Department of Energy

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June 13, 2025

Mr. Brian Begley
Federal Facility Agreement Manager
U.S. Environmental Protection Agency, Region 4
61 Forsyth Street
Atlanta, Georgia 30303

PPPO-02-10032947-25

Ms. April Webb
Interim Federal Facility Agreement Manager
Division of Waste Management
Kentucky Department for Environmental Protection
300 Sower Boulevard, 2nd Floor
Frankfort, Kentucky 40601

Dear Mr. Begley and Ms. Webb:

TRANSMITTAL OF THE ADDENDUM TO THE REMEDIAL INVESTIGATION REPORT FOR THE C-400 COMPLEX OPERABLE UNIT AT THE PADUCAH GASEOUS DIFFUSION PLANT, PADUCAH, KENTUCKY (DOE/LX/07-2474&D2/A1)

Please find enclosed the *Addendum to the Remedial Investigation Report for the C-400 Complex Operable Unit at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-2474&D2/A1. This report documents the investigation of the area located north of the C-400 Complex Operable Unit. A certification page is also enclosed.

In accordance with Section XX.G and Appendix F of the Federal Facility Agreement (FFA), the U.S. Environmental Protection Agency and the Kentucky Department for Environmental Protection have a 90-day review and comment period, which ends on September 11, 2025. If the FFA parties have no substantive comments, the U.S. Department of Energy requests a letter of concurrence.

If you have any questions or require additional information, please contact me at (270) 217-2029.

Sincerely,

APRIL LADD Digitally signed by APRIL LADD
Date: 2025.06.13 11:35:43 -05'00'

April Ladd
Federal Facility Agreement Manager
Portsmouth/Paducah Project Office

Enclosures:
1. Certification Page
2. *Addendum to the Remedial Investigation Report for the C-400 Complex Operable Unit at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-2474&D2/A1
3. Appendix E - C-400 RIFS Addendum OREIS Data Field QC Sample Analyses (Data)
4. Appendix F - C-400 RIFS Addendum OREIS Data Samples

Administrative Record File—ARF 400OUREMEDIAL

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CERTIFICATION

Document Identification: ***Addendum to the Remedial Investigation Report for the C-400 Complex Operable Unit at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-2474&D2/A1, dated June 2025**

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision according to a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Four Rivers Nuclear Partnership, LLC

MYRNA REDFIELD (Affiliate) Digitally signed by MYRNA REDFIELD (Affiliate) Date: 2025.06.09 15:58:29 -05'00'

Myrna E. Redfield, Program Manager/Date Signed
Four Rivers Nuclear Partnership, LLC

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision according to a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

U.S. Department of Energy

APRIL LADD Digitally signed by APRIL LADD Date: 2025.06.13 11:36:00 -05'00'

April Ladd, Paducah Site Lead/Date Signed
Portsmouth/Paducah Project Office
U.S. Department of Energy

DOE/LX/07-2474&D2/A1
Primary Document

Addendum to the Remedial Investigation Report for the C-400 Complex Operable Unit at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky

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Addendum to the Remedial Investigation Report for the C-400 Complex Operable Unit at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky

Date Issued—June 2025

U.S. DEPARTMENT OF ENERGY
Office of Environmental Management

Prepared by
FOUR RIVERS NUCLEAR PARTNERSHIP, LLC,
managing the
Deactivation and Remediation at the
Paducah Gaseous Diffusion Plant
under Contract DE-EM0004895

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CONTENTS

FIGURES

TABLES

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ACRONYMS

CSM	conceptual site model
DNAPL	dense nonaqueous phase liquid
DOE	U.S. Department of Energy
DPT	direct-push technology
DQO	data quality objective
DT22	dual tube 22
ECD	electrical conductivity detector
EPA	U.S. Environmental Protection Agency
FFA	Federal Facility Agreement
FID	flame ionization detector
FRNP	Four Rivers Nuclear Partnership, LLC
FS	feasibility study
HDPE	high-density polyethylene
HU	hydrogeological unit
LCD	lower continental deposit
MDL	method detection limit
MIP	membrane interface probe
MS	matrix spike
MSD	matrix spike duplicate
MW	monitoring well
NSDD	North-South Diversion Ditch
OU	operable unit
PGDP	Paducah Gaseous Diffusion Plant
PID	photoionization detector
PQL	practical quantitation limit
PS	post-digestion spike
PSD	post-digestion spike duplicate
QA	quality assurance
QAPP	quality assurance project plan
QC	quality control
RGA	Regional Gravel Aquifer
RI	remedial investigation
ROD	Record of Decision
RPD	relative percent difference
UCD	upper continental deposit
UCRS	Upper Continental Recharge System
VOC	volatile organic compound
XSD	halogen-specific detector

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EXECUTIVE SUMMARY

The C-400 Complex Operable Unit (OU) remedial investigation (RI) evaluated and identified the presence of confirmed/probable source zones, containing trichloroethene (TCE) as dense nonaqueous phase liquid and high concentration TCE contamination, in the southern portion of the C-400 Complex OU. A likely source of the radionuclide technetium-99 (Tc-99) contamination was identified under the west-central area of the C-400 Cleaning Building. The associated feasibility study identified two data gaps regarding the area immediately north of the C-400 Complex OU, which became the RI addendum investigation area:

- The nature and extent of the potential TCE source zone(s) in Upper Continental Recharge System (UCRS) soils and in Regional Gravel Aquifer (RGA) and McNairy Formation groundwater have not been fully characterized.

- Tc-99 levels in UCRS soils and in RGA groundwater have not been fully characterized.

To address these data gaps, Four Rivers Nuclear Partnership, LLC, conducted a C-400 RI addendum investigation beginning in late October 2024 and continuing through mid-February 2025, consisting of two phases (DOE 2024). The first phase involved membrane interface probe (MIP) characterization of the investigation area in 12 locations, extending down into the upper McNairy Formation where possible. This was followed by an environmental media sampling phase, collecting soil samples to 60 ft depth and groundwater samples down to the base of the RGA at 84 ft depth.

The RI addendum investigation provides three-dimensional characterization of TCE and Tc-99 levels into the RGA and the uppermost McNairy Formation via MIP logs and TCE (and anaerobic degradation products) and Tc-99 analyses of UCRS soil and RGA groundwater for the area north of the C-400 Complex OU.

CONCLUSIONS

The MIP and sample data of the C-400 RI and this RI addendum are sufficient to identify the three-dimensional alignment of the primary Northwest Plume centroid in the area of the RI addendum investigation and can be used to optimize the location(s) of extraction well(s) of a forthcoming Northwest Plume optimization action.

The data demonstrate that potential and confirmed/probable TCE[1] and Tc-99 source zones are not present in the RI addendum investigation area.

[1] A confirmed/probable TCE source zone is the part of the source zone where it is known or highly likely for dense nonaqueous phase liquid (DNAPL) to exist. A potential TCE source zone is the part of the source zone where it is possible that DNAPL exists, but the lines of evidence indicating DNAPL presence are either fewer or are not as strong as those associated with a confirmed/ probable source zone. Refer to Section 1.2 for additional information.

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1. INTRODUCTION

Four Rivers Nuclear Partnership, LLC, (FRNP) performed the C-400 Complex Operable Unit (OU) remedial investigation (RI) from November 2019 through April 2022, with the issuance of the final report on January 5, 2023. The RI evaluated and identified the presence of confirmed/probable source zones, containing trichloroethene (TCE) as dense nonaqueous phase liquid (DNAPL) [2] and high concentration TCE contamination, in the southern portion of the C-400 Complex OU. A likely source of technetium-99 (Tc-99) contamination was identified under the west-central area of the C-400 Building.

Chromium; Tc-99; *cis*-1,2-dichloroethene (*cis*-1,2-DCE); 1,1,2-trichloroethane; and TCE were the five primary risk drivers identified by the RI in Regional Gravel Aquifer (RGA) groundwater (DOE 2023).

1.1 C-400 COMPLEX OPERABLE UNIT REMEDIAL INVESTIGATION REPORT

The report of the RI is *Remedial Investigation Report for the C-400 Complex Operable Unit at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2023). It provides significant site background and other context pertinent to this RI addendum investigation.

Contaminated groundwater is the primary risk driver to a potential off-site receptor. The associated feasibility study (FS) identified four applicable remediation alternatives, beyond the No Action Alternative, to eliminate risk to the public from C-400. A significant uncertainty remained after the RI regarding the potential for a related TCE source zone located immediately north of the C-400 Complex OU.

1.2 REMEDIAL INVESTIGATION ADDENDUM PROJECT SCOPE AND RATIONALE

Assessment and Delineation of DNAPL Source Zones at Hazardous Waste Sites defines a DNAPL source zone as the overall volume of the subsurface containing residual and/or pooled DNAPL (EPA 2009). Not all portions (e.g., lenses, laminations, fractures) of the DNAPL source zone will contain residual and/or pooled DNAPL. A confirmed/probable source zone is the part of the source zone where it is known or highly likely for DNAPL to exist. The potential source zone is the part of the source zone where it is possible that DNAPL exists, but the lines of evidence indicating DNAPL presence are either fewer or are not as strong as those associated with a confirmed/probable source zone. EPA suggests a 1% rule of thumb as a generality that sampled groundwater concentrations in excess of 1% effective solubility [TCE = 11,000 micrograms per liter (µg/L)] indicate that DNAPL may be present in the vicinity in any direction of the monitoring point of interest. (DOE 2023). This RI addendum follows EPA's terminology and uses the terms "confirmed/probable" and "potential" when discussing the source zones related to DNAPL.

For the purposes of this RI addendum investigation, source zones composed of TCE DNAPL and high-concentration TCE contamination will be defined using multiple lines of evidence.

- Potential TCE source zones are defined as areas with groundwater TCE contamination between 11,000 and 33,000 µg/L.

[2] TCE DNAPL is the occurrence of TCE as a separate phase from soil, groundwater, or air (not chemically bound to soil or dissolved in groundwater or air).

- Confirmed/probable TCE source zones are defined as areas with groundwater TCE contamination > 33,000 µg/L, TCE concentrations in soil > 100,000 micrograms per kilogram (µg/kg), and MIP photoionization detector (PID) responses > 700,000 microvolts (µV). (DOE 2024)

Assessment of the additional sampling provided by this RI addendum supports the development of remedial alternatives and the optimization of the Northwest Plume interim remedial action by filling the listed data gaps for the adjacent area north of the C-400 Complex OU (DOE 2024) that were jointly identified by the U.S. Department of Energy (DOE), the U.S. Environmental Protection Agency (EPA), and the Kentucky Department for Environmental Protection, the parties providing oversight of the site's Federal Facility Agreement (FFA). These data gaps included the following.

- The nature and extent of the potential and/or confirmed/probable TCE source zone(s) in Upper Continental Recharge System (UCRS) soils and in RGA and McNairy Formation groundwater have not been fully characterized.

- Tc-99 levels in UCRS soils and in RGA groundwater have not been fully characterized.

To fill these data gaps, the addendum to the RI/FS work plan (DOE 2024) described a phased investigation as follows:

- Perform a membrane interface probe (MIP) survey consisting of 12–22 MIP borings advanced to the RGA/McNairy Formation interface, and as much as 20 ft depth in the McNairy Formation where dense nonaqueous phase liquid (DNAPL) is not pooled at the base of the RGA; and

- Install 5–10 soil borings advanced to the depth of the RGA/McNairy Formation interface at a minimum, located based on MIP results and selected by the Federal Facility Agreement parties, which includes: (1) sampling of the UCRS soils every 10 ft, starting at 10 ft below ground surface, along with (2) two groundwater samples collected in the middle and lower RGA from each boring. Groundwater samples will also be collected where feasible and appropriate from the McNairy Formation where MIP results indicate the presence of a confirmed/probable TCE source zone. The soil and groundwater samples will be analyzed for TCE, anaerobic TCE degradation products,[3] and Tc-99.

Both the existing historical data and the data generated from this RI addendum investigation have been used to characterize the nature and extent of potential and/or confirmed probable TCE source zone(s), to define the extent of TCE and Tc-99 in the UCRS, RGA, and McNairy Formation in the area north and adjacent to the C-400 Complex OU, and to revise the C-400 Complex OU conceptual site model (see Section 4). The fate and transport assessment and screening risk evaluation for the C-400 OU RI (DOE 2023) are not significantly impacted by the results of this investigation and are not replicated in this report.

1.3 SITE BACKGROUND AND HISTORY

The C-400 Cleaning Building, a primary facility of interest to the RI addendum investigation, is located inside the C-400 Complex OU, which is bound by 10th and 11th Streets to the west and east, respectively, and by Virginia and Tennessee Avenues to the north and south, respectively. Figure 1 depicts the relationship of the C-400 Cleaning Building, the C-400 Complex OU, and the area of interest to this investigation, located north of the C-400 Complex OU.

[3] The anaerobic TCE degradation products include 1,1-dichloroethene (1,1-DCE); *cis*-1,2-DCE; *trans*-1,2-dichloroethene (*trans*-1,2-DCE); and vinyl chloride.

C-400 is a rectangular structure with a footprint of approximately 116,000 ft^2 (roughly 200 ft × 520 ft, plus appurtenances that make up the remaining footprint). The east side of the building, as well as the central and southern portions of the west half of the building, housed disassembly and part-cleaning equipment. The northwest section included the former laundry area.

It was one of the first buildings constructed in the early 1950s and was operational from 1952 to 2014 (the former plant laundry remained operational in C-400 until July 2016 before it was moved to the C-720 Maintenance and Storage Building). The building and adjacent structures have been used in a wide variety of functions to support operations at the plant. The primary functions of the C-400 Cleaning Building included cleaning (e.g., clothes laundry, machinery parts) and cleaning/maintaining equipment from the uranium enrichment process buildings (MMES 1995). Other functions of the C-400 Cleaning Building included metal etching and plating, radioactive materials stabilization and recovery, metals recovery, uranium hexafluoride cylinder washing, uranium trioxide production, diffusion process equipment testing, treatment of radiological waste streams, and uranium tetrafluoride (green salt) pulverization. TCE was the primary degreasing solvent used in the C-400 Cleaning Building; trichloroethane was used to a lesser extent. The building also housed other processes and activities, including recovery of precious metals (other contractual work).

The North-South Diversion Ditch (NSDD) is an original surface water channel of the Paducah Gaseous Diffusion Plant (PGDP) that is located primarily north of the C-400 Cleaning Building and extends north of the plant security fence along the landfill access road. It was used historically to transfer effluents from the C-400 Cleaning Building, coal pile runoff, and storm water off-site. Originally, wastewater from C-400 was captured by a waste discard system on the west and an acid sewer system on the east sides of the building and discharged into the C-404 holding pond via a C-401 transfer line. Beginning in 1957, this C-404 wastewater process was discontinued and both the east and west wastewater systems discharged directly to the NSDD (MMES 1995). The wastewaters contained both TCE and Tc-99. Moreover, runoff from the north end of the C-400 OU flowed into the NSDD. The principal contaminants in the ditch were radionuclides, metals, and polychlorinated biphenyls (PCBs) (DOE 1999). In March 1993, the DOE ceased all discharges from C-400 building processes to the NSDD.

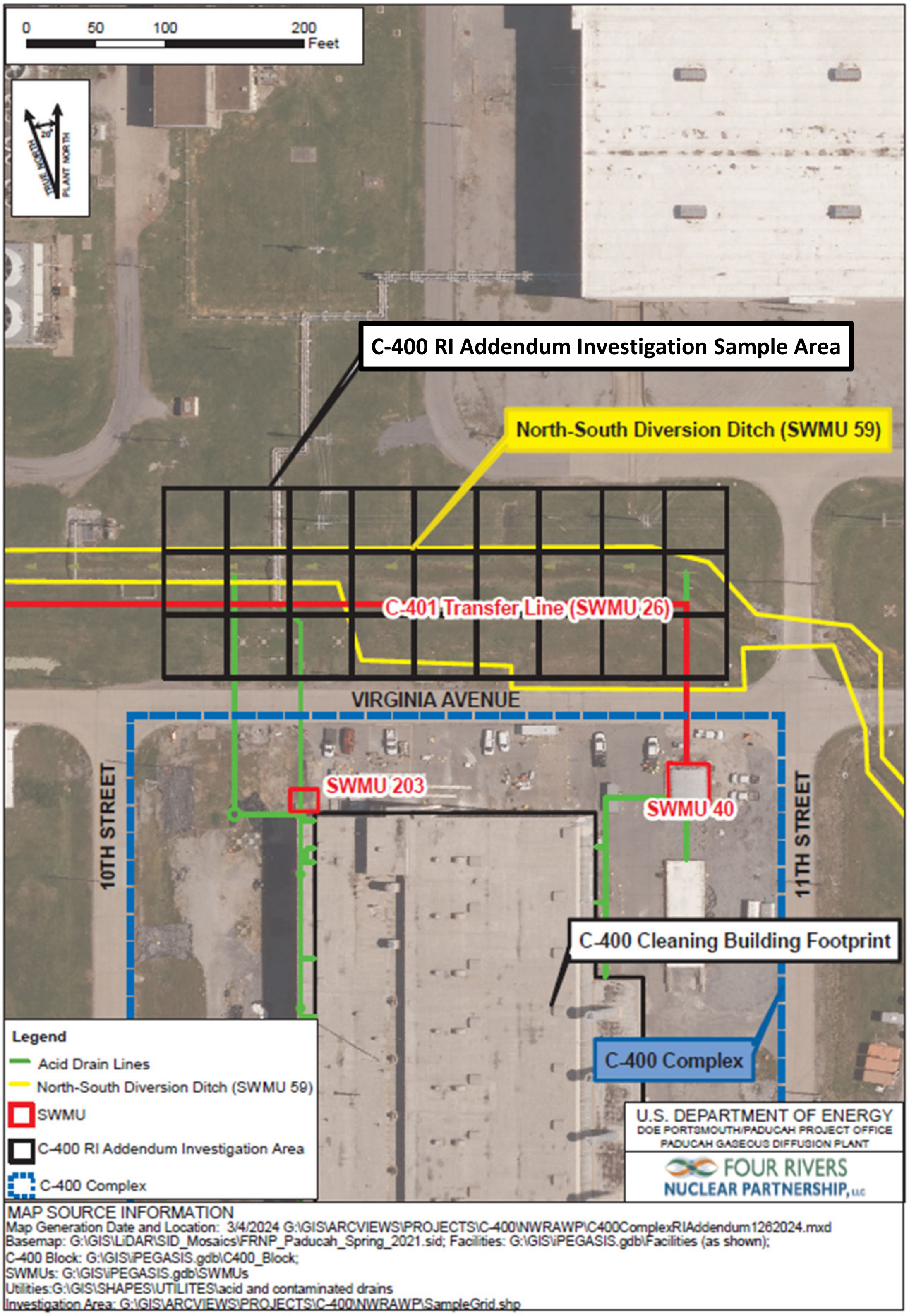


Figure 1. C-400 Remedial Investigation Addendum Investigation Area

Fly ash and coal dust accounted for much of the sediment infilling the ditch prior to a 2002 remedial action to remove the sediments (DOE 2002). This highly reactive infilling sediment tended to readily sorb dissolved contaminants.

1.4 PREVIOUS INVESTIGATIONS AND REMEDIAL ACTIONS

Previous investigations that included all or part of the RI addendum investigation area were the Phase I and Phase II Site Investigations of PGDP (CH2M HILL 1991 and 1992) and sampling of Solid Waste Management Unit 26, and the C-400 to C-404 underground transfer line for the Waste Area Grouping 6 Remedial investigation (CH2M HILL 1999).

1.4.1 NSDD Remedial Actions

DOE completed construction of interim remedial actions in a 1994 (Phase I) NSDD Record of Decision (ROD) (DOE 1994). The major components of the interim remedy included the following related to the RI addendum investigation area:

- Installation and operation of an ion exchange filtration unit in the C-400 Cleaning Building to reduce radionuclide concentration in the building wastewater;

- Treatment to remove fly ash from the C-600 Utility Plant wastewater effluent prior to discharge into the NSDD to reduce the potential for cross contamination of other materials in the ditch and prevent increases in the volume of contaminated material within the ditch; and

- Installation of a lift station in the NSDD near the C-400 Cleaning Building and the C-600 Utility Plant that intakes and then pipes wastewater and storm water runoff from the southern end of the NSDD to the KPDES Outfall 001 lift station, thereby bypassing half of the NSDD and reducing the potential for mobilization of contaminants from the sediments.

During remedial design, the action was modified so that the treated effluent from the C-400 Cleaning Building was piped to KPDES Outfall 008 rather than be released in the NSDD.

A 2002 NSDD ROD (DOE 2002) provided for the excavation of NSDD Section 1 (including the RI addendum investigation area) to a depth of 4 ft, conducting post-excavation sampling, restoring the excavated area with clean clay and soil, and managing and properly disposing of remediation waste.

2. PHYSICAL CHARACTERISTICS OF THE AREA

2.1. LOCATION AND TOPOGRAPHY

The total C-400 RI addendum investigation area (including the area of the MIP borings) is a predominantly grassy area located north of and adjacent to the C-400 Complex OU (Figure 2). Major surface features are the NSDD, which is approximately 3 to 4 ft deep, an aboveground steam pipeline, and an approximately 50 ft × 260 ft gravel pad adjacent to Virginia Avenue. The RI addendum investigation sample grid measures 30,000 ft^2 in the area between 10th and 11th Streets and bounded by Virginia Avenue to the south.

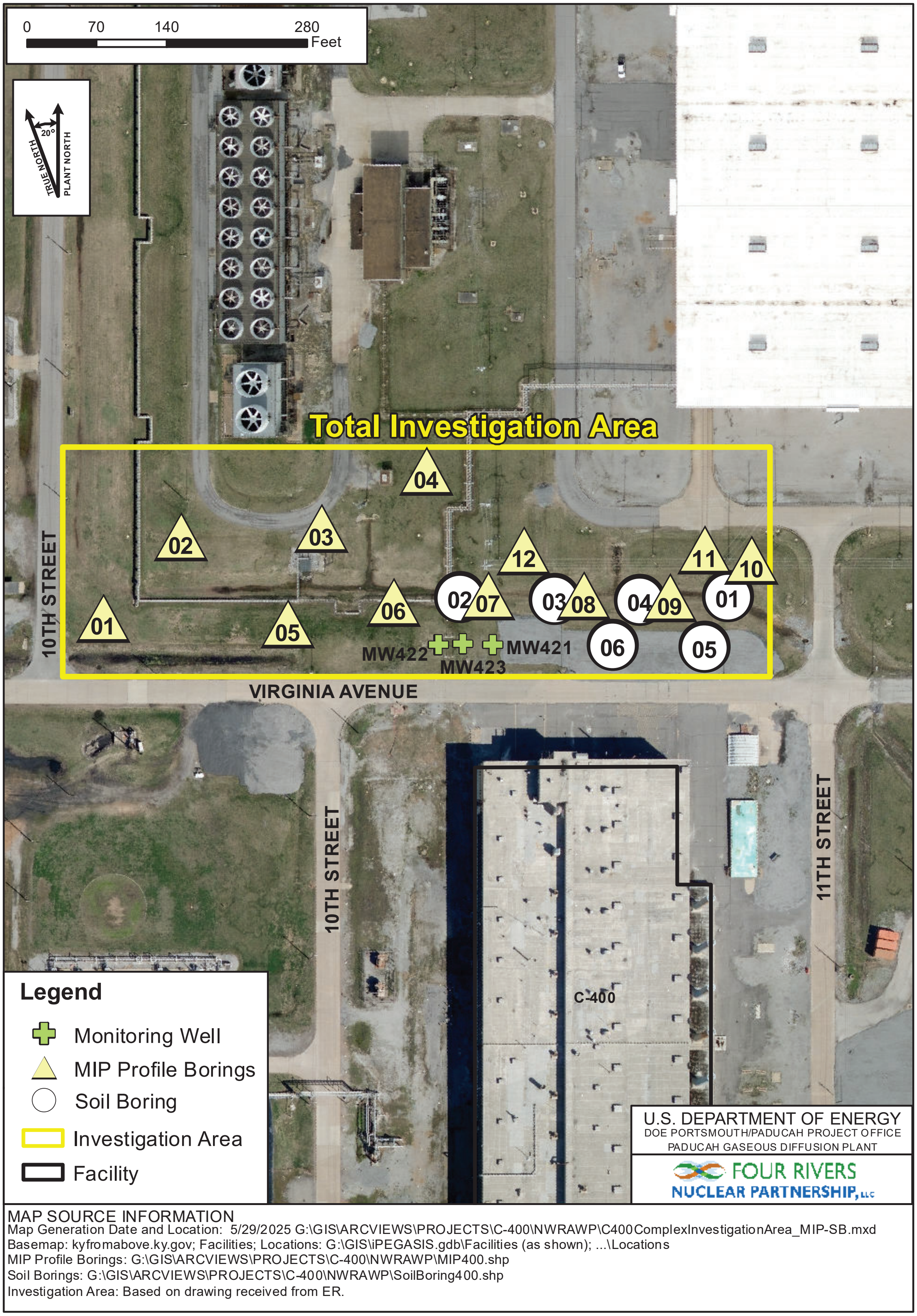


Figure 2. C-400 RI Addendum Investigation Area

2.2. GEOLOGY

The general soil map for Ballard and McCracken Counties delineates three soil associations within the vicinity of the Paducah Site: the Rosebloom-Wheeling-Dubbs association, the Grenada-Calloway association, and the Calloway-Henry association (USDA 1976). Inside the fenced security area of the plant, the best description of the soil would be urban, because many of the characteristics of these soil types have been changed due to construction and maintenance activities (USDA 2005).

Continental sediments [Pliocene (5.3 to 2.5 million years ago [mya]) to Pleistocene (2.5 mya to 11,000 years ago)] unconformably overlie the Cretaceous strata beneath the site. These continental deposits represent Plio-Pleistocene valley fill sediments that comprise a general fining-upward sequence. The continental sediments have been informally divided into the following two distinct facies beneath the Paducah Site.

- The upper continental deposits (UCD) is a Pleistocene age, fine-grained facies that commonly overlies the lower continental deposits (LCD). The UCD includes three general horizons beneath the Paducah Site: (1) an upper silt and sand interval, (2) an intermediate interval of common sand and gravel lenses, and (3) a lower silt, sand, and clay interval.

- The LCD is a gravelly sand deposit consisting of chert, ranging from pebbles to cobbles, in a matrix of well graded sand and silt, resting on an erosional surface at an elevation of approximately 280 ft above mean sea level (amsl). This Plio-Pleistocene member of the LCD averages approximately 30 ft in thickness.

The underlying McNairy Formation consists of Upper Cretaceous sediments of gray to yellow to reddish-brown, very fine- to medium-grained sand interbedded with grayish-white to dark gray micaceous silt and clay. A basal sand member also is present beneath the Paducah Site. The total thickness of the McNairy Formation ranges from 190 ft to 250 ft thick and is approximately 245 ft thick beneath the C-400 Complex OU.

In the vicinity of the Paducah Site, the McNairy Formation includes an upper silt and sand member; a middle silt, clay, and sand member (known as the Levings Member); and a lower sand-dominant member. Laterally extensive, smaller scale bedding has not been identified in the McNairy Formation members in the proximity of the Paducah Site.

The upper member of the McNairy Formation primarily consists of interlensing, fine-grained, silt and sand. In the area of the Paducah Site, the Paleocene age Clayton Formation and upper member of the Cretaceous age McNairy Formation are indistinguishable based on soil textures and are referred to collectively as the McNairy Formation upper member. The irregular erosional surface created by the ancestral Tennessee River, at an approximate elevation of 250 ft to 280 ft amsl, is the top of the McNairy Formation upper member under the site.

The general geologic sequence, including hydrogeological units (HUs), beneath the C-400 Complex OU consists of the following (from top to bottom):

- Silt and sandy silt to a depth of approximately 24 ft (disturbed soils and loess) (HU 1);

- Sand and gravel units (ranging from 2 ft to 5 ft thick), separated by fine sands and silts to a depth of approximately 43 ft UCD (HU 2);

- Silt to silty sand to a depth of approximately 54 ft UCD (HU 3);

- Very fine sand to a depth of approximately 60 ft UCD (HU 4);
- Sand and gravel to a depth of approximately 90 ft LCD (HU 5); and
- Interbedded clay, sand, and silt to the total depth of the borings (McNairy Formation).

2.3. C-400 COMPLEX OPERABLE UNIT HYDROGEOLOGY

Beneath the Paducah Site and north, shallow groundwater flows downward through the silts and fine sands of HU 1, HU 2, and HU 3 (i.e., the UCRS) until it encounters the upper HU 4 sand member and lower HU 5 sand and gravel members of the RGA. Once in the RGA, groundwater flow is generally north, toward the Ohio River. Lateral flow in the RGA dominates this hydrologic regime, with comparatively little groundwater migrating downward into the underlying McNairy Formation. Lateral groundwater flow rate in the more permeable pathways of the RGA ranges from approximately 1 to 3 ft/day.

2.3.1 UCRS

The average thickness of the UCRS members at C-400, as measured in the C-400 Complex OU RI soil borings, consists of 24.3 ft of HU 1, 18.0 ft of HU 2, and 10.8 ft of HU 3, for a total average thickness of 53.1 ft. HU 1 is predominantly silt (84%), with minor sand beds. The primary soil textures in HU 2 are sand (66%), silt and silty sand (26%), and gravel (6%). HU 3 is predominantly silt and silty sand (64%) with common sand interbeds (35%).

As measured in the C-400 Complex OU RI geotechnical samples, the porosity of HU 1 averages 38% with approximately 95% water saturation. The porosity of HU 2 averages 29% with 83% water saturation. HU 3 has an average porosity of 35% and is fully saturated. The representative vertical hydraulic conductivity of the three dominant soil textures in HU 3, as measured by permeameter test, range from 8.19×10^{-4} ft/day for silt (55% of the HU 3 thickness) to 1.81×10^{-3} ft/day for silty sand (8% of the HU 3 thickness) to 9.35×10^{-3} ft/day for poorly graded sand (30% of the HU 3 thickness).

The water table is greater than 30 ft deep in the C-400 Complex OU. Of the three UCRS monitoring wells (MWs) in the C-400 Complex OU boundary where water level measurements can be attempted, MW157, located in the southeast, is the only one in which water is commonly present. In that well, the water table is typically 34 ft below ground surface (bgs). The vertical hydraulic gradient, as measured by water levels in MW157 and adjacent upper RGA MW156, is approximately 1 ft/ft downward.

2.3.2 RGA

Infiltrating water from the UCRS primarily moves downward into a basal sand member of the UCD and the Plio-Pleistocene gravelly sand member of the LCD and then laterally northward in the sand and gravel members (of the RGA) towards the Ohio River. This lateral flow system is called the RGA (which is typically present between 60 ft and 90 ft bgs beneath the C-400 Complex OU). As documented in the Paducah Site groundwater flow model and based on site-specific lithological data, the RGA is the shallow aquifer beneath the Paducah Site and contiguous lands to the north (DOE 2017).

The conceptual site model (CSM) of groundwater flow at C-400 (before the RI) assumed the primary groundwater flow path under C-400 to be to the northwest because the primary C-400 TCE source zones were in the southeast C-400 Complex OU and the Northwest Plume was present off the northwest corner of C-400. The alignment of the Northwest Plume (flow in a northwest direction inside the PGDP industrial area) has been consistent since the discovery of the plume and is well documented. Moreover, the extraction wells of the Northwest Plume Containment System are a hydraulic stress that enforces flow to the northwest.

The C-400 Complex OU RI included the installation of additional MWs, both inside and outside the C-400 Cleaning Building, with near-continuous water level record (by pressure transducer/data logger system), quarterly water level measurements, and colloidal borescope tests. Collectively, the well measurements and dissolved groundwater contaminant trends define a more intricate flow pattern in the RGA under the C-400 Complex OU, which varies in response to pumping in both the Northeast Plume and Northwest Plume containment systems.

On average, the top of the RGA (HU 4) occurs at a depth of 53.5 ft and the base of the RGA (HU 5) occurs at a depth of 89.7 ft in the 64 C-400 Complex OU RI soil borings that penetrated the full thickness of the RGA. The HU 4 sand member averages 6.5 ft thick. Geologists' logs describe the HU 4 primarily as a poorly graded sand with lesser silt content. The porosity of the HU 4, based on geotechnical analyses for the RI, ranges from 25% to 37%.

The HU 5 sand and gravel member averages 29.7 ft thick and consists of poorly to well-graded sand and gravel. Porosity of the HU 5 geotechnical samples for the C-400 Complex OU RI ranges from 17% to 33%, with an average of 26%. Effective porosity of the RGA is assumed to be 25% for hydrologic calculations consistent with landfill permit reporting. The C-400 Complex OU RI calculated the overall hydraulic conductivity of the RGA to be 555 ft/day and the hydraulic gradient to be 3.91×10^{-4} ft/ft northward.

2.3.3 McNairy Formation

The contact between the LCD and the McNairy Formation is a marked hydraulic properties boundary. Groundwater flow in the fine sands and silts of the McNairy Formation is called the McNairy Flow System.

Potentiometric trends of the RGA and the McNairy Formation are similar at the Paducah Site. Hydraulic potential is greater in the RGA than in the McNairy Flow System beneath the Paducah Site with a vertical gradient of approximately -1.30×10^{-2} ft/ft. Horizontal gradients are on the order of 4.65×10^{-4} ft/ft to 4.20×10^{-4} ft/ft, northward.

The C-400 Complex OU RI tested McNairy Formation soil samples for vertical hydraulic conductivity using a permeameter. Vertical hydraulic conductivity values ranged from 1.22×10^{-6} to 5.39×10^{-1} ft/day. The hydraulic conductivity of samples classified as clay commonly ranged between 1.22×10^{-6} to 8.79×10^{-5} ft/day; sandy samples commonly ranged between 2.15×10^{-2} to 5.39×10^{-1} ft/day.

3. REMEDIAL INVESTIGATION ADDENDUM INVESTIGATION

The field crew and FRNP oversight committee met on October 29, 2024, for a project kickoff meeting and job hazard analysis review, followed by fieldwork at the first MIP location (MIP 01) the next day. The drilling crew used a Geoprobe Systems® direct push technology (DPT) drill rig, model 7822DT, with Geoprobe Systems® MIP system, to perform the MIP borings, concluding the MIP borings on December 11, 2024. The same Geoprobe Systems® drill rig with Dual Tube 22 (DT22) soil sample system and SP-16 groundwater sample system was used to collect the soil and groundwater samples, respectively, beginning on January 14, 2025, and concluding sampling on February 11, 2025.

DPT offered several advantages to the RI addendum investigation. The small, tracked rig was able to easily and safely access MIP and sample boring locations in the area of the NSDD. Both the soil and groundwater sample systems provide discrete-depth samples of good quality. Moreover, the samplers have a small cross section, generating small waste volumes for the project.

3.1 DATA QUALITY OBJECTIVES

The addendum to the RI/FS work plan for the C-400 Complex OU (DOE 2024) documents the project data quality objectives (DQOs) in an appendix of quality assurance project plan (QAPP) worksheets. The problem description developed in the DQO process is as follows (DOE 2024):

> Groundwater analytical levels in monitoring wells adjacent to and north of the C-400 Complex indicate the potential[4] of a TCE source zone in the RGA outside of the C-400 Complex. Additional investigation of this area is required to characterize the nature and extent of the TCE source zone, if present, to revise the C-400 Complex OU CSM, and to support the development of remedial alternatives, and to support changes to the Northwest Plume Interim Remedial Action to further optimize the hydraulic control of and contaminant mass removal for the northwest TCE and technetium-99 (Tc-99) plume.

Goals of the study for the project DQOs are as follows:

- Characterize the nature and extent of potential and confirmed/probable TCE source zone(s) in UCRS soils and RGA and McNairy Formation groundwater north of the C-400 Complex OU, and
- Characterize the Tc-99 levels in UCRS soils and RGA groundwater north of the C-400 Complex OU.

The identified information inputs are as follows:

- MIP data for qualitative use to determine the nature and extent of the potential[5] UCRS, RGA, and McNairy Formation TCE source zone(s), and
- Soil and groundwater sample results for quantitative use to characterize TCE and Tc-99 contamination levels in the UCRS, RGA, and McNairy Formation north of the C-400 Complex OU.

3.2 MEMBRANE INTERFACE PROBE PROFILE BORINGS

The RI addendum investigation fieldwork included downhole profile surveys using MIP tooling to provide initial characterization of sorbed (UCRS and McNairy Formation soil) and dissolved (RGA groundwater) volatile organic compound (VOC) levels (qualitative) and the depth of the top of the McNairy Formation in the area of the NSDD north and west (downstream) of C-400. This tool offered continuous downhole profiles of VOC levels, with TCE being the primary VOC present in the C-400 area. The locations of MIP profile borings are shown in Figure 3. Table 1 summarizes the actual termination depth (targeted or refusal depth) and completion horizon for each attempted MIP boring and offset.

The downhole MIP tooling consisted of a 1.75-inch diameter probe at the base of a string of 1.5-inch diameter DPT rods. Where needed, the pre-probe system consisted of 1.5-inch diameter DPT rods and probe point. The optimal RI addendum investigation sequence (MIP locations 01, 02, 03, and 12) was to

[4] In this context, the use of "potential" relates to "possibility" and is not related to the "potential and/or confirmed/probable source zones" discussed in Section 1.2.
[5] See note 4.

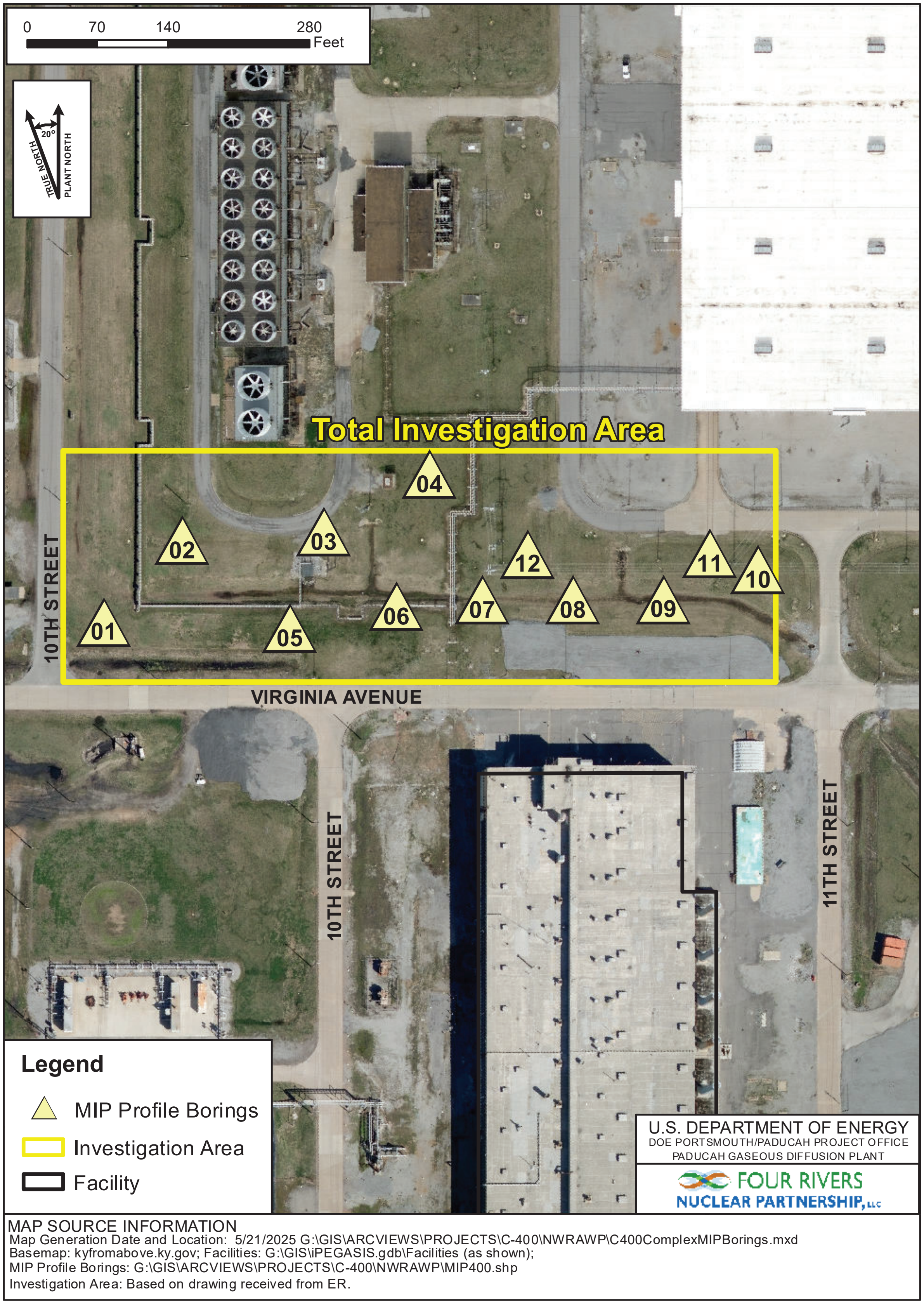


Figure 3. C-400 RI Addendum Investigation Area - MIP Profile Borings

Table 1. Summary of Membrane Interface Probe Investigation[a]

MIP LOCATION	DATE(S)/ TOTAL TIME (hrs/mins)	MIP DEPTH (ft)	PRE-PROBE DEPTH (ft)	COMPLETION HORIZON[b]	OFFSET[c]
01	10/30/2024 – 11/5/2024 08:14	97.0	NA	McNairy Formation	NA
02	11/11/2024 10:32	108.5	NA	McNairy Formation	NA
03	11/12/2024 09:14	102.0	NA	McNairy Formation	13 ft West (overhead power line)
04	11/12/2024 14:07	77.0	--	Middle RGA	NA
04	11/13/2024 07:40	--	104	McNairy Formation	NA
04	11/13/2024 08:31	77.0	--	Middle RGA	NA
04A	11/14/2024 08:04	77.0	--	Middle RGA	9 ft North
04A	11/14/2024 09:06	--	90	McNairy Formation	9 ft North
04A	11/14/2024 09:44	60	--	Top of RGA	9 ft North
04B	12/9/2024 11:28	--	79	Middle RGA	6 ft East/Southeast
05	Reported below				
06	11/14/2024 13:43	77.0	--	Middle RGA	5 ft Southeast (buried utilities)
06	11/14/2024 14:32	--	95	McNairy Formation	5 ft Southeast (buried utilities)
06	11/18/2024 08:30	101.2	--	McNairy Formation	5 ft Southeast (buried utilities)
07	11/18/2024 13:21	77.1	--	Middle RGA	NA
07	11/18/2024 13:21	--	90	McNairy Formation	NA
07	11/19/2024 08:44		90 (during MIP repair)	McNairy Formation	NA
07	11/20/2024 13:35	84.6	--	Lower RGA	NA
08	11/21/2024 07:53	52.8	--	UCRS	NA
08	11/21/2024 08:33	--	77.0	Middle RGA	NA
08A	11/21/2024 10:16	19.8	--	UCRS	10 ft East
08A	11/21/2024 10:45	--	35	UCRS	10 ft East
08B	11/21/2024 13:03	--	24	UCRS	10 ft North
08C	11/21/2024 13:45	--	26	UCRS	10 ft South
09	12/3/2024 08:38	32	--	UCRS	NA
09	12/3/2024 09:08	--	58	UCRS	NA
09A	12/3/2024 10:37	--	57	UCRS	20 ft East
10	12/3/2024 14:19	--	53	UCRS	
10A	12/3/2024 15:29	--	57.5	UCRS	20 ft South
10B	12/11/2024 11:08	57.0	--	UCRS	30 ft North
11	12/4/2024 08:45	56.9	--	UCRS	NA
11	12/4/2024 09:43	--	87.3	Lower RGA	NA
11	12/4/2024 13:42	86.8	--	Lower RGA	NA
12	12/9/2024 08:56	92.4	--	McNairy Formation	NA
05	12/9/2024 14:33	--	64	Upper RGA	25 ft North (ditch-standing water)
05A	12/10/2024 09:43	--	64	Upper RGA	17 ft South
05B	12/10/2024 10:36	--	64	Upper RGA	22 ft South
05C	12/10/2024 13:23	61.8	--	Upper RGA	22 ft South and 32 ft East
05C	12/10/2024 14:00	--	90	McNairy Formation	22 ft South and 32 ft East
05C	12/11/2024	92.4	--	McNairy Formation	22 ft South and 32 ft East

[a]Shading denotes MIP attempts that are not used to represent the location.
[b]Relative to original location shown in the work plan.
[c]In the area of the RI addendum investigation, the base of the RGA occurred at approximate depth of 84 ft.

push/drive the MIP probe to the target depth in the top of the McNairy Formation. Where the MIP probe reached an early refusal depth, the DPT operator removed the rods with the MIP probe and reentered the boring with preprobe rods and advanced to target depth, when possible. Then, the DPT operator extracted the preprobe rods and completed the MIP advance to the target depth (MIP locations 05C and 06). In some cases, after preprobing, the MIP advance stalled in the RGA (MIP locations 04, 07, and 11).

Where field conditions dictated (area of very dense soils in the shallow subsurface), the MIP profiles began with a preprobe, followed by the MIP survey. The preprobe was not always successful. Locations with shallow depths of failure include MIP locations 05, 05A/B, 08, 08A/B/C, 9, 9A, 10, and 10A.

The electrical conductivity detector (ECD) log of the MIP tool was used to identify the depth of the top of the McNairy Formation in the field. MIP borings were advanced to the base of the RGA/top of the McNairy Formation, where possible (in six of the 12 locations), and up to 22 ft deep into the McNairy Formation.

The MIP theory of operation is the following: Under a concentration gradient, VOCs move across the MIP (probe) membrane via diffusion and then are transported to a series of detectors at the surface in an inert carrier gas that continuously sweeps past the MIP membrane (Geoprobe 2020).

Three gas chromatograph detectors of the MIP provided qualitative measure of organic compounds in the subsurface:

- Flame ionization (FID)—detects (all) organic compounds, with the response dependent upon the mass of carbon-based molecules in the carrier gas stream.
- PID—detects petroleum compounds and chlorinated solvents, dependent upon the excitation energy (electron voltage/eV) of the PID lamp. The common lamp used with an excitation energy of 10.6eV will detect TCE. (The RI addendum investigation MIP PID used a 10.6eV lamp.)
- Halogen-specific detector (XSD)—responds only to halogenated compounds (chlorinated, brominated, and fluorinated compounds). TCE and related solvents are chlorinated compounds.

MIP results (ECD, XSD, PID, and FID) are summarized as graphs of detector response versus depth bgs in Appendix A.

Figure 4 plots MIP responses for each of the 12 profiles, overlain, with separate graphs for each of the three detectors: PID, XSD, and FID. The primary element of the CSM for the RI addendum area, based on the investigation of the C-400 OU RI addendum and decades of groundwater monitoring results, is the presence of a dissolved-phase TCE plume located in the lower RGA. By inspection, the XSD provides the best delineation of the dissolved-phase TCE plume in the lower RGA.

Figure 5 provides closer inspection of the XSD plot for the lower RGA. (The base of the RGA is approximately 84 ft bgs in the MIP profiles, based on the companion ECD log.) Strongest XSD response occurs in the MIP 06 and 07 locations, with significant-but-lesser response in the MIP 02, 03, and 05 locations. Table 2 summarizes the significant MIP responses for the three detectors in all 12 profiles.[6]

The RI addendum investigation MIP fieldwork (completed during the period October 30, 2024, to December 11, 2024) attempted MIP profiles in the 12 locations identified in the RI addendum investigation work plan (DOE 2024). Up to 10 contingency MIP borings were available. Need for additional MIP borings was assessed based on the initial MIP profiles and the success rates of the MIP borings. The MIP profiles

[6] Based on subjective assessment of the MIP logs.

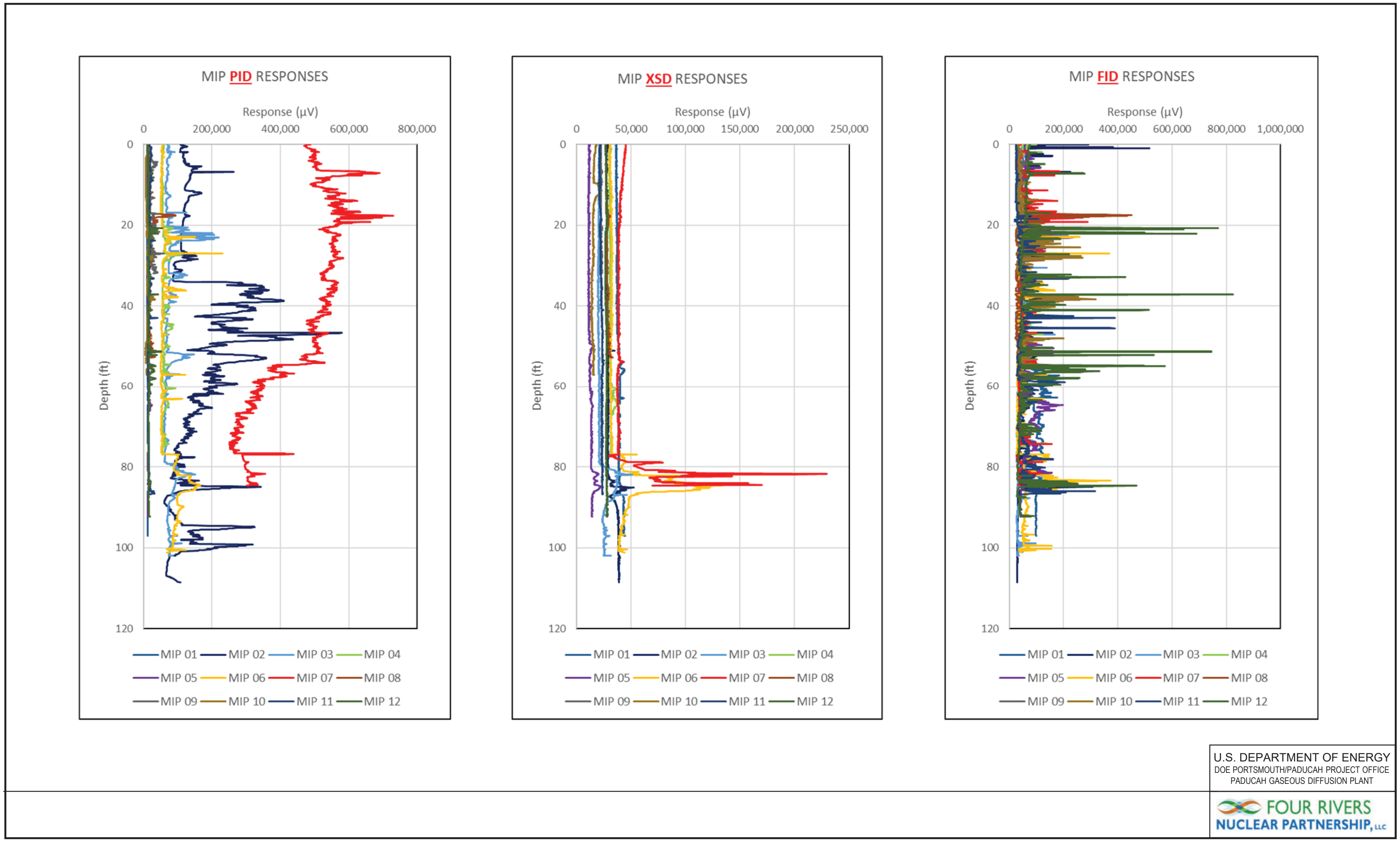


Figure 4. MIP Responses (Combined)

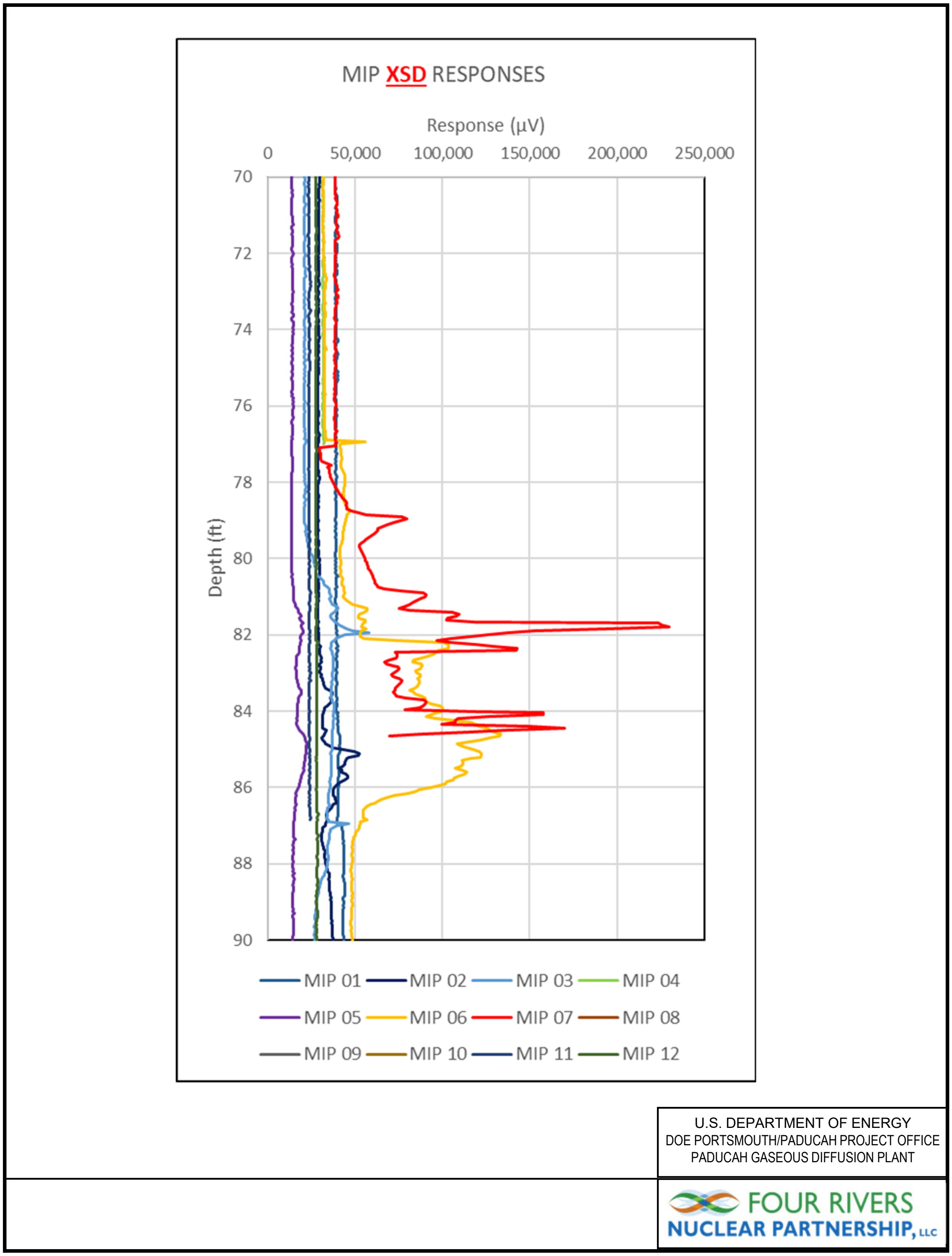


Figure 5. Response in the Lower RGA

Table 2A. Summary of Significant MIP Responses – UCRS

		XSD		PID		FID	
Interval	MIP ID	Depth (ft)	XSD (µV)	Depth (ft)	PID (µV)	Depth (ft)	FID (µV)
0-20 ft	MIP 01						
	MIP 02			11.50-13.00	~169500	0.75-1.05	~400,000-500,000
	MIP 03						
	MIP 04						
	MIP 05						
	MIP 06						
	MIP 07			6.55-8.55	~700,000	6.70-7.60	~150,000-200,000
				17.45-19.55	~700,000	16.55-18.25	~150,000-350,000
						19.2	~300,000
	MIP 08			17.25-18.00	~94,500	17.30-18.00	~400,000
	MIP 09						
	MIP 10	9.80-12.60	~20,000				
	MIP 11						
	MIP 12						
20-40 ft	MIP 01						
	MIP 02			27.50-28.50	~140,000		
				34.00-40.00	~350,000		
	MIP 03			22.00-23.65	~200,000	20.06-23.75	~150,000-250,000
						32.00-33.10	~100,000
	MIP 04						
	MIP 05					20.65-27.55	~100,000-200,000
	MIP 06			23.10-23.45	~100,000	35.50-36.30	~100,000-150,000
				27	~231,000		
				35.35-38.10	~100,000		
	MIP 07			20.00-40.00	~550,000		
	MIP 08						
	MIP 09						
	MIP 10					23.15-25.55	~125,000-175,000
						27.60-28.55	~250,000
						37.60-39.25	~150,000-300,000
	MIP 11						
	MIP 12					20.45-20.90	~650,000-750,000
						21.90-22.20	~500,000-700,000
						32.25-33.00	~200,000-400,000
						37.2	800,000
						39.00-39.85	~200,000
40-60 ft	MIP 01	53.50-54.00	~43,000			56.05-60.00	~125,000-175,000
		55.50-57.00	~44,000				
	MIP 02			40.00-60.00	~300,000-200,000		
	MIP 03			51.50-53.50	~120,000		
	MIP 04						
	MIP 05	49.40-50.40	~15,500				
	MIP 06						
	MIP 07	53.50-54.00	~43,700	40.00-56.50	~500,000		
	MIP 08						
	MIP 09						
	MIP 10					54.25-55.55	~100,000
	MIP 11					42.40-43.05	~225,000-400,000
						45.6	~400,000
						58.75-59.75	~150,000
	MIP 12					40.95	~500,000
						51.35-52.20	~500,000-750,000
						54.70-54.90	~500,000-550,000
						55.60-58.10	~250,000-300,000

NOTE: Values in red font indicate the depth extent of the interval or the bottom depth of the MIP profile. (Blank entries indicate no significant detector response was present.) Table cells are shaded where the MIP probed did not penetrate the depth interval.

Table 2B. Summary of Significant MIP Responses – RGA and McNairy Formation

		XSD		PID		FID	
Interval	MIP ID	Depth (ft)	XSD (µV)	Depth (ft)	PID (µV)	Depth (ft)	FID (µV)
60-80 ft	MIP 01						
	MIP 02						
	MIP 03			79.30-80.00	~100,000		
	MIP 04	60.40-67.40	~33,000 - 40,000				
	MIP 05					63.85-66.25	~150,000
	MIP 06	77.10-80.00	~41,500- 48,000	76.95-80.00	~100,000	76.95-78.45	~100,000-150,000
	MIP 07	77.45-80	~40,000-80,000	76.70-77.00	~430,000		
				77.00-84.55	~300,000		
	MIP 08						
	MIP 09						
	MIP 10						
	MIP 11						
	MIP 12						
80-100 ft	MIP 01						
	MIP 02			82.75-84.55	~150,000	85.00	~300,000
				84.55-86.00	~300,000		
				94.40-95.75	~300,000		
				99.10-100.00	~300,000		
	MIP 03	80.55-88.15	~40,000				
	MIP 04						
	MIP 05	81.30-86.00	~20,000			80.95-81.70	~125,000-150,000
	MIP 06	80.00-86.00	~40,000-132,750	82.25-85.75	~150,000	82.05-85.75	~150,000-350,000
	MIP 07	80.00-85.00	~56,700-230,000				
	MIP 08						
	MIP 09						
	MIP 10						
	MIP 11					86.00	~300,000
	MIP 12	84.8-87.25	~50,000			83.30-84.80	~200,000-400,000
100-120 ft	MIP 01						
	MIP 02			100.00-102.00	200,000-~100,000		
	MIP 03						
	MIP 04						
	MIP 05						
	MIP 06						
	MIP 07						
	MIP 08						
	MIP 09						
	MIP 10						
	MIP 11						
	MIP 12						

NOTE: Values in red font indicate the depth extent of the interval or the bottom depth of the MIP profile. (Blank entries indicate no significant detector response was present.) Table cells are shaded where the MIP probed did not penetrate the depth interval.

did not indicate the presence of a significant TCE source zone in the study area. In a meeting on December 10, 2024, to discuss the status of the C-400 RI addendum, the FFA parties concurred that no contingency MIP borings were merited. Soil borings with soil and groundwater grab samples were better suited to address the remaining uncertainty.

3.3 SUBSURFACE SOIL SAMPLING

The RI addendum investigation used the same Geoprobe Systems® DPT rig of the MIP investigation to collect soil samples for laboratory analysis of TCE and its anaerobic degradation products (using SW-846 Test Method 8260D) and Tc-99 (using laboratory Method Tc-02-RCM) from six locations (S01/Station 400RIA-01 through S06/Station 400RIA-06), in a sample grid centered on the NSDD (Figure 6). The drill crew collected soil core in 5 ft long high-density polyethylene (HDPE) liners, using the Geoprobe Systems® DT22 sample system that minimizes cross contamination from the sample borehole by advancing the soil sampler through a sting of larger (2.25-inch outer diameter), hollow probe rods.

3.3.1 Soil Grab Samples

The RI addendum investigation collected soil samples in accordance with procedure CP4-ES-2300, *Collection of Soil Sample*s, and CP4-ER-1020, *Collection of Soil Samples with Direct Push Technology Sampling*, from each 10 ft depth interval of the UCRS, beginning at 10 ft depth. The beginning depth of 10 ft was intended to minimize the influence of disturbed soils that are common to the investigation area. The RI addendum investigation targeted sample collection to depths of highest VOC and radioactivity levels as identified by surveys of each 10 ft interval of the UCRS, using handheld PIDs, performed by the project geologists, and beta/gamma activity rate meters, performed by the project radiological technicians (Table 3). Project geologists corrected the survey depths for soil compaction or expansion over each 5 ft depth drilled. The surveys documented offgas VOC levels and radioactivity for each 1 ft depth of the UCRS (Appendix B).

The sample collection process began with a survey of VOC levels in offgas of the soil core by a handheld ppbRAE 3000 PID, accessed through punch holes in the 5 ft long HDPE liner at each end of the soil core and at intermediate 1 ft depth intervals.[7] After the geologists identified the highest VOC depth (the TCE sample depth) for each 10 ft depth interval survey, the investigation sample crew, first, slit a window along the length of the HDPE liner to access the soil core for sampling and then collected the VOC sample in three 5-gram cores collected from the exposed soil, using EnCore® samplers. A collocated sample, in a 4 oz glass jar, provided soil matrix for the determination of soil moisture content so that the laboratory could report the analytical results on a dry-weight basis.

Upon collection of the VOC sample for each 10 ft depth interval, the investigation radiological technicians surveyed the beta/gamma activity of the remaining exposed soil core at each 1 ft depth interval using a handheld Ludlum Measurements, Inc., Model 12 General Purpose Survey Meter with a Model 44-9 GM pancake-type detector and identified the depth of highest activity (the Tc-99 sample depth). The sample crew then collected the soil for Tc-99 analysis in a 125 mL HDPE bottle.

[7] The length of core and spacing of 1 ft depth intervals varied between core liners based on soil compression or expansion.

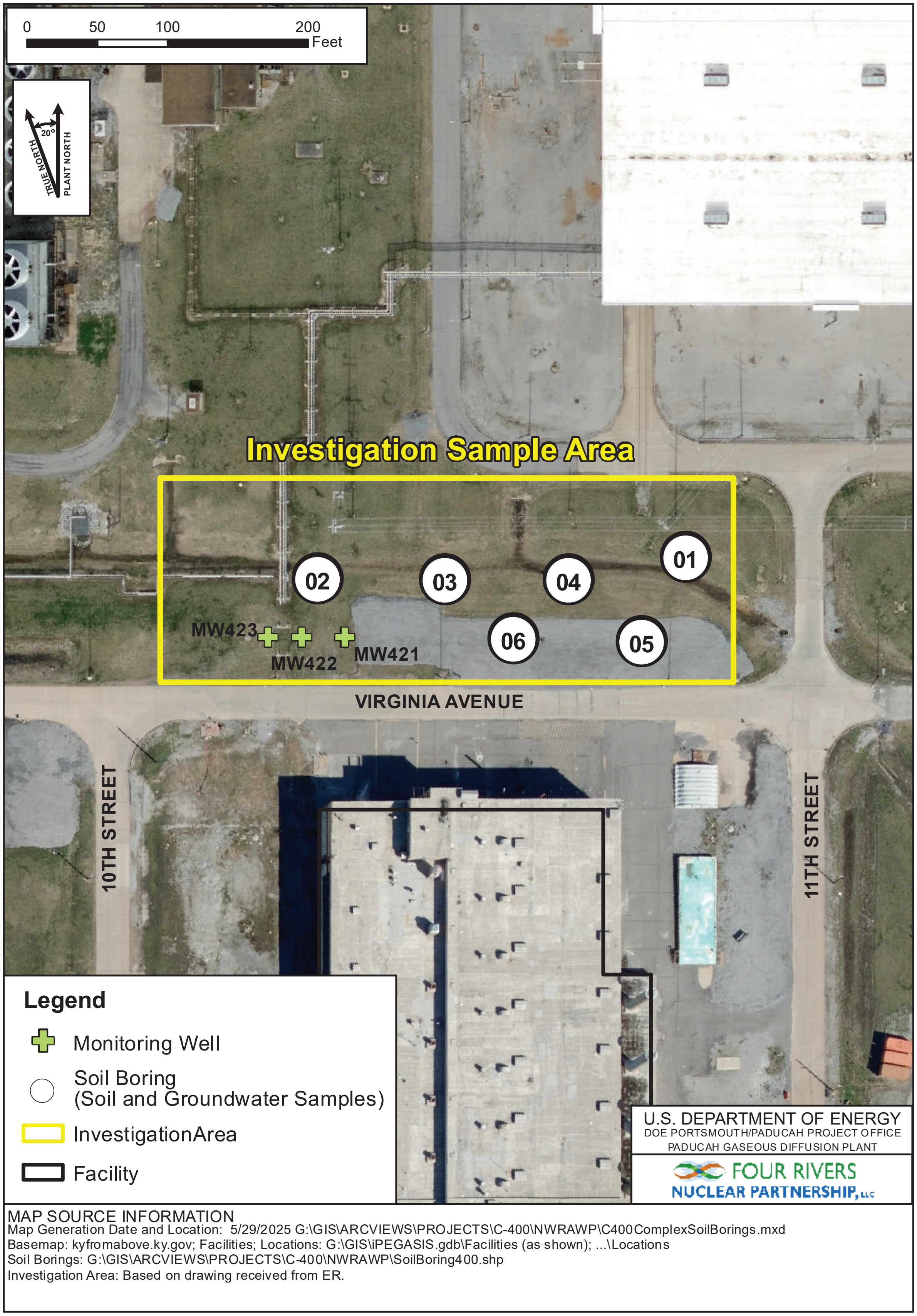


Figure 6. C-400 RI Addendum Investigation Area—Soil Borings

Table 3. Sample Depths of the RI Addendum Investigation

	DATES	JAN 14–15, 2025 JAN 22–23, 2025 JAN 27, 2025		JAN 27–29, 2025		JAN 29–30, 2025 FEB 3, 2025		FEB 3–5, 2025		FEB 5–6, 2025 FEB 10, 2025		FEB 10–11, 2025	
	SAMPLE LOCATIONS	**C400RIAS01 (MIP-10)**		**C400RIAS02 (MIP-07)**		**C400RIAS03 (MIP-08)**		**C400RIAS04 (MIP-09)**		**C400RIAS05 (EAST PAD)**		**C400RIAS06 (WEST PAD)**	
SAMPLE TARGET DEPTH		**VOCs**	**Tc-99**	**VOCs**	**Tc-99**	**VOCs**	**Tc-99**	**VOCs**	**Tc-99**	**VOCs**	**Tc-99**	**VOCs**	**Tc-99**
10–20 ft	SOIL SAMPLE DEPTHS (ft)	18	18	12	11	19	13	19	10	13	11	11	14
20–30 ft		23	21	20	21	20	29	21	24	25	20	26	22
30–40 ft		38	33	39	40	30	36	34	33	35	38	38	31
40–50 ft		49	46	45	41	46	46	45	47	40	50	49	44
50–60 ft		51	51	NOT SAMPLED		56	54	54	56	50	51	60	59
70 ft	GROUNDWATER SAMPLE DEPTHS (ft) & PURGE VOL (gal)	66–70 (5 gal)		66–70 (3 gal)		66–70[a] (3 gal)		70–74[b] (5 gal)		70–74 (5 gal)		70–74 (5 gal)	
80 ft		76–80 (5 gal)		76–80 (5 gal)		76–80 (5 gal)		76–80 (5 gal)		78–82 (5 gal)		78–82 (5 gal)	
Base of RGA		80–84 (5 gal)		NOT SAMPLED		83–84[c] (5 gal)		82–84[c] (5 gal)		NOT SAMPLED			

[a] VOCs only.

[b] Sampled deeper after the 70 ft sample in C400RIAS03 purged dry.

[c] The exposed length of sample screen in the Base of RGA samples for C400RIAS03 and C400RIAS04 was intentionally restricted to provide a more discrete depth sample.

3.3.2 Lithologic Descriptions

In each sample boring, after the collection of all soil samples to 60 ft depth, the project geologists laid out the soil core in its sequential depths and completed a lithologic log in accordance with CP4-ES-2303 *Borehole Logging*. The log noted soil texture (i.e., clay, silt, sand, gravel) and color variations over depth as well as the primary soil properties applicable to each texture. The geologists identified gaps in the soil core where the samples were collected. Appendix C provides the lithologic logs for the sample borings The area of the RI addendum investigation is underlain by approximately 60 ft of Quaternary-age fine-grained sediments, overlying approximately 30 ft of gravelly sand that comprise the fill of the ancestral Tennessee River channel.

Lithologic logs of the six sample locations (S01–S06) and the electrical conductivity log of the 12 MIP profile borings (MIP-01–MIP-12) document that the lithology of the upper 60 ft of unlithified sediments that underlie the investigation area largely consist of fine sand and silt horizons with little clay and some gravel. The sediments are mineralogically mature, consisting almost exclusively of quartz and chert. The roundness of gravels ranges widely from subangular to rounded, reflecting the alluvial fan and braided stream origins of these components. There is little provenance for clay minerals.

Silt units of loess origin, down to a depth of 17 ft to 23 ft in the sample borings, comprise the most distinguishable stratigraphic unit, locally known as HU 1. The soil column commonly consists of a 0.1 ft to 0.2 ft root zone, overlying disturbed soils down to 2.0 ft to 3.6 ft. (A dark silt, 0.4 ft to 2.5 ft thick, placed as the bottom soil liner in the 2004 excavation of the NSDD, marks the base of recently disturbed soils.) From studies of the C-746-U Contained Landfill area, the loess is known to include the lower Peoria Loess and Roxanna silt, as well as an unnamed intermediate loess. The base of the HU 1 unit occurs at 353 ft to 356 ft elevation in the sample borings.

HU 1 is underlain by a 15 ft to 20 ft thick section of interbedded fine sand and silt distinguished by gravelly horizons, locally knows as HU 2. The sedimentary units appear to be discontinuous and the elevation of the base of the HU, defined by the lowest gravelly horizon, ranges from 334 ft to 339 ft amsl.

A 9 ft to 15 ft thick sequence of very fine sand and silt, known as HU 3, underlies HU 2. The base is largely defined by elevation (324 ft to 326 ft amsl), as it grades downward into the fine-sand-dominant HU 4 member. Where the sample borings extended to 60 ft depth, HU 4 is 8 ft to 12 ft thick.

As characterized by the C-400 OU Remedial Investigation (DOE 2023) and numerous other soil borings of the Paducah Site, HU 4 is underlain by a thick gravelly sand unit, the braided stream deposit of the ancestral Tennessee River, locally known as HU 5. Electrical conductivity logs of the MIP borings distinctly identify the base of HU 5 (which overlies Cretaceous-age sands, silts, and clays of the McNairy Formation) at a common elevation of 284 ft amsl.

3.4 GROUNDWATER SAMPLING

The Geoprobe Systems® DPT rig was used to collect groundwater samples for laboratory analysis (Method SW-846 Test Method 8260D for VOCs and Method Tc-02-RCM for Tc-99) from the same six locations within and near the NSDD, S01 through S06. The RI addendum investigation work plan (DOE 2024) identified two sample depths at each location in the main member of the RGA (the gravelly sand member of the LCD), at depths of approximately 70 ft and 80 ft, with a third sample depth in the underlying McNairy Formation where MIP results indicated the presence of a confirmed/probable TCE source zone. (MIP results did not identify a McNairy Formation sample depth in the investigation area.)

MIP was unable to characterize the RGA at the east end of the sampling grid (locations MIP-08, MIP-09, and MIP-10). The RI addendum investigation collected a third groundwater sample at the base of the RGA in each of these three locations (S03/MIP-08, S04/MIP-09, and S01/MIP-10) to provide discrete characterization of VOC levels at the RGA/McNairy Formation interface.

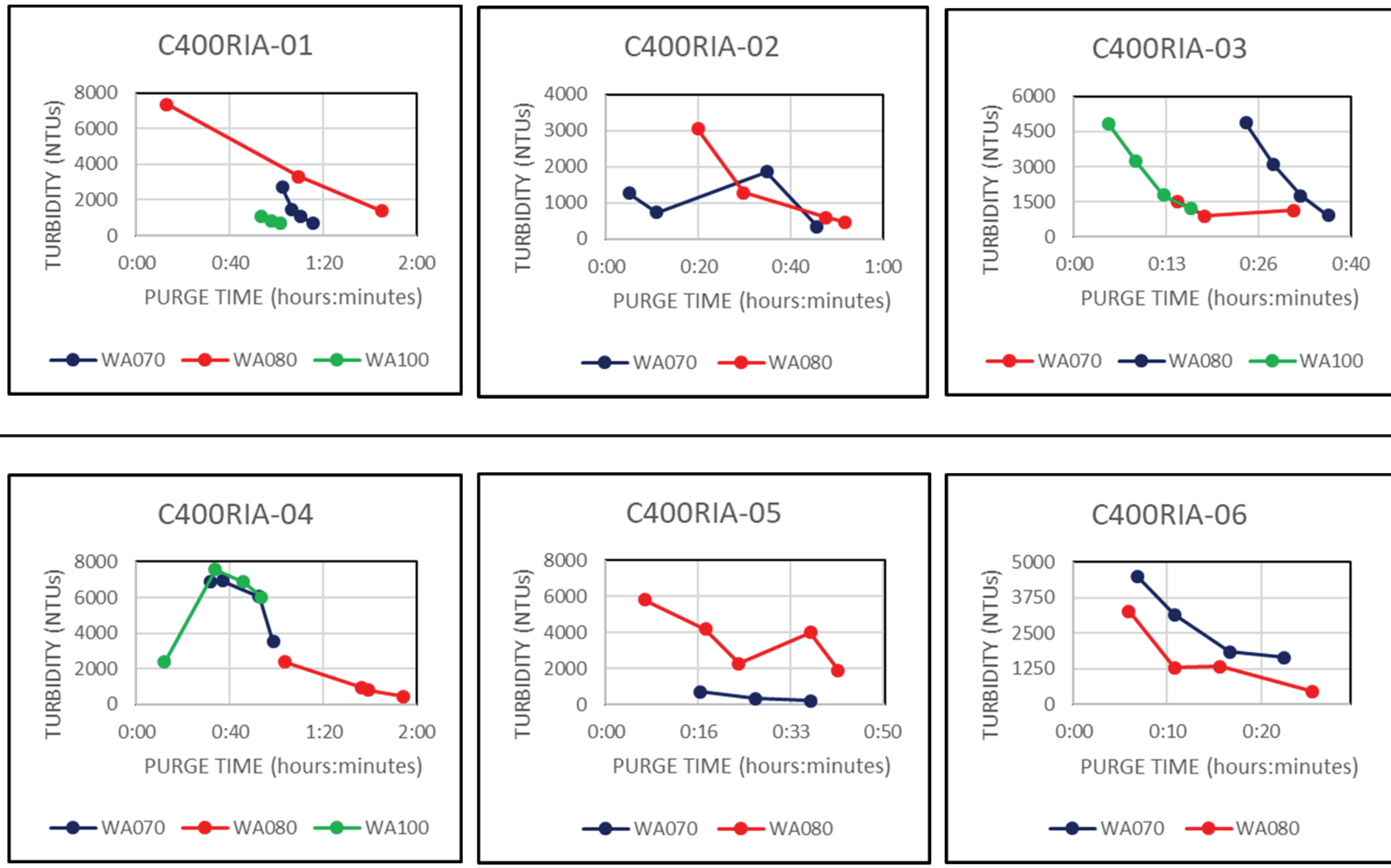
3.4.1 Groundwater Grab Samples

The RI addendum investigation collected groundwater samples with a Geoprobe Systems® SP-16 sample system that consists of a 41-inch-long well screen (with a 1.6-inch outside diameter) at the end of a string of hollow probe rods. (The well screen is retracted inside the probe rods as the sample system is being advanced to the target depth and exposed as the probe rods are extracted.) Samples were recovered using a tubing check valve seated on the base of a length of HDPE tubing (3/8-inch outer diameter, ¼-inch inner diameter). A Geoprobe Systems® electric actuator was used to oscillate the tubing, which provided the pumping action. Sampling in the RGA proved problematic due to the sample depths and suspended solids of the purge water. Failures of the tubing (loss of tubing rigidity) and check valve (frequent blockage by sediments and occasional mechanical failure) were common during operation.

In most (13 of 15) samples, the RI addendum investigation was able to purge 5 gal of water prior to collection of the samples. Interim measurements of water quality parameters (temperature, conductivity, pH, dissolved oxygen, redox potential, and turbidity), measured in a Yellow Springs Instruments, Inc., flow cell, documented the general quality of the purge water (Appendix D). Although turbidity was high (219 to 7,571 nephelometric turbidity units), turbidity decreased with increasing purge volume in most cases (Figure 7). Upon completion of purging, the investigation sample crew collected samples for laboratory analysis in three 40 mL vials (for VOCs) and a single 1 L HDPE bottle (for Tc-99).

3.5 CIVIL SURVEYING

As required by procedure CP3-HS-2016, *Excavation and Penetration*, buried utilities were marked in the field in the area of the targeted MIP locations, as defined in the RI addendum investigation work plan (DOE 2024), and sample locations, as concurred upon by the FFA parties, and the target locations were staked in the field via civil survey. Upon completion of each field activity (MIP borings and sample borings), a surveyor performed the final as-built survey of each sample location. Site locations were surveyed using a Trimble® R12i Global Navigation Satellite System survey method. Grid coordinates were measured to an accuracy of ± 0.066 ft and elevations to an accuracy of ± 0.164 ft and tied to the North American Datum of 1983 (horizontal) and the North American Vertical Datum of 1988 (vertical). Electronic files documented the surveying field activities for archival. Table 4 provides the survey targeted and final sample locations.



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PADUCAH GASEOUS DIFFUSION PLANT

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Note: WA070 = middle RGA sample purge water, WA080 = lower RGA sample purge water, and WA100 = base of the RGA sample purge water.

Figure 7. Turbidity Measurements in Sample Purge Water

Table 4. RI Addendum Investigation Location Surveys

SAMPLE LOCATIONS	TARGETED LOCATION		COMPLETED LOCATION		ELEVATION	X-Y DEVIATION
	PLANT X	PLANT Y	PLANT X	PLANT Y	(ft AMSL)	(ft)
MIP BORINGS						
MIP-01	-4724.34	-1065.39	-4724.29	-1065.39	373.57	0.06
MIP-02	-4646.18	-986.18	-4646.43	-984.51	375.13	1.69
MIP-03	-4494.38	-984.52	-4506.28	-975.85	375.90	14.73
MIP-04	-4400.74	-918.96	-4400.93	-919.08	376.76	0.22
MIP-05	-4570.78	-1032.80	-4539.95	-1071.43	374.03	49.42
MIP-06	-4438.30	-1043.00	-4433.79	-1049.88	375.00	8.23
MIP-07	-4348.30	-1043.00	-4348.84	-1043.40	373.31	0.68
MIP-08	-4258.30	-1043.00	-4258.42	-1043.49	373.06	0.50
MIP-09	-4168.30	-1043.00	-4168.70	-1042.81	373.82	0.45
MIP-10	-4078.30	-1043.00	-4075.45	-1013.67	377.23	29.47
MIP-11	-4123.30	-998.12	-4123.25	-997.41	376.68	0.71
MIP-12	-4303.06	-998.80	-4303.50	-998.11	375.93	0.82
SAMPLE BORINGS						
S-01	-4078.30	-1043.00	-4091.59	-1028.25	374.21	19.86
S-02	-4348.30	-1043.00	-4353.82	-1043.73	373.46	5.56
S-03	-4258.30	-1043.00	-4263.32	-1044.17	372.98	5.15
S-04	-4168.30	-1043.00	-4174.95	-1044.11	373.76	6.74
S-05	-4123.30	-1087.87	-4123.06	-1088.21	375.73	0.41
S-06	-4213.30	-1087.87	-4214.31	-1086.37	375.24	1.81

3.6 DEVIATIONS

The performance of the MIP profiles required several deviations from the work plan. Standing water in the NSDD prevented access to some of the staked locations, notably MIP-05 and MIP-10. Moreover, the MIP system was unable to penetrate into the RGA at locations MIP-08, MIP-09, and MIP-10 and failed to achieve the targeted depth of the RGA/McNairy Formation interface at locations MIP-04, MIP-07, and MIP-11. Groundwater analyses for sample locations S01 (Station 400RIA-01, which is nearby MIP-10), S02 (Station 400RIA-02, which is collocated with MIP-07), S03 (Station 400RIA-03, which is collocated with MIP08), and S04 (Station RIA-04, which is collocated with MIP 09) addressed some of the shortcomings.

A few planned samples were not collected from the sample locations. The deep UCRS soils of the S02 location/Station 400RIA-02 proved sufficiently stiff that the driller did not sample the targeted 50 ft to 60 ft depth interval (intended soil sample). The 70 ft groundwater sample at locations S02/Station 400RIA-02 and S03/Station 400RIA-03 could not be purged of 5 gal prior to sample collection. Apparently, pumping dewatered the sediments (in the top of the RGA) around the sampler's well screen. The investigation sample crew collected all planned groundwater samples in location S02/Station 400RIA-02. In Sample Location S03/Station 400RIA-03, insufficient water was available to collect the 70 ft groundwater interval Tc-99 sample. The 70 ft groundwater interval VOC sample in Location S03/Station 400 RIA-03 was collected as drainage water from the sample system tubing.

3.7 QUALITY ASSURANCE/QUALITY CONTROL

Quality control (QC) was monitored throughout the RI process. QC included field sampling, laboratory analysis, and data management.

3.7.1 Field Sampling QC

Field QC samples were collected to assess data quality. Table 5 compares the number of actual field QC samples collected during field implementation with the targeted number of field QC samples in the QAPP (DOE 2024). The target frequency of collection for QC samples for this project was 1 in 20 (5%) for field duplicates, field blanks, and equipment blanks. Overall, this target was met for the project. Trip blanks were collected at a frequency of one per day, or one per sample cooler containing VOC samples. Appendix E includes the data from the field QC samples in a searchable format on compact disk.

Table 5. Field QC Samples (Actual versus QAPP[a])

Analyte/ Analytical Group	Field Samples Actual[b]/QAPP	Field Duplicate Actual/QAPP	Field Blanks Actual/QAPP	Equipment Blanks Actual/QAPP	Trip Blanks[c] Actual
VOCs (Soil)	29/30	2/2	2/2	2/2	9
Radionuclides (Soil)	29/30	2/2	2/2	2/2	NA
VOCs (Groundwater)	15[d]/12	1/1	1/1	1/1	9
Radionuclides (Groundwater)	14[e]/12	1/1	1/1	1/1	NA

[a] The QAPP counts were based on 10 sample borings. The counts have been adjusted to reflect the number of sample borings performed. The Field Duplicates, Blanks, and Equipment Blanks are based on 5% of Field Samples, per the QAPP.

[b] Sample counts include one contingency boring.

[c] QAPP specified trip blanks at one per day or one per cooler for VOCs.

[d] The greater number of Actual Samples for groundwater VOCs reflects the addition of two optional 100 ft water samples.

e The greater number of Actual Samples for groundwater Radionuclides reflects the addition of two optional 100 ft samples and one missing 70 ft sample.

3.7.2 Laboratory QC

The analytical laboratory was contracted through the Sample Management Office and was licensed by the U.S. Nuclear Regulatory Commission to handle samples with potential radiological contamination. The laboratory was audited annually for compliance with DOE Consolidated Audit Program requirements. EPA-approved methods were utilized, as specified in the *Addendum to the Remedial Investigation/Feasibility Study Work Plan for the C-400 Complex Operable Unit at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-2433&D2/R1/A1/R1 (DOE 2024). The analysis followed appropriate protocols and Level IV data packages were provided along with electronic data deliverables.

The following data qualifiers were used for reporting fixed-base laboratory results:

Organic analysis

U	Not detected.
J	Estimated quantitation.
Y1	Matrix spike (MS)/matrix spike duplicate (MSD) recovery outside acceptance criteria.
Y2	MS/MSD relative percent difference (RPD) outside acceptance criteria.
Q	Quality issue exists with instrument calibration.

Radionuclide analysis

U	Value reported is less than the minimum detectable activity and/or total propagated uncertainty.

Precision, accuracy, and completeness objectives were presented in QAPP Worksheet #12-A, 12-B, 12-C, and 12-D of the addendum to the RI/FS work plan (DOE 2024) and are summarized below. Based on data verification, validation, and assessment, laboratory analytical data have been determined to be usable and to meet the DQOs. An assessment of these objectives for laboratory analytical data was performed. The results of this assessment are provided in Table 6.

Table 6. Quality Assurance (QA) Assessment for Laboratory Measurements of RI Addendum Data

Parameter	Method	Precision (Analytical) (%)	Accuracy (%)	Field (Analytical) Completeness (%)
VOCs	SW846-8260	100	77	92 (100)
Tc-99	HASL 300, Tc-02-RC M	100	100	90 (100)

Precision—measures the agreement among a set of replicate measurements. Analytical precision is estimated by duplicate/replicate analyses, usually on laboratory control samples, spiked samples, and/or field samples. The most commonly used estimates of precision are the relative standard deviation (RSD) and the relative percent difference (RPD). Field precision is evaluated by comparing analytical results of samples and associated field duplicates. Precision was determined for this RI by reviewing laboratory-applied qualifiers that pertain to laboratory duplicates, laboratory control sample duplicates, matrix spike duplicates, and/or post-digestion spike duplicates (PSD).

Accuracy—refers to the closeness of a measured result to an accepted reference value. Accuracy is usually measured as a percent recovery. QC analyses used to measure accuracy include standard recoveries, laboratory control samples, spiked samples, surrogates, and tracers. Accuracy for this RI was determined by reviewing laboratory-applied qualifiers that pertain to laboratory spikes and blanks over all analyses.

Representativeness—is the degree to which discrete samples accurately and precisely reflect a characteristic of a population, variations at a sampling location, or an environmental condition. Representativeness is a qualitative parameter and will be achieved through careful, informed selection of sampling sites, drilling sites, drilling depths, and analytical parameters and through the proper collection and handling of samples to avoid interference and minimize contamination and sample loss. This objective was achieved for the RI addendum investigation by evaluating field conditions before and during the data acquisition process to ensure that the most representative sample set possible was collected.

Completeness—is a measure of the amount of valid data collected compared to the amount planned. Measurements are considered to be valid if they are unqualified or qualified as estimated during validation. Field completeness is a measure of the number of samples collected versus the number of samples planned. Laboratory completeness is a measure of the number of valid measurements compared to the total number of measurements planned.

The completeness objective stated in the QAPP was met and exceeded during this investigation. While some planned samples may not have been collected for various reasons (e.g., insufficient water), > 90% of the samples were collected that were planned for each analytical group (shown in the second column of Table 5).

Comparability—expresses the degree of confidence with which one data set can be compared to another. It is dependent upon the proper design of the sampling program and will be satisfied by ensuring that the approved plans are followed and that proper sampling and analysis techniques are applied. Further, when assessing comparability, data sets should be of known and documented quality. Comparability was assessed in terms of field standard operating procedures, analytical methods, QC, and data reporting. In addition, data validation assesses the processes employed by the laboratory that affect data comparability.

Sensitivity—is the capability of a method or instrument to discriminate between measurement responses representing different levels of the variable of interest. This is achieved for each analyte using the method detection limit (MDL), instrument detection limit, or by the laboratory practical quantitation limit (PQL). MDLs and PQLs are laboratory-dependent and were obtained from the analytical laboratory selected to perform work. For this data set, sensitivity was evaluated by reviewing the reporting limits received from the laboratory.

4. NATURE AND EXTENT OF CONTAMINATION

The nature and extent of contamination in the RI addendum investigation area are characterized by MIP logs and sample analyses of the UCD soils, down to a depth of 60 ft, MIP logs and sample analyses of RGA groundwater at two common depth intervals and at the basal RGA at three of the six boring locations, and by MIP logs in the upper McNairy Formation. Appendix A provides the MIP logs, and Appendix F provides the sample analyses for the C-400 RI addendum investigation.

4.1 SUBSURFACE SOIL (UPPER CONTINENTAL RECHARGE SYSTEM)

MIP logs and soil analyses[8] identify scant levels of contamination in the RI addendum investigation area. Inspection of the MIP logs identified one suspect area of contamination in the UCRS (Figure 8). Frequent spikes on the PID and FID logs in MIP-07 (adjacent to Sample Location S02/Station 400RIA-02) at depths of 18.0 ft to 19.2 ft, in MIP-08 (adjacent to Sample Location S03/Station 400RIA-03) at depths of 18.0 ft to 19.6 ft, and in MIP-12 (no adjacent Sample Location) at depths of 18.3 ft to 21.0 ft indicate a zone of shallow contamination. Spikes in the PID log of MIP-07 exceed the "confirmed/probable source zone" criterion (>700,000 µV) of the addendum to the RI/FS work plan for the C-400 Complex OU (DOE 2024); however, the XSD log (detecting chlorinated compounds) offers no evidence of a response at these depths. Coincident PID and FID detections with no XSD response are symptomatic of petroleum hydrocarbons (Geoprobe 2021).

Laboratory results were largely nondetect for the soil samples[9]. The only detections were five analyses of TCE in soil samples from Sample Location S03/Station 400RIA-03 (30.0 µg/kg and 22.2 µg/kg in the two deepest samples at 56 ft and 46 ft depths respectively), Sample Location S06/Station 400RIA-06 (3.21 µg/kg and 1.15 µg/kg in the two deepest samples at 49 and 60 ft depths respectively), and Sample Location S02/Station 400RIA-02 (0.743 µg/kg in the deepest soil sample at 46 ft depth). No results exceeded the > 100,000 µg/kg TCE criteria for confirmed/probable source zones. There were no detectable results of Tc-99 in any of the soil samples.

.

[8] Refer to Section 1.2 for the potential and/or confirmed/probable TCE source zone multiple lines of evidence criteria.

[9] There were no laboratory detections for 1,1-DCE; *cis*-1,2-DCE; *trans*-1,2-DCE, or vinyl chloride in soil samples.

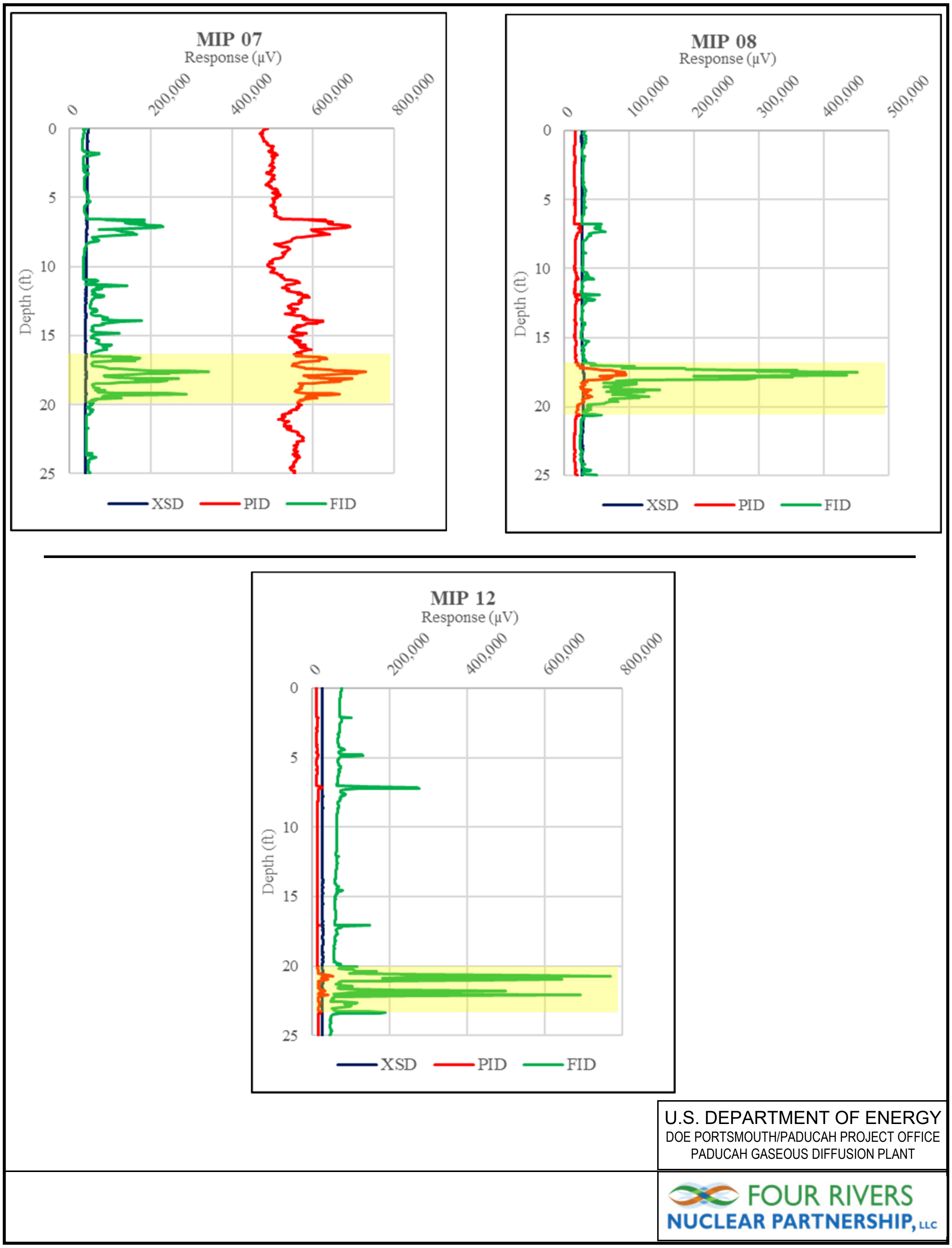

Figure 8. MIP Logs of Suspect Area of Contamination

4.2 GROUNDWATER (REGIONAL GRAVEL AQUIFER)

From the groundwater samples collected, the detectable results (including duplicate samples), were as follows. [10]

- TCE and *cis*-1,2-DCE each had 16 detectable results of the 16 samples collected. The maximum TCE concentration was 10,900 µg/L and the maximum *cis*-1,2-DCE concentration was 75.9 J µg/L, both from Sample Location S04/Station 400RIA-04.

- Tc-99 had 15 detectable results of the 15 samples collected. The maximum Tc-99 concentration was 4,790 pCi/L at Sample Location S02/Station 400RIA-02.

- 1,1-DCE had three detectable results of the 16 samples collected. The maximum 1,1-DCE concentration was 3.19 µg/L at Sample Location S02/Station 400RIA-02.

- *trans*-1,2-DCE had only one detectable result of the 16 samples collected. The *trans*-1,2-DCE concentration was 1.05 µg/L at Sample Location S04/Station 400RIA-04.

The TCE and *cis*-1,2-DCE plume alignments are similar (Figures 9 and 10).

The TCE analysis of the basal RGA sample in Sample Location S04/Station 400RIA-04 (10, 900 µg/L) is two orders-of-magnitude greater than all other sample location results and is similar in magnitude to TCE levels in recent samples from nearby MW421 Port 3 (22,200 to 23,700 µg/L). None of the analyses meet the criterion of a confirmed/probable TCE source zone as defined for the C-400 Complex OU RI (> 33,000 µg/L); however, the basal RGA sample in Sample Location S04/Station 400RIA-04 (10,900 µg/L TCE) is close to the lower criterion (11,000 µg/L) for a potential TCE source zone.[11] This sample location is in close proximity to, and likely related to, the upgradient potential and/or confirmed/probable TCE source zone(s) identified in the C-400 OU RI (DOE 2023). It should be noted that no MIP PID responses in the RGA exceeded the confirmed/probable TCE source zone criterion of 700,000 µV.

Tc-99 levels are an order-of-magnitude greater in the two sample depths of Sample Location S02/Station 400RIA-02 compared to all other Sample Location results (Figure 11). Sample Location S02/Station 400RIA-02 is located within the Tc-99 centroid associated with the Northwest Plume.

4.3 MCNAIRY FORMATION

The highest TCE concentration of the groundwater samples of the RI addendum investigation (10,900 µg/L), from the base of the RGA in Sample Location S04/Station 400RIA-04, is in close proximity to an upgradient potential and/or confirmed/probable TCE source zone(s) identified in the C-400 OU RI (DOE 2023). TCE soil analyses for the closest soil boring of the C-400 OU RI (Boring S2-C07) are highest at the base of the RGA (1,590 µg/kg)[12] and are nondetectable 10 ft deeper (<2.35 µg/kg), in the McNairy Formation, and 20 ft deeper (<1.67 µg/kg). The potential and/or confirmed/probable TCE source zone (s)

[10] Vinyl chloride was not detected in any groundwater analysis of this investigation.
[11] EPA suggests a 1% rule of thumb as a generality that sampled groundwater concentrations in excess of 1% effective solubility (TCE =11,000 µg/L) indicate that DNAPL may be present in the vicinity of any direction of the monitoring point of interest (EPA 2009).
[12] The groundwater TCE concentration at the base of the RGA in Boring S2-C07 was 19,600 µg/L.

identified in the C-400 OU RI (Boring S2-C07) that is likely related to Sample Location S04/Station 400RIA-04, does not extend downward into the McNairy Formation.

MIP log spikes in the top of the McNairy Formation for the XSD and PID detectors identify thin zones of sorbed TCE, derived from prolonged exposure to the dissolved phase plume in the RGA.[13] Of the 12 MIP borings, six provide characterization of the upper McNairy Formation, at depths of 5 ft to 22 ft. None of the PID responses meet the C-400 Complex OU RI/FS criterion of a confirmed/probable TCE source zone.[14]

4.4 EVALUATION

Highest dissolved TCE levels in MW421 and TCE levels in Sample Location S02/Station 400RIA-02 corroborate a northwest-trending centroid of the Northwest Plume, exiting from the C-400 Cleaning Building (a main premise of the CSM). XSD logs for MIP-06 and MIP-07 limit the TCE plume to the base of the RGA and are consistent with years of monitoring results from Ports 1 through 3 of MW421–MW423. Highest Tc-99 levels occurred in Sample Location S02/Station 400RIA-02, consistent with the previous interpretation of the Tc-99 centroid in the Northwest Plume.

The TCE analyses of the lower RGA samples for Sample Location S04/Station 400RIA-04 identify a previously undefined plume centroid with an unknown trajectory and are likely related to the upgradient potential and/or confirmed/probable TCE source zone (s) identified in the C-400 OU RI (DOE 2023).

[13] Recent declining TCE trends in the Northeast Plume and Northwest Plume indicate that the sorbed TCE is being attenuated.
[14] Refer to Section 1.2 for the potential and/or confirmed/probable TCE source zone multiple lines of evidence criteria.

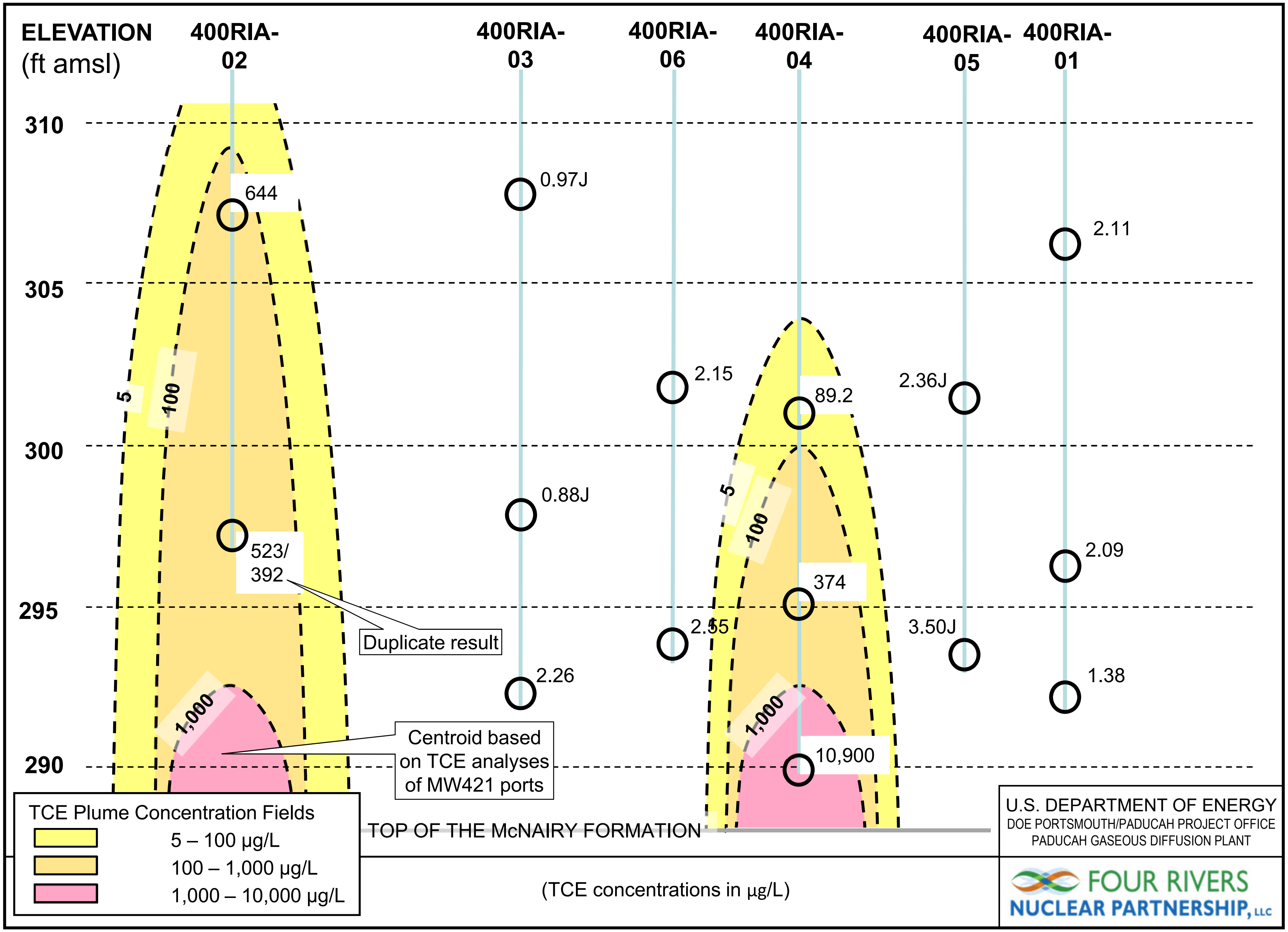

Figure 9. TCE Transect (Looking North)

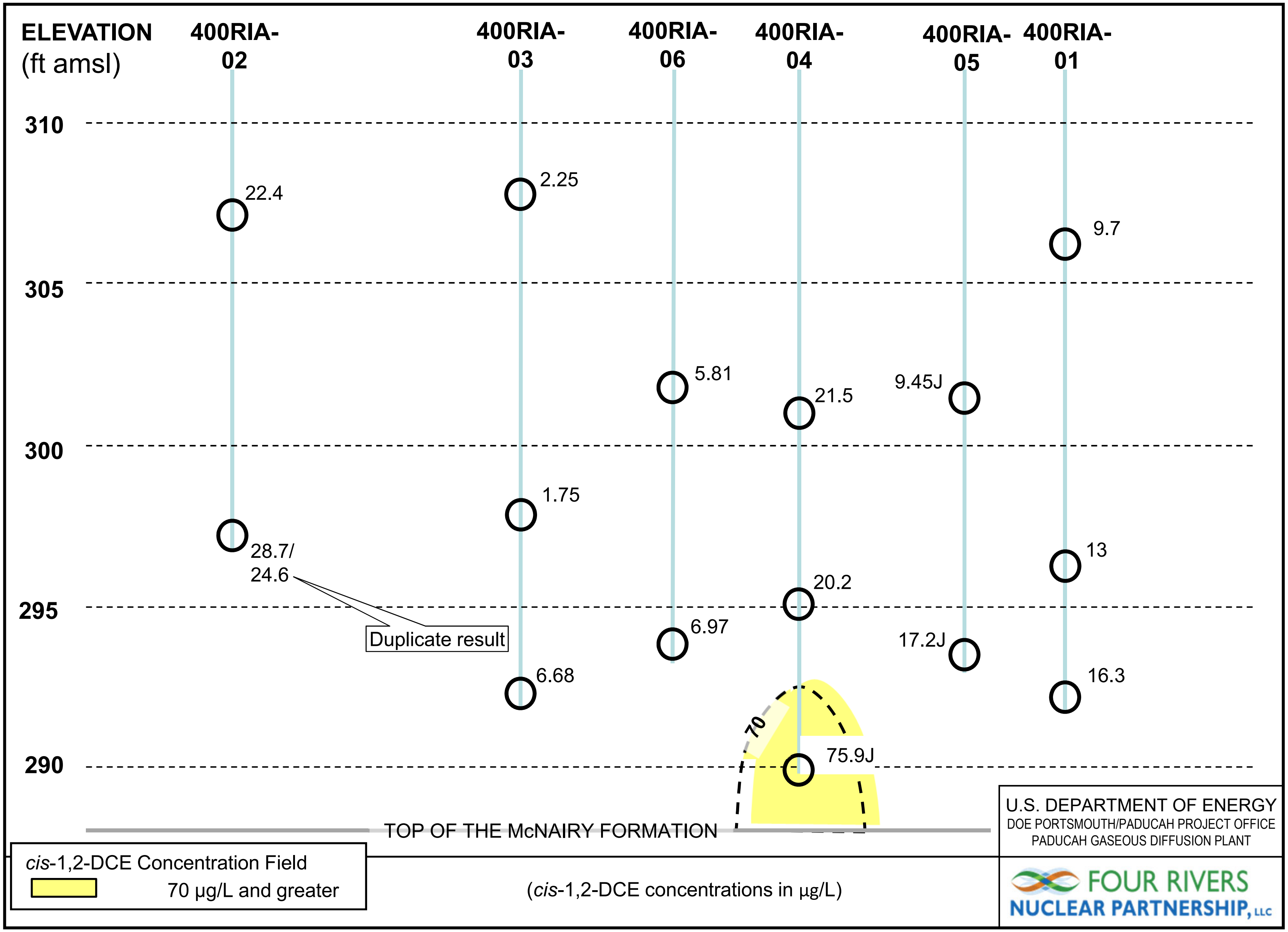

Figure 10. ***cis*-1,2-DCE Transect (Looking North)**

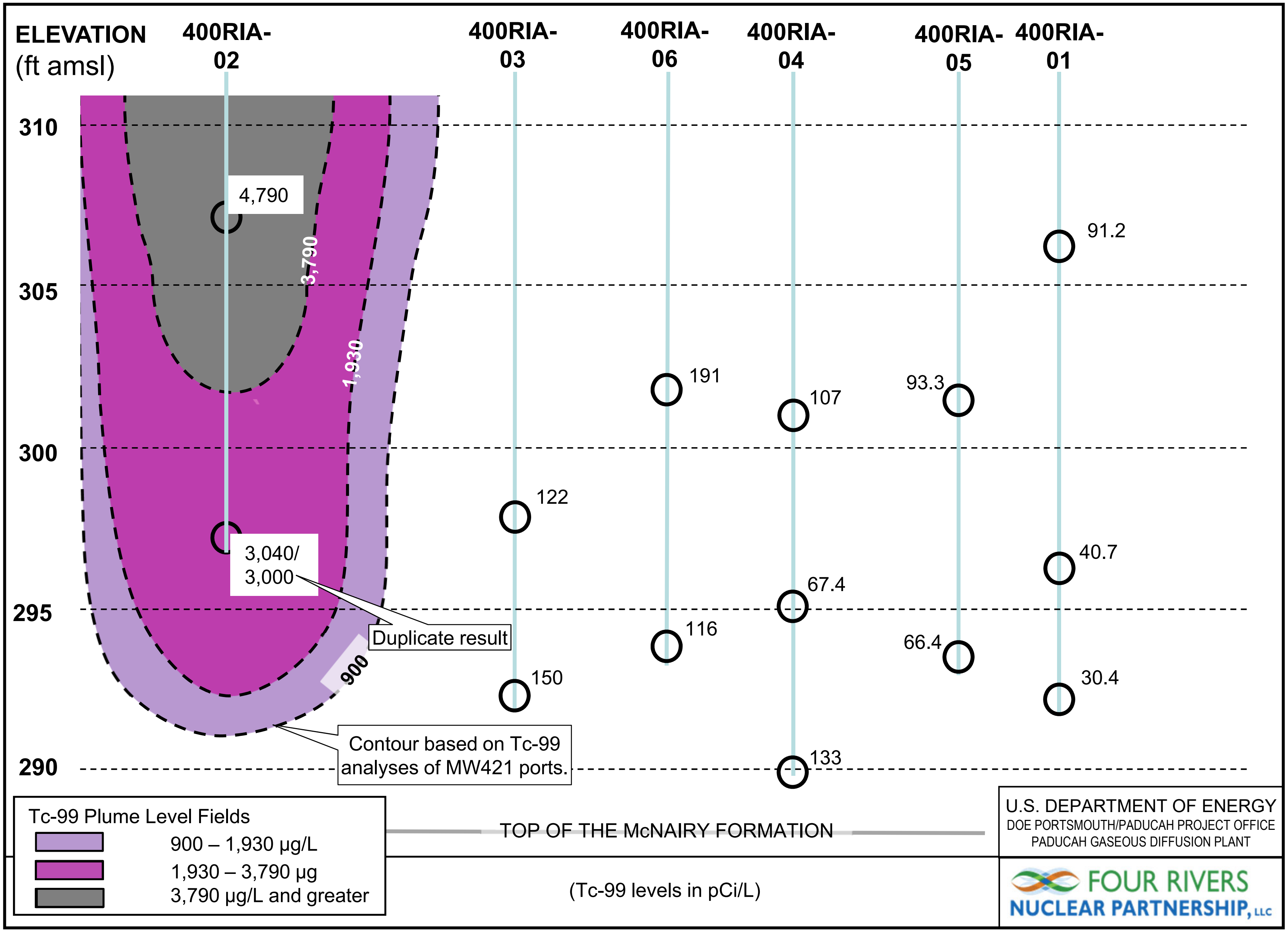

Figure 11. Tc-99 Transect (Looking North)

5. SUMMARY AND CONCLUSIONS

Interpretation of the combined MIP logs and sample results are sufficient to identify the three-dimensional alignment of the Northwest Plume in the area of the RI addendum investigation and can be used to optimize the location(s) of extraction well(s) of a forthcoming Northwest Plume optimization action.

5.1 SUMMARY

The C-400 Complex OU RI evaluated and identified the presence of confirmed/probable source zones containing TCE as DNAPL and high concentration TCE contamination in the southern portion of the C-400 Complex OU. A likely source of Tc-99 contamination was identified under the west-central area of the C-400 Cleaning Building. The associated FS identified two data gaps regarding the area immediately north of the C-400 Complex OU.

- The nature and extent of the potential and/or confirmed/probable TCE source zone(s) in UCRS soils and in RGA and McNairy Formation groundwater have not been fully characterized.

- Tc-99 levels in UCRS soils and in RGA groundwater have not been fully characterized.

To address these data gaps, FRNP conducted a C-400 RI addendum investigation beginning in late October 2024 and continuing through mid-February 2025, consisting of two phases. The first phase involved MIP characterization of the investigation area in 12 locations, extending down into the upper McNairy Formation where possible. This was followed by an environmental media sampling phase, collecting soil samples to 60 ft depth and groundwater samples down to the base of the RGA at 84 ft depth.

The RI addendum investigation provides three-dimensional characterization of TCE and Tc-99 levels in the RGA and the uppermost McNairy Formation via MIP logs and TCE (and anaerobic degradation products) and Tc-99 analyses of UCRS soil and RGA groundwater for the area north of the C-400 Complex OU.

5.2 CONCLUSIONS

The MIP and sample data are sufficient to identify the three-dimensional alignment of the primary Northwest Plume TCE and Tc-99 centroids in the area of the RI addendum study and can be used to optimize the location(s) of extraction well(s) of a forthcoming Northwest Plume action.

The data demonstrate that potential and confirmed/probable TCE and Tc-99 source zones are not present in the RI addendum investigation area.

- In the UCRS, the MIP PID response spikes above the confirmed/probable TCE criterion in MIP-07. The absence of a spike in the corollary XSD log of MIP-07 demonstrates the contamination is likely petroleum hydrocarbons. No soil laboratory results exceeded the > 100,000 µg/kg TCE criteria for confirmed/probable source zones.

- There were no detectable results of Tc-99 in any of the soil samples.

- In the RGA, the lone TCE groundwater analysis close to the potential TCE source zone criterion of 11,000 µg/L is found at the base of the RGA in Sample Location S04/Station 400RIA-04. The TCE groundwater contamination is derived from a potential TCE source zone identified in the C-400 OU RI (DOE 2023) that is immediately upgradient of Sample Location S04/Station 400RIA-04. No groundwater results or PID responses exceed the criteria for confirmed/probable TCE source zones (33,000 µg/L and 700,000 µV, respectively).

- The location that had the maximum Tc-99 activity in RGA groundwater (3,000 to 4,790 pCi/L) occurs in Sample Location S02/Station 400RIA-02, which is located in the Northwest Plume and sourced upgradient, under the C-400 Building. All other locations had Tc-99 analyses of <200 pCi/L. No Tc-99 source zones are evident in the area of the RI addendum.

- No MIP PID responses in the McNairy Formation exceed the confirmed/probable TCE source zone criterion of 700,000 µV.

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APPENDIX A

MIP LOGS

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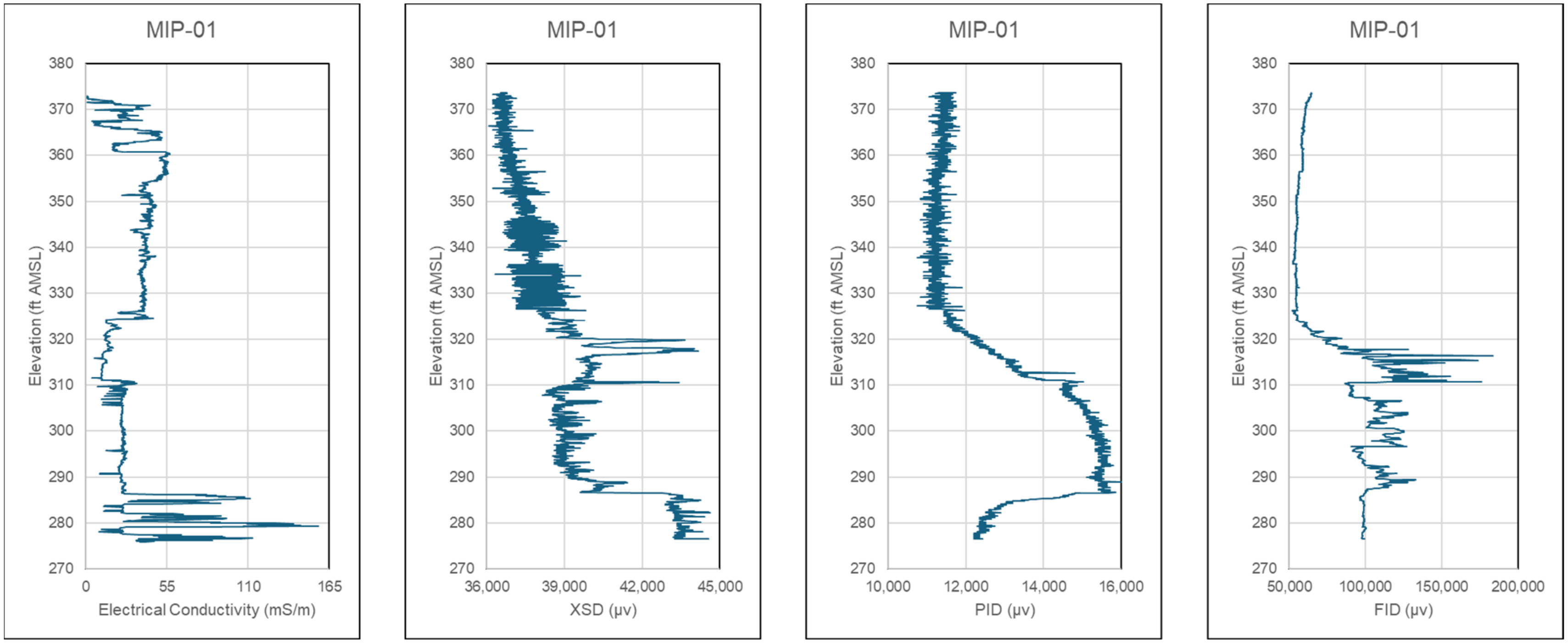

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Figure A.1. MIP Logs for MIP 01

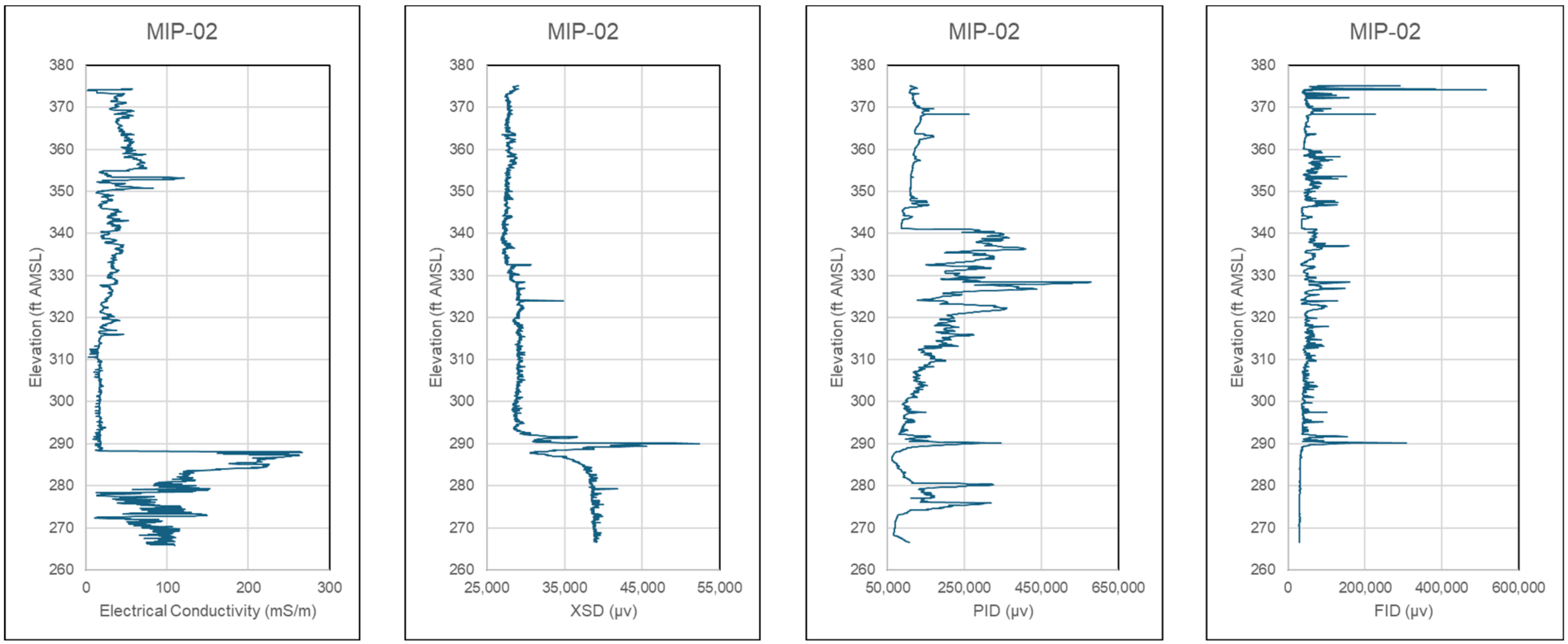

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Figure A.2. MIP Logs for MIP 02

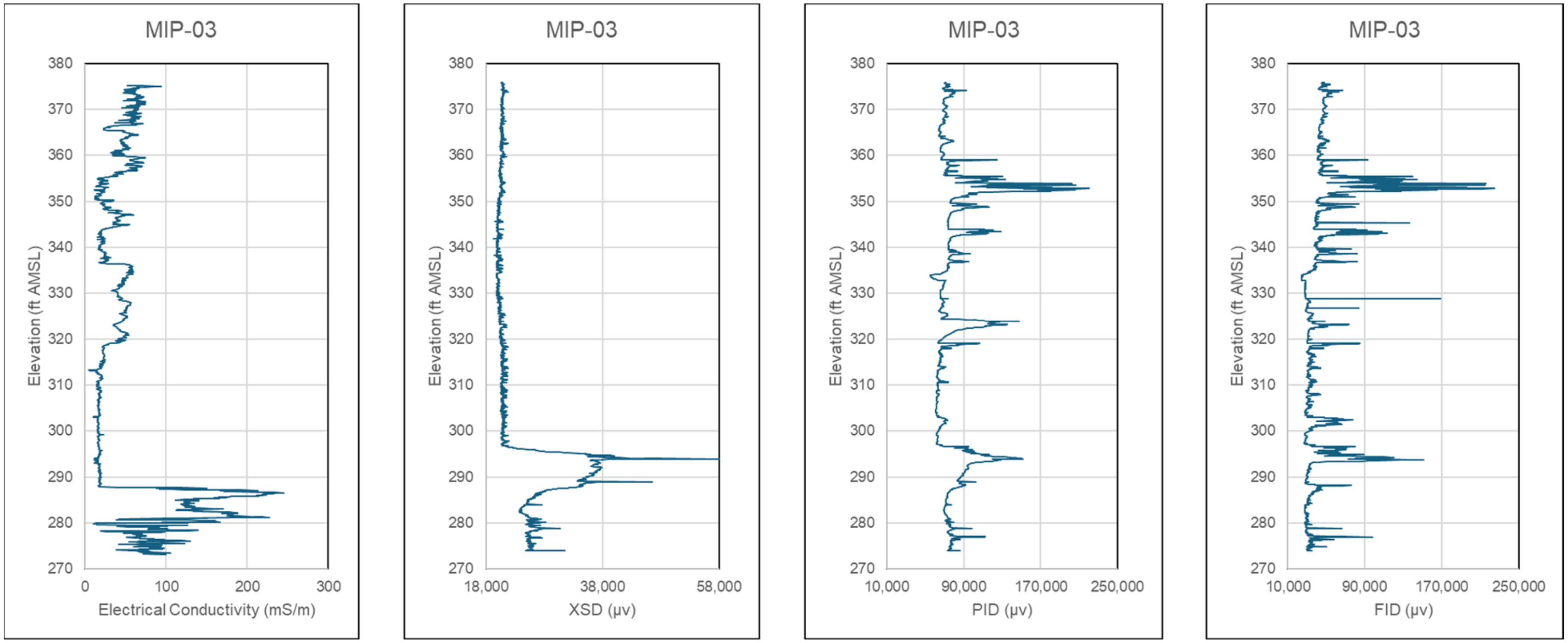

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Figure A.3. MIP Logs for MIP 03

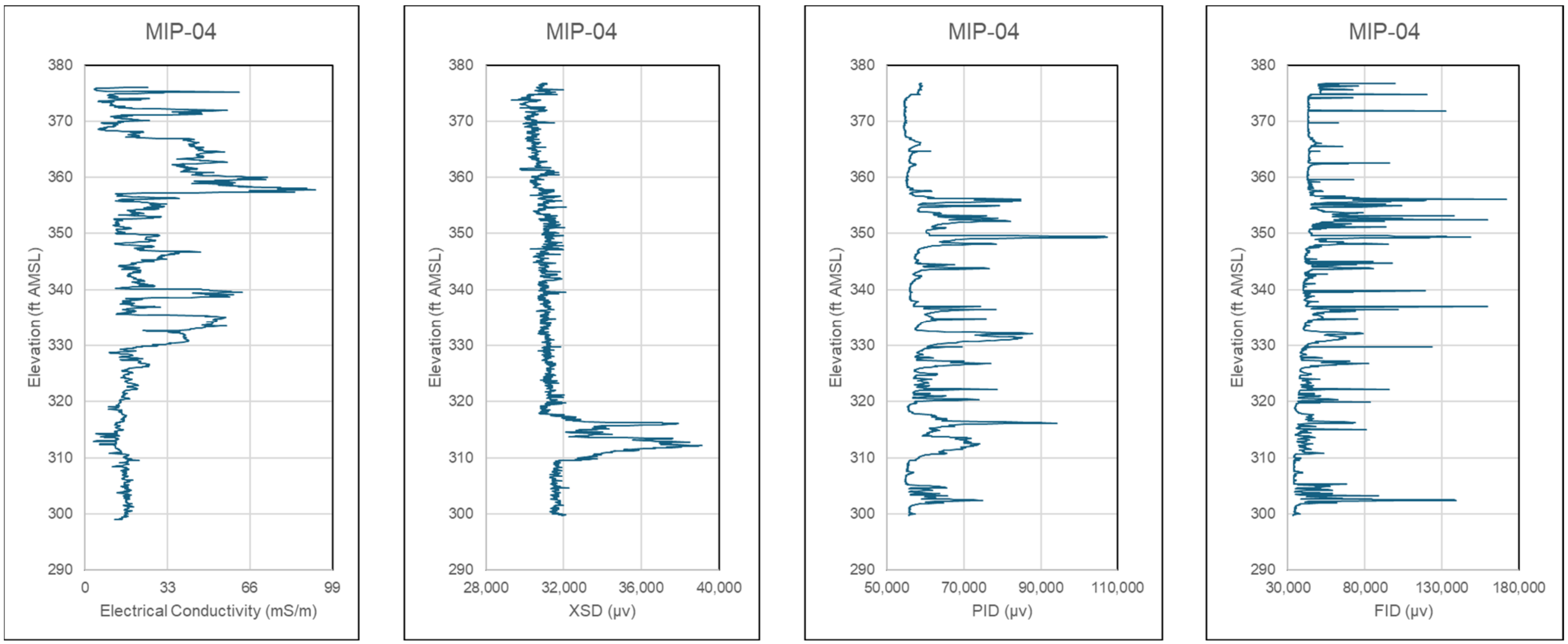

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Figure A.4. MIP Logs for MIP 04

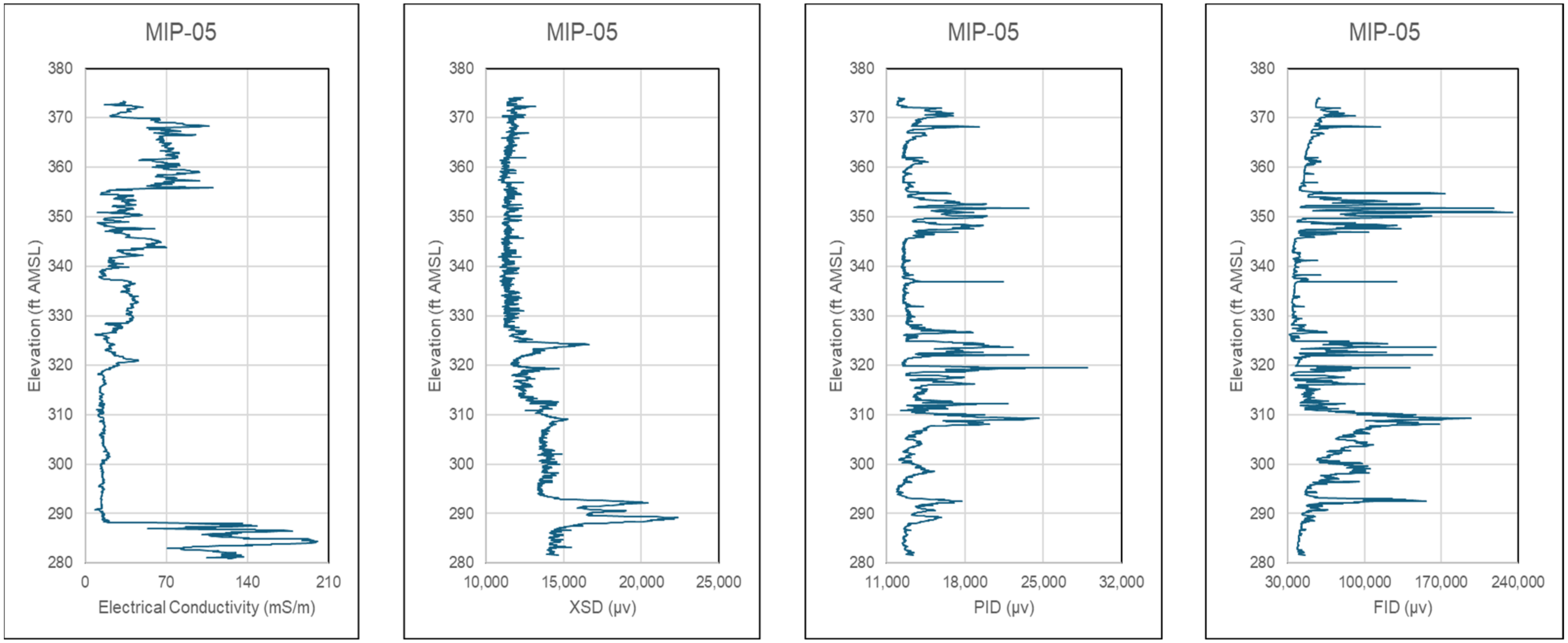

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Figure A.5. MIP Logs for MIP 05

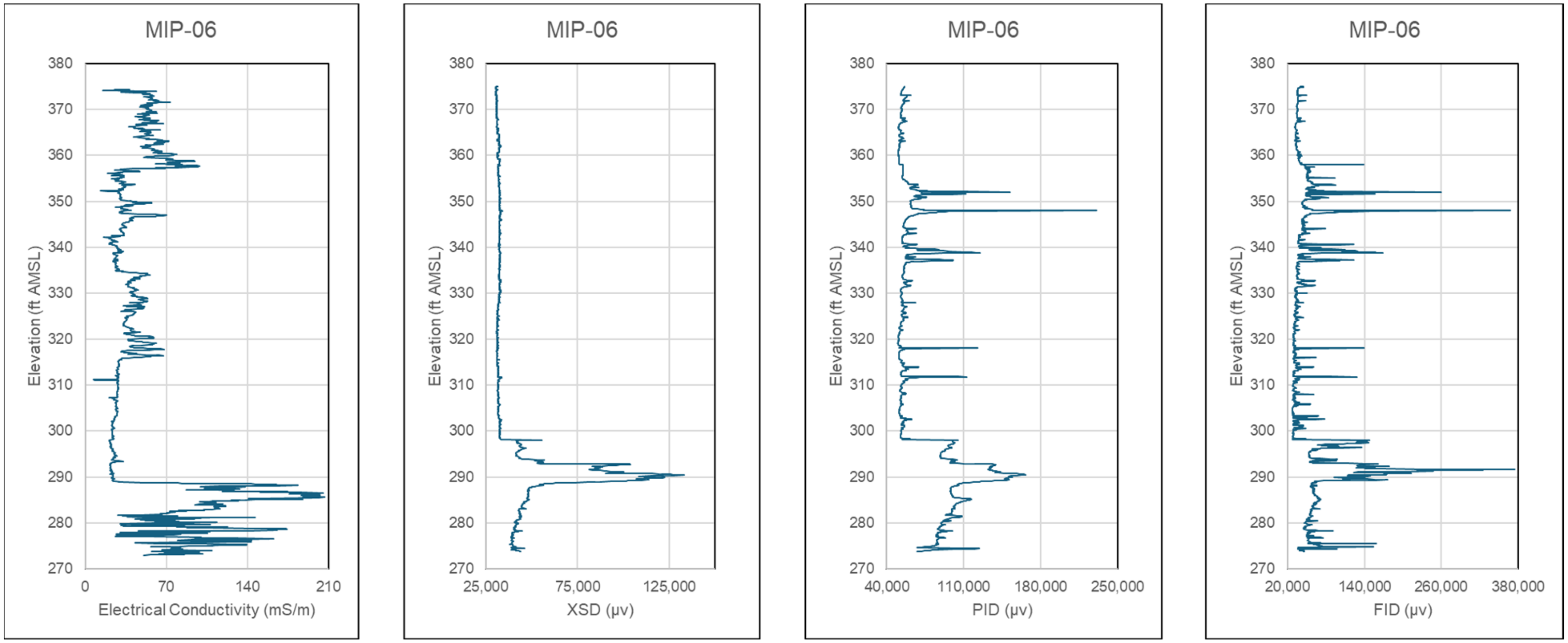

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Figure A.6. MIP Logs for MIP 06

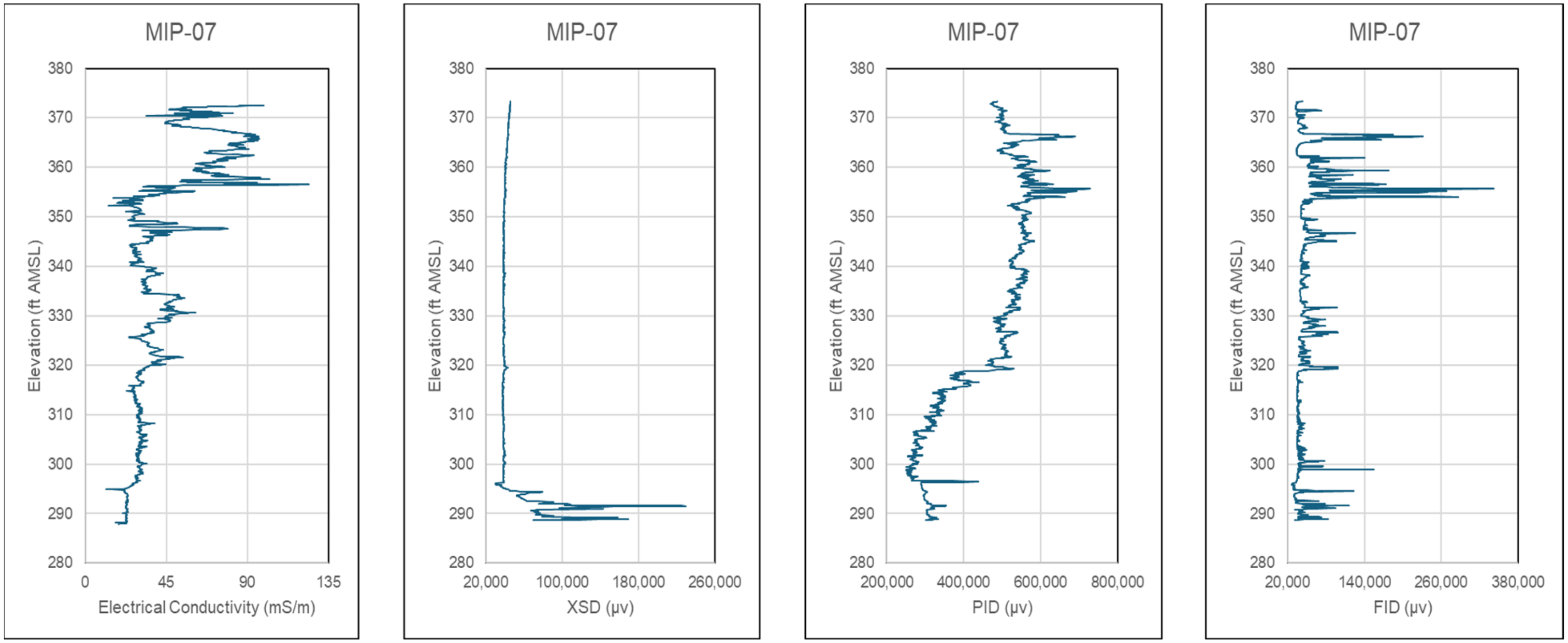

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Figure A.7. MIP Logs for MIP 07

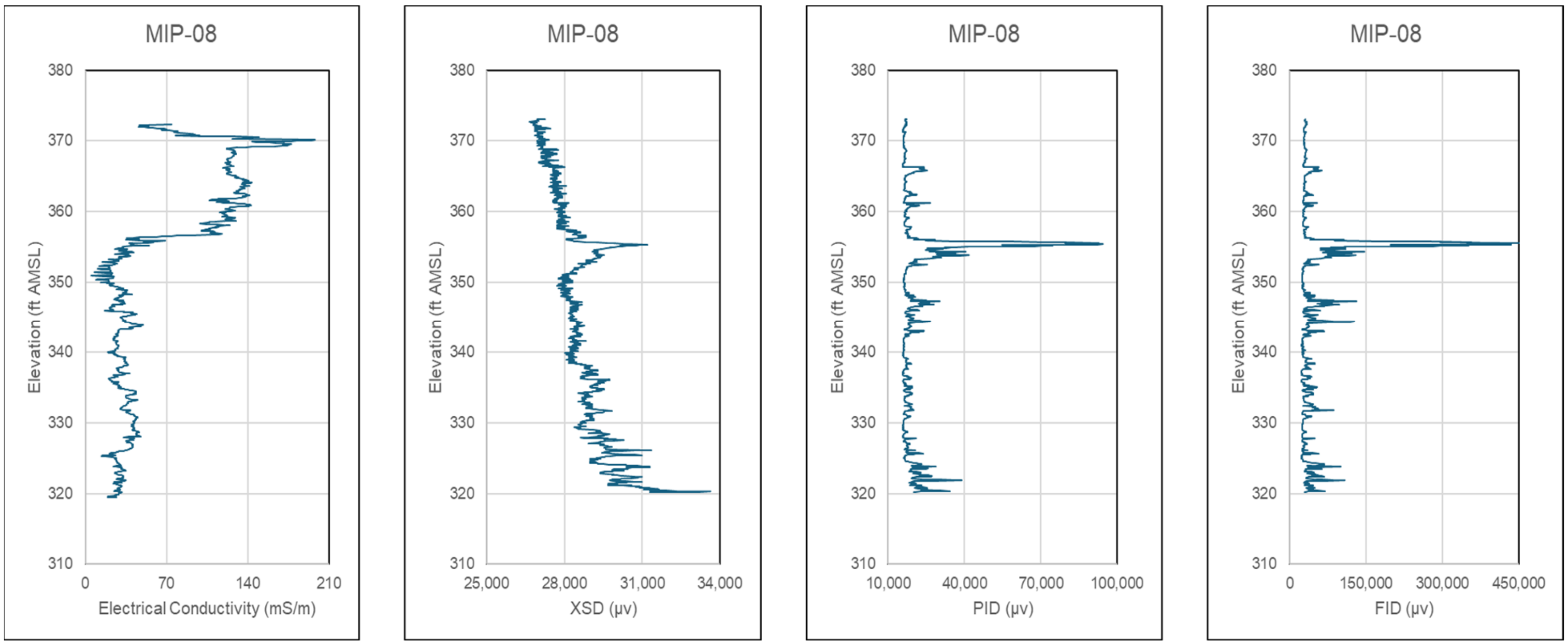

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Figure A.8. MIP Logs for MIP 08

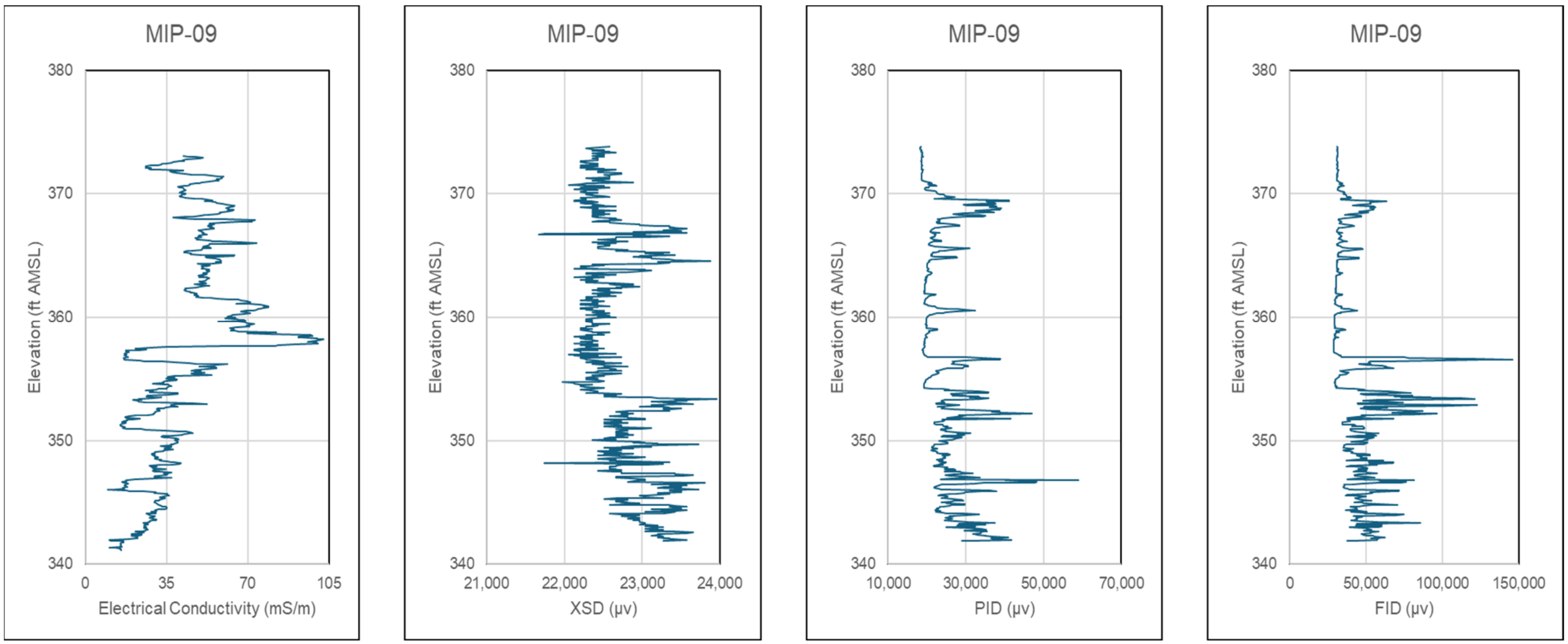

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Figure A.9. MIP Logs for MIP 09

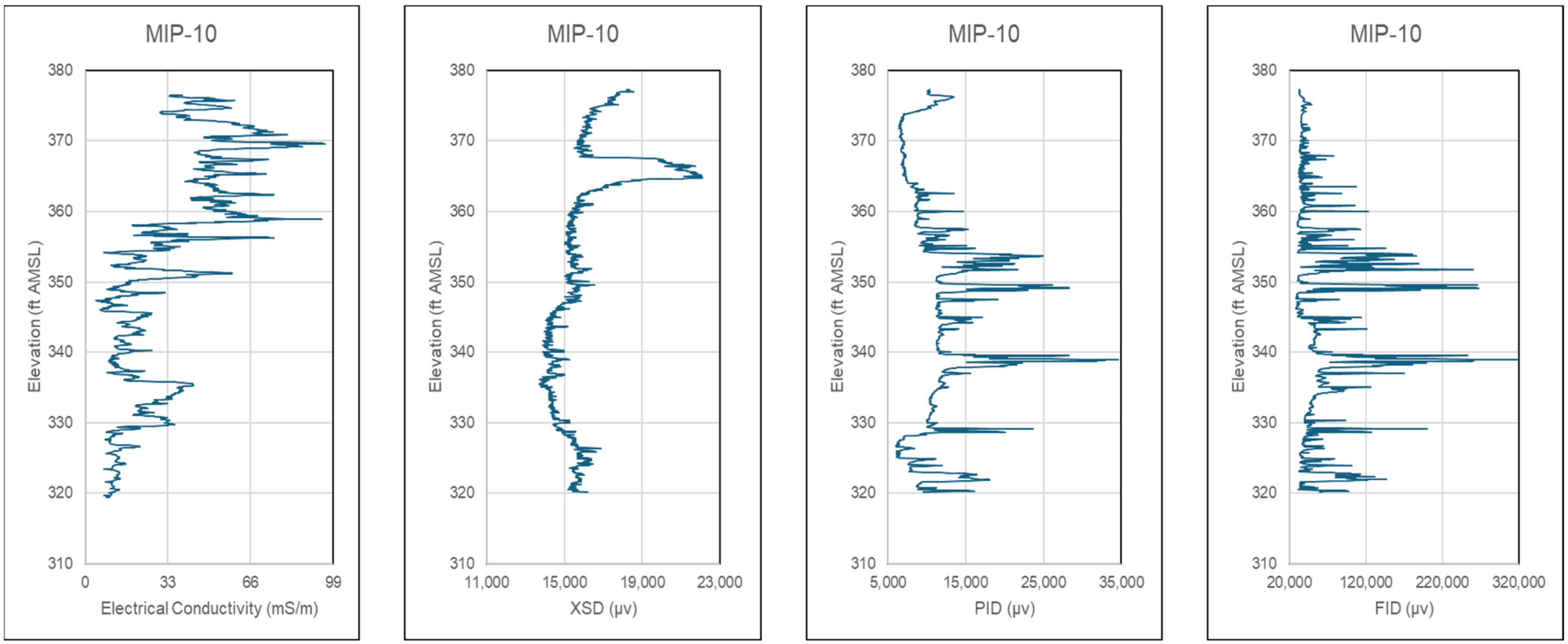

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Figure A.10. MIP Logs for MIP 10

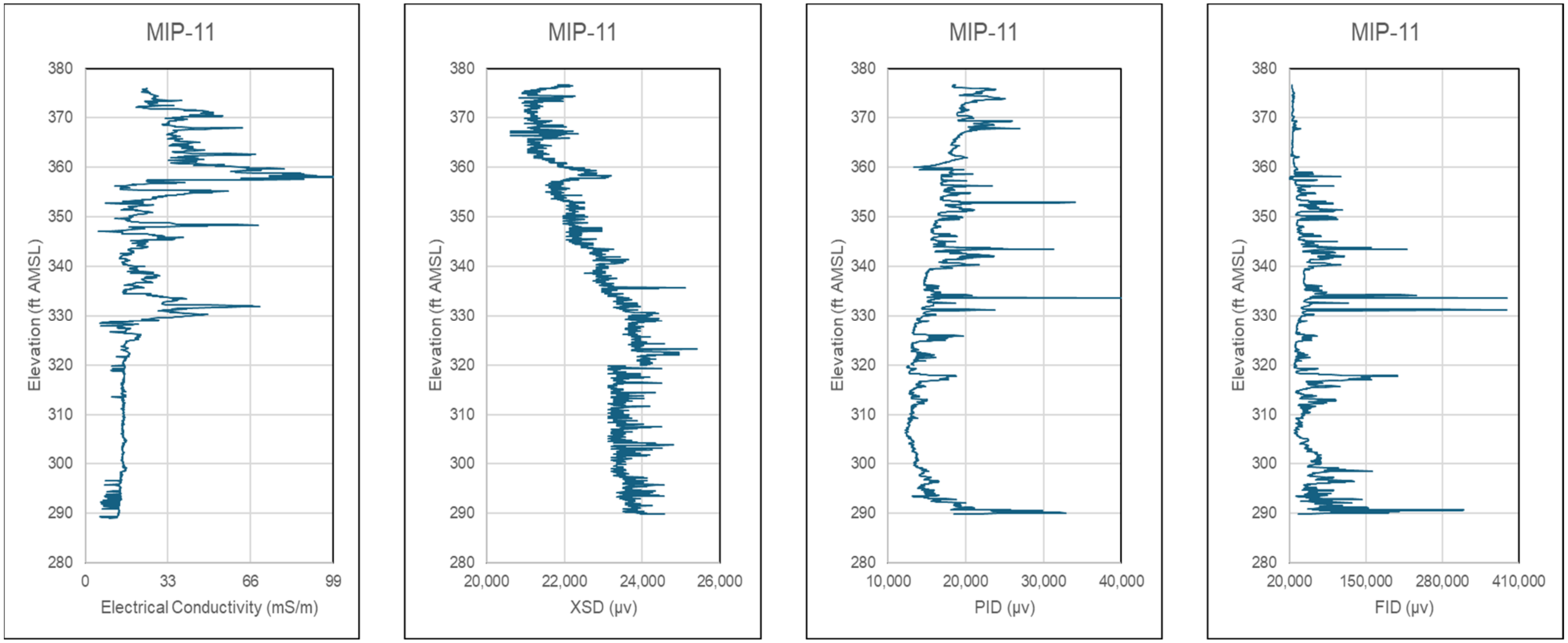

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Figure A.11. MIP Logs for MIP 11

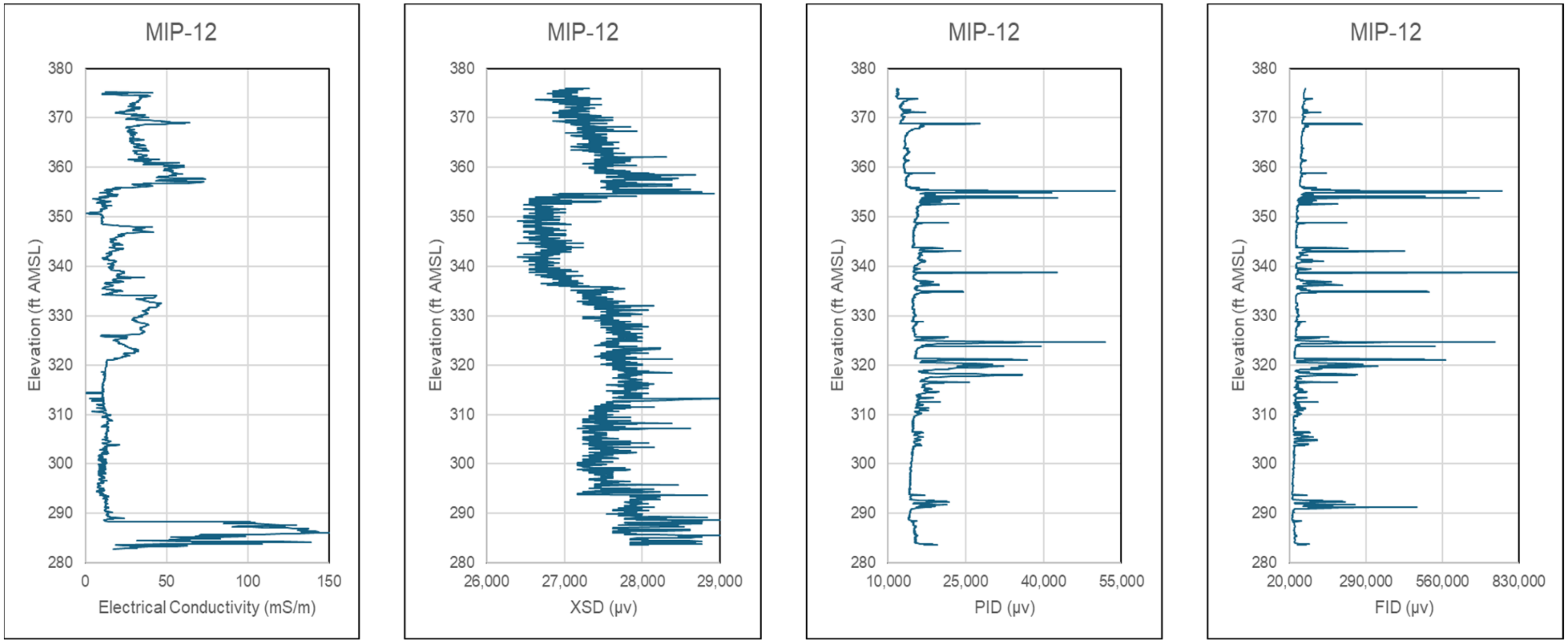

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Figure A.12. MIP Logs for MIP 12

APPENDIX B

PID AND BETA/GAMMA SURVEYS

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Table B.1. PID Survey Results and Sample Interval

	PID (ppb)					
DEPTH	C400RIA-01	C400RIA-02	C400RIA-03	C400RIA-04	C400RIA-05	C400RIA-06
0.1	0	134	435	0	891	54
1.0	0	13	192	0	1,451	100
2.0	0	0	602	0	30	445
3.0	0	71	77	0	34	970
4.0	0	5	54	0	66	3,887
4.9	0	49	75	0	73	36,070
5.1	0	8	220	0	38	19,970
6.0	0	113	93	0	165	684
7.0	0	18	127	0	276	616
8.0	0	26	248	0	59	457
9.0	0	41	224	0	49	392
9.9	0	32	149	0	45	371
10.1	0	0	227	731	38	1,702
11.0	0	326	46	1	0	1,158
12.0	0	471	43	0	0	68
13.0	0	76	67	0	4,868	81
14.0	0	31	55	0	269	16
14.9	0	27	136	0	204	0
15.1	0	0	278	508	92	275
16.0	0	60	237	0	1,036	0
17.0	0	5	383	0	2,116	143
18.0	0	4	214	1,331	417	65
19.0	0	61	10,610	3,555	191	41
19.9	0	338	1,187	1,228	66	1,452
20.1	0	2,881	4,041	1,722	0	416
21.0	0	741	789	5,773	2,235	559
22.0	0	115	511	503	2,528	243
23.0	1,342	161	3,639	4,181	0	629
24.0	0	588	461	0	0	301
24.9	0	22	343	26	0	350
25.1	0	1,380	1,560	241	8,276	600
26.0	0	287	373	8	0	800
27.0	0	0	286	266	0	172
28.0	30	1,464	392	400	2,157	548
29.0	950	898	288	388	0	429
29.9	0	498	380	749	0	244

Table B.1. PID Survey Results and Sample Interval (Continued)

	PID (ppb)					
DEPTH	C400RIA-01	C400RIA-02	C400RIA-03	C400RIA-04	C400RIA-05	C400RIA-06
30.1	0	305	4,271	471	143	1,327
31.0	139	390	418	50	0	875
32.0	0	577	151	537	0	450
33.0	0	463	233	86	1,294	617
34.0	0	457	95	1,624	0	889
34.9	0	482	94	385	0	685
35.1	1,194	594	1,263	299	5,479	463
36.0	0	409	158	175	0	341
37.0	101	407	220	319	0	417
38.0	6,977	1,011	206	1,211	0	1,464
39.0	135	2,424	231	105	0	340
39.9	91	431	210	265	6	325
40.1	109	30	284	54	9,008	258
41.0	623	261	204	0	91	313
42.0	339	186	217	55	426	341
43.0	6,470	1,143	235	1,825	390	463
44.0	8,026	1,422	3,866	4,195	489	402
44.9	1,226	505	252	75	353	424
45.1	1,276	14,760	947	11,530	3,054	602
46.0	2,919	12,130	6,322	264	345	487
47.0	1,544	4,988	371	147	810	658
48.0	960	1,719	440	329	782	536
49.0	9,400	12,150	660	2,114	4,659	1,039
49.9	617	11,050	446	1,102	1,905	916
50.1	1,671	NA	1,228	1,023	1,187	626
51.0	5,511	NA	413	245	302	1,545
52.0	437	NA	377	131	0	608
53.0	480	NA	392	161	520	2,189
54.0	495	NA	453	1,536	0	523
54.9	710	NA	1,554	559	0	548
55.1	2,782	NA	1,005	1,175	821	525
56.0	656	NA	2,197	924	0	833
57.0	742	NA	677	NA	0	690
58.0	854	NA	609	NA	NA	810
59.0	NA	NA	1,553	NA	NA	1,509
59.9	NA	NA	342	NA	NA	3,301

NOTE: Yellow highlighting identifies the sample interval.

Table B.2. Beta/Gamma Survey Results and Sample Interval

	Beta/Gamma (cpm)					
DEPTH	C400RIA-01	C400RIA-02	C400RIA-03	C400RIA-04	C400RIA-05	C400RIA-06
0.1	34	44	53	40	47	65
1.0	50	39	57	36	50	73
2.0	62	40	50	42	42	76
3.0	53	42	59	44	52	104
4.0	48	36	61	45	45	89
4.9	41	39	64	36	38	71
5.1	51	51	55	51	42	74
6.0	64	54	53	38	39	58
7.0	55	45	56	44	40	61
8.0	47	42	54	30	46	54
9.0	54	46	60	52	43	50
9.9	39	48	57	43	39	52
10.1	45	47	50	40	53	47
11.0	46	55	52	36	48	49
12.0	49	50	48	31	45	54
13.0	43	43	55	28	49	46
14.0	50	52	51	33	46	55
14.9	43	39	45	30	52	43
15.1	43	44	46	34	68	48
16.0	51	51	51	28	60	45
17.0	53	47	49	33	56	39
18.0	47	50	48	32	48	46
19.0	52	42	47	37	53	44
19.9	44	45	53	36	47	50
20.1	40	45	34	37	46	44
21.0	45	48	36	34	41	47
22.0	39	43	39	32	35	51
23.0	NA	40	42	35	38	50
24.0	NA	36	49	44	32	45
24.9	31	41	46	40	39	42
25.1	44	33	46	36	41	38
26.0	35	48	48	29	44	44
27.0	39	38	45	33	37	41
28.0	37	39	48	35	34	36
29.0	40	45	54	31	40	39
29.9	42	37	49	32	36	41

Table B.2. Beta/Gamma Survey Results and Sample Interval (Continued)

	Beta/Gamma (cpm)					
DEPTH	C400RIA-01	C400RIA-02	C400RIA-03	C400RIA-04	C400RIA-05	C400RIA-06
30.1	47	41	43	38	43	54
31.0	43	38	47	43	40	63
32.0	44	40	46	42	31	49
33.0	74	44	41	51	36	45
34.0	43	39	38	46	37	52
34.9	42	40	42	43	40	53
35.1	50	45	49	46	40	44
36.0	48	37	70	41	37	37
37.0	34	42	54	44	46	38
38.0	59	43	57	38	53	42
39.0	43	47	51	43	45	38
39.9	54	50	48	44	46	40
40.1	46	54	49	44	38	43
41.0	59	63	52	39	42	45
42.0	54	40	53	41	45	38
43.0	50	39	48	45	39	40
44.0	52	47	58	44	42	48
44.9	35	60	55	40	43	44
45.1	43	51	57	47	40	36
46.0	63	42	61	42	37	40
47.0	55	49	56	49	38	41
48.0	52	53	51	46	44	44
49.0	62	46	45	43	41	37
49.9	61	55	38	39	48	40
50.1	59	NA	48	40	42	37
51.0	45	NA	42	43	46	32
52.0	42	NA	39	40	37	37
53.0	40	NA	56	42	34	35
54.0	42	NA	52	41	38	31
54.9	34	NA	46	43	43	28
55.1	34	NA	55	44	32	40
56.0	27	NA	44	45	37	43
57.0	44	NA	50	NA	40	38
58.0	43	NA	46	NA	NA	44
59.0	NA	NA	40	NA	NA	47
59.9	NA	NA	38	NA	NA	41

NOTE: Yellow highlighting identifies the sample interval.

APPENDIX C

LITHOLOGIC LOGS

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C400RIA-01

DEPTH INTERVAL (ft)	TOP ELEVATION (ft) AMSL	SOIL DESCRIPTION	NOTES
0.0 -1.2	374.21	SILT, ML, 10YR5/2, Grayish Brown, nonplastic, soft, and moist. Root zone 0.0 - 0.2 ft.	
1.2 - 3.6	373.01	SILT, ML, 10YR4/6, Dark Yellowish Brown, nonplastic, soft, and moist.	
3.6 - 5.5	370.61	SILT, ML, 10YR7/3, Very Pale Brown, low plasticity, soft-to-medium-stiff, and moist.	
5.5 - 6.0	368.71	CLAYEY SILT, ML, 10YR7/2, Light Gray, plastic, very soft, and moist.	
6.0 - 13.9	368.21	SILT, ML, 10YR6/6, Brownish Yellow, low plasticity, medium stiff, and moist	
13.9 - 14.6	360.31	SANDY SILT, ML, 10YR7/6, Yellow, mottled with 10YR8/1, White, low plasticity, stiff, and moist.	
14.6 - 16.0	359.61	SILT, ML, 10YR7/2, Light Gray, nonplastic, stiff, and slightly moist.	
16.0 - 18.7	358.21	Sample interval - no core for description.	
18.7 - 20.0	355.51	SILT WITH LITTLE SAND, ML, 10YR7/3, Very Pale Brown, low plasticity, stiff, and slightly moist. Sand is very fine grained. Contains trace angular chert, 0.4-inch diameter.	
20.0 - 21.6	354.21	CLAYEY SILT, ML, 10YR7/1, Light Gray, mottled with 7.5YR6/6, Reddish Yellow, medium plasticity, soft-to-medium stiff, and moist.	
21.6 - 22.3	352.61	SANDY SILT WITH GRAVEL, ML, 10YR7/2, Light Gray, low plasticity, stiff, and moist.	Top of HU2
22.3 - 22.5	351.91	SILTY SAND WITH GRAVEL, SP, 7.5YR5/6, Strong Brown, gap graded, medium dense, and moist. Sand is very fine grained. Gravel is subangular to subrounded chert with iron patina, 0.2 - 0.5-inch diameter.	
22.5 - 24.2	351.71	Sample interval - no core for description.	
24.2 - 25.5	350.01	SILTY FINE SAND, SP, 10YR7/2, Light Gray, mottled with 10YR6/6, Reddish Yellow, poorly graded, medium dense, and moist. Sand is very fine quartz.	
25.5 - 26.3	348.71	SILTY FINE SAND, SP, 7.5YR6/4, Light Brown, poorly graded, loose-to-medium-dense, and moist.	
26.3 - 27.6	347.91	SILT, ML, 7.5YR6/4, Light Brown, low plasticity, soft, and moist.	
27.6 - 28.8	346.61	SILTY FINE SAND, SP, 10YR7/4, Very Pale Brown, poorly graded, medium dense, and moist.	
28.8 - 29.8	345.41	FINE SAND WITH SOME GRAVEL, SP, 10YR7/3, Very Pale Brown, gap graded, medium-dense-to-dense, and moist. Sand is fined grained quartz. Gravel is subangular chert with minor iron patina, 0.2 - 0.4-inch diameter.	
29.8 - 30.0	344.41	SILTY VERY FINE SAND, SP, 7.5YR7/6, Reddish Yellow, poorly graded, medium dense, and moist.	
30.0 - 32.9	344.21	SILTY SAND, SM, 10YR7/6, Yellow, poorly graded, loose-to-medium-dense, and moist. Sand is fine grained quartz. Trace of course sand composed of rounded chert.	
32.9 - 35.0	341.31	Sample interval - no core for description.	
35.0 - 37.5	339.21	SILTY SAND With Some Gravel, SM, 7.5YR6/6, Reddish Yellow, loose-to-medium- dense, and moist. Sand is fine grained quartz. Gravel is rounded chert, 0.1-0.4 inch diameter.	
37.5 - 38.0	336.71	SAND, SP, 7.5YR8/3, Pink, poorly graded, loose, and moist. Sand is very fine grained quartz.	Top of HU3
38.0 - 40.0	336.21	Sample interval - no core for description.	
40.0 - 43.0	334.21	CLAYEY SILT, ML, 7.5YR7/4, Pink, mottled with 7.5YR8/1, White, high plasticity, medium stiff, and moist.	
43.0 - 44.5	331.21	SANDY SILT, ML, 7.5YR7/4, Pink, low plasticity, soft-to-medium-stiff, and moist.	
44.5 - 48.2	329.71	SILTY CLAY, CL, 7.5YR6/4, Light Brown, medium plasticity, medium stiff, and moist.	
48.2 - 50.0	326.01	FINE SAND, SP, 7.5YR6/6, Reddish Yellow, poorly graded, loose, and moist. Sand is fine grained quartz.	Top of HU4
50.0 - 50.2	324.21	SANDY SILT, ML, 7.5YR6/4, Light Brown, low plasticity, medium stiff, and moist.	
50.2 - 51.6	324.01	Sample interval - no core for description.	
51.6 - 57.3	322.61	SAND, SP, 7.5YR6/4, Light Brown, poorly graded, loose, and moist to 55 ft/wet below 55 ft. Sand is fine grained quartz.	
57.3 - 57.5	316.91	SAND, SP, 7.5YR3/3, Dark Brown, poorly graded, loose, and wet.	
57.5 - 60.0	316.71	No core description. Sample lost to sampler malfunction.	
	314.21	Bottom depth.	

C400RIA-02

DEPTH INTERVAL (ft)	TOP ELEVATION (ft) AMSL	SOIL DESCRIPTION	NOTES
0.0 -0.2	373.46	SILT, ML, 10YR3/2, Very Dark Grayish Brown, low plasticity, soft, and moist. Root zone.	
0.2 - 2.0	373.26	SILT, ML, 10YR7/4,Very Pale Brown, nonplastic, stiff, and dry.	
2.0 - 3.6	371.46	SILT, ML, 10YR3/2, Very Dark Grayish Brown, low-to-medium plasticity, soft, and moist.	
3.6 - 5.7	369.86	SILT, ML, 10YR7/2, Light Gray, mottled with 10YR7/6, Yellow, medium plasticity, soft, and moist.	
5.7 - 10.3	367.76	SILT, ML, 10YR7/4, Very Pale Brown, low plasticity, soft, and moist	
10.3 - 13.3	363.16	Sample interval - no core for description.	
13.3 - 15.0	360.16	SILT, ML, 10YR7/4, Very Pale Brown, low plasticity, soft, and moist	
15.0 - 18.8	358.46	SILT, ML, 10YR7/3, Very Pale Brown, mottled with 10YR8/3, Very Pale Brown, low-to-medium plasticity, medium stiff, and moist	
18.8 - 25.0	354.66	GRAVELLY SAND, SW, 7.5YR6/6, Reddish Yellow, well graded, dense, and dry. Sand is predominately fine quartz. Gravel is 2-mm-to-0.5-inch diameter, angular chert, with no patina	Top of HU2
25.0 - 25.4	348.46	SAND WITH LITTLE GRAVEL, SP, 5YR6/6, Reddish Yellow, poorly graded, medium dense, and moist. Sand is fine-grained quartz. Gravel is angular, 2 mm diameter, chert.	
25.4 - 25.9	348.06	SILT, ML, 10YR6/3, Pale Brown, low-to-medium plasticity, medium stiff, and moist.	
25.9 - 26.0	347.56	COARSE SAND, SP, 10YR7/1, Light Gray, subrounded, poorly graded, medium dense, and moist. Sand is 2 mm diameter chert with no patina.	
26.0 - 27.0	347.46	CLAYEY SILT, ML, 10YR6/2, Light Brownish Gray, medium plasticity, stiff, and moist.	
27.0 - 27.5	346.46	SILT, ML, 10YR6/1, Gray, mottled/interlaminated with 7.5YR6/6, Reddish Yellow, low-to-medium plasticity, medium stiff, and moist.	
27.5 - 30.5	345.96	VERY FINE SAND, SP, 10YR6/3, Pale Brown, poorly graded, medium dense, and moist.	
30.5 - 34.1	342.96	FINE SAND WITH SOME GRAVEL, SW, 7.5YR7/4, Pink, well graded, medium dense, and moist. Gravel is 2-mm-to-0.3-inch diameter, subangular, chert with no iron patina.	
34.1 - 38.4	339.36	VERY FINE SAND, SP, 10YR6/3, Pale Brown, poorly graded, medium dense, and moist.	Top of HU3
38.4 - 40.0	335.06	Sample interval - no core for description.	
40.0 - 42.6	333.46	SANDY SILT, ML, 7.5YR8/1, White, interlayered with 7.5YR7/6, Reddish Yellow, with some 2 mm blebs of 10YR2/1, Black (manganese?), nonplastic, soft, and moist. Sand is very fine grained quartz.	
42.6 - 45.0	330.86	SILT, ML, 7.5YR7/6, Yellow, with some mottling by 7.5YR8/1, White, low-to-medium plasticity, soft, and moist.	
45.0 - 47.4	328.46	Sample interval - no core for description.	
47.4 - 49.2	326.06	SILTY SAND, SP, 5YR5/4, Reddish Brown, grading downward to 7.5YR6/6, Reddish Yellow, poorly graded, loose-to-medium dense, and moist. Sand is very fine grained quartz.	
49.2 - 50.0	324.26	FINE SAND, SP, 7.5YR7/6, Reddish Yellow, poorly graded, loose, and moist.	Top of HU4
	323.46	Bottom depth.	

C400RIA-03

DEPTH INTERVAL (ft)	TOP ELEVATION (ft) AMSL	SOIL DESCRIPTION	NOTES
0.0 -0.1	372.98	SILT, ML, 10YR4/2, Dark Grayish Brown, medium plasticity, soft, and moist. Root zone.	
0.1 - 0.7	372.88	SILT, ML, 10YR6/2, Light Brownish Gray, low plasticity, soft, and moist.	
0.7 - 3.2	372.28	CLAYEY SILT, ML, 10YR3/2, Very Dark Grayish Brown with minor interlayering of 10YR6/4, Light Yellowish Brown, low-to-medium plasticity, soft, and moist. Micaceous (muscovite?)	
3.2 - 4.7	369.78	CLAYEY SILT, ML, 10YR6/6, Brownish Yellow interspersed with 10YR7/1, Light Gray (former root path?), medium plasticity, soft, and moist.	
4.7 - 10.3	368.28	CLAYEY SILT, ML, 7.5YR6/4, Light Brown, medium-to-high plasticity, soft, and moist	
10.3 - 11.6	362.68	SLIGHTLY CLAYEY SILT, ML, 10YR3/3, Dark Brown, medium plasticity, soft, and moist.	
11.6 - 14.0	361.38	SILT, ML, 10YR7/3, Very Pale Brown with 10YR5/2, Grayish Brown marling, low plasticity, soft, and moist.	
14.0 - 17.6	358.98	SLIGHTLY CLAYEY SILT, ML, 10YR7/S, Light Gray, mottled with 7.5YR7/8, Reddish Yellow, low-to-medium plasticity, soft, and moist.	
17.6 - 17.9	355.38	VERY FINE SAND, SP, 10YR7/1, Very Pale Brown, poorly graded, medium dense, and moist.	
17.9 - 18.2	355.08	CLAYEY SILT, ML, 10YR7/1, Light Gray, medium plasticity, soft, and moist.	
18.2 - 18.5	354.78	CLAYEY GRAVEL, GW, 10YR5/3, Brown, well graded, dense, and moist. Gravel is 2-mm-to-0.3-inch diameter, angular chert with no iron patina. Little fine quartz sand.	Top of HU2
18.5 - 20.0	354.48	GRAVELLY SAND, SW, 5YR6/8, Reddish Yellow, well graded, hard, and moist. Sand is fine-to-medium grained quartz. Gravel is 2 mm diameter chert.	
20.0 - 21.4	352.98	Sample interval - no core for description.	
21.4 - 24.9	351.58	GRAVELLY SAND, SW, 5YR6/8, Reddish Yellow, well graded, dense, and moist. Sand is fine grained quartz. Gravel is 2-mm-to-0.5-inch diameter, subangular-to-subrounded chert with no iron patina.	
24.9 - 27.8	348.08	SILTY FINE SAND WITH GRAVEL, SW, 10YR7/3, Very Pale Brown, well graded, dense-to-very-dense, and moist. Sand is fine-grained quartz. Gravel is 2-mm-to-0.6-inch diameter chert, subangular to subrounded, with no iron patina.	
27.8 - 29.8	345.18	FINE SAND, SP, 10YR7/3, Very Pale Brown, poorly graded, medium dense, and moist.	
29.8 - 31.1	343.18	FINE SAND WITH GRAVEL, SP, 10YR7/3, Very Pale Brown, poorly graded, medium dense, and moist. Gravel is 2-mm-to-0.4-inch diameter, chert, subangular to subrounded, with iron patina.	
31.1 - 31.3	341.88	FINE SAND, SP, 10YR7/3, Very Pale Brown, poorly graded, medium dense, and moist.	
31.3 - 38.5	341.68	SAND WITH SOME GRAVEL, SW, 10YR7/3, Very Pale Brown, well graded, loose, and wet. Sand is bimodal, very fine grained quartz and 2 mm diameter chert. Gravel is subrounded chert with iron patina, 0.4 inch diameter.	
38.5 - 41.4	334.48	SILTY SAND, SM, 10YR7/2, Light Gray, grading downwards to 5YR7/4, Pink, poorly graded, loose, and moist-to-wet. Sand is very fine grained quartz.	Top of HU3
41.4 - 45.0	331.58	VERY FINE SAND, SP, 7.5YR7/6, Reddish Yellow, with layering by 7.5YR6/8, Reddish Yellow, poorly graded, medium stiff, and moist. Sand is fine grained quartz.	
45.0 - 47.8	327.98	SILT, ML, 5YR6/6, Reddish Yellow, low plasticity, soft, and moist.	
47.8 - 48.3	325.18	FINE SAND, SP, 5YR6/4, Light Reddish Brown, poorly graded, loose, and moist.	
48.3 - 54.0	324.68	SILTY SAND, SM, 5YR6/6, Reddish Yellow, poorly graded, loose, and moist.	Top of HU4
54.0 - 60.0	318.98	FINE SAND, SP, 10YR7/3, Very Pale Brown, poorly graded, medium dense, and moist.	

C400RIA-04

DEPTH INTERVAL (ft)	TOP ELEVATION (ft) AMSL	SOIL DESCRIPTION	NOTES
0.0 - 0.1		SILT, ML, 10YR5/3, Brown, medium plasticity, soft, and moist. Root zone.	
0.1 - 1.2		SILT, ML, 10YR5/4, Yellowish Brown, low plasticity, soft, and moist.	
1.2 - 2.0		SILT WITH LITTLE CLAY, ML, 10YR3/3, Dark Brown, low-to-medium plasticity, soft, and moist.	
2.0 - 4.7		SILT, ML, 10YR7/2, Light Gray, low plasticity, soft, and moist.	
4.7 - 6.8		SILT, ML, 7.5YR6/4, Light Brown, low-to-medium plasticity, soft, and moist.	
6.8 - 9.0		SILT, ML, 10YR7/1, Light Gray, medium plasticity, soft, and moist.	
9.0 - 10.0		SILT, ML, 7.5YR7/3, Pink, nonplastic-to-low plasticity, soft, and moist.	
10.0 -12.2		SILT, ML, 7.5YR6/4, Light Brown, nonplastic, soft, and moist.	
12.2 - 15.0		CLAYEY SILT, ML, 10YR7/2, Light Gray, interlaminated with 7.5YR6/6, Reddish Yellow, low plasticity, medium stiff, and moist.	
15.0 - 15.8		CLAYEY SILT, ML, 7.5YR6/4, Light Brown, medium plasticity, soft, and moist.	
15.8 - 17.6		CLAYEY SILT, ML, 10YR7/2, Light Gray, interlaminated with 7.5YR6/6, Reddish Yellow, low plasticity, medium stiff, and moist.	
17.6 - 17.8	Top of HU2	SANDY GRAVEL WITH SOME CLAY, GW, 10YR6/4, Light Yellowish Brown, well graded, medium dense, and moist. Gravel is 2-mm-to-0.5-inch diameter, subrounded-to-angular chert with an iron patina. Sand is fine grained quartz.	Top of HU2
17.8 - 19.8		Sample interval - no core for description.	
19.8 - 20.6		SANDY GRAVEL WITH SOME CLAY, GW, 10YR6/4, Light Yellowish Brown, well graded, medium dense, and moist. Gravel is 2-mm-to-0.5-inch diameter, subrounded-to-angular chert with an iron patina. Sand is fine grained quartz.	
20.6 - 21.5		Sample interval - no core for description.	
21.5 - 21.7		SAND, SP, 5YR6/6, Reddish Yellow, poorly graded, loose, and moist. Sand is fine grained quartz.	
21.7 - 21.9		SANDY GRAVEL, GW, 5YR6/6, Reddish Yellow, well graded, loose-to-medium-dense, and moist. Gravel is 0.1-to-0.6-inch diameter, subangular-to-angular chert with an iron patina. Sand is fine grained quartz.	
21.9 - 23.7		SAND, SP, 5YR6/6, Reddish Yellow, poorly graded, loose, and moist. Sand is fine grained quartz.	
23.7 - 27.3		SILT GRADING DOWNWARD TO SANDY SILT, ML, 10YR7/3, Very Pale Brown, low-plasticity-to-nonplastic, soft, and moist. Sand is very fine grained quartz.	
27.3 - 27.8		GRAVELLY SAND, SW, 10YR6/4, Light Yellowish Brown, well graded, medium-dense-to-dense, and moist. Sand is fine grained quartz. Gravel is 2-mm-to-0.5-inch diameter, subrounded chert with an iron patina.	
27.8 - 31.6		SILT, ML, 10YR7/3, Very Pale Brown, nonplastic, soft, and moist.	
31.6 - 34.6		CLAYEY SAND WITH GRAVEL, SW, 10YR7/4, Very Pale Brown, well graded, dense, and moist. Sand is bimodal: fine grained quartz and very coarse grained, subangular chert with an iron patina. Gravel is 0.2-to-0.4-inch diameter, subrounded chert with an iron patina.	
34.6 - 37.5	Top of HU3	SILT, ML, 10YR7/3, Very Pale Brown, low-to-medium plasticity, soft, and moist.	Top of HU3
37.5 - 38.8		SAND, SP, 10YR7/2, Light Gray, poorly graded, loose, and moist. Sand is very fine grained quartz.	
38.8 - 40.2		SILT, ML, 7.5YR7/6, Reddish Yellow, interlaminated with 7.5YR8/1, White, low-to-medium plasticity, soft, and moist.	
40.2 - 42.6		SAND, SP, 7.5YR7/6, Reddish Yellow, poorly graded, medium dense, and moist. Sand is very fine grained quartz.	
42.6 -48.2		CLAYEY SILT, ML, 7.5YR7/8, Reddish Yellow, medium-to-high plasticity, soft, and moist.	
48.2 - 48.5	Top of HU4	SAND, SP, 7.5YR4/3, Brown, poorly graded, dense, and dry. Sand is hematite-cemented, fine grained quartz.	Top of HU4
48.5 - 50.4		SAND, SP, 5YR6/8, Reddish Yellow, poorly graded, loose, and moist. Sand is fine grained quartz.	
50.4 - 53.1		CLAYEY SILT, ML, 7.5YR7/6, Reddish Yellow, interlaminated with 7.5YR8/1, White, medium plasticity, soft, and moist.	
53.1 - 53.3		SAND, SP, 10YR8/3, Very Pale Brown, poorly graded, medium dense, and moist. Sand is very fine grained quartz.	
53.3 - 54.6		Sample interval - no core for description.	
54.6 - 56.5		SAND, SP, 10YR8/3, Very Pale Brown, poorly graded, loose, and moist. Sand is fine grained quartz.	

C400RIA-05

DEPTH INTERVAL (ft)	TOP ELEVATION (ft) AMSL	SOIL DESCRIPTION	NOTES
0.0 - 0.8		Dense Grade Aggregate	
0.8 - 1.9		SILT, ML, 7.5YR6/4, Light Brown, nonplastic, soft, and moist.	
1.9 - 8.0		SILT, ML, 10YR7/2, Light Gray, medium plasticity, soft, and moist.	
8.0 - 10.7		SILT, ML, 10YR7/3, Pink, medium plasticity, soft, and moist.	
10.7 - 11.2		Sample interval - no core for description.	
11.2 - 12.6		SILT, ML, 10YR7/3, Pink, medium plasticity, soft, and moist.	
12.6 - 14.6		Sample interval - no core for description.	
14.6 - 19.5		SILT, ML, 7.5YR8/2, Pinkish White, with marling by 7.5YR8/1, White, plastic, soft, and moist.	
19.5 - 20.0		SAND, SP, 7.5YR7/4, Pink, poorly graded, loose, and moist. Sand is fine grained quartz.	
20.0 - 22.2		SILT, ML, 10YR7/2, Light Gray, with marling by 7.5YR7/8, Reddish Yellow, medium plasticity, soft, and moist.	
22.2 - 22.7		SILT, ML, 7.5YR7/4, Pink, with marling by 2.5YR6/6, Light Red, medium-to-high plasticity, medium stiff, and moist.	
22.7 - 23.4		SILTY SAND WITH SOME CLAY, SM, 2.5YR6/6, Light Red, with marling by 7.5YR7/4, Pink, poorly graded, medium dense, and moist.	Top of HU2
23.4 - 24.6		SILT, ML, 7.5YR7/4, Pink, with marling by 2.5YR6/6, Light Red, medium-to-high plasticity, medium stiff, and moist.	
24.6 - 25.0		SAND, SP, 10YR8/3, Very Pale Brown, poorly graded, loose, and moist. Sand is fine grained quartz.	
25.0 - 27.3		Sample interval - no core for description.	
27.3 - 29.1		SAND, SP, 7.5YR6/6, Reddish Yellow, poorly graded, loose, and moist. Sand is fine grained quartz.	
29.1 - 30.0		SAND WITH SOME GRAVEL AND LITTLE SILT, SP, 10YR8/2, Very Pale Brown, gap graded, dense, and moist. Sand is fine grained quartz. Gravel is 0.3-to-0.5-inch diameter, subangular chert with an iron patina.	
30.0 - 34.6		SILT, ML, 10YR8/2, Very Pale Brown, low plasticity, soft, and moist.	
34.6 - 35.0		CLAYEY SILT WITH TRACE GRAVEL, ML, 10YR7/2, Light Gray, with marling by 7.5YR7/4, Pink, medium plasticity, soft, and moist. Gravel is 0.3-to-0.4-inch diameter, subrounded chert with no iron patina.	
35.0 - 37.0		Sample interval - no core for description.	
37.0 - 37.5		SILT, ML, 10YR7/2, Light Gray, low plasticity, soft, and moist.	
37.5 - 38.3		Sample interval - no core for description.	
38.3 - 39.3		CLAYEY SILT, ML, 10YR7/3, Very Pale Brown, medium plasticity, soft, and moist.	
39.3 - 40.0		SANDY GRAVEL WITH SOME CLAY, GW, 7.5YR6/3, Light Brown, well graded, dense, and moist. Gravel is 2-mm-to-0.3-inch diameter, subangular to subrounded chert with no iron patina. Sand is fine grained quartz.	
40.0 - 41.0		Sample interval - no core for description.	Top of HU3
41.0 - 49.3		SAND, SP, 5YR6/8, Reddish Yellow, poorly graded, medium-dense-to-loose, and moist. Sand is very fine grained quartz.	
49.3 - 51.9		Sample interval - no core for description.	Top of HU4
51.9 - 52.9		SILTY SAND, SM, 7.5YR7/6, Reddish Yellow, poorly graded, medium dense, and moist. Sand is very fine grained quartz.	
52.9 - 55.4		SILTY CLAY, CL, 7.5YR7/6, Reddish Yellow, high plasticity, very soft, and moist.	
55.4 - 57.5		SAND, SP, 7.5YR6/4, Light Brown, poorly graded, loose-to-medium-dense, and moist-grading-down-to-wet. Sand is fine grained quartz.	

C400RIA-06

DEPTH INTERVAL (ft)	TOP ELEVATION (ft) AMSL	SOIL DESCRIPTION	NOTES
0.0 -0.2	375.2	Dense Grade Aggregate (DGA)	
0.2 - 3.0	375.0	SILT, ML, 10YR7/2, Light Gray, nonplastic, medium stiff, and moist.	
3.0 - 3.4	372.2	SILT WITH SOME CLAY, ML, 10YR3/1, Very Dark Gray, low-to-medium plasticity, soft, and moist.	
3.4 - 5.4	371.8	SILT, ML, 5YR6/1, Gray, nonplastic, soft, and moist.	
5.4 - 10.0	369.8	SILT, ML, 7.5YR7/4, Pink, low plasticity, soft, and moist.	
10.0 - 11.7	365.2	Sample interval - no core for description.	
11.7 - 13.7	363.5	SILT, ML, 7.5YR7/3, Pink, with marling by 7.5YR8/1, White, low plasticity, soft-to-medium-stiff, and moist.	
13.7 - 14.2	361.5	Sample interval - no core for description.	
14.2 - 16.6	361.0	SILT, ML, 7.5YR7/3, Pink, with marling by 7.5YR8/1, White, low plasticity, soft-to-medium-stiff, and moist.	
16.6 - 18.7	358.6	SILT, ML, 10YR7/1, Light Gray, with marling by 7.5YR7/4, Pink, nonplastic, medium-stiff-to-stiff, and moist.	
18.7 - 20.0	356.5	SILT, ML, 10YR7/1, Light Gray, nonplastic, medium-stiff-to-stiff, and moist.	
20.0 - 21.0	355.2	SILT, ML, 10YR7/3, Very Pale Brown, medium plasticity, soft, and moist.	
21.0 - 21.4	354.2	GRAVELLY SAND WITH SILT, SW, 7.5YR6/4, Light Brown, well graded, dense, and moist. Sand is very fine grained quartz. Gravel is 0.2 - 0.7 inch diameter chert with iron patina, subangular to angular.	Top of HU2
21.4 - 22.0	353.8	Sample interval - no core for description.	
22.0 - 23.4	353.2	SAND, SP, 5YR6/6, Reddish Yellow, poorly graded, loose, and moist. Sand is fine grained quartz.	
23.4 - 25.5	351.8	SAND WITH GRAVEL, SP, 5YR6/6, Reddish Yellow, gap graded, loose, and moist. Sand is fine grained quartz. Gravel is 0.2 - 0.5 inch diameter chert with iron patina, subangular.	
25.5 - 26.6	349.7	Sample interval - no core for description.	
26.6 - 28.8	348.6	SANDY SILT, ML, 10YR7/3, Very Pale Brown, nonplastic, medium stiff, and moist. Sand is very fine grained quartz. Trace 0.3 inch diameter chert with iron patina, subrounded.	
28.8 - 29.3	346.4	SAND, SW, 7.5YR6/4, Light Brown, well graded, medium dense, and moist. Sand consists of fine grained quartz and medium-to-very-coarse-grained chert, subangular.	
29.3 - 29.8	345.9	SILTY SAND, SM, 10YR6/3, Pale Brown, poorly graded, medium dense, and moist. Sand is very fine grained quartz.	
29.8 - 30.7	345.4	GRAVELLY SAND, SP, 7.5YR6/6, Reddish Yellow, gap graded, loose, and moist. Sand is fine grained quartz. Gravel is 0.2 - 0.4 inch diameter chert with iron patina, subangular.	
30.7 - 31.4	344.5	Sample interval - no core for description.	
31.4 - 32.5	343.8	SAND, SP, 10YR7/3, Very Pale Brown, poorly graded, loose, and moist. Sand is fine grained quartz.	
32.5 - 33.0	342.7	SAND, SW, 7.5YR7/3, Pink, well graded, medium dense, and moist. Sand consists of fine grained quartz and medium-to-coarse grained chert, subangular to subrounded.	
33.0 - 35.0	342.2	SAND, SP, 10YR7/3, Very Pale Brown, poorly graded, loose, and moist. Sand is fine grained quartz.	
35.0 - 35.9	340.2	SAND WITH SOME GRAVEL, SP, 7.5YR7/6, Reddish Yellow, gap graded, medium dense, and moist. Sand is fine grained quartz. Gravel is 0.2 - 0.5 inch diameter chert with no iron patina, subrounded.	
35.9 - 37.2	339.3	SILT, ML, 10YR7/4, Very Pale Brown, low-to-medium plasticity, very soft, and moist.	
37.2 - 37.8	338.0	SAND WITH SOME GRAVEL, SP, 7.5YR7/6, Reddish Yellow, gap graded, medium dense, and moist. Sand is fine grained quartz. Gravel is 0.2 - 0.5 inch diameter chert with no iron patina, subrounded.	
37.8 - 39.0	337.4	Sample interval - no core for description.	Top of HU3
39.0 - 40.2	336.2	SILT, ML, 10YR7/2, Light Gray, medium plasticity, soft, and moist.	
40.2 - 42.4	335.0	SANDY SILT, ML, 7.5YR7/6, Reddish Yellow, interlaminated with 7.5YR8/1 White, low plasticity, soft, and moist.	
42.4 - 43.9	332.8	SILTY SAND, SM, 7.5YR6/6, Reddish Yellow, poorly graded, soft, and moist. Sand is very fine grained quartz.	
43.9 - 44.1	331.3	Sample interval - no core for description.	
44.1 - 48.9	331.1	SANDY SILT, ML, 5YR6/6, Reddish Yellow, low-to-medium plasticity, soft, and moist.	
48.9 - 49.8	326.3	Sample interval - no core for description.	
49.8 - 51.7	325.4	SAND, SP, 5YR6/6, Reddish Yellow, poorly graded, loose, and moist. Sand is fine grained quartz.	Top of HU4
51.7 - 54.0	323.5	SANDY SILT, ML, 5YR6/6, Reddish Yellow, nonplastic, soft, and moist. Sand is very fine grained quartz.	
54.0 - 54.7	321.2	Sample interval - no core for description.	
54.7 - 55.0	320.5	SAND, SP, 5YR6/6, Reddish Yellow, poorly graded, loose, and moist. Sand is fine grained quartz.	
55.0 - 57.1	320.2	SAND, SP, 7.5YR6/4, Light Brown, poorly graded, medium dense, and moist. Sand is very fine grained quartz.	
57.1 - 60.0	318.1	Sample interval - no core for description.	

APPENDIX D

PURGE WATER QUALITY MEASUREMENTS

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Table D.1. Water Quality Measurements of Purge Water

		DATE	TIME	ELAPSED TIME (hours:minutes)	Conductivity (µmhos/cm)	Diss. Oxygen (mg/L)	Temp. (deg F)	pH (Std. Units)	Eh (approx.) (mV)	Turbidity (NTU)			
400RIA-01	WA100	1/23/2025	8:28	0:00	NA	NA	NA	NA	NA	NA	Start		
			9:22	0:54	677	6.02	54.1	5.89	242.9	1062.40			
			9:26	0:58	708	6.08	53.2	6.00	242.6	828.34			
			9:30	1:02	714	8.28	51.3	6.16	249.4	705.59			
			10:22	1:54	NA	NA	NA	NA	NA	NA	Sample		(purge vol = 5 gal)
	WA080	1/23/2025	12:44	0:00	NA	NA	NA	NA	NA	NA	Start		
			12:57	0:13	749	5.75	57.0	6.07	-101.8	7356.60			
			13:54	1:10	804	5.85	59.8	6.21	-49.3	3303.26			
			14:30	1:46	755	4.83	53.9	6.18	-38.3	1380.40			
			14:15	1:31	NA	NA	NA	NA	NA	NA	Sample		(purge vol = 5 gal)
	WA070	1/23/2025	14:36	0:00	NA	NA	NA	NA	NA	NA	Start		
		1/27/2025	9:01	1:03	777	3.89	57.5	6.16	179.1	2702.58			
			9:05	1:07	794	3.67	58.9	6.25	220.2	1460.26			
			9:09	1:11	795	3.14	60.3	6.22	229.7	1101.34			
			9:14	1:16	796	2.92	61.0	6.22	241.8	686.81			
			9:20	1:22	NA	NA	NA	NA	NA	NA	Sample		(purge vol = 5 gal)
400RIA-02	WA080	1/28/2025	10:00	0:00	NA	NA	NA	NA	NA	NA	Start		
			10:20	0:20	631	5.80	59.8	6.25	272.4	3052.97			
			10:30	0:30	640	6.40	59.2	6.28	234.0	1289.15			
			10:48	0:48	634	5.50	61.8	6.10	265.5	594.77			
			10:52	0:52	631	5.49	62.0	6.13	256.2	472.50			
			12:45	2:45	NA	NA	NA	NA	NA	NA	Sample		(purge vol = 5 gal)
	WA070	1/28/2025	14:07	0:00	NA	NA	NA	NA	NA	NA	Start		
			14:12	0:05	685	6.13	62.3	6.20	193.9	1261.82			
			14:18	0:11	691	5.14	62.1	6.17	229.5	732.42			
			14:42	0:35	690	6.19	59.2	6.33	214.6	1858.40			
			14:53	0:46	673	6.06	59.7	6.30	280.0	345.01			
			15:03	0:56	NA	NA	NA	NA	NA	NA	Sample		(purge vol = 3 gal)
400RIA-03	WA100	1/30/2025	7:57	0:00	NA	NA	NA	NA	NA	NA	Start		
			8:02	0:05	530	4.90	55.7	6.11	186.7	4830.40			
			8:06	0:09	530	5.16	58.2	6.11	197.8	3234.90			
			8:10	0:13	529	6.09	58.4	6.12	226.3	1790.63			
			8:14	0:17	521	6.52	56.7	6.18	235.4	1207.50			
			8:23	0:26	NA	NA	NA	NA	NA	NA	Sample		(purge vol = 5 gal)
	WA080	2/3/2025	8:15	0:00	NA	NA	NA	NA	NA	NA	Start		
			8:40	0:25	527	6.10	62.4	6.21	219.8	4870.45			
			8:44	0:29	534	5.85	63.4	6.22	165.4	3084.38			
			8:48	0:33	530	5.65	63.9	6.20	174.3	1772.27			
			8:52	0:37	535	6.43	65.0	6.34	181.2	920.65			
			9:03	0:48	NA	NA	NA	NA	NA	NA	Sample		(purge vol = 5 gal)
	WA070	2/3/2025	9:36	0:00	NA	NA	NA	NA	NA	NA	Start		
			9:51	0:15	588	7.80	66.7	6.29	204.5	1514.90			
			9:55	0:19	570	5.66	64.6	6.23	214.5	900.11			
			10:08	0:32	580	7.14	65.5	6.48	185.3	1149.25			
			12:34	2:58	NA	NA	NA	NA	NA	NA	Sample		(purge vol = 3 gal)

Table D.1. Water Quality Measurements of Purge Water (Continued)

		DATE	TIME	ELAPSED TIME (hours:minutes)	Conductivity (µmhos/cm)	Diss. Oxygen (mg/L)	Temp. (deg F)	pH (Std. Units)	Eh (approx.) (mV)	Turbidity (NTU)		
400RIA-04	WA100	2/4/2025	13:30	0:00	NA	NA	NA	NA	NA	NA	Start	
			13:42	0:12	495	4.37	60.9	6.20	227.8	2369.29		
			14:04	0:34	480	7.16	58.4	6.34	222.5	7570.77		
			14:16	0:46	499	5.80	58.7	6.34	146.5	6856.11		
			14:24	0:54	500	6.19	59.2	6.28	175.6	6005.61		
			14:30	1:00	NA	NA	NA	NA	NA	NA	Sample	(purge vol = 5 gal)
	WA080	2/4/2025	14:45	0:00	NA	NA	NA	NA	NA	NA	Start	
		2/5/2025	7:42	1:04	541	4.60	54.8	5.95	70.5	2372.47		
			8:15	1:37	536	5.68	56.4	6.05	136.5	942.56		
			8:18	1:40	533	6.10	57.4	5.96	172.3	787.59		
			8:33	1:55	529	5.50	55.8	5.96	200.5	429.97		
			8:35	1:57	NA	NA	NA	NA	NA	NA	Sample	(purge vol = 5 gal)
	WA070	2/5/2025	9:04	0:00	NA	NA	NA	NA	NA	NA	Start	
			9:36	0:32	612	5.01	55.9	6.08	149.9	6894.72		
			9:41	0:37	626	6.08	57.2	6.08	145.6	6924.12		
			9:57	0:53	625	6.19	57.2	6.21	140.5	6059.18		
			10:03	0:59	622	7.20	55.9	6.35	192.8	3512.28		
			10:13	1:09	NA	NA	NA	NA	NA	NA	Sample	(purge vol = 5 gal)
400RIA-05	WA080	2/6/2025	13:13	0:00	NA	NA	NA	NA	NA	NA	Start	
			13:20	0:07	NA	4.40	60.8	6.10	152.5	5822.10		
			13:31	0:18	NA	5.85	59.6	6.21	209.3	4206.68		
			13:37	0:24	NA	5.62	59.7	6.13	228.3	2287.27		
		2/10/2025	7:48	0:37	NA	7.70	53.1	5.85	243.5	3997.27		
			7:53	0:42	NA	6.19	54.5	6.14	207.2	1896.23		
			7:56	0:45	NA	NA	NA	NA	NA	NA	Sample	(purge vol = 5 gal)
	WA070	2/10/2025	8:23	0:00	NA	NA	NA	NA	NA	NA	Start	
			8:40	0:17	NA	6.69	49.4	6.19	251.2	718.20		
			8:50	0:27	NA	8.15	52.9	6.19	235.5	353.54		
			9:00	0:37	NA	7.20	53.8	6.12	250.4	218.66		
			9:10	0:47	NA	NA	NA	NA	NA	NA	Sample	(purge vol = 5 gal)
400RIA-06	WA080	2/11/2025	12:34	0:00	NA	NA	NA	NA	NA	NA	Start	
			12:40	0:06	638	4.99	58.2	6.25	268.7	3278.75		
			12:45	0:11	530	5.98	58.4	6.14	226.5	1287.15		
			12:50	0:16	539	5.40	56.8	6.30	165.6	1342.30		
			13:00	0:26	539	5.52	58.5	6.11	217.5	465.44		
			13:10	0:36	NA	NA	NA	NA	NA	NA	Sample	(purge vol = 5 gal)
	WA070	2/11/2025	13:29	0:00	NA	NA	NA	NA	NA	NA	Start	
			13:36	0:07	541	5.33	58.0	6.35	186.6	4484.10		
			13:40	0:11	549	5.67	58.1	6.33	199.2	3164.47		
			13:46	0:17	537	5.56	57.6	6.31	206.2	1844.28		
			13:52	0:23	524	6.06	56.5	6.42	185.3	1645.16		
			14:00	0:31	NA	NA	NA	NA	NA	NA	Sample	(purge vol = 5 gal)

APPENDIX E

FIELD QC SAMPLE ANALYSES (DATA)

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Field QC Sample Analyses (Data)

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APPENDIX F

SAMPLE ANALYSES (DATA)

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Sample Analyses (Data)

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