DOE/LX/07-2475&D1

Compilation of Meeting Summaries and White Papers (Fiscal Year 2021)

A Product of the Paducah Gaseous Diffusion Plant Site Groundwater Modeling Working Group

CLEARED FOR PUBLIC RELEASE

DOE/LX/07-2475&D1

Compilation of Meeting Summaries and White Papers (Fiscal Year 2021)

A Product of the Paducah Gaseous Diffusion Plant Site Groundwater Modeling Working Group

Date Issued—December 2021

U.S. DEPARTMENT OF ENERGY
Office of Environmental Management

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

THIS PAGE INTENTIONALLY LEFT BLANK

CONTENTS

THIS PAGE INTENTIONALLY LEFT BLANK

ACRONYMS

DOE	U.S. Department of Energy
EMP	environmental monitoring plan
FY	fiscal year
GW	groundwater
KRCEE	Kentucky Research Consortium for Energy and the Environment
KY	Commonwealth of Kentucky
PEGASIS	PPPO Environmental Geographic Analytical Spatial Information System
PFAS	per- and polyfluoroalkyl substances
PGDP	Paducah Gaseous Diffusion Plant
PZ	piezometer
TVA	Tennessee Valley Authority

THIS PAGE INTENTIONALLY LEFT BLANK

INTRODUCTION

The purpose of this document is to present the meeting summaries from the Paducah Groundwater Modeling Working Group completed during fiscal year (FY) 2021. The meeting summaries are provided for historical information to promote program consistency over time and facilitate succession planning. The meeting summaries include slides from the presentations provided during the FY 2021 meetings. The following meeting summaries are included in the appendices.

- October 14, 2020 Meeting Summary
  - Attachment 1: Groundwater Elevation Data for TVA Wells Collected by KY on August 27, 2020
  - Attachment 2: 2020 EMP Schedule for Groundwater Strategy Project
  - Attachment 3: Groundwater Curriculum: Paducah Site Groundwater, Continued
  - Attachment 4: Lithology Paper Outline and Schedule
  - Attachment 5: Precipitation and Ohio River Stage Data
  - Attachment 6: 2020 Well Abandonment Listing
- January 13, 2021 Meeting Summary
  - Attachment 1: Revised Lithologic Technical Paper Schedule
  - Attachment 2: 2021 EMP Schedule for Groundwater Strategy Project
  - Attachment 3: Draft Large Building PZ White Paper Outline
  - Attachment 4: KRCEE Presentation
  - Attachment 5: Precipitation and Ohio River Stage Data
  - Attachment 6: Blank DOE PFAS Survey
- April 7, 2021 Meeting Summary
  - Attachment 1: Groundwater Elevation Data for TVA Wells Collected by KY on February 22, 2021
  - Attachment 2: 2021 EMP Schedule for Groundwater Strategy Project
  - Attachment 3: TCE GW Fate & Transport Characterization TCE Degradation/TCE Half-Life ($t^{1/2}$)"
  - Attachment 4: Precipitation and Ohio River Stage Data
- July 14, 2021 Meeting Summary
  - Attachment 1: Groundwater Elevation Data for TVA Wells Collected by KY on February 22, 2021
  - Attachment 2: 2021 EMP Schedule for Groundwater Strategy Project
  - Attachment 3: Second Survey White Paper Draft Outline
  - Attachment 4: Precipitation and Ohio River Stage Data
  - Attachment 5: PEGASIS

Organizations and their affiliations that participate in the production of this document are the U.S. Department of Energy, the U.S. Environmental Protection Agency Region 4, the Commonwealth of Kentucky Energy and Environment Cabinet, the Commonwealth of Kentucky Radiation Health Branch, and the Tennessee Valley Authority.

No white papers were developed by the Paducah Groundwater Modeling Working Group during FY 2021. As discussed during the January 13, 2021, meeting, a white paper, *Summary of Survey Activities Associated with Updating the Reference Measuring Point Elevations for the Groundwater Monitoring Well Network at the Paducah Site, Paducah, Kentucky*, FRNP-RPT-0165, was developed as part of a separate initiative to provide a summary of the survey activities performed to update reference measurement point elevations for the groundwater monitoring well network. This white paper was included as Appendix F of the FY 2021 update of the *Paducah Gaseous Diffusion Plant Programmatic Quality Assurance Project Plan*, DOE/LX/07-2459&D1. A second survey white paper, to be developed by the Modeling Working Group in FY 2022, will document the potential impacts of the new survey data to the groundwater model. As

discussed during the April 7, 2021, and July 14, 2021, meetings, this second survey white paper is currently planned to be appended to the 2016 Groundwater Model Report.

APPENDIX A

GROUNDWATER MODELING WORKING GROUP MEETING SUMMARY—OCTOBER 14, 2020

THIS PAGE INTENTIONALLY LEFT BLANK

ACRONYMS[1]

ACO	administrative consent order
AIP	agreement in principle
amsl	above mean sea level
ASER	annual site environmental report
BGOU	burial grounds operable unit
CA	cost analysis
CAS	chemical abstracts service
CB	colloidal borescope
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	contaminant of concern
COPC	chemical or radionuclide of potential concern
CSM	conceptual site model
CY	calendar year
DNAPL	dense nonaqueous-phase liquid
DOE	U.S. Department of Energy
DQO	data quality objective
DTW	depth to water
EE	engineering evaluation
EECA	engineering evaluation/cost analysis
EMP	environmental monitoring plan
EPA	U.S. Environmental Protection Agency
ERH	electrical resistance heating
ESD	explanation of significant differences
EW	extraction well
FRNP	Four Rivers Nuclear Partnership, LLC
FS	feasibility study
FY	fiscal year
GW	groundwater
GWOU	groundwater operable unit
HU	hydrogeological unit
IRA	interim response action
KDEP	Kentucky Department for Environmental Protection
KRCEE	Kentucky Research Consortium for Energy and the Environment
KY	Commonwealth of Kentucky
LASAGNA	Lasagna™ in-situ Remediation Technology
LBCSP	Little Bayou Creek seep
LRGA	lower Regional Gravel Aquifer
MOA	memorandum of agreement
MRGA	middle Regional Gravel Aquifer
MW	monitoring well
MWG	Modeling Working Group
NEPCS	northeast plume containment system
NGVD	National Geodetic Vertical Datum
NWPGS	northwest plume groundwater system
O&M	operations and maintenance
OREIS	Oak Ridge Environmental Information System

[1] Acronym list was not part of the original meeting summaries.

OU	operable unit
PEGASIS	PPPO Environmental Geographic Analytical Spatial Information System
PEMS	Project Environmental Measurements System
PGDP	Paducah Gaseous Diffusion Plant
PT	pressure transducer
P&T	pump and treat
PTZ	permeable treatment zone
PZ	piezometer
Q	quarter
QAPP	quality assurance project plan
RACR	remedial action completion report
RAO	remedial action objective
RGA	Regional Gravel Aquifer
RI	remedial investigation
ROD	Record of Decision
SOU	soils operable unit
SWMU	solid waste management unit
SWOU	surface water operable unit
TOC	top of casing
TS	treatability study
TVA	Tennessee Valley Authority
UCRS	upper continental recharge system
URGA	Upper Regional Gravel Aquifer
VI	vapor intrusion
VOC	volatile organic compound
WAG	waste area grouping
WDA	waste disposal alternative
WKWMA	West Kentucky Wildlife Management Area

Paducah Site Groundwater Modeling Working Group
Meeting Summary—October 14, 2020

MWG Member List:

Noman Ahsanuzzaman ✓	Ken Davis ✓	Mac McRae ✓
Brian Begley ✓	Dave Dollins ✓	~~Tabitha Owens~~
Ben Bentkowski ✓	Rob Flynn ✓	Todd Powers ✓
Rich Bonczek ✓	Bruce Ford ✓	Bruce Stearns ✓
Stephanie Brock	Stefanie Fountain ✓	Joe Tarantino ✓
Martin Clauberg ✓	LeAnne Garner	Tracy Taylor ✓
Bryan Clayton	Nathan Garner ✓	Chris Travis ✓
Lisa Crabtree	Steve Hampson ✓	Denise Tripp ✓
Jana Dawson ✓	Brian Lainhart ✓	Victor Weeks ✓
Eva Davis ✓	~~Kelly Layne~~	

Tabitha Owens and Kelly Layne have changed roles and will no longer be participating in Groundwater Modeling Working Group (MWG). Joe Tarantino has joined the Groundwater MWG.

Original meeting agenda items are provided followed by meeting notes; the meeting notes are provided in italics with action items noted in green.

1. Call for Issues from Groundwater Modeling Working Group (MWG) Members

No comments received to July 15, 2020, Meeting Summary (sent to participants on 7/30/2020). This summary will be considered final.

Comments to the July 15, 2020 Meeting Summary were received from B. Begley on August 12. The changes made in response to these comments were agreed upon during the meeting and a revised Meeting Summary was emailed to the MWG on October 14. This summary is considered final.

2. FY 2020+ Work Plan/Schedule

The remaining FY 2020+ schedule is below.

Quarterly Meeting (October)	10/14/2020

Quarterly meetings will be Web/teleconference 8:00 a.m.–11:00 a.m. (Central), 9:00 a.m.–12:00 p.m. (Eastern)
If topics warrant, a face-to-face meeting will be considered.
Color code for schedule:

Due date	Quarterly meeting
Submittal date	Concurrence/acknowledgement date

The Meeting Notes [Summaries] compilation (2019-2020) will include meeting summaries from 2019 through the July 15, 2020 meeting; this activity is included in the Proposed FY 2021 Work Plan/Schedule.

The Quarterly Meeting (October) was held October 14, 2020.

3. Work Plan/Schedule

a. Proposed FY 2021 Work Plan/Schedule

Activity	Date
Provide Draft Final Lithologic Technical Paper Outline to MWG	9/30/2020
Submit FY21 Schedule to MWG	9/30/2020
Comments Due for July Meeting Draft Summary	10/7/2020
Quarterly Meeting (October/FY21Q1)	10/7/2020
Submit Draft Compilation of Meeting Summaries and White Papers (1/2019-7/2020)	10/14/2020
MWG concurs with FY21 Schedule	10/14/2020
Provide Final Outline for Lithologic Technical Paper to MWG	10/22/2020
Submit Draft Compilation of Meeting Summaries and White Papers (1/2019-7/2020)	10/28/2020
Comments Due for Draft Compilation of Meeting Summaries and White Papers (1/2019-7/2020)	11/25/2020
Submit Final Compilation of Meeting Summaries and White Papers (1/2019-7/2020)	12/3/2020
Quarterly Meeting (January/FY21Q2)	1/13/2021
Quarterly Meeting (April/FY21Q3)	4/7/2021
Quarterly Meeting (July/FY21Q4)	7/14/2021
Submit Draft Meeting Summaries and White Papers Compilation (FY21)	9/29/2021

The Proposed FY 2021 Work Plan/Schedule was revised to reflect the actual date for the Quarterly Meeting (October) of October 14, 2020. Other dates impacted by this change were also revised as shown below in red font.

Activity	Date
Provide Draft Final Lithologic Technical Paper Outline to MWG	9/30/2020
Submit FY21 Schedule to MWG	9/30/2020
Comments Due for July Meeting Draft Summary	10/14/2020
Quarterly Meeting (October/FY21Q1)	10/14/2020
MWG concurs with FY21 Schedule	10/21/2020
Submit Draft Compilation of Meeting Summaries and White Papers (1/2019-7/2020)	10/28/2020
Provide Final Outline for Lithologic Technical Paper to MWG	10/28/2020
Comments Due for Draft Compilation of Meeting Summaries and White Papers (1/2019-7/2020)	11/25/2020
Submit Final Compilation of Meeting Summaries and White Papers (1/2019-7/2020)	12/3/2020
Quarterly Meeting (January/FY21Q2)	1/13/2021
Quarterly Meeting (April/FY21Q3)	4/7/2021
Quarterly Meeting (July/FY21Q4)	7/14/2021
Submit Draft Meeting Summaries and White Papers Compilation (FY21)	9/29/2021

b. Draft FY 2022 Activities

Activity	Date
Quarterly Meeting (October/FY22Q1)	10/6/2021

Activity	Date
MWG Provide Comments on Draft Compilation of Meeting Summaries and White Papers (FY21)	10/13/2021
Issue Draft Final Lithologic Technical Paper to MWG	11/4/2021
Submit Final Compilation of Meeting Summaries and White Papers (FY21)	11/10/2021
MWG Meeting to Discuss Draft Final Lithologic Technical Paper	11/17/2021
MWG Provide Comments on Draft Final Lithologic Technical Paper	12/6/2021
Quarterly Meeting (January/FY22Q2)	1/12/2022
Submit Final Lithologic Technical Paper to EPA and KY	1/31/2022

These activities and dates are provided for advance planning.

4. Update on Water Levels

Mobilization for field data collection occurred on August 24, 2020 and field data collection resumed on August 27, 2020 with a synoptic water level event. This schedule was communicated to KY (B. Begley and B. Lainhart) on July 20, 2020. Synoptic water level events will be collected quarterly going forward.

Revised groundwater elevation data for TVA wells collected by KY on September 8, 2020, is provided as Attachment 1.

The synoptic water levels were collected August 24-27, 2020. Kentucky collected the groundwater elevations for the TVA wells on August 27, 2020 and transmitted the data on September 8, 2020. The TVA groundwater elevations are included as Attachment 1.

5. Update on Paducah Site Groundwater Strategy

Deployment of colloidal borescopes and pressure transducers began on August 17, 2020. No changes have been made to the program. The project restarted with Month 1 based on the importance of evaluating data during a 12 month cycle. The project pressure transducers were sent offsite for calibration and have been received and redeployed.

FRNP has reviewed KY's AIP monitoring wells sampling schedule and schedule conflicts between sampling and borescope measurements have been resolved.

The Environmental Monitoring Plan (EMP) includes a spreadsheet/schedule for monitoring wells planned for colloidal borescope and pressure transducer deployment beginning "Month 1." The schedule from the EMP is included as Attachment 2. In this schedule, "Month 1" is now considered September 2020.

The new roadway and access to MW99/MW477 was completed by TVA in August 2020.

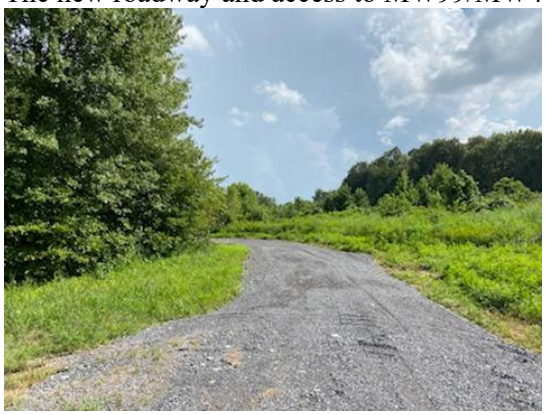


Photo of access road to MW99/477 provided by TVA on August 13, 2020.

The background for the need for the MW99/MW477 access road was discussed: the reconfiguration of the TVA property lines and fencing had resulted in the access to these locations being blocked. Additional discussion on TVA planned operations and property changes are included in the Watch Topics (Item 12).

6. Discussion on Installation of Piezometers …Associated with Several of the Large Process Buildings

Preliminary information to be collected for the "Installation of piezometers …associated with several of the large process buildings…." white paper will benefit from the information learned during the vapor intrusion (VI) project. Comments to the VI Work Plan were received July 22. The D2 Work Plan is scheduled to be issued September 8 with approval planned for October 8. If all goes as planned, this would result in field work, laboratory analysis, validation, etc. occurring October 2020 through March 2021.

Activity	Target Start	Target Finish
Quarterly Meeting (October/FY21Q1)		10/7/2020
VI Field Sampling / Laboratory Analysis / Validation	Oct-20	Mar-21
Develop Outline for Large Building PZ White Paper	10/14/2020	12/11/2020
Provide Large Building PZ White Paper Outline to MWG		12/11/2020
MWG Review Large Building PZ White Paper Outline	12/11/2020	1/13/2021
Quarterly Meeting (January/FY21Q2)		1/13/2021
Revise Outline for Large Building PZ White Paper Based on MWG Discussions	1/13/2021	1/28/2021
Develop Draft Large Building PZ White Paper	1/28/2021	7/2/2021
Quarterly Meeting (April/FY21Q3)		4/7/2021
Issue Draft Final Large Building PZ White Paper to MWG		7/2/2021
Quarterly Meeting (July/FY21Q4)		7/14/2021
MWG Review and Provide Comments on Draft Final Large Building PZ White Paper	7/2/2021	8/3/2021
MWG Meeting to Discuss Draft Final Large Building PZ White Paper		7/27/2021
MWG Provide Comments on Draft Final Large Building PZ White Paper		8/3/2021
Revise Draft Final Large Building PZ White Paper	8/3/2021	9/23/2021
Submit Final Large Building PZ White Paper to EPA and KY		9/24/2021
Quarterly Meeting (October/FY22Q1)		10/6/2021

Activity	Target Start	Target Finish
Quarterly Meeting (January/FY22Q2)		1/12/2022

The scope of the Large Building PZ White Paper will be developed as the part of the outline development. The outline will be provided to the MWG for review and discussion by the MWG prior to finalization. The group discussed the benefits of considering the vapor intrusion project findings as part of this white paper.

The D2 Plant Industrial Area Vapor Intrusion Preliminary Risk Assessment Work Plan, DOE/LX/07-2447&D2, was submitted to EPA and KDEP on September 8, 2020. EPA and KDEP concurred on September 10, 2020, and September 14, 2020, respectively. Implementation of the sampling detailed in the Work Plan will be performed during the heating season (colder weather months) and is tentatively scheduled for the late fall/winter of 2020. The current target date is December 1 to begin sampling but is dependent on procurement of the analytical laboratory and weather. The project team has targeted November 19, 2020 to provide redline page changes to the QAPP that reflect specific information from the analytical laboratory. Routine meetings are anticipated to be held during the vapor intrusion sampling, possibly as part of the routine weekly groundwater meetings.

The schedule of activities for the Large Building PZ White Paper have been updated (in red font) to reflect the MWG meeting date of October 14, 2020.

Activity	Target Start	Target Finish
Quarterly Meeting (October/FY21Q1)		10/14/2020
VI Field Sampling / Laboratory Analysis / Validation	Oct-20	Mar-21
Develop Outline for Large Building PZ White Paper	10/21/2020	12/11/2020
Provide Large Building PZ White Paper Outline to MWG		12/11/2020
MWG Review Large Building PZ White Paper Outline	12/11/2020	1/13/2021
Quarterly Meeting (January/FY21Q2)		1/13/2021
Revise Outline for Large Building PZ White Paper Based on MWG Discussions	1/13/2021	1/28/2021
Develop Draft Large Building PZ White Paper	1/28/2021	7/2/2021
Quarterly Meeting (April/FY21Q3)		4/7/2021
Issue Draft Final Large Building PZ White Paper to MWG		7/2/2021
Quarterly Meeting (July/FY21Q4)		7/14/2021
MWG Review and Provide Comments on Draft Final Large Building PZ White Paper	7/2/2021	8/3/2021
MWG Meeting to Discuss Draft Final Large Building PZ White Paper		7/27/2021
MWG Provide Comments on Draft Final Large Building PZ White Paper		8/3/2021
Revise Draft Final Large Building PZ White Paper	8/3/2021	9/23/2021
Submit Final Large Building PZ White Paper to EPA and KY		9/24/2021
Quarterly Meeting (October/FY22Q1)		10/6/2021
Quarterly Meeting (January/FY22Q2)		1/12/2022

7. Groundwater Curriculum

a. Geology (presented January 8, 2020)

b. Paducah Site Groundwater, "Big Picture" (presented April 8, 2020)
c. Paducah Site Groundwater, Continued (to be presented July 15, 2020)
d. Paducah Site Groundwater, Contamination (to be presented October 7, 2020)

The 'Paducah Site Groundwater, Contamination' presentation for this meeting is provided as Attachment 3.

Ken Davis presented a summary of site history 'Paducah Site Groundwater, Contamination' (Attachment 3) to the group. The date on Slide 1 has been updated to reflect the meeting date of October 14, 2020. Several questions were asked and responded to during the presentation:

- *Slide 15 – What were the historically high concentrations in groundwater going offsite?*
  Discussion: Groundwater TCE levels were as high as 10 mg/L, and greater, at the south extraction well field when the Northwest Plume pump and treat system began operations. The north well field was placed near the downgradient extent of 1 mg/L TCE in groundwater.
- *Slide 26 – When was the Southwest Plume first recognized?*
  Discussion: The Southwest Plume was first recognized early by the Paducah Site remediation program. The Data Gaps Report of the WAGs 8 and 28 RI (1999) provided some key sample locations. The very first of the series of plume map documents for the site (for CY1999) included the Southwest Plume.
- *Slide 31 - For the thermal treatment of the lower RGA, was there an effort to control or reduce the higher groundwater velocities? With a higher groundwater flux through a treatment zone, the heat would not be retained. Had the heat been retained, had the groundwater flux been controlled, there could have been a more effective outcome.*
  Discussion: Both the Phase I and Phase IIa ERH applications included multiphase extraction wells in the upper RGA, which were used, in part, to maintain a flat to inward hydraulic gradient during the operation of the ERH system. Only Phase I attempted heating in the lower RGA, to assess the effectiveness of ERH in the lower zone. No additional pumping from the lower RGA zone or other control of groundwater velocity, was performed. Phase I demonstrated that ERH was ineffective in the lower RGA, which was attributed, in part, to higher groundwater flow velocity in the lower RGA. A later steam injection pilot study was able to heat the lower RGA to treatment temperatures. An analysis of the results indicates the lower RGA has a higher hydraulic conductivity.
- *Slide 39 – Are the temperatures still elevated in the RGA?*
  Discussion: Yes. 50-mil plastic and DGA have been placed over the Phase IIa area to mitigate infiltration into this area. Groundwater samples collected from the C-400 area from monitoring wells and the C-400 Complex RI soil borings currently have temperatures of 10 – 20 degrees (Fahrenheit) above "background."
- *Slide 40: If Phase IV of the Groundwater Remediation Strategy is not practicable, will that impact the other phases?*
  Discussion: We will learn a lot though the C-400 Remedial Investigation. Earlier actions (Phases 1-III), are expected to move forward as planned. The question will be any remaining source areas and what those impacts will mean to the other goals. There are no plans to stop operating the pump & treat systems anytime soon.

8. CSM for the RGA in SWMU 211-A Remedial Action Work Plan

Section 1.1.2, "Regional Hydrogeology," references an axis in describing thickness trends for gravel deposits forming the RGA. EPA would like to discuss if the use of the term axis has any implied significance to groundwater flow direction(s) (i.e., a north-south lateral groundwater flow divide) or

any implication for implied subsurface structural feature(s) forming the RGA (i.e., the existence of an east-west fault-controlled structural low).

The site geologist explained the east-west trend is consistent with ancestral Tennessee River and is believed to be an erosional surface (thalweg is the geomorphology term). EPA suggested that the Paducah Site area may have several generations of seismic activities, overprinting of seismicity could be happening, and east-west faulting may have occurred. Steve Hampson had a follow-up after discussion with Dr. Woolery and Dr. Zhu.

Steve Hampson reported that an east-west trend is prevalent at PGDP, as evidenced in both regional and local studies. Regional faults commonly trend northeast-southwest but that there could be local structural controls under PGDP that could influence groundwater flow. Seismic studies have not previously been conducted between the east and west fences and from the Porters Creek terrace to north fence because it was not possible to filter out the noise of the operating plant. Most of the plant infrastructure is no longer operating and Steve Hampson discussed that Dr. Woolery has noted there are now seismic reflection techniques that could give a better view of what the structure is beneath the site.

DOE and FRNP are reviewing whether there are any ways to further reduce (temporarily) sources of noise to facilitate new testing without disrupting site activities.

Steve planned to discuss this with DOE during the next KRCEE/DOE call (October 14, 2020). The MWG will continue to track this item and it will be included on the agenda for the next MWG meeting (January 13, 2020).

9. CSM for the McNairy in the C-400 Complex Area

FRNP has set up a website to house a library of McNairy information. Access the website at the following link: https://fourriversnuclearpartnership.com/McNCSM. The site requires a password that has been sent separately. Contact Stefanie if you need the password to the website.

A lithology white paper is being prepared as part of the resolution of dispute on the CERCLA Five Year Review. DOE will issue the technical paper within one month of submittal of the D1 C-400 Complex OU RI/FS Report to support the review and comment of the C-400 specific data interpretation as part of the C-400 Complex OU RI/FS Report review process and the performance of the FY 2023 Five-Year Review revised protectiveness determinations for the Northeast, Northwest, and Water Policy response actions. Currently, the regulatory milestone date for the D1 C-400 Complex OU RI/FS Report is December 31, 2021, although this date will likely be adjusted to account for the shutdown.

A draft schedule and annotated outline for the paper are included as Attachment 4.

The MWG asked when it would be possible to discuss the Groundwater Strategy Plan data and the group discussed that 12 months of data would be collected. The complete dataset will be available in October 2021. Preliminary data will be discussed when appropriate and as the project moves forward. Of interest during the discussion was the area on the west side of the Northeast Plume. The Groundwater Strategy is intended to address this area. Until the Groundwater Strategy Plan data becomes available, the Groundwater Operable Unit FS of 2001 (DOE/OR/07-1857&D2) provides the comprehensive summary of nature and extent of groundwater contamination for the Paducah Site.

The MWG discussed that the Lithology Paper is intended to integrate the new data being collected at C-400 and that the schedule is tied to the data collection schedule. The submittal data for the Lithology Paper is to be 30 days after submittal of the D1 C-400 Remedial Investigation Report. The C-400

schedule is in the process of being revised to address the field stand-down from March through August. In general, the plan is to get the draft Lithology Paper to the MWG before the D1 C-400 Report is submitted so that substantive comments may be addressed prior to the D1 C-400 Report being issued. The Lithology Paper will then be revised and submitted.

The schedule for the Lithology Paper was revised during the meeting to reflect the actual meeting date of October 24, 2020 (Attachment 4). No comments to the outline were received during the meeting and the final outline is included in Attachment 4.

The KRCEE spreadsheet database of soil boring logs (R9_MSTR_Hydrolithostrat_Dbase_Upload_110419.xlsx) will be uploaded to https://fourriversnuclearpartnership.com/McNCSM.

10. Resurvey of wells

The spreadsheet of resurveyed coordinates and elevations was completed in January 2020. An independent review of the data was conducted in March 2020. The review prompted the resurveying of a small subset of wells. Resurveying of the wells began in August 2020 and is expected to be completed in November 2020. The updated schedule was communicated to EPA and KY during the Routine Groundwater Call on August 6, 2020. The information will be uploaded to PEGASIS following review and acceptance of the data.

As of the MWG meeting, the field resurveying effort is in progress and expected to be completed late October or early November. The field resurveying effort was completed October 9, 2020 and the data are in review. Following the data review information will be uploaded to PEGASIS. Additionally, a review of the data and any impact on the groundwater model will be performed (schedule is pending).

A white paper summarizing the resurvey work is in review by DOE with comments received by FRNP on October 20, 2020. Once finalized, the paper will be shared with the MWG.

11. Precipitation and Ohio River Stage

Attachment 5 includes precipitation and Ohio River stage charts through August 2020.

Ken Davis presented the Ohio River stage charts to the MWG. As of the meeting, the precipitation trend continues. The site is currently 12" below 2019 precipitation levels, but 6" above historical average levels. The summer low pool continues into October. The synoptic groundwater levels collected August 24-27, 2020 may be suitable for use as model stress periods.

12. Projects on the "Watch Topics" List

- **Update on Paducah Site Monitoring Well Abandonment/Replacement**
  Several wells/piezometers are being abandoned as part of plus-up funding. Attachment 6 has a list and map of these wells/piezometers.

  MW152 and MW153 have been abandoned because of the basin built by Tennessee Valley Authority (TVA). Installation of one new "sentinel" well (MW583) on TVA property that replaces MW152 still is pending. TVA's new equipment bridge is needed to complete this well. Installation of the well now is anticipated to be completed in late 2020 or early 2021.

Monitoring well abandonment began on July 28, 2020 and 46 locations were abandoned through September 21, 2020. Locations that have been abandoned are shown in Attachment 6 with text strikeout.

As of the MWG meeting on October 14, 2020, all wells listed in Attachment 6 (50 locations) have been abandoned. Attachment 6 has been updated to reflect this status.

- **Consider stream gauging in relation to the synoptic water levels.** Stream gauging has been discussed as part of out-year activities. See October 2018 Meeting Summary for additional information. Stream gauging will support new modeling.

  On August 5, FRNP and KY walked down the two seeps reported in the June 6, 2020 meeting. Seep A appears to be 4 ft higher in elevation than the creek bottom and south of LBC5. Seep B is also in Little Bayou Creek and on the side of the creek bank. KY sampled Seep A in August.

  Seep A is now LBCSP8 and Seep B is now LBCSP9. Split samples were collected at both locations by the site and KY on August 20, 2020. One of the seeps is upgradient of most of the site seeps. KY transmitted their results, which showed TCE at approximately 1 ppb. The MWG discussed the potential for the seeps to be related to higher precipitation amounts in 2019 and 2020 or the higher river stage with the startup of operations at Olmsted Lake Dam. ***FRNP will prepare a map to be included in the agenda for the next MWG meeting.***

  The MWG discussed the construction of the new ash ponds and a recent RFP for a 3,800 ft sheet pile wall to be constructed in close proximity to Little Bayou Creek and several seeps. The sheet pile wall may intercept the RGA and influence the creek. ***A new Watch Topic, TVA Changes, will be included in the agenda for the next MWG meeting.***

- Corridors where overhead transmission lines have been removed have been considered for monitoring well placement, especially with respect to the west side of the NE Plume. Previously, overhead transmission lines prevented installation of wells to the west in the northern-most transect of wells. The 161kV overhead lines currently in place to C-331 will be taken down (currently planned for 2020). A new substation has been constructed east of the C-755 trailer complex. On the west side of the new substation, 161kV overhead lines will be installed along the existing overhead line corridor. On the east side of the new substation, 161kV overhead lines (near the C-755 parking lot and between K010 and K011) will be installed along the 161kV lines.

  Most of the overhead lines down from McCaw Road to the plant with only a static line remaining on the towers on the south into the C-331 yard.

  FRNP will continue to update status on this item and will prepare a map of the formerly unavailable utility corridor area(s) to be included in the agenda for the next MWG meeting.

  DOE reported that the site is working on new wetlands maps. These updates will be uploaded and available through PEGASIS. The map layers previously available in PEGASIS did not include information from the WDA project. No field work is being performed as part of the map updates.

13. Poll MWG Members/Open Discussion

KRCEE is in a transition phase with Steve Hampson going to semi-retirement and working part-time.

DOE proposed future presentations:

- *January 2021: Steve Hampson to present a summary of KRCEE activities from 2006 to present, including the lithology database, aerobic degradation rates in the RGA, and public input to site reuse alternatives.*
- *February/March/April 2021: EarthCon present their 2017 evaluation of the RGA groundwater plumes. Currently, the plan is to have EarthCon update their evaluation in 2022.*
- *April/May/June/July 2021: C-400 Remedial Investigation findings and McNairy information.*

Attachment 1

Groundwater Elevation Data for TVA Wells Collected by KY on August 27, 2020

OREISName	Well	Description	Aquifer	Top of Casing	Top of Ground	xconv Easting (Ft)	yconv Northing (Ft)	Status	Screen Top Depth (Ft)	Screen bot depth (Ft)	tscreenelev (Ft)	bscreenelev (Ft)	GW Elev. (Datum - DTW)	Water Level	Date & Time	Barometric Pressure (inHg)	Measuring Point
TVAGW-6D	TVAGW-6D	4" PVC	Upper RGA	368.8	365.9	760787.8774	1946731.539	active	58.3	68.3	307.6	297.6	320.5	48.3	8/27/20_1021	29.56	TOC
TVAGW-5D	TVAGW-5D	4" PVC	Upper RGA	368.5	365.7	760131.6259	1947315.953	active	60.1	70.1	305.6	295.6	320.05	48.45	8/27/20_1016	29.56	TOC
TVAGW-4D	TVAGW-4D	4" PVC	Upper RGA	365.8	363	759456.7195	1947561.73	active	57	67.5	306	295.5	320.15	45.65	8/27/20_1012	29.56	TOC
TVAGW-3D	TVAGW-3D	4" PVC	Upper RGA	363.8	360.9	758982.49	1947793.858	active	65.3	75.3	295.6	285.6	320.07	43.73	8/27/20_1010	29.56	TOC
TVAGW-2D	TVAGW-2D	4" PVC	Upper RGA	370	367.1	759966.7809	1944870.473	active	55.6	65.6	311.5	301.5	325.6	44.4	8/27/20_1033	29.56	TOC
TVAGW-1D	TVAGW-1D	4" PVC	Upper RGA	370.1	367.5	757847.0459	1946203.79	active	56	66	311.5	301.5	320.47	49.63	8/27/20_0958	29.56	TOC
TVA-D8A	SHF-D8A	4" PVC	Upper RGA	331.82	329	754060.01	1953586.25	active	17.5	27.5	311.5	301.5	317.15	14.67	8/27/20_1051	29.56	TOC
TVA-D75B	SHF-D75B	2" PVC	Upper RGA	353.08	350	753297.07	1955971.69	active	48	58	302	292	310.86	42.22	8/27/20_1103	29.56	TOC
TVA-D74B	SHF-D74B	2" PVC	Upper RGA	331.99	329	756125.35	1956489.82	active	39	49	290	280	309.79	22.2	8/27/20_1111	29.56	TOC
TVA-D30B	SHF-D30B	2" PVC	Upper RGA	324.61	320.9	757594	1955563.41	active	39	49	281.9	271.9	302.8	21.81	8/27/20_1115	29.56	TOC
TVA-D17	SHF-D17	2" PVC	Upper RGA	365.43	362.8	758809.17	1950015.71	active	14	17	348.8	345.8	317.33	48.1	8/27/20_1142	29.56	TOC
TVA-D11B	SHF-D11B	2" PVC	Upper RGA	321.79	319.2	753434.76	1958481.44	active	32	42	287.2	277.2	305.1	16.69	8/27/20_1126	29.56	TOC
TVA-D10	SHF-D10	4" PVC	Upper RGA	351.74	351	752950.26	1956644.9	active	36.5	46.5	31.5	304.5	308.04	43.7	8/27/20_1105	29.56	TOC
TVA SHF-201C	SHF-201C	4" PVC	Upper RGA	323.75	320	746799.24	1960068.889	active	44.5	54.5	275.5	265.5	306.97	16.78	8/27/20_1332	29.52	TOC
TVA SHF-201B	SHF-201B	4" PVC	Upper RGA	323.75	320.2	746641.107	1960082.768	active	32	37	288.2	283.2	306.81	16.94	8/27/20_1334	29.52	TOC
TVA SHF-201A	SHF201A	4" PVC	Upper RGA	323.75	320	747030.226	1960036.252	active	14.5	24.5	305.5	295.5	306.65	17.1	8/27/20_1336	29.52	TOC
TVA SHF-102G	SHF-102G	4" PVC	Upper RGA	362.85	359.1	845764.387	1927473.284	active	47.1	57.4	312	301.7	321.25	41.6	8/27/20_1344	29.52	TOC
TVA River Elevation														300.9	8/27/20_1141	29.56	

LEGEND:
TOC: Top of Casing
DTW: Depth to Water
National Geodetic Vertical Datum of 1929 (NGVD 29).

Attachment 2

2020 EMP Schedule for Groundwater Strategy Project

Monitoring Wells Planned For Colloidal Borescope and Pressure Transducer Deployment

Well Number	MONTH 1	MONTH 2	MONTH 3	MONTH 4	MONTH 5	MONTH 6	MONTH 7	MONTH 8	MONTH 9	MONTH 10	MONTH 11	MONTH 12
MW20 (also R4)	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2
MW63			M1			M1			M1			M1
MW65			M1			M1			M1			M1
MW66			M1			M1			M1			M1
MW67			M1			M1			M1			M1
MW68			M1			M1			M1			M1
MW71	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW72			M1			M1			M1			M1
MW73			M1			M1			M1			M1
MW76			M1			M1			M1			M1
MW77 (PZ)			M1			M1			M1			M1
MW78			M1			M1			M1			M1
MW79			M1			M1			M1			M1
MW80			M1			M1			M1			M1
MW81			M1			M1			M1			M1
MW84			M1			M1			M1			M1
MW86			M1			M1			M1			M1
MW87			M1			M1			M1			M1
MW89			M1			M1			M1			M1
MW90A			M1			M1			M1			M1
MW92			M1			M1			M1			M1
MW93			M1			M1			M1			M1
MW95A			M1			M1			M1			M1
MW98			M1			M1			M1			M1
MW99	M1	M1	CB+M1	M1	M1	M1	M1	M1	CB+M1	M1	M1	M1
MW100	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW102			M1			M1			M1			M1
MW103			M1			M1			M1			M1
MW106A	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2
MW108			M1			M1			M1			M1
MW120			M1			M1			M1			M1
MW121	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2
MW122			M1			M1			M1			M1
MW123			M1			M1			M1			M1
MW124			M1			M1			M1			M1

Monitoring Wells Planned for Colloidal Borescope and Pressure Transducer Deployment (Continued)

Well Number	MONTH 1	MONTH 2	MONTH 3	MONTH 4	MONTH 5	MONTH 6	MONTH 7	MONTH 8	MONTH 9	MONTH 10	MONTH 11	MONTH 12
MW125			M1			M1			M1			M1
MW126	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW132	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW133			M1			M1			M1			M1
MW134	PT+M2	CB+PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2
MW135	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW137	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW139	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW144			M1			M1			M1			M1
MW145	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW146			M1			M1			M1			M1
MW147	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW148	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW150	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW152*	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW155			M1			M1			M1			M1
MW156			M1			M1			M1			M1
MW161			M1			M1			M1			M1
MW163			M1			M1			M1			M1
MW165A			M1			M1			M1			M1
MW168			M1			M1			M1			M1
MW169			M1			M1			M1			M1
MW173			M1			M1			M1			M1
MW175			M1			M1			M1			M1
MW178			M1			M1			M1			M1
MW185			M1			M1			M1			M1
MW188			M1			M1			M1			M1
MW191	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW193	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW194	CB+M2	M2	CB+M2	M2	CB+M2	M2	CB+M2	M2	CB+M2	M2	CB+M2	M2
MW197			M1			M1			M1			M1
MW199	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2
MW200			M1			M1			M1			M1
MW201	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2
MW202	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2
MW203			M1			M1			M1			M1
MW205			M1			M1			M1			M1
MW220			M1			M1			M1			M1

Monitoring Wells Planned for Colloidal Borescope and Pressure Transducer Deployment (Continued)

Well Number	MONTH 1	MONTH 2	MONTH 3	MONTH 4	MONTH 5	MONTH 6	MONTH 7	MONTH 8	MONTH 9	MONTH 10	MONTH 11	MONTH 12
MW221			M1			M1			M1			M1
MW222			M1			M1			M1			M1
MW223			M1			M1			M1			M1
MW224			M1			M1			M1			M1
MW225			M1			M1			M1			M1
MW226			M1			M1			M1			M1
MW227			M1			M1			M1			M1
MW233			M1			M1			M1			M1
MW236			M1			M1			M1			M1
MW238			M1			M1			M1			M1
MW239			M1			M1			M1			M1
MW240			M1			M1			M1			M1
MW241A			M1			M1			M1			M1
MW242			M1			M1			M1			M1
MW243			M1			M1			M1			M1
MW244			M1			M1			M1			M1
MW245			M1			M1			M1			M1
MW247			M1			M1			M1			M1
MW248			M1			M1			M1			M1
MW249			M1			M1			M1			M1
MW250			M1			M1			M1			M1
MW252	M1	CB+M1	M1	M1	M1	M1	M1	CB+M1	M1	M1	M1	M1
MW253A	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW255			M1			M1			M1			M1
MW256			M1			M1			M1			M1
MW257			M1			M1			M1			M1
MW258			M1			M1			M1			M1
MW260			M1			M1			M1			M1
MW261			M1			M1			M1			M1
MW262	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW283			M1			M1			M1			M1
MW284			M1			M1			M1			M1
MW288			M1			M1			M1			M1
MW291	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW292			M1			M1			M1			M1
MW293A			M1			M1			M1			M1
MW294A			M1			M1			M1			M1
MW325			M1			M1			M1			M1

Monitoring Wells Planned for Colloidal Borescope and Pressure Transducer Deployment (Continued)

Well Number	MONTH 1	MONTH 2	MONTH 3	MONTH 4	MONTH 5	MONTH 6	MONTH 7	MONTH 8	MONTH 9	MONTH 10	MONTH 11	MONTH 12
MW326			M1			M1			M1			M1
MW327			M1			M1			M1			M1
MW328			M1			M1			M1			M1
MW329	PT+M2	PT+M2	PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	PT+M2	PT+M2	PT+M2	CB+PT+M2
MW330			M1			M1			M1			M1
MW333			M1			M1			M1			M1
MW337			M1			M1			M1			M1
MW338			M1			M1			M1			M1
MW339			M1			M1			M1			M1
MW340			M1			M1			M1			M1
MW341			M1			M1			M1			M1
MW342			M1			M1			M1			M1
MW343			M1			M1			M1			M1
MW345			M1			M1			M1			M1
MW346			M1			M1			M1			M1
MW347			M1			M1			M1			M1
MW353	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW354	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2
MW355			M1			M1			M1			M1
MW356			M1			M1			M1			M1
MW357			M1			M1			M1			M1
MW358			M1			M1			M1			M1
MW360			M1			M1			M1			M1
MW361			M1			M1			M1			M1
MW363			M1			M1			M1			M1
MW364			M1			M1			M1			M1
MW366	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW367			M1			M1			M1			M1
MW369			M1			M1			M1			M1
MW370			M1			M1			M1			M1
MW372			M1			M1			M1			M1
MW373			M1			M1			M1			M1
MW376			M1			M1			M1			M1
MW380			M1			M1			M1			M1
MW381			M1			M1			M1			M1
MW384			M1			M1			M1			M1
MW385			M1			M1			M1			M1
MW387			M1			M1			M1			M1

Monitoring Wells Planned for Colloidal Borescope and Pressure Transducer Deployment (Continued)

Well Number	MONTH 1	MONTH 2	MONTH 3	MONTH 4	MONTH 5	MONTH 6	MONTH 7	MONTH 8	MONTH 9	MONTH 10	MONTH 11	MONTH 12
MW388			M1			M1			M1			M1
MW391			M1			M1			M1			M1
MW392			M1			M1			M1			M1
MW394	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW395			M1			M1			M1			M1
MW397			M1			M1			M1			M1
MW401			M1			M1			M1			M1
MW402			M1			M1			M1			M1
MW409	PT+M1	CB+PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1
MW410	CB+PT+M1	CB+PT+M1	CB+PT+M1	CB+PT+M1	PT+M1	PT+M1	CB+PT+M1	CB+PT+M1	CB+PT+M1	CB+PT+M1	PT+M1	PT+M1
MW411	CB+PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1
MW414			M1			M1			M1			M1
MW415			M1			M1			M1			M1
MW416			M1			M1			M1			M1
MW417			M1			M1			M1			M1
MW418	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW419			M1			M1			M1			M1
MW420			M1			M1			M1			M1
MW421			M1			M1			M1			M1
MW422			M1			M1			M1			M1
MW423			M1			M1			M1			M1
MW424			M1			M1			M1			M1
MW425			M1			M1			M1			M1
MW426	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2
MW427	M2	CB+M2	M2	M2	CB+M2	M2	M2	CB+M2	M2	M2	CB+M2	M2
MW428	M2	M2	CB+M2	M2	M2	CB+M2	M2	M2	CB+M2	M2	M2	CB+M2
MW429 A	M2	CB+M2	M2	M2	M2	M2	M2	CB+M2	M2	M2	M2	M2
MW430	CB+M2	M2	M2	M2	M2	M2	CB+M2	M2	M2	M2	M2	M2
MW431	M2	M2	M2	CB+M2	M2	M2	M2	M2	M2	CB+M2	M2	M2
MW432	M2	M2	M2	CB+M2	M2	M2	M2	M2	M2	CB+M2	M2	M2
MW433			M1			M1			M1			M1
MW435			M1			M1			M1			M1
MW439			M1			M1			M1			M1
MW440			M1			M1			M1			M1
MW441			M1			M1			M1			M1
MW442			M1			M1			M1			M1
MW443			M1			M1			M1			M1
MW444			M1			M1			M1			M1

Monitoring Wells Planned for Colloidal Borescope and Pressure Transducer Deployment (Continued)

Well Number	MONTH 1	MONTH 2	MONTH 3	MONTH 4	MONTH 5	MONTH 6	MONTH 7	MONTH 8	MONTH 9	MONTH 10	MONTH 11	MONTH 12
MW445	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW447			M1			M1			M1			M1
MW448			M1			M1			M1			M1
MW450			M1			M1			M1			M1
MW451			M1			M1			M1			M1
MW452			M1			M1			M1			M1
MW453			M1			M1			M1			M1
MW454			M1			M1			M1			M1
MW455			M1			M1			M1			M1
MW456			M1			M1			M1			M1
MW457			M1			M1			M1			M1
MW458			M1			M1			M1			M1
MW459	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW460			M1			M1			M1			M1
MW461			M1			M1			M1			M1
MW462			M1			M1			M1			M1
MW463	CB+PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1
MW464	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1
MW465	PT+M1	PT+M1	CB+PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	CB+PT+M1	PT+M1
MW466	M1	M1	M1	CB+M1	M1	CB+M1	M1	M1	M1	CB+M1	M1	CB+M1
MW467	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW468	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW469	CB+M1	M1	M1	M1	CB+M1	M1	CB+M1	M1	M1	M1	CB+M1	M1
MW470	M1	M1	M1	CB+M1	M1	M1	M1	M1	M1	CB+M1	M1	M1
MW471	CB+PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1
MW472	M1	CB+M1	M1	CB+M1	M1	M1	M1	CB+M1	M1	CB+M1	M1	M1
MW473	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1
MW474	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1
MW475	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW476	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1
MW477	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1
MW478			M1			M1			M1			M1
MW479			M1			M1			M1			M1
MW480			M1			M1			M1			M1
MW481	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW482	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW483	CB+PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1
MW484	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1

Monitoring Wells Planned for Colloidal Borescope and Pressure Transducer Deployment (Continued)

Well Number	MONTH 1	MONTH 2	MONTH 3	MONTH 4	MONTH 5	MONTH 6	MONTH 7	MONTH 8	MONTH 9	MONTH 10	MONTH 11	MONTH 12
MW485	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1
MW486A	M1	M1	M1	M1	M1	CB+M1	M1	M1	M1	M1	M1	CB+M1
MW487	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW488	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1
MW489			M1			M1			M1			M1
MW490			M1			M1			M1			M1
MW491	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW492			M1			M1			M1			M1
MW493			M1			M1			M1			M1
MW494			M1			M1			M1			M1
MW495			M1			M1			M1			M1
MW496	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW497			M1			M1			M1			M1
MW498			M1			M1			M1			M1
MW499			M1			M1			M1			M1
MW500			M1			M1			M1			M1
MW501			M1			M1			M1			M1
MW502			M1			M1			M1			M1
MW503			M1			M1			M1			M1
MW504			M1			M1			M1			M1
MW505			M1			M1			M1			M1
MW506			M1			M1			M1			M1
MW507			M1			M1			M1			M1
MW524			PT+M1			M1			M1			M1
MW525			M1			CB+PT+M1			M1			M1
MW526			M1			M1			CB+PT+M1			M1
MW527			CB+PT+M1			M1			M1			M1
MW528			M1			M1			M1			M1
MW529			M1			PT+M1			M1			M1
MW530			M1			M1			PT+M1			M1
MW531			M1			M1			M1			M1
MW532 (PZ)			M1			M1			M1			M1
MW533			M1			M1			M1			M1
MW534 (PZ)			M1			M1			M1			M1
MW535 (PZ)			M1			M1			M1			M1
MW536			M1			M1			M1			M1
MW537			M1			M1			M1			M1
MW538			M1			M1			M1			M1

Monitoring Wells Planned for Colloidal Borescope and Pressure Transducer Deployment (Continued)

Well Number	MONTH 1	MONTH 2	MONTH 3	MONTH 4	MONTH 5	MONTH 6	MONTH 7	MONTH 8	MONTH 9	MONTH 10	MONTH 11	MONTH 12
MW539			M1			M1			M1			M1
MW540 (PZ)			M1			M1			M1			M1
MW541 (PZ)			M1			M1			M1			M1
MW542			M1			M1			M1			M1
MW543			M1			M1			M1			M1
MW544			M1			M1			M1			M1
MW545			M1			M1			M1			M1
MW546			M1			M1			M1			M1
MW547			M1			M1			M1			M1
MW548			M1			M1			M1			M1
MW549			M1			M1			M1			M1
MW550			M1			M1			M1			M1
MW551			M1			M1			M1			M1
MW553 (PZ)			M1			M1			M1			M1
MW554 (PZ)			M1			M1			M1			M1
MW555 (PZ)			M1			M1			M1			M1
MW556			M1			M1			M1			M1
PZ107			M1			M1			M1			M1
PZ109			M1			M1			M1			M1
PZ110			M1			M1			M1			M1
PZ114			M1			M1			M1			M1
PZ115			M1			M1			M1			M1
PZ117			M1			M1			M1			M1
PZ118			M1			M1			M1			M1
PZ287			M1			M1			M1			M1
PZ289			M1			M1			M1			M1
PZ290			M1			M1			M1			M1
PZ349			M1			M1			M1			M1
PZ351			M1			M1			M1			M1
EW232			M1			M1			M1			M1
EW233			M1			M1			M1			M1
EW234			M1			M1			M1			M1
EW235			M1			M1			M1			M1

M1: Manual water level collected once per month
M2: Manual water level collected twice per month
*MW152 was abandoned in October 2018 in order for the Tennessee Valley Authority to construct a new process water basin. Another location has been selected for installation of a new well once construction activities have been completed. This new well will be MW583.

PT = Pressure Transducer; CB = Colloidal Borescope

Attachment 3

Groundwater Curriculum: Paducah Site Groundwater, Continued

PADUCAH SITE GROUNDWATER CONTAMINATION (Session 4)

Presented by Ken Davis
Groundwater Modeling Working Group
Quarterly Meeting
October 14, 2020

Curriculum

- ✓ **Geology (January 8, 2020)**
  - Geologic Provinces
  - Paducah Site and Illinois portion of Joppa Quadrangle
- ✓ **Paducah Site Groundwater, "Big Picture" (April 8, 2020)**
  - Primary features
  - Water balance
  - Deep groundwater systems (McNairy, Mississippian)
- ✓ **Paducah Site Groundwater, Continued (July 15, 2020)**
  - UCRS: HU1 through HU3
  - RGA: HU4 and HU5
  - 2016 Update of Paducah Site GW Flow Model
- ➢ **Paducah Site Groundwater, Contamination (October 7, 2020)**
  - History
  - "Big Picture" GW Investigations (post 1988)
  - Monitoring Network
  - Plume maps
  - COPCs
  - Groundwater Strategy

Contents Summary

Timeline

	Date	Event
Discovery	Aug-88	Discovery
	Aug-88	10 Residences Restricted from Water Use
	Jul-89	Start of Phase I Site Investigation
	Mar-91	First Plume Maps for Paducah Site
	Feb-92	Conclusion of Phase III Groundwater Investigation
	Apr-92	Phase II Site Investigation Report
	Jan-92	Aerobic Bio of Hydrocarbons Treatability Study (TS)
Early Actions	Jul-93	Water Policy Engineering Eval/Cost Analysis (EECA)
	Jul-93	Northwest Plume Record of Decision (ROD)
	Feb-94	Iron Filings TS - TCE & Tc-99
	Jun-94	Water Policy Action Memorandum
	Oct-94	Conclusion of Phase IV Groundwater Investigation
	Jun-95	Northeast Plume ROD
	Aug-95	Start of Northwest Plume Operations
	Sep-95	SWMUs 2 & 3 ROD
	Jan-95	C-400 Surfactants TS
	Dec-95	Iron Filings TS - TCE
	Jul-96	SWMU 2 Interim Remedial Design Investigation
	Feb-97	Start of Northeast Plume Operations
	Apr-97	LASAGNA Phase I Feasibility Evaluation
	Aug-98	Restructuring of the Remedial Strategy
	Mar-98	Pump and Treat Resins TS
	Feb-99	C-400 Chemical Oxidation TS
	Feb-99	Pump and Treat Resins TS
	May-00	First of TCE and Tc-99 Plume Map Series (CY1999)
	May-00	Permeable Treatment Zone (PTZ) Work Plan
	Aug-01	Groundwater Operable Unit Feasibility Study (FS)
	Mar-04	C-400 Six-Phase Heating TS
	Jul-05	C-400 ROD
	Oct-06	DOE Site-wide Review and US Corps of Engineers Evaluation
	Jan-07	BGOU Remedial Investigation (RI): SWMUs 2, 3, 4, 7, 30, and 145
	Sep-08	TCE Aerobic Biodegradation TS
	Aug-10	Start of Northwest Plume Optimized Operations
	Dec-10	Northwest Plume Optimiz. Explanation of Signif. Differences (ESD)
	Aug-11	C-400 ERH Phase 1 Evaluation Report
	Sep-12	SWMU 4 Remedial Investigation
	Jun-13	Cessation of Uranium Enrichment
	Sep-13	Start of Operations of Northeast Plume Alternate Treatment Unit
	Nov-14	Completed C-400 Phase IIa Electrical Resistance Heating (ERH)
	Jul-15	Northeast Plume Memorandum of Agreement (MOA) for Resolution
	May-16	C-400 Steam Injection TS Report
	Jan-17	SWMU 1 Soil Mixing Remedial Action Completion Report (RACR)
	Mar-17	EarthCon Plume Stability Analysis
	Oct-17	Start of Northeast Plume Optimized Operations
	Jul-18	C-400 ERH RACR
	Jan-20	Groundwater Strategy
	Oct-20	Start? Of C-720 "Bio"

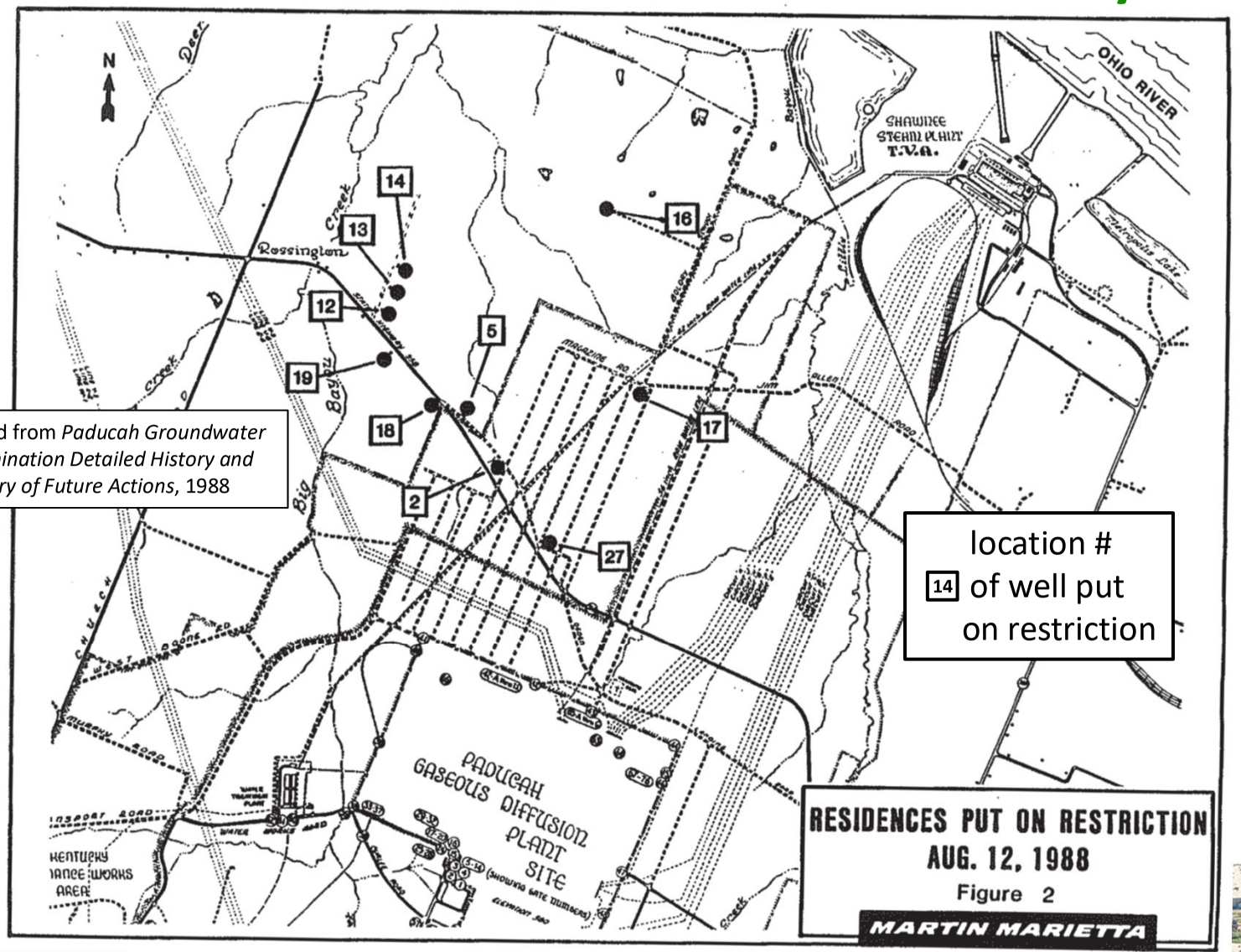
Related to Pump and Treat Projects

Paducah Site History
Groundwater Contamination Discovery

Discovery: Summer 1988

- July 25: Paducah/McCracken Co. Health Department sampled WKWMA manager's well
- August 9: Results available to WKWMA and reported to DOE
- August 10: PGDP sampled 6 local wells (beta activity and radionuclides)
- August 11:
  - PGDP lab confirmed presence of technetium in 3 of the wells
  - PGDP sampled MW66 for Tc-99 and TCE
- August 12: ten households were restricted from using their wells and bottled water was provided to these residents
- October 3: construction of waterline extension began
- October 5: ~135 residential wells had been sampled and analyzed
  - 8 (of 135) residential wells contained Tc-99 and/or TCE contamination

Paducah Site History
Groundwater Contamination Discovery

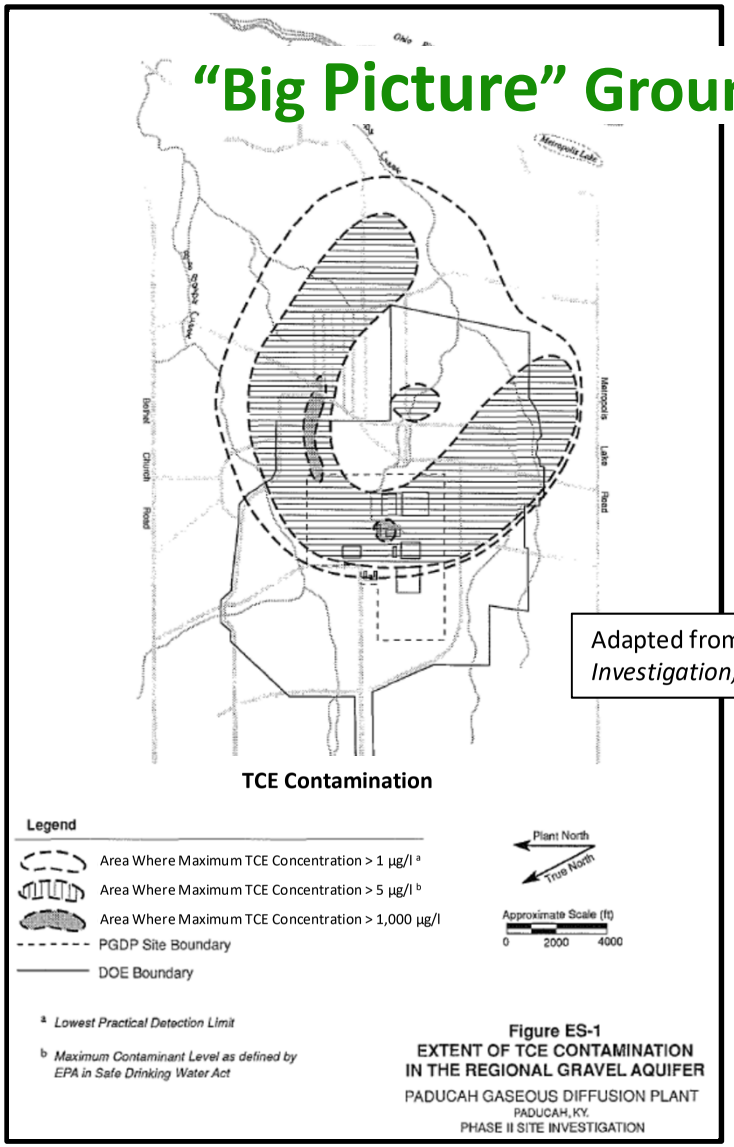


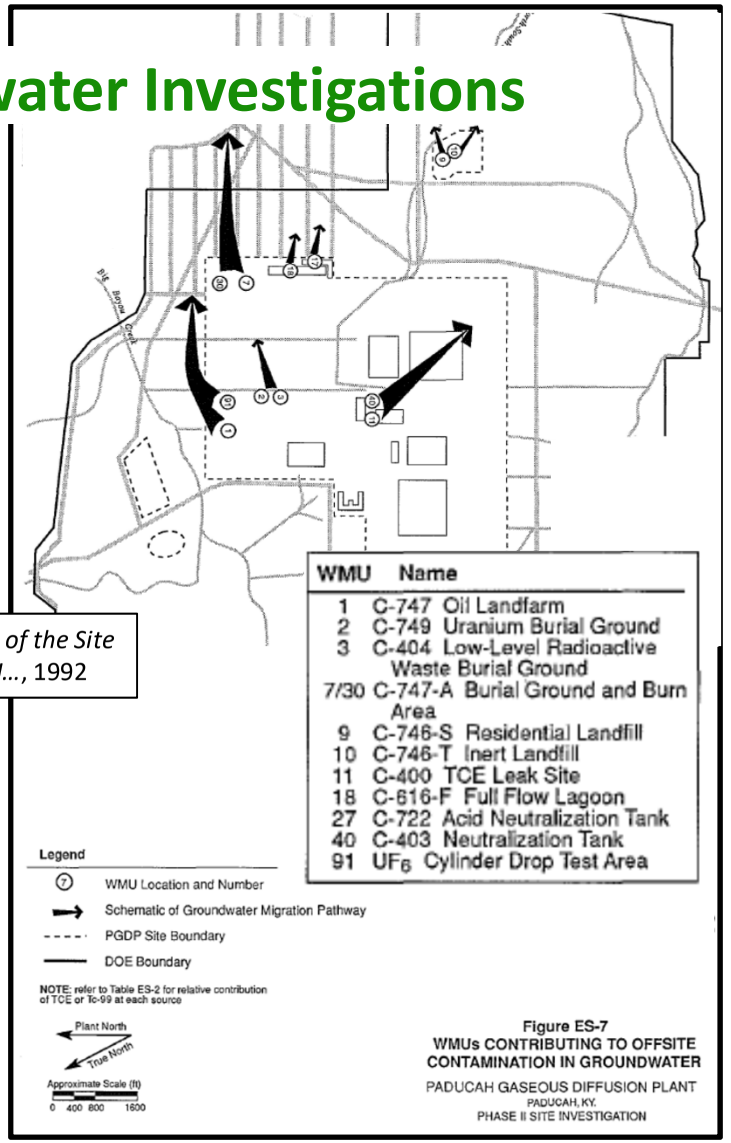
Adapted from *Paducah Groundwater Contamination Detailed History and Summary of Future Actions*, 1988

"Big Picture" Groundwater Investigations

- **Phase I and II Site Investigations (1989 – 1991)**
  - ACO action:
    - Objectives:
      - ❑ Phase I: evaluate nature and extent of offsite contamination
        1) Determine the **lateral and vertical extent of the contamination in surface water and groundwater**
        2) Evaluate the **onsite sources of Tc-99 and TCE** most likely to be contaminating groundwater and surface water
        3) Evaluate the **onsite source of PCBs** that may be the cause of sediment and surface water contamination
      - ❑ Phase II: evaluate onsite sources and sufficiently characterize for an assessment of remedial actions
    - Phase I: 1989 and 1990
    - Phase II: 1990 and 1991

"Big Picture" Groundwater Investigations





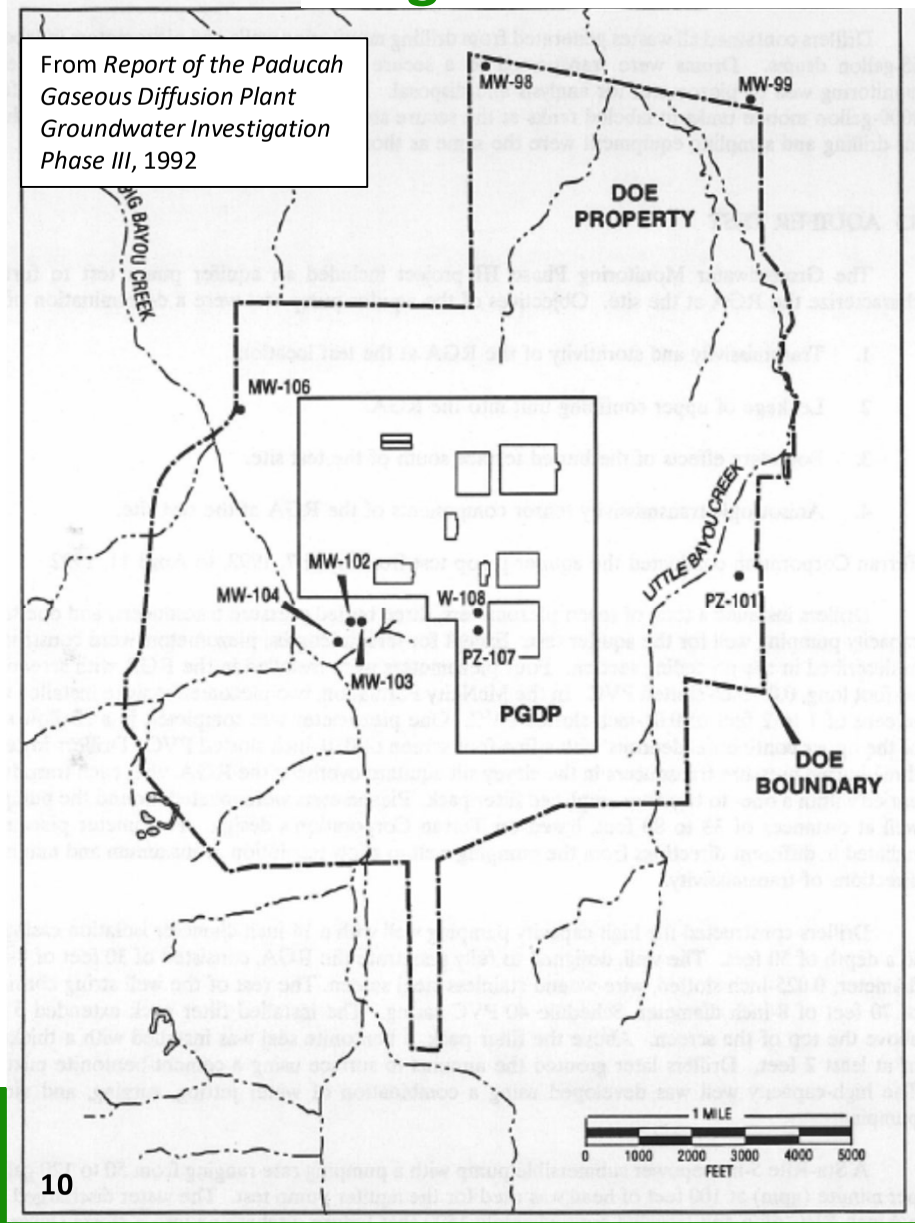
Adapted from *Results of the Site Investigation, Phase II…*, 1992

“Big Picture” Groundwater Investigations

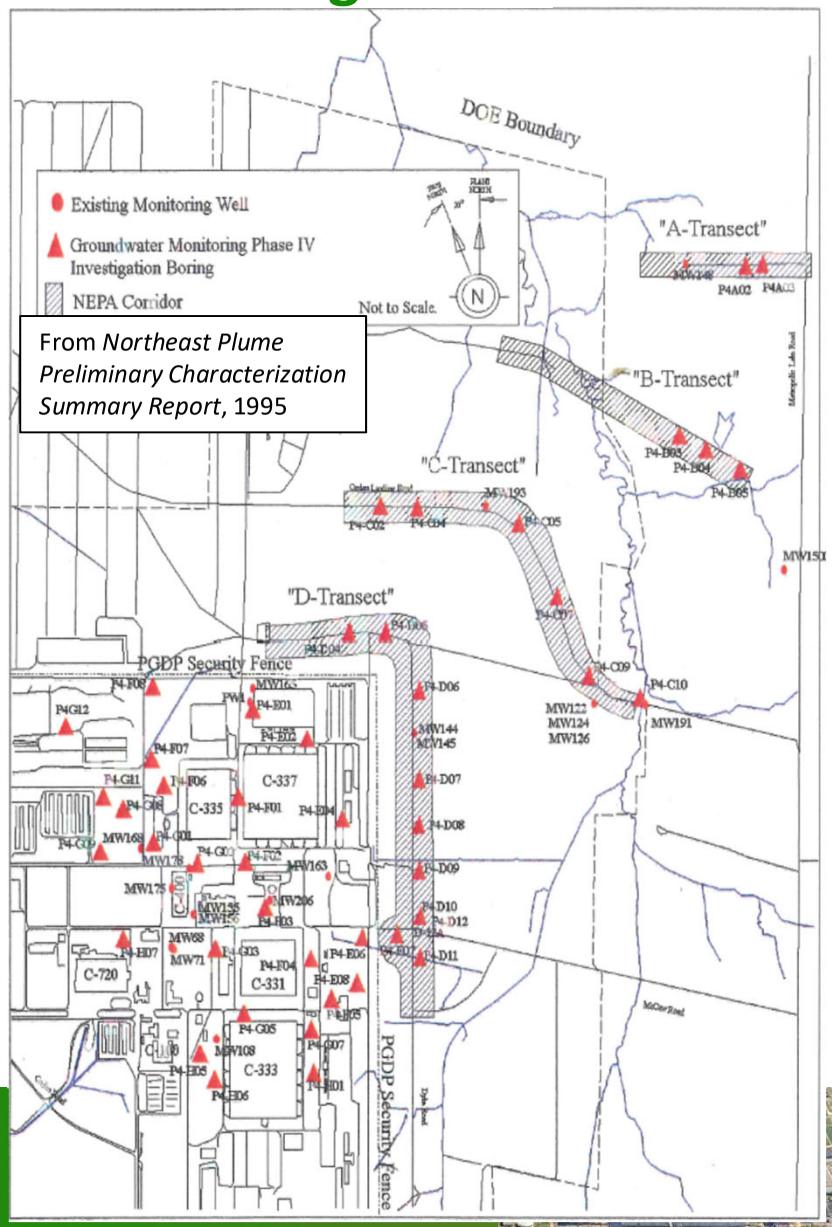
- **Groundwater Phase III Investigation: 1991 - 1992**
  - “In house” investigation to support development of the site conceptual model
    - Continuity of the shallow groundwater system over the buried terrace
    - Hydraulic head in areas of uncertainty
    - Quantification of RGA parameters in an area of suspected high hydraulic conductivity (C-333 area)
  - Monitoring well (MW) and piezometer (PZ) Construction
  - C-333 Aquifer pump test
- **Groundwater Phase IV Investigation: 1994**
  - Address data gaps (contaminant distribution) before corrective measures could be proposed for the Northeast Plume
    - Recognized C-400 as a primary source for the Northwest Plume (as well as one of several sources for the Northeast Plume)
  - 48 sample borings
    - VOC & Tc-99 analyses
    - Gamma ray & neutron porosity logs

"Big Picture" Groundwater Investigations

From *Report of the Paducah Gaseous Diffusion Plant Groundwater Investigation Phase III*, 1992



From *Northeast Plume Preliminary Characterization Summary Report*, 1995



10

COPCs

Methods for Conducting Risk Assessments and Risk Evaluations… Human Health (2020a)

Table 2.1. Significant Chemicals and Radionuclides of Potential Concern at PGDP

Inorganic Chemicals		Organic Compounds						Radionuclides	
Analyte	CAS Number	Analyte	CAS Number	Analyte	CAS Number	Analyte	CAS Number	Analyte	CAS Number
Aluminum	7429-90-5	Acenaphthene	83-32-9	N-Nitroso-di-n-propylamine	621-64-7	Benz(a)anthracene[3]	56-55-3	Americium-241	14596-10-2
Antimony	7440-36-0	Acenaphthylene	208-96-8	Pentachlorophenol	87-86-5	Benzo(a)pyrene[3]	50-32-8	Cesium-137+D	10045-97-3
Arsenic	7440-38-2	Acrylonitrile	107-13-1	Phenanthrene	85-01-8	Benzo(b)fluoranthene[3]	205-99-2	Neptunium-237+D	13994-20-2
Barium	7440-39-3	Anthracene	120-12-7	Pyrene	129-00-0	Benzo(k)fluoranthene[3]	207-08-9	Plutonium-238	13981-16-3
Beryllium	7440-41-7	Benzene	71-43-2	Tetrachloroethene	127-18-4	Chrysene[3]	218-01-9	Plutonium-239	15117-48-3
Boron	7440-42-8	Bromodichloromethane	75-27-4	1,1,1-Trichloroethane	71-55-6	Dibenz(a,h)anthracene[3]	53-70-3	Plutonium-240	14119-33-6
Cadmium	7440-43-9	Carbazole	86-74-8	1,1,2-Trichloroethane	79-00-5	Indeno(1,2,3-cd)pyrene[3]	193-39-5	Technetium-99	14133-76-7
Chromium III	16065-83-1	Carbon tetrachloride	56-23-5	Trichloroethene[3]	79-01-6	Total PCBs	1336-36-3	Thorium-230	14269-63-7
Chromium VI[3]	18540-29-9	Chloroform	67-66-3	Total Dioxins/Furans	1746-01-6	Aroclor 1016	12674-11-2	Uranium-234	13966-29-5
Cobalt	7440-48-4	1,1-Dichloroethene	75-35-4	2,3,7,8-HpCDD	37871-00-4	Aroclor 1221	11104-28-2	Uranium-235+D	15117-96-1
Copper	7440-50-8	1,2-Dichloroethane	107-06-2	2,3,7,8-HpCDF	38998-75-3	Aroclor 1232	11141-16-5	Uranium-238+D	7440-61-1
Fluoride	16984-48-8	1,2-Dichloroethene (mixed)	540-59-0	2,3,7,8-HxCDD	34465-46-8	Aroclor 1242	53469-21-9		
Iron	7439-89-6	*trans*-1,2-Dichloroethene	156-60-5	2,3,7,8-HxCDF	55684-94-1	Aroclor 1248	12672-29-6		
Lead	7439-92-1	*cis*-1,2-Dichloroethene	156-59-2	OCDD	3268-87-9	Aroclor 1254	11097-69-1		
Manganese	7439-96-5	Dieldrin	60-57-1	OCDF	39001-02-0	Aroclor 1260	11096-82-5		
Mercury	7439-97-6	Ethylbenzene	100-41-4	2,3,7,8-PeCDD	36088-22-9	Vinyl chloride[3]	75-01-4		
Molybdenum	7439-98-7	Fluoranthene	206-44-0	1,2,3,7,8-PeCDF	57117-41-6	Xylenes (Mixture)	1330-20-7		
Nickel	7440-02-0	Fluorene	86-73-7	2,3,4,7,8-PeCDF	57117-31-4	p-Xylene	106-42-3		
Selenium	7782-49-2	Hexachlorobenzene	118-74-1	2,3,7,8-TCDD	1746-01-6	m-Xylene	108-38-3		
Silver	7440-22-4	Naphthalene	91-20-3	2,3,7,8-TCDF	51207-31-9	o-Xylene	95-47-6		
Thallium	7440-28-0	2-Nitroaniline	88-74-4	Total Carcinogenic PAHs[3]	50-32-8				
Uranium	NA								
Vanadium	7440-62-2								
Zinc	7440-66-6								

COCs:
Groundwater Operable Unit Feasibility Study (DOE 2001)

Priority COCs

		UCRS	RGA	McNairy
Inorganic Chemicals				
	antimony	X	X	X
	arsenic	X	X	X
	beryllium	X	X	X
	cadmium	X	X	X
	chromium	X	X	X
	iron	X	X	X
	lead	X	X	
	manganese	X	X	X
	molybdenum		X	X
	nickel	X		
	vanadium	X	X	X
Organic Compounds				
	1,1-dichloroethene	X	X	
	acrylonitrile		X	
	Aroclor-1254		X	
	benzene	X		
	carbon tetrachloride		X	
	chloroform	X		
	ethylbenzene	X		
	naphthalene	X		
	tetrachloroethene		X	
	cis-1,2-dichloroethene	X	X	
	trans-1,2-dichloroethene	X	X	
	trichloroethene	X	X	X
	vinyl chloride	X	X	
Radionuclides				
	^{226}Ra		X	
	^{222}Rn	X	X	X

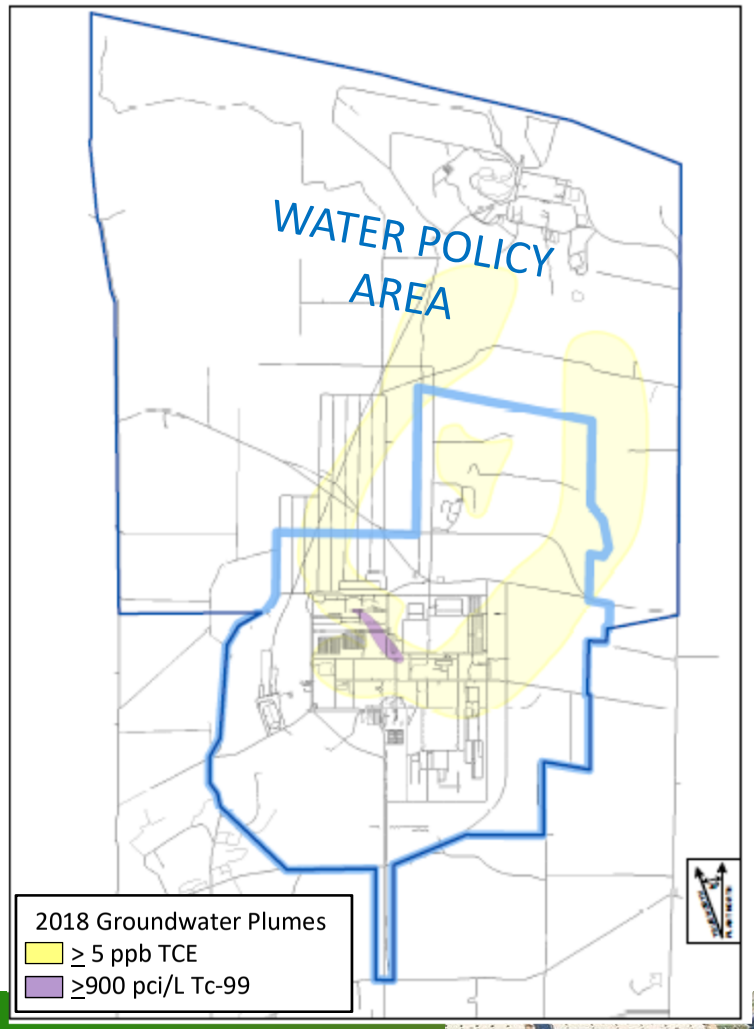
COCs Used in the FS to Develop RAOs and Screen Remedial Technologies

- 1,1-dichloroethene
- *cis*-1,2-dichloroethene
- *trans*-1,2-dichloroethene
- carbon tetrachloride
- tetrachloroethene
- trichloroethene
- vinyl chloride
- technetium-99

Response Actions

Response: Water Policy

- *Engineering Evaluation/Cost Analysis for the Water Policy*… (July 1993)
  - Non-time critical removal action: selection of provision of an alternative water supply
- *Action Memorandum for the Water Policy*… (June 1994)
  - Provision of municipal water
  - License agreements
  - Residential well/monitoring well sampling program



Response Actions

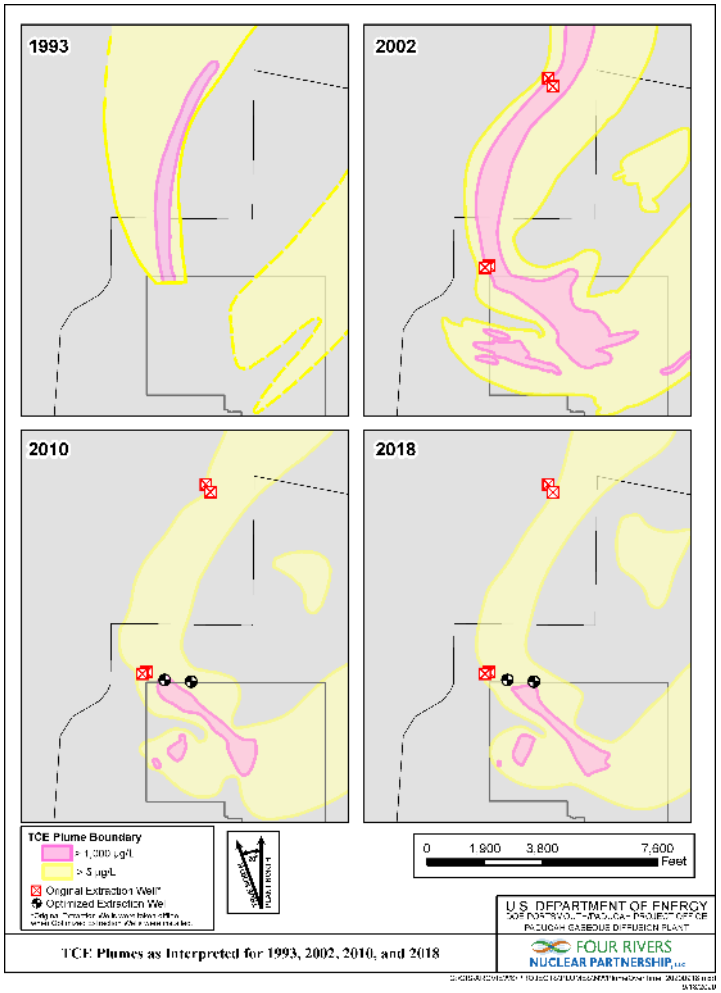
Response: Northwest Plume IRA

- **ROD**: July 1993
  - Installation and maintenance of 2 extraction well (EW) fields: with 2 EWs each
    - Initiate hydraulic control of the high-concentration zone of TCE and Tc-99
  - Construction of the C-612 water treatment facility
- Northwest Plume Groundwater System (NWPGS) has continued to operate since August 1995
  - Brief shutdowns for maintenance, as needed, and two periods for facility upgrades (May 2015 – June 2015 and November 2015-February 2016)
- 2006 DOE Sitewide Remedy Review and U.S. Army Corps of Engineers Remediation System Evaluation
  - Recommendation: terminate extraction at northern EWs – increase extraction in vicinity of southern EWs
- **ESD**: December 2010
  - 2 new EWs, at optimized locations in south well field, began operation in August 2010

Response Actions

Response: Northwest Plume IRA

Adapted from *CY 2018 Five-Year Review for Remedial Actions at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, 2019



Response Actions

Response: Northeast Plume IRA

- **ROD**: June 1995
  - Installation and maintenance of 1 EW field: with 2 EWs
    - Initiate hydraulic control at northern end of the high-concentration TCE plume (1,000 µg/L)
  - Use process water cooling towers for treatment system
- NEPCS (Northeast Plume Containment System) has continued to operate since February 1997
- 2006 DOE Sitewide Remedy Review and U.S. Army Corps of Engineers Remediation System Evaluation
  - Recommendation: goal achieved – place NEPCS in standby mode
- Cessation of uranium enrichment June 2013: loss of operation of cooling towers
  - Alternate treatment unit: operations began September 2013
- **MOA for Resolution**: July 2015
  - Upgradient relocation of 2 new EWs
  - Began operations of new EWs: October 2017

Response Actions

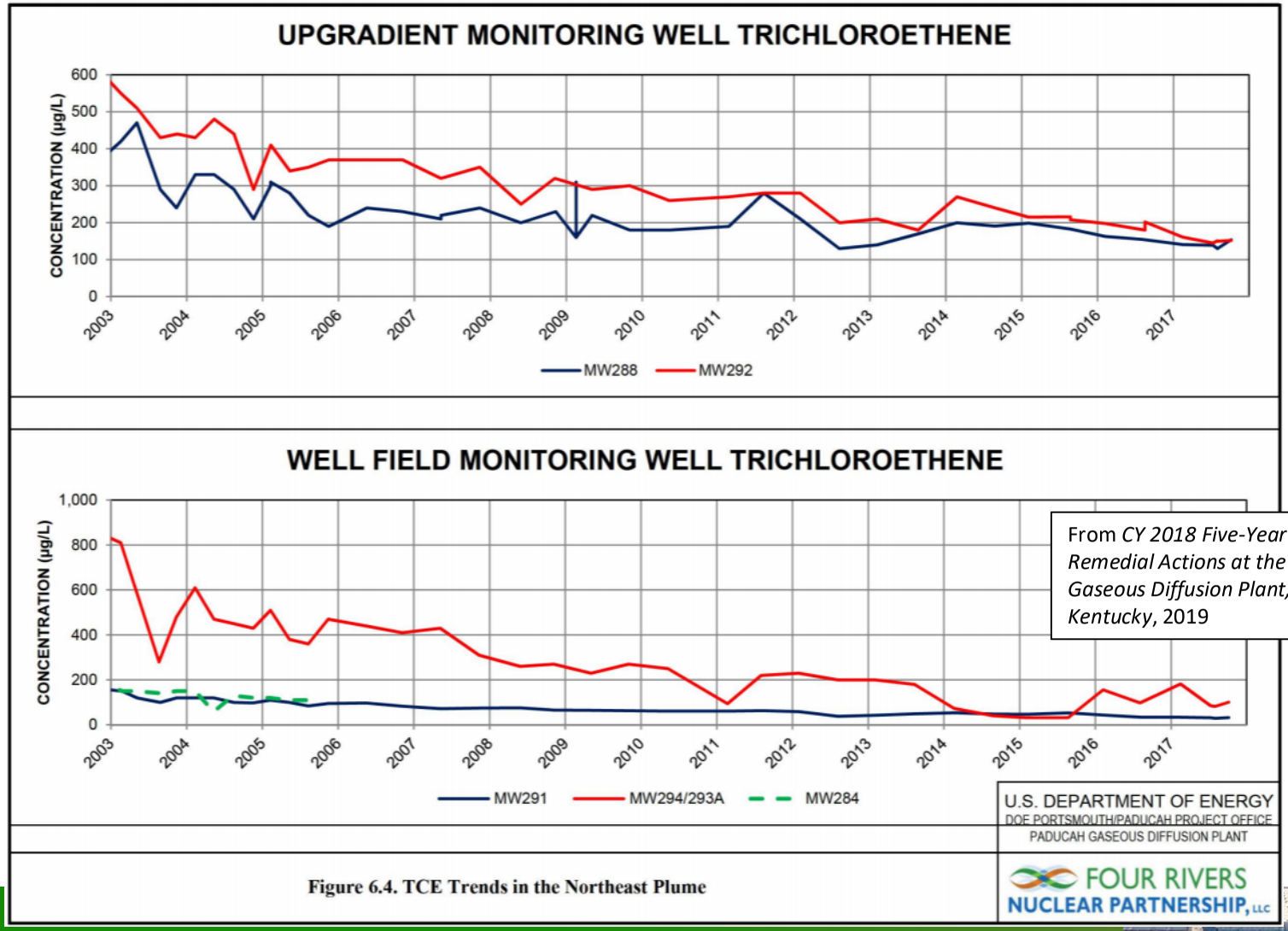


Figure 6.4. TCE Trends in the Northeast Plume

From *CY 2018 Five-Year Review for Remedial Actions at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, 2019

Groundwater Operable Unit Feasibility Study

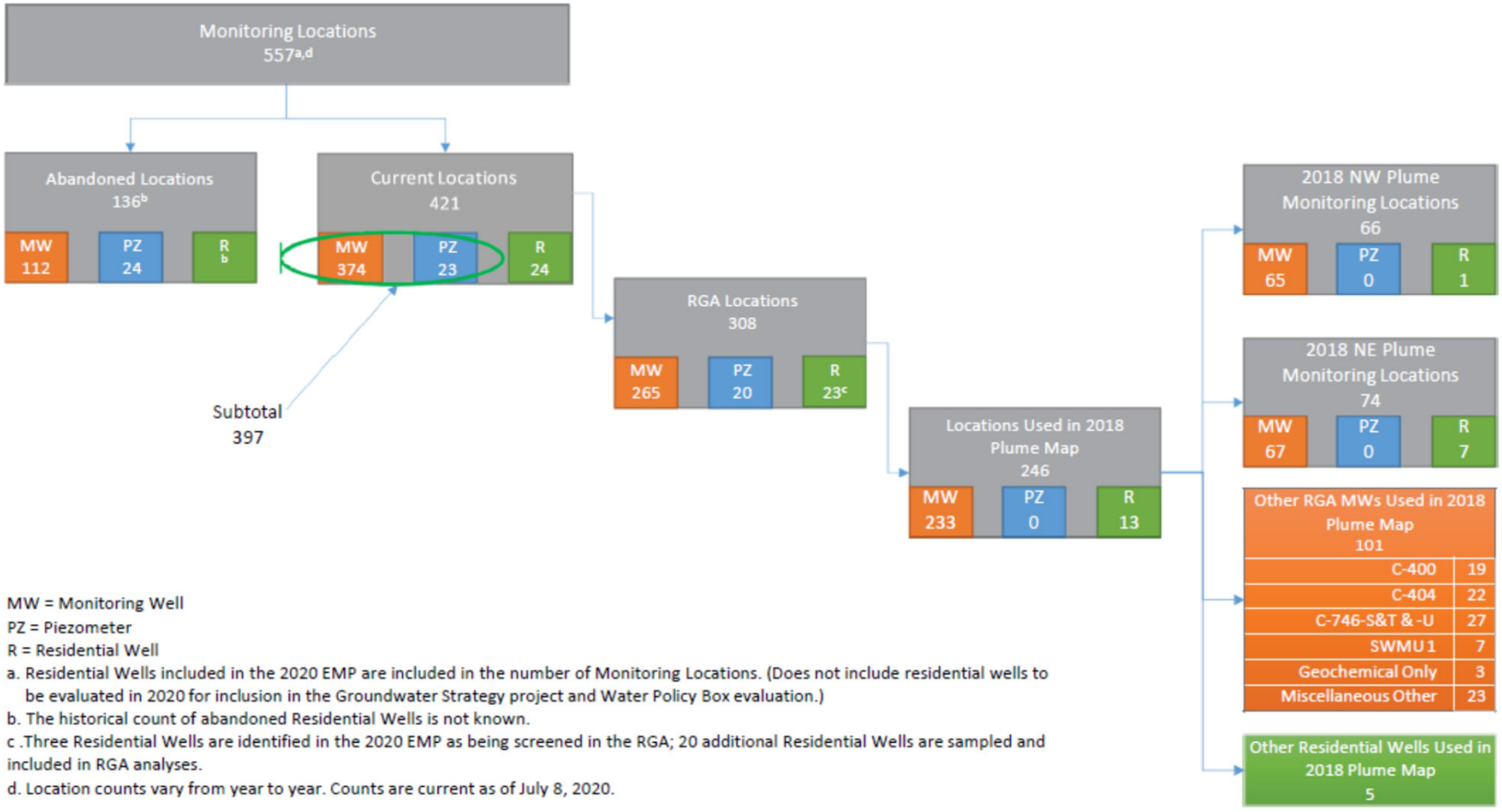
***Feasibility Study for the Groundwater Operable Unit at Paducah Gaseous Diffusion Plant Paducah, Kentucky*, 2001**

- Based on 1998 restructuring of the remedial strategy: sitewide remedial objectives
  1) Protection of offsite residents from consumption of contaminated groundwater and a return of groundwater to beneficial use
  2) Protection of recreational users associated with Bayou/Little Bayou Creeks and the WKWMA
  3) Protection of industrial workers, and
  4) Protection of ecosystems

  - 4 remedial action operable units: GWOU, SWOU, SOU, and BGOU
  - Target contaminants: TCE, TCE DNAPL, TCE degradation products, and Tc-99

- Includes:
  - Data summary report
  - Baseline risk assessment
  - Draft groundwater background

Groundwater Monitoring Network



MW = Monitoring Well
PZ = Piezometer
R = Residential Well

a. Residential Wells included in the 2020 EMP are included in the number of Monitoring Locations. (Does not include residential wells to be evaluated in 2020 for inclusion in the Groundwater Strategy project and Water Policy Box evaluation.)
b. The historical count of abandoned Residential Wells is not known.
c .Three Residential Wells are identified in the 2020 EMP as being screened in the RGA; 20 additional Residential Wells are sampled and included in RGA analyses.
d. Location counts vary from year to year. Counts are current as of July 8, 2020.

Groundwater Monitoring Network

Environmental Monitoring Plan, Fiscal Year 2020,
Paducah Gaseous Diffusion Plant

- Routine environmental assessment samples:
  - 270 monitoring wells and 24 residential wells
  - 1 seep

- Design of groundwater monitoring program criteria:
  - Baseline conditions
  - Compliance with regulations and DOE orders
  - Early detection of groundwater contamination
  - Identify groundwater contamination sources
  - Data for decisions about waste disposal on land-based units and protection of groundwater sources

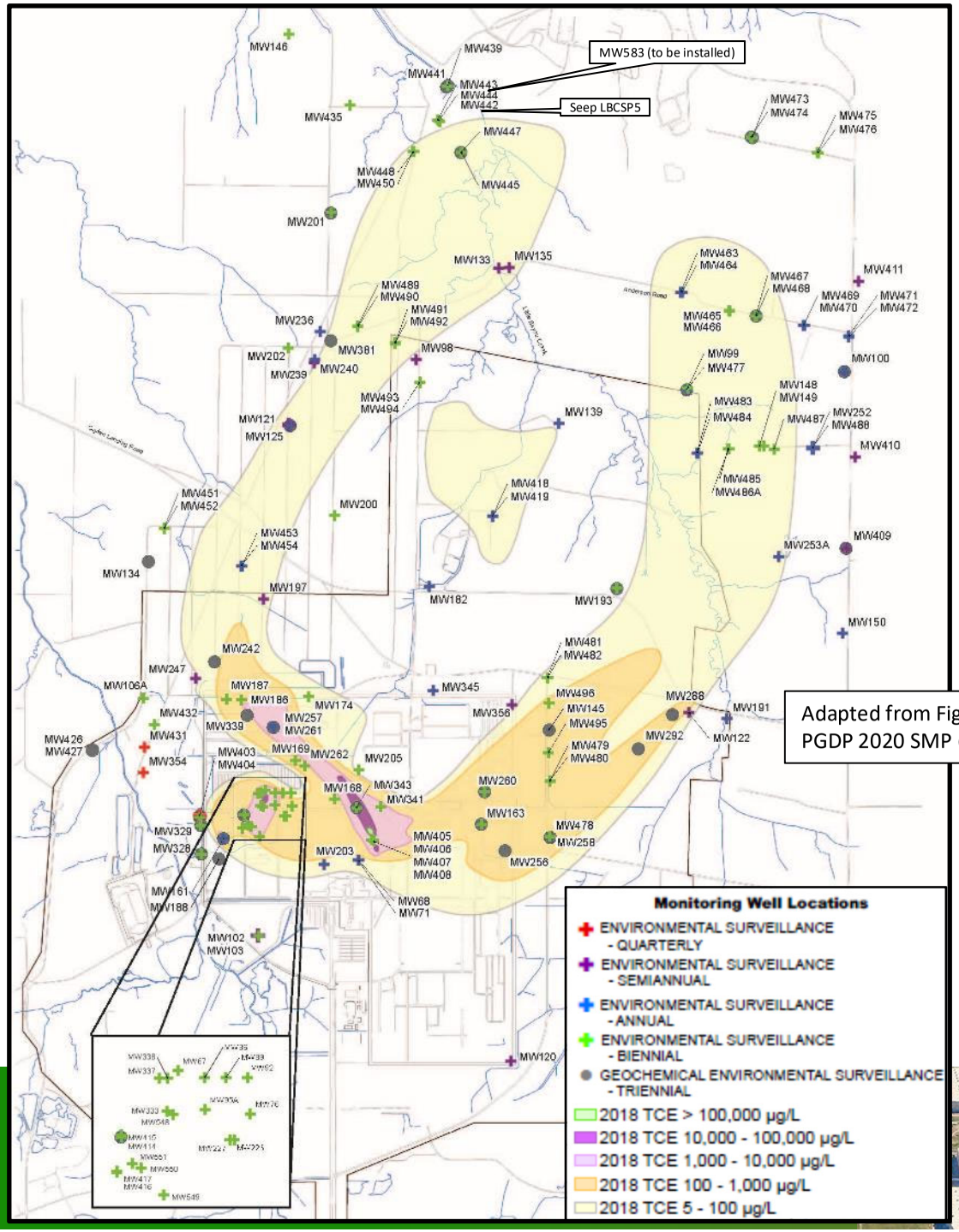
Groundwater Monitoring Network

Environmental Monitoring Plan, Fiscal Year 2020, Paducah Gaseous Diffusion Plant

Groundwater Sample Programs

- C-400
- C-404 Landfill
- C-746-K Landfill
- C-746-S&T Landfills
- C-746-U Landfill
- Carbon filter treatment system (residential well)
- Environmental surveillance
- Geochemical surveillance
- Northeast Plume
- Northwest Plume
- SWMU 1
- Water Policy Boundary

Groundwater Monitoring Network



Adapted from Figure C.10 of PGDP 2020 SMP (DOE 2020b)

Groundwater Monitoring Network

Database Management

- **PEMS** (Paducah Project Environmental Measurements System)
- **OREIS** (Paducah Oak Ridge Environmental Information System)
  - Automated data processing system
  - Prerequisites
    - Data verification
    - Data assessment
    - Data validation (if required)
- **PEGASIS** (Portsmouth/Paducah Project Office Environmental Geographic Analytical Spatial Information System)
  - Updated from OREIS periodically (usually on a quarterly basis)
  - Available to public stakeholders
- **ASER** (Annual Site Environmental Report)
  - Results are published and made available to the public

Plume Maps

History:

- 1991 (1st map) *Results of the Site Investigation, Phase 1…*
- 1993 – 1997 ASERs
- 1998: *Maximum Dissolved Trichloroethene Concentration/Technetium-99 Activity in the Regional Gravel Aquifer*
- *Trichloroethene and Technetium-99 Groundwater Contamination in the Regional Gravel Aquifer for Calendar Year… 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2007, 2010, 2012, 2014, 2016, 2018*

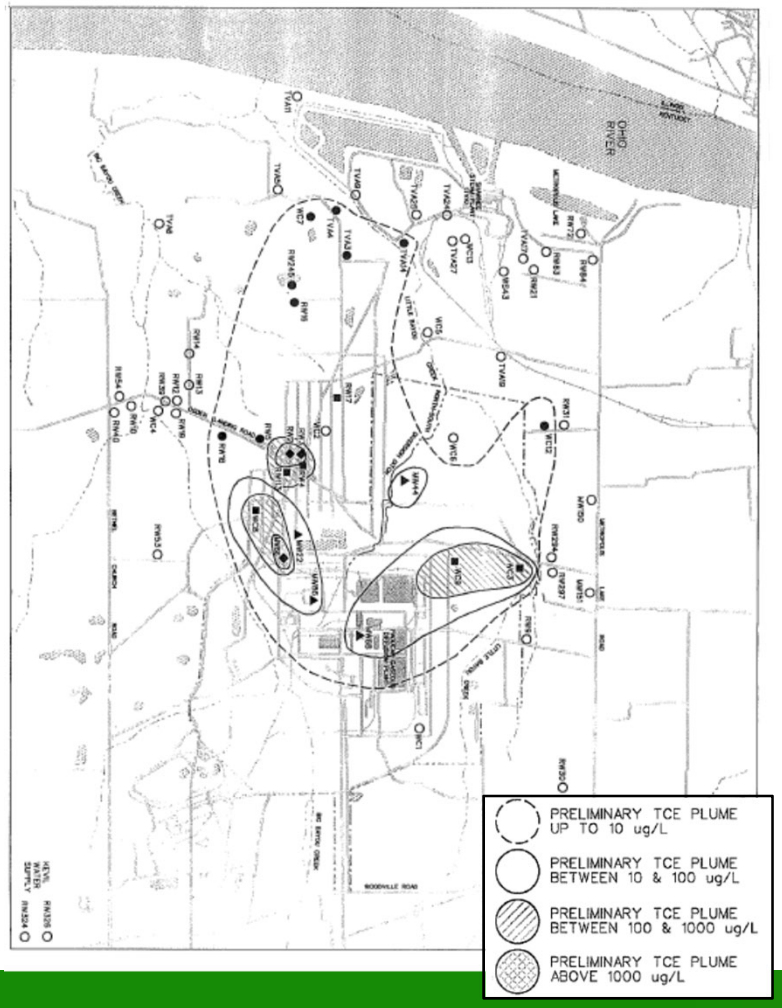
2018 Significant Trends:

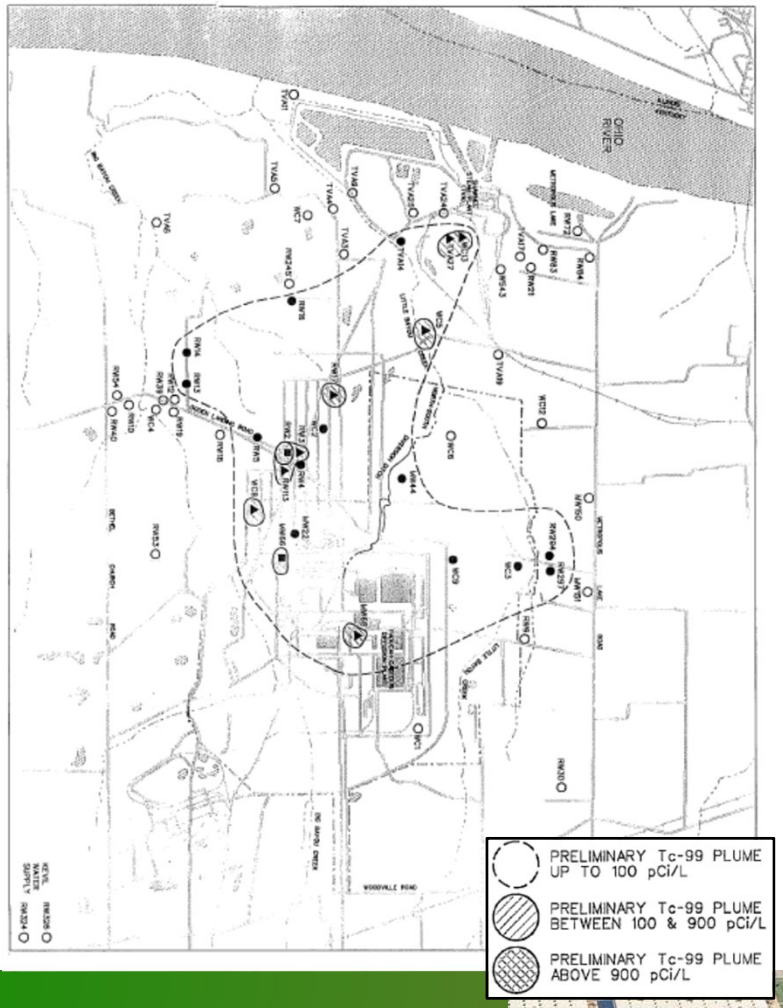
- Northwest Plume
  - Decline of overall TCE levels upgradient of optimized extraction wells
  - Eastward shift of core of plume in the area of EW232 and EW233
  - Decline of TCE levels at the north tip (MW152*, LBCSP5)
- Northeast Plume
  - Continuation of 2 lobes east of plant boundary
  - Overall decline in TCE levels in the area of MW253 (north of the old EWs)
  - No significant change in TCE levels at the north tip

*MW152 has been abandoned to accommodate construction at TVA's Shawnee Steam Plant. DOE will construct MW583 (planned for 2020) to replace the monitoring well.

Plume Maps

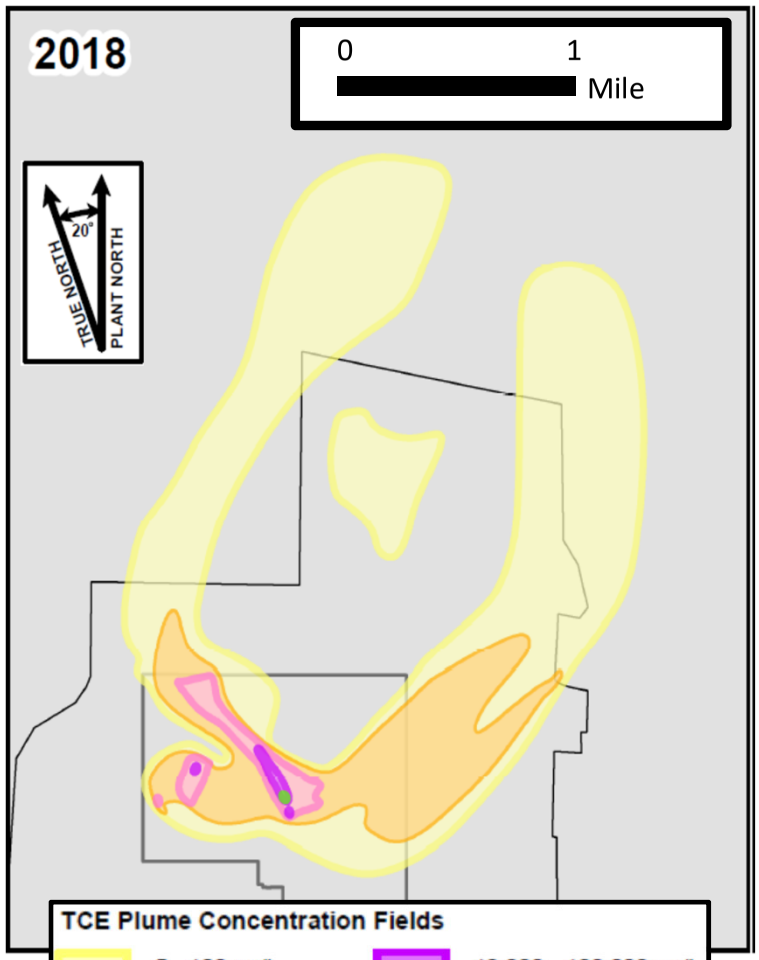
- 1st map: *Results of the Site Investigation, Phase 1…*, March 1991

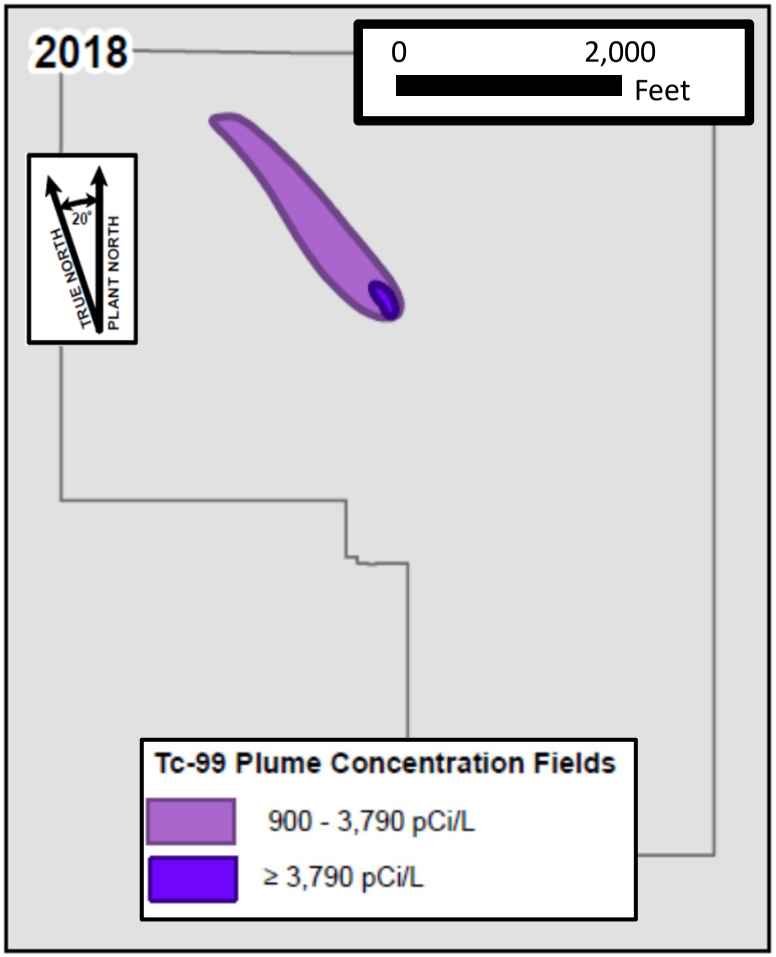




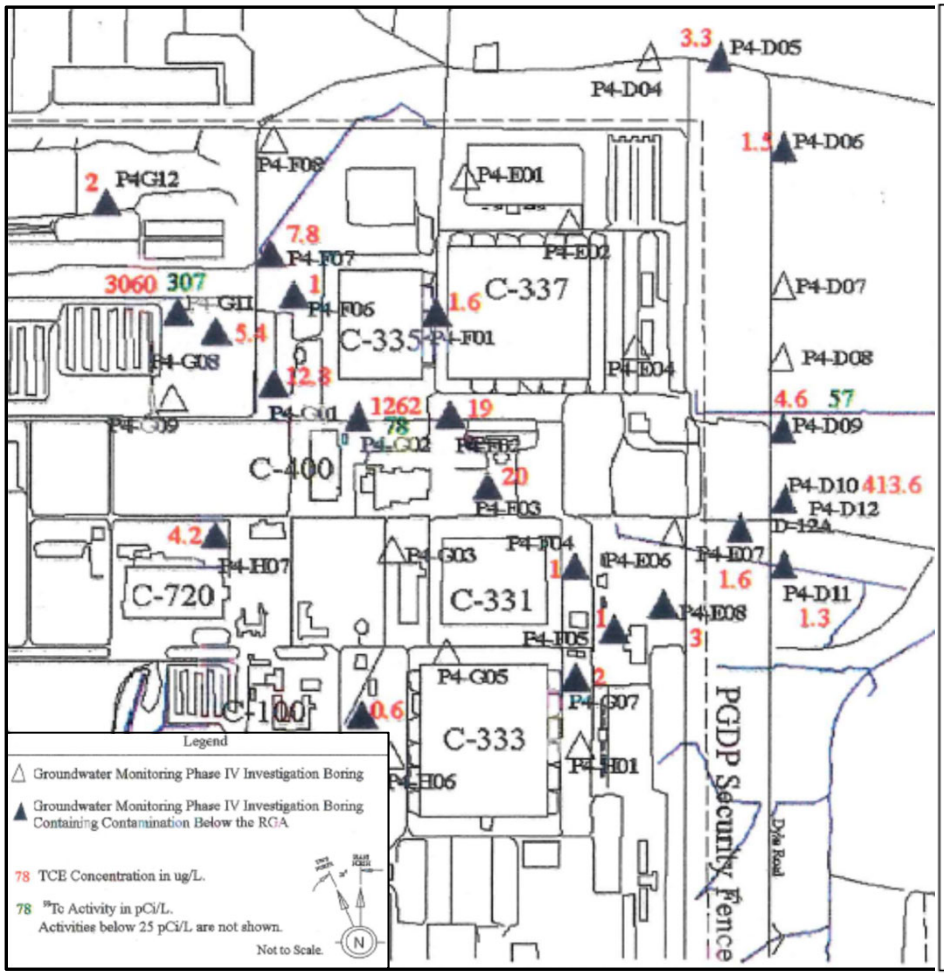
Plume Maps

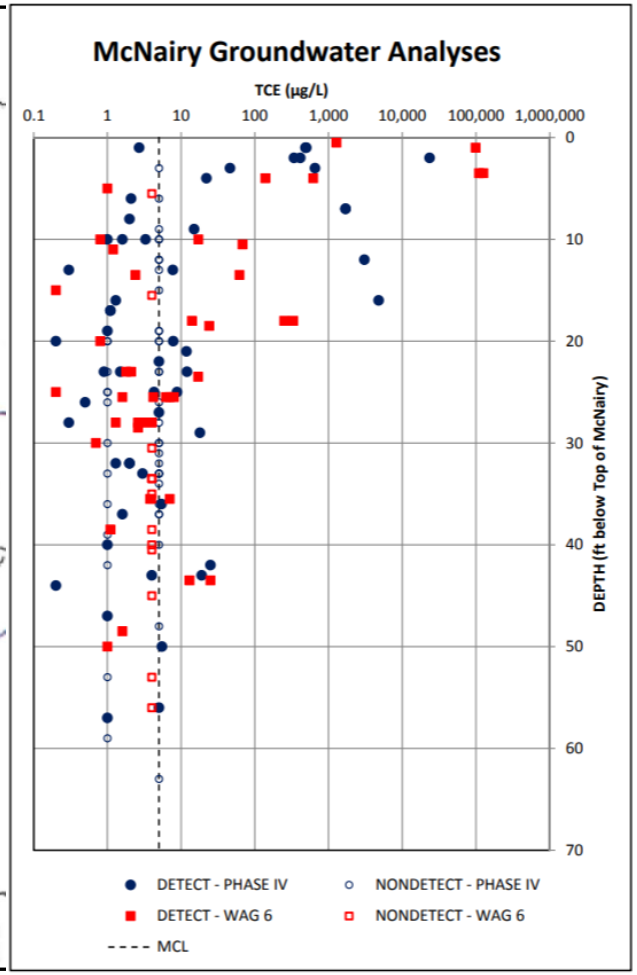
- Latest map: *Trichloroethene and Technetium-99 Groundwater Contamination in the Regional Gravel Aquifer for Calendar Year 2018* (FRNP 2019b)





McNairy Groundwater Contamination





Adapted from Figure 26 of the Groundwater Phase IV Investigation Report: Maximum TCE and ^{99}Tc Detected Below the RGA

Remedial/Removal Actions and Treatability Studies

Northwest Plume Pump and Treat (P&T)

- Initial operations (using EW228, EW229, EW230, and EW231) began **1995**
- Operations after optimization (using EW232 and EW233) began **2010**

Northeast Plume P&T

- Initial operations (using EW331 and EW332) began **1997**
- Operations after optimization (using EW234 and EW235) began **2017**

Remedial Actions* – other than P&T

- LASAGNA Phase I (1998)
- C-400 ERH (2011 & 2016)
- SWMU 1 soil mixing (2017)
- C-720 “bio” (2020)

Treatability Studies*

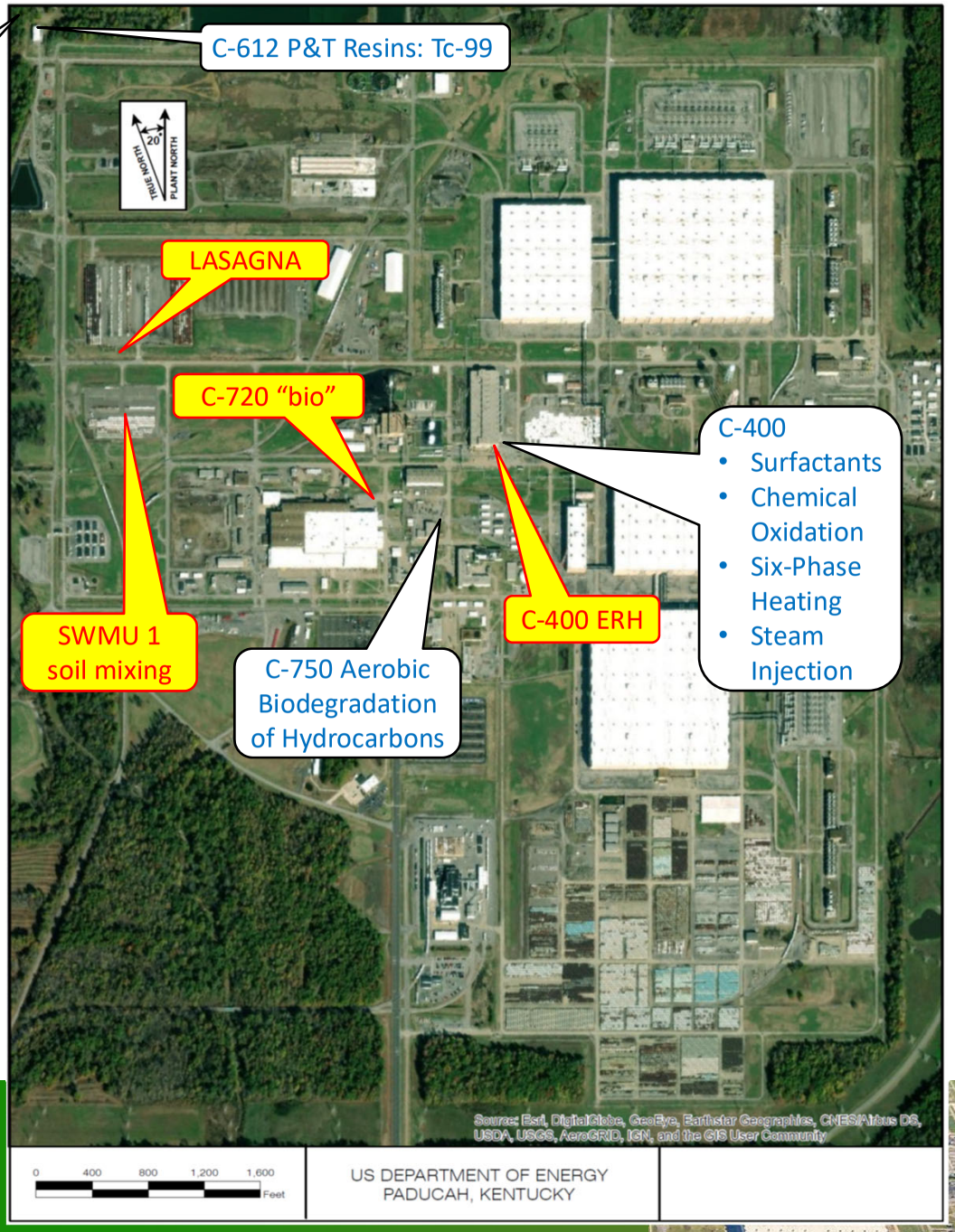
- Aerobic biodegradation of hydrocarbons (1992)
- Iron filings: TCE (1995)
- C-400: surfactants (1995)
- P&T resins: Tc-99 (1998 & 1999)
- C-400: chemical oxidation (1999)
- C-400: six-phase heating (2004)
- TCE aerobic biodegradation (2008)
- C-400: steam injection (2016)

*Year of issuance of final report

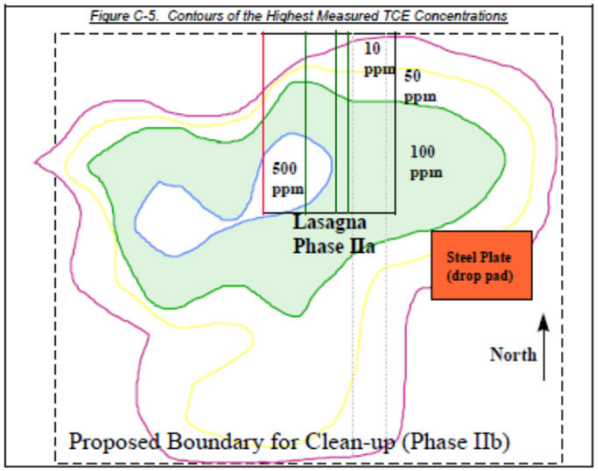
Remedial Actions

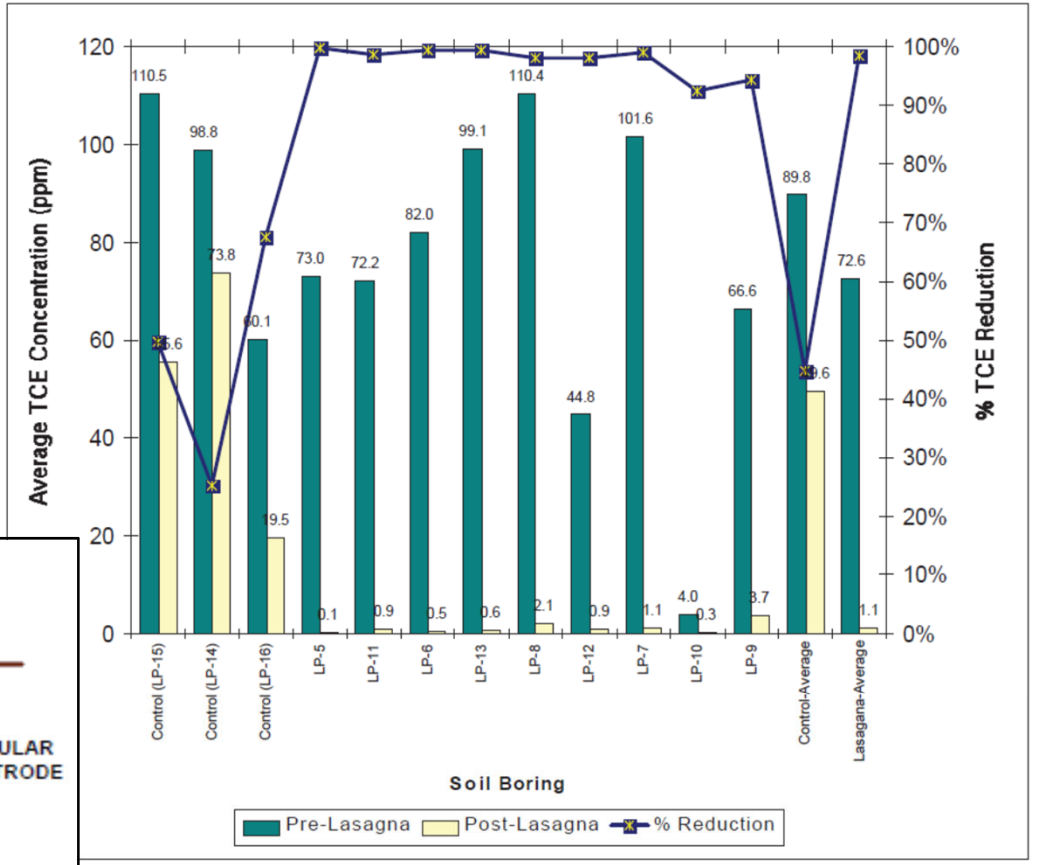
&

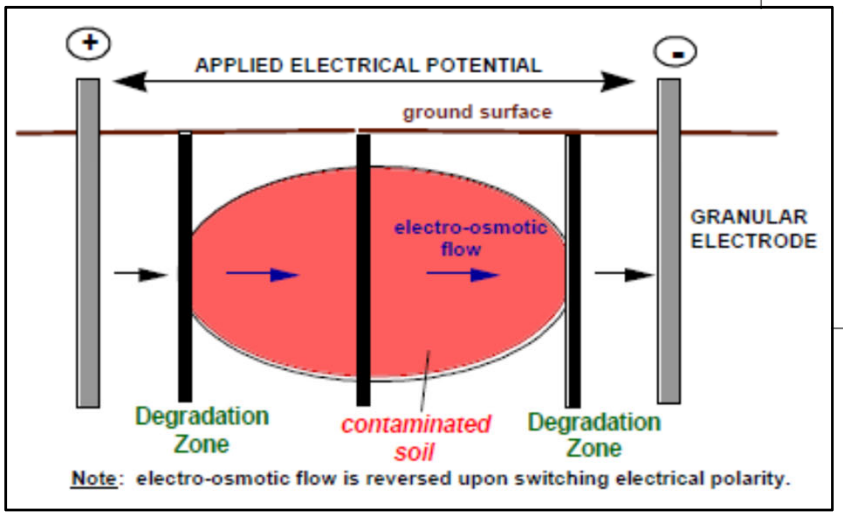
Treatability Studies



Remedial Actions - LASAGNA

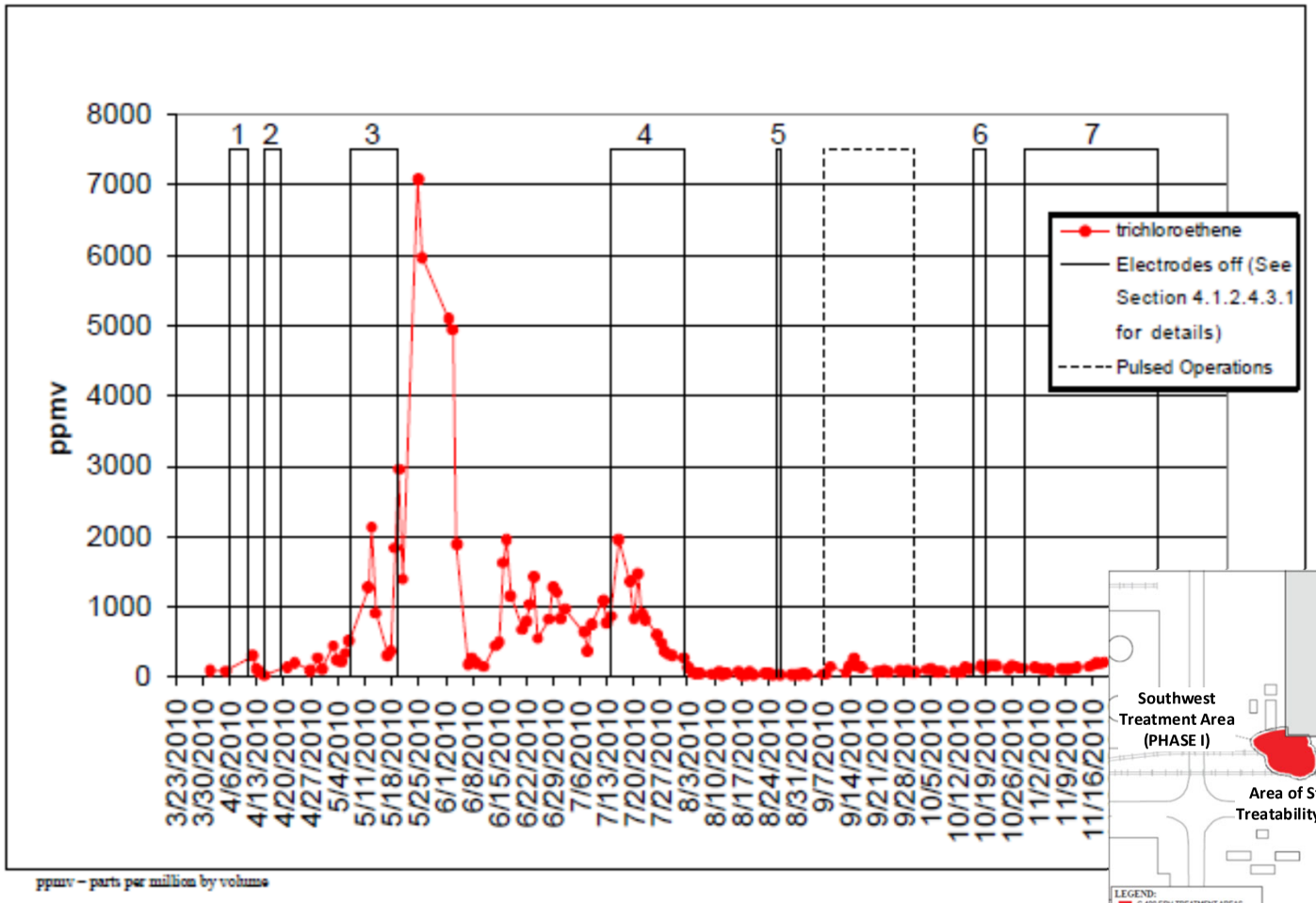






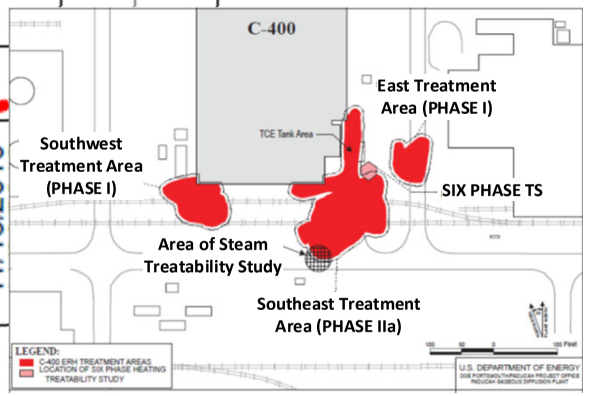
Figures from Rapid Commercialization Initiative Final Report (Monsanto 1998)

Remedial Actions – C-400 ERH



ppmv – parts per million by volume

Figure 4.17. East Treatment Area Header Average TCE Photoacoustic Readings



Figures adapted from C-400 Remedial Action Completion Report (DOE 2018)

Remedial Actions – SWMU 1 Soil Mixing

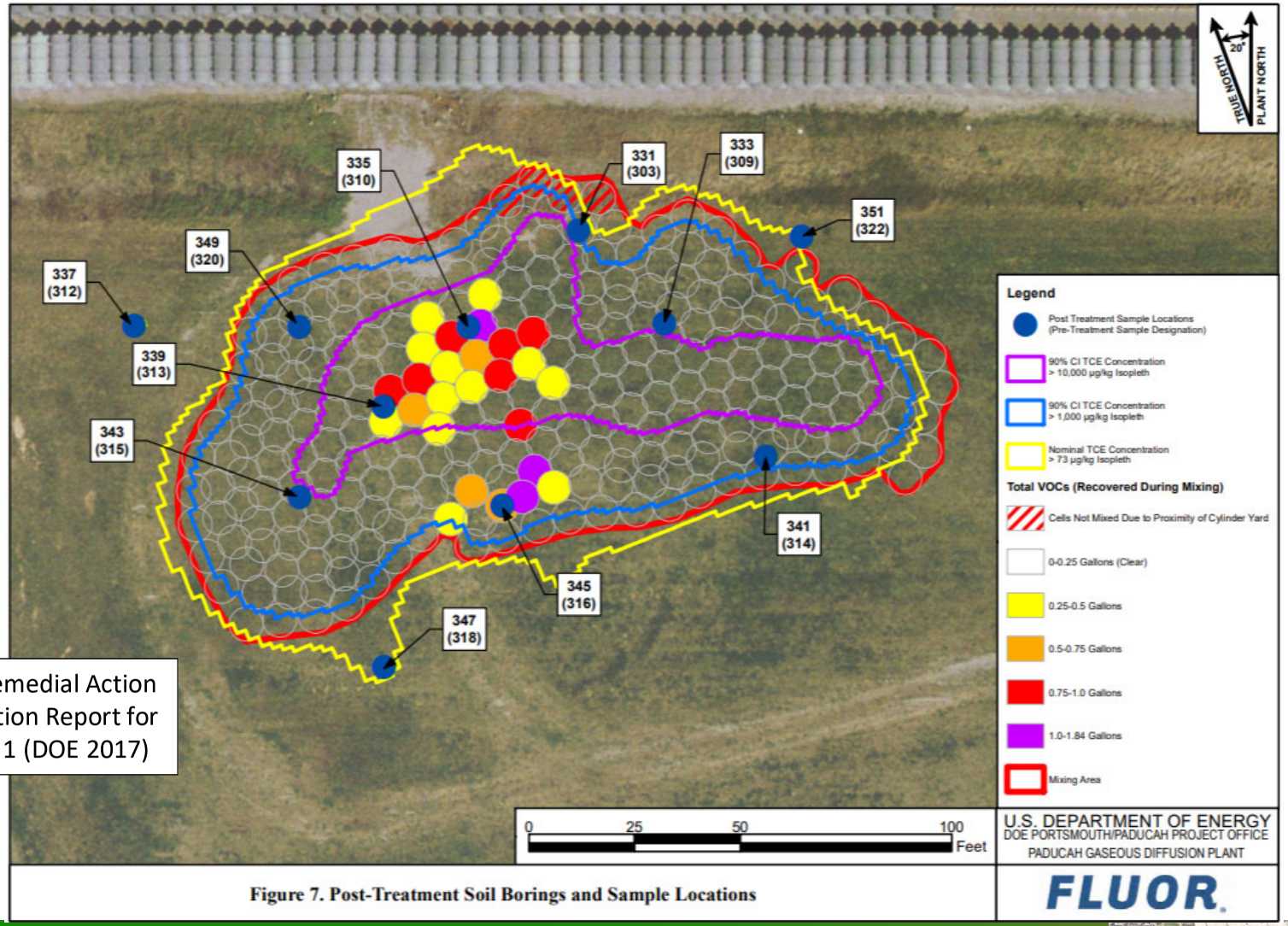


Figure 7. Post-Treatment Soil Borings and Sample Locations

From Remedial Action Completion Report for SWMU 1 (DOE 2017)

Treatability Studies

Aerobic biodegradation of hydrocarbons, 1992 (C-750 Garage) (OHM 1992)

- Demonstrated biological treatment of BTEX groundwater contamination was viable

Iron filings column test, 1995 (Northwest Plume) (GE 1995)

- Measured TCE degradation rates for a permeable treatment wall in the RGA

Pump & Treat resins, 1998 & 1999 (C-612 P&T System) (ORNL 1998 and 1999)

- Assessed newly-developed synthetic resin for Tc-99 capture

TCE soil and groundwater contamination (C-400)

- Surfactants, 1995 (INTERA 1995)
  - Optimized surfactant for PGDP
  - Field test demonstrated site limitations
- Chemical oxidation, 1999 (DOE 1999)
  - Bench test - evaluated in-situ chemical oxidation treatment parameters
- Six-phase heating, 2004 (DOE 2004)
  - Field demonstration of electrical resistance heating
  - Led to ERH remedial actions
- Steam injection, 2016 (DOE 2016)
  - Modeling of steam injection
  - Field demonstration

TCE aerobic biodegradation, 2008 (Northwest Plume) (KRCEE 2008)

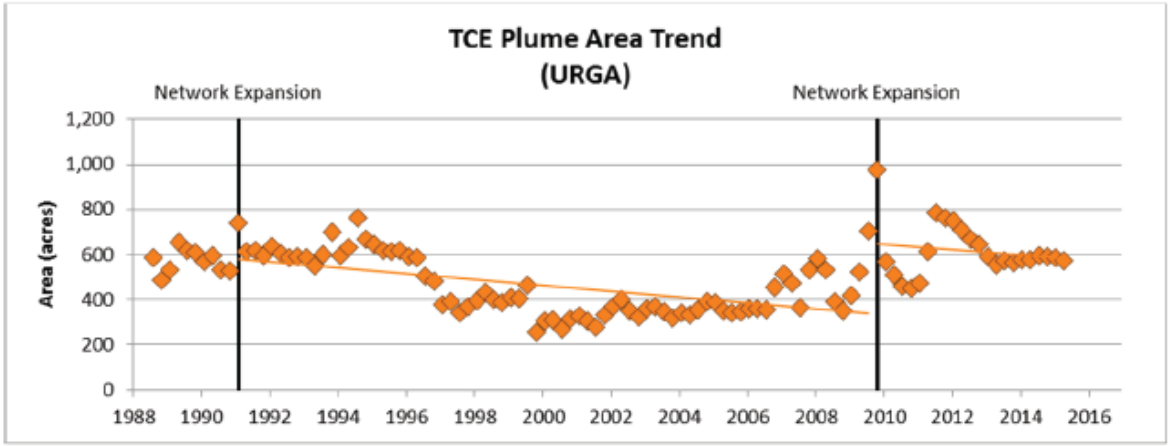
- Documented occurrence of biodegradation by modeling and genetic testing

EarthCon Plume Stability Study

2017 EarthCon Consultants, Inc.
Memphis, TN
Ricker Method® Plume Stability Analysis

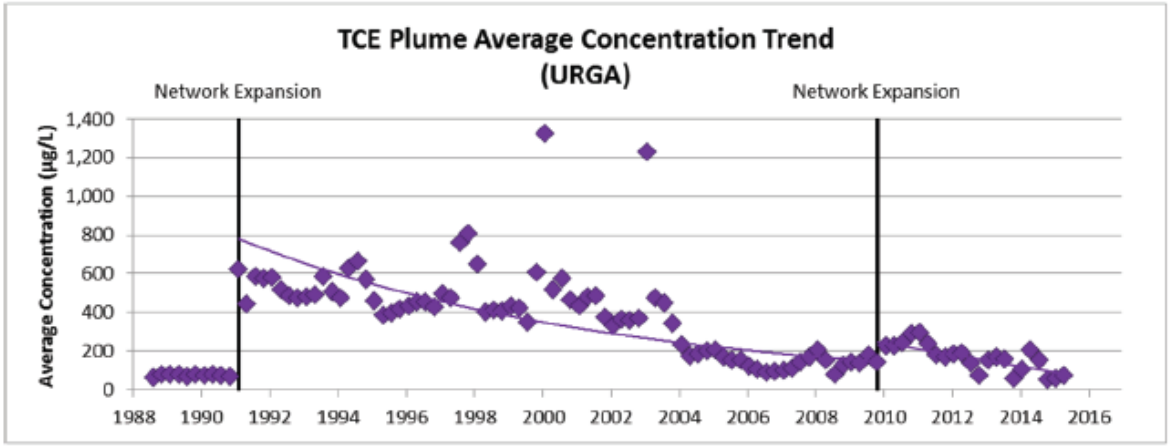
Site-wide TCE Plume Stability Summary			
(Trends From November 2009 to May 2015)			
Plume Metric	**URGA**	**MRGA**	**LRGA**
Area	Stable	Decreasing	Decreasing
Average Concentration	Decreasing	Decreasing	Decreasing
Mass Indicator	Decreasing	Decreasing	Decreasing

Plume Stability Study – URGA



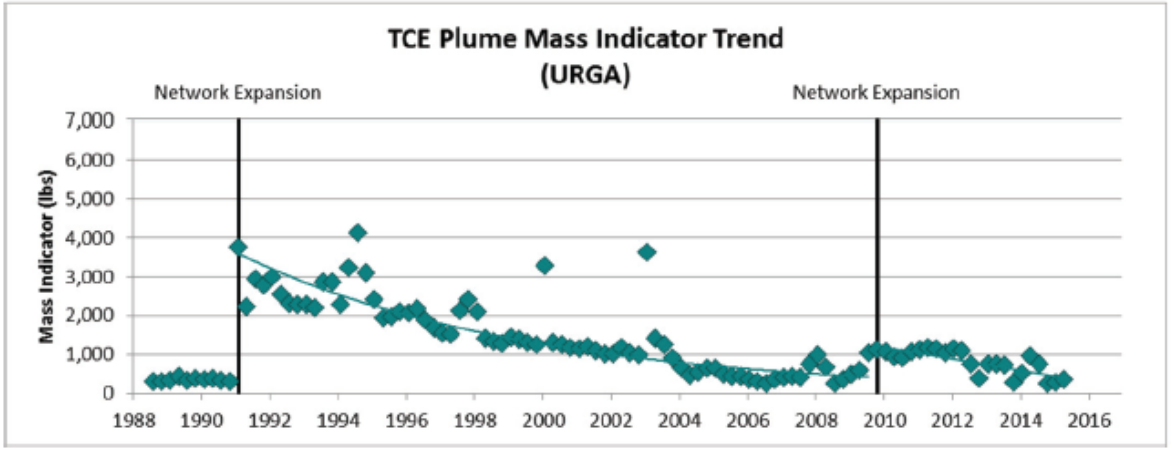
Feb-1991 to Aug-2009
Decreasing Trend
Mann-Kendall: >99% Confidence
Regression: >99% Confidence

Nov-2009 to May-2015
No Trend
Mann-Kendall: 66% Confidence
Regression: 56% Confidence



Feb-1991 to Aug-2009
Decreasing Trend
Mann-Kendall: >99% Confidence
Regression: >99% Confidence

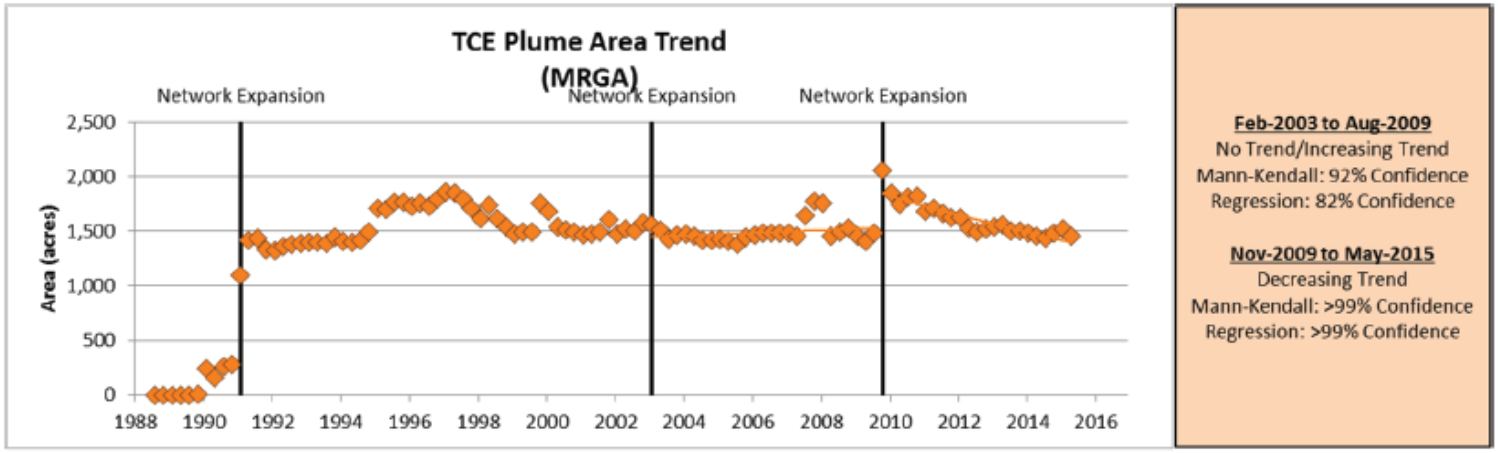
Nov-2009 to May-2015
Decreasing Trend
Mann-Kendall: >99% Confidence
Regression: >99% Confidence



Feb-1991 to Aug-2009
Decreasing Trend
Mann-Kendall: >99% Confidence
Regression: >99% Confidence

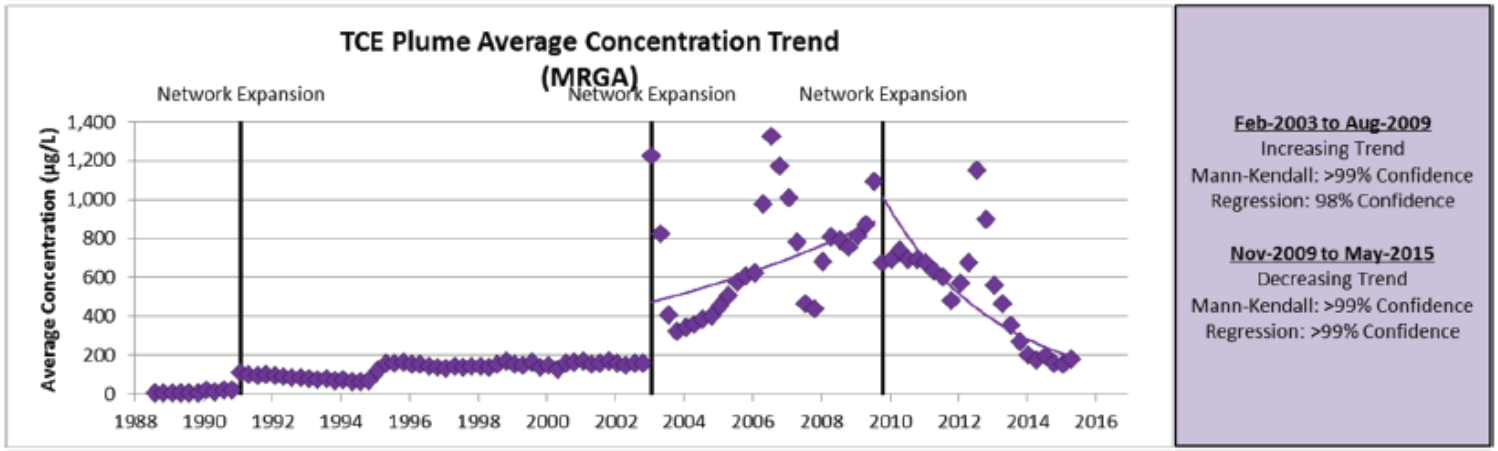
Nov-2009 to May-2015
Decreasing Trend
Mann-Kendall: >99% Confidence
Regression: >99% Confidence

Plume Stability Study – MRGA



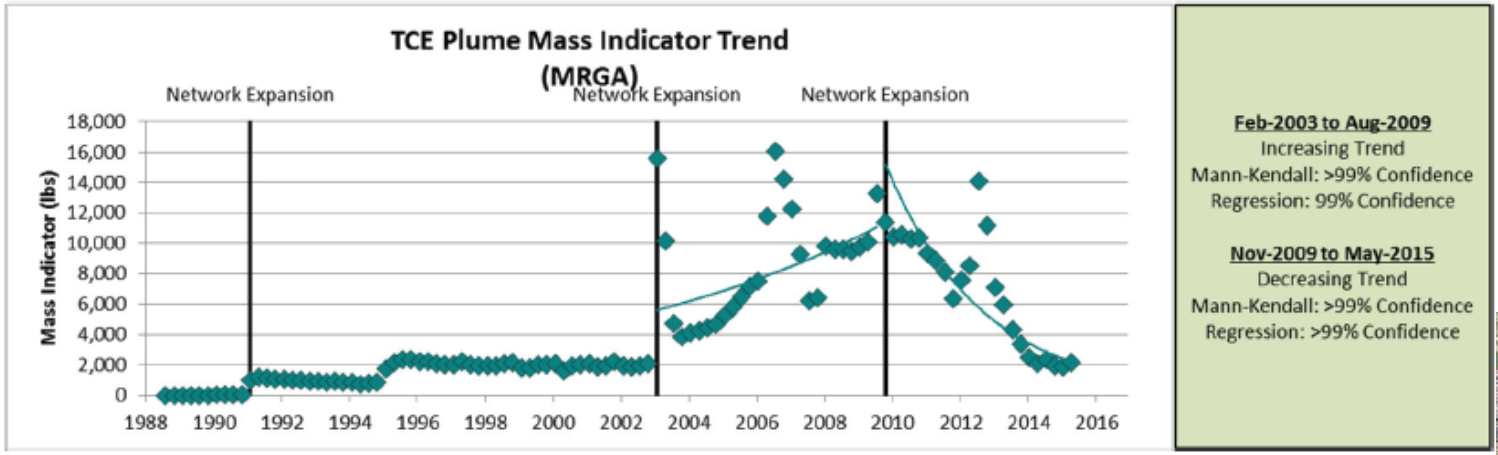
Feb-2003 to Aug-2009
No Trend/Increasing Trend
Mann-Kendall: 92% Confidence
Regression: 82% Confidence

Nov-2009 to May-2015
Decreasing Trend
Mann-Kendall: >99% Confidence
Regression: >99% Confidence



Feb-2003 to Aug-2009
Increasing Trend
Mann-Kendall: >99% Confidence
Regression: 98% Confidence

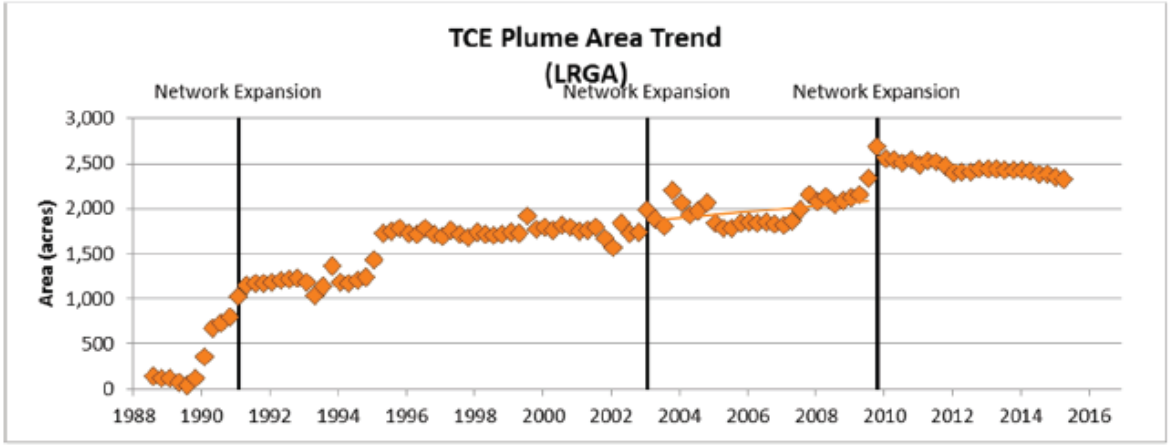
Nov-2009 to May-2015
Decreasing Trend
Mann-Kendall: >99% Confidence
Regression: >99% Confidence



Feb-2003 to Aug-2009
Increasing Trend
Mann-Kendall: >99% Confidence
Regression: 99% Confidence

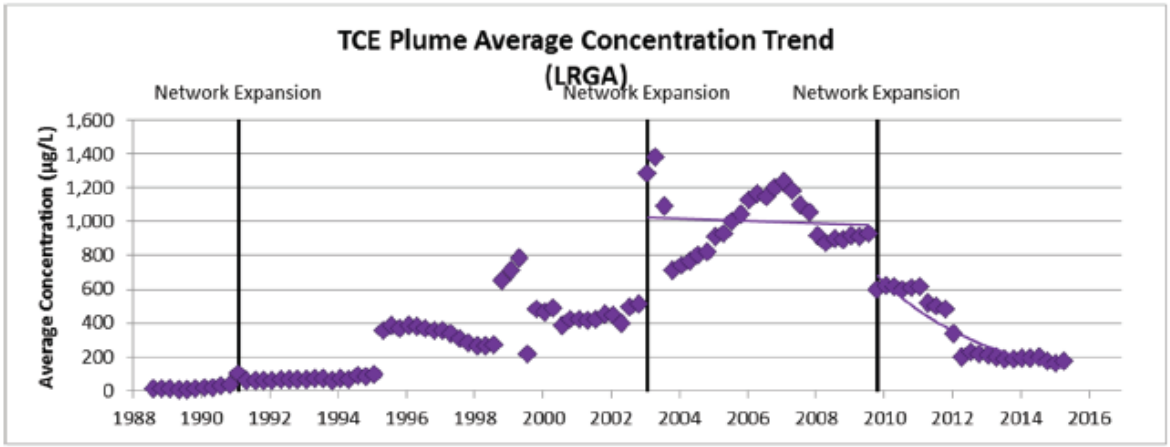
Nov-2009 to May-2015
Decreasing Trend
Mann-Kendall: >99% Confidence
Regression: >99% Confidence

Plume Stability Study – LRGA



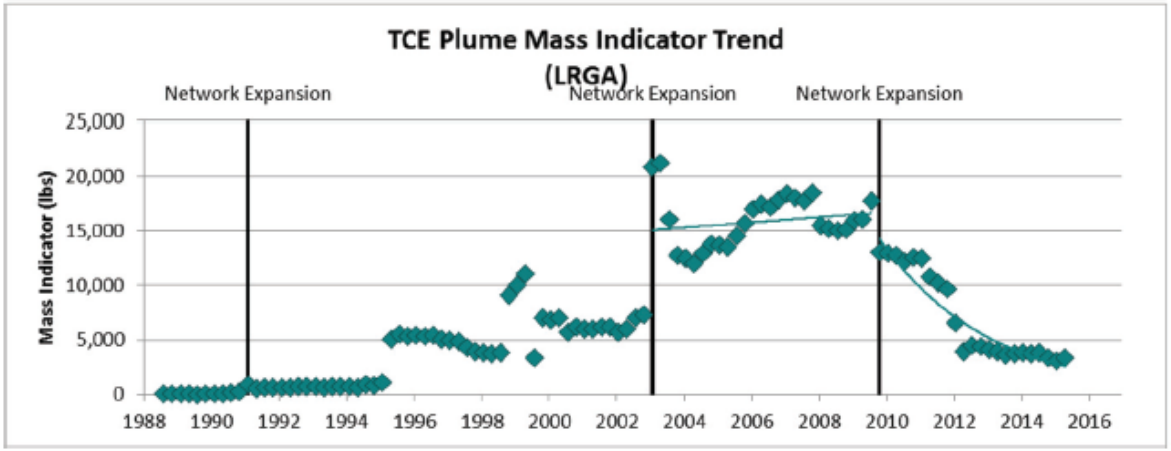
Feb-2003 to Aug-2009
Increasing Trend
Mann-Kendall: 99% Confidence
Regression: 98% Confidence

Nov-2009 to May-2015
Decreasing Trend
Mann-Kendall: >99% Confidence
Regression: >99% Confidence



Feb-2003 to Aug-2009
No Trend
Mann-Kendall: 61% Confidence
Regression: 30% Confidence

Nov-2009 to May-2015
Decreasing Trend
Mann-Kendall: >99% Confidence
Regression: >99% Confidence



Feb-2003 to Aug-2009
No Trend/Increasing Trend
Mann-Kendall: 94% Confidence
Regression: 68% Confidence

Nov-2009 to May-2015
Decreasing Trend
Mann-Kendall: >99% Confidence
Regression: >99% Confidence

Current Groundwater Strategy Project

Goals

- Determine information needed and information to be collected to change the status of the site Environmental Indicators to "Yes" for *Human Exposure Under Control* and for *Groundwater Migration Under Control*;
- Prevent exposure to groundwater, prevent or minimize plume migration, and prevent or minimize further migration from sources;
- Resolve data needs in various portions of the dissolved-phase TCE Northeast, Northwest, and Southwest Plumes; and
- Provide inputs to maintenance and updates to the groundwater model

Current Groundwater Strategy Project

Manual water level measurements, pressure transducer measurements, and colloidal borescope measurements

Activity No.	Area of Concern	Task(s)	Subtask(s)
1	TCE Extent West of PGDP (SW Plume)	Optimize exiting groundwater monitoring network	Review frequency of sampling and analysis and synoptic sampling and analysis
		RGA potentiometric trend investigation	Water level/colloidal borescope investigation
		Develop/revise CSM	Review geology, hydrology, and contaminant trends
2	TCE Extent East of PGDP (Downgradient NE Plume)	RGA potentiometric trend investigation	Map sitewide synoptic water level measurements
			NE Plume synoptic water level measurements
			Continuous water level measurements
			Colloidal borescope investigation
		NE Plume optimization hydraulic analysis	NA
8	TCE Extent and Trends in West Side of Downgradient NE Plume	RGA potentiometric trend investigation	Map sitewide synoptic water level measurements
			NE Plume synoptic water level measurements
			Continuous water level measurements
			Colloidal borescope measurements

Activity No.	Area of Concern	Task(s)	Subtask(s)
13	Continuous RGA Water Level Monitoring	Continuous RGA water level records over a period of a year in the vicinity of the Ohio River and along a transect of wells extending back to the PGDP industrial area	White Paper
			Continuous and manual water level measurements
			Report
14	Synoptic Water Level Measurement	Increased water level measurement events conducted during different seasons	Seasonal water level measurements
		A synoptic data set collected under steady conditions at the higher river stage anticipated to start in 2018 when the Olmsted Locks and Dam are scheduled to be operational	Synoptic data set before operation begins at Olmsted Locks and Dam
			Synoptic data set after operation begins at Olmsted Locks and Dam
15	Water Level Divide Study	Assessing water level and water quality data collected from the newly installed transect of monitoring wells located east of the C-400 Building	NA
		Colloidal borescope study in the vicinity of the apparent groundwater divide located east of the C-400 Building to refine understanding of groundwater flow in the area	NA
17	Monitoring Well Survey Study	Review existing monitoring well survey information	NA
		Review survey data in context of plume maps	NA
18	Groundwater Chemical Trend Evaluation	Assess existing groundwater analytical data for trends and whether analyses should be revised	NA

Current activity

Groundwater Remediation Strategy

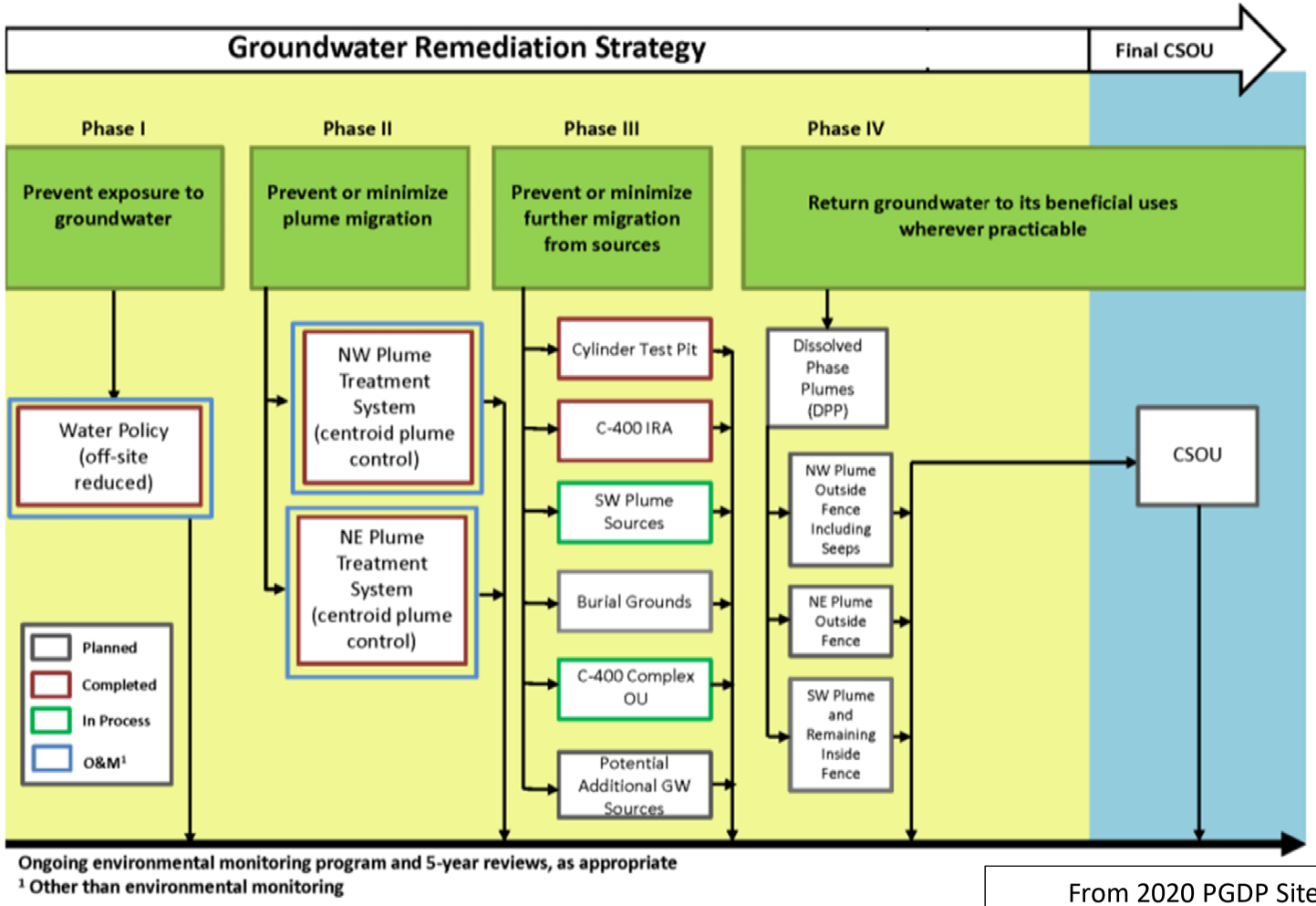


Figure 3.1. Groundwater Remediation Strategy

From 2020 PGDP Site Management Plan (DOE 2020b)

SUMMARY

ACTION	DATE
Groundwater contamination discovered	August 1988
Immediate actions:	
• Provide alternate water supply	August 1988
• Water Policy actions:	
o EECA	1993
o Action Memorandum	1994
Site-wide investigations:	
• Phase I and II Site Investigations	1989 - 1992
• Groundwater Phase III and IV investigations	1992 - 1994
Pump and Treat:	
• Northwest Plume:	
o ROD	1993
o Start of Operations	1995
• Northeast Plume:	
o ROD	1995
o Start of Operations	1997

SUMMARY

ACTION	DATE
Areas and SWMUs contributing to groundwater contamination:	
• SWMU 1:	
o SW Plume ROD (SWMU 1 and SWMUs 211A & B)	2012
o Soil Mixing (24 ±12 gals VOCs removed)	2017
• SWMUs 2 and 3:	
o SWMUs 2 and 3 ROD	1995
o SWMU 2 Remedial Design Investigation	1996
o Burial Grounds OU RI	2007
• SWMU 4:	
o Burial Grounds OU RI	2007
o SWMU 4 RI	2012
• SWMUs 7 and 30:	
o SWMUs 7 & 30 RI	1996 - 1997
o Burial Grounds OU RI	2007
• C-400:	
o WAG 6 RI	1997
o Six-Phase Heating TS	2004
o C-400 ROD	2005
o C-400 Remedial Design Investigation	2006
o Phase I and II ERH (1,672 gals VOCs removed)	2011 and 2014
• Cylinder Drop Test Area:	
o LASAGNA	1997

SUMMARY

ACTION	DATE
Groundwater OU FS	2001
Treatability Studies:	
• Aerobic biodegradation of hydrocarbons	1992
• Iron filings: TCE permeable reactive barrier	1995
• C-400 surfactants (TCE removal)	1995
• P&T Resins: C-612 Tc-99 capture	1998 and 1999
• C-400 chemical oxidation (TCE destruction)	1999
• C-400 Six-Phase Heating (TCE removal) o Led to ERH action	2004
• TCE aerobic biodegradation	2008
• C-400 steam injection	2016
Plume Maps:	
• Earlies plume maps from Phase II Site Investigation	1991
• Start of plume map series	2000
EarthCon Plume Stability Analysis:	2017
• Decreasing area, contaminant levels, and mass since 2009	

SUMMARY

CURRENT ACTIONS

Groundwater Monitoring System:

- 270 RGA wells and 1 seep
- Design:
  - Baseline conditions
  - Compliance with regulations and DOE orders
  - Early detection of groundwater contamination
  - Identify groundwater contamination sources
  - Data for decisions

Groundwater Strategy Program goals:

- Change status of EIs Human Exposure Under Control and Groundwater Migration Under Control to "yes"
- Prevent exposure to groundwater, prevent or minimize plume migration, and prevent or minimize further migration from sources
- Resolve data needs in the dissolved-phase TCE plumes
- Provide inputs to groundwater model

Groundwater Remediation Strategy:

• Phase I: Prevent exposure to groundwater	O & M Phase
• Phase II: Prevent or minimize plume migration	O & M Phase
• Phase III: Prevent of minimize further migration from sources	Completed, In Process, and Planned Phases
• Phase IV: Return groundwater to its beneficial uses wherever practicable	Planning Phase
• Final Comprehensive Site OU actions	Planning Phase

REFERENCES

CH2M HILL 1991. *Results of the Site Investigation, Phase I, at the Paducah Gaseous Diffusion Plant*, *Paducah, Kentucky*, KY/ER-4, CH2M HILL, Paducah, KY.

CH2M HILL 1992. *Results of the Site Investigation, Phase II, at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, KY/SUB/13B-97777C P-03/1991/1, CH2M HILL, Paducah, KY.

Clausen, J.L., K.R. Davis, J.W. Douthitt, and B.E. Phillips 1992. *Report of the Paducah Gaseous Diffusion Plant Groundwater Investigation Phase III*, KY/E-150, Paducah, KY.

COE (U.S. Army Corps of Engineers) 2007. *Review Report: Groundwater Remedial System Performance Optimization at PGDP, Paducah, Kentucky*, U.S. Army Corps of Engineers, Nashville, TN, May.

DOE 1993a. *Record of Decision for Interim Remedial Action for the Northwest Dissolved Phase Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/06-1143&D4, U.S. Department of Energy, Paducah, KY, July.

DOE 1993b. *Engineering Evaluation/Cost Analysis for the Water Policy at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/06-1142&D3, U.S. Department of Energy, Paducah, KY, July.

DOE 1994. *Action Memorandum for the Water Policy at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/06-1201&D2, U.S. Department of Energy, Paducah KY, June.

DOE 1995a. *Record of Decision for Interim Remedial Action at the Northeast Plume, Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/06-1356&D2, U.S. Department of Energy, Paducah, KY, June.

DOE 1995b. *Northeast Plume Preliminary Characterization Summary Report*, DOE/OR/07-1339/V1&D1, U.S. Department of Energy, Paducah, KY, February.

DOE 1999, *Bench Scale In-Situ Chemical Oxidation Studies of Trichloroethene in Waste Aare Grouping 6 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-1788&D1, U.S. Department of Energy, Paducah, KY, February.

REFERENCES

DOE 2001. *Feasibility Study for the Groundwater Operable Unit at Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-1857&D2, 6 Volumes, U.S. Department of Energy, Paducah, KY, February

DOE 2004, *Final Report, Six-Phase Heating Treatability Study at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-2113&D2, U.S. Department of Energy, Paducah, KY, March.

DOE 2007, *Review Report: Groundwater Remedial System Performance Optimization at PGDP, Paducah, Kentucky*, prepared for Office of Groundwater and Soil Remediation and Office of Engineering and Technology, U.S. Department of Energy, May 24.

DOE 2010. *Explanation of Significant Differences to the Record of Decision for Interim Remedial Action of the Northwest Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-0343&D2, U.S. Department of Energy, Paducah, KY, December.

DOE 2011. *Technical Performance Evaluation for Phase I of the C-400 Interim Remedial Action at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-1260&D1, U.S. Department of Energy, Paducah, KY, August.

DOE 2015. *Memorandum of Agreement for Resolution of Formal Dispute of the Explanation of Significant Differences to the Record of Decision for the Interim Remedial Action of the Northeast Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, DOE/LX/07-1291&D2, and Remedial Action Work Plan for Optimization of the Northeast Plume Interim Remedial Action at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, DOE/LX/07-1280&D2*, U.S. Department of Energy, Paducah, KY, July.

DOE 2016. *Treatability Study Report for the C-400 Interim Remedial Action Phase IIb Steam Injection Treatability Study at Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-2202&D2, U.S. Department of Energy, Paducah, KY, May.

DOE 2017. *Remedial Action Completion Report for In Situ Source Treatment by Deep Soil Mixing of the Southwest Groundwater Plume Volatile Organic Source at the C-747-C Oil Landfarm (Solid Waste Management Unit 1) at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-2405&D2, U.S. Department of Energy, Paducah, KY, February 14.

REFERENCES

DOE 2018. *Remedial Action Completion Report for the Interim Remedial Action for the Groundwater Operable Unit for the Volatile Organic Compound Contamination at the C-400 Cleaning Building at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-2417&D2, U.S. Department of Energy, Paducah, KY, July.

DOE 2019. *CY 2018 Five-Year Review for Remedial Actions at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky (Fourth Synchronized Five-Year Review)*, DOE/LX/07-2426&D2, U.S. Department of Energy, Paducah, KY, May.

DOE 2020a. *Methods for Conducting Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, Volume 1. Human Health*, DOE/X/07-0107&D2/R11/V1, U.S. Department of Energy, Paducah, KY, June.

DOE 2020b. *Site Management Plan, Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-2444&D2/R1, U.S. Department of Energy, Paducah, KY, May.

*EARTHCON 2017. *Groundwater Plume Analytics™ Services Including a Ricker Method® Plume Stability Analysis and Well Sufficiency Analysis™, Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, EARTHCON Consultants, Incorporated, Memphis, TN, March.

FRNP (Four Rivers Nuclear Partnership, LLC) 2018. *Environmental Monitoring Plan Fiscal Year 2018 Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, CP2-ES-0006/FR1, Four Rivers Nuclear Partnership, LLC, Paducah, KY, January.

FRNP 2019a. *Environmental Monitoring Plan Fiscal Year 2020 Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, CP2-ES-0006/FR5, Four Rivers Nuclear Partnership, LLC, Paducah, KY, October.

FRNP 2019b. *Trichloroethene and Technetium-99 Groundwater Contamination in the Regional Gravel Aquifer for Calendar Year 2018 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, FRNP-RPT-0074, Four Rivers Nuclear Partnership, LLC, Paducah, KY, June.

FRNP 2020. *Project Management Plan for Groundwater Strategy at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, FRNP-RPT-0094, Four Rivers Nuclear Partnership, LLC, Paducah, KY, January.

GE 1995. Zero-Valent Iron Treatability Study for Groundwater Contaminated with Chlorinated Organic Solvents at the Paducah, KY GDP Site, General Electric Corporate Research and Development, Schenectady, New York, December.

REFERENCES

INTERA 1995. *The In-Situ Decontamination of Sand and Gravel Aquifers by Chemically Enhanced Solubilization of Multiple-Component DNAPLs with Surfactant Solutions – Phase I Final Topical Report: Laboratory and Pilot Field-Scale Testing, DOE Contract Number DE-AC21-92MC29111*, INTERA Incorporated, Austin, TX, January.

*KRCEE (Kentucky Research Consortium for Energy and Environment) 2008, *PGDP Trichloroethene Biodegradation Investigation Summary Report, Regional Gravel Aquifer & Northwest Plume*, University of Kentucky, Kentucky Research Consortium for Energy and Environment, Lexington, KY, September.

MMES (Martin Marietta Energy System, Inc.) 1988, *Paducah Groundwater Contamination, Detailed History and Summary of Future Actions*, KY/H-41, Martin Marietta Energy System, Incorporated, Paducah, KY, December.

MMES 1994. *Treatability Studies Using Iron Filings to Remediate Trichloroethylene and Technetium*, KY/ER-51, Martin Marietta Energy System, Incorporated, Paducah, KY, February.

Monsanto 1998. *Rapid Commercialization Initiative (RCI) Final Report for an integrated in-situ Remediation Technology (Lasagna™)*, Monsanto Company, St. Louis, MO, March.

*OHM 1992. *Final Report of the Laboratory Treatability Study Designed to Determine the Aerobic Biodegradation Potential of Petroleum Hydrocarbons in Soil and Groundwater at Martin Marietta Energy Systems' C-750 Garage Underground Storage Tanks Site in Paducah, Kentucky*, OHM Remediation Services Corporation, Findlay, OH, January.

*ORNL 1998. *A Field Trial of Novel Bifunctional Resins for Removing Pertechnetate (TcO4-) from Contaminated Groundwater*, ORNL/TM-13593, Oak Ridge National Laboratory, Environmental Sciences Division, Oak Ridge, TN, March.

*ORNL 1999. *Selective Anion Exchange Resins for the Removal of Perchlorate (ClO4-) from Groundwater*, ORNL/TM-13753, Oak Ridge National Laboratory, Environmental Sciences Division, Oak Ridge, TN, February.

*Shell, S.L. 1988, *Groundwater Contamination Update* (internal presentation), Martin Marietta Energy System, Inc., Environmental Compliance Department, Paducah, KY, October 5.

*Not available from the Paducah Environmental Information Center

Attachment 4

Lithology Paper Outline and Schedule

The schedule has been revised per discussion and agreement during the meeting (noted in red font).

The Lithology Paper outline is now final per discussion and agreement during the meeting.

Activity	Target Start	Target Finish	Notes
FRNP/DOE Develop Outline for Draft Lithologic Technical Paper	7/7/2020	9/30/2020	
Collect C-400 Lithology Data	8/10/2020	6/9/2021	From C-400 Schedule
Provide Draft Final Lithologic Technical Paper Outline to MWG		9/30/2020	
MWG Review Draft Final Lithologic Technical Paper Outline	9/30/2020	10/14/2020	
Quarterly Meeting (October/FY21Q1)		10/14/2020	
FRNP/DOE Revise Draft Final Outline for Lithologic Technical Paper Based on MWG Discussions	10/14/2020	10/28/2020	
Provide Final Outline for Lithologic Technical Paper to MWG		10/28/2020	
Quarterly Meeting (January/FY21Q2)		1/13/2021	Draft FY2021 MWG Work Plan Date
FRNP/DOE Develop Draft Lithologic Technical Paper Text	10/28/2020	6/4/2021	
Quarterly Meeting (April/FY21Q3)		4/7/2021	Draft FY2021 MWG Work Plan Date
Finish Collection of C-400 Lithology Data		6/9/2021	From C-400 Schedule
FRNP/DOE Incorporate C-400 Results into Draft Lithologic Technical Paper	6/4/2021	11/4/2021	
Develop C-400 RI Report	6/10/2021	12/8/2021	From C-400 Schedule
Quarterly Meeting (July/FY21Q4)		7/14/2021	Draft FY2021 MWG Work Plan Date
Quarterly Meeting (October/FY22Q1)		10/6/2021	Draft FY2021 MWG Work Plan Date
Issue Draft Final Lithologic Technical Paper to MWG		11/4/2021	
MWG Review and Provide Comments on Draft Final Lithologic Technical Paper	11/4/2021	12/6/2021	Accounts for Veteran's Day and Thanksgiving
MWG Meeting to Discuss Draft Final Lithologic Technical Paper		11/17/2021	Draft FY2021 MWG Work Plan Date
MWG Provide Comments on Draft Final Lithologic Technical Paper		12/6/2021	
C-400 RI Report Submitted to EPA and KY		12/31/2021	Current Milestone
FRNP/DOE Revise Draft Final Lithologic Technical Paper	12/6/2021	1/31/2022	No formal CRS; accounts for Christmas and New Year holidays
Quarterly Meeting (January/FY22Q2)		1/12/2022	Proposed date for FY2022 MWG Work Plan
Submit Final Lithologic Technical Paper to EPA and KY		1/31/2022	Tech Paper Due 1 Month After C-400 RI Report (Currently 12/31/2021)

DETAILED CORRELATIONS BETWEEN LITHOLOGIC UNITS IN THE McNAIRY FORMATION ACROSS THE PADUCAH SITE

FINAL ANNOTATED OUTLINE

From the Memorandum of Agreement for Resolution of Informal Dispute Concerning U.S. Environmental Protection Agency and Kentucky Department for Environmental Protection Requirements for Additional Actions or Modifications Regarding the CY 2018 Five-Year Review for Remedial Actions at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, DOE/LX/07-2426&D2 (MOA; DOE 2020):

> "As part of the U.S. Environmental Protection Agency's (EPA's) independent assessment of the FY 2018 Five-Year Review, EPA made a protectiveness deferred determination for the Northeast Plume, the Northwest Plume, and Water Policy response actions, until additional data are collected to verify that human exposures are not occurring. EPA determined additional actions are needed, specifically the collection of additional geological data at the C-400 Complex OU and the development of detailed correlations between lithologic units in the McNairy Formation across the entire Paducah Site, to support an accurate characterization of site faulting and the potential for fault-controlled plume migration across the Plant and beyond the Plant boundaries (including the Water Policy Affected Area). EPA requested that the detailed correlations of the McNairy Formation be reported not later than the C-400 Complex OU D1 Remedial Investigation/Feasibility Study (RI/FS) Report.
>
> The following uncertainties were identified regarding protectiveness for the Northwest Plume, Northeast Plume, and Water Policy response actions:
>
> — The presence of unknown contamination in off-site areas.
> — The presence of unknown migration of contamination due to pathways not understood.

To help manage these uncertainties regarding protectiveness, EPA proposed additional characterization of site faulting and the potential for fault-controlled plume migration across the Paducah Site (including the Water Policy Affected Area) as part of the 2023 Five-Year Review.

DOE will develop a technical paper discussing two lithological correlations of the McNairy Formation: one along a north-south transect and the other along an east-west transect (see Figure 1 [of MOA]). The transects will be developed using the existing data from previously drilled 8 deeper soil borings and from 6 discrete locations, that extend near/through the base of the McNairy Formation (which occurs at elevations of -2 to 66 ft amsl beneath the Paducah Site).

— A north-south transect (relative to the Plant coordinate system) of 5 previously drilled soil borings/4 locations over ~ 19,200 ft (~ 3.6 miles), extending from immediately south of the Paducah Site industrial complex to near TVA's Shawnee Steam Plant.

— An east-west transect (relative to the Plant coordinate system) of 4 previously drilled soil borings/3 locations over ~ 5,500 ft (~ 1.0 miles) across the north side of the Plant.

Inputs into the lithological correlations will include a combination of the historical soil boring logs from both the deeper and shallower McNairy Formation within the Paducah Site and the adjacent TVA Shawnee Steam Plant and soil boring logs of the McNairy Formation from the C-400 Complex OU RI/FS (currently underway) that fall along the north-south and east-west transects."

1.2 OBJECTIVES

Characterization of site faulting and the potential for fault-controlled plume migration across the Paducah Site (including the Water Policy Affected Area) are needed to better understand

- the presence of unknown contamination in off-site areas and
- the presence of unknown migration of contamination due to pathways[1] not understood.

DOE will develop a technical paper discussing two lithological correlations of the McNairy Formation: one along a north-south transect and the other along an east-west transect (see Figure 1 [of MOA]) within the Paducah Site and Water Policy Affected Area to assess the presence of fault displacement and, if present, the magnitude of fault displacement.

Inputs into the lithological correlations will include a combination of the historical soil boring logs from both the deeper and shallower McNairy Formation within the Paducah Site and the adjacent TVA Shawnee Steam Plant and soil boring logs of the McNairy Formation from the C-400 Complex OU RI/FS (currently underway) that fall along the north-south and east-west transects.

[1] The term "pathways" is used synonymously with "preferential pathways for contaminant migration."

Characterization of site faulting and the potential for fault-controlled plume migration across the Paducah Site (including the Water Policy Affected Area) are needed to better understand

- the presence of unknown contamination in off-site areas and
- the presence of unknown migration of contamination due to pathways not understood.

This white paper will address characterization of site faulting.

5.1.2 Identify the Decision

The correlation of lithologic units in the McNairy Formation is intended to assess whether there is significant faulting beneath the Paducah Site that could be a contaminant migration pathway.

5.1.3 Identify Inputs to the Decision

Inputs to this characterization will be based on historical soil boring logs of the McNairy Formation at the Paducah Site and the adjacent TVA Shawnee Steam Plant as well as soil boring logs of the McNairy Formation from the C-400 Complex OU RI.

5.1.4 Define the Study Boundaries

1. McNairy Formation
2. Existing soil boring logs of the Paducah Site and adjacent TVA Shawnee Steam Plant
3. Soil boring logs that will be completed for the C-400 Complex Remedial Investigation

5.1.5 Develop a Decision Rule

This correlation will utilize the following decision rules:

1. If a lithologic contact disruption is identified, assess if the discontinuity is fault-related.
   a. The McNairy Formation consists of lagoonal-to-shallow marine deposits with frequent depositional discontinuities.
   b. The McNairy Formation consisted of "soft" sediment deposition that may have resulted in diagenetic-related discontinuities (unrelated to faulting).
   c. Large bioturbation features are abundant.
2. If faulting is identified, assess the orientation and continuity of the structure(s).
   d. The expected trend, consistent with the Fluorspar Area Complex of southern Illinois, is NE-SW.

5.1.6 Specify Limits on Decision Errors

Decision errors will be determined primarily by the frequency of sample collection and impacted by the quality of the data.

5.1.7 Optimize the Design for Obtaining Data

Where marker horizons can be identified, adjacent continuous geologic and geophysical logs may be able to identify small-scale discontinuities (on the order of 5 ft) with reasonable confidence. The resolution of faulting using logs based on grab samples at regular intervals will be governed by the sampling frequency (depth-wise). Initially scrutinizing the available logs to identify candidate marker horizons will increase the effectiveness of the lateral comparison of the logs.

6 DATA SETS

6.1 EXISTING DATA

6.1.1 Lithologic Logs

Soil boring logs are available from reports from individual projects (hardcopy) and in a spreadsheet database prepared by the Kentucky Research Consortium for Energy and Environment (KRCEE) (R9_MSTR_Hydrolithostrat_Dbase_Upload_110419.xlsx).

Historical soil boring logs consist of the following:

— Eight soil borings in six discrete locations that extend to/through the base of the McNairy Formation.

— Approximately 159 soil borings that extend downward to an elevation of 240 ft amsl or deeper (providing characterization of $\geq$40 ft of the upper McNairy/Clayton Formation). Soil boring depths range from 91 to 359 ft.

– A cluster of shallower soil borings are within and near the industrial complex. This includes most of the air-rotary soil borings with grab sample logs and continuous core logs.

— Additional soil borings at the Shawnee Steam Plant extend downward to an elevation of 240 ft amsl or deeper.

Several types of logs are available for the Paducah Site soil borings. A few of the soil borings have geologists' descriptions of continuous core. Several of the soil borings have geologists' descriptions of grab samples collected at regular, frequent intervals. Many of the soil borings have geologists' descriptions of cuttings collected from the cyclone discharge of an air rotary rig. These samples are of limited use for detailed lithologic characterization. However, most of these soil borings also have paper strip logs of natural gamma activity and neutron porosity that may be used to interpret and correlate geology. Three of the deep soil borings have logs of shear wave velocities.

With few exceptions (notably soil boring DB01/DB02), the geologic descriptions are captured in the database of Paducah lithologic logs (R9_MSTR_Hydrolithostrat_Dbase_Upload_110419.xlsx) prepared by KRCEE. Hard copies of the geologic logs are available for all of the soil borings in various project reports.

6.1.2 Geophysical logs

Geophysical logs extending into the McNairy Formation are available for 97 soil borings of the Paducah Site. The majority of these soil borings were drilled by the remedial investigations of Waste Area Groupings 3, 6, and 27; the Data Gaps Investigation associated with the remedial investigation of Waste Area Groupings 8 and 28; and the Phase IV Groundwater Investigation. Most soil boring records include downhole logs for both gamma ray and neutron porosity.

6.2 C-400 Complex RI

The C-400 Complex Remedial Investigation will complete a minimum of 17 soil borings to depths of at least 50 ft within the McNairy Formation. Lithologic logs will be developed for each of the soil borings.

7 DATA ADEQUACY

7.1 DEPTH OF DATA/THICKNESS OF MCNAIRY INVESTIGATED

7.2 SPACING OF SAMPLE LOCATIONS

7.3 QUALITY OF DATA

7.3.1 Sampling method

7.3.2 Vertical frequency

8 ASSESSMENT METHODS

8.1 CROSS SECTIONS

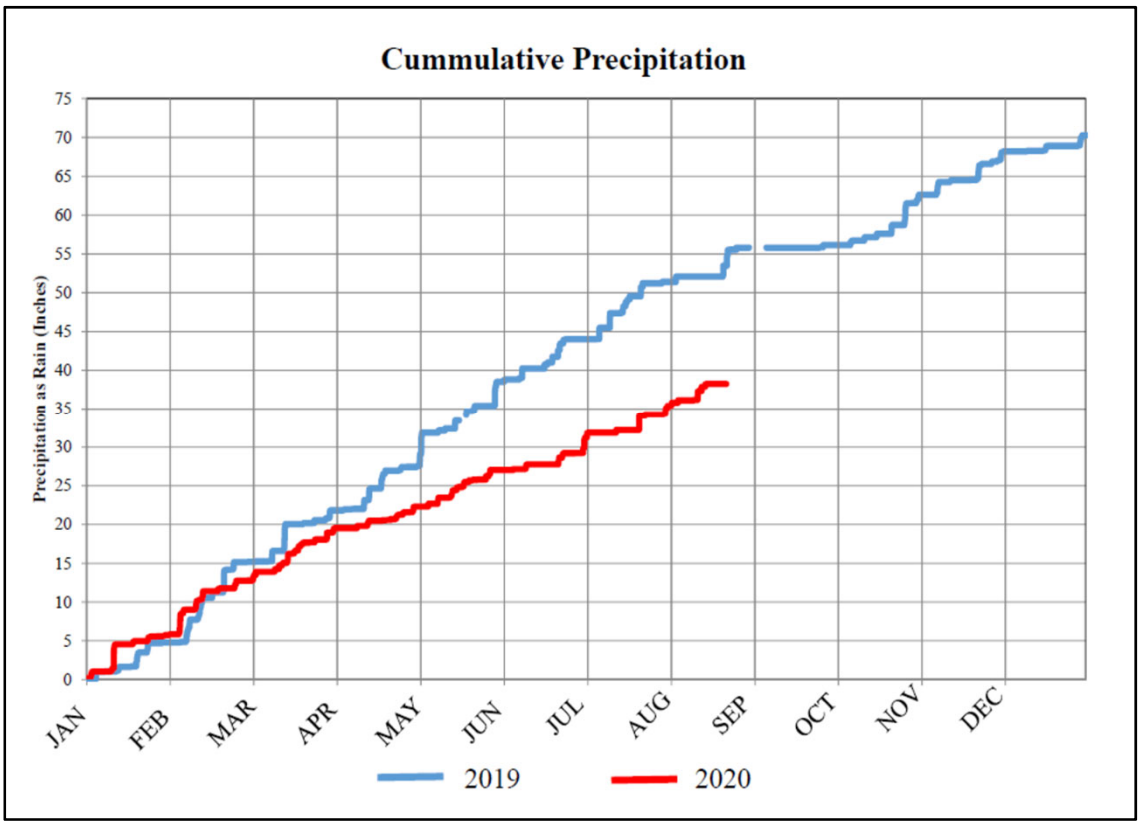
The Paducah Site McNairy soil boring logs can be generalized as two primary populations as discussed below.

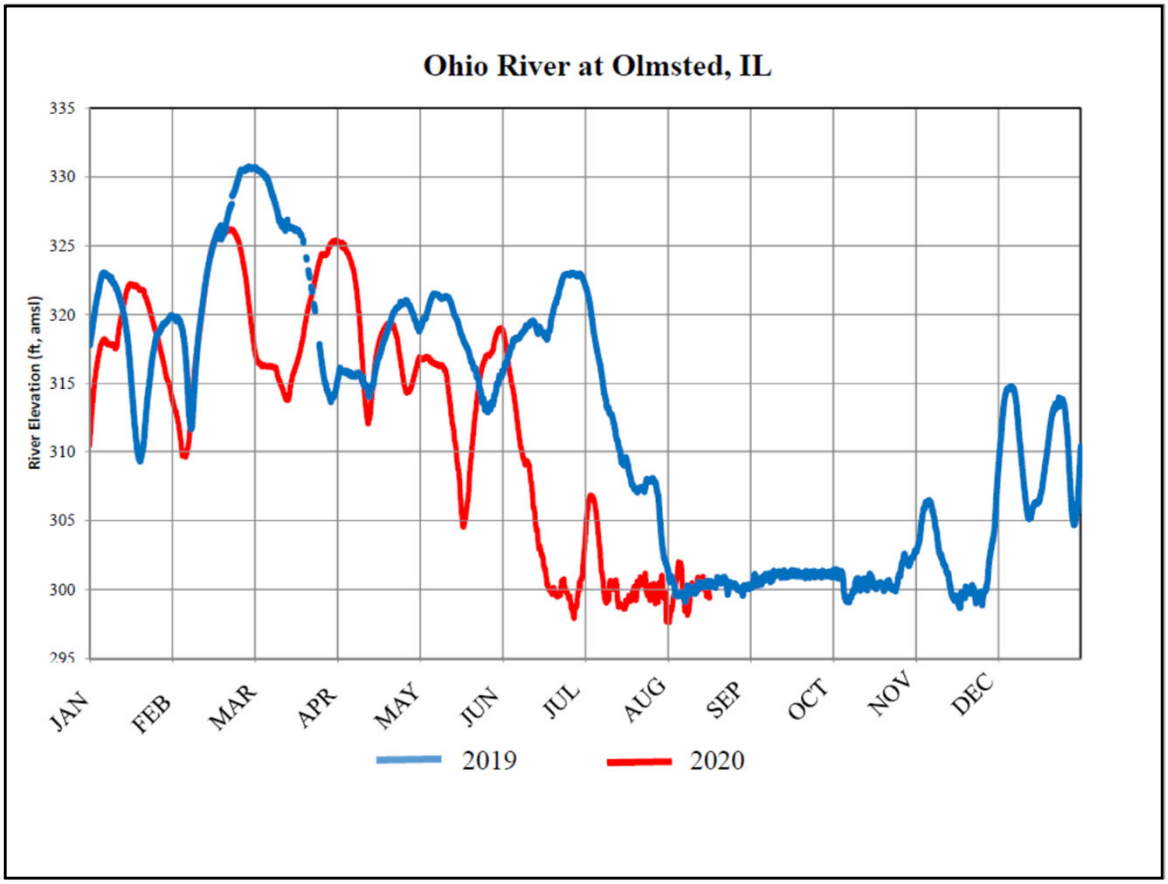
— A north-south transect (relative to the plant coordinate system) of ~19,200 ft (approximately 3.6 miles), extending from immediately south of the plant industrial complex to near TVA's Shawnee Steam Plant.
— An east-west transect (relative to the plant coordinate system) of ~ 5,500 ft across the north side of the industrial complex.

For detailed McNairy correlations, the following geologic information should be noted.
— North of the buried Porters Creek Clay Terrace Slope, the top of the McNairy/Clayton Formation is truncated by an erosional unconformity marking the bottom of the channel of the ancestral Tennessee River Valley, commonly occurring at an elevation of approximately 280 ft amsl.
— South of the buried Porters Creek Clay Terrace Slope, the top of the McNairy/Clayton Formation slopes to the south with a shallow dip (<10°) beneath the Porters Creek Clay.

Attachment 5

Precipitation and Ohio River Stage Data


Cummulative Precipitation
Precipitation as Rain (Inches)
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
2019
2020


Ohio River at Olmsted, IL
River Elevation (ft, amsl)
335
330
325
320
315
310
305
300
295
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
2019
2020

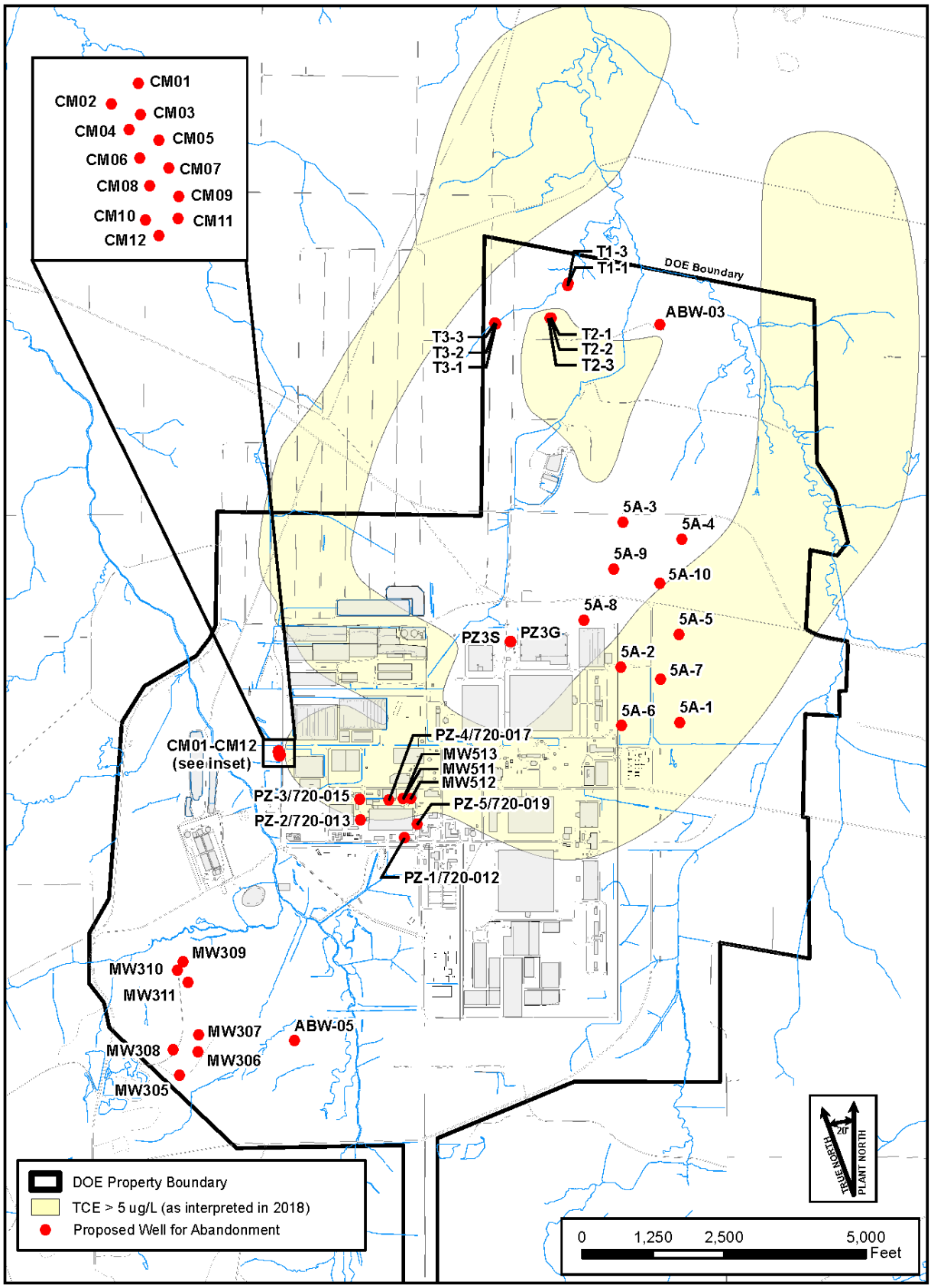
Attachment 6

2020 Well Abandonment Listing

All 50 monitoring wells/piezometers were abandoned prior to the October 14, 2020 MWG Meeting. The listing has been updated to reflect this status.

Well/Piezometer No.	Year Installed	AKGWA #	Project
PZ3G	NA	NA	Site Investigation Phase II Aquifer Test
PZ3S	NA	NA	Site Investigation Phase II Aquifer Test
CM01	2000	NA	SW Plume Permeable Treatment Zone Study
CM02	2000	NA	SW Plume Permeable Treatment Zone Study
CM03	2000	NA	SW Plume Permeable Treatment Zone Study
CM04	2000	NA	SW Plume Permeable Treatment Zone Study
CM05	2000	NA	SW Plume Permeable Treatment Zone Study
CM06	2000	NA	SW Plume Permeable Treatment Zone Study
CM07	2000	NA	SW Plume Permeable Treatment Zone Study
CM08	2000	NA	SW Plume Permeable Treatment Zone Study
CM09	2000	NA	SW Plume Permeable Treatment Zone Study
CM10	2000	NA	SW Plume Permeable Treatment Zone Study
CM11	2000	NA	SW Plume Permeable Treatment Zone Study
CM12	2000	NA	SW Plume Permeable Treatment Zone Study
PZ-1/720-012	1998	NA	WAG 27
PZ-2/720-013	1998	NA	WAG 27
PZ-3/720-015	1998	NA	WAG 27
PZ-4/720-017	1998	NA	WAG 27
PZ-5/720-019	1998	NA	WAG 27
5A-1	2015	8007-0112	WDA Temp PZs
5A-2	2015	8007-0113	WDA Temp PZs
5A-3	2015	8007-0114	WDA Temp PZs
5A-4	2015	8007-0115	WDA Temp PZs
5A-5	2015	8007-0116	WDA Temp PZs
5A-6	2015	8007-0117	WDA Temp PZs
5A-7	2015	8007-0118	WDA Temp PZs
5A-8	2015	8007-0119	WDA Temp PZs
5A-9	2015	8007-0120	WDA Temp PZs
5A-10	2015	8007-0121	WDA Temp PZs
11-1(T1-1)	2015	8007-0122	WDA Temp PZs
11-2(T1-2)	2015	NA	WDA Temp PZs
11-3 (T1-3)	2015	8007-0123	WDA Temp PZs
11-4 (T2-1)	2015	8007-0124	WDA Temp PZs
11-5 (T2-2)	2015	8007-0125	WDA Temp PZs
11-6 (T2-3)	2015	8007-0126	WDA Temp PZs
11-7 (T3-1)	2015	80070127	WDA Temp PZs
11-8 (T3-2)	2015	8007-0128	WDA Temp PZs
11-9 (T3-3)	2015	8007-0129	WDA Temp PZs
MW305	1994	8001-3661	WAGs 1& 7
MW306	1994	8001-3662	WAGs 1& 7
MW307	1994	8001-3663	WAGs 1& 7
MW308	1994	8001-2424	WAGs 1& 7
MW309	1994	8001-3664	WAGs 1& 7

Well/Piezometer No.	Year Installed	AKGWA #	Project
~~MW310~~	~~1994~~	~~8001-3665~~	~~WAGs 1& 7~~
~~MW311~~	~~1994~~	~~8001-3666~~	~~WAGs 1& 7~~
~~MW511~~	~~2012~~	~~8006-5911~~	~~Remedial Design Support Investigation – 211-A and 211-B~~
~~MW512~~	~~2012~~	~~8006-5912~~	~~Remedial Design Support Investigation – 211-A and 211-B~~
~~MW513~~	~~2012~~	~~8006-5913~~	~~Remedial Design Support Investigation – 211-A and 211-B~~
~~ABW-03~~	~~NA~~	~~NA~~	~~Homestead Wells~~
~~ABW-05~~	~~NA~~	~~NA~~	~~Homestead Wells~~



Proposed Well Abandonment

G:\GIS\ARCVIEWS\PROJECTS\MISC\Well_Abandon2020wR3.mxd
2/24/2020

APPENDIX B

GROUNDWATER MODELING WORKING GROUP MEETING SUMMARY—JANUARY 13, 2021

THIS PAGE INTENTIONALLY LEFT BLANK

ACRONYMS[1]

AFFF	aqueous-film-forming foam
AIP	agreement in principle
AP	Advanced Placement®
ASAP	as soon as possible
ASER	annual site environmental report
bgs	below ground surface
CAB	Citizens Advisory Board
CAER	Center for Applied Energy Research
CB	colloidal borescope
CBPC	community based participatory communication
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CoD	College of Design
CRS	comment response summary
CSM	conceptual site model
CUSSO	Central United States Seismic Observatory
D&D	decontamination and decommissioning
DOE	U.S. Department of Energy
DQO	data quality objective
DWGIS	data warehouse development/deployment
EAP	enzyme activity probes
ECI	Exhibit Concepts, Inc.
EES	Earth and Environmental Sciences
EM	Environmental Management
EMP	environmental monitoring plan
EPA	U.S. Environmental Protection Agency
ERH	electrical resistance heating
ET-DSP	Electro Thermal Dynamic Stripping Process
F&T	fate and transport
FT	fate and transport
FFA	Federal Facility Agreement
FRNP	Four Rivers Nuclear Partnership, LLC
FS	feasibility study
FY	fiscal year
GW	groundwater
GWSP	Groundwater Strategy Project
GWOU	groundwater operable unit
HS	high school
ID	identify
IGS	Illinois Geological Survey
ITRC	Interstate Technology & Regulatory Council
KGS	Kentucky Geological Survey
KRCEE	Kentucky Research Consortium for Energy and the Environment
KTC	Kentucky Technical College
KWRRI	Kentucky Water Resources Research Institute
KY	Commonwealth of Kentucky
LBC	Little Bayou Creek

[1] Acronym list was not part of the original meeting summaries.

LRGA	Lower Regional Gravel Aquifer
M	million
MCHS	Marshall County High School
MRGA	Middle Regional Gravel Aquifer
MW	monitoring well
MWG	Modeling Working Group
NMSZ	New Madrid Seismic Zone
NWP	northwest plume?
OREIS	Oak Ridge Environmental Information System
OU	operable unit
PEGASIS	PPPO Environmental Geographic Analytical Spatial Information System
PFAS	per- and polyfluoroalkyl substances
PGDP	Paducah Gaseous Diffusion Plant
PI	preliminary investigation
PM	project manager
PPE	personal protective equipment
PPPO	Portsmouth/Paducah Project Office
P-QAPP	programmatic quality assurance project plan
PRS	Paducah Remediation Services, LLC
PT	pressure transducer
P&T	pump and treat
PVC	polyvinyl chloride
PWS	public water system
PZ	piezometer
Q	quarter
REDOX	reduction-oxidation
RFP	request for proposal
RGA	Regional Gravel Aquifer
RI	remedial investigation
SADA	spatial analysis decision assistance
SCI	stable carbon isotope
SME	subject matter expert
SRNL	scenarios selection tool
STEM	science, technology, engineering, and mathematics
SW	surface water
SWMU	solid waste management unit
T-RFLP	terminal restriction fragment length polymorphism
TMDL	total maximum daily load
TRS	Thermal Remediation Services
TVA	Tennessee Valley Authority
UCRS	upper continental recharge system
UK	University of Kentucky
UK-CHFS	Kentucky Cabinet for Health and Family Services
ULF	ultra low frequency
UN	United Nations
URGA	Upper Regional Gravel Aquifer
VI	vapor intrusion
VM	virtual museum
VSAP	vertical seismic array Paducah
VSP	visual sample plan
WDA	waste disposal alternative
WKWMA	West Kentucky Wildlife Management Area

Paducah Site Groundwater Modeling Working Group
Meeting Summary—January 13, 2021

MWG Member List:

Noman Ahsanuzzaman ✓	Eva Davis ✓	Mac McRae ✓
Brian Begley ✓	Ken Davis ✓	Tabitha Owens
Ben Bentkowski ✓	David Dollins ✓	Todd Powers ✓
Rich Bonczek ✓	Rob Flynn ✓	Bruce Sterns ✓
Stephanie Brock ✓	Bruce Ford ✓	Joe Tarantino ✓
Austin Buckhalter ✓	Stefanie Fountain ✓	Tracy Taylor ✓
Martin Clauberg ✓	LeAnne Garner	Chris Travis ✓
Bryan Clayton	Nathan Garner ✓	Denise Tripp ✓
Lisa Crabtree	Steve Hampson ✓	Victor Weeks ✓
Jana Dawson	Brian Lainhart	Alexis Wiltfong ✓

1. Call for Issues from Groundwater Modeling Working Group (MWG) Members

Comment received from E. Davis on December 1, 2020 on Item 7, Bullet 3 of the October 14, 2020 draft meeting summary (sent November 21, 2020):

"Correction/clarification on what was said during the call:

#7 on Ken's presentation, 3rd bullet, it states:

Slide 31 - For the thermal treatment of the lower RGA, was there an effort to control or reduce the higher groundwater velocities? With a higher groundwater flux through a treatment zone, the heat would not be retained. Had the heat been retained, had the groundwater flux been controlled, there could have been a more effective outcome. Discussion: Both the Phase I and Phase IIa ERH applications included multiphase extraction wells, which were used, in part, to maintain a flat to inward hydraulic gradient during the operation of the ERH system.

The lower RGA was never treated using thermal remediation during Phases I & IIa - both only treated the upper portion of the RGA. During Phase IIa, a pilot was conducted in the lower RGA to determine if it could be heated using the using ET-DSP (the version of ERH deployed by the vendor McMillian-McGee), that involved 3 electrodes into the deep RGA, but I don't believe there was groundwater extraction from the deep RGA, only from the shallower zones which were actually being treated (contrary to what I said during the call, there was groundwater extraction from the shallower treated areas). This pilot did not demonstrate that the lower RGA could be heated to treatment temperatures using that technology. The ERH pilot carried out earlier by TRS using 6 phase heating also did not demonstrate that the lower RGA could be heated using that technology. No groundwater was extracted during this pilot, but if sufficient groundwater had been extracted it is possible that better heating of the lower RGA could have been achieved. But it is not clear that that would have been achievable or cost effective.

The steam injection pilot that was carried out in the RGA demonstrated that the lower RGA (including the top of the McNairy) can be heated to treatment temperatures using steam injection. This technology is applicable to the entire RGA."

Proposed revision to Item 7, Bullet 3 of the October 14, 2020 draft meeting summary:

Slide 31 - For the thermal treatment of the lower RGA, was there an effort to control or reduce the higher groundwater velocities? With a higher groundwater flux through a treatment zone, the heat would not be retained. Had the heat been retained, had the groundwater flux been controlled, there could have been a more effective outcome. Discussion: Both the Phase I and Phase IIa ERH applications included multiphase extraction wells in the upper RGA, which were used, in part, to maintain a flat to inward hydraulic gradient during the operation of the ERH system. Only Phase I attempted heating in the lower RGA, to assess the effectiveness of ERH in the lower zone. No additional pumping from the lower RGA zone or other control of groundwater velocity, was performed. Phase I demonstrated that ERH was ineffective in the lower RGA, which was attributed, in part, to higher groundwater flow velocity in the lower RGA. A later steam injection pilot study was able to heat the lower RGA to treatment temperatures. An analysis of the results indicates the lower RGA has a higher hydraulic conductivity.

The revisions were discussed by the MWG members; no changes were made to the proposed revised text. ***The revised text will be incorporated into October meeting summary.***

2. FY 2021+ Work Plan/Schedule

a. FY 2021 Work Plan/Schedule

Activity	Date
~~Provide Draft Final Lithologic Technical Paper Outline to MWG~~	~~9/30/2020~~
~~Submit FY21 Schedule to MWG~~	~~9/30/2020~~
~~Comments Due for July Meeting Draft Summary~~	~~10/7/2020~~
~~Quarterly Meeting (October/FY21Q1)~~	~~10/7/2020~~
~~Submit Draft Compilation of Meeting Summaries and White Papers (1/2019-7/2020)~~	~~10/14/2020~~
~~MWG concurs with FY21 Schedule~~	~~10/14/2020~~
~~Provide Final Outline for Lithologic Technical Paper to MWG~~	~~10/22/2020~~
~~Submit Draft Compilation of Meeting Summaries and White Papers (1/2019-7/2020)~~	~~10/28/2020~~
~~Comments Due for Draft Compilation of Meeting Summaries and White Papers (1/2019-7/2020)~~	~~11/25/2020~~
~~Submit Final Compilation of Meeting Summaries and White Papers (1/2019-7/2020)~~	~~12/11/2020~~
Quarterly Meeting (January/FY21Q2)	1/13/2021
Quarterly Meeting (April/FY21Q3)	4/7/2021
Quarterly Meeting (July/FY21Q4)	7/14/2021
Submit Draft Meeting Summaries and White Papers Compilation (FY21)	9/29/2021

No comments were received on the FY 2021 schedule.

c. Draft FY 2022+ Activities

Activity	Date
Quarterly Meeting (October/FY22Q1)	10/6/2021
MWG Provide Comments on Draft Compilation of Meeting Summaries and White Papers (FY21)	10/13/2021
~~Issue Draft Final Lithologic Technical Paper to MWG~~	~~11/4/2021~~
Submit Final Compilation of Meeting Summaries and White Papers (FY21)	11/10/2021
~~MWG Meeting to Discuss Draft Final Lithologic Technical Paper~~	~~11/17/2021~~
~~MWG Provide Comments on Draft Final Lithologic Technical Paper~~	~~12/6/2021~~
Quarterly Meeting (January/FY22Q2)	1/12/2022
~~Submit Final Lithologic Technical Paper to EPA and KY~~	~~1/31/2022~~

No comments were received on the draft FY 2022+ schedule.

The draft dates for the Lithologic Technical Paper are being revised to align with the revised schedule for the C-400 Remedial Investigation project, specifically the revised FFA date for the D1 C-400 RI/FS Report of October 7, 2022 (previously December 31, 2021):

Activity	Date
Issue Draft Final Lithologic Technical Paper to MWG	8/11/2022
MWG Meeting to Discuss Draft Final Lithologic Technical Paper	8/24/2022
MWG Provide Comments on Draft Final Lithologic Technical Paper	9/12/2022
Submit Final Lithologic Technical Paper to EPA and KY	11/7/2022

A more comprehensive version of the revised Lithology Technical Paper schedule is included in Attachment 1 to this summary (Agenda Attachment 2). The schedule logic was not revised, only the dates were revised to align with the new dates for the C-400 project. No comments were received on the schedule.

3. Update on Water Levels

Synoptic water level events are being collected quarterly and have occurred on August 24-26, 2020 and December 21-22, 2020.

The last groundwater elevation data for TVA wells collected by KY occurred on August 27 and was included in the October 7 meeting agenda and summary materials.

KY confirmed the last date of the TVA well groundwater elevation data collection as August. No comments were received on the water levels update.

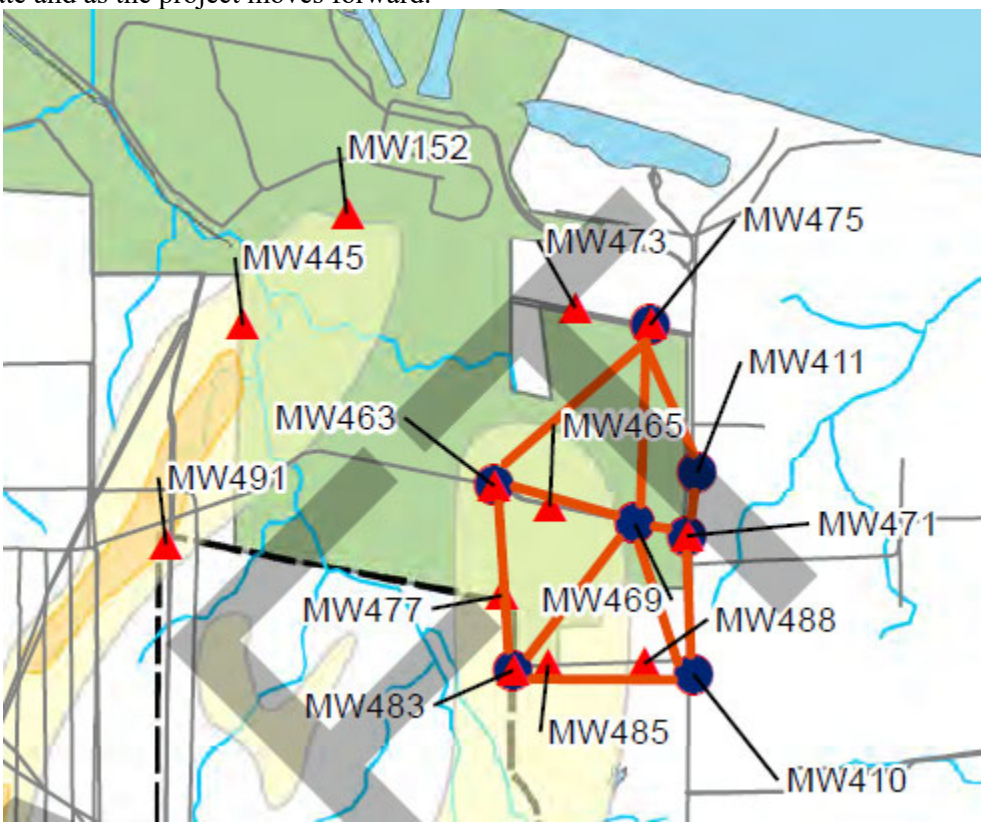
4. Update on Paducah Site Groundwater Strategy

The Groundwater Strategy Project (GWSP) schedule from the EMP is included as Attachment 1 [of the agenda]. In this schedule, "Month 1" is September 2020. Data has been collected for Months 1-4 (September-December) and Month 5 data collection is in progress. Data processing is in progress.

Field conditions encountered to date:

- Month 1: Removal of MW411 from the colloidal borescope data collection portion of the GWSP (Email November 19 and response from KY on November 20)
    - Nearby wells MW469 (west), MW471 (south), and MW475 (north) are part of the GWSP colloidal borescope program (see map next page). There are no wells to the east of MW471.
- Month 2: MW99 and MW477 manual water levels were not able to be collected due to wet conditions. The transducers had sufficient memory to continue to collect data.
- Month 3: MW71 pressure transducer malfunction– transducer has been repaired.
- Month 4: All data collected.
- Month 5: MW469 is not accessible for colloidal borescope deployment due to TVA road construction activities and will be substituted with MW472 (collocated with MW471).

The complete dataset will be available in October 2021. Preliminary data will be discussed when appropriate and as the project moves forward.



From: "Draft Figure 5. Colloidal Borescope and Pressure Transducer Wells – Month 1" presented at the April 2019 Groundwater MWG meeting.

FRNP continues to coordinate with KY on the AIP monitoring wells sampling schedule and schedule conflicts between sampling and borescope measurements have been resolved.

No comments were received on the status update. The Groundwater Strategy Project (GWSP) schedule (Agenda Attachment 1) is included as Attachment 2.

5. Discussion on Installation of Piezometers …Associated with Several of the Large Process Buildings

Preliminary information to be collected for the "Installation of piezometers …associated with several of the large process buildings…." white paper will benefit from the information learned during the

vapor intrusion (VI) project. The D2/R1 VI Work Plan was issued November 17, 2020 and field work began November 4, 2020 with marking of subslab sampling locations. Vapor pin installation is scheduled for January 4-21, 2021. Field sample collection is tentatively scheduled for January 25, 2021 through February 4, 2021 (contingent on weather and travel restrictions). Routine meetings are anticipated to be held during the vapor intrusion sampling, possibly as part of the routine weekly groundwater meetings.

The following scheduled was accepted as part of the October 2020 Groundwater MWG meeting. The tentative dates for the VI sampling are provided.

Activity	Target Start	Target Finish
~~Quarterly Meeting (October/FY21Q1)~~	-	~~10/7/2020~~
~~Develop Outline for Large Building PZ White Paper~~	~~10/14/2020~~	~~12/11/2020~~
~~Provide Large Building PZ White Paper Outline to MWG~~	-	~~12/11/2020~~
MWG Review Large Building PZ White Paper Outline	12/11/2020	1/13/2021
Quarterly Meeting (January/FY21Q2)		1/13/2021
Revise Outline for Large Building PZ White Paper Based on MWG Discussions	1/13/2021	1/28/2021
VI Field Sampling / Laboratory Analysis / Validation	Jan-21	Apr-21
Develop Draft Large Building PZ White Paper	1/28/2021	7/2/2021
Quarterly Meeting (April/FY21Q3)		4/7/2021
Issue Draft Final Large Building PZ White Paper to MWG		7/2/2021
Quarterly Meeting (July/FY21Q4)		7/14/2021
MWG Review and Provide Comments on Draft Final Large Building PZ White Paper	7/2/2021	8/3/2021
MWG Meeting to Discuss Draft Final Large Building PZ White Paper		7/27/2021
MWG Provide Comments on Draft Final Large Building PZ White Paper		8/3/2021
Revise Draft Final Large Building PZ White Paper	8/3/2021	9/23/2021
Submit Final Large Building PZ White Paper to EPA and KY		9/24/2021
Quarterly Meeting (October/FY22Q1)		10/6/2021
Quarterly Meeting (January/FY22Q2)		1/12/2022

The scope of the Large Building PZ White Paper will be developed as the part of the outline development. The draft outline was provided to the MWG for review on December 11, 2020 and is included as [agenda] Attachment 2.

The Vapor Intrusion project sample collection schedule has been revised to start February 15. This date does not impact the reporting schedule.

The Large Building PZ White Paper outline has been annotated to reflect the discussions held during the meeting and is included as Attachment 3. ***Please provide comments or additions to the annotated outline as part of your comments on this Meeting Summary.***

6. 2021 Presentations

- January 2021: Steve Hampson to present a summary of KRCEE activities from 2006 to present, including the lithology database, aerobic degradation rates in the RGA, and public input to site reuse alternatives.
- April 2021 (Proposed): EarthCon present their 2017 evaluation of the RGA groundwater plumes. Currently, the plan is to have EarthCon update their evaluation in 2022.
- July 2021 (Proposed): C-400 Remedial Investigation findings and McNairy information.

Steve presented on the KRCEE activities from 2006 to present. The presentation is included as Attachment 4.

The EarthCon presentation will be moved back in the schedule as their contract with DOE is pending. DOE suggested potential topics including: a presentation on what PEGASIS is and how it works; follow-up to the KRCEE presentation given today to cover TCE degradation rates and lithology; inviting Brian Looney to present. ***MWG members should provide any presentation requests to Stefanie.***

7. CSM for the RGA in SWMU 211-A Remedial Action Work Plan

Section 1.1.2, "Regional Hydrogeology," references an axis in describing thickness trends for gravel deposits forming the RGA. EPA would like to discuss if the use of the term axis has any implied significance to groundwater flow direction(s) (i.e., a north-south lateral groundwater flow divide) or any implication for implied subsurface structural feature(s) forming the RGA (i.e., the existence of an east-west fault-controlled structural low).

The site geologist explained the east-west trend is consistent with ancestral Tennessee River and is believed to be an erosional surface (thalweg is the geomorphology term). EPA suggested that the Paducah Site area may have several generations of seismic activities, overprinting of seismicity could be happening, and east-west faulting may have occurred. Steve Hampson had a follow-up after discussion with Dr. Woolery and Dr. Zhu.

Steve Hampson reported that an east-west trend is prevalent at PGDP, as evidenced in both regional and local studies. Regional faults commonly trend northeast-southwest but that there could be local structural controls under PGDP that could influence groundwater flow. Seismic studies have not previously been conducted between the east and west fences and from the Porters Creek terrace to north fence because it was not possible to filter out the noise of the operating plant. Most of the plant infrastructure is no longer operating and Steve Hampson discussed that Dr. Woolery has noted there are now seismic reflection techniques that could give a better view of what the structure is beneath the site.

DOE and FRNP are reviewing whether there are any ways to further reduce (temporarily) sources of noise to facilitate new testing without disrupting site activities. Steve discussed this topic with DOE during the October 14, 2020 KRCEE/DOE call.

Steve talked to Dr. Woolery on January 12, 2021 and Dr. Woolery has offered to support any requests or initiatives that may develop regarding additional seismic surveys at the Paducah Site.

8. CSM for the McNairy in the C-400 Complex Area

FRNP has set up a website to house a library of McNairy information. Access the website at the following link: https://fourriversnuclearpartnership.com/McNCSM. The site requires a password that has been sent separately. Contact Stefanie if you need the password to the website.

A lithology white paper is being prepared as part of the resolution of dispute on the CERCLA Five Year Review. DOE will issue the technical paper within one month of submittal of the D1 C-400 Complex OU RI/FS Report to support the review and comment of the C-400 specific data interpretation as part of the C-400 Complex OU RI/FS Report review process and the performance of the FY 2023 Five-Year Review revised protectiveness determinations for the Northeast, Northwest, and Water Policy response actions. The regulatory milestone date for the D1 C-400 Complex OU RI/FS Report has been revised to October 7, 2022.

A draft schedule and annotated outline for the paper were discussed during the October 2020 Groundwater MWG meeting. The schedule has been revised to reflect the new C-400 Complex OU RI/FS Report date ([Agenda] Attachment [2]). The plan continues to be that the draft Lithology Paper will be available to the MWG before the D1 C-400 Report is submitted so that substantive comments may be addressed prior to the D1 C-400 Report being issued. The Lithology Paper will then be revised and submitted.

The KRCEE spreadsheet database of soil boring logs (R10 HydroLitho Dbase posted 121620.xlsx) will be uploaded to https://fourriversnuclearpartnership.com/McNCSM.

The schedule for the Lithology Technical Paper is included as Attachment 1.

Steve provided the latest database file and CSM figures to Stefanie; these materials will be updated to the website and ***Stefanie will let the MWG know when the materials have been uploaded to the website.***

9. Resurvey of wells

The spreadsheet of resurveyed coordinates and elevations was completed in January 2020. An independent review of the data was conducted in March 2020. The review prompted the resurveying of a small subset of wells. Resurveying of the wells began in August 2020 and is expected to be completed in November 2020. The updated schedule was communicated to EPA and KY during the Routine Groundwater Call on August 6, 2020. The information will be uploaded to PEGASIS following review and acceptance of the data.

The field resurveying effort was completed October 9, 2020 and the data review was completed in November 2020. The data are in the process of being uploaded to OREIS. Additionally, a review of the data and any impact on the groundwater model will be performed (schedule is pending with initial scoping planned for late-February).

A white paper summarizing the resurvey work was developed and will be appended to the 2021 update to the P-QAPP.

The group discussed that there are localized areas where the survey data are changed, but generally groundwater flow is to the Ohio River. A second white paper on potential impacts of the new survey data and the impact to the groundwater model will be developed. ***A status update on this second paper will be presented at the next MWG meeting.***

10. Precipitation and Ohio River Stage

[Agenda] Attachment 4 includes precipitation and Ohio River stage charts through December 2020.

Ken reported that the base of the Ohio River stage was at 300 feet in 2020; this is 10 feet higher than the base level before operations began at the Olmsted Lock and Dam in September 2018. The charts are included as Attachment 5. Total rainfall for 2020 was 58.87 inches, which was 10 inches higher than average (but approximately 10 inches less than in 2019). During both 2019 and 2020, rainfall was near consistent throughout the year. (There were no distinct "wet" or "dry" periods.)

11. Projects on the "Watch Topics" List

- **TVA Changes.** During the October 2020 meeting, the MWG discussed the construction of the new ash ponds and a recent RFP for a 3,800 ft sheet pile wall to be constructed in close proximity to Little Bayou Creek and several seeps. The sheet pile wall may intercept the RGA and influence the creek.

  No new information was presented at the MWG meeting. As discussed in Agenda Item #4, Month 5, MW469 is not accessible for colloidal borescope deployment due to TVA road construction activities and will be substituted with MW472 (collocated with MW471).

- **Consider stream gauging in relation to the synoptic water levels.** Stream gauging has been discussed as part of out-year activities. See October 2018 Meeting Summary for additional information. Stream gauging will support new modeling.

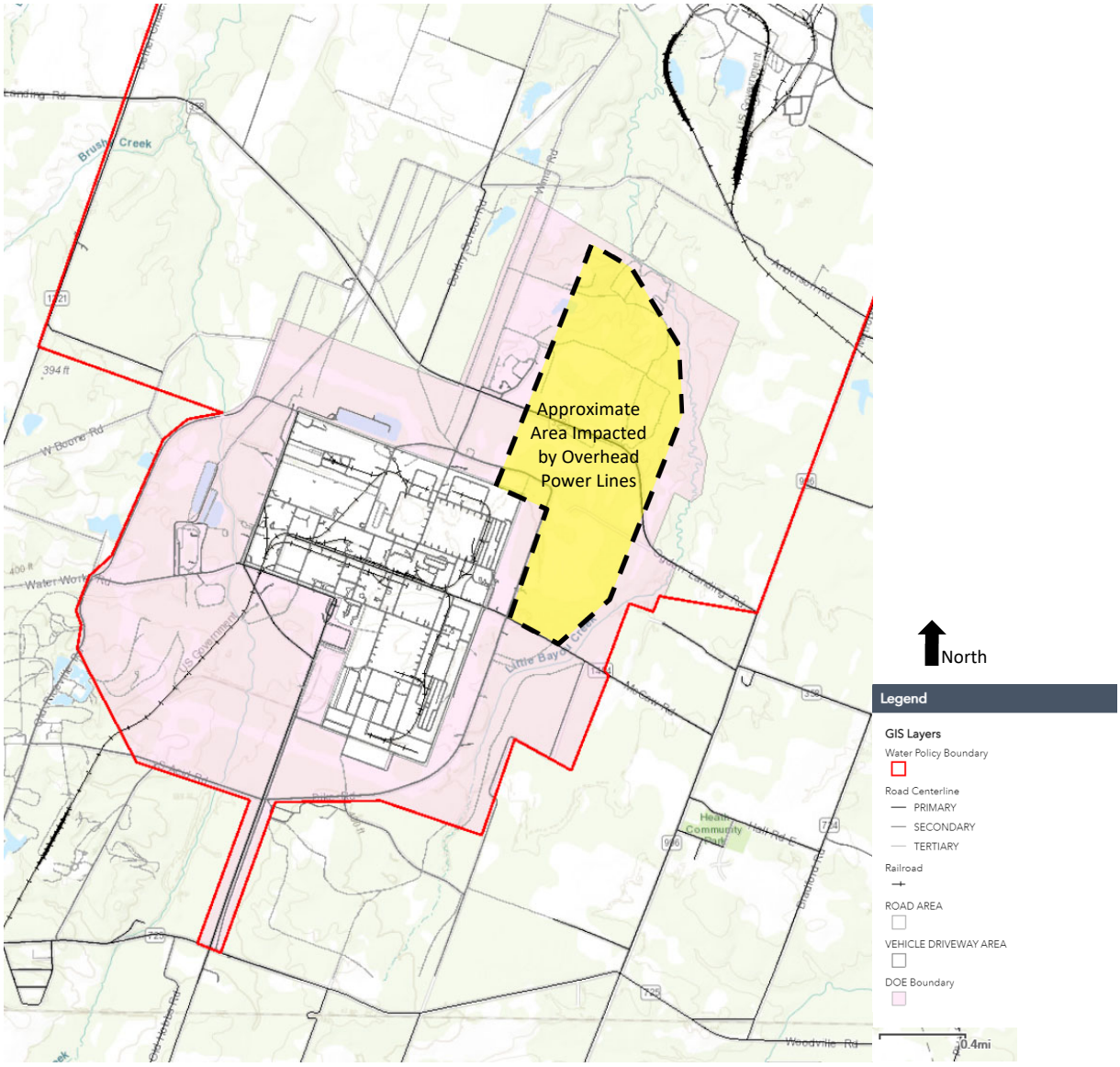
  No new information was presented at the MWG meeting.

- On August 5, FRNP and KY walked down the two seeps reported in the June 6, 2020 meeting. Seep A appears to be 4 ft higher in elevation than the creek bottom and south of LBC5. Seep B is also in Little Bayou Creek and on the side of the creek bank. KY sampled Seep A in August.

  The seep data collected by KY have been provided for upload to PEGASIS. KY is currently working on a letter transmitting the data. TCE was detected in the seeps. The status of the data collected by FRNP will be provided during the next MWG meeting.

- **"No Go" Areas for Monitoring Well Installations.**
  - Corridors where overhead transmission lines have been removed have been considered for monitoring well placement, especially with respect to the west side of the NE Plume. Previously, overhead transmission lines prevented installation of wells to the west in the northern-most transect of wells. The 161kV overhead lines currently in place to C-331 will be taken down (currently planned for 2020). A new substation has been constructed east of the C-755 trailer complex. On the west side of the new substation, 161kV overhead lines will be installed along the existing overhead line corridor. On the east side of the new substation, 161kV overhead lines (near the C-755 parking lot and between K010 and K011) will be installed along the 161kV lines. Most of the overhead lines down from McCaw Road to the plant with only a static line remaining on the towers on the south into the C-331 yard.

Map of the formerly unavailable utility corridor area(s).



https://pegasis.pad.pppo.gov/ (Accessed January 5, 2021)

The MWG discussed adding information to the map to show power lines in the corridor that are still in place and will continue to be present and prevent installation of new monitoring wells, and any new power lines in the area, as well as the new substation. ***An updated map will be prepared for discussion during the next MWG meeting.***

- **Wetlands map layer.** The site is working on new wetlands maps. These updates will be uploaded and available through PEGASIS. The map layers previously available in PEGASIS did not include information from the WDA project. No field work is being performed as part of the map updates.

  DOE clarified that different projects have used different source data for wetlands and floodplains maps. As part of the ongoing map consistency project, these shapefiles are being reviewed and layers will be made available in PEGASIS, potentially by the summer.

12. Poll MWG Members/Open Discussion

***PFAS Survey**: The completed survey for Paducah was sent to DOE headquarters on 12/17/2020. The information included in the survey has been discussed with EPA and KY in various meetings. The DOE PFAS Working Group bimonthly meeting will be held on January 14, 2021. Participants in the PFAS Working Group include DOE-EM, DOE-Office of Science, Interstate Technology & Regulatory Council (ITRC), and DOE contractors. The blank PFAS survey is included as Attachment 6.*

Attachment 1

Revised Lithologic Technical Paper Schedule

Activity	Target Start	Target Finish	Notes
FRNP/DOE Develop Outline for Draft Lithologic Technical Paper	7/7/2020	9/30/2020	COMPLETE
Provide Draft Final Lithologic Technical Paper Outline to MWG		9/30/2020	COMPLETE
MWG Review Draft Final Lithologic Technical Paper Outline	9/30/2020	10/7/2020	COMPLETE
Quarterly Meeting (October/FY21Q1)		10/7/2020	COMPLETE
FRNP/DOE Revise Draft Final Outline for Lithologic Technical Paper Based on MWG Discussions	10/7/2020	10/22/2020	COMPLETE
Provide Final Outline for Lithologic Technical Paper to MWG		10/22/2020	COMPLETE
Quarterly Meeting (January/FY21Q2)		1/13/2021	
Quarterly Meeting (April/FY21Q3)		4/7/2021	
Quarterly Meeting (July/FY21Q4)		7/14/2021	
Collect C-400 Lithology Data	5/17/2021	3/16/2022	From C-400 Schedule
FRNP/DOE Develop Draft Lithologic Technical Paper Text	8/4/2021	3/10/2022	
Quarterly Meeting (October/FY21Q3)		10/6/2021	
Finish Collection of C-400 Lithology Data		3/16/2022	From C-400 Schedule
FRNP/DOE Incorporate C-400 Results into Draft Lithologic Technical Paper	3/16/2022	8/11/2022	
Develop C-400 RI Report	3/17/2022	9/14/2022	From C-400 Schedule
Issue Draft Final Lithologic Technical Paper to MWG		8/11/2022	
MWG Review and Provide Comments on Draft Final Lithologic Technical Paper	8/11/2022	9/12/2022	
MWG Meeting to Discuss Draft Final Lithologic Technical Paper		8/24/2022	Draft FY2021 MWG Work Plan Date
MWG Provide Comments on Draft Final Lithologic Technical Paper		9/12/2022	
C-400 RI Report Submitted to EPA and KY		10/7/2022	Current Milestone
FRNP/DOE Revise Draft Final Lithologic Technical Paper	9/12/2022	11/7/2022	No formal CRS
Submit Final Lithologic Technical Paper to EPA and KY		11/7/2022	Tech Paper Due 1 Month After C-400 RI Report (Currently 10/8/2022)

Attachment 2

2021 EMP Schedule for Groundwater Strategy Project

From 2021 EMP Pages B-28 through B-35

Monitoring Wells Planned For Colloidal Borescope and Pressure Transducer Deployment

Well Number	MONTH 1	MONTH 2	MONTH 3	MONTH 4	MONTH 5	MONTH 6	MONTH 7	MONTH 8	MONTH 9	MONTH 10	MONTH 11	MONTH 12
MW20 (also R4)	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2
MW63			M1			M1			M1			M1
MW65			M1			M1			M1			M1
MW66			M1			M1			M1			M1
MW67			M1			M1			M1			M1
MW68			M1			M1			M1			M1
MW71	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW72			M1			M1			M1			M1
MW73			M1			M1			M1			M1
MW76			M1			M1			M1			M1
MW77 (PZ)			M1			M1			M1			M1
MW78			M1			M1			M1			M1
MW79			M1			M1			M1			M1
MW80			M1			M1			M1			M1
MW81			M1			M1			M1			M1
MW84A			M1			M1			M1			M1
MW86			M1			M1			M1			M1
MW87A			M1			M1			M1			M1
MW89			M1			M1			M1			M1
MW90A			M1			M1			M1			M1
MW92			M1			M1			M1			M1
MW93A			M1			M1			M1			M1
MW95A			M1			M1			M1			M1
MW98			M1			M1			M1			M1
MW99	M1	M1	CB+M1	M1	M1	M1	M1	M1	CB+M1	M1	M1	M1
MW100	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW102			M1			M1			M1			M1
MW103			M1			M1			M1			M1
MW106A	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2
MW108			M1			M1			M1			M1
MW120			M1			M1			M1			M1
MW121	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2
MW122			M1			M1			M1			M1
MW123			M1			M1			M1			M1
MW124			M1	P		M1			M1			M1

From 2021 EMP Pages B-28 through B-35

Well Number	MONTH 1	MONTH 2	MONTH 3	MONTH 4	MONTH 5	MONTH 6	MONTH 7	MONTH 8	MONTH 9	MONTH 10	MONTH 11	MONTH 12
MW125			M1			M1			M1			M1
MW126	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW132	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW133			M1			M1			M1			M1
MW134	PT+M2	CB+PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2
MW135	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW137	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW139	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW144			M1			M1			M1			M1
MW145	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW146			M1			M1			M1			M1
MW147	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW148	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW150	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW152*	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW155			M1			M1			M1			M1
MW156			M1			M1			M1			M1
MW161			M1			M1			M1			M1
MW163			M1			M1			M1			M1
MW165A			M1			M1			M1			M1
MW168			M1			M1			M1			M1
MW169			M1			M1			M1			M1
MW173			M1			M1			M1			M1
MW175			M1			M1			M1			M1
MW178			M1			M1			M1			M1
MW185			M1			M1			M1			M1
MW188			M1			M1			M1			M1
MW191	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW193	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW194	CB+M2	M2	CB+M2	M2	CB+M2	M2	CB+M2	M2	CB+M2	M2	CB+M2	M2
MW197			M1			M1			M1			M1
MW199	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2
MW200			M1			M1			M1			M1
MW201	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2
MW202	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2
MW203			M1			M1			M1			M1
MW205			M1			M1			M1			M1
MW220			M1			M1			M1			M1

From 2021 EMP Pages B-28 through B-35

Well Number	MONTH 1	MONTH 2	MONTH 3	MONTH 4	MONTH 5	MONTH 6	MONTH 7	MONTH 8	MONTH 9	MONTH 10	MONTH 11	MONTH 12
MW221			M1			M1			M1			M1
MW222			M1			M1			M1			M1
MW223			M1			M1			M1			M1
MW224			M1			M1			M1			M1
MW225			M1			M1			M1			M1
MW226			M1			M1			M1			M1
MW227			M1			M1			M1			M1
MW233			M1			M1			M1			M1
MW236			M1			M1			M1			M1
MW238			M1			M1			M1			M1
MW239			M1			M1			M1			M1
MW240			M1			M1			M1			M1
MW241A			M1			M1			M1			M1
MW242			M1			M1			M1			M1
MW243			M1			M1			M1			M1
MW244			M1			M1			M1			M1
MW245			M1			M1			M1			M1
MW247			M1			M1			M1			M1
MW248			M1			M1			M1			M1
MW249			M1			M1			M1			M1
MW250			M1			M1			M1			M1
MW252	M1	CB+M1	M1	M1	M1	M1	M1	CB+M1	M1	M1	M1	M1
MW253A	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW255			M1			M1			M1			M1
MW256			M1			M1			M1			M1
MW257			M1			M1			M1			M1
MW258			M1			M1			M1			M1
MW260			M1			M1			M1			M1
MW261			M1			M1			M1			M1
MW262	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW283			M1			M1			M1			M1
MW284			M1			M1			M1			M1
MW288			M1			M1			M1			M1
MW291	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW292			M1			M1			M1			M1
MW293A			M1			M1			M1			M1
MW294A			M1			M1			M1			M1
MW325			M1			M1			M1			M1

From 2021 EMP Pages B-28 through B-35

Well Number	MONTH 1	MONTH 2	MONTH 3	MONTH 4	MONTH 5	MONTH 6	MONTH 7	MONTH 8	MONTH 9	MONTH 10	MONTH 11	MONTH 12
MW326			M1			M1			M1			M1
MW327			M1			M1			M1			M1
MW328			M1			M1			M1			M1
MW329	PT+M2	PT+M2	PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	PT+M2	PT+M2	PT+M2	CB+PT+M2
MW330			M1			M1			M1			M1
MW333			M1			M1			M1			M1
MW337			M1			M1			M1			M1
MW338			M1			M1			M1			M1
MW339			M1			M1			M1			M1
MW340			M1			M1			M1			M1
MW341			M1			M1			M1			M1
MW342			M1			M1			M1			M1
MW343			M1			M1			M1			M1
MW345			M1			M1			M1			M1
MW346			M1			M1			M1			M1
MW347			M1			M1			M1			M1
MW353	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW354	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2
MW355			M1			M1			M1			M1
MW356			M1			M1			M1			M1
MW357			M1			M1			M1			M1
MW358			M1			M1			M1			M1
MW360			M1			M1			M1			M1
MW361			M1			M1			M1			M1
MW363			M1			M1			M1			M1
MW364			M1			M1			M1			M1
MW366	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW367			M1			M1			M1			M1
MW369			M1			M1			M1			M1
MW370			M1			M1			M1			M1
MW372			M1			M1			M1			M1
MW373			M1			M1			M1			M1
MW376			M1			M1			M1			M1
MW380			M1			M1			M1			M1
MW381			M1			M1			M1			M1
MW384			M1			M1			M1			M1
MW385			M1			M1			M1			M1
MW387			M1			M1			M1			M1

From 2021 EMP Pages B-28 through B-35

Well Number	MONTH 1	MONTH 2	MONTH 3	MONTH 4	MONTH 5	MONTH 6	MONTH 7	MONTH 8	MONTH 9	MONTH 10	MONTH 11	MONTH 12
MW388			M1			M1			M1			M1
MW391			M1			M1			M1			M1
MW392			M1			M1			M1			M1
MW394	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW395			M1			M1			M1			M1
MW397			M1			M1			M1			M1
MW401			M1			M1			M1			M1
MW402			M1			M1			M1			M1
MW409	PT+M1	CB+PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1
MW410	CB+PT+M1	CB+PT+M1	CB+PT+M1	CB+PT+M1	PT+M1	PT+M1	CB+PT+M1	CB+PT+M1	CB+PT+M1	CB+PT+M1	PT+M1	PT+M1
MW411	CB+PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1
MW414			M1			M1			M1			M1
MW415			M1			M1			M1			M1
MW416			M1			M1			M1			M1
MW417			M1			M1			M1			M1
MW418	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW419			M1			M1			M1			M1
MW420			M1			M1			M1			M1
MW421			M1			M1			M1			M1
MW422			M1			M1			M1			M1
MW423			M1			M1			M1			M1
MW424			M1			M1			M1			M1
MW425			M1			M1			M1			M1
MW426	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2
MW427	M2	CB+M2	M2	M2	CB+M2	M2	M2	CB+M2	M2	M2	CB+M2	M2
MW428	M2	M2	CB+M2	M2	M2	CB+M2	M2	M2	CB+M2	M2	M2	CB+M2
MW429 A	M2	CB+M2	M2	M2	M2	M2	M2	CB+M2	M2	M2	M2	M2
MW430	CB+M2	M2	M2	M2	M2	M2	CB+M2	M2	M2	M2	M2	M2
MW431	M2	M2	M2	CB+M2	M2	M2	M2	M2	M2	CB+M2	M2	M2
MW432	M2	M2	M2	CB+M2	M2	M2	M2	M2	M2	CB+M2	M2	M2
MW433			M1			M1			M1			M1
MW435			M1			M1			M1			M1
MW439			M1			M1			M1			M1
MW440			M1			M1			M1			M1
MW441			M1			M1			M1			M1
MW442			M1			M1			M1			M1
MW443			M1			M1			M1			M1
MW444			M1			M1			M1			M1

From 2021 EMP Pages B-28 through B-35

Well Number	MONTH 1	MONTH 2	MONTH 3	MONTH 4	MONTH 5	MONTH 6	MONTH 7	MONTH 8	MONTH 9	MONTH 10	MONTH 11	MONTH 12
MW445	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW447			M1			M1			M1			M1
MW448			M1			M1			M1			M1
MW450			M1			M1			M1			M1
MW451			M1			M1			M1			M1
MW452			M1			M1			M1			M1
MW453			M1			M1			M1			M1
MW454			M1			M1			M1			M1
MW455			M1			M1			M1			M1
MW456			M1			M1			M1			M1
MW457			M1			M1			M1			M1
MW458			M1			M1			M1			M1
MW459	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW460			M1			M1			M1			M1
MW461			M1			M1			M1			M1
MW462			M1			M1			M1			M1
MW463	CB+PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1
MW464	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1
MW465	PT+M1	PT+M1	CB+PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	CB+PT+M1	PT+M1
MW466	M1	M1	M1	CB+M1	M1	CB+M1	M1	M1	M1	CB+M1	M1	CB+M1
MW467	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW468	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW469	CB+M1	M1	M1	M1	CB+M1	M1	CB+M1	M1	M1	M1	CB+M1	M1
MW470	M1	M1	M1	CB+M1	M1	M1	M1	M1	M1	CB+M1	M1	M1
MW471	CB+PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1
MW472	M1	CB+M1	M1	CB+M1	M1	M1	M1	CB+M1	M1	CB+M1	M1	M1
MW473	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1
MW474	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1
MW475	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW476	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1
MW477	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1
MW478			M1			M1			M1			M1
MW479			M1			M1			M1			M1
MW480			M1			M1			M1			M1
MW481	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW482	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW483	CB+PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1
MW484	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1

From 2021 EMP Pages B-28 through B-35

Well Number	MONTH 1	MONTH 2	MONTH 3	MONTH 4	MONTH 5	MONTH 6	MONTH 7	MONTH 8	MONTH 9	MONTH 10	MONTH 11	MONTH 12
MW485	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1
MW486A	M1	M1	M1	M1	M1	CB+M1	M1	M1	M1	M1	M1	CB+M1
MW487	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW488	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1
MW489			M1			M1			M1			M1
MW490			M1			M1			M1			M1
MW491	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW492			M1			M1			M1			M1
MW493			M1			M1			M1			M1
MW494			M1			M1			M1			M1
MW495			M1			M1			M1			M1
MW496	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW497			M1			M1			M1			M1
MW498			M1			M1			M1			M1
MW499			M1			M1			M1			M1
MW500			M1			M1			M1			M1
MW501			M1			M1			M1			M1
MW502			M1			M1			M1			M1
MW503			M1			M1			M1			M1
MW504			M1			M1			M1			M1
MW505			M1			M1			M1			M1
MW506			M1			M1			M1			M1
MW507			M1			M1			M1			M1
MW524			PT+M1			M1			M1			M1
MW525			M1			CB+PT+M1			M1			M1
MW526			M1			M1			CB+PT+M1			M1
MW527			CB+PT+M1			M1			M1			M1
MW528			M1			M1			M1			M1
MW529			M1			PT+M1			M1			M1
MW530			M1			M1			PT+M1			M1
MW531			M1			M1			M1			M1
MW532 (PZ)			M1			M1			M1			M1
MW533			M1			M1			M1			M1
MW534 (PZ)			M1			M1			M1			M1
MW535 (PZ)			M1			M1			M1			M1
MW536			M1			M1			M1			M1
MW537			M1			M1			M1			M1
MW538			M1			M1			M1			M1

From 2021 EMP Pages B-28 through B-35

Well Number	MONTH 1	MONTH 2	MONTH 3	MONTH 4	MONTH 5	MONTH 6	MONTH 7	MONTH 8	MONTH 9	MONTH 10	MONTH 11	MONTH 12
MW539			M1			M1			M1			M1
MW540 (PZ)			M1			M1			M1			M1
MW541 (PZ)			M1			M1			M1			M1
MW542			M1			M1			M1			M1
MW543			M1			M1			M1			M1
MW544			M1			M1			M1			M1
MW545			M1			M1			M1			M1
MW546			M1			M1			M1			M1
MW547			M1			M1			M1			M1
MW548			M1			M1			M1			M1
MW549			M1			M1			M1			M1
MW550			M1			M1			M1			M1
MW551			M1			M1			M1			M1
MW553 (PZ)			M1			M1			M1			M1
MW554 (PZ)			M1			M1			M1			M1
MW555 (PZ)			M1			M1			M1			M1
MW556			M1			M1			M1			M1
PZ107			M1			M1			M1			M1
PZ109			M1			M1			M1			M1
PZ110			M1			M1			M1			M1
PZ114			M1			M1			M1			M1
PZ115			M1			M1			M1			M1
PZ117			M1			M1			M1			M1
PZ118			M1			M1			M1			M1
PZ287			M1			M1			M1			M1
PZ289			M1			M1			M1			M1
PZ290			M1			M1			M1			M1
PZ349			M1			M1			M1			M1
PZ351			M1			M1			M1			M1
EW232			M1			M1			M1			M1
EW233			M1			M1			M1			M1
EW234			M1			M1			M1			M1
EW235			M1			M1			M1			M1

M1: Manual water level collected once per month
M2: Manual water level collected twice per month
*MW152 was abandoned in October 2018 in order for the Tennessee Valley Authority to construct a new process water basin. Another location has been selected for installation of a new well once construction activities have been completed. This new well will be MW583.

Attachment 3

Draft Large Building PZ White Paper Outline

Ken led a discussion of the outline; those discussions are included in the attached draft annotated outline.

KY discussed the potential to propose installation in two of the four process buildings, with a preference of selecting one of the smaller process buildings and one of the larger process buildings.

The lessons learned and information obtained on the C-400 building foundation as part of that building remedial investigation were discussed, including the uniqueness of the C-400 foundation compared to the process buildings and the approximately 6-7 ft of gravel underlying the foundation.

KY suggested that adding a discussion of how this white paper and any derived field investigation could be used for the groundwater model would be of added value.

INSTALLATION OF PIEZOMETERS TO CHARACTERIZE ROOF DRAIN LEAKS TO GRAVEL SUB BASE OF PADUCAH SITE PROCESS BUILDINGS

DRAFT ANNOTATED OUTLINE

EXECUTIVE SUMMARY

TABLE OF CONTENTS

FIGURES

TABLES

ACRONYMS

ATTACHMENTS

1. INTRODUCTION
   1.1. BACKGROUND
   - Objectives
     - Characterize Roof Drain Leaks to Process Building Gravel Sub Base
     - Assess Significance of Roof Drain Recharge to Groundwater
   - Paducah Site Overview
   - Environmental Remediation Program Overview
   - 2016 Update of Sitewide Groundwater Flow Model
     - Evidence of Roof Drain Leakage
   - Anthropogenic Recharge Estimates for the Paducah Site
   - Interaction with Other Projects
     - Groundwater Strategy (input to)
     - Potential Future Update of the Sitewide Groundwater Flow Model (input to)
     - C-400 Complex Remedial Investigation (Remedial Investigation project will generate complimentary assessment information)
     - Plant Industrial Area Vapor Intrusion Study (source of complimentary assessment information from facility walkdowns, observation of sumps, etc.)
   - Lessons Learned from Portsmouth or Oak Ridge Regarding Process Buildings, as applicable

2. PROCESS BUILDINGS (C-331, C-333, C-335, C-337)
   - Roof Areas
   - Roof Drain Systems
     - Recent Improvements
   - Foundation Suppression Systems
   - Fire Suppression Systems
   - Sub Slab Construction (Elevations)
     - Bounds of Uncertainties
     - Uncertainty of presence of temporary reservoir following rainfall events
   - Building Construction Drawings/Photographs

  - Basements, sumps (number and operational history), roof drains, underground utilities, foundation type and thickness, foundation penetrations, foundation drainage systems, etc.
  - To the extent able to be released
- Building Walkdowns
  - To confirm as-built conditions
- Stratigraphy/Hydrogeology

3. CRITERIA FOR SELECTION OF CANDIDATE PIEZOMETER LOCATIONS
   - Facility Physical Characteristics Considerations
     - Basements, sumps, roof drains, foundation type and thickness, foundation penetrations, etc.
     - Typical operations and maintenance of sumps and other drain systems
     - Access
   - Building Walkdown Considerations
   - Schedule of Decommissioning Activities
   - Potential number of piezometers of up to four based on selection of two of the four process buildings to represent the other two process buildings4

4. APPROACH
   - Piezometer Installation Considerations
     - Screen Depth (Base of Sub Slab Gravel)
     - Water Level Monitoring (Continuous and Episodic)
     - Surface Completion (Stickup vs Flush Mount, Protective Casing, etc.)
     - Access and Protection
     - Subsurface Utilities (e.g., existing piping, trenches, and drainage systems)
     - Construction Variances
     - Bentonite Seal/Annular Seal/Prepack Bentonite Seal with Foam Bridge
     - Screen Construction in Loose, Unsaturated Materials
     - Screen Material (e.g., PVC prepack piezometers, PVC vs Stainless Steel)
     - Filter Pack
   - Drilling Method (i.e., Direct Push Technology)
     - In-Building Access
     - Piezometer Development (if possible)

5. PRELIMINARY DATA QUALITY OBJECTIVES (DQOS)

5.1. STATE THE PROBLEM

Roof drain systems of some of the Paducah Site process buildings are known to have leaked into the gravel sub base and may be acting as points of infiltration where foundation drainage systems are not present, not functioning as designed, or do not have sufficient capacity for drainage.

5.2. IDENTIFY THE DECISION

Characterize the variation of saturation of the gravel sub base relative to precipitation events.

5.3. IDENTIFY THE INPUTS

- Paducah Site precipitation and barometric records.
- Piezometers with continuous water level recorder.
- Manual set-up and calibration water level measurements.

- Water level record of the gravel sub base (for each of the selected process buildings).

5.4. DEFINE THE BOUNDARIES

- Paducah Site process buildings (C-331, C-333, C-335, C-337).
- Duration of measurements.

5.5. DEVELOP A DECISION RULE

IF water level measurements demonstrate temporal variable saturation of the gravel sub base of the process buildings, THEN determine if the saturation variation relates to precipitation events.

5.6. SPECIFY TOLERABLE LIMITS ON DECISION ERRORS

- +/-0.05 inches precipitation.
- +/-0.01 inches (mercury) barometric pressure
- +/-0.10 ft water level.

5.7. OPTIMIZE THE DESIGN

Locate piezometers where the gravel sub base is deepest (if it can be determined) in proximity to roof drain piping systems and foundation drainage systems.

6. CONCLUSIONS AND RECOMMENDATIONS

- Potential placement of piezometers based on knowledge of physical characteristics of each building.
- Data assessment approaches.
- Data reporting.
- Value
    - Input to update of groundwater flow model (infiltration rate as a percent of rainfall and area of infiltration associated with each process building)
    - Added information towards demolition of process buildings

7. REFERENCES

ATTACHMENT 1. WALKDOWN INFORMATION

ATTACHMENT 2: RELEVANT BUILDING DRAWINGS OR FIGURES (IF ABLE TO BE CLEARED FOR RELEASE)

Attachment 4

KRCEE Presentation

KENTUCKY RESEARCH CONSORTIUM for ENERGY and ENVIRONMENT

EXPLORE THE SITE

ABOUT PROJECTS OUTREACH PROJECT DOCUMENTS PGDP HISTORY PGDP MULTIMEDIA

BACKGROUND ("Mission")

Created in 2003 through the efforts of Senator McConnell and the Kentucky Congressional Delegation"

"to support the technically sound, expeditious and economically viable environmental restoration and future use of the Paducah Gaseous Diffusion Plant (PGDP), the Western Kentucky Wildlife Management Area (WKWMA), and surrounding areas …"

Through "use of University and industry expertise" administered as 'Project Team' approach to specific Projects/Project tasks

More than 100 individuals representing Universities/Industry/Government (Federal/State) as Project Team participants and Project PI's

KRCEE scope of projects was expansion of ongoing UK-CHFS AIP work (Volpe/Hampson)

KRCEE PROJECTS

Projects range from Chemical Engineering/Geo-sciences to Public Outreach/STEM

Project Categories (8):

1. Data Access, Assessment, Visualization *(Active)*
2. Ecological *(Active)*
3. Scrap and Contaminated Metals
4. Soil Contamination
5. Surface Water
6. Public Outreach/STEM *(Active)*
7. Geological Sciences & Engineering *(Active)*
8. *Administration*

Approaching 400 distinct Project/Project Tasks as deliverables or major components of deliverables (Not including Administration Tasks/Deliverables)

sidebar_____

25	Students supported in Graduate Studies in EES, Engineering, Ag, CoD (MS, PhD)
7	EES (Geological Sciences) Graduate students summer employment
16	Students in EES 685 have utilized PGDP 2016 GW Model as basis for course (2018-20)
80	College of Design seniors & graduate students involved in course work re: PGDP future use (Physical PGDP Models, GW Accomplishments, Virtual Museum)
300+	Senior students at Marshall County HS participate in ASER project
250+	Participants in outreach events for “Land Study” and “PGDP End State Vision” projects

PROJECTS (8 Categories)

1. **Data Access, Assessment, Visualization** *(Active)*
   - *Data Warehouse Development/Deployment "DWGIS" (Became PEGASIS)*
   - *Developed automated query to address Radionuclide data quality reporting (2019 -20)*
     - *Corrected > 30,000 incorrect DETECT column entries (D, ND, R) for radionuclides*
   - *Software Training: DWGIS/SADA/ASAP/VSP*
2. **Ecological** *(Active)*
   - *Compilation of ecological work conducted at PGDP (indexed)*
     - *Trophic web models/Future Monitoring Rec's*
   - *Wetlands, Species Habitat & Abundance Studies*
     - *Racoon Study, Leopard Frog Study, Wetlands Study (type of wetlands as habitat)*
   - *Ongoing STEM projects ~ Student ASER*
3. **Scrap and Contaminated Metals**
   - *Depleted Uranium (issues, value, re-use)*
   - *Nickel (separation of Nickel from 99Tc and transuranic rads)*
4. **Soil Contamination**
   - *'Real Time' Demonstration Project – (ASAP, TRIAD approaches to expanding technical coverage of remedial activities while expediting cleanup & substantially reducing costs)*
     - *Outfall 011 Soils/Soil Piles characterization/assessment/cleanup & verification in 1 mobilization*
5. **Surface Water**
   - *LBC Seeps Investigations (LaSage/Sexton/Tripathi)*
   - *Sediment Release Control Project – ID'd readily implemented sediment control measures*
   - *TMDL Development (Ormsbee)*
   - *Field Data Collection & TMDL Recommendations for LBC metals (Ormsbee)*

PROJECTS (8 Categories - Continued)

6. Public Outreach/STEM *(Active)*

Student ASER Project

- *Annual program with Marshall County High School*
  - *Seniors in Environmental Science, AP Chemistry and AP Physics classes*
- *Students Review Site ASER (very regulatory document),*
  - *Answer In-Depth Outline Questions, Summarize*
  - *Publish & Distribute Student Version*
- *Briefings (class presentations) start with Site Introduction and PGDP Site Tour (DOE)*
  - *SME presentations about 'science topics' encountered in ASER (Rad, Eco)*
  - *History & relevance to local community/national security/nuclear science (Virtual Museum)*
- *Students trained in "Hands on Scientific Method" through ecological fieldwork at WKWMA*
  - *Collect specimens and data (flora/fauna/abundance)*
  - *Data supports habitat study publications (UK Forestry/WKWMA)*

Virtual Museum (VM)

- *In-depth History of PGDP ~ Interactive Website*
  - *Science basics starting with 'The Atom' progressing to 'Enrichment' via gaseous diffusion*
  - *Chronicles plant inception, construction, operations, impacts*
- *CoD graduate students conducted research, learned web coding, compiled Beta VM*
- *UK-DOE-Contractor Project Team compiled beta release into current VM*
  - *Current VM used with MCHS students annually*
- *Re-designed web layout 2019-20 to keep pace with end-user's device capabilities*
- *VM under ECI review prior to public release*

PROJECTS (8 Categories - Continued)

6. Public Outreach/STEM *(Active)*

PGDP Virtual Symposia (Videos)

PGDP Future Vision Stakeholder Involvement Process
Dr. Lindell Ormsbee (UK KWRRI/UK KTC/UK Journalism)

Advanced Material and Membrane Technology Development for Remediation of TCE and PCBs
Dr. Lindell Ormsbee (UK KWRRI/UK ChemE)

PGDP Little Bayou Creek Groundwater Plume Discharge Characterizations: 1999 – Present
Dr. Alan Fryar (UK EES)

Seismicity and Seismic Monitoring of the Paducah Gaseous Diffusion Plant and Vicinity
Dr. Zhenming Wang (UK KGS/UK EES)

Paducah Physical Model Development
Gary Rohrbacher (CoD) /Anne Filson (CoD) /Dr. Rodney Andrews (CAER) / Steve Hampson (KRCEE)

Paducah Video Oral History -
WKCTC Visual Communications Students and PGDP CAB

PGDP History Documentary
UK KWRRI/UK KRCEE

PROJECTS (8 Categories - Continued)

6. Public Outreach/STEM *(Active)*

Public End State Vision Project

- *Outreach to Identify Public Preferences for Future Use of PGDP Site*
- *Approach based upon recommendations from:*
  - *DOE's "Politics of Cleanup" document*
  - *Community Based Participatory Communication (CBPC) – international approach (U.N)*
  - *Structured Public Involvement approach to public engagement (Academia)*
- *Meetings with McCracken and Ballard County stakeholders to "Focus" on issues associated with PGDP*
- *"Community Informational Meetings" disseminate and discuss Education material developed from stakeholder meetings*
  - *History/Operations, Economic Impacts, Environmental Impacts & Range of Remedies*
- *Developed 'Scenarios' for Future Use of PGDP based on meetings above*
- *"Community Scenarios Meetings" held to discuss and obtain Scenarios preferences (rank)*

- *Evaluation of Project Data (ranked preferences) from Informational/Community Scenarios meetings suggested:*
  - *General preference for Industrial Re-use,*
  - *General preference for Nuclear Industry Re-use*
  - *General preference for removal of all Burial Grounds*
  - *General preference for not constructing a Waste Disposal Cell to handle D&D wastes*
  - *All Participants generated an additional 'Scenario' preference for an Environmental Research & Education/Training Center*

PROJECTS (8 Categories - Continued)

7. Geological Sciences & Engineering *(Active)*

Seismic Hazard Monitoring and Seismic Hazard Assessment

- **Development of Seismic Hazard Assessment for PGDP**
  - *Appropriate application of Deterministic vs. Probabilistic Approaches for determining W. KY. seismic hazard (very controversial in seismic community)*
  - *Symposia @ KGS to discuss approaches to seismic hazard assessment*
  - *Assessments impact future use(s) of PGDP*
  - *Assessments impacts construction (costs) across Jackson Purchase Region*
- **Jackson Purchase Region Seismic Monitoring Network - Implementation and Monitoring**
  - *> 6 Locations: Includes one location at PGDP (VSAP)*
    - *W. Ky. had previous shortage of monitoring despite location on and adjacent to centroid of New Madrid Seismic Zone (NMSZ)*
    - *Monitoring of KY events from in neighboring states to KY events relatively inaccurate*
  - *Annual or bi-annual findings reports (KGS)*
- **Central United States Seismic Observatory (CUSSO)**
  - *Seismic monitoring in northern centroid of NMSZ from bedrock (>1900' bgs) to surface*
  - *Determine engineering characteristics of unconsolidated material response to NMSZ events*
  - *Maintenance upgrades in 2020*

PROJECTS (8 Categories - Continued)

7. Geological Sciences & Engineering *(Active)*

Geophysics

- **Geophysical Characterization of PGDP & Vicinity (I)**
  - *PGDP located adjacent to well defined fault trends in southern Illinois*
    - *Trends project beneath and adjacent to PGDP reservation*
    - *Characterization ends at Ill. – Ky. border (Ohio River)*
  - *13 km of SH- and P- wave data collected in early 1990s*
    - *Suggested series of NE trending faults into RGA (Lower Continental Deposits) at PGDP*
  - *KGS linear features study early 1990s supported above (regionally)*
- **Geophysical Characterization of PGDP & Vicinity (II & III)**
  - *Additional SH- & P-wave Data Collection - Verification of 1990s results above (II & III)*
  - *Collection of Electrical Resistivity data (II)*
    - *Along down-thrown fault block(s) (ID'ed saturated trends from near ground to depth)*
    - *Adjacent to seeps in LBC above water line crossing*
  - *Integration of Electrical Resistivity Data into geophysical model (III)*
  - *Industry provided "state of the art" software for processing and filtering old and new data (much improved filters and algorithms)*
  - *Conducted 'bi-refringence' field study – ID'ed fast-slow "flow" directions in RGA (structural trend)*
  - *Seismic modeling correlations with improved lithologic data around geophysical lines*

PROJECTS (8 Categories - Continued)

7. Geological Sciences & Engineering *(Active)*

Geophysics

- **Site 3A Seismic Investigation**
  - *Participated in DOE Site 3A Project Seismic Work Group activities (Woolery/Hampson)*
    - *Regional Geophysics/Seismic/Fault Evaluation*
    - *Site-Specific Data collection*
      - *S. End of PGDP industrial site, Barnes Creek*
    - *Data Interpretation*
      - *UK-EES independently processed geophysical data for verification of PT results*

- **U-Landfill "Holocene" Investigation**
  - *Built upon DOE Field Investigation and Report "Technical Memorandum for the C-746-U Landfill Complex at the Paducah Gaseous Diffusion Plant"*
    - *Geophysical investigation of ULF to Identify underlying faults*
  - *Objective: Utilize seismic interpretation from Technical Memorandum and evaluate overlying Continental Deposits and Loess for Evidence of Holocene Faulting*
  - *Assembled DOE SME Team from DOE-PGDP, DOE-Charleston (seismic), DOE Contractors, UK, Wm. Lettis & Assoc. (California), Illinois Geological Survey (IGS)*
  - *In depth (inch x inch) characterization of Loess packages and uppermost fringe of Continental Deposits by soils SME's (Lettis, Nelson/IGS, Follmer/IGS)*

PROJECTS (8 Categories - Continued)

6. Public Outreach/STEM *(Active)*

LAND USE STUDY

- *GW MODELING & PROPERTY BASED EVALUATION OF:*
  - *LONG-TERM REMEDIAL PERFORMANCE & COSTS*
  - *PURCHASE OF PROPERTY or EASEMENTS TO ENHANCE PROTECTION & DECREASE COSTS*
- *Mandated by Congress*
- *Contingent upon use of PGDP GW Flow/Transport Models*
- *Contingent upon use of Remedial Alternatives ID'ed in FFA Project documents (GW & SW)*
  - *Addresses No Action to Complete Removal of sources and secondary sources*
- *Project Team consisted of SME's from:*
  - *KWRRI & KRCEE (FFA Projects Experience)*
  - *UK Civil Engineering – GW Modeling*
  - *UK Ag – Land Use / Ag Real Estate*
  - *UK Ag & Biosystems Engineering – Land Use / Ag Real Estate*
  - *UK College of Law – Property Acquisition Options/Land Use/Legal Considerations*

6 SLIDES SUMMARIZE PROJECT & OUTCOMES

PROJECTS (8 Categories - Continued)

7. Geological Sciences & Engineering *(Active)*

GROUNDWATER MODELING: LAND USE STUDY

- *Utilized KRCEE & KWRRI experience in PGDP GW Modeling (Radiation Control – AIP)*
  - *Dr. Srinivasa Lingireddy - UK-Civil Engineering*
  - *Dr. Chandramouli Viswanathan - UK-Civil Engineering*
  - *Dr. Lindell Ormsbee – KWRRI & UK-Civil Engineering*

- *Land Use Study utilized existing 1998-99 PGDP Flow and Transport Models (Bechtel-Jacobs)*

  - DOE (U.S. Department of Energy) 1998. Ground Water Flow Model Recalibration and Transport Model Construction at the PGDP, Paducah, Kentucky, DOE/OR/07-1742&DO, United States Department of Energy, Paducah, KY, June, 1998.

  - DOE (U.S. Department of Energy) 1999. Transport Modeling Results for the Northeast Plume Interim Remedial Action and the Northwest Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, DOE/OR/07-1803&D1, Jacobs EM Team, Kevil, Kentucky. DOE (U.S. Department of Energy) 2000.

  - Modeling Transition Report for the Paducah Gaseous Diffusion Plant, Bechtel Jacobs Company, LLC, Oak Ridge, TN.

  - DOE (U.S. Department of Energy) 2001. Feasibility Study for the Groundwater Operable Unit at Paducah Gaseous Diffusion Plant, Paducah, Kentucky – Volume 4. Appendix C Supporting Information for Feasibility Study, DOE/OR/07-1857&D2, Bechtel Jacobs Company, LLC, Oak Ridge, TN

Project Goals

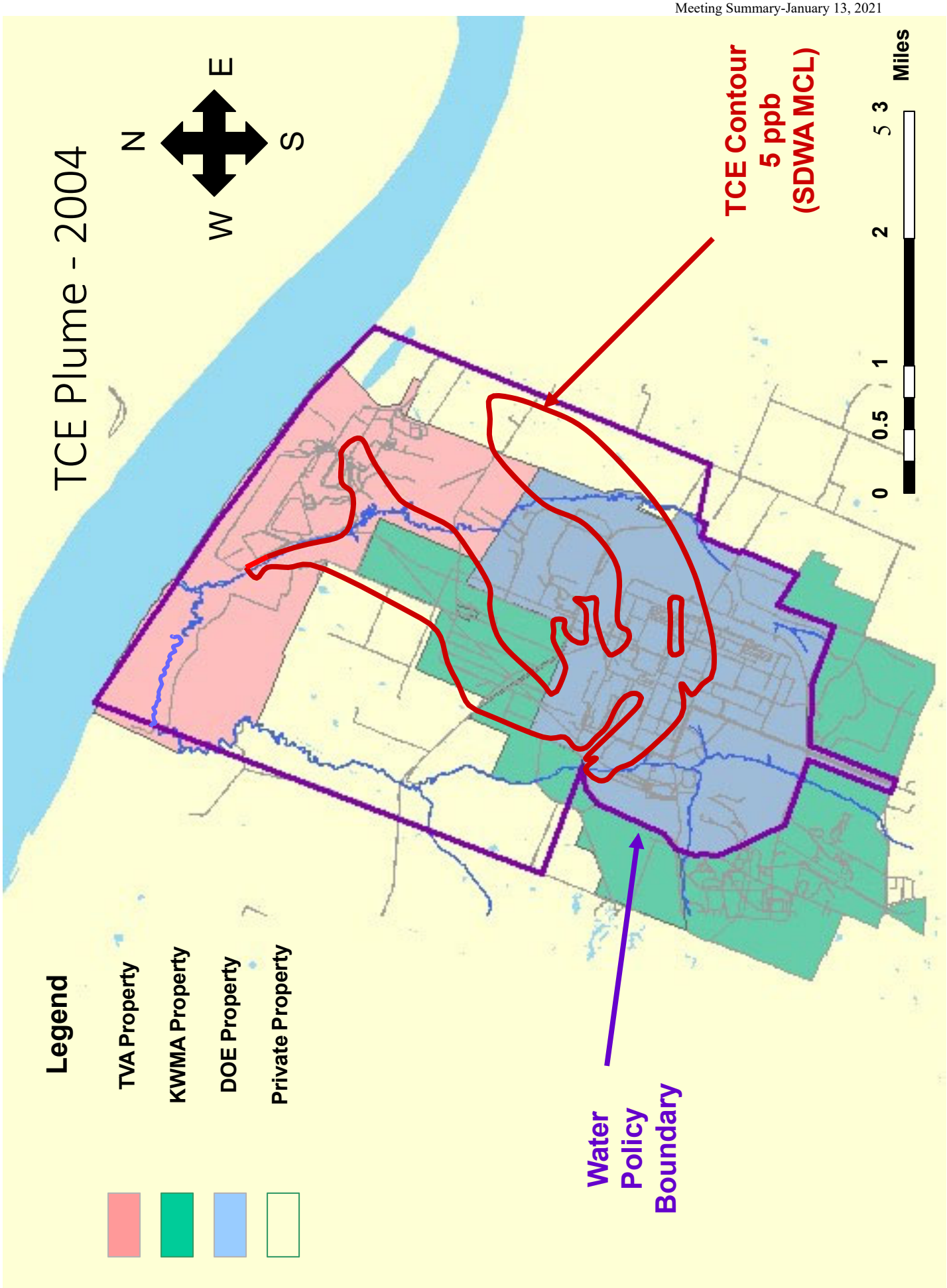
- **The PGDP Property Acquisition Study is being conducted in accordance with a Congressional Directive to DOE in the 2006 Energy and Water Development Appropriations Act.**

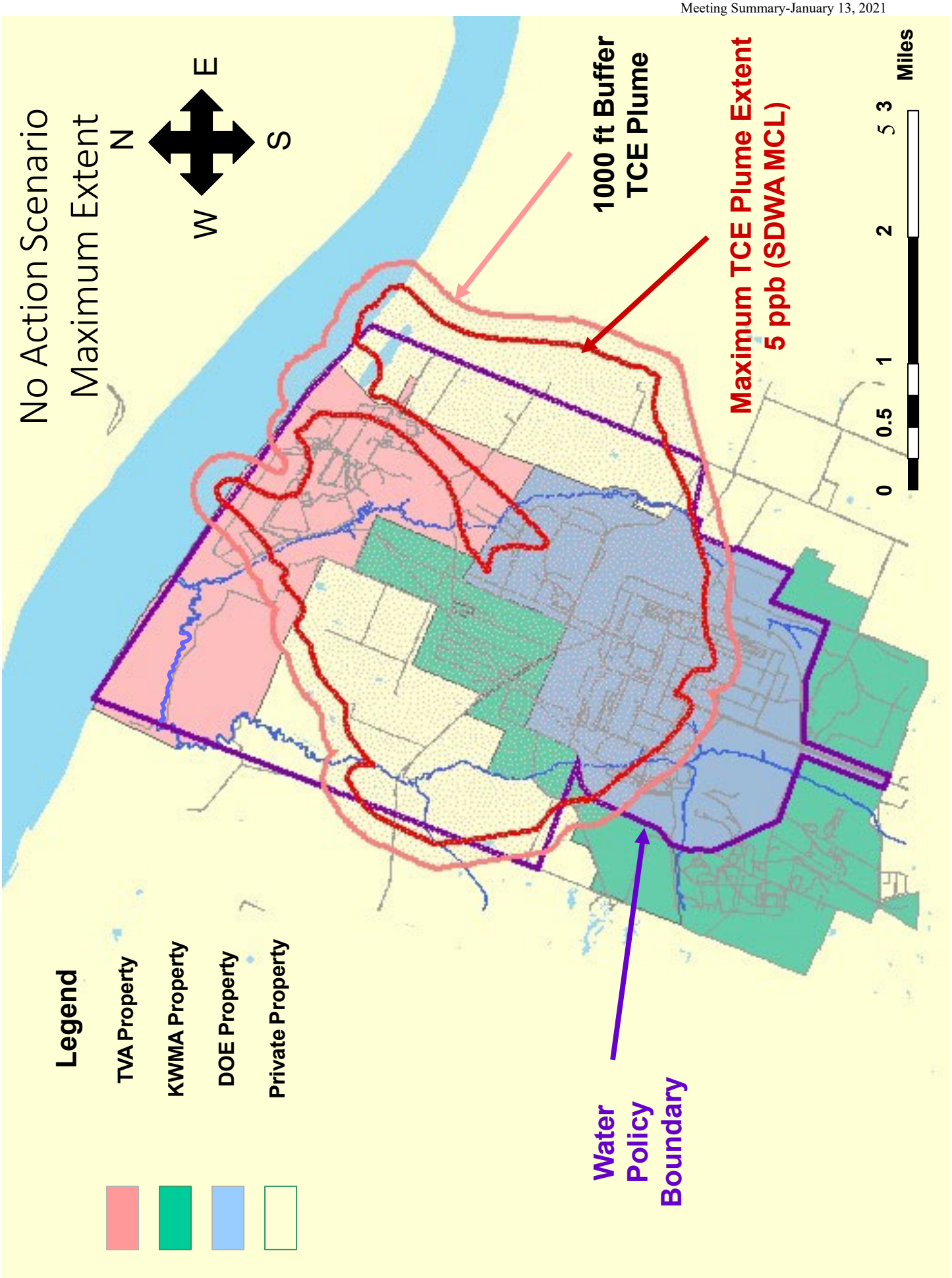
> *"Within the funds provided the Department shall undertake a study of the potential purchase of property or options to purchase property that is located above the plume of contaminated groundwater near the facility site. The study shall evaluate the adequate protection of human health and environment from exposure to contaminated groundwater and consider whether such purchase, when taking into account the cost of remediation, long-term surveillance, and maintenance, is in the best interest of taxpayers."*

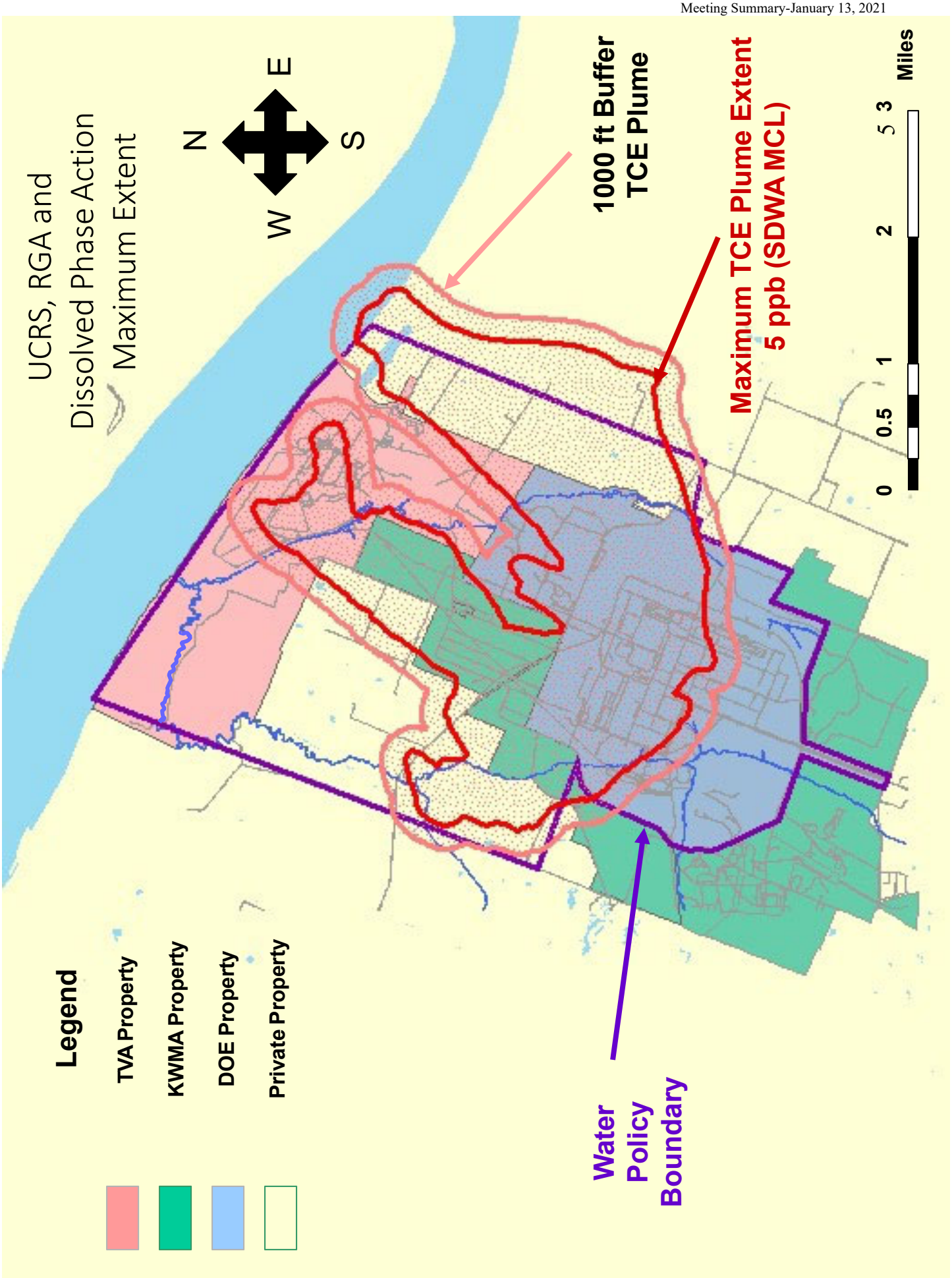
Energy and Water Development Appropriation Bill, 2006 (Senate Report 109-084)

Property Acquisition Study Tasks

- **Potential Remedial Action Alternative Analysis**
  - Compile remedial alternatives identified in PGDP decision documents
  - Identify costs and effectiveness of potential alternatives
  - 5 potential remedial action approaches identified
    - No Action - thru
    - Complete source and dissolved phase plume remediation
- **Groundwater Modeling**
  - Model each potential remedial action approach for 100 years
  - Identify temporal extents and maximum extents of impacted properties
- **Property Acquisition Potential Options**
  - Identify legal options for acquiring property interests
- **Property Acquisition Potential Costs**
  - Develop costs for various acquisition options
- **Economic Analysis**
  - Develop cost relationships for combinations of potential remedial options and potential acquisition options


TCE Plume - 2004
N
E
S
W
TCE Contour
5 ppb
(SDWA MCL)
0
0.5
1
2
3
5
Miles
Legend
TVA Property
KWMA Property
DOE Property
Private Property
Water
Policy
Boundary


No Action Scenario
Maximum Extent
N
E
S
W
1000 ft Buffer
TCE Plume
Maximum TCE Plume Extent
5 ppb (SDWA MCL)
0
0.5
1
2
3
Miles
Legend
TVA Property
KWMA Property
DOE Property
Private Property
Water
Policy
Boundary


UCRS, RGA and
Dissolved Phase Action
Maximum Extent
N
E
S
W
1000 ft Buffer
TCE Plume
Maximum TCE Plume Extent
5 ppb (SDWA MCL)
0
0.5
1
2
3
5
Miles
Legend
TVA Property
KWMA Property
DOE Property
Private Property
Water
Policy
Boundary

Preliminary Cost Estimate Ranges

- Property acquisition costs
  - Fee Simple - $19 M to $47 M
  - Easements - $2 M to $16 M
- Remediation costs
  - No Action (without long-term stewardship cost) - $0 M
  - Pump and Treat - $68 M
  - Primary (UCRS) Source Action - $28 M to $380 M
  - Secondary (RGA) Source Action - $15 M to $175 M
  - Primary and Secondary Source and Dissolved Phase Action - $208 M to $853 M

All remediation costs are based on a 30-year evaluation period

PROJECTS (8 Categories - Continued)

7. Geological Sciences & Engineering *(Active)*

GROUNDWATER MODELING: LAND USE STUDY

Conclusions:

- *"….Cost of possible property acquisition options is essentially independent of the response actions considered…"*
- *"… Even if all contaminant sources were removed today, residual, dissolved-phased contamination will remain on impacted properties and will likely spread and impact new properties throughout the expected life of most current residents. …."* *(100 years evaluated in Study)*

PROJECTS: *TCE FATE AND TRANSPORT*

Background: Historical TCE Attenuation Activities/Information

- **PGDP Groundwater Flow & Transport Models** (Bechtel-Jacobs)
  - *MODFLOW & MODFLOWT*
  - *Development 1990 – 1999*
  - *Applied TCE half-life of 26.7 years to sources and all dissolved phase plume concentrations*

- **Evaluation of Natural Attenuation Processes for TCE and ^{99}Tc in the Northwest and Northeast Plumes** (Lockheed Martin Energy Systems,1997)
  - *Evaluated RGA Geochemistry*
  - *Evaluated Biological and Abiotic Processes based on existing site monitoring data*
  - *Estimated TCE half-life range from 9.4 to 26.7 years*

- **Chlorine Isotope Investigation of Natural Attenuation in an Aerobic Aquifer** (Sturchio, Claussen, et.al.,1999)

- ***Southwest Plume Site Investigation*** (DOE, 2004)
  - *1st Order Decay Calculations revisited*
  - *Used ^{99}Tc to estimate TCE half-life range from 3.2 to 11.3 years.*

PROJECTS: *TCE FATE AND TRANSPORT*

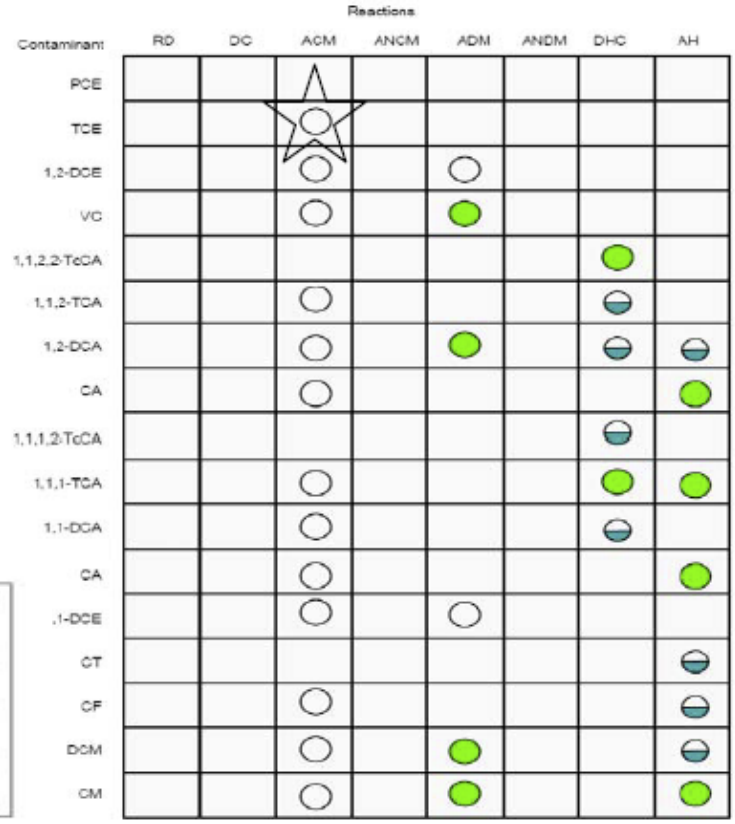
- **Following cited studies:**
  - *Mechanisms and rates of attenuation not sufficiently supported by site data*
  - *Mechanisms and rates of attenuation not widely accepted by technical or regulatory community.*

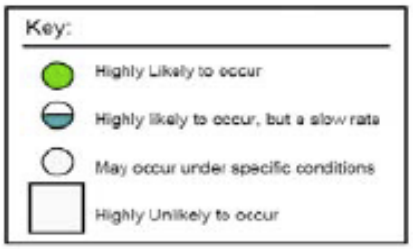
- **Need for site to identify & quantify TCE Fate & Transport parameters in order to proceed with assessment of:**
  - *Long term environmental impacts*
  - *Long term risks*
  - *Remedial options*

- **KRCEE asked by DOE-Portsmouth/Paducah Project Office (PPPO) to assemble a Project Team to address TCE Fate and Transport**
  - *Use DQO Process, Available Technical Guidance*
  - *Degradation rate of TCE in the RGA is only one of several parameters affecting fate and transport being*
    - *Address additional parameters that may affect TCE Fate and Transport in the RGA*
  - *Discussions with project team participants started Summer 2005*

PROJECTS: *TCE FATE AND TRANSPORT*

- **Initial Project Activity**
  - *Narrow down broad range of degradation mechanisms to those most likely to occur in the RGA*
- **Utilized SRNL "Scenarios Selection Tool" (SRNL) to ID most likely degradation mechanisms in RGA** (B. Looney/SRNL, K. Davis/PRS, B. Clayton/PRS)
- **Tool evaluates primary and modifying factors which include:**
  - *Sources (aquifer and vadose zone)*
  - *Plume Geometry*
  - *Plume Stability (Expanding, Decreasing, Perturbed, Stable)*
  - *Hydrogeologic Setting (aquifer and vadose zone)*
  - *Geochemical Setting*
- ***AEROBIC CoMetabolism** = ID'ed as most likely degradation process*





REACTIONS

ACM	Aerobic Co-Metabolism
ANCM	Anaerobic Co-Metabolism
ADM	Aerobic Direct Metabolism
ANDM	Anaerobic Direct Metabolism
DHC	Dehydrochlorination (abiotic)
AH	Abiotic Hydrolysis
DC	Dichloroelimination (biotic)
RD	Reductive Dechlorination (hydrogenolysis)

PROJECTS: *TCE FATE AND TRANSPORT*

Aerobic CoMetabolism -a process in which available organic matter in an aerobic environment induces the production of specific types of enzymes that are also capable of breaking down a contaminant such as TCE.

PROJECTS: *TCE FATE AND TRANSPORT*

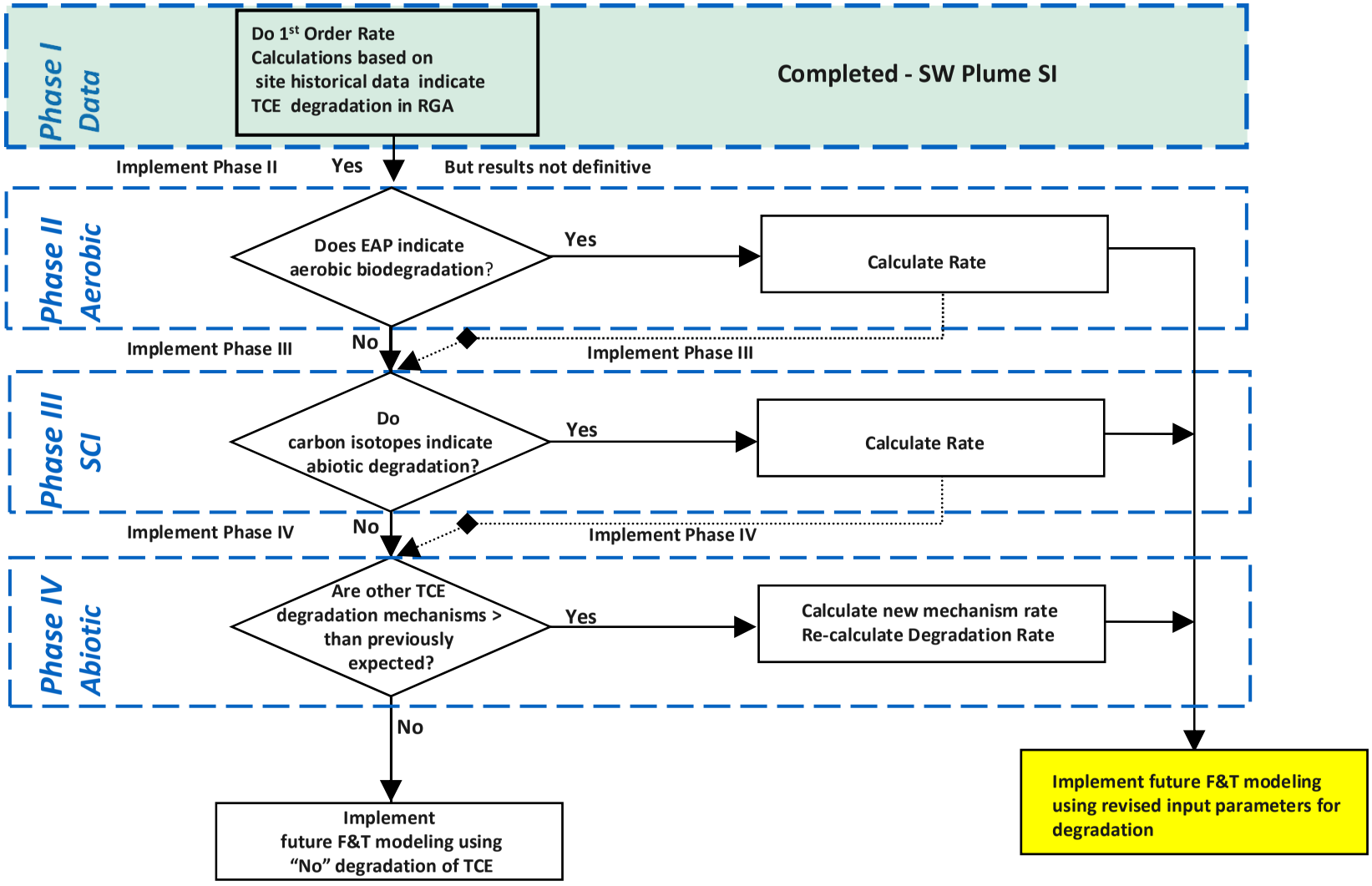
- **Project Team recruited and Project Planning Activities Commenced in 2005.**
- **Planning Process incorporated EPA's** *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater*, EPA/600/R-98/128 (EPA, 1998)
- **Technical Protocol requires multiple lines of evidence needed to account for degradation process**
  - *First line of evidence – evaluation of contaminant and daughter product concentration trends over time and space at monitoring wells along a contaminant plume's flow path*
  - *Second line of evidence - identification and recognition of specific attenuation processes and hydrogeochemical conditions to support those processes*
  - *Third line of evidence - use of a microcosm, or an alternative laboratory or field study to establish a degradation rate*
- ***Developed 4-Phased Sampling and Analysis Plan***
- ***Developed Data Quality Objectives (embedded in 4-Phased Sampling Approach)***

PROJECTS: *TCE FATE AND TRANSPORT*

Organization	Representatives
DOE-PPPO	Rich Bonczek (PPPO Tech Lead) Dave Dollins (PGDP GWOU PM)
KRCEE	Steve Hampson, John Volpe
USEPA Region IV	David Williams
Kentucky Division of Waste Mgmt	Ed Winner, Todd Mullins
DOE-EM	Beth Moore
Savannah River National Laboratory	Brian Looney
North Wind Environmental	Hope Lee
Paducah Remediation Services	Bryan Clayton, Ken Davis
Navarro Engineering	Bruce Phillips, Tracey Fitzgerald
USEPA – R.S. Kerr Remediation Laboratory	*John Wilson*
University of Oklahoma (Isotope Lab)	*R. Paul Philp*

PROJECTS: *TCE FATE AND TRANSPORT*

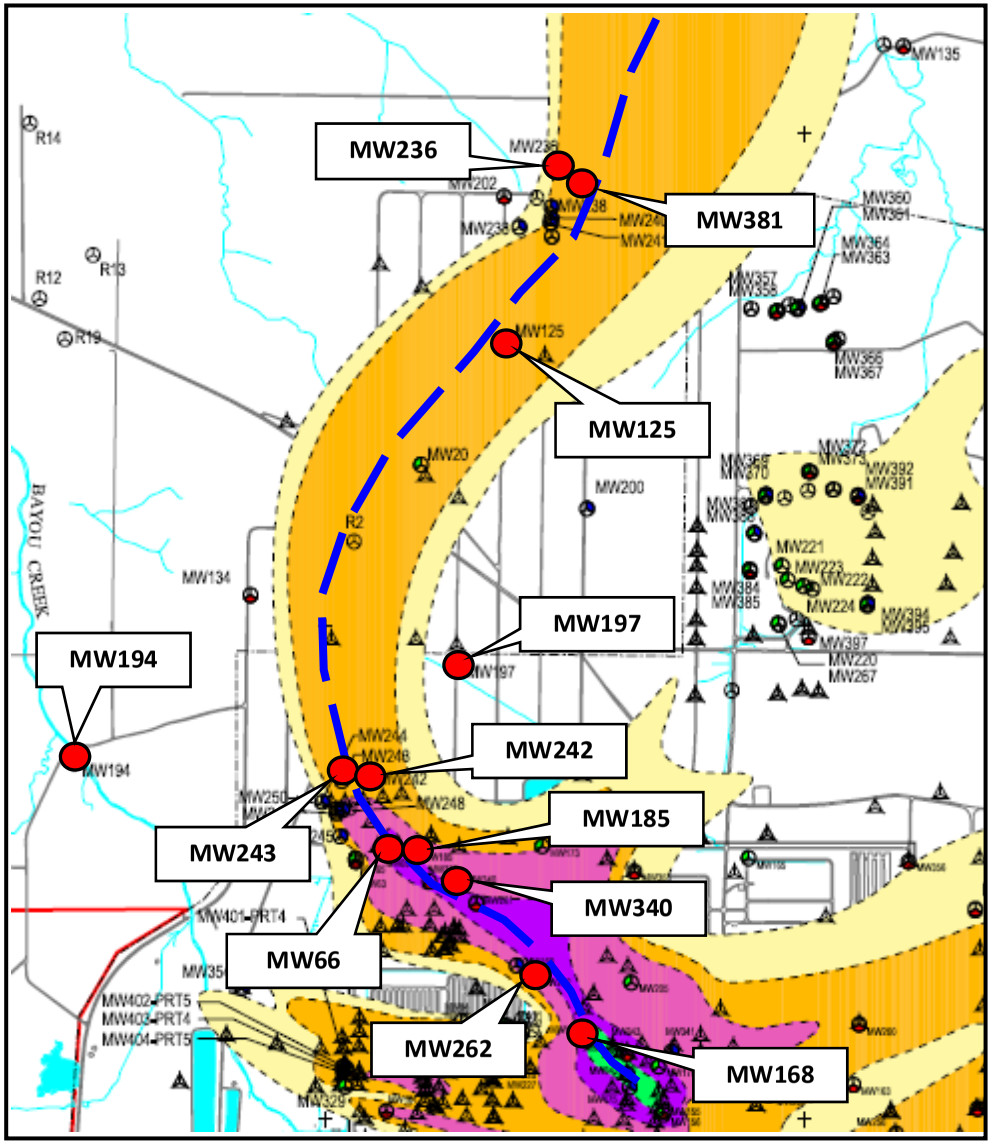
4 Phased Project Approach



PROJECTS: *TCE FATE AND TRANSPORT*

Study Area along approximate centerline of NWP

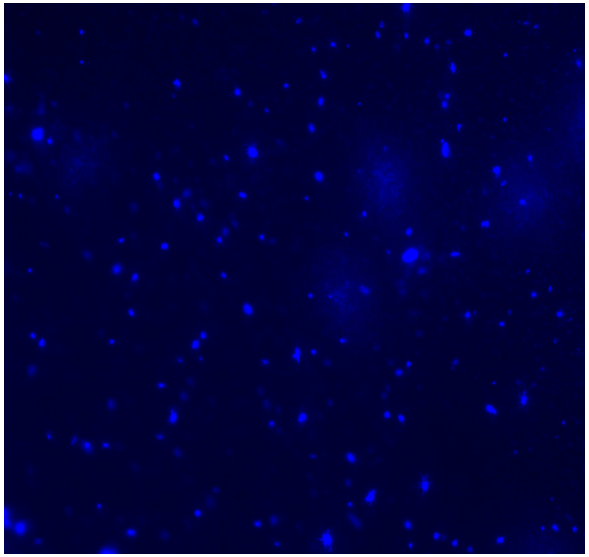
Red Circles are sample collection locations



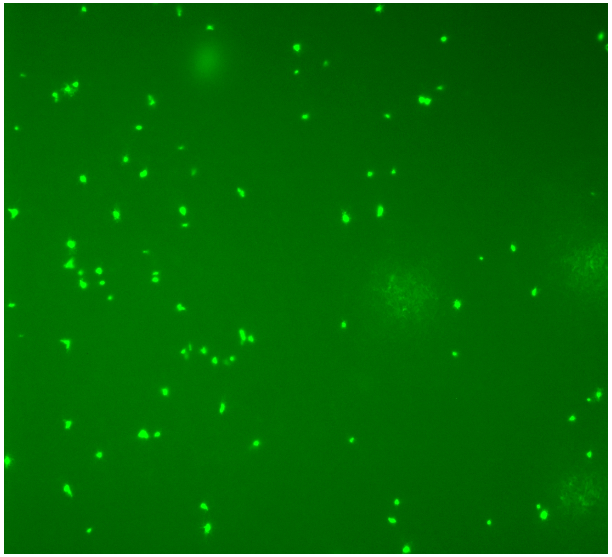
PROJECTS: *TCE FATE AND TRANSPORT: Phase II Aerobic*

Enzyme Activity Probes (EAP) used to identify the microbial production of oxygenase enzymes that capable of breaking down TCE

EAP micrographs



DAPI- total cells



Enzyme probes- positive response

Enzyme probes- negative response

PROJECTS: *TCE FATE AND TRANSPORT: Phase II Aerobic*

Table 3. Enzyme Activity Probe assay results for groundwater from monitoring wells at the Northwest Plume at PGDP.

Monitoring Well	Aquifer Designation	Screened Interval Depth (ft bgs)	Qualitative data (5/4/7)		Toluene probes			Total –DAPI cells/mL
			cMMO probe Coumarin	Toluene probes	Quantitative data (fluorescent cells/mL)			
					3HPA	PA	Cinnamonitrile	
MW168	URGA	63 - 68	-	-	nd	$2.41x10^{3}$	nd	$1.90x10^{5}$
MW66		55 - 60	+	+++	$1.43x10^{4}$	$2.10x10^{4}$	$9.14x10^{3}$	$3.67x10^{5}$
MW194		47 - 52	+	+++	$3.13x10^{3}$	$9.52x10^{3}$	$1.20x10^{4}$	$1.76x10^{5}$
MW197		58 - 63	-	+	$1.73x10^{4}$	$6.28x10^{4}$	$2.23x10^{3}$	$1.59x10^{5}$
MW197 (resample)			na	na	$5.03x10^{3}$	$1.20x10^{4}$	$2.04x10^{3}$	$7.05x10^{5}$
MW185	MRGA	68 - 73	-	++	$1.79x10^{4}$	$1.37x10^{4}$	$1.95x10^{3}$	$9.75x10^{5}$
MW242		65 - 75	-	-	$3.57x10^{3}$	$1.24x10^{3}$	$8.85x10^{3}$	$7.76x10^{5}$
MW243		65 - 75	-	-	$3.29x10^{3}$	$4.61x10^{3}$	$1.32x10^{3}$	$4.27x10^{5}$
MW381		66 - 76	-	++	$6.14x10^{4}$	$3.52x10^{4}$	$5.51x10^{3}$	$9.66x10^{5}$
MW262	LRGA	90 - 95	+	+++	$1.35x10^{4}$	$1.36x10^{4}$	$2.79x10^{4}$	$3.52x10^{5}$
MW 262 (resample)			na	na	$1.05x10^{4}$	$1.22x10^{4}$	$5.71x10^{3}$	$2.84x10^{5}$
MW340		85.5 - 95.3	+	+	$3.63x10^{2}$	$9.57x10^{3}$	nd	$7.25x10^{5}$
MW236		69.5 - 79.5	+	+++	$3.24x10^{4}$	$5.26x10^{4}$	$9.28x10^{3}$	$8.84x10^{5}$
MW125		78 - 88	+	++	$1.39x10^{4}$	$6.37x10^{4}$	$2.03x10^{4}$	$7.99x10^{5}$

URGA: Upper Regional Gravel Aquifer

MRGA: Middle Regional Gravel Aquifer

LRGA: Lower Regional Gravel Aquifer

3HPA: 3-hydroxy-phenylacetylene --> probe for toluene oxidase and related activity

PA: Phenylacetylene --> probe for toluene oxidase and related activity

cinnamonitrile: probe for toluene dioxygenase and related activity

DAPI: 4',6-Diamidino-2-Phenylindole (double stranded DNA staining)

ft bgs– feet below ground surface

µg/L – micrograms per liter

pCi/L – picocuries per liter

cells/mL – per milliliter

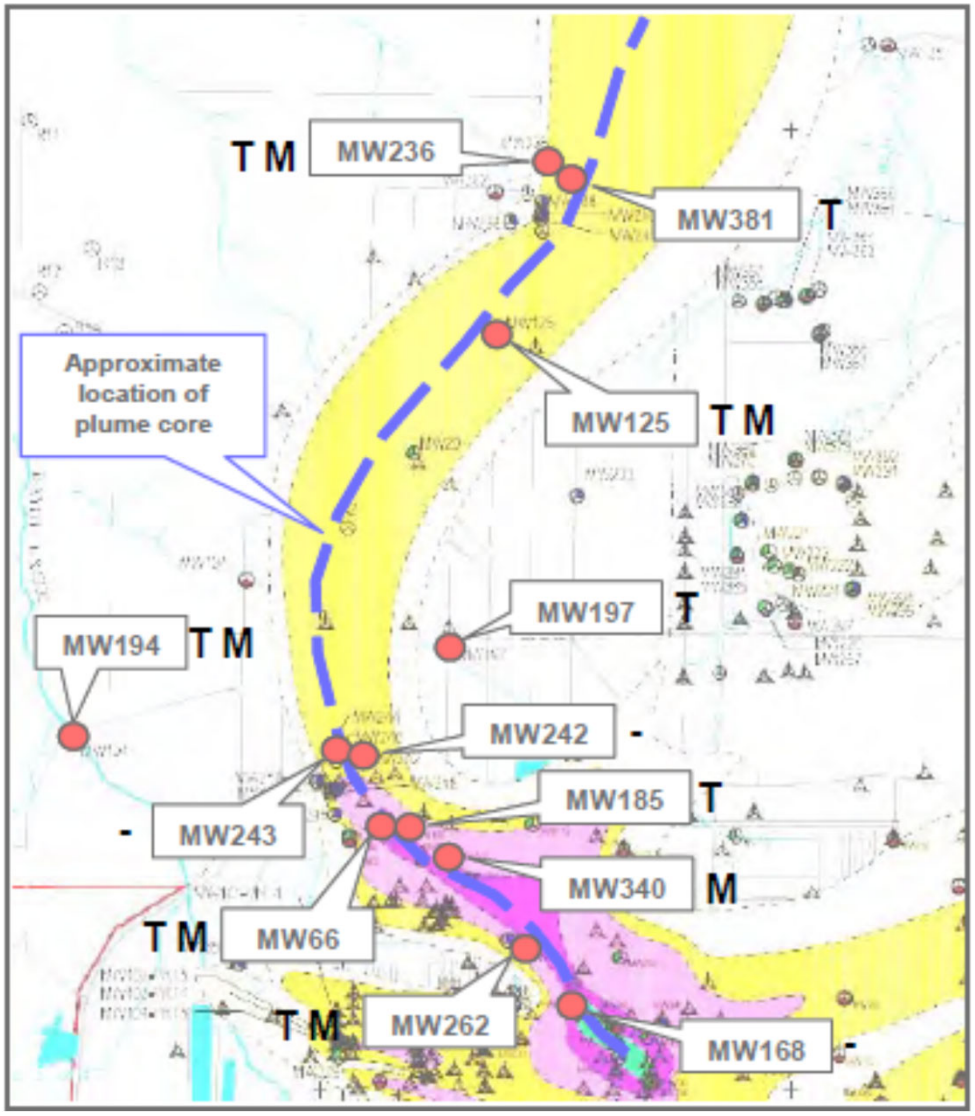
Highlight denotes that the toluene probe response was considered moderate (fluorescent activity > $3x10^{3}$ cells/mL and < $8x10^{3}$ cells/mL) – see text for explanation

Highlight denotes that the cMMO probe was significantly above background or the toluene probe response was considered significant (> $8x10^{3}$ cells/mL fluorescent activity)

PROJECTS: *TCE FATE AND TRANSPORT*

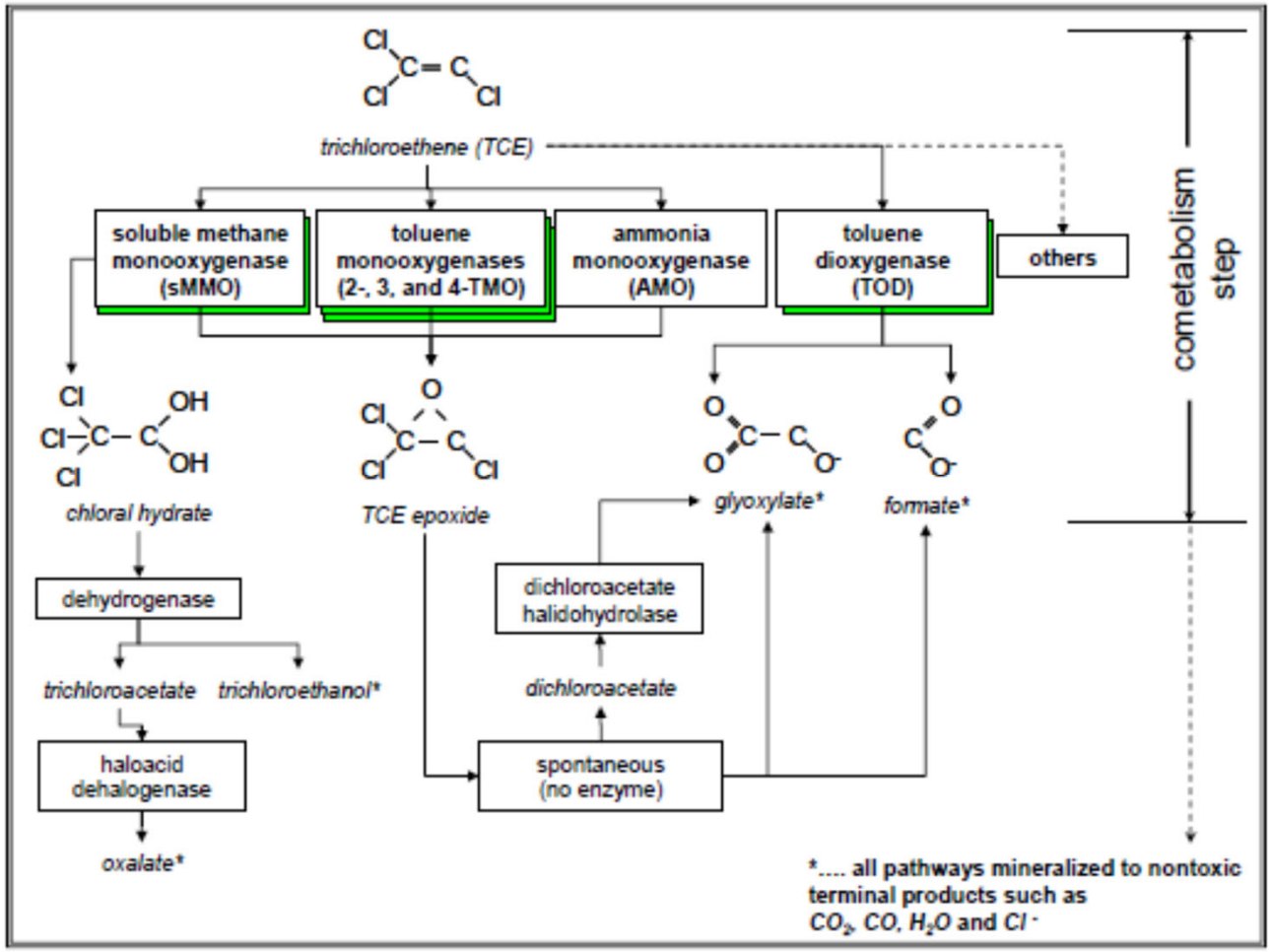
Study Area along approximate centerline of NWP

Bold Letters indicate identification of Toluene and Methane Oxygenase Activity



PROJECTS: *TCE FATE AND TRANSPORT: Phase II Aerobic*

'x_Oxygenase' TCE degradation pathways



PROJECTS: *TCE FATE AND TRANSPORT: Phase II Aerobic*

- Results of EAP Analyses followed by DNA Profiling
  - *verified presence of appropriate microbes by identifying key genes*

Table 4. Results of DNA control studies. A positive mark indicates the gene of interest was amplified from the groundwater sample.

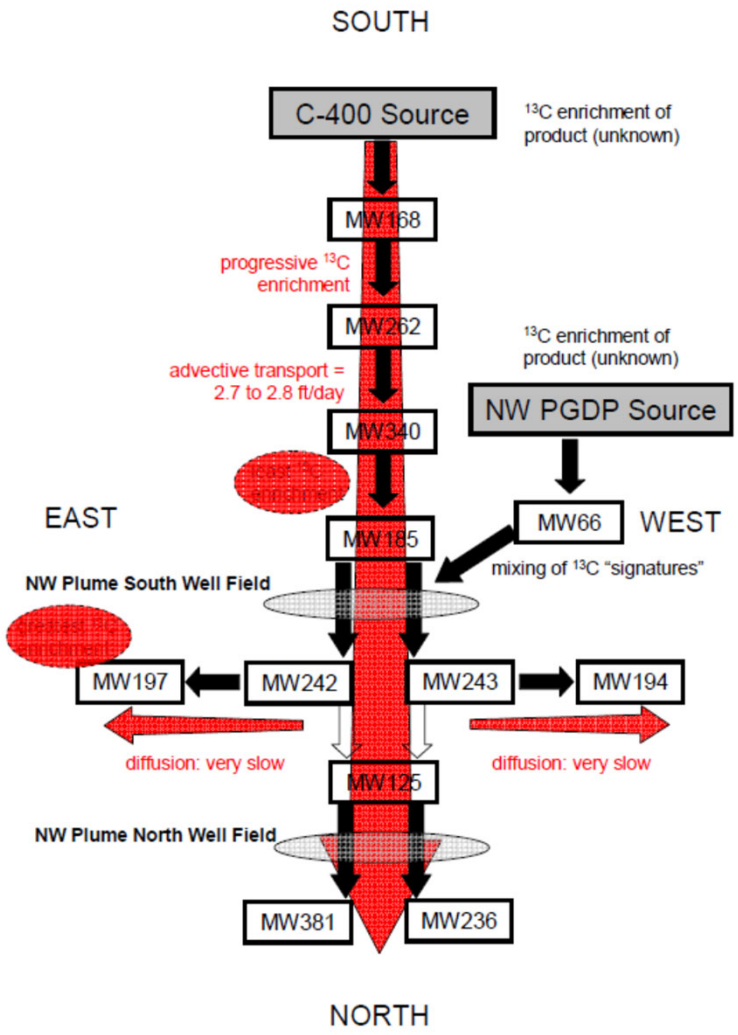
Monitoring Well	Aquifer Designation	Genes amplified			
		sMMO	RMO	PHE	TOD
MW168	URGA	+	-	+	-
MW66		+	+	+	+
MW194		+	+	+	+
MW197		-	+	+	+
MW185	MRGA	-	-	+	+
MW242		+	-	+	+
MW243		+	-	+	+
MW381		-	+	+	+
MW262	LRGA	+	+	+	+
MW340		+	-	+	+
MW236		+	+	+	+
MW125		+	+	+	+

URGA: Upper Regional Gravel Aquifer
MRGA: Middle Regional Gravel Aquifer
LRGA: Lower Regional Gravel Aquifer
sMMO: Soluble Methane Monooxygenase
RMO: Ringhydroxylation Toluene Monooxygenase
PHE: Phenol Monooxygenase
TOD: Toluene/xylene Monooxygenase

- EAP/DNA Analyses followed by **T-RFLP (RNA) population profiling**
  - *verified EAP and DNA Profiling results*

PROJECTS: *TCE FATE AND TRANSPORT: Phase III SCI*

- Stable Carbon Isotope (SCI) Evaluation
  - Microbes utilize Carbon as food source
  - Microbes metabolize lighter C isotopes preferentially over heavier isotopes
  - Measure $^{13}C/^{12}C$ ratio along flowpath
  - Enrichment of ^{13}C, depletion of ^{12}C, along flowpath indicates microbial uptake
- SCI provides verification that microbial (biotic) activity is responsible for metabolic uptake of C along NWP centerline



PROJECTS: *TCE FATE AND TRANSPORT: Phase IV Abiotic*

- **Abiotic Fate and Transport of Trichloroethene (TCE) in the RGA was evaluated as a portion of Phase IV Abiotic TCE Fate and Transport Project Activities.**
  - *Dr. Kevin Henke, Geochemist, Center for Applied Energy Research*
  - *Provided recommendations for future monitoring that included analytical work to distinguish aerobic, anaerobic and abiotic degradation mechanisms.*

Project Documents: Short List

Abiotic Fate and Transport of Trichloroethene (TCE) at the Paducah Gaseous Diffusion Plant, Kentucky: Recommendations for Future Monitoring (CAER, 2015)

Enzyme Activity Probe and Geochemical Assessment for Potential Aerobic Co-metabolism of Trichloroethene in Groundwater of the Northwest Plume, Paducah Gaseous Diffusion Plant, Kentucky. Prepared for U. S. Department of Energy Office of Environmental Management. WSRC-STI-2008-00309, June 2008.

TCE Fate and Transport Evaluation for Paducah Groundwater: Attenuation Mechanisms. Powerpoint Presentation. PNNL, 2015.

PGDP Trichloroethene Biodegradation Investigation Summary Report: Regional Gravel Aquifer & Northwest Plume. Prepared by TCE Fate and Transport Project Team & University of Kentucky - Kentucky Research Consortium for Energy and Environment, September 2008

PROJECTS: *TCE FATE AND TRANSPORT: Recommendations*

KRCEE FFY 09-10 Project Status
TCE FT Project: 80% Complete
TCE FT Ph 2 Report Submission – December 2010

WP RECOMMENDATIONS

1. **Collect off-site NEP microbial samples for to ensure presence and abundance of microbial populations similar to NWP**
   a. DAPI
   b. RNA/DNA
   c. Enzyme Probe analyses
   d. Collect microbial samples from NEP at PGDP east security fence to determine impacts of near site low DO anomaly
2. **Conduct biodegradation modeling for NEP, NWP, and SnT**
   a. Develop matrix of probable future conditions at site relative to:
      i. Plant shutdown
      ii. Biotic and Abiotic Remedial Implementations
3. **Establish near site and offsite transects for continuous monitoring of mass flux**
   a. Recommended as metric to identify loss of contaminants in plume
   b. Encompass plume bounds
   c. Establish baseline ASAP
   d. Obtain technical concurrence on mass flux transect locations relative to P & T and other facilities
   e. Obtain technical concurrence on NW 99Tc mass flux relative to NW TCE Plume
4. **Identify appropriate field techniques for evaluating microorganisms responsible for aerobic co-metabolism of TCE**
   a. Confirm field results with lab results
5. **Collect REDOX condition and process geochemical parameters to establish on and off-site baselines**
   1. Sulfide (solid, groundwater)
   2. H2S/HS/S (groundwater)
   3. S (solid and solid surface)
   4. Fe3+ (solid and solid surface)

1

PROJECTS: *TCE FATE AND TRANSPORT: Recommendations*

KRCEE FFY 09-10 Project Status
TCE FT Project: 80% Complete
TCE FT Ph 2 Report Submission – December 2010

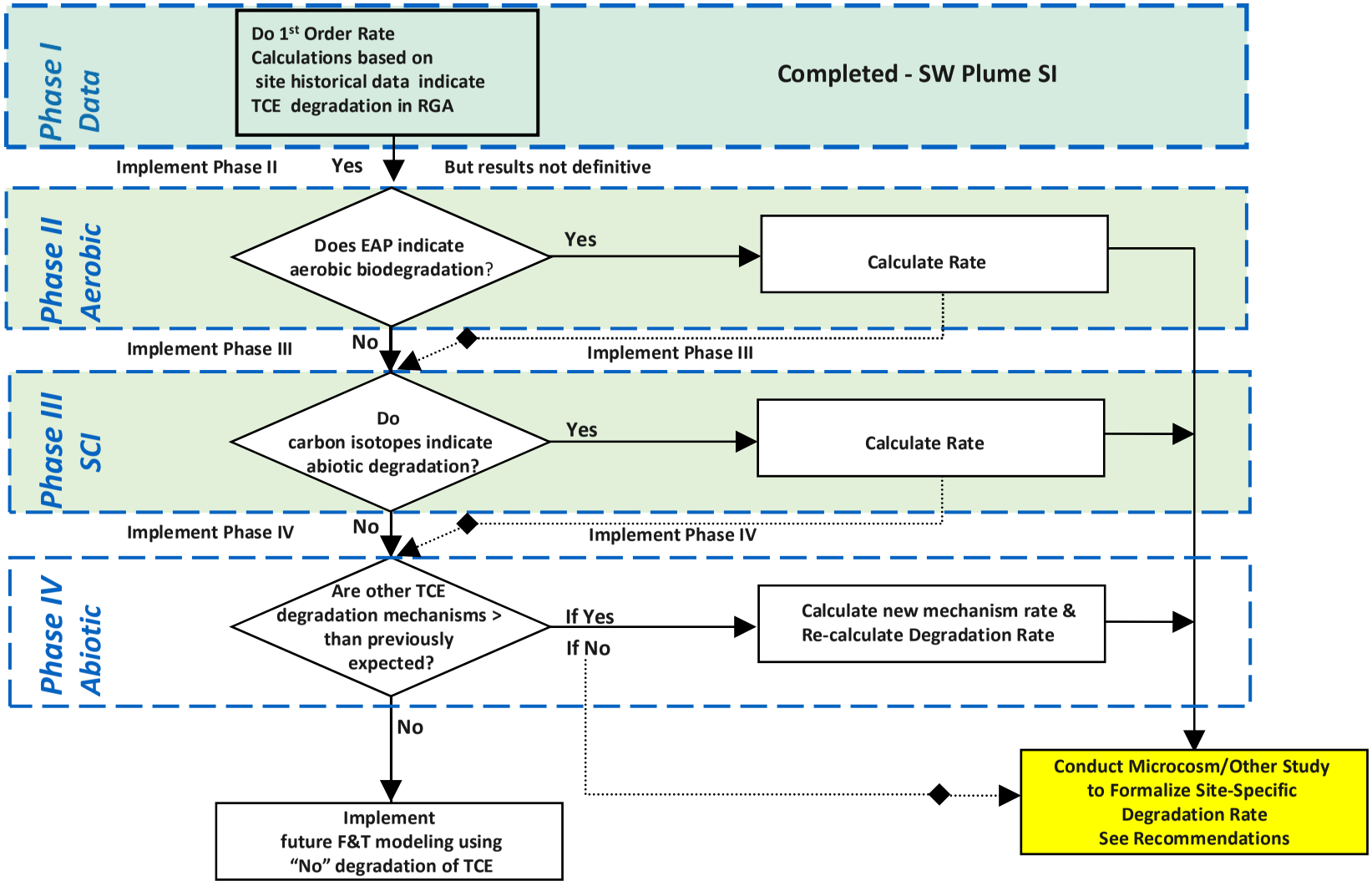
WP RECOMMENDATIONS (cont'd)

6. **Collect additional geochemical parameters on-site to account for occurrence of multiple degradation processes**
   1. H (gas, groundwater)
   2. CO_2 (gas, groundwater)
   3. Methane (gas, groundwater)
   4. Ethene (gas, groundwater
   5. NH_4 (groundwater)
   6. DOC (groundwater)
7. **Evaluate water levels and Redox process geochemistry in the vicinity of facilities that are likely to impact the RGA**
   1. Sewage treatment system facilities (basins and lagoons)
8. **Collect soil and groundwater REDOX Geochemical data beneath, adjacent to, and downgradient of the C-616 lagoons**
   1. Sulfide (solid, groundwater)
   2. H2S/HS/S (groundwater)
   3. S (solid and solid surface)
   4. Fe3+ (solid and solid surface)
9. **Confirm/deny the occurrence of intrinsic Biotic/Abiotic degradation relative to NW 99Tc Plume and TCE Plumes**
   1. Collect water level and REDOX geochemical data in the vicinity of the C-616 Lagoons in order to evaluate potential impacts of C-616 lagoons on the UCRS in the vicinity of SWMUs 7/30

CAER UK UNIVERSITY OF KENTUCKY College of Arts and Sciences Earth & Environmental Sciences KRCEE

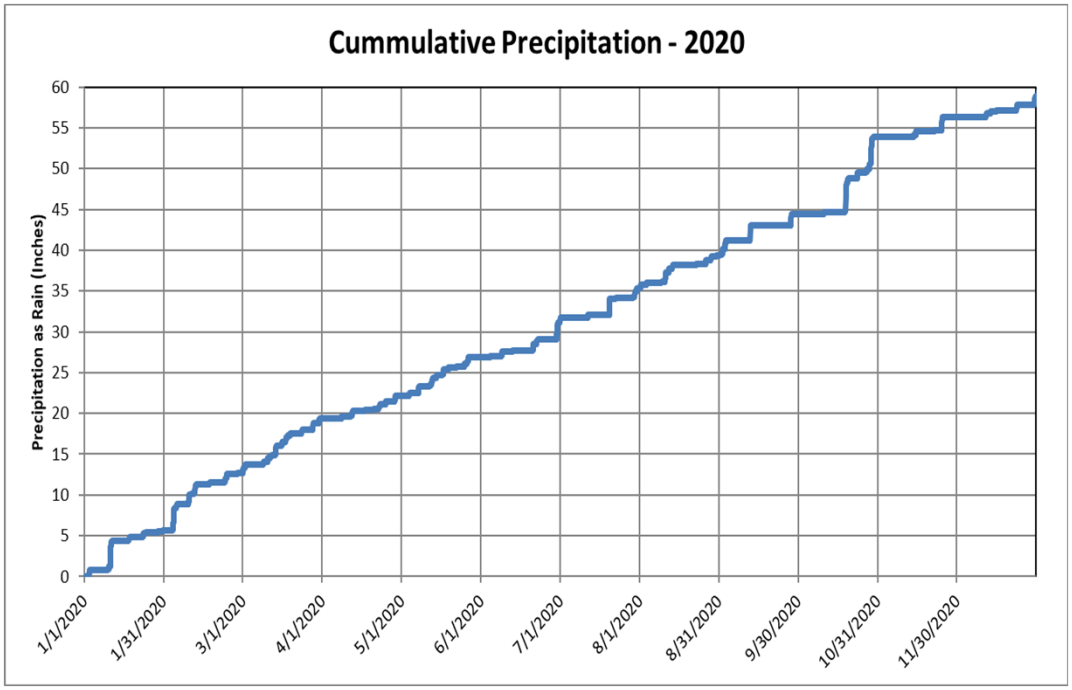
PROJECTS: *TCE FATE AND TRANSPORT*

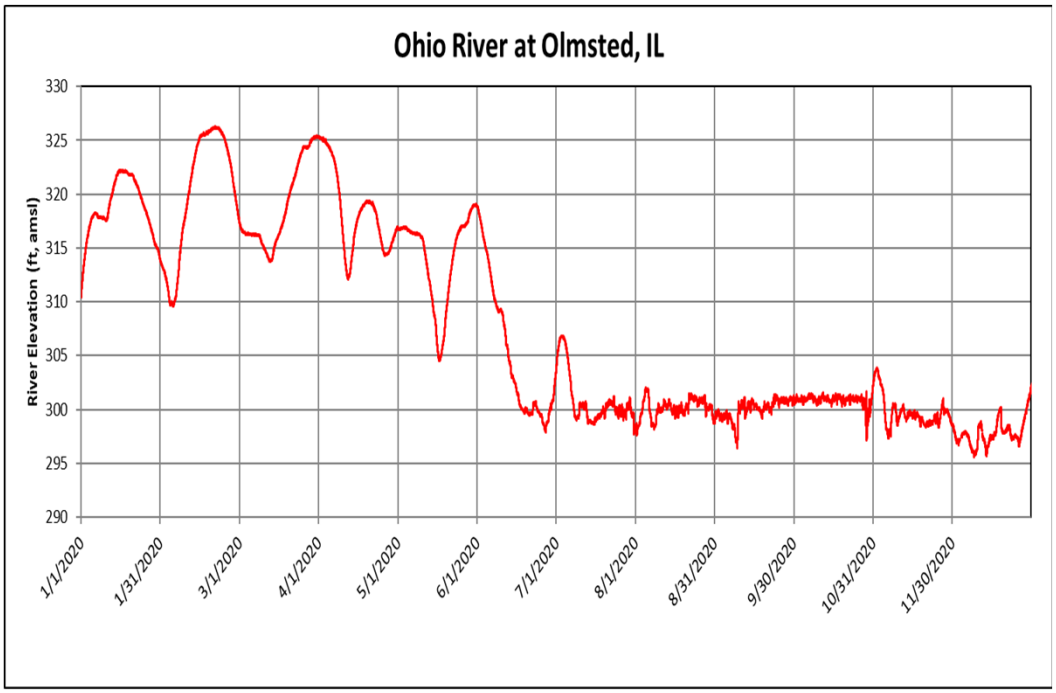
4 Phased Project Approach



Attachment 5

Precipitation and Ohio River Stage Data


Cummulative Precipitation - 2020
Precipitation as Rain (Inches)
60
55
50
45
40
35
30
25
20
15
10
5
0
1/1/2020
1/31/2020
3/1/2020
4/1/2020
5/1/2020
6/1/2020
7/1/2020
8/1/2020
8/31/2020
9/30/2020
10/31/2020
11/30/2020


Ohio River at Olmsted, IL
River Elevation (ft, amsl)
330
325
320
315
310
305
300
295
290
1/1/2020
1/31/2020
3/1/2020
4/1/2020
5/1/2020
6/1/2020
7/1/2020
8/1/2020
8/31/2020
9/30/2020
10/31/2020
11/30/2020

Attachment 6

Blank DOE PFAS Survey

Emerging Contaminants: Per- and Polyfluoroalkyl Substances (PFAS)
General Assessment Survey for DOE-EM Sites

On-Site Drinking Water

- If the site provides potable drinking water, check all boxes that apply:
  ☐ Population served by public water system (PWS) is under 10,000
  ☐ Population served by PWS is over 10,000
  ☐ Site provides potable water to residential wells
  ☐ Site does not provide drinking water to workforce

- Has drinking water at the site been sampled for PFAS?
  ☐ Yes, no PFAS were detected
  ☐ Yes, PFAS were detected
  ☐ No, drinking water has not been sampled

PFAS Usage

- Does your site currently have or previously had any of the following facilities, events, and/or disposal units?
  ☐ Fire training facility
  ☐ Fire department
  ☐ Presence of AFFF-based fire suppression system
  ☐ Documented release of AFFF
  ☐ Uranium enrichment
  ☐ Metal plating processing
  ☐ Plutonium production
  ☐ Manhattan project liquid discharges
  ☐ Cold War era liquid waste discharges
  ☐ Landfill
  ☐ Wastewater treatment plant

- Does your site track and maintain past and present inventories of PFAS?
  ☐ Yes, the site has more than 100 pounds of any one PFAS
  ☐ Yes, the site does not have more than 100 pounds of any one PFAS
  ☐ No

On-Site Sampling/Monitoring Equipment

- Check all environmental media that has been tested at the site with positive PFAS results:
  ☐ Drinking water
  ☐ Surface water
  ☐ Groundwater
  ☐ Soil
  ☐ Biota
  ☐ Wastewater

Emerging Contaminants: Per- and Polyfluoroalkyl Substances (PFAS)
General Assessment Survey for DOE-EM Sites

☐ Leachate
☐ Sediment
☐ Biosolids/sludge
☐ No positive detections
☐ The site has not sampled

- Are on site PFAS concentrations actively monitored?
  ☐ Yes, in drinking water
  ☐ Yes, in surface water
  ☐ Yes, in groundwater
  ☐ Yes, in soil
  ☐ Yes, in biota
  ☐ Yes, in wastewater
  ☐ Yes, in leachate
  ☐ Yes, in sediment
  ☐ Yes, in biosolids/sludge
  ☐ No; previous positive detections, but not actively monitoring
  ☐ No; have not detected or sampled for PFAS

- Are there analytical results available from PFAS sampling?
  ☐ Yes
  ☐ No

- Have PFAS been measured beyond the DOE site boundary?
  ☐ Yes
  ☐ No

- If your site has not yet sampled for PFAS, do you currently use monitoring equipment that contains PFAS (e.g. Teflon)? Select all that apply.
  ☐ Yes, new monitoring wells would be required for PFAS sampling
  ☐ Yes, monitoring wells liners would need to be replaced for PFAS sampling
  ☐ Yes, new sampling supplies would be required for PFAS sampling
  ☐ Yes, new PPE would be required for PFAS sampling
  ☐ Other _____
  ☐ No

- If your site has sampled for PFAS, was sampling conducted with the appropriate methods to avoid inadvertent contamination (e.g. proper PPE, monitoring equipment, and sampling tools)?
  ☐ Yes
  ☐ No

Emerging Contaminants: Per- and Polyfluoroalkyl Substances (PFAS)
General Assessment Survey for DOE-EM Sites

Regulatory & Stakeholder

- Has the site been contacted by regulators/stakeholders regarding PFAS?
  - ☐ Federal
  - ☐ State
  - ☐ Tribal Nations
  - ☐ Local
  - ☐ Other _____
  - ☐ No

- Have regulators/stakeholders prompted any of the following responses?
  - ☐ Search for historical uses of AFFF or other PFAS related materials
  - ☐ Include PFAS analysis in current monitoring program
  - ☐ Site sampling for PFAS
  - ☐ Other _____

APPENDIX C

GROUNDWATER MODELING WORKING GROUP MEETING SUMMARY—APRIL 7, 2021

THIS PAGE INTENTIONALLY LEFT BLANK

ACRONYMS[1]

AIP	agreement in principle
amsl	above mean sea level
AT123D	analytical transient 1-, 2-, 3-dimensional
CB	colloidal borescope
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CRS	comment response summary
CSM	conceptual site model
DOE	U.S. Department of Energy
DTW	depth to water
EMP	environmental monitoring plan
EPA	U.S. Environmental Protection Agency
ETAS	Enterprise Technical Assistance Services, Inc.
FRNP	Four Rivers Nuclear Partnership, LLC
FS	feasibility study
FY	fiscal year
GW	groundwater
GWSP	groundwater strategy project
KRCEE	Kentucky Research Consortium for Energy and the Environment
KY	Commonwealth of Kentucky
LBCSP	Little Bayou Creek seep
MEPAS	multimedia environmental pollutant assessment system
MNA	monitored natural attenuation
MODFLOW	modeling program
MW	monitoring well
MWG	Modeling Working Group
NWP	Northwest Plume
OREIS	Oak Ridge Environmental Information System
OU	operable unit
PEGASIS	PPPO Environmental Geographic Analytical Spatial Information System
PGDP	Paducah Gaseous Diffusion Plant
P-QAPP	programmatic quality assurance project plan
PT	pressure transducer
PTS	pump and treat system
PZ	piezometer
Q	quarter
RFP	request for proposal
RGA	Regional Gravel Aquifer
RI	remedial investigation
SESOIL	seasonal soil model
SI	site investigation
SWMU	solid waste management unit
SWP	Southwest Plume
TBD	to be determined
TIC	top of inner casing
TVA	Tennessee Valley Authority
UCRS	upper continental recharge system

[1] Acronym list was not part of the original meeting summaries.

VI	vapor intrusion
WDA	waste disposal alternative

Paducah Site Groundwater Modeling Working Group
Meeting Summary—April 7, 2021

MWG Member List:

DOE	EPA	FRNP
Rich Bonczek ✓	Noman Ahsanuzzaman ✓	Austin Buckhalter ✓
Dave Dollins ✓	Ben Bentkowski ✓	Bryan Clayton
	Eva Davis ✓	Lisa Crabtree
ETAS	Jana Dawson	Ken Davis
Martin Clauberg ✓	Mac McRae ✓	Rob Flynn ✓
Bruce Stearns ✓	Victor Weeks ✓	Bruce Ford ✓
Tracy Taylor ✓		Stefanie Fountain ✓
	Kentucky	LeAnne Garner
KRCEE	Brian Begley ✓	Todd Powers ✓
Steve Hampson ✓	Stephanie Brock ✓	Joe Tarantino ✓
	Nathan Garner ✓	Denise Tripp ✓
	Brian Lainhart	Alexis Wiltfong ✓
	Chris Travis ✓	

✓ Indicates member was present

Original meeting agenda items are provided followed by meeting notes; the meeting notes are provided in italics with action items noted in green.

1. Call for Issues from Groundwater Modeling Working Group (MWG) Members

No comments received to the January 13, 2021, Meeting Summary (sent to participants on 1/28/2021). This summary will be considered final.

No comments were received to the January 13, 2021 Meeting Summary. This summary is now final.

2. FY 2021+ Work Plan/Schedule

a. FY 2021 Work Plan/Schedule

Activity	Date
~~Provide Draft Final Lithologic Technical Paper Outline to MWG~~	~~9/30/2020~~
~~Submit FY21 Schedule to MWG~~	~~9/30/2020~~
~~Comments Due for July Meeting Draft Summary~~	~~10/7/2020~~
~~Quarterly Meeting (October/FY21Q1)~~	~~10/7/2020~~
~~Submit Draft Compilation of Meeting Summaries and White Papers (1/2019-7/2020)~~	~~10/14/2020~~
~~MWG concurs with FY21 Schedule~~	~~10/14/2020~~
~~Provide Final Outline for Lithologic Technical Paper to MWG~~	~~10/22/2020~~
~~Submit Draft Compilation of Meeting Summaries and White Papers (1/2019-7/2020)~~	~~10/28/2020~~
~~Comments Due for Draft Compilation of Meeting Summaries and White Papers (1/2019-7/2020)~~	~~11/25/2020~~
~~Submit Final Compilation of Meeting Summaries and White Papers (1/2019-7/2020)~~	~~12/11/2020~~
~~Quarterly Meeting (January/FY21Q2)~~	~~1/13/2021~~

Activity	Date
Quarterly Meeting (April/FY21Q3)	4/7/2021
Quarterly Meeting (July/FY21Q4)	7/14/2021
Submit Draft Meeting Summaries and White Papers Compilation (FY21)	9/29/2021

Items shown in strikeout text are completed.

b. Draft FY 2022+ Activities

Activity	Date
Quarterly Meeting (October/FY22Q1)	10/6/2021
MWG Provide Comments on Draft Compilation of Meeting Summaries and White Papers (FY21)	10/13/2021
MWG Meeting to Discuss Draft Final Lithologic Technical Paper	11/17/2021
MWG Provide Comments on Draft Final Lithologic Technical Paper	12/6/2021
Quarterly Meeting (January/FY22Q2)	1/12/2022

FY2021 schedule items related to the second survey white paper and the Large Building PZ White Paper were discussed and added to the schedule:

Activity	Date
~~Provide Draft Final Lithologic Technical Paper Outline to MWG~~	~~9/30/2020~~
~~Submit FY21 Schedule to MWG~~	~~9/30/2020~~
~~Comments Due for July Meeting Draft Summary~~	~~10/7/2020~~
~~Quarterly Meeting (October/FY21Q1)~~	~~10/7/2020~~
~~Submit Draft Compilation of Meeting Summaries and White Papers (1/2019-7/2020)~~	~~10/14/2020~~
~~MWG concurs with FY21 Schedule~~	~~10/14/2020~~
~~Provide Final Outline for Lithologic Technical Paper to MWG~~	~~10/22/2020~~
~~Submit Draft Compilation of Meeting Summaries and White Papers (1/2019-7/2020)~~	~~10/28/2020~~
~~Comments Due for Draft Compilation of Meeting Summaries and White Papers (1/2019-7/2020)~~	~~11/25/2020~~
~~Submit Final Compilation of Meeting Summaries and White Papers (1/2019-7/2020)~~	~~12/11/2020~~
~~Quarterly Meeting (January/FY21Q2)~~	~~1/13/2021~~
Quarterly Meeting (April/FY21Q3)	4/7/2021
Survey White Paper 2 Outline	6/30/2021
Develop Draft Large Building PZ White Paper	7/2/2021
Quarterly Meeting (July/FY21Q4)	7/14/2021
MWG Review Draft Final Large Building PZ White Paper	8/3/2021
MWG Meeting to Discuss Draft Final Large Building PZ White Paper	7/27/2021
Submit Final Large Building PZ White Paper to EPA and KY	9/24/2021
Submit Draft Meeting Summaries and White Papers Compilation (FY21)	9/29/2021

3. Update on Water Levels

Synoptic water level events are being collected quarterly and since the last meeting (January 13, 2021) have occurred on February 22-24, 2021.

Groundwater elevation data for TVA wells collected by KY occurred on February 22, 2021 and is included as Attachment 1.

Groundwater elevation data will be reviewed and discussed with the MWG following completion of the 12 months of data collection (Month 12 is August 2021). Ongoing and future use of the quarterly synoptic water level events was discussed, including project-level, as-needed use, and for future development of potentiometric water surface maps.

4. Update on Paducah Site Groundwater Strategy

The Groundwater Strategy Project (GWSP) schedule from the EMP is included as Attachment 2. In this schedule, "Month 1" is September 2020. Data has been collected for Months 1-6 (September-February) and Month 7 (March) data collection is in progress. Data processing is in progress.

Field conditions encountered to date:

- Month 1 (September 2020): Removal of MW411 from the colloidal borescope data collection portion of the GWSP (Email November 19 and response from KY on November 20)
    - Nearby wells MW469 (west), MW471 (south), and MW475 (north) are part of the GWSP colloidal borescope program. There are no wells to the east of MW471.
- Month 2 (October 2020): MW99 and MW477 manual water levels were not able to be collected due to wet conditions. The transducers had sufficient memory to continue to collect data.
- Month 3 (November 2020): MW71 pressure transducer malfunction– transducer has been repaired.
- Month 4 (December 2020): All data collected.
- Month 5 (January 2021): MW469 is not accessible for colloidal borescope deployment due to TVA road construction activities and will be substituted with MW472 (collocated with MW471).
- Month 6 (February 2021):
    - MW477 was not accessible for colloidal borescope deployment due to wet conditions; the team will continue to monitor access.
    - There were multiple issues with colloidal borescope equipment during the month. Potential actions to correct are in review. Several colloidal borescope locations to be re-performed once the equipment issues are resolved and there is an opening in the schedule.
- Month 7 (March 2021): Data collection is in progress.

The complete dataset will be available in October 2021. Preliminary data will be discussed when appropriate and as the project moves forward.

FRNP continues to coordinate with KY on the AIP monitoring wells sampling schedule.

No comments were received on this topic during the meeting.

5. Discussion on Installation of Piezometers …Associated with Several of the Large Process Buildings

Preliminary information to be collected for the "Installation of piezometers …associated with several of the large process buildings…." white paper will benefit from the information learned during the vapor intrusion (VI) project. The D2/R1 VI Work Plan was finalized in December 2020 and field sample collection occurred February 22, 2021 through March 9, 2021.

The Vapor Intrusion sample data are in assessment/validation. A scoping meeting for the Vapor Intrusion Report is planned for the end of April/early May [meeting was held April 27, 2021].

The following scheduled was accepted as part of the October 2020 Groundwater MWG meeting.

Activity	Target Start	Target Finish
~~Quarterly Meeting (October/FY21Q1)~~	-	~~10/7/2020~~
~~Develop Outline for Large Building PZ White Paper~~	~~10/14/2020~~	~~12/11/2020~~
~~Provide Large Building PZ White Paper Outline to MWG~~	-	~~12/11/2020~~
~~MWG Review Large Building PZ White Paper Outline~~	~~12/11/2020~~	~~1/13/2021~~
~~Quarterly Meeting (January/FY21Q2)~~	-	~~1/13/2021~~
~~Revise Outline for Large Building PZ White Paper Based on MWG Discussions~~	~~1/13/2021~~	~~1/28/2021~~
~~VI Field Sampling / Laboratory Analysis / Validation~~	~~2/28/2021~~	~~4/27/2021~~
Develop Draft Large Building PZ White Paper	1/28/2021	7/2/2021
Quarterly Meeting (April/FY21Q3)		4/7/2021
Issue Draft Final Large Building PZ White Paper to MWG		7/2/2021
Quarterly Meeting (July/FY21Q4)		7/14/2021
MWG Review Draft Final Large Building PZ White Paper	7/2/2021	8/3/2021
MWG Meeting to Discuss Draft Final Large Building PZ White Paper		7/27/2021
MWG Provide Comments on Draft Final Large Building PZ White Paper		8/3/2021
Revise Draft Final Large Building PZ White Paper	8/3/2021	9/23/2021
Submit Final Large Building PZ White Paper to EPA and KY		9/24/2021
Quarterly Meeting (October/FY22Q1)		10/6/2021
Quarterly Meeting (January/FY22Q2)		1/12/2022

Items shown in strikeout text are completed.

The draft annotated outline was included in the January 13, 2021 MWG meeting summary (sent to participants on 1/28/2021). No comments were received on the included outline and the outline will be considered final.

FY2021 dates have been added to the MWG schedules in Item 2.

6. 2021 Presentations

- April 2021: Steve Hampson presentation on TCE degradation rates

  There have been questions on the TCE degradation rates being used by different site projects. This presentation provided the source(s) of information available for TCE degradation rates. The Dissolved Phase OU project would use this information; work on this OU has been suspended and archived. The information is also relevant for source remediation. The presentation is included with this summary as Attachment 3.

- July 2021 (Proposed):.FRNP to present on PEGASIS, including how PEGASIS works and what data is included in PEGASIS.

The EarthCon presentation will be moved back in the schedule as their contract with DOE is pending. MWG members should provide any presentation requests to Stefanie.

The EarthCon statement of work is currently in review and is anticipated to be approved for FY2022. The group discussed having a presentation on the 2016 Groundwater Model Report at one of the quarterly meetings.

7. CSM for the RGA in SWMU 211-A Remedial Action Work Plan

Section 1.1.2, "Regional Hydrogeology," references an axis in describing thickness trends for gravel deposits forming the RGA. EPA would like to discuss if the use of the term axis has any implied significance to groundwater flow direction(s) (i.e., a north-south lateral groundwater flow divide) or any implication for implied subsurface structural feature(s) forming the RGA (i.e., the existence of an east-west fault-controlled structural low).

The site geologist explained the east-west trend is consistent with ancestral Tennessee River and is believed to be an erosional surface (thalweg is the geomorphology term). EPA suggested that the Paducah Site area may have several generations of seismic activities, overprinting of seismicity could be happening, and east-west faulting may have occurred. Steve Hampson had a follow-up after discussion with Dr. Woolery and Dr. Zhu.

Steve Hampson reported that an east-west trend is prevalent at PGDP, as evidenced in both regional and local studies. Regional faults commonly trend northeast-southwest but that there could be local structural controls under PGDP that could influence groundwater flow. Seismic studies have not previously been conducted between the east and west fences and from the Porters Creek terrace to north fence because it was not possible to filter out the noise of the operating plant. Most of the plant infrastructure is no longer operating and Steve Hampson discussed that Dr. Woolery has noted there are now seismic reflection techniques that could give a better view of what the structure is beneath the site.

DOE and FRNP are reviewing whether there are any ways to further reduce (temporarily) sources of noise to facilitate new testing without disrupting site activities. Dr. Woolery has offered to support any requests or initiatives that may develop regarding additional seismic surveys at the Paducah Site.

No comments were received on this topic during the meeting.

8. CSM for the McNairy in the C-400 Complex Area

FRNP has set up a website to house a library of McNairy information. Access the website at the following link: https://fourriversnuclearpartnership.com/McNCSM. The site requires a password that has been sent separately. Contact Stefanie if you need the password to the website.

A lithology white paper is being prepared as part of the resolution of dispute on the CERCLA Five Year Review. DOE will issue the technical paper within one month of submittal of the D1 C-400 Complex OU RI/FS Report to support the review and comment of the C-400 specific data interpretation as part of the C-400 Complex OU RI/FS Report review process and the performance of the FY 2023 Five-Year Review revised protectiveness determinations for the Northeast, Northwest, and Water Policy response actions. The regulatory milestone date for the D1 C-400 Complex OU RI/FS Report has been revised to October 7, 2022.

A draft schedule and annotated outline for the paper were discussed during the October 2020 Groundwater MWG meeting. The schedule was revised to reflect the new C-400 Complex OU RI/FS Report date and was discussed during the January 13, 2021 meeting (see below). The plan continues to be that the draft Lithology Paper will be available to the MWG before the D1 C-400 Report is submitted so that substantive comments may be addressed prior to the D1 C-400 Report being issued. The Lithology Paper will then be revised and submitted.

Activity	Target Start	Target Finish	Notes
~~FRNP/DOE Develop Outline for Draft Lithologic Technical Paper~~	~~7/7/2020~~	~~9/30/2020~~	COMPLETE
~~Provide Draft Final Lithologic Technical Paper Outline to MWG~~		~~9/30/2020~~	COMPLETE
~~MWG Review Draft Final Lithologic Technical Paper Outline~~	~~9/30/2020~~	~~10/7/2020~~	COMPLETE
~~Quarterly Meeting (October/FY21Q1)~~		~~10/7/2020~~	COMPLETE
~~FRNP/DOE Revise Draft Final Outline for Lithologic Technical Paper Based on MWG Discussions~~	~~10/7/2020~~	~~10/22/2020~~	COMPLETE
~~Provide Final Outline for Lithologic Technical Paper to MWG~~		~~10/22/2020~~	COMPLETE
~~Quarterly Meeting (January/FY21Q2)~~		~~1/13/2021~~	COMPLETE
Quarterly Meeting (April/FY21Q3)		4/7/2021	
Quarterly Meeting (July/FY21Q4)		7/14/2021	
Collect C-400 Lithology Data	5/17/2021	3/16/2022	From C-400 Schedule
FRNP/DOE Develop Draft Lithologic Technical Paper Text	8/4/2021	3/10/2022	
Quarterly Meeting (October/FY21Q3)		10/6/2021	
Finish Collection of C-400 Lithology Data		3/16/2022	From C-400 Schedule
FRNP/DOE Incorporate C-400 Results into Draft Lithologic Technical Paper	3/16/2022	8/11/2022	
Develop C-400 RI Report	3/17/2022	9/14/2022	From C-400 Schedule
Issue Draft Final Lithologic Technical Paper to MWG		8/11/2022	
MWG Review and Provide Comments on Draft Final Lithologic Technical Paper	8/11/2022	9/12/2022	
MWG Meeting to Discuss Draft Final Lithologic Technical Paper		8/24/2022	Draft FY2021 MWG Work Plan Date
MWG Provide Comments on Draft Final Lithologic Technical Paper		9/12/2022	
C-400 RI Report Submitted to EPA and KY		10/7/2022	Current Milestone
FRNP/DOE Revise Draft Final Lithologic Technical Paper	9/12/2022	11/7/2022	No formal CRS
Submit Final Lithologic Technical Paper to EPA and KY		11/7/2022	Tech Paper Due 1 Month After C-400 RI Report (Currently 10/8/2022)

Items shown in strikeout text are completed.

The KRCEE spreadsheet database of soil boring logs (R10 HydroLitho Dbase posted 121620.xlsx) is available at https://fourriversnuclearpartnership.com/McNCSM.

No comments were received on this topic during the meeting.

9. Resurvey of wells

The field resurveying effort for the monitoring well reference point elevations was completed October 9, 2020 and the data review was completed in November 2020. The data are in the process of being reviewed for upload to OREIS. Additionally, a review of the data and any impact on the groundwater model will be performed (schedule is pending with initial scoping planned for late-February).

A white paper summarizing the approach and scope of the resurvey work was developed and will be appended to the 2021 update to the P-QAPP. A second white paper on potential impacts of the new survey data and the impact to the groundwater model will be developed.

DOE proposed appending the second survey white paper to 2016 Groundwater Model Report. KY and EPA agreed on this approach. ***DOE will discuss this approach with Site management when the paper is developed in draft.***

10. Precipitation and Ohio River Stage

Attachment 3 includes precipitation and Ohio River stage charts through December 2020.

No comments were received on this topic during the meeting.

11. Projects on the "Watch Topics" List

- **TVA Changes.** During the October 2020 and January 2021 meeting, the MWG discussed the construction of the new ash ponds and a recent RFP for a 3,800 ft sheet pile wall to be constructed in close proximity to Little Bayou Creek and several seeps. The sheet pile wall may intercept the RGA and influence the creek.

  The group did not have any updates on this topic. ***FRNP will attempt to confirm the project's status. KY and FRNP will review their files for a drawing depicting the proposed alignment of the sheet pile wall.***

- **Consider stream gauging in relation to the synoptic water levels.** Stream gauging has been discussed as part of out-year activities. See October 2018 Meeting Summary for additional information. Stream gauging will support new modeling.

  No comments were received on this topic during the meeting.

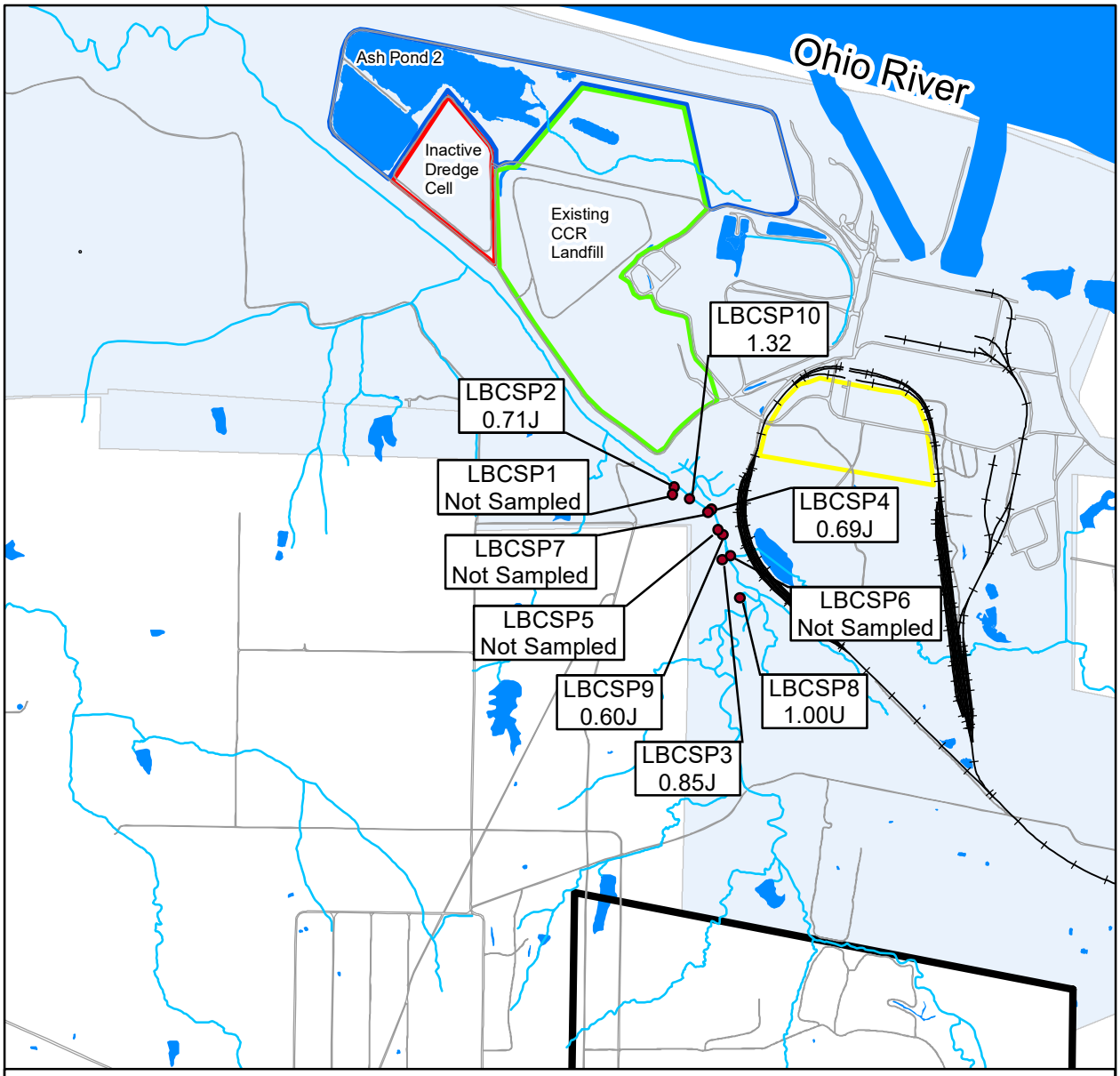
- **Seeps.** On August 5, FRNP and KY walked down the two seeps reported in the June 6, 2020 meeting. Seep A appears to be 4 ft higher in elevation than the creek bottom and south of LBC5. Seep B is also in Little Bayou Creek and on the side of the creek bank. KY sampled Seep A in August.

  The seep data collected by KY have been provided for upload to PEGASIS. KY is currently working on a letter transmitting the data. TCE was detected in the seeps. Site data for the split sampling has been loaded to OREIS: TCE was detected at LBCSP10; TCE was detected at an estimated concentration for LBCSP2, LBCSP3, LBCSP4, LBCSP9; TCE was nondetect at LBCSP8.

The group discussed whether the seeps may be impacted by the sheet pile wall TVA is planning to install. ***FRNP will download the TCE data for the seeps to discuss during the next meeting.***

- **"No Go" Areas for Monitoring Well Installations.**
  - Corridors where overhead transmission lines have been removed have been considered for monitoring well placement, especially with respect to the west side of the NE Plume. Previously, overhead transmission lines prevented installation of wells to the west in the northern-most transect of wells. A new substation (C-538) has been constructed east of the C-755 trailer complex. On the west side of the new substation, 161kV overhead lines will be installed along the existing overhead line corridor. On the east side of the new substation, 161kV overhead lines (near the C-755 parking lot and between K010 and K011) will be installed along the 161kV lines. Most of the overhead lines down from McCaw Road to the plant with only a static line remaining on the towers on the south into the C-331 yard.
    - The 161 KV feeder line from TVA to C-531 Switchyard are in the process of being removed.
    - Map of the formerly unavailable utility corridor area(s).

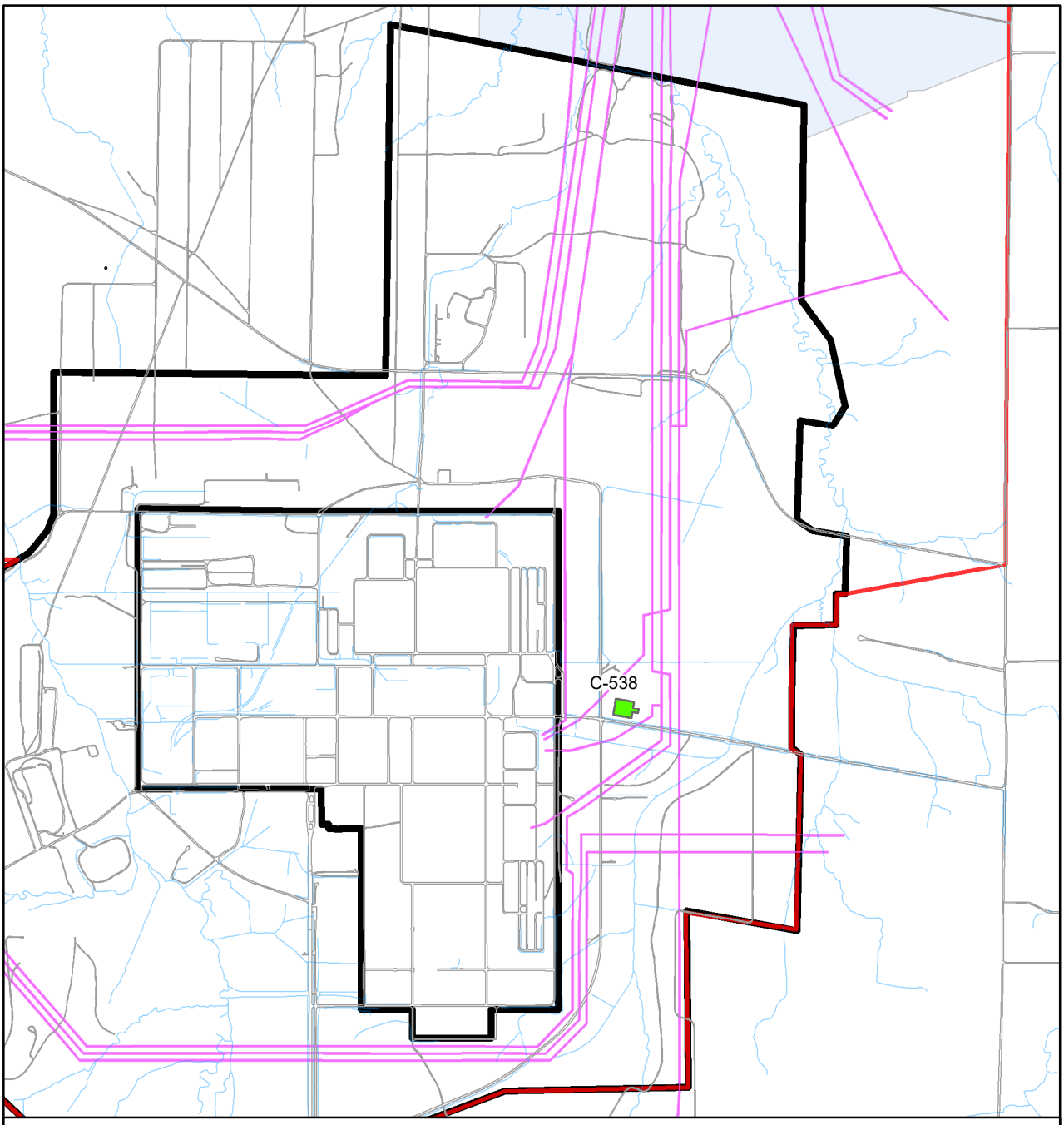
No comments were received on this topic during the meeting.



MAP SOURCE INFORMATION
Map Generation Date and Location: 03/17/2021 Geosyntec\Knoxville-01\PROJECTS\Paducah_FRNP\GIS\FRNP Maps.
Layer: DOE Boundary, Surface Water, Surface Water Body, TVA, and Road Source: Geosyntec\Knoxville-01\PROJECTS\Shapefiles\zipfolder\Paducah_FRNP\GIS\FRNP Maps From PEGASIS; downloaded 3/16/2021.
Layer: Seeps LBCSP2, LBCSP3, LBCSP4, LBCSP5, LBCSP8, LBCSP9, LBCSP10 Sourced from iPEGASIS on 3/17/2021.
Layer: Seeps LBCSP1, LBCSP6, LBCSP7 Sourced from PEGASIS; downloaded 3/17/2021.
Layer: Railroad Sourced from PEGASIS; downloaded 4/8/2021.
Layer: LBCSP2, LBCSP3, LBCSP4, LBCSP8, LBCSP9, LBCSP10, and Railroad Sourced from PEGASIS; downloaded 4/9/2021.
Layer: TVA Construction/Dewatering Area Created: 4/21/2021.

U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

FOUR RIVERS NUCLEAR PARTNERSHIP, LLC



MAP SOURCE INFORMATION

Map Generation Date and Location: 03/17/2021 P: Geosyntec\Knoxville-01\PROJECTS \Paducah_FRNP\GIS\FRNP Maps\Power line no-go zones_20210317.mxd
Layer: DOE Boundary, Road, Surface Water, TVA, Water Policy Boundary, and Facility. Source: PEGASIS 3/16/2021 (Layer: 'GIS Layers')
Layer: Power lines and C-538 Source: (provided by FRNP on 3/16/2021; power lines last updated 5/15/2018 and switchyard boundary from Engineering Drawing C5E-6523 rev11 last updated on 12/30/2019.)
Layer: Switchyards (from Facility shapfile downloaded from PEGASIS 3/17/2021 with query for C-531-2, C-533-2, C-535-2, C-537-2).

U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

FOUR RIVERS NUCLEAR PARTNERSHIP, LLC

- **Wetlands map layer.** The site is working on new wetlands maps.
  - Different projects have used different source data for wetlands and floodplains maps.
  - The map layers previously available in PEGASIS did not include information from the WDA project.

These updates will be uploaded and available through PEGASIS. No field work is being performed as part of the map updates. As part of the ongoing map consistency project, these shapefiles are being reviewed and layers will be made available in PEGASIS, potentially by the summer.

No comments were received on this topic during the meeting.

12. Poll MWG Members/Open Discussion

No new topics were brought forward by the group. PEGASIS and potential features of interest to the MWG for possible future development were discussed.

Attachment 1

Groundwater Elevation Data for TVA Wells Collected by KY on February 22, 2021

OREISName	Well	Description	Aquifer	Top of Casing	Top of Ground	xconv Easting (Ft)	yconv Northing (Ft)	Status	Screen Top Depth (Ft)	Screen bot depth (Ft)	tscreenelev (Ft)	bscreenelev (Ft)	GW Elev. (Datum - DTW)	Water Level	Date & Time	Barometric Pressure (inHg)	Measuring Point
TVAGW-6D	TVAGW-6D	4" PVC	Upper RGA	368.8	365.9	760787.8774	1946731.539	active	58.3	68.3	307.6	297.6	319.72	48.72	02/22/2021_1349	30.06	TIC
TVAGW-5D	TVAGW-5D	4" PVC	Upper RGA	368.5	365.7	760131.6259	1947315.953	active	60.1	70.1	305.6	295.6	319.7	48.78	02/22/2021_1402	30.06	TIC
TVAGW-4D	TVAGW-4D	4" PVC	Upper RGA	365.8	363	759456.7195	1947561.73	active	57	67.5	306	295.5	319.71	46.1	02/22/2021_1414	30.06	TIC
TVAGW-3D	TVAGW-3D	4" PVC	Upper RGA	363.8	360.9	758982.49	1947793.858	active	65.3	75.3	295.6	285.6	324.46	44.09	02/22/2021_1424	30.05	TIC
TVAGW-2D	TVAGW-2D	4" PVC	Upper RGA	370	367.1	759966.7809	1944870.473	active	55.6	65.6	311.5	301.5	320.05	45.54	02/22/2021_1320	30.07	TIC
TVAGW-1D	TVAGW-1D	4" PVC	Upper RGA	370.1	367.5	757847.0459	1946203.79	active	56	66	311.5	301.5	317.42	50.05	02/22/2021_1440	30.05	TIC
TVA-D8A	SHF-D8A	4" PVC	Upper RGA	331.82	329	754060.01	1953586.25	active	17.5	27.5	311.5	301.5	310.89	14.4	02/22/2021_1536	30.05	TIC
TVA-D75B	SHF-D75B	2" PVC	Upper RGA	353.08	350	753297.07	1955971.69	active	48	58	302	292	309.73	42.19	02/22/2021_1530	30.05	TIC
TVA-D74B	SHF-D74B	2" PVC	Upper RGA	331.99	329	756125.35	1956489.82	active	39	49	290	280	305.66	22.26	02/22/2021_1537	30.04	TIC
TVA-D30B	SHF-D30B	2" PVC	Upper RGA	324.61	320.9	757594	1955563.41	active	39	49	281.9	271.9	317	18.95	02/22/2021_1540	30.04	TIC
TVA-D17	SHF-D17	2" PVC	Upper RGA	365.43	362.8	758809.17	1950015.71	active	14	17	348.8	345.8	308.21	48.43	02/22/2021_1553	30.04	TIC
TVA-D11B	SHF-D11B	2" PVC	Upper RGA	321.79	319.2	753434.76	1958481.44	active	32	42	287.2	277.2	311.76	13.58	02/22/2021_1500	30.05	TIC
TVA-D10	SHF-D10	4" PVC	Upper RGA	351.74	351	752950.26	1956644.9	active	36.5	46.5	31.5	304.5	308.05	39.98	02/22/2021_1532	30.04	TIC
SHF-201C	SHF-201C	4" PVC	Upper RGA	323.75	320	746799.24	1960068.889	active	44.5	54.5	275.5	265.5	308.2	15.7	02/22/2021_1624	30.03	TIC
SHF-201B	SHF-201B	4" PVC	Upper RGA	323.75	320.2	746641.107	1960082.768	active	32	37	288.2	283.2	307.96	15.55	02/22/2021_1625	30.03	TIC
SHF201A	SHF201A	4" PVC	Upper RGA	323.75	320	747030.226	1960036.252	active	14.5	24.5	305.5	295.5	319.11	15.79	02/22/2021_1626	30.03	TIC
SHF-102G	SHF-102G	4" PVC	Upper RGA	362.85	359.1	845764.387	1927473.284	active	47.1	57.4	312	301.7	-303.4	43.74	02/22/2021_1612	30.03	TIC
TVA River Elevation														303.4	02/22/2021_1656	30.02	

LEGEND:

TIC: Top of Inner Casing

DTW: Depth to Water

National Geodetic Vertical Datum of 1929 (NGVD 29).

Attachment 2

2021 EMP Schedule for Groundwater Strategy Project

From 2021 EMP Pages B-28 through B-35

Monitoring Wells Planned For Colloidal Borescope and Pressure Transducer Deployment

Well Number	MONTH 1	MONTH 2	MONTH 3	MONTH 4	MONTH 5	MONTH 6	MONTH 7	MONTH 8	MONTH 9	MONTH 10	MONTH 11	MONTH 12
MW20 (also R4)	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2
MW63			M1			M1			M1			M1
MW65			M1			M1			M1			M1
MW66			M1			M1			M1			M1
MW67			M1			M1			M1			M1
MW68			M1			M1			M1			M1
MW71	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW72			M1			M1			M1			M1
MW73			M1			M1			M1			M1
MW76			M1			M1			M1			M1
MW77 (PZ)			M1			M1			M1			M1
MW78			M1			M1			M1			M1
MW79			M1			M1			M1			M1
MW80			M1			M1			M1			M1
MW81			M1			M1			M1			M1
MW84A			M1			M1			M1			M1
MW86			M1			M1			M1			M1
MW87A			M1			M1			M1			M1
MW89			M1			M1			M1			M1
MW90A			M1			M1			M1			M1
MW92			M1			M1			M1			M1
MW93A			M1			M1			M1			M1
MW95A			M1			M1			M1			M1
MW98			M1			M1			M1			M1
MW99	M1	M1	CB+M1	M1	M1	M1	M1	M1	CB+M1	M1	M1	M1
MW100	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW102			M1			M1			M1			M1
MW103			M1			M1			M1			M1
MW106A	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2
MW108			M1			M1			M1			M1
MW120			M1			M1			M1			M1
MW121	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2
MW122			M1			M1			M1			M1
MW123			M1			M1			M1			M1
MW124			M1	P		M1			M1			M1

From 2021 EMP Pages B-28 through B-35

Well Number	MONTH 1	MONTH 2	MONTH 3	MONTH 4	MONTH 5	MONTH 6	MONTH 7	MONTH 8	MONTH 9	MONTH 10	MONTH 11	MONTH 12
MW125			M1			M1			M1			M1
MW126	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW132	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW133			M1			M1			M1			M1
MW134	PT+M2	CB+PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2
MW135	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW137	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW139	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW144			M1			M1			M1			M1
MW145	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW146			M1			M1			M1			M1
MW147	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW148	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW150	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW152*	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW155			M1			M1			M1			M1
MW156			M1			M1			M1			M1
MW161			M1			M1			M1			M1
MW163			M1			M1			M1			M1
MW165A			M1			M1			M1			M1
MW168			M1			M1			M1			M1
MW169			M1			M1			M1			M1
MW173			M1			M1			M1			M1
MW175			M1			M1			M1			M1
MW178			M1			M1			M1			M1
MW185			M1			M1			M1			M1
MW188			M1			M1			M1			M1
MW191	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW193	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW194	CB+M2	M2	CB+M2	M2	CB+M2	M2	CB+M2	M2	CB+M2	M2	CB+M2	M2
MW197			M1			M1			M1			M1
MW199	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2
MW200			M1			M1			M1			M1
MW201	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2
MW202	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2
MW203			M1			M1			M1			M1
MW205			M1			M1			M1			M1
MW220			M1			M1			M1			M1

From 2021 EMP Pages B-28 through B-35

Well Number	MONTH 1	MONTH 2	MONTH 3	MONTH 4	MONTH 5	MONTH 6	MONTH 7	MONTH 8	MONTH 9	MONTH 10	MONTH 11	MONTH 12
MW221			M1			M1			M1			M1
MW222			M1			M1			M1			M1
MW223			M1			M1			M1			M1
MW224			M1			M1			M1			M1
MW225			M1			M1			M1			M1
MW226			M1			M1			M1			M1
MW227			M1			M1			M1			M1
MW233			M1			M1			M1			M1
MW236			M1			M1			M1			M1
MW238			M1			M1			M1			M1
MW239			M1			M1			M1			M1
MW240			M1			M1			M1			M1
MW241A			M1			M1			M1			M1
MW242			M1			M1			M1			M1
MW243			M1			M1			M1			M1
MW244			M1			M1			M1			M1
MW245			M1			M1			M1			M1
MW247			M1			M1			M1			M1
MW248			M1			M1			M1			M1
MW249			M1			M1			M1			M1
MW250			M1			M1			M1			M1
MW252	M1	CB+M1	M1	M1	M1	M1	M1	CB+M1	M1	M1	M1	M1
MW253A	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW255			M1			M1			M1			M1
MW256			M1			M1			M1			M1
MW257			M1			M1			M1			M1
MW258			M1			M1			M1			M1
MW260			M1			M1			M1			M1
MW261			M1			M1			M1			M1
MW262	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW283			M1			M1			M1			M1
MW284			M1			M1			M1			M1
MW288			M1			M1			M1			M1
MW291	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW292			M1			M1			M1			M1
MW293A			M1			M1			M1			M1
MW294A			M1			M1			M1			M1
MW325			M1			M1			M1			M1

From 2021 EMP Pages B-28 through B-35

Well Number	MONTH 1	MONTH 2	MONTH 3	MONTH 4	MONTH 5	MONTH 6	MONTH 7	MONTH 8	MONTH 9	MONTH 10	MONTH 11	MONTH 12
MW326			M1			M1			M1			M1
MW327			M1			M1			M1			M1
MW328			M1			M1			M1			M1
MW329	PT+M2	PT+M2	PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	PT+M2	PT+M2	PT+M2	CB+PT+M2
MW330			M1			M1			M1			M1
MW333			M1			M1			M1			M1
MW337			M1			M1			M1			M1
MW338			M1			M1			M1			M1
MW339			M1			M1			M1			M1
MW340			M1			M1			M1			M1
MW341			M1			M1			M1			M1
MW342			M1			M1			M1			M1
MW343			M1			M1			M1			M1
MW345			M1			M1			M1			M1
MW346			M1			M1			M1			M1
MW347			M1			M1			M1			M1
MW353	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW354	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2
MW355			M1			M1			M1			M1
MW356			M1			M1			M1			M1
MW357			M1			M1			M1			M1
MW358			M1			M1			M1			M1
MW360			M1			M1			M1			M1
MW361			M1			M1			M1			M1
MW363			M1			M1			M1			M1
MW364			M1			M1			M1			M1
MW366	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW367			M1			M1			M1			M1
MW369			M1			M1			M1			M1
MW370			M1			M1			M1			M1
MW372			M1			M1			M1			M1
MW373			M1			M1			M1			M1
MW376			M1			M1			M1			M1
MW380			M1			M1			M1			M1
MW381			M1			M1			M1			M1
MW384			M1			M1			M1			M1
MW385			M1			M1			M1			M1
MW387			M1			M1			M1			M1

From 2021 EMP Pages B-28 through B-35

Well Number	MONTH 1	MONTH 2	MONTH 3	MONTH 4	MONTH 5	MONTH 6	MONTH 7	MONTH 8	MONTH 9	MONTH 10	MONTH 11	MONTH 12
MW388			M1			M1			M1			M1
MW391			M1			M1			M1			M1
MW392			M1			M1			M1			M1
MW394	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW395			M1			M1			M1			M1
MW397			M1			M1			M1			M1
MW401			M1			M1			M1			M1
MW402			M1			M1			M1			M1
MW409	PT+M1	CB+PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1
MW410	CB+PT+M1	CB+PT+M1	CB+PT+M1	CB+PT+M1	PT+M1	PT+M1	CB+PT+M1	CB+PT+M1	CB+PT+M1	CB+PT+M1	PT+M1	PT+M1
MW411	CB+PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1
MW414			M1			M1			M1			M1
MW415			M1			M1			M1			M1
MW416			M1			M1			M1			M1
MW417			M1			M1			M1			M1
MW418	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW419			M1			M1			M1			M1
MW420			M1			M1			M1			M1
MW421			M1			M1			M1			M1
MW422			M1			M1			M1			M1
MW423			M1			M1			M1			M1
MW424			M1			M1			M1			M1
MW425			M1			M1			M1			M1
MW426	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2
MW427	M2	CB+M2	M2	M2	CB+M2	M2	M2	CB+M2	M2	M2	CB+M2	M2
MW428	M2	M2	CB+M2	M2	M2	CB+M2	M2	M2	CB+M2	M2	M2	CB+M2
MW429 A	M2	CB+M2	M2	M2	M2	M2	M2	CB+M2	M2	M2	M2	M2
MW430	CB+M2	M2	M2	M2	M2	M2	CB+M2	M2	M2	M2	M2	M2
MW431	M2	M2	M2	CB+M2	M2	M2	M2	M2	M2	CB+M2	M2	M2
MW432	M2	M2	M2	CB+M2	M2	M2	M2	M2	M2	CB+M2	M2	M2
MW433			M1			M1			M1			M1
MW435			M1			M1			M1			M1
MW439			M1			M1			M1			M1
MW440			M1			M1			M1			M1
MW441			M1			M1			M1			M1
MW442			M1			M1			M1			M1
MW443			M1			M1			M1			M1
MW444			M1			M1			M1			M1

From 2021 EMP Pages B-28 through B-35

Well Number	MONTH 1	MONTH 2	MONTH 3	MONTH 4	MONTH 5	MONTH 6	MONTH 7	MONTH 8	MONTH 9	MONTH 10	MONTH 11	MONTH 12
MW445	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW447			M1			M1			M1			M1
MW448			M1			M1			M1			M1
MW450			M1			M1			M1			M1
MW451			M1			M1			M1			M1
MW452			M1			M1			M1			M1
MW453			M1			M1			M1			M1
MW454			M1			M1			M1			M1
MW455			M1			M1			M1			M1
MW456			M1			M1			M1			M1
MW457			M1			M1			M1			M1
MW458			M1			M1			M1			M1
MW459	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW460			M1			M1			M1			M1
MW461			M1			M1			M1			M1
MW462			M1			M1			M1			M1
MW463	CB+PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1
MW464	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1
MW465	PT+M1	PT+M1	CB+PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	CB+PT+M1	PT+M1
MW466	M1	M1	M1	CB+M1	M1	CB+M1	M1	M1	M1	CB+M1	M1	CB+M1
MW467	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW468	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW469	CB+M1	M1	M1	M1	CB+M1	M1	CB+M1	M1	M1	M1	CB+M1	M1
MW470	M1	M1	M1	CB+M1	M1	M1	M1	M1	M1	CB+M1	M1	M1
MW471	CB+PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1
MW472	M1	CB+M1	M1	CB+M1	M1	M1	M1	CB+M1	M1	CB+M1	M1	M1
MW473	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1
MW474	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1
MW475	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW476	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1
MW477	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1
MW478			M1			M1			M1			M1
MW479			M1			M1			M1			M1
MW480			M1			M1			M1			M1
MW481	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW482	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW483	CB+PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1
MW484	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1

From 2021 EMP Pages B-28 through B-35

Well Number	MONTH 1	MONTH 2	MONTH 3	MONTH 4	MONTH 5	MONTH 6	MONTH 7	MONTH 8	MONTH 9	MONTH 10	MONTH 11	MONTH 12
MW485	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1
MW486A	M1	M1	M1	M1	M1	CB+M1	M1	M1	M1	M1	M1	CB+M1
MW487	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW488	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1
MW489			M1			M1			M1			M1
MW490			M1			M1			M1			M1
MW491	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW492			M1			M1			M1			M1
MW493			M1			M1			M1			M1
MW494			M1			M1			M1			M1
MW495			M1			M1			M1			M1
MW496	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW497			M1			M1			M1			M1
MW498			M1			M1			M1			M1
MW499			M1			M1			M1			M1
MW500			M1			M1			M1			M1
MW501			M1			M1			M1			M1
MW502			M1			M1			M1			M1
MW503			M1			M1			M1			M1
MW504			M1			M1			M1			M1
MW505			M1			M1			M1			M1
MW506			M1			M1			M1			M1
MW507			M1			M1			M1			M1
MW524			PT+M1			M1			M1			M1
MW525			M1			CB+PT+M1			M1			M1
MW526			M1			M1			CB+PT+M1			M1
MW527			CB+PT+M1			M1			M1			M1
MW528			M1			M1			M1			M1
MW529			M1			PT+M1			M1			M1
MW530			M1			M1			PT+M1			M1
MW531			M1			M1			M1			M1
MW532 (PZ)			M1			M1			M1			M1
MW533			M1			M1			M1			M1
MW534 (PZ)			M1			M1			M1			M1
MW535 (PZ)			M1			M1			M1			M1
MW536			M1			M1			M1			M1
MW537			M1			M1			M1			M1
MW538			M1			M1			M1			M1

From 2021 EMP Pages B-28 through B-35

Well Number	MONTH 1	MONTH 2	MONTH 3	MONTH 4	MONTH 5	MONTH 6	MONTH 7	MONTH 8	MONTH 9	MONTH 10	MONTH 11	MONTH 12
MW539			M1			M1			M1			M1
MW540 (PZ)			M1			M1			M1			M1
MW541 (PZ)			M1			M1			M1			M1
MW542			M1			M1			M1			M1
MW543			M1			M1			M1			M1
MW544			M1			M1			M1			M1
MW545			M1			M1			M1			M1
MW546			M1			M1			M1			M1
MW547			M1			M1			M1			M1
MW548			M1			M1			M1			M1
MW549			M1			M1			M1			M1
MW550			M1			M1			M1			M1
MW551			M1			M1			M1			M1
MW553 (PZ)			M1			M1			M1			M1
MW554 (PZ)			M1			M1			M1			M1
MW555 (PZ)			M1			M1			M1			M1
MW556			M1			M1			M1			M1
PZ107			M1			M1			M1			M1
PZ109			M1			M1			M1			M1
PZ110			M1			M1			M1			M1
PZ114			M1			M1			M1			M1
PZ115			M1			M1			M1			M1
PZ117			M1			M1			M1			M1
PZ118			M1			M1			M1			M1
PZ287			M1			M1			M1			M1
PZ289			M1			M1			M1			M1
PZ290			M1			M1			M1			M1
PZ349			M1			M1			M1			M1
PZ351			M1			M1			M1			M1
EW232			M1			M1			M1			M1
EW233			M1			M1			M1			M1
EW234			M1			M1			M1			M1
EW235			M1			M1			M1			M1

M1: Manual water level collected once per month
M2: Manual water level collected twice per month
*MW152 was abandoned in October 2018 in order for the Tennessee Valley Authority to construct a new process water basin. Another location has been selected for installation of a new well once construction activities have been completed. This new well will be MW583.

Attachment 3

TCE GW Fate & Transport Characterization
TCE Degradation/TCE Half-Life ($t^{1/2}$)

TCE GW Fate & Transport Characterization
TCE Degradation/TCE Half-Life ($t^{1/2}$)

PGDP GW MODELING WORKING GROUP
APRIL 7th 2021

Steve Hampson
Kentucky Research Consortium for Energy and Environment

TCE GW Transport – Fate Characterization
TCE Half-Life ($t^{1/2}$)

Numerous investigations have assessed the groundwater fate and transport of TCE and 99Tc at the PGDP.

PGDP Investigations Addressing TCE Groundwater Fate & Transport:

1. Clausen et al., 1997; Clausen, J.L., N.C. Sturchio, L.J. Heraty, L. Huang, and T. Abranjano 1997. *Evaluation of Natural Attenuation Processes for Trichloroethylene and Technetium-99 in the Northeast and Northwest Plumes at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, KY/EM-113.
2. Sturchio et al., 1998; Sturchio, N.C., J.L. Clausen, L.J. Heraty, L. Huang, B.D. Holt, and T.A. Abranjano, Jr. 1998. "*Chlorine Isotope Investigation of Natural Attenuation of Trichloroethene in an Aerobic Aquifer*: in Environmental Science and Technology, Volume 32, Number 20 pp. 3037-3042, American Chemical Society.
3. Starr et al., 2005; *ASSESSING AEROBIC NATURAL ATTENUATION OF TRICHLOROETHENE AT FOUR DOE SITES*
4. Screening Level Fate and Transport Modeling. *Numerous PGDP Projects.* ID'ed because of discussion of modeling approaches
5. DOE, 2007; *Site Investigation Report for the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-2180&D2/R1, United States Department of Energy, June.
6. Phillips, Bruce. *An Evaluation of Aerobic Trichloroethene Attenuation in a Perturbed Hydrologic System* National Ground Water Association, Ground Water Summit, Memphis, TN, March 2008.
7. SRNL, 2008. M. Hope Lee, Brian Looney and Steve Hampson, *Enzyme Activity Probe and Geochemical Assessment for Potential Aerobic Cometabolism of Trichloroethene in Groundwater of the Northwest Plume, Paducah Gaseous Diffusion Plant, Kentucky*, June 2008, WSRC-STI-2008-00309.
8. KRCEE, 2008. *PGDP Trichloroethene Biodegradation Investigation Summary Report Regional Gravel Aquifer & Northwest Plume*, September, 2008.

TCE GW Transport – Fate Characterization
TCE Half-Life ($t^{1/2}$)

Chronology of Activities:

TCE GW Transport – Fate Characterization
TCE Half-Life ($t^{1/2}$)

1. **Clausen and others, 1997. The Evaluation of Natural Attenuation Processes for Trichloroethylene and Technetium-99 in the Northeast and Northwest Plumes at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky (Clausen et al., 1997)**

OVERVIEW:

- In-depth investigation of TCE attenuation and biodegradation in the RGA.
- Reports that although natural attenuation processes are active
- Reports plume attenuation is occurring,
  - However, the rate (of natural attenuation) is insufficient to utilize as a remedial measure (in the absence of a source zone remedial measure). (MNA guidance was pending at this point in time)
- Provides a summary evaluation of the geochemical conditions in the RGA and indicated that RGA geochemical conditions "are consistent with aerobic respiration by microorganisms within the aquifer".
- Report notes that geochemical conditions within the aquifer do not indicate the presence of an energy source for TCE microbial degradation, whether it be organic carbon, toluene, methane, ammonia or other substrates.
- Two geochemical condition scenarios were hypothesized to explain the geochemical data evaluated in the report:
  1) (The first scenario) assumed that current intrinsic biodegradation is negligible
     and that the evidence for biodegradation is a remnant of past microbiological activity, when now depleted co-metabolites were sufficient to support aerobic degradation
  2) (The second scenario) assumed the presence of organic-rich anaerobic microenvironments within the RGA that supported reductive dechlorination of the TCE.
     TCE degradation products produced were assumed to remain sorbed to the organic-rich materials of the microenvironments.

TCE GW Transport – Fate Characterization
TCE Half-Life ($t^{1/2}$)

1. Clausen and others, 1997. The Evaluation of Natural Attenuation Processes for Trichloroethylene and Technetium-99 in the Northeast and Northwest Plumes at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky (Clausen et al., 1997) **(cont'd)**

TCE biodegradation rate

- Quantified utilizing the geochemical model BIOSCREEN (Newell et al. 1996).
- Was based on the downgradient decline in the mass flux of TCE through several transects of the Northwest Plume

Estimated rate for TCE attenuation in the RGA of 0.0206 to 0.074 year-1 = **a TCE half-life of 9.4 to 26.7 years**.

- The effects of sorption and diffusion were not accounted for in the calculation of the TCE attenuation rate
- Estimated a biodegradation half-life greater than 26.6 years for TCE in the RGA if the potential influences of diffusion and sorption were considered.

2. Sturchio N.C., J.L. Clausen, L.J. Heraty, L. Huang, B.D. Holt, and T.A. Abranjano, Jr. 1998. "Chlorine Isotope Investigation of Natural Attenuation of Trichloroethene in an Aerobic Aquifer: in Environmental Science and Technology, Volume 32, Number 20 pp. 3037-3042, American Chemical Society

- Peer-reviewed paper
- Based in part on results in Clausen et al. (1997).
- Measured carbon, oxygen, and chlorine isotope ratios for groundwater from UCRS, RGA background locations, on-site source areas, and the RGA in the dissolved phases of the Northeast and Northwest Plumes.
- Noted indicators of electrochemical state (of Groundwater) were consistent with an aerobic groundwater environment.
  - Oxygen levels greater than 1 mg/L in all samples
  - Common reductive-dechlorination byproducts absent or present at very low levels in the RGA.
  - Highest cis-1,2-dichloroethene concentrations were identified in UCRS wells.
  - Hypothesized anaerobic conditions were most likely to have existed (previously) in the UCRS.
- Identified downgradient trends:
  - of increasing dissolved inorganic carbon
  - decreasing inorganic carbon 13C isotope ratios
  - decreasing dissolved oxygen concentrations

    Attributed to oxygen consumption and carbon dioxide production by aerobic microbial respiration.
  - Identified downgradient increasing ^{37}Cl isotopic ratio with decreasing TCE concentration in the samples
  - Cl isotope and TCE trends were not compatible with simple closed-system models
  - **Concluded data are consistent with model of past TCE degradation in the overlying UCRS and little or no RGA degradation**

3. Starr and others, 2005. Assessing Aerobic Natural Attenuation of Trichloroethene

- Starr conducted an assessment of 24 DOE sites with 127 plumes of contaminated aerobic groundwater to identify five (5) sites that warranted further investigation and quantification of aerobic TCE degradation.
  - Screening criteria:
    - 1) TCE must be present in an aerobic groundwater;
    - 2) A conservative co-contaminant tracer must be present and have approximately the same source location as the TCE; and
    - 3) The groundwater velocity of the site must be known.
  - Based on screening of site's geochemical and contaminant data, the sites chosen for assessment were:
    - 1) Brookhaven National Laboratory;
    - 2) Paducah Gaseous Diffusion Plant;
    - 3) Rocky Flats Environmental Technology Site; and
    - 4) Savannah River Site, A/M Area Plume.
    - Idaho National Engineering and Environmental Laboratory.
- Starr applied the approach and methods described in An Evaluation of Aerobic Trichloroethene Attenuation Using First Order Rate Estimation (Sorenson et al., 2000) to calculate first-order rate constants for the four retained sites.
- For PGDP assessment
  - Lower RGA (LRGA) data was used for assessment
  - Groundwater velocity was a site-specific parameter identified as 1.3 ft/day (Clausen et al., 1997)
  - Dispersion was accounted because it is a physical process affecting groundwater and is not dependent upon contaminants (properties). All contaminants and tracers subject to dispersion.
- Because adsorption and volatilization are site specific parameters, they were not accounted for.
- **Based on PGDP LRGA data, a half-life of seven (7) years was calculated for the Northwest Plume at the PGDP.**

TCE GW Transport – Fate Characterization
TCE Half-Life ($t^{1/2}$)

4. Screening Level Fate and Transport Modeling.

- PGDP's risk assessment guidance (DOE 2000b) outlines a tiered approach to fate and transport modeling based on the intended use of the model results.
- Recent fate and transport modeling (DOE 2003 and 2007) employed the SESOIL (GSC 1995, 1996a) and AT123D (GSC 1996b and Yeh 1981) codes in a probabilistic approach as a means of reducing model uncertainty.
- Screening-level fate and transport modeling of TCE has been used at PGDP in support of site and remedial investigations, treatability studies, and design investigations.
- The earliest remedial investigation (DOE 1996a) relied on the Summers Model (EPA 1989) to assess dissolved-phase TCE levels resulting from source units.
- Subsequent fate and transport models (DOE 1996b, 1998a, 2007) were based on the combination of
  - SESOIL code (GSC 1995, 1996a) to simulate migration through the UCRS, and
  - AT123D code (GSC, 1996b and Yeh, 1981) to simulate migration through the RGA.
- Subsequent investigations have used MEPAS (PNNL 1989) to derive dissolved-contaminant levels at downgradient points of exposure.
- **TCE degradation has been accounted for in screening level fate and transport modeling efforts through the application of a 26.6 year TCE half-life.**
  - The 26.6 year half-life is based on the upper end of the range of potential TCE half-lives identified by Clausen, et al. (1997).
- The 2006/8 and 2016 PGDP MODFLOW updates and data being collected at sites with similar hydrogeology and hydro-geochemistry may impact the estimates for future fate and transport inputs. (TBD)
- (Recent other sites studies and PGDP studies have been conducted but not reviewed and summarized for this presentation)

CAER | KRCEE

TCE GW Transport – Fate Characterization
TCE Half-Life ($t^{1/2}$)

5. Southwest Plume Site Investigation (DOE, 2007)

- Evaluated four potential source areas along the western perimeter of the PGDP Restricted Area and profiled the magnitude and distribution of volatile organic compounds (VOCs) and 99Tc in the SWP.
- Summarized the current status of site-wide TCE fate and transport parameters used for PGDP modeling and risk assessment.
- The site-wide fate and transport parameters were used for the derivation of first-order degradation rate constants based on a range of groundwater velocities between 1 and 3 feet/day.
- The SWP Site Investigation Report (DOE 2007) applied a probabilistic approach to risk evaluation from the transport and fate of TCE.
- Two scenarios were evaluated for the probabilistic transport modeling:
  - 1) a variable degradation scenario in which the degradation rate for TCE was allowed to vary over the potential range of values calculated using total chloride and 99Tc as tracers to normalize TCE concentrations (Clausen, 1997); and
  - 2) a fixed degradation scenario in which the UCRS TCE degradation half-life was 26.6 yr and no degradation half-life was applied to the RGA. Other parameters in the probabilistic analysis were allowed to vary for both scenarios.

CAER | KRCEE

TCE GW Transport – Fate Characterization
TCE Half-Life ($t^{1/2}$)

5. Southwest Plume Site Investigation **(cont'd)**

- Derivation of 1st order rate constant for TCE utilized:
  - Northwest Plume data from pre-pump and treat operations
- Methods followed the Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Ground Water (EPA, 1998).
  - Rate derivation method utilizes downgradient chlorinated solvent concentrations that are predicted or "normalized" based on the concentrations of non-conservative tracers chloride and 99Tc.
  - The difference in the normalized downgradient TCE concentration and the measured downgradient TCE concentration provides the measure of the rate of natural attenuation processes acting upon TCE, exclusive of sorption and volatilization.

    (In transport calculations, sorption is accounted for through the application of a retardation factor for transport velocity. At PGDP Sorption of TCE and 99Tc are considered similar and minimal)
- The SWP SI assumptions for first-order degradation rate constant(s) derivation were:
  - Analytical data derived from pre-NWP Pump and Treat System (PTS) operation
  - Utilized three requirements for use of 99Tc and Cl- as tracers per Technical Protocol (EPA 1998):
    - 1) The source of the tracer should be the source of the dissolved chlorinated solvent plume or must be co-located;
    - 2) The tracer should not degrade within the aquifer; and
    - 3) The relative sorption of the tracer and the chlorinated solvent on the aquifer matrix should be known (Sorenson et al. 2000).
  - Utilized total chlorine concentration, consisting of the sum of concentration of ionic chloride and organic chlorine, for normalizing downgradient TCE concentrations (EPA 1998).

TCE GW Transport – Fate Characterization
TCE Half-Life ($t^{1/2}$)

5. Southwest Plume Site Investigation **(cont'd)**

Derivation of 1st order rate constant for TCE utilized:

- Northwest Plume data from pre-pump and treat operations
- Methods followed the Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Ground Water (EPA, 1998).
  - Rate derivation method utilizes downgradient chlorinated solvent concentrations that are predicted or "normalized" based on the concentrations of non-conservative tracers chloride and 99Tc.
  - The difference in the normalized downgradient TCE concentration and the measured downgradient TCE concentration provides the measure of the rate of natural attenuation processes acting upon TCE, exclusive of sorption and volatilization.

    (In transport calculations, sorption is accounted for through the application of a retardation factor for transport velocity. At PGDP Sorption of TCE and 99Tc are considered similar and minimal)
- Assumptions for first-order degradation rate constant(s) derivation were:
  - Analytical data derived from pre-NWP Pump and Treat System (PTS) operation

TCE GW Transport – Fate Characterization
TCE Half-Life ($t^{1/2}$)

- **5. Southwest Plume Site Investigation (cont'd)**
  - Utilized three requirements for use of 99Tc and Cl- as tracers per Technical Protocol (EPA 1998):
    - 1) The source of the tracer should be the source of the dissolved chlorinated solvent plume or must be co-located;
    - 2) The tracer should not degrade within the aquifer; and
    - 3) The relative sorption of the tracer and the chlorinated solvent on the aquifer matrix should be known (Sorenson et al. 2000).
  - Utilized total chlorine concentration, consisting of the sum of concentration of ionic chloride and organic chlorine, for normalizing downgradient TCE concentrations (EPA 1998).
  - Six (6) wells were used for derivation of first order rate constants
    - located along the approximate axis of the NWP with available data for the first-order rate calculation are identified in Table 10.

MW248
MW250
MW243
MW241
MW238
MW236

TCE GW Transport – Fate Characterization
TCE Half-Life ($t^{1/2}$)

- **5. Southwest Plume Site Investigation (cont'd)**

TCE GW Transport – Fate Characterization
TCE Half-Life ($t^{1/2}$)

6. Phillips, Bruce. *An Evaluation of Aerobic Trichloroethene Attenuation in a Perturbed Hydrologic System* National Ground Water Association, Ground Water Summit, Memphis, TN, March 2008.

- Four (4) locations in the vicinity of the extraction wells were excluded from the data set.

TCE GW Transport – Fate Characterization
TCE Half-Life ($t^{1/2}$)

7. **SRNL, 2008**. M. Hope Lee, Brian Looney and Steve Hampson, *Enzyme Activity Probe and Geochemical Assessment for Potential Aerobic Cometabolism of Trichloroethene in Groundwater of the Northwest Plume, Paducah Gaseous Diffusion Plant, Kentucky*, June 2008, WSRC-STI-2008-00309.
8. **KRCEE, 2008**. *PGDP Trichloroethene Biodegradation Investigation Summary Report Regional Gravel Aquifer & Northwest Plume*, September, 2008.

- Provided support for previous work (in particular SWP Site Investigation)

- Provided recommendations for further work to characterize NEP and utilize in future transport calculations

The method uses the following equation to normalize downgradient TCE concentrations:

$$TCE_{B,normalized} = TCE_B \times [Tracer_A/Tracer_B]$$

Where:

$TCE_{B,normalized}$ = normalized TCE concentration at the downgradient location
TCE_B = measured TCE concentration at the downgradient location
$Tracer_A$ = measured tracer level at the upgradient location
$Tracer_B$ = measured tracer level at the downgradient location

The TCE degradation rate coefficient is related to the upgradient and normalized downgradient TCE concentrations by the following equation:

$$\text{TCE Degradation Rate Coefficient} = Ln(TCE_{B,normalized}/TCE_A)/t$$

Where:

$TCE_{B,normalized}$ = normalized TCE concentration at the downgradient location
TCE_A = measured TCE concentration at the upgradient location
t = travel time between upgradient and downgradient locations
The travel time (t) between two points is given by:

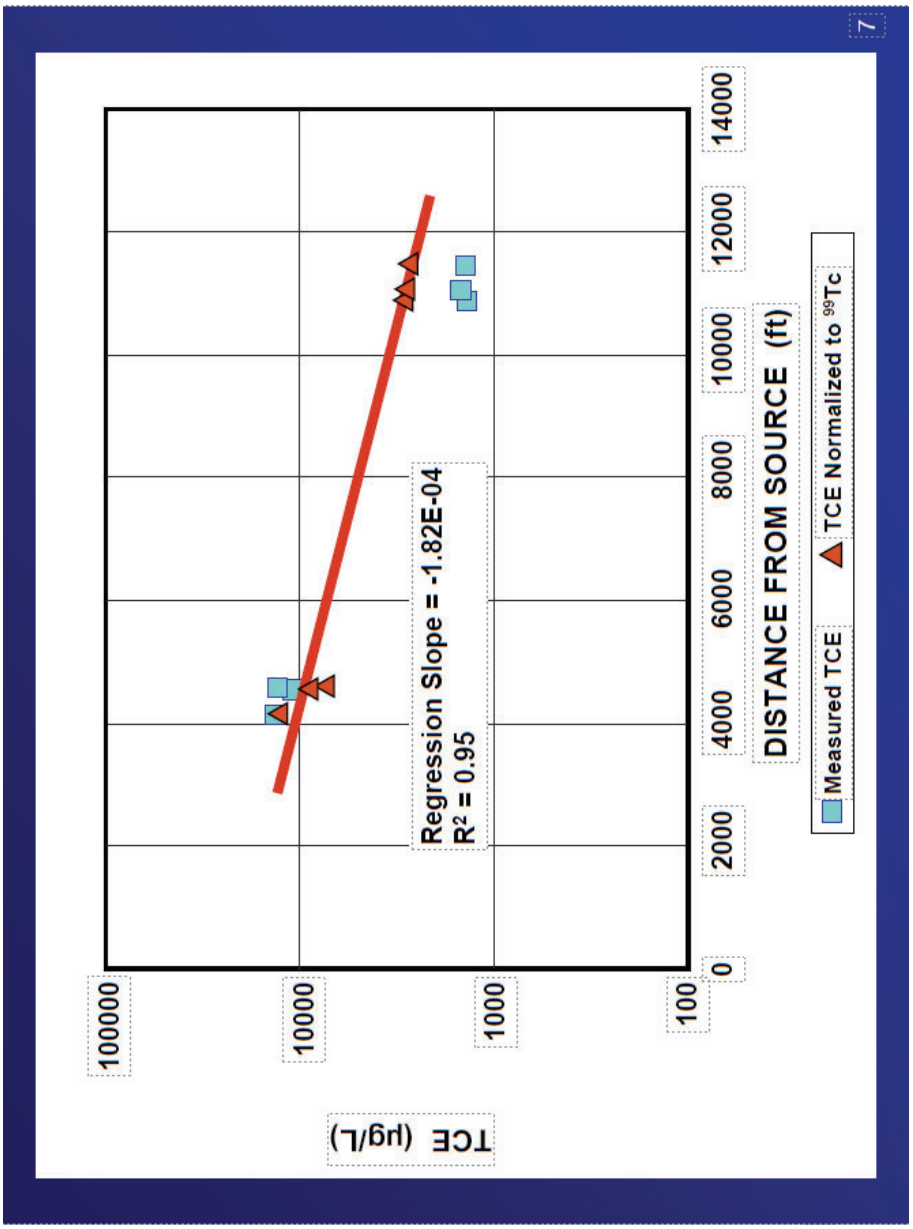
$$t = x / V_{TCE}$$

Where:

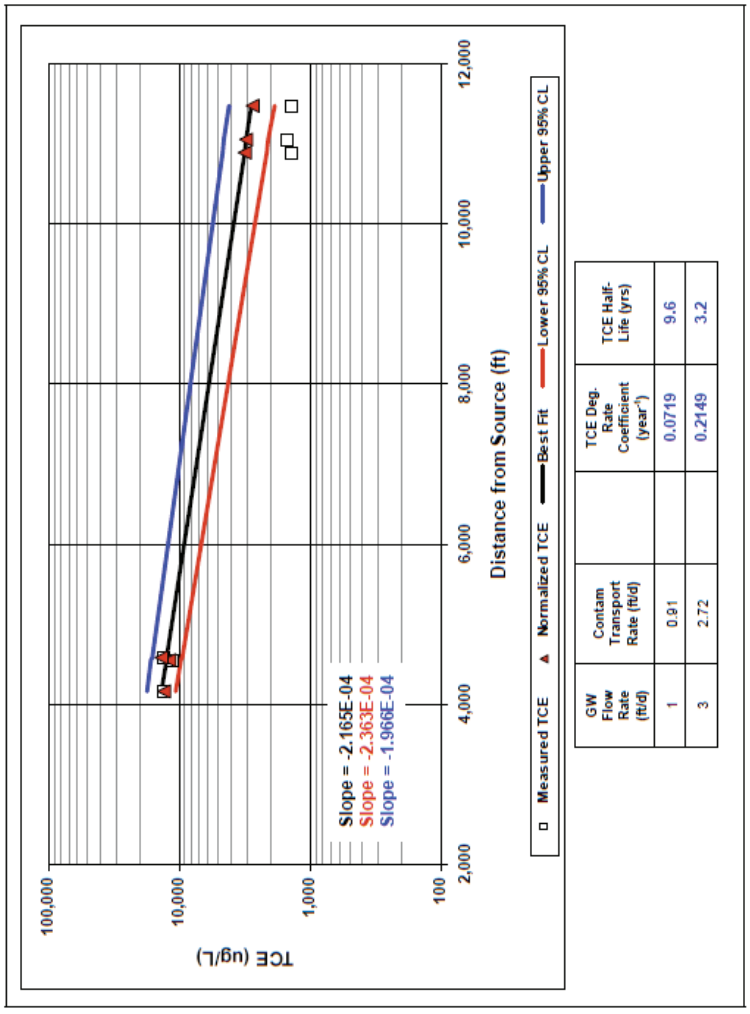
x = distance between the north and south well fields
V_{TCE} = TCE transport velocity

Because travel time is inversely related to groundwater flow velocity, the degradation rate varies directly with the flow velocity.

Figure 9. Normalization calculation from the Technical Protocol (EPA, 1998)



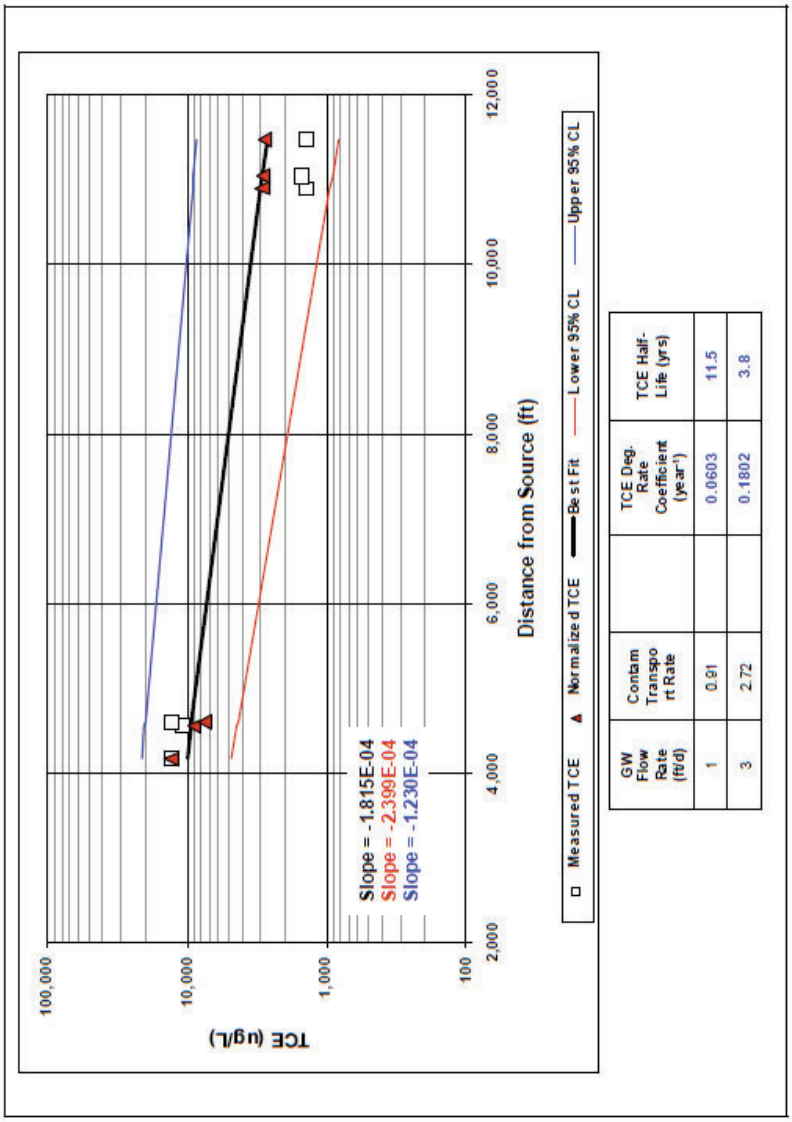
(Phillips, 2008)



GW Flow Rate (ft/d)	Contam Transport Rate (ft/d)		TCE Deg. Rate Coefficient ($year^{-1}$)	TCE Half-Life (yrs)
1	0.91		0.0749	9.6
3	2.72		0.2149	3.2

Figure 10. NWP TCE first order degradation rate constant calculation using chloride as the conservative tracer

(SWP SI, 2007)



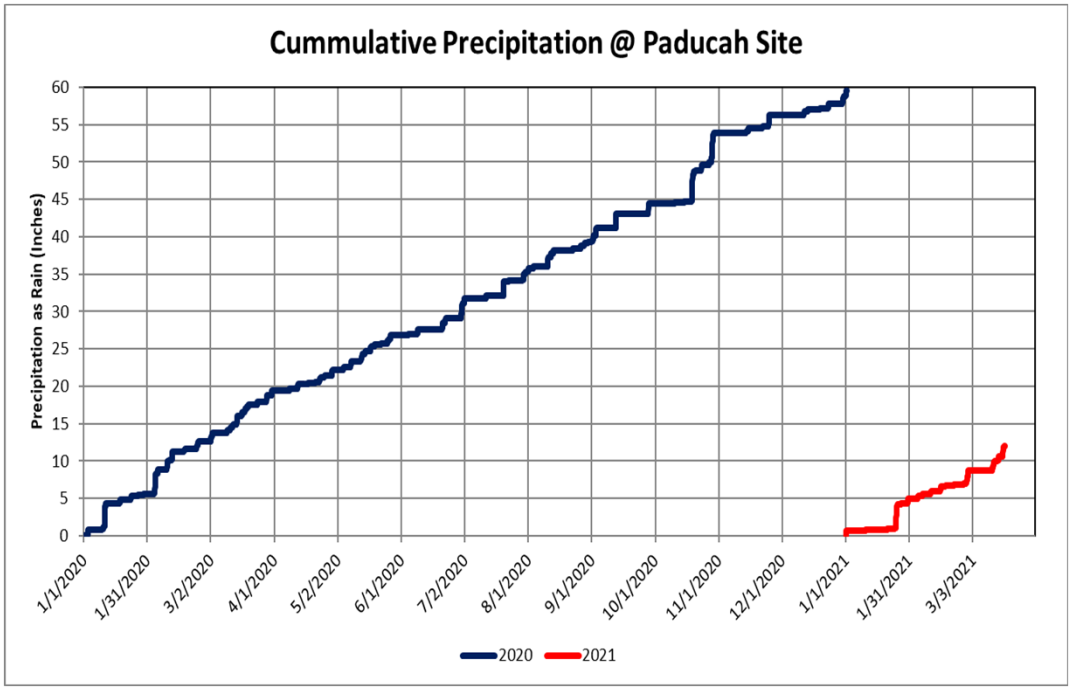
GW Flow Rate (ft/d)	Contam Transport Rate		TCE Deg. Rate Coefficient ($year^{-1}$)	TCE Half-Life (yrs)
1	0.91		0.0603	11.5
3	2.72		0.1802	3.8

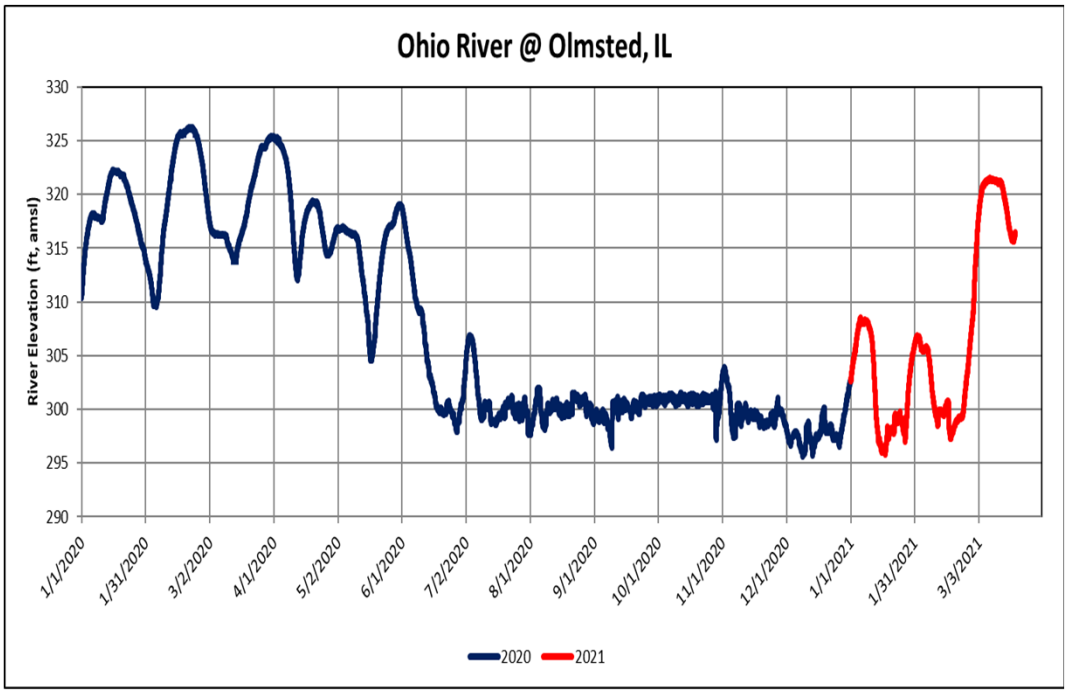
Figure 11. NWP TCE first order degradation rate constant calculation using ^{99}Tc as the conservative tracer

(SWP SI, 2007)

Attachment 4

Precipitation and Ohio River Stage Data


Cummulative Precipitation @ Paducah Site
Precipitation as Rain (Inches)
60
55
50
45
40
35
30
25
20
15
10
5
0
1/1/2020
1/31/2020
3/2/2020
4/1/2020
5/2/2020
6/1/2020
7/2/2020
8/1/2020
9/1/2020
10/1/2020
11/1/2020
12/1/2020
1/1/2021
1/31/2021
3/3/2021
2020
2021


Ohio River @ Olmsted, IL
River Elevation (ft, amsl)
330
325
320
315
310
305
300
295
290
1/1/2020
1/31/2020
3/2/2020
4/1/2020
5/2/2020
6/1/2020
7/2/2020
8/1/2020
9/1/2020
10/1/2020
11/1/2020
12/1/2020
1/1/2021
1/31/2021
3/3/2021
2020
2021

APPENDIX D

GROUNDWATER MODELING WORKING GROUP MEETING SUMMARY—JULY 14, 2021

THIS PAGE INTENTIONALLY LEFT BLANK

ACRONYMS[1]

AIP	agreement in principle
amsl	above mean sea level
CB	colloidal borescope
CCR	coal combustion residuals
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CRS	comment response summary
DOE	U.S. Department of Energy
DQO	data quality objective
DTW	depth to water
EMP	environmental monitoring plan
EPA	U.S. Environmental Protection Agency
ETAS	Enterprise Technical Assistance Services, Inc.
FRNP	Four Rivers Nuclear Partnership, LLC
FS	feasibility study
FY	fiscal year
GW	groundwater
GIS	geographic information system
GWSP	Groundwater Strategy Project
KDEP	Kentucky Department for Environmental Protection
KRCEE	Kentucky Research Consortium for Energy and the Environment
KY	Commonwealth of Kentucky
KYRHB	Kentucky Radiation Health Branch
LBCSP	Little Bayou Creek seep
MCL	maximum concentration limit
MW	monitoring well
MWG	Modeling Working Group
NGVD	National Geodetic Vertical Datum
OREIS	Oak Ridge Environmental Information System
OU	operable unit
PEGASIS	PPPO Environmental Geographic Analytical Spatial Information System
PGDP	Paducah Gaseous Diffusion Plant
PT	pressure transducer
P-QAPP	programmatic quality assurance project plan
PZ	piezometer
Q	quarter
RGA	Regional Gravel Aquifer
RI	remedial investigation
SVOC	semi volatile organic compound
TBD	to be determined
TOC	top of casing
TVA	Tennessee Valley Authority
UCRS	Upper Continental Recharge System
VI	vapor intrusion
VOC	volatile organic compound
WDA	waste disposal alternative

[1] Acronym list was not part of the original meeting summaries.

THIS PAGE INTENTIONALLY LEFT BLANK

Paducah Site Groundwater Modeling Working Group
Meeting Summary—July 14, 2021

MWG Member List:

DOE
Rich Bonczek ✓
Dave Dollins ✓

ETAS
Martin Clauberg ✓
Bruce Stearns ✓
Tracy Taylor ✓

KRCEE
Steve Hampson ✓

TVA
Anna Fisher ✓
Dominic Norman ✓
Paul Thomas

EPA
Noman Ahsanuzzaman ✓
Ben Bentkowski ✓
Eva Davis ✓
Mac McRae ✓
Victor Weeks ✓

Kentucky
Brian Begley ✓
Stephanie Brock
Nathan Garner
Brian Lainhart
Bart Schaffer ✓
Chris Travis

FRNP
Austin Buckhalter
Evan Clark ✓
Bryan Clayton
Lisa Crabtree ✓
Ken Davis ✓
Rob Flynn ✓
Bruce Ford ✓
Stefanie Fountain ✓
LeAnne Garner
Bruce Meadows ✓
Jason Orr ✓
Todd Powers ✓
Joe Tarantino ✓
Denise Tripp ✓
Alexis Wiltfong ✓

✓ Indicates member was present

Original meeting agenda items are provided followed by meeting notes; the meeting notes are provided in italics with action items noted in green.

1. Call for Issues from Groundwater Modeling Working Group (MWG) Members

No comments received to the April 7, 2021, Meeting Summary (sent to participants on 5/10/2021). This summary will be considered final.

No comments were received to the April 7, 2021 Meeting Summary; the summary is now final.

Brian Begley introduced Anna Fisher and Dominic Norman of TVA, to restart TVA representation on this group. Anna summarized TVA activities relevant to this group,including sharing water levels for use in DOE synoptic water level events through KDEP, embankment sheet piling at Little Bayou Creek, new landfill installation with new groundwater monitoring system, groundwater investigations and some groundwater modeling.

2. FY 2021+ Work Plan/Schedule

a. FY 2021 Work Plan/Schedule

Dates for the Large Building PZ White Paper and the Draft Meeting Summaries and White Papers Compilation (FY21) have been revised as shown below.

Activity	Date
~~Provide Draft Final Lithologic Technical Paper Outline to MWG~~	~~9/30/2020~~
~~Submit FY21 Schedule to MWG~~	~~9/30/2020~~
~~Comments Due for July Meeting Draft Summary~~	~~10/7/2020~~

Activity	Date
~~Quarterly Meeting (October/FY21Q1)~~	~~10/7/2020~~
~~Submit Draft Compilation of Meeting Summaries and White Papers (1/2019-7/2020)~~	~~10/14/2020~~
~~MWG concurs with FY21 Schedule~~	~~10/14/2020~~
~~Provide Final Outline for Lithologic Technical Paper to MWG~~	~~10/22/2020~~
~~Submit Draft Compilation of Meeting Summaries and White Papers (1/2019-7/2020)~~	~~10/28/2020~~
~~Comments Due for Draft Compilation of Meeting Summaries and White Papers (1/2019-7/2020)~~	~~11/25/2020~~
~~Submit Final Compilation of Meeting Summaries and White Papers (1/2019-7/2020)~~	~~12/11/2020~~
~~Quarterly Meeting (January/FY21Q2)~~	~~1/13/2021~~
~~Quarterly Meeting (April/FY21Q3)~~	~~4/7/2021~~
~~Survey White Paper 2 Outline~~	~~6/30/2021~~
Develop Draft Large Building PZ White Paper	Revised 1/12/2022
Quarterly Meeting (July/FY21Q4)	7/14/2021
MWG Review Draft Final Large Building PZ White Paper	Revised 2/16/2022
MWG Meeting to Discuss Draft Final Large Building PZ White Paper	Revised TBD
Submit Final Large Building PZ White Paper to EPA and KY	Revised 4/15/2022
Submit Draft Meeting Summaries and White Papers Compilation (FY21) – *Move to after October 2021 meeting to allow for finalization of July meeting summary*	Revised

Items shown in strikeout text are completed.
TBD - To Be Determined
Color code for schedules:

Due date	Quarterly meeting
Submittal date	Concurrence/acknowledgement date

FY2021 schedule item "Survey White Paper Outline" was included with the agenda for this meeting and is complete.

b. Draft FY 2022+ Activities

Activity	Date
Quarterly Meeting (October/FY22Q1)	10/6/2021
Submit Draft Meeting Summaries and White Papers Compilation (FY21)	11/15/2021
MWG Provide Comments on Draft Compilation of Meeting Summaries and White Papers (FY21)	11/30/2021
Submit Final Meeting Summaries and White Papers Compilation (FY21)	12/21/2021
Submit Draft Final Large Building PZ White Paper to MWG	1/12/2022
Quarterly Meeting (January/FY22Q2)	1/12/2022
MWG Review Draft Final Large Building PZ White Paper	2/16/2022
Submit Draft Final Survey White Paper 2 to MWG	3/3/2022
Submit Final Large Building PZ White Paper to EPA and KY	4/15/2022
Submit Draft Final Lithologic Technical Paper to MWG	8/11/2022
MWG Meeting to Discuss Draft Final Lithologic Technical Paper	TBD

Activity	Date
MWG Provide Comments on Draft Final Lithologic Technical Paper	9/12/2022
Submit Final Lithologic Technical Paper to EPA and KY	11/7/2022

The FY 2022 work plan, consisting of the schedule of activities for the MWG in FY 2022, will be sent to the MWG prior to the October 6, 2021 meeting for approval prior to or during that meeting.

3. Update on Water Levels

Synoptic water level events are being collected quarterly, and since the last meeting (April 7, 2021) a synoptic event occurred on May 24-27, 2021. Groundwater elevation data will be reviewed and discussed with the MWG following completion of the 12 months of data collection (Month 12 is August 2021).

Groundwater elevation data for TVA wells collected by KY occurred on May 24, 2021 and is included as Attachment 1.

The group discussed the evaluation and the 2020 Plume Map document contents, specifically the inclusion of the August 2019 and August 2020 potentiometric maps. The 2020 Plume Map document is expected to be issued after the meeting and be available to discuss during the October meeting.

The group also discussed the second survey white paper, which will focus on groundwater elevations and datums and how the new datums relate to the 2016 groundwater model.

4. Update on Paducah Site Groundwater Strategy

The Groundwater Strategy Project (GWSP) schedule from the EMP is included as Attachment 2. In this schedule, "Month 1" is September 2020. Data has been collected for Months 1-9 (September-May) and Month 10 (June) data collection is in progress.

Field conditions encountered to date:

- Month 1 (September 2020): Removal of MW411 from the colloidal borescope data collection portion of the GWSP (Email November 19 and response from KY on November 20)
    - Nearby wells MW469 (west), MW471 (south), and MW475 (north) are part of the GWSP colloidal borescope program. There are no wells to the east of MW471.
- Month 2 (October 2020): MW99 and MW477 manual water levels were not able to be collected due to wet conditions. The transducers had sufficient memory to continue to collect data.
- Month 3 (November 2020): MW71 pressure transducer malfunction– transducer has been repaired.
- Month 4 (December 2020): All data collected.
- Month 5 (January 2021): MW469 is not accessible for colloidal borescope deployment due to TVA road construction activities and will be substituted with MW472 (collocated with MW471).
- Month 6 (February 2021):
    - MW477 was not accessible for colloidal borescope deployment due to wet conditions; the team will continue to monitor access.
    - There were multiple issues with colloidal borescope equipment during the month.
- Month 7 (March 2021): All data collected, but there were multiple issues with colloidal borescope equipment during the month.

- Month 8 (April 2021): All other data collected, but there were multiple issues with colloidal borescope equipment during the month.
- Month 9 (May 2021): MW477 was not accessible for colloidal borescope deployment due to wet conditions; the team will continue to monitor access. Evaluation of the performance of the colloidal borescope equipment is in progress with multiple equipment and software variables checked. Remaining data collection was performed with all but one test providing usable data. Additional testing at MW194 will be conducted in Month 10.
- Month 10 (June 2021): Data collection is in progress.

All available datasets from Month 1 through present, and also including the January 2020-March 2020 datasets, are being reviewed; inconclusive datasets will be reviewed against DQOs to understand if additional testing is indicated and if so, when that testing should be performed to meet DQOs (e.g., seasonal objectives).

Preliminary data will be discussed when appropriate and as the project moves forward.

FRNP continues to coordinate with KY on the AIP monitoring wells sampling schedule.

July (Month 11) data collection for the Groundwater Strategy project is now in progress. The group discussed that FY 2022 activities are being considered and that the review of the current data collection efforts against DQOs will inform whether any follow-on work from the current data collection efforts are needed. ***The outcome(s) of the data review on completeness and other planned activities for Groundwater Strategy for FY 2022 will be discussed during the October meeting.***

5. Discussion on Installation of Piezometers …Associated with Several of the Large Process Buildings

Preliminary information to be collected for the "Installation of piezometers …associated with several of the large process buildings…." white paper will benefit from the information learned during the vapor intrusion (VI) project. The D2/R1 VI Work Plan was finalized in December 2020 and field sample collection occurred February 22, 2021 through March 9, 2021. A scoping meeting for the VI Report was held April 27, 2021 and the report is being prepared.

The schedule for this white paper has been revised as shown below to allow for integration of VI Report information into the white paper, as appropriate.

Activity	Target Start	Target Finish
~~Quarterly Meeting (October/FY21Q1)~~		~~10/7/2020~~
~~Develop Outline for Large Building PZ White Paper~~	~~10/14/2020~~	~~12/11/2020~~
~~Provide Large Building PZ White Paper Outline to MWG~~		~~12/11/2020~~
~~MWG Review Large Building PZ White Paper Outline~~	~~12/11/2020~~	~~1/13/2021~~
~~Quarterly Meeting (January/FY21Q2)~~		~~1/13/2021~~
~~Revise Outline for Large Building PZ White Paper Based on MWG Discussions~~	~~1/13/2021~~	~~1/28/2021~~
~~VI Field Sampling / Laboratory Analysis / Validation~~	~~Feb 21~~	~~Apr 21~~
~~Quarterly Meeting (April/FY21Q3)~~		~~4/7/2021~~
Quarterly Meeting (July/FY21Q4)		7/14/2021

Activity	Target Start	Target Finish
Develop Draft Large Building PZ White Paper	9/1/2021	1/12/2022
Quarterly Meeting (October/FY22Q1)		10/6/2021
Submit Draft Final Large Building PZ White Paper to MWG		1/12/2022
Quarterly Meeting (January/FY22Q2)		1/12/2022
MWG Review and Provide Comments on Draft Final Large Building PZ White Paper	1/23/2022	2/16/2022
MWG Meeting to Discuss Draft Final Large Building PZ White Paper		TBD
MWG Provide Comments on Draft Final Large Building PZ White Paper		2/16/2022
Revise Draft Final Large Building PZ White Paper	2/17/2022	4/15/2022
Submit Final Large Building PZ White Paper to EPA and KY		4/15/2022

Items shown in strikeout text are completed.

The draft annotated outline was included in the January 13, 2021 MWG meeting summary (sent to participants on 1/28/2021). No comments were received on the included outline and the outline is considered final.

The group discussed that during the C-400 Remedial Investigation, no water has been observed in the UCRS in monitoring points installed through the foundation of the C-400 building. It was discussed that the C-400 building observations may not be representative of the buildings of interest in this white paper.

6. CSM for the RGA in SWMU 211-A Remedial Action Work Plan

Section 1.1.2, "Regional Hydrogeology," references an axis in describing thickness trends for gravel deposits forming the RGA. EPA would like to discuss if the use of the term axis has any implied significance to groundwater flow direction(s) (i.e., a north-south lateral groundwater flow divide) or any implication for implied subsurface structural feature(s) forming the RGA (i.e., the existence of an east-west fault-controlled structural low).

The site geologist explained the east-west trend is consistent with ancestral Tennessee River and is believed to be an erosional surface (thalweg is the geomorphology term). EPA suggested that the Paducah Site area may have several generations of seismic activities, overprinting of seismicity could be happening, and east-west faulting may have occurred. Steve Hampson had a follow-up after discussion with Dr. Woolery and Dr. Zhu.

Steve Hampson reported that an east-west trend is prevalent at PGDP, as evidenced in both regional and local studies. Regional faults commonly trend northeast-southwest but that there could be local structural controls under PGDP that could influence groundwater flow. Seismic studies have not previously been conducted between the east and west fences and from the Porters Creek terrace to north fence because it was not possible to filter out the noise of the operating plant. Most of the plant infrastructure is no longer operating and Steve Hampson discussed that Dr. Woolery has noted there are now seismic reflection techniques that could give a better view of what the structure is beneath the site.

DOE and FRNP are reviewing whether there are any ways to further reduce (temporarily) sources of noise to facilitate new testing without disrupting site activities. Dr. Woolery has offered to support any requests or initiatives that may develop regarding additional seismic surveys at the Paducah Site.

No comments were received on this topic during the meeting.

7. CSM for the McNairy in the C-400 Complex Area

FRNP has set up a website to house a library of McNairy information. Access the website at the following link: https://fourriversnuclearpartnership.com/McNCSM. The site requires a password that has been sent separately. Contact Stefanie if you need the password to the website.

A lithology white paper is being prepared as part of the resolution of dispute on the CERCLA Five Year Review. DOE will issue the technical paper within one month of submittal of the D1 C-400 Complex OU RI/FS Report to support the review and comment of the C-400 specific data interpretation as part of the C-400 Complex OU RI/FS Report review process and the performance of the FY 2023 Five-Year Review revised protectiveness determinations for the Northeast, Northwest, and Water Policy response actions. The regulatory milestone date for the D1 C-400 Complex OU RI/FS Report has been revised to October 7, 2022.

A draft schedule and annotated outline for the paper were discussed during the October 2020 Groundwater MWG meeting. The schedule was revised to reflect the new C-400 Complex OU RI/FS Report date and was discussed during the January 13, 2021 meeting (see below). The plan continues to be that the draft Lithology Paper will be available to the MWG before the D1 C-400 Report is submitted so that substantive comments may be addressed prior to the D1 C-400 Report being issued. The Lithology Paper will then be revised and submitted.

Activity	Target Start	Target Finish	Notes
~~FRNP/DOE Develop Outline for Draft Lithologic Technical Paper~~	~~7/7/2020~~	~~9/30/2020~~	COMPLETE
~~Provide Draft Final Lithologic Technical Paper Outline to MWG~~		~~9/30/2020~~	COMPLETE
~~MWG Review Draft Final Lithologic Technical Paper Outline~~	~~9/30/2020~~	~~10/7/2020~~	COMPLETE
~~Quarterly Meeting (October/FY21Q1)~~		~~10/7/2020~~	COMPLETE
~~FRNP/DOE Revise Draft Final Outline for Lithologic Technical Paper Based on MWG Discussions~~	~~10/7/2020~~	~~10/22/2020~~	COMPLETE
~~Provide Final Outline for Lithologic Technical Paper to MWG~~		~~10/22/2020~~	COMPLETE
~~Quarterly Meeting (January/FY21Q2)~~		~~1/13/2021~~	COMPLETE
~~Quarterly Meeting (April/FY21Q3)~~		~~4/7/2021~~	COMPLETE
Quarterly Meeting (July/FY21Q4)		7/14/2021	
Collect C-400 Lithology Data	5/17/2021	3/16/2022	From C-400 Schedule
FRNP/DOE Develop Draft Lithologic Technical Paper Text	8/4/2021	3/10/2022	
Quarterly Meeting (October/FY21Q3)		10/6/2021	
Finish Collection of C-400 Lithology Data		3/16/2022	From C-400 Schedule
FRNP/DOE Incorporate C-400 Results into Draft Lithologic Technical Paper	3/16/2022	8/11/2022	

Activity	Target Start	Target Finish	Notes
Develop C-400 RI Report	3/17/2022	9/14/2022	From C-400 Schedule
Issue Draft Final Lithologic Technical Paper to MWG		8/11/2022	
MWG Review and Provide Comments on Draft Final Lithologic Technical Paper	8/11/2022	9/12/2022	
MWG Meeting to Discuss Draft Final Lithologic Technical Paper		8/24/2022	Draft FY2021 MWG Work Plan Date
MWG Provide Comments on Draft Final Lithologic Technical Paper		9/12/2022	
C-400 RI Report Submitted to EPA and KY		10/7/2022	Current Milestone
FRNP/DOE Revise Draft Final Lithologic Technical Paper	9/12/2022	11/7/2022	No formal CRS
Submit Final Lithologic Technical Paper to EPA and KY		11/7/2022	Tech Paper Due 1 Month After C-400 RI Report (Currently 10/8/2022)

Items shown in strikeout text are completed.

The KRCEE spreadsheet database of soil boring logs (R10 HydroLitho Dbase posted 121620.xlsx) is available at https://fourriversnuclearpartnership.com/McNCSM.

The final annotated outline was included in the October 14, 2020 MWG meeting summary (sent to participants on 11/23/2020 and with agreed-upon revision discussed during the 1/13/2021 meeting). No comments were received on the outline and the outline was considered final. The MWG will discuss the Draft Lithologic Technical Paper Text between the October 2020 and March 2021 MWG meetings.

8. Resurvey of wells

The field resurveying effort for the monitoring well reference point elevations was completed October 9, 2020 and the data review was completed in November 2020. The data are in the process of being reviewed for upload to OREIS. Additionally, a review of the data and any impact on the groundwater model will be performed (schedule is pending with initial scoping planned for late-February).

A white paper summarizing the approach and scope of the resurvey work was developed and has been appended to the 2021 update to the P-QAPP. A second white paper on potential impacts of the new survey data and the impact to the groundwater model will be developed. The draft outline for this paper is included as Attachment 3.

This white paper is currently planned to be appended to the 2016 Groundwater Model Report. KY and EPA have agreed on this approach and DOE will confirm the approach with Site management when the paper is developed in draft.

Comments from the MWG on the draft outline are requested by July 28th. EPA stated that if the MWG does not receive an email from EPA by that date the MWG could assume that EPA has no comments.

9. Precipitation and Ohio River Stage

Attachment 4 includes precipitation and Ohio River stage charts through December 2020.

The MWG discussed the figures which show that June was a drought month and July has been very wet to date. A revised Ohio River at Olmsted, IL chart is included in Attachment 4.

10. Projects on the "Watch Topics" List

- **TVA Changes.** During the October 2020 and January 2021 meeting, the MWG discussed the construction of the new ash ponds and a recent RFP for a 3,800 ft sheet pile wall to be constructed in close proximity to Little Bayou Creek and several seeps. The sheet pile wall may intercept the RGA and influence the creek.

  The MWG discussed that the sheet pile wall is along Little Bayou Creek and along the southwest portion of existing CCR landfill as shown on the figure on the next page. The wall is intended to stabilize the creek's bank, as opposed to control groundwater, and is installed above the RGA. The sheet pile wall is installed between 29-35 ft to 42-45 ft below ground surface depending on the ground surface slope, which are very steep (20-25 ft) incised cut. ***TVA will provide the elevations of the sheet pile wall. Following receipt, FRNP will prepare a cross section of the sheet pile wall, the creek, and the upper limit of the RGA.***

- **Consider stream gauging in relation to the synoptic water levels.** Stream gauging has been discussed as part of out-year activities. See October 2018 Meeting Summary for additional information. Stream gauging will support new modeling. The figure on the next page depicts the planned alignment of the sheet pile wall.

  The MWG discussed that this is a targeted activity for Groundwater Strategy and that the Groundwater Strategy plan for FY 2022 is in development.

- **Seeps.** On August 5, FRNP and KY walked down the two seeps reported in the June 6, 2020 meeting. Seep A appears to be 4 ft higher in elevation than the creek bottom and south of LBC5. Seep B is also in Little Bayou Creek and on the side of the creek bank. KY sampled Seep A in August.

  The seep data collected by KY have been provided for upload to PEGASIS. KY is currently working on a letter transmitting the data. TCE was detected in the seeps. Site data for the split sampling has been loaded to OREIS: TCE was detected at LBCSP10; TCE was detected at an estimated concentration for LBCSP2, LBCSP3, LBCSP4, LBCSP9; TCE was nondetect at LBCSP8.

  There have been no seep results above the maximum concentration limit (MCL) for trichloroethene (TCE) for many years.

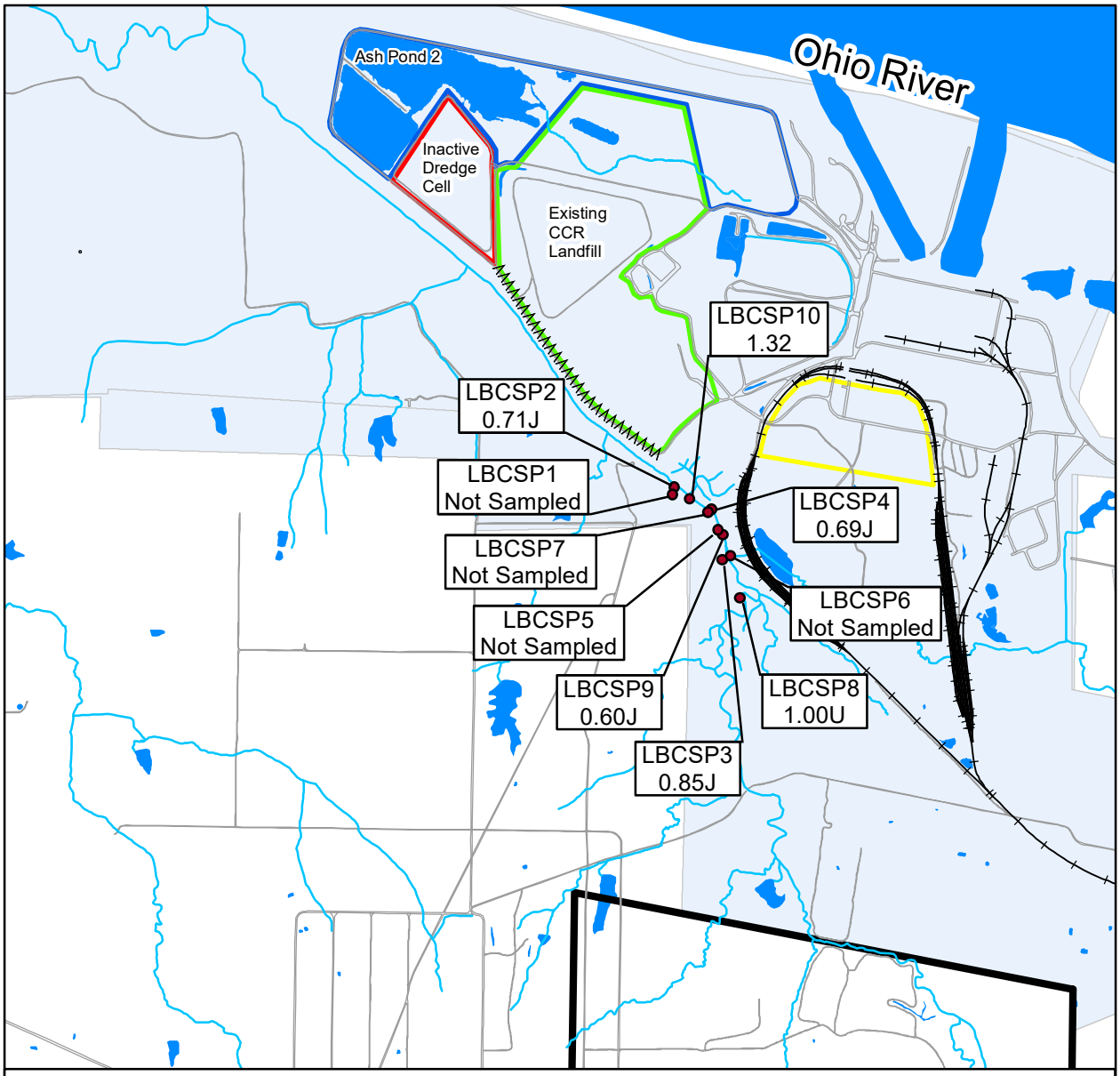
  The location of the seeps and TCE data for the seeps are depicted on the figure on the next page.

  KY clarified that some of the seeps on the figure are in the creek and some are on the banks of the creek. ***KY plans to walk downstream from LBCSP8 to the Ohio River to identify any additional potential seeps.***

- **"No Go" Areas for Monitoring Well Installations.**
  Corridors where overhead transmission lines have been removed have been considered for monitoring well placement, especially with respect to the west side of the NE Plume. Previously, overhead transmission lines prevented installation of wells to the west in the northern-most transect of wells. A new substation (C-538) has been constructed east of the C-755 trailer complex. On the

west side of the new substation, 161kV overhead lines will be installed along the existing overhead line corridor. On the east side of the new substation, 161kV overhead lines (near the C-755 parking lot and between K010 and K011) will be installed along the 161kV lines. Most of the overhead lines down from McCaw Road to the plant with only a static line remaining on the towers on the south into the C-331 yard.

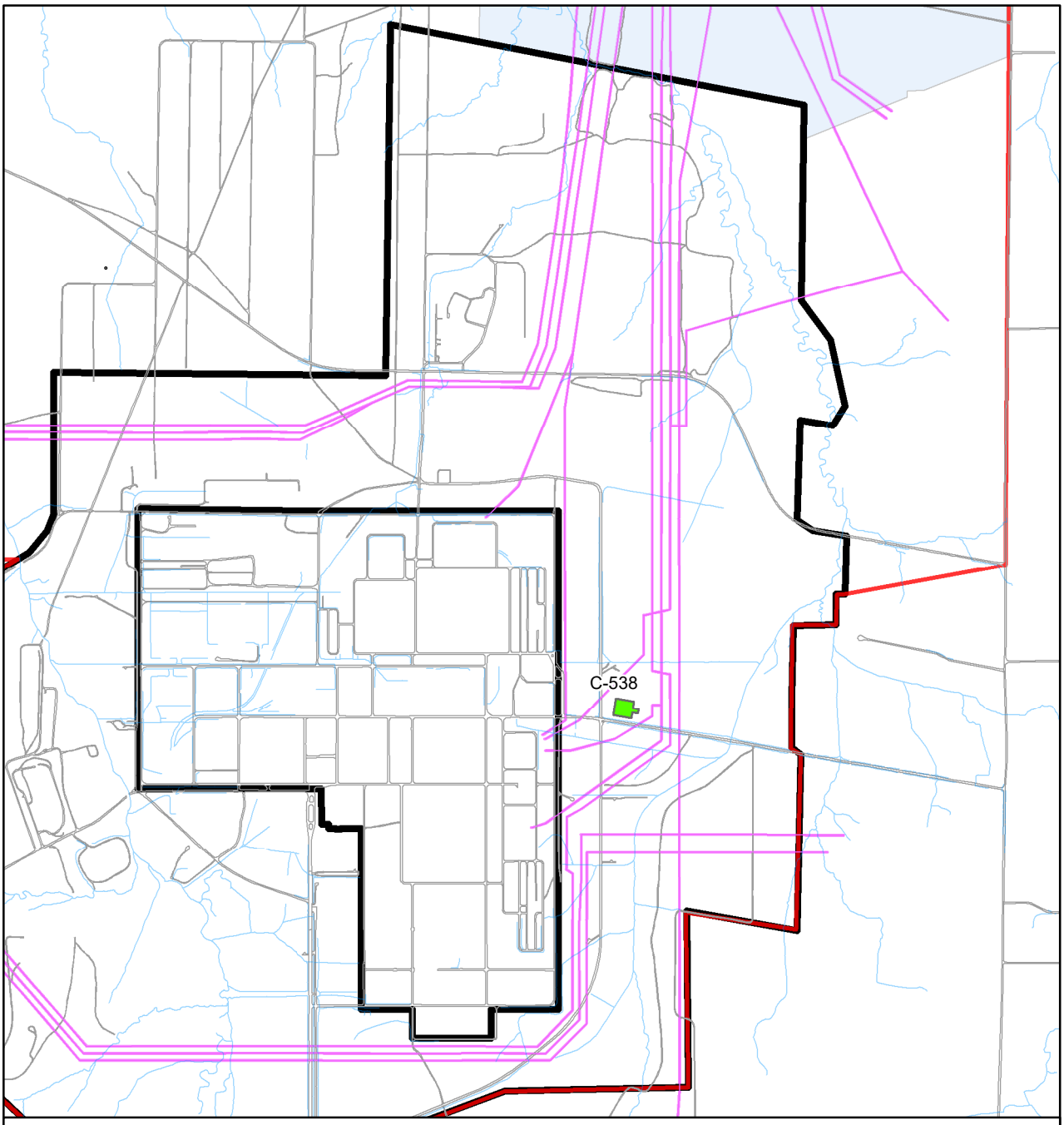
- The 161 KV feeder line from TVA to C-531 Switchyard are in the process of being removed.
- Map of the formerly unavailable utility corridor area(s) is included on Page 9 *[Page 10 in this summary]*.



MAP SOURCE INFORMATION
Map Generation Date and Location: 03/17/2021 Geosyntec\Knoxville-01\PROJECTS\Paducah_FRNP\GIS\FRNP Maps.
Layer: DOE Boundary, Surface Water, Surface Water Body, TVA, and Road Source: Geosyntec\Knoxville-01\PROJECTS\Shapefiles\zipfolder\Paducah_FRNP\GIS\FRNP Maps From PEGASIS; downloaded 3/16/2021.
Layer: Seeps LBCSP2, LBCSP3, LBCSP4, LBCSP5, LBCSP8, LBCSP9, LBCSP10 Sourced from iPEGASIS on 3/17/2021.
Layer: Seeps LBCSP1, LBCSP6, LBCSP7 Sourced from PEGASIS; downloaded 3/17/2021.
Layer: Railroad Sourced from PEGASIS; downloaded 4/8/2021.
Layer: LBCSP2, LBCSP3, LBCSP4, LBCSP8, LBCSP9, LBCSP10, and Railroad Sourced from PEGASIS; downloaded 4/9/2021.
Layer: TVA Construction/Dewatering Area Created: 4/21/2021.

U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

FOUR RIVERS NUCLEAR PARTNERSHIP, LLC



Legend

- Surface Water Course Centerline
- Power Line
- Road Area
- Water Policy Boundary
- DOE Boundary
- Tennessee Valley Authority Area
- Power Transmission Line
- C-538

0 875 1,750 3,500 Feet

TRUE NORTH 20° PLANT NORTH

MAP SOURCE INFORMATION

Map Generation Date and Location: 03/17/2021 P: Geosyntec\Knoxville-01\PROJECTS \Paducah_FRNP\GIS\FRNP Maps\Power line no-go zones_20210317.mxd
Layer: DOE Boundary, Road, Surface Water, TVA, Water Policy Boundary, and Facility. Source: PEGASIS 3/16/2021 (Layer: 'GIS Layers')
Layer: Power lines and C-538 Source: (provided by FRNP on 3/16/2021; power lines last updated 5/15/2018 and switchyard boundary from Engineering Drawing C5E-6523 rev11 last updated on 12/30/2019.)
Layer: Switchyards (from Facility shapfile downloaded from PEGASIS 3/17/2021 with query for C-531-2, C-533-2, C-535-2, C-537-2).

U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

FOUR RIVERS NUCLEAR PARTNERSHIP, LLC

FRNP will review the "no-go" figure for any changes to transmission line status (removed, de-energized, etc.) and provide an updated figure at the October meeting.

- **Wetlands map layer.** The site is working on new wetlands maps.
  - Different projects have used different source data for wetlands and floodplains maps.
  - The map layers previously available in PEGASIS did not include information from the WDA project.

These updates will be uploaded and available through PEGASIS. No field work is being performed as part of the map updates. As part of the ongoing map consistency project, these shapefiles are being reviewed and layers will be made available in PEGASIS, potentially by the summer.

DOE discussed that there are no updates at this time. KY expressed interest in understanding any differences between the different wetlands map layers.

11. 2021 Presentations

- July 2021: FRNP presentation on PEGASIS, including how PEGASIS works and what data is included in PEGASIS (Attachment 5).

FRNP provided a tour of PEGASIS during the meeting. Following the tour and at the end of the meeting, the group discussed:

- *The challenges of reproducing large project datasets and the need to understand the decision rules for data use;*
- *The need to understand data qualifiers and the decision rules for flagging data as detections versus non-detections. These rules are not currently included in the User Manual and* ***DOE and FRNP will discuss if these should be added to the manual.***
  - *(https://pegasis.pad.pppo.gov/pdf/PEGASIS%20Manual%202019%20Rev%205.pdf)*
- *KYRHB and KRCEE have completed a review of radiological analytical type data and have provided updates to the data for inclusion in PEGASIS. A review of metals is in progress and reviews of SVOC and VOC data are planned*

- October 2021 (Proposed): FRNP to present on the *2016 Update of the Paducah Gaseous Diffusion Plant Sitewide Groundwater Flow Model* (DOE/LX/07-2415&D2).

The EarthCon presentation will be moved back in the schedule as their contract with DOE is pending. MWG members should provide any presentation requests to Stefanie.

The EarthCon contract is anticipated to be in place by August and a presentation on the 2015-2016 EarthCon work will be targeted for the January or March meeting.

12. Poll MWG Members/Open Discussion

Paducah is preparing a virtual museum similar to the one developed for the Portsmouth site: http://www.portsvirtualmuseum.org/.

Attachment 1

Groundwater Elevation Data for TVA Wells Collected by KY on February 22, 2021

OREISName	Well	Description	Aquifer	Top of Casing	Top of Ground	xconv Easting (Ft)	yconv Northing (Ft)	Status	Screen Top Depth (Ft)	Screen bot depth (Ft)	tscreenelev (Ft)	bscreenelev (Ft)	GW Elev. (Datum - DTW)	Water Level	Date & Time	Barometric Pressure (inHg)	Measuring Point
TVAGW-6D	TVAGW-6D	4" PVC	Upper RGA	368.8	365.9	760787.8774	1946731.539	active	58.3	68.3	307.6	297.6	321.42	47.38	05/24/2021_1355	29.71	TOC
TVAGW-5D	TVAGW-5D	4" PVC	Upper RGA	368.5	365.7	760131.6259	1947315.953	active	60.1	70.1	305.6	295.6	321.95	46.55	05/24/2021_1400	29.71	TOC
TVAGW-4D	TVAGW-4D	4" PVC	Upper RGA	365.8	363	759456.7195	1947561.73	active	57	67.5	306	295.5	323.98	41.82	05/24/2021_1403	29.71	TOC
TVAGW-3D	TVAGW-3D	4" PVC	Upper RGA	363.8	360.9	758982.49	1947793.858	active	65.3	75.3	295.6	285.6	321.89	41.91	05/24/2021_1406	29.71	TOC
TVAGW-2D	TVAGW-2D	4" PVC	Upper RGA	370	367.1	759966.7809	1944870.473	active	55.6	65.6	311.5	301.5	326.66	43.34	05/24/2021_1344	29.71	TOC
TVAGW-1D	TVAGW-1D	4" PVC	Upper RGA	370.1	367.5	757847.0459	1946203.79	active	56	66	311.5	301.5	322.4	47.7	05/24/2021_1420	29.72	TOC
TVA-D8A	SHF-D8A	4" PVC	Upper RGA	331.82	329	754060.01	1953586.25	active	17.5	27.5	311.5	301.5	325.32	6.5	05/24/2021_1443	29.73	TOC
TVA-D75B	SHF-D75B	2" PVC	Upper RGA	353.08	350	753297.07	1955971.69	active	48	58	302	292	310.83	42.25	05/24/2021_1532	29.67	TOC
TVA-D74B	SHF-D74B	2" PVC	Upper RGA	331.99	329	756125.35	1956489.82	active	39	49	290	280	308.62	23.37	05/24/2021_1504	29.69	TOC
TVA-D30B	SHF-D30B	2" PVC	Upper RGA	324.61	320.9	757594	1955563.41	active	39	49	281.9	271.9	301.92	22.69	05/24/2021_1459	29.69	TOC
TVA-D17	SHF-D17	2" PVC	Upper RGA	365.43	362.8	758809.17	1950015.71	active	14	17	348.8	345.8	319.27	46.16	05/24/2021_1434	29.72	TOC
TVA-D11B	SHF-D11B	2" PVC	Upper RGA	321.79	319.2	753434.76	1958481.44	active	32	42	287.2	277.2	307.96	13.83	05/24/2021_1516	29.70	TOC
TVA-D10	SHF-D10	4" PVC	Upper RGA	351.74	351	752950.26	1956644.9	active	36.5	46.5	31.5	304.5	307.79	43.95	05/24/2021_1530	29.67	TOC
SHF-201C	SHF-201C	4" PVC	Upper RGA	323.75	320	746799.24	1960068.889	active	44.5	54.5	275.5	265.5	309.75	14	05/24/2021_1605	29.71	TOC
SHF-201B	SHF-201B	4" PVC	Upper RGA	323.75	320.2	746641.107	1960082.768	active	32	37	288.2	283.2	309.79	13.96	05/24/2021_1604	29.71	TOC
SHF201A	SHF201A	4" PVC	Upper RGA	323.75	320	747030.226	1960036.252	active	14.5	24.5	305.5	295.5	309.73	14.02	05/24/2021_1603	29.71	TOC
SHF-102G	SHF-102G	4" PVC	Upper RGA	362.85	359.1	845764.387	1927473.284	active	47.1	57.4	312	301.7	322.95	39.9	05/24/2021_1613	29.71	TOC
Ohio River Elevation													298.8		05/24/2021_1700	29.66	TVA

LEGEND:
TOC: Top of Casing
DTW: Depth to Water
National Geodetic Vertical Datum of 1929 (NGVD 29).

Attachment 2

2021 EMP Schedule for Groundwater Strategy Project

From 2021 EMP Pages B-28 through B-35

Monitoring Wells Planned For Colloidal Borescope and Pressure Transducer Deployment

Well Number	MONTH 1	MONTH 2	MONTH 3	MONTH 4	MONTH 5	MONTH 6	MONTH 7	MONTH 8	MONTH 9	MONTH 10	MONTH 11	MONTH 12
MW20 (also R4)	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2
MW63			M1			M1			M1			M1
MW65			M1			M1			M1			M1
MW66			M1			M1			M1			M1
MW67			M1			M1			M1			M1
MW68			M1			M1			M1			M1
MW71	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW72			M1			M1			M1			M1
MW73			M1			M1			M1			M1
MW76			M1			M1			M1			M1
MW77 (PZ)			M1			M1			M1			M1
MW78			M1			M1			M1			M1
MW79			M1			M1			M1			M1
MW80			M1			M1			M1			M1
MW81			M1			M1			M1			M1
MW84A			M1			M1			M1			M1
MW86			M1			M1			M1			M1
MW87A			M1			M1			M1			M1
MW89			M1			M1			M1			M1
MW90A			M1			M1			M1			M1
MW92			M1			M1			M1			M1
MW93A			M1			M1			M1			M1
MW95A			M1			M1			M1			M1
MW98			M1			M1			M1			M1
MW99	M1	M1	CB+M1	M1	M1	M1	M1	M1	CB+M1	M1	M1	M1
MW100	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW102			M1			M1			M1			M1
MW103			M1			M1			M1			M1
MW106A	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2
MW108			M1			M1			M1			M1
MW120			M1			M1			M1			M1
MW121	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2
MW122			M1			M1			M1			M1
MW123			M1			M1			M1			M1
MW124			M1	P		M1			M1			M1

From 2021 EMP Pages B-28 through B-35

Well Number	MONTH 1	MONTH 2	MONTH 3	MONTH 4	MONTH 5	MONTH 6	MONTH 7	MONTH 8	MONTH 9	MONTH 10	MONTH 11	MONTH 12
MW125			M1			M1			M1			M1
MW126	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW132	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW133			M1			M1			M1			M1
MW134	PT+M2	CB+PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2
MW135	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW137	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW139	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW144			M1			M1			M1			M1
MW145	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW146			M1			M1			M1			M1
MW147	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW148	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW150	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW152*	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW155			M1			M1			M1			M1
MW156			M1			M1			M1			M1
MW161			M1			M1			M1			M1
MW163			M1			M1			M1			M1
MW165A			M1			M1			M1			M1
MW168			M1			M1			M1			M1
MW169			M1			M1			M1			M1
MW173			M1			M1			M1			M1
MW175			M1			M1			M1			M1
MW178			M1			M1			M1			M1
MW185			M1			M1			M1			M1
MW188			M1			M1			M1			M1
MW191	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW193	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW194	CB+M2	M2	CB+M2	M2	CB+M2	M2	CB+M2	M2	CB+M2	M2	CB+M2	M2
MW197			M1			M1			M1			M1
MW199	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2
MW200			M1			M1			M1			M1
MW201	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2
MW202	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2
MW203			M1			M1			M1			M1
MW205			M1			M1			M1			M1
MW220			M1			M1			M1			M1

From 2021 EMP Pages B-28 through B-35

Well Number	MONTH 1	MONTH 2	MONTH 3	MONTH 4	MONTH 5	MONTH 6	MONTH 7	MONTH 8	MONTH 9	MONTH 10	MONTH 11	MONTH 12
MW221			M1			M1			M1			M1
MW222			M1			M1			M1			M1
MW223			M1			M1			M1			M1
MW224			M1			M1			M1			M1
MW225			M1			M1			M1			M1
MW226			M1			M1			M1			M1
MW227			M1			M1			M1			M1
MW233			M1			M1			M1			M1
MW236			M1			M1			M1			M1
MW238			M1			M1			M1			M1
MW239			M1			M1			M1			M1
MW240			M1			M1			M1			M1
MW241A			M1			M1			M1			M1
MW242			M1			M1			M1			M1
MW243			M1			M1			M1			M1
MW244			M1			M1			M1			M1
MW245			M1			M1			M1			M1
MW247			M1			M1			M1			M1
MW248			M1			M1			M1			M1
MW249			M1			M1			M1			M1
MW250			M1			M1			M1			M1
MW252	M1	CB+M1	M1	M1	M1	M1	M1	CB+M1	M1	M1	M1	M1
MW253A	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW255			M1			M1			M1			M1
MW256			M1			M1			M1			M1
MW257			M1			M1			M1			M1
MW258			M1			M1			M1			M1
MW260			M1			M1			M1			M1
MW261			M1			M1			M1			M1
MW262	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW283			M1			M1			M1			M1
MW284			M1			M1			M1			M1
MW288			M1			M1			M1			M1
MW291	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW292			M1			M1			M1			M1
MW293A			M1			M1			M1			M1
MW294A			M1			M1			M1			M1
MW325			M1			M1			M1			M1

From 2021 EMP Pages B-28 through B-35

Well Number	MONTH 1	MONTH 2	MONTH 3	MONTH 4	MONTH 5	MONTH 6	MONTH 7	MONTH 8	MONTH 9	MONTH 10	MONTH 11	MONTH 12
MW326			M1			M1			M1			M1
MW327			M1			M1			M1			M1
MW328			M1			M1			M1			M1
MW329	PT+M2	PT+M2	PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	PT+M2	PT+M2	PT+M2	CB+PT+M2
MW330			M1			M1			M1			M1
MW333			M1			M1			M1			M1
MW337			M1			M1			M1			M1
MW338			M1			M1			M1			M1
MW339			M1			M1			M1			M1
MW340			M1			M1			M1			M1
MW341			M1			M1			M1			M1
MW342			M1			M1			M1			M1
MW343			M1			M1			M1			M1
MW345			M1			M1			M1			M1
MW346			M1			M1			M1			M1
MW347			M1			M1			M1			M1
MW353	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW354	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2
MW355			M1			M1			M1			M1
MW356			M1			M1			M1			M1
MW357			M1			M1			M1			M1
MW358			M1			M1			M1			M1
MW360			M1			M1			M1			M1
MW361			M1			M1			M1			M1
MW363			M1			M1			M1			M1
MW364			M1			M1			M1			M1
MW366	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW367			M1			M1			M1			M1
MW369			M1			M1			M1			M1
MW370			M1			M1			M1			M1
MW372			M1			M1			M1			M1
MW373			M1			M1			M1			M1
MW376			M1			M1			M1			M1
MW380			M1			M1			M1			M1
MW381			M1			M1			M1			M1
MW384			M1			M1			M1			M1
MW385			M1			M1			M1			M1
MW387			M1			M1			M1			M1

From 2021 EMP Pages B-28 through B-35

Well Number	MONTH 1	MONTH 2	MONTH 3	MONTH 4	MONTH 5	MONTH 6	MONTH 7	MONTH 8	MONTH 9	MONTH 10	MONTH 11	MONTH 12
MW388			M1			M1			M1			M1
MW391			M1			M1			M1			M1
MW392			M1			M1			M1			M1
MW394	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW395			M1			M1			M1			M1
MW397			M1			M1			M1			M1
MW401			M1			M1			M1			M1
MW402			M1			M1			M1			M1
MW409	PT+M1	CB+PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1
MW410	CB+PT+M1	CB+PT+M1	CB+PT+M1	CB+PT+M1	PT+M1	PT+M1	CB+PT+M1	CB+PT+M1	CB+PT+M1	CB+PT+M1	PT+M1	PT+M1
MW411	CB+PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1
MW414			M1			M1			M1			M1
MW415			M1			M1			M1			M1
MW416			M1			M1			M1			M1
MW417			M1			M1			M1			M1
MW418	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW419			M1			M1			M1			M1
MW420			M1			M1			M1			M1
MW421			M1			M1			M1			M1
MW422			M1			M1			M1			M1
MW423			M1			M1			M1			M1
MW424			M1			M1			M1			M1
MW425			M1			M1			M1			M1
MW426	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2
MW427	M2	CB+M2	M2	M2	CB+M2	M2	M2	CB+M2	M2	M2	CB+M2	M2
MW428	M2	M2	CB+M2	M2	M2	CB+M2	M2	M2	CB+M2	M2	M2	CB+M2
MW429 A	M2	CB+M2	M2	M2	M2	M2	M2	CB+M2	M2	M2	M2	M2
MW430	CB+M2	M2	M2	M2	M2	M2	CB+M2	M2	M2	M2	M2	M2
MW431	M2	M2	M2	CB+M2	M2	M2	M2	M2	M2	CB+M2	M2	M2
MW432	M2	M2	M2	CB+M2	M2	M2	M2	M2	M2	CB+M2	M2	M2
MW433			M1			M1			M1			M1
MW435			M1			M1			M1			M1
MW439			M1			M1			M1			M1
MW440			M1			M1			M1			M1
MW441			M1			M1			M1			M1
MW442			M1			M1			M1			M1
MW443			M1			M1			M1			M1
MW444			M1			M1			M1			M1

From 2021 EMP Pages B-28 through B-35

Well Number	MONTH 1	MONTH 2	MONTH 3	MONTH 4	MONTH 5	MONTH 6	MONTH 7	MONTH 8	MONTH 9	MONTH 10	MONTH 11	MONTH 12
MW445	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW447			M1			M1			M1			M1
MW448			M1			M1			M1			M1
MW450			M1			M1			M1			M1
MW451			M1			M1			M1			M1
MW452			M1			M1			M1			M1
MW453			M1			M1			M1			M1
MW454			M1			M1			M1			M1
MW455			M1			M1			M1			M1
MW456			M1			M1			M1			M1
MW457			M1			M1			M1			M1
MW458			M1			M1			M1			M1
MW459	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW460			M1			M1			M1			M1
MW461			M1			M1			M1			M1
MW462			M1			M1			M1			M1
MW463	CB+PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1
MW464	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1
MW465	PT+M1	PT+M1	CB+PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	CB+PT+M1	PT+M1
MW466	M1	M1	M1	CB+M1	M1	CB+M1	M1	M1	M1	CB+M1	M1	CB+M1
MW467	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW468	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW469	CB+M1	M1	M1	M1	CB+M1	M1	CB+M1	M1	M1	M1	CB+M1	M1
MW470	M1	M1	M1	CB+M1	M1	M1	M1	M1	M1	CB+M1	M1	M1
MW471	CB+PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1
MW472	M1	CB+M1	M1	CB+M1	M1	M1	M1	CB+M1	M1	CB+M1	M1	M1
MW473	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1
MW474	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1
MW475	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW476	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1
MW477	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1
MW478			M1			M1			M1			M1
MW479			M1			M1			M1			M1
MW480			M1			M1			M1			M1
MW481	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW482	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW483	CB+PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1
MW484	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1

From 2021 EMP Pages B-28 through B-35

Well Number	MONTH 1	MONTH 2	MONTH 3	MONTH 4	MONTH 5	MONTH 6	MONTH 7	MONTH 8	MONTH 9	MONTH 10	MONTH 11	MONTH 12
MW485	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1
MW486A	M1	M1	M1	M1	M1	CB+M1	M1	M1	M1	M1	M1	CB+M1
MW487	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW488	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1
MW489			M1			M1			M1			M1
MW490			M1			M1			M1			M1
MW491	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW492			M1			M1			M1			M1
MW493			M1			M1			M1			M1
MW494			M1			M1			M1			M1
MW495			M1			M1			M1			M1
MW496	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW497			M1			M1			M1			M1
MW498			M1			M1			M1			M1
MW499			M1			M1			M1			M1
MW500			M1			M1			M1			M1
MW501			M1			M1			M1			M1
MW502			M1			M1			M1			M1
MW503			M1			M1			M1			M1
MW504			M1			M1			M1			M1
MW505			M1			M1			M1			M1
MW506			M1			M1			M1			M1
MW507			M1			M1			M1			M1
MW524			PT+M1			M1			M1			M1
MW525			M1			CB+PT+M1			M1			M1
MW526			M1			M1			CB+PT+M1			M1
MW527			CB+PT+M1			M1			M1			M1
MW528			M1			M1			M1			M1
MW529			M1			PT+M1			M1			M1
MW530			M1			M1			PT+M1			M1
MW531			M1			M1			M1			M1
MW532 (PZ)			M1			M1			M1			M1
MW533			M1			M1			M1			M1
MW534 (PZ)			M1			M1			M1			M1
MW535 (PZ)			M1			M1			M1			M1
MW536			M1			M1			M1			M1
MW537			M1			M1			M1			M1
MW538			M1			M1			M1			M1

From 2021 EMP Pages B-28 through B-35

Well Number	MONTH 1	MONTH 2	MONTH 3	MONTH 4	MONTH 5	MONTH 6	MONTH 7	MONTH 8	MONTH 9	MONTH 10	MONTH 11	MONTH 12
MW539			M1			M1			M1			M1
MW540 (PZ)			M1			M1			M1			M1
MW541 (PZ)			M1			M1			M1			M1
MW542			M1			M1			M1			M1
MW543			M1			M1			M1			M1
MW544			M1			M1			M1			M1
MW545			M1			M1			M1			M1
MW546			M1			M1			M1			M1
MW547			M1			M1			M1			M1
MW548			M1			M1			M1			M1
MW549			M1			M1			M1			M1
MW550			M1			M1			M1			M1
MW551			M1			M1			M1			M1
MW553 (PZ)			M1			M1			M1			M1
MW554 (PZ)			M1			M1			M1			M1
MW555 (PZ)			M1			M1			M1			M1
MW556			M1			M1			M1			M1
PZ107			M1			M1			M1			M1
PZ109			M1			M1			M1			M1
PZ110			M1			M1			M1			M1
PZ114			M1			M1			M1			M1
PZ115			M1			M1			M1			M1
PZ117			M1			M1			M1			M1
PZ118			M1			M1			M1			M1
PZ287			M1			M1			M1			M1
PZ289			M1			M1			M1			M1
PZ290			M1			M1			M1			M1
PZ349			M1			M1			M1			M1
PZ351			M1			M1			M1			M1
EW232			M1			M1			M1			M1
EW233			M1			M1			M1			M1
EW234			M1			M1			M1			M1
EW235			M1			M1			M1			M1

M1: Manual water level collected once per month
M2: Manual water level collected twice per month
*MW152 was abandoned in October 2018 in order for the Tennessee Valley Authority to construct a new process water basin. Another location has been selected for installation of a new well once construction activities have been completed. This new well will be MW583.

Attachment 3

Second Survey White Paper Draft Outline

DRAFT

EVALUATION OF THE 2016 GROUNDWATER MODEL WITH UPDATED REFERENCE POINT ELEVATIONS FOR THE GROUNDWATER MONITORING NETWORK AT THE PADUCAH GASEOUS DIFFUSION PLANT, PADUCAH, KENTUCKY

DRAFT ANNOTATED OUTLINE

EXECUTIVE SUMMARY

TABLE OF CONTENTS

FIGURES

TABLES

ACRONYMS

1. INTRODUCTION

1.1. BACKGROUND

- Objectives
    - Evaluate the 2016 groundwater flow model results using calibration target water level elevations calculated with updated reference measuring point elevations for the Site groundwater monitoring well network
    - Assess impacts to model calibration and subsequent model-based conclusions
- Summary of new survey data efforts documented in the first survey white paper
- Summary of 2016 GW model update

2. DATA EVALUATION

- Model Stress periods

2.1. STRESS PERIOD 1 – FEBRUARY 1995

- Updated water level calibration targets
- Effect on water level residuals (observed minus calculated water levels)
- Calibration assessment

2.2. STRESS PERIOD 2 – SEPTEMBER 2014

- Updated water level calibration targets
- Effect on water level residuals
- Calibration assessment

3. PRELIMINARY DATA QUALITY OBJECTIVES (DQOS)

3.1. STATE THE PROBLEM

Revisions to the water level target data relied on for the calibration of the 2016 groundwater model based on recently updated Site groundwater monitoring well reference measuring point elevations may impact the model calibration and subsequent model-based findings and conclusions.

3.2. IDENTIFY THE DECISION

Characterize the model calibration using revised target data and assess model conclusions.

3.3. IDENTIFY THE INPUTS

- Updated (2019) monitoring well reference point elevation data.
- Groundwater model water level calibration target data.
- 2016 groundwater model input files (GroundwaterVistas electronic file)

3.4. DEFINE THE BOUNDARIES

- 2016 Groundwater Model domain
- Model stress periods February 1995 and September 2014

3.5. DEVELOP A DECISION RULE

IF updated water level residuals demonstrate significant differences from the 2016 residuals, THEN determine if the differences have a significant impact on model calibration.

3.6. SPECIFY TOLERABLE LIMITS ON DECISION ERRORS

- +/-0.1 feet difference in water level target residual.

3.7. OPTIMIZE THE DESIGN

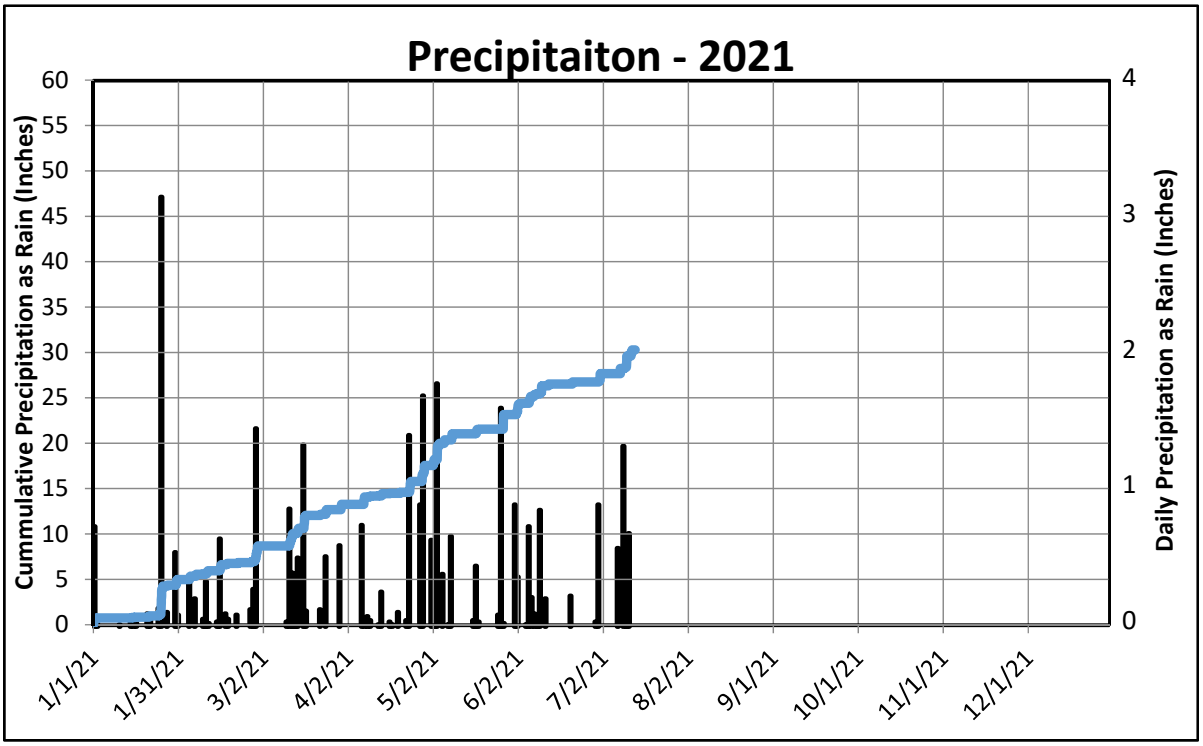
Characterize the impact of updated water level calibration targets on 2016 model-based findings and conclusions.

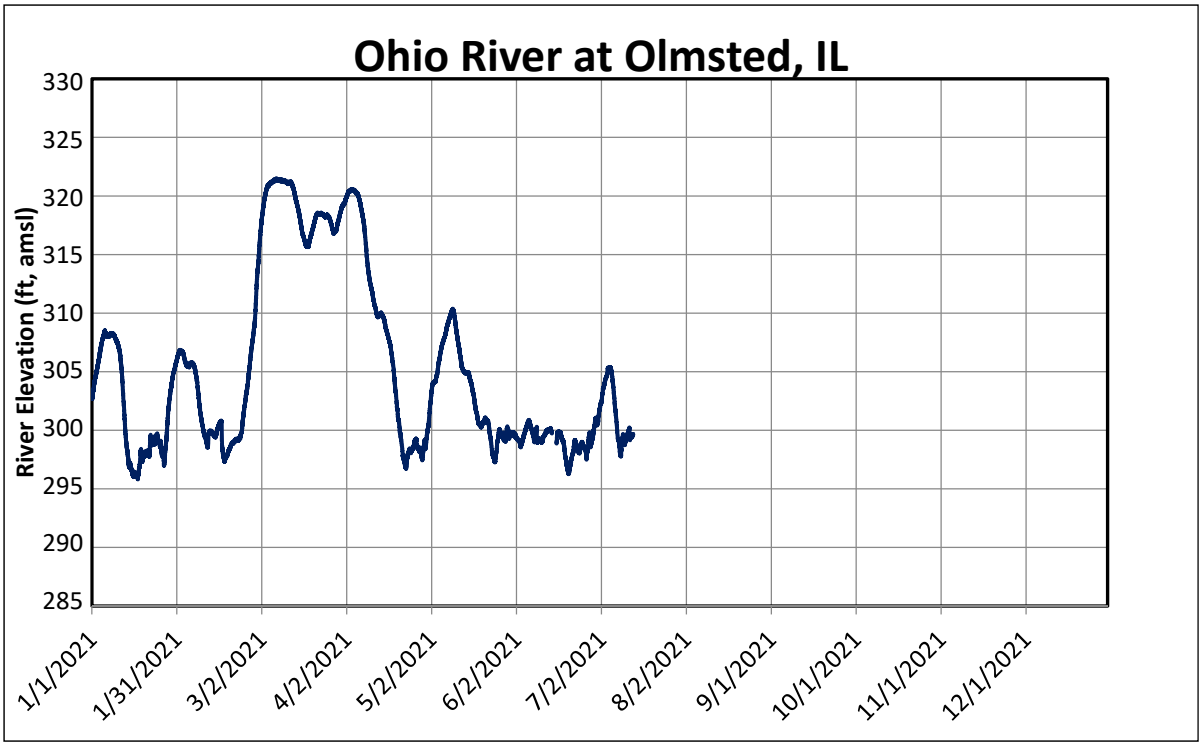
4. CONCLUSIONS AND RECOMMENDATIONS

5. REFERENCES

Attachment 4

Precipitation and Ohio River Stage Data


Precipitaiton - 2021
Cummulative Precipitation as Rain (Inches)
Daily Precipitation as Rain (Inches)
60
55
50
45
40
35
30
25
20
15
10
5
0
4
3
2
1
0
1/1/21
1/31/21
3/2/21
4/2/21
5/2/21
6/2/21
7/2/21
8/2/21
9/1/21
10/1/21
11/1/21
12/1/21


Ohio River at Olmsted, IL
River Elevation (ft, amsl)
330
325
320
315
310
305
300
295
290
285
1/1/2021
1/31/2021
3/2/2021
4/2/2021
5/2/2021
6/2/2021
7/2/2021
8/2/2021
9/1/2021
10/1/2021
11/1/2021
12/1/2021

Attachment 5

PEGASIS

PEGASIS Demonstration Agenda
July 14, 2021
Paducah Site Groundwater Modeling Working Group Meeting

1. **Introductions**

2. **General Information**
   - What is PEGASIS?
   - Related Links
   - Process for reporting problems or requesting information
   - Frequency of PEGASIS Updates
   - User Manual

3. **Site GIS Viewer Tool**

4. **Analytical Data and Plotting Tool**

5. **Well and Bore Logs Tool**

6. **Groundwater Level Data Tool**

7. **Coordinate Converter App Tool**

8. **Questions/Discussion of any issues using PEGASIS**

PEGASIS Link: **https://pegasis.pad.pppo.gov/**