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PHYSICAL PROPERTY CHARACTERIZATION OF 183H BASIN
SLUDGE

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		Safety				G. T. McDonald			L5-31	3	
		Env.				J. L. Westcott			T3-04	3	

18. R. K. Biyani <i>RKBiyani</i> 9/1/95 Signature of EDT Originator	19. K. L. Hladek <i>K.L. Hladek</i> 9-7-95 Authorized Representative Date for Receiving Organization	20. J. A. Hunter <i>J.A. Hunter</i> 9/5/95 Cognizant Manager Date	21. DOE APPROVAL (if required) Ctrl. No. ☐ Approved ☐ Approved w/comments ☐ Disapproved w/comments
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Document Number: WHC-SD-WM-TRP-243, Rev. 0

Document Title: Physical Property Characterization of 183-H^{Basin} Sludge

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5. Key Words Bulk Density, Absorbent Density, Absorbance, Free Liquids, Loss-on-ignition, Calcination		6. Author Name: R. K. Biyani <i>Rk Biyani</i> Signature Organization/Charge Code OM570/A4219	
7. Abstract This document describes the characterization of 183-H Basin sludge physical properties, e.g. bulk density of sludge and absorbent, and determination of free liquids. Calcination of crucible-size samples of sludge was also done and the resulting 'loss-on-ignition' was compared to the theoretical weight loss based on sludge analysis obtained from Weston Labs.			
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PHYSICAL PROPERTY CHARACTERIZATION
OF 183-H BASIN SLUDGE

R. K. Biyani & C. H. Delegard
Westinghouse Hanford Company

September 1995

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1.0 INTRODUCTION

Solar evaporation of wastewaters from fuel fabrication activities in the 1970's and 1980's resulted in the generation of sludge in the 183-H Basins. This sludge, currently stored in 208L (55-gal) drums in the Central Waste Complex, is being characterized.

Extensive chemical analyses of 183-H Basin sludge have been performed offsite by Weston Labs in Lionville, Pennsylvania. WHC's Solid Waste Systems Engineering also required physical property measurements of sludge samples. This work was done by Engineered Process Applications' personnel in Building 377. Sludge and absorbent density, presence of free liquids, and water absorbance were measured. Sludge samples were also calcined and the resulting weight loss measured. Data from those analyses are presented in this report.

2.0 PHYSICAL PROPERTY MEASUREMENTS

Wastes from the 183-H Basins have been divided into 7 categories:

- Basin 3
- Basin 4
- Unknown 3&4 Basin solids
- Sandblast Grit
- Precipitated Crystals
- Evaporated Liquids
- Solidified Seepage Liquids

Multiple samples from each waste category were analyzed. The properties measured were water absorption capacity of absorbent, and bulk density of both waste and absorbent. The procedure used for bulk density measurement is documented in Section 4.2 of McGuffey (1994) & Section GEL-14 of Benny (1993).

Bulk densities were measured by weighing a fixed volume (206 mL) of the sludge or absorbent. A 50mm diameter x 100mm long cylindrical plastic mold was used for this.

The presence of free liquids was determined by a 'paint filter liquids test' described in Section GEL-39 of Benny (1993).

Water absorption capacity of the absorbents was measured by the procedure described in Section 4.3 of McGuffey (1994). Measured aliquots of water were added to 100 g of absorbent until free liquid appeared. Free liquid was verified by the paint filter test referenced above.

Detailed data for each sample tested are presented by sample number in Appendices 1 & 2. A summary of median values is presented in Table 1. The generic term 'soil' in Appendices 1 & 2 has been interchangeably used to describe sludge.

TABLE 1. Summary of sludge & absorbent density and capacity by waste category.

WASTE TYPE	#SAMPLE (Soils)	# SAMPLES (Absorbents)	MEDIAN SOIL (Sludge) DENSITY g/cc	# Samples with free liquids	MEDIAN ABSORBENT DENSITY g/cc	MEDIAN ABSORPTION CAPACITY (% of specimen mass)
BASIN 3	24	19	1.9	3	0.9	15
BASIN 4	19	18	2.0	11	0.75	25
UNKNOWN 3 & 4	7	7	1.2	0	0.9	30
SANDBLAST GRIT	8	2	2.25	2	0.85	28
PRECIPITATED CRYSTALS	22	2	1.3	0	0.75	60
EVAPORATED LIQUIDS	17	17	1.0	0	0.4	120
SEEPAGE LIQUIDS	16	16	1.0	0	0.4	155

3.0 LOSS-ON-IGNITION TESTS

These loss-on-ignition tests evaluate the effect of heating the sludge at 950°C for 16 hours. The detailed procedure, which includes the calculation of moisture content, is given in Section 7.1 of Building 377 Procedures (Greenhalgh et al. 1995).

A theoretical estimation of the weight loss has also been made using information from an exhaustive thermodynamic simulation of calcination of Hanford tank wastes (Delegard et al. 1994). Preferred species, formed on calcination of typical compounds present in the wastes listed in that report, and quantitative sludge analysis obtained from Weston Labs, have been used to determine the theoretical composition of calcination residues of 183-H Basin wastes. Data obtained from this theoretical development, and actual lab tests, are presented in Table 2 and a comparison made in Sections 3.2 and 3.3.

3.1 Data from Lab Testing, and Evaluation of Theoretical LOI

Seventy sludge samples from Basin 183-H were calcined in crucibles using this method, and the decrease in weight measured. This measured decrease in weight is termed 'loss-on-ignition' (LOI). Only median values from test results have been reported (Table 2, row 3).

Using data provided by Weston, median analyte concentrations of the 7 waste categories have been established (Table 2, rows 10 thru 40). These median figures have been used to determine the species likely to remain in the residue after calcination. Detailed results of these calculations and analyses have been presented in the form of spreadsheet printouts in Appendix 3. Calcination assumptions and important observations on Weston analyses have been noted therein. A summary of this theoretical evaluation is given in Table 2, row 8.

Rows 6 and 7 (Table 2) give the median wt% water present in the sludge samples.

3.2 Discussion of Results

In the data in Appendix 3, a significant parameter is the total weight of anions and cations reported by Weston. The unanalyzed portion of the waste (Table 2, row 5) ranges from 9.6% for Basin 4 samples to 98.1% for Sand Blast Grit. These figures presented in Table 2, row 5 have been taken from the upper right hand corner of the spreadsheets in Appendix 3. The large unanalyzed portion in some categories of Basin 183-H waste could be due to incomplete dissolution of the sample being prepared for analysis.

The median theoretical LOI (Table 2, row 2) has been based on the sum of the weight of the anions and cations reported by Weston in the waste samples (see the figure in 'ppm' at the bottom of the 3rd column in the spreadsheets in Appendix 3). In many cases the latter figure is considerably lower than 10E6 ppm i.e. 100 wt%, e.g. for Sand Blast Grit this figure is only 1.9% of total sample weight. The generic calculation method for the theoretical LOI, used with only

slight modification for all types of wastes, resulted in negative LOI's (see row 8 of Table 2) for 3 waste types. This anomaly was probably due to this discrepancy in Weston Lab's figures.

The theoretical LOI described above, can be compared with LOI figures obtained by direct lab measurement. The lab LOI figures range from 0% for Sand Blast Grit to 59.3% for Precipitated Crystal waste. No samples from the Evaporated Liquids category were calcined in the lab.

Determination of LOI in the lab has been based on the weight of the waste after drying at 110°C for 4 hours, whereas the theoretical LOI method has been based on the sum of the weight of the anions and cations reported by Weston.

3.3 Conclusions

In accordance with 183-H Basin Mixed Waste Analysis & Test Plan (McGuffey 1994) a difference of under 10% between the two LOI figures (compare row 3 and row 8 of Table 2) will enhance the reliability of the composition characterization of Basin 183-H sludge. The waste categories Basin 4, Unknown 3 & 4 Basin solids, and Precipitated Crystals meet this criteria. In the cases where the agreement in LOI figures is not within 10%, the waste types have an unanalyzed portion of Weston solids greater than 30%.

There is excellent agreement between row 2 and row 8 figures. Reiterating, row 2 figures are median results from Weston's analyses of 70 samples, individually, in the standard calculation method given in Appendix 3. Row 8 figures are based on median analytical figures provided by Weston; spreadsheets of these calculations are presented in Appendix 3. This confirms that median analytical data, presented by Weston, is a valid representation of the results of their individual sample analysis. It does not reflect upon the accuracy of their analyses which was sought to be corroborated, as a goal of this study.

Comparison of rows 6 and 7 of Table 2 shows good agreement between the wt% water in the waste types reported by Weston and that measured in the Building 377 lab.

TABLE 2. Summary of LOI & % Water Calculations

Sample	BASIN 3	BASIN 4	UNK 3&4	SAND B.G.	PPT CRYST	EVAP LIQ	SEEP LIQ
Median LOI (calc)	6.2%	33.0%	22.8%	-82.2%	52.6%		-9.9%
Median LOI(Bldg 377)	24.9%	34.1%	19.6%	0.0%	59.3%		33.9%
# of Bldg 377 Samples Analyzed	17	12	5	7	13		16
%Wes Unanalyzed	31.6%	9.6%	51.1%	98.1%	10.0%	66.2%	67.9%
%H2O(Bldg 377)	16.7%	15.4%	24.0%	4.9%	1.8%		28.6%
%H2O (Weston)	15.0%	11.9%	23.3%	5.3%	2.1%	22.5%	22.6%
LOI using Median values	5.3%	29.3%	22.9%	-33.3%	51.7%	-6.6%	-7.5%
MEDIAN ANALYTICAL VALUES							
Ag	34.4	35.1	9.5	0.4	0.3	0.3	0.3
Al	9270.0	428.0	7990.0	1565.0	375.5	7405.0	7005.0
Ba	177.0	4.4	150.0	19.9	2.0	16.5	15.7
Be	4.3	4.0	0.0	0.1	0.0	0.3	0.3
Ca	7380.0	281.5	9900.0	5340.0	1520.0	149000.0	140150.0
Cd	2.7	2.8	3.6	0.1	0.2	0.3	0.3
Co	4.7	0.9	5.1	1.6	0.2	2.4	2.0
Cr	202.0	168.5	110.0	8.9	4.5	37.6	25.1
Cu	86500.0	81700.0	31700.0	167.9	156.5	18.4	10.3
Fe	3550.0	1470.0	7570.0	3985.0	275.5	3445.0	3485.0
Hg	2.8	13.6	1.7	0.0	0.0	0.3	0.0
K	440.0	534.5	1155.0	178.5	78.4	1680.0	1685.0
Mg	1060.0	14.7	4590.0	1028.0	349.5	17900.0	17550.0
Mn	670.0	554.0	363.0	74.4	3.8	53.7	54.4
Mo	5.7	5.1	0.0	1.1	1.5	2.9	2.9
Na	202000.0	222000.0	133000.0	650.5	241000.0	75900.0	73900.0
Ni	74.9	75.5	49.9	1.6	1.5	16.0	13.0
Sb	8.2	10.0	0.0	6.9	1.7	1.7	2.9
Se	0.5	0.4	1.1	0.1	0.0	0.9	1.5
Si	2680.0	3190.0	2130.0	401.0	384.5	6555.0	1595.0
Ti	0.0	0.0	0.0	135.0	0.0	275.0	274.5
U	1200.0	660.0	510.0	9.8	26.0	320.0	165.0
V	31.6	1.2	32.3	3.5	0.8	5.9	5.8
Zn	253.0	226.0	140.0	50.6	3.3	12.7	9.9
Zr	22300.0	24500.0	9460.0	159.5	67.6	37.2	18.0
Cl	82.0	139.8	584.0	53.2	32.0	802.5	688.5
F	38854.0	39650.0	18000.0	79.1	2740.0	503.5	410.0
Formate	366.0	84.7	40.7	3.3	697.0	216.0	177.0
CN	1.6	0.5	1.4	0.3	9.6	0.3	0.3
SO4	171000.0	143000.0	59300.0	348.5	13000.0	10400.0	6750.0
NO3	122622	358128	192123	395	635246	20031	19168
TOC	3990	4575	1893	2010	1132.5	19560	22185
HPO4	676	141	284	338	52	137	227
HCO3	8244	22058	8244	1741	2835	33874	25580
pH	11.6	9.5	9.9	9.2	11.3	13.2	13.1
% Solids	85.0	88.1	76.7	94.7	97.9	77.5	77.4
N	27700.0	80900.0	43400.0	89.2	143500.0	4525.0	4330.0
TOC(raw)	1330.0	1525.0	631.0	670.0	377.5	6520.0	7395.0
P	218.0	45.5	91.8	109.0	16.7	44.1	673.3
TIC(raw)	1650.0	4415.0	1650.0	348.5	567.5	6780.0	5120.0

4.0 REFERENCES

- Benny, et al. 1993, *Geotechnical Engineering Procedures Manual*, WHC-IP-0635, Westinghouse Hanford Company, Richland, Washington.
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- Greenhalgh, W. O., et al. 1995, *Building 377 Procedures*, WHC-IP-1071, Westinghouse Hanford Company, Richland, Washington.
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5.0 ACKNOWLEDGEMENT

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APPENDIX 1: WASTE PHYSICAL PROPERTY MEASUREMENTS

183H SOIL DENSITY BASIN 3 SOLIDS

183H Soil Identification	Density	Free Liquid Confirmed?
183H-1213 (BO8ZH7)	2.1	N
183H-1403	2.1	N
183H-467 (BO8ZH9)	2.0	N
183H-1213	2.0	N
183H-1627	2.0	N
183H-106	1.9	N
183H-1333	1.9	N
183H-1527	1.9	N
183H-1844	1.9	N
183H-1478	1.6	Y
183H-467	1.5	Y
183H-617	1.3	N
183H-2157	2.0	N
183H-2527	2.0	N
183H-2585	2.0	N
183H-2942	2.0	N
183H-2978 (BO8ZN2)	2.0	N
183H-3134	2.0	N
183H-1922	1.8	N
183H-2893	1.7	N
183H-2978	1.6	Y
183H-1844 (BO8ZM8)	1.5	N
183H-2463	1.4	N
183H-2991	1.4	N

Density units are grams / cubic centimeter

183H SOIL DENSITY BASIN 4 SOLIDS

183H Soil Identification	Density	Free Liquid Confirmed?
183-H4-734	2.2	Y
183-H4-965	2.2	N
183-H4-965 (B08ZH1)	2.2	N
183-H4-472	2.1	Y
183-H4-667	2.1	N
183-H4-736	2.1	Y
183-H4-875	2.1	N
183-H4-1126	2.1	N
183-H4-1278	2.1	N
183-H4-480	2.0	Y
183-H4-484	2.0	Y
183-H4-484	2.0	Y
183-H4-578	2.0	Y
183-H4-578	2.0	Y
183-H4-580	2.0	Y
183-H4-1055	2.0	N
183-H4-556	1.9	Y
183-H4-227	1.8	Y
183-H4-51	1.4	N

Density units are grams / cubic centimeter

183H SOIL DENSITY UNKNOWN SOLIDS

183H Soil Identification	Density	Free Liquid Confirmed?
90-DD-6474	1.6	N
90-DD-6442	1.5	N
90-DD-6439	1.2	N
90-DD-6503	1.2	N
90-DD-6515	1.2	N
90-DD-6454	1.0	N
90-DD-6469	0.9	N

183H SOIL DENSITY SANDBLAST GRIT

183H Soil Identification	Density	Free Liquid Confirmed?
89-DD-71	2.5	N
89-DD-56	2.4	Y
89-DD-1652	2.4	Y
89-DD-142	2.3	N
89-DD-06	2.2	N
89-DD-66	2.0	N
90-DD-6540	1.8	N
90-DD-6517	1.7	N

Density units are grams / cubic centimeter

183H SOIL DENSITY PRECIPITATED CRYSTALS

183H Soil Identification	Density	Free Liquid Confirmed?
90-DD-4184	1.4	N
90-DD-5751	1.4	N
90-DD-6090	1.4	N
90-DD-7245	1.4	N
90-DD-7252	1.4	N
90-DD-1813	1.3	N
90-DD-2150	1.3	N
90-DD-2172	1.3	N
90-DD-4346	1.3	N
90-DD-4349	1.3	N
90-DD-4644	1.3	N
90-DD-5009	1.3	N
90-DD-5189	1.3	N
90-DD-5220	1.3	N
90-DD-5467 (BOBRJ3)	1.3	N
90-DD-5500 (BOBRJ2)	1.3	N
90-DD-6661	1.3	N
90-DD-7341	1.3	N
90-DD-1905	1.2	N
90-DD-2227 (BOBRJ4)	1.2	N
90-DD-2306 (BOBRJ1)	1.2	N
90-DD-2560	1.2	N

Density units are grams / cubic centimeter

183H SOIL DENSITY SOLIDIFIED EVAPORATED LIQUIDS

183H Soil Identification	Density	Free Liquid Confirmed?
89-DD-546	1.0	N
89-DD-573	1.0	N
89-DD-728	1.0	N
89-DD-750	1.0	N
89-DD-894	1.0	N
89-DD-1079	1.0	N
89-DD-1183	1.0	N
89-DD-1190	1.0	N
89-DD-1221	1.0	N
89-DD-1384	1.0	N
89-DD-383	0.9	N
89-DD-843	0.9	N
89-DD-912	0.9	N
89-DD-1037	0.9	N
89-DD-1150	0.9	N
89-DD-1287	0.9	N
90-DD-1767	0.9	N

Density units are grams / cubic centimeter

183H SOIL DENSITY SOLIDIFIED SEEPAGE LIQUIDS

183H Soil Identification	Density	Free Liquid Confirmed?
90-DD-5102	1.5	N
90-DD-3013	1.4	N
90-DD-2969	1.1	N
90-DD-3018	1.0	N
90-DD-3039	1.0	N
90-DD-3073	1.0	N
90-DD-3259	1.0	N
90-DD-3373	1.0	N
90-DD-3686	1.0	N
90-DD-3987	1.0	N
90-DD-4031	1.0	N
90-DD-4916	1.0	N
90-DD-4967	1.0	N
90-DD-3268	0.9	N
90-DD-3469	0.9	N
90-DD-4048	0.9	N

Density units are grams / cubic centimeter

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APPENDIX 2: ABSORBENT PHYSICAL PROPERTY MEASUREMENTS

183H ABSORBENT DENSITY and ABSORPTION CAPACITY BASIN 3 SOLIDS

183H Absorbent Identification	Density	Absorbance (% of specimen mass)
183H-1922 (BO8ZN3)	1.0	15
183H-2463 (BO8ZH5)	1.0	20
183H-2527 (BO8ZH6)	1.0	15
183H-2585 (BO8ZM7)	1.0	15
183H-106 (BO8ZM5)	0.9	20
183H-1213 (BO8ZH7)	0.9	15
183H-1333	0.9	30
183H-1403	0.9	20
183H-1478 (BO8ZJ1)	0.9	20
183H-1627 (BO8ZH8)	0.9	15
183H-1844	0.9	15
183H-1844 (BO8ZM8)	0.9	15
183H-2157 (BO8ZM9)	0.9	10
183H-2893 (BO8ZN0)	0.9	15
183H-2942 (BO8ZJ0)	0.9	20
183H-2978 (BO8ZN2)	0.9	15
183H-2991 (BO8ZN1)	0.9	15
183H-3134 (BO8ZJ4)	0.9	15
183H-467 (BO8ZH9)	0.5	90

Density units are grams / cubic centimeter

183H ABSORBENT DENSITY and ABSORPTION CAPACITY BASIN 4 SOLIDS

183H Absorbent Identification	Density	Absorbance (% of specimen mass)
183-H4-578	1.2	0.0
183-H4-875 (BO8Z87)	1.0	20
183-H4-484	0.9	20
183-H4-578 (BO8ZG8)	0.9	20
183-H4-736	0.9	15
183-H4-736 (BO8ZH2)	0.9	20
183-H4-965 (BO8ZH1)	0.9	20
183-H4-1278	0.9	20
183-H4-472 (BO8ZG7)	0.8	30
183-H4-480 (BO8ZG9)	0.7	40
183-H4-556 #1	0.7	20
183-H4-484 (BO8Z93)	0.6	40
183-H4-667 (BO8ZH0)	0.5	50
183-H4-1126 (BO8Z91)	0.5	45
183-H4-556 #2	0.4	80
183-H4-580 (BO8Z88)	0.4	129
183-H4-1055 (BO8Z86)	0.3	89
183-H4-51	0.1	601

Density units are grams / cubic centimeter
Specimen 183-H4-578 was saturated

183H ABSORBENT DENSITY and ABSORPTION CAPACITY UNKNOWN SOLIDS

183H Absorbent Identification	Density	Absorbance (% of specimen mass)
90-DD-6503	1.1	25
90-DD-6439	0.9	35
90-DD-6442	0.9	40
90-DD-6469	0.9	30
90-DD-6474	0.9	30
90-DD-6515	0.9	25
90-DD-6454	0.8	40

SANDBLAST GRIT

183H Absorbent Identification	Density	Absorbance (% of specimen mass)
89-DD-66	0.9	30
89-DD-06	0.8	25

PRECIPITATED CRYSTALS

183H Absorbent Identification	Density	Absorbance (% of specimen mass)
90-DD-1905	0.8	35
90-DD-1813	0.5	84

Density units are grams / cubic centimeter

183H ABSORBENT DENSITY and ABSORPTION CAPACITY SOLIDIFIED EVAPORATED LIQUIDS

183H Absorbent Identification	Density	Absorbance (% of specimen mass)
89-DD-912	0.5	120
89-DD-1150	0.5	109
89-DD-1221	0.5	114
89-DD-383	0.4	135
89-DD-546	0.4	124
89-DD-573	0.4	110
89-DD-728	0.4	109
89-DD-750	0.4	140
89-DD-843	0.4	134
89-DD-894	0.4	124
89-DD-1037	0.4	120
89-DD-1079	0.4	120
89-DD-1183	0.4	119
89-DD-1190	0.4	115
89-DD-1287	0.4	114
89-DD-1384	0.4	115
90-DD-1767	0.4	120

Density units are grams / cubic centimeter

183H ABSORBENT DENSITY and ABSORPTION CAPACITY SOLIDIFIED SEEPAGE LIQUIDS

183H Absorbent Identification	Density	Absorbance (% of specimen mass)
90-DD-4967	0.7	94
90-DD-5102	0.7	80
90-DD-4916	0.6	100
90-DD-2969	0.5	134
90-DD-3373	0.5	139
90-DD-4031	0.5	165
90-DD-3013	0.4	149
90-DD-3018	0.4	160
90-DD-3039	0.4	154
90-DD-3073	0.4	155
90-DD-3259	0.4	159
90-DD-3268	0.4	180
90-DD-3469	0.4	170
90-DD-3686	0.4	155
90-DD-3987	0.4	150
90-DD-4048	0.4	160

Density units are grams / cubic centimeter

APPENDIX 3: SPREADSHEETS OF LOI CALCULATIONS

Blank.

BASIN 3

Sample	BASIN 3	Weston Labs Analysis		
		Cat. Equiv.	Mole Conc.	
Metals/Cations	At. Wt. (g)	[], ppm	(Eq./kg)	(mol/kg)
Ag	107.868	3.44E+01	3.19E-04	3.19E-04
Al	26.982	9.27E+03		3.44E-01
Ba	137.33	1.77E+02	2.58E-03	1.29E-03
Be	9.0122	4.25E+00	9.43E-04	4.72E-04
Ca	40.08	7.38E+03	3.88E-01	1.84E-01
Cd	112.41	2.70E+00	4.80E-05	2.40E-05
Co	58.933	4.70E+00		7.98E-05
Cr	51.996	2.02E+02		3.88E-03
Cu	63.546	8.65E+04		1.38E+00
Fe	55.847	3.55E+03		6.38E-02
Hg	200.59	2.80E+00	2.79E-05	1.40E-05
K	39.098	4.40E+02	1.13E-02	1.13E-02
Mg	24.305	1.08E+03	8.72E-02	4.38E-02
Mn	54.938	6.70E+02		1.22E-02
Mo	95.94	5.70E+00		5.84E-05
Na	22.99	2.02E+05	8.79E+00	8.79E+00
Ni	58.7	7.49E+01		1.28E-03
Sb	121.75	8.20E+00		6.74E-05
Se	78.96	5.00E-01		6.33E-06
Si	28.086	2.68E+03		9.54E-02
Ti	47.88	0.00E+00		0.00E+00
U	238.03	1.20E+03		5.04E-03
V	50.942	3.16E+01		6.20E-04
Zn	65.38	2.53E+02	3.87E-03	3.87E-03
Zr	91.22	2.23E+04		2.44E-01
Sum		337852	9.261	

Anions	Form Wt. (g)	[], ppm	An. Equiv.	
			(Eq./kg)	
Cl	35.453	8.20E+01	2.31E-03	2.31E-03
F	18.998	3.89E+04	2.05E+00	2.05E+00
Formate	45.018	3.68E+02	8.13E-03	8.13E-03
CN	26.018	1.60E+00	8.15E-05	8.15E-05
SO4	96.058	1.71E+05	3.56E+00	1.78E+00
NO3	62.005	1.23E+05	1.98E+00	1.98E+00
TOC	36.033	3.98E+03	1.11E-01	1.11E-01
HPO4	95.980	6.76E+02	1.41E-02	7.04E-03
CO3	61.017	8.24E+03	2.70E-01	1.35E-01
Sum		345838	7.989	
pH	11.6			
Sum Metals/Anions		683687	1.272	
Weston % Solids		85.0		

NO3: result for N*(((14.0067 + 3*15.9994)/14.0067)

TOC: result for TOC*3; to represent unspiculated carboxylic acid anions

HPO4: result for P*(((30.974 + 4*15.9994 + 1.0079)/30.974)

CO3: result for total inorganic carbon*(((12.011 + 3*15.9994)/12.011)

RBIyani&CDelegard/BASIN3/28 - July - 1995

Calcined Compound Material Balance				
Moles/	Mole	Formula	Weight	Weight/
kg sol'n.	Fraction	Compound	Weight (g)	Mole Calcine
3.52E-03	4.23E-04	Ca3(PO4)2	310.1828	1.68E-03
1.29E-03	1.55E-04	BaO	153.3394	2.37E-02
4.38E-02	5.24E-03	MgO	40.3044	2.71E-03
3.19E-04	3.83E-05	AgO	123.8874	2.11E-01
3.87E-03	4.65E-04	ZnO	81.3694	4.74E-03
3.88E-03	4.68E-04	Na2CO3	161.8732	3.78E-02
1.13E-02	1.35E-03	KOH	56.1084	7.55E-02
1.74E-01	2.08E-02	CaO	56.0784	7.58E-02
3.44E-01	4.12E-02	NaAlO2	61.9701	1.17E+00
6.38E-02	7.63E-03	NaFeO2	110.8356	3.38E+00
9.54E-02	1.15E-02	Na4SiO4	184.0428	8.48E-01
2.44E-01	2.93E-02	ZrO2	123.2188	2.71E-02
2.46E-01	2.95E-02	Na2CO3	105.9889	3.62E+00
1.38E+00	1.63E-01	CuO	79.5454	3.13E+00
1.22E-02	1.46E-03	MnO2	86.9376	1.30E+01
1.78E+00	2.14E-01	Na2SO4	142.0412	1.27E-01
2.05E+00	2.45E-01	NaF	41.9882	3.04E+01
1.88E+00	2.27E-01	NaOH	39.9972	1.03E+01
2.31E-03	2.78E-04	NaCl	58.4428	9.08E+00
0.00E+00	0.00E+00	Na2TiO3	141.8778	1.62E-02
5.04E-03	6.05E-04	UO3	286.0262	0.00E+00
Sum	8.33		2.22E-03	1.73E-01
				77.86

CALCINATION ASSUMPTIONS:

- All "N" present as nitrate.
- All nitrate calcined to give hydroxide.
- No species volatilized except H2O and N2/O2 (from decomposition of nitrate).
- All organic carbon converted to carbonate (CO2 from TOC oxidation captured by NaOH).
- Phosphate reacts preferentially with Ca (Mg, Ba form oxides).
- Al, Cr, Fe, and Si make sodium salts, not oxides.
- Carbonate, fluoride, hydroxide, and sulfate form sodium salts.

COMMENTS ON WESTON (AQUEOUS) ANALYSES:

- Analyte material balance (total 683687 ppm) lower than 85.0 wt% solids reported.
- Cation/anion balance about 14% low for anions.
- Anion selection (CO3, HPO4) consistent with pH 11.6 observed.
- Metals that are cationic at pH ~ 11.6 are Ag, Ba, Be, Ca, Cd, Hg, K, Mg, Na, and Zn and react with PO4/SO4/CO3/Cl or form nitrate salts; others (e.g., transition metals) are hydrolyzed to make hydrous oxides (e.g., ZrO2.xH2O).

100 - % Weston analyzed 31.6%			
Sample	[], ppm		
Analyte	BASIN 3	Calcine	g/kg sol'n
Ag	34.4	Ca3(PO4)2	1.1
Al	9270	BaO	0.2
Ba	177	MgO	1.8
Be	4.25	AgO	0.0
Ca	7380	ZnO	0.3
Cd		2.7 Na2CO3	0.8
Co		4.7 KOH	0.8
Cr		202 CaO	9.7
Cu	86500	NaAlO2	28.2
Fe	3550	NaFeO2	7.0
Hg		2.8 Na4SiO4	17.6
K	440	ZrO2	30.1
Mg	1060	Na2CO3	26.1
Mn	870	CuO	108.3
Mo		5.7 MnO2	1.1
Na	202000	Na2SO4	252.9
Ni		74.9 NaF	65.9
Sb		8.2 NaOH	75.8
Se		0.5 NaCl	0.1
Si	2880	Na2TiO3	0.0
Ti		0 UO3	1.4
U	1200	Sum	647.2
V	31.6		
Zn	253	LOI(dry)	5.3%
Zr	22300		
Cl	82		
F	38854		
Formate	388		
CN	1.8		
SO4	171000		
NO3	122622		
TOC	3980		
HPO4	676		
CO3	8244		
pH	11.6		
%Solids	85		

BASIN 4

Sample	BASIN 4	Weston Labs Analysis	Cat. Equiv.	Mole Conc.	Calcd Compound Material Balance	Moles/	Formula	Weight	Weight	Weight/	Sample	100 - % Weston analyzed	Basin 4	Calcine	g/kg soln
Metals/Cations	At. Wt. (g)	[], ppm	(Eq/kg)	(mole/kg)	Fraction	Compound	Weight (g)	Fraction	Mole Calcine		Analyte	[], ppm	BASIN 4	Calcine	
Ag	107.868	3.51E+01	3.25E-04	3.25E-04	8.23E-05	Ca3(PO4)2	310.1828	3.56E-04	2.55E-02		Ag	35.1	Ca3(PO4)2		0.2
Al	26.982	4.28E+02	1.59E-02	1.59E-02	3.20E-05	BaO	153.3394	7.68E-06	5.50E-04		Al	428	BaO		0.0
Ba	137.33	4.40E+00	6.41E-05	3.20E-05	6.05E-04	MgO	40.3044	3.81E-05	2.73E-03		Ba	4.4	MgO		0.0
Be	9.0122	4.00E+00	8.88E-04	4.44E-04	3.25E-04	AgO	123.8674	6.30E-05	4.52E-03		Be	0.0			0.0
Ca	40.08	2.82E+02	1.40E-02	7.02E-03	3.46E-03	ZnO	81.3684	4.40E-04	3.15E-02		Ca	281.5	ZnO		0.3
Cd	112.41	8.80E+00	4.98E-05	2.49E-05	3.24E-03	Na2CO3	161.9732	8.21E-04	5.88E-02		Cd	2.8	Na2CO3		0.5
Co	58.933	9.00E-01	1.53E-05	1.53E-05	1.37E-02	KOH	56.1084	1.20E-03	8.59E-02		Co	0.9	KOH		0.8
Cr	51.996	1.68E+02	3.24E-03	1.29E+00	4.82E-03	CaO	56.0784	2.23E-04	3.03E-02		Cr	188.5	CaO		0.3
Cu	63.546	8.17E+04	6.17E+03	1.29E+00	1.59E-02	NaAlO2	81.9701	2.03E-03	1.46E-01		Cu	81700	NaAlO2		1.3
Fe	55.847	1.47E+03	6.78E-05	2.63E-02	2.63E-02	NaFeO2	110.8358	4.56E-03	3.27E-01		Fe	1470	NaFeO2		2.8
Hg	200.59	1.38E+01	1.36E-04	1.14E-01	1.27E-02	Na2SiO4	184.0428	3.27E-02	2.34E+00		Hg	13.8	Na2SiO4		20.8
K	39.098	3.35E+02	1.37E-02	1.37E-02	2.68E-01	ZrO2	123.2188	5.17E-02	3.71E+00		K	534.5	ZrO2		33.1
Mg	24.305	1.47E+01	1.21E-03	6.05E-04	4.88E-01	Na2CO3	105.9889	8.09E-02	5.90E+00		Mg	14.7	Na2CO3		51.8
Mn	54.938	5.54E+02	1.01E-02	1.29E+00	1.44E-01	CaO	78.5454	1.80E-01	1.15E+01		Mn	554	CaO		102.3
Mo	95.94	5.10E+00	5.32E-05	9.88E+00	1.01E-02	MnO2	68.9378	1.37E-03	9.82E-02		Mo	5.1	MnO2		0.9
Na	22.99	2.22E+05	1.29E-03	1.49E+00	1.67E-01	Na2SO4	142.0412	3.31E-01	2.37E+01		Na	222000	Na2SO4		211.5
Ni	58.7	7.55E+01	8.21E-05	2.09E+00	2.34E-01	NaF	41.9882	1.37E-01	9.82E+00		Ni	87.8	NaF		87.8
Sb	121.75	1.00E+01	3.11E+00	3.48E-01	3.48E-01	NaOH	39.9872	1.94E-01	1.39E+01		Sb	75.5	NaOH		124.3
Se	78.96	4.00E-01	5.07E-06	3.94E-03	4.42E-04	NaCl	58.4428	3.60E-04	2.50E-02		Se	0.4	NaCl		0.2
Si	28.086	3.19E+03	1.14E-01	0.00E+00	0.00E+00	Na2TiO3	141.8778	0.00E+00	0.00E+00		Si	3190	Na2TiO3		0.0
Ti	47.90	0.00E+00	0.00E+00	2.77E-03	3.11E-04	UO3	268.0282	1.24E-03	8.89E-02		Ti	0.8	UO3		0.8
U	238.03	6.80E+02	2.77E-03	2.77E-03	8.93					71.87	U	660	Sum		638.8
V	50.942	1.20E+00	2.38E-05	2.38E-05							V	1.2			
Zn	65.38	2.26E+02	3.48E-03	3.46E-03							Zn	226	LO(dry)		29.3%
Zr	91.22	2.45E+04	2.88E-01	2.89E-01							Zr	24500			
Sum	335880		9.690								F	39850			
											Formate	84.7			
											CN	0.5			
											SO4	143000			
											NO3	358128			
											TOC	4575			
											HPO4	141			
											HCO3	22058			
											pH	9.5			
											%Solids	88.1			

Calcination Assumptions:

1. All "N" present as nitrate.

2. All nitrate calcined to give hydroxide.

3. No species volatilized except H2O and N2/O2 (from decomposition of nitrate).

4. All organic carbon converted to carbonate (CO2 from TOC oxidation captured by NaOH).

5. Phosphate reacts preferentially with Ca (Mg, Ba form oxides).

6. Al, Cr, Fe, and Si make sodium salts, not oxides.

7. Carbonate, fluoride, hydroxide, and sulfate form sodium salts.

CALCINATION ASSUMPTIONS:

1. All "N" present as nitrate.
2. All nitrate calcined to give hydroxide.
3. No species volatilized except H2O and N2/O2 (from decomposition of nitrate).
4. All organic carbon converted to carbonate (CO2 from TOC oxidation captured by NaOH).
5. Phosphate reacts preferentially with Ca (Mg, Ba form oxides).
6. Al, Cr, Fe, and Si make sodium salts, not oxides.
7. Carbonate, fluoride, hydroxide, and sulfate form sodium salts.

COMMENTS ON WESTON (AQUEOUS) ANALYSES:

1. Analyte material balance (total 903658 ppm) comparable with 88.1 wt% solids reported.
2. Cation/anion balance about 15% low for anions.
3. Anion selection (HCO3, HPO4) consistent with pH 9.5 observed.
4. Metals that are cationic at pH ~ 8.5 are Ag, Ba, Be, Ca, Cd, Hg, K, Mg, Na, and Zn and react with PO4/SO4/CO3/Cl or form nitrate salts; others (e.g., transition metals) are hydrolyzed to make hydrous oxides (e.g., ZrO2.xH2O).

NO3: result for N*[(14.0067 + 3*15.9994)/14.0067]
 TOC: result for TOC*3; to represent unspectated carboxylic acid anions
 HPO4: result for P*[(30.974 + 4*15.9994 + 1.0076)/30.974]
 HCO3: result for total inorganic carbon*[(12.011 + 3*15.9994 + 1.0076)/12.011]

RBIyanika.Delegard/BASIN4/28 - July - 1995

Sample	UNK 3&4	Weston Labs Analysis		
Metals/Cations	At. Wt. (g)	[], ppm	Cat. Equiv. (Eq./kg)	Mole Conc. (mole/kg)
Ag	107.868	9.50E+00	8.81E-05	8.81E-05
Al	26.982	7.99E+03		2.96E-01
Ba	137.33	1.50E+02	2.18E-03	1.09E-03
Be	9.0122	0.00E+00	0.00E+00	0.00E+00
Ca	40.08	9.90E+03	4.94E-01	2.47E-01
Cd	112.41	3.80E+00	8.41E-05	3.20E-05
Co	58.933	5.10E+00		8.65E-05
Cr	51.996	1.10E+02		2.12E-03
Cu	63.546	3.17E+04		4.99E-01
Fe	55.847	7.57E+03		1.38E-01
Hg	200.59	1.70E+00	1.69E-05	8.47E-06
K	39.098	1.16E+03	2.95E-02	2.95E-02
Mg	24.305	4.59E+03	3.78E-01	1.89E-01
Mn	54.938	3.63E+02		6.81E-03
Mo	95.94	0.00E+00		0.00E+00
Na	22.99	1.33E+05	5.79E+00	5.79E+00
Ni	58.7	4.89E+01		8.50E-04
Sb	121.75	0.00E+00		0.00E+00
Se	78.96	1.10E+00		1.39E-05
Si	28.086	2.13E+03		7.58E-02
Ti	47.90	0.00E+00		0.00E+00
U	238.03	5.10E+02		2.14E-03
V	50.942	3.23E+01		6.34E-04
Zn	65.38	1.40E+02	2.14E-03	2.14E-03
Zr	91.22	9.46E+03		1.04E-01
Sum		208871.2	8.691	

Anions	Form Wt. (g)	[], ppm	An. Equiv. (Eq./kg)	
Cl	35.453	5.84E+02	1.65E-02	1.65E-02
F	18.998	1.80E+04	9.47E-01	9.47E-01
Formate	45.018	4.07E+01	9.04E-04	9.04E-04
CN	26.018	1.40E+00	5.38E-05	5.38E-05
SO4	96.058	5.93E+04	1.23E+00	6.17E-01
NO3	62.005	1.92E+05	3.10E+00	3.10E+00
TOC	36.033	1.89E+03	5.25E-02	5.25E-02
HPO4	95.980	2.84E+02	5.92E-03	2.98E-03
HCO3	61.017	8.24E+03	1.35E-01	1.35E-01
Sum		280470	5.492	
pH	9.9			
Sum Metals/Anions		489341	1.199	
Weston % Solids		76.7		

NO3: result for N* $\left(\frac{14.0087}{3} + 3 \times \frac{15.9994}{14.0087}\right)$

TOC: result for TOC*3; to represent unspiculated carboxylic acid anions

HPO4: result for P* $\left(\frac{30.974}{4} + 4 \times \frac{15.9994}{30.974} + \frac{1.0079}{30.974}\right)$

HCO3: result for total inorganic carbon* $\left(\frac{12.011}{3} + 3 \times \frac{15.9994}{12.011} + \frac{1.0079}{12.011}\right)$

RBlyani&COlegard/UNK3&4/28-July-1995

Calcined Compound Material Balance				
Moles/	Mole	Formula	Weight	Weight/
kg sol'n.	Fraction	Compound	Weight (g)	Fraction
1.48E-03	2.54E-04	Ca3(PO4)2	310.1828	1.21E-03
1.09E-03	1.87E-04	BaO	153.3384	4.43E-04
1.89E-01	3.24E-02	MgO	40.3044	2.01E-02
8.81E-05	1.51E-05	AgO	123.8674	2.89E-05
2.14E-03	3.67E-04	ZnO	81.3694	4.61E-04
2.12E-03	3.83E-04	Na2CrO4	161.8732	8.08E-04
2.95E-02	5.07E-03	KOH	56.1094	4.38E-03
2.43E-01	4.16E-02	CaO	56.0794	3.80E-02
2.98E-01	5.08E-02	NaAlO2	81.9701	6.42E-02
1.38E-01	2.33E-02	NaFeO2	110.8356	3.97E-02
7.58E-02	1.30E-02	Na4SiO4	184.0428	3.89E-02
1.04E-01	1.78E-02	ZrO2	123.2188	3.38E-02
1.88E-01	3.22E-02	Na2CO3	105.9889	5.26E-02
4.99E-01	8.58E-02	CuO	79.5454	1.05E-01
6.61E-03	1.13E-03	MnO2	86.9376	1.52E-03
6.17E-01	1.08E-01	Na2SO4	142.0412	2.32E-01
9.47E-01	1.63E-01	NaF	41.9882	1.05E-01
2.47E+00	4.24E-01	NaOH	39.9972	2.81E-01
1.65E-02	2.83E-03	NaCl	58.4428	2.55E-03
0.00E+00	0.00E+00	Na2TiO3	141.8778	0.00E+00
2.14E-03	3.68E-04	UO3	286.0282	1.62E-03
Sum	5.83			84.88

CALCINATION ASSUMPTIONS:

- All "N" present as nitrate.
- All nitrate calcined to give hydroxide.
- No species volatilized except H2O and N2/O2 (from decomposition of nitrate).
- All organic carbon converted to carbonate (CO2 from TOC oxidation captured by NaOH).
- Phosphate reacts preferentially with Ca (Mg, Ba form oxides).
- Al, Cr, Fe, and Si make sodium salts, not oxides.
- Carbonate, fluoride, hydroxide, and sulfate form sodium salts.

COMMENTS ON WESTON (AQUEOUS) ANALYSES:

- Analyte material balance (total 489341 ppm) much less than 76.7 wt% solids reported; implies undissolved solids.
- Cation/anion balance about 22% low for anions.
- Anion selection (HCO3, HPO4) consistent with pH 9.9 observed.
- Metals that are cationic at pH ~ 11.8 are Ag, Ba, Be, Ca, Cd, Hg, K, Mg, Na, and Zn and react with PO4/SO4/CO3/Cl or form nitrate salts; others (e.g., transition metals) are hydrolyzed to make hydrous oxides (e.g., ZrO2.xH2O).

100 - % Weston analyzed		51.1%	
Sample	[], ppm	Sample	[], ppm
Ag	9.5	Ca3(PO4)2	0.5
Al	7990	BaO	0.2
Ba	150	MgO	7.6
Be	0	AgO	0.0
Ca	9900	ZnO	0.2
Cd	3.8	Na2CrO4	0.3
Co	5.1	KOH	1.7
Cr	110	CaO	13.6
Cu	31700	NaAlO2	24.3
Fe	7570	NaFeO2	15.0
Hg	1.7	Na4SiO4	14.0
K	1155	ZrO2	12.8
Mg	4590	Na2CO3	19.9
Mn	383	CuO	39.7
Mo	0	MnO2	0.8
Na	133000	Na2SO4	87.7
Ni	49.9	NaF	39.8
Sb	0	NaOH	98.9
Se	1.1	NaCl	1.0
Si	2130	Na2TiO3	0.0
Ti	0	UO3	0.8
U	510	Sum	377.5
V	32.3		
Zn	140	LOI(dry)	22.9%
Zr	9460		
Cl	584		
F	18000		
Formate	40.7		
CN	1.4		
SO4	59300		
NO3	192123		
TOC	1893		
HPO4	284		
HCO3	8244		
pH	9.9		
%Solids	76.7		

UNKNOWN 3 & 4

SAND BLAST GRIT

Sample	Metals/Cations	SAND B.G.	Weston Labs Analysis	Calcined Compound Material Balance	Formula	Fraction	Weight/ Mole Calcine	100 - % Weston analyzed	98.1%	g/kg soln
Ag	Ag	107.888	4.00E-01	1.76E-03	4.82E-03 Ca3(PO4)2	2.16E-02	1.52E+00	Ag	0.4 Ca3(PO4)2	0.5
Al	Al	26.982	1.57E+03	1.45E-04	4.05E-04 BaO	8.90E-04	8.20E+02	Al	1585 BaO	0.0
Ba	Ba	137.33	1.99E+01	4.23E-02	1.18E-01 MgO	6.75E-02	4.78E+00	Ba	18.9 MgO	1.7
Be	Be	9.0122	1.00E-01	2.22E-05	1.11E-05 AgO	1.82E-05	1.28E+03	Be	0.1 AgO	0.0
Ca	Ca	40.08	5.34E+03	2.68E-01	3.71E-06	1.04E-05 AgO	1.23E+03	Ca	5340 ZnO	0.1
Cd	Cd	112.41	1.00E-01	8.90E-07	2.18E-03 ZnO	81.3894	1.78E-01	Cd	0.1 ZnO	0.0
Co	Co	58.933	1.80E+00	2.71E-05	4.57E-03	1.27E-02 KOH	5.15E-04	Co	1.8 KOH	0.3
Cr	Cr	51.998	8.90E+00	1.71E-04	4.00E-02	1.12E-01 CaO	7.15E-01	Cr	8.9 CaO	2.2
Cu	Cu	63.546	1.88E+02	2.64E-03	5.80E-02	8.10E-02 Al2O3	6.28E+00	Cu	167.9 Al2O3	5.9
Fe	Fe	55.847	3.99E+03	7.14E-02	1.35E-02	9.98E-02 Fe2O3	1.59E+01	Fe	3985 Fe2O3	11.4
Hg	Hg	200.59	0.00E+00	0.00E+00	1.43E-02	3.98E-02 SiO2	2.38E+00	Hg	0 SiO2	0.9
K	K	39.098	1.79E+02	4.57E-03	1.75E-03	4.88E-03 ZnO	6.01E-01	K	178.5 ZnO	0.2
Mg	Mg	24.305	1.03E+03	4.23E-02	8.43E-02	2.35E-01 CaCO3	2.38E+01	Mg	1028 CaCO3	8.4
Mn	Mn	54.938	7.44E+01	1.35E-03	2.64E-03	7.38E-03 CuO	5.87E-01	Mn	74.4 CuO	0.2
Mo	Mo	95.94	1.10E+00	1.15E-05	1.35E-03	3.78E-03 MnO2	3.29E-01	Mo	1.1 MnO2	0.1
Na	Na	22.99	6.51E+02	2.83E-02	3.63E-03	1.01E-02 CaSO4	1.38E+00	Na	650.5 CaSO4	0.5
Ni	Ni	58.7	1.60E+00	2.73E-05	4.16E-03	1.16E-02 NaF	4.88E-01	Ni	1.6 NaF	0.2
Sb	Sb	121.75	6.90E+00	5.67E-05	2.26E-02	6.32E-02 NaOH	2.53E+00	Sb	6.9 NaOH	0.9
Se	Se	78.96	1.00E-01	1.27E-06	1.50E-03	4.19E-03 NaCl	2.45E-01	Se	0.1 NaCl	0.1
Si	Si	28.086	4.01E+02	1.43E-02	2.82E-03	7.87E-03 TiO2	8.29E-01	Si	401 TiO2	0.2
Ti	Ti	47.90	1.35E+02	2.82E-02	4.12E-05	1.15E-04 UO3	3.29E-02	Ti	135 UO3	0.0
U	U	238.03	9.80E+00	4.12E-05	0.36			U	9.8 Sum	33.7
V	V	50.942	3.50E+00	6.87E-05				V	3.5 LO(dry)	-79.5%
Zn	Zn	65.38	5.06E+01	7.74E-04				Zn	50.8	
Zr	Zr	91.22	1.80E+02	1.75E-03				Zr	159.5	
Sum	Sum	13789.4	0.385					Sum	79.1	

CALCINATION ASSUMPTIONS:

1. All "N" present as nitrate.
 2. All nitrate calcined to give hydroxide.
 3. No species volatilized except H2O and N2/O2 (from decomposition of nitrate).
 4. All organic carbon converted to carbonate (CO2 from TOC oxidation captured by NaOH).
 5. Phosphate reacts preferentially with Ca (Mg, Ba form oxides).
 6. Al, Cr, Fe, and Si make oxides.
 7. Fluoride, chloride, and hydroxide form sodium salts; sulfate and carbonate form calcium salts.
- COMMENTS ON WESTON (AQUEOUS) ANALYSES:
1. Analyte material balance (total 18758 ppm) DOES NOT compare with 94.7 wt% solids reported.
 2. Cation/anion balance not good (3x cations as anions; probably due to Ca hydrolysis).
 3. Anion selection (HCO3, HPO4) consistent with pH 9.2 observed.
 4. Metals that are cationic at pH ~9.2 are Ag, Ba, Be, Ca, Cd, Hg, K, Mg, Na, and Zn and react with PO4/SO4/CO3/Cl or form nitrate salts; others (e.g., transition metals and excess Ca) are hydrolyzed to make hydrous oxides (e.g., ZnO.xH2O and CaO).
 5. Apparently, incomplete dissolution occurred in analyzing.

Sample	Metals/Cations	SAND B.G.	Weston Labs Analysis	Mole Conc. (mole/kg)	Eq. Conc. (Eq/kg)	Cat. Equiv.	Form Wt. (g)	Eq. Conc. (Eq/kg)	An. Equiv.
Ag	Ag	107.888	4.00E-01	3.71E-06	3.71E-06		35.453	1.50E-03	1.50E-03
Al	Al	26.982	1.57E+03	5.80E-02	1.57E-05		18.998	7.81E-01	4.16E-03
Ba	Ba	137.33	1.99E+01	1.45E-04	2.80E-04		45.018	3.30E+00	7.33E-05
Be	Be	9.0122	1.00E-01	2.22E-05	2.22E-05		26.018	3.00E-01	1.15E-05
Ca	Ca	40.08	5.34E+03	1.11E-05	2.22E-05		69.058	3.48E+02	7.28E-03
Cd	Cd	112.41	1.00E-01	8.90E-07	2.68E-01		62.005	3.95E+02	6.37E-03
Co	Co	58.933	1.80E+00	2.71E-05	1.78E-06		36.033	2.01E+03	5.58E-02
Cr	Cr	51.998	8.90E+00	1.71E-04	1.78E-06		65.980	3.38E+02	7.04E-03
Cu	Cu	63.546	1.88E+02	2.64E-03	2.64E-03		61.017	1.74E+03	2.85E-02
Fe	Fe	55.847	3.99E+03	7.14E-02	0.00E+00		9.2	18758	0.274
Hg	Hg	200.59	0.00E+00	0.00E+00	4.57E-03				84.7
K	K	39.098	1.79E+02	4.57E-03	8.46E-02				
Mg	Mg	24.305	1.03E+03	4.23E-02	1.35E-03				
Mn	Mn	54.938	7.44E+01	1.35E-03	2.64E-03				
Mo	Mo	95.94	1.10E+00	1.15E-05	2.83E-02				
Na	Na	22.99	6.51E+02	2.83E-02	2.83E-02				
Ni	Ni	58.7	1.60E+00	2.73E-05	2.73E-05				
Sb	Sb	121.75	6.90E+00	5.67E-05	5.67E-05				
Se	Se	78.96	1.00E-01	1.27E-06	1.27E-06				
Si	Si	28.086	4.01E+02	1.43E-02	1.43E-02				
Ti	Ti	47.90	1.35E+02	2.82E-02	2.82E-02				
U	U	238.03	9.80E+00	4.12E-05	4.12E-05				
V	V	50.942	3.50E+00	6.87E-05	6.87E-05				
Zn	Zn	65.38	5.06E+01	7.74E-04	7.74E-04				
Zr	Zr	91.22	1.80E+02	1.75E-03	1.75E-03				
Sum	Sum	13789.4	0.385						

NO3: result for N*(14.0087 + 3*15.9994/14.0087)
 TOC: result for TOC*3; to represent unsaponified carboxylic acid anions
 HPO4: result for P*(50.974 + 4*15.9994 + 1.0079)/50.974
 HCO3: result for total inorganic carbon*((12.011 + 3*15.9994 + 1.0079)/12.011)

FBlyand8CDelegard/SANDGRIT/28-July-1995

SAND BLAST GRIT

Sample	SAND B.G.	Weston Labs Analysis	Mole Conc. (mol/kg)	Cat. Equiv. (Eq/kg)	AL. Wt. (g)	100 - % Weston analyzed	86.1%
Metals/Cations	AL. Wt. (g)	[], ppm					
Ag	107.888	4.00E-01	3.71E-06	3.71E-06	3.71E-06	0.4 Ca3(PO4)2	0.5
Al	26.982	1.57E+03	5.80E-02	5.80E-02	5.80E-02	1565 BaO	0.0
Ba	137.33	1.98E+01	1.45E-04	1.45E-04	1.45E-04	19.9 MgO	1.7
Be	9.0122	1.00E-01	2.22E-05	2.22E-05	2.22E-05	0.1 AgO	0.0
Ca	40.08	5.34E+03	2.68E-01	2.68E-01	2.68E-01	5340 ZnO	0.1
Cd	112.41	1.00E-01	1.33E-01	1.33E-01	1.33E-01	0.1 Cr2O3	0.0
Co	58.933	1.60E+00	8.90E-07	8.90E-07	8.90E-07	1.8 KOH	0.3
Cr	51.998	8.90E+00	1.71E-04	1.71E-04	1.71E-04	8.9 CaO	2.2
Cu	63.546	1.68E+02	2.64E-03	2.64E-03	2.64E-03	187.9 Al2O3	3.0
Fe	55.847	3.98E+03	7.14E-02	7.14E-02	7.14E-02	3985 Fe2O3	5.7
Hg	200.59	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0 SiO2	0.9
K	39.098	1.79E+02	4.57E-03	4.57E-03	4.57E-03	178.5 SiO2	0.2
Mg	24.305	1.03E+03	8.48E-02	8.48E-02	8.48E-02	1028 CaCO3	8.4
Mn	54.938	7.44E+01	1.35E-03	1.35E-03	1.35E-03	74.4 CuO	0.2
Mo	95.94	1.10E+00	1.15E-05	1.15E-05	1.15E-05	1.1 MnO2	0.1
Na	22.99	6.51E+02	2.83E-02	2.83E-02	2.83E-02	850.5 CaSO4	0.5
Ni	58.7	1.60E+00	2.73E-05	2.73E-05	2.73E-05	1.6 NaF	0.2
Sb	121.75	6.90E+00	5.67E-05	5.67E-05	5.67E-05	6.9 NaOH	0.9
Se	78.96	1.00E-01	1.27E-08	1.27E-08	1.27E-08	0.1 NaCl	0.1
Si	28.086	4.01E+02	1.43E-02	1.43E-02	1.43E-02	40.1 TiO2	0.2
Ti	47.90	1.35E+02	2.82E-03	2.82E-03	2.82E-03	135 UO3	0.0
U	238.03	8.80E+00	4.12E-05	4.12E-05	4.12E-05	9.8 Sum	25.0
V	50.942	3.50E+00	4.12E-05	4.12E-05	4.12E-05	50.8 V	3.5
Zn	65.38	5.06E+01	7.74E-04	7.74E-04	7.74E-04	159.5 Zn	159.5
Zr	91.22	1.60E+02	1.75E-03	1.75E-03	1.75E-03	55.2 Cl	55.2
Sum	13788.4		0.385			78.1 F	78.1
						Formate	3.3
						CN	0.3
						SO4	348.5
						NO3	395
						TOC	2010
						HPO4	338
						HCO3	1741
						pH	9.2
						%Solids	94.7

CALCULATION ASSUMPTIONS:

1. All "N" present as nitrate.
2. All nitrate calcined to give hydroxide.
3. No species volatilized except H2O and N2/O2 (from decomposition of nitrate).
4. All organic carbon converted to carbonate [CO2 from TOC oxidation captured by NaOH].
5. Phosphate reacts preferentially with Ca (Mg, Ba form oxides).
6. Al, Cr, Fe, and Si make oxides.
7. Fluoride, chloride, and hydroxide form sodium salts; sulfate and carbonate form calcium salts.

COMMENTS ON WESTON (AQUEOUS) ANALYSES:

1. Analyte material balance (total 18758 ppm) DOES NOT compare with 94.7 wt% solids reported.
2. Cation/anion balance not good (3x cations as anions; probably due to Ca hydrolysis).
3. Anion selection (HCO3, HPO4) consistent with pH 9.2 observed.
4. Metals that are cationic at pH ~9.2 are Ag, Ba, Be, Ca, Cd, Hg, K, Mg, Na, and Zn and react with PO4/SO4/CO3/Cl or form nitrate salts; others (e.g., transition metals and excess Ca) are hydrolyzed to make hydrous oxides (e.g., ZnO.xH2O and CaO).
5. Apparently, incomplete dissolution occurred in analyzing.

NO3: result for N*[(14.0067 + 3*15.9994)/14.0067]

TOC: result for TOC*3; to represent unspectated carboxylic acid anions

HPO4: result for P*[(30.874 + 4*15.9994 + 1.0079)/30.874]

HCO3: result for total inorganic carbon*[(12.011 + 3*15.9994 + 1.0079)/12.011]

RBlyen&CDelegard/SANDGRIT728 - July - 1995

Sample	EVAP LIQ	Weston Labs Analysis		
Metals/Cations	At. Wt. (g)	[], ppm	Cat. Equiv. (Eq./kg)	Mole Conc. (mol/kg)
Ag	107.868	3.00E-01	2.78E-08	2.78E-08
Al	26.982	7.41E+03		2.74E-01
Ba	137.33	1.85E+01	2.40E-04	1.20E-04
Be	9.0122	3.00E-01	8.66E-05	3.33E-05
Ca	40.08	1.49E+05	7.44E+00	3.72E+00
Cd	112.41	3.00E-01	5.34E-08	2.87E-08
Co	58.933	2.40E+00		4.07E-05
Cr	51.996	3.76E+01		7.23E-04
Cu	63.546	1.84E+01		2.90E-04
Fe	55.847	3.45E+03		6.17E-02
Hg	200.59	3.00E-01	2.99E-08	1.50E-08
K	39.098	1.68E+03	4.30E-02	4.30E-02
Mg	24.305	1.79E+04	1.47E+00	7.36E-01
Mn	54.938	5.37E+01		9.77E-04
Mo	95.94	2.90E+00		3.02E-05
Na	22.99	7.59E+04	3.30E+00	3.30E+00
Ni	58.7	1.60E+01		2.73E-04
Sb	121.75	1.70E+00		1.40E-05
Se	78.96	9.00E-01		1.14E-05
Si	28.086	6.56E+03		2.33E-01
Ti	47.90	2.75E+02		5.74E-03
U	238.03	3.20E+02		1.34E-03
V	50.942	5.90E+00		1.16E-04
Zn	65.38	1.27E+01	1.94E-04	1.94E-04
Zr	91.22	3.72E+01		4.08E-04
Sum		262667.1	12.253	

Anions	Form Wt. (g)	[], ppm	An. Equiv. (Eq./kg)	Mole Conc. (mol/kg)
Cl	35.453	8.03E+02	2.26E-02	2.26E-02
F	18.998	5.04E+02	2.65E-02	2.65E-02
Formate	45.018	2.18E+02	4.80E-03	4.80E-03
CN	26.018	3.00E-01	1.15E-05	1.15E-05
SO4	96.058	1.04E+04	2.17E-01	1.08E-01
NO3	62.005	2.00E+04	3.23E-01	3.23E-01
TOC	36.033	1.96E+04	5.43E-01	5.43E-01
PO4	94.972	1.37E+02	4.33E-03	1.44E-03
CO3	60.009	3.39E+04	1.13E+00	5.84E-01
Sum		85524	2.270	
pH	13.2			
Sum Metals/Anions		348211	9.983	
Weston % Solids		77.5		

NO3: result for N*(((14.0067 + 3*15.9994)/14.0067)

TOC: result for TOC*3; to represent unspectated carboxylic acid anions

PO4: result for P*(((30.974 + 4*15.9994)/30.974)

CO3: result for total inorganic carbon*(((12.011 + 3*15.9994)/12.011)

RBIyan&CDelegard/EVAPLIQ/28 - July - 1995

Calcd Compound Material Balance

Moles/ kg sol'n	Mole Fraction	Compound	Formula	Weight Fraction (g)	Weight Mole Calcine
7.21E-04	1.27E-04	Ca3(PO4)2		310.1828	8.01E-04
1.20E-04	2.12E-05	BaO		153.3394	4.95E-05
7.36E-01	1.30E-01	MgO		40.3044	7.98E-02
2.78E-06	4.80E-07	AgO		123.8674	9.26E-07
1.94E-04	3.43E-05	ZnO		81.3694	4.25E-05
7.23E-04	8.38E-05	Cr2O3		151.9902	1.48E-04
4.30E-02	7.58E-03	KOH		56.1094	8.48E-03
2.50E+00	4.41E-01	CaO		56.0794	3.77E-01
2.74E-01	4.84E-02	NaAlO2		81.9701	8.05E-02
6.17E-02	5.44E-03	Fe2O3		159.8922	1.32E-02
2.33E-01	4.12E-02	SiO2		60.0848	3.77E-02
4.08E-04	7.19E-05	ZrO2		123.2188	1.35E-04
1.11E+00	1.95E-01	Na2CO3		105.9888	3.15E-01
2.90E-04	5.11E-05	CuO		79.5454	6.19E-05
9.77E-04	1.72E-04	MnO2		88.9376	2.28E-04
1.08E-01	1.91E-02	Na2SO4		142.0412	4.13E-02
2.65E-02	4.67E-03	NaF		41.9882	2.99E-03
5.47E-01	9.84E-02	NaOH		39.9972	5.88E-02
2.28E-02	3.98E-03	NaCl		58.4428	3.56E-03
5.74E-03	1.01E-03	TiO2		79.8988	1.23E-03
1.34E-03	2.37E-04	UO3		286.0282	1.03E-03
Sum	5.67				65.62

CALCINATION ASSUMPTIONS:

- All "N" present as nitrate.
- All nitrate calcined to give hydroxide and reacts further to make NaAlO2.
- No species volatilized except H2O and N2/O2 (from decomposition of nitrate).
- All organic carbon converted to carbonate (CO2 from TOC oxidation captured by NaOH).
- Phosphate reacts preferentially with Ca (Mg, Ba form oxides; "excess" Ca as CaO).
- Cr, Fe, and Si make oxides. Al makes NaAlO2 from NaNO3 calcine.
- Fluoride, chloride, sulfate, carbonate form sodium salts; "excess" sodium accounted as hydroxide.

COMMENTS ON WESTON (AQUEOUS) ANALYSES:

- Analyte material balance (total 348211 ppm) DOES NOT compare with 77.5 wt% solids reported.
- Cation/anion balance not good (5x cations as anions; probably due to Ca hydrolysis).
- Anion selection (CO3, PO4) consistent with pH 13.2 observed.
- Metals that are cationic at pH ~ 13.2 are Ag, Ba, Be, Ca, Cd, Hg, K, Mg, Na, and Zn and react with PO4/SO4/CO3/Cl or form nitrate salts; others (e.g., transition metals and excess Ca) are hydrolyzed to make hydrous oxides (e.g., ZrO2.xH2O and CaO).
- Apparently, incomplete dissolution occurred in analyzing.

100 - % Weston analyzed		65.2%
Sample	[], ppm	
Analyte	EVAP LIQ	Calcine g/kg soln
Ag	0.3 Ca3(PO4)2	0.2
Al	7405 BaO	0.0
Ba	18.5 MgO	29.7
Be	0.3 AgO	0.0
Ca	149000 ZnO	0.0
Cd	0.3 Cr2O3	0.1
Co	2.4 KOH	2.4
Cr	37.6 CaO	140.2
Cu	18.4 NaAlO2	22.5
Fe	3445 Fe2O3	9.9
Hg	0.3 SiO2	14.0
K	1680 ZrO2	0.1
Mg	17900 Na2CO3	117.4
Mn	53.7 CuO	0.0
Mo	2.8 MnO2	0.1
Na	75900 Na2SO4	15.4
Ni	16 NaF	1.1
Sb	1.7 NaOH	21.8
Se	0.9 NaCl	1.3
Si	8555 TiO2	0.5
Ti	275 UO3	0.4
U	320 Sum	376.2
V	5.9	
Zn	12.7 LOI(dry)	-8.0%
Zr	37.2	
Cl	802.5	
F	503.5	
Formate	216	
CN	0.3	
SO4	10400	
NO3	20031	
TOC	19580	
PO4	137	
CO3	33874	
pH	13.2	
%Solids	77.5	

Sample	EVAP LIQ	Weston Labs Analysis		
		Cat. Equiv.	Mole Conc.	
Metals/Cations	At. Wt. (g)	[], ppm	(Eq./kg)	(mol/kg)
Ag	107.868	3.00E-01	2.78E-08	2.78E-08
Al	26.982	7.41E+03		2.74E-01
Ba	137.33	1.65E+01	2.40E-04	1.20E-04
Be	9.0122	3.00E-01	6.86E-05	3.33E-05
Ca	40.08	1.48E+05	7.44E+00	3.72E+00
Cd	112.41	3.00E-01	5.34E-06	2.67E-06
Co	58.933	2.40E+00		4.07E-05
Cr	51.996	3.76E+01		7.23E-04
Cu	63.546	1.84E+01		2.90E-04
Fe	55.847	3.45E+03		6.17E-02
Hg	200.59	3.00E-01	2.99E-06	1.50E-06
K	39.098	1.68E+03	4.30E-02	4.30E-02
Mg	24.305	1.79E+04	1.47E+00	7.36E-01
Mn	54.938	5.37E+01		9.77E-04
Mo	95.94	2.90E+00		3.02E-05
Na	22.99	7.59E+04	3.30E+00	3.30E+00
Ni	58.7	1.80E+01		2.73E-04
Sb	121.75	1.70E+00		1.40E-05
Se	78.96	9.00E-01		1.14E-05
Si	28.086	6.56E+03		2.33E-01
Ti	47.90	2.75E+02		5.74E-03
U	238.03	3.20E+02		1.34E-03
V	50.942	5.90E+00		1.16E-04
Zn	65.38	1.27E+01	1.94E-04	1.94E-04
Zr	91.22	3.72E+01		4.08E-04
Sum		262687.1	12.253	
Anions	Form Wt. (g)	[], ppm	An. Equiv.	
			(Eq./kg)	
Cl	35.453	8.03E+02	2.26E-02	2.26E-02
F	18.998	5.04E+02	2.85E-02	2.85E-02
Formate	45.018	2.16E+02	4.80E-03	4.80E-03
CN	26.018	3.00E-01	1.15E-05	1.15E-05
SO4	96.058	1.04E+04	2.17E-01	1.08E-01
NO3	62.005	2.00E+04	3.23E-01	3.23E-01
TOC	36.033	1.96E+04	5.43E-01	5.43E-01
PO4	94.972	1.37E+02	4.33E-03	1.44E-03
CO3	60.009	3.38E+04	1.13E+00	5.64E-01
Sum		85524	2.270	
pH	13.2			
Sum Metals/Anions		348211	9.983	
Weston % Solids		77.5		

NO3: result for $N^*[(14.0067 + 3*15.9994)/14.0067]$

TOC: result for TOC*3: to represent unspeciatiated carboxylic acid anions

PO4: result for $P^*[(30.974 + 4*15.9994)/30.974]$

CO3: result for total inorganic carbon* $[(12.011 + 3*15.9994)/12.011]$

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Calced Compound Material Balance				
Moles/	Mole	Compound	Formula	Weight
kg sol'n	Fraction		Weight (g)	Fraction
7.21E-04	1.28E-04	Ca3(PO4)2	310.1828	6.05E-04
1.20E-04	2.13E-05	BaO	153.3394	4.98E-05
7.36E-01	1.31E-01	MgO	40.3044	8.03E-02
2.78E-08	4.93E-07	AgO	123.8674	9.32E-07
1.94E-04	3.44E-05	ZnO	81.3694	4.28E-05
3.62E-04	3.21E-05	Cr2O3	151.9902	7.43E-05
4.30E-02	7.62E-03	KOH	56.1094	6.52E-03
2.50E+00	4.43E-01	CaO	56.0794	3.79E-01
2.74E-01	4.87E-02	NaAlO2	81.9701	8.09E-02
3.08E-02	2.73E-03	Fe2O3	159.6922	6.66E-03
2.33E-01	4.14E-02	SiO2	60.0848	3.78E-02
4.08E-04	7.23E-05	ZrO2	123.2188	1.36E-04
1.11E+00	1.96E-01	Na2CO3	105.9888	3.18E-01
2.90E-04	5.13E-05	CuO	79.5454	6.23E-05
9.77E-04	1.73E-04	MnO2	86.9376	2.30E-04
1.08E-01	1.92E-02	Na2SO4	142.0412	4.16E-02
2.65E-02	4.70E-03	NaF	41.9882	3.01E-03
5.47E-01	9.69E-02	NaOH	39.9972	5.92E-02
2.26E-02	4.01E-03	NaCl	58.4428	3.58E-03
5.74E-03	1.02E-03	TiO2	79.8988	1.24E-03
1.34E-03	2.38E-04	UO3	286.0282	1.04E-03
Sum	5.64			65.54

CALCINATION ASSUMPTIONS:

1. All "N" present as nitrate.
2. All nitrate calcined to give hydroxide and reacts further to make NaAlO2.
3. No species volatilized except H2O and N2/O2 (from decomposition of nitrate).
4. All organic carbon converted to carbonate (CO2 from TOC oxidation captured by NaOH).
5. Phosphate reacts preferentially with Ca (Mg, Ba form oxides; "excess" Ca as CaO).
6. Cr, Fe, and Si make oxides. Al makes NaAlO2 from NaNO3 calcine.
7. Fluoride, chloride, sulfate, carbonate form sodium salts; "excess" sodium accounted as hydroxide.

COMMENTS ON WESTON (AQUEOUS) ANALYSES:

1. Analyte material balance (total 348211 ppm) DOES NOT compare with 77.5 wt% solids reported.
2. Cation/anion balance not good (5x cations as anions; probably due to Ca hydrolysis).
3. Anion selection (CO3, PO4) consistent with pH 13.2 observed.
4. Metals that are cationic at pH ~ 13.2 are Ag, Ba, Be, Ca, Cd, Hg, K, Mg, Na, and Zn and react with PO4/SO4/CO3/Cl or form nitrate salts; others (e.g., transition metals and excess Ca) are hydrolyzed to make hydrous oxides (e.g., ZrO2.xH2O and CaO).
5. Apparently, incomplete dissolution occurred in analyzing.

100 - % Weston analyzed		85.2%	
Sample	[], ppm		
Analyte	EVAP LIQ	Calcine	g/kg sol'n
Ag	0.3	Ca3(PO4)2	0.2
Al	7405	BaO	0.0
Ba	18.5	MgO	29.7
Be	0.3	AgO	0.0
Ca	149000	ZnO	0.0
Cd	0.3	Cr2O3	0.1
Co	2.4	KOH	2.4
Cr	37.6	CaO	140.2
Cu	18.4	NaAlO2	22.5
Fe	3445	Fe2O3	4.9
Hg	0.3	SiO2	14.0
K	1880	ZrO2	0.1
Mg	17900	Na2CO3	117.4
Mn	53.7	CuO	0.0
Mo	2.9	MnO2	0.1
Na	75900	Na2SO4	15.4
Ni	16	NaF	1.1
Sb	1.7	NaOH	21.9
Se	0.9	NaCl	1.3
Si	8555	TiO2	0.5
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Cl	802.5		
F	503.5		
Formate	216		
CN	0.3		
SO4	10400		
NO3	20031		
TOC	19560		
PO4	137		
CO3	33674		
pH	13.2		
%Solids	77.5		

EVAPORATED LIQUIDS

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