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DEC 17 2015

Mr. Brian Begley
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PPPO-02-3287657-16

Ms. Julie Corkran
U.S. Environmental Protection Agency, Region 4
Federal Facilities Branch
61 Forsyth Street
Atlanta, Georgia 30303

Dear Mr. Begley and Ms. Corkran:

FINAL CHARACTERIZATION NOTIFICATION FOR SOLID WASTE MANAGEMENT UNIT 211-A AND SOLID WASTE MANAGEMENT UNIT 211-B AT THE PADUCAH GASEOUS DIFFUSION PLANT, PADUCAH, KENTUCKY

References:

1. Letter from J. Tufts to R. Blumenfeld, "EPA Modification Request to the Remedial Design Work Plan for SWMUs 1, 211-A and 211-B Volatile Organic Compound Sources for the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, KY (DOE/LX/07-1268&D2/R2)," dated February 25, 2014
2. Letter from R. Blumenfeld to T. Mullins and J. Tufts, "Final Characterization Notification for Solid Waste Management Unit 211-A and Solid Waste Management Unit 211-B at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky," (PPPO-02-1979222-13B), dated July 10, 2013

The remedy selected in the Record of Decision (ROD) for the Sources of the Southwest Groundwater Plume (DOE/LX/07-0365&D2/R1) requires completion of a Final Characterization/Remedial Design Support Investigation (RDSI). The ROD states that the Federal Facility Agreement (FFA) parties will review results of the this investigation and select either Enhanced *In Situ* Bioremediation with Interim Land Use Controls (LUCs) (Alternative 8) or Long-Term Monitoring with Interim LUCs (Alternative 2) for implementation at Solid Waste Management Unit (SWMU) 211-A and SWMU 211-B.

The FFA parties agreed the investigation results would be documented in a Final Characterization Report. The agencies also agreed the U.S. Department of Energy (DOE) would

issue a "Letter Notification" that presents DOE's recommendation to implement Alternative 2 or Alternative 8.

In June 2013, DOE issued the D1 Final Characterization Report (DOE/LX/07-1288&D1) and in July 2013, the D1 Letter Notification (Reference 2) recommending implementation of Alternative 2, Long-Term Monitoring with Interim LUCs for SWMUs 211-A and 211-B. DOE issued a D2 Final Characterization Report (DOE/LX/07-1288&D2) on December 10, 2013.

In February 2014, the U.S. Environmental Protection Agency (EPA) requested additional groundwater data for the Regional Gravel Aquifer (RGA) to support the recommended remedy (Reference 1).

The sampling and analysis plan to collect additional groundwater data was documented as an Addendum to the Remedial Design Work Plan (DOE/LX/07-1268&D2/R2/A1). The FFA parties agreed that an Addendum to the Final Characterization Report and Letter Notification would be submitted to EPA and Kentucky Division of Waste Management by December 18, 2015.

The ROD further states, once the chosen alternative has been identified, a public notice of that alternative will be published and placed in the Administrative Record and documented in an FFA primary document. Following concurrence by the FFA parties and public notice of selection of the final remedy, DOE proposes that the final remedy selection be documented further in the Remedial Design Report.

RGA Groundwater Decision Rules

The following decision rules and guidelines for evaluating results of the RGA groundwater investigation are documented in the Appendix C, Sampling and Analysis Plan Addendum to the Remedial Design Work Plan (DOE/LX/07-1268&D2/R2/A1).

For SWMU 211-A, in the upper or middle RGA [in the zone of higher trichloroethene (TCE)]:

- **IF** the average of downgradient minus upgradient TCE levels is less than approximately 400 ppb, **THEN** the conceptual site model (CSM) and the predicted TCE mass in the Upper Continental Recharge System (UCRS) are confirmed. The remedial action will be implementation of long-term monitoring with interim LUCs.

- **IF** the average of downgradient minus upgradient TCE levels is greater than approximately 400 ppb and less than 11,000 ppb, **THEN** the CSM is valid, but the TCE mass in the UCRS is greater than estimated. The remedial action will be implementation of enhanced *in situ* bioremediation (EISB) with interim LUCs and long-term monitoring.

For SWMU 211-A, if investigation results indicate substantial contamination throughout the RGA in the downgradient location only, dispersed dense nonaqueous-phase liquid (DNAPL) ganglia are present throughout the RGA. The CSM is invalid. The FFA parties will confer to evaluate the impact of the discovered DNAPL.

For SWMU 211-B, in the upper or middle RGA (in the zone of higher TCE), where upgradient TCE levels are assumed to be negligible:

- **IF** the average of TCE levels beneath SWMU 211-B is less than approximately 400 ppb, **THEN** the CSM and the predicted TCE mass in the UCRS is confirmed. The remedial action will be implementation of long-term monitoring with interim LUCs.

- **IF** the average of TCE levels beneath SWMU 211-B is greater than approximately 400 ppb and less than 11,000 ppb, **THEN** the CSM is valid, but the TCE mass in the UCRS is greater than estimated. The remedial action will be implementation of EISB with interim LUCs and long-term monitoring.

For SWMU 211-B, if investigation results indicate substantial contamination in the upper or middle RGA, DNAPL may be present in either the UCRS or the RGA. The CSM is invalid, and the FFA parties will confer to evaluate the impact of the potential DNAPL.

Moreover, for SWMU 211-B, if investigation results indicate substantial contamination in the lower RGA only, an upgradient source is impacting TCE levels beneath the SWMU. The CSM may be invalid. The FFA parties will confer to evaluate the impact of the upgradient source.

Results of Final Characterization Data Collection

DOE performed the RGA groundwater sampling investigation at SWMUs 211-A and 211-B in late June and early July 2015. Groundwater samples were collected on 5-ft intervals throughout the RGA from six sample borings. The sample boring locations are shown on Figure 1 (enclosure attached to this letter). TCE and degradation product analyses of the 2015 investigation are summarized on Table 1 (enclosure attached to this letter). The following are the key results of the Final Characterization/RDSI (DOE/LX/07-1288&D2/A1).

SWMU 211-A

- During the 2015 Final Characterization/RDSI, 36 groundwater samples (not including Quality Control samples) were collected for volatile organic compound (VOC) analysis from a total of five sample borings: 35 samples contained detectable TCE; 34 samples contained detectable 1,1 dichloroethene (1,1-DCE) and *cis*-1,2-dichloroethene (*cis*-1,2-DCE); 22 samples contained detectable *trans*-1,2-dichloroethene (*trans*-1,2-DCE); and 10 samples contained detectable vinyl chloride.

- The maximum observed TCE concentration was 1,400 ppb, at a depth of 75 ft below ground surface (ft bgs), in sample boring 211-A-049 (located downgradient of the west side of SWMU 211-A).

- 1,1-DCE was present in groundwater samples from each sample boring, but was markedly higher (1,400 to 2,200 ppb) in samples of the upper and middle RGA in sample boring 211-A-049 (downgradient of SWMU 211-A). These results are consistent with the UCRS and upper RGA soils results of the 2012 and 2013 Final Characterization/RDSI, which found higher 1,1-DCE concentrations upgradient (south) of sample boring 211-A-049.

- *cis*-1,2-DCE was present in groundwater samples from each sample boring, but was markedly higher (610 to 740 ppb) in the upper RGA in upgradient sample boring 211-A-048. Vinyl chloride also was markedly higher (57 to 79 ppb) in these same 211-A-048 samples. In general, TCE concentrations in this sample boring also were higher in the upper RGA. Both *cis*-1,2-DCE and vinyl chloride are degradation products of TCE in anaerobic settings. The co-occurrence of these VOCs in the upper RGA and the sample boring's location–immediately north (downgradient) of the C-720 Building (which limits vertical recharge to the RGA and promotes anaerobic conditions) suggests the occurrences of higher concentrations of *cis*-1,2-DCE and vinyl chloride are derived from anaerobic degradation of TCE.

SWMU 211-B

- Of the seven groundwater samples from one sample boring (211-B-021) collected during 2015 Final Characterization/RDSI for VOC analysis (not including Quality Control samples), all seven samples contained detectable TCE and *cis*-1,2-DCE; two samples contained detectable 1,1-DCE; and one sample contained detectable *trans*-1,2-DCE. No samples contained detectable vinyl chloride.

- The maximum observed TCE concentration was 10,000 ppb, in the uppermost groundwater sample, taken from a depth of 65 ft below ground surface (ft bgs). With a control limit range (error range) for the analysis of 1,100 ppb, this analysis approximates the project criterion for recognizing the presence of DNAPL (11,000 ppb).

- Other upper RGA samples from 70 ft bgs depth (1,100 ppb TCE) and from 75 ft bgs depth (1,000 ppb TCE) have markedly higher TCE concentrations than middle and lower RGA samples.

- *cis*-1,2-DCE concentrations exhibit a similar trend: 210 ppb *cis*-1,2-DCE at 65 ft bgs depth; 26 ppb *cis*-1,2-DCE at 70 ft bgs depth; 28 ppb *cis*-1,2-DCE at 75 ft bgs depth. Concentrations of *cis*-1,2-DCE in deeper samples (from 80, 85, and 90 ft bgs) are 2.4 ppb and less.

- 1,1-DCE, *trans*-1,2-DCE, and vinyl chloride are mostly below detectable concentrations in the groundwater samples from 211-B-021.

Discussion

A holistic review of the data, as summarized in the Addendum to the Final Characterization Report for the 2015 Final Characterization/RDSI (DOE/LX/07-1288&D2/A1) indicates that the investigation data are appropriate for assessing the impact of SWMUs 211-A and 211-B to dissolved TCE levels in the RGA. Table 2 summarizes the TCE sample results.

Table 2. Assessment of SWMU 211-A and 211-B Sample Results

RGA Zone (depth in feet)	Downgradient TCE Average[a] (ppb)	Upgradient TCE Average[a] (ppb)	Difference of Averages (ppb)	Decision Rules	
				Difference of Averages < Approximately 400 ppb	11,000 ppb > Difference of Averages > 400 ppb
East SWMU 211-A	211-A-047	211-A-045			
Upper (65–75)	101	155	-54	X	--
Middle (75–90)	455	233	223	X	--
Lower (90–95)	340	100	240	X	--
	211-A-047	211-A-046			
Upper (65–75)	101	30	71	X	--
Middle (75–90)	455	74	381	X	--
Lower (90–95)	340	55	286	X	--
West SWMU 211-A	211-A-049	211-A-048			
Upper (65–70)	935	225	710	--	X
Middle (75–80)	840	105	735	--	X
Lower (85–90)	103	74	29	X	--
SWMU 211-B	211-B-021				
Upper (65)	10,000	NA[b]	--	--	~X[c]
Middle (70-75)	1,050	NA	--	--	X
Lower (80-90)	42	NA	--	X	--

[a] Duplicate results were not used in calculating average concentrations.
[b] An upgradient sample boring was not sampled for SWMU 211-B.
[c] The sum of the analysis result and error range is 11,100 ppb.

The TCE sample results of SWMU 211-A are consistent with the CSM. SWMU 211-A is contributing TCE levels in excess of 400 ppb, but less than 11,000 ppb. The SWMU 211-A decision rules direct implementation of *In Situ* Source Treatment using EISB with interim LUCs (Alternative 8).

The RGA groundwater analyses from the 2015 Final Characterization/RDSI support focused application of enhanced bioremediation on the west side of SWMU 211-A. These results are consistent with the TCE analyses of UCRS soils from the earlier, 2013 Final Characterization/ RDSI where the area defined by 90% confidence level TCE concentration greater than 1,000 µg/kg was more extensive on the west side of SWMU 211-A [Figure 2 (enclosure attached to this letter)–taken from the report of the 2013 Final Characterization/RDSI (DOE/LX/07-1288&D2)].

211-A-048, the upgradient sample boring for the west side of SWMU 211-A, is impacted by an upgradient contaminant source. That contaminant source may be SWMU 211-B or another source underlying C-720 Building.

The SWMU 211-B sample results are consistent with a UCRS or upper RGA source zone impacting the RGA water quality at SWMU 211-B, which may extend to SWMU 211-A. The shallowest groundwater result for TCE (65 ft depth) at SWMU 211-B approximates the established project criterion for the recognition of the presence of DNAPL, which would be inconsistent with the CSM basis of the ROD (DOE/LX/07-0365&D2/R1). Future decommissioning of C-720 Building may allow opportunity to sample adjacent soil beneath the

building (currently inaccessible) and reduce the uncertainty regarding the extent of TCE contamination at SWMU 211-B, including the presence of DNAPL.

Conclusions

TCE analyses of RGA groundwater from the SWMUs 211-A and 211-B sample borings in the 2015 Final Characterization/RDSI indicate that remedial actions are required for each SWMU. However, the newly collected data, notably the analyses of upper RGA groundwater samples from sample boring 211-B-021, located within SWMU 211-B, identify significant uncertainty regarding the presence of a TCE DNAPL source, potentially impacting each SWMU. The presence of a DNAPL source at SWMU 211-B is inconsistent with the CSM presented in the ROD, and the selected alternatives are expected to be ineffective for a DNAPL source beneath the C-720 Building.

Following the identification of potential DNAPL concentrations of TCE in the groundwater near SWMU 211-B on the south side of the C-720 Building, a walkthrough was conducted to identify where samples could be collected to determine if TCE concentrations in ambient air exceeded the American Conference of Governmental Industrial Hygienists threshold limit value of 10 ppm. Screening sampling was conducted during the walk through with a photoionization detector capable of detecting TCE in air at a concentration of 100 ppb. There were no detections.

Based upon these results, and in consideration of the potential for vapor intrusion from the possible TCE DNAPL source and current building use and occupancy, further ambient air sampling of C-720 is planned. Ten samples are planned for collection in December 2015 using summa canister samples for TCE and degradation products. Sample collection and analysis will be conducted in accordance with EPA Method TO-15.

Recommendation for Remedy Selection

The following are descriptions of the remedies identified in the ROD for the Southwest Plume VOC sources at the C-720 Building (SWMUs 211-A and 211-B).

- Long-Term Monitoring with Interim LUCs (Alternative 2) consists of the following:
    - Interim LUCs
    - Groundwater monitoring
    - Secondary waste management

- *In Situ* Source Treatment Using EISB with Interim LUCs (Alternative 8) consists of the following:
    - Interim LUCs
    - Installation and operation of EISB system
    - Introduction of bioamendment
    - Confirmatory sampling
    - Site restoration
    - Groundwater monitoring

- Secondary waste management

Viewed holistically, RGA groundwater quality at both SWMUs 211-A and 211-B potentially is impacted by a TCE DNAPL source in the UCRS or upper RGA soil of SWMU 211-B.

Although the Southwest Plume ROD allows for selection of either Alternative 8 or Alternative 2 for these units, based on the 2015 Final Characterization/RDSI results, DOE recommends implementation of Alternative 8 for the west side of SWMU 211-A and Alternative 2 for the east side of SWMU 211-A. DOE recognizes that monitoring contaminant concentration changes in RGA groundwater on the west side of SWMU 211-A resulting from the EISB will present some significant technical challenges due to the upgradient VOC source.

The investigation results reveal significant uncertainty as to the presence of DNAPL in the UCRS and upper RGA of SWMU 211-B. The TCE concentration of the uppermost RGA groundwater sample approximates the project criterion for recognition of DNAPL. The CSM is invalid because TCE DNAPL likely is present at SWMU 211-B beneath C-720: none of the selected remedial alternatives of the ROD are applicable. DOE recommends discussions among the FFA parties to evaluate impacts of the likely discovered DNAPL at SWMU 211-B. These discussions may lead to deferral or identification of a new remedial action at both SWMUs 211-A and 211-B. Coordination of additional characterization with future decommissioning of the C-720 Building would afford opportunity to sample adjacent soils beneath the building (currently inaccessible). Based on location of the probable DNAPL, the FFA parties may select a remedial action that was not identified by the ROD.

The current agreed schedule did not anticipate the potential for subdividing SWMU 211-A and selecting EISB (Alternative 8) for the western portion of SWMU 211-A and long term monitoring (Alternative 2) for the eastern portion of SWMU 211-A. It is recommended that a specific implementation schedule be included in discussions when the FFA parties confer.

Once the path forward is finalized for SWMU 211-A and SWMU 211-B, then the FFA parties can make necessary determinations related to the decision documents, as needed, to reflect the agreed upon path forward. Due to the upcoming holidays and previously scheduled meetings among the FFA parties, DOE proposes that the FFA parties convene during the first week of February 2016 to discuss the recommended path forward for final remedy. If you have any questions or require additional information, please contact David Dollins at (270) 441-6819.

Sincerely,

Tracey Duncan
Federal Facility Agreement Manager
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Enclosures:
1. Figure 1
2. Table 1
3. Figure 2

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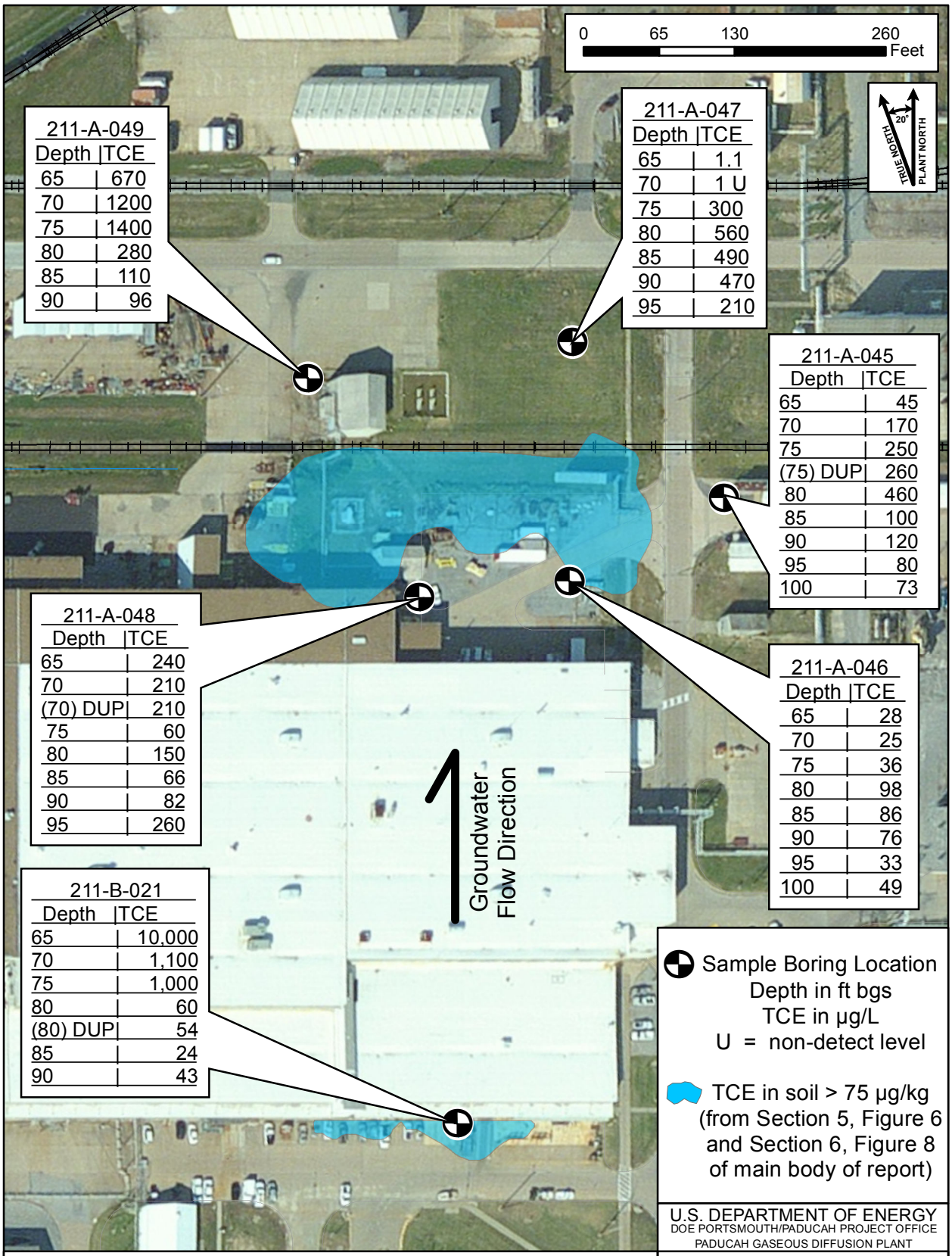

Figure 1 Sample Boring Locations

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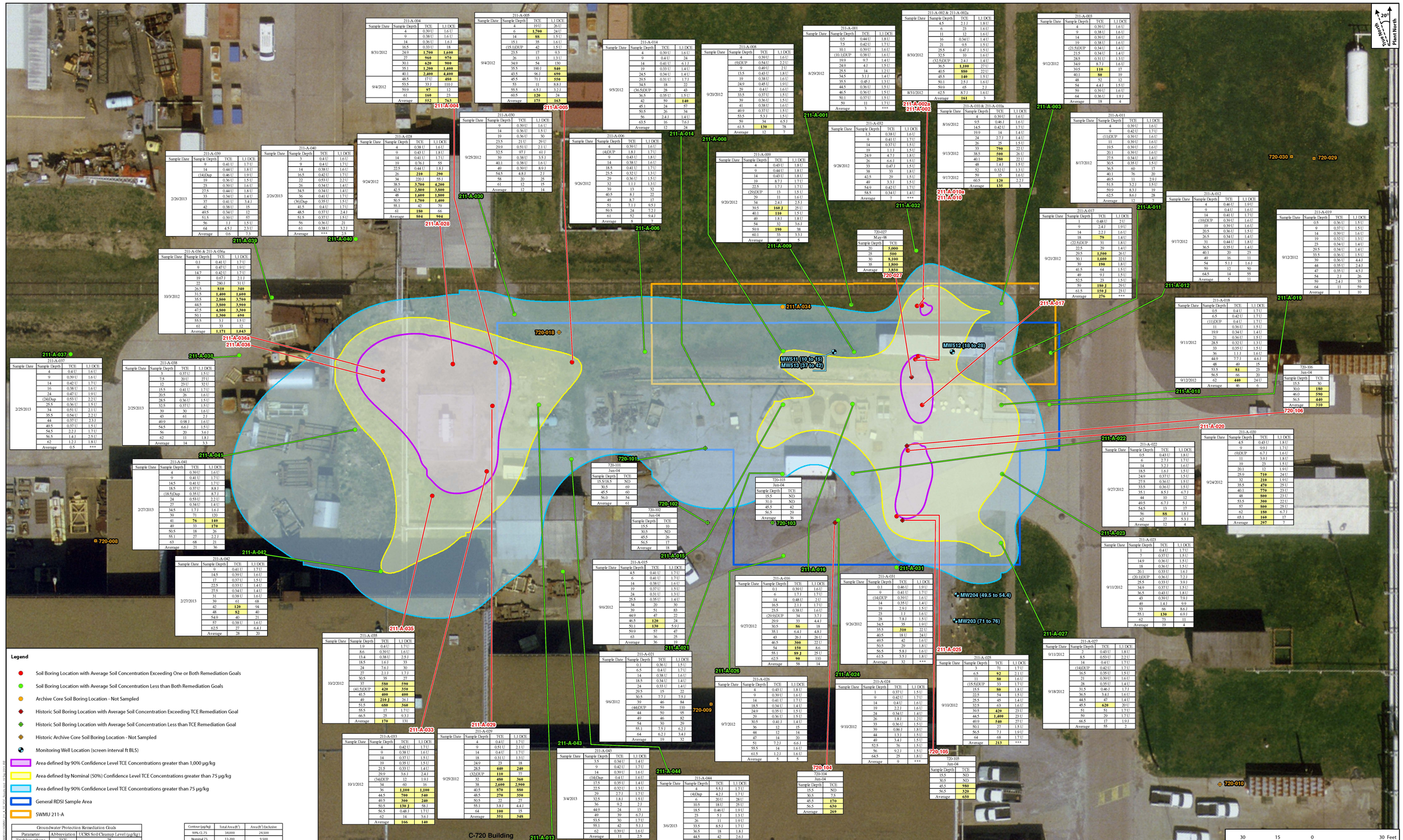
Table 1. Volatile Organic Compound Analyses for the 2015 Groundwater Investigation of the Remedial Design Support Investigation

Station	Depth Sampled (ft)	Date Collected	Trichloroethene (ug/L)		1,1-Dichloroethene (ug/L)		cis-1,2-Dichloroethene (ug/L)		*cis*-1,2-Dichloroethene/ Trichloroethene Ratio (%)	*trans*-1,2-Dichloroethene (ug/L)		Vinyl Chloride (ug/L)	
			Result	Qualifier	Result	Qualifier	Result	Qualifier		Result	Qualifier	Result	Qualifier
211-A-045	65	6/29/2015	45		4.2		2.5		6	1	U	1	U
211-A-045	70	6/29/2015	170		22		7.8		5	1	U	1	U
211-A-045	75	6/30/2015	250		39		13		5	0.36	J	1	U
211-A-045	(duplicate) 75	6/30/2015	260		40		13		5	0.38	J	1	U
211-A-045	80	6/30/2015	460		49		19		4	0.33	J	1	U
211-A-045	85	6/30/2015	100		9.5		32		32	1	U	1	U
211-A-045	90	6/30/2015	120		7.5		26		22	0.32	J	1	U
211-A-045	95	6/30/2015	80		2.4		22		28	1	U	1	U
211-A-045	100	6/30/2015	73		5.7		19		26	1	U	1	U
211-A-046	65	6/23/2015	28		2.2		4		14	1	U	1	U
211-A-046	70	6/23/2015	25		3.4		4.4		18	1	U	1	U
211-A-046	75	6/24/2015	36		3.3		10		28	1	U	1	U
211-A-046	80	6/24/2015	98		11		51		52	1	U	1	U
211-A-046	85	6/24/2015	86		5.6		32		37	1	U	1	U
211-A-046	90	6/24/2015	76		2.3		19		25	1	U	1	U
211-A-046	95	6/24/2015	33		1.5		7.6		23	1	U	1	U
211-A-046	100	6/24/2015	49		2.6		14		29	1	U	1	U
211-A-047	65	6/24/2015	1.1		1	U	1	U	91	1	U	1	U
211-A-047	70	6/25/2015	1	U	1	U	1	U	100	1	U	1	U
211-A-047	75	6/25/2015	300		58		29		10	0.54	J	1	U
211-A-047	80	6/25/2015	560		72		32		6	0.89	J	1	U
211-A-047	85	6/25/2015	490		71		34		7	1.2		1	U
211-A-047	90	6/25/2015	470		62		31		7	1.1		1	U
211-A-047	95	6/25/2015	210		26		49		23	1.3		1	U
211-A-048	65	6/25/2015	240		29		740		308	0.8	J	79	
211-A-048	70	6/26/2015	210		21	J	610		290	0.78	J	57	
211-A-048	(duplicate) 70	6/26/2015	210		20		640		305	0.69	J	60	
211-A-048	75	6/26/2015	60		15		49		82	0.34	J	3.5	
211-A-048	80	6/26/2015	150		56		81		54	0.62	J	1.6	
211-A-048	85	6/26/2015	66		21		45		68	0.36	J	1.4	
211-A-048	90	6/26/2015	82		15		45		55	0.45	J	0.65	J
211-A-048	95	6/27/2015	260		22	J	49		19	0.41	J	0.96	J
211-A-049	65	6/30/2015	670		1,400		56		8	1	U	1.9	
211-A-049	70	7/1/2015	1,200		2,100		79		7	0.47	J	3	
211-A-049	75	7/1/2015	1,400		2,200		77		6	0.54	J	3.2	
211-A-049	80	7/1/2015	280		360		44		16	0.49	J	0.76	J
211-A-049	85	7/1/2015	110		59		42		38	0.39	J	1	U
211-A-049	90	7/1/2015	96		50		36		38	1	U	1	U
211-B-021	65	6/27/2015	10,000		1.1		210		2	0.6	J	1	U
211-B-021	70	6/29/2015	1,100		0.31	J	26		2	1	U	1	U
211-B-021	75	6/29/2015	1,000		1	U	28		3	1	U	1	U
211-B-021	80	6/29/2015	60		1	U	2.4		4	1	U	1	U
211-B-021	(duplicate) 80	6/29/2015	54		1	U	2.2		4	1	U	1	U
211-B-021	85	6/29/2015	24		1	U	1.6		7	1	U	1	U
211-B-021	90	6/29/2015	43		1	U	1.5		3	1	U	1	U



211-A-004			
Sample Date	Sample Depth	TCE	1,1 DCE
8/31/2012	4	0.39 U	1.6 U
	9	0.38 U	1.6 U
	14	0.36 U	1.6 J
	16.5	0.33 U	18
9/4/2012	24.0	**1,700**	**1,600**
	27	**960**	**970**
	30.1	**620**	**900**
	35.1	**1,200**	**1,400**
	40.1	**2,400**	**4,400**
	48.5	17 U	**450**
	53.5	33 J	110 J
	59.0	**97**	12
	61	**160**	23
	Average	**552**	**763**

211-A-005			
Sample Date	Sample Depth	TCE	1,1 DCE
9/4/2012	4	10 U	26 U
	6	**1,700**	24 U
	14	**88**	1.5 U
	15.1	35	1.6 U
	(15.1)DUP	42	1.5 U
	23.5	17	9.3
	26	13	1.3 U
	34.9	54	130
	35.5	190 J	**540**
	43.5	96 J	**690**
	45.5	71 J	**550**
	53	11	8.8 J
	55.5	6.5 J	3.2 J
	60.5	**120**	24
	Average	**175**	**163**

211-A-014			
Sample Date	Sample Depth	TCE	1,1 DCE
9/5/2012	4	0.39 U	1.6 U
	9	0.4 U	24
	14	0.41 U	6.1 J
	19	0.33 U	1.4 U
	24.5	0.34 U	1.4 U
	29.5	0.31 U	1.7 J
	34.5	18	22
	(36.5)DUP	28	43
	36.5	0.35 U	1.5 U
	42	50	**140**
	45.1	24	57
	50.5	26	34
	56	2.4 J	1.4 U
	63.5	16	7.6 J
	Average	12	24

211-A-008			
Sample Date	Sample Depth	TCE	1,1 DCE
9/20/2012	4	0.39 U	1.6 U
	(9)DUP	0.54 U	2.2 U
	9	0.49 U	2 U
	13.5	0.43 U	1.8 U
	19	0.38 U	1.6 U
	24.9	0.45 U	1.9 U
	29	0.4 U	1.6 U
	33.5	0.37 U	1.5 U
	39	0.36 U	1.5 U
	41	0.38 U	1.6 U
	49.9	0.37 U	1.5 U
	53.5	5.3 J	1.5 U
	59	34	6.5 J
	61.5	**130**	78
	Average	12	7

211-A-001			
Sample Date	Sample Depth	TCE	1,1 DCE
8/29/2012	0.5	0.44 U	1.8 U
	7.5	0.42 U	1.7 U
	10.1	0.39 U	1.6 U
	(10.1)DUP	0.38 U	1.6 U
	19.9	9.7	1.4 U
	24.9	4.4	1.5 U
	25.5	14	1.2 U
	34.5	3.1 J	1.4 U
	35.5	0.45 J	1.3 U
	44.5	0.36 U	1.5 U
	46.5	0.36 U	1.5 U
	50.1	0.37 U	1.5 U
	59	11	1.7 U
	Average	3	***

211-A-002 & 211-A-002a			
Sample Date	Sample Depth	TCE	1,1 DCE
8/30/2012	4.5	2.1 J	1.8 U
	6	23	1.6 U
	11	12	1.6 U
	16	0.34 U	1.4 U
	21	9.5	1.5 U
	25.5	0.47 J	1.5 U
	32.5	10	1.6 U
	(32.5)DUP	2.4 J	1.4 U
	36.5	**1,100**	27 U
	40.5	**850**	22 U
	45.5	**140**	1.5 U
	50.1	2.5 J	1.6 U
	59.0	68	2 J
8/31/2012	62.5	8.7 J	1.6 U
	Average	**161**	3

211-A-003			
Sample Date	Sample Depth	TCE	1,1 DCE
9/12/2012	4	0.39 U	1.6 U
	9	0.38 U	1.6 U
	14	0.39 U	1.6 U
	19	0.38 U	1.6 U
	(21.5)DUP	0.34 U	1.4 U
	21.5	0.34 U	1.4 U
	28.5	0.31 U	1.3 U
	34.0	8.7 J	1.6 U
	39.5	**110**	17
	40.1	**80**	19
	48	52	12
	54	4.4 J	1.5 U
	59	0.39 U	1.6 U
	64	0.36 U	1.9 J
	Average	18	4

211-A-010 & 211-A-010a			
Sample Date	Sample Depth	TCE	1,1 DCE
8/16/2012	4	0.39 U	1.6 U
	9.5	0.46 J	1.6 U
	14.5	0.42 U	1.7 U
9/13/2012	19.9	14	1.4 U
	24	2.7 J	1.4 U
	26	25	1.5 U
	33	**790**	22 U
	38.5	**500**	26 U
	40.1	**280**	22 U
	48	1.4 J	1.5 U
	52	0.32 U	1.3 U
9/17/2012	59	15	1.6 U
	60.5	**120**	2.2 J
	Average	**135**	3

211-A-011			
Sample Date	Sample Depth	TCE	1,1 DCE
8/17/2012	4	0.39 U	1.6 U
	9	0.42 U	1.7 U
	(11)DUP	0.39 U	1.6 U
	11	0.39 U	1.6 U
	19.5	0.39 U	1.6 U
	20.1	0.39 U	1.6 U
	27.5	0.34 U	1.4 U
	30.5	0.35 U	1.5 U
	36.5	60	17
	40.1	76	20
	40.5	11	2.9 J
	51.5	3.2 J	1.5 U
	59.0	8.3 J	19
	62.5	8.6 J	28
	Average	12	7

211-A-032			
Sample Date	Sample Depth	TCE	1,1 DCE
9/28/2012	13	0.38 U	1.6 U
	9	0.41 U	1.7 U
	14	0.37 U	1.5 U
	19	1.1 J	1.5 U
	24.9	4.7 J	1.8 U
	26	6.6 J	1.5 U
	33	0.47 J	1.5 U
	38	33	1.8 U
	42.5	29	1.5 U
	49	3.3 J	1.5 U
	54.0	0.42 U	1.7 U
	58.5	0.34 U	1.4 U
	Average	7	***

211-A-009			
Sample Date	Sample Depth	TCE	1,1 DCE
9/20/2012	4	0.43 U	1.8 U
	9	0.44 U	1.8 U
	14	0.43 U	1.8 U
	19	8.7 J	1.7 U
	22.5	1.7 J	1.7 U
	(29)DUP	13	1.5 U
	29	11	1.6 U
	34	2.4 J	2.5 J
	39.5	**160 J**	25 U
	40.1	**110**	1.5 U
	49	1.8 J	1.8 U
	54	32	3.6 J
	59.0	**190**	38
	60.1	33	3.3 J
	Average	40	5

720-027
May-98
Sample Depth	TCE
20	**5,000**
25	**500**
30	**8,100**
35	**1,800**
Average	**3,850**

211-A-017			
Sample Date	Sample Depth	TCE	1,1 DCE
9/21/2012	7	0.48 U	2 U
	9	2.4 J	1.9 U
	14	2.2 J	1.6 U
	18	**79**	1.4 U
	(22.5)DUP	31	1.8 U
	22.5	29	1.4 U
	29.5	**1,500**	26 U
	30.1	**1,600**	22 U
	39	**190**	1.8 U
	41.5	64	1.5 U
	49	9 J	1.5 U
	52.5	23	1.5 U
	59	**150 J**	29 U
	61.5	**150 J**	23 U
	Average	**276**	***

211-A-012			
Sample Date	Sample Depth	TCE	1,1 DCE
9/17/2012	4	0.46 U	1.9 U
	9	0.4 U	1.6 U
	14	0.41 U	1.7 U
	(19)DUP	0.39 U	1.6 U
	19	0.39 U	1.6 U
	20.5	0.36 U	1.5 U
	26.5	0.34 U	1.4 U
	31	0.44 U	1.8 U
	36.5	0.35 U	1.4 U
	40.1	20	23
	49	16	11
	54	5.1 J	1.6 J
	59	12	50
	64.5	14	55
	Average	5	11

211-A-019			
Sample Date	Sample Depth	TCE	1,1 DCE
9/12/2012	0.5	0.36 U	1.5 U
	9	0.37 U	1.5 U
	14	0.39 U	1.6 U
	19	0.32 U	1.3 U
	23	0.34 U	1.4 U
	29.5	0.34 U	1.4 U
	33.5	0.36 U	1.5 U
	39	0.36 U	4.4 J
	44	0.35 U	2.4 J
	47	0.35 U	4.5 J
	54	2 J	26
	59	2.4 J	35
	64	11	59
	Average	1	10

211-A-018			
Sample Date	Sample Depth	TCE	1,1 DCE
9/11/2012	0.5	0.4 U	1.7 U
	6.5	0.42 U	1.7 U
	(11)DUP	0.4 U	1.7 U
	11	0.36 U	1.5 U
	19.9	0.34 U	1.4 U
	21	0.36 U	1.5 U
	28.5	0.32 U	1.3 U
	33	0.35 U	1.5 U
	36	1.1 J	1.6 U
	44.9	7.7 J	4.6 J
	48	49	15
	53.5	**81**	23
	56.5	66	20
9/12/2012	62	**440**	24 U
	Average	46	6

720-106
Jun-04
Sample Depth	TCE
15.5	30
30.0	**180**
46.0	**590**
56.5	**440**
Average	**310**

211-A-020			
Sample Date	Sample Depth	TCE	1,1 DCE
9/24/2012	4.5	0.43 U	1.8 U
	9	0.9 J	1.7 U
	(9)DUP	6.7 J	1.6 U
	11	3.9 J	1.8 U
	19	23	1.5 U
	20.1	12	1.9 U
	25.9	**710**	24 U
	32	**210**	1.9 U
	35.5	**470**	25 U
	40.1	**770**	23 U
	48	**500**	23 U
	53.5	**300**	22 U
	57	**500**	25 U
	62	**150**	6.7 J
	65.1	**160**	17
	Average	**297**	7

211-A-022			
Sample Date	Sample Depth	TCE	1,1 DCE
9/27/2012	0.5	0.43 U	1.8 U
	6	2.7 J	1.7 U
	14	3.2 J	1.6 U
	18.5	1.6 J	1.5 U
	24.9	0.37 U	1.5 U
	27.5	0.36 U	1.5 U
	33.5	0.36 U	1.5 U
	35.1	8.5 J	6.7 J
	44	10	12
	49.5	6.7 J	5 J
	54.5	13	17
	56	**88**	1.8 J
	62	7	5.3 J
	Average	12	4

211-A-023			
Sample Date	Sample Depth	TCE	1,1 DCE
9/11/2012	1	0.4 U	1.7 U
	7	0.37 U	1.5 U
	14.9	0.36 U	1.5 U
	18	0.36 U	1.5 U
	20.1	0.33 U	1.6 J
	(20.1)DUP	0.36 U	7.2 J
	25.5	0.33 U	3.9 J
	34.9	0.37 U	1.5 U
	36.5	0.43 U	1.8 U
	43	0.39 U	7.9 J
	49	1.4 J	9.0
	53	66	8.6 J
	55.1	**130**	6.9 J
	62	73	11
	Average	19	4

211-A-031			
Sample Date	Sample Depth	TCE	1,1 DCE
9/26/2012	0.1	0.46 U	1.9 U
	9	0.41 U	1.7 U
	(14)DUP	0.39 U	1.6 U
	14	0.35 U	1.4 U
	19	2.9 J	1.5 U
	23	1.1	1.6 U
	28	7.8 J	1.5 U
	34.5	35	1.9 U
	35.5	**310**	22 U
	40.5	18 U	24 U
	49.5	42	1.6 U
	50.5	29	1.8 U
	56.5	5.8 J	1.6 U
	61.5	3.5 J	1.8 U
	Average	32	***

211-A-027			
Sample Date	Sample Depth	TCE	1,1 DCE
9/11/2012	2	0.43 U	1.8 U
	8.5	0.53 U	2.2 U
9/18/2012	14	0.4 U	1.7 U
	(14)DUP	0.42 U	1.7 U
	16.5	0.35 U	1.5 U
	21	0.39 U	1.6 U
	28	0.35 U	1.4 U
	31.5	0.46 J	1.7 J
	36.5	3.4 J	1.6 U
	44.5	47	1.4 U
	45.5	**620**	20 U
	51	51	1.7 U
	59	29	1.7 U
	66.5	17	1.9 J
	Average	55	2

211-A-025			
Sample Date	Sample Depth	TCE	1,1 DCE
9/10/2012	3	71	1.7 U
	6.5	**92**	2.1 U
	11	**80**	1.6 U
	(15.5)DUP	33	1.7 U
	15.5	**50**	1.8 U
	22.5	54	1.5 U
	25.5	45	1.4 U
	32.5	63	1.6 U
	39.5	**420**	23 U
	44.5	**1,400**	23 U
	49.9	**540**	27 U
	50.1	27	1.5 U
	56.5	7.3	1.9 U
	64	68	1.7 U
	Average	**213**	***

720-105
Jun-04
Sample Depth	TCE
15.5	ND
30.5	ND
45.5	**980**
56.5	**320**
Average	**650**

211-A-024			
Sample Date	Sample Depth	TCE	1,1 DCE
9/10/2012	1	0.37 U	1.5 U
	9	0.42 U	1.7 U
	14	0.4 U	1.6 U
	19	2.2 J	1.6 U
	24	0.34 U	1.4 U
	26	1.8 J	1.2 U
	33	0.36 U	1.5 U
	39	0.86 J	1.8 U
	44	1.3 J	1.5 U
	49	3.4 J	1.5 U
	52.5	36	1.5 U
	56	9.2 J	1.5 U
	64.5	25	1.8 U
	Average	9	***

211-A-026			
Sample Date	Sample Depth	TCE	1,1 DCE
9/7/2012	4	0.43 U	1.8 U
	9	0.39 U	1.6 U
	14	0.41 U	1.7 U
	18.5	0.34 U	1.4 U
	24.9	0.35 U	1.5 U
	29	0.36 U	1.5 U
	30.5	0.41 J	1.4 U
	36	12	15
	44	12	14
	47	14	20
	51	7.2 J	6.6 J
	55.5	14	1.6 U
	61.5	1.2 J	1.6 U
	Average	5	5

211-A-021			
Sample Date	Sample Depth	TCE	1,1 DCE
9/6/2012	0.1	0.36 U	1.5 U
	6.5	0.4 U	1.7 U
	14	0.38 U	1.6 U
	18.5	0.34 U	1.4 U
	24	0.33 U	1.4 U
	29.5	15	22
	30.5	7.7 J	7.5 J
	39	46	84
	(44)DUP	59	110
	44	50	95
	49	46	82
	54	30	29
	55.1	7.5 J	6.2 J
	64	6.2 J	3.4 J
	Average	19	32

720-104
Jun-04
Sample Depth	TCE
15.5	ND
30.5	7.5
45.5	**170**
56.5	**630**
Average	**269**

211-A-044			
Sample Date	Sample Depth	TCE	1,1 DCE
3/6/2013	4	5.5 J	1.7 U
	(4)Dup	4.2 J	1.7 U
	6	20 U	28 U
	10.5	18 U	25 U
	18.5	0.46 U	1.9 U
	23	5 J	1.3 U
	26	11	1.9 U
	33.5	8.5 J	1.7 U
	36.5	18	1.8 J
	44.5	42	2.6 J
	49	**76**	9.6
	54.5	2.7 J	1.5 U
	55.5	2.5 J	1.9 U
	62.5	0.47 U	1.9 U
	Average	14	3.4

211-A-036 & 211-A-036a			
Sample Date	Sample Depth	TCE	1,1 DCE
10/3/2012	0.1	0.41 U	1.7 U
	9	0.47 U	1.9 U
	14.7	0.42 U	1.7 U
	19	0.67 J	2.1 J
	22	280 J	31 U
	26.5	**810**	**340**
	31.5	**1,400**	**1,600**
	35.5	**2,800**	**3,700**
	44.5	**3,500**	**3,900**
	47.5	**4,500**	**3,300**
	50.1	**1,300**	**690**
	55.5	3 J	1.5 U
	61	33	12
	Average	**1,171**	**1,043**

211-A-037			
Sample Date	Sample Depth	TCE	1,1 DCE
2/25/2013	4	0.4 U	1.6 U
	9	0.39 U	1.6 U
	14	0.42 U	1.7 U
	16	0.38 U	1.6 U
	24	0.47 U	1.9 U
	(24)Dup	0.55 U	2.2 U
	25.5	0.36 U	1.5 U
	34	0.51 U	2.1 U
	35.5	0.54 U	2.2 U
	44	0.37 U	2.3 J
	49.5	0.37 U	1.5 U
	54.5	2.2 J	1.7 U
	56.5	1.4 J	2.5 U
	62	1.2 J	1.8 U
	Average	0.5	***

211-A-038			
Sample Date	Sample Depth	TCE	1,1 DCE
2/25/2013	3	0.37 U	1.5 U
	7.5	20 U	27 U
	12	23 U	32 U
	15.5	0.41 U	1.7 U
	20.5	26	1.6 U
	26.5	0.36 U	1.5 U
	32.5	0.37 U	1.5 U
	39	30	1.6 U
	43	61	2 J
	49.9	0.98 J	1.6 U
	54.5	6.6 J	1.5 U
	56	20	3.6 J
	62	11	1.8 J
	Average	14	3.3

211-A-041			
Sample Date	Sample Depth	TCE	1,1 DCE
2/27/2013	4	0.39 U	1.6 U
	9	0.41 U	1.7 U
	14.5	0.41 U	1.7 U
	18.5	0.37 U	8.8 J
	(18.5)Dup	0.35 U	8.7 J
	24	0.53 U	2.2 U
	27	0.34 U	1.4 U
	34.5	1.7 J	1.6 J
	39	71	120
	41	**76**	**140**
	49	33	**170**
	50.5	18	26
	55.1	27	2.2 J
	63	68	21
	Average	21	36

211-A-042			
Sample Date	Sample Depth	TCE	1,1 DCE
2/27/2013	9	0.41 U	1.7 U
	14.5	0.39 U	1.6 U
	17	0.37 U	1.5 U
	22.5	0.33 U	1.4 U
	27.5	0.34 U	1.4 U
	31	0.38 U	1.6 U
	39	61	68
	42	**120**	94
	48	**52**	40
	54.0	40	21
	57	0.38 U	1.6 U
	62.5	27	6.4 J
	Average	28	20

211-A-015			
Sample Date	Sample Depth	TCE	1,1 DCE
9/6/2012	4.5	0.41 U	1.7 U
	6	0.41 U	1.7 U
	14	0.38 U	1.6 U
	19	0.37 U	1.5 U
	24	0.31 U	1.3 U
	26.5	0.35 U	1.4 U
	34	20	30
	39	51	83
	44.9	47	22
	46.5	**120**	24
	50.1	**130**	5.9 J
	50.0	57	47
	63	36	25
	Average	36	19

211-A-016			
Sample Date	Sample Depth	TCE	1,1 DCE
9/27/2012	0.1	0.39 U	1.6 U
	6	1.7 J	1.7 U
	14	0.48 U	2 U
	16.5	2.1 J	1.7 U
	23.5	0.38 U	1.6 U
	(29.9)DUP	34	3.7 J
	29.9	33	4.4 J
	30.5	**86**	18
	35.1	6.4 J	4.8 J
	43	26 J	26 U
	46.5	**300**	22 U
	54	**150**	8.6
	55.1	**89 J**	25 U
	62.5	**90**	110
	Average	58	14

211-A-013			
Sample Date	Sample Depth	TCE	1,1 DCE
9/4/2012	4.9	0.34 U	1.4 U
	6.5	5.7 J	1.6 U
	14	42	1.6 U
	18.5	0.37 U	1.5 U
	20.5	0.3	1.4 U
	26.5	8.3 J	1.4 U
	30.1	22	7.8 J
	35.5	29	5.1 J
	44.5	**170 J**	**350**
	47.5	**78 J**	**150 J**
	53.5	13	11
	55.1	13	12
	64	56	13
	Average	34	45

211-A-033			
Sample Date	Sample Depth	TCE	1,1 DCE
10/1/2012	4	0.42 U	1.7 U
	9	0.38 U	1.6 U
	14	0.37 U	1.5 U
	19	0.35 U	1.5 U
	21.5	0.33 U	1.4 U
	29.9	3.6 J	2.4 J
	(34)DUP	12	1.9 J
	34	60	16
	36	**1,100**	**1,100**
	44.5	**700**	**540**
	49.5	**300**	**240**
	50.5	**130 J**	58 J
	56.5	0.48 J	1.7 U
	62	14	3.6 J
	Average	**166**	**140**

211-A-029			
Sample Date	Sample Depth	TCE	1,1 DCE
9/25/2012	4	0.4 U	1.7 U
	9	0.51 U	2.1 U
	14	0.41 U	1.7 U
	18	0.31 U	1.3 U
	24.9	23	18
	28.5	**440**	**240**
	(32)DUP	**110**	77
	32	**450**	**360**
	38	**2,600**	**2,900**
	40.5	**870**	**850**
	48.5	**270**	**350**
	50.5	22	27
	55.1	3.8 J	4.4 J
	64	**160**	15
	Average	**351**	**348**

211-A-043			
Sample Date	Sample Depth	TCE	1,1 DCE
3/4/2013	3.5	0.34 U	1.4 U
	9	0.42 U	1.7 U
	14	0.39 U	1.6 U
	(14)Dup	0.4 U	1.6 U
	17.5	0.35 U	1.4 U
	22.5	0.32 U	1.3 U
	29	2.7 J	1.7 U
	32.5	1.8 J	1.5 U
	36	9.2	2 J
	44.9	24	13
	49	39	6.7 J
	53.5	30	1.7 U
	55.1	42	5.3 J
	62	0.39 U	1.6 U
	Average	11	2.5

720-101
Jun-04
Sample Depth	TCE
15.5/18.5	ND
30.5	69
45.5	60
56.0	54
Average	61

720-102
Jun-04
Sample Depth	TCE
15.5	10
30.5	ND
45.5	26
56.5	17
Average	18

720-103
Jun-04
Sample Depth	TCE
15.5	ND
30.5	ND
31.0	ND
45.5	42
56.5	29
Average	36

Legend

- Soil Boring Location with Average Soil Concentration Exceeding One or Both Remediation Goals
- Soil Boring Location with Average Soil Concentration Less than Both Remediation Goals
- Archive Core Soil Boring Location - Not Sampled
- Historic Soil Boring Location with Average Soil Concentration Exceeding TCE Remediation Goal
- Historic Soil Boring Location with Average Soil Concentration Less than TCE Remediation Goal
- Historic Archive Core Soil Boring Location - Not Sampled
- Monitoring Well Location (screen interval ft BLS)
- Area defined by 90% Confidence Level TCE Concentrations greater than 1,000 µg/kg
- Area defined by Nominal (50%) Confidence Level TCE Concentrations greater than 75 µg/kg
- Area defined by 90% Confidence Level TCE Concentrations greater than 75 µg/kg
- General RDSI Sample Area
- SWMU 211-A

Groundwater Protection Remediation Goals		
Parameter	Abbreviation	UCRS Soil Cleanup Level (µg/kg)
Trichloroethene	TCE	75
1,1-Dichloroethene	1,1 DCE	137

Contour (µg/kg)	Total Area (ft²)	Area (ft²) Exclusive
90% CL 75	34,000	24,500
Nominal 75	13,200	9,500
90% CL 1000	3,700	3,700

Notes:
1. Results are presented in microgram per kilogram (µg/kg).
2. Sample depth is presented in feet below land surface (ft BLS).
3. Only those individual volatile organic compounds (VOC) with a result exceeding remediation goals are presented.
4. DUP indicates duplicate sample.
5. J indicates an estimated value.
6. U indicates compound analyzed for but not detected at or below the lowest concentration reported.
7. Yellow shaded, bold text indicates an exceedance of the Groundwater Protection Remediation Goal UCRS Soil Cleanup Target Level for VOCs.
8. *** - indicates average concentration not calculated as all boring samples were "U" qualified for specific VOC.
9. TCE isopleths are based upon individual soil sample results over all depths of sampling.
10. Section 7 of the Final Characterization Report includes explanation of the modeling conducted to establish the TCE contours based upon confidence levels.
11. Source of 2009 Aerial: Williams Aerial & Mapping, Inc.

SWMU 211-A Soil VOC Results

Paducah Gaseous Diffusion Plant
Kevil, Kentucky

Geosyntec consultants

Titusville, FL | May 2013

Figure 2