL)	3.5	31	(DTL)	164	22	3093	20
Cum.release calc. 1D 64d:	2806365	< .74	-	< 11	24	< 50	< 4.8	921	495	< 19833	84
Cum.release calc. 3D 64d: (mg/m^2)	3994578	< 1.2	-	< 17	39	< 80	< 7.4	1489	807	< 8102	138
Chemical Retention R:	163	172861521	-	5889612	7522694	310256414	55899	50798	-	-	91114745
$R_{range-min}$:	106	59677048	-	-	2387385	35393356	-	33648	-	-	32869123
$R_{range-max}$:	251	500713531	-	-	23704150	271969246	-	76689	-	-	252574333

pD_e for R=1 will be ≥
Availability(%) becomes ≥

APC-Residue
Productcode: V9FC

Concentration in µg/L Time (days)	TDS	Na	TOC
1	3650000	238000	1160
2	5180000	405000	1780
4	6730000	514000	2130
8	8370000	500000	1400
16	< 30	500000	2000
32	8250000	418000	2880
64	6230000	314000	2590
pD_e (-log[m^2/s]) :	> 8.7	8.22	> 12.3
Standard deviation :	.57	.07	.54
Used data points :	1 - 7	2 - 3	1 - 4
Slope :	-	.34	(.6)
Std.Dev. of slope :		?	(.48)
Deviat.slope=½ (3 fases):	+ - =	+ - -	+ - -
Wash-off(mg/m^2),Diss/Lag:	=	(Lag)	=
Total Concentrat.(mg/kg):	164364	10460	3867
Availability (mg/kg):	164365	13812	3867
Availability perc. (%):	100.00	132.05	100.01
Mean factor above DTL :	-	460	-
Max.Cum.release (mg/m^2):	< 5686826	477878	< 133793
Cum.release 64d. (mg/m^2):	10041141	755242	3644
Leaching-perc. 64d. (%):	177	158	2.7
Mean factor above DTL :	182905	13757	-
Cum.release calc. 1D 64d:	< 13430640	1937095	< 4920
Cum.release calc. 3D 64d: (mg/m^2)	< 5604623	476476	< 7898
	Tortuosity	0	
Chemical Retention R:	2.4	1.0	9920
$R_{range-min}$:	.65	.86	2857
$R_{range-max}$:	8.9	1.2	34443

540

Bottom Ash — Surf.area: .0324 m^2 — Bulk Density : 1979 kg/m^3 — 2 October 1991
Productcode: V9BA — Weight : 1.63 kg — Extraction volume: 8.47 L

Concentration in µg/L Time (days)	K	Na	Li	Br	Cl	NO3	SO4	Al	B	Ba
1	68700	65100	17	2820	157000	120	5860	1570	77.30	85.30
2	87700	78700	11.10	4270	226000	170	4850	1880	80.90	100
4	191000	156000	45.60	7590	482000	110	4280	4160	66.80	154
8	102000	107000	36.70	5980	310000	380	3160	2560	62.70	120
16	140000	152000	34.30	9800	470000	460	3800	3120	85	182
32	164000	161000	36.10	8450	506000	370	6000	3280	125	205
64	228000	235000	69.20	13000	716000	460	8030	3910	150	324
pD_e (-log[m^2/s]) :	9.36	9.38	> 10.5	9.14	9.99	8.86	14.11	12.57	-	11.98
Standard deviation :	.11	.14	.25	.20	.12	.08	.06	.24	-	.25
Used data points :	4 - 7	4 - 7	4 - 7	4 - 7	4 - 7	6 - 7	4 - 7	4 - 7	-	3 - 7
Slope :	.37	.35	.28	.31	.37	.31	.47	.19	(.3)	.29
Std.Dev. of slope :	.03	.06	.17	.13	.06	?	.05	.03	(.09)	.10
Deviat.slope=½ (3 fases):	+ − ≈	+ − −	+ − ≈	+ − −	+ − −	+ ≈ −	+ − ≈	+ − −	+ − ≈	+ − ≈
Wash-off(mg/m^2),Diss/Lag:	≈	≈	(Lag)	(Lag)	(Lag)	≈	1498	≈		≈
Total Concentrat.(mg/kg):	1530	20440	8.80	198.0	8911	4.51	39.60	23102	.000	456.6
Availability (mg/kg):	4180	4400	< 4.40	190.8	27063	4.51	31683	3520	-	123.2
Availability perc. (%):	273.23	21.53	< 50.00	96.36	303.70	100.00	80008.0	15.24	-	26.99
Mean factor above DTL :	42	147	(DTL)	4	271	5	317	704	-	35
Max.Cum.release (mg/m^2):	210290	221358	< 221.4	9599	1361503	226.9	1593929	177086	-	6198
Cum.release 64d. (mg/m^2):	256557	249604	65	13570	749490	541	9406	5354	-	306
Leaching-perc. 64d. (%):	122	113	29.4	141	55.0	238	.6	3.0	-	4.9
Mean factor above DTL :	187	4547	12	15	819	30	10	266	-	167
Cum.release calc. 1D 64d:	228157	236395	< 63	13444	719510	438	7362	4775	-	332
Cum.release calc. 3D 64d:	188362	197442	< 90	9055	867366	221	11972	7671	-	526
(mg/m^2)	Tortuosity (Na):		3	range:	2 - 4					
Chemical Retention R:	1.6	1.0	-	.89	6.2	.44	47863	579	-	275
$R_{range-min}$:	1.2	.73	-	.57	4.7	.37	41616	331	-	153
$R_{range-max}$:	2.0	1.4	-	1.4	8.3	.53	55047	1013	-	494
pD_e for R=1 will be ≥				9.2		9.2				
Availability(%) becomes ≥				101.9		151.0				

Bottom Ash
Productcode: V9BA

Surf.area .0324 m^2 Bulk Density 1979 kg/m^3 (continued)
Weight 1.63 kg Extraction volume 8.47 L

Concentration in µg/L Time (days)	Ca	Cd	Cr	Cu	Fe	Mg	Ni	Pb	Si	Sr	Zn
1	36700	1.90	6.20	12.10	237	102	< 5	8.40	1120	190	269
2	48800	.30	< 3	8.10	196	74.40	< 5	28.10	1400	263	301
4	104000	< .2	17.80	76.20	346	352	< 5	2.20	1340	1080	61.90
8	41600	< .2	7.10	11.50	96.10	133	12.10	1.30	1690	478	32.40
16	50800	< .2	4.50	< 4	27.80	53.80	< 5	< 1	1760	663	17.20
32	59900	< .2	4.30	< 4	74	107	< 5	3.20	1910	885	54.40
64	94100	< .2	4	< 4	153	200	< 5	1.80	2050	1310	18.10
pD_e ($-\log[m^2/s]$) :	12.62	> 14.5	12.30	13.55	12.06	> 15.5	> 12.7	15.88	13.48	> 11.1	16.73
Standard deviation :	.12	.59	.89	.96	.44	.73	-	1.38	.19	.03	.63
Used data points :	4 - 7	1 - 7	1 - 7	1 - 7	5 - 7	1 - 7	1 - 7	1 - 7	3 - 5	4 - 7	5 - 7
Slope :	.38	-	-	-	1.23	.23	-	-	.20	.48	.04
Std.Dev. of slope :	.07				.11	.22			.08	.02	.94
Deviat.slope=½ (3 fases):	+ - ≈	- ? ?	+ - -	+ - ?	+ - +	+ - +		- - -	+ - -	+ - ≈	- - -
Wash-off(mg/m^2),Dias/Lag:	?≈	≈.144	(Lag)	(Lag)	98.02	≈	(Lag)	?≈	≈	(Lag)	143.3
Total Concentrat.(mg/kg):	139800	28.60	102.3	1210	97500	.000	220.0	847.1	99134	.000	3300
Availability (mg/kg):	68207	16.50	6.16	121.0	35.20	(5720.6)	26.40	286.0	8361	(154.0)	2860
Availability perc. (%):	48.79	57.69	6.02	10.00	.04	#VALUE!	12.00	33.77	8.43	#VALUE!	86.67
Mean factor above DTL :	1364	83	10	61	35	-	7	286	418	-	1430
Max.Cum.release (mg/m^2):	3431402	830.1	309.9	6087	1771	(287796)	1328	14388	420631	(7748)	143883
Cum.release 64d. (mg/m^2):	113953	< .8	12	< 31	295	267	< 11	12	2946	1273	197
Leaching-perc. 64d. (%):	3.3	< .10	3.9	< .5	16.7	.09	< .8	.08	.7	16.4	.1
Mean factor above DTL :	3114	2.2	2.2	4.2	32	146	(DTL)	7	73	348	54
Cum.release calc. 1D 64d:	88185	< 2.5	11	53	86	< 259	< 31	8.6	4003	< 1169	32
Cum.release calc. 3D 64d: (mg/m^2)	141772	< 4.0	18	87	136	< 435	< 50	14	6492	< 1714	53
Chemical Retention R:	1026	70346	402	9430	258	746319	1109	2438612	-	-	14393168
$R_{range-min}$:	778	17984	52	1038	93	137700	-	100784	-	-	3375963
$R_{range-max}$:	1353	275165	3090	85656	716	4044964	-	59005679	-	-	61364196

pD_e for R=1 will be ≥
Availability(%) becomes ≥

Bottom Ash
Productcode: V9BA

Concentration in µg/L Time (days)	TDS	Na	TOC
1	346000	65100	1640
2	434000	78700	2750
4	1010000	156000	10300
8	471000	107000	2860
16	1000000	152000	3000
32	972000	161000	2930
64	1440000	235000	2580
pD_e (-log[m^2/s]) :	> 9.2	9.38	> 11.8
Standard deviation :	.45	.14	.87
Used data points :	1 - 7	4 - 7	1 - 4
Slope :	.49	.35	(1.0)
Std.Dev. of slope :	.15	.06	(.73)
Deviat.slope=½ (3 fases):	+ - -	+ - -	+ - -
Wash-off(mg/m^2),Diss/Lag:	(Lag)	≈	(Lag)
Total Concentrat.(mg/kg):	22882	20440	3385
Availability (mg/kg):	22882	4400	(3385.0)
Availability perc. (%):	100.00	21.53	(100)
Mean factor above DTL :	-	147	-
Max.Cum.release (mg/m^2):	< 1151162	221358	(170295)
Cum.release 64d. (mg/m^2):	1483034	249604	6813
Leaching-perc. 64d. (%):	129	113	4.0
Mean factor above DTL :	27014	4547	-
Cum.release calc. 1D 64d:	< 1524473	236395	< 10604
Cum.release calc. 3D 64d:	< 1074291	197442	< 17598
(mg/m^2)	Tortuosity	3	
Chemical Retention R:	.53	1.0	240
$R_{range-min}$:	.19	.73	32
$R_{range-max}$:	1.5	1.4	1798

Bottom Ash
Productcode: V98B

Surf.area: .0324 m^2
Weight : 1.64 kg

Bulk Density : 1991 kg/m^3
Extraction volume: 8.47 L

2 October 1991

Concentration in µg/L Time (days)	K	Na	Li	Br	Cl	NO3	SO4	Al	B	Ba
1	66700	60900	8.10	2940	152000	110	4240	1350	79.80	73.40
2	91400	79600	12.50	4830	347000	170	11300	1730	67	94.70
4	194000	149000	39.90	7310	452000	90	4520	4600	29.20	669
8	127000	138000	35.10	8070	399000	270	6070	2820	58.80	107
16	134000	154000	32.70	11000	490000	360	5000	2640	66.60	122
32	206000	216000	46.90	12300	659000	400	6620	3390	100	212
64	180000	201000	74	11400	592000	400	6970	3350	150	268
pD_e (-log[m^2/s]) :	8.99	9.14	-	8.73	9.88	10.05	14.02	12.53	-	12.24
Standard deviation :	.13	.24	-	.13	.09	.29	.17	.23	-	.09
Used data points :	4 - 6	2 - 6	-	4 - 6	4 - 6	3 - 7	5 - 7	4 - 6	-	4 - 7
Slope :	.35	.29	(.7)	.30	.36	.49	.24	.13	(.4)	.48
Std.Dev. of slope :	.16	.09	(.18)	.08	.04	.18	.10	.13	(.10)	.08
Deviat.slope=½ (3 fases):	+ - -	+ - -	+ - ≈	+ - -	+ - -	+ + -	+ - -	+ - -	- ≈ ≈	+ - ≈
Wash-off(mg/m^2),Diss/Lag:	≈	(Lag)		(Lag)	≈	≈	?≈	≈		≈
Total Concentrat.(mg/kg):	5100	24350	10.71	160.6	9636	19.27	36.40	31049	.000	513.9
Availability (mg/kg):	3212	5000	-	160.6	29764	19.27	29979	3640	-	124.2
Availability perc. (%):	62.98	20.53	-	100.00	308.89	100.00	82358.8	11.72	-	24.17
Mean factor above DTL :	32	167	-	3	298	19	300	728	-	35
Max.Cum.release (mg/m^2):	162583	253086	-	8129	1506573	975.4	1517456	184247	-	6287
Cum.release 64d. (mg/m^2):	261184	261028	-	15123	808048	471	11691	5197	-	404
Leaching-perc. 64d. (%):	161	103	-	186	53.6	48.3	.8	2.8	-	6.4
Mean factor above DTL :	190	4755	-	17	883	26	13	258	-	221
Cum.release calc. 1D 64d:	271177	354295	-	18382	901579	480	7742	5236	-	248
Cum.release calc. 3D 64d: (mg/m^2)	156715	238731	-	8001	1039951	591	12587	8405	-	395
	Tortuosity (Na):		2	range:	1 - 3					
Chemical Retention R:	1.1	1.0	-	.59	8.4	12	67404	896	-	874
$R_{range-min}$:	.83	.57	-	.44	6.8	5.9	45891	522	-	712
$R_{range-max}$:	1.5	1.8	-	.79	10	23	99004	1539	-	1072
pD_e for R=1 will be ≥				9.0		9.0				
Availability(%) becomes ≥				130.2		29.3				

Bottom Ash Surf.area .0324 m^2 Bulk Density 1991 kg/m^3 (continued)
Productcode: V9BB Weight 1.64 kg Extraction volume 8.47 L

Concentration in µg/L Time (days)	Ca	Cd	Cr	Cu	Fe	Mg	Ni	Pb	Si	Sr	Zn
1	37400	1.80	< 3	5	40.70	112		4.30	1010	181	17.50
2	56100	< .2	3.90	< 4	30.70	126		24.10	1180	249	9.10
4	91800	< .2	< 3	68.80	133	191		7	1450	939	41.40
8	56600	.50	< 3	13.60	51.60	100		1.30	1920	542	9.80
16	44400	< .2	< 3	< 4	39.70	58.90		< 1	1830	604	< 2
32	75400	.30	4.20	6.40	53.30	111		< 1	2300	1120	7.40
64	93200	< .2	6	< 4	87.30	184		2.30	2500	1230	10.60
pD_e (-log[m^2/s]) :	12.68	> 14.8	> 12.7	14.41	13.77	> 14.4	-	15.36	13.58	> 11.1	16.99
Standard deviation :	.08	1.00	.66	1.18	.06	.63	-	1.43	.17	.12	.01
Used data points :	5 - 7	1 - 7	1 - 7	1 - 7	5 - 7	1 - 7	-	1 - 7	5 - 7	4 - 7	6 - 7
Slope :	.53	-	-	-	.57	.19	-	-	.23	.44	.52
Std.Dev. of slope :	.13				.08	.17			.06	.11	?
Deviat.slope=½ (3 fases):	+ - =	? - ?	? ? +	+ - ?	+ - =	+ - +		+ - ?	+ - -	+ - =	+ - +
Wash-off(mg/m^2),Diss/Lag:	?=	=.264	(Lag)	(Lag)	?=	?=		?=	=	(Lag)	5.29
Total Concentrat.(mg/kg):	122200	26.77	246.3	1820	120900	.000	353.3	1392	146614	.000	3747
Availability (mg/kg):	70664	11.13	6.85	164.9	207.7	(1584.6)	11.99	205.6	6424	(160.6)	1113
Availability perc. (%):	57.83	41.58	2.78	9.06	.17	#VALUE!	3.39	14.77	4.38	#VALUE!	29.71
Mean factor above DTL :	1413	56	11	82	208	-	3	206	321	-	557
Max.Cum.release (mg/m^2):	3676820	563.4	346.7	8347	10513	(80208)	606.9	10407	325165	(8129)	56337
Cum.release 64d. (mg/m^2):	118920	< .9	< 6.8	< 28	114	231	-	11	3187	1272	26
Leaching-perc. 64d. (%):	3.3	< .2	< 2.0	< .3	1.1	.3	-	.1	1.0	15.6	.05
Mean factor above DTL :	3249	2.5	(DTL)	3.8	12	126	-	6	79	348	7
Cum.release calc. 1D 64d:	85612	< 1.2	< 8.2	27	72	< 251	-	11	2766	< 1230	9.4
Cum.release calc. 3D 64d: (mg/m^2)	137776	< 1.9	< 13	44	117	< 430	-	18	4489	< 1798	15
Chemical Retention R:	2033	226524	1683	119324	22259	106443	-	1281896	-	-	45113659
$R_{range-min}$:	1682	22766	372	7897	19179	25015	-	48165	-	-	44304336
$R_{range-max}$:	2457	2253926	7616	1802937	25833	452929	-	34117370	-	-	45937767

pD_e for R=1 will be -- ≥
Availability(%) becomes ≥

Bottom Ash
Productcode: V9BB

Concentration in µg/L Time (days)	TDS	Na	TOC
1	400000	60900	2500
2	554000	79600	2740
4	1010000	149000	9300
8	385000	138000	3040
16	990000	154000	3000
32	1240000	216000	2920
64	1210000	201000	2040
pD_e (-log[m^2/s]) :	> 9.0	9.14	> 11.8
Standard deviation :	.48	.24	.70
Used data points :	1 - 7	2 - 6	1 - 4
Slope :	.44	.29	(.8)
Std.Dev. of slope :	.16	.09	(.60)
Deviat.slope=½ (3 fases):	+ - -	+ - -	+ - -
Wash-off(mg/m^2),Diss/Lag:	=	(Lag)	(Lag)
Total Concentrat.(mg/kg):	19486	24350	3685
Availability (mg/kg):	(19486.0)	5000	3685
Availability perc. (%):	(100)	20.53	100.01
Mean factor above DTL :	-	167	-
Max.Cum.release (mg/m^2):	(986328)	253086	< 186525
Cum.release 64d. (mg/m^2):	1513359	261028	6677
Leaching-perc. 64d. (%):	153	103	3.6
Mean factor above DTL :	27567	4755	-
Cum.release calc. 1D 64d:	< 1579232	354295	< 11651
Cum.release calc. 3D 64d:	< 949711	238731	< 19275
(mg/m^2)	Tortuosity	2	
Chemical Retention R:	.62	1.0	410
$R_{range-min}$:	.21	.57	82
$R_{range-max}$:	1.9	1.8	2050

Bottom Ash — Surf.area: .0324 m^2 — Bulk Density : 2076 kg/m^3 — 2 October 1991
Productcode: V9BC — Weight : 1.71 kg — Extraction volume: 8.47 L

Concentration in µg/L Time (days)	K	Na	Li	Br	Cl	NO3	SO4	Al	B	Ba
1	54600	49600	8.90	2400	110000	120	4720	1280	48.30	61.20
2	87900	81500	18.40	4910	258000	130	8880	2400	63.70	85.70
4	200000	157000	31.90	7010	448000	80	3900	4040	32	684
8	121000	134000	35.10	7780	382000	360	5160	3010	46.80	108
16	135000	156000	37.50	11000	520000	340	5200	2890	58.50	140
32	192000	201000	43.30	11400	610000	370	6480	3410	92.90	221
64	179000	201000	76.40	12100	610000	440	7140	3490	157	284
pD_e (-log[m^2/s]) :	9.22	9.20	> 10.6	9.09	9.68	9.97	13.94	12.92	-	11.93
Standard deviation :	.12	.36	.11	.16	.22	.11	.17	.22	-	.05
Used data points :	4 - 6	3 - 7	5 - 7	4 - 6	2 - 5	6 - 7	5 - 7	5 - 7	-	4 - 7
Slope :	.33	.13	.51	.28	.28	.25	.23	.14	(.4)	.48
Std.Dev. of slope :	.10	.06	.18	.13	.13	?	.05	.06	(.12)	.04
Deviat.slope=½ (3 fases):	+ − −	+ − −	+ − ≈	+ − −	+ − −	≈ + −	+ − −	+ − −	≈ ≈ +	+ − ≈
Wash-off(mg/m^2),Diss/Lag:	≈	(Lag)	(Lag)	(Lag)	(Lag)	≈	?≈	?≈		≈
Total Concentrat.(mg/kg):	6700	20290	8.62	226.3	10776	15.09	49.57	25862	.000	495.7
Availability (mg/kg):	3879	4310	< 4.31	226.3	29310	15.09	26724	4310	-	88.36
Availability perc. (%):	57.90	21.24	< 50.00	100.00	272.00	100.00	53911.9	16.67	-	17.83
Mean factor above DTL :	39	144	(DTL)	5	293	15	267	862	-	25
Max.Cum.release (mg/m^2):	204725	227472	< 227.5	11944	1546917	796.4	1410433	227472	-	4663
Cum.release 64d. (mg/m^2):	253446	256218	66	14796	768051	481	10844	5364	-	414
Leaching-perc. 64d. (%):	124	113	29.0	124	49.7	60.4	.8	2.4	-	8.9
Mean factor above DTL :	185	4667	12	16	839	26	12	266	-	226
Cum.release calc. 1D 64d:	261275	299315	< 63	17705	1168605	428	7851	4105	-	263
Cum.release calc. 3D 64d:	190132	212423	< 84	11358	1213368	513	12762	6627	-	416
(mg/m^2)	Tortuosity (Na):		2	range:	1 - 4					
Chemical Retention R:	1.7	1.0	-	1.2	4.6	8.6	50032	1964	-	376
$R_{range-min}$:	1.3	.43	-	.85	2.8	6.7	34121	1178	-	337
$R_{range-max}$:	2.2	2.3	-	1.7	7.8	11	73362	3275	-	418
pD_e for R=1 will be ≥				9.0		9.0				
Availability(%) becomes ≥				90.8		34.1				

547

Bottom Ash — Surf.area .0324 m^2 — Bulk Density 2076 kg/m^3 — (continued)
Productcode: V9BC — Weight 1.71 kg — Extraction volume 8.47 L

Concentration in µg/L Time (days)	Ca	Cd	Cr	Cu	Fe	Mg	Ni	Pb	Si	Sr	Zn
1	27100	1.80	< 3	5.10	462	180	< 5	5.10	883	133	20.10
2	45000	.40	< 3	8.10	803	269	6	15.90	1810	223	41
4	82000	< .2	< 3	67.40	73.40	149	< 5	2.40	1400	926	15.40
8	46300	< .2	< 3	4.20	28.10	77	< 5	1.30	1830	519	12.10
16	45400	< .2	4.70	< 4	45.80	72.90	< 5	< 1	1750	631	6
32	74900	< .2	12.20	< 4	42.60	121	< 5	< 1	2050	1080	10.20
64	86900	< .2	< 3	< 4	114	181	< 5	2.90	2360	1220	14.10
pD_e (-log[m^2/s]) :	13.12	> 14.4	> 12.5	14.34	13.80	> 15.1	> 12.2	15.98	13.86	> 10.9	16.99
Standard deviation :	.16	.38	.37	1.28	.23	.74	-	1.18	.17	.10	.09
Used data points :	4 - 7	1 - 7	1 - 7	1 - 7	4 - 7	1 - 7	1 - 7	1 - 7	5 - 7	4 - 7	5 - 7
Slope :	.34	-	-	-	.60	.07	-	-	.22	.45	.62
Std.Dev. of slope :	.10				.20	.17			.01	.08	.09
Deviat.slope=½ (3 fases):	+ - ≈	- ? ?	? + +	+ - ?	- - +	+ - +		- - ?	+ - -	+ - ≈	+ - +
Wash-off(mg/m^2),Diss/Lag:	≈	≈	(Lag)	(Lag)	?≈	?≈	(Lag)	?≈	?≈	(Lag)	?≈
Total Concentrat.(mg/kg):	130900	28.02	150.9	2155	110400	.000	258.6	1832	138114	.000	4526
Availability (mg/kg):	120690	16.16	7.33	174.6	215.5	(3879.3)	14.01	323.3	7974	(131.5)	1358
Availability perc. (%):	92.20	57.67	4.86	8.10	.20	#VALUE!	5.42	17.65	5.77	#VALUE!	30.00
Mean factor above DTL :	2414	81	12	87	216	-	4	323	399	-	679
Max.Cum.release (mg/m^2):	6369750	852.9	386.9	9215	11374	(204741)	739.4	17063	420850	(6940)	71672
Cum.release 64d. (mg/m^2):	106293	< .8	< 8.3	< 25	410	274	< 9.4	7.74	3159	1237	31
Leaching-perc. 64d. (%):	1.7	< .09	< 2.1	< .3	3.6	.1	< 1.3	.05	.8	17.8	.04
Mean factor above DTL :	2904	2.2	1.5	3.4	45	150	(DTL)	4.2	78	338	8
Cum.release calc. 1D 64d:	91029	< 2.8	< 11	32	75	< 289	< 30	9.1	2573	< 1217	12
Cum.release calc. 3D 64d: (mg/m^2)	147262	< 4.6	< 18	53	122	< 491	< 49	15	4181	< 1892	20
Chemical Retention R:	5038	89254	973	88880	21118	459674	530	4697850	-	-	39427986
$R_{range-min}$:	3454	36998	412	4620	12374	83309	-	309950	-	-	32259279
$R_{range-max}$:	7349	215320	2296	1709715	36041	2536324	-	71204431	-	-	48189734
pD_e for R=1 will be ≥											
Availability(%) becomes ≥											

Bottom Ash
Productcode: V9BC

Concentration in µg/L Time (days)	TDS	Na	TOC
1	232000	49600	2350
2	520000	81500	2590
4	1080000	157000	9510
8	781000	134000	2970
16	978000	156000	3000
32	1170000	201000	2910
64	1200000	201000	1810

pD_e (-log[m^2/s]) :	> 9.1	9.20	> 11.8
Standard deviation :	.58	.36	.73
Used data points :	1 - 7	3 - 7	1 - 4
Slope :	.52	.13	(.8)
Std.Dev. of slope :	.20	.06	(.62)
Deviat.slope=½ (3 fases):	+ - -	+ - -	+ - -
Wash-off(mg/m^2),Diss/Lag:	(Lag)	(Lag)	(Lag)
Total Concentrat.(mg/kg):	21551	20290	3232
Availability (mg/kg):	21552	4310	3233
Availability perc. (%):	100.00	21.24	100.02
Mean factor above DTL :	-	144	-
Max.Cum.release (mg/m^2):	< 1137467	227472	< 170631
Cum.release 64d. (mg/m^2):	1558323	256218	6572
Leaching-perc. 64d. (%):	137	113	3.9
Mean factor above DTL :	28386	4667	-
Cum.release calc. 1D 64d:	< 1599159	299315	< 11311
Cum.release calc. 3D 64d: (mg/m^2)	< 1080533	212423	< 17632
	Tortuosity	2	
Chemical Retention R:	.72	1.0	322
$R_{range-min}$:	.19	.43	61
$R_{range-max}$:	2.7	2.3	1710

5449

Combined Ash
Productcode: V9CA

Surf.area: .0324 m^2 Bulk Density : 1857 kg/m^3 2 October 1991
Weight : 1.53 kg Extraction volume: 8.47 L

Concentration in µg/L Time (days)	K	Na	Li	Br	Cl	NO3	SO4	Al	B	Ba
1	111000	76100	14	2690	192000	90	2360	1960	41.80	218
2	153000	105000	24.40	5710	374000	80	4040	3050	48.20	442
4	124000	117000	22.80	< 500	344000	100	< 500	2740	61.30	122
8	176000	162000	56.70	8680	540000	150	4770	4120	51.30	649
16	141000	141000	46.30	9200	530000	200	4600	3090	43.30	540
32	238000	205000	77.50	11000	751000	200	10600	5480	70.60	733
64	216000	204000	117	11900	858000	180	14200	6440	80.60	785
pD_e (-log[m^2/s]) :	9.24	8.95	> 10.1	8.85	9.84	9.39	13.68	12.50	-	11.24
Standard deviation :	.25	.13	.10	.10	.00	.05	.19	.10	-	.15
Used data points :	3 - 6	2 - 4	5 - 7	5 - 6	5 - 6	2 - 5	4 - 7	5 - 7	-	5 - 7
Slope :	.25	.31	.67	.26	.50	.46	.59	.53	(.3)	.27
Std.Dev. of slope :	.14	.09	.04	?	?	.03	.16	.17	(.12)	.10
Deviat.slope=½ (3 fases):	+ - -	+ - -	+ ≈ +	+ ≈ -	+ - -	+ - -	+ + +	+ - ≈	+ - ≈	≈ + -
Wash-off(mg/m^2),Diss/Lag:	≈	(Lag)	(Lag)	≈	≈	(Lag)	≈	?≈		≈
Total Concentrat.(mg/kg):	6500	21770	10.93	163.9	18579	7.54	196.7	29508	.000	852.5
Availability (mg/kg):	5902	5464	< 4.37	163.9	32009	7.54	32009	4372	-	144.3
Availability perc. (%):	90.79	25.10	< 39.98	100.00	172.28	100.00	16271.1	14.81	-	16.92
Mean factor above DTL :	59	182	(DTL)	3	320	8	320	874	-	41
Max.Cum.release (mg/m^2):	278706	258022	< 206.4	7740	1511536	356.1	1511536	206456	-	6814
Cum.release 64d. (mg/m^2):	302985	264060	94	12987	938235	261	10737	7027	-	912
Leaching-perc. 64d. (%):	109	102	45.6	168	62.1	73.3	.7	3.4	-	13.4
Mean factor above DTL :	221	4810	17	14	1025	14	12	349	-	498
Cum.release calc. 1D 64d:	349241	449036	< 95	15098	947033	374	11380	6031	-	855
Cum.release calc. 3D 64d:	257953	249708	< 120	7557	1072778	316	18483	9680	-	1302
(mg/m^2)	Tortuosity (Na):		1	range:	1 - 1					
Chemical Retention R:	3.1	1.0	-	1.2	12	3.9	47838	1311	-	133
$R_{range-min}$:	1.7	.75	-	.97	12	3.5	30703	1030	-	94
$R_{range-max}$:	5.5	1.3	-	1.6	12	4.4	74537	1668	-	188
pD_e for R=1 will be ≥				8.8		8.8				
Availability(%) becomes ≥				90.4		50.4				

Combined Ash — Surf.area .0324 m^2 — Bulk Density 1857 kg/m^3 — (continued)
Productcode: V9CA — Weight 1.53 kg — Extraction volume 8.47 L

Concentration in µg/L Time (days)	Ca	Cd	Cr	Cu	Fe	Mg	Ni	Pb	Si	Sr	Zn
1	56500	2.80	< 3	30.10	103	62.80	< 5	9.60	778	466	25.50
2	104000	< .2	< 3	44.20	16.30	30.40	< 5	29.80	1040	765	11.90
4	54200	< .2	< 3	< 4	52.50	107	< 5	15.70	1640	454	58.20
8	104000	< .2	6.50	86.30	190	110	18.20	6.10	1410	1210	23.10
16	72100	< .2	< 3	67.60	470	173	< 5	< 1	972	951	< 2
32	144000	< .2	4.60	124	69.50	108	< 5	2.80	1270	1750	10.60
64	198000	< .2	< 3	98.10	65.30	172	6.60	2.90	1600	2040	10.70
pD_e (-log[m^2/s]) :	12.59	> 13.9	> 12.1	13.40	13.20	> 15.4	> 12.3	16.58	13.93	> 10.6	17.00
Standard deviation :	.17	-	.64	.25	.25	.38	1.26	.19	.09	.23	.21
Used data points :	5 - 7	1 - 7	1 - 7	5 - 7	6 - 7	1 - 7	1 - 7	6 - 7	5 - 7	3 - 7	6 - 7
Slope :	.73	-	-	.27	-.09	.50	-	.05	.36	.49	.01
Std.Dev. of slope :	.16			.35	?	.13		?	.02	.14	?
Deviat.slope=½ (3 fases):	+ ≈ +		? - ?	+ + -	≈ - -	+ - -	? ? ?	+ - +	+ - ≈	+ ≈ ≈	+ - +
Wash-off(mg/m^2),Diss/Lag:	?≈	(Lag)	(Lag)	≈	18.54	(Lag)	(Lag)	?≈	?≈	≈	7.78
Total Concentrat.(mg/kg):	137800	26.23	78.69	1202	73700	.000	85.25	1530	100229	.000	3388
Availability (mg/kg):	128962	20.11	4.37	240.4	115.9	(4153.0)	9.40	240.4	5902	(157.4)	1443
Availability perc. (%):	93.59	76.67	5.55	20.00	.16	#VALUE!	11.03	15.71	5.89	#VALUE!	42.58
Mean factor above DTL :	2579	101	7	120	116	-	2	240	295	-	721
Max.Cum.release (mg/m^2):	6089872	949.6	206.4	11352	5473	(196114)	443.9	11352	278706	(7433)	68142
Cum.release 64d. (mg/m^2):	191568	< 1.0	< 6.8	119	253	200	< 13	18	2277	1996	37
Leaching-perc. 64d. (%):	3.1	< .1	< 3.3	1.0	4.6	.1	< 2.9	.2	.8	26.9	.05
Mean factor above DTL :	5234	2.7	(DTL)	16	28	109	(DTL)	10	57	545	10
Cum.release calc. 1D 64d:	160497	< 5.9	< 9.8	118	72	< 202	< 16	3.0	1584	< 2022	11
Cum.release calc. 3D 64d:	258010	< 9.0	< 15	192	116	< 326	< 26	4.9	2575	< 2741	18
(mg/m^2)											
Chemical Retention R:	2591	42914	656	17812	9414	1510525	1134	32924603	-	-	70443112
$R_{range-min}$:	1766	-	151	9953	5280	622631	62	21193992	-	-	43726551
$R_{range-max}$:	3802	-	2853	31873	16785	3664589	20709	51147962	-	-	113483271

pD_e for R=1 will be ≥
Availability(%) becomes ≥

Combined Ash
Productcode: V9CA

Concentration in µg/L Time (days)	TDS	Na	TOC
1	556000	76100	5740
2	802000	105000	7500
4	915000	117000	3120
8	849000	162000	10100
16	1180000	141000	9000
32	1470000	205000	15500
64	1540000	204000	6990
pD_e (-log[m^2/s]) :	> 8.9	8.95	> 12.1
Standard deviation :	.38	.13	.52
Used data points :	1 - 7	2 - 4	1 - 4
Slope :	.42	.31	(.6)
Std.Dev. of slope :	.13	.09	(.46)
Deviat.slope=½ (3 fases):	+ - -	+ - -	* + -
Wash-off(mg/m^2),Diss/Lag:	≈	(Lag)	≈
Total Concentrat.(mg/kg):	23000	21770	9071
Availability (mg/kg):	(23000.0)	5464	(9071.0)
Availability perc. (%):	(100)	25.10	(100)
Mean factor above DTL :	-	182	-
Max.Cum.release (mg/m^2):	(1086111)	258022	(428353)
Cum.release 64d. (mg/m^2):	1911501	264060	15149
Leaching-perc. 64d. (%):	176	102	3.5
Mean factor above DTL :	34819	4810	-
Cum.release calc. 1D 64d:	< 2094957	449036	< 18956
Cum.release calc. 3D 64d:	< 1056466	249708	< 31669
(mg/m^2)	Tortuosity	1	
Chemical Retention R:	.66	1.0	1263
$R_{range-min}$:	.27	.75	385
$R_{range-max}$:	1.6	1.3	4141

Combined Ash
Productcode: V9CB

Surf.area: .0324 m^2 Bulk Density : 1845 kg/m^3 2 October 1991
Weight : 1.52 kg Extraction volume: 8.47 L

Concentration in µg/L Time (days)	K	Na	Li	Br	Cl	NO3	SO4	Al	B	Ba
1	110000	76600	28.80	3400	304000	70	1990	1860	47.10	300
2	155000	110000	22.90	6700	404000	50	3610	3210	37.40	541
4	137000	133000	20.50	7120	361000	180	7930	2920	55.10	98.50
8	200000	152000	43.80	8070	509000	210	5420	4810	23.50	730
16	179000	174000	56.70	9000	550000	220	8200	4450	52.60	663
32	210000	173000	63.10	9050	620000	200	12100	5450	79.70	559
64	248000	217000	103	11900	798000	230	17200	6490	87.50	650
pD_e (-log[m^2/s]) :	8.87	8.71	> 10.1	8.69	9.70	8.57	12.94	12.24	-	11.15
Standard deviation :	.22	.16	.16	.25	.24	.33	.05	.14	-	.32
Used data points :	3 - 5	2 - 4	2 - 7	4 - 6	3 - 7	1 - 2	4 - 7	5 - 7	-	5 - 7
Slope :	.19	.23	.46	.08	.26	1.29	.56	.27	(.4)	-.01
Std.Dev. of slope :	.20	.02	.07	.04	.04	?	.01	.01	(.12)	.13
Deviat.slope=½ (3 fases):	+ - -	+ - -	+ ≈ ≈	+ - -	+ - -	+ - -	+ - ≈	+ - -	+ - ≈	- + -
Wash-off(mg/m^2),Diss/Lag:	≈	(Lag)	≈	≈	≈	≈	(Lag)	≈		?≈
Total Concentrat.(mg/kg):	5900	25130	12.94	140.2	14024	1.51	101.4	22654	.000	323.6
Availability (mg/kg):	4746	4315	< 4.31	140.2	28479	1.51	17756	3668	-	120.8
Availability perc. (%):	80.45	17.17	< 33.31	100.00	203.08	100.00	17511.0	16.19	-	37.33
Mean factor above DTL :	47	144	(DTL)	3	285	2	178	734	-	35
Max.Cum.release (mg/m^2):	222652	202432	< 202.2	6577	1336052	70.84	832998	172079	-	5667
Cum.release 64d. (mg/m^2):	323899	270726	89	14441	926994	303	14757	7631	-	926
Leaching-perc. 64d. (%):	145	134	44.0	220	69.4	428	1.8	4.4	-	16.3
Mean factor above DTL :	236	4931	16	16	1013	17	16	379	-	506
Cum.release calc. 1D 64d:	428875	466000	< 94	15516	980519	192	14721	6816	-	785
Cum.release calc. 3D 64d: (mg/m^2)	217196	199403	< 118	6485	1033385	70	23775	10876	-	1187
	Tortuosity (Na):		1	range:	0 - 1					
Chemical Retention R:	2.3	1.0	-	1.5	15	1.0	15191	1248	-	191
$R_{range-min}$:	1.4	.69	-	.82	8.7	.48	13657	910	-	91
$R_{range-max}$:	3.8	1.4	-	2.6	26	2.2	16897	1712	-	399
pD_e for R=1 will be ≥				8.5		8.6				
Availability(%) becomes ≥				82.6		98.5				

Combined Ash Surf.area .0324 m^2 Bulk Density 1845 kg/m^3 (continued)
Productcode: V9CB Weight 1.52 kg Extraction volume 8.47 L

Concentration in µg/L Time (days)	Ca	Cd	Cr	Cu	Fe	Mg	Ni	Pb	Si	Sr	Zn
1	55200	1.80	18.60	63.20	213	157	21	7.10	719	468	48
2	89500	< .2	< 3	36.20	46.90	22.80	< 5	8.10	1200	732	20.10
4	54400	< .2	< 3	7.30	96.20	262	< 5	8.80	2080	445	11.60
8	126000	< .2	8.90	69.60	429	1420	< 5	5	2930	1100	14.30
16	94700	< .2	3.50	90.50	223	109	< 5	< 1	1410	1000	26.70
32	104000	< .2	4.80	101	27	86.70	< 5	2.40	1390	1240	10.70
64	188000	< .2	< 3	85.20	49.20	189	8.90	3.20	1910	1680	18.40
pD_e ($-\log[m^2/s]$) :	12.39	> 14.3	11.83	13.23	13.99	> 15.0	> 12.4	16.67	13.82	> 10.5	16.89
Standard deviation :	.13	-	.81	.14	.16	1.11	1.05	.04	.19	.08	.12
Used data points :	5 - 7	1 - 7	1 - 7	4 - 6	6 - 7	1 - 7	1 - 7	6 - 7	5 - 7	5 - 7	6 - 7
Slope :	.49	-	-	.27	.87	.31	-	.42	.22	.37	.78
Std.Dev. of slope :	.21			.06	?	.37		?	.14	.04	?
Deviat.slope=½ (3 fases):	+ - ≈		? - ≈	- + -	- - -	+ - ≈	? ? ?	+ - +	+ - -	+ ≈ ≈	- - -
Wash-off(mg/m^2),Diss/Lag:	?≈	(Lag)	2.48	≈	61.11	≈	≈2.07	3.45	?≈	≈	15.17
Total Concentrat.(mg/kg):	129700	29.13	57.17	722.8	84200	.000	118.7	1402	109702	.000	2913
Availability (mg/kg):	99245	20.71	4.53	258.9	155.3	(4099.2)	12.51	258.9	6472	(123.0)	1704
Availability perc. (%):	76.52	71.10	7.92	35.82	.18	#VALUE!	10.54	18.46	5.90	#VALUE!	58.52
Mean factor above DTL :	1985	104	8	129	155	-	3	259	324	-	852
Max.Cum.release (mg/m^2):	4655938	971.6	212.5	12146	7286	(192308)	586.9	12146	303625	(5770)	79941
Cum.release 64d. (mg/m^2):	186079	< .8	< 12	118	283	587	< 14	9.31	3043	1742	39
Leaching-perc. 64d. (%):	4.0	< .08	< 5.6	1.0	3.9	.3	< 2.4	.08	1.0	30.2	.05
Mean factor above DTL :	5084	2.2	2.2	16	31	321	1.5	5	76	476	11
Cum.release calc. 1D 64d:	154998	< 3.8	13	154	39	< 333	< 19	2.9	1960	< 1612	15
Cum.release calc. 3D 64d:	243329	< 5.8	21	249	63	< 517	< 31	4.8	3185	< 2344	24
(mg/m^2)											
Chemical Retention R:	2842	190185	638	21159	99859	936361	2691	69700508	-	-	97824096
$R_{range-min}$:	2131	-	99	15171	69775	72374	240	64130651	-	-	74191162
$R_{range-max}$:	3789	-	4128	29511	142913	12114409	30206	75754116	-	-	128985090

pD_e for R=1 will be ≥
Availability(%) becomes ≥

Combined Ash
Productcode: V9CB

Concentration in µg/L Time (days)	TDS	Na	TOC
1	471000	76600	6910
2	826000	110000	7970
4	803000	133000	3180
8	855000	152000	9900
16	1080000	174000	11000
32	1270000	173000	12100
64	1530000	217000	5270
pD_e (-log[m^2/s]) :	> 9.0	8.71	> 11.7
Standard deviation :	.41	.16	.49
Used data points :	1 - 7	2 - 4	1 - 4
Slope :	.43	.23	(.6)
Std.Dev. of slope :	.14	.02	(.45)
Deviat.slope=½ (3 fases):	+ - -	+ - -	- ≈ -
Wash-off(mg/m^2),Diss/Lag:	≈	(Lag)	≈
Total Concentrat.(mg/kg):	23948	25130	5717
Availability (mg/kg):	23948	4315	5717
Availability perc. (%):	100.00	17.17	100.01
Mean factor above DTL :	-	144	-
Max.Cum.release (mg/m^2):	< 1123486	202432	< 268205
Cum.release 64d. (mg/m^2):	1786804	270726	14726
Leaching-perc. 64d. (%):	159	134	5.5
Mean factor above DTL :	32548	4931	-
Cum.release calc. 1D 64d:	< 1950168	466000	< 20154
Cum.release calc. 3D 64d:	< 1081777	199403	< 30961
(mg/m^2)	Tortuosity	1	
Chemical Retention R:	1.4	1.0	766
$R_{range-min}$:	.55	.69	247
$R_{range-max}$:	3.7	1.4	2381

Combined Ash
Productcode: V9CC

Surf.area: .0324 m^2 Bulk Density : 1821 kg/m^3 2 October 1991
Weight : 1.50 kg Extraction volume: 8.47 L

Concentration in µg/L Time (days)	K	Na	Li	Br	Cl	NO3	SO4	Al	B	Ba
1	98300	65100	13.30	3800	256000	70	2330	1270	37.70	223
2	159000	110000	24.40	6340	364000	80	3480	2730	34.70	546
4	123000	129000	22.80	6800	340000	220	6170	3210	50.80	101
8	191000	145000	35.90	7030	448000	180	5080	4080	44.20	656
16	162000	157000	49.50	11000	640000	180	6400	4380	47.80	542
32	227000	189000	70.30	8310	611000	230	12600	5740	98.80	596
64	185000	166000	95.50	8500	560000	230	17400	5410	124	493
pD_e (-log[m^2/s]) :	8.77	8.72	-	8.50	9.71	> 7.9	13.67	12.36	-	11.51
Standard deviation :	.24	.22	-	.14	.03	.20	.14	.05	-	.15
Used data points :	3 - 6	3 - 5	-	3 - 5	3 - 5	4 - 6	4 - 7	5 - 6	-	5 - 6
Slope :	.24	.14	(.6)	.35	.46	.18	.63	.39	(.5)	.14
Std.Dev. of slope :	.12	.02	(.13)	.17	.03	.10	.08	?	(.10)	?
Deviat.slope=½ (3 fases):	+ - -	+ - -	+ ≈ ≈	+ - -	+ - -	+ - -	+ - +	+ - -	+ - +	- + -
Wash-off(mg/m^2),Diss/Lag:	≈	(Lag)		(Lag)	(Lag)	(Lag)	(Lag)	(Lag)		?≈
Total Concentrat.(mg/kg):	7200	26110	10.74	150.4	13963	1.29	77.34	29001	.000	1074
Availability (mg/kg):	3652	3437	-	150.4	34372	< 1.29	39098	4726	-	199.8
Availability perc. (%):	50.72	13.16	-	100.00	246.15	< 100.00	50553.1	16.30	-	18.60
Mean factor above DTL :	37	115	-	3	344	(DTL)	391	945	-	57
Max.Cum.release (mg/m^2):	169074	159120	-	6963	1591296	< 59.72	1810093	218796	-	9250
Cum.release 64d. (mg/m^2):	299404	251251	-	13536	841510	311	13976	7011	-	825
Leaching-perc. 64d. (%):	177	158	-	194	52.9	521	.8	3.2	-	8.9
Mean factor above DTL :	218	4577	-	15	920	17	15	348	-	451
Cum.release calc. 1D 64d:	363947	361498	-	20379	1161870	< 349	13793	7526	-	853
Cum.release calc. 3D 64d: (mg/m^2)	166021	156648	-	6910	1227577	< 60	22396	12043	-	1323
	Tortuosity (Na):		1	range:	0 - 1					
Chemical Retention R:	1.8	1.0	-	.93	15	.22	79581	1611	-	420
$R_{range-min}$:	1.0	.61	-	.67	14	.14	57987	1447	-	294
$R_{range-max}$:	3.1	1.6	-	1.3	16	.35	109216	1794	-	599
pD_e for R=1 will be ≥				8.5						
Availability(%) becomes ≥				103.9						

Combined Ash (continued)
Productcode: V9CC

Surf.area .0324 m^2 Bulk Density 1821 kg/m^3
Weight 1.50 kg Extraction volume 8.47 L

Concentration in µg/L Time (days)	Ca	Cd	Cr	Cu	Fe	Mg	Ni	Pb	Si	Sr	Zn
1	48800	1.80	< 3	18.10	31.70	22.80	< 5	5.10	551	356	24
2	86400	< .2	< 3	32.20	9.10	15.60	< 5	7.90	1000	702	15.40
4	51200	< .2	< 3	< 4	141	207	< 5	5	1920	426	23.80
8	89000	< .2	< 3	68.60	51.40	43.20	< 5	1.80	1460	940	11.60
16	64000	< .2	< 3	76	80	55.70	6.60	< 1	1410	814	< 2
32	108000	< .2	< 3	101	42.90	97.20	< 5	1.60	1500	1250	12.30
64	129000	< .2	10.70	64.50	58	190	< 5	2.90	1470	1230	14.90
pD_e (-log[m^2/s]) :	12.42	> 15.4	> 12.3	13.52	13.86	> 15.5	> 13.2	16.09	14.30	> 11.1	17.10
Standard deviation :	.09	1.66	-	.14	.03	.75	-	1.01	.23	.17	.10
Used data points :	5 - 7	1 - 7	1 - 7	4 - 6	6 - 7	1 - 7	1 - 7	1 - 7	6 - 7	5 - 7	6 - 7
Slope :	.51	-	-	.28	.44	.64	-	-	-.03	.30	.28
Std.Dev. of slope :	.14			.08	?	.25			?	.19	?
Deviat.slope=½ (3 fases):	+ - ≈			+ + -	+ - -	+ - +		+ - +	+ - -	+ ≈ -	+ - +
Wash-off(mg/m^2),Diss/Lag:	?≈	≈.297	(Lag)	(Lag)	≈	(Lag)	(Lag)	?≈	?≈	≈	7.76
Total Concentrat.(mg/kg):	128400	20.41	118.2	1396	98500	.000	139.6	859.3	111489	.000	3008
Availability (mg/kg):	81633	20.41	5.59	343.7	186.9	(3007.5)	19.12	343.7	9237	(204.1)	2105
Availability perc. (%):	63.58	100.00	4.73	24.62	.19	#VALUE!	13.69	40.00	8.29	#VALUE!	70.00
Mean factor above DTL :	1633	102	9	172	187	-	5	344	462	-	1053
Max.Cum.release (mg/m^2):	3779306	944.9	258.8	15912	8653	(139236)	885.2	15912	427639	(9449)	97454
Cum.release 64d. (mg/m^2):	150682	< .8	< 7.5	95	108	165	< 9.6	6.61	2434	1495	27
Leaching-perc. 64d. (%):	4.0	< .08	< 2.9	.6	1.2	.1	< 1.1	.04	.6	15.8	.03
Mean factor above DTL :	4117	2.2	(DTL)	13	12	90	(DTL)	3.6	60	408	7
Cum.release calc. 1D 64d:	121491	< .97	< 9.6	144	53	< 130	< 12	7.5	1576	< 1360	14
Cum.release calc. 3D 64d: (mg/m^2)	194646	< 1.6	< 15	234	86	< 211	< 19	12	2565	< 2090	23
Chemical Retention R:	2968	2612597	1838	40127	73202	3141090	14984	17843637	-	-	152074837
$R_{range-min}$:	2431	57208	-	29026	68689	560715	-	1740051	-	-	122172750
$R_{range-max}$:	3624	119313611	-	55471	78013	17596197	-	182980479	-	-	189295534
pD_e for R=1 will be ≥		9.0									
Availability(%) becomes ≥		.1									

Combined Ash
Productcode: V9CC

Concentration in µg/L Time (days)	TDS	Na	TOC
1	521000	65100	3290
2	842000	110000	8160
4	739000	129000	2960
8	8140	145000	9580
16	1150000	157000	10000
32	1220000	189000	13200
64	1140000	166000	4420
pD_e (-log[m^2/s]) :	> 9.5	8.72	> 11.7
Standard deviation :	1.54	.22	.70
Used data points :	1 - 7	3 - 5	1 - 4
Slope :	.37	.14	(.8)
Std.Dev. of slope :	.53	.02	(.59)
Deviat.slope=½ (3 fases):	+ + −	+ − −	+ + −
Wash-off(mg/m^2),Diss/Lag:	?≈	(Lag)	≈
Total Concentrat.(mg/kg):	22986	26110	4940
Availability (mg/kg):	(22986.0)	3437	4941
Availability perc. (%):	(100)	13.16	100.02
Mean factor above DTL :	-	115	-
Max.Cum.release (mg/m^2):	(1064167)	159120	< 228750
Cum.release 64d. (mg/m^2):	1469216	251251	13492
Leaching-perc. 64d. (%):	138	158	5.9
Mean factor above DTL :	26763	4577	-
Cum.release calc. 1D 64d:	< 969970	361498	< 16407
Cum.release calc. 3D 64d: (mg/m^2)	< 908859	156648	< 26406
	Tortuosity	1	
Chemical Retention R:	5.1	1.0	819
$R_{range-min}$:	.15	.61	164
$R_{range-max}$:	175	1.6	4102