

**APPENDIX R**

**Soils Analysis Report, USACE Waterways Experiment Station**



US Army Corps  
of Engineers



Report to Philadelphia District  
Dupont-Chambers Uranium Mobility Study

By:

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## **Introduction**

The Philadelphia District, USACE, has contracted ERDC-Vicksburg to analyze a series of samples from the Dupont-Chambers FUSRAP Site for Uranium concentration and geochemical characterization. This report discusses the findings from the initial set of samples received on 10 September 2003. All chemical analyses reported were performed at the Environmental Chemistry Branch, Vicksburg, MS or Omaha, NE facilities. Subsamples for SEM and XRD analysis were subcontracted to New Mexico Institute of Mining and Technology for analysis. Samples were received from the field such that the combined uranium activity was less than 54 pCi/g.

## **Materials, Methods and Quality Control**

Eleven samples were received with intact chain of custody seals on 10 September 2003. Samples were stored at 4°C in a locked cooler. A battery of analytical tests was requested for these samples as outlined in the ERDC cost estimate attached to this report as Appendix 1. The tests requested included: Scanning Electron Microscopy (SEM), X-ray Diffraction (XRD), Sequential Extraction, Total Digestion Uranium and Strontium, Distribution Coefficient ( $K_d$ ), Total Organic Carbon (TOC), Cation Exchange Capacity (CEC), and qualitative total Strontium-90. The  $K_d$  experiments will be expanded and data will be reported in subsequent reports. All experiments were determined on air-dried samples and the percent solids are given in table 1.

Liquid digestion or extractions samples were analyzed following US EPA SW846 Method 6020 that utilizes laboratory blanks, sample duplicates, and NIST Traceable Standards for a four point calibration curve, continuing calibration standards, laboratory control samples, and internal standards (Bismuth-209). All QC was within acceptable limits except as noted below for sample 3-SS-28-R-0-01, which was reported with the qualification that it contained a substantial amount of Bismuth (the internal standard used for Uranium analysis), and therefore the concentration had to be corrected for the internal standard error. The samples generated from the sequential extraction and distribution coefficient studies were analyzed in duplicate. The average of the two analyses was used to calculate the reported data.

Liquid samples for Uranium analysis (e.g. Distribution Coefficient and Sequential Extraction) were analyzed by Inductively Coupled Plasma Mass Spectrometry following EPA Standard Method 6020, using Bismuth-209 as the internal standard. Total Uranium and Strontium were determined by ICP-MS after digestion according to EPA Standard Method 3050B. Qualitative Strontium-90 was investigated by comparing raw 'counts per second' intensity measured (after correction of isobaric Zirconium-90) with Strontium-88, this resulted in an empirical 'guess' as to the Strontium-90 concentration.

Sequential extraction procedures were modified from that described in Ryan et al. (2001). The modification of the sequential extraction procedure consisted of adding a 'soluble' phase prior to the 'exchangeable' phase and using a small deionized water wash (~2mL) between each extraction step to reduce carryover contamination.

Total organic carbon and soil cation exchange capacity were determined using standard combustion and titration methods, respectively.

The Scanning Electron Microscopy (SEM) experimental procedure used consisted of scanning the electron beam across the sample in a high vacuum chamber and measuring 'backscattered' X-Rays emitted from the sample. Backscattered X-Rays are generated when the electron beam excites an inner-shell electron of an atom. The excited electron then drops back to a lower energy level, emitting the X-Ray of a specific energy, characteristic of that element. This causes backscatter X-Rays to be indicative of elements in an analogous manner to visible elemental spectroscopy in Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP-AES) or Flame Atomic Absorption Spectroscopy (FAAS).

## **Results and Discussion**

### Total Concentrations:

Uranium concentrations in the samples ranged from over 400 to less than 1 mg/kg, in general agreement with the uranium activities reported by the field personal submitting the samples. The concentration for sample 3-SS-28-R-0-01 is reported with the qualification that it contained a substantial amount of Bismuth (the internal standard used for Uranium analysis), and therefore the concentration had to be corrected for the internal standard error. This further explains the discrepancy between the total digestion and the sum of the sequential extraction steps described below. The results are shown in table 2.

Strontium was analyzed for in these samples and generally found not to trend with Uranium, as shown in table 2. Strontium-90 was semi-quantitatively scanned for on the ICP-MS and was not detected in any of the samples. Since Strontium-90 was not seen in any of the samples, it cannot be concluded if there is a component of radioactive Strontium that correlates with Uranium.

Sample 3-SB-01-B-0-04 was the only sample to have a significant concentration of Thorium, in agreement with the sequential extraction results discussed below.

### Sample pH:

The paste pH of the air dried samples is shown in table 3. For the most part, the samples are circumneutral with the exceptions of 3-SB-01-B-0-04 and 1-BH-007 0-2. Both low and high pH can contribute to mobilization of adsorbed metals by different mechanisms, and therefore could increase uranium mobilization from these sample sites.

### Sequential Extraction:

The data in table 4 shows the results of the sequential extraction experiments. A brief geochemical explanation for relevant samples is given below for each of the extraction phases.

*Soluble-* This phase represents any form of an element that is easily dissolved by water and does not readily re-associate with the soil matrix by sorption processes. Any element observed in this phase will be extremely mobile in the environment. Substantial Uranium concentrations were seen in samples 2-BH025 0-2 and Elevator Shaft 0-2. Therefore, it is suggested that Uranium will be very easily mobilized from these locations at the site.

*Exchangable-* The primary difference between this phase and the previous phase is the presence of a molar excess of magnesium ions in the extraction fluid will result in release of elements sequestered by sorption processes. Any element released during this stage of the extraction will be mobile in natural waters containing ions that will compete with it for sorption sites in the soil matrix. Because natural waters always contain some competing ions (natural waters are never 'pure' deionized water), this phase is also expected to be highly mobile in the environment. Samples numbered 3-SS-28-R-0-01, 2-BH025 0-2, and Elevator Shaft 0-2 all have substantial concentrations of Uranium in this phase.

*Carbonates-* This phase is slightly misleading in name. Whereas carbonate minerals will be dissolved during this procedure, it will also dissolve any other substance that is soluble in weak acid. Therefore, this procedure will release elements that are susceptible to dissolution in weak acid, which might mimic natural acid rain, and as such, this phase can be considered relatively mobile under certain environmental circumstances. Samples numbered 3-SS-28-R-0-01, 2-BH025 0-2, 1-BH018 0-2, and Elevator Shaft 0-2 all have substantial concentrations of Uranium in this phase.

*Iron & Manganese Oxides-* Transition metal oxides are known to sequester concomitant ions by sorption and co-precipitation mechanisms. This extraction step selectively dissolves these phases by a reductive dissolution mechanism. The extraction would mimic the sample being buried in an anoxic/reducing environment, such as a marsh, and therefore predicts what elements would be mobilized in such an environment. The elements measured in this phase can be considered relatively mobile under reducing environmental conditions. Samples numbered 3-SS-28-R-0-01, 2-BH025 0-2, 1-BH018 0-2, and Elevator Shaft 0-2 all have substantial concentrations of Uranium in this phase.

*Organic Matter and Sulfide-* Elements in these phases will be released in an oxidizing environment or with the mobilization of colloidal material (e.g. NOM coated soil particles). Oxidation of sulfide minerals is a major mechanism of release of metals in acid mine drainage systems and therefore can represent a huge input of constituents under acid and oxic environmental conditions. Samples numbered 3-SS-28-R-0-01, 1-BH018 0-2, and Elevator Shaft 0-2 all have substantial concentrations of Uranium in this phase.

*Residual-* This phase is considered refractory and not easily mobilized in the environment in the 'dissolved' phase, although colloidal transport can be significant in some environments. Samples numbered 3-SS-28-R-0-01, 2-BH025 0-2, and 1-BH018 0-2 all have substantial concentrations of Uranium in this phase.

Based on the above described geochemical definitions, 3-SS-28-R-0-01, 2-BH025 0-2, 1-BH018 0-2, and Elevator Shaft 0-2 have significant potential to be sources of mobile Uranium. Further geochemical characterization of these samples is warranted.

Thorium analysis was also conducted on the samples submitted and found to be only a minor constituent in most of the samples with the exception of 3-SB-01-B-0-04. It is most likely not of environmental concern in these samples, particularly from a mobility standpoint.

Strontium analysis was conducted on the samples submitted and found to be in the more mobile phases of the extraction procedure, however, it is not an environmentally toxic element, and therefore should not pose a concern.

Zirconium analysis was conducted on the samples because it has an isotope at mass 90, which had to be corrected for in Strontium-90 determinations. The data are submitted and found to be only a minor constituent in most of the samples.

#### Total Organic Carbon

Organic matter is known to complex with metal cations, including radionuclides, and therefore it was determined in selected samples (Lenhart, et al., 2000). Table 5 lists the organic carbon content of the four samples requested. As can be seen, sample 3-SB-19-B-1-03 is 20% carbon. The other samples were 0.5 to 9% organic carbon, which is more in line with what would be expected for a soil (although 9% is quite high). Incidentally, even though 3-SB-19-B-1-03 did not have a large amount of total Uranium, 32% of the uranium measured in the sequential extraction was in the “organic matter and sulfide” sequential extraction phase.

#### Cation Exchange Capacity

Sample 3-SB-19-B-1-03 had the highest CEC of the four samples requested for analysis (table 6). This is in general agreement with the previously discussed organic matter content, as organic matter is known to bind cations. Additionally, 3-SB-19-B-1-03 had a substantial amount of strontium in the ‘exchangeable’ sequential extraction phase.

#### Scanning Electron Microscope

Samples were submitted to New Mexico Institute of Mining and Technology for SEM analysis. This lab was chosen because they are currently doing collaborative work with ECB, Vicksburg on radionuclide containing soils.

In order to investigate further for the presence of U, X-ray maps were collected over a 4x4 mm area, scanning for Si, U, and Pb (as well as also collecting a BSE image of the same area). The object of this analysis was to determine the location and distribution of U within the sample. The U maps reveal that no significant, discrete concentrations of U exist in these samples. Any U present in the samples must be finely disseminated, rather than existing as large (>5 micron) U-rich particles, which would be detected in the X-ray maps. It is suggested that either the concentrations were uniformly distributed

throughout the sample, or were just too low to be observed (SEM is usually useful for constituents that are in the percent level).

#### X-Ray Diffraction

The results are reported in table 7. There were no phases observed that contained uranium as a major constituent which is in agreement with the SEM results.

#### Future Research

The research capabilities exist to increase knowledge of the mobility of the uranium contamination at the Dupont Chambers site. The USACE Environmental Chemistry Branch has recently developed methods for uranium speciation using the ICP-MS in conjunction with HPLC separation as seen in the attached chromatogram showing Uranium complexation with Glutathione and EDTA. Molecular weight cut-off filters can further be used to determine if colloidal uranium is leached from the sediments, which can be overlooked by traditional 'dissolved' 0.45µm filtration. Additionally, following EPA method 1312, a Synthetic Precipitation Leaching Procedure can mimic the effects of acid rain on the contaminated site and would provide more information concerning uranium mobility under 'natural' leaching of the sediments exposed to acid rain. Other studies to consider would be artificial weathering of site soil using freeze/thaw and heat/UV techniques followed by surface water overflow and wind erosion to determine the potential for colloidal transport of uranium.

#### **References**

Langmuir, D., 1997. Aqueous Environmental Geochemistry. Prentice-Hall, Inc. Upper Saddle River, NJ, 600 pp.

Lenhart, J.J., Cabaniss, S.E., MacCarthy, P., Honeyman, B.D., 2000. Uranium(VI) complexation with citric, humic, and fulvic acids. *Radiochim. Acta.*, **88**, 345-53.

Ryan, J.A., Zhang, P., Hesterberg, D., Chou, J., Sayers, D.E., 2001. Formation of Chloropyromorphite in a lead-contaminated soil amended with hydroxyapatite. *Environ. Sci. & Tech.*, **35**, 3798-803.

**TABLE 1**  
**Percent Solids**

<b>Sample ID</b>	<b>% solid</b>
3-SS-28-R-0-01	54.2
5-SB-10-B-1-03	63.1
3-SB-19-B-1-03	24.5
3-SB-01-B-0-04	75.4
2-BH025 0-2	89.9
1-BH018 0-2	81.0
Elevator Shaft 0-2	89.3
1-BH-007 2-4	86.5
2-BH025 2-4	84.8
1-BH018 2-4	73.5
1-BH-007 0-2	91.7

**TABLE 2**  
**Total Digests, Dry Weight**

<b>Sample ID</b>	<b>U (mg/Kg)</b>	<b>Th (mg/kg)</b>	<b>Sr (mg/kg)</b>	<b>Qualifier</b>
3-SS-28-R-0-01	422.3	3.5	768.4	<b>E</b>
5-SB-10-B-1-03	1.1	3.6	16.5	
3-SB-19-B-1-03	4.1	4.1	32.9	
3-SB-01-B-0-04	1.7	7.5	8.6	
2-BH025 0-2	43.3	2.2	18.1	
1-BH018 0-2	187.0	4.8	21.5	
Elevator Shaft 0-2	327.2	4.2	83.3	
1-BH-007 2-4	0.5	1.6	6.3	
2-BH025 2-4	5.0	3.9	38.0	
1-BH018 2-4	1.8	4.2	13.6	
1-BH-007 0-2	1.0	2.9	64.0	

<b>Laboratory QC</b>	<b>U (mg/Kg)</b>	<b>% Recovery</b>	<b>RPD</b>
Blank	<0.010		
Duplicate (5-SB-10-B-1-03)	1.2		8.7
MS (5-SB-10-B-1-03)	1619.4	81.0	

E = Estimated due to interferences with the internal standard



**TABLE 3**  
**pH**

<b>Sample ID</b>	<b>pH</b>
3-SS-28-R-0-01	7.31
5-SB-10-B-1-03	7.82
3-SB-19-B-1-03	5.52
3-SB-01-B-0-04	4.87
2-BH025 0-2	7.98
1-BH018 0-2	7.12
Elevator Shaft 0-2	8.33
1-BH-007 2-4	6.91
2-BH025 2-4	8.09
1-BH018 2-4	6.73
1-BH-007 0-2	9.94

**TABLE 4  
SEQUENTIAL EXTRACTION**

	U (mg/Kg)	Th (mg/Kg)	Sr (mg/Kg)	Zr (mg/Kg)	Qualifier
<b>Seq Ex Blank</b>					
Soluble	0.0001	0.0001	0.0001	0.0001	
Exchangeable	0.0003	0.0000	0.0017	0.0516	
Carbonates	0.0016	0.0000	0.0030	0.0011	
Fe-Mn Oxides	0.0000	0.0000	0.0005	0.0098	
OM & Sulfides	0.0000	0.0000	0.0004	0.0018	
Residual	0.0000	0.0000	0.0002	0.0069	
<b>3-SS-28-R-0-01</b>					
Soluble	0.0185	0.0002	3.6690	0.0028	E
Exchangeable	8.9637	0.0000	40.1421	0.0233	E
Carbonates	4.3293	0.0003	29.1081	0.1006	E
Fe-Mn Oxides	2.1776	0.0000	6.6061	1.4093	E
OM & Sulfides	3.4198	0.0000	1.7452	3.2122	E
Residual	141.5922	0.4450	327.3306	37.6562	E
<b>5-SB-10-B-1-03</b>					
Soluble	0.0351	0.0238	0.0875	0.0239	
Exchangeable	0.0271	0.0000	7.4750	0.0019	
Carbonates	0.5624	0.0802	3.8048	0.0265	
Fe-Mn Oxides	0.5421	0.0400	1.4711	0.0933	
OM & Sulfides	0.0838	0.0881	0.3585	0.3108	
Residual	0.3865	3.7816	7.3633	32.9082	
<b>3-SB-19-B-1-03</b>					
Soluble	0.0002	0.0000	5.5347	0.0002	
Exchangeable	0.0000	0.0000	11.4716	0.0088	
Carbonates	0.7558	0.0154	3.0384	0.0588	
Fe-Mn Oxides	0.4766	0.0095	1.0619	0.0665	
OM & Sulfides	0.6989	0.9227	0.9923	7.7294	
Residual	0.3447	2.0146	7.3207	15.2807	
<b>3-SB-01-B-0-04</b>					
Soluble	0.0103	0.0064	0.0175	0.0010	
Exchangeable	0.0106	0.0000	3.9819	0.0030	
Carbonates	0.5043	0.3657	0.4848	0.0694	
Fe-Mn Oxides	0.3518	0.1496	0.0916	0.2555	
OM & Sulfides	0.1646	0.1938	0.1048	0.2063	
Residual	0.5627	6.0955	6.1106	36.6133	
<b>2-BH025 0-2</b>					
Soluble	2.9718	0.0002	0.9805	0.0062	
Exchangeable	2.8954	0.0000	5.9569	0.0061	
Carbonates	30.1112	0.1201	3.3476	0.1780	
Fe-Mn Oxides	7.7395	0.0892	3.5862	0.4791	
OM & Sulfides	1.0683	0.0131	0.4771	0.4040	
Residual	2.4969	2.0475	4.4609	27.8896	

**TABLE 4  
SEQUENTIAL EXTRACTION**

	U (mg/Kg)	Th (mg/Kg)	Sr (mg/Kg)	Zr (mg/Kg)	Qualifier
<b>1-BH018 0-2</b>					
Soluble	0.6126	0.0059	1.1014	0.0104	
Exchangeable	0.0000	0.0000	6.8258	0.0213	
Carbonates	136.9142	0.1058	1.3163	0.1690	
Fe-Mn Oxides	28.5611	0.0825	2.5424	0.4439	
OM & Sulfides	3.9257	0.0614	0.6853	2.5206	
Residual	10.3601	3.2012	4.4057	25.4510	
<b>Elevator Shaft 0-2</b>					
Soluble	127.8852	0.0004	1.8153	0.0015	
Exchangeable	74.4520	0.0000	10.3555	0.0675	
Carbonates	191.5048	0.1317	33.4920	0.2653	
Fe-Mn Oxides	47.1768	0.1505	41.0292	1.0737	
OM & Sulfides	2.4104	0.0127	1.7181	0.6742	
Residual	0.7568	0.3181	12.3254	3.9046	

= below reporting limit (<0.010 mg/kg)  
 E = Estimated due to interferences with the internal standard

**TABLE 5**  
**TOC**

<b>Sample ID</b>	<b>TOC (mg/kg)</b>
3-SS-28-R-0-01	90000
5-SB-10-B-1-03	23000
3-SB-19-B-1-03	200000
3-SB-01-B-0-04	5500

<b>Laboratory QC</b>	<b>TOC (mg/kg)</b>	<b>Recovery/RPD</b>
Method Blank	ND (<250)	
LCS	26000	106%
Duplicate (3-SB-01-B-0-04)	5600	2%
CCV	26000	105%

**TABLE 6**  
**CEC**

<b>Sample ID</b>	<b>CEC (mg/kg)</b>
3-SS-28-R-0-01	<5 meq/100g
5-SB-10-B-1-03	8 meq/100g
3-SB-19-B-1-03	29 meq/100g
3-SB-01-B-0-04	<5 meq/100g

<b>Laboratory QC</b>	<b>CEC (mg/kg)</b>
Method Blank	<5 meq/100g

**TABLE 7**  
**XRD Results**  
**Qualitative Mineralogical Report**

Sample ID	Phases	Qualitative Results
<b>3-SS-28-R-0-01</b>	Quartz	Major Phase
	Galena	Major Phase
	Anglesite	Major Phase
	Fluorite	Major Phase
	Alkali Feldspar	Minor Phase
	Mica	Possible Phase
-----		
<b>5-SB-10-B-1-03</b>	Quartz	Major Phase
	Alkali Feldspar	Major Phase
	Plagioclase Feldspar	Minor Phase
	Mica	Trace Phase
	Clays	Possible Phase
-----		
<b>3-SB-19-B-1-03</b>	Quartz	Major Phase
	Pyrite	Minor Phase
	Bassanite	Minor Phase
-----		
<b>3-SB-01-B-0-04</b>	Quartz	Major Phase
	Mica	Trace Phase
	Plagioclase Feldspar	Trace Phase
	Alkali Feldspar	Trace Phase
	Clays	Possible Phase
-----		
<b>2-BH025 0-2</b>	Quartz	Major Phase
	Dolomite	Minor Phase
	Plagioclase Feldspar	Trace Phase
	Alkali Feldspar	Possible Phase
	Mica	Possible Phase
	Calcite	Possible Phase
	Clays	Possible Phase
-----		
<b>1-BH018 0-2</b>	Quartz	Major Phase
	Dolomite	Minor Phase
	Calcite	Minor Phase
	Plagioclase Feldspar	Minor Phase
	Alkali Feldspar	Trace Phase
	Mica	Trace Phase
	Clays	Possible Phase

**NOTES:**

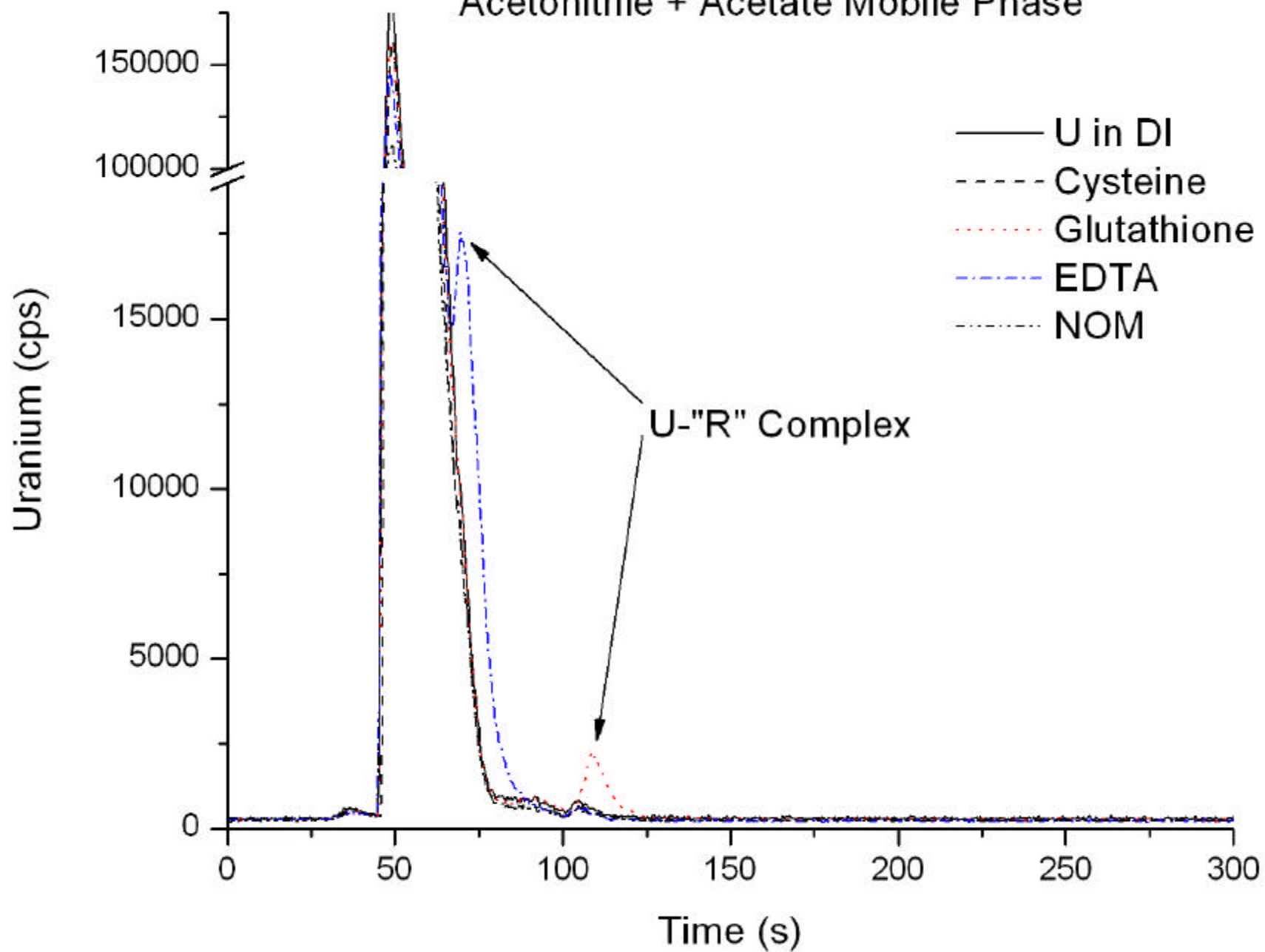
Major Phase = Relative intensity of most intense peak >30.

Minor Phase = Relative intensity of most intense peak >7 and <30.

Trace Phase = Relative intensity of most intense peak <7.

Possible Phase = Not confirmed by the presence of at least three peaks.

Zorbax SB-Aq Column  
Acetonitrile + Acetate Mobile Phase



# Chain of Custody Record

**SEVERN  
TRENT  
SERVICES**

USACE-ERDC-WES-Q  
Severn-Trent Laboratories, Inc.

STL-4124 (0703)

Client: **USACE-CENAB** Project Manager: **GEORGE BOCK CEVAP** Date: **9-9-03** Chain of Custody Number: **027831**

Address: Telephone Number (Area Code): Fax Number: **410-456-3415 / 410-~~456~~-8183** Lab Number: \_\_\_\_\_ Page \_\_\_\_\_ of \_\_\_\_\_

City: \_\_\_\_\_ State: \_\_\_\_\_ Zip Code: \_\_\_\_\_ Site Contact: **CARL YOUNG** Lab Contact: \_\_\_\_\_

Project Name and Location (State): **FUSRAP - DUPONT OU2** Carrier/Waybill Number: \_\_\_\_\_

Contract/Purchase Order/Quote No.:

Sample I.D. No. and Description (Containers for each sample may be combined on one line)	Date	Time	Matrix						Containers & Preservatives						SEREX	SEM	XRD	TOC	CEC	Kd	Special Instructions/ Conditions of Receipt			
			As	Aqueous	Solid	Soil	Unproa	H2SO4	HNO3	HCl	MeOH	ZnAc2	HNO3											
2-BH 025 0-2	8-15-03	1030			X		X								X	X	X			X				
2-BH 025 2-4		1040																						SPARE - HOLD
1-BH 018 0-2		0845													X	X	X			X				
1-BH 018 2-4		0850																						SPARE - HOLD
1-BH-007 2-4		0830																		X				
1-BH-007 0-2	8-15-03	0815																						SPARE - HOLD
ELEVATOR SHAFT 0-2	8-18-03	0720													X	<del>X</del>	X							SEWEX & Kd ONLY
3-SS-28-R-0-01	8-21-03	0700													X	X	X	X	X	X				
5-SB-10-B-1-03	9-3-03	0953													X	X	X	X	X	X				
3-SB-19-B-1-03	8-25-03	0655													X	X	X	X	X	X				
3-SB-01-B-0-04	8-13-03	0610			X		X								X	X	X	X	X	X				

Possible Hazard Identification:  Non-Hazard  Flammable  Skin Irritant  Poison B  Unknown  Return To Client  Disposal By Lab  Archive For \_\_\_\_\_ Months (A fee may be assessed if samples are retained longer than 3 months)

Turn Around Time Required:  24 Hours  48 Hours  7 Days  14 Days  21 Days  Other **STANDARD**

QC Requirements (Specify): \_\_\_\_\_

1. Relinquished By: <b>Carl Young</b>	Date: <b>9-9-03</b>	Time: <b>1609</b>	1. Received By:	Date:	Time:
2. Relinquished By:	Date:	Time:	2. Received By:	Date:	Time:
3. Relinquished By:	Date:	Time:	3. Received By:	Date:	Time:

Comments: **WEIGHTED AVG. ACTIVITY IS 49.78 pCi/g**



WES-EE-C  
COOLER RECEIPT FORM

ECB Log-in # \_\_\_\_\_

Date Received: 9/10/03

Project: Fusrap Dupont Chambers D42

USE OTHER SIDE OF THIS FORM TO NOTE DETAILS CONCERNING CHECK-IN PROBLEMS.

A. PRELIMINARY EXAMINATION PHASE:

Date cooler opened: 9/10/03 by (print) Lynn Escalon  
(signature) [Signature]

Did cooler come with a shipping slip (air bill, etc.) .....  YES NO

If YES, enter carrier name & air bill number here: FedEx TRK# 791669301306

1. Were custody seals on outside of cooler? .....  YES NO

How many & where: 2 - on each end of cooler top & 2 on back of cooler top seal date: 9/9/03 seal name: See below

2. Were custody seals unbroken and intact at the date and time of arrival? .....  YES NO

3. Were custody papers sealed in a plastic bag & taped inside to the lid? .....  YES NO

4. Were custody papers filled out properly (ink, signed, etc.)? .....  YES NO

5. Did you sign custody papers in the appropriate place? .....  YES NO

6. Was project identifiable from custody papers? If YES, enter project name at the top of this form .....  YES NO

7. If required, was enough ice used? (Type of ice: bagged ice) (Temperature: 3°C) .....  YES NO

8. Have designated person initial here to acknowledge receipt of cooler: LE (date) 9/10/03

B. LOG-IN PHASE:

Date samples were logged-in: \_\_\_\_\_ by (print) \_\_\_\_\_  
(signature) \_\_\_\_\_

9. Describe type of packing in cooler: \_\_\_\_\_

10. Were all bottles sealed in separate plastic bags? ..... YES NO

11. Did all bottles arrive unbroken & were labels in good condition? ..... YES NO

12. Were all bottle labels complete (ID, date, time, signature, preservative, etc.)? ..... YES NO

13. Did all bottle labels agree with custody papers? ..... YES NO

14. Were correct containers used for the tests indicated? ..... YES NO

15. Were correct preservatives added to samples? ..... YES NO

16. Was a sufficient amount of sample sent for tests indicated? ..... YES NO

17. Were bubbles absent in Volatile samples? If NO, list by Project ID #: \_\_\_\_\_ YES NO

18. Was the project manager called and status discussed? If YES, give details on the back of this form ..... YES NO

19. Who was called? \_\_\_\_\_ By whom? \_\_\_\_\_ (Date) \_\_\_\_\_

**CUSTODY SEAL**

Date 9 SEPT 03

Signature [Signature]

Sample no.	Depth [ft]	Date	Time	mass [g]	activity matrix	analysis
2BH025	0-2	8/15	10:30	~750	7.26 soil	Kd, SeqEx, SEM, XRD
2BH025	2-4	8/15	10:40	~750	1.72 soil	spare
1BH018	2 feet	8/15	08:45	~750	56.8 soil	Kd, SeqEx, SEM, XRD
1BH018	4 feet	8/15	8:50	~750	1.22 soil	spare
1BH-007	2-4	8/15	8:30	~750	0.76 soil	Kd
1BH-007	0-2	8/15	8:15	~750	1.31 soil	spare
elevator shaft	0-2	8/18	7:20	~750	67.65 soil	SeqEx, Kd
3-SS-28-R-0-01	0-1	8/21	7:00	1500	30 soil	SeqEx, SEM, XRD, TOC, CEC, Kd
5-SB-10-B-1-03	4-6	9/3	9:53	1900	0.43 soil	SeqEx, SEM, XRD, TOC, CEC, Kd
3-SB-19-B-1-03	4-6	8/25	6:55	721	0.33 soil	SeqEx, SEM, XRD, TOC, CEC
3-SB-01-B-0-04	6-8	8/13	8:10	1500	1.49 soil	SeqEx, SEM, XRD, TOC, CEC

**Appendix 1: ERDC cost estimate for requested analytical procedures.**

**Project Info: USACE Cost Estimate for DuPont Chambers, Deepwater New Jersey  
Uranium Mobility Study  
USACE ERDC, Vicksburg, MS**

**Date:** 11-Jul-03

**Philadelphia**

**Project Manager:** George Bock, 215-656-6513

**Philadelphia POC:** Glen Stevens, 215-656-6687

**Philadelphia**

**Technical POC:** Dr. Laura Toran, 215-204-2352

**ERDC POC:** Dr. Anthony Bednar, 601-634-3652

**ERDC POC:** Lynn Escalon, 601-634-2741

Item number	Line item price lists for Uranium mobility study Analytical Procedure	Price/ sample (\$) with overhead	number of samples	Minimum Sample Mass (g) Total	Container and storage
1	Sequential Extraction (Soluble) Elements mobilized (solubilized) with DI water.	\$34.00	6	10 (covers all steps)	Plastic bottle/ cold
2	Sequential Extraction (Exchangable) Elements sorbed to soil particles by exchanging with magnesium cations.	\$34.00	6	see above	see above
3	Sequential Extraction (Carbonate) Elements associated with carbonate soil constituents which can be mobilized under mildly acidic conditions.	\$34.00	6	see above	see above
4	Sequential Extraction (Oxides) Elements associated with iron and manganese oxide soil constituents.	\$34.00	6	see above	see above
5	Sequential Extraction (Organics) Elements associated with organic matter coatings.	\$34.00	6	see above	see above
6	Sequential Extraction (Acid Leachable) Elements associated with strong acid soluble mineral phases.	\$34.00	6	see above	see above
7	Sequential Extraction (Residual) This determines the remaining soil material except some silicates.	\$34.00	6	see above	see above
8	Total Soil Organic Carbon	\$95.00	9	10	glass bottle/ cold
9	Soil Cation Exchange Capacity	\$190.00	9	200	Plastic bottle/ cold
10	X-ray Diffraction Determines if a specific mineral phase of an element is present.	\$150.00	9	10	Plastic bottle
11	Scanning Electron Microscopy/ Electron Microprobe Analysis Will suggest if element phases are dynamic, i.e. if soil particles are coated with secondary minerals	\$350.00	6	10	Plastic bottle

**Project Info: USACE Cost Estimate for DuPont Chambers, Deepwater New Jersey  
 Uranium Mobility Study  
 USACE ERDC, Vicksburg, MS**

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Item number	Line item price lists for Uranium mobility study Analytical Procedure	Price/ sample (\$) with overhead	number of samples	Minimum Sample Mass (g) Total	Container and storage
12	Distribution Coefficient (Kd) Will indicate potential for desorption of elements from soil particles, and thus the potential for migration.	\$550.00	4	300	Plastic bottle/ cold
13	Elemental Analysis will determine the concentration of elements in soil, laboratory extract, and water samples.				
	Uranium*	\$23.00	42	10 (all metals)	Plastic bottle/ cold
14	Strontium* (total)	\$23.00	42	see above	see above
15	SemiQuant* Sr-90 One digestion per sample must be included to get totals	\$300.00		see above	see above
*		\$73.00		see above	see above
			<b>Total</b>	<b>~550</b>	