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APR 25 2016

PPPO-02-3444761-16

Mr. Brian Begley
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Division of Waste Management
Kentucky Department for Environmental Protection
200 Fair Oaks Lane, 2nd Floor
Frankfort, Kentucky 40601

Ms. Julie Corkran
Federal Facility Agreement Manager
U.S. Environmental Protection Agency, Region 4
61 Forsyth Street
Atlanta, Georgia 30303

Dear Mr. Begley and Ms. Corkran:

TRANSMITTAL OF THE ADDENDUM TO THE FINAL CHARACTERIZATION REPORT FOR SOLID WASTE MANAGEMENT UNITS 211-A AND 211-B AT THE PADUCAH GASEOUS DIFFUSION PLANT, PADUCAH, KENTUCKY, DOE/LX/07-1288&D2/A1/R1

References:

1. Letter from A. Webb to T. Duncan, "Submittal of Comments to the Addendum to the Final Characterization Report for Solid Waste Management Units 211-A and 211-B Volatile Organic Compound Sources for the Southwest Groundwater Plume, DOE/LX/07-1288&D2/A1," dated March 10, 2016
2. Letter from J. Corkran to T. Duncan, "U.S. EPA Region 4 Comments on: Addendum to the Final Characterization Report for Solid Waste Management Units 211-A and 211-B Volatile Organic Compound Sources for the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, DOE/LX/07-1288&D2/A1, Paducah, Kentucky, Issued December 11, 2016, (PPPO-02-3218324-16B), EPA ID KY8890008982, McCracken County, KY," dated March 5, 2016

Enclosed for your approval is the *Addendum to the Final Characterization Report for Solid Waste Management Units 211-A and 211-B Volatile Organic Compound Sources at the Southwest Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-1288&D2/A1/R1. The subject document has been revised in response to comments received from the U.S. Environmental Protection Agency and the Kentucky Department for Environmental Protection on March 5, 2016, and March 10, 2016, respectively. A redline document and comment response summaries also are included.

If you have any questions or require additional information, please contact David Dollins at (270) 441-6819.

Sincerely,

Tracey Duncan
Federal Facility Agreement Manager
Portsmouth/Paducah Project Office

Enclosures:
1. Addendum to the Final Characterization Report for SWMUs 211-A and 211-B VOC Sources at the Southwest Plume DOE/LX/07-1288&D2/A1/R1, Clean
2. Addendum to the Final Characterization Report for SWMUs 211-A and 211-B VOC Sources at the Southwest Plume DOE/LX/07-1288&D2/A1/R1, Redline
3. Draft Kentucky Department for Environmental Protection Comment Response Summary
4. Draft U.S. Environmental Protection Agency Comment Response Summary

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DOE/LX/07-1288&D2/A1/R1
Secondary Document

Addendum to the Final Characterization Report for Solid Waste Management Units 211-A and 211-B Volatile Organic Compound Sources for the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky

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DOE/LX/07-1288&D2/A1/R1
Secondary Document

Addendum to the Final Characterization Report for Solid Waste Management Units 211-A and 211-B Volatile Organic Compound Sources for the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky

Date Issued—April 2016

U.S. DEPARTMENT OF ENERGY
Office of Environmental Management

Prepared by
FLUOR FEDERAL SERVICES, INC.,
Paducah Deactivation Project
managing the
Deactivation Project at the
Paducah Gaseous Diffusion Plant
under Task Order DE-DT0007774

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APPENDIX H

ADDENDUM TO THE FINAL CHARACTERIZATION REPORT FOR SOLID WASTE MANAGEMENT UNITS 211-A AND 211-B VOLATILE ORGANIC COMPOUND SOURCES FOR THE SOUTHWEST GROUNDWATER PLUME AT THE PADUCAH GASEOUS DIFFUSION PLANT

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ACRONYMS

CME	Central Mine Equipment
CSM	conceptual site model
DNAPL	dense nonaqueous-phase liquid
DOE	U.S. Department of Energy
DPT	direct push technology
EPA	U.S. Environmental Protection Agency
FCR	final characterization report
FFA	Federal Facility Agreement
HSA	hollow-stem auger
KDWM	Kentucky Division of Waste Management
LATA Kentucky	LATA Environmental Services of Kentucky, LLC
LUC	land use control
NTU	nephleometric turbidity unit
PEGASIS	PPPO Environmental Geographic Analytical Spatial Information System
RDSI	remedial design support investigation
RDWP	remedial design work plan
RGA	Regional Gravel Aquifer
ROD	record of decision
SWMU	solid waste management unit
UCRS	Upper Continental Recharge System
VOC	volatile organic compound

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H.1. PROJECT DESCRIPTION

Solid Waste Management Units (SWMUs) 211-A and 211-B are areas of trichloroethene (TCE) contamination in soil to a depth of 65 ft on the north and south sides of the C-720 Maintenance and Stores Building. Identified remedies for SWMUs 211-A and 211-B in the Record of Decision (ROD) (DOE 2012) are *in situ* source treatment using enhanced *in situ* bioremediation with interim land use controls (LUCs) and long-term monitoring (Alternative 8) or long-term monitoring with interim LUCs (Alternative 2). The U.S. Department of Energy (DOE) issued a letter notification, *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, on July 10, 2013 (Blumenfeld 2013). This Final Characterization Notification identified DOE's recommendation for the remedy selection of SWMUs 211-A and 211-B as long-term monitoring with interim LUCs (Alternative 2). The recommendation was based on the results of a Remedial Design Support Investigation (RDSI) of SWMUs 211-A and 211-B that were summarized in *Final Characterization Report for Solid Waste Management Units 211-A and 211-B Volatile Organic Compound Sources for the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-1288&D2 (FCR) (DOE 2013a).

The U.S. Environmental Protection Agency (EPA) requested additional groundwater data for the Regional Gravel Aquifer (RGA) to support the basis for the final selected remedy (Tufts 2014a).[1] EPA issued an additional work request (Tufts 2014b), as provided in the Paducah Gaseous Diffusion Plant Federal Facility Agreement (FFA), to collect the additional groundwater data as a follow-on phase of the SWMUs 211-A and 211-B RDSI. Negotiations among DOE, Kentucky Division of Waste Management (KDWM), and EPA followed to determine the type and location of groundwater sampling required to address the remaining concern. The resulting sampling and analysis plan is documented in the Appendix C Addendum of the Remedial Design Work Plan (RDWP) for SWMUs 211-A and 211-B (DOE 2015). LATA Environmental Services of Kentucky, LLC, (LATA Kentucky) and its subcontractors performed sampling for this phase of the SWMUs 211-A and 211-B RDSI during the period June 22, 2015, through July 1, 2015.

The following decision rules and guidelines for evaluating the results of the RGA groundwater investigation are documented in the Appendix C sampling and analysis plan of the Addendum to the RDWP (DOE 2015).

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

- **IF** the average of downgradient minus upgradient TCE levels is less than approximately 400 parts per billion (ppb),[2] **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.[3]

- **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

[1] The KDWM accepted DOE's recommendation in the Final Characterization Notification (letter from April Webb to Rachel Blumenfeld, dated December 17, 2013).
[2] The 400 ppb exceeds the expected impact of SWMUs 211-A and 211-B to the RGA.
[3] In conjunction with interim LUCs.

estimated. The remedial action will be implementation of enhanced bioremediation and long-term monitoring.[4]

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.[5]

- **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 enhanced bioremediation and long-term monitoring.[6]

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.

The investigation data of SWMU 211-A and 211-B are intended to be evaluated holistically. DOE will evaluate the data and prepare a revised letter notification identifying DOE's recommendation for final remedy selection for SWMUs 211-A and 211-B.

H.2. CONCEPTUAL SITE MODELS

DOE completed RDSI activities to characterize the concentration and extent of TCE [and related volatile organic compounds (VOCs)] in soils of the UCRS and upper RGA to a depth of approximately 65 ft over the period August 2012 through March 2013. The FCR (DOE 2013a) results are the basis of the revised CSM applicable to development of this investigation's decision rules. In the investigation results and the CSM, SWMU 211-A consists of a broad area with soil remediation goal exceedances (depth-average TCE concentration in soil greater than 75 µg/kg) in the UCRS, covering approximately 34,000 ft^2 laterally with a depth interval of 6 to 65.1 ft below ground surface (bgs). The combined volume (mass) estimate of TCE in SWMU 211-A ranges from 0.2 gal (1 kg) to 2.2 gal (12 kg). Additional dissolved TCE concentrations derived from SWMU 211-A are not expected to exceed approximately 400 ppb in the RGA on the downgradient side of SWMU 211-A.

[4] In conjunction with interim LUCs.
[5] In conjunction with interim LUCs.
[6] In conjunction with interim LUCs.

The CSM for SWMU 211-B consists of a single area in the UCRS with soil remediation goal exceedances covering approximately 3,000 ft^2 laterally with a depth interval of 8.5 ft bgs to 64.5 ft bgs. The TCE volume (mass) estimate for SWMU 211-B ranges from 0.1 gal (0.6 kg) to 0.8 gal (4 kg). The dissolved TCE concentrations derived from SWMU 211-B are not expected to exceed approximately 400 ppb in the upper and middle RGA below SWMU 211-B.

General groundwater flow is northward in the areas of SWMUs 211-A and 211-B. The upgradient side is anticipated to be the south side of SWMUs 211-A and 211-B: the downgradient side is anticipated to be the north side of SWMUs 211-A and 211-B. RGA water level measurements are available for up to nine monitoring wells to the east, west, and north of SWMUs 211-A and 211-B for the following periods:

- October 10 and 11, 2011, measurements for eight monitoring wells;
- January 9 and 10, 2012, measurements for eight monitoring wells;
- April 9 and 10, 2012, measurements for nine monitoring wells;
- July 17, 2012, measurements for nine monitoring wells; and
- September 24, 2013, measurements for eight monitoring wells.

Inferred groundwater flow directions for the periods range from north/northeast to north/northwest under groundwater gradients of 2×10^{-4} to 4×10^{-4}. Figure H.1 presents the RGA potentiometric surface map for the SWMUs 211-A and 211-B area for September 24, 2013.

H.3. GROUNDWATER SAMPLING STRATEGY

For the 2015 RDSI groundwater investigation, the general strategy for SWMU 211-A was to characterize dissolved TCE concentrations throughout the thickness of the RGA in upgradient and downgradient locations to assess the downgradient impact of the SWMU. At SWMU 211-B, where upgradient dissolved TCE levels were assumed to be negligible and the near-downgradient area was inaccessible because of the presence to the C-720 Building,[7] the general strategy was to characterize dissolved TCE concentrations throughout the thickness of the RGA immediately below the SWMU. The Addendum to the RDWP (DOE 2015) identified five locations to sample around SWMU 211-A, based on perceived upgradient and downgradient relationships, and one location to sample within SWMU 211-B.

Previous UCRS soil sampling and analysis as part of the SWMUs 211-A and 211-B RDSI of 2012 and 2013 characterized TCE levels from near surface to a depth of approximately 65 ft bgs. The 2015 RDSI sampled and analyzed dissolved TCE levels in RGA groundwater beginning at a depth of 65 ft bgs and continuing in 5-ft intervals to the base of the RGA, found at depths between 90 ft bgs and 100 ft bgs.

The sampling and analysis plan identified the use of direct push technology (DPT) to collect the groundwater samples, unless proven ineffective. A small-diameter, hollow-stem auger (HSA) system was the back-up sampling approach. Groundwater samples were analyzed for TCE and the related VOCs 1,1-dichloroethene (DCE) (1,1-DCE); *cis*-1,2-DCE; *trans*-1,2-DCE; and vinyl chloride.

[7] The C-720 Building extends approximately 380 ft to the north. Investigation boring 211-A-048, with characterization of dissolved VOC levels through the RGA thickness, is located approximately downgradient of SWMU 211-B on the north side of the C-720 Building.

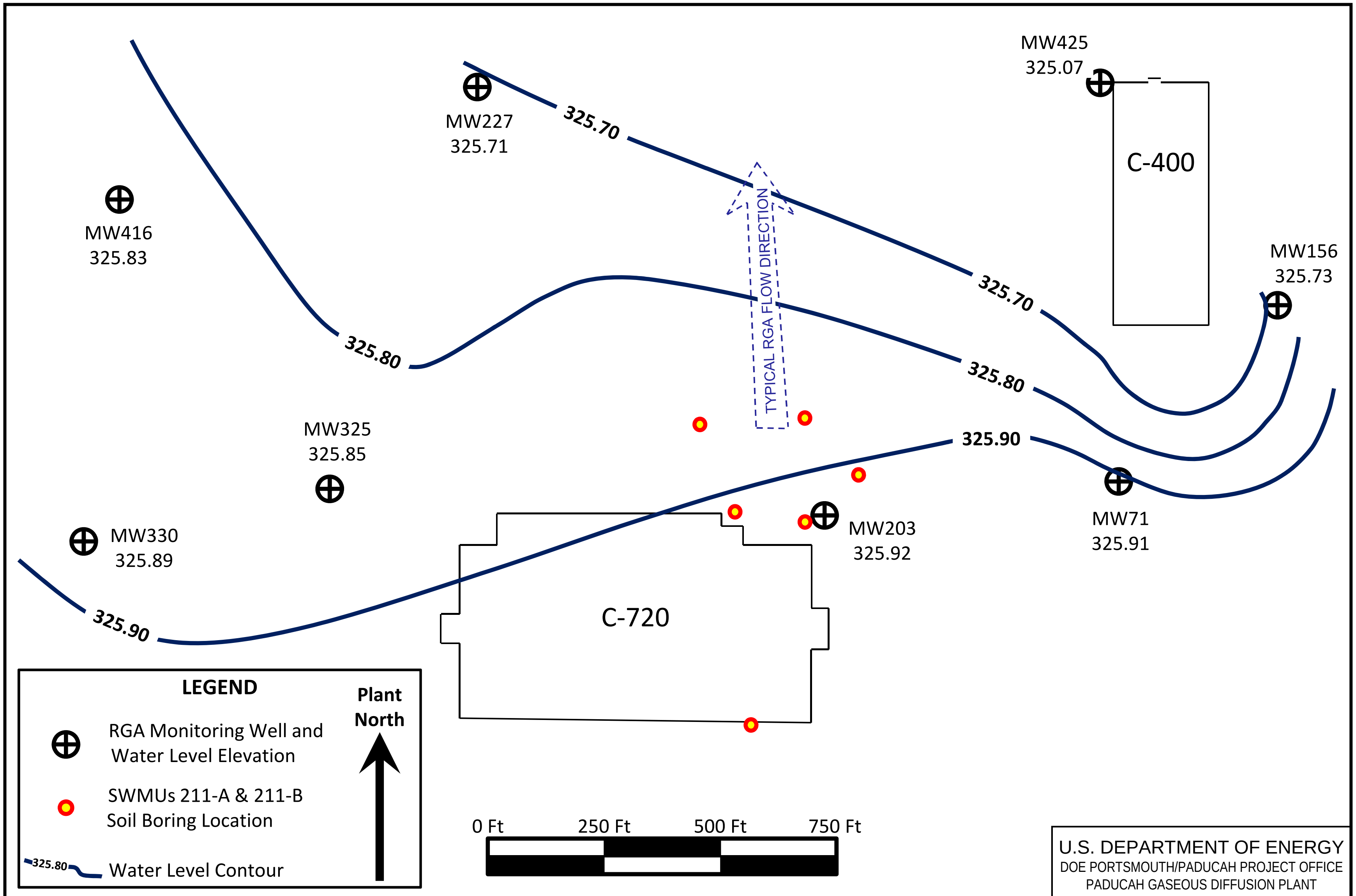

Figure H.1. RGA Potentiometric Surface for September 24, 2013

H.4. INVESTIGATION

The investigation fieldwork was completed primarily during the two weeks beginning June 22, 2015, and June 29, 2015, which was a scheduled break in the then current phase of field investigation of SWMU 4. Sampling efforts for the SWMU 4 investigation previously had documented that DPT was ineffective for sampling groundwater through the RGA. (The DPT rig, using a dual-tube sampling system, was able to penetrate to the base of the RGA, but the penetration resistance of the RGA gravels caused the dual-tube sampling system to fail.) Therefore, the SWMUs 211-A and 211-B investigation (as well as the SWMU 4 investigation) used HSAs to access the planned sample depths.

In most locations, a smaller, Central Mine Equipment (CME)-55 drill rig, using 4 ¼-inch inside diameter (8 ¼-inch outside diameter) augers pre-drilled locations to 65 ft depth and later abandoned the boreholes once sampling was completed. A larger, CME-75 drill rig, using the same augers, drilled through the RGA and placed the sampling pump. A pilot assembly with center head attached to a string of AWJ drill rod (1.75-inch outside diameter/0.625-inch inside diameter) within the augers kept soils out of the internal bore of the augers.

The project drilling subcontractor employed special steps and equipment to minimize disturbance of the RGA matrix that was exposed in the bottom of the augers. Upon reaching the depth of the sample interval, the driller immediately ceased operation of the augers (did not raise the auger string, as is customary, to create an open interval of borehole and did not over rotate the augers to clear the outer auger flights). The pilot assembly with center head that was used for the investigation was vented into the string of AWJ rod to minimize suction on the RGA matrix[8] as the pilot assembly with center head was withdrawn. The driller intentionally extracted the pilot assembly with center head slowly (with hand rotation) to minimize further suction on the RGA matrix at the base of the augers.

The sampling system consisted of a bladder pump (Well Wizard T1100) with a packer (QSP Packers, LLC, PQ wireline packer) mounted above to isolate water that was accessible to the pump from water in the augers located above the packer. The packer minimized the volume of water to be purged prior to sampling. Compressed nitrogen provided the "air" supply for operation of both the pump and packer.

The investigation schedule necessitated a one-hour limit to the groundwater purge and sampling effort for most sampling intervals. At depths of 75 ft bgs and below in the RGA, samplers were able to purge one-to-two times the volume of groundwater in the augers below the packer before sampling. The purge efforts were less effective for the upper two sample intervals (65 ft bgs and 70 ft bgs) because the height of the water column above the pump was insufficient for effective pump operation. (Greater purge volumes are less important for the uppermost sample depths where less water column is available for mixing.) With one exception (the first sample borehole, 211-A-046), sampling ceased at the base of the RGA. The underlying McNairy Formation was recognized primarily by the presence of significantly lower water levels inside the auger string prior to purging and by the inability of the formation to sustain a minimal pumping rate.

The investigation crew collected most samples directly from the discharge stream of the pump. Because of an excessive entrained sediment load in the pumped water from the 80-ft depth in soil boring

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[8] The importance of minimizing suction at the base of the augers is to limit the tendency of saturated sands of the RGA from flowing into the then-open augers, which would increase turbidity of the water and potentially prevent reseating of the pilot assembly in the HSAs.

211-A-046, samplers decanted that sample for VOC analysis from a precleaned, stainless steel cup.[9] Prior to sample collection, field parameters were measured in a cup sample with a Hydrolab water quality meter. The entrained sediment load was too great to permit use of a flow cell for field parameter measurements. For the investigation, the field parameters consisted of conductivity, dissolved oxygen, temperature, pH, oxidation/reduction potential, and turbidity. The sample vial labels and chains-of-custody were completed and maintained "real time." The samples were stored in sample coolers with wet ice during the day and transferred to sample refrigerators for storage. Trip blanks were collected at the beginning of each day of the field investigation and maintained in the sample coolers and sample refrigerators, along with the groundwater samples. Samples were shipped to the laboratory on the next day, except for the following:

- Samples of 211-A-048, 70 ft to 90 ft (sampled on Friday and shipped on Monday);
- Samples of 211-A-048, 95 ft, and 211-B-021, 65 ft (sampled on Saturday and shipped on Monday); and
- Samples of 211-A-049, 70 to 90 ft (sampled and shipped on the same-day, Wednesday).

Following the sample collection effort at each sample interval, the pump and inside of the associated sample discharge tubing (Teflon™) was decontaminated in a three-step process (soap water wash, followed by tap water and deionized water rinses), consistent with LATA Kentucky procedure *Decontamination of Sampling Equipment and Devices*, PAD-ENM-2702/R0. The packer and outside of the air supply and discharge tubing were rinsed with tap water and wiped down as the sampling assembly was extracted after each sampling effort. (All but the bottom of the packer and the interior of the tubing were isolated from the sample interval during the sample process.)

H.4.1 INVESTIGATION-DERIVED WASTE

The SWMUs 211-A and 211-B investigation of 2015 produced waste in the form of soil cuttings, purge and decontamination water, and used personal protective equipment. Drill crew members shoveled soil cuttings into the bucket of a skid steer, which, as filled, was emptied into a roll-off box for storage. Used personal protective equipment was disposed of with the soil cuttings. While pumping, purge water collected into graduated, 5-gal plastic tanks to allow visual monitoring of turbidity and purge volume. The plastic 5-gal tanks were emptied routinely into an on-site, mobile, 1,100-gal tank. At the end of each day, soil and water wastes were secured in an on-site waste storage area. The drill crew used an on-site, dedicated, decontamination facility for drill rig and auger decontamination. At the decontamination facility, waste water collected into waste storage tanks built into the facility floor.

All investigation-derived wastes were containerized and have been characterized. The soil cuttings met the waste acceptance criteria for disposition in the C-746-U Landfill, and are scheduled for disposition in April 2016. The wastewater has been characterized, and will undergo treatment at the C-612 Northwest Plume Groundwater Treatment facility, prior to discharge.

[9] This field decision to collect the sample from a cup adds uncertainty to the analysis for this sample (biasing the VOC levels low).

H.5. DATA EVALUATION

Data verification, validation, and assessment were performed for the project data in accordance with CP3-ES-5003, "Quality Assured Data" (Fluor Federal Services 2015). The data evaluation results are stored in Paducah Project Environmental Measurements System and have been transferred with the data to the Paducah Oak Ridge Environmental Information System database. Results are available through the Paducah version of DOE's PPPO Environmental Geographic Analytical Spatial Information System (PEGASIS) Web site at http://padgis.latakentucky.com/padgis/.

The data evaluation for the 2015 groundwater investigation of the RDSI identified the following variances. At SWMU 211-A, a total of 40 groundwater samples (excluding quality control samples) was allotted (five soil borings with eight samples each, at depths of 65 to 100 ft). The investigation sampled each of the planned borings to the base of the RGA (the project objective). Due to the field-determined depth of the base of the RGA, the deepest groundwater sample was collected from 2 of the borings at a depth of approximately 100 ft, in 2 of the borings at a depth of approximately 95 ft, and in 1 of the borings from an approximate depth of 90 ft. A total of 36 groundwater samples was collected. At SWMU 211-B, 6 groundwater samples were collected from the lone soil boring, to 90 ft depth due to the field-determined depth of the base of the RGA.

All of the investigation groundwater analyses met the laboratory reporting limits required by the RDWP (DOE 2015). Data verification assured that the data was flagged correctly. Chains-of-custody were reviewed and found to be compliant. The data assessment determined that the data were of known quality and useable.

Results for 25 analyses were qualified "J" (indicating estimated values), of which two were for duplicate samples. Of the 25 "J" results, 23 were analyses below the required laboratory reporting limit. Two of the "J" results were associated with 1,1-DCE analyses that exceed the laboratory reporting limit: Sample 211-A-048 at 70 ft depth (21 μg/L) and Sample 211-A-048 at 95 ft depth (22 μg/L) where the matrix spike recovery was below the lower control limit.

Level IV data validation for the 2015 groundwater investigation of the RDSI was performed at a rate of 18% of planned and duplicate samples (8 of 45 samples) and 31% of water quality control samples (4 of 13 samples), which exceeded the requirements of the RDSI characterization plan (10% data validation). No data were rejected during data validation. The data validation qualified only 2 of 60 results where the matrix spike recovery was below the lower control limit, as summarized above. The analyses of the validated samples were compliant with quality control requirements set forth by the analytical methods.

Except for analyses that were qualified "U" (meaning "compound analyzed for but not detected at or below the lowest concentration reported"), the laboratory and validation process applied no other result qualifiers to the investigation data.

Continuous measurement of field water quality parameters is used commonly to determine when pumped water represents formation conditions. In the case of the RGA, the HSA drilling process typically generates excessive entrained sediment load in the groundwater samples. The excessive entrained sediment load prevents use of a flow cell to measure water quality parameters continuously: water quality measurements must be made from cup samples.

During this investigation, the excessive entrained sediment load prevented continuous measurement and attainment of target goals for water quality parameters to demonstrate the pumped water represents formation water. Measurements were made to document water quality of the final produced water to the extent possible. Measurements of turbidity and conductivity of the groundwater samples were biased high by the sediment load and were not representative of ambient groundwater quality. The measured temperatures commonly ranged from 67°F to 82°F. Higher temperatures recorded for samples from 65-ft depth at locations 211-A-046, 211-A-047, and 211-B-021 reflect the slower pumping rates at these depths and increased time required to fill the sample cup.

The cup samples were open to the atmosphere, which limits the usefulness of measurements of dissolved oxygen and oxidation-reduction potential and, to a lesser degree, pH. Despite the shortcomings in measurement of water quality, the validity and representativeness of the VOC samples are not affected by the same sampling process.

Table H.1 compares the field measurements of SWMUs 211-A and 211-B investigation to the range of field measurements from MW203, the only RGA monitoring well in the investigation area, for samples collected between 1993 and 2015.

Table H.1. SWMUs 211-A and 211-B Water Quality Parameters

Parameter	2015 Investigation Data				MW203 (1993–2015)		
	Minimum	Median	Maximum		Minimum	Median	Maximum
Dissolved Oxygen (ppm)	1.78	4.11	11.72		0.67	2.08	5.70
pH (SU)	5.83	6.96	8.51		5.33	5.90	6.30
Temperature (°F)	64.30	73.05	86.10		59.10	68.05	75.10

H.6. DATA ASSESSMENT AND VERIFICATION

Data assessment and verification were performed on 100% of the data. Data verification includes checking methods, units, reporting limits, holding times, and analytical completeness. No exceptions were identified for the project data during data verification. Data assessment considered results of data verification, laboratory data qualifiers, laboratory comments, and sampler's comments. All data were found to be of known quality, and it was determined that decisions could be made from the data based on the review. The project data have been attributed with the "QUAL" code in Paducah Oak Ridge Environmental Information System to indicate the data should be considered qualitative due to the sampling process and variability in the medium sampled.

The data assessment process further attributed VOC sample results for the 80-ft sample from soil boring 211-A-046 (the sample collected from a cup) with a "BL-SAMP" qualifier in the Paducah Oak Ridge Environmental Information System data base to document the results may be biased low due to the sample collection method.

H.7. UNCERTAINTY EVALUATION

Factors that may affect uncertainty in site characterization data sets commonly include the following:

- Results and frequencies of quality control samples, quality control exceedances, and qualifiers;
- Biases and trends in the data; and
- Project completeness.

The field investigation collected two field blank samples, three equipment rinseate samples, and eight trip blank samples for analysis of quality control. All quality control samples were analyzed for TCE; 1,1-DCE; *cis*-1,2-DCE; *trans*-1,2-DCE; and vinyl chloride. All quality control analysis results were < 1 ppb, the lab reporting limit, indicating good quality control of the decontamination process and sample shipping and minimal, if any, bias from airborne VOC levels.

The investigation also collected three duplicate samples for analysis. In each case, the difference of the original sample and duplicate sample results were ≤ +/-10% of the value of the original sample analysis, indicating good repeatability of the sampling process and laboratory analysis.

As documented above, there were very few quality control exceedances and the occurrence of data qualifiers were limited primarily to estimated results below the laboratory-required reporting limit and nondetect results compliant with project requirements. These factors do not affect the utility of the data for assessing the level of the contribution of the SWMUs to RGA contaminant levels with regard to selection of the final remedy.

VOC results of the one sample collected from a cup (depth of 80 ft in soil boring 211-A-046) may be biased low due to volatilization of VOCs during the sampling process. Because the sample represents an upgradient location, a low bias in the sample result would cause the difference of upgradient and downgradient results to increase from the actual difference. However, even if the difference between middle RGA samples from 211-A-046 and 211-A-047 is artificially high, the difference has not exceeded approximately 400 ppb; therefore, the evaluation of the decision rules has not changed.

Sampling and analysis protocols identified in the sampling and analysis plan addendum for the 2015 groundwater investigation of the RDSI were selected to optimize the representativeness of the sample and minimize the loss of VOCs, thereby reducing the potential of uncertainty associated with underestimating the presence of VOCs. The field investigation followed the sampling and analysis plan addendum for sample technique and laboratory methods except for the following:

- The dual tube sampling system for DPT, the preferred drilling method, failed due to the significant penetration resistance of the gravels of the RGA. HSAs, identified in the sampling and analysis plan as the alternative drilling method, were used to access the sample intervals.

- The investigation schedule did not allow for the targeted purge volume (based on the flooded volume of the augers) prior to sampling, as specified in the sampling and analysis plan, due to the larger volume of the HSAs.

DPT was the preferred drilling system primarily due to the expectation that the drilling method would minimally disturb the RGA at the point of sampling. Steps were taken to minimize the disturbance of the formation due to use of the HSAs. Upon reaching the sample depth, the augers were not over-rotated, a customary technique that clears the auger flights of soil, but mixes the formation matrix at the auger head and creates pathways to mingle groundwater from different depths. A vented pilot bit for the HSAs minimized the suction created (and soil disturbance) as the center rod assembly was withdrawn to permit sampling. Moreover, the driller intentionally withdrew the pilot bit slowly, with rotation, to further minimize suction.

Purging prior to sampling was intended to minimize the impact of the drilling system on the groundwater sample quality. Groundwater purging, prior to sampling, was implemented with the HSAs. Limited time of availability of the drill rig did not permit the completion of the targeted purge volume of three times the flooded volume of the augers, but a packer was used above the pump within the augers to minimize the effective volume to be purged. The pump/packer setting was adjusted based on field experience to minimize the entrained sediment load of the purge water[10] and minimize the effective flooded volume of the augers. Purge volumes achieved ranged from one to two flooded volumes of the augers.

Significantly lower water levels were measured inside the augers when the augers penetrated into the underlying McNairy Formation, as compared to the RGA. These measurements demonstrated that the seals between augers were effective at limiting inflow of water. The demonstrated integrity of the HSA system provided additional assurance that the water column inside the HSAs was representative of the sample depth and the achieved purge volume was sufficient to provide a quality sample.

As discussed in Section H.6, "Data Validation," field measurements of water quality parameters for this investigation derive from cup samples of the final purged groundwater, which are subject to atmospheric interaction and are separate from the water collected for VOC analyses. Significant uncertainty exists with regard to the representiveness of the field measurement results because of the method of collection and measurement. This same uncertainty does not extend to the VOC analyses, and the field measurements have no bearing on decisions to be made for SWMUs 211-A and 211-B based upon this investigation.

The 2015 groundwater investigation of the RDSI achieved a high degree of completeness. All six of the planned soil borings were sampled for RGA groundwater beginning at 65-ft depth, as planned. Samples were collected in each 5-ft interval to the base of the RGA in all of the soil borings.

H.8. SAMPLE RESULTS AND ASSESSMENT

Six soil boring locations, documented in Table H.2 and shown in Figure H.2, were performed, with five locations around SWMU 211-A and one location within SWMU 211-B. (Relationships are assigned with the assumption that groundwater flows northerly, consistent with the broader site trends.[11]) The investigation collected groundwater samples in each of the soil borings at 5-ft intervals, beginning at 65-ft depth and continuing to the base of the RGA (at depths of 90 to 100 ft).

Table H.3 presents the investigation analyses for TCE as well as the related VOCs 1,1-DCE; *cis*-1,2-DCE; *trans*-1,2-DCE; and vinyl chloride.

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[10] When the pump was set near the bottom of the auger string, entrained sediment plugged the pump screen. Setting the pump higher in the auger string provided a thicker water column for settling the sediments but increased the flooded volume to be purged.

[11] For this investigation, the FFA parties agreed during project scoping that 211-A-045 would be assessed as an upgradient location to 211-A-047 to address uncertainty regarding the impact of higher dissolved TCE levels located to the east and associated with TCE sources at the C-400 Cleaning Building.

Table H.2. SWMUs 211-A and 211-B Sample Borings

Sample Boring	Relationship	Plant Coordinates	
		East	North
211-A-045 • East side of SWMU 211-A	Upgradient Location of SWMU 211-A	-4,890	-2,060
211-A-046 • South side of SWMU 211-A	Upgradient Location of SWMU 211-A	-5,030	-2,145
211-A-047 • North side of SWMU 211-A	Downgradient Location of SWMU 211-A	-5,030	-1,955
211-A-048 • South side of SWMU 211-A	Upgradient Location of SWMU 211-A	-5,180	-2,135
211-A-049 • North side of SWMU 211-A	Downgradient Location of SWMU 211-A	-5,260	-1,955
211-B-021 • Internal Boring for SWMU 211-B	Beneath/“Downgradient” of SWMU 211-B	-5,138	-2,600

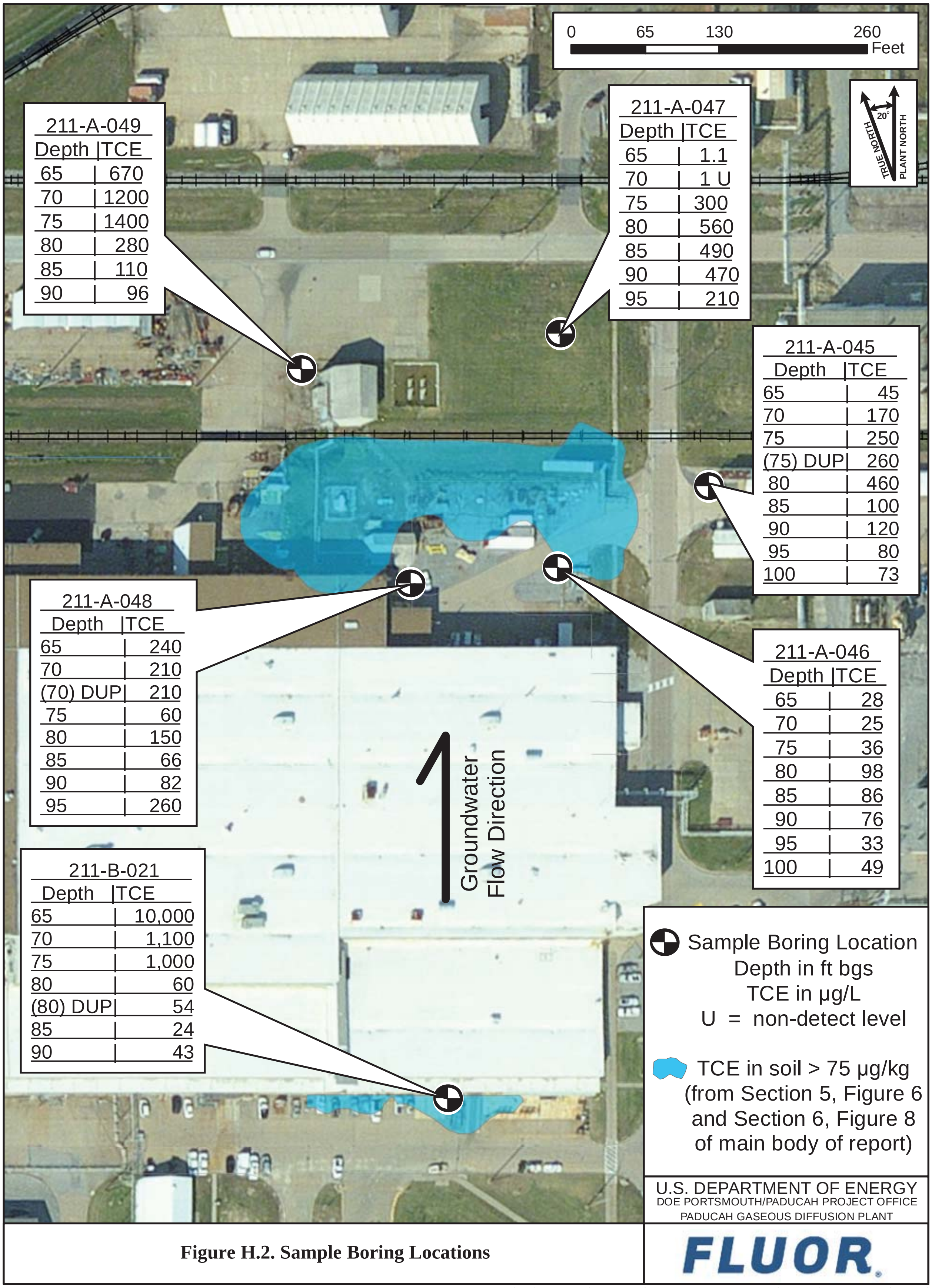

Figure H.2. Sample Boring Locations

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11/18/2015

Table H.3. Volatile Organic Compound Analyses for the 2015 Groundwater Investigation of the Remedial Design Support Investigation

Station	Depth Sampled (ft)	Date Collected	Trichloroethene (µg/L)		1,1-Dichloroethene (µg/L)		cis-1,2-Dichloroethene (µg/L)		*cis*-1,2-Dichloroethene/ Trichloroethene Ratio (%)	*trans*-1,2-Dichloroethene (µg/L)		Vinyl Chloride (µg/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[a]		11[a]		51[a]		52[a]	1[a]	U	1[a]	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

[a]Sample collected from a cup; result is potentially biased low.

Table H.3. Volatile Organic Compound Analyses for the 2015 Groundwater Investigation of the Remedial Design Support Investigation (Continued)

Date Collected	Station(s)	Quality Control Sample Type	Trichloroethene (µg/L)		1,1-Dichloroethene (µg/L)		cis-1,2-Dichloroethene (µg/L)		*trans*-1,2-Dichloroethene (µg/L)		Vinyl Chloride (µg/L)	
			Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier
6/23/15	211-A-046	Rinseate	1	U	1	U	1	U	1	U	1	U
		Trip Blank	1	U	1	U	1	U	1	U	1	U
6/24/15	211-A-046 211-A-047	Trip Blank	1	U	1	U	1	U	1	U	1	U
6/25/15	211-A-047 211-A-048	Trip Blank	1	U	1	U	1	U	1	U	1	U
6/26/2015	211-A-048	Field Blank	1	U	1	U	1	U	1	U	1	U
		Rinseate	1	U	1	U	1	U	1	U	1	U
		Trip Blank	1	U	1	U	1	U	1	U	1	U
6/27/2015	211-A-048 211-B-021	Trip Blank	1	U	1	U	1	U	1	U	1	U
6/29/2015	211-A-045 211-B-021	Trip Blank	1	U	1	U	1	U	1	U	1	U
6/30/15	211-A-045 211-A-049	Field Blank	1	U	1	U	1	U	1	U	1	U
		Rinseate	1	U	1	U	1	U	1	U	1	U
		Trip Blank	1	U	1	U	1	U	1	U	1	U
7/1/15	211-A-049	Trip Blank	1	U	1	U	1	U	1	U	1	U

H.8.1 TCE ANALYSES

Table H.4 summarizes the comparisons of TCE analyses, consistent with the project decision rules. Sample depths are grouped into upper, middle, and lower RGA zones to yield the greatest downgradient difference (to minimize the chance of not recognizing a significant difference). Sample results for the 75-ft and 90-ft depths in the samples for East SWMU 211-A in Table H.4 were used in the average of two adjacent RGA zones (upper, middle, or lower).

Table H.4. 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		
				< Approx 400 ppb	> Approx 400 ppb & < 11,000 ppb	> 11,000 ppb
				Implement LTM[b]	Implement Bio[c] & LTM[b]	FFA Parties Convene[d]
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	X[e]	--
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[f]	NA[f]	--	X	~ X[g]
Middle (70–75)	1,050	NA[f]	NA[f]	--	X	--
Lower (80–90)	42	NA[f]	NA[f]	X	--	--

[a] Duplicate results were not used in calculating average concentrations.
[b] LTM = long-term monitoring.
[c] Bio = bioremediation
[d] The FFA parties will convene and discuss a path forward for the SWMU.
[e] The difference of averages exceeds 400 ppb using the error ranges of the analyses.
[f] An upgradient sample boring was not sampled for SWMU 211-B.
[g] The sum of the analysis result and error range is 11,100 ppb.

In the east SWMU 211-A area, the difference of average upgradient and downgradient TCE levels is less than the lower criterion of approximately 400 ppb used in the decision rules.[12] In the west SWMU 211-A

[12] Discussions with the investigation laboratory indicate the control limit range for the samples is approximately 11.3%. By inspection of Table H.4, the downgradient-less-upgradient difference of TCE sample results for the middle RGA samples (collected between 75 and 90 ft) in soil borings 211-A-047 and 211-A-046 (381 ppb TCE) could be impacted significantly by the control limit range. By applying the approximate control limit range to the average of the results of these samples, the difference ranges from 321 ppb (lesser downgradient result and greater upgradient result) to 441 ppb (lesser upgradient result and greater downgradient result).

area, the difference falls between the approximately 400 ppb and 11,000 ppb criteria for remedial decisions at SWMUs 211-A and 211-B. The different results of the east and west areas of SWMU 211-A provide a basis for focusing remedial action components of the selected remedy for SWMU 211-A.

At SWMU 211-B, the analyses for three upper RGA samples from depths of 65 ft, 70 ft, and 75 ft depth substantially exceed the approximately 400 ppb action level. Moreover, the analysis for the sample at 65 ft depth—10,000 ppb with a control limit range (error range) of 1,100 ppb—approximates the project criterion for recognizing the presence of DNAPL (11,000 ppb).

The objective of the 2015 groundwater investigation of the RDSI was to assess the contribution of the SWMUs to levels of TCE and related VOCs in RGA groundwater. The field investigation used a biased sampling approach, characterizing groundwater quality in upgradient and downgradient areas at SWMU 211-A and sampling directly beneath SWMU 211-B, where upgradient levels of TCE and related VOCs are anticipated to be low and where sampling is inaccessible in the near-downgradient area due to the proximity of the C-720 Building. Separate decision rules exist for SWMUs 211-A and 211-B, but the data set was intended to be evaluated holistically. The data support a straightforward analysis of SWMU 211-A. The CSM for SWMU 211-A is validated. TCE analyses for SWMU 211-B unequivocally indicate a significant impact at the SWMU: DNAPL may be present in either the UCRS or the RGA, and the CSM may be invalid.

H.8.2 OTHER VOLATILE ORGANIC COMPOUND ANALYSES

The decision rules do not address the analyses for 1,1-DCE; *cis*-1,2-DCE; *trans*-1,2-DCE; and vinyl chloride. However, an assessment of this data provides useful context for understanding the groundwater flow system at the C-720 Building and the area of SWMUs 211-A and 211-B.

At Paducah Gaseous Diffusion Plant, infiltrating groundwater principally flows downward through the UCRS (approximately upper 60 ft of soil) and into the underlying RGA, where groundwater flows laterally northward to discharge into the Ohio River and adjacent creeks. In areas of TCE contamination in the UCRS, the underlying upper RGA typically will contain dissolved TCE levels derived from the UCRS. In areas of no TCE contamination in the UCRS, the upper-most RGA groundwater will be free of TCE contamination even though the deeper RGA may have dissolved TCE levels from an upgradient source.

The UCRS and RGA are dominantly aerobic groundwater systems. *Cis*-1,2-DCE is the primary degradation product/co-contaminant that is observed in most areas. Levels are commonly low in the RGA in areas of recharge (< 10% of total VOCs) and increase with greater flow distance in the RGA. In the limited areas where anaerobic degradation is significant, higher levels of dissolved *cis*-1,2-DCE occur along with *trans*-1,2-DCE and vinyl chloride.

The earlier UCRS soils investigation of SWMUs 211-A and 211-B (DOE 2013a) defined a distinct area of 1,1-DCE contamination in the west end of SWMU 211-A. The occurrence of higher dissolved levels of 1,1-DCE in the RGA identifies downgradient flow from the west SWMU 211-A area.

The relationships of TCE and *cis*-1,2-DCE in sample borings 211-A-046 and 211-A-047 are consistent with expectations for background and upgradient/downgradient associations. (Levels of *trans*-1,2-DCE and vinyl chloride are less than 2 ppb.)

- Upgradient sample boring 211-A-046 has a uniformly low level of TCE (< 100 ppb) with *cis*-1,2-DCE/TCE ratios > 10%, indicative of a longer contaminant residence time in the RGA.

- The upper portion of downgradient boring 211-A-047 (samples for 65 ft and 70 ft depths) is uniquely devoid of VOCs (1.1 ppb or less combined VOCs), suggestive of vertical flow to 70 ft depth with no contribution of contamination from the UCRS.

- Between 75 ft and 90 ft in sample boring 211-A-047, TCE levels spike to 300 ppb or greater with *cis*-1,2-DCE/TCE ratios ≤ 10%, indicative of a close upgradient source and lesser contaminant residence time.

A similar "downgradient to contamination" pattern is apparent in 211-A-045, with lowest TCE values in the 65 ft sample but highest TCE values in the 70 ft to 80 ft samples (170 to 460 ppb) and with *cis*-1,2-DCE/TCE ratios of 6% or less (65 to 80 ft). If the source of the shallow contamination in 211-A-045 is SWMU 211-A, then local groundwater flow has a strong easterly component.

Groundwater at 211-A-048, the upgradient sample boring for the west side of SWMU 211-A, has an upgradient contaminant source.

- Soils analyses from the SWMUs 211-A and 211-B RDSI of 2012 and 2013 document very low levels of VOC contamination in the area UCRS soils.

- Groundwater analyses from the 2015 phase of the RDSI have highest TCE levels (210 ppb to 240 ppb[13]) and *cis*-1,2-DCE levels (610 ppb to 740 ppb) in the samples from 65 ft and 70 ft depths. Ratios of *cis*-1,2-DCE/TCE range from 290% to 308% in the samples from 65 ft and 70 ft depths.

This ratio suggests the occurrence of active anaerobic degradation of TCE, as does relatively high levels of vinyl chloride (57–79 ppb) from 65 ft and 70 ft depths.[14] Anaerobic conditions may be supported by locally reduced UCRS recharge due to the area's paved surface and the sample boring's location immediately to the north (downgradient) of the C-720 Building.

Both TCE and 1,1-DCE trends in sample boring 211-A-049 are suggestive of a "downgradient to contamination" relationship.

- The highest TCE and 1,1-DCE contaminant levels were found in the samples at 70-ft and 75-ft deep (1,200 ppb and 1,400 ppb TCE and 2,100 and 2,200 ppb 1,1-DCE).

- Lesser contaminant levels at the 65 ft depth (670 ppb TCE and 1,400 ppb 1,1-DCE) reflect the influence of UCRS recharge.

- Ratios of *cis*-1,2-DCE/TCE are 8% or less between 65-ft and 75-ft deep, consistent with minimal contaminant residence time in the RGA and the presence of a nearby source zone.

The lesser *cis*-1,2-DCE levels in 211-A-049 (highest level of 79 ppb) compared to 211-A-048 (highest level of 740 ppb) indicate 211-A-049 is not directly downgradient of 211-A-048. Sample borings

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[13] Excluding the bottom RGA sample (95 ft) TCE result of 260 ppb.

[14] Field measurements for the groundwater samples from 211-A-048 document high dissolved oxygen levels (1.97 to 11.72 ppm), which are incompatible with anaerobic conditions. High entrained sediment content prevented use of a flow cell for field measurements: the measurements were made in a cup sample. Dissolved oxygen levels appear to have been biased high during field measurements.

211-A-048 and 211-A-049 are downgradient to different sources; however, the upgradient/downgradient comparison of TCE levels of the decision rules would not differ significantly with lower upgradient TCE levels. The occurrence of elevated levels of 1,1-DCE in groundwater samples from 211-A-049 is consistent with the west side of the SWMU 211-A source zone, as defined in the RDSI of 2012 and 2013. UCRS soils of the west side contained appreciable levels of both TCE and 1,1-DCE.

Dissolved RGA contaminant trends at SWMU 211-B, notably TCE and *cis*-1,2-DCE, are consistent with a UCRS contaminant source in the area of 211-B-021. TCE and *cis*-1,2-DCE levels are highest in the 65 ft depth sample (10,000 ppb TCE and 210 ppb *cis*-1,2-DCE) and drop to approximately 10% of the concentrations in the samples at 70 ft and 75 ft, showing the influence of mixing of vertical flow from the UCRS with the lateral flow that predominates in the RGA.

H.9. CONCLUSIONS

The 2015 phase of the SWMUs 211-A and 211-B investigation sampled groundwater from the RGA in 5-ft intervals from a depth of 65 ft to the base of the RGA in all six proposed locations. A holistic review of the data, as summarized above, 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.[15]

The SWMU 211-B sample results are consistent with a UCRS source zone impacting the RGA. The shallowest groundwater result for TCE (65 ft depth) 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 2012). The available remedies of the ROD did not consider the possibility of the presence of DNAPL at or near SWMU 211-B. According to the decision rules for SWMU 211-B, the FFA parties must confer to evaluate the impact of the potential for DNAPL. Future decommissioning of the C-720 Building may allow opportunity to sample adjacent soils beneath the building (and currently inaccessible) and reduce the uncertainty with regard to the extent of TCE contamination at SWMU 211-B, including the presence of DNAPL.

The 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 on the west side only. The SWMU 211-A decision rules direct implementation of enhanced bioremediation and long-term monitoring[16] (Alternative 8). These results support focused application of enhanced bioremediation on the west side.

Results of the 2015 phase of the investigation indicate DNAPL may be present at SWMU 211-B and the CSM may be invalid. SWMU 211-B is upgradient of SWMU 211-A. The project decision rules do not consider the implications of the invalidation of the CSM at SWMU 211-B upon the remedial actions at SWMU 211-A. 211-A-048, the upgradient sample boring for the west side of SWMU 211-A, appears to be impacted by an upgradient contaminant source. That contaminant source may be SWMU 211-B or another source underlying the C-720 Building. Further discussions are warranted among the FFA parties with regard to the TCE source located upgradient of SWMU 211-A, the possibility that anaerobic degradation is affecting this source, and on the timing of the SWMU 211-A remedial action.

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[15] The analytical results of the sample for 80-ft depth from location 211-A-046 may be biased low by the method of collection.
[16] In conjunction with interim LUCs.

H.10. REFERENCES

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ATTACHMENT

FIELD MEASUREMENTS AND BAROMETRIC PRESSURE

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Field Measurements and Barometric Pressure

Station	Date Collected	Depth Sampled (ft)	Height of Top of Auger (approx. inches)	Open Hole Depth (ft)	Purge Volume		Starting Depth to Water (ft)	Barometric Pressure (inch/Hg)
					(gal)	(% flooded volume[17])		
211-A-045	6/29/2015	65	12	65.3	7.25 gal	60%	33.05	29.92
		70	14	70.6	12.25 gal	80%	43.37	
	6/30/2015	75	14	74.5	22.25 gal	150%	47.29	29.96
		80	14	79.8	23.75 gal	160%	47.02	29.92
		85	14	84.1	20.75 gal	140%	47.75	
		90	20	89.7	18.25 gal	120%	47.27	
		95	14	94.5	15.0 gal	100%	47.66	29.94
		100	15	99.3	20.25 gal	130%	47.80	29.96
211-A-046	6/23/2015	65	12	65.6	6.0 gal	80%	46.37	29.96
		70	12	70.0	20.0 gal	130%	45.13	
	6/24/2015	75	12	74.7	20.0 gal	130%	46.75	29.89
		80	12	79.5	20.0 gal	130%	49.47	29.86
		85	12	84.3	20.0 gal	130%	47.39	29.87
		90	12	89.3	25.0 gal	170%	47.60	
		95	12	94.3	22.0 gal	150%	47.74	29.90
		100	12	100.0	2.75 gal	20%	61.35	29.91
211-A-047	6/24/2015	65	12	65.1	2.0 gal	10%	45.50	29.91
	6/25/2015	70	12	69.0	10.0 gal	70%	44.69	29.87
		75	12	74.8	20.0 gal	130%	46.28	
		80	12	80.0	22.0 gal	150%	48.12	
		85	12	84.8	32.0 gal	210%	47.87	
		90	12	90.0	21.0 gal	140%	47.51	29.90
		95	12	94.4	21.5 gal	140%	48.20	29.96
211-A-048	6/25/2015	65	12	64.8	9.5 gal	60%	38.63	29.91
	6/26/2015	70	10	70.5	9.5 gal	60%	43.70	29.87
		75	14	75.0	20.5 gal	140%	49.31	
		80	12	79.0	23.75 gal	160%	48.10	
		85	12	84.2	23.0 gal	150%	47.68	29.90
		90	12	89.5	24.0 gal	160%	48.12	
	6/27/2015	95	14	95.1	21.5 gal	140%	49.18	29.91
211-A-049	6/30/2015	65	14	64.6	15.5 gal	200%	48.78	29.96
	7/1/2015	70	24	70.0	21.5 gal	190%	47.15	30.00
		75	24	74.8	22.75 gal	200%	46.91	
		80	24	79.0	21.25 gal	190%	46.84	
		85	24	84.3	17.75 gal	160%	48.75	
		90	24	89.0	21.0 gal	140%	48.46	
211-B-021	6/27/2015	65	12	65.5	16.5 gal	210%	27.07	29.96
	6/29/2015	70	10	68.6	13.25 gal	120%	43.48	29.91
		75	14	75.4	20.5 gal	140%	48.97	
		80	14	78.0	25.0 gal	170%	45.03	29.97
		85	12	84.5	24.0 gal	160%	46.58	29.92
		90	16	89.5	17.0 gal	110%	46.91	

[17] Flooded volume refers to the volume of the HSAs below the packer.

Field Measurements and Barometric Pressure

Station	Depth Sampled (ft)	Conductivity (µmho/cm)	Dissolved Oxygen (mg/L)	Oxidation-Reduction Potential (mV)	pH (Std Units)	Temp (deg F)	Turbidity* (NTU)
211-A-045	65	1370	4.16	291	7.84	77.0	5999
	70	1258	6.04	163	6.71	75.8	5999
	75	1023	5.87	529	7.52	67.9	2000
	80	735	8.05	112	7.46	68.9	2000
	85	527	6.11	204	7.38	71.2	5999
	90	434	2.63	156	7.94	72.5	5999
	95	454	2.61	173	6.56	73.4	5999
	100	425	7.37	89	7.39	72.2	5999
211-A-046	65	875	1.80	250	6.26	86.1	5999
	70	947	2.37	155	6.96	75.4	5999
	75	834	2.95	-168	6.67	70.5	5999
	80	555	3.04	175	6.22	72.7	2000
	85	514	2.90	186	6.36	75.4	2000
	90	507	3.32	160	6.92	78.6	1734
	95	338	3.59	166	6.93	79.6	5999
	100	546	7.18	100	7.17	78.7	2000
211-A-047	65	234	4.43	339	6.82	83.7	5999
	70	1139	3.64	154	6.25	69.3	1118
	75	657	3.67	110	6.58	71.1	5999
	80	630	7.84	142	7.26	69.8	5999
	85	633	3.41	328	6.51	73.4	2000
	90	657	3.75	334	6.96	74.7	5999
	95	613	6.85	317	7.05	74.5	5999
211-A-048	65	422	6.49	92	7.95	74.9	5999
	70	477	1.97	122	6.99	77.0	615
	75	671	11.72	253	6.52	72.0	5999
	80	646	7.35	241	6.26	72.7	2456
	85	477	4.60	101	7.71	76.9	5999
	90	456	2.22	131	7.12	79.9	2000
	95	671	6.34	161	6.56	64.3	5999
211-A-049	65	336	4.52	129	7.31	71.2	2000
	70	491	5.50	199	6.69	68.6	1312
	75	506	3.68	235	5.83	68.6	1010
	80	440	5.97	233	5.96	68.2	5999
	85	450	2.53	139	7.84	68.8	2000
	90	441	4.06	125	8.51	70.0	5999
211-B-021	65	1407	2.48	49	7.64	85.6	5999
	70	422	2.49	-103	6.39	69.8	5999
	75	337	4.75	33	6.45	71.4	5999
	80	310	5.83	37	7.25	74.7	2000
	85	236	5.71	36	8.04	74.9	2000
	90	373	1.78	93	7.18	81.5	200

*The value of 5999 is the upper limit of the range of the instrument.