Waste Characterization at the Harshaw FUSRAP Site Cleveland, OH – 10270

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ABSTRACT

During the course of environmental investigations, waste streams are generated which do not always fit the typical waste profile. This was the case at the Former Harshaw Chemical FUSRAP Site in Cleveland, Ohio.

During the initial stages of Remedial Investigation field work, it was determined that Building G-1 required some general "house keeping" in order to remove material which might shield radioactivity from survey instruments. Additionally, this extraneous material had the potential to pose a risk to worker health and safety as a result of its organic composition. This material was a combination of dust, chipped lead based paint, bird droppings, and other similar miscellaneous accumulated material. These wastes were swept/shoveled into 55-gallon drums and given their own waste designation, Waste Stream 1 - Composite Group 1 (WS1 - CG1). Notable analytical results for WS1 - CG1 were 960 - 76 - 1010 pCi/g for U-234, -235/236, -238 respectively and 11.7 mg/L lead – TCLP.

Following completion of the third phase of a four phase Remedial Investigation, all Investigation Derived Wastes (IDW) were being characterized and disposed at the same time. A Characterization and Disposal Plan containing information for 207 drums of IDW, including the 9 drums of atypical IDW in WS1 - CG1 was prepared by the RI Contractor. This plan was turned over to a different radiation services Contractor to complete profiling of the wastes, prepare them for shipment, and transport and dispose of the waste at an appropriate facility or facilities as necessary.

During the course of executing the work, several issues came up regarding the profiling of wastes. Issues included defining the of "point of generation;" determining which data best represented a specific group of drums; confirming that the waste characterization parameters met a facility's Waste Acceptance Criteria with respect to various hazardous and radioactive limits; drum labeling and manifesting; dealing with a potential etiological hazard that required coordination with the Centers for Disease Control and Prevention; and selecting effective treatment technologies for specific types of wastes.

INTRODUCTION

The Former Harshaw Chemical Company once produced uranium trioxide, uranium tetrafluoride and uranium hexafluoride under contract to the US government to support the Nation's early atomic energy program. The main process building at Harshaw was Plant C, now known as building G-1. Within building G-1, approximately 5,000 metric tons of uranium was processed. In 1953, uranium processing operations ceased at Harshaw and building G-1 placed in stand-by status. By 1960, building G-1 was decontaminated by Harshaw and released from Atomic Energy Commission control. However, the building is still contaminated. As a result of activities associated with the decontamination and removal of equipment, G-1 was left in a condition which allowed for the deterioration of the brick façade and parapet wall. Figure 1 below depicts building G-1 in 2003.

Figure 1: Building G-1

GENERATION

The USACE Buffalo District conducted a Remedial Investigation at the Harshaw Site between 2003 and 2007. To being its investigation, the USACE performed general "housekeeping" in building G-1. This was to remove years of built up dust, building debris, bird droppings, etc, which had accumulated in the building. This material had significant potential to shield radioactivity from survey instruments during building radiation surveys and could have posed a biological hazard to workers. These floor sweepings generated 9 drums of waste. During the course of the Remedial Investigation, a total of 393 individual waste containers had been generated by July 2007 with 212 remaining on-site at the time the building G-1 floor sweeping drums were scoped to be disposed of off-site.

In 2007, the USACE RI Contractor was tasked to characterize the wastes generated during the Remedial Investigation. The RI Contractor was to formulate a characterization plan based on site knowledge, execute the sampling and analysis of the waste, and perform a cursory screening of the results against Waste Acceptance Criteria for potential waste disposal facilities. The findings are documented in the Harshaw Investigation Derived Waste Characterization and Disposal Plan, Revision 3, dated July 11, 2007 [1].

CHARACTERIZATION

Two primary types of Investigation Derived Waste (IDW) were generated, indigenous and non-indigenous. Non-indigenous wastes included personal protective equipment (PPE), expendable sampling materials, decontamination pad materials, tin cans from the on-site gamma spectroscopy laboratory, polyvinyl chloride well casings, hydraulic fluids and plastic buckets. Indigenous wastes included the building G-1 floor sweepings, soil cuttings, decontamination and well purge waters, concrete asphalt and pavement debris, and unused Portland cement grout.

The wastes were further classified in to waste streams based on physical matrix, process knowledge of the site, and field analytical results. These waste streams, description, and method of characterization are presented in Table I.

Table I: Waste Streams at Harshaw Chemical

Waste Stream	Description	Method of Characterization
1	Building G-1 residues/scat	Direct Sampling
2	Unused Grout	Characterized by MSDS and process knowledge
3	Gamma Spectroscopy Sample Containers (Used, empty sample containers)	Characterized by association with WS4
4	Soil Cuttings	Direct Sampling
5	Water	Direct Sampling
6	Decon Mud	Characterized by association with WS4
7	PPE	Characterized by association with WS4

Each of these waste streams was then divided into composite groups to facilitate characterization. Based on Waste Acceptance Criteria at several of the most likely disposal facilities, composite groups to be sampled did not exceed ten drums. Samples were collected from Waste Streams 1, 4, and 5. The remaining waste streams were characterized based on process knowledge and association with other remedial investigation activities.

A list of analytical parameters was developed based on conservative assumptions regarding potential waste disposal facilities thus ensuring the characterization sampling would be sufficient for all disposal options.

To collect a sample from a composite group, each drum had a sample collected from it by hand-augering to a depth inches from the container bottom. This material was placed in a stainless steel bowl and homogenized. Material from each stainless steel bowl was then added to a second bowl where it was homogenized with material from each of the other drums within the composite group. Where TCLP VOC analysis was required, material from each of the first sets of stainless steel bowls was placed in the sample container prior to homogenizing all the drums together.

RESULTS

The results of the direct sampling for the two solid matrix waste streams, 4 and 5 are presented in Table II.

These results were screened against Waste Acceptance Criteria for the American Ecology RCRA facility in Grand View, Idaho and the Energy*Solutions* facility in Clive, Utah. Additionally they were screened against Resource Conservation and Recovery Act Toxicity Characteristic Leaching Procedure (TCLP) Limits (40 CFR 261.24 Table 1) and other miscellaneous parameters (pH, reactive cyanide/sulfide, paint filter).

None of the miscellaneous parameters identified were exceeded/failed for any of the composite groups.

Only one of the composite groups failed a RCRA TCLP Limit. The composite sampling value for Waste Stream I – Composite Group 1 (WS1-CG1) for lead was 11.7 mg/L, exceeding the regulatory limit of 5 mg/L.

American Ecology accepts wastes with multiple radionuclides presents up to a concentration limit of 2,000 pCi/g. Additionally, American Ecology provides a spreadsheet to calculate a unity equation for uranium and thorium and total activity for radium, uranium and thorium. Of the composite groups, only one failed to meet the WAC for American Ecology, WS1-CG1 whose uranium concentration and total radionuclide concentration both exceeded the WAC limits.

Energy*Solutions* is licensed to accept Class A radioactive wastes and shall comply with Utah Administrative Code (UAC) R313-15-1008 which does contain specific limits for certain radionuclides. Of the radionuclides present in the UAC, a total of three were detected in one or more of the composite group samples. These were cesium-137, tritium and radium-226. If detected, a sum of fractions is required to be calculated to ensure the waste does not exceed a value of one. None of the composite groups had a sum of fractions greater than one.

DISPOSAL OPTIONS

At the time the Harshaw IDW C&D plan was developed, USACE was performing an additional phase of Remedial Investigation field work, Phase IV. The objective of Phase IV was to provide

Table II: Waste Characterization Results

Station	Units	WS1-CC1		WS4-CC1		WS4-CC2		WS4-CC3		WS4-CC4		WS4-CC5		WS4-CC6		WS4-CC7		WS4-CC8	
		Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Miscellaneous																			
Reactive Hexavalent Chromium	mg/kg	500	U	500	U	49.3	J	38	U										
Paint Filter Test	TIA			PASS		PASS		PASS		PASS		PASS		PASS				PASS	
pH	SU	6.35	H	8.33	H	7.21	H	7.72	H	7.89	H	7.46	H						
Reactive Releasable Cyanide	ug/kg	642	J	648	J	125	J	414	J	25000	J	25000	J						
Radionuclides																			
AM-241	pCi/g	0.091	U	0.032	U	0.33	U	-0.017	U	-0.004	U	0.003	U	0.04	U	-0.02	U	0.08	U
U-234	pCi/g	0.37	U	0.47	U	0.39	U	0.33	U	0.5	J	0.18	J	0.11	U	0.05	U	0.32	U
CM-243	pCi/g	-0.006	U	-0.006	U	-0.006	U	-0.006	U	0.0006	U	-0.006	U	-0.006	U	-0.01	U	0	U
CO-60	pCi/g	0.01	U	0.018	U	0.024	U	0.03	U	0.007	J	J	J	J	U	0.02	U	0.0006	U
CS-137	pCi/g	0.14	U	0.05	U	0.119	U	0.112	J	0.001	U	-0.02	U	0.028	U	0.02	U	0.003	U
EU-29	pCi/g	-0.3	U	0.3	U	0.35	U	-0.02	U	0.1	U	0.12	U	0.02	U	0.2	U	-0.04	U
NP-04	pCi/g	0.0457	U	-0.019	U	0.121	U	0.135	U	0.011	U	-0.006	U	0.009	U	0.004	U	0.004	U
PU-39	pCi/g	J	J	J	U	U	U	U	U	J	J	J	J	J	U	0.0592	U	J	J
U-45	pCi/g	0.5	U	-0.14	U	-0.2	U	0.5	U	0.1	U	-0.2	U	0.35	U	-0.5	U	0.25	U
PO-238	pCi/g	-0.009	U	0.011	U	0.017	U	-0.02	U	-0.006	U	0.002	U	-0.005	U	0.003	U	-0.009	U
PO 239/40	pCi/g	0.41	J	0.014	U	0.095	J	0.047	U	0.009	U	0.022	U	0.009	U	0.007	U	0.0006	U
PO-241	pCi/g	...7	U	0.36	U	0.45	U	1.17	U	0.92	U	1.45	U	0.28	U	0.36	U	...5	U
RA-226	pCi/g	2.23		1.41		1.52		1.3		1.39		1.59		1.42		1.41		1.26	
RA-228	pCi/g	0.28	U	1.5		1.2	J	1.72	J	1.05		1.91		0.88	J	1.01		0.97	J
SR-90	pCi/g	0.37	U	0.24	U	-0.14	U	1.24	U	...16	U	0.12	U	0.45	U	0.23	U	0.36	U
TC-99	pCi/g	-0.34	U	-0.4	U	-0.27	U	-0.5	U	-0.38	U	-0.38	U	-0.49	U	-0.78	U	-0.77	U
TH-228	pCi/g	0.05	U	...7		0.25	J	1.36		1.31		1.35		0.58	J	0.87	J	0.95	J
TH-230	pCi/g	59		1.34		6.47		6.9		1.05		1.53		2.55		1.36		1.09	
TH-232	pCi/g	0.8	U	0.82	J	1.35	J	1.52	J	1.35		1.35		1.1		0.67	J	0.9	J
Total Activity	pCi/g	1.30		2	U	82		2.1		0.5	J	3.6	J	2.2		5	U	2	U
Tritium	pCi/g	-0.14	U	0.2	U	1.52	J	1.47	U	0.14	U	0.99	U	0.54	U	0.22	U	0.38	J
U-235/236	pCi/g	9.0		1.29		39.1		49.1		1.5		3.05		10.5		3.28		2.47	
U-235/236	pCi/g	.76	J	0.032	U	1.51		2.55		0.097	J	0.18	J	0.5	J	0.7	J	0.093	J
U-238	pCi/g	10.10		1.29		37.9		49.5		1.37		1.87		10.6		3.78		2.26	
Herbicides - TCLP																			
2,4,5-TP/TCLP	mg/L	0.005	U	0.005	U	0.005	U	0.005	U	0.0055	U	0.0055	U	0.01	U	0.01	U	0.01	U
2,4-D-TCLP	mg/L	0.005	U	0.005	U	0.005	U	0.005	U	0.0055	U	0.0055	U	0.04	U	0.04	U	0.04	U
Metals - TCLP																			
Arsenic-TCLP	mg/L	0.0027	U	0.0027	U	0.013	U	0.027	U	0.0028	U	0.0028	U	0.5	U	0.5	U	0.5	U
Barium-TCLP	mg/L	0.52	J	0.446	J	0.245	J	0.195	J	0.438	U	0.315	U	0.168		0.0952	B	0.134	
Cadmium-TCLP	mg/L	0.295	J	0.0027	J	0.002	J	0.006	J	0.0014	U	0.017	J	0.0282		0.0041		0.018	
Chromium-TCLP	mg/L	0.007	J	0.005	U	0.005	U	0.005	U	0.005	U	0.005	U	0.0053	U	0.0014	B	0.0027	U
Lead-TCLP	mg/L	...7	J	0.07	J	0.037	J	0.072	J	0.018	U	0.049	J	0.0306	B	0.733		3.5	
Mercury-TCLP	mg/L	0.0003	UJ	0.0003	UJ	0.0003	UJ	0.0003	UJ	0.00033	UJ	0.00033	UJ	0.01	U	0.01	U	0.01	U
Selenium-TCLP	mg/L	0.045	UJ	0.225	UJ	0.225	UJ	0.225	UJ	0.225	UJ	0.045	UJ	0.5	U	0.5	U	0.5	U
Silver-TCLP	mg/L	0.005	U	0.005	U	0.005	U	0.005	U	0.005	U	0.05	U	0.01	U	0.004	U	0.004	U
Zinc-TCLP	mg/L	46	J	2...	J	4.14	J	2.44	J	0.1	UJ	0.345	UJ	0.525		0.633		2.28	

Station	Units	WS1-CG1		WS4-CG1		WS4-CG2		WS4-CG3		WS4-CG4		WS4-CG5		WS4-CG6		WS4-CG7		WS4-CG8	
		Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Pesticides - TCLP																			
Chlordane-TCLP	mg/L	0.0025	U	0.0025	U	0.0025	U	0.0025	U	0.0025	U	0.0025	U	0.005	U	0.005	U	0.005	U
Endrin-TCLP	mg/L	0.0004	U	0.0004	U	0.0004	U	0.0004	U	0.0004	U	0.0004	U	0.0005	U	0.0005	U	0.0005	U
gamma-BHC-TCLP	mg/L	0.0002	U	0.0002	U	0.0002	U	0.0002	U	0.0002	U	0.0002	U	0.0005	U	0.0005	U	0.0005	U
Heptachlor-TCLP	mg/L	0.0002	U	0.0002	U	0.0002	U	0.0002	U	0.0002	U	0.0002	U	0.0005	U	0.0005	U	0.0005	U
Heptachlor epoxide-TCLP	mg/L	0.0002	U	0.0002	U	0.0002	U	0.0002	U	0.0002	U	0.0002	U	0.0005	U	0.0005	U	0.0005	U
Methoxychlor-TCLP	mg/L	0.002	U	0.002	U	0.002	U	0.002	U	0.002	U	0.002	U	0.001	U	0.001	U	0.001	U
Toxaphene-TCLP	mg/L	0.01	U	0.01	U	0.01	U	0.01	U	0.01	U	0.01	U	0.02	U	0.02	U	0.02	U
SVOC - TCLP																			
1,4-Dichlorobenzene-TCLP	mg/L	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U
2,4,5-Trichlorophenol-TCLP	mg/L	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U
2,4,6-Trichlorophenol-TCLP	mg/L	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U						
2,4-Dinitrotoluene-TCLP	mg/L	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U
3-Methylphenol & 4-Methylphenol-TCLP	mg/L													0	U	0.1	U	0	U
Hexachlorobenzene-TCLP	mg/L	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U
Hexachlorobutadiene-TCLP	mg/L													0.05	U	0.05	U	0.05	U
Hexachloroethane-TCLP	mg/L	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U
m,p-Cresols-TCLP	mg/L	0.035	J	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U						
Nitrobenzene-TCLP	mg/L	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U
o-Cresol-TCLP	mg/L	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U
Pentachlorophenol-TCLP	mg/L	0.048	J	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	0.25	U	0.25	U	0.25	U
Pyridine-TCLP	mg/L	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	0.1	U	0.1	U	0.1	U
VOC TCLP																			
1,1-Dichloroethene-TCLP	mg/L													0.05	U	0.05	U	0.05	U
1,1-Dichloroethylene-TCLP	mg/L	0.01	U	0.01	U	0.01	U	0.01	U	0.01	U	0.01	U						
1,2-Dichloroethane-TCLP	mg/L	0.01	U	0.01	U	0.01	U	0.01	U	0.01	U	0.01	U	0.05	U	0.05	U	0.05	U
1,4-Dichlorobenzene-TCLP	mg/L													0.05	U	0.05	U	0.05	U
2-Butanone-TCLP	mg/L	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U
Benzene-TCLP	mg/L	0.01	U	0.01	U	0.01	U	0.01	U	0.01	U	0.01	U	0.05	U	0.05	U	0.05	U
Carbon Tetrachloride-TCLP	mg/L	0.01	UJ	0.01	UJ	0.01	UJ	0.01	UJ	0.01	UJ	0.01	UJ						
Chlorobenzene-TCLP	mg/L	0.01	U	0.01	U	0.01	U	0.0034	J	0.01	U	0.01	U	0.05	U	0.05	U	0.05	U
Chloroform-TCLP	mg/L	0.01	U	0.01	U	0.01	U	0.01	U	0.01	U	0.01	U	0.05	U	0.05	U	0.05	U
Hexachlorobutadiene-TCLP	mg/L	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U						
Tetrachloroethene-TCLP	mg/L													0.05	U	0.05	U	0.05	U
Tetrachloroethylene-TCLP	mg/L	0.01	U	0.01	U	0.01	U	0.0035	J	0.01	U	0.01	U						
Trichloroethane-TCLP	mg/L													0.05	U	0.05	U	0.05	U
Trichloroethylene-TCLP	mg/L	0.01	UJ	0.01	UJ	0.01	UJ	0.01	UJ	0.01	U	0.01	U						
Vinyl chloride-TCLP	mg/L	0.01	U	0.01	U	0.01	U	0.01	U	0.01	U	0.01	U	0.1	U	0.1	U	0.1	U

Qualifiers: J: Result: greater than calibrated range
M: Holding time exceeded
U: Non-detect
UJ: Estimated non-detect

additional characterization data regarding the potential for the presence of enriched/depleted/recycled uranium on the site. Therefore, the recommendations in the C&D plan were made with the caveat that disposal options might change based on Phase IV results.

Based on the analytical results from the characterization sampling performed prior to Phase IV sampling results, Energy*Solutions* could have accepted all the Remedial Investigation wastes but may not have necessarily been the most cost effective option. American Ecology could accept low activity radioactive material wastes containing uranium, radium and thorium but with limits which might have precluded the disposal of one of the composite groups. Both facilities could accept RCRA regulated wastes. Any waste determined to be Hazardous Waste would have to be disposed of at a licensed Subtitle C landfill if background radionuclide concentrations for that facility were not exceeded. The Characterization and Disposal plan did not provide any further classification or recommendation for the Harshaw wastes.

PHASE IV RESULTS

At the conclusion of Phase IV of the Remedial Investigation, it was determined that there was no significant quantity of enriched uranium at the Harshaw Site. Uranium-236 was detected in low concentrations and in samples with similarly low detections of related radionuclides such as technecium-99 and americium-241. The Phase IV results provided USACE with no indication that waste characterization would be impacted by the presence of low occurrences of recycled uranium and related non-naturally occurring radionuclides.

WASTE PROFILING

In August 2007, USACE contracted a radiation services company to transport and dispose of the Harshaw investigation derived wastes. The Contractor was provided the previously completed Harshaw IDW Characterization and Disposal Plan.

The Scope of Work for this contract contained the following language, “The Contractor shall not mix soil with debris or other IDW for any purpose, however, partial containers of like material maybe combined to reduce number of containers to be shipped.
Wastes maybe combined per the approved Waste Profile description if shipment is to be in bulk.

Soil shall not be mixed with debris in individual containers being transported unless the IDW is being shipped in bulk packages.

If IDW sampling/laboratory analysis identifies that any of the containerized IDW is also a ‘RCRA hazardous waste,’ the Contractor shall not mix or place those ‘mixed wastes’ in the same containers with any other IDW not deemed mixed waste. ”

Based on the above language and the proposal submitted by the Contractor, the wastes were going to be shipped in their individual containers (mostly 55-gallon drums and overpacked as necessary). The transport and disposal of the waste was to comply with all federal, state and local regulations including but not limited to:

- Comprehensive Environmental Response, Compensation and Liability Act (CERCLA): USACE follows CERCLA at all FUSRAP sites per congressional direction. CERCLA regulations may be referenced in 40 Code of Federal Regulations (CFR) Part 300 (Ohio Revised Code [ORC] 3734.01 Q).
- Resource Conservation and Recovery Act (RCRA): RCRA regulations apply if IDW is determined through characterization to be hazardous per 40 CFR Part 261 Subpart C or Subpart D (Ohio Administrative Code [OAC] 3745-51).
- Toxic Substances Control Act (TSCA): TSCA regulations apply if the IDW is determined through characterization to contain polychlorinated biphenyls (PCBs) at levels specified in 40 CFR Part 761.
- Clean Water Act (CWA): The CWA will regulate the discharge of waters to either navigable waterways or publicly owned treatment works (POTWs). The CWA effluent guidelines and standards are specified in 40 CFR Subchapter N, Effluent Guidelines and Standards.
- Safe Drinking Water Act (SDWA): Analytical data from water matrices will be compared against SDWA standards to determine appropriate disposition. The SDWA is regulated in Ohio per OAC 3745-96-02.
- Ohio Department of Health (ODH) and Nuclear Regulatory Commission (NRC): ODH and NRC may apply to the handling and disposal of some radioactive materials.
- Department of Transportation (DOT): The DOT regulates the transportation, documentation, packaging, and labeling of hazardous materials that are shipped off-site.

The first step in characterizing waste was to ensure that all the wastes were separated appropriately into Waste Streams for profiling. Waste streams are classified at their "point of generation." The USACE team interpreted this to mean when the wastes were placed in the drums. Though regulations are not entirely clear on this point, USACE determined this interpretation is consistent with the intent of the regulation. It could be argued that all of the Harshaw IDW drums were generated by the same activity, the remedial investigation. However, some of the drums contain materials which are significantly different in nature than others. For example, the building G-1 drums are "debris" and not "soil-like" and therefore were not considered the same waste stream as soil cuttings resultant from direct push and hollow stem auger sampling.

Additionally, some matrices are not easily sampled. In these instances, process knowledge was used to determine the method to best characterize these wastes such as the case for the waste stream containing personal protective equipment. It was assumed that any contamination found on the PPE would be present as a result of contact with soil cuttings. Therefore, though the PPE and soil cuttings were two distinctly different waste streams, characterization data from the soil could reasonably be applied to the PPE waste stream.

The Contractor that had been awarded the Transportation and Disposal contract and had assumed a single waste stream for the entire site and was scoped for disposal at Energy*Solutions* given the uncertainty associated with the outstanding Phase IV Remedial Investigation results. The draft profile for the waste included the radionuclides shown in Table III.

Table III: Draft Profile Radionuclides

Isotope	Manifested Upper Concentration (pCi/g)	Weighted Avg. per Container (pCi/g)
Ra-226	5.0	1.5
Ra-228	5.0	1.5
Pu-239	1.0	1.0
Pu-240	1.0	1.0
Th-230	100	10
Th-232	5.0	1.5
U-233	1000	50
U-234	1000	50
U-235	100	10
U-236	100	10
U-238	1200	50

Table IV shows the results for detected metals from 40 CFR 261.24 Table 1:

Table IV: Draft Profile Metals

Metal	TCLP (mg/kg) Result
Chromium	0.07
Barium	0.51
Lead	1.85
Cadmium	0.45
Zinc	46

Generally, in all cases the maximum activity/concentration was reported. However, the lead TCLP results were averaged over the entire lot thus making it appear as though WS1-CG1 was not Hazardous Waste as defined by 40 CFR 261. Additionally, the lead result for WS4-CG8 was 3.5 mg/kg and would have exceeded the manifested concentration.

USACE determined that in order to ship this waste in compliance with all applicable federal, state and local regulations, that a minimum of two waste profiles would be required. Had the contract not already been awarded with cost to dispose at Energy*Solutions* included, it is likely that the drums not included in WS1-CG1 would have been more closely examined for consideration of disposal at alternative facilities. A second waste profile for WS1-CG1 was requested by USACE.

WS1-CG1

Waste Stream 1 – Composite Group 1 was unique in its composition. No where else on the Harshaw Site was waste with such high radioactivity mixed with Hazardous Waste and also contain the potential for a biological hazard as well resultant from the organic matter as well. In order to ensure the proper profiling, manifesting, labeling and ultimate disposal, several outside

sources were consulted including the Ohio Environmental Protection Agency and the Centers for Disease Control and Prevention.

Initially, the OEPA was contacted to discuss shipping the waste under a single profile. They verified the USACE assumption that it was more appropriate to ship under two profiles citing 40 CFR 268.3 prohibiting the dilution of a waste.

Due to concerns regarding the potential presence of the fungus *Histoplasma capsulatum* (i.e. hystoplasmosis) in the waste stream, the Department of Transportation was contacted to help with a possible infectious substance (i.e. DOT Division 6.2 Category B) determination. Based on discussions with DOT regulatory specialist staff, DOT referred the project team to Dr. Janet Nicholson at the CDC. After further discussions with CDC, it was determined this specific waste stream did not warrant any formal DOT hazard communication requirements as an infectious substance. Coordination with the CDC resulted in the following language being included on the waste profile for WS-CG1:
"The waste has a pungent order that may be attributed to bird droppings collected during floor sweep clean-up. The droppings are not believed to present a respirable biohazard, however waste management personnel are advised to avoid prolonged unprotected contact with this waste." The waste was not required to be shipped/labeled as a biological hazard.

Once separated out, the WS1-CG1 profiled data is shown in Table V.

Table V: Final Profile Radionuclides for WS1-CG1

Isotope	Manifested Upper Concentration (pCi/g)	Weighted Avg. per Container (pCi/g)
Ra-226	5.0	2.5
Ra-228	5.0	1.5
Th-230	100	90
Th-232	5.0	1.5
U-nat	2500	2100

The waste was classified as Hazardous with EPA HW Code D008 lead with a worst case concentration of 11.7 mg/kg. Lastly, cadmium was identified as an underlying hazardous constituent per 40 CFR 268.48 with a worst case concentration of 0.295 mg/kg because it exceeded the Universal Treatment Standard concentration. Given the radioactivity contained within the sample, per 10 CFR 40, source material means: (1) Uranium or thorium, or any combination thereof, in any physical or chemical form or (2) ores which contain by weight one-twentieth of one percent (0.05%) or more of: (i) Uranium, (ii) thorium or (iii) any combination thereof. Source material does not include special nuclear material.

To ensure compliance with Department of Transportation regulation (49 CFR 172) these drums were labeled "UN2912, WASTE RADIOACTIVE MATERIAL, LOW SPECIFIC ACTIVITY (LSA-I), 7; RQ (D008)." The basis for this is 49 CFR 172.203(c)(2) which states "The letters 'RQ' shall be entered on the shipping paper either before or after the basic description required by

172.202 for each hazardous substance (see definition in 171.8 of this subchapter)." Furthermore, 49 CFR 172.202(b) defines the basic description as the identification number, the proper shipping name, hazard class or division, and packing group (if appropriate).

Once received at Energy*Solutions* confirmation sampling was performed. Since the initial assumption regarding all wastes generated during the remedial investigation was that it was non-hazardous, the following analyses were performed: reactive releasable sulfide, paint filter test, pH, reactive releasable cyanide, radionuclides, herbicides-TCLP, pesticides-TCLP, metals-TCLP, VOCs-TCLP and SVOCs-TCLP. However, WS1-GS1 was eventually classified as hazardous waste which should have then required additional testing for Total Organics. Confirmation analysis at Energy*Solutions* indicated greater than treatment standard concentrations for 12 polycyclic aromatic hydrocarbons, the highest of which was fluoranthene at 50.2 ppm whose treatment standard is 3.4 ppm. Polycyclic aromatic hydrocarbons were not anticipated to be in the wastes generated at Harshaw. Their presence could not be reasonably tied to activities occurring in the vicinity of the site which would have resulted in PAH generation after the wastes were placed in the drums. Therefore WS1-CG1 would require treatment prior to disposal. Energy*Solutions* identified two possible treatment technologies, chemical oxidation or thermal treatment. Given the high PAH levels found in the waste, Energy*Solutions* could not guarantee this method would treat the waste to meet land disposal requirements. Due to the potential for chemical oxidation to not treat the waste sufficiently and the additional cost associated with a second treatability study, USACE determined that thermal treatment was the best path-forward. Additionally, a campaign was on-going at Energy*Solutions* which would result in a cost savings if the same treatment would be required at a later date.

CONCLUSIONS

The remainder of the wastes generated during the Remedial Investigation were shipped as Class 9 wastes and disposed at Energy*Solutions*. WS1-CG1 was eventually successfully disposed of at Energy*Solutions* as well. However, had more research been performed prior to initial contract award, there was significant potential for cost savings to ship the Class 9 wastes to a different disposal facility. Once Phase IV confirmed that the material did not contain radionuclides which would preclude disposal at a facility other than Energy*Solutions*, the contract could have been renegotiated with this in mind.

The building G-1 drums proved to be more complicated to characterize due to the high radioactivity and chemical content. Neither of these factors was anticipated during characterization sampling. These results were obtained during sampling in performed in 2003. When additional sampling was performed in 2007, WS1-CG1 should have been reanalyzed for the additional parameters required by Energy*Solutions* to ensure sufficient data had been collected for a Hazardous Waste profile. Though this would not have changed the outcome, it would have provided for more accurate profiling and budgeting of funds.

REFERENCES

[1] Harshaw Investigation Derived Waste Characterization and Disposal Plan, Revision 3, dated July 11, 2007