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Revision 0

SALTSTONE CY07 TCLP RESULTS

A.D. Cozzi

June 2008

Environmental & Chemical Process Technology
Savannah River National Laboratory
Aiken, SC 29808

Prepared for the U.S. Department of Energy Under Contract Number DEAC09-96SR18500

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SAVANNAH RIVER NATIONAL LABORATORY

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2.0 EXECUTIVE SUMMARY

Saltstone waste forms were prepared in the Savannah River National Laboratory from Tank 50H samples and Z-Area premix material for each of the four quarters of calendar year 2007 (CY07). After the prescribed 28 day cure, samples of the saltstone were collected, and the waste form was shown to meet the South Carolina Hazardous Waste Management Regulations (SCHWMR) R.61-79.261.24 and R.61-79.268.48(a) requirements for a nonhazardous waste form with respect to RCRA metals and underlying hazardous constituents. These analyses met all quality assurance specifications of USEPA SW-846.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS

B&WTSG-RACL	B & W Technical Services Group-Radioisotope and Analytical Chemistry Laboratory
CVAA	Cold Vapor Atomic Absorption
DL	Detection Limit
ESS-WP	Environmental Services Section – Waste Programs
ETP	Effluent Treatment Project
ICP-MS	Inductively Coupled Plasma – Mass Spectrometer
ISWLF	Industrial Solid Waste Landfill
LCS	Laboratory Control Sample
MCL	Maximum Contaminant Level
MS	Matrix Spike
MSD	Matrix Spike Duplicate
QL	Quantitation Limit
RCRA	Resource Conservation and Recovery Act
RL	Reporting Limit
RPD	Relative Percent Differences
SCDHEC	South Carolina Department of Health and Environmental Control
SDF	Saltstone Disposal Facility
SDG	Sample Delivery Group
SPF	Saltstone Production Facility
SRNL	Savannah River National Laboratory
TCLP	Toxic Characteristic Leaching Procedure
UHC	Underlying Hazardous Constituent
UTS	Universal Treatment Standards

2.0 INTRODUCTION

The Saltstone Production Facility (SPF) receives waste from Tank 50H for treatment. In the 2007 calendar year (CY07), in addition to the H-Canyon low-activity waste and Effluent Treatment Project (ETP) waste that comprised Batch 0, which was processed for disposal in the Saltstone Disposal Facility (SDF) from 12/04/2006 through 02/13/2007, Tank 50H received a significant waste transfer from Tank 23H and a smaller transfer from Tank 49H.

The Saltstone Grout Sampling plan provides the South Carolina Department of Health and Environmental Control (SCDHEC) with the chemical and physical characterization strategy for the salt solution which is to be disposed of in the Z-Area Industrial Solid Waste Landfill (ISWLF) during CY07 processing. During operation, samples were collected from Tank 50H and grout samples prepared to determine the non-hazardous nature of the grout to meet the requirements of SCHWMR R.61-79.261.24(b) and R.61-79.268.48(a).[1]

SRNL was asked to prepare saltstone from a sample of Tank 50H obtained during CY07 processing to determine the non-hazardous nature of the grout. The samples were cured and shipped to Babcock & Wilcox Technical Services Group-Radioisotope and Analytical Chemistry Laboratory (B&WTSG-RACL) to perform the Toxic Characteristic Leaching Procedure (TCLP)[2] and subsequent extract analysis on saltstone samples for the analytes required for the quarterly analysis saltstone sample. In addition to the eight toxic metals—arsenic, barium, cadmium, chromium, mercury, lead, selenium silver—analytes included the underlying hazardous constituents (UHC) beryllium, nickel, and thallium which could not be eliminated from analysis by process knowledge.[3] B&WTSG-RACL provided subsamples to GEL Laboratories, LLC for analysis for benzene, phenols and total and amenable cyanide.

3.0 EXPERIMENTAL

This section is a summary of the approach taken to prepare and characterize the saltstone samples. The saltstone sample preparation was performed in SRNL. Saltstone sample characterization was performed at both B&WTSG-RACL facility in Lynchburg, Virginia and the GEL laboratory facility in Charleston, South Carolina. Figure 1 is a flowchart of the steps taken to prepare and characterize the saltstone samples.

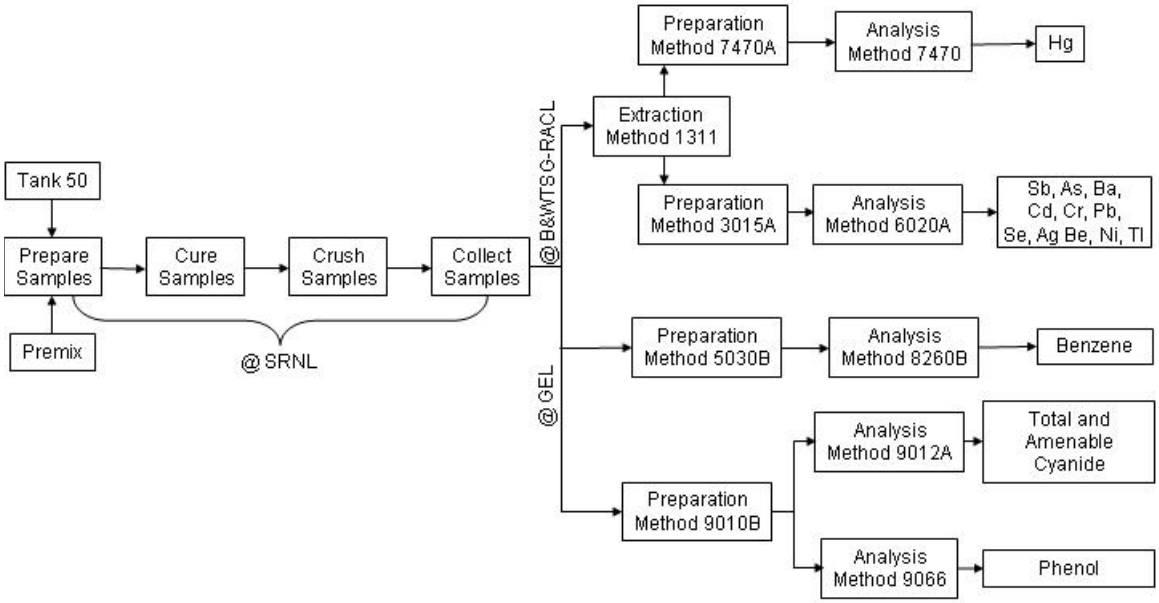

Figure 1 Flowchart of saltstone sample preparation and analysis.

3.1 Saltstone Preparation

Saltstone preparation was performed at SRNL. The weight percent solids data used for the TCLP samples were taken from the quarterly Waste Acceptance Criteria (WAC) analyses performed on Tank 50.[4-7] Table 1 lists the concentration TCLP metals of interest in the salt solution from the WAC analyses from the samples taken in 2007. Complete analyses of the salt solution used are in References 2-5. Table 2 contains the parameters used to prepare each of the TCLP samples.

Saltstone samples for TCLP were prepared with the Tank 50H blended salt solution and a premix of cement, slag, and fly ash. Figure 2 shows the formulation used to prepare these samples. The salt solution, admixtures and premix materials were combined in a blender and mixed at low speed for one minute, inspected for incorporation of the premix, and then mixed at high speed for an additional two minutes. After the saltstone slurry was mixed, it was cast into glass bottles with Teflon lined lids to cure.

After curing for not less than 28 days,* the saltstone was removed from the container and a portion of the saltstone was crushed to particles less than 0.9 centimeters (3/8 inch) as prescribed by Section 7.13 of the TCLP method.[2] The crushed saltstone was packaged into containers provided by Environmental Services Section – Waste Programs (ESS-WP). After the saltstone has been crushed, sieved and packaged, the sample is deemed "collected."[8] ESS-WP retrieved the samples from SRNL and transported them to B&WTSG-RACL for extraction and analysis.

* Samples are considered ready for analysis after 28 days. Samples are not crushed until shipment has been scheduled.

B&WTSG-RACL repackaged 9-10 grams of each of the four samples and shipped the samples to GEL Laboratories to perform totals analysis for the UHCs benzene, phenol and total and amenable cyanide.

Table 1. Sample Results of TCLP Metal from Tank 50 WAC Analyses.

-	Sample Results (mg/L)				Regulatory Limits (mg/L)
-	**1Q07[4]**	**2Q07[5]**	**3Q07[6]**	**4Q07[7]**	**Toxicity[a]**
As	< 0.715	< 0.061	< 0.0535	< 0.0463	5
Ba	< 10.7	1.56	< 1.23	1.91	100
Cd	< 3.98	< 0.304	< 1.6	< 1.39	1
Cr	< 20.4	15.3	11.5	14.9	5
Pb	< 253	1.44	0.879	1.93	5
Hg	6.93	68.3	26.0	101	0.2
Se	< 1.43	< 0.122	< 0.107	< 0.0926	1
Ag	< 8.7	< 0.719	< 0.568	< 4.90	5
--	--	--	--	--	**UHC[b]**
Be	NM	< 1.59E-02	< 0.217	< 0.187	1.22
Ni	< 29.6	43.3	16.2	37.4	11
Tl	NM	0.464	< 2.63E-04	0.134	0.20
-	-	-	-	-	**(mg/kg)**
benzene	< 0.25	<0.25	<0.25	<0.25	10
phenol	< 1	< 0.1	1.5	< 0.1	5.2
cyanide (total)	NM	NM	NM	NM	1.2
cyanide (amenable)	NM	NM	NM	NM	0.86

NM – Not Measured
[a] R.61-79.261.24(b) "Characteristic of Toxicity."
[b] R.61-79.268.48 "Universal Treatment Standards."

Table 2. Customer Recommended Values for Preparation of TCLP Samples.

Parameter	1Q07	2Q07	3Q07	4Q07
Water-to-Premix ratio	0.63	0.63	0.62	0.62
Set Retarder g/g premix	0.27	0.27	0.27	0.19
(Daratard 17) gal/Ton premix	0.53	0.53	0.53	0.37
Defoamer g/g premix	0.14	0.14	0.066	0.066
(Clean Air 100) gal/Ton premix	0.35	0.35	0.16	0.16

As can be gleaned from Table 1, mercury and chromium are the two constituents positively identified above toxic levels. The analyses of the constituents shaded in gray were reported with detection limits greater than the toxicity limit and therefore must be considered toxic for those constituents. Because the samples are considered hazardous, treatment is required for the UHCs nickel and thallium, as they exceed the regulatory limits as shown in Table 1. For the 2Q sample, SRNL Analytical Development was asked to reduce the detection limit to below the toxicity level. This was accomplished for all constituents but cadmium. To determine if a TCLP is required, the maximum release can be calculated from the contaminant level in the waste solution, normalized to the concentration in saltstone, and multiplied by twenty to account for the TCLP extract. For example, from Table 1, the concentration of cadmium in the fourth quarter sample is <1.39 mg/L. To be conservative, one can assume the detection limit is the value, 1.39 mg/L Cd. From Figure 2, it can be seen that the saltstone sample is 45.52 wt% salt solution. Reference [7] reports a specific gravity of 1.22.

$$\frac{mg\,Cd}{kg\,saltstone} = \frac{1.39\,mg\,Cd}{L\,salt\,solution} \times \frac{1\,L\,salt\,solution}{1.22\,kg\,salt\,solution} \times \frac{0.4552\,kg\,salt\,solution}{1\,kg\,saltstone} = 0.52 \qquad (1)$$

In the TCLP, the saltstone is extracted by a 20x mass of extraction fluid.[2] When the extraction is complete, the regulatory limits are applied to the concentration of the contaminant in the analysis of the extract solution. Continuing the example, 100 grams of saltstone—containing 0.052 mg cadmium—is extracted by 2 L of TCLP extract. If *all* of the cadmium is extracted, the cadmium concentration in the extract would be 0.026 mg Cd/L extract. The regulatory limit for cadmium in Table 1 is 1 mg Cd/L extract. Therefore, it can be demonstrated without analysis that saltstone prepared for the fourth quarter of CY07 is not hazardous for cadmium. Using this methodology, it can be determined that the saltstone prepared with the salt solutions in Table 1 that the only contaminant that cannot be mathematically excluded from analysis for each sample is mercury.

Saltstone Mix Data Sheet

MIX # 0078			Date: 12/19/2007
Material	**%**	**WT%**	**Grams**
Waste Solution: Tank 50 Batch 0 Q1 **Wt% Solids #** 30 **Grams Water** 252.00		47.27	360.00
Admixture: Daratard 17		0.27	1.08
Admixture: Clear Air 100		0.14	0.56
Admixture:			
Premix		52.52	400.00
Cement (% of Premix)	10	5.25	40.00
Slag (% of Premix)	45	23.63	180.00
Fly Ash (% of Premix)	45	23.63	180.00
Total	100	100.2	761.64
Water to Premix Ratio	0.63		

Calculations:
Sample Collected 2/07 for 1Q07 WAC

W/P 0.63
Daratard 17 0.27 wt% of premix
Clear Air 0.14 wt% of premix

Saltstone Mix Data Sheet

MIX # 0079			Date: 12/19/2007
Material	**%**	**WT%**	**Grams**
Waste Solution: Tank 50 Batch 1 Q2 **Wt% Solids #** 30.45 **Grams Water** 253.86		47.61	365.00
Admixture: Daratard 17		0.27	1.08
Admixture: Clear Air 100		0.14	0.56
Admixture:			
Premix		52.18	400.00
Cement (% of Premix)	10	5.22	40.00
Slag (% of Premix)	45	23.48	180.00
Fly Ash (% of Premix)	45	23.48	180.00
Total	100	100.2	766.64
Water to Premix Ratio	0.63		

Calculations:
wt % solids from TK 50 WAC for 4/07 samples

W/P 0.63
Daratard 17 0.27 wt% of premix
Clear Air 0.14 wt% of premix

Saltstone Mix Data Sheet

MIX # 0080			Date: 12/19/2007
Material	**%**	**WT%**	**Grams**
Waste Solution: Tank 50 Batch 2 Q3 **Wt% Solids #** 27.4 **Grams Water** 246.84		45.86	340.00
Admixture: Daratard 17		0.27	1.08
Admixture: Clear Air 100		0.07	0.26
Admixture:			
Premix		53.96	400.00
Cement (% of Premix)	10	5.40	40.00
Slag (% of Premix)	45	24.28	180.00
Fly Ash (% of Premix)	45	24.28	180.00
Total	100	100.2	741.34
Water to Premix Ratio	0.62		

Calculations:
wt % solids from TK 50 WAC for 9/07 samples

Per LWO-WSE-2007-00216
W/P 0.62
Daratard 17 0.27 wt% of premix
Clear Air 0.066 wt% of premix

Saltstone Mix Data Sheet

MIX # 0082			Date: 12/19/2007
Material	**%**	**WT%**	**Grams**
Waste Solution: Tank 50 Batch 2 Q4 **Wt% Solids #** 26.2 **Grams Water** 247.23		45.52	335.00
Admixture: Daratard 17		0.19	0.75
Admixture: Clear Air 100		0.07	0.26
Admixture:			
Premix		54.35	400.00
Cement (% of Premix)	10	5.43	40.00
Slag (% of Premix)	45	24.46	180.00
Fly Ash (% of Premix)	45	24.46	180.00
Total	100	100.1	736.01
Water to Premix Ratio	0.62		

Calculations:
wt % solids from TK 50 WAC for 11/07 samples

Per LWO-WSE-2007-00216
W/P 0.62
Daratard 17 0.19 wt% of premix
Clear Air 0.066 wt% of premix

Figure 2. Data sheets for the saltstone mixes used to prepare samples for TCLP.

3.2 Saltstone Testing

Saltstone testing was performed by B&WTSG-RACL and GEL Laboratories, LLC. Activities associated with the four CY07 saltstone samples were:

At B&WTSG-RACL,

- performing the TCLP extraction,
- digesting the TCLP leachate,
- analyzing the digested leachate.

At GEL

- performing extractions on solid subsamples shipped from B&WTSG-RACL,
- analyzing extracts.

3.2.1 B&WTSG-RACL

The samples arrived at B&WTSG-RACL, Lynchburg, Virginia on March 17, 2008 for analysis. Shipping container temperatures were documented to be within specifications. The samples were delivered with proper chain of custody documentation and signatures. All sample containers arrived without any visible signs of tampering or breakage.

The Metals method 6020A analysis was performed on an X-7 Series Inductively Coupled Plasma – Mass Spectrometer (ICP-MS). The instrument measures ions produced by a radio-frequency inductively coupled plasma. Analyte species originating in a liquid are nebulized and the resulting aerosol transported by argon gas into the plasma torch. The ions produced by high temperatures are entrained in the plasma gas and introduced, by means of an interface, into a mass spectrometer. The ions produced in the plasma are sorted according to their mass-to-charge rations and quantified with a channel electron multiplier. Mass interferences must be assessed and valid corrections applied or the data flagged to indicate problems.

The Metals method 7470A analysis was performed on a Leman PC 200 II instrument which consists of a cold vapor atomic absorption spectrometer (CVAA) set to detect mercury at a wavelength of 253.7 nm. The mercury is reduced to the elemental state and aerated from solution in a closed system. The mercury vapor passes through a cell positioned in the light path of an atomic absorption spectrophotometer. Absorbance (peak height) is measured as a function of mercury concentration.

A portion of the leachate from the first quarter sample was used as the quality control sample (matrix spike) for the ICP-MS and CVAA.

3.2.2 GEL Laboratories, LLC

The subsamples arrived at GEL Laboratories, LLC, Charleston, South Carolina on March 20, 2008 for analysis. Shipping container temperatures were documented to be within specifications. The samples were delivered with proper chain of custody documentation and signatures. All sample containers arrived without any visible signs of tampering or breakage.

The method 8260B analysis was performed with an HP6890/HP5973 gas chromatograph/mass spectrometer using an Agilent DB-624 column.

The methods 9012A and 9066 were performed using a Lachat QuickChem FIA+ Ion Analyzer.

4.0 RESULTS & DISCUSSION

4.1 Sample Results

Results were summarized in Table 3 from the data package for these analyses.[9] Data is presented as reported by the vendors.

4.1.1 B&WTSG-RACL

Analytes detected but at concentrations too low to determine quantitatively have been flagged with the "J" qualifier. Analytes that were not detected have been flagged with the "U" qualifier. In addition to the results, Detection Limits (DLs) have been given. The DL is the minimum concentration of an analyte that can be identified, measured, and reported with 99% confidence that the concentration is above zero. The DL values given in the table are the results from this study adjusted for sample dilution. The QL is the lowest level at which an analyte may be accurately and reproducibly quantitated.

Results in Table 3, when compared with the DLs and QLs, can be organized into three groups:

- Cadmium, silver, and beryllium were not detected in any leachates.
- Chromium, lead, selenium, nickel, and thallium were detected below the QLs.
- Arsenic, barium and mercury were detected in all leachates at concentrations above the QLs.

Table 3. TCLP Leachates RCRA Metal Concentrations, DLs, and QLs.

-	Methods	Sample Limits (µg/L)	Sample Limits (µg/L)	Sample Results (µg/L)			
SRS ID	**-**	**-**	**-**	**1Q07**	**2Q07**	**3Q07**	**4Q07**
B&W ID	**-**	**DL**	**QL**	**0803011-01**	**0803011-02**	**0803011-03**	**0803011-04**
As	3015A, 6020A	0.100	5.556	16.8	15.0	18.1	16.5
Ba	3015A, 6020A	0.439	55.556	168	186	177	187
Cd	3015A, 6020A	0.111	5.556	[U]0.111	[U]0.111	[U]0.111	[U]0.111
Cr	3015A, 6020A	0.306	11.111	6.8	4.9	5.6	5.5
Pb	3015A, 6020A	0.483	5.556	2.6	[U]0.483	[U]0.483	[U]0.483
Hg	7470A	0.068	0.200	2.510	6.740	3.920	5.000
Se	3015A, 6020A	0.244	27.778	8.9	8.6	10.3	7.9
Ag	3015A, 6020A	0.061	5.556	[U]0.061	[U]0.061	[U]0.061	[U]0.061
Be	3015A, 6020A	0.156	5.556	[U]0.156	[U]0.156	[U]0.156	[U]0.156
Ni	3015A, 6020A	1.6	5.556	3.7	3.9	3.0	3.3
Tl	3015A, 6020A	0.206	5.556	[B]0.483	3.4	[B]1.4	[B]0.817

- Indicates a location in the table for which an entry would not be appropriate.
[U] Final concentration of the analyte was found to be below the DL.
[B] Analyte is present at a concentration above the DL but less than the QL.

4.1.2 Comparison of Results to Regulatory Limits

Results from the TCLP leachate analyses from Table 3 are replicated in Table 4—with units changed from µg/L to mg/L—along with the regulatory limits that may be applied to the Saltstone waste form. Table 4 includes the SCHWMR R.61-79.261.24(b) limits above which a waste is to be considered characteristically hazardous for toxicity and the SCHWMR R.61-

79.268.48 Universal Treatment Standards (UTS) for hazardous constituents. In addition, Maximum Contaminant Levels (MCLs) from the State Primary Drinking Water Regulations† also have been included in Table 4. By comparing the sample results and the regulatory limits in Table 4, the following conclusions can be made:

- The saltstone waste form was not characteristically hazardous for toxicity.
- The leachate metals concentrations were below the Nonwastewater Standard for all of the metals.
- The leachate metals concentrations were below the MCLs for barium, cadmium, chromium, lead, selenium, silver and thallium—except for the 2Q07 sample. Nickel does not have an MCL value.
- Arsenic and mercury exceeded the MCL in all samples. Thallium exceeded the MCL in the 2Q07 sample. The MCL is the limit for a constituent in drinking water. The MCL is used to determine the class of landfill required. At 10x MCL, a Class 3 landfill is required. The SDF vaults are permitted as a Class 3 landfill.

The TCLP leachate RCRA metal concentrations were well below the SCHWMR R.61-79.261.24(b) limits for characteristically hazardous toxic waste. Similarly, all results were less than the UTS Nonwastewater Standard. None of the analyses were greater than 5x the MCL.

Table 4 Saltstone TCLP Results and Corresponding Regulatory Limits.

-	Sample Results (mg/L)				Regulatory Limits		
SRS ID	**1Q07**	**2Q07**	**3Q07**	**4Q07**	**Toxicity[a]**	**UTS[b]**	**MCL[c]**
B&W ID	**0803011-01**	**0803011-02**	**0803011-03**	**0803011-04**	**(mg/L)**	**Nonwastewater Standard (mg/L TCLP)**	**(mg/L)**
As	0.0168	0.0150	0.0181	0.0165	5	5	0.010
Ba	0.168	0.186	0.177	0.187	100	21	2
Cd	U1.E-04	U1.E-04	U1.E-04	U1.E-04	1	0.11	0.005
Cr	B6.8E-03	B4.9E-03	B5.6E-03	B5.5E-03	5	0.6	0.1
Pb	B2.6E-03	U4.83E-04	U4.83E-04	U4.83E-04	5	0.75	0.015[d]
Hg	2.5E-03	6.7E-03	3.9E-03	5.0E-03	0.2	0.025	2E-03
Se	B8.9E-03	B8.6E-03	B1.0E-02	B7.9E-03	1	5.7	0.05
Ag	U6.1E-05	U6.1E-05	U6.1E-05	U6.1E-05	5	0.14	0.1[e]
Be	U1.6E-04	U1.6E-04	U1.6E-04	U1.6E-04	-	1.22	4E-03
Ni	B3.7E-03	B3.9E-03	B3.0E-03	B3.3E-03	-	11	-
Tl	B4.8E-04	B3.4E-03	B1.4E-03	B8.2E-04	-	0.20	2E-03

- Indicates a location in the table for which an entry would not be appropriate.
U Final concentration of the analyte was found to be below the DL.
BAnalyte is present at a concentration above the DL but less than the QL.
[a] R.61-79.261.24(b) "Characteristic of Toxicity".
[b] R.61-79.268.48 "Universal Treatment Standards".
[c] SCDHEC State Primary Drinking Water Regulation Maximum Contaminant Levels.
[d] Lead action level from SCDHEC 61-58.11.B.
[e] Secondary drinking water parameter.

† Regulations 61-58 through 61-58.15 are promulgated pursuant to S.C. Code Sections 44-55-10 et seq. and are collectively known as the State Primary Drinking Water Regulations.

4.1.3 Quality Assurance

The following subsections include summaries of results from blanks, laboratory control samples, matrix spikes, and matrix spike duplicates. The data package for this task also includes data for calibration verifications, interference checks, and serial dilutions.

4.1.4 Blanks

Blank concentrations are given in Table 5. In the Method Blank, arsenic, lead, selenium and nickel were present at levels above their DLs, but below their QLs. In the TCLP Blank, barium, chromium, lead, selenium, silver, nickel and thallium were present at levels above their DLs, but below their QLs. The Method Blanks analyzed with this Sample Delivery Group (SDG) met the acceptance criteria. Nickel is of the same magnitude in both blanks and in the quarterly samples. This suggests that the vendor is experiencing difficulty with measuring nickel in their system—either the Torch is producing a high background level of nickel, or there is a mass interference with this measurement.

Table 5. Method Blank and TCLP Blank.

Analyte	Method Blank (μg/L)	TCLP Blank (μg/L)
As	[B]-0.111	[U]0.100
Ba	[U]0.439	[B]9.5
Cd	[U] 0.111	[U]0.111
Cr	[U] 0.306	[B]5.38
Pb	[B]0.606	[B]1.3
Hg	[U]0.068	[U]0.068
Se	[B] 1.978	[B]1.3
Ag	[U] 0.061	[B]0.128
Be	[U]0.156	[U]0.156
Ni	[B]3.106	[B]4.5
Tl	[U]0.206	[B]0.828

[U] Final concentration of the analyte was found to be below the DL.
[B] Analyte is present at a concentration above the DL but less than the QL.

4.1.5 Laboratory Control Samples

Results from the Laboratory Control Sample (LCS) are given in Table 6. All LCS recoveries except selenium met USEPA SW-846 acceptance limits (85-125% recovery). Laboratory Control Samples are clean aqueous solutions analyzed to assure integrity of the analytical technique exclusive of matrix effects.

Table 6. RCRA Metal Laboratory Control Sample.

Analyte	Laboratory Control (µg /L)		Recovery (%)
-	True	Measured	-
As	755.0	646.11	86
Ba	2180.0	2030.0	93
Cd	112.0	102.44	91
Cr	417.0	396.56	95
Pb	1630.0	1562.22	96
Hg	8.4	9.78	116.3
Se	502.0	391.22	*78*
Ag	574.0	547.78	95
Be	629.0	581.11	92
Ni	843.0	789.44	94
Tl	445.0	408.61	92

4.1.6 Matrix Spikes

Results from analysis of the matrix spike (MS) and matrix spike duplicates (MSD) are given in Table 7. These results show that:

- The percent recoveries (%R) obtained from the MS analyses met the recommended quality control acceptance criteria for percent recoveries for all applicable analytes with the exceptions of silver, nickel, selenium, and cadmium.
- The percent recoveries (%R) obtained from the MSD analyses met the recommended quality control acceptance criteria for percent recoveries for all applicable analytes with the exceptions of silver, nickel, selenium, and cadmium.
- The RPD(s) between the MS and MSD met the acceptance limits.

Table 7. TCLP Leachates RCRA Metal Matrix Spike and Duplicate Results.

Analyte	Initial Concentrations (µg /L)		Spiked Sample (µg /L)		Recovery (%)		RPD (%)
-	B&W ID 08037-SS-07FY01	Spike Added	Spike	Spike Duplicate	Spike	Spike Duplicate	-
As	16.8	2222.22	1741.6667	1692.7779	78	76	3
Ba	168	2222.22	2035.0000	2057.7779	90	91	1
Cd	[U]0.111	55.56	40.8556	41.3722	74	74	1
Cr	[B]6.8	222.22	180.2778	183.8333	81	82	2
Pb	[B]2.6	555.56	490.3889	503.5000	88	91	3
Hg	2.510	5.0	7.900	7.960	107.8	109	0.8
Se	[B]8.9	2222.22	1565.5554	1445.5556	70	*65*	8
Ag	[U]0.061	55.56	11.8222	11.8167	*21*	*21*	0
Be	[U]0.156	55.56	44.6944	45.8500	80	83	3
Ni	[B]3.7	555.56	401.7222	410.5000	72	74	2
Tl	[B]0.483	2222.22	2003.3333	2061.1112	90	93	3

[U] Final concentration of the analyte was found to be below the DL.
[B] Analyte is present at a concentration above the DL but less than the QL.

4.1.7 Calibration Information

- All initial calibration requirements have been met for this sample delivery group (SDG).
- All Contract Required Detection Limit standard(s) met the referenced advisory control limits.
- All interference check samples associated with this SDG met the established acceptance criteria.
- All continuing calibration blanks bracketing this batch met the established acceptance criteria.
- All continuing calibration verifications bracketing this SDG met the acceptance criteria.

4.1.8 GEL Laboratories, LLC

Analytes detected but at concentrations too low to determine quantitatively have been flagged with the "J" qualifier. Analytes that were not detected have been flagged with the "U" qualifier. In addition to the results, Detection Limits (DLs) and Reporting Limits (RLs) have been given. The DL is the minimum concentration of an analyte that can be identified, measured, and reported with 99% confidence that the concentration is above zero. The DL values given in Table 8 are the results from this study adjusted for sample dilution. The RL is the lowest level at which an analyte may be accurately and reproducibly quantitated.

Table 8. Totals Concentrations, DLs, and RLs.

-	Methods	Sample Limits (µg/kg)	Sample Limits (µg/kg)	Sample Results (µg/kg)			
SRS ID	-	-	-	**1Q07**	**2Q07**	**3Q07**	**4Q07**
GEL ID	-	**DL**	**RL**	**205116001**	**205116002**	**205116003**	**205116004**
benzene	5030B, 8260B	1.65	5.00	[U]5.00	[J]3.30	[J]3.38	9.93
phenol	9010B, 9066	72.1	240	[U]ND	[J]217	[J]174	[U]ND
cyanide (total)	9010B, 9012A	63.7	236	5610	5050	5540	5320
cyanide (amenable)	9012A	63.7	236	[U]ND	1280	[U]ND	630

- Indicates a location in the table for which an entry would not be appropriate.
ND – Not Detectable
[U] Final concentration of the analyte was found to be below the DL.
[J] Analyte is present at a concentration above the DL but less than the RL.

4.1.9 Comparison of Results to Regulatory Limits

Results from the analyses from Table 8 are replicated in Table 9—with units changed from µg/kg to mg/kg—along with the regulatory limits that may be applied to the Saltstone waste form. Table 9 includes the SCHWMR R.61-79.268.48 Universal Treatment Standards (UTS) for hazardous constituents. By comparing the sample results and the regulatory limits in Table 9, the following conclusions can be made:

- The totals concentrations were below the Nonwastewater Standard for all of the analytes.

Table 9 Saltstone Totals Results and Corresponding Regulatory Limits.

-	Sample Results (mg/kg)				Regulatory Limits (mg/kg)
SRS ID	**1Q07**	**2Q07**	**3Q07**	**4Q07**	**UTS[b]**
GEL ID	**205116001**	**205116002**	**205116003**	**205116004**	
benzene	[U]0.00500	[J]0.00330	[J]0.00338	0.00993	10
phenol	[U]ND	[J]0.217	[J]0.174	[U]ND	6.2
cyanide (total)	5.610	5.050	5.540	5.320	590
cyanide (amenable)	[U]ND	0.1280	[U]ND	0.630	30

- Indicates a location in the table for which an entry would not be appropriate.
[U] Final concentration of the analyte was found to be below the DL.
[B]Analyte is present at a concentration above the DL but less than the QL.
[b] R.61-79.268.48 “Universal Treatment Standards”.

4.1.10 Quality Assurance

The following subsections include summaries of results from blanks, laboratory control samples, matrix spikes, and matrix spike duplicates. The data package for this task also includes data for calibration verifications, interference checks, and serial dilutions.

4.1.11 Blanks

Blank concentrations are given in Table 10. No analytes were detected in the Method Blank. Amenable to chlorination cyanide is determined by subtracting the results determined in the

chlorinated cyanide test from those determined in the total cyanide test. The Method Blanks analyzed with this Sample Delivery Group (SDG) met the acceptance criteria.

Table 10. Method Blank.

Analyte	Method Blank (µg/kg)
benzene	[U]1.0
phenol	[U]ND
cyanide (total)	[U]ND
cyanide (amenable)	--

- Indicates a location in the table for which an entry would not be appropriate.
ND – Not Detectable
[U] Final concentration of the analyte was found to be below the DL.

4.1.12 Laboratory Control Samples

Results from the Laboratory Control Sample (LCS) are given in Table 11. All LCS recoveries met USEPA SW-846 acceptance limits (85-125% recovery). Laboratory Control Samples are clean aqueous solutions analyzed to assure integrity of the analytical technique exclusive of matrix effects.

Table 11. Laboratory Control Sample.

Analyte	Laboratory Control (µg /kg)			Recovery (%)	
-	True	Measured		-	
benzene	50.0	41.8	41.7	84	83
phenol	2500	2750	2490	110	99
cyanide (total)	174000	283000		162[a]	
cyanide (amenable)	--	--		--	

[a] The recovery % for the LCS was outside of the normal acceptance limits. However, the value was within the acceptance criteria.

4.1.13 Matrix Spikes

Total cyanide is the only method where a matrix spike would be applicable. The result from analysis of the matrix spike (MS) is given in Table 12. These results show that the percent recoveries (%R) obtained from the MS analyses met the recommended quality control acceptance criteria for percent recoveries.

Table 12. Matrix Spike Results.

Analyte	Initial Concentrations (µg /kg)		Spiked Sample (µg /kg)	Recovery (%)
-	GEL ID 120115411701	Spike Added		
cyanide (total)	[U]ND	5520	4650	84

ND-Not Detectable

4.1.14 Calibration Information

- All initial calibration requirements have been met for this sample delivery group (SDG).
- All Contract Required Detection Limit standard(s) met the referenced advisory control limits.
- All interference check samples associated with this SDG met the established acceptance criteria.
- All continuing calibration blanks bracketing this batch met the established acceptance criteria.
- All continuing calibration verifications bracketing this SDG met the acceptance criteria.

5.0 CONCLUSIONS

Preparation of the CY07 saltstone samples and the subsequent TCLP analyses showed that:

- All of saltstone waste form disposed of in the Saltstone Disposal Facility in CY07 was not characteristically hazardous for toxicity.
- The concentrations of the eight RCRA metals and UHCs identified as possible in the saltstone waste form were present at levels below the UTS.
- Analyses met all quality assurance specifications of USEPA SW-846.

The saltstone waste form placed in the Saltstone Disposal Facility in CY07 met the SCHWMR R.61-79.261.24(b) RCRA metals requirements for a nonhazardous waste form. The TCLP leachate concentrations were less than 5x the MCLs in SCDHEC Regulations R.61-107.16, Subpart A, 16.5.

The saltstone waste form placed in the Saltstone Disposal Facility in CY07 met the R.61-79.268.48(a) non wastewater treatment standards.

Analyses met all USEPA SW-846 quality assurance requirements. This included limits on holding times, laboratory control sample recoveries, matrix spike recoveries, serial dilution results when applicable, calibration verification, and interference checks.

6.0 REFERENCES

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