DOE/LX/07-2451&D1

Compilation of Meeting Summaries and White Papers (2019–July 2020)

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

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

Date Issued—December 2020

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 Task Order DE-EM0004895

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CONTENTS

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INTRODUCTION

The purpose of this document is to present the meeting summaries from the Paducah Groundwater Modeling Working Group completed between February 2019 and July 2020. The meeting summaries are provided for historical information to promote program consistency over time and facilitate succession planning. The January, April, and July 2020 meeting summaries include slides from the Groundwater Curriculum presentations. These presentations provided a comprehensive overview of groundwater at the site for new Modeling Working Group members. The meeting summaries included in the appendices are as follow.

- February 6, 2019 Meeting Summary
- April 10, 2019 Meeting Summary
- July 17, 2019 Meeting Summary
- October 2, 2019 Meeting Summary
- January 8, 2020 Meeting Summary
- April 8, 2020 Meeting Summary
- July 15, 2020 Meeting Summary

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

No white papers were developed by the Paducah Groundwater Modeling Working Group between February 2019 and July 2020.

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APPENDIX A

GROUNDWATER MODELING WORKING GROUP MEETING SUMMARY—FEBRUARY 6, 2019

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ACRONYMS

amsl	above mean sea level
DNAPL	dense nonaqueous phase liquid
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
EQ	environmental qualification
EW	extraction well
FFA	Federal Facility Agreement
FRNP	Four Rivers Nuclear Partnership, LLC
FY	fiscal year
GW	groundwater
KRCEE	Kentucky Research Consortium for Energy and the Environment
KY	Commonwealth of Kentucky
MW	monitoring well
MWG	Modeling Working Group
O&M	operations and maintenance
PGDP	Paducah Gaseous Diffusion Plant
RGA	Regional Gravel Aquifer
TVA	Tennessee Valley Authority
UK	University of Kentucky
USGS	U.S. Geological Survey

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Groundwater Modeling Working Group
Meeting Summary—February 6, 2019

Noman Ahsanuzzaman ✓
Brian Begley ✓
Ben Bentkowski
Rich Bonczek ✓
Stephanie Brock
Martin Clauberg ✓
Bryan Clayton ✓
Julie Corkran ✓
Jana Dawson
Eva Davis ✓
Ken Davis ✓
Dave Dollins ✓
Bruce Ford
Stefanie Fountain ✓
LeAnne Garner ✓
Nathan Garner ✓
Steve Hampson ✓
Jeri Higginbotham ✓
Chris Jung ✓
Brian Lainhart
Kelly Layne ✓
Mac McRae ✓
Teresa Overby ✓
Todd Powers ✓
Bruce Stearns ✓
Tracy Taylor ✓
Chris Travis ✓
Denise Tripp ✓

✓ Indicates member was present.

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

None.

2. Status of Previous Meeting Summary

No comments received from October Meeting Summary. The October Meeting Summary will be considered final.

3. Proposed FY 2019 Work Plan/Schedule

Schedule/work plan has been acknowledged by the MWG.

Develop Draft FY 2019 Schedule	9/12/2018
Quarterly Meeting (October)	10/3/2018
Submit FY 2019 Schedule	10/10/2018
MW460 White Paper Revision	10/30/2018
MWG concurs with FY 2019 Schedule	11/9/2018
MW460 White Paper Comments Due	11/30/2018
Quarterly Meeting (January)	1/9/2019 (revised to 2/6/2019)
Submit Compilation of Meeting Notes and White Papers to be completed	2/12/2019
Comments due for Meeting Notes and White Papers compilation	3/12/2019
Quarterly Meeting (April)	4/10/2019
Quarterly Meeting (July)	7/17/2019
Quarterly Meeting (October)	10/2/2019

Quarterly meetings will be by Web/teleconference 8:00 a.m.–11:00 a.m. (Central) and 9:00 a.m.–12:00 p.m. (Eastern)*
If topics warrant, a face-to-face meeting will be considered. Currently, a face-to-face meeting is not scheduled.

Color code for schedule:

Due date	Quarterly meeting
Submittal date	Concurrence/acknowledgement date

Additional details for projects discussed at the October 2018 meeting are the following.

- **Look at west side of site associated with the Southwest (SW) Plume [Trichloroethene (TCE) extents] to address anomaly in plume maps.** A Regional Gravel Aquifer (RGA) water level study is planned, including use of colloidal borescope and pressure transducers. Data collection is expected to last about one year. Twenty-four manual water level measurements are planned to be collected in 20 wells (i.e., approximately 2 per month for each well). Additionally, measurements from 3 colloidal borescopes and 4 pressure transducers over 12 mobilizations/time periods are planned be collected.

A project plan is being developed and will be shared once it is ready. That project plan is close to being ready to share and is being incorporated programmatically. The information will be reflected in the Environmental Monitoring Plan.

Bimonthly water level measurements began in December, and Ken is tracking the results. A list of wells is included as Attachment 1.

- **Similar look at downgradient Northeast (NE) Plume (TCE extents).** Similar steps as described above for SW Plume. Manual water level measurements are planned to be collected in about 40 wells. Additionally, measurements from 3 colloidal borescopes and 4 pressure transducers over 12 mobilizations/time periods are planned to be collected. Data collection is planned to be completed over east and west sides of NE Plume, over a one-year time period. The two studies (NE and SW Plumes) are planned to be run concurrently, to the extent coordination is practical.

  Water level measurements began for the NE Plume wells in December also. Details of which wells are getting manual water levels are included in project plan. (See above.)

  Kentucky will incorporate the details of the project plan with their sampling plans as well.

- **Continuous water level monitoring to assess transient conditions.** Continuous monitoring of RGA monitoring wells is recommended 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.

  FRNP is working on plans to deploy pressure transducers. Pressure transducer measurements should begin this month (now scheduled to begin in April 2019). Details on which wells will get pressure transducers, according to the white paper, are forthcoming.

- **Synoptic water levels to assess seasonal fluctuation.** Previous synoptic water level measurements have been completed annually, but now are planned to be completed more frequently during the year-long test. Manual water level measurements are planned to be collected for up to four quarterly events for one year in approximately 248 wells (i.e., all of the RGA wells). At least one of the quarterly synoptic efforts is planned to include water level measurements in some Upper Continental Recharge System and other wells that are part of the Paducah Site monitoring network. At the MWG's suggestion, this project also included McNairy wells.

  Manual water level measurements started with quarterly measurements in August 2018. The draft August 2018 potentiometric map is included as Attachment 2. Attachment 3 shows the 2018 and 2019 (to date) Ohio River stages at the Olmsted location. There is a significant jump in water levels beginning in September 2018 with the operation of the dam.

- **Look at water level divide (NE Plume hydraulic study).** Hydraulic study was included in FFA Semiannual Report. A separate report will be developed to include colloidal borescope information from the upcoming study. Colloidal borescope of the hydraulic divide area is expected to begin in 5-6 months.

Comments typically are not provided on the FFA Semiannual Report, but comments from Kentucky and possibly EPA are expected for the October 2018 report. This group will discuss the hydraulic study at the next quarterly meeting.

4. MW460 White Paper

Comments received from KY (an excerpt from Brian Begley's 12/20/2018 e-mail is below).

> The Division of Waste Management (Division) has completed its review of the white paper: *Evaluation of TCE Trends in MW460*. The revised white paper does not consider the option of lowering the pump(s) in EW232 or EW233 from their current configuration of being placed in the middle with ~10ft of screen above and below the screen. The Division encourages discussion at the next January 9th groundwater modeling meeting of the merits for lowering the pump in one or both optimized extraction wells. The Division concurs with the approach of updating the groundwater model as proposed in order to evaluate the identified options and wants further discussion on lowering the pumps.
>
> Still unclear about the following…
>
> – Please refer to Begley notes to July 10th GW Modeling Working Group Meeting Summary in regards to a question regarding recent upgrades to the NW Treatment System and if that had any impact on treatment capacity. We also would like to understand the limiting factors which determines the treatment capacity for the NW Pump-N-Treat system.
>
> – If the current extraction wells have received rehabilitation since 2010 or if they are known to have any biofouling present/observed during subsequent inspections?

Upgrades to the NW Plume system include moving the ion treatment system to a separate building. System capacity limits are as follows.

Equipment	Nominal	Maximum Flow Rate	Notes
O&M Plan	200 GPM	220 GPM	Listed from O&M Plan
Extraction Well 232	100 GPM	110 GPM	Listed from O&M Plan
Extraction Well 233	100 GPM	110 GPM	Listed from O&M Plan
EQ Tank Pump	200 GPM	230 GPM	Drawing J5E-18113-A00
Sand Filter Vessels	200 GPM	230 GPM	Drawing J5E-18113-A00, Limited by necessity for online backwashes
Air Stripper	200 GPM	250 GPM	Listed from Manufacturer. Also limited by small air stripper basin capacity. Larger flows may require a larger basin or would result in process upsets.
Air Stripper Pump	200 GPM	220 GPM	Listed from Pump Curve. Capable of 250 GPM but limited due to head loss at approximately 200 GPM. Assumes 165.5 ft Head.
Ion Exchange Vessels	100 GPM each leg	200 GPM	Limited by necessity for online backwashes
System Piping	200 GPM	250 GPM	System documentation

There has not been a need for well rehab in the NW Plume treatment area. There has not been a noticeable decline in the specific capacity of the wells pumps. One previous hypothesis was the NW extraction wells may have been biofouled. A camera inspection has not been performed of the extraction wells.

The current hypothesis for plume bypass would not benefit from operation of the former extraction wells.

The Five Year Review contains recommendations for the NW Plume extraction.

February's compilation will contain a markup with KY's recommendations. Any EPA recommendations will be included at a later date. (LeAnne will follow up with Julie.)

5. 2018 Plume Maps Document

Preparation is beginning. Submittal is targeted for summer 2019. The document will include RGA potentiometric surface map for August 2018 (immediately before commencement of operations for the Olmsted Locks and Dam).

Recent plume maps have used the most recent TCE/technetium-99 value. It was suggested using the maximum concentration for the year or that the maps give the high and low for the year or an indication of trend for each well. The plume map document has a meta-analysis of the trends when incorporating the values and updating the contours. Appendices in the document show trend graphs for all the wells from the previous 10 years. The group suggested that a separate map with 2017-2018 maximum values be included in an appendix for reference.

Additionally, Kentucky provided comments on the 2016 Plume Map Document in a letter to the U.S. Department of Energy (DOE) dated December 11, 2017. These comments should be considered for the 2018 Plume Maps Document.

6. Update on Option(s) to Establish a Water Level Gauge at Metropolis Lake

Ken updated that a water level gauge has not been established yet. There are difficulties with logistics in surveying the tree in the lake. He shared a plan for using a reference photograph of the tree as a water level gauge. One survey would be taken during low water, then subsequent measurements would be compared to the low water. Additional ideas for measuring the water levels were to use a permanent structure near the lake. Ken will put together a plan for collection and share it with the group.

7. Update on TVA Process Water Basin

MW152 and MW153 have been abandoned. FRNP is waiting for TVA's final design and building of the road for installation. Teresa will let the group know when MW152A is to be installed.

8. Update on Paducah Site Monitoring Well Abandonment/Replacement

MW486 (NE Plume) has been abandoned and replaced (MW486A) because casing had failed.

MW253 (NE Plume) has been abandoned and replaced (MW253A) because casing failure is suspected. MW486A and MW253A still are waiting for development. The well development is weather-dependent.

9. Projects on the "Watch Topics" List

- **Stream gauging in relation to the synoptic water levels should be considered.** Stream gauging has been discussed as part of out-year activities. See October 2018 Meeting Summary for additional information.

- White paper in FY 2020 to address "Installation of piezometers equipped with continuous water level monitors associated with several of the large process buildings [or evaluation of sumps] would define the thickness of the sub-slab gravel base and the temporal water level fluctuations beneath several of the large buildings better."

- White paper in FY 2020 to address "Flow rate in the McNairy Formation is negligible compared to the RGA because the hydraulic conductivity is 2 to 3 orders of magnitude lower than in the RGA; however, the McNairy Formation may be significant for DNAPL source accumulation and contaminant transport. Future transport models based on the 2016 flow model will need to consider potential mass flux from the McNairy to the RGA resulting from back diffusion." See October 2018 Meeting Summary for additional information.

- 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. Installation of additional wells in this transect can be considered for efficiency during installation of the new MW152A.

  Two corridors currently are being used. (Information provided following the meeting.) It was suggested that NE Plume monitoring would benefit having a well west of MW463/MW464.

10. Poll MWG Members/Open Discussion

- Five Year Review comments included significant comments on groundwater flow with respect to seismic issues. These comments will be discussed during a Five Year Review comment resolution meeting. A suggestion was made to have a topic discussion at the next MWG meeting. FRNP will look at putting together a presentation for groundwater contaminants/groundwater flow in relation to seismic issues. The following two references were discussed as having additional information that would benefit understanding the seismic issues:

  — FFA Semi-annual Reports (Appendix B McNairy topography)
  — Information from KRCEE (the link below was provided following the meeting)

    http://pgdpvirtualmuseum.org/Seismic/

    The capitalization on "Seismic" in this URL is necessary.

    login: seismic
    password: seismicaccess

Documents are in folders organized by UK-KRCEE Project as follows:

1. Street_Langston Dissertation Report (Initial Site-wide Background Investigation)
2. Holocene Displacement Investigation C-746 Complex
3. Woolery_Anderson-Blitz Theses & Presentations
4. Woolery_Al-Mayahi Dissertation & Presentations

- Kelly is looking for information from the Impaired Waters public comments regarding the surveys in fisheries program. Brian had spoken with Tim Kreher regarding surveys that had been taken along Bayou and Little Bayou Creeks. Brian provided additional information following the meeting.

Attachment 1

The collection of manual water level measurements began in October 2018 in the following wells:

Southwest Plume – Bi-monthly Measurements:

Monitoring Wells			
MW63	MW245	MW426	MW431
MW106A	MW248	MW427	MW432
MW194	MW249	MW428	MW455
MW243	MW329	MW429A	MW497
MW244	MW354	MW430	MW501

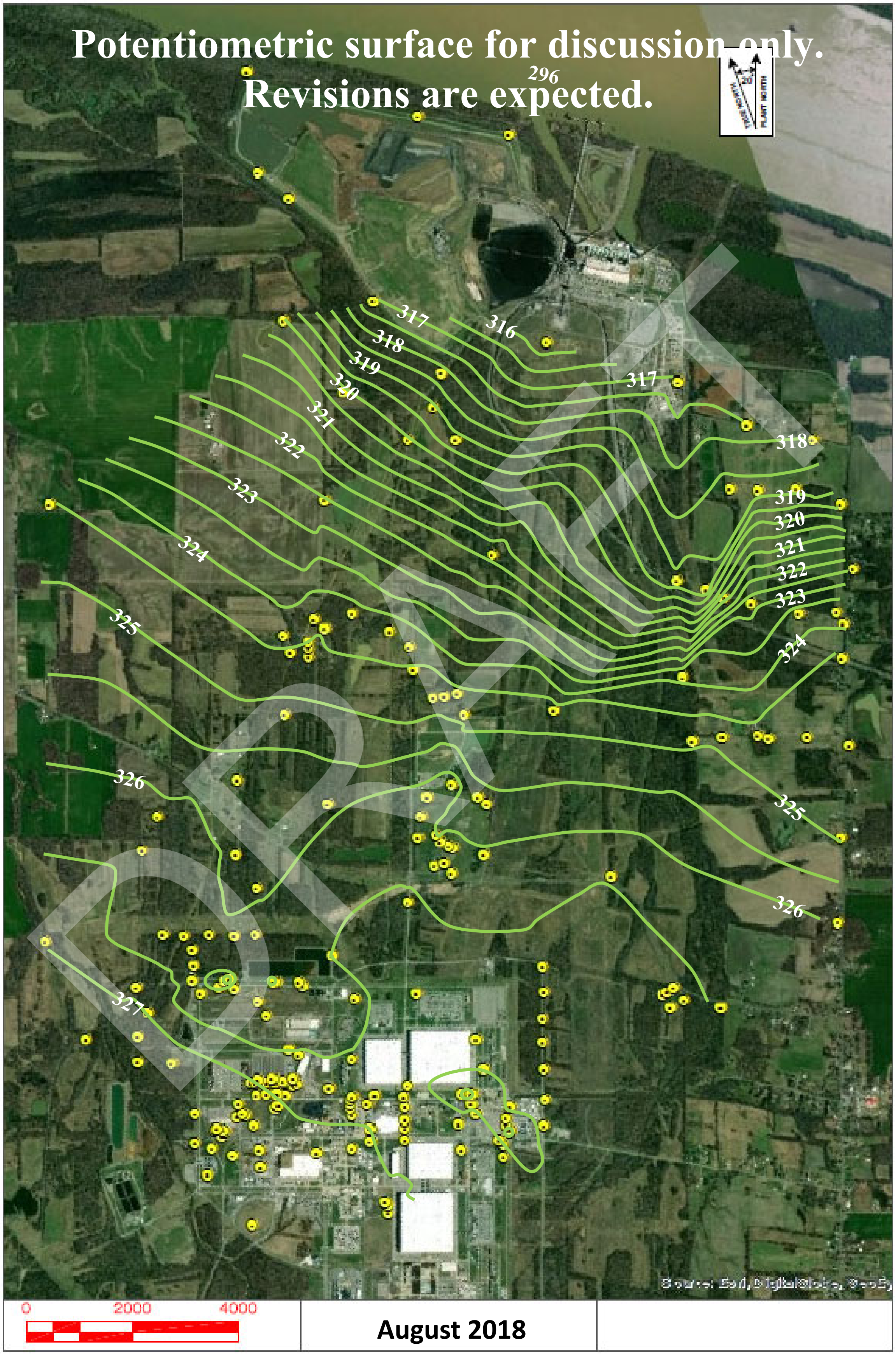
Northeast Plume – Monthly Measurements:

Monitoring Wells			
MW99[1]	MW291	MW467	MW481
MW100	MW366	MW468	MW482
MW126	MW394	MW469	MW483[2]
MW132	MW409	MW470	MW484[2]
MW135	MW410	MW471	MW485[2]
MW137	MW411[2]	MW472	MW487[2]
MW139	MW418	MW473	MW488[2]
MW148[2]	MW463	MW474	MW496
MW150	MW464	MW475	
MW193	MW465	MW476	
MW252[2]	MW466	MW477[1]	

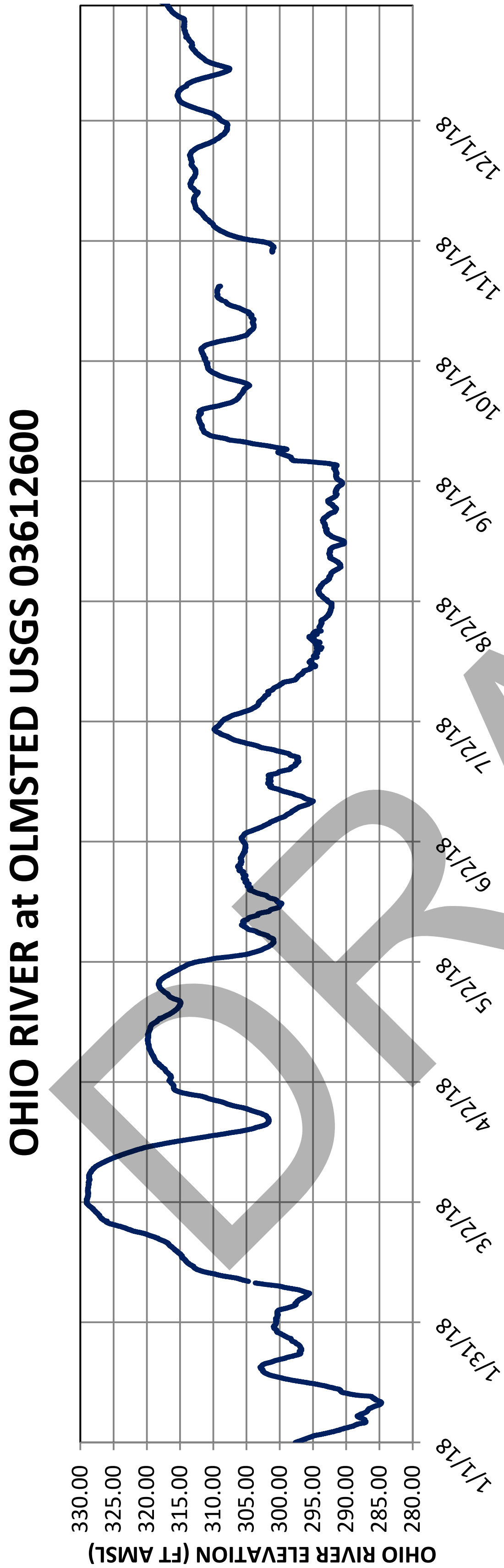
[1] Currently inaccessible

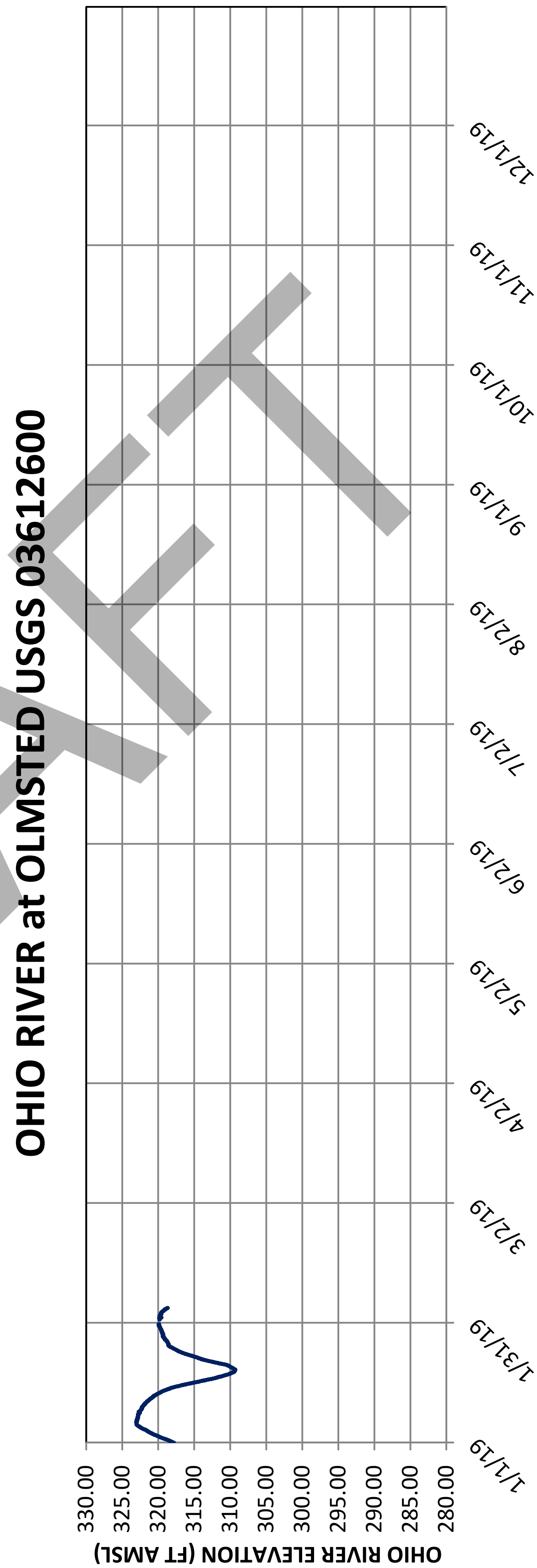
[2] No measurement is available for October

Attachment 2



Attachment 3





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APPENDIX B

GROUNDWATER MODELING WORKING GROUP MEETING NOTES—APRIL 10, 2019

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ACRONYMS

AIP	agreement in principal
amsl	above mean sea level
CB	colloidal boroscope
CDP	common depth point
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CUSMAP	Conterminous United States Mineral Assessment Program
CY	calendar year
DNAPL	dense nonaqueous phase liquid
DOE	U.S. Department of Energy
DPT	direct-push technology
DQO	data quality objective
EW	extraction well
FRNP	Four Rivers Nuclear Partnership, LLC
FS	feasibility study
FY	fiscal year
GDP	gaseous diffusion plant
GPR	ground-penetrating radar
GW	groundwater
KRCEE	Kentucky Research Consortium for Energy and the Environment
KY	Commonwealth of Kentucky
M1	manual water level collected once per month
M2	manual water level collected twice per month
MOA	Memorandum of Agreement
MW	monitoring well
MWG	Modeling Working Group
N/A	not applicable
OREIS	Oak Ridge Environmental Information System
OSL	optically stimulated luminescence
PGDP	Paducah Gaseous Diffusion Plant
PT	pressure transducer
PZ	piezometer
Q&A	question and answer
RGA	Regional Gravel Aquifer
RI	remedial investigation
TVA	Tennessee Valley Authority
UK	University of Kentucky
USGS	U.S. Geological Survey
WAG	waste area grouping

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Groundwater Modeling Working Group
Meeting Summary—April 10, 2019

Noman Ahsanuzzaman ✓
Brian Begley ✓
Ben Bentkowski ✓
Rich Bonczek ✓
Stephanie Brock ✓
Martin Clauberg ✓
Bryan Clayton ✓
Julie Corkran ✓
Jana Dawson ✓
Eva Davis ✓
Ken Davis ✓
Dave Dollins ✓
Jaime Feliciano ✓
Rob Flynn ✓
Bruce Ford ✓
Stefanie Fountain ✓
LeAnne Garner ✓
Nathan Garner ✓
Steve Hampson ✓
Jeri Higginbotham ✓
Dave Hutchison ✓
Chris Jung ✓
Brian Lainhart ✓
Kelly Layne
Mac McRae ✓
Teresa Overby ✓
Tabitha Owens ✓
Rob Pope ✓
Todd Powers ✓
Bruce Stearns ✓
Tracy Taylor ✓
Chris Travis ✓
Denise Tripp ✓
Dr. Ed Woolery ✓

✓ Indicates member was present.

The April 10, 2019, Groundwater Modeling Working Group Meeting was held at the University of Kentucky Center for Applied Energy Research in Lexington, KY. The majority of the group attended in person. Web/teleconference also was utilized.

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

None.

2. Status of Previous Meeting Summary

Comments were received from January Meeting Summary and shown to the group. The January Meeting Summary will be considered final, as corrected.

3. FY 2019 Work Plan/Schedule

Following is the schedule for the remainder of fiscal year (FY) 2019.

Quarterly Meeting (April)	4/10/2019
Quarterly Meeting (July)	7/17/2019
Comments due for Meeting Notes and White Papers compilation (see Item 7)	9/30/2019
Quarterly Meeting (October)	10/2/2019

Quarterly meetings will be by Web/teleconference 8:00 a.m.–11:00 a.m. (Central) and 9:00 a.m.–12:00 p.m. (Eastern)*
If topics warrant, a face-to-face meeting will be considered. Currently, a face-to-face meeting is not scheduled.

Color code for schedule:

Due date	Quarterly meeting
Submittal date	Concurrence/acknowledgement date

4. Seismic Considerations

Seismic Considerations were presented by Ken Davis and are included as attachments to this summary.

- Regional and local geologic setting (Attachment 1)
- Regional seismic interpretations (Attachment 2)
- Previous PGDP seismic investigations (Attachment 3)

Following the presentation, interpretation of possible seismic impacts to groundwater and other technical aspects were discussed.

During the discussion, the working group had questions about contamination in the McNairy. Back-diffusion near DNAPL zone was noted to be of concern. The group questioned whether there is a plume in the McNairy at the Paducah Site. It was stated that TCE was found in the McNairy during the Waste Area Grouping (WAG) 6 Remedial Investigation; however, the McNairy formation is composed of material that promotes degradation.

The group asked if there is any information deeper than 20 ft into the McNairy in the C-400 area, and questioned whether C-400 RI/FS sampling should continue to 50 ft instead of stopping at 20 ft, as currently planned in the D1 work plan. (NOTE: Additional information about McNairy sampling in the C-400 area is included in the WAG 6 Remedial Investigation Report.)

For future studies, the group asked for the following.

a) A summary of McNairy contamination across the site. The summary should include where McNairy monitoring wells are screened within the formation, the well construction details, and whether the wells are equipped with dedicated pumps. LeAnne will check with FRNP's Sample Management Office to see if all KY's Agreement in Principle (AIP) data is available in OREIS.

   The group needs a data dump and compilation of McNairy data in order to better understand the C-400 RI/FS.

   The group agreed to pass on to Kelly Layne the need to consider sampling McNairy wells as part of the Environmental Monitoring Plan.

b) A determination if existing seismic data can be reworked to provide additional information. It was reported that the data is available, but has been reprocessed in the past. Additionally, Steve will discuss potential downhole and cross well geophysics approaches with Dr. Woolery.

5. Groundwater Strategy

Groundwater Strategy was presented by Stefanie Fountain and is included as an attachment to this summary (Attachment 4). The presentation included a comprehensive plan summary, data gaps (map), and near-term activities and current status.

Questions and discussion regarding groundwater strategy included the following:

- What is the origin of the C-746-S&T Plume?

- For Activity 15 (Water Level Divide Study), after data collection and analysis, consider focusing more on divide mid-plant. Also consider adding colloidal borescope here.

- For the Metropolis Lake water level gauge, Ken Davis will be taking photos and a survey will be conducted to calibrate the levels.

6. Northeast Plume Transect Well Data

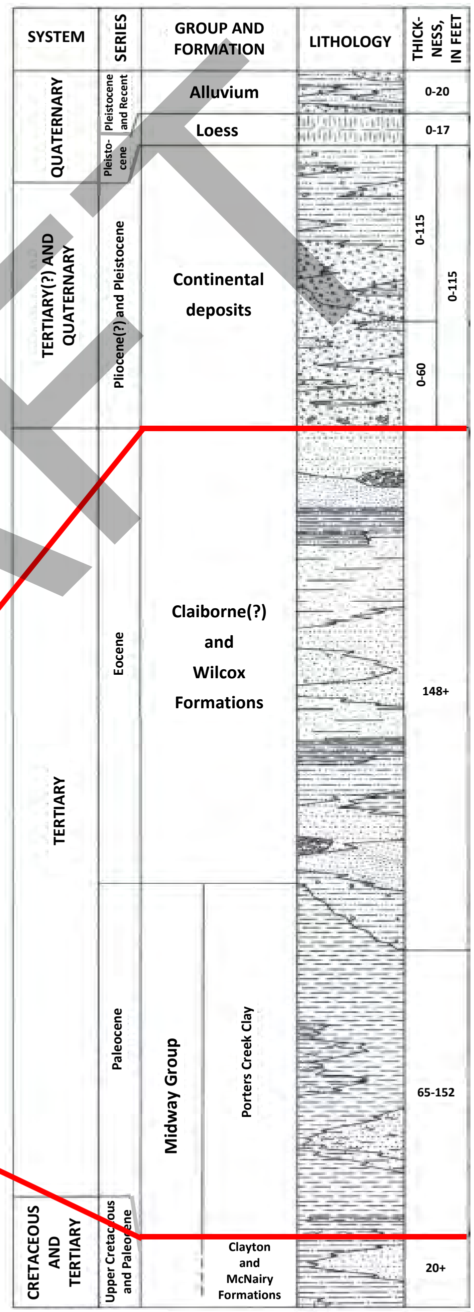
Northeast Plume Transect Well Data was presented by Todd Powers and is included as Attachment 5. The group decided that the Northeast Plume Memorandum of Agreement (MOA) will remain in Condition 3, and the data will be evaluated quarterly. An e-mail will be sent to document this decision. Additionally, the data mix-up by the analytical laboratory for Tc-99 was discussed.

7. Additional Topics

- For the Compilation of Meeting Notes and White Papers, the group decided to move the due date for comments to the end of the FY. LeAnne has resent the draft compilation for comments.
- A new meeting will be scheduled with the C-400 RI/FS team.

Regional and Local Geologic Setting

Geologic Map of the Heath Quadrangle, McCracken and Ballard Counties, Kentucky, U.S.G.S. Map GQ-561



Geologic Time Scale

Period	Epoch	Start, million years ago
Quaternary	Holocene	0.0117
	Pleistocene	2.58
Neogene	Pliocene	5.333
	Miocene	23.03
Paleogene	Oligocene	33.9
	Eocene	56
	Paleocene	66
Cretaceous	Late	100.5

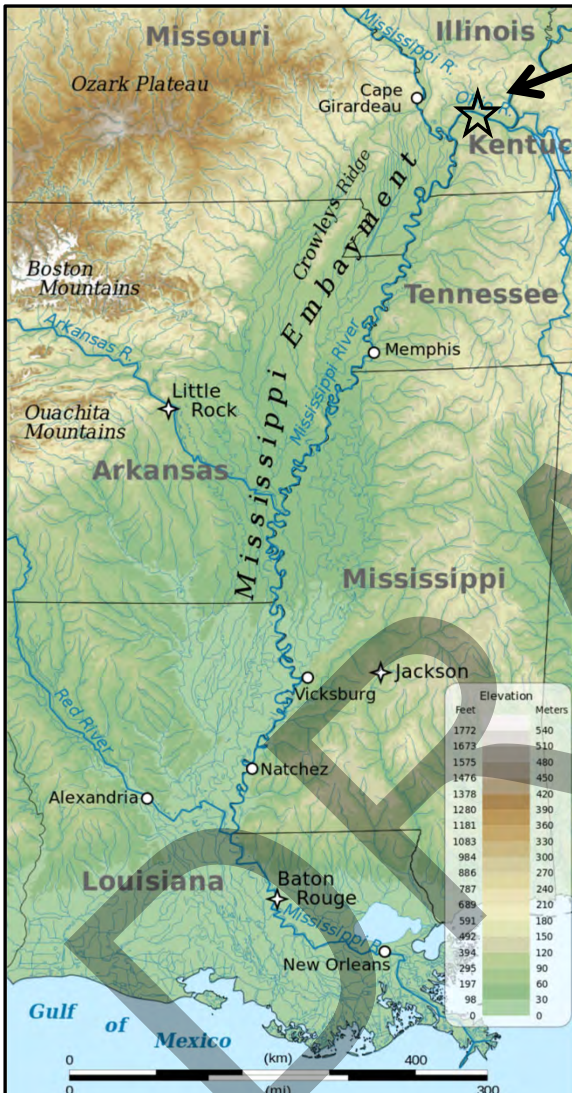
Shaded epochs indicate periods of missing strata at the Paducah Site

Missing beneath the plant site.

Chronology and Paducah Site Stratigraphy

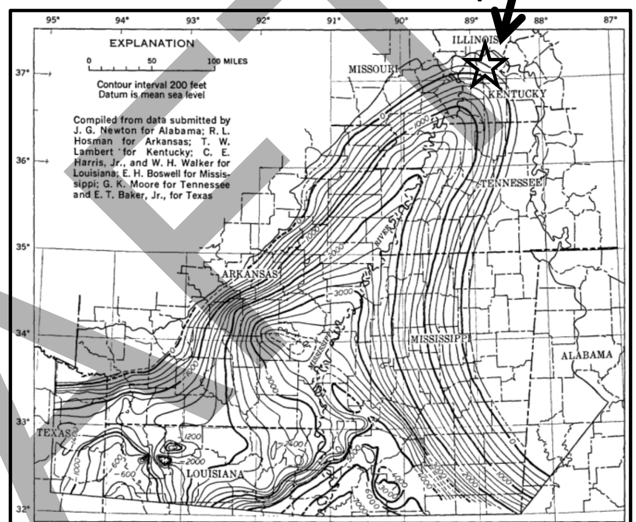
U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

Paducah Site

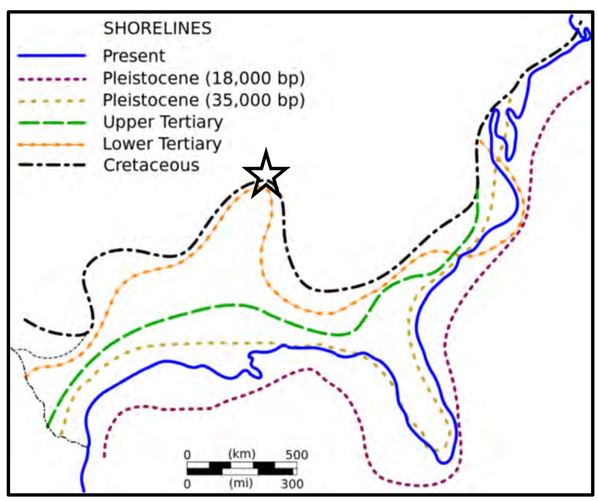


By Kbh3rd - Own work, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=10209178

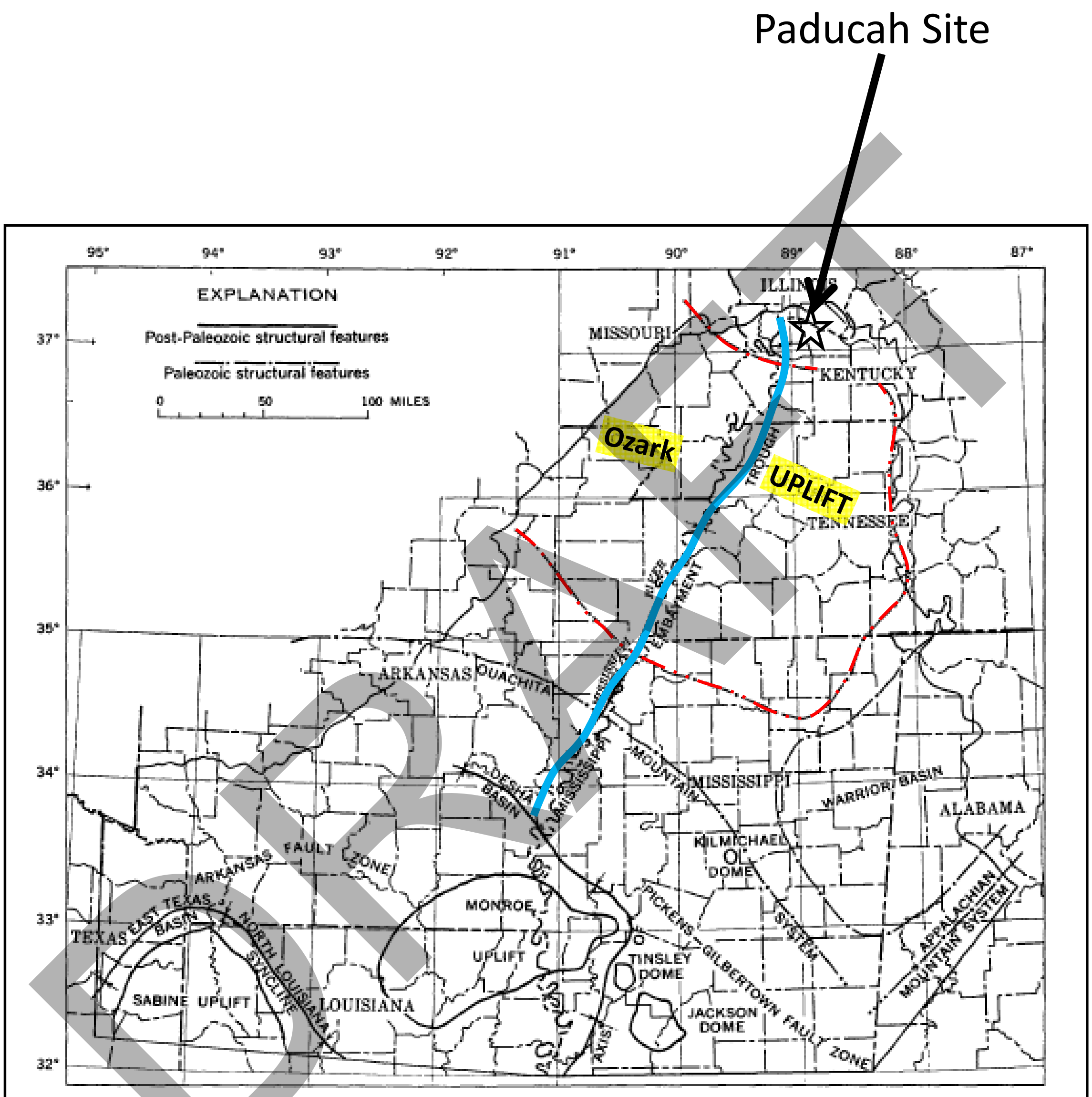
Cretaceous Contour Map



U.S.G.S. Professional Paper 448-B

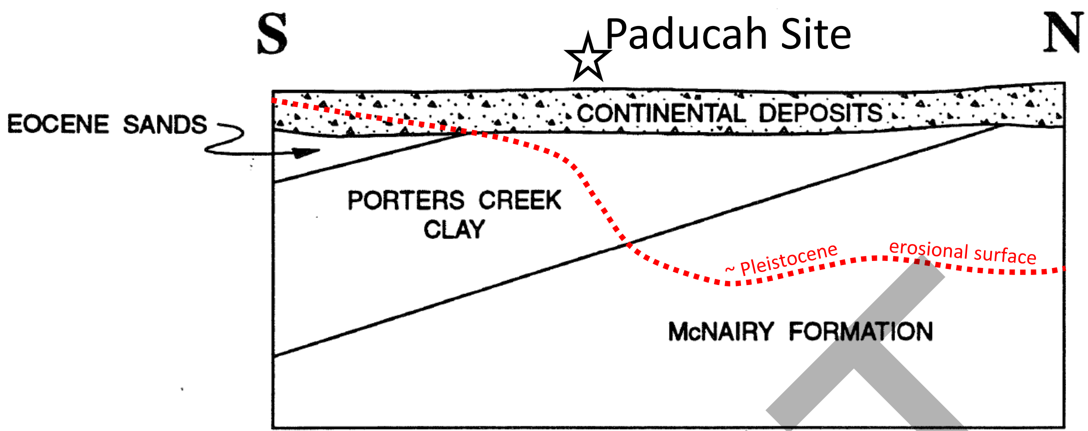


Mississippi Embayment	U.S. DEPARTMENT OF ENERGY DOE PORTSMOUTH/PADUCAH PROJECT OFFICE PADUCAH GASEOUS DIFFUSION PLANT



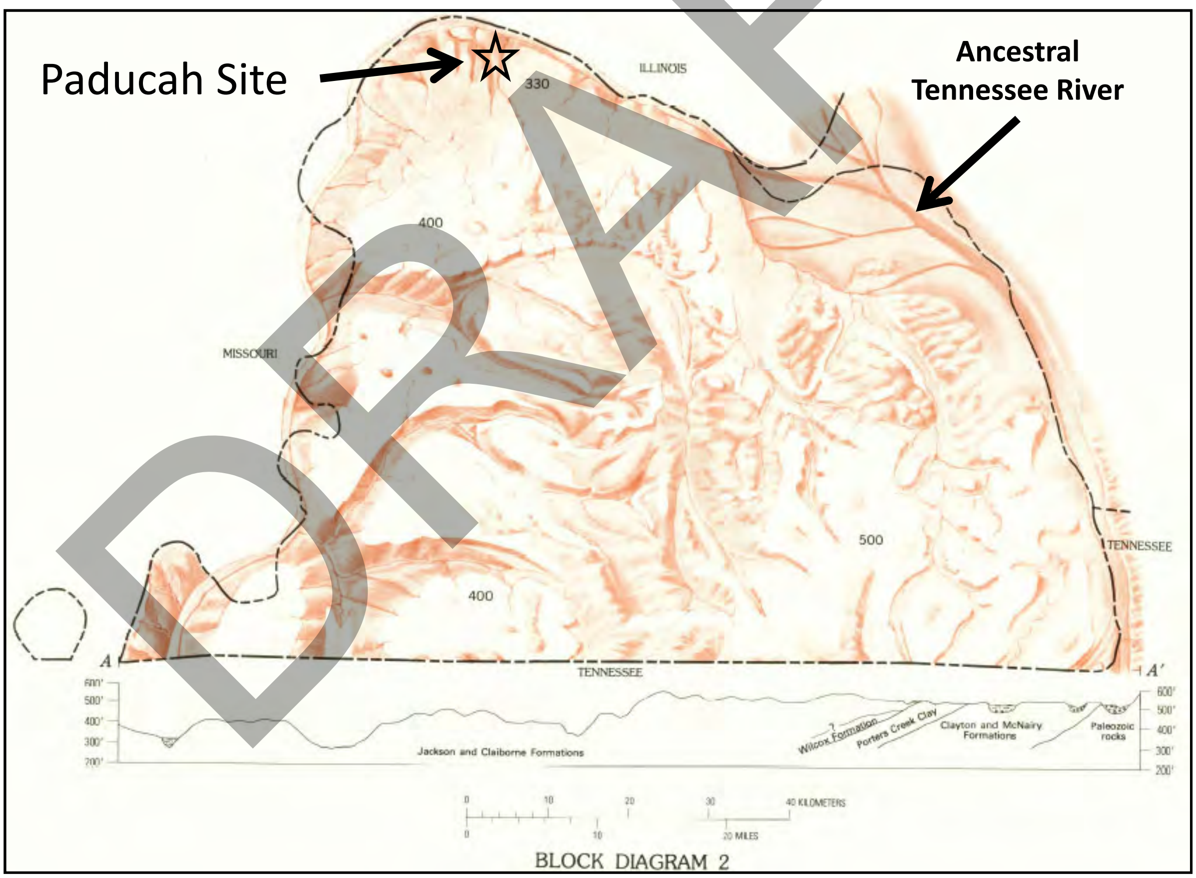
U.S.G.S. Professional Paper 448-B

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



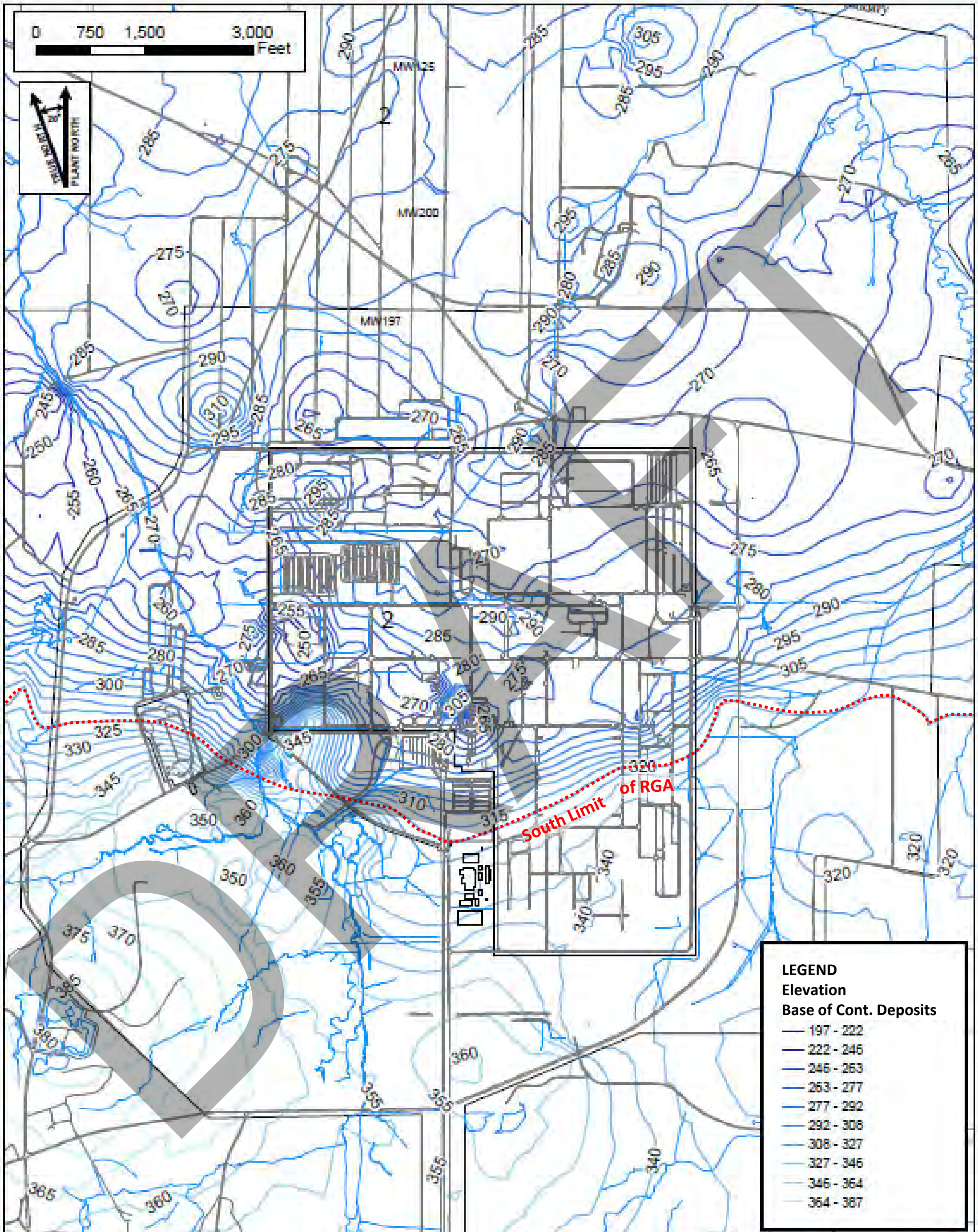
(A)

During the Miocene (?)-Pliocene, alluvial fan deposits blanketed the site.



Initial Deposition of Jackson Purchase Alluvial Fan
U.S.G.S. Map I-1217

Generalized Depositional Sequence for the Continental Deposits Miocene(?)-Pliocene	U.S. DEPARTMENT OF ENERGY DOE PORTSMOUTH/PADUCAH PROJECT OFFICE PADUCAH GASEOUS DIFFUSION PLANT



Base of the Continental Deposits

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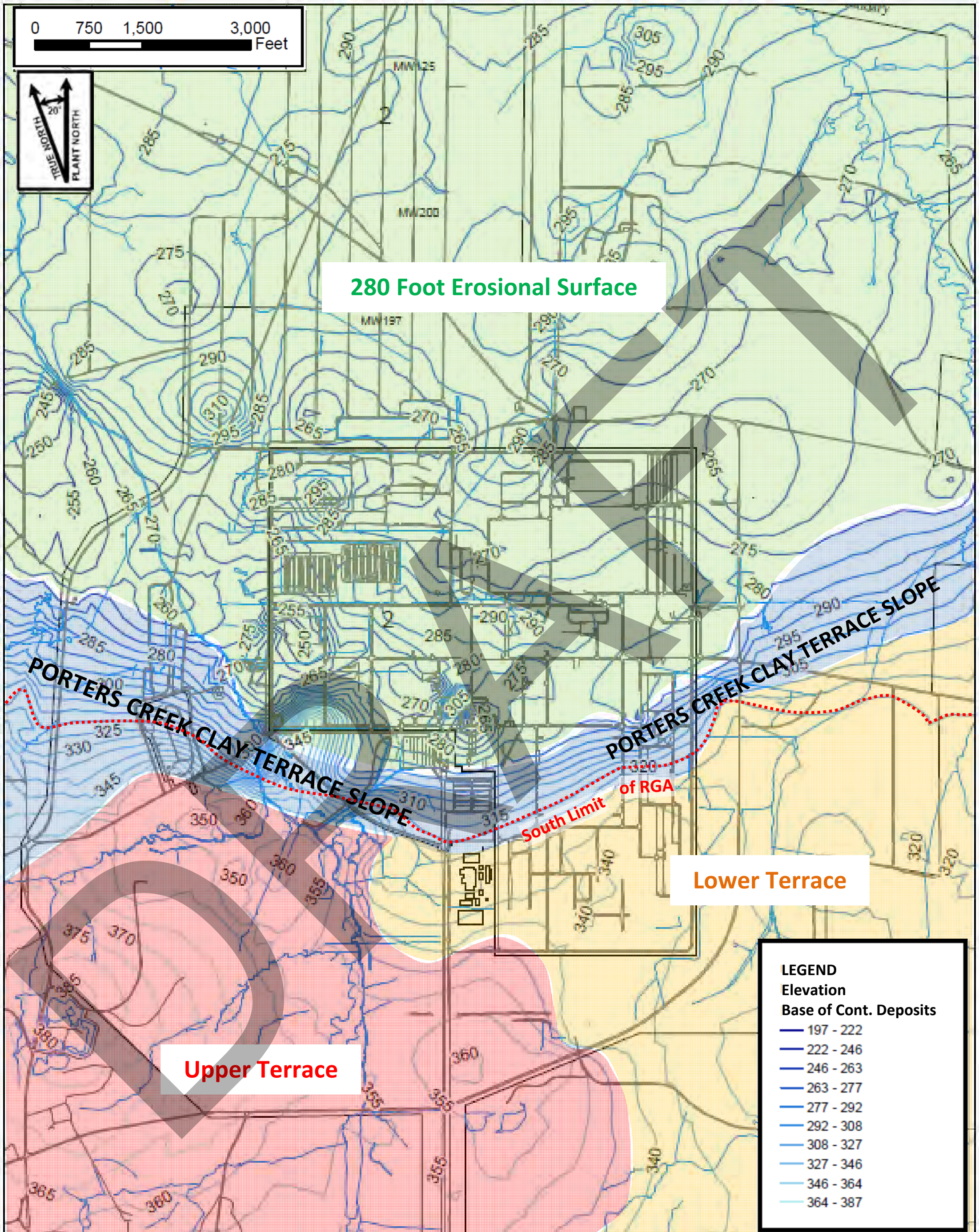
PADUCAH GASEOUS DIFFUSION PLANT

FIGURE No. G:\GIS\ARCVIEWS\PROJECTS\FFA SemiAnnual\20181001_NEP_RGA.mxd
DATE 10/1/2018



Erosional Surfaces Beneath Continental Deposits

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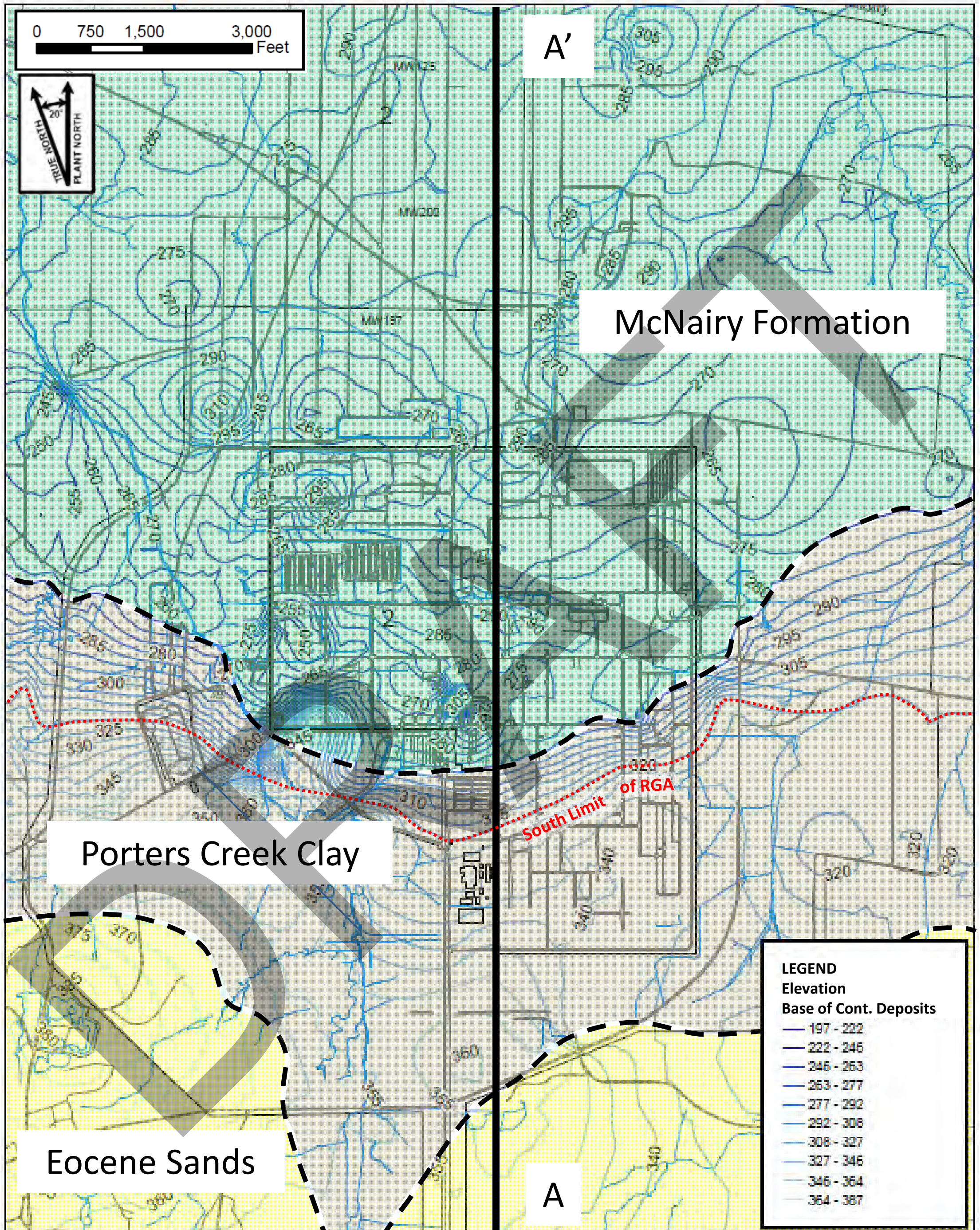
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT



Geologic Units Subcroping Beneath Continental Deposits

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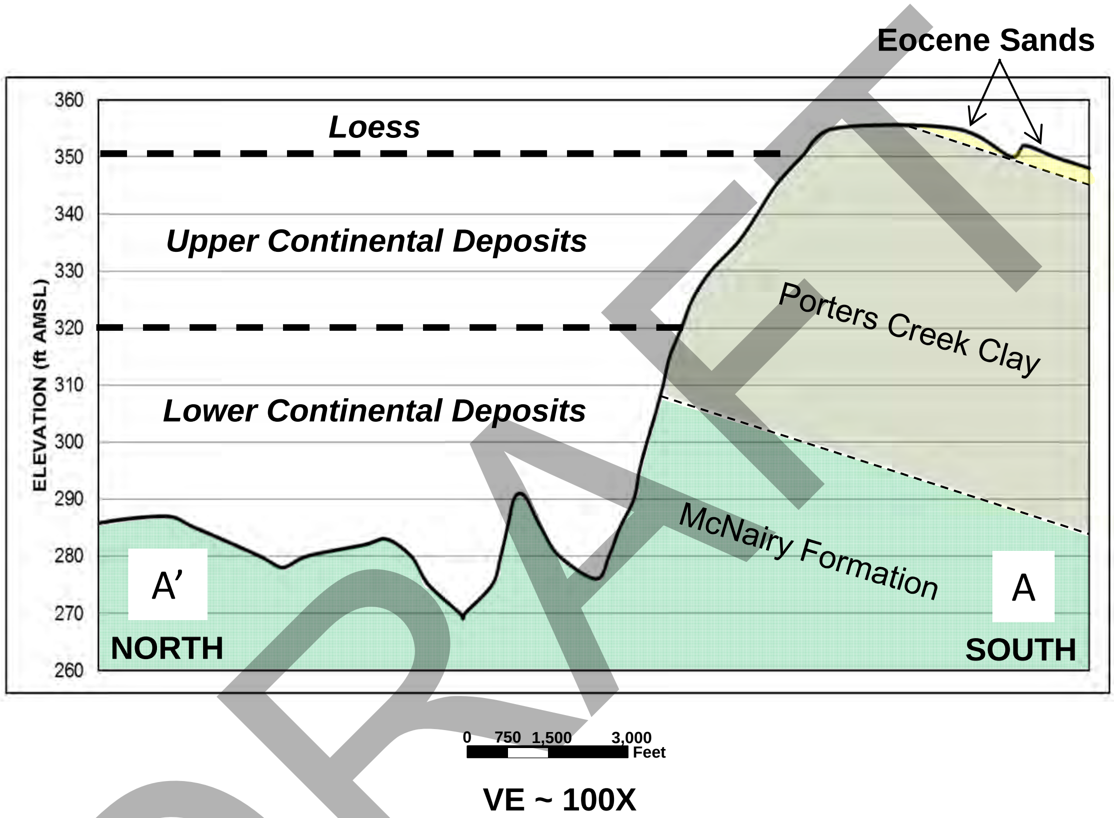
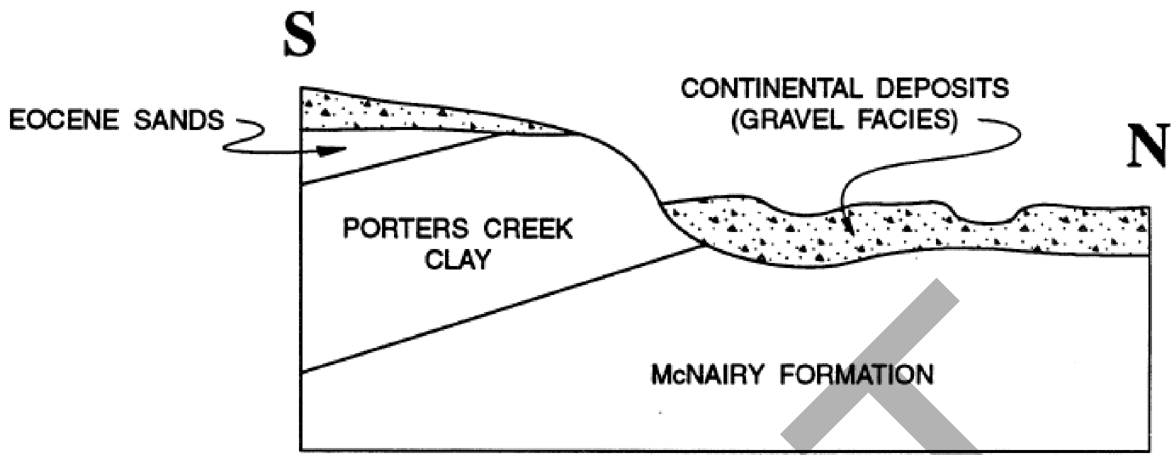
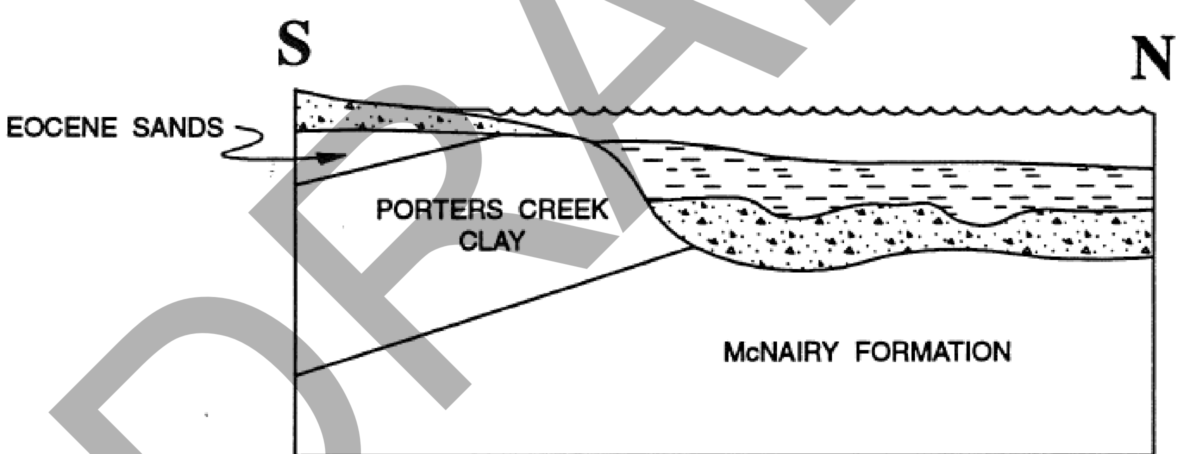


Conceptual Base of Continental Deposits Elevation/Subcrop Cross Section	U.S. DEPARTMENT OF ENERGY DOE PORTSMOUTH/PADUCAH PROJECT OFFICE PADUCAH GASEOUS DIFFUSION PLANT



(B)

During the Pleistocene, the ancestral Tennessee River downcut into alluvial fan and older sediments and redeposited gravel on an erosional surface of approximately 280 ft amsl.

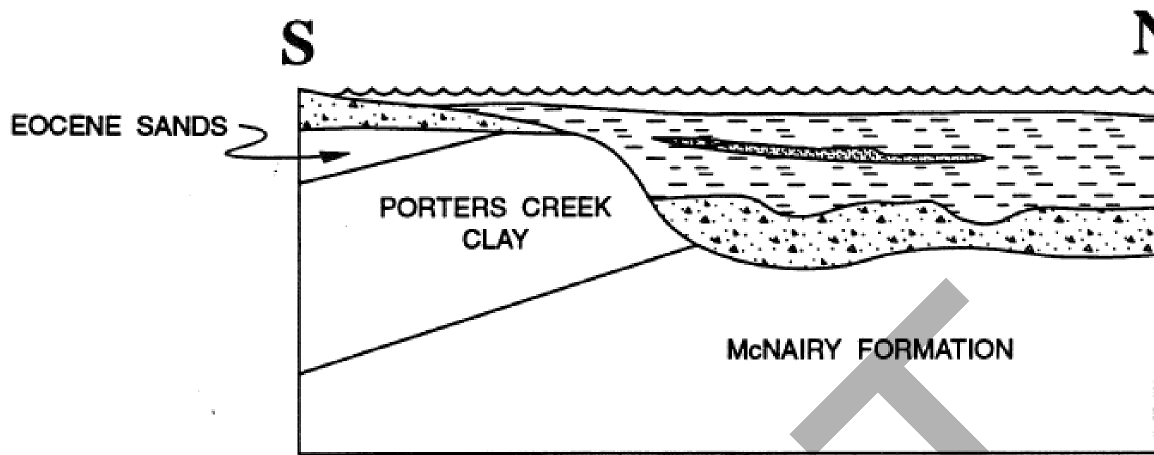


(C)

Later, during the Woodfordian glacial substage, a lake occupied the valley as the ancestral Tennessee River was dammed by glacial outwash.

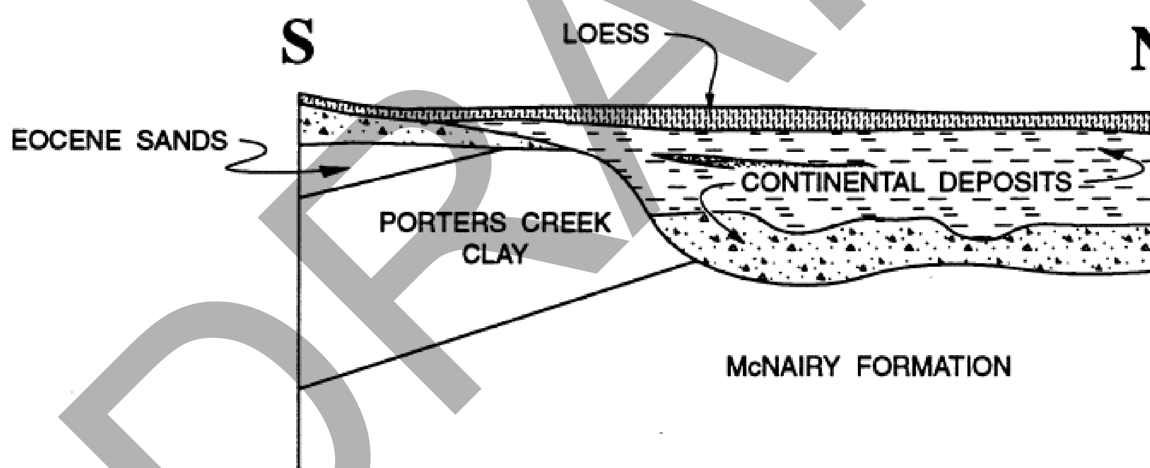
Report of the Paducah Gaseous Diffusion Plant, Groundwater Investigation Phase III, KY/E-150

Generalized Depositional Sequence for the Continental Deposits Pleistocene	U.S. DEPARTMENT OF ENERGY DOE PORTSMOUTH/PADUCAH PROJECT OFFICE PADUCAH GASEOUS DIFFUSION PLANT



(D)

As lake levels reached a maximum, an extensive lake plain, consisting primarily of fine-grained sediments, attained an elevation of 360 to 375 ft amsl.



(E)

A blanket of loess eventually covered the site.

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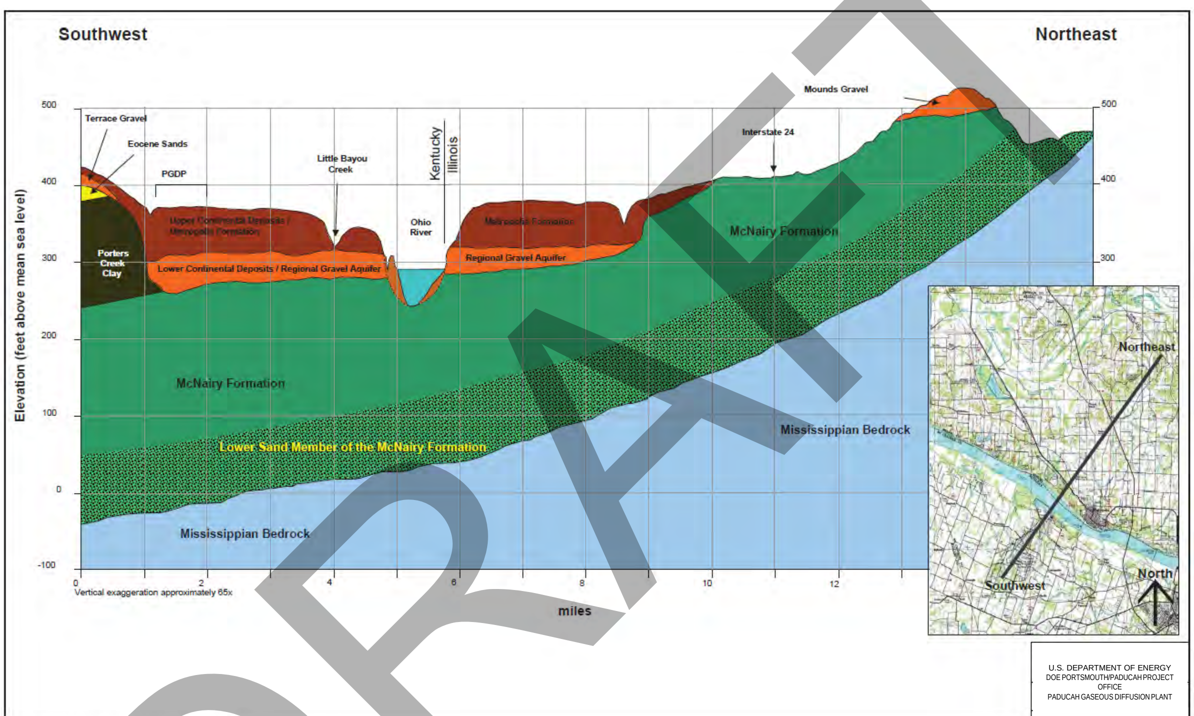
Generalized Depositional Sequence for the Continental Deposits Late Pleistocene	U.S. DEPARTMENT OF ENERGY DOE PORTSMOUTH/PADUCAH PROJECT OFFICE PADUCAH GASEOUS DIFFUSION PLANT



Source: Adapted from Paducah Remediation Services, 2009; Figure 1
Note: Regional Gravel Aquifer thickness is variable. See Figure 3.4.

Geologic Cross Section

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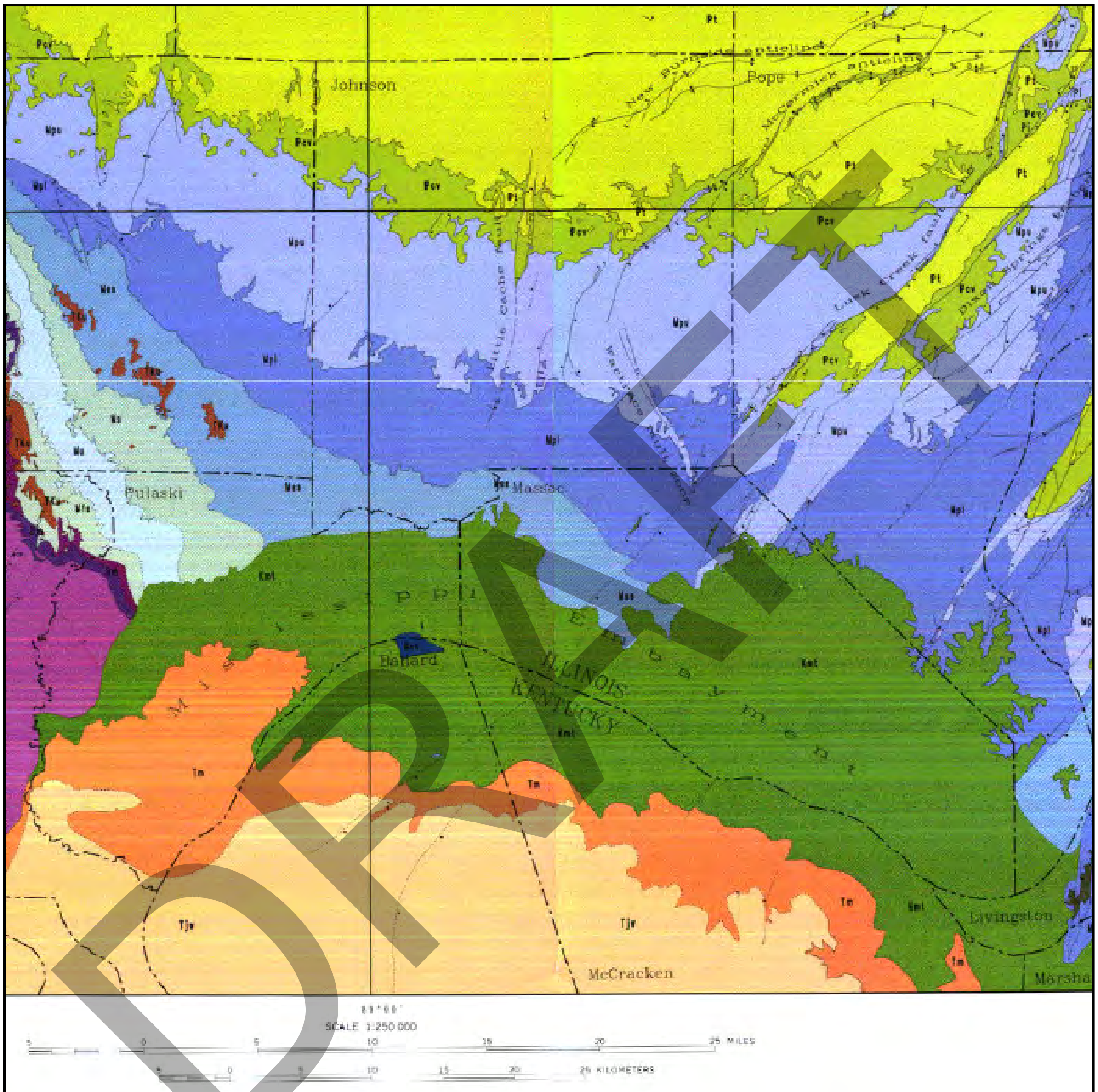

U.S.G.S. Bulletin 2150-B

Bedrock Geology of the Paducah 1°x2° CUSMAP Quadrangle, Illinois, Indiana, Kentucky, and Missouri

Proximity of Fluorspar Area Fault Complex

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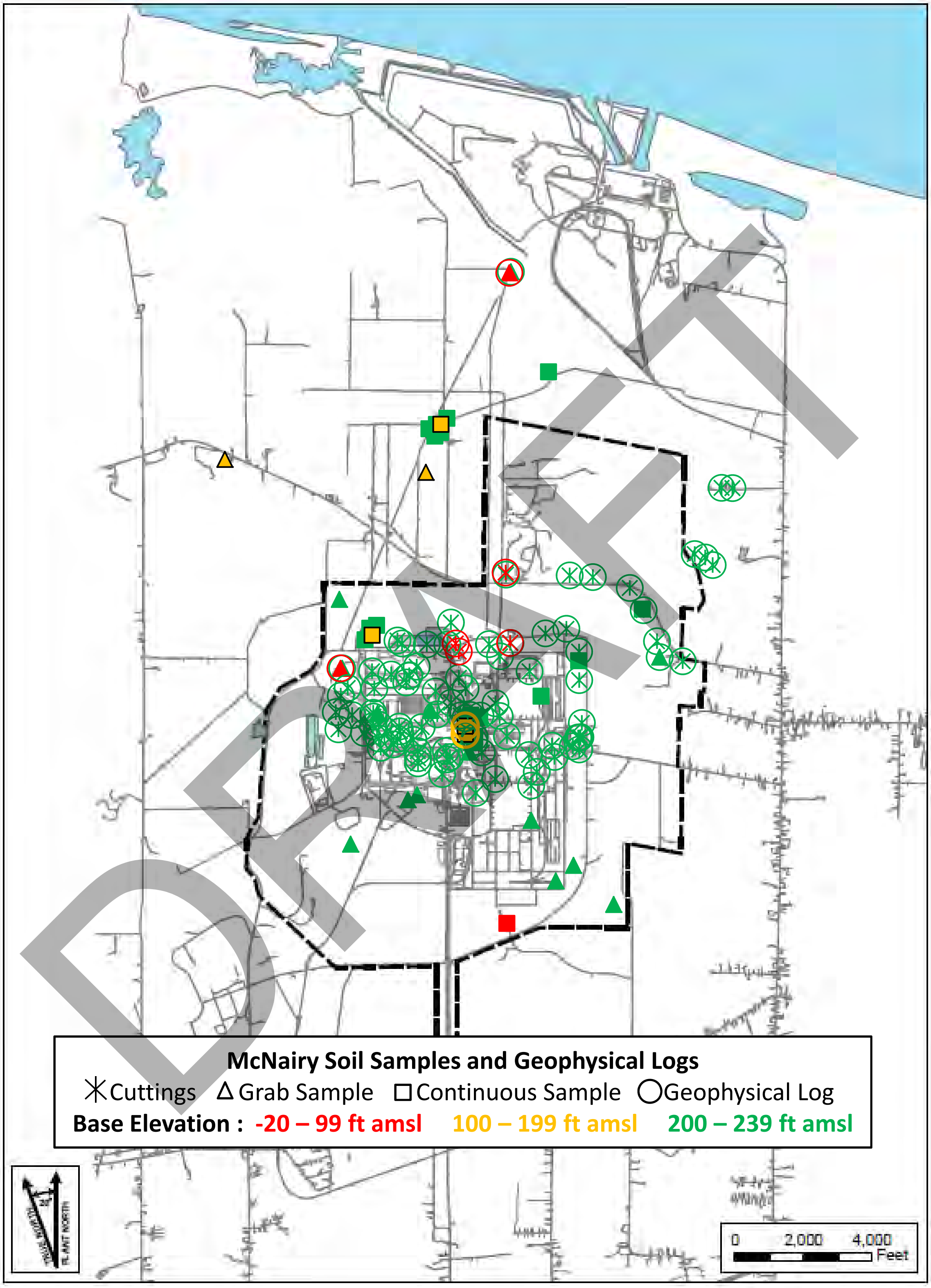

McNairy Soil Borings (bottom at 239 ft amsl or less)

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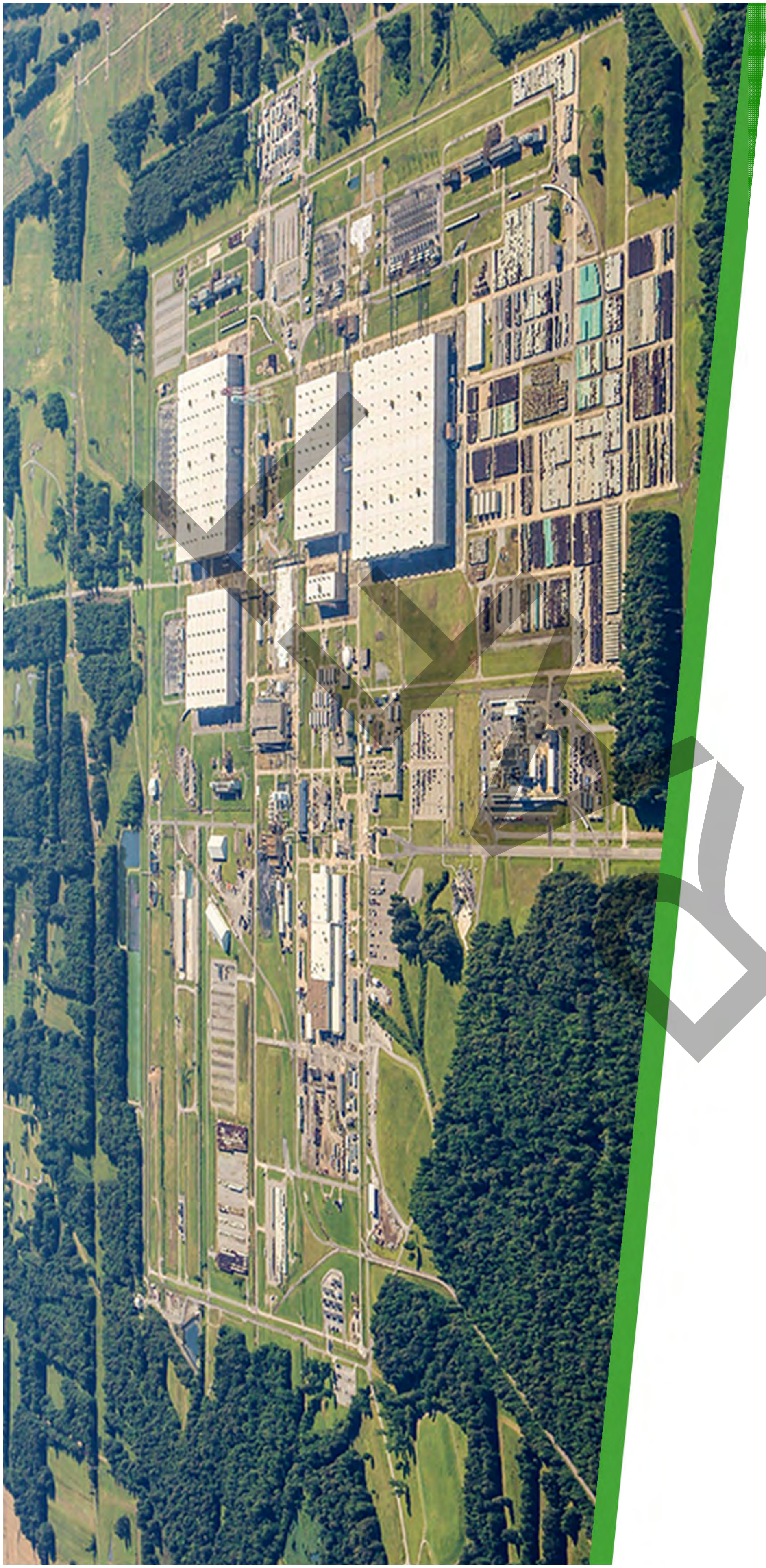
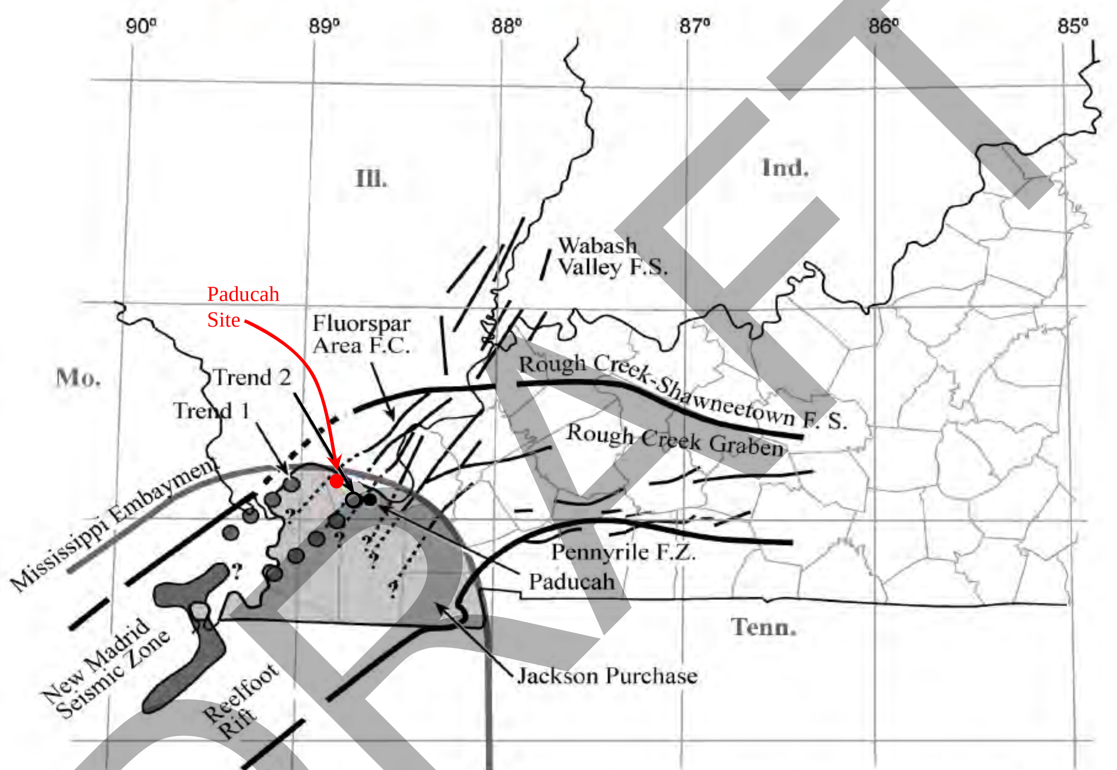
Attachment 2



Regional Seismic Interpretations

Regional Geology and Seismicity



Major structural features in the central Mississippi Valley (modified from Kolata and Nelson, 1997, and Woolery and Street, 2002). The lines of shaded circles represent the locations of Wheeler's (1997) trends 1 and 2 seismicity in relation to the New Madrid seismic zone and the study site (red circle). The Jackson Purchase Region of western Kentucky is also identified in the light shaded area.

From Woolery, E.W., Baldwin, J., Kelson, K., Hampson, S., and Givler, R., 2008

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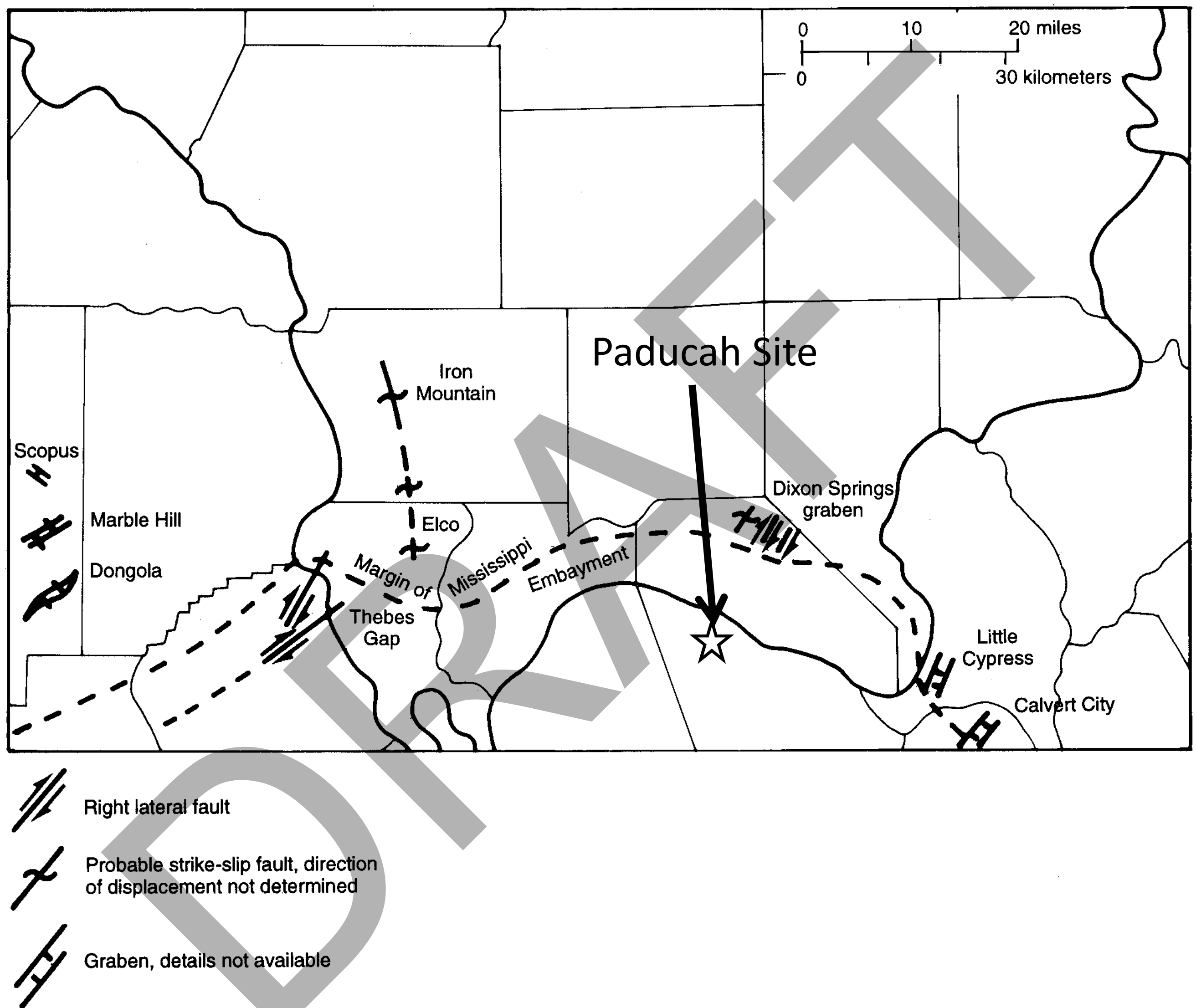

Faults that displace Cretaceous and younger strata from
***Bedrock Geology of the Paducah 1° x 2° CUSMAP Quadrangle*, U.S.G.S. Bulletin 2150-B**

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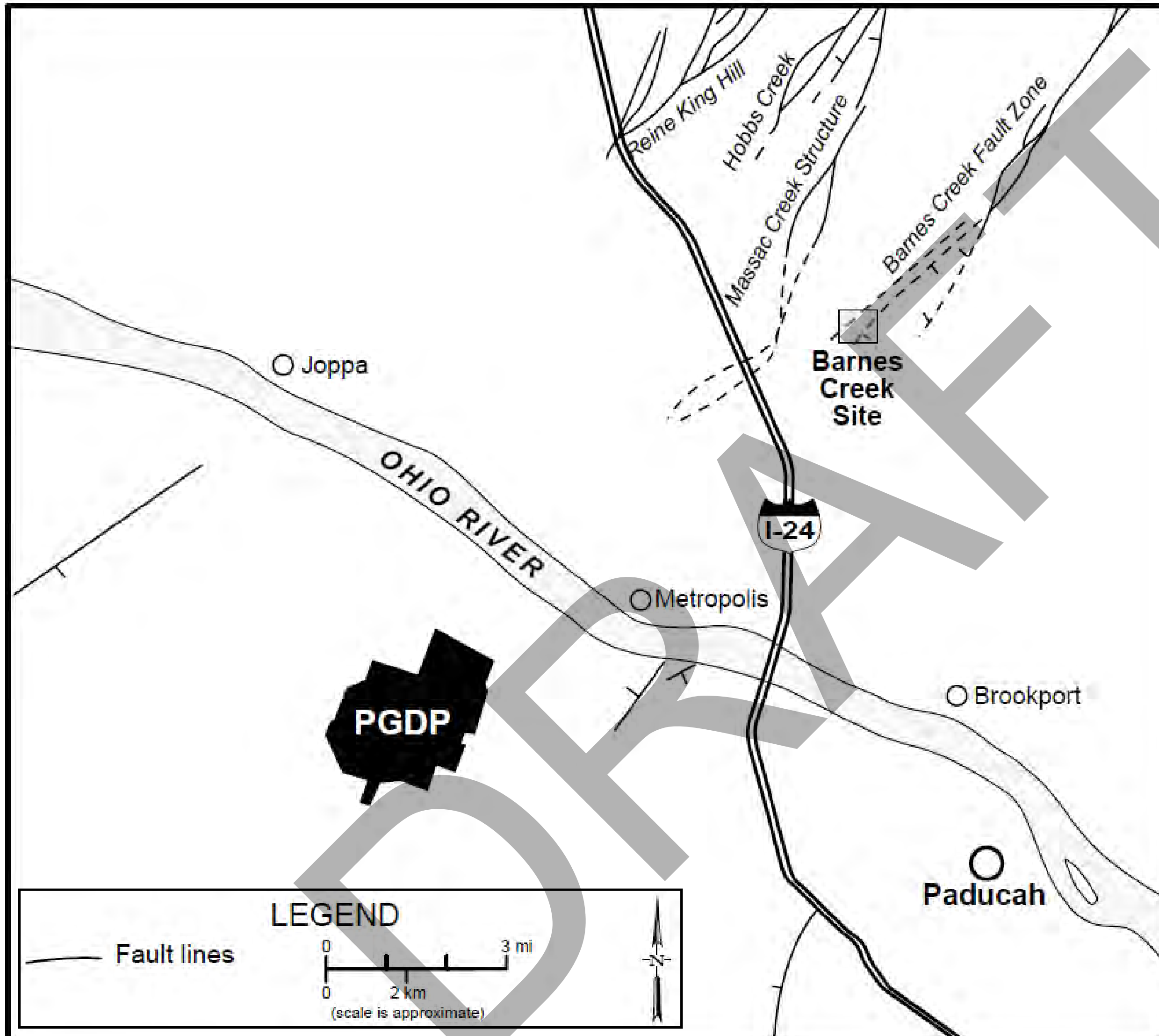
Post-Cretaceous Tectonism

The Paducah quadrangle lies immediately north of the most active earthquake region of the North American Midcontinent – the New Madrid seismic zone.

- The New Madrid zone is an ancient zone of weakness, the Reelfoot rift.
- Reactivated repeatedly since Cambrian time.

The present-day stress regime of the Paducah area is one of horizontal compression.

- Principal stress axis oriented East-West to 65° East.
- Cretaceous and younger faulting of the Paducah quadrangle is consistent with the contemporary stress regime and with active faults in the New Madrid area.



Barnes Creek Study (Site 3A Investigation)

- DPT and GPR transects of terrace
- Creek bank exposures (2,600 ft)
  - Clay dikes, faults, grabens, and joints
  - Faulting in McNairy Fm. through Upper Metropolis (Holocene)
  - Max displacement of 1 ft in a single event in the lower Metropolis

Closest mapped faults to the Paducah Site

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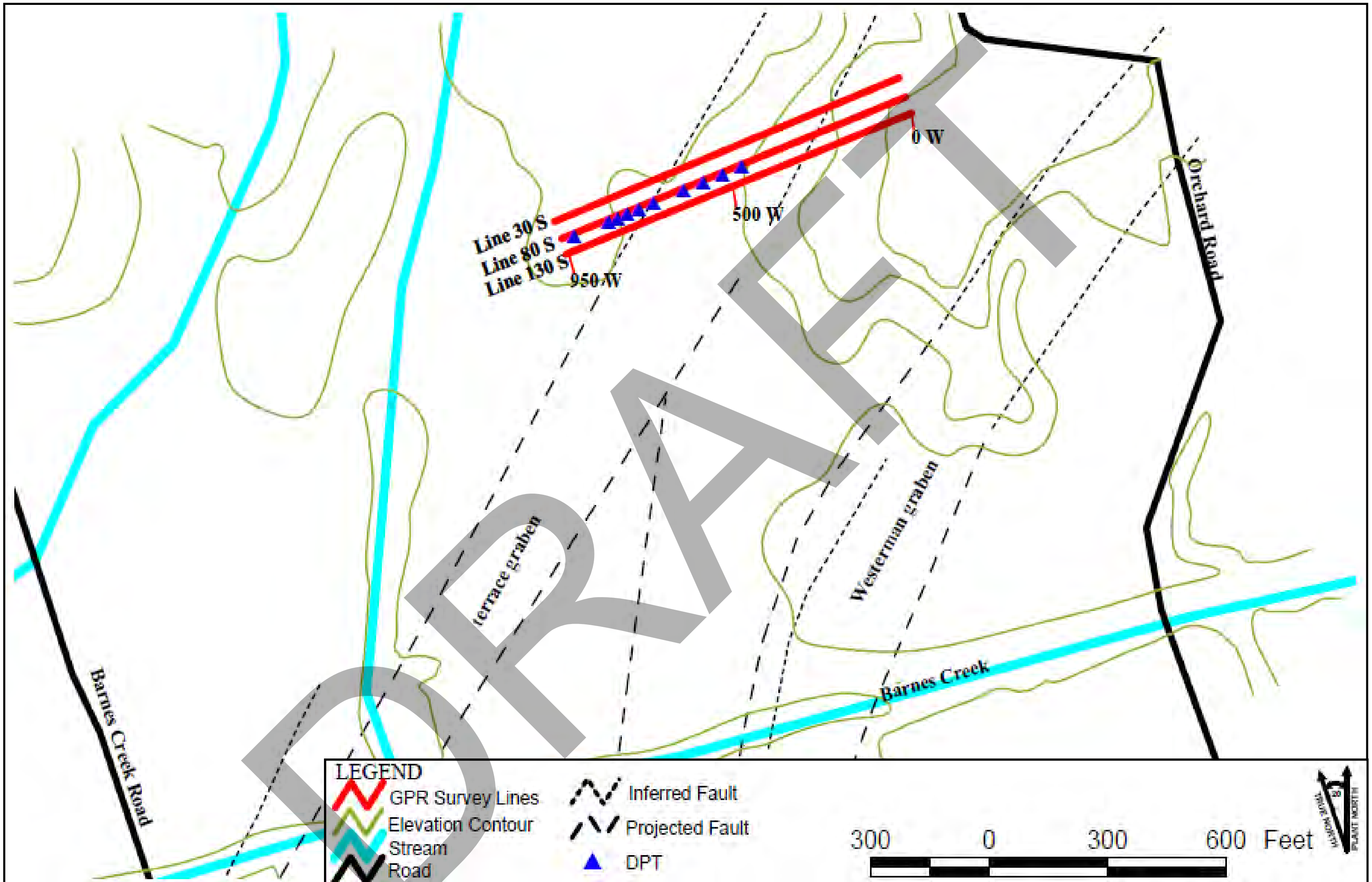

Ground Penetrating Radar Survey Lines and DPT Locations at Barnes Creek Site

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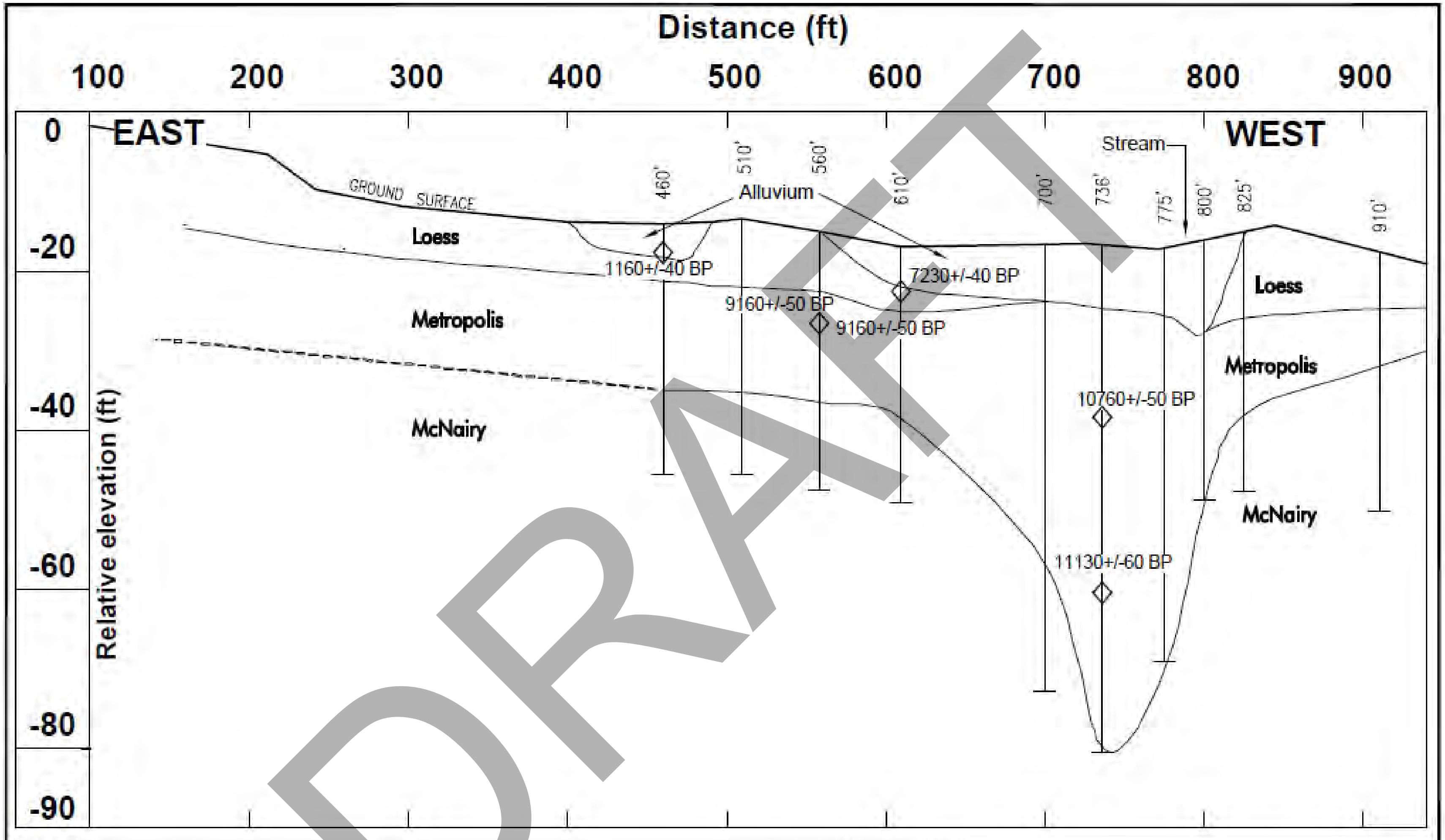

East-west DPT cross section of the terrace graben area.

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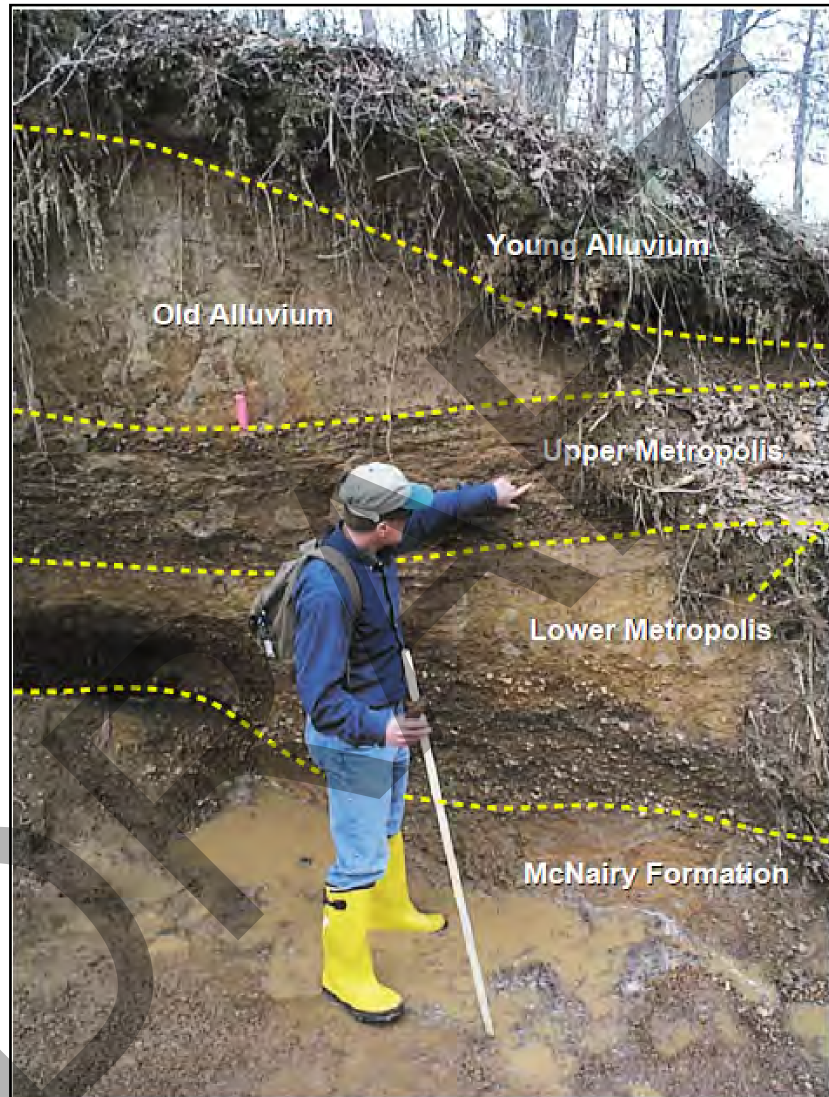

Stratigraphic section at Barnes Creek

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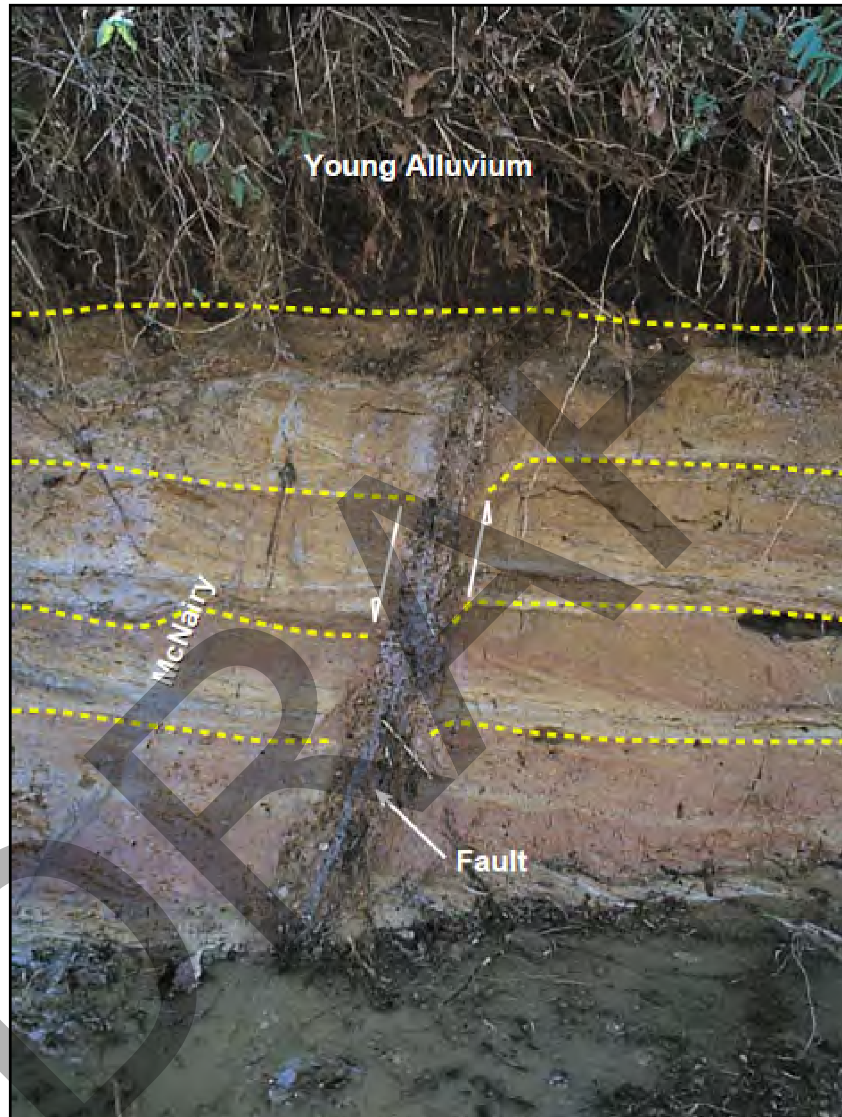

Fault at Barnes Creek.

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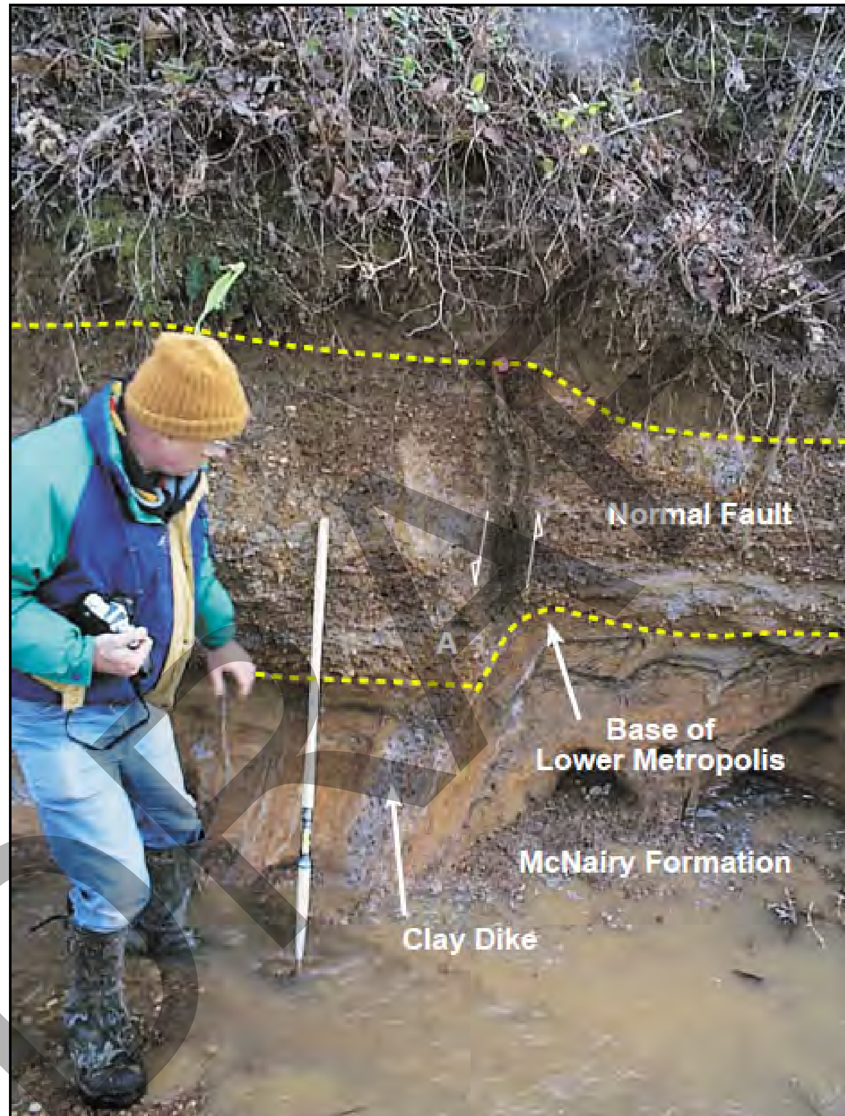

Normal faulting at Barnes Creek

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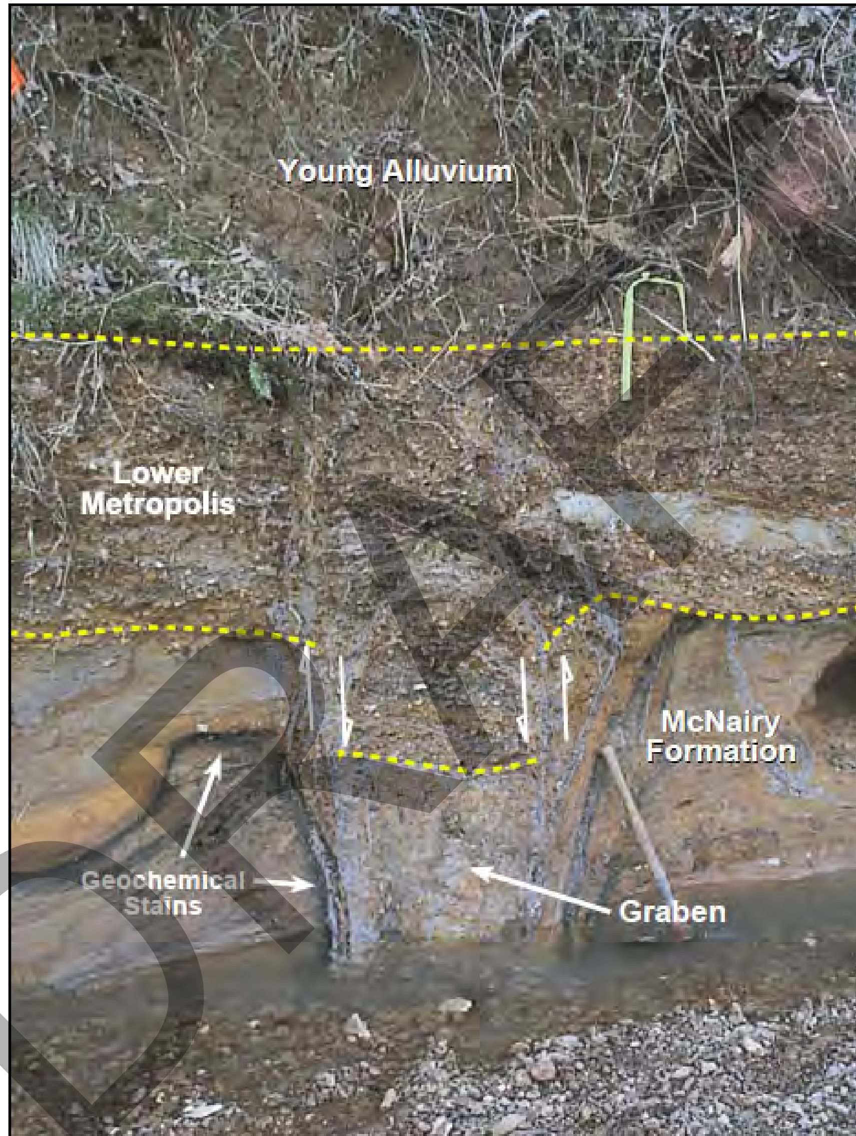

Example of graben at Barnes Creek.

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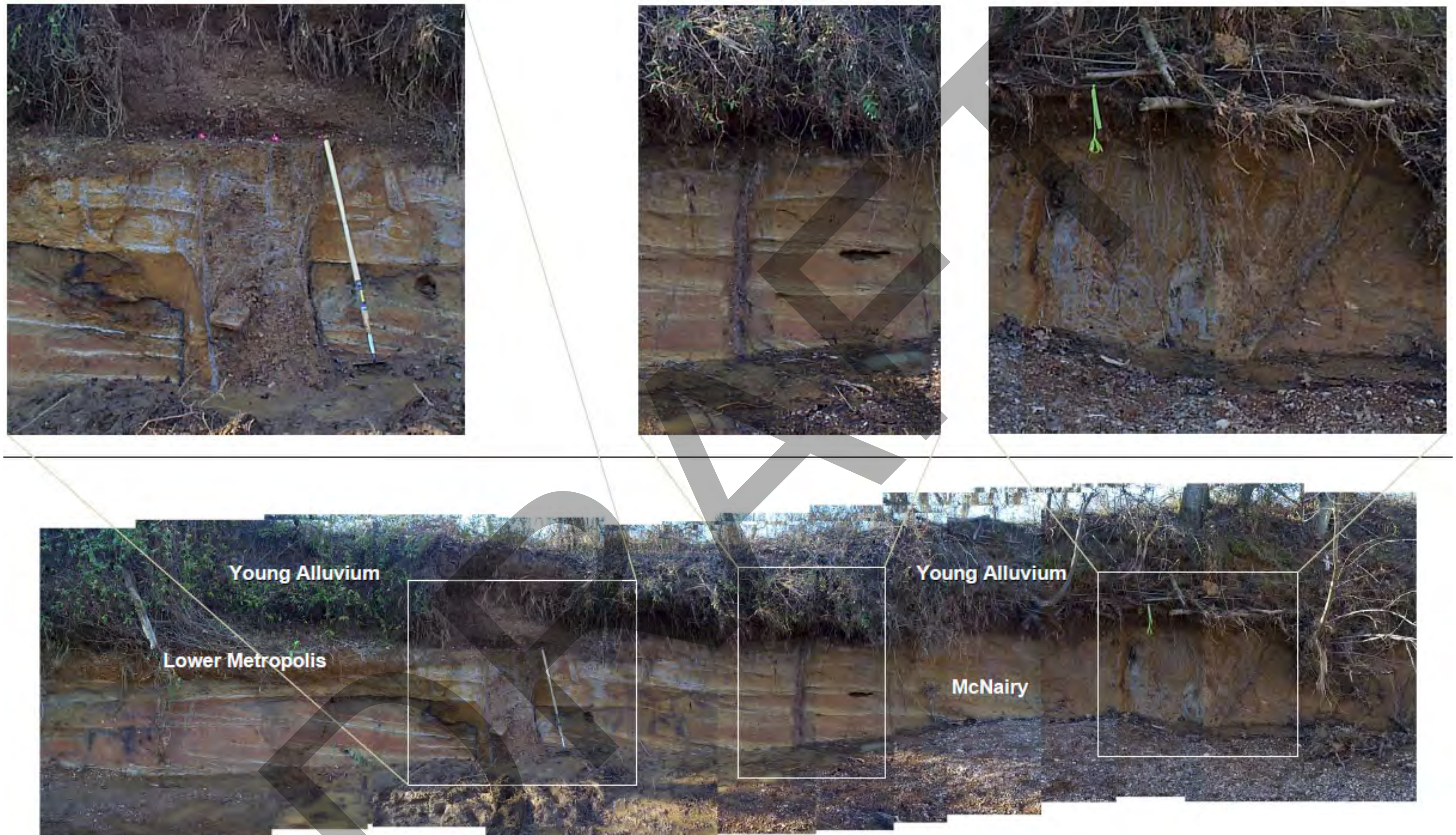

Faulting and stratigraphy at Barnes Creek

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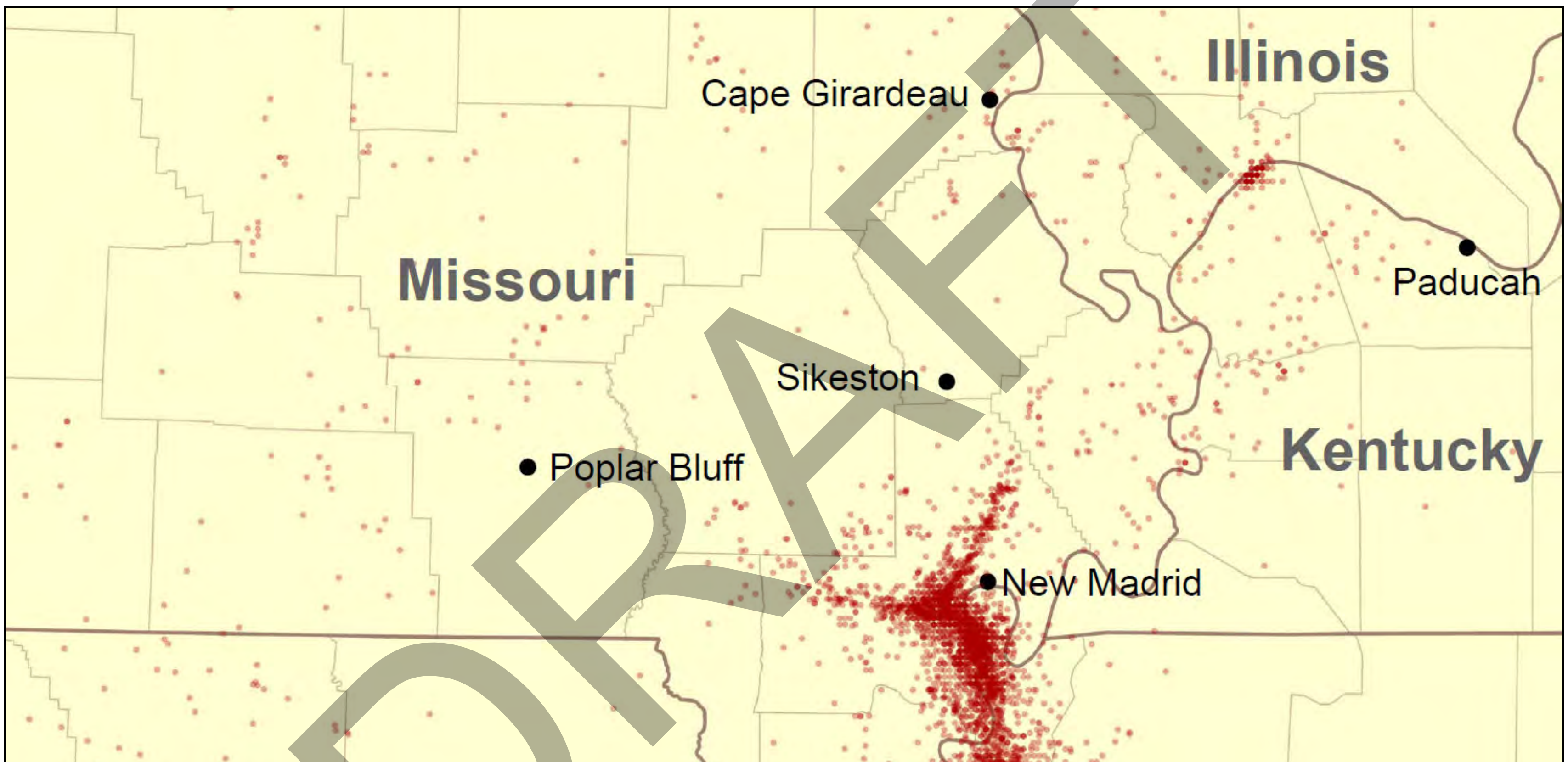

New Madrid Region Epicenters 1974-2011

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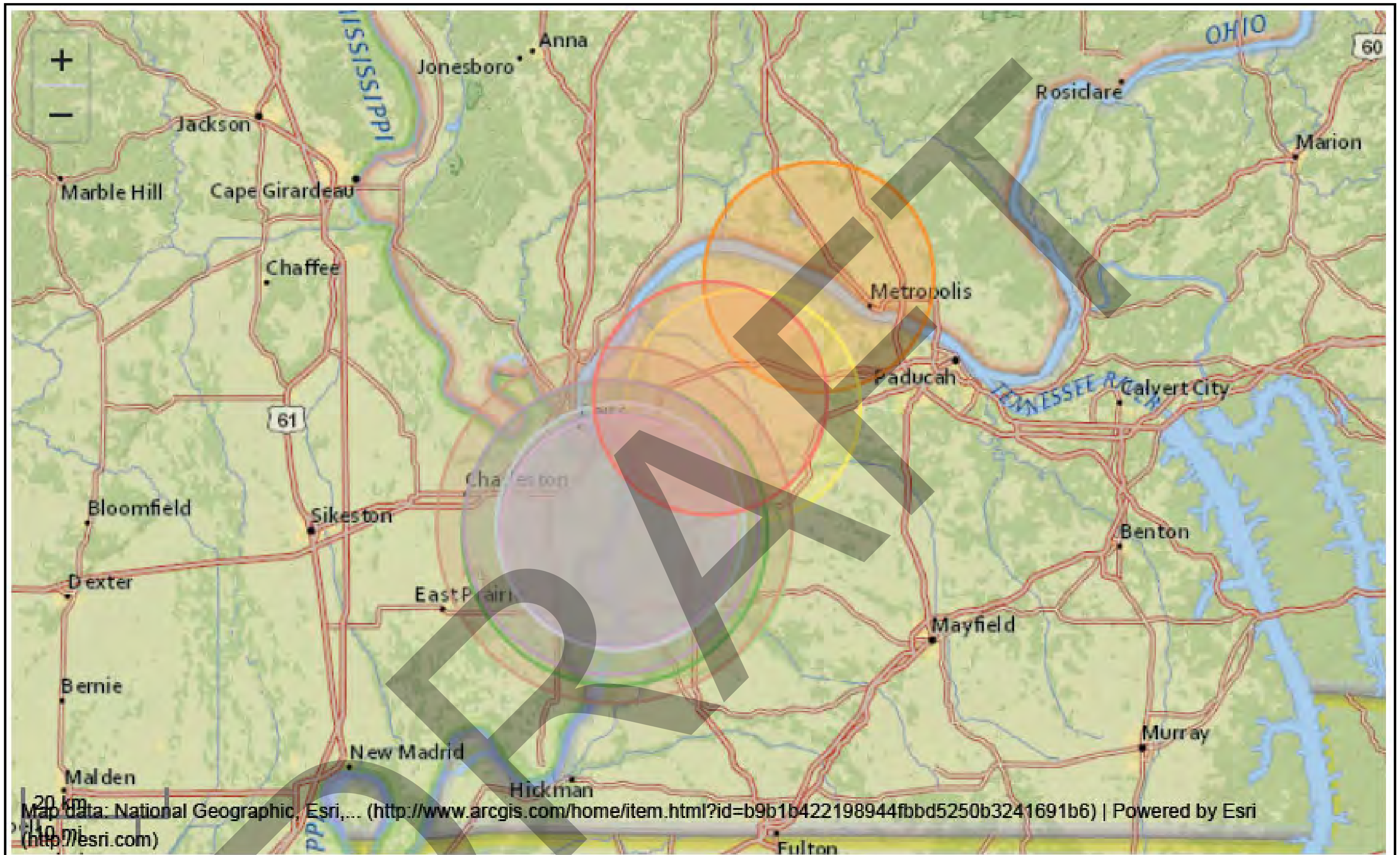

Western Kentucky has had: *(M1.5 or greater)*

0 earthquakes in the past 24 hours
2 earthquakes in the past 365 days

West Kentucky Epicenters 2017 – 2019 (April 7, 2019).

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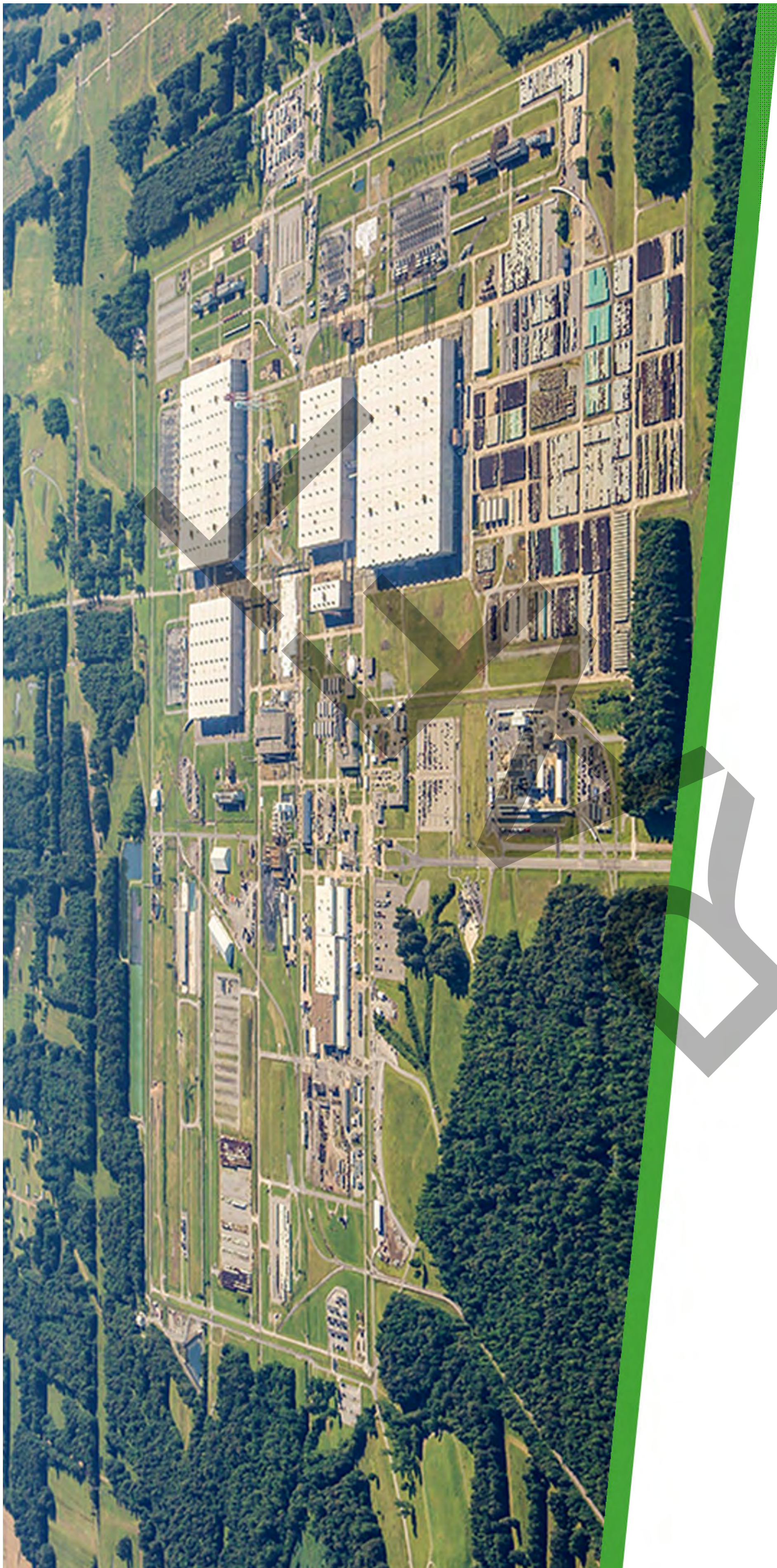

Paducah Site Seismic Investigations

The characterization of the seismicity of the Paducah area has been of significant interest to design of structures at the Paducah Site.

December 1982, *Recommended Seismic Hazard Levels for the Oak Ridge, Tennessee; Paducah, Kentucky; Fernald, Ohio; and Portsmouth, Ohio, Department of Energy Reservations*, K/BD-1025/R1

November 1989, *Seismic Issues at the Paducah Gaseous Diffusion Plant, Report of the Seismic Expert Workshop Held at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, March 13-15, 1989*, KY/H-111

October 1990, *Overview of Seismic Considerations at the Paducah Gaseous Diffusion Plant*, K/GDP/SAR-3

January 1993, *Probabilistic Seismic Hazard Analysis for the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, K/GDP/SAR/SUB-1/R1

January 1993, *Seismic Hazard Evaluation for the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, K/GDP/SAR/SUB-1/R1

August 1993, *Site-Specific Earthquake Response Analysis for Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, Waterways Experiment Station, Vicksburg, MS, Miscellaneous Paper GL-93-14

August 1994, *Technical Application for Contained Solid Waste Landfill, 1995, Permit Number 073-00045NWLC1*,

December 1995, *Seismic Hazard Criteria for the Oak Ridge, Tennessee; Paducah , Kentucky; and Portsmouth, Ohio, U.S. Department of Energy Reservations*, ES/CNPE-95/2.

April 1996, *Reassessment of Liquefaction Potential and Estimation of Earthquake-Induced Settlements at Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, Waterways Experiment Station, Vicksburg, MS, GL-96-6.

April 1999, *Updated Probabilistic Seismic Hazard Analysis for the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, Final Report (Revision 3), Purchase Order No. 495153.

July 2000, *Initial Assessment of Consideration of On-Site Disposal of Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) Waste as a Potential Disposal Option at the Paducah Gaseous Diffusion Plant*, DOE/OR/07-1893&D1.

February 2001, *U.S. Department of Energy Paducah Gaseous Diffusion Plant, Seismic Design Criteria Assessment for the C-746-U Contained Landfill, A White Paper*.

March 2002, *Paducah Gaseous Diffusion Plant: Re-evaluation of Site-specific Soil Column Effects on Ground Motion*, BJC/PAD-356.

2002 *Seismic Investigation Report for Siting of a Potential on-site CERCLA Waste Disposal Facility at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*. DOE/OR/07-2038&D1.

June 2007, *Final Report: Seismic Hazard Assessment of the Paducah Gaseous Diffusion Plant*, Wang, Z. and Woolery, E.W., UK/KRCEE Doc #: P11.6 2007.

June 2009, *DOE Headquarters Independent Review Team Report on Paducah Gaseous Diffusion Plant Seismic Characterization*

Paducah Site Seismic Response Investigations/Reports

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Previous seismic design studies and recent investigations provide data to asses the potential for fault rupture at the Paducah Site.

November 1990, *Recommended Soil Columns for Use in Amplification Studies, Paducah Gaseous Diffusion Plant, Paducah, Kentucky, ERCE File No. B672*

February 1991, *Final Data Package, Geophysical Study of Subsurface Conditions in the Vicinity of the Paducah Gaseous Diffusion Plant*, ASG/U-101

April 1991, *Shallow High-Resolution Seismic Reflection Studies Near the Paducah Gaseous Diffusion Plant*, KY/E-104

September 1991, *Assessment and Interpretation of Cross- and Down-Hole Seismograms at the Paducah Gaseous Diffusion Plant*, K/GDP/SAR-9

May 1994, *Shallow Seismic Reflection Feasibility Study at the Drop Test Facility, Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, Kansas Geological Survey, Open-file Report #94-22

October 2003. *Technical Memorandum for the C-746-U Landfill Fault Study at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-2097&D2

March 2004. *Seismic Investigation Report for Siting of a Potential On-Site CERCLA Waste Disposal Facility at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-2038&D2.

July 2006, *Investigation of Holocene Faulting at Proposed C-746-Landfill Expansion*, UK/KRCEE Doc #: P17.6 2006.

June 2009, *DOE Headquarters Independent Review Team Report on Paducah Gaseous Diffusion Plant Seismic Characterization*

Several investigations by the Kentucky Geologic Survey and University of Kentucky have assessed faulting at the Paducah Site.

Harris, J.B., Street, R.L., Kiefer, J.D., Allen, D.L., and Wang, Z.M., 1994. *Modeling Site Response in the Paducah, Kentucky Area*, Earthquake Spectra. Vol. 10, No. 3.

Drahovzal, J.A. and Hendricks, R.T. 1996. *Geologic Features Relevant to Ground-Water Flow in the Vicinity of the Paducah Gaseous Diffusion Plant*, Open File Report OF-97-02, Kentucky Geological Survey, November 27 (update on April 30, 1997).

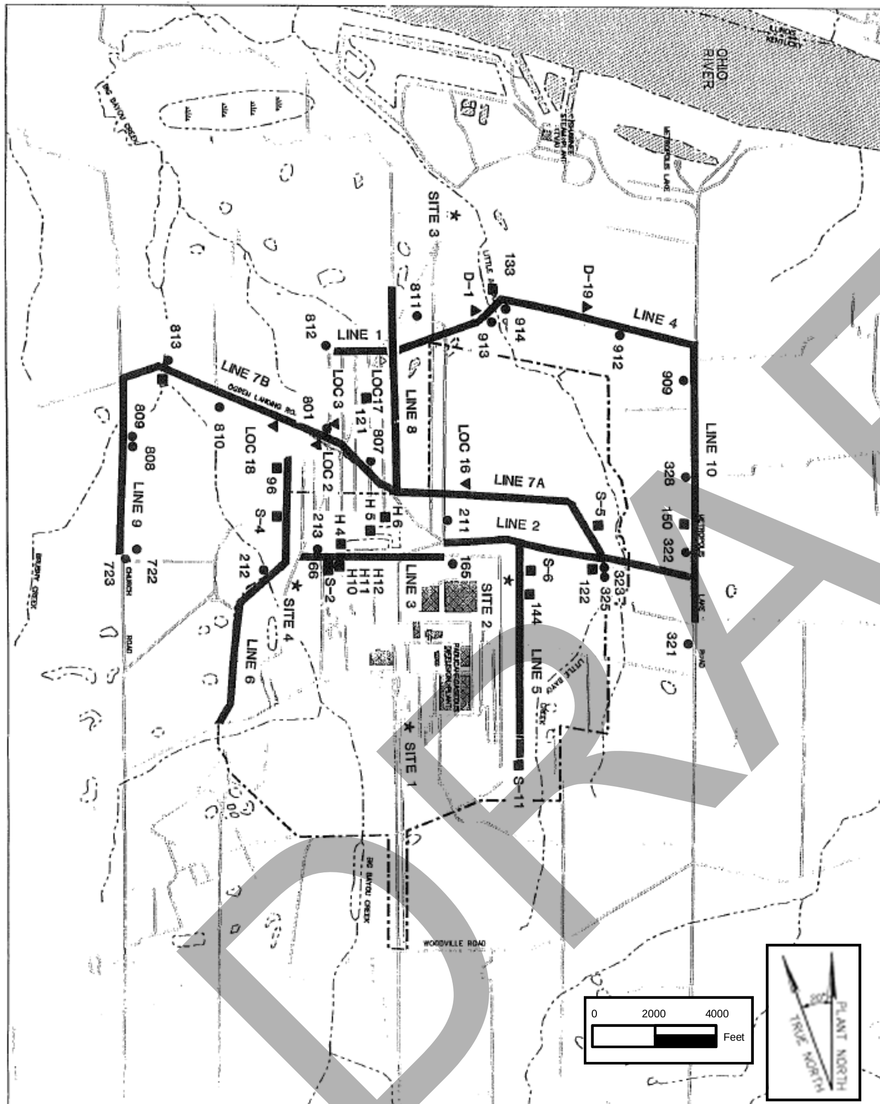
Street, R., and Langston, C. 1998. *Acquisition of SH-Wave Seismic Reflection and Refraction Data in the Area of the Northeastward Trending Contaminant Plume at the PGDP*, final report, Department of Geological Sciences, University of Kentucky, July 31.

Baldwin, J., Kelson, K, Givler, R., Sundermann, S., Woolery, E. and Hampson, S., 2007. *Field Investigation of Holocene Faulting, Proposed C-746-U Landfill Expansion, Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, KRCEE-PGDP Technical Symposium, October 30.

Blits, C.A., Woolery, E.W., Macpherson, K.A., and Hampson, S., 2008. *Integrated Geophysical Imaging Techniques for Detecting Neotectonic Deformation in the Fluorspar Area Fault Complex of Western Kentucky*, 42nd Annual Meeting of the North Central Section of the Geological Society of America, Evansville, IN, April.

Woolery, E., Baldwin, J., Kelson, K., Hampson, S., Givler, R., and Sundermann, S., 2009. *Site-specific Fault Rupture Hazard Assessment – Fluorspar Area Fault Complex, Western Kentucky*, Seismological Research Letters, Volume 80, Number 6, November/December.

Almayahi, A. and Woolery, E., 2018. *Fault-controlled contaminant plume migration: Inferences from SH-wave reflection and electrical resistivity experiments*, Journal of Applied Geophysics 158 (2018) 57-64.



Location of Seismic Lines and Well Control Points

- Approximately 15 miles of P-wave reflection data
- 10 survey lines
- 3-fold data
- Shows configuration of the RGA and subsurface terrace features
- Imaged internal layering in RGA topographic depressions
- Topographic depressions in the RGA continue downward

DRAFT

Speece, M.A., Early T.O., Switek, J., Hanson, J.A., and Williams, R.T., 1991. Shallow High-Resolution Seismic Reflection Studies Near the Paducah Gaseous Diffusion Plant

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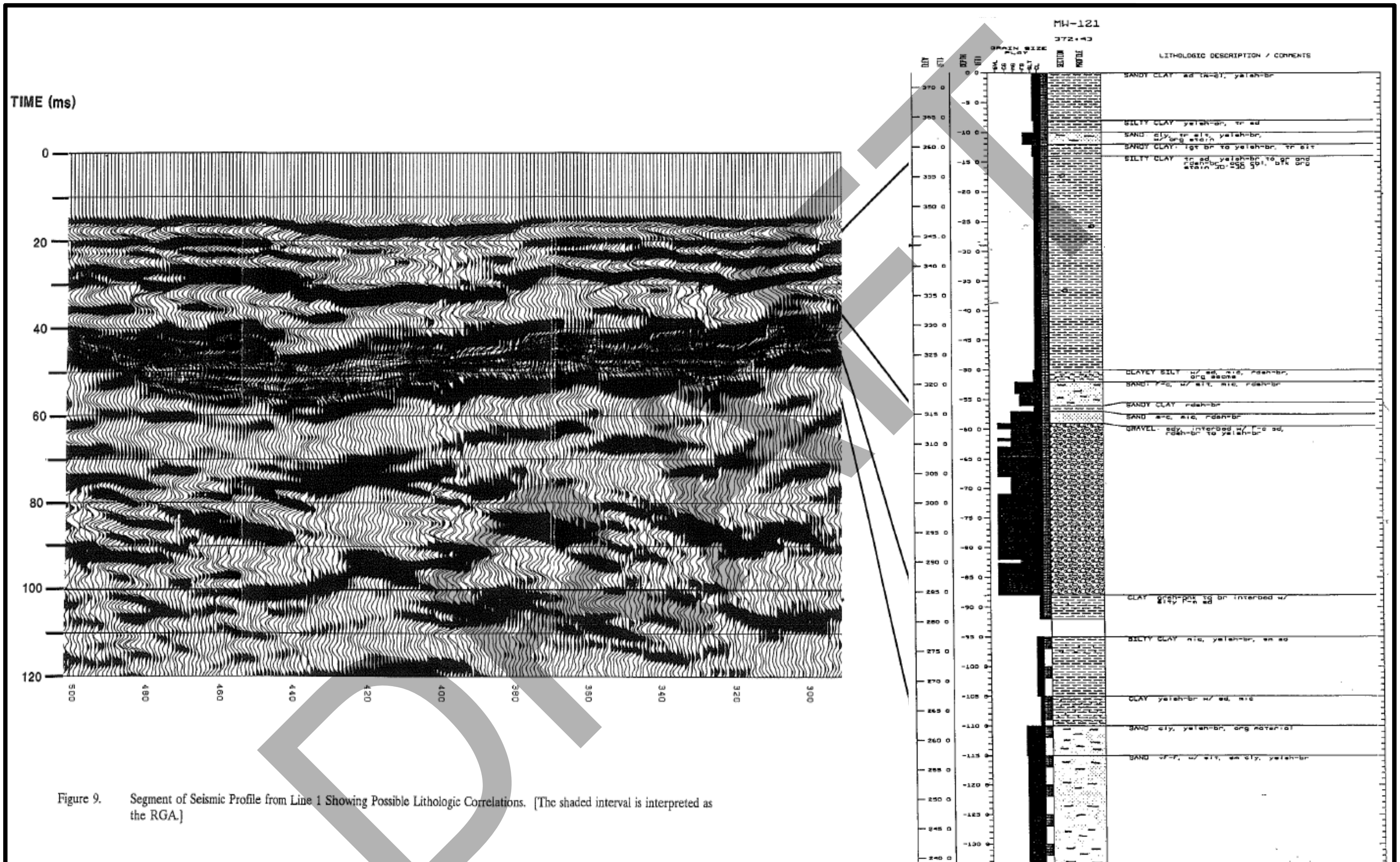

Figure 9. Segment of Seismic Profile from Line 1 Showing Possible Lithologic Correlations. [The shaded interval is interpreted as the RGA.]

Speece, M.A., Early T.O., Switek, J., Hanson, J.A., and Williams, R.T., 1991. Shallow High-Resolution Seismic Reflection Studies Near the Paducah Gaseous Diffusion Plant

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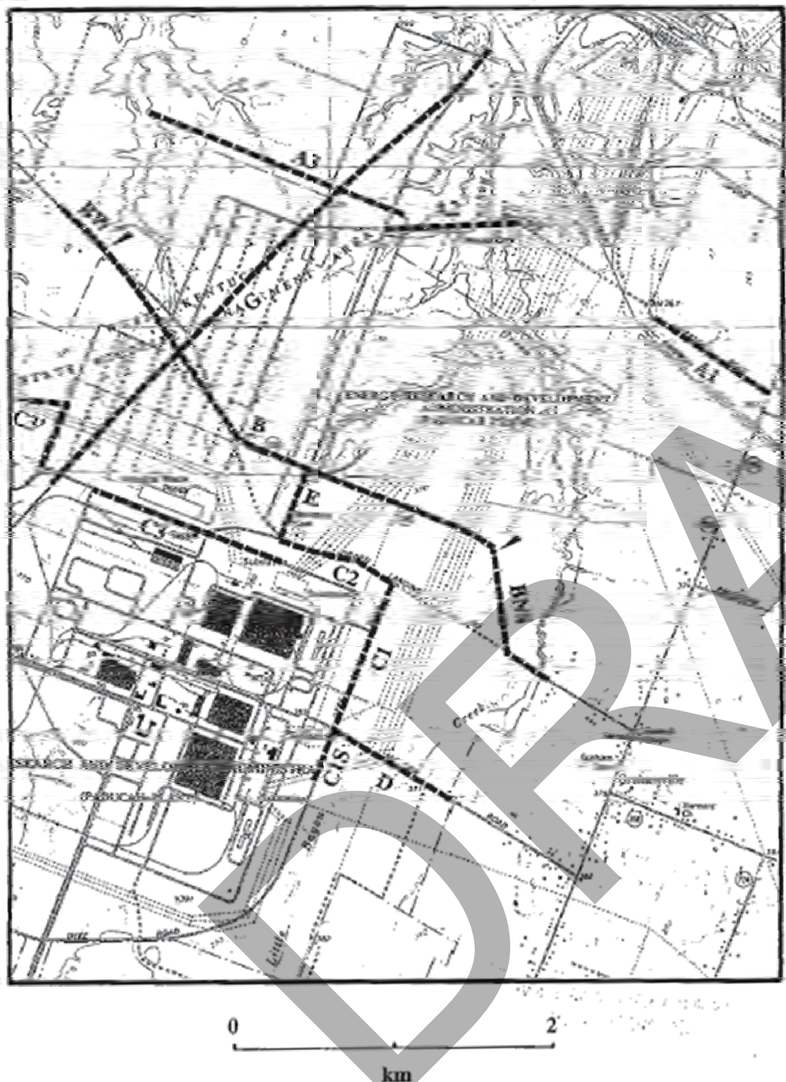

2 objectives:

- Seismically image the top of RGA, top of the Clayton and McNairy Formations, and the top of the limestone bedrock
- Find evidence of faulting or other aspects of the subsurface that could be controlling migration of the contaminant plumes

Approach:

- high-resolution, S_H-wave seismic CDP data using a seismic hammer
- 17 KM of shallow, high-resolution S_H-wave reflection and refraction data
- 12-fold CDP data

Langston, C. and Street, R., 1998. Acquisition of SH-Wave Seismic Reflection and Refraction Data in the Area of the Northeastward Trending Contaminant Plume at the PGDP

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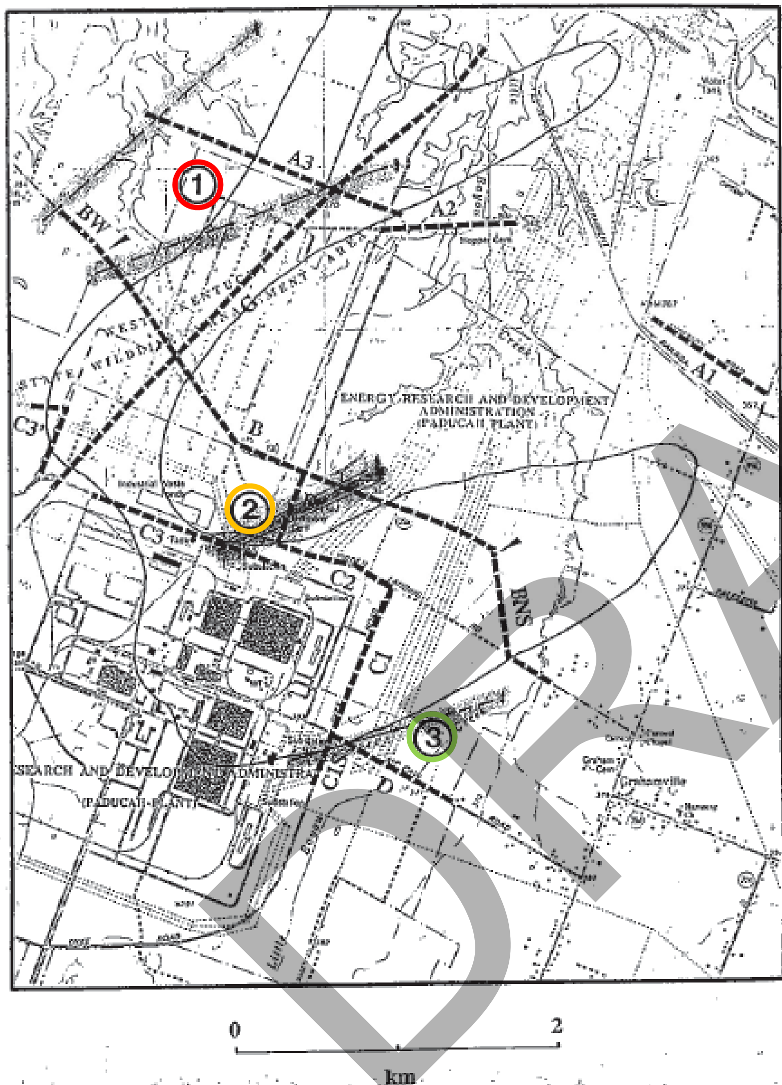

Preliminary results indicated the presence of two fault zones near the northwest corner of the plant (1).

Two major zones of faulting ((2) and (3)) have been identified in the north-eastern part of the DOE reservation and are coincident with the direction of migration and edges of the northeast contaminant plume.

“The trend of the faults, and the fact that many of these faults appear to propagate from the bedrock into the RGA, strongly suggests that faulting is controlling the migration of the contaminant plumes associated with the PGDP.”

Langston, C. and Street, R., 1998. Acquisition of SH-Wave Seismic Reflection and Refraction Data in the Area of the Northeastward Trending Contaminant Plume at the PGDP

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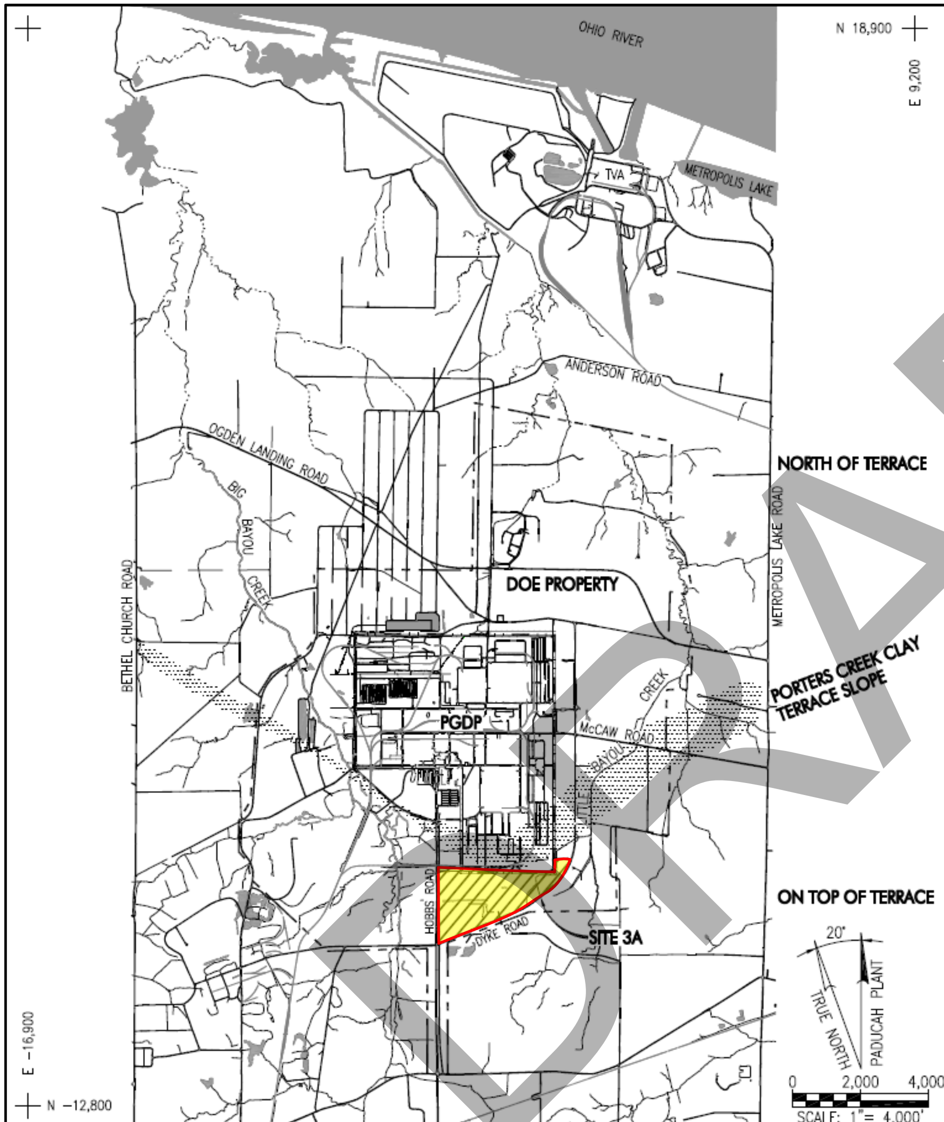

Site 3A Investigation:

- Deep borehole
- Suspension P & S_H-wave velocities
- P-wave seismic reflection survey
- S_H-wave seismic reflection survey
- DPT survey

DOE 2003. Seismic Investigation Report for Siting of a Potential On-Site CERCLA Waste Disposal Facility at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky (DOE/OR/07-2038&D2

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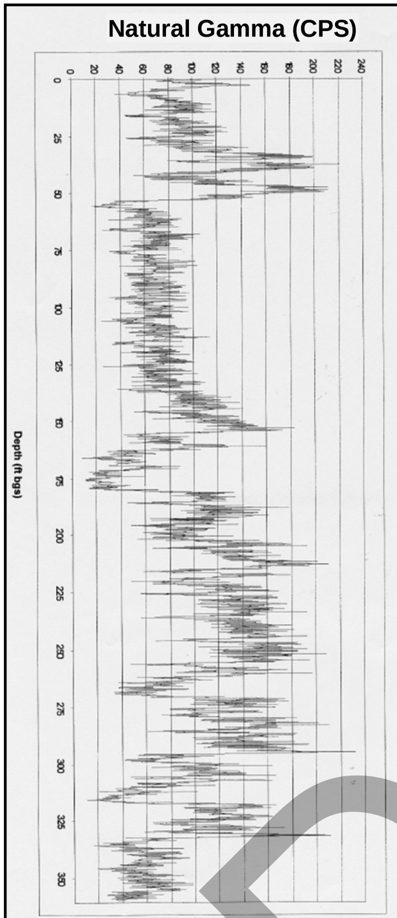

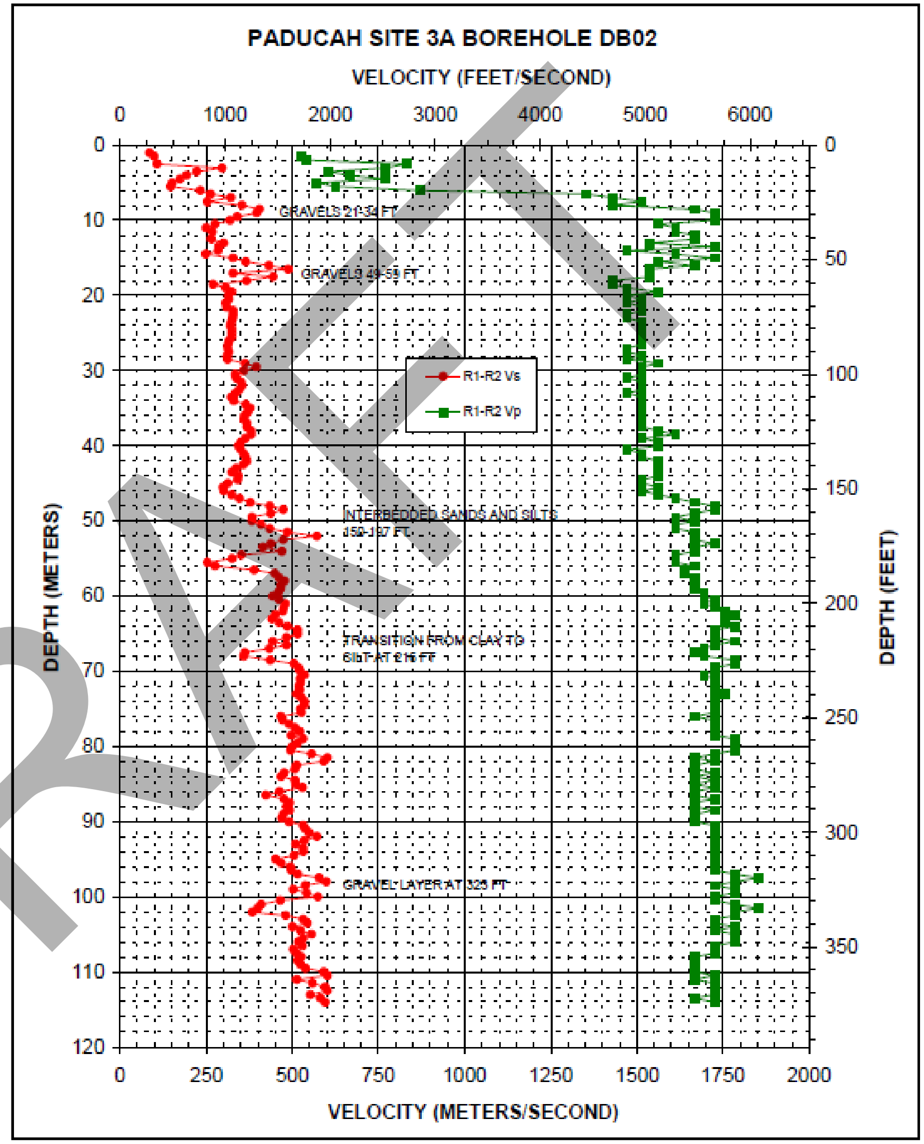

Deep borehole with P- and S_H-wave velocities study

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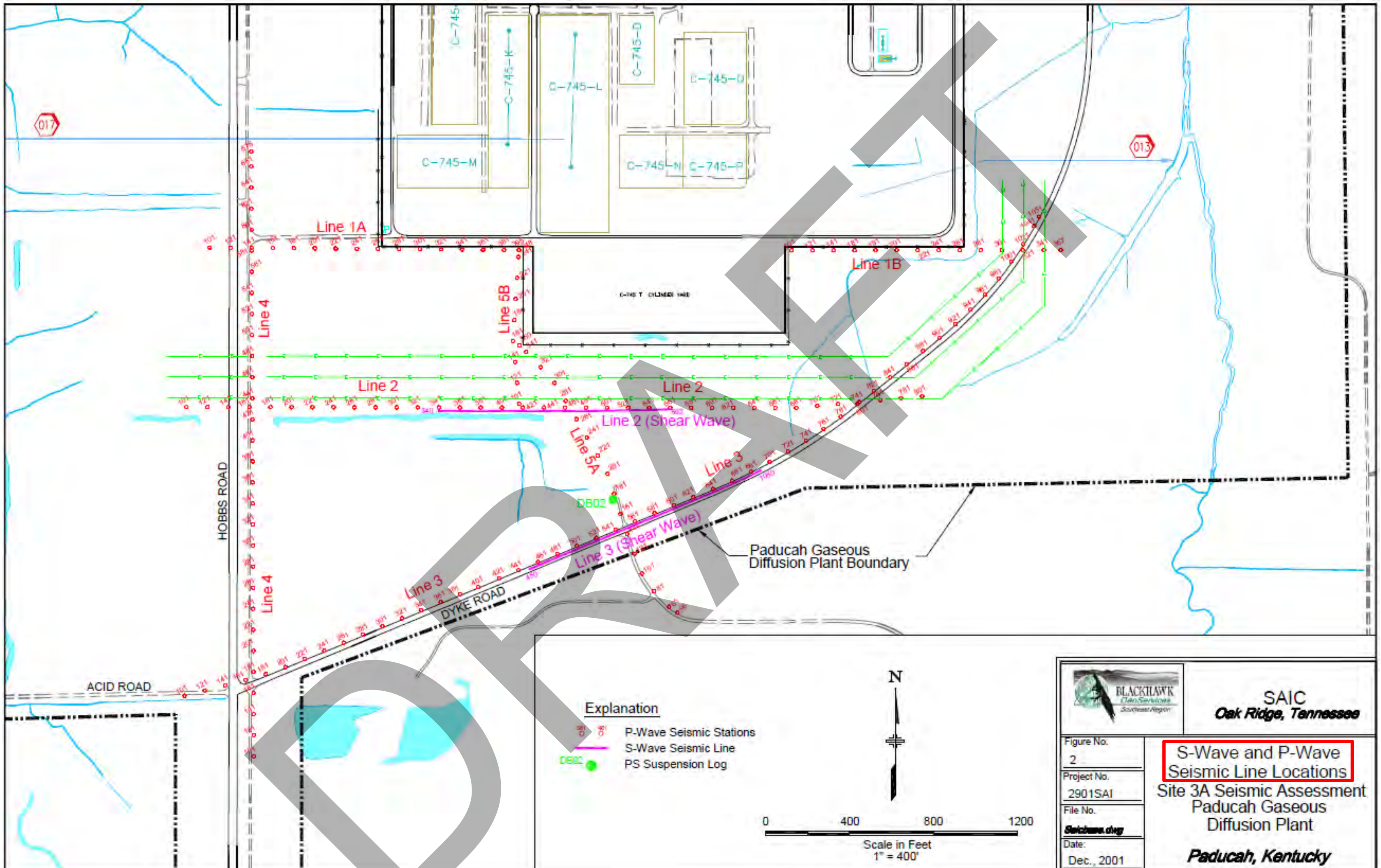

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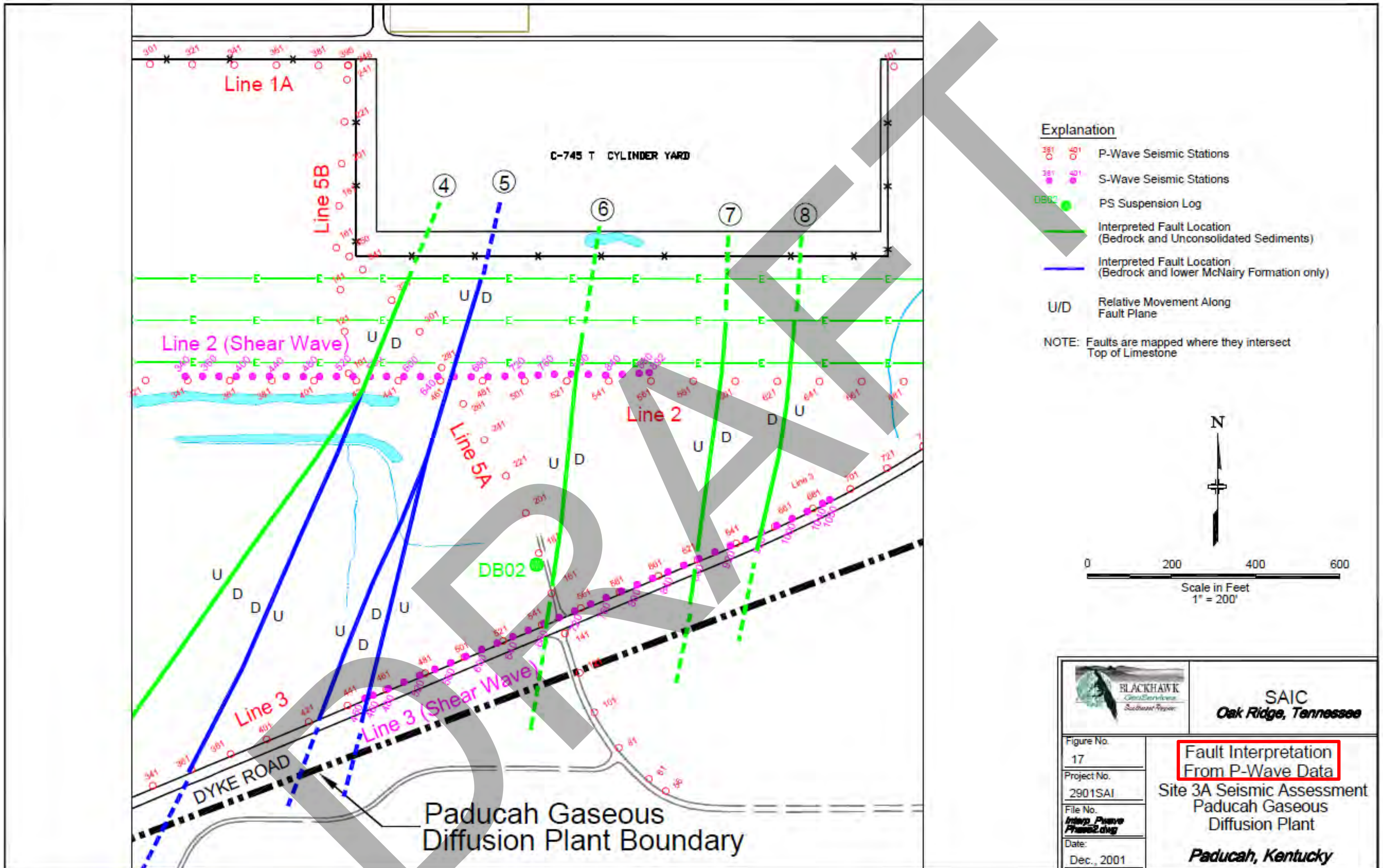

DOE 2003. Seismic Investigation Report for Siting of a Potential On-Site CERCLA Waste Disposal Facility at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky (DOE/OR/07-2038&D2

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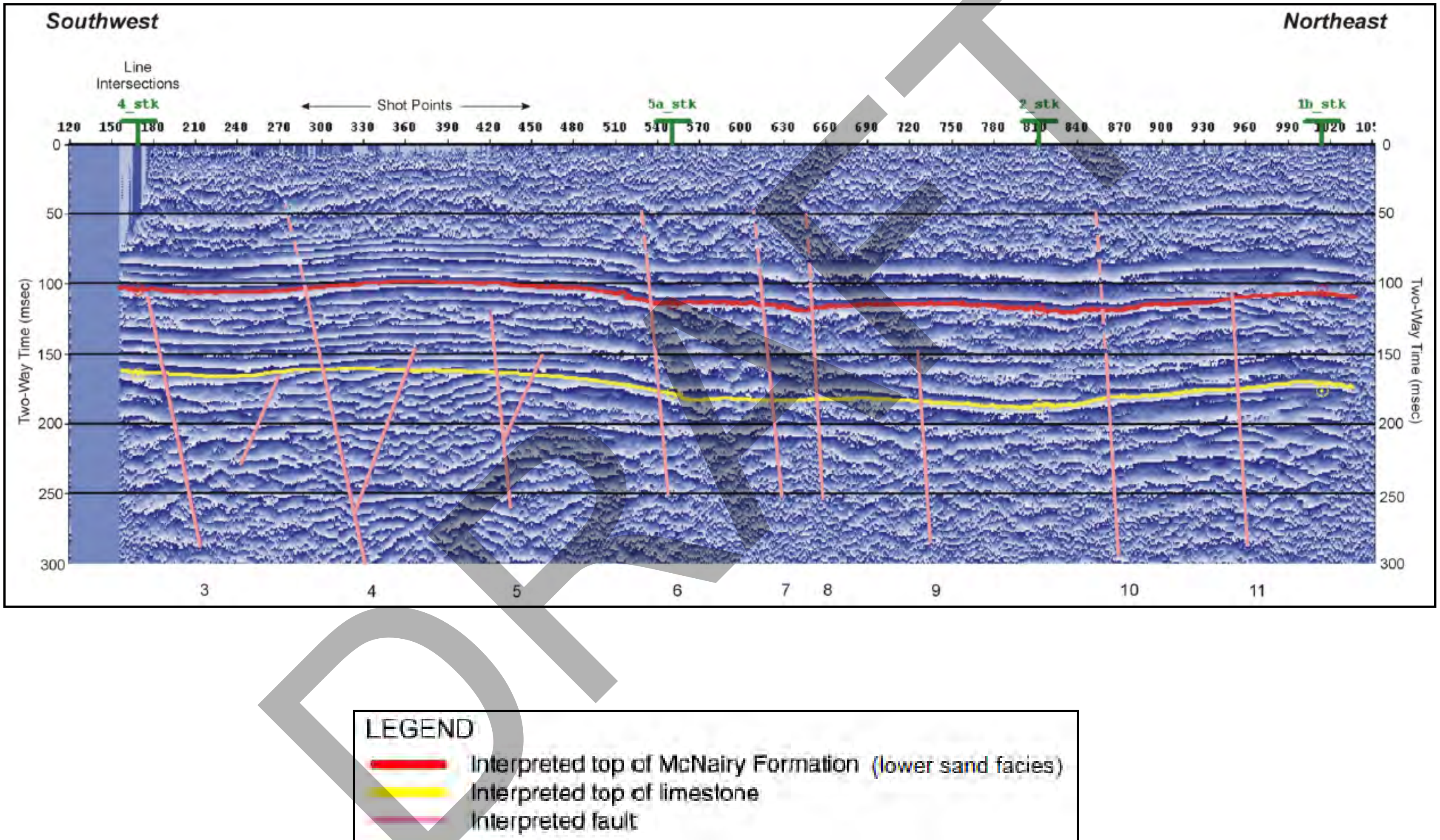
Line 3 interpreted instantaneous phase section – P-wave survey



DOE 2003. Seismic Investigation Report for Siting of a Potential On-Site CERCLA Waste Disposal Facility at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky (DOE/OR/07-2038&D2

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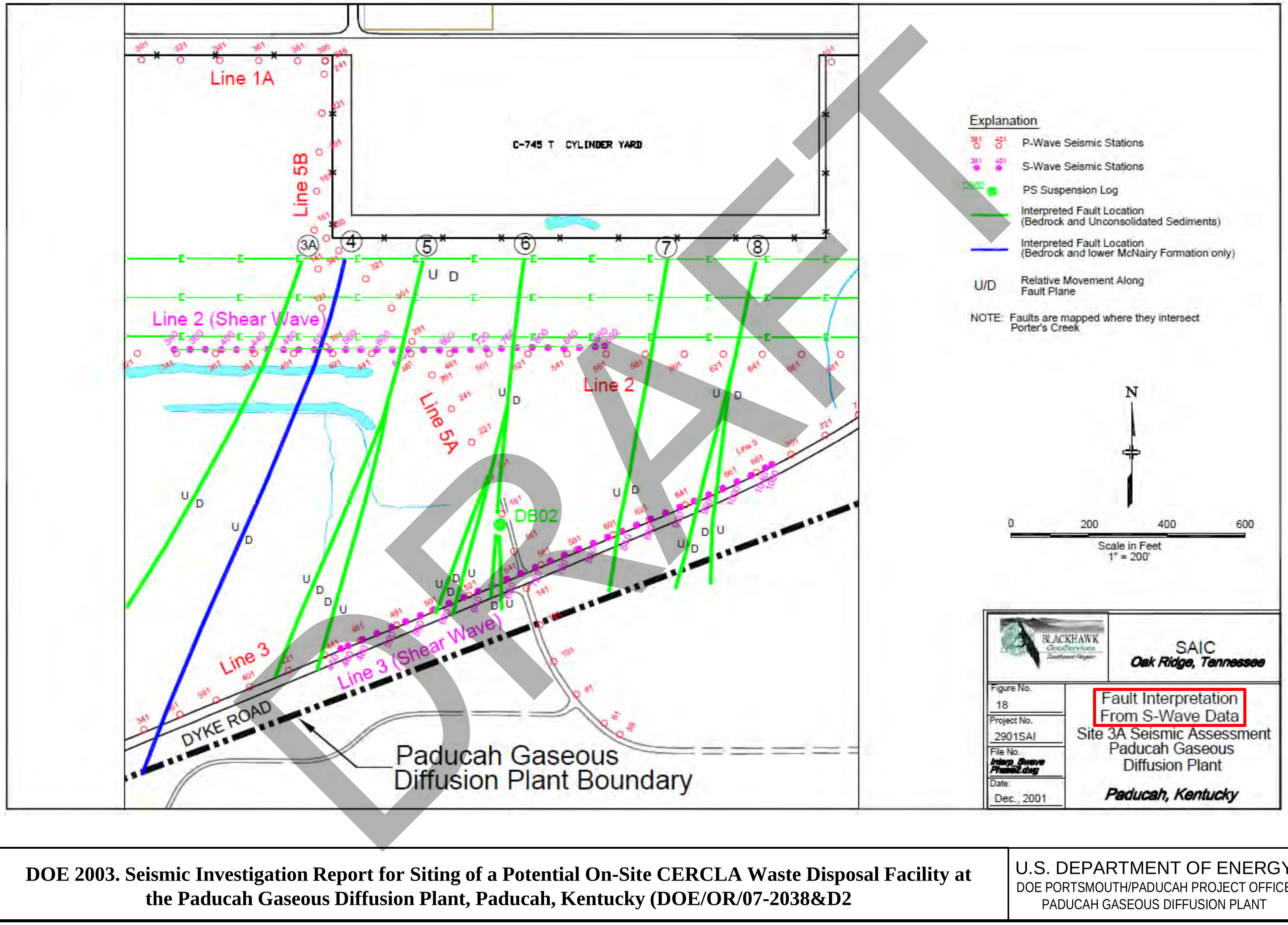
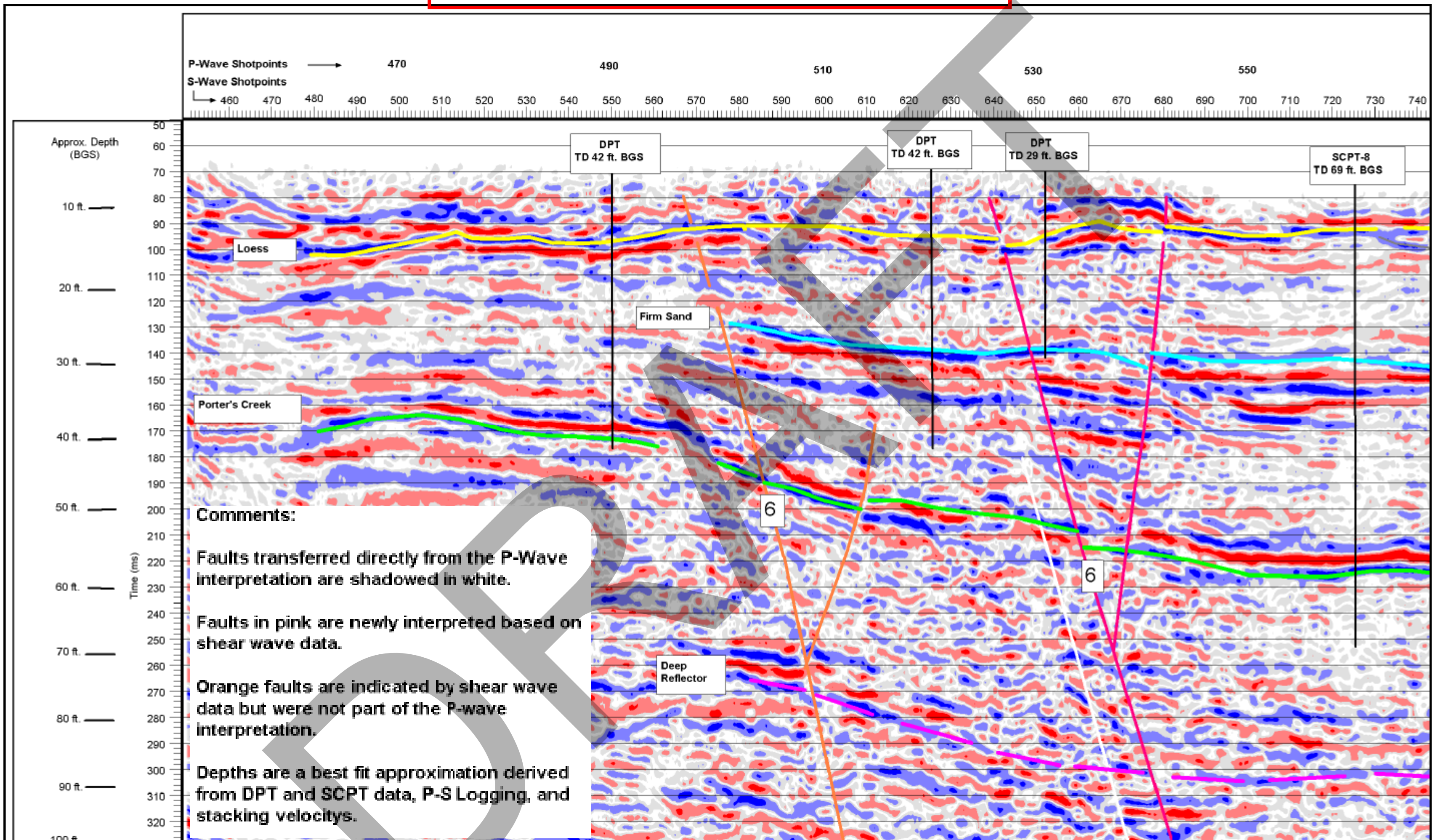


DOE 2003. Seismic Investigation Report for Siting of a Potential On-Site CERCLA Waste Disposal Facility at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky (DOE/OR/07-2038&D2

Line 3S S_H-wave migrated section



DOE 2003. Seismic Investigation Report for Siting of a Potential On-Site CERCLA Waste Disposal Facility at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky (DOE/OR/07-2038&D2

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Summary answers to Project Core Team questions to address seismic issues at Site 3A (excerpted)

Is there evidence of Holocene displacement of faults at PGDP?

This study did not find Holocene displacement of faults at Site 3A. Several faults identified in seismic reflection data at Site 3A have been confirmed to extend through the Porters Creek Clay and into the materials underlying the surficial loess deposits. Three of these faults are interpreted to extend to within approximately 20 ft of the ground surface. One deeper DPT borehole encountered three fault planes at depths between 22 ft and 28 ft. Tightly spaced, shallower DPT boreholes at these locations found no faults in the overlying loess. The radiocarbon dating at Site 3A found that the loess is late Pleistocene in age, and the deposits are at least as old as the oldest roots that grew into them (17,100 years old).

Are there faults underlying the potential disposal facility site?

The site-specific Fault Study identified a series of faults beneath Site 3A. For most of the faults beneath Site 3A, relative movement along the main fault plane is normal, with the downthrown side to the east. These normal faults, along with their associated splays, either form a series of narrow horst and graben features, or divide the local sediments into a series of rotated blocks. Several of the faults extend through the Porters Creek Clay and into the materials underlying the surficial loess. Three of these faults extend to within approximately 20 ft of the ground surface. Tightly spaced shallower DPT boreholes found no evidence that these faults extend upward into the Pleistocene loess deposits and, therefore, are not Holocene in age.

DOE 2003. Seismic Investigation Report for Siting of a Potential On-Site CERCLA Waste Disposal Facility at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky (DOE/OR/07-2038&D2

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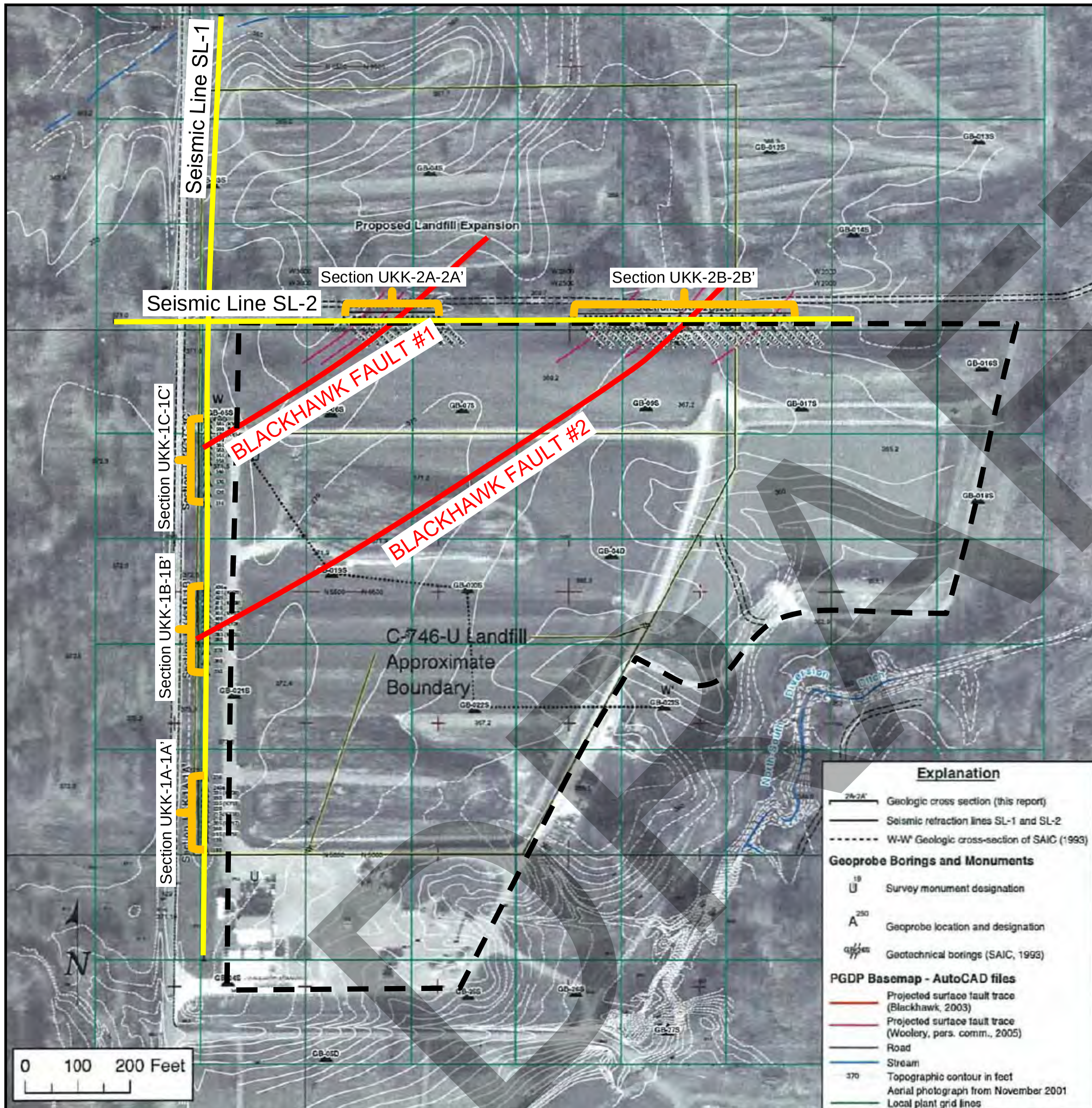
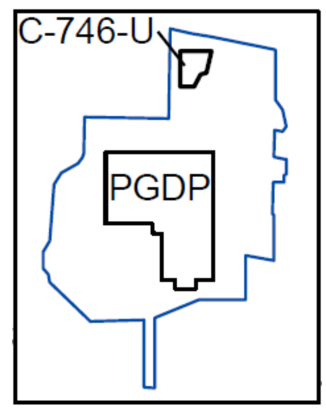


Seismic reflection profiles (Blackhawk Geosciences, 2003) image at least two faults offsetting Quaternary to Tertiary (Mounds Gravel) deposits beneath the project area.

- Subsurface exploration to confirm existence, locations and ages of the inferred faults.



William Lettis & Associates, Inc., 2006. Investigation of Holocene Faulting, Proposed C-746-U Landfill Expansion

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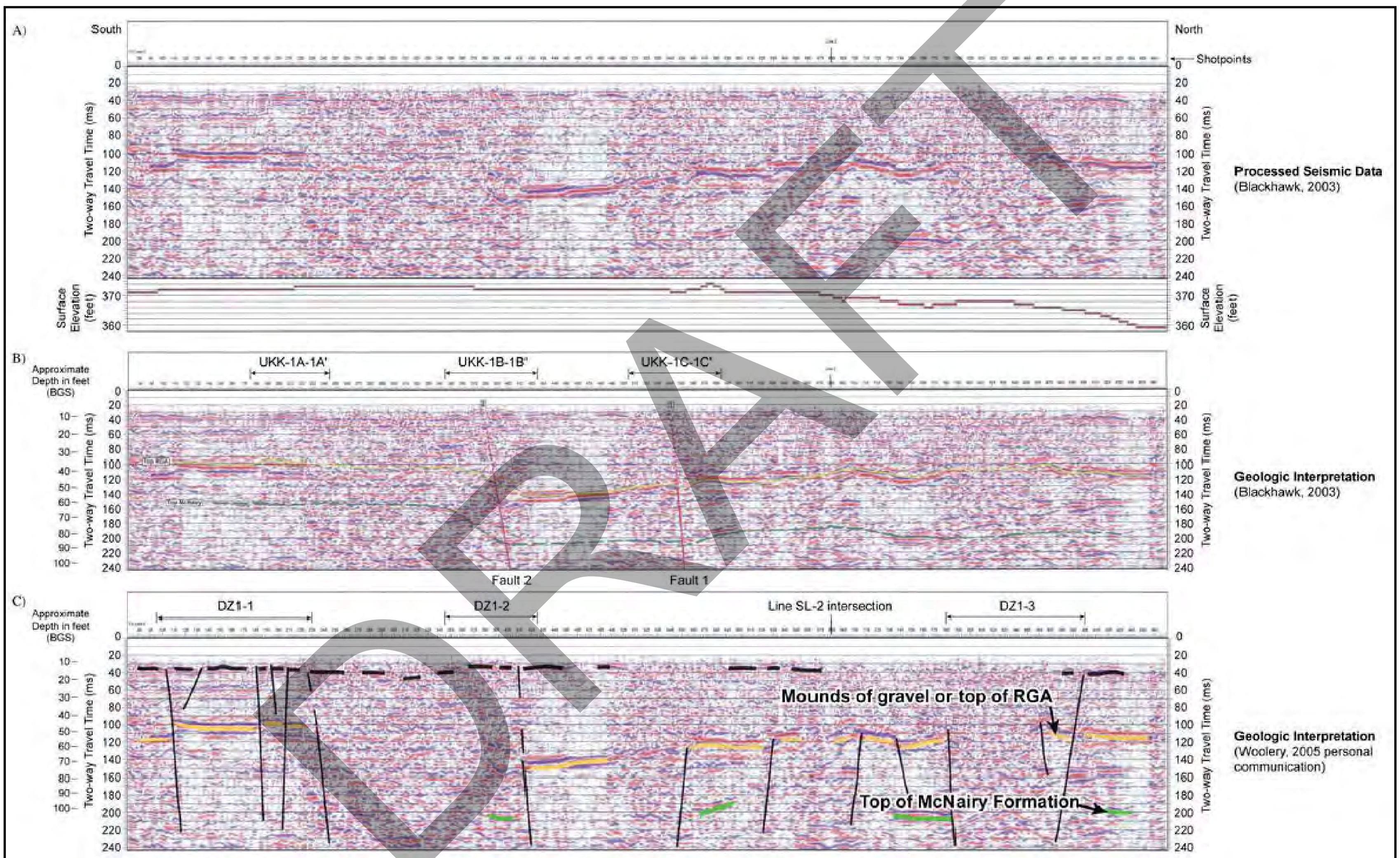
S_H-Wave Seismic Reflection Profile SL-1



William Lettis & Associates, Inc., 2006. Investigation of Holocene Faulting, Proposed C-746-U Landfill Expansion

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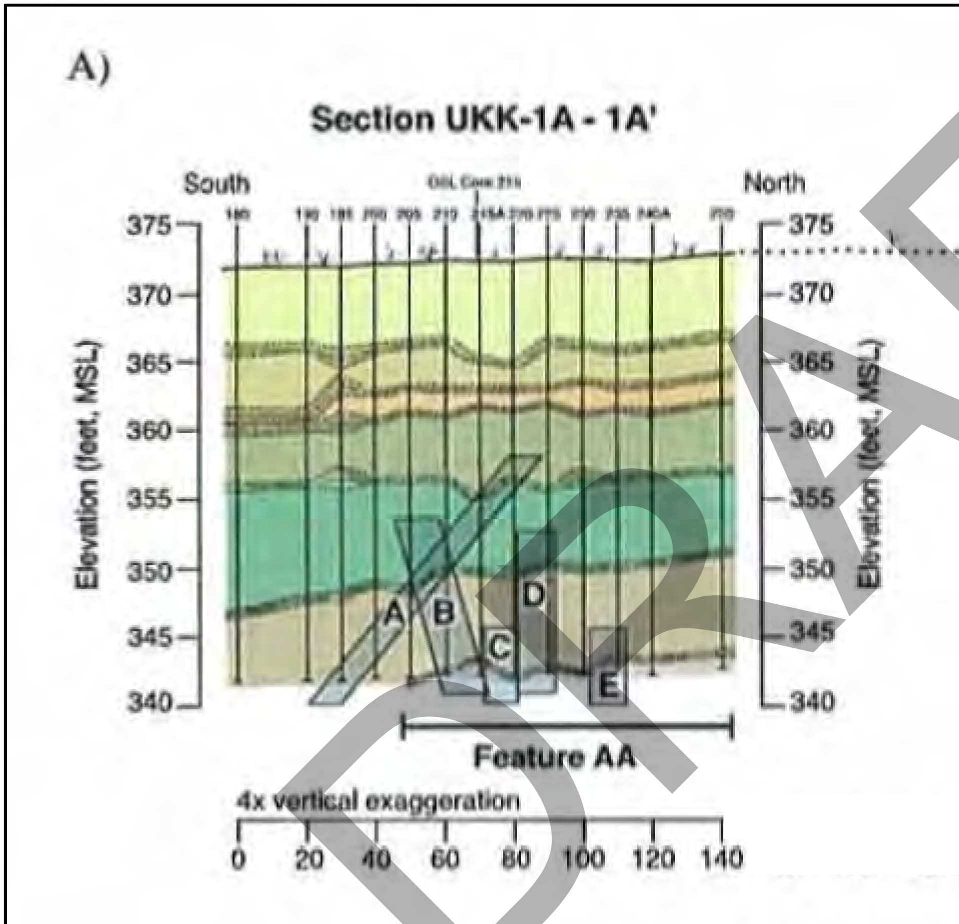
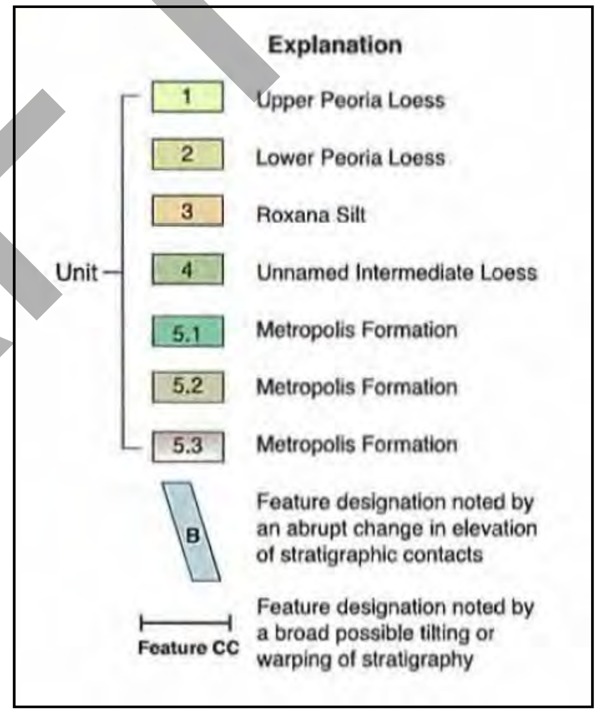
Selected Features Interpreted from the DPT Data





William Lettis & Associates, Inc., 2006. Investigation of Holocene Faulting, Proposed C-746-U Landfill Expansion

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Summary

Methodology:

- 1 km of seismic reflection data
- (86) 30-ft deep continuous soil cores
- OSL age-dating of loess

Conclusions:

- Geophysical data exhibit northeast-trending faults with oblique normal and reverse displacement.
- Upper (3) loess units generally flat-lying and mantle pre-existing topography.
- Lower older units exhibit subtle to abrupt undulations of basal contacts.
- Most recent fault displacement, if present at the site, is constrained to post-date deposition of the Unnamed Intermediate Silt (53.6 to 75.5 thousand years ago).

William Lettis & Associates, Inc., 2006. Investigation of Holocene Faulting, Proposed C-746-U Landfill Expansion

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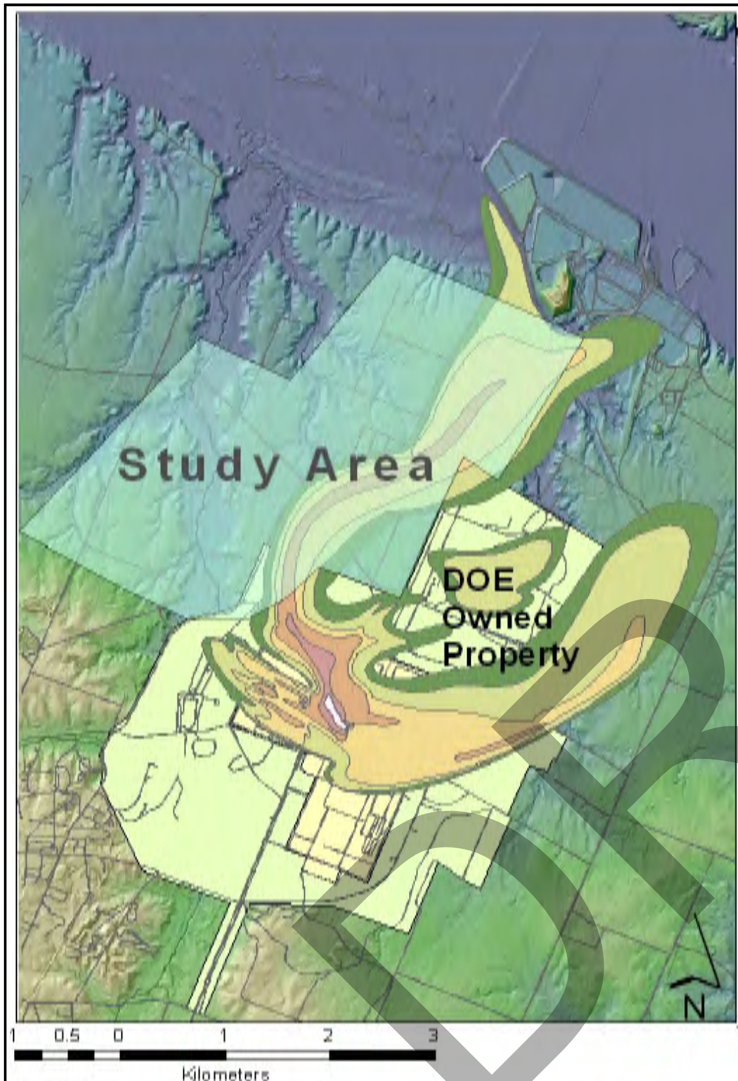

Over 7.8 Km of S_H-wave reflection data and 2 km of electrical resistivity data.

Imaged high-angle faults extending into Pleistocene horizons.

Structural features preferentially oriented with groundwater and contaminant migration.

Blits, C.A., Woolery, E.W., Macpherson, K.A., and Hampson, S. 2008. Integrated Geophysical Imaging Techniques for Detecting Neotectonic Deformation in the Fluorspar Area Fault Complex of Western Kentucky

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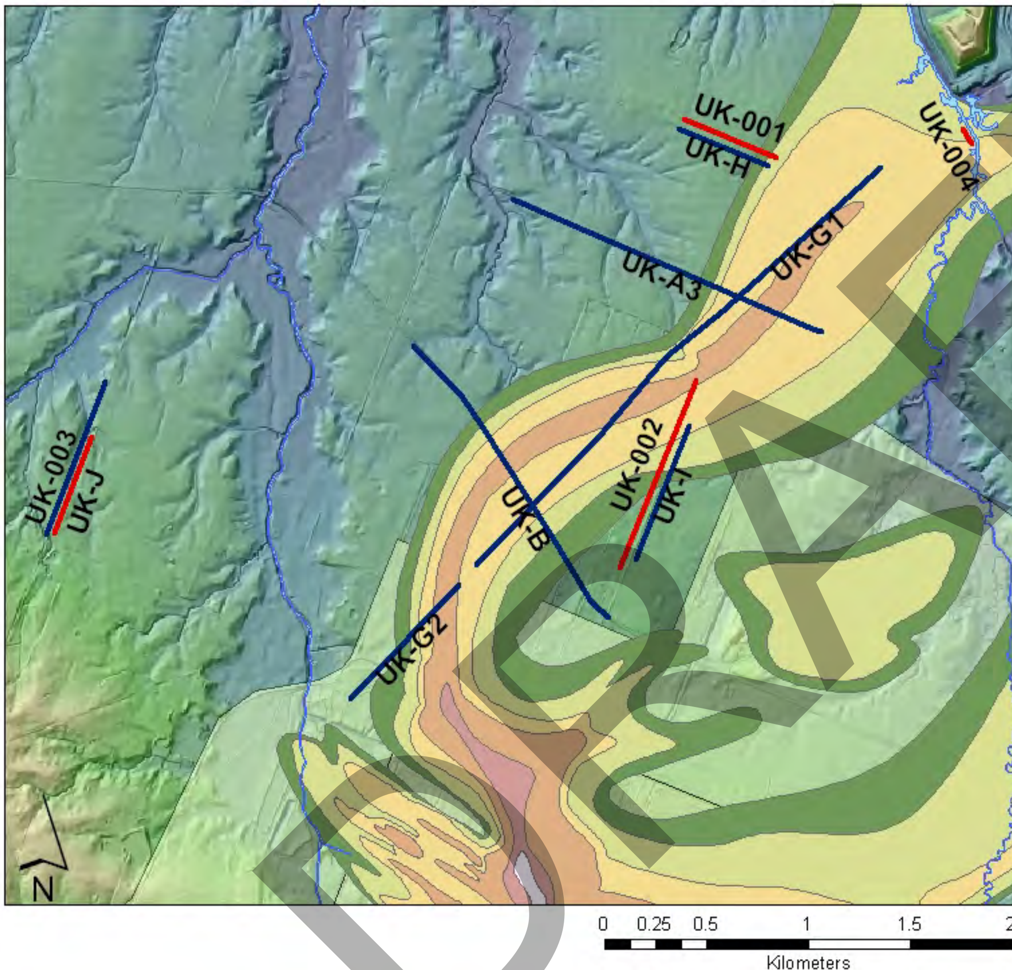

Geophysical Surveys

Line Name	Survey Type
Seismic Reflection	
UK-A3[1]	S_H-wave
UK-B[1]	S_H-wave
UK-G1[1]	S_H-wave
UK-G2[1]	S_H-wave
UK-H	S_H-wave
UK-I	S_H-wave
UK-J[2]	$S_H$wave
Electrical Resistivity	
UK-001	Dipole-Dipole
UK-002	Dipole-Dipole
UK-003	Dipole-Dipole
UK-004	Dipole-Dipole

[1] Collected by Langston and Street (1997)
[2] Collected by Wood, McDowell, Woolery and Wang (2000-2001)

Blits, C.A., Woolery, E.W., Macpherson, K.A., and Hampson, S. 2008. Integrated Geophysical Imaging Techniques for Detecting Neotectonic Deformation in the Fluorspar Area Fault Complex of Western Kentucky

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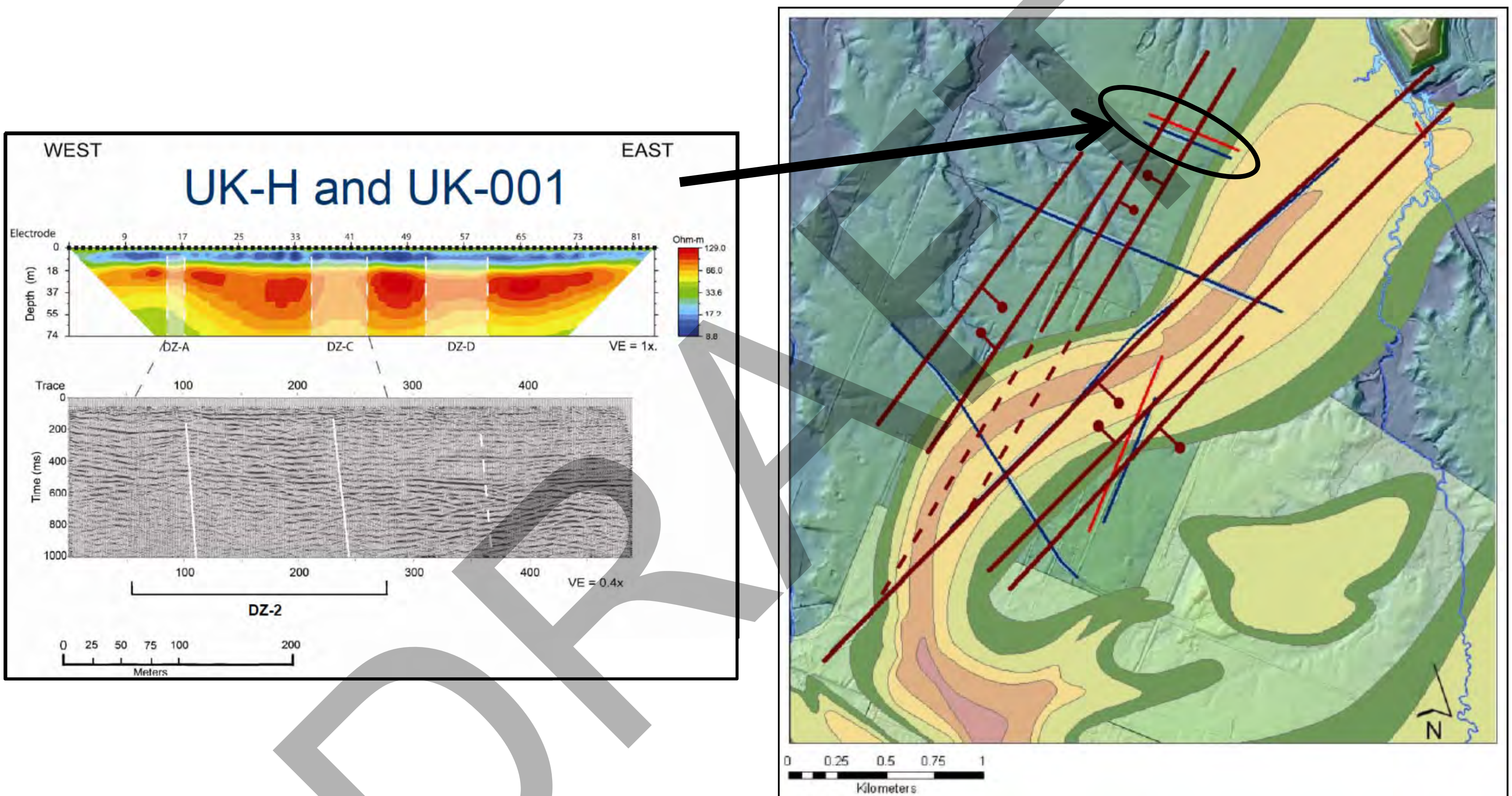

Blits, C.A., Woolery, E.W., Macpherson, K.A., and Hampson, S. 2008. Integrated Geophysical Imaging Techniques for Detecting Neotectonic Deformation in the Fluorspar Area Fault Complex of Western Kentucky

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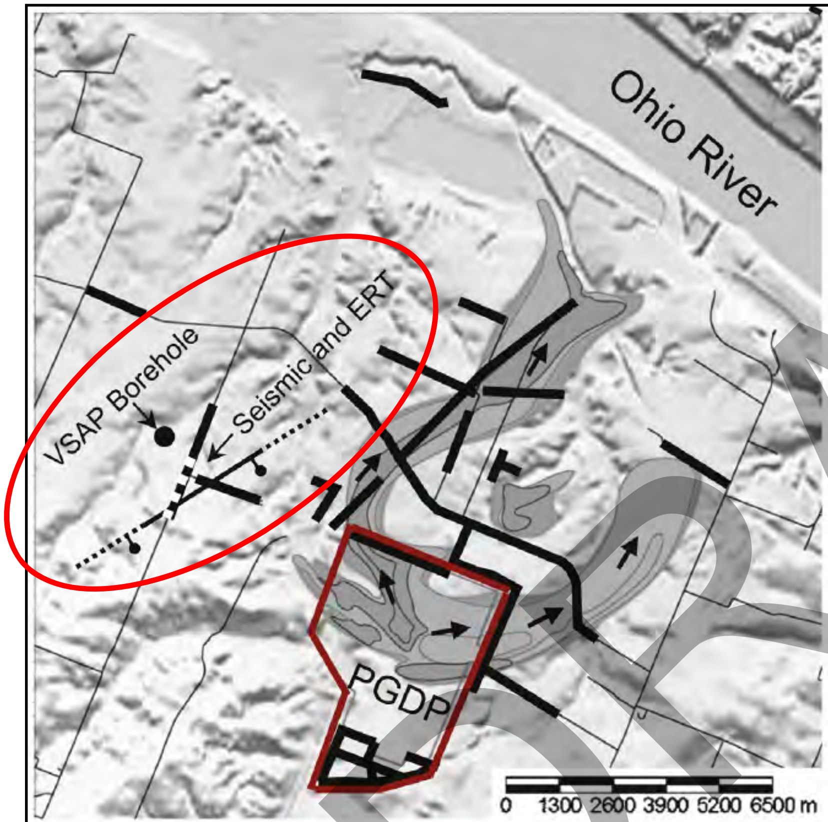

Can near-surface structural features within unlithified sediment locally influence hydraulic conductivity and act as a preferential pathway for fluid migration?
(The answer is “Yes”.)

Based on:
- One seismic reflection line (of ~17.5 km of seismic reflection lines),
- one electrical-resistivity tomography survey line, and
- the single S_H-wave splitting survey (to determine structural orientation)

Ali Almayahi and Edward Woolery, 2018. Fault-controlled contaminant plume migration: Inferences from SH-wave reflection and electrical resistivity experiments

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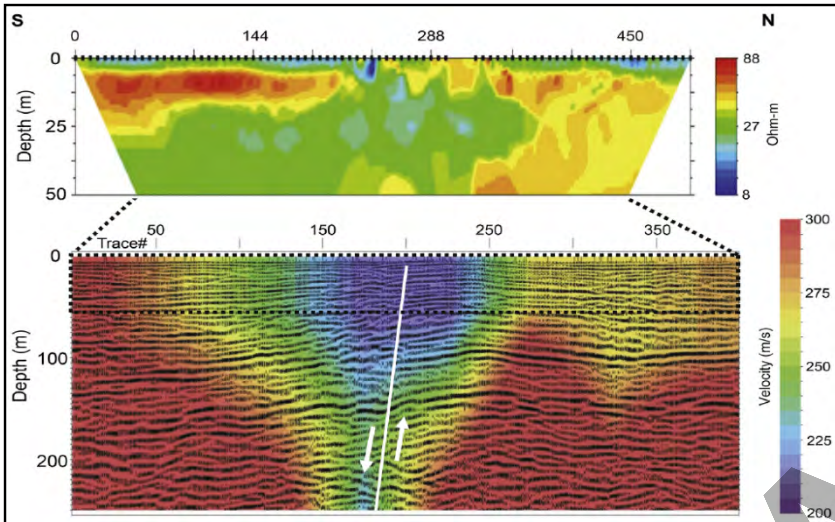
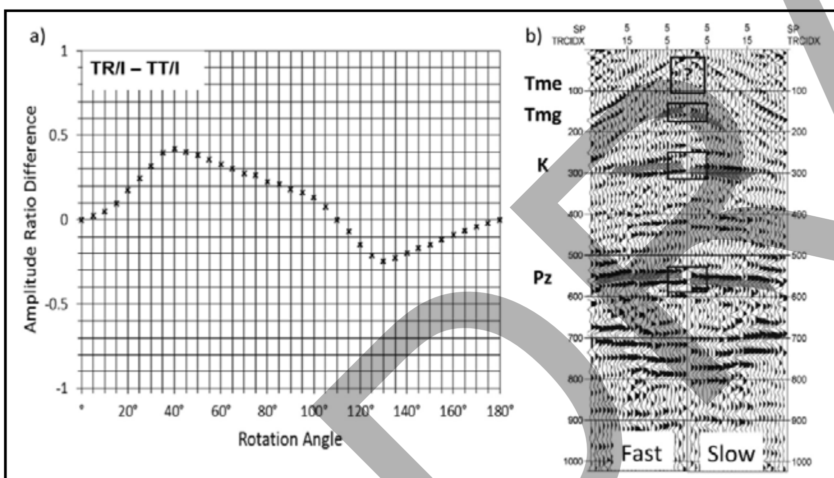


- The S_H-wave velocity in the fault zone is ~100 m/s slower than the surrounding area.
- As much as 80 Ω-m reduction in resistivity within the fault zone relative to the surrounding undeformed sediments.



S_H-wave splitting experiment

a) Fast and slow directions

b) Symmetric mirror view of a field-file seismogram from the same shot point that has been rotated into the fast and slow directions.

Integrated geophysical measurements show significant variation in the elastic and electrical properties between deformed and undeformed sediments

Ali Almayahi and Edward Woolery, 2018. Fault-controlled contaminant plume migration: Inferences from SH-wave reflection and electrical resistivity experiments

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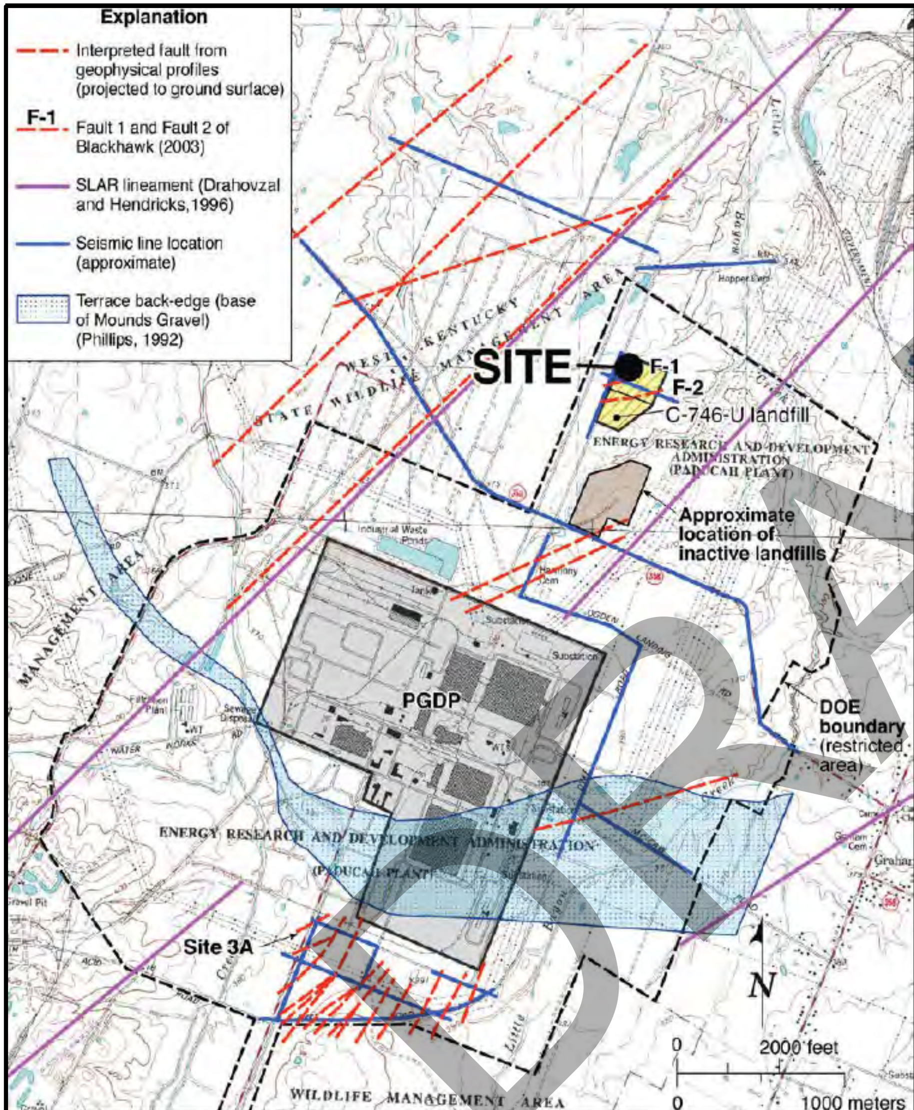

SUMMARY

- Seismic investigations provide good coverage of the area of the Paducah Site outside of the industrial area.

- Seismic investigations (principally S_H-wave) have identified numerous high-angle faults within and adjacent to the Paducah Site, consistent with trends of the Fluorspar Area Fault Complex of southern Illinois.

- Seismic surveys image faults extending upwards through the lower Continental Deposits.

Local Faulting and Related Features in the Vicinity of the Paducah Site

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Attachment 4

Groundwater Strategy
April 10, 2019

Summary of Discussion Topics:

- Comprehensive plan summary
- Near-term activities and current status
- Q&A

Comprehensive Plan Summary: Develop a groundwater strategy that closes out various issues for the site:

- Change status of two Environmental Indicator Performance Measures to "Yes"
  - Human exposure under control
  - Groundwater migration under control
- Resolution of data needs
- Groundwater Modeling Working Group (MWG) recommended maintenance and updates

Summary of Activities for the Groundwater Strategy

Activity #	Issue of Concern
Human Exposure Under Control	
1	TCE Extent West of PGDP (SW Plume)
2	TCE Extent East of PGDP (Downgradient NE Plume)
3	North Extent of PGDP TCE Plumes (Impact to Ohio River)
4	Nature and Extent of Contaminants Currently Contributed by Little Bayou Creek Seeps
5	Nature and Extent of Dissolved-Phase Contaminants Other than TCE and Tc-99
Groundwater Migration Under Control	
6	Capture Efficiency of NW Plume Extraction Wells
7	TCE Extent and Trends in East Side of Downgradient NW Plume
8	TCE Extent and Trends in West Side of Downgradient NE Plume
9	RGA Dissolved-Phase and DNAPL Contaminant Impacts to the McNairy Formation
Groundwater MWG Inputs	
10	Characterize Underflow from the Terrace Area
11	Expansion of Groundwater Monitoring Network
12	Water Balance Study
13	Continuous RGA Water Level Monitoring
14	Synoptic Water Level Measurement
15	Water Level Divide Study
16	Hydraulic conductivity
17	Monitoring Well Survey Study

Blue indicates field data collection 2019-2020.

Near-term Activities and Current Status:

- Activity tasks identified for next 12-18 months (highlighted above)
- DQO process for activity tasks planned for next 12-18 months developed (separate handouts)
- Several activity tasks completed (see schedule)
- Activities underway:
  - Water level/colloidal borescope investigation (separate maps)
    - Manual water level measurements
    - Vertical profiling for colloidal borescope data (velocity and direction) collection
  - Monitoring Well (MW) Survey Study – survey of 139 MWs using level loop (separate map)

Groundwater Strategy Summary of Near-Term Activities

Activity #	Area of Concern	Task(s)	Subtask(s)	Field Completion
1	TCE Extent West of PGDP (SW Plume)	Optimize existing groundwater monitoring network	Review frequency of sampling and analysis and synoptic sampling and analysis	N/A
		RGA potentiometric trend investigation	Water level/colloidal borescope investigation	• 12 months of field data collection from 11 wells o 36 colloidal borescope datasets o 4 continuous water level datasets o 264 manual water level measurements
		Develop/revise conceptual site model	Review geology, hydrology, and contaminant trends	N/A
2	TCE Extent East of PGDP (Downgradient NE Plume)	RGA potentiometric trend investigation	Map site-wide synoptic water level data	N/A
			NE Plume synoptic water level measurements	• 12 months of field data collection from 42 wells o 70 colloidal borescope datasets o 6 continuous water level datasets o 504 manual water level measurements
			Continuous water level measurements	
			Colloidal borescope investigation	
		NE Plume optimization hydraulics analysis	N/A	N/A
8	TCE Extent and Trends in West Side of Downgradient NE Plume	RGA potentiometric trend investigation	Map site-wide synoptic water level data	N/A
			NE Plume synoptic water level measurements	• 12 months of field data collection from Activity #2
			Continuous water level measurements	
			Colloidal borescope measurements	

Activity #	Area of Concern	Task(s)	Subtask(s)	Field Completion
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	N/A
			Continuous and manual water level measurements	• 12 months of field data collection from 15 wells o 9 continuous water level datasets o 180 manual water level measurements
			Report	N/A
		Deployment of continuous water level recorders in select monitoring wells/piezometers within the plant area to assess recharge better and its impact on nearby water levels	Continuous water level measurements	• Estimate deployment in (3) wells for a 12 months
14	Synoptic Water Level Measurement	Increased water level measurement events conducted during different seasons	Seasonal water level measurements	N/A
		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 lock and dam	• 1 quarter of field data collection from 296 wells o
			Synoptic data set after operation begins at Olmsted lock and dam	• 4 quarters of field data collection from 296 wells o 1,184 manual water level measurements •
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	N/A	• 4 quarters of field data collection from 46 wells o 3 colloidal borescope datasets o 6 continuous water level datasets o 184 manual water level measurements
		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	N/A	

Activity #	Area of Concern	Task(s)	Subtask(s)	Field Completion
17	Monitoring Well Survey Study	Review existing monitoring well survey information	N/A	• Survey of 139 monitoring wells inside the main plant area • Survey of 26 MWs near the main plant area.
		Review survey data in context of plume maps	N/A	N/A

Activity	Task Name	CY2018	CY2019	CY2020	CY2021	CY2022	CY2023
	Environmental Indicator - Human Exposure Under Control						
1	**#1 - TCE Extent West of PGDP (SW Plume)**						
	Optimize Existing GW Monitoring Network	Complete					
	Procure Colloidal Borescopes		Complete				
	Procure Groundwater Level Data Loggers		Complete				
	Calibrate On-Site Groundwater Data Loggers		Complete				
	Water Level/Colloidal Borescope Investigation (1 Year of Data Collection)						
	Develop/Revise Conceptual Site Model						
	Reporting						
2	**#2 - TCE Extent East of PGDP (Downgradient NE Plume)**						
	NE Plume Optimization Hydraulic Assessment	Complete					
	Map Sitewide Synoptic Water Level Data	Complete					
	Water Level/Colloidal Borescope Investigation (1 Year of Data Collection)						
	Review Data and Prepare Map(s)						
	Reporting						
3	**#3 - North Extent of PGDP TCE Plumes (Impacts to Ohio River)**						
	Develop/Revise Conceptual Site Model			2, 8, 13, 14			
	Reporting			Task Development and Schedule Pending			
4	**#4 - Nature and Extent of Dissolved-Phase Contaminants Currently Contributed by Little Bayou Creek Seeps**						
	Hydraulic Trend Investigation						
	Develop/Revise Conceptual Site Model			1, 2			
	Stream Flow Gain/Loss in the Seeps Area and Stream Sampling			Task Development and Schedule Pending			
	Reporting						
5	**#5 - Nature and Extent of Dissolved-Phase Contaminants Other than TCE and Tc-99**						
	Develop/Revise Conceptual Site Model				1, 2, 4, 8		
	Review/Summary of Analytical Data				Task Development and Schedule Pending		
	Reporting						
	Environmental Indicator - Groundwater Migration Under Control						
6	**#6 - Capture Efficiency of NW Plume Extraction Wells**						
	White Paper: *Revised Evaluation of TCE Trends in MW460* (DOE 2019)		Complete				
	Develop/Revise Conceptual Site Model						
	Optimize Extraction Well Pump Rates and Pump Depths						
	Optimize Groundwater Monitoring Network						
	Colloidal Borescope Investigation			1, 13, 14			
	Monitoring Well Installation			Task Development and Schedule Pending			
	Update NW Plume Extraction Well Capture Zone Assessment						
	Reporting						
7	**#7 - TCE Extent and Trends in East Side of Downgradient NW Plume**						
	Map Sitewide Synoptic Water Level Data						
	Water Level/Colloidal Borescope Investigation (1 Year of Data Collection)			1, 13, 14			
	Drive Point Geology/TCE investigation			Task Development and Schedule Pending			
	Monitoring Well/Piezometer Installation						
	Reporting						
8	**#8 - TCE Extent and Trends in West Side of Downgradient NE Plume**						
	Map Sitewide Synoptic Water Level Data	Complete					
	Water Level/Colloidal Borescope Investigation (1 Year of Data Collection)						
	Drive Point Geology/TCE Investigation						
	Monitoring Well/Piezometer Installation			Task Development and Schedule Pending			
	Reporting						
9	**#9 - RGA Dissolved-phase and DNAPL contaminant impacts to the McNairy formation**						
	Develop/Revise Conceptual Site Model			8			
	Review/Summary of Analytical Data			Task Development and Schedule Pending			
	Reporting						
	Modeling Working Group - Recommendations and Data Needs						
10	**#10 - Characterize Underflow from the Terrace Area**						
	Conceptual Site Plan						
	Piezometer Installation			8			
	Terrace Area Synoptic Water Level Measurements			Task Development and Schedule Pending			
	Reporting						
11	**#11 - Expansion of GW Monitoring Network**						
	Review of Earthcon evaluation						
	Monitoring Well Installation		1, 2, 8, 13, 14, 15				
	Civil Survey of Creek Bottom		Task Development and Schedule Pending				
	Reporting						
	Obtain and Review TVA Monitoring System Data		Complete				
12	**#12 - Water Balance Study**						
	Monitoring and Documentation of the Ongoing Utility Optimization Program						
	Compilation of Available Information Regarding the Chronology of Roof Drain Repairs			Task Development and Schedule Pending			
	Expanded Assessment of the Water Supply and Storm Water Systems						
	Reporting						
13	**#13 - Continuous RGA Water Level Monitoring**						
	White Paper: *Continuous Regional Gravel Aquifer Water Level Monitoring at the Paducah Site*		Complete				
	Water Level Investigation (1 Year of Data Collection)						
	Reporting						
14	**#14 - Synoptic Water Level Events**						
	Field Synoptic Water Level Measurement Pre-Olmstead Dam Operation	Complete					
	Field Synoptic Water Level Measurement Post-Olmstead Dam Operation						
	Reporting						
15	**#15 - Water Level Divide Study**						
	White Paper: *Assessment of Sitewide Groundwater Flow Model Using Monitoring Wells at the Paducah Site*		Complete				
	Water Level/Colloidal Borescope Investigation (1 Year of Data Collection)						
	Reporting						
16	**#16 - Hydraulic Conductivity**						
	White Paper: *Measurement of Hydraulic Conductivity in the Regional Gravel Aquifer Using Monitoring Wells at the Paducah Site*		Complete				
	Characterization of Bottom Sediments in Metropolis Lake				Task Development and Schedule Pending		
	Slug Testing to Better Define Hydraulic Conductivity Across the Model Domain						
	Reporting						
17	**#17 - Monitoring Well Survey Study**						
	Review Existing Monitoring Well Survey Information						
	Survey of Monitoring Wells						
	Assessment of Confidence on Plume Map Depiction and Other Site Reports						
	Reporting						

Notes

(blue)	Activity/Task Currently In-Progress or Completed
(green)	Future Activity/Task Pending Scope Development
#	Future Activity/Task Pending Scope Development where the # indicates a precursor Activity

Att4-5

		MONTH											
Activity	**Well Number**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
14	MW20 (also R4)			M1			M1			M1			M1
14	MW63			M1			M1			M1			M1
14	MW65			M1			M1			M1			M1
14	MW66			M1			M1			M1			M1
14	MW67			M1			M1			M1			M1
14	MW68			M1			M1			M1			M1
13, 14	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
14	MW72			M1			M1			M1			M1
14	MW73			M1			M1			M1			M1
14	MW76			M1			M1			M1			M1
14	MW77 (PZ)			M1			M1			M1			M1
14	MW78			M1			M1			M1			M1
14	MW79			M1			M1			M1			M1
14	MW80			M1			M1			M1			M1
14	MW81			M1			M1			M1			M1
14	MW84			M1			M1			M1			M1
14	MW86			M1			M1			M1			M1
14	MW87			M1			M1			M1			M1
14	MW89			M1			M1			M1			M1
14	MW90A			M1			M1			M1			M1
14	MW92			M1			M1			M1			M1
14	MW93			M1			M1			M1			M1
14	MW95A			M1			M1			M1			M1
14	MW98			M1			M1			M1			M1
2, 14	MW99	M1	M1	CB+M1	M1	M1	M1	M1	M1	CB+M1	M1	M1	M1
2, 14	MW100	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
14	MW102			M1			M1			M1			M1
14	MW103			M1			M1			M1			M1
1, 14	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
14	MW108			M1			M1			M1			M1
14	MW120			M1			M1			M1			M1
14	MW121			M1			M1			M1			M1
14	MW122			M1			M1			M1			M1
14	MW123			M1			M1			M1			M1
14	MW124			M1			M1			M1			M1
14	MW125			M1			M1			M1			M1
2, 14	MW126	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
2, 14	MW132	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
14	MW133			M1			M1			M1			M1
14	MW134			M1			M1			M1			M1
2, 14	MW135	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
13, 14	MW137	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
2, 14	MW139	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
14	MW144			M1			M1			M1			M1
13, 14	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
14	MW146			M1			M1			M1			M1
13, 14	MW147	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
2, 14	MW148	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
2, 14	MW150	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
13, 14	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
14	MW155			M1			M1			M1			M1
14	MW156			M1			M1			M1			M1
14	MW161			M1			M1			M1			M1
14	MW163			M1			M1			M1			M1
14	MW165A			M1			M1			M1			M1
14	MW168			M1			M1			M1			M1
14	MW169			M1			M1			M1			M1
14	MW173			M1			M1			M1			M1
14	MW175			M1			M1			M1			M1
14	MW178			M1			M1			M1			M1
14	MW185			M1			M1			M1			M1
14	MW188			M1			M1			M1			M1
14	MW191			M1			M1			M1			M1
2, 14	MW193	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
1, 14	MW194	CB+M2	M2	CB+M2	M2	CB+M2	M2	CB+M2	M2	CB+M2	M2	CB+M2	M2
14	MW197			M1			M1			M1			M1
13, 14	MW199	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
14	MW200			M1			M1			M1			M1
14	MW201			M1			M1			M1			M1
14	MW202			M1			M1			M1			M1
14	MW203			M1			M1			M1			M1
14	MW205			M1			M1			M1			M1
14	MW220			M1			M1			M1			M1
14	MW221			M1			M1			M1			M1
14	MW222			M1			M1			M1			M1
14	MW223			M1			M1			M1			M1
14	MW224			M1			M1			M1			M1
14	MW225			M1			M1			M1			M1
14	MW226			M1			M1			M1			M1
14	MW227			M1			M1			M1			M1
14	MW233			M1			M1			M1			M1
14	MW236			M1			M1			M1			M1
14	MW238			M1			M1			M1			M1
14	MW239			M1			M1			M1			M1
14	MW240			M1			M1			M1			M1
14	MW241A			M1			M1			M1			M1
14	MW242			M1			M1			M1			M1
14	MW243			M1			M1			M1			M1
14	MW244			M1			M1			M1			M1
14	MW245			M1			M1			M1			M1
14	MW247			M1			M1			M1			M1
14	MW248			M1			M1			M1			M1
14	MW249			M1			M1			M1			M1
14	MW250			M1			M1			M1			M1
2, 14	MW252	M1	CB+M1	M1	M1	M1	M1	M1	CB+M1	M1	M1	M1	M1
2, 14	MW253A	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
14	MW255			M1			M1			M1			M1
14	MW256			M1			M1			M1			M1
14	MW257			M1			M1			M1			M1
14	MW258			M1			M1			M1			M1
14	MW260			M1			M1			M1			M1
14	MW261			M1			M1			M1			M1
13, 14	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
14	MW283			M1			M1			M1			M1
14	MW284			M1			M1			M1			M1
14	MW288			M1			M1			M1			M1
2, 14	MW291	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
14	MW292			M1			M1			M1			M1
14	MW293A			M1			M1			M1			M1
14	MW294A			M1			M1			M1			M1
14	MW325			M1			M1			M1			M1
14	MW326			M1			M1			M1			M1
14	MW327			M1			M1			M1			M1
14	MW328			M1			M1			M1			M1
1, 14	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

		MONTH											
Activity	**Well Number**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
14	MW330			M1			M1			M1			M1
14	MW333			M1			M1			M1			M1
14	MW337			M1			M1			M1			M1
14	MW338			M1			M1			M1			M1
14	MW339			M1			M1			M1			M1
14	MW340			M1			M1			M1			M1
14	MW341			M1			M1			M1			M1
14	MW342			M1			M1			M1			M1
14	MW343			M1			M1			M1			M1
14	MW345			M1			M1			M1			M1
14	MW346			M1			M1			M1			M1
14	MW347			M1			M1			M1			M1
13, 14	MW353	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
1, 14	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
14	MW355			M1			M1			M1			M1
14	MW356			M1			M1			M1			M1
14	MW357			M1			M1			M1			M1
14	MW358			M1			M1			M1			M1
14	MW360			M1			M1			M1			M1
14	MW361			M1			M1			M1			M1
14	MW363			M1			M1			M1			M1
14	MW364			M1			M1			M1			M1
2, 14	MW366	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
14	MW367			M1			M1			M1			M1
14	MW369			M1			M1			M1			M1
14	MW370			M1			M1			M1			M1
14	MW372			M1			M1			M1			M1
14	MW373			M1			M1			M1			M1
14	MW376			M1			M1			M1			M1
14	MW380			M1			M1			M1			M1
14	MW381			M1			M1			M1			M1
14	MW384			M1			M1			M1			M1
14	MW385			M1			M1			M1			M1
14	MW387			M1			M1			M1			M1
14	MW388			M1			M1			M1			M1
14	MW391			M1			M1			M1			M1
14	MW392			M1			M1			M1			M1
2, 14	MW394	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
14	MW395			M1			M1			M1			M1
14	MW397			M1			M1			M1			M1
14	MW401			M1			M1			M1			M1
14	MW402			M1			M1			M1			M1
2, 14	MW409	M1	CB+M1	CB+M1	M1	M1	M1	M1	CB+M1	CB+M1	M1	M1	M1
2, 14	MW410	CB+M1	CB+M1	CB+M1	CB+M1	M1	M1	CB+M1	CB+M1	CB+M1	CB+M1	M1	M1
2, 14	MW411	CB+M1	M1	M1	CB+M1	M1	M1	CB+M1	M1	M1	CB+M1	M1	M1
14	MW414			M1			M1			M1			M1
14	MW415			M1			M1			M1			M1
14	MW416			M1			M1			M1			M1
14	MW417			M1			M1			M1			M1
2, 14	MW418	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
14	MW419			M1			M1			M1			M1
14	MW420			M1			M1			M1			M1
14	MW421			M1			M1			M1			M1
14	MW422			M1			M1			M1			M1
14	MW423			M1			M1			M1			M1
14	MW424			M1			M1			M1			M1
14	MW425			M1			M1			M1			M1
1, 14	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
1, 14	MW427	M2	CB+M2	M2	M2	CB+M2	M2	M2	CB+M2	M2	M2	CB+M2	M2
1, 14	MW428	M2	M2	CB+M2	M2	M2	CB+M2	M2	M2	CB+M2	M2	M2	CB+M2
1, 14	MW429 A	M2	CB+M2	M2	M2	M2	M2	M2	CB+M2	M2	M2	M2	M2
1, 14	MW430	CB+M2	M2	M2	M2	M2	M2	CB+M2	M2	M2	M2	M2	M2
1, 14	MW431	M2	M2	M2	CB+M2	M2	M2	M2	M2	M2	CB+M2	M2	M2
1, 14	MW432	M2	M2	M2	CB+M2	M2	M2	M2	M2	M2	CB+M2	M2	M2
14	MW433			M1			M1			M1			M1
14	MW435			M1			M1			M1			M1
14	MW439			M1			M1			M1			M1
14	MW440			M1			M1			M1			M1
14	MW441			M1			M1			M1			M1
14	MW442			M1			M1			M1			M1
14	MW443			M1			M1			M1			M1
14	MW444			M1			M1			M1			M1
13, 14	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
14	MW447			M1			M1			M1			M1
14	MW448			M1			M1			M1			M1
14	MW450			M1			M1			M1			M1
14	MW451			M1			M1			M1			M1
14	MW452			M1			M1			M1			M1
14	MW453			M1			M1			M1			M1
14	MW454			M1			M1			M1			M1
14	MW455			M1			M1			M1			M1
14	MW456			M1			M1			M1			M1
14	MW457			M1			M1			M1			M1
14	MW458			M1			M1			M1			M1
13, 14	MW459	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
14	MW460			M1			M1			M1			M1
14	MW461			M1			M1			M1			M1
14	MW462			M1			M1			M1			M1
2, 14	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
2, 14	MW464	M1	M1	M1	M1	M1	CB+M1	M1	M1	M1	M1	M1	CB+M1
2, 13, 14	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
2, 14	MW466	M1	M1	M1	CB+M1	M1	CB+M1	M1	M1	M1	CB+M1	M1	CB+M1
2, 14	MW467	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
2, 14	MW468	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
2, 14	MW469	CB+M1	M1	M1	M1	CB+M1	M1	CB+M1	M1	M1	M1	CB+M1	M1
2, 14	MW470	M1	M1	M1	CB+M1	M1	M1	M1	M1	M1	CB+M1	M1	M1
2, 13, 14	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
2, 14	MW472	M1	CB+M1	M1	CB+M1	M1	M1	M1	CB+M1	M1	CB+M1	M1	M1
2, 13, 14	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
2, 14	MW474	M1	M1	M1	CB+M1	M1	M1	M1	M1	M1	CB+M1	M1	M1
2, 14	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
2, 14	MW476	M1	M1	M1	CB+M1	M1	M1	M1	M1	M1	CB+M1	M1	M1
2, 14	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
14	MW478			M1			M1			M1			M1
14	MW479			M1			M1			M1			M1
14	MW480			M1			M1			M1			M1
2, 14	MW481	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
2, 14	MW482	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
2, 14	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
2, 14	MW484	M1	M1	M1	M1	M1	CB+M1	M1	M1	M1	M1	M1	CB+M1
2, 13, 14	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
2, 14	MW486A	M1	M1	M1	M1	M1	CB+M1	M1	M1	M1	M1	M1	CB+M1
2, 14	MW487	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
2, 14	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
14	MW489			M1			M1			M1			M1

		MONTH											
Activity	Well Number	1	2	3	4	5	6	7	8	9	10	11	12
14	MW490			M1			M1			M1			M1
13, 14	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
14	MW492			M1			M1			M1			M1
14	MW493			M1			M1			M1			M1
14	MW494			M1			M1			M1			M1
14	MW495			M1			M1			M1			M1
2, 14	MW496	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
14	MW497			M1			M1			M1			M1
14	MW498			M1			M1			M1			M1
14	MW499			M1			M1			M1			M1
14	MW500			M1			M1			M1			M1
14	MW501			M1			M1			M1			M1
14	MW502			M1			M1			M1			M1
14	MW503			M1			M1			M1			M1
14	MW504			M1			M1			M1			M1
14	MW505			M1			M1			M1			M1
14	MW506			M1			M1			M1			M1
14	MW507			M1			M1			M1			M1
14, 15	MW524			PT+M1			M1			M1			M1
14, 15	MW525			M1			CB+PT+M1			M1			M1
14, 15	MW526			M1			M1			CB+PT+M1			M1
14, 15	MW527			CB+PT+M1			M1			M1			M1
14	MW528			M1			M1			M1			M1
14, 15	MW529			M1			PT+M1			M1			M1
14, 15	MW530			M1			M1			PT+M1			M1
14	MW531			M1			M1			M1			M1
14	MW532 (PZ)			M1			M1			M1			M1
14	MW533			M1			M1			M1			M1
14	MW534 (PZ)			M1			M1			M1			M1
14	MW535 (PZ)			M1			M1			M1			M1
14	MW536			M1			M1			M1			M1
14	MW537			M1			M1			M1			M1
14	MW538			M1			M1			M1			M1
14	MW539			M1			M1			M1			M1
14	MW540 (PZ)			M1			M1			M1			M1
14	MW541 (PZ)			M1			M1			M1			M1
14	MW542			M1			M1			M1			M1
14	MW543			M1			M1			M1			M1
14	MW544			M1			M1			M1			M1
14	MW545			M1			M1			M1			M1
14	MW546			M1			M1			M1			M1
14	MW547			M1			M1			M1			M1
14	MW548			M1			M1			M1			M1
14	MW549			M1			M1			M1			M1
14	MW550			M1			M1			M1			M1
14	MW551			M1			M1			M1			M1
14	MW553 (PZ)			M1			M1			M1			M1
14	MW554 (PZ)			M1			M1			M1			M1
14	MW555 (PZ)			M1			M1			M1			M1
14	MW556			M1			M1			M1			M1
14	PZ107			M1			M1			M1			M1
14	PZ109			M1			M1			M1			M1
14	PZ110			M1			M1			M1			M1
14	PZ114			M1			M1			M1			M1
14	PZ115			M1			M1			M1			M1
14	PZ117			M1			M1			M1			M1
14	PZ118			M1			M1			M1			M1
14	PZ287			M1			M1			M1			M1
14	PZ289			M1			M1			M1			M1
14	PZ290			M1			M1			M1			M1
14	PZ349			M1			M1			M1			M1
14	PZ351			M1			M1			M1			M1
14	EW232			M1			M1			M1			M1
14	EW233			M1			M1			M1			M1
14	EW234			M1			M1			M1			M1
14	EW235			M1			M1			M1			M1

Notes

CB=Colloidal Borescope Deployment

PT=Pressure Transducer Deployment

M1=Manual Water Level Collected Once per Month

M2= Manual Water Level Collected Twice per Month

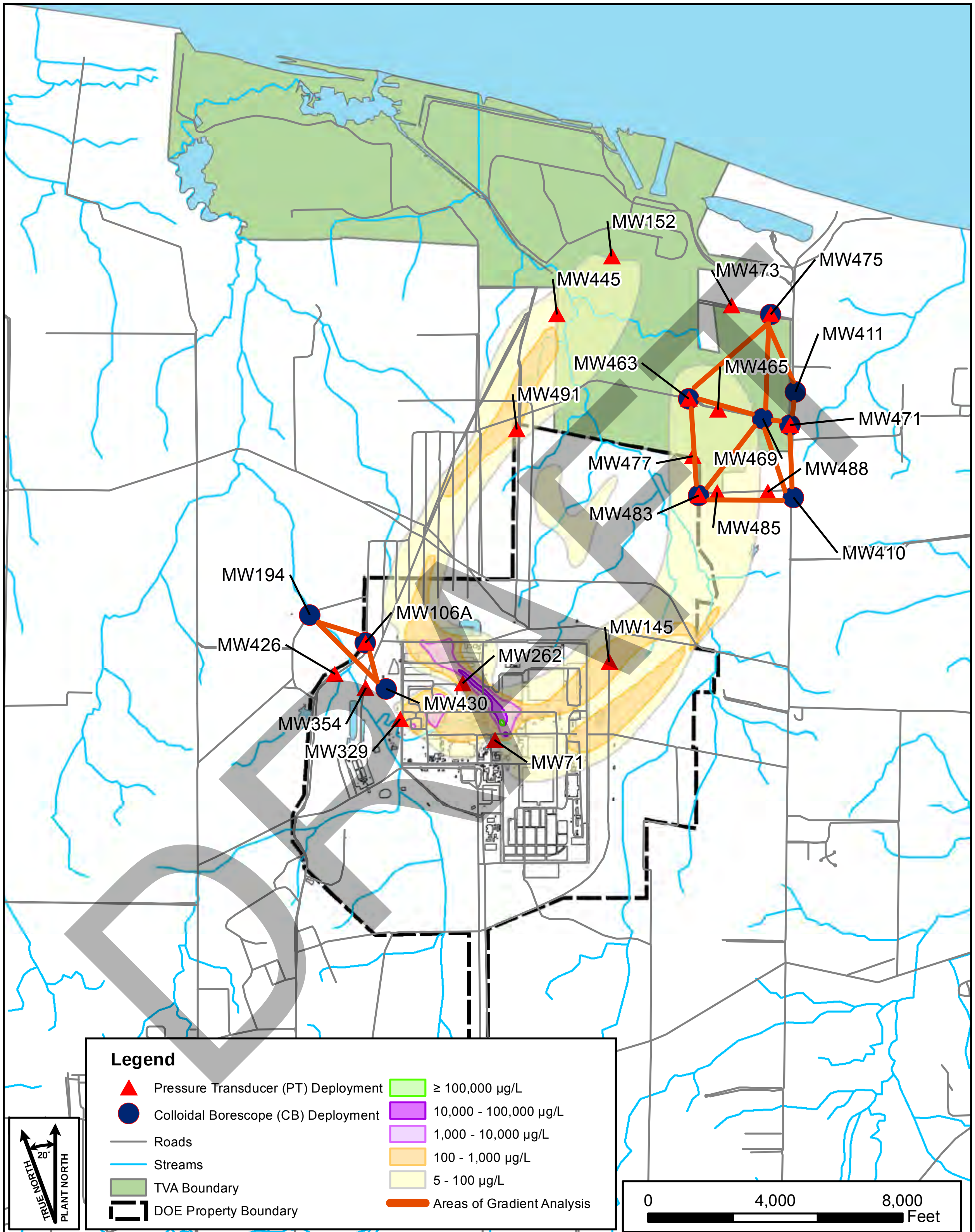

Figure 5. Colloidal Borescope and Pressure Transducer Wells – Month 1

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

FOUR RIVERS NUCLEAR PARTNERSHIP, LLC

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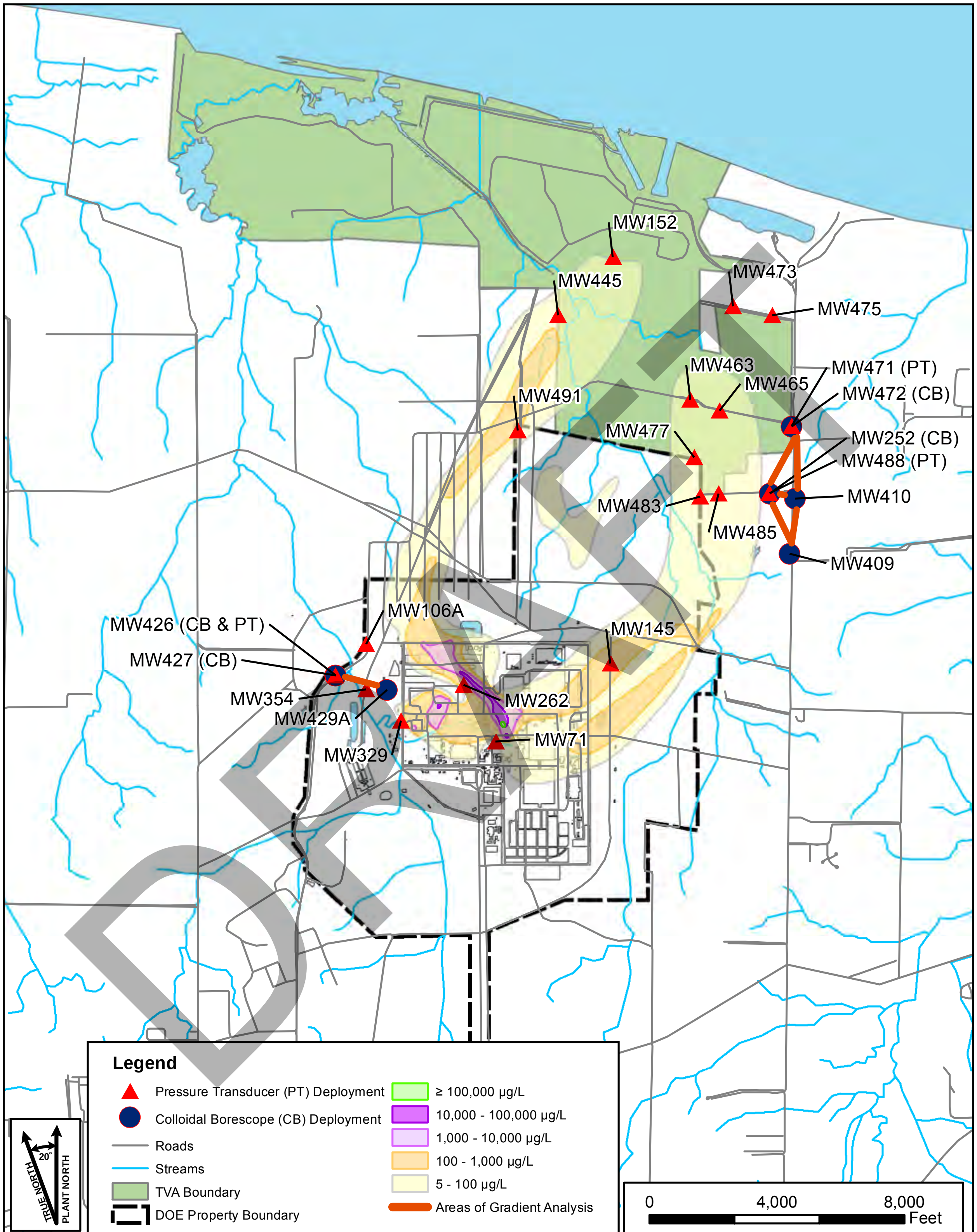

Figure 5. Colloidal Borescope and Pressure Transducer Wells – Month 2

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

FOUR RIVERS NUCLEAR PARTNERSHIP, LLC

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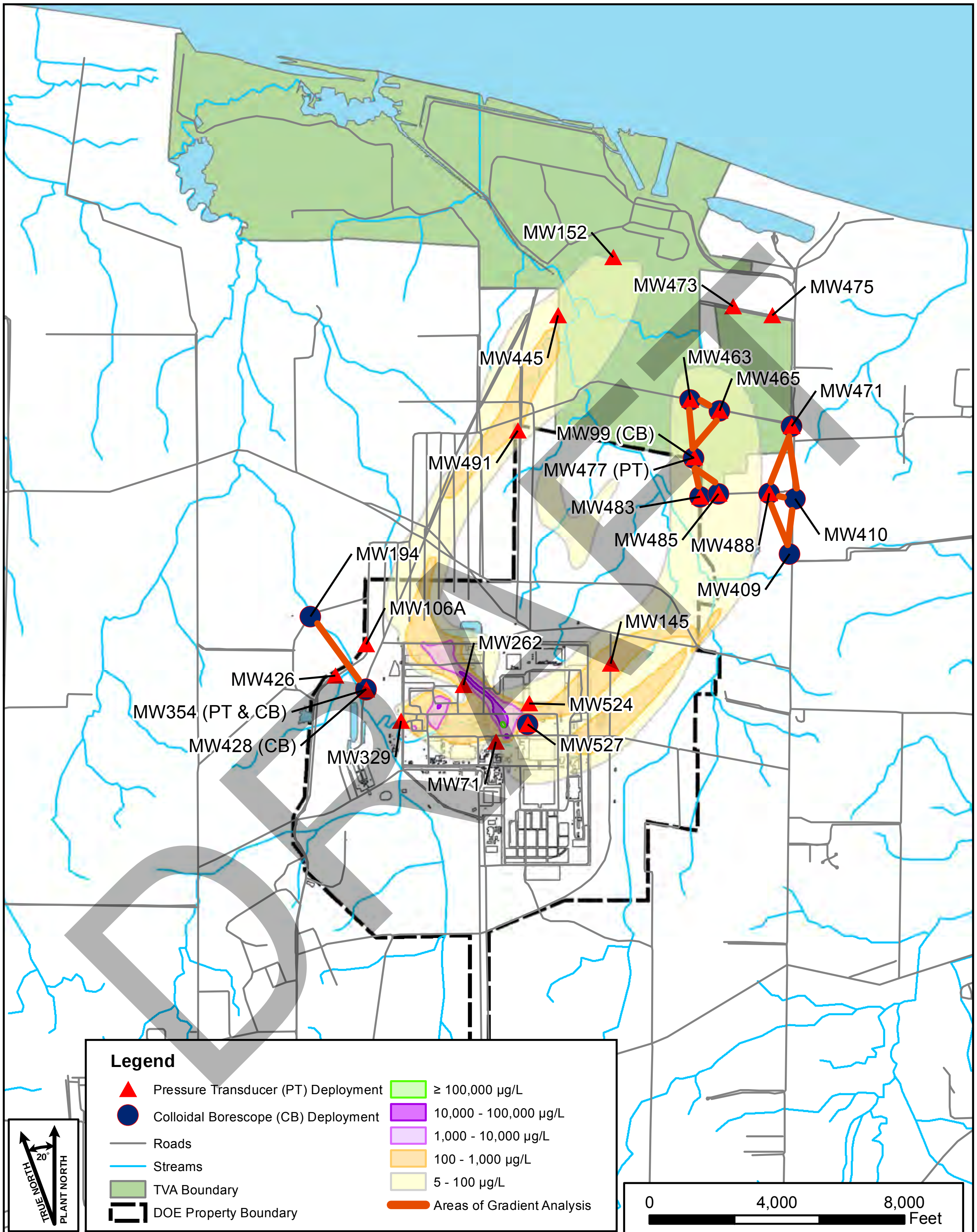

Figure 5. Colloidal Borescope and Pressure Transducer Wells – Month 3

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DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
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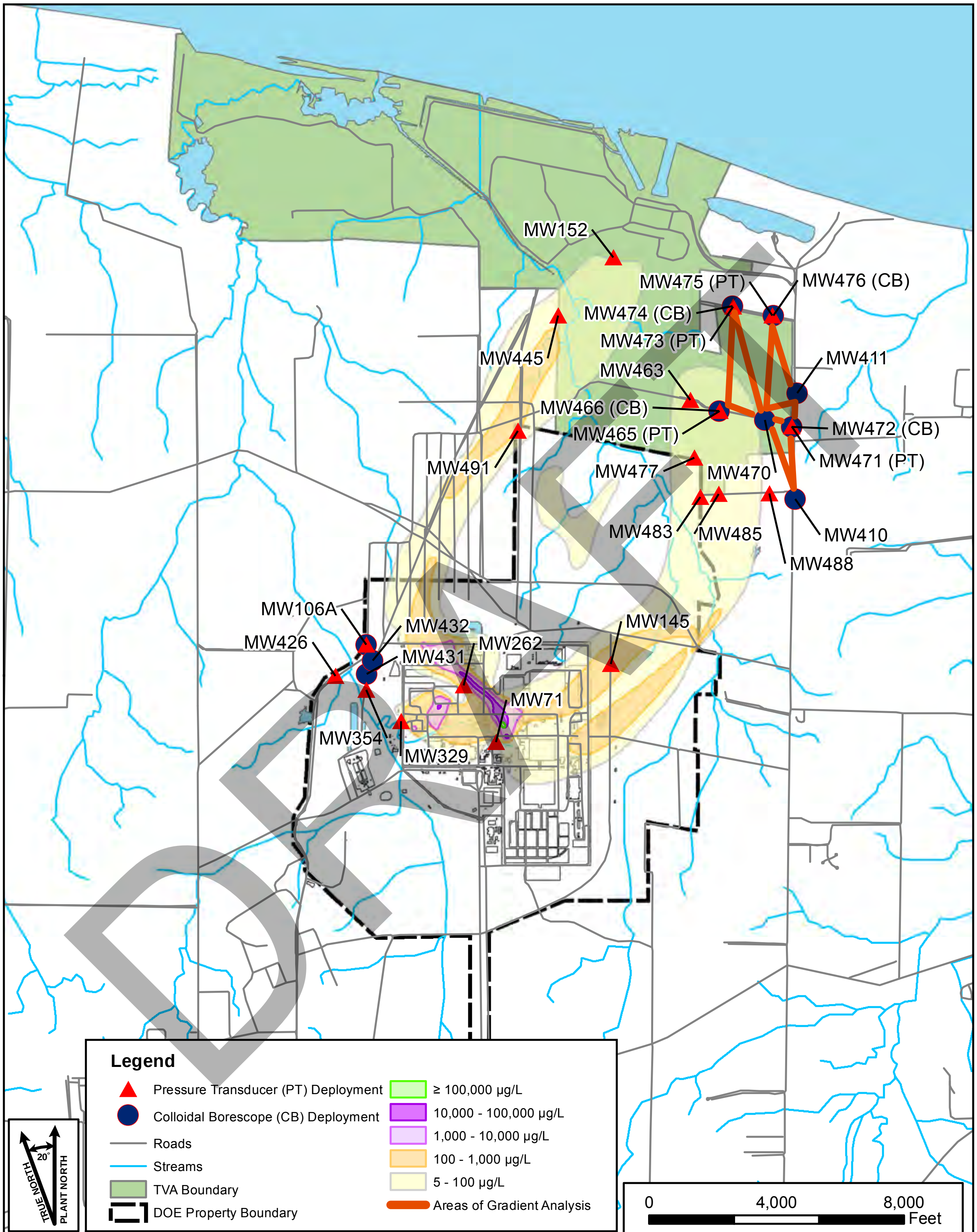

Figure 5. Colloidal Borescope and Pressure Transducer Wells – Month 4

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

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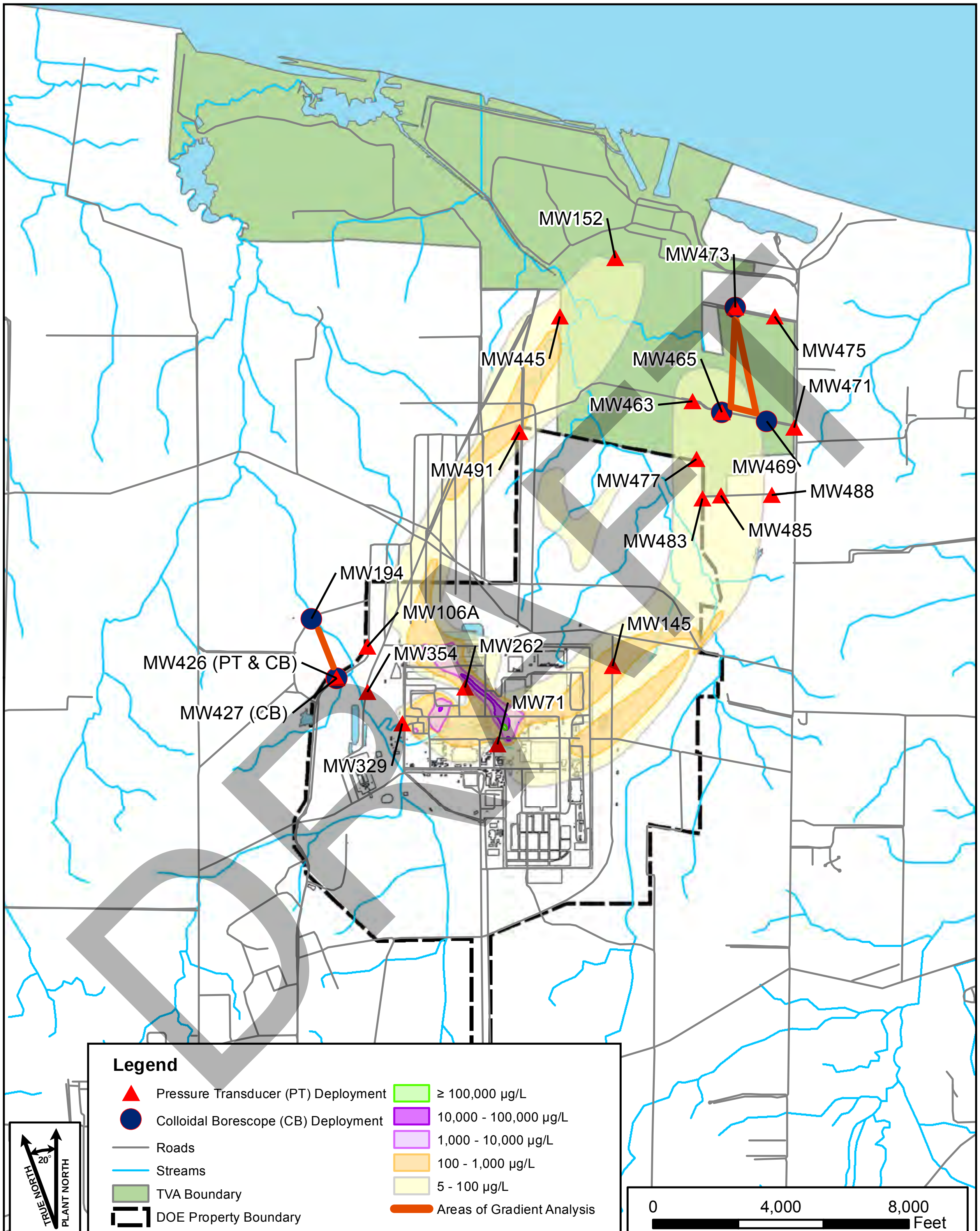

Figure 5. Colloidal Borescope and Pressure Transducer Wells – Month 5

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

FOUR RIVERS NUCLEAR PARTNERSHIP, LLC

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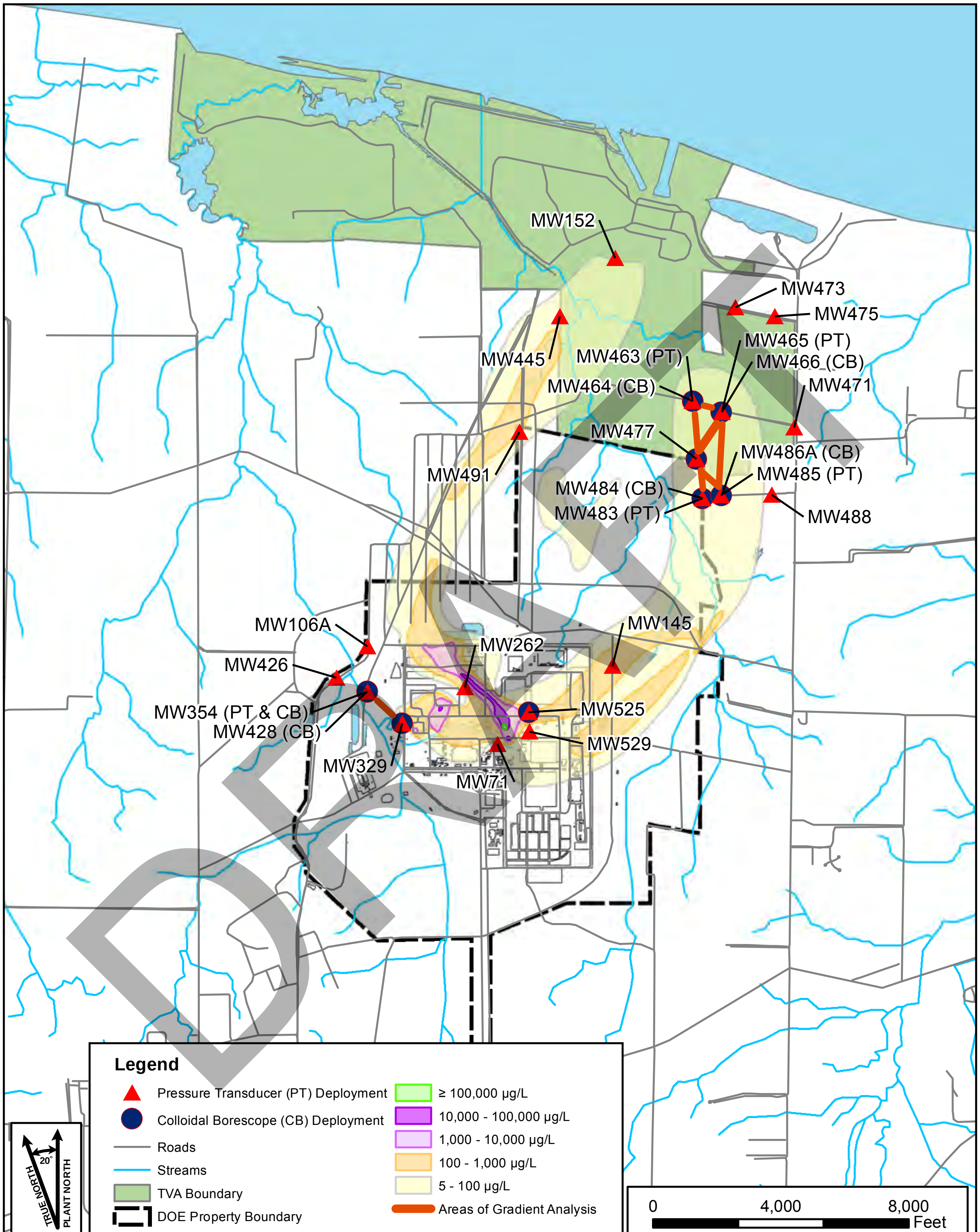

Figure 5. Colloidal Borescope and Pressure Transducer Wells – Month 6

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

FOUR RIVERS NUCLEAR PARTNERSHIP, LLC

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2/14/2019

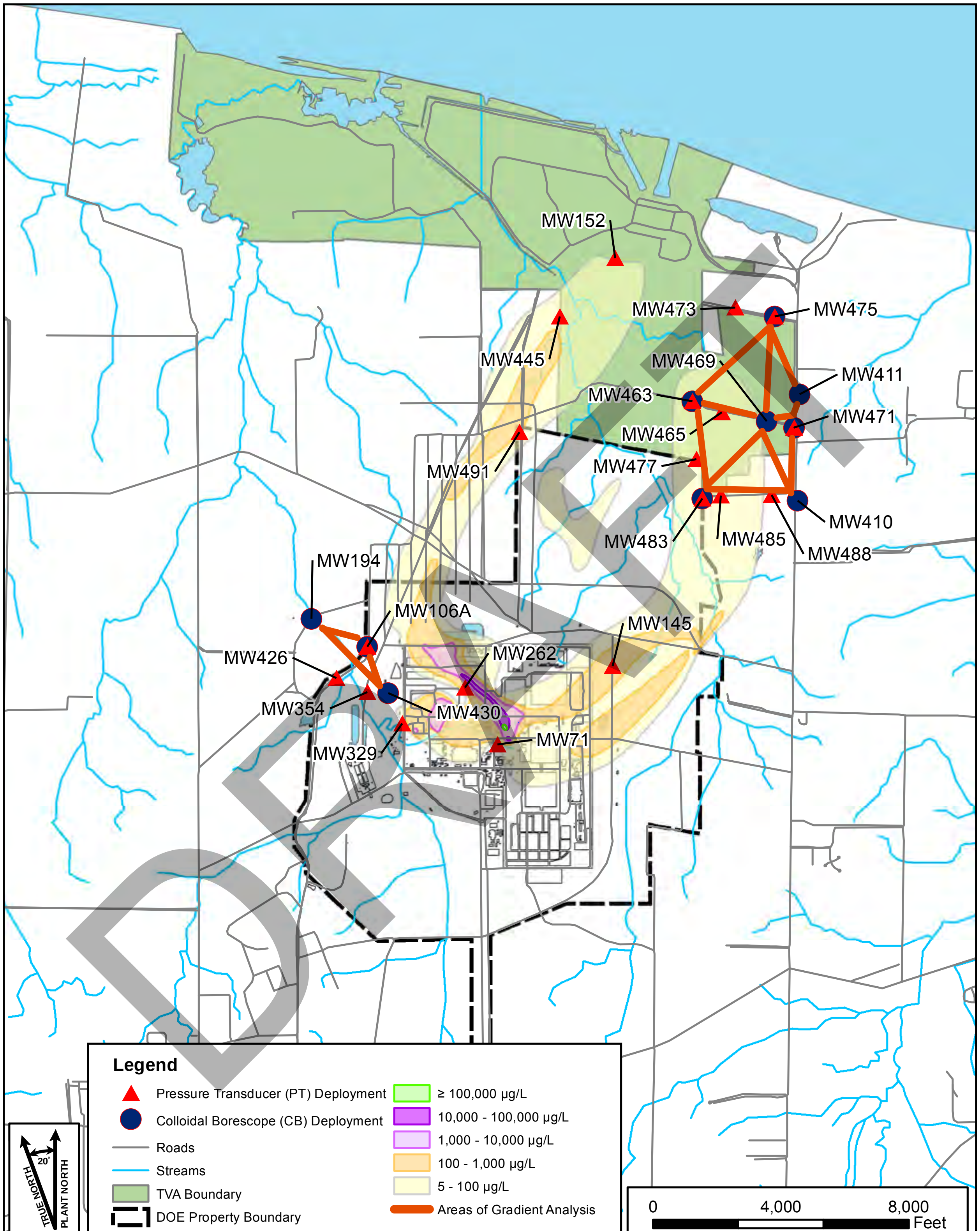

Figure 5. Colloidal Borescope and Pressure Transducer Wells – Month 7

U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT
FOUR RIVERS NUCLEAR PARTNERSHIP, LLC

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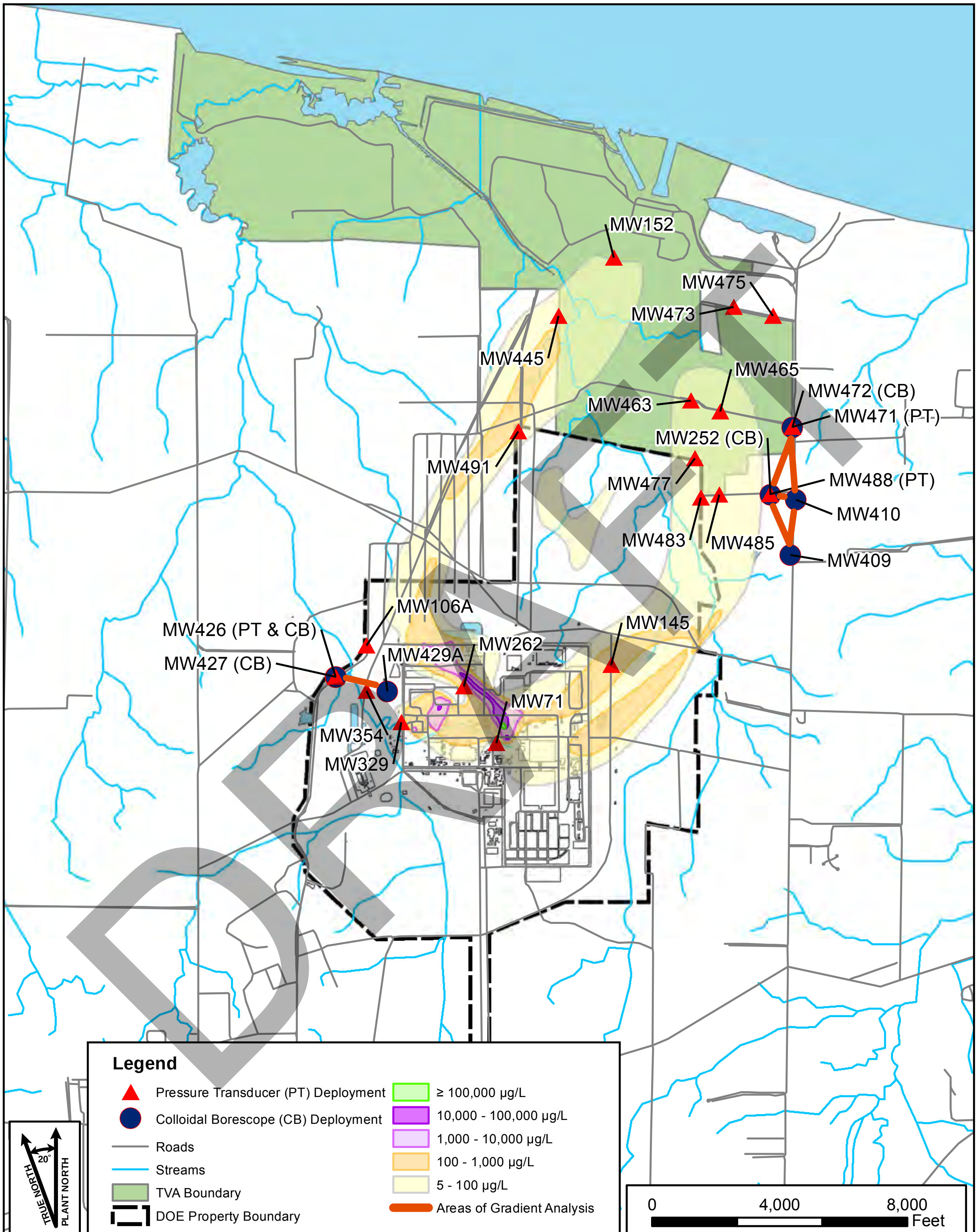

Figure 5. Colloidal Borescope and Pressure Transducer Wells – Month 8

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

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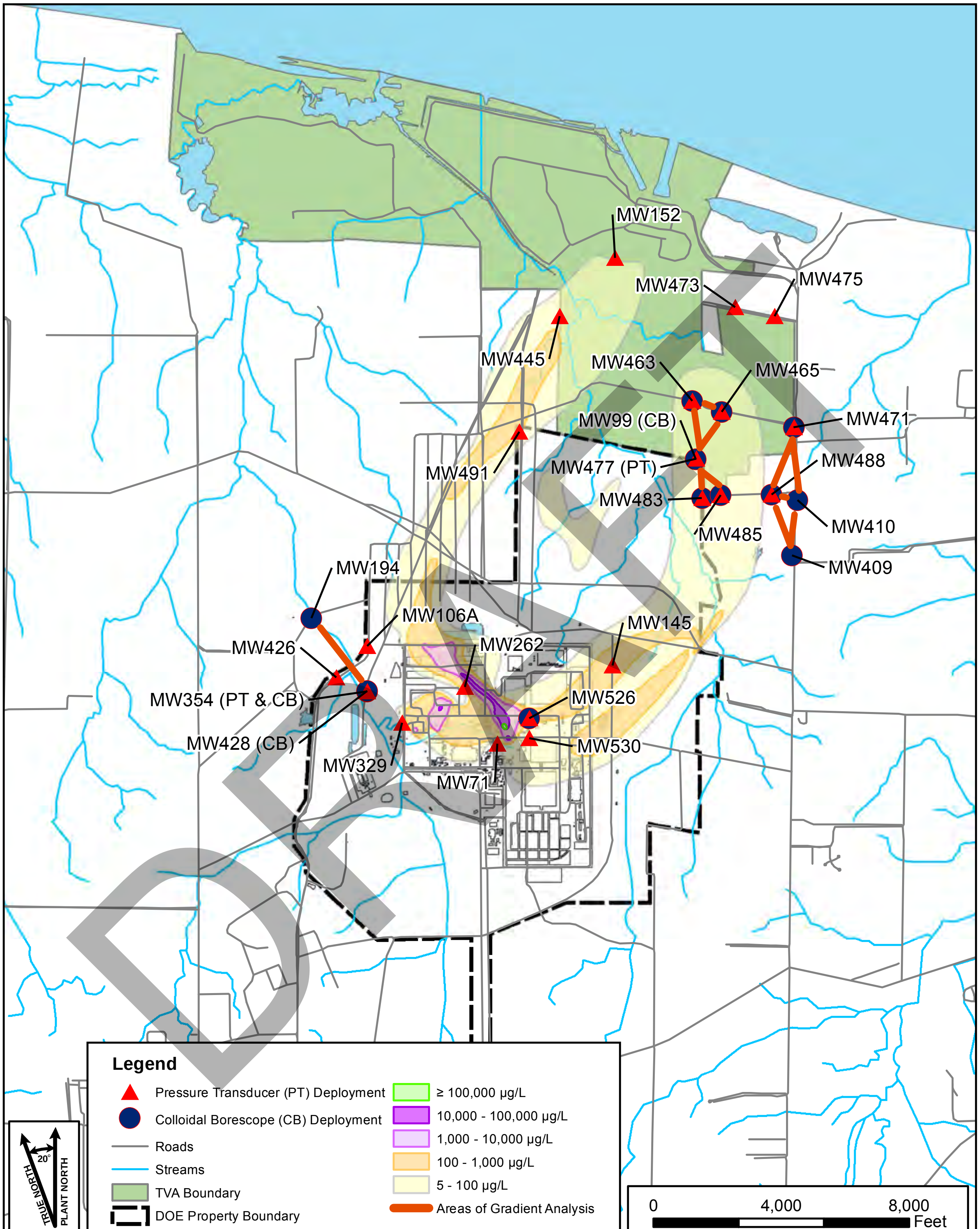

Figure 5. Colloidal Borescope and Pressure Transducer Wells – Month 9

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

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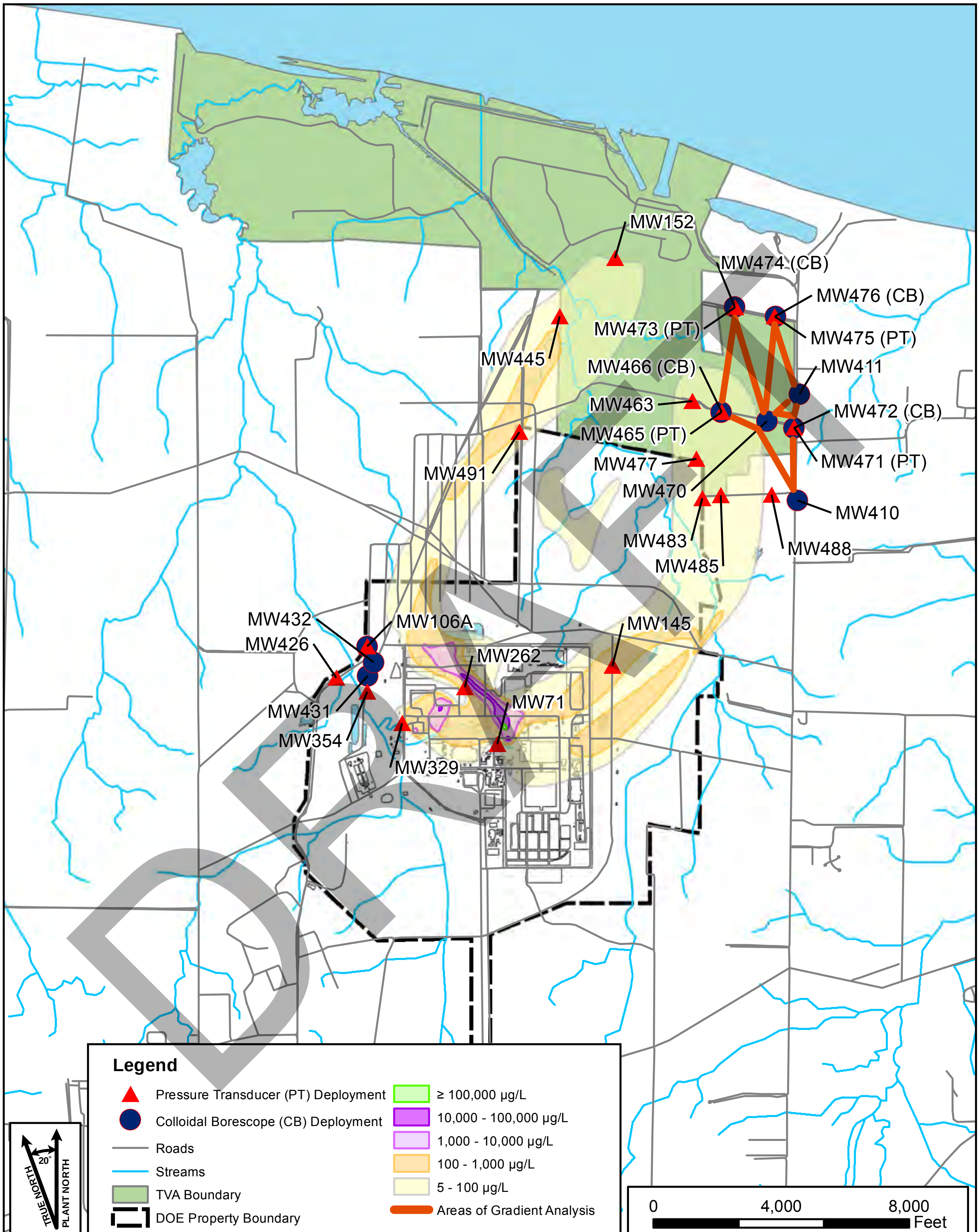

Figure 5. Colloidal Borescope and Pressure Transducer Wells – Month 10

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

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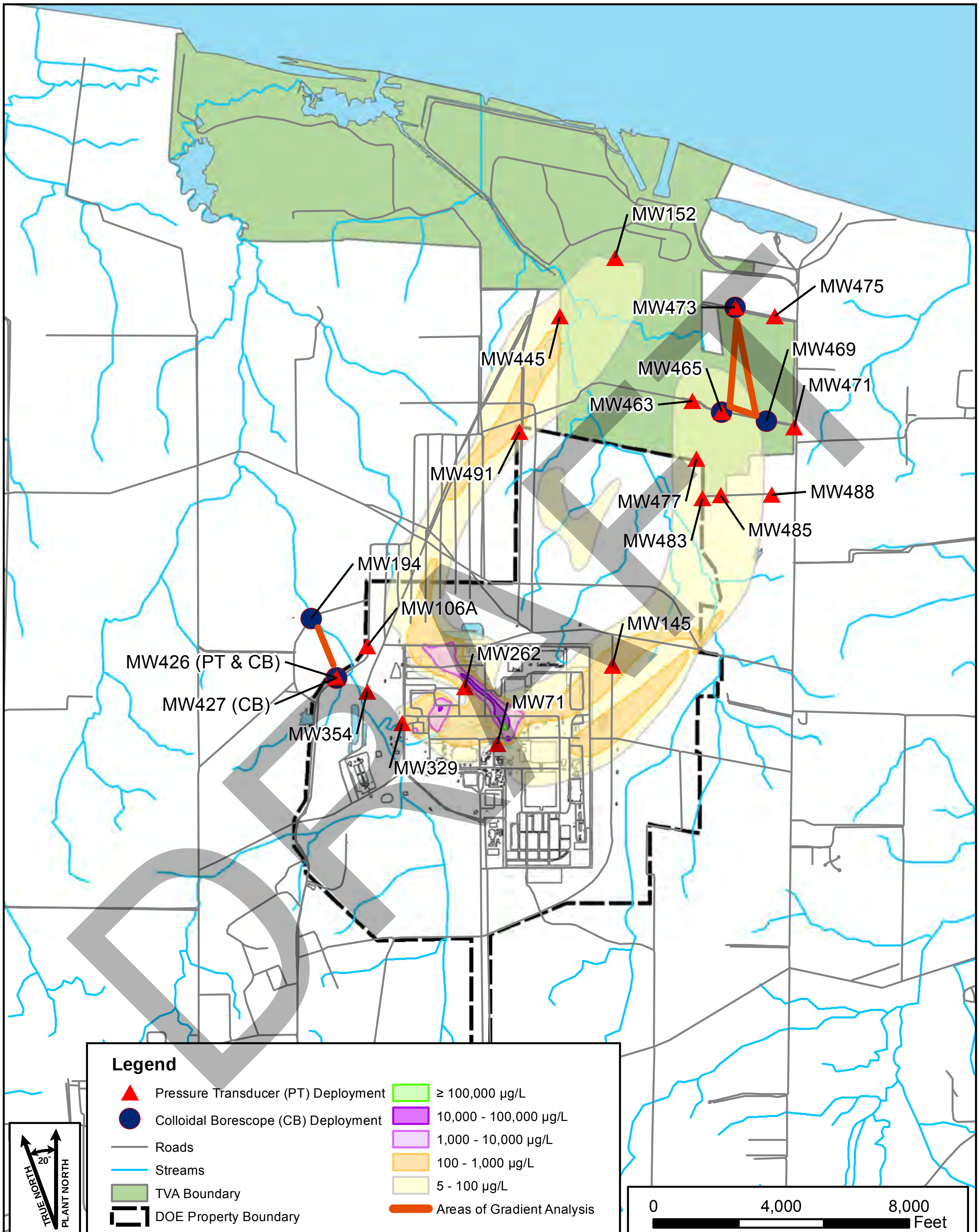

Figure 5. Colloidal Borescope and Pressure Transducer Wells – Month 11

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

FOUR RIVERS NUCLEAR PARTNERSHIP, LLC

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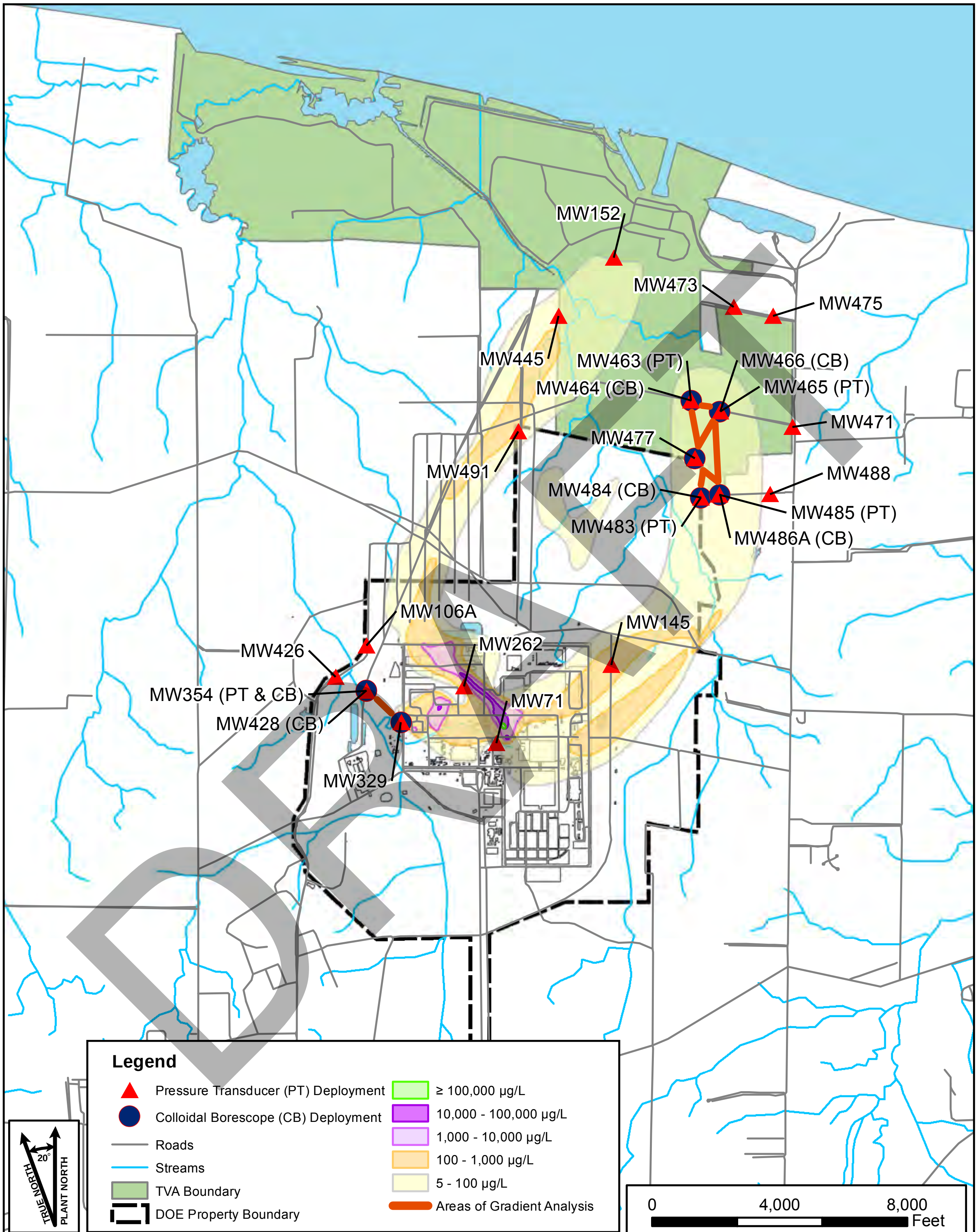

Figure 5. Colloidal Borescope and Pressure Transducer Wells – Month 12

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

FOUR RIVERS NUCLEAR PARTNERSHIP, LLC

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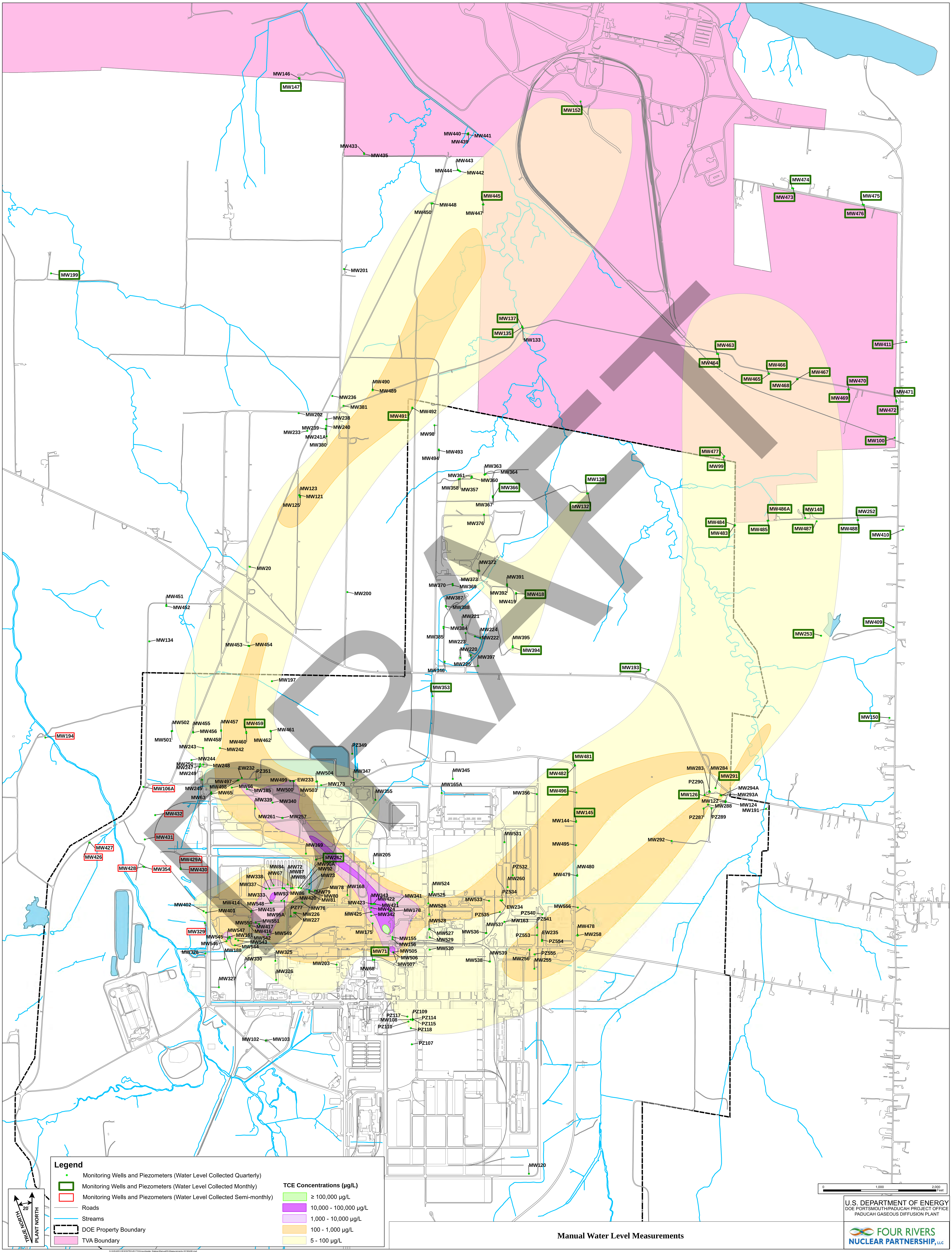
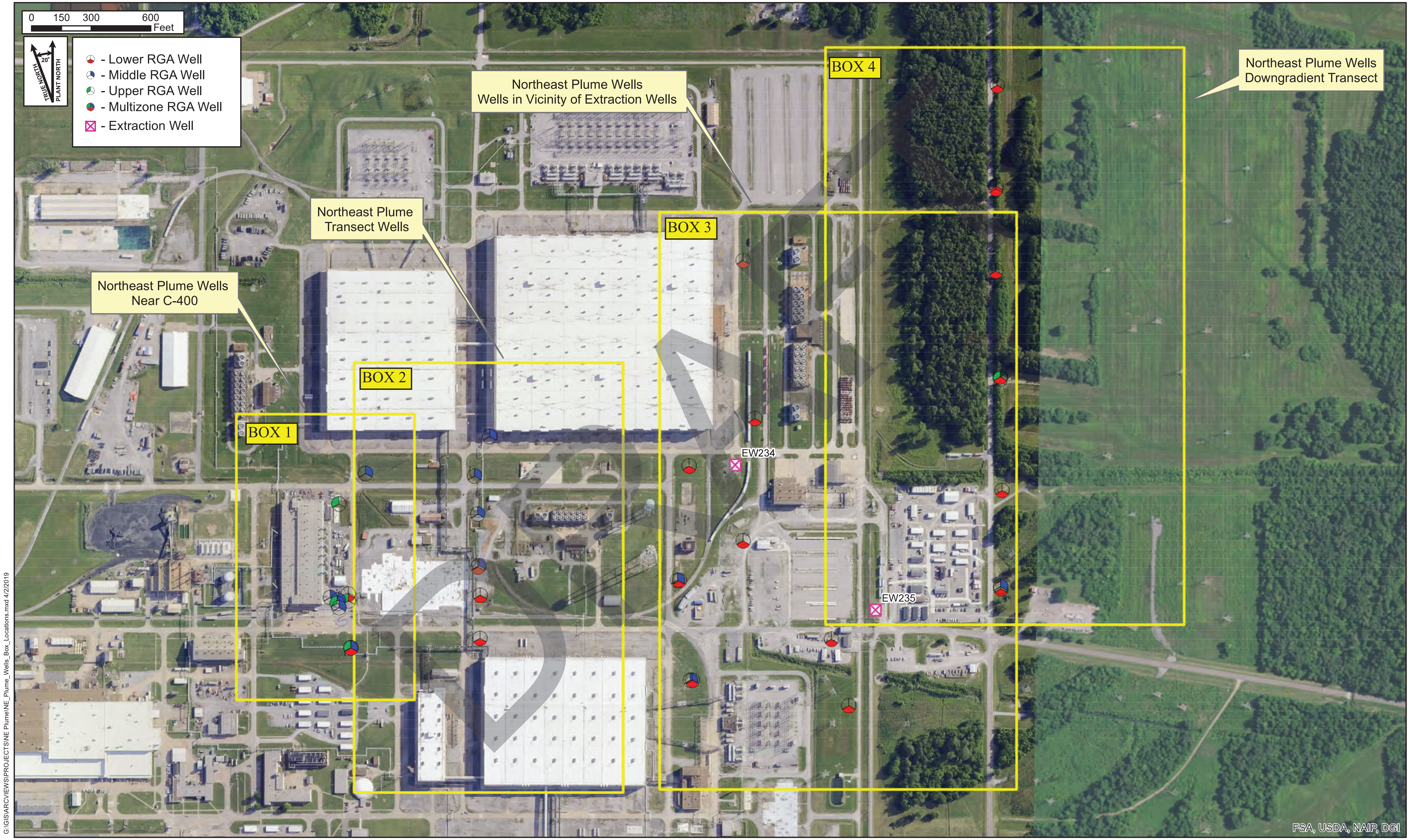


DRAFT FOR DISCUSSION ONLY

Attachment 5



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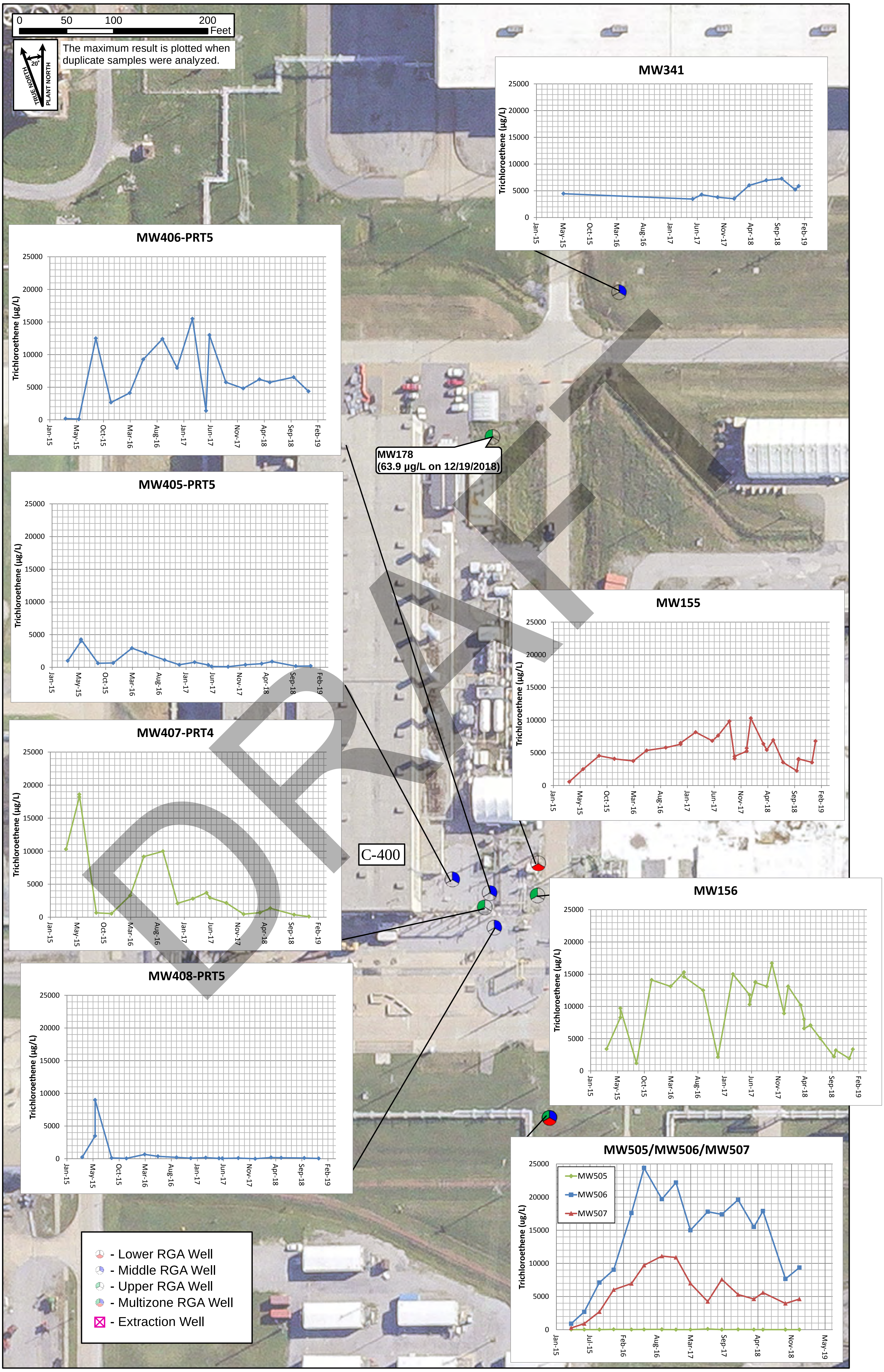
Box 1

Northeast Plume Wells
Near C-400
TCE Sampling Results



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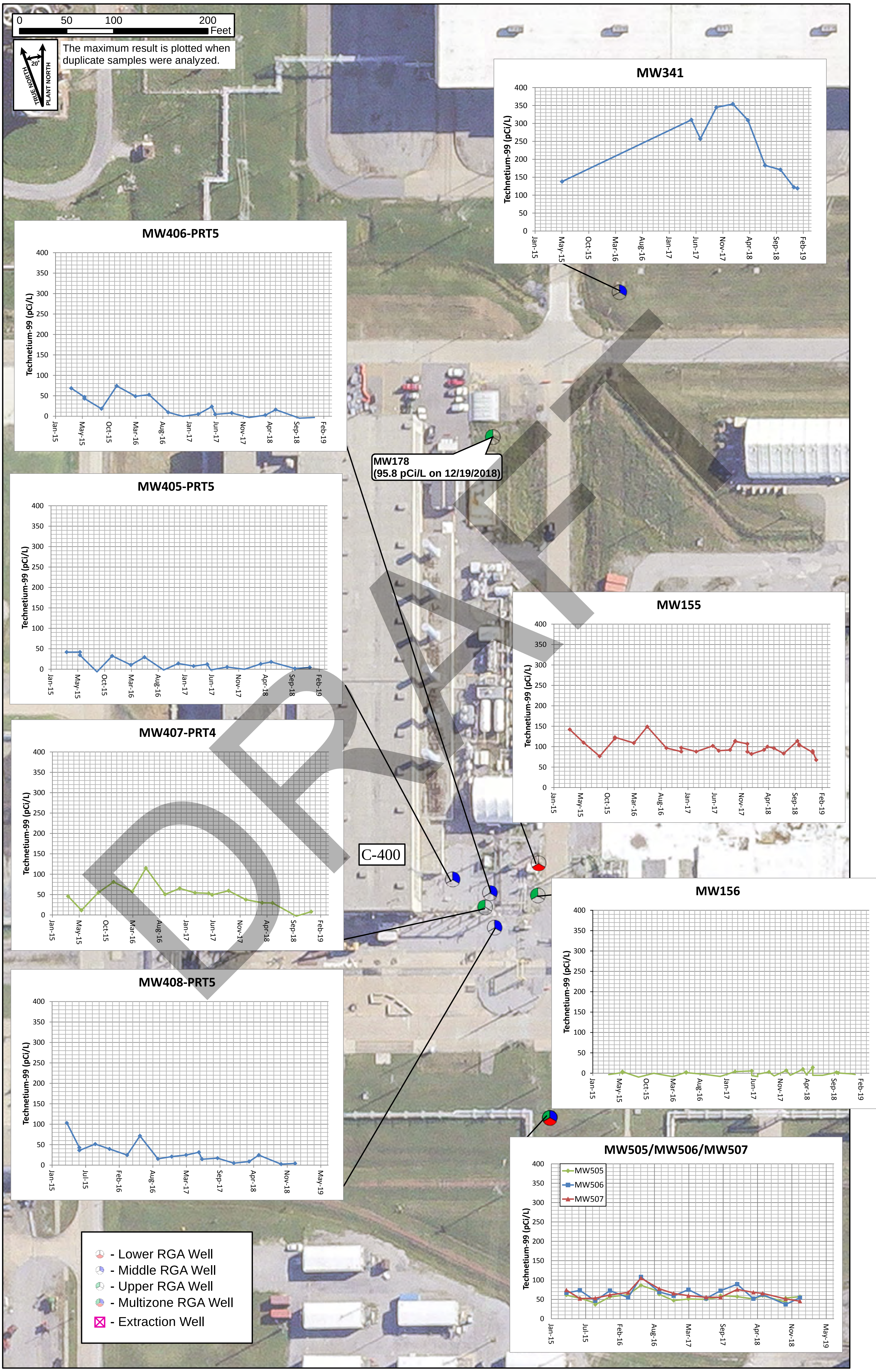
Att5-2

Box 1

Northeast Plume Wells
Near C-400
Tc-99 Sampling Results



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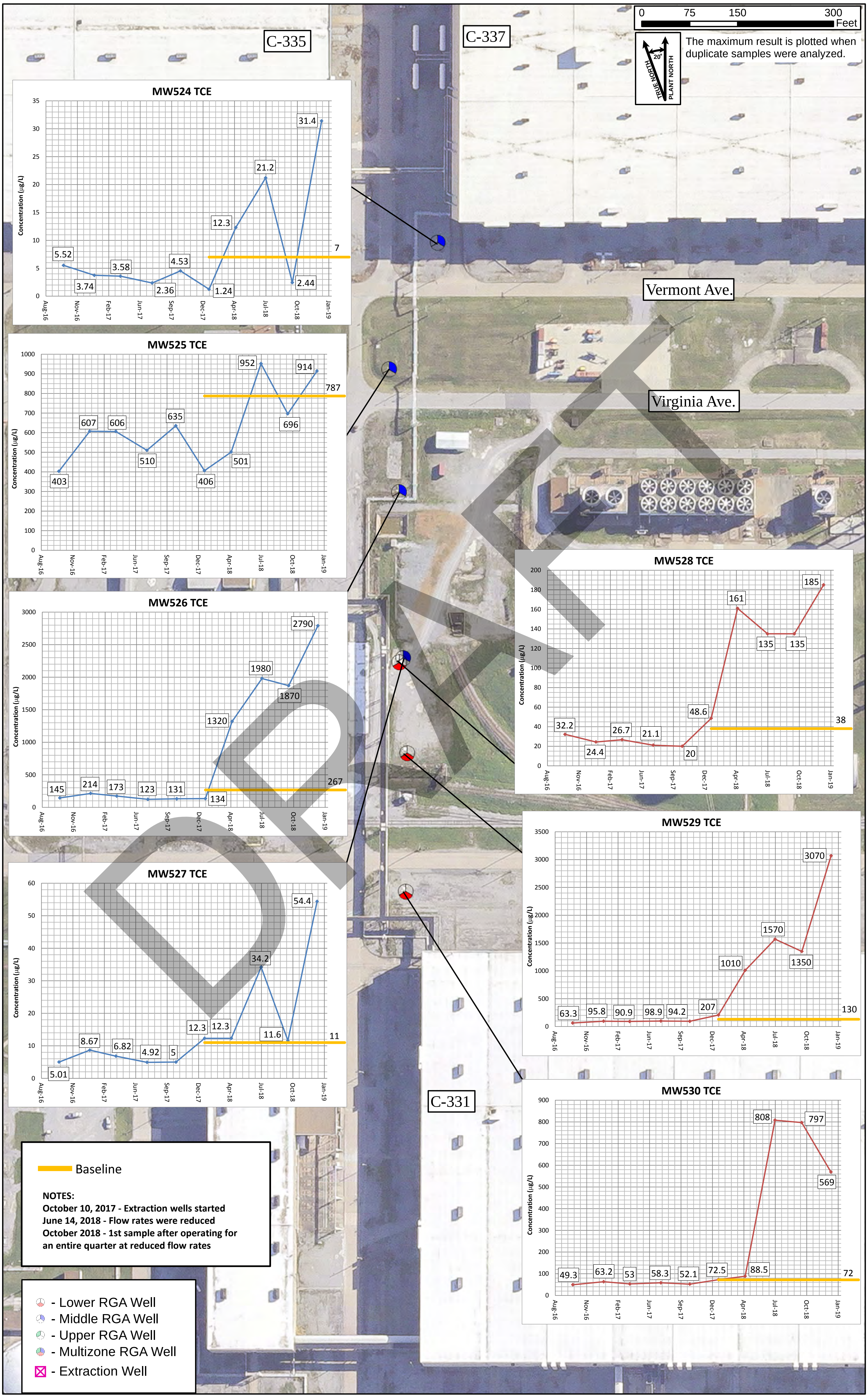
Att5-3

DRAFT WORKING COPY FOR DISCUSSION ONLY

Box 2

Northeast Plume Transect Well
Quarterly Sampling Results
Trichloroethene (TCE)



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Att5-4

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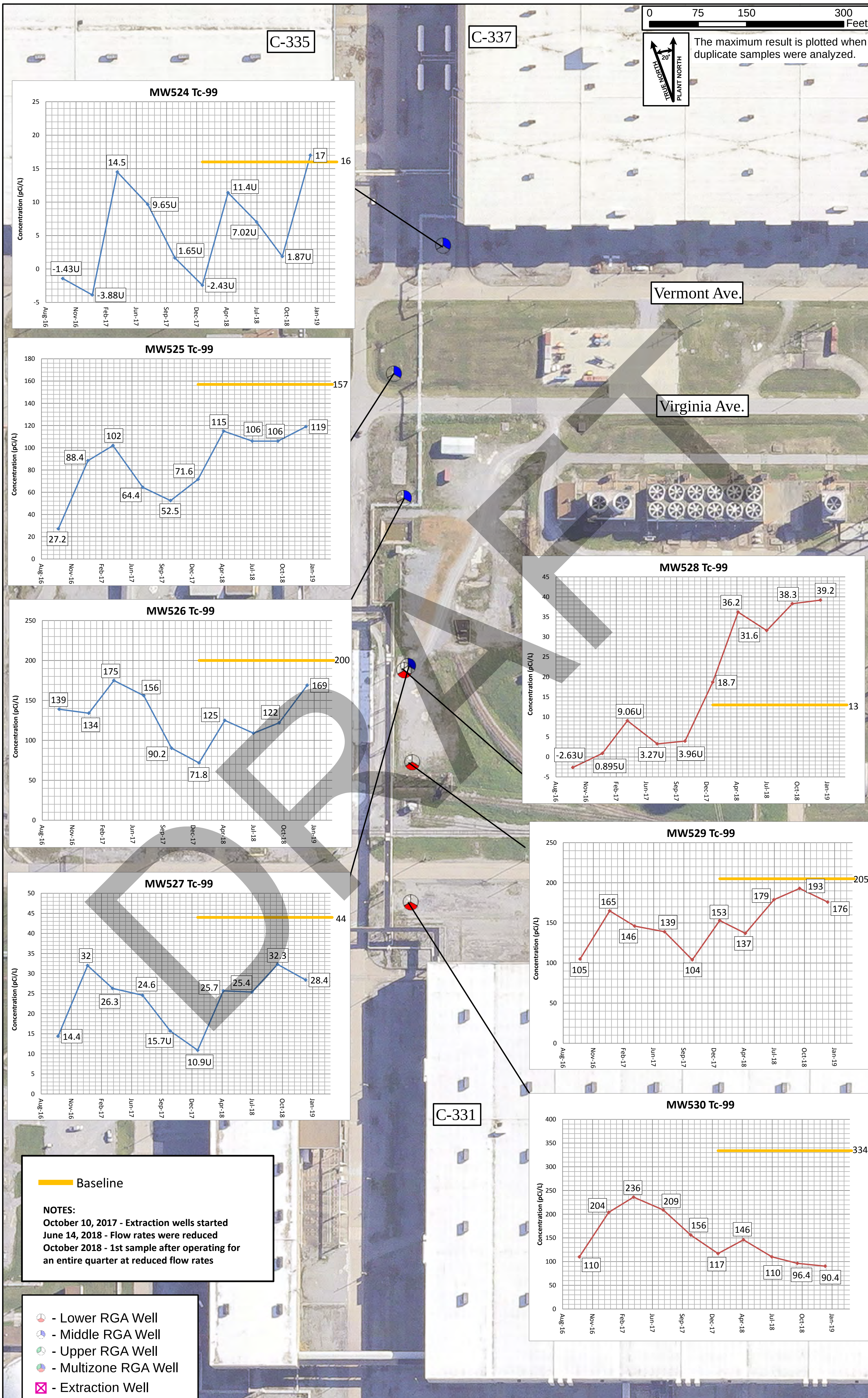
Northeast Plume Transect Well
Quarterly Sampling Results
Technetium-99 (Tc-99)

Box 2



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Att5-5

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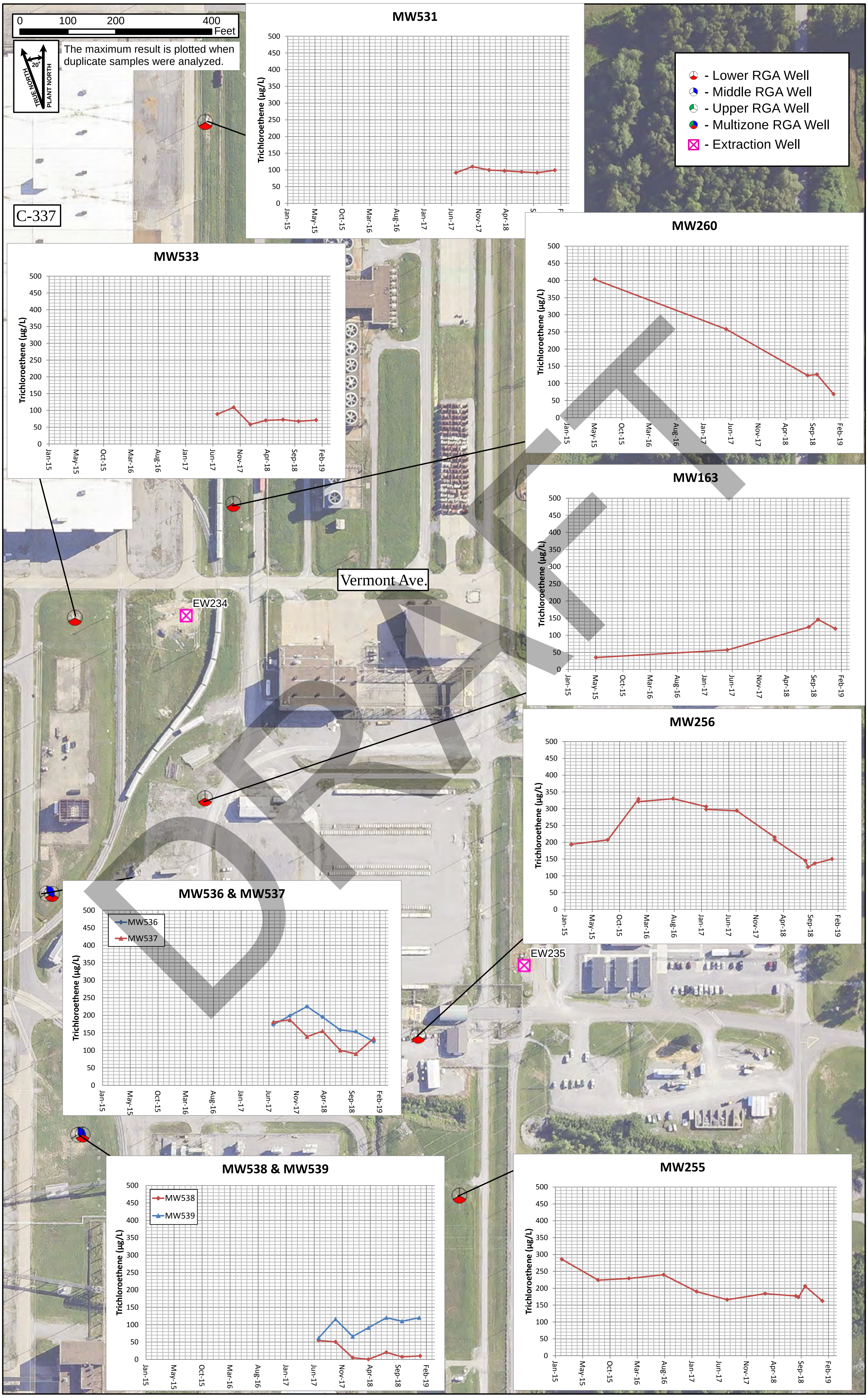
Northeast Plume Wells
Wells in Vicinity of Extraction Wells
TCE Sampling Results

Box 3



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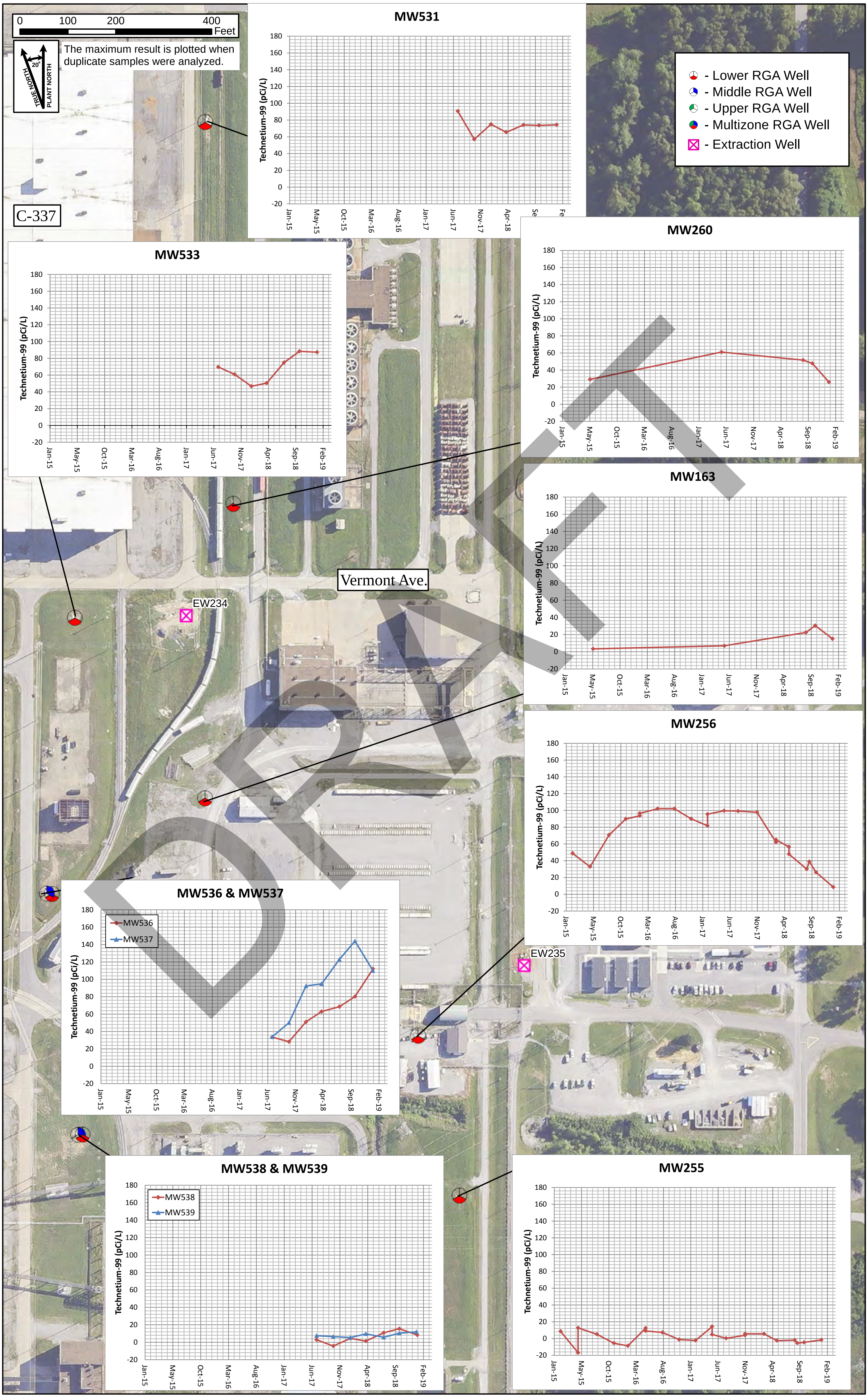
Att5-6

DRAFT WORKING COPY FOR DISCUSSION ONLY

Box 3

Northeast Plume Wells
Wells in Vicinity of Extraction Wells
Tc-99 Sampling Results



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Att5-7

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APPENDIX C

GROUNDWATER MODELING WORKING GROUP MEETING SUMMARY—JULY 17, 2019

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ACRONYMS

AIP	agreement in principal
amsl	above mean sea level
DNAPL	dense nonaqueous phase liquid
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
FY	fiscal year
KY	Commonwealth of Kentucky
LIDAR	light detection and ranging
MW	monitoring well
MWG	Modeling Working Group
PGDP	Paducah Gaseous Diffusion Plant
PZ	piezometer
RGA	Regional Gravel Aquifer
RI	remedial investigation
SWMU	solid waste management unit
TVA	Tennessee Valley Authority
USGS	U.S. Geological Survey

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Paducah Site Groundwater Modeling Working Group
Meeting Summary—July 17, 2019

Noman Ahsanuzzaman ✓
Brian Begley ✓
Ben Bentkowski
Rich Bonczek ✓
Stephanie Brock
Martin Clauberg ✓
Bryan Clayton ✓
Julie Corkran ✓
Jana Dawson
Eva Davis ✓
Ken Davis ✓
Dave Dollins ✓
Rob Flynn ✓
Bruce Ford ✓
Stefanie Fountain
LeAnne Garner ✓
Nathan Garner ✓
Steve Hampson
Jeri Higginbotham ✓
Chris Jung
Brian Lainhart
Kelly Layne
Mac McRae ✓
Teresa Overby ✓
Todd Powers ✓
Bruce Stearns ✓
Tracy Taylor ✓
Chris Travis ✓
Denise Tripp ✓

✓ Indicates member was present.

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

Comments to the MW460 white paper were made in April 2019. Julie included suggested additions to the paper. Rich provided revisions to the suggested additions (revisions are noted below in redline/struck-through text).

Consistent with our discussions and agreement on text for inclusion in the fiscal year (FY) 2018 Five-Year Review, EPA would like to see the following paragraph inserted into the Introduction (or Interpretation) section of the MW460 By-Pass White Paper:

It is noted that a recent review of seismic information indicates that some contaminant plume migration at PGDP might be fault-controlled. More recently, a review of results from seismic (shear wave) and electrical resistivity (dipole-dipole) experiments inferred that the groundwater TCE plumes at PGDP is aligned with the general orientation of an underlying Paleozoic fault system (Almayahi and Wollery 2018). This inference is consistent with alignment of the Northwest Plume with a series of imaged grabens identified by Blits, Woolery, Macpherson, and Hampson in 2008. As such, the increasing TCE levels in downgradient MW460 may be an indication of plume migration along structurally controlled preferential pathway(s) due to faulting. Currently, uncertainty exists regarding the influence of fault-control plume migration both within the PGDP security-fenced area and outside this area. Detailed correlations between lithologic units across the site ~~will~~ should be developed so an accurate characterization of site faulting can be performed.

And the following sentence repeated in the Conclusions section of the paper:

Detailed correlations between lithologic units across the site ~~will~~ should be developed so that the uncertainty in the presence of ~~an accurate characterization of~~ site faulting and its potential impact on contaminant movement and groundwater flow can be ~~performed~~addressed.

These additions will be included in the revised MW460 white paper.

2. Status of Previous Meeting Summary

No comments received on April 10, 2019, face-to-face Meeting Summary (sent to participants on 4/18/2019). McNairy well information and data were provided as follow-up information by Dave Dollins on 5/6/2019. A map depicting McNairy wells (with the RGA TCE Plume) was included with that follow-up information. A similar map without the RGA TCE Plume has been attached to this summary as Attachment 1.

3. FY 2019 Work Plan/Schedule

Schedule/work plan has been acknowledged by the MWG.
Remaining schedule:

Quarterly Meeting (July)	7/17/2019
Comments due for Meeting Notes and White Papers compilations	9/30/2019
Quarterly Meeting (October)	10/2/2019

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. Currently, a face-to-face meeting is not scheduled.

Color code for schedule:

Due date	Quarterly meeting
Submittal date	Concurrence/acknowledgement date

LeAnne will send out Meeting Notes and White Papers compilations in draft for a final round of comments.

4. FY 2020 Work Plan/Schedule

A draft schedule/work plan will be developed before the October 2019 quarterly meeting. Suggestions should be sent to LeAnne by September 16, 2019.

5. 2018 Plume Maps Document

The document was provided June 19, 2019. A link to the document can be found here:
https://pubdocs.pad.pppo.gov/?dir=Plume%20Map%20Documents/2018%20Update

Early observations from the document follow.

- The Northwest Plume shows a reduction in TCE levels and may be moving slightly to the east. Reduction of the plume may be due to several factors, including the new extraction wells and/or a change of chemistry in the lagoons [e.g., oxidation-reduction potential no longer being affected by phosphates/sulfates (anaerobic/abiotic degradation supported by leakage from lagoons, etc.)]

- Northeast Plume extent is similar to the one mapped for 2016, but is moving slightly to the west. There are continuing changes near the C-400/electrical resistance heating area.

- Areas outside the mapped plume (e.g., MW106A and MW354 in the former Southwest Plume area) are near maximum contaminant levels. (This area is being investigated by the colloidal borescope.)

An initial observation by EPA is that comments made by KY and EPA on the 2016 Plume Map Document do not appear addressed in the 2018 Plume Map Document. Plume maps for the maximum results were added for the 2018 Plume Maps and are similar to plume maps drawn for the most recent data. The alternate maps (with maximum results) aided in drawing the official plume maps (with the most recent data).

KY and EPA expect to provide comments on the 2018 Plume Map.

6. Update on Paducah Site Monitoring Well Abandonment/Replacement

Any planned monitoring well abandonment/replacements should be listed here in the quarterly meetings as a standing item (i.e., this should be left on the agenda for future meetings).

MW84, MW87, and MW93 at the C-404 Landfill were abandoned and replaced. Final steps still are being completed (e.g., well pads and posts). The wells are expected to be sampled this quarter. For reference, the C-404 Landfill is SWMU 3, an aboveground RCRA landfill. The wells were replaced because there was evidence of failure of the casing at MW93. All three wells were installed in the 1988 time frame.

MW152 has been abandoned because of the basin built by Tennessee Valley Authority (TVA). Installation of a new "sentinel" well on TVA property that replaces MW152 still is to be installed. That well will be designated MW583.

7. KY Agreement in Principle (AIP) Update

AIP updates should be listed here in the quarterly meetings as a standing item (i.e., this should be left on the agenda for future meetings).

KY AIP will collect water levels from TVA wells during the synoptic events (planned for the week of August 12). AIP will be measuring water levels in the same 15 wells, in addition to measuring water levels in wells not measured previously along West Kentucky Wildlife Management Area Tract 6.

Brian will distribute boring logs/well construction for the Tract 6 wells. Elevations for reference points will be determined; LIDAR data may be used.

The following individuals from TVA were included in the electronic distribution for the 2018 Plume Map Document: bwhatton@tva.gov; hjlawrence@tva.gov; and rkdehart@tva.gov

8. Update on Water Level Gauge at Metropolis Lake

Ken provided an update on the water level measurements at Metropolis Lake. A map of the area, charts, and area pictures are included as Attachment 2. Surveying for the water level of the lake will take place in August. The high-water levels shown in the picture taken July 4, 2019, that had fallen as shown in the picture taken July 13, 2019, likely drained through a natural spill way at the west of the lake.

The water level elevations for the lake will be good for the groundwater model. Wet season data also is important for modelling, because it will provide a top level boundary.

A path forward for determining the lake elevation still is being discussed. Options include surveying at opportune times and adding two measuring points for high- and low-water levels.

9. Update on Paducah Site Groundwater Strategy

- Update of measuring point elevations for on-site monitoring wells and piezometers is ongoing. Field survey was completed in May 2019, and the data are being quality checked. The next step in this activity is to compare the new elevations with the previously used elevations.

Approximately 200 wells have been resurveyed. Some near field interpretations of the water level surface prompted the resurvey. Historical groundwater elevations that are affected by revised datum elevations will be assessed, including water levels previously thought to be anomalous. Impacts will be discussed with the group.

Reference points have been standardized. This resurvey includes the standardized reference points in addition to other reference points.

Ultimately, a letter report or white paper will be developed to document the information and findings.

- Mobilization and pilot testing is nearing completion for the colloidal borescope investigation. Data review/processing of pilot data are in progress. Additionally the long duration tests are complete.

  Four Rivers Nuclear Partnership, LLC, is working toward a target start date for the study of 8/5/2019. A project plan will be submitted to DOE.

  The colloidal borescope project's schedule will be updated and distributed (by the October 2019 quarterly meeting). The
  FY 2020 schedule for events will be shared so that field work can be coordinated with the AIP.

10. Projects on the "Watch Topics" List

- **Stream gauging in relation to the synoptic water levels should be considered.** Stream gauging has been discussed as part of out-year activities. See October 2018 Meeting Summary for additional information.

  Stream gauging is not being completed as part of the August 2019 synoptic water level event, but it is needed to support future updates to groundwater model.

- White paper in FY 2020 to address, "Installation of piezometers equipped with continuous water level monitors associated with several of the large process buildings [or evaluation of sumps] would define the thickness of the sub-slab gravel base and the temporal water level fluctuations beneath several of the large buildings better."

  A white paper will be included on the FY 2020 schedule. The white paper should provide recommendations.

- White paper previously was slated for FY 2020 to address, "Flow rate in the McNairy Formation is negligible compared to the RGA because the hydraulic conductivity is 2 to 3 orders of magnitude lower than in the RGA; however, the McNairy Formation may be significant for DNAPL source accumulation and contaminant transport. Future transport models based on the 2016 flow model will need to consider potential mass flux from the McNairy to the RGA resulting from back diffusion." See October 2018 Meeting Summary for additional information.

  It was suggested that this white paper be moved to FY 2021 so that the C-400 RI information can be included. It is important to consider whether the C-400 team is collecting the correct information as part of the C-400 RI; important to ensure that the field work for C-400 will meet the needs for this information. C-400 RI measurements of McNairy soil for distribution coefficient, fraction organic carbon, vertical hydraulic conductivity, and soil water characteristic curve will provide key data for the assessment of contaminant transport.

- **Corridors where overhead transmission lines have been removed should be considered.** Previously, overhead transmission lines prevented installation of wells to the west in the northern-most transect of wells in the Northeast Plume.

  No wells currently are planned. Information from the groundwater strategy will provide input as to whether additional wells are needed and identify their locations. Additional wells on the west side of the Northeast Plume far downgradient transect (near the road formerly called Anderson Rd) would help with the environmental indicator status. Borescope information and expanded water level measurements will provide input that may site additional monitoring wells and these corridors will be considered.

- Additional topics to watch are the following.

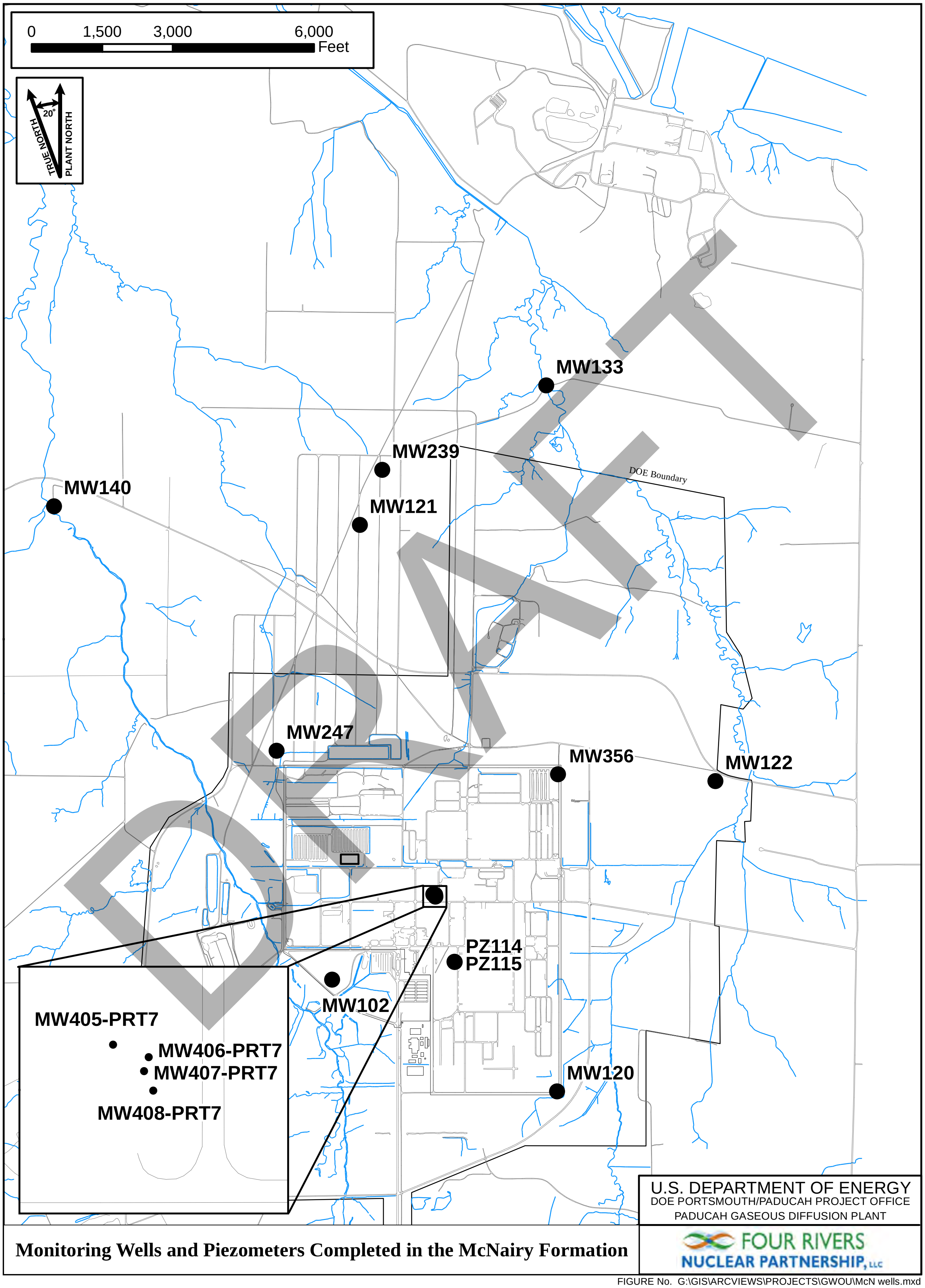
  — Data from the Northeast Plume Optimization Project that may be used to assess the flow model.

  — Changes of water usage related to utility optimization that will be needed to update the flow model.

11. Poll MWG Members/Open Discussion

C-400 RI Work Plan Scoping/Comment Resolution meeting was discussed.

Attachment 1

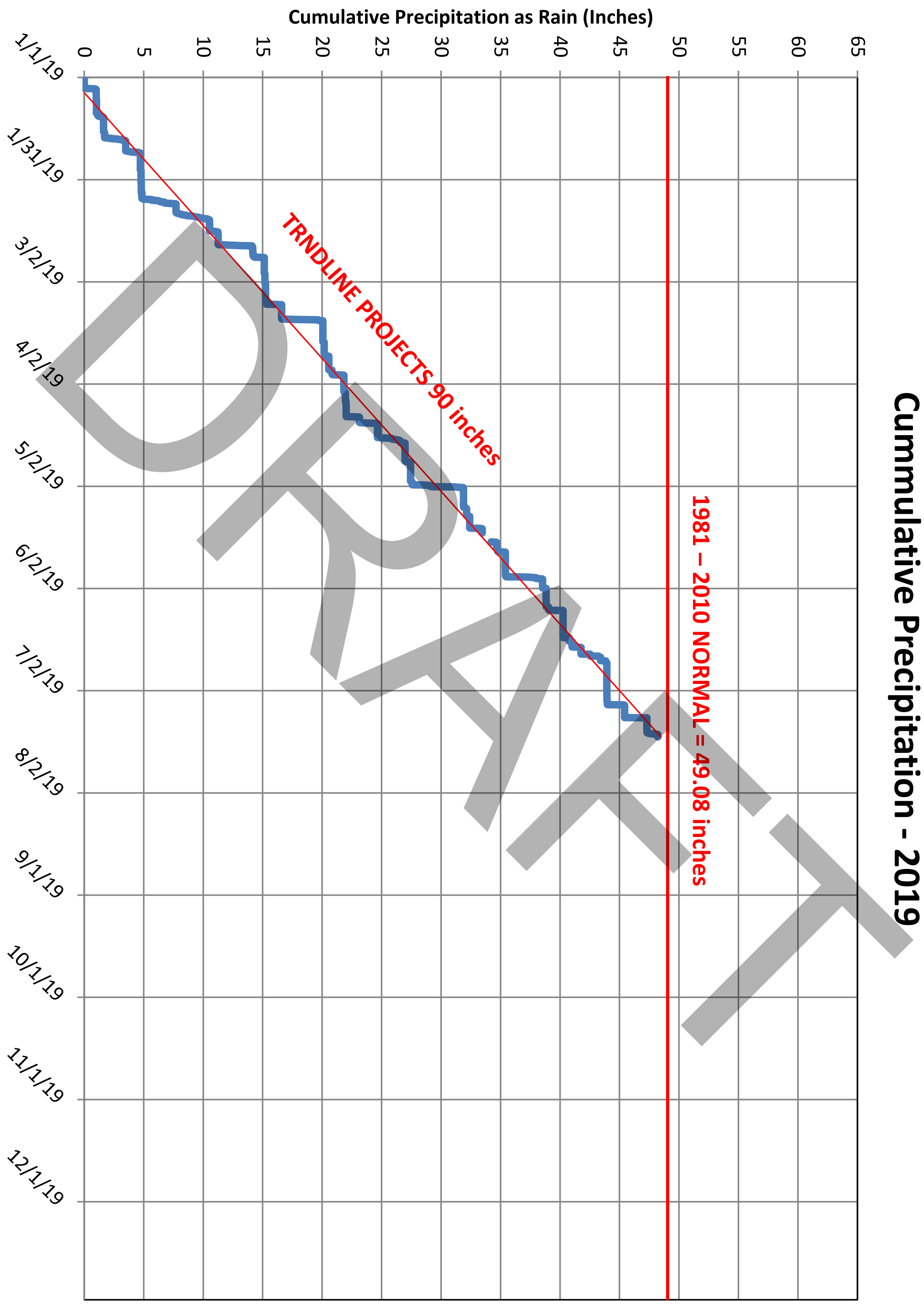


Monitoring Wells and Piezometers Completed in the McNairy Formation

DRAFT Work Product – For Discussion Only

Att2-1

Attachment 2


Cummulative Precipitation - 2019
Cumulative Precipitation as Rain (Inches)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
1/1/19
1/31/19
3/2/19
4/2/19
5/2/19
6/2/19
7/2/19
8/2/19
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TRNDLINE PROJECTS 90 inches
1981 – 2010 NORMAL = 49.08 inches
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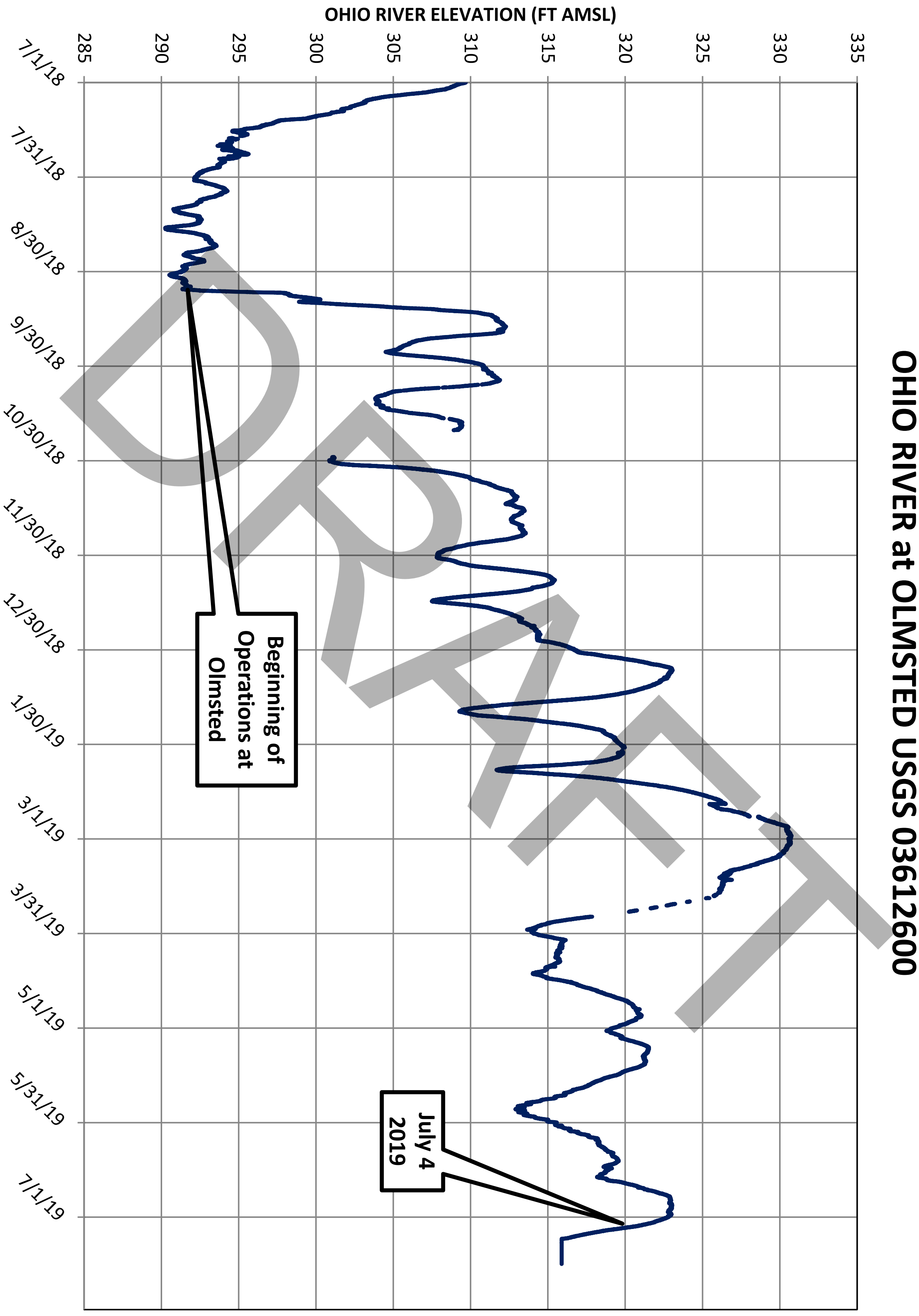
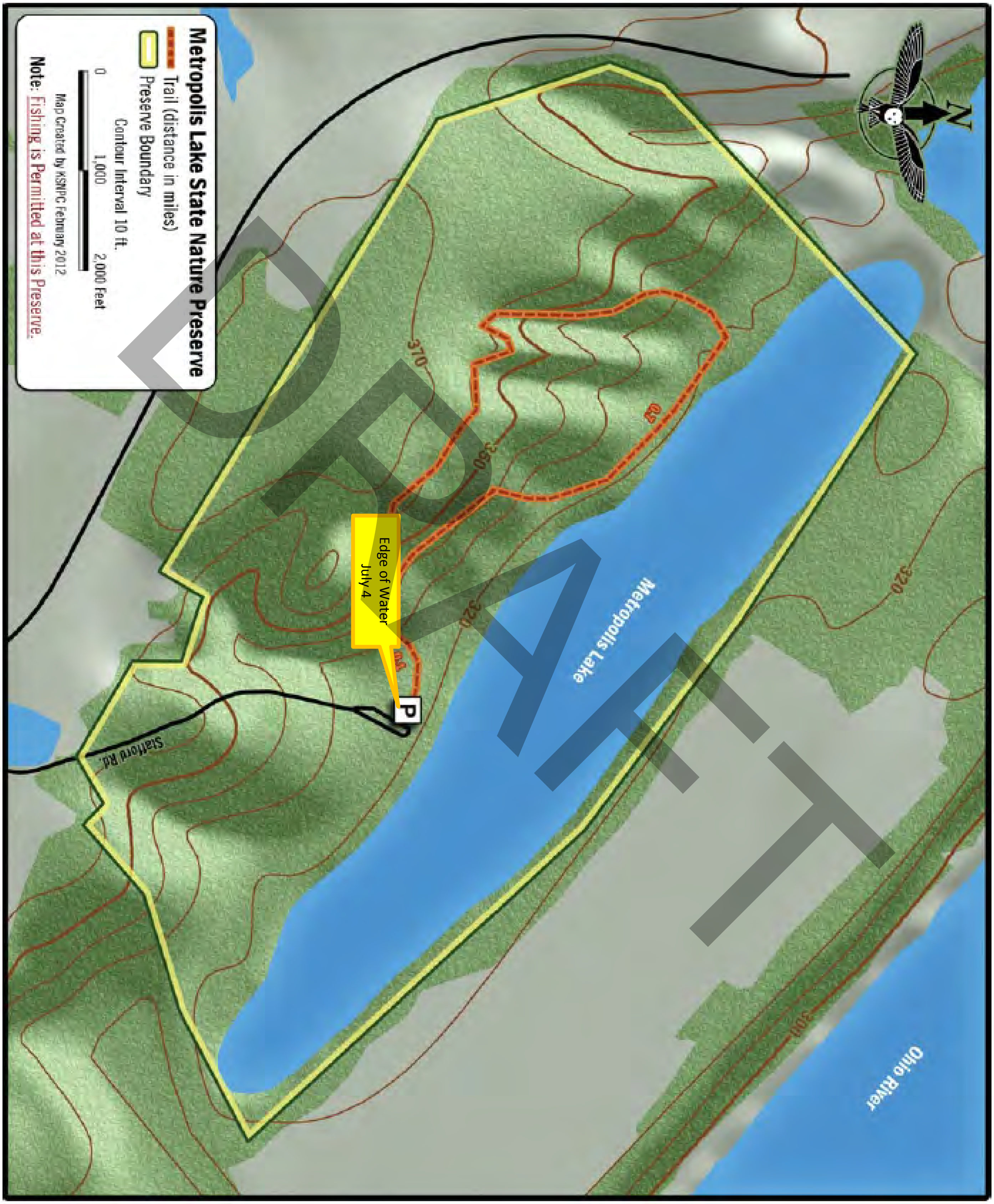


OHIO RIVER at OLMSTED USGS 03612600
OHIO RIVER ELEVATION (FT AMSL)
285
290
295
300
305
310
315
320
325
330
335
7/1/18
7/31/18
8/30/18
9/30/18
10/30/18
11/30/18
12/30/18
1/30/19
3/1/19
3/31/19
5/1/19
5/31/19
7/1/19
Beginning of Operations at Olmsted
July 4 2019
DRAFT


Metropolis Lake State Nature Preserve
Trail (distance in miles)
Preserve Boundary
Contour Interval 10 ft.
0
1,000
2,000 Feet
Map Created by KSNPC February 2012
Note: Fishing is Permitted at this Preserve.
Edge of Water
July 4
P
Stafford Rd.
Metropolis Lake
Ohio River
370
350
320
320
300
N
DRAFT

July 4, 2019

July 13, 2019

July 13, 2019

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APPENDIX D

GROUNDWATER MODELING WORKING GROUP MEETING SUMMARY—OCTOBER 2, 2019

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ACRONYMS

amsl	above mean sea level
CSM	conceptual site model
DNAPL	dense nonaqueous phase liquid
EPA	U.S. Environmental Protection Agency
FRNP	Four Rivers Nuclear Partnership, LLC
FY	fiscal year
KRCEE	Kentucky Research Consortium for Energy and the Environment
MW	monitoring well
MWG	Modeling Working Group
PGDP	Paducah Gaseous Diffusion Plant
RGA	Regional Gravel Aquifer
RI	remedial investigation
TVA	Tennessee Valley Authority

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Paducah Site Groundwater Modeling Working Group
Meeting Summary—October 2, 2019

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

✓ Indicates member was present.

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

EPA's recommendation for collaboration during the next five months, through this working group, to reach consensus to the maximum extent possible on the baseline conceptual site model (CSM) for the McNairy in the C-400 Complex area has been added as Item 7.

Ken has compiled climate data and Ohio River stage data. These data are included as Attachment 1. The graph of cumulative precipitation data from Barkley Regional Airport (approximately 5 miles from PGDP) shows an aggressive rainfall through August and a sudden stop in September. The Ohio River stage data reflects the first summer data after commencement of operations of the Olmsted Dam, which gives a good indication of what the base level in the Ohio River will be (approximately 302 ft amsl).

Ken requested Ohio River stage data for the TVA gauge following the meeting. This information is provided as Attachment 2.

2. Status of Previous Meeting Summary

No comments received to July 10, 2019, Meeting Summary (sent to participants on 7/24/2019). This summary will be considered final.

3. FY 2019 Work Plan/Schedule

Remaining schedule:

Comments due for Meeting Notes and White Papers compilation (sent to the working group on 3/12/2019 and 8/4/2019)	9/30/2019
Quarterly Meeting (October)	10/2/2019

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. Currently, a face-to-face meeting is not scheduled.

Color code for schedule:

Due date	Quarterly meeting

No comments received on the Meeting Notes and White Papers compilation, so we will proceed with publishing the compilation.

4. FY 2020+ Work Plan/Schedule

A draft schedule/work plan is presented below.

Develop Draft FY 2020 Schedule	9/18/2019
Comments due for Meeting Notes and White Papers compilation	9/30/2019
Quarterly Meeting (October)	10/2/2019
Submit FY 2020 Schedule	10/10/2019
MWG concurs with FY 2020 Schedule	11/8/2019
Initial discussions for McNairy CSM in C-400 Complex area (and how/if it relates to overall McNairy flow in general)	11/2019
Quarterly Meeting (January) – to include discussion on white paper regarding "Installation of piezometers …associated with several of the large process buildings…" and also CSM for the McNairy in the C-400 Complex area.	1/8/2020
Quarterly Meeting (April)	4/8/2020
Quarterly Meeting (July)	7/15/2020
Quarterly Meeting (October)	10/7/2020
Submit Draft Meeting Notes compilation (2019-2020)	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

Note: Completion of two white papers is expected in FY 2021 (see #13 and #14 of the Recommendations table in the September 19, 2017, Meeting Summary and also the July 10, 2018, and subsequent meeting summaries).

White papers address the following:

- "Installation of piezometers equipped with continuous water level monitors associated with several of the large process buildings [or evaluation of sumps] that would define the thickness of the sub-slab gravel base and the temporal water level fluctuations beneath several of the large buildings better."

- "Flow rate in the McNairy Formation is negligible compared to the RGA because the hydraulic conductivity is 2 to 3 orders of magnitude lower than in the RGA; however, the McNairy Formation may be significant for DNAPL source accumulation and contaminant transport. Future transport models based on the 2016 flow model will need to consider potential mass flux from the McNairy to the RGA resulting from back diffusion."

For both of these white papers, additional time is needed to complete C-400 RI to utilize data collected during the investigation. Should installation of additional piezometers be necessary for the process buildings, this work potentially could be accomplished as part of the C-400 RI field effort.

Discussion of preliminary information for the "Installation of piezometers …associated with several of the large process buildings…" white paper is expected during the January quarterly meeting. Preliminary information will include the following:

- A thorough review of the building design drawings (in conjunction with vapor intrusion project);

- A report from an inspection of each building to confirm as-built conditions;

- Suggested placement of piezometers based on knowledge of physical characteristics of each building;
- Suggested recommendation for monitoring sump discharge; and
- Review of sumps in the process buildings (discuss with Andy Anderson).

5. Update on Water Level Gauge at Metropolis Lake

A survey control point near the lake was established, and the lake level will be surveyed for each synoptic water level event. For the latest synoptic water level event, the water level in Metropolis Lake was surveyed on August 12, 2019. The Metropolis Lake water elevation was 311.7 ft amsl, the Ohio River elevation near Metropolis Lake at noon was approximately 300.9 ft.

Synoptic water level events now are quarterly; the next event is in December.

6. Update on Paducah Site Groundwater Strategy

Strategy for the upcoming year consists of manual water level measurements, pressure transducers, and colloidal borescopes. Both pilot projects for colloidal borescopes (vertical profiling in each of the wells for colloidal borescope collection to identify the highest velocity zone in the screened intervals and running two 24-hr data collection events to evaluate the needed duration of borescope data collection) are complete. FRNP is evaluating the data.

The overall schedule for the strategy likely will be the same, but will slide to accommodate the longer duration of the pilot project.

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

FRNP will set up a library of McNairy information. Historical documents need to include data as much as possible (electronic, not hardcopy). A website was established following the meeting at https://fourriversnuclearpartnership.com/McNCSM. Additional login information will be sent separately.

FRNP is looking into the historical "Phase V Investigation," as requested by EPA. The only documentation of the project found so far is, it is referenced in a letter. An additional records search is being conducted. The project is not thought to have advanced beyond initial scoping.

The CSM for the McNairy will be added to the schedule. The overall goal is to have information to help direct contingency borings and apply that information to the feasibility study. A list of potential study questions that are needed to develop a CSM would be helpful. EPA will provide a start for the list of study questions.

The first working group discussion is expected to take place in November 2019.

8. Projects on the "Watch Topics" List

- **Update on Paducah Site Monitoring Well Abandonment/Replacement**

MW84, MW87, and MW93 at the C-404 Landfill were abandoned and replaced. First quarterly sampling has been completed. The new wells (MW84A, MW87A, and MW93A) seem to have taken care of the quality problem observed in the old wells.

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 to be installed. The schedule indicates this installation should occur soon. (Information learned after the meeting indicates that the bridge needed to complete this well now is expected to be completed in late November or December 2019.)

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

- 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.

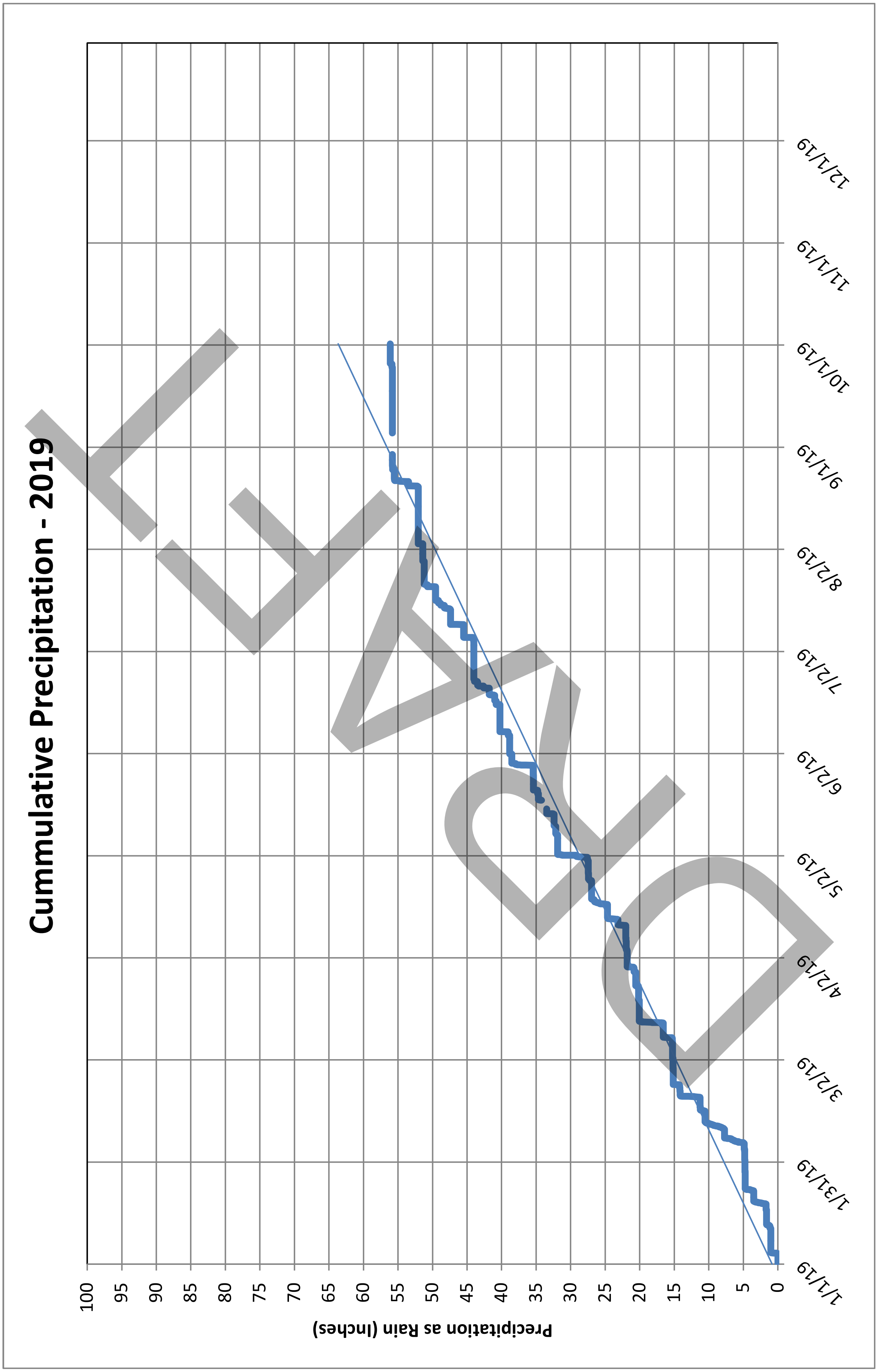
9. Poll MWG Members/Open Discussion

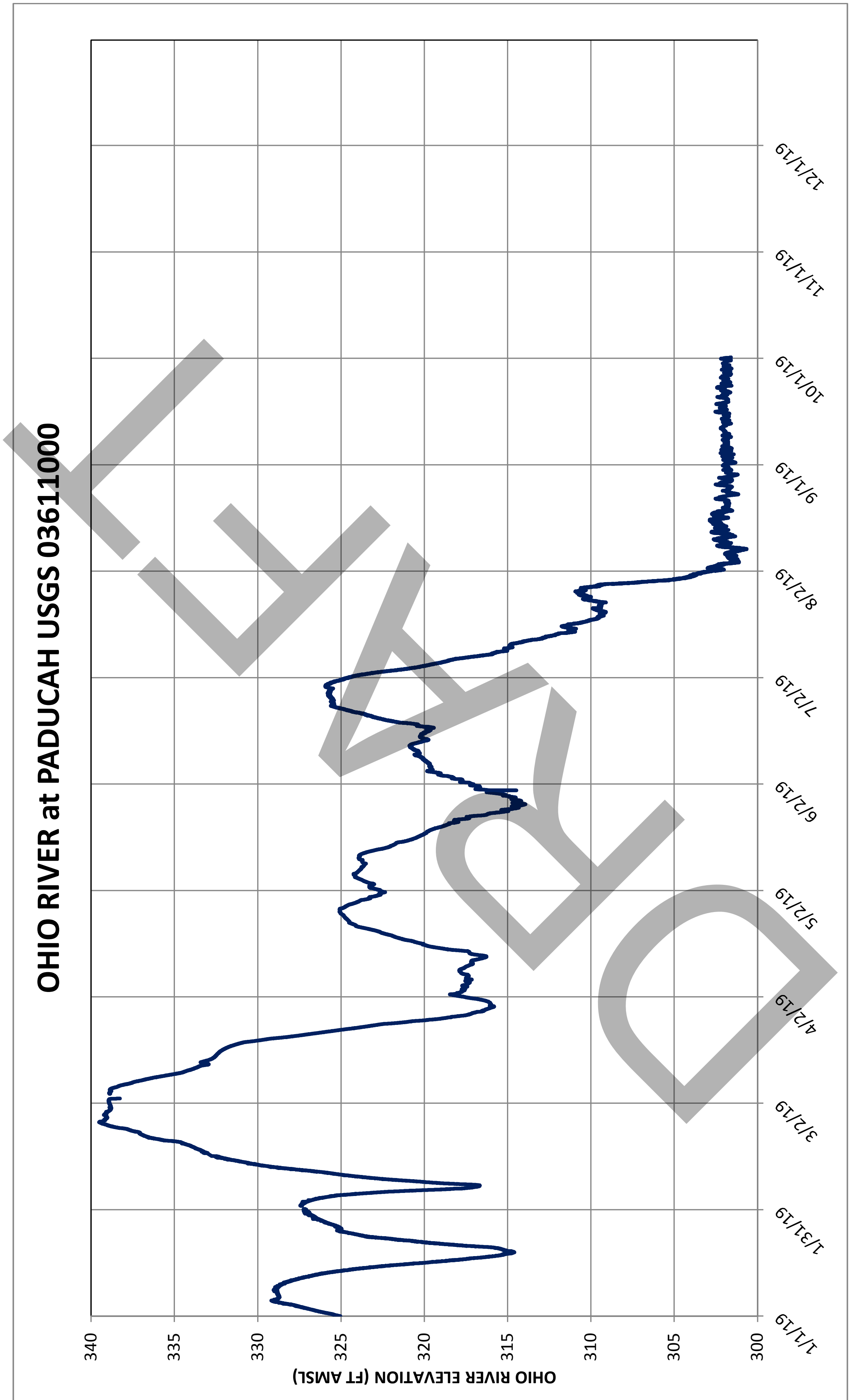
A comprehensive groundwater presentation is proposed for groundwater and remediation efforts at Paducah since 1989. This information could be presented during these quarterly meetings during the span of 2-3 quarterly meeting times. In addition, Kentucky Research Consortium for Energy and Environment (KRCEE) could be available to provide input to the groundwater impacts from conclusions of previous Paducah Site investigations (e.g. seismic, bio- and abiotic degradation, etc.). (Note that KRCEE's web site has been down recently.) A curriculum needs to be developed in order to understand how long the presentation will be. This comprehensive groundwater presentation also goes with the Groundwater Strategy.

After a curriculum is developed, historical information from previous presentations (updated) can be sent to the working group.

Curriculum may need to be provided around November 2019 time frame.

Attachment 1




OHIO RIVER at PADUCAH USGS 03611000
OHIO RIVER ELEVATION (FT AMSL)
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1/31/19
3/2/19
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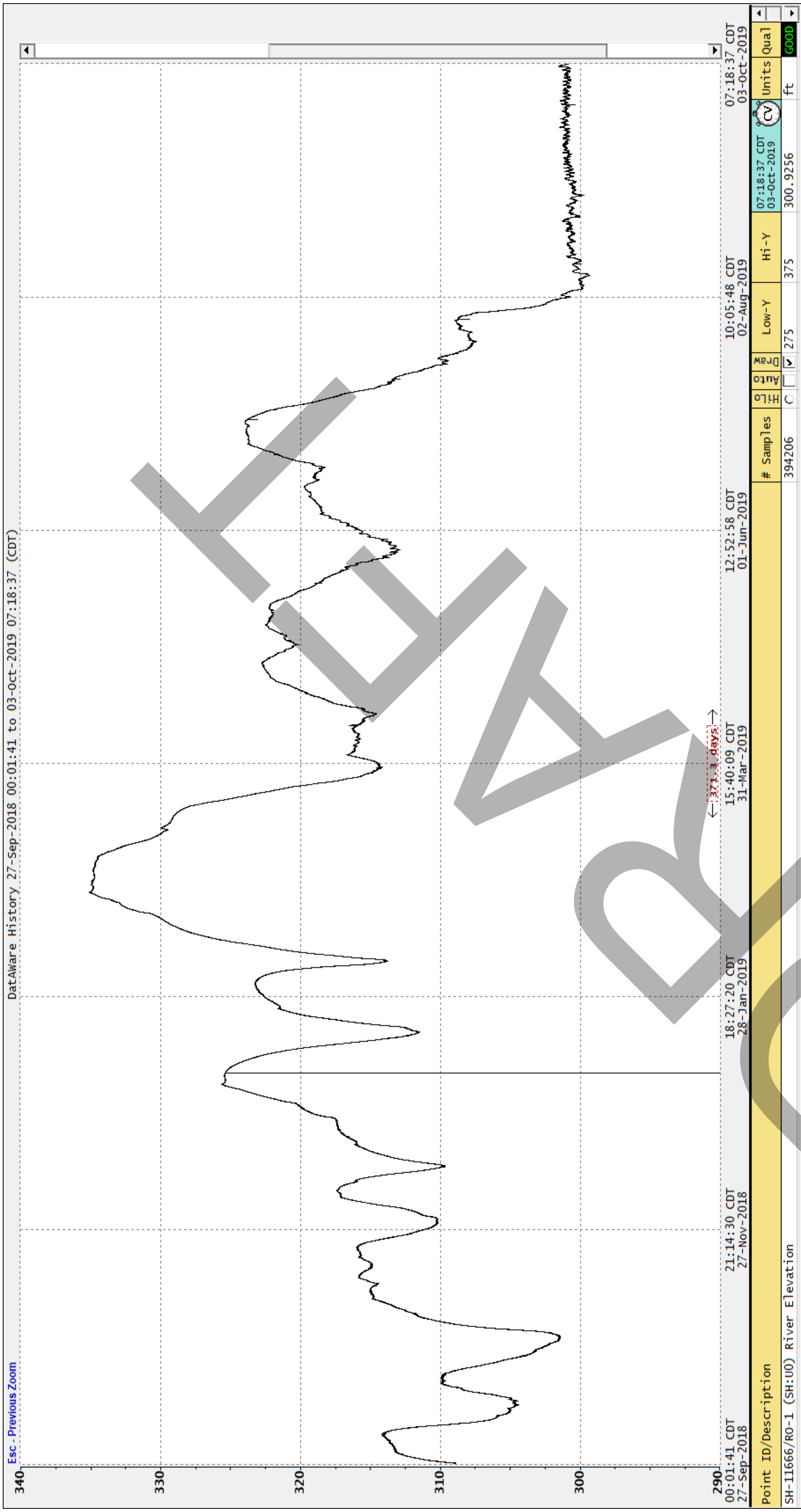
11/1/19
12/1/19
DRAFT

Att1-2

Attachment 2



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APPENDIX E

GROUNDWATER MODELING WORKING GROUP MEETING SUMMARY—JANUARY 8, 2020

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ACRONYMS

AIP	agreement in principal
amsl	above mean sea level
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CSM	conceptual site model
CUSMAP	Conterminous United States Mineral Assessment Program
DNAPL	dense nonaqueous phase liquid
DOE	U.S. Department of Energy
EMP	Environmental Monitoring Plan
EPA	U.S. Environmental Protection Agency
FFA	Federal Facility Agreement
FRNP	Four Rivers Nuclear Partnership, LLC
FS	feasibility study
FY	fiscal year
GDP	gaseous diffusion plant
GW	groundwater
HU	hydrogeologic unit
KDEP	Kentucky Department for Environmental Protection
KDWM	Kentucky Division of Waste Management
KRCEE	Kentucky Research Consortium for Energy and the Environment
KY	Commonwealth of Kentucky
MW	monitoring well
MWG	Modeling Working Group
N/A	not applicable
OREIS	Oak Ridge Environmental Information System
OSL	optically stimulated luminescence
PGDP	Paducah Gaseous Diffusion Plant
RGA	Regional Gravel Aquifer
RI	remedial investigation
SWMU	solid waste management unit
TIC	top of inner casing
TVA	Tennessee Valley Authority
UCRS	Upper Continental Recharge System
USGS	U.S. Geological Survey
VI	vapor intrusion
WAG	waste area grouping
WKWMA	West Kentucky Wildlife Management Area

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Paducah Site Groundwater Modeling Working Group
Meeting Summary—January 8, 2020

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

✓ Indicates member was present.

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

Brian Begley sent notification to the Risk Assessment Working Group and it was shared with the MWG that Jeri Higginbotham passed away before the new year. Jeri will be missed greatly.

2. Status of Previous Meeting Summary

No comments received to October 2, 2019, Meeting Summary (sent to participants on 10/9/2019). This summary is considered final.

3. FY 2020+ Work Plan/Schedule

The schedule was concurred upon by working group members, with the understanding that additional items may be added.

Develop Draft FY 2020 Schedule	9/18/2019
Comments due for Meeting Notes and White Papers compilation	9/30/2019
Quarterly Meeting (October)	10/2/2019
Submit FY 2020 Schedule	10/10/2019
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Initial discussions for McNairy CSM in C-400 Complex area (and how/if it relates to overall McNairy flow in general)	11/2019
Quarterly Meeting (January)—to include discussion on white paper regarding "Installation of piezometers …associated with several of the large process buildings…." and also CSM for the McNairy in the C-400 Complex area.	1/8/2020
Quarterly Meeting (April)	4/8/2020
Quarterly Meeting (July)	7/15/2020
Quarterly Meeting (October)	10/7/2020
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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

4. Update on Water Levels

Synoptic water level events now are quarterly; the December event was collected the week of December 16, 2019.

KY shared groundwater elevation data for TVA wells collected on August 15, 2019 and December 19, 2019 (Attachment 1). Brian Begley is double-checking that the levels were measured from top of inner casing. Reference datum elevation needs to be understood and will be followed up on by the group.

For the December synoptic water level survey, FRNP surveyed the surface elevation of Metropolis Lake as 316.89 ft amsl on December 23, 2019, at the boat ramp area.

5. Update on Paducah Site Groundwater Strategy

Deployment of the pressure transducers began the week of December 30, 2019. The Environmental Monitoring Plan (EMP) includes a spreadsheet/schedule for monitoring wells planned for colloidal borescope and pressure transducer deployment beginning "Month 1." In this schedule, "Month 1" is considered January 2020. FRNP will review KY's AIP monitoring wells sampling schedule to determine if there are any schedule conflicts between sampling and borescope measurements.

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 be performed in conjunction with the vapor intrusion (VI) project. Information reviewed, where available, will include the following:

- Building design drawings (e.g., basements, sumps, roof drains, foundation type and thickness, foundation penetrations);
- Hydraulic information regarding roof drains;
- A walkdown of each building to confirm as-built conditions;
- Review of sumps and hydraulic discharge in the process buildings; and
- Suggested placement of piezometers based on knowledge of physical characteristics of each building.

Document review and visual observations are scheduled to begin this quarter (Jan-Mar 2020).

Borings near the process buildings and UCRS thickness in those areas should be considered. Depth to water will be looked at as part of VI. Water level measurements from the floor of the process buildings down should be considered with respect to the sumps. If there are any lessons learned from Portsmouth or Oak Ridge regarding process buildings, these also should be considered.

7. Groundwater Curriculum

a. Geology (presented January 8, 2020)

- Geologic Provinces
- Paducah Site and Illinois portion of Joppa Quadrangle

b. Paducah Site Groundwater, "Big Picture" (to be presented April 8, 2020)

- Primary features
- Water balance
- Deep groundwater systems (McNairy, Mississippian)

c. Paducah Site Groundwater, Continued (to be presented July 15, 2020)

- UCRS: HU1 through HU3
- RGA: HU4 and HU5
- 2016 Update of Paducah Site GW Flow Model

d. Paducah Site Groundwater, Contamination (to be presented October 7, 2020)

- History
- "Big Picture" GW Investigations (post 1988)
- Monitoring Network
- Plume maps
- Current GW Strategy
- Other COPCs

The MWG was asked to provide feedback for the curriculum topics.

For item (b.), clarified water balance to be the big picture water balance (e.g., rainfall and stream leakage). KY would like an update on anthropogenic effects to water balance (e.g., repairs to leaking water lines). Additionally for item (b.), clarified deep groundwater systems to be primarily the McNairy Flow System, with some information on the Mississippian bedrock.

The "Geology" presentation from this meeting is provided as Attachment 2.

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 will address this suggestion with Dr. Woolery.

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.

EPA provided a letter regarding the development of the CSM (included as Attachment 3). EPA asked for a clarification call about the letter's intent before DOE sends a response to EPA. Additional clarification will take place during biweekly groundwater call.

10. Projects on the "Watch Topics" List

- **Update on Paducah Site Monitoring Well Abandonment/Replacement**
  MW84, MW87, and MW93 at the C-404 Landfill were abandoned and replaced in June 2019. First quarterly sampling has been completed. The new wells (MW84A, MW87A, and MW93A) seem to have taken care of the quality problem observed in the old wells.

  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 expected to be completed in spring 2020.

- **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.

- **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. FRNP will report to the MWG regarding the plan for the new TVA substation, including where overhead lines are expected and what areas still will be accessible.

11. Poll MWG Members/Open Discussion

An internal draft of the resurvey of monitoring wells is expected to be near completion next month. A report will be issued following completion. Differences in datum reference points (new vs. old) are being compared (approx. 80% complete).

KY previously provided examples of site-specific software from Hanford for querying and reporting water levels. It was reported in the FFA Manager's meeting that discussion was held with the data warehouse group. A tool would be beneficial that takes the raw analytical data and distills it to a usable data set.

Precipitation and river stage data were provided (Attachment 4). Based on their work at Calvert City, Kentucky, EPA shared that an elevation of 302 ft amsl seems to be the base level for both the Ohio and the Tennessee Rivers.

RECEIVED
By Carolee.Thompson at 2:35 pm, Sep 18, 2019

FR-19-0269

MATTHEW G. BEVIN
GOVERNOR

CHARLES G. SNAVELY
SECRETARY

ANTHONY R. HATTON
COMMISSIONER

ENERGY AND ENVIRONMENT CABINET
DEPARTMENT FOR ENVIRONMENTAL PROTECTION

300 SOWER BOULEVARD
FRANKFORT, KENTUCKY 40601
TELEPHONE: 502-564-2150
TELEFAX: 502-564-4245

September 18, 2019

Ms. Tracey Duncan
U.S. Department of Energy
Portsmouth/Paducah Project Office
5501 Hobbs Road
Kevil, KY 42053

RE: Groundwater Elevation Data for Tennessee Valley Authority Wells Collected on August 15, 2019
Paducah Site
Paducah, McCracken County, Kentucky
#KY8-890-008-982

Ms Duncan:

On August 15, 2019 the Kentucky Division of Waste Management (KDWM) Agreement In Principle (AIP) staff recorded 17 Regional Gravel Aquifer (RGA) groundwater elevations from Tennessee Valley Authority (TVA) Shawnee Fossil Plant monitoring wells. The collection of groundwater elevations at TVA's Shawnee Plant is intended to enhance the annual synoptic water level event for U.S. Department of Energy (DOE) monitoring wells. Four of the 17 TVA monitoring wells were not accessed during last years' effort and do not currently have assigned names in OREIS. The four TVA wells are located along the Western Kentucky Wildlife Management Area (WKWMA) Tract 6. Please find all of the supporting documentation attached for water elevations associated with the 17 TVA monitoring wells.

If you have any questions or require additional information, please contact Chris Jung at (502) 782-6391 or christopher.jung@ky.gov.

Sincerely,

Brian D. Begley, P.G., Supervisor
Paducah Site Section
Hazardous Waste Branch

BDB/chj/bsl

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Joe Eubanks, TVA – W. Paducah; Jleubanks@tva.gov
Holly Lawrence, TVA – W. Paducah; HJLawrence@tva.gov
Ronda Hooper, TVA – Chattanooga; RLHoope0@tva.gov

DWM File: #970-A; Graybar: AIN20190005 (2019 AIP Sample Results)

Attachment: TVA Groundwater Level Elevations Table

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)	Water Level	Date & Time
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	46.25	8/15/2019_0908
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	4605	8/15/2019_0915
TVAGW-4D	TVAGW-4D	4" PVC	upper RGA	365.8	363	759456.7195	1947561.73	active	57	67.5	306	295.5	43.61	8/15/2019_0926
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	41.58	8/15/2019_0931
TVAGW-2D	TVAGW-2D	4" PVC	upper RGA	370	367.1	759966.7809	1944870.473	active	55.6	65.6	311.5	301.5	41.46	8/15/2019_0942
TVAGW-1D	TVAGW-1D	4" PVC	upper RGA	370.1	367.5	757847.0459	1946203.79	active	56	66	311.5	301.5	47.41	8/15/2019_0949
TVA-D17	SHF-D17	2" PVC	upper RGA	365.43	362.8	758809.17	1950015.71	active	14	17	348.8	345.8	46.37	8/15/2019_1008
TVA-D8A	SHF-D8A	4" PVC	upper RGA	331.82	329	754060.01	1953586.25	active	17.5	27.5	311.5	301.5	14.15	8/15/2019_1024
TVA-D75B	SHF-D75B	2" PVC	upper RGA	353.08	350	753297.07	1955971.69	active	48	58	302	292	41.2	8/15/2019_1046
TVA-D10	SHF-D10	4" PVC	upper RGA	351.74	351	752950.26	1956644.9	active	36.5	46.5	31.5	304.5	43.23	8/15/2019_1050
TVA-D30B	SHF-D30B	2" PVC	upper RGA	324.61	320.9	757594	1955563.41	active	39	49	281.9	271.9	20.99	8/15/2019_1102
TVA-D74B	SHF-D74B	2" PVC	upper RGA	331.99	329	756125.35	1956489.82	active	39	49	290	280	22.26	8/15/2019_1116
TVA-D11B	SHF-D11B	2" PVC	upper RGA	321.79	319.2	753434.76	1958481.44	active	32	42	287.2	277.2	14.16	8/15/2019_1133
NA	SHF-201C	4" PVC	upper RGA	323.75	320	746799.24	1960068.889	active	44.5	54.5	275.5	265.5	14.73	8/15/2019_1228
NA	SHF-201B	4" PVC	upper RGA	323.75	320.2	746641.107	1960082.768	active	32	37	288.2	283.2	14.61	8/15/2019_1229
NA	SHF201A	4" PVC	Upper RGA	323.75	320	747030.226	1960036.252	active	14.5	24.5	305.5	295.5	14.57	8/15/2019_1230
NA	SHF-102G	4" PVC	Upper RGA	362.85	359.1	845764.387	1927473.284	active	47.1	57.4	312	301.7	39.61	8/15/2019_1244
TVA River Elevation													300.69	8/15/2019_1324

ANDY BESHEAR
GOVERNOR

REBECCA W. GOODMAN
SECRETARY

TONY HATTON
COMMISSIONER

ENERGY AND ENVIRONMENT CABINET
DEPARTMENT FOR ENVIRONMENTAL PROTECTION

300 SOWER BOULEVARD
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December 30, 2019

Ms. Tracey Duncan
U.S. Department of Energy
Portsmouth/Paducah Project Office
5501 Hobbs Road
Kevil, KY 42053

RE: Groundwater Elevation Data for TVA Wells Collected on December 19, 2019
Paducah Site: Paducah, McCracken County, Kentucky
#KY8-890-008-982

Ms Duncan:

On December 19, 2019 the Kentucky Division of Waste Management (KDWM) Agreement In Principle (AIP) staff recorded 17 Regional Gravel Aquifer (RGA) groundwater elevations from Tennessee Valley Authority (TVA) Shawnee Fossil Plant monitoring wells. The collection of groundwater elevations at TVA is intended to enhance the quarterly synoptic water level event for U.S. Department of Energy (DOE) monitoring wells. Please find all of the supporting documentation attached for water elevations associated with the 17 TVA monitoring wells.

If you have any questions or require additional information, please contact Brian Begley at (502) 782-6317 or Brian.Begley@ky.gov.

Sincerely,

Brian D. Begley, P.G., Supervisor
Paducah Site Section
Hazardous Waste Branch

BDB/tso/bsl

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Joe Eubanks, TVA – W. Paducah; Jleubanks@tva.gov
Holly Lawrence, TVA – W. Paducah; HJLawrence@tva.gov
Ronda Hooper, TVA – Chattanooga; RLHoope0@tva.gov

DWM File: #970-A; Graybar: AIN20190005 (2019 AIP Sample Results)

Attachment: TVA Groundwater Level Elevations Table

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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)	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	**48.49**	12/19/2019_0911	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	**48.64**	12/19/2019_0915	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	**45.92**	12/19/2019_0920	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	**43.98**	12/19/2019_0924	30.06	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	**46.07**	12/19/2019_0906	30.06	TIC
TVAGW-1D	**TVAGW-1D**	4" PVC	upper RGA	370.1	367.5	757847.0459	1946203.79	active	56	66	311.5	301.5	**50.3**	12/19/2019_0942	30.06	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	**14.4**	12/19/2019_1046	30.07	TIC
TVA-D75B	**SHF-D75B**	2" PVC	upper RGA	353.08	350	753297.07	1955971.69	active	48	58	302	292	**38.78**	12/19/2019_1051	30.07	TIC
TVA-D74B	**SHF-D74B**	2" PVC	upper RGA	331.99	329	756125.35	1956489.82	active	39	49	290	280	**16.91**	12/19/2019_1103	30.07	TIC
TVA-D30B	**SHF-D30B**	2" PVC	upper RGA	324.61	320.9	757594	1955563.41	active	39	49	281.9	271.9	**10.88**	12/19/2019_1126	30.09	TIC
TVA-D17	**SHF-D17**	2" PVC	upper RGA	365.43	362.8	758809.17	1950015.71	active	14	17	348.8	345.8	**47.77**	12/19/2019_1134	30.03	TIC
TVA-D11B	**SHF-D11B**	2" PVC	upper RGA	321.79	319.2	753434.76	1958481.44	active	32	42	287.2	277.2	**7.94**	12/19/2019_1119	30.10	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	**43.23**	12/19/2019_1055	30.07	TIC
NA	**SHF-201C**	4" PVC	upper RGA	323.75	320	746799.24	1960068.889	active	44.5	54.5	275.5	265.5	**15.45**	12/19/2019_1006	30.11	TIC
NA	**SHF-201B**	4" PVC	upper RGA	323.75	320.2	746641.107	1960082.768	active	32	37	288.2	283.2	**15.3**	12/19/2019_1012	30.11	TIC
NA	**SHF201A**	4" PVC	upper RGA	323.75	320	747030.226	1960036.252	active	14.5	24.5	305.5	295.5	**15.35**	12/19/2019_1015	30.11	TIC
NA	**SHF-102G**	4" PVC	upper RGA	362.85	359.1	845764.387	1927473.284	active	47.1	57.4	312	301.7	**42.15**	12/19/2019_1024	30.07	TIC
TVA River Elevation													**312**	12/19/2019_0930	30.06	TVA Station

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Attachment 2

GEOLOGY

January 8, 2020

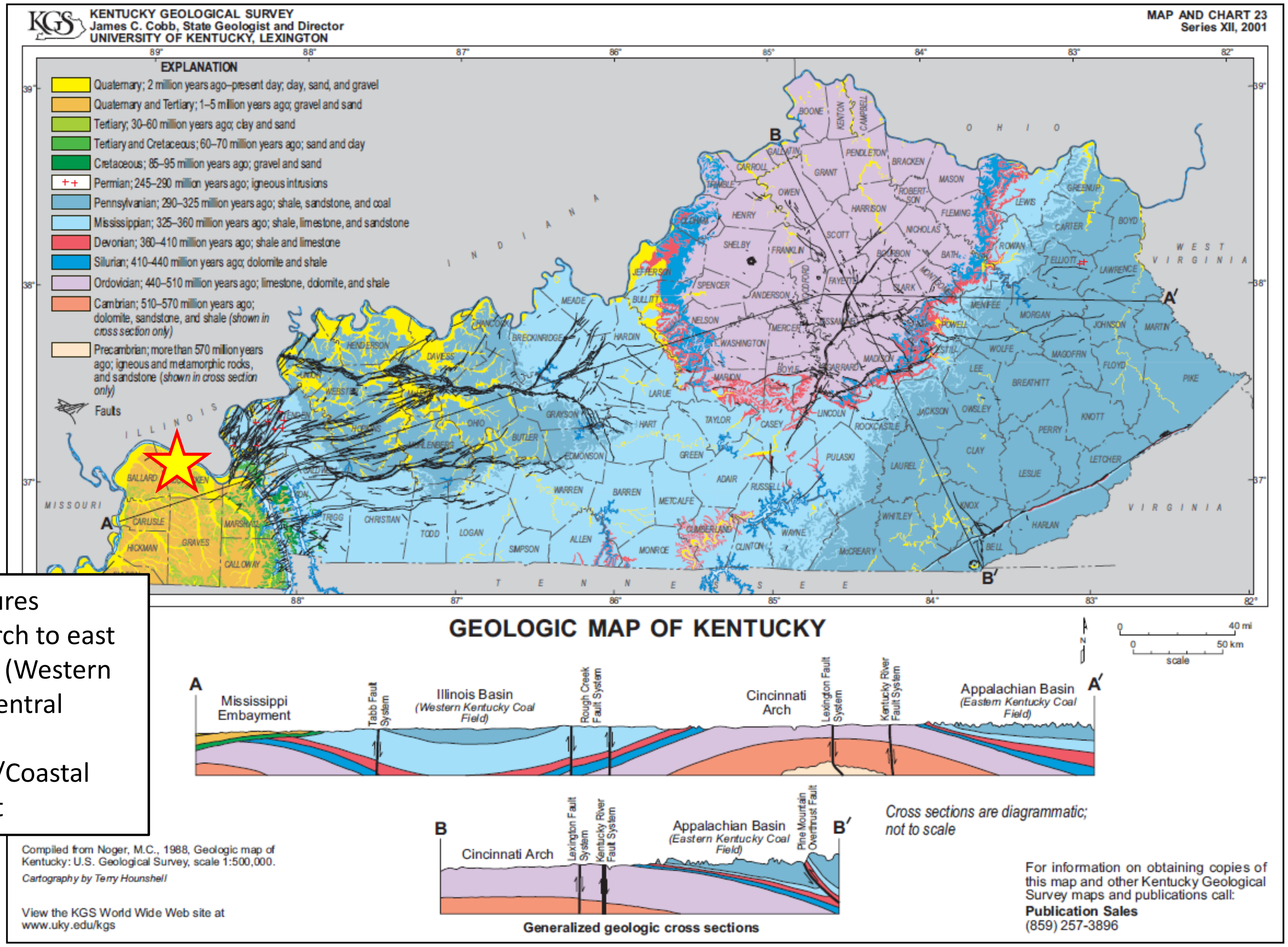
Geologic Provinces of the U.S.

Paducah Site
- Located at north end of Mississippi Embayment
- Nashville Arch was source of Lower Continental Deposits gravel

https://gotbooks.miracosta.edu/geology/images2/provinces_names_medium.jpg

2

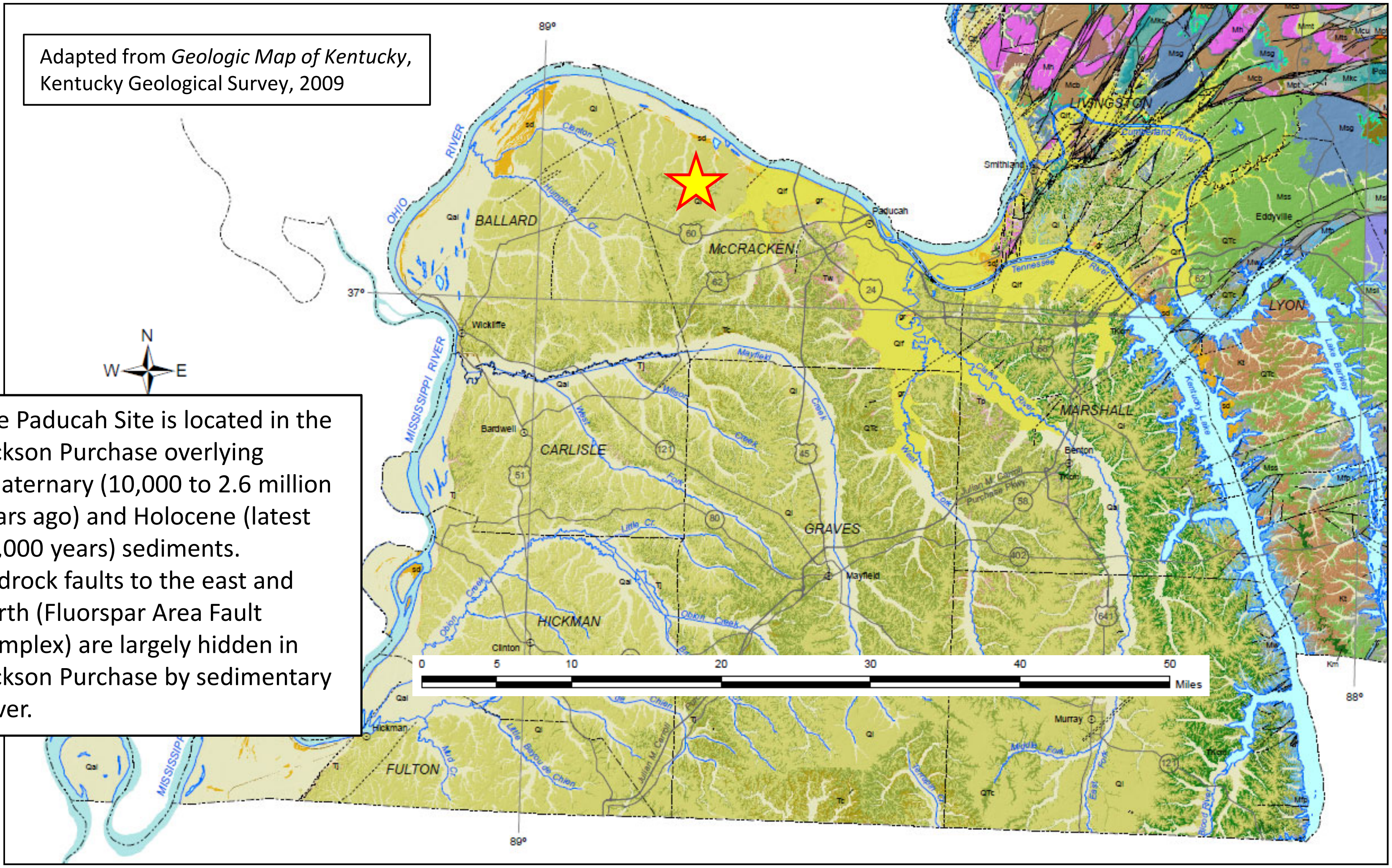
Geology of Kentucky



Primary Structures
- Cincinnati Arch to east
- Illinois Basin (Western Coal Field) central
- Mississippi Embayment/Coastal Plain to west

Jackson Purchase

Adapted from *Geologic Map of Kentucky*, Kentucky Geological Survey, 2009



- The Paducah Site is located in the Jackson Purchase overlying Quaternary (10,000 to 2.6 million years ago) and Holocene (latest 10,000 years) sediments.
- Bedrock faults to the east and north (Fluorspar Area Fault Complex) are largely hidden in Jackson Purchase by sedimentary cover.

PADUCAH GW FLOW SYSTEMS

Jackson Purchase Stratigraphy

Adapted from *Geologic Map of Kentucky*, Kentucky Geological Survey, 2009

MAPPED UNITS OF WEST-CENTRAL KENTUCKY AND JACKSON PURCHASE REGION (WESTERN KENTUCKY)
(NOTE: NOT ALL UNITS LABELED)

UCRS

RECENT
- af — Artificial fill (compacted rock debris from highway, railroad, and reservoir construction; or mine tailings)

QUATERNARY
- Qal — Alluvium
- Qe — Eolian sand, dune sand
- Qala — Alluvium and lacustrine deposits
- Qao — Older alluvium
- Qt — Terrace deposits
- Qlt — Lacustrine and terrace deposits
- Qlf — Lacustrine and fluvial deposits
- Qcd — Glacial outwash, Cary substage
- Qtd — Glacial outwash, Tazewell substage
- Ql — Loess
- sd — Sand and silt deposits, sand of alluvium, lacustrine, and fluvial deposits
- gr — Gravel of alluvium, lacustrine, and fluvial deposits

TERRACE

RGA

TERTIARY and QUATERNARY
- QTc — Continental deposits
- QTg — Chert gravel or gravel deposits

TERTIARY
- Tj — Jackson Formation
- Tc — Claiborne Formation
- Tw — Wilcox Formation
- Tp — Porters Creek Clay

McN

CRETACEOUS and TERTIARY
- TKcm — Clayton and McNairy Formations

CRETACEOUS
- Km — McNairy Formation
- Kt — Tuscaloosa Formation

BEDROCK

PENNSYLVANIAN
- IPmcl — McLeansboro Group
- IPm — Mattoon Formation
- IPbm — Bond and Mattoon Formations
- IPb — Bond Formation
- IPp — Patoka Formation
- IPsh — Shelburn Formation
- IPsc — Shelburn and Carbondale Formations
- IPc — Carbondale Formation
- IPt — Tradewater Formation
- IPtc — Tradewater and Caseyville Formations
- IPca — Caseyville Formation

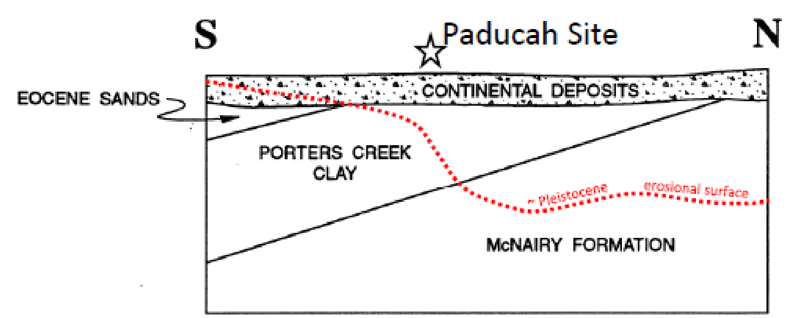
MISSISSIPPIAN
- Mcu — Chesterian series (upper part)
- Mbw — Buffalo Wallow Formation
- Ml — Leitchfield Formation
- Mk — Kinkaid Limestone
- Mkc — Kinkaid Limestone, Degonia Sandstone, and Clore Limestone
- Mkp — Kinkaid Limestone, Degonia Sandstone, Clore Limestone, and Palestine Sandstone
- Mdc — Degonia Sandstone and Clore Limestone
- Mdm — Degonia Sandstone, Clore Limestone, Palestine Sandstone, and Menard Limestone
- Mcp — Clore Limestone and Palestine Sandstone
- Mpt — Palestine Sandstone
- Mme — Menard Limestone
- Mmt — Menard Limestone, Walterburg Sandstone, Vienna Limestone, and Tar Springs Sandstone
- Mwv — Waltersburg Sandstone and Vienna Limestone
- Mts — Tar Springs Sandstone
- Mcm — Chesterian series (middle part)
- Mgd — Glen Dean Limestone
- Mh — Hardinsburg Sandstone
- Mhgc — Hardinsburg Sandstone, Golconda Formation, and Cypress Sandstone
- Mgo — Golconda Formation
- Mgh — Haney Limestone Member
- Mgb — Big Clifty Sandstone Member
- Mgbc — Big Clifty Sandstone and Beech Creek Limestone Members
- Mgcy — Big Clifty Sandstone Member and Cypress Sandstone
- Mcl — Chesterian series (lower part)
- Mgc — Beech Creek Limestone Member
- Mgcc — Beech Creek Limestone Member and Cypress Sandstone
- Mg — Girkin Formation
- Me — Elwren Sandstone
- Mr — Reelsville Limestone
- Mrs — Reelsville Limestone and Sample Sandstone
- Msa — Sample Sandstone
- Mbp — Beaver Bend Limestone, Mooretown Formation, and Paoli Limestone
- Mmoh — Mooretown Formation (shale member)
- Mmos — Mooretown Formation (sandstone member)
- Mc — Cypress Sandstone
- Mcb — Cypress Sandstone, Paint Creek Shale, and Bethel Sandstone
- Mpc — Paint Creek Limestone
- Mpr — Paint Creek Limestone, Bethel Sandstone, and Renault Limestone
- Mbe — Bethel Sandstone
- Mre — Renault Limestone
- Msg — Ste. Genevieve Limestone
- Mssu — Ste. Genevieve Limestone and St. Louis Limestone, upper member
- Mss — St. Louis Limestone and Salem Limestone
- Msll — St. Louis Limestone, lower member
- Ms — Salem Limestone
- Msw — Salem and Warsaw Limestones
- Mhb — Harrodsburg Limestone
- Mw — Warsaw Formation
- Mfp — Fort Payne Formation

DEVONIAN and MISSISSIPPIAN
- MDc — Chattanooga Shale
- Dsj — Sellersburg and Jeffersonville Limestones

SILURIAN
- Swl — Louisville Limestone, Waldron Shale, and Laurel Dolomite

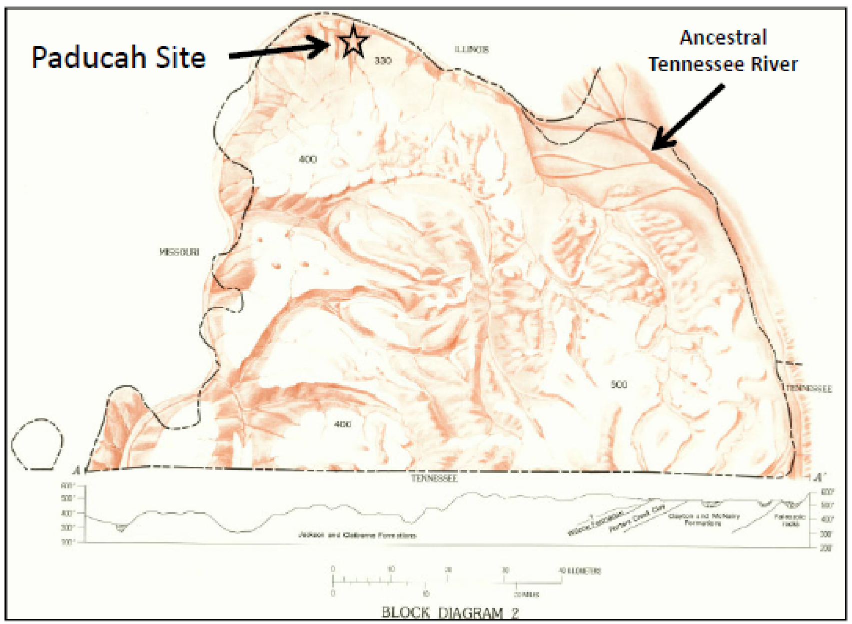
ORDOVICIAN
- Oc — Cumberland Formation

Generalized Depositional Sequence for the Continental Deposits: Miocene(?)-Pliocene



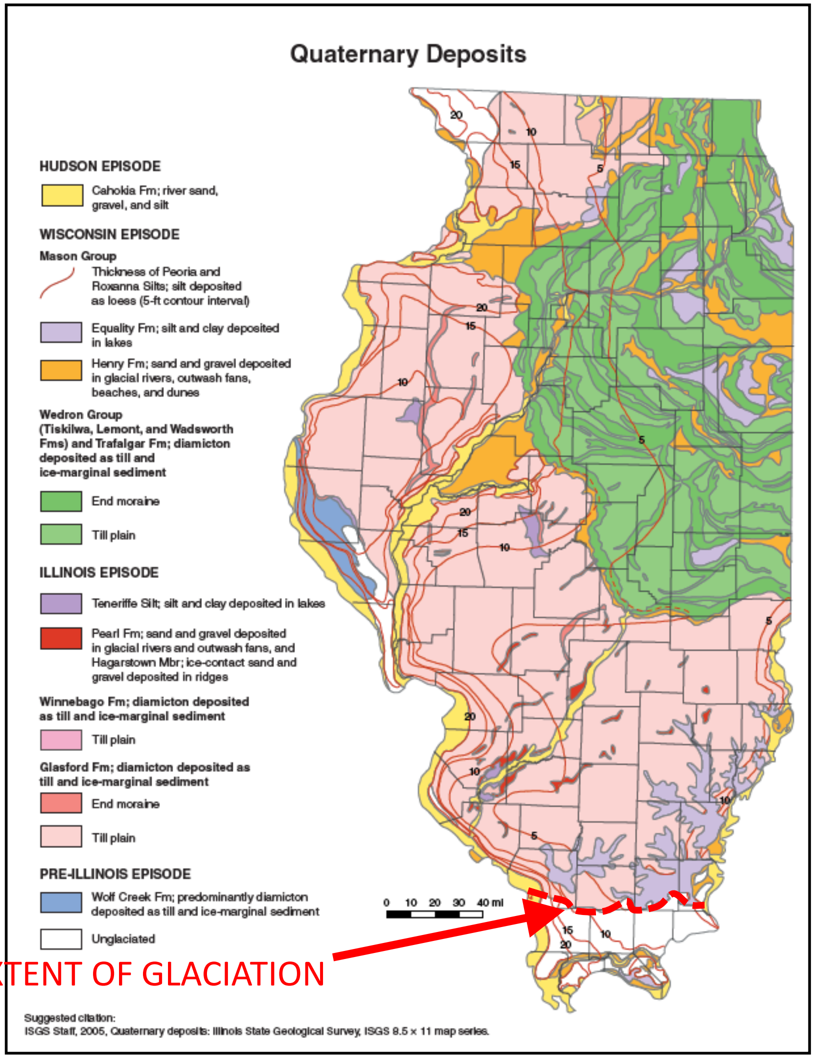
(A)

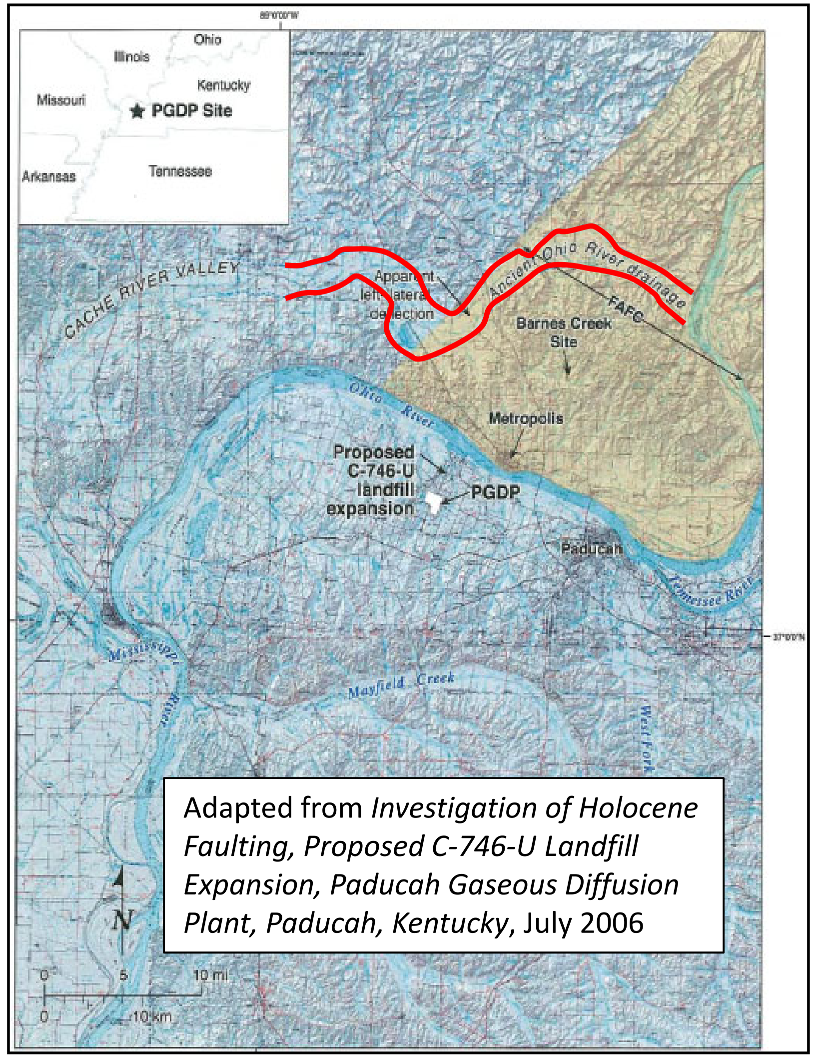
During the Miocene (?)-Pliocene, alluvial fan deposits blanketed the site.



Initial Deposition of Jackson Purchase Alluvial Fan
U.S.G.S. Map I-1217

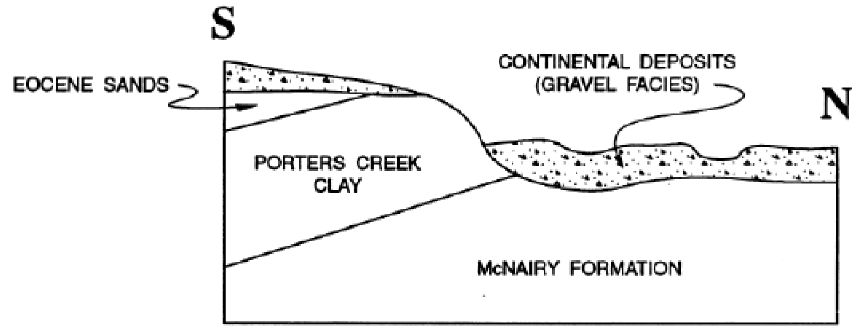
Quaternary Glaciation (13,500 to 300,000 Years Ago)





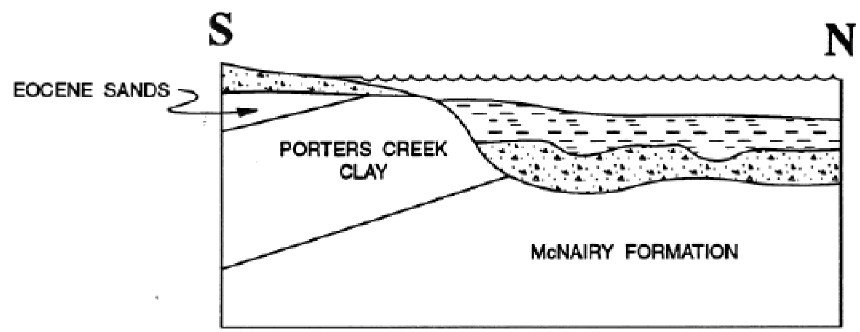
Adapted from *Investigation of Holocene Faulting, Proposed C-746-U Landfill Expansion, Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, July 2006

Generalized Depositional Sequence for the Continental Deposits: Pleistocene



(B)

During the Pleistocene, the ancestral Tennessee River downcut into alluvial fan and older sediments and redeposited gravel on an erosional surface of approximately 280 ft amsl.

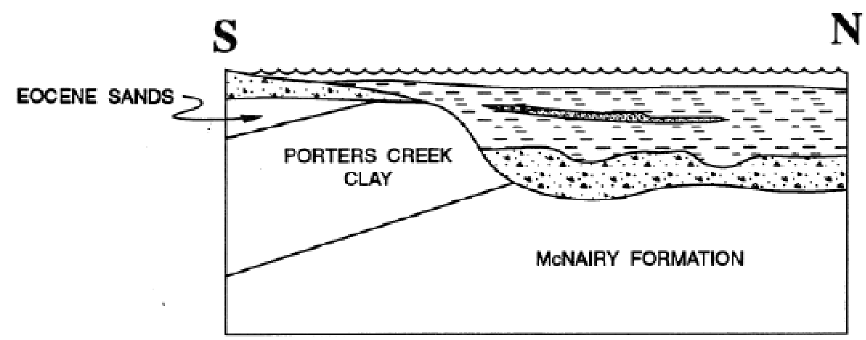


(C)

Later, during the Woodfordian glacial substage, a lake occupied the valley as the ancestral Tennessee River was dammed by glacial outwash.

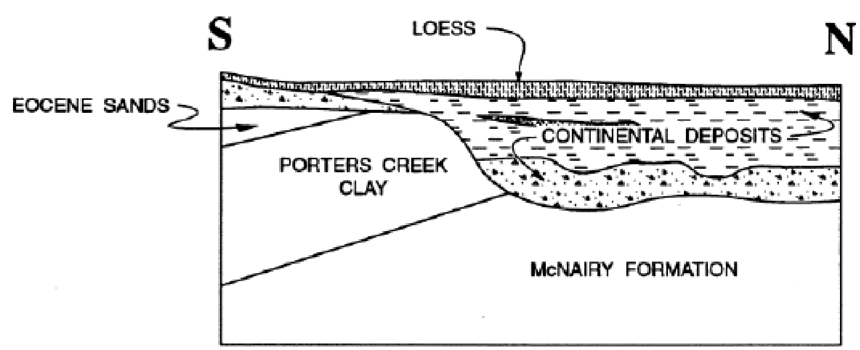
Report of the Paducah Gaseous Diffusion Plant, Groundwater Investigation Phase III, KY/E-150

Generalized Depositional Sequence for the Continental Deposits: Late Pleistocene



(D)

As lake levels reached a maximum, an extensive lake plain, consisting primarily of fine-grained sediments, attained an elevation of 360 to 375 ft amsl.

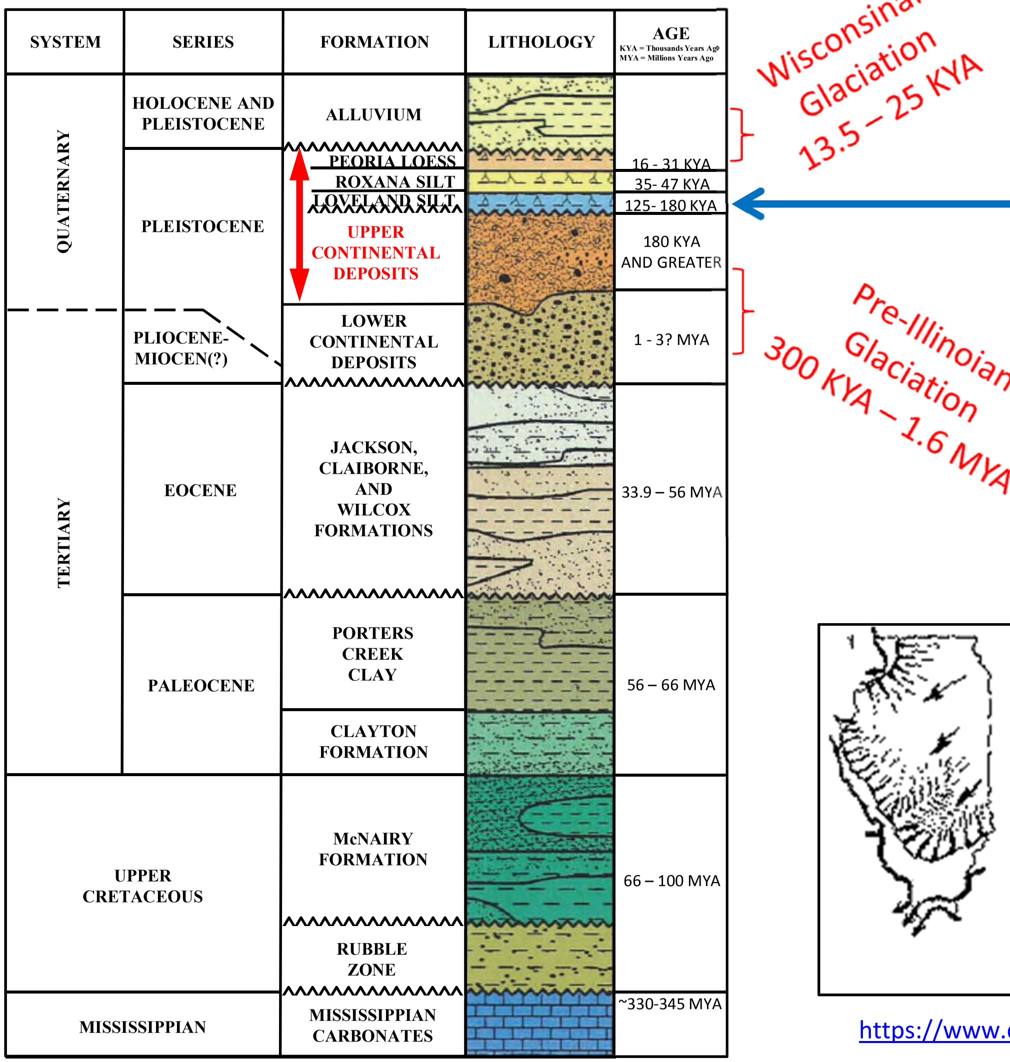


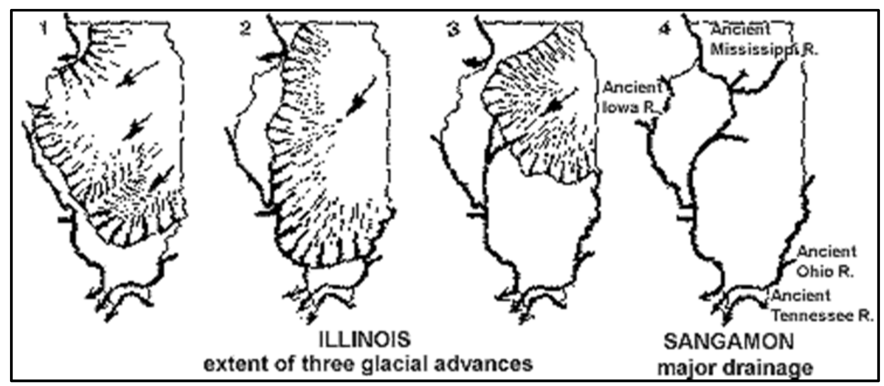
(E)

A blanket of loess eventually covered the site.

Report of the Paducah Gaseous Diffusion Plant, Groundwater Investigation Phase III, KY/E-150

Paducah Site Geologic Column





https://www.dnr.illinois.gov/education/Pages/SchwegmanGlacier.aspx

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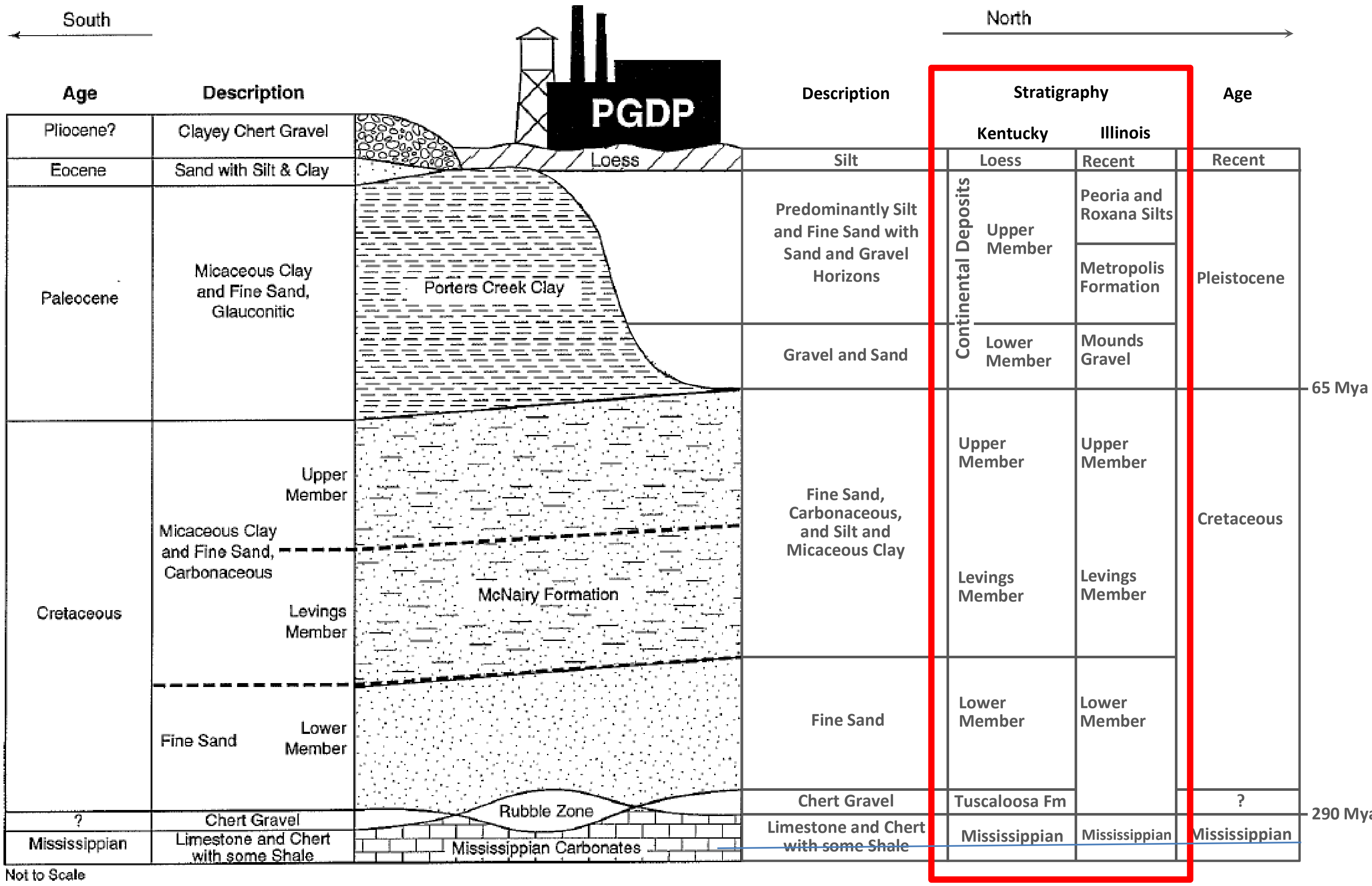
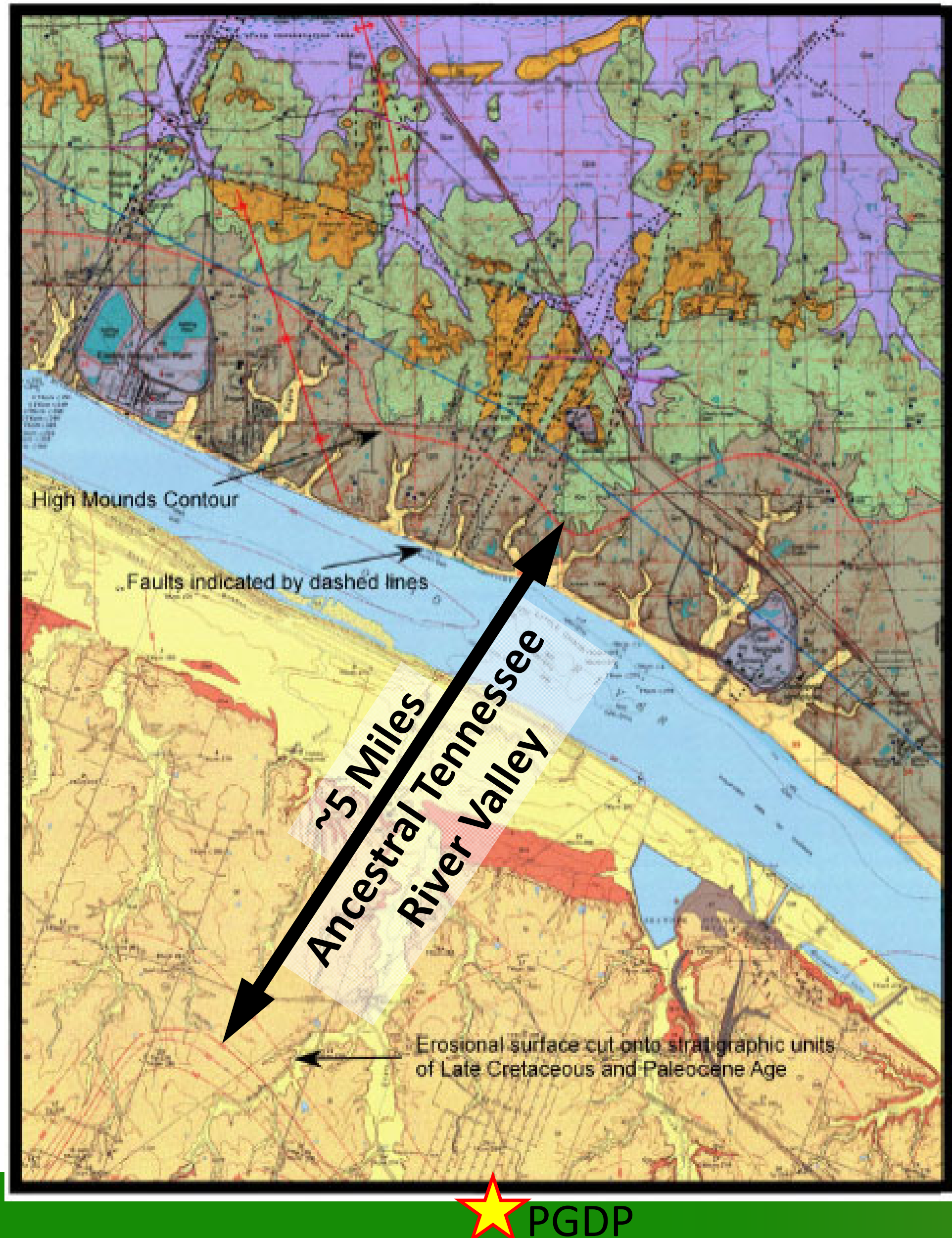
Kentucky vs Illinois Stratigraphy



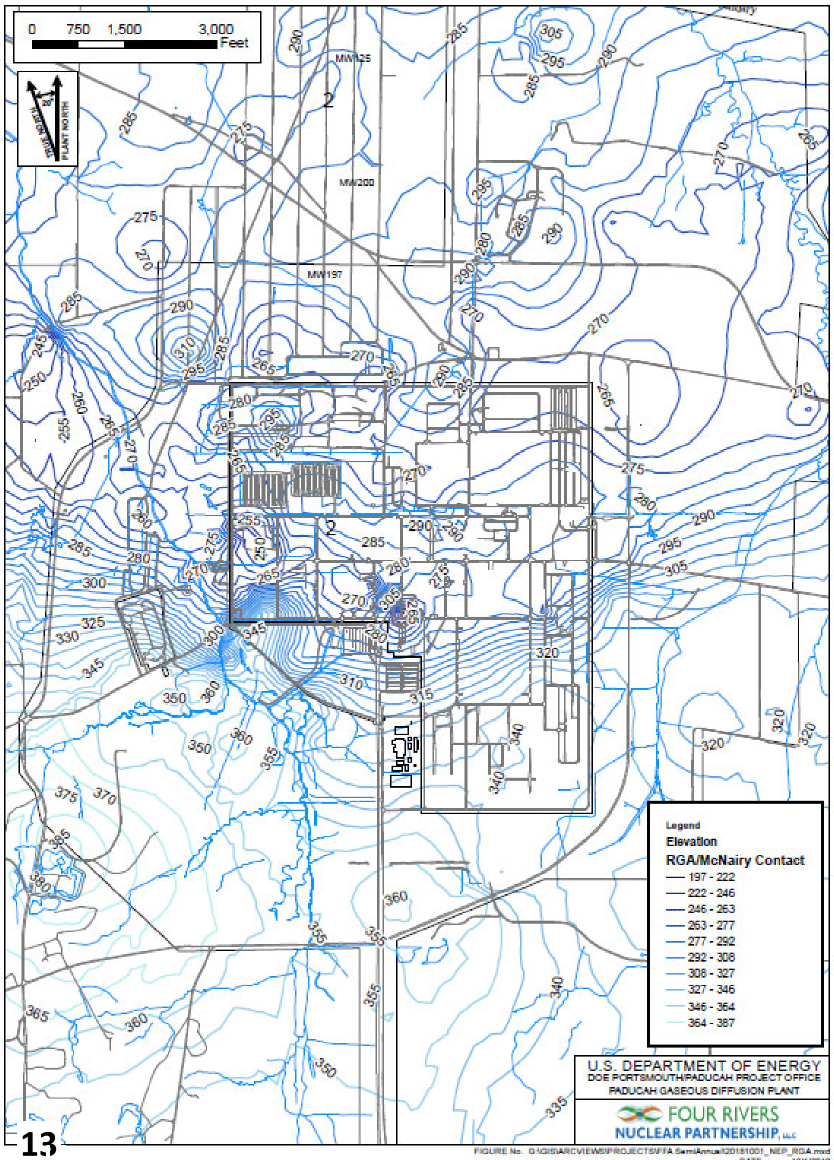
Paducah Site and Illinois Portion of Joppa Quadrangle

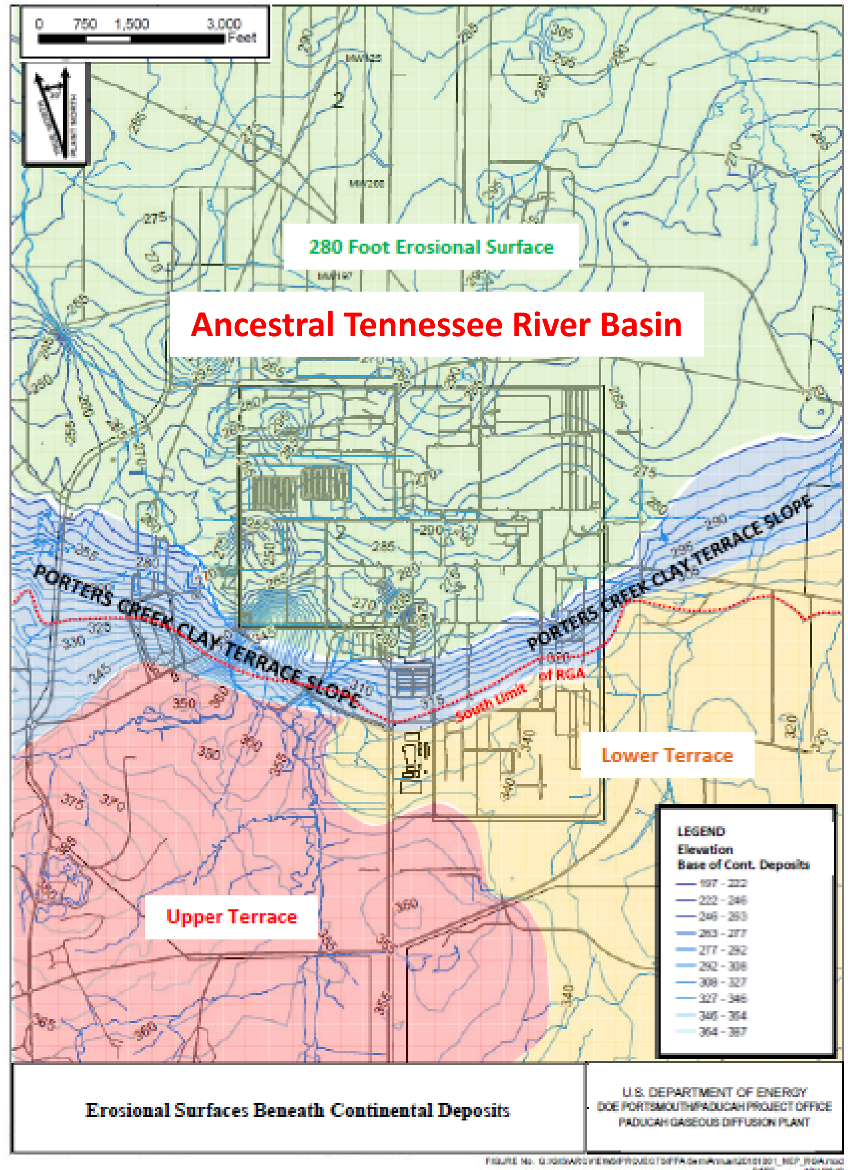


Adapted from *Lithologic and Stratigraphic Compilation of Near-Surface Sediments for the Paducah Gaseous Diffusion Plant, McCracken County, KY*, UK MS Thesis by John Sexton, 2006

12

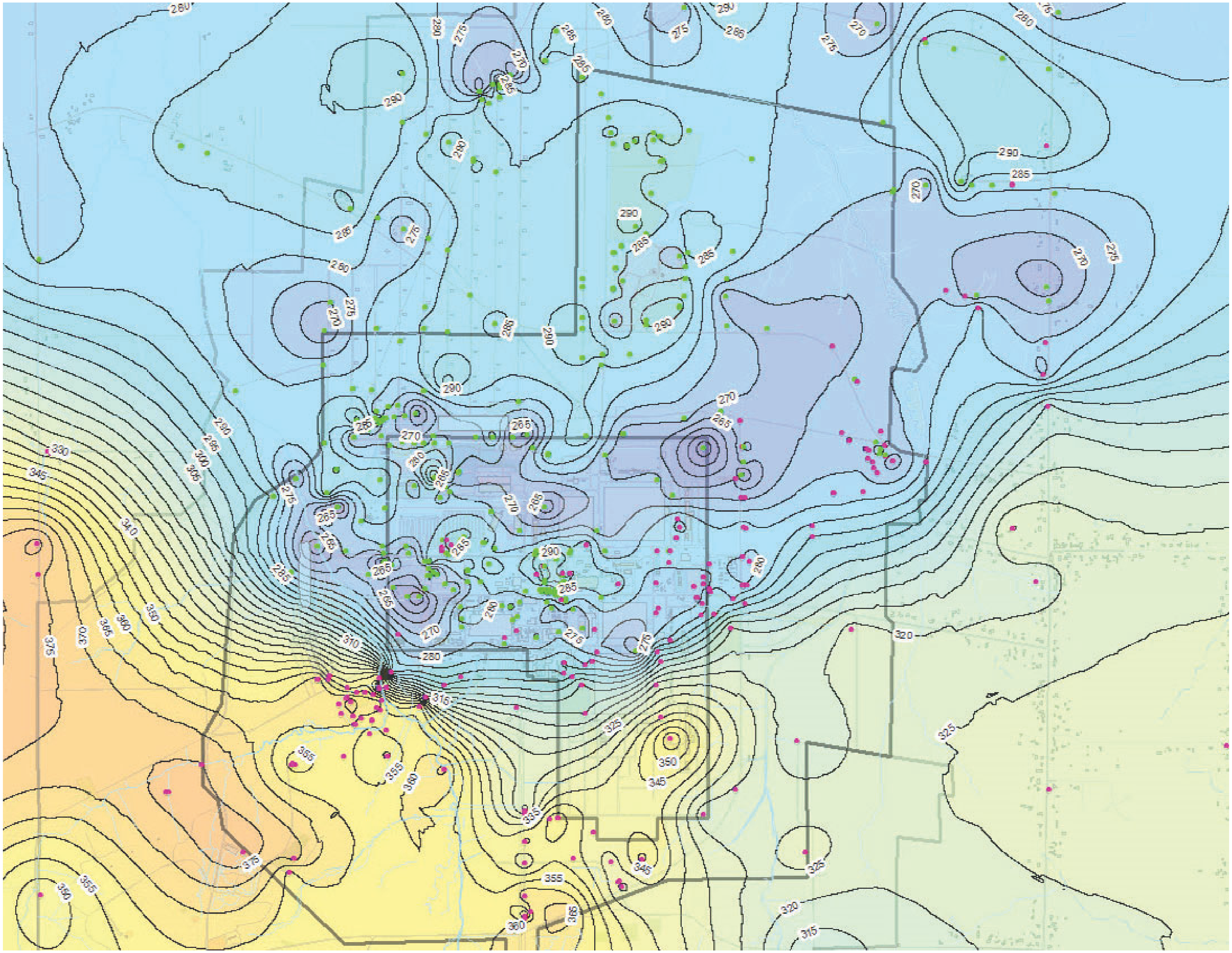
Depositional/Erosional Structure



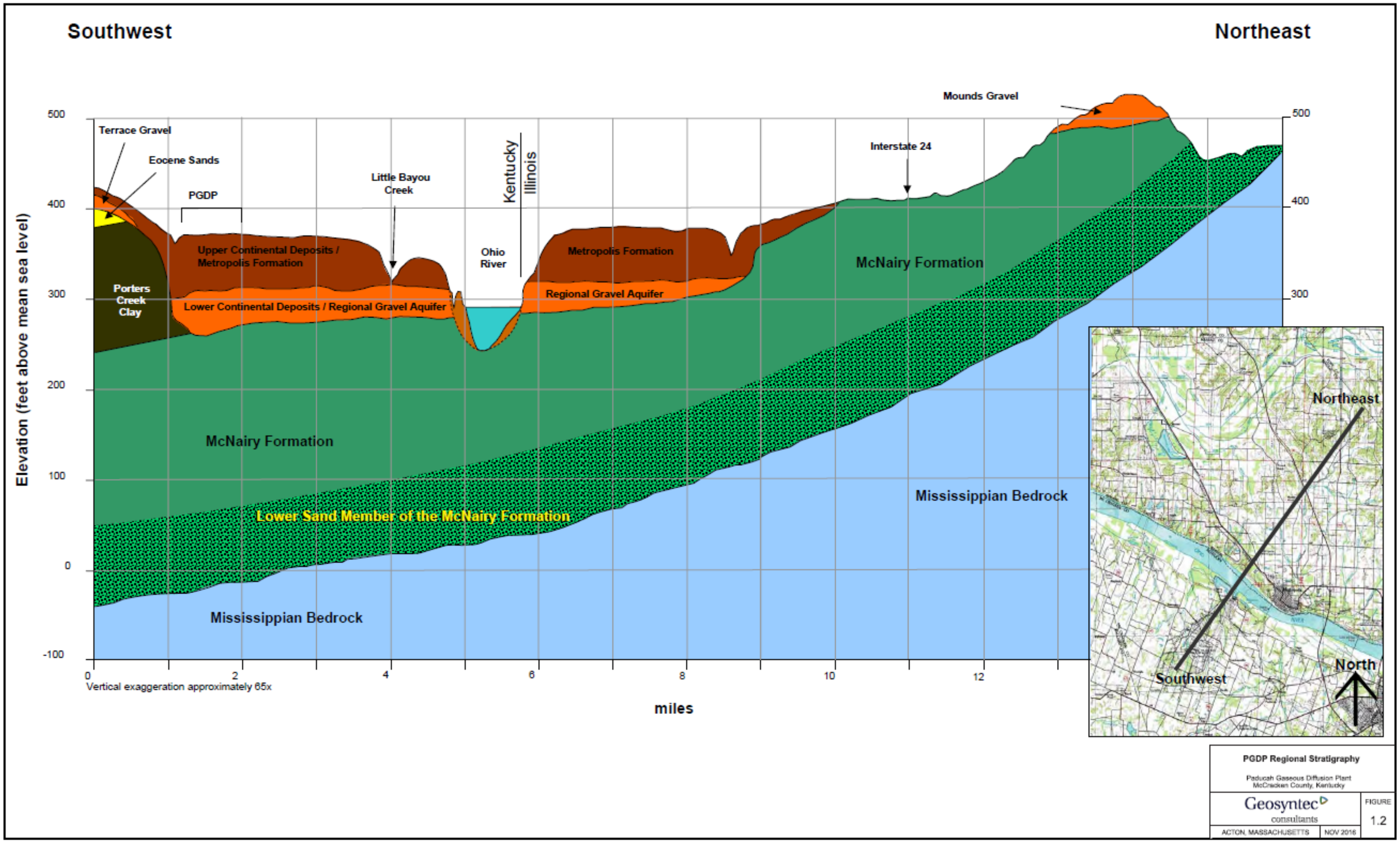


13

Updated KRCEE Map

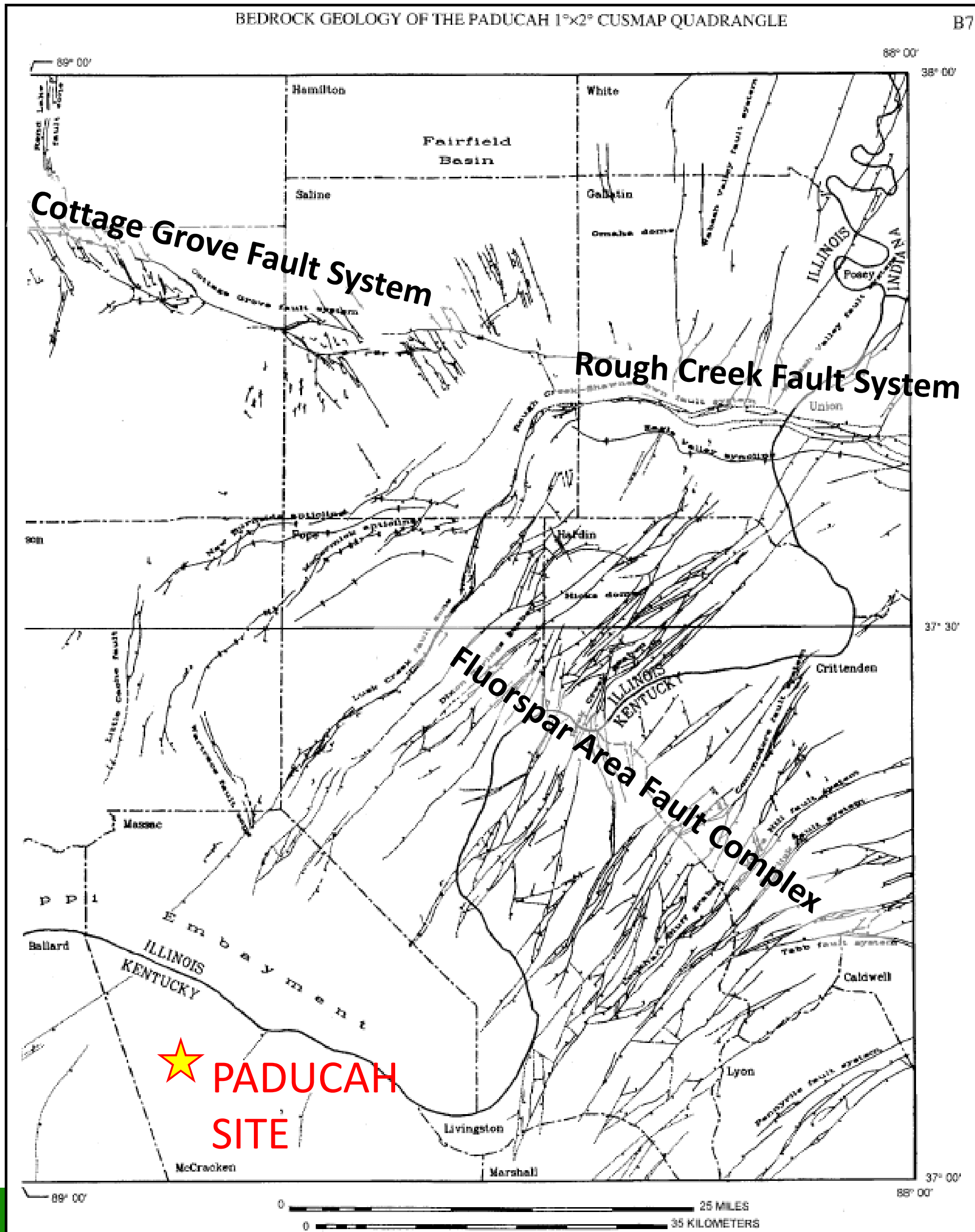


Depositional/Erosional Structure



Source: Adapted from Paducah Remediation Services, 2009; Figure 1
Note: Regional Gravel Aquifer thickness is variable. See Figure 3.4.

Structural Features in the Paducah Quadrangle



Adapted from *Bedrock Geology of the Paducah 1°x2° CUSMAP Quadrangle, Illinois, Indiana, Kentucky, and Missouri*, 1998

Lineaments and Faults at the Paducah Site

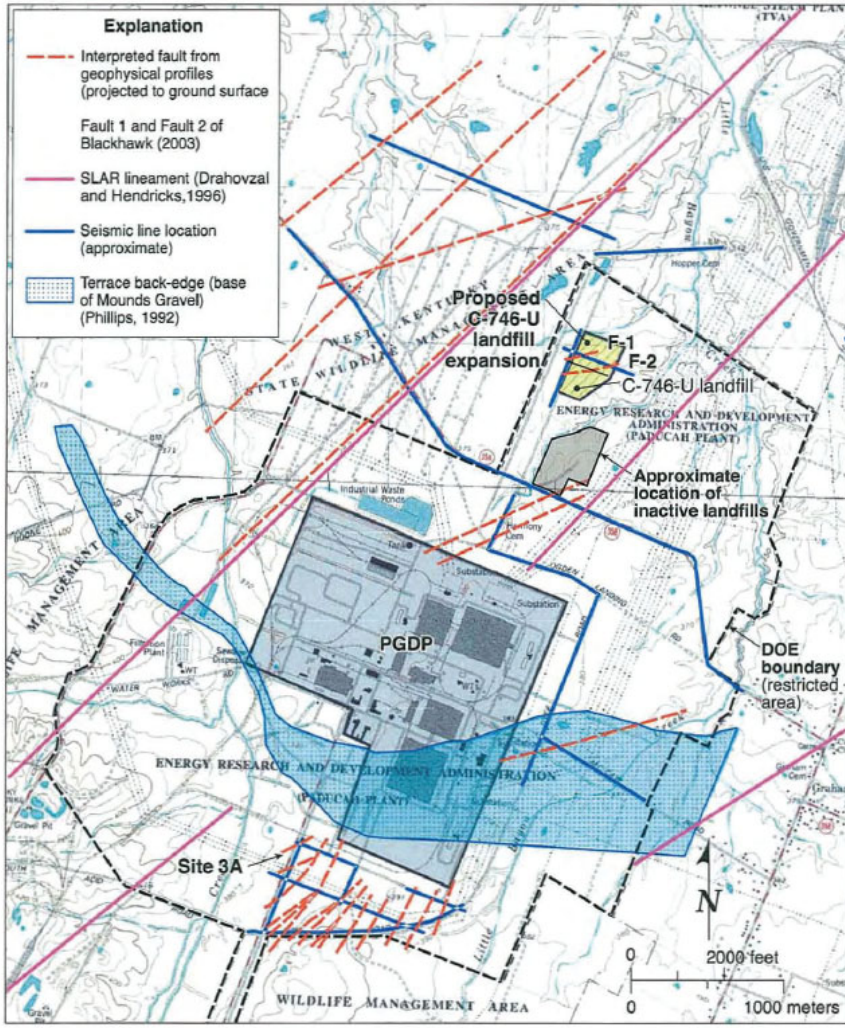


Figure 2. Site map of Paducah Gaseous Diffusion Plant (PGDP) and proposed C-746-U landfill expansion. Seismic line and fault traces considered approximate (taken from Langston and Street, 1998; Woolery and Street, 2002; and SAIC, 2004). SLAR lineaments from Drahovzal and Hendricks (1996). U.S.G.S. topographic base map from Joppa and Heath 7.5-minute quadrangles (1990).

From *Investigation of Holocene Faulting, Proposed C-746-U Landfill Expansion, Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, July 2006

Faulting: C-746-U Landfill Study

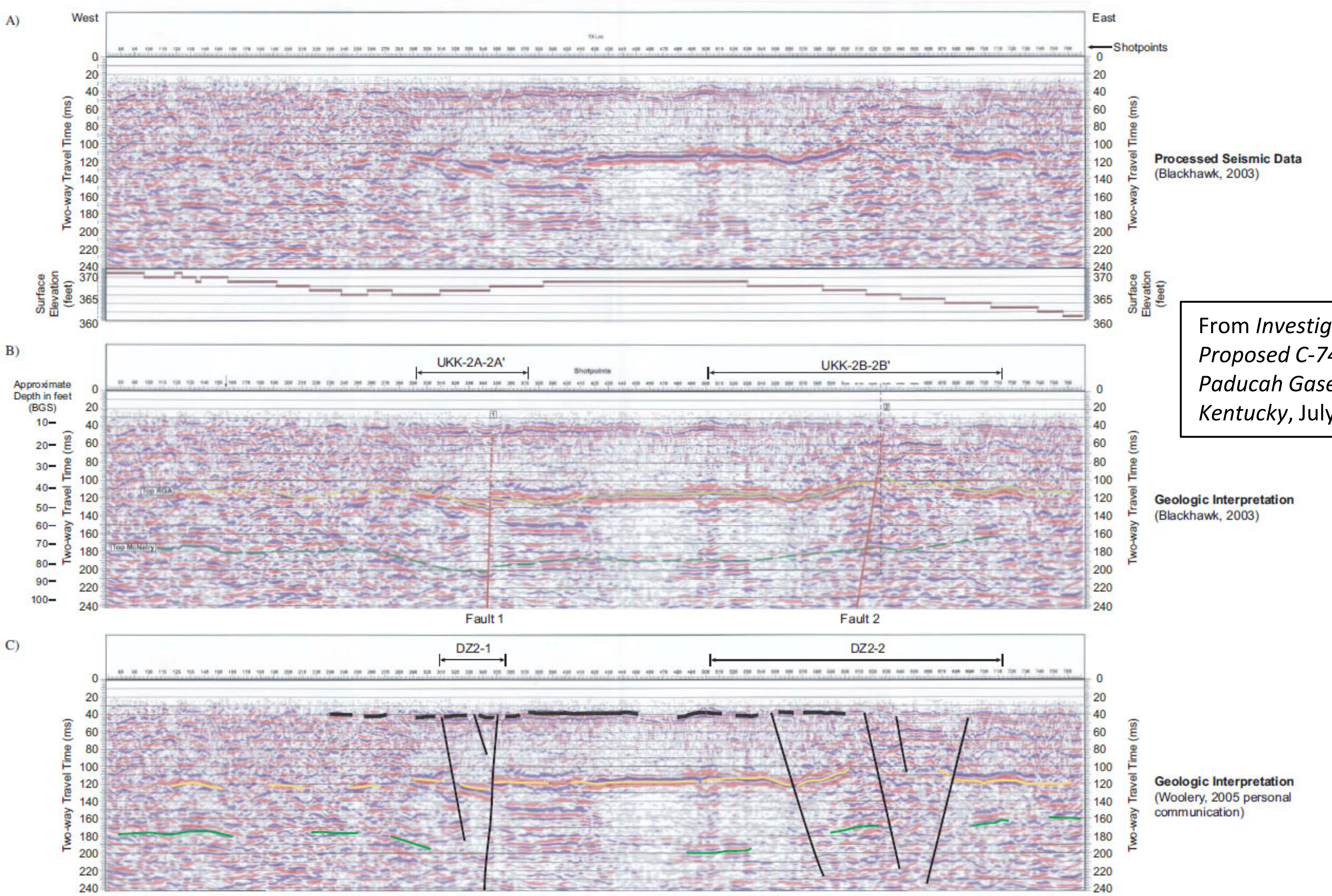
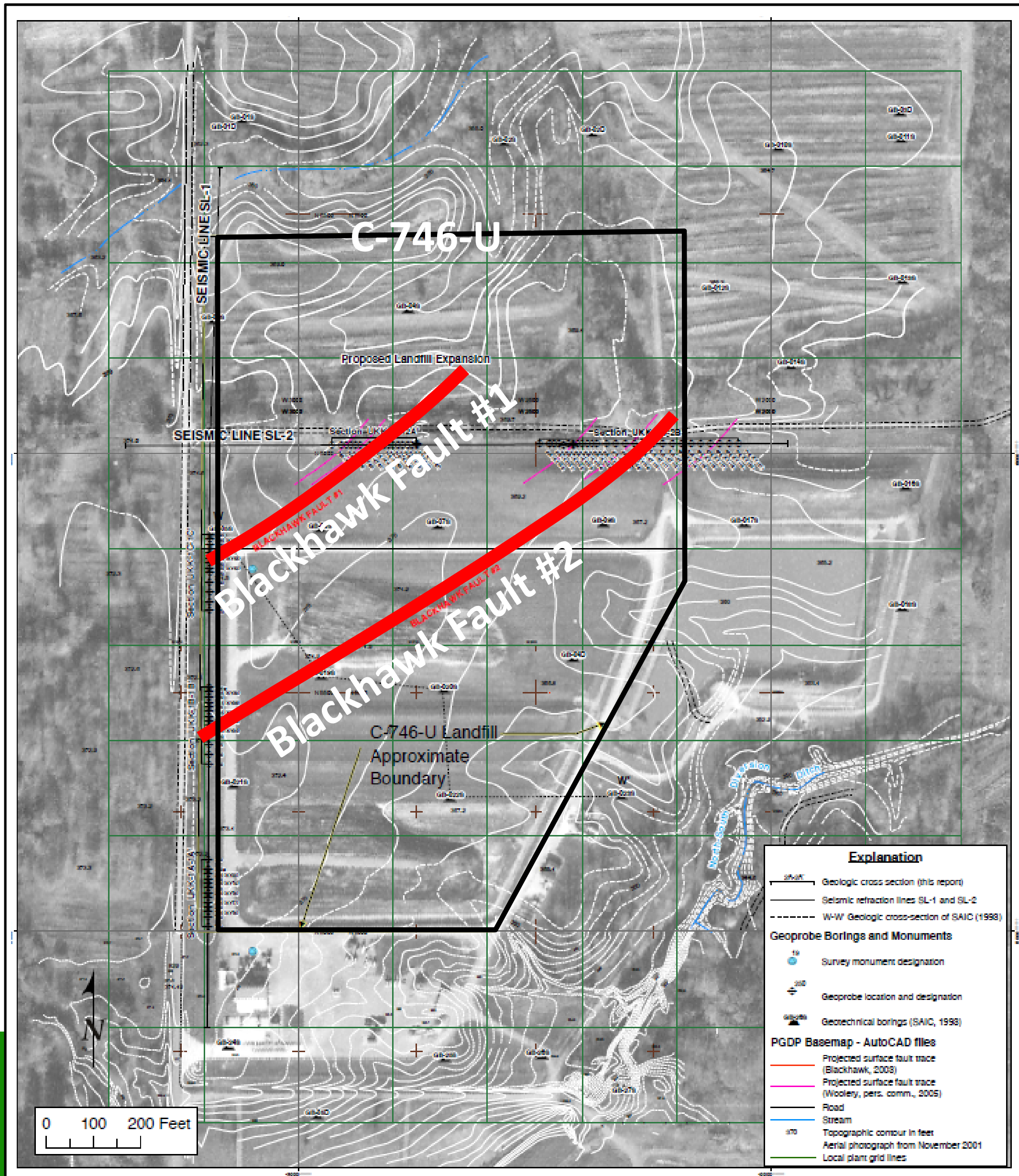


Figure 9. Seismic reflection profile SL-2 of Blackhawk (2003). A) Uninterpreted seismic reflection. B) Blackhawk (2003) interpretation UKK-2A-2A' represents location of geologic cross section based on DPT data (this study). RGA = regional groundwater aquifer. C) Woolery (this study) interpretation DZ2-1 and DZ2-2 and represent deformation zones of seismic line SL-2. Black subhorizontal lines denote stratigraphy within the Metropolis Formation; yellow colored subhorizontal line denotes the Mounds Gravel or top of the regional groundwater aquifer. Green colored subhorizontal line represents the top of the McNairy Formation.

1725 Paducah
Revised 07/26/06

From *Investigation of Holocene Faulting, Proposed C-746-U Landfill Expansion, Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, July 2006

Faulting: C-746-U Landfill Study



Adapted from *Investigation of Holocene Faulting, Proposed C-746-U Landfill Expansion, Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, July 2006

Faulting: Site 3A Study

Document No. DOE/OR/07-2038&D2

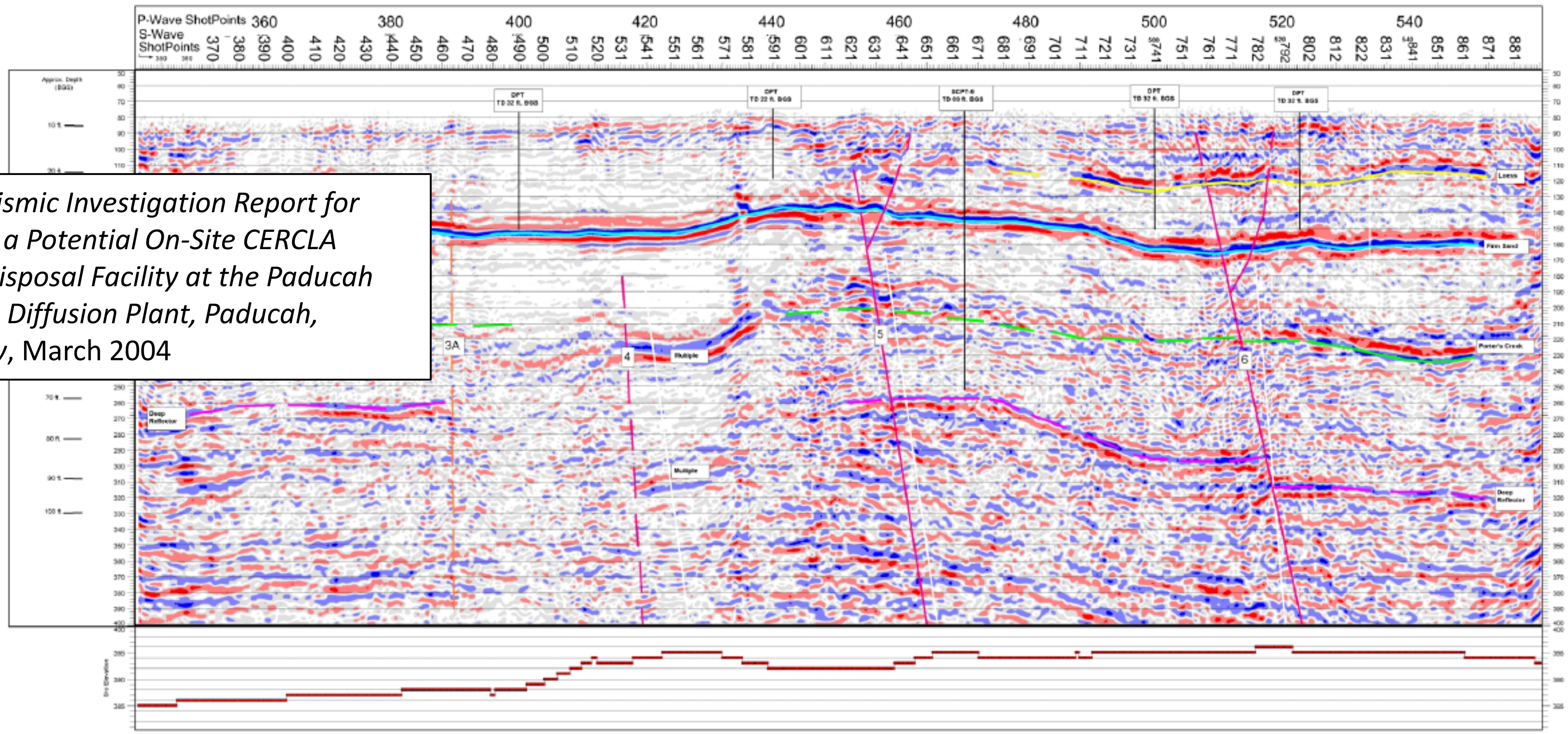


Fig. 6.23. Migrated section for s-wave survey Line 2S.

U.S. DEPARTMENT OF ENERGY
DOE OAK RIDGE OPERATIONS
PADUCAH GASEOUS DIFFUSION PLANT

BECHTEL JACOBS COMPANY, LLC

Science Applications International Corporation

Figure No. 6.23
DATE 7/3/02

6-37

From *Seismic Investigation Report for Siting of a Potential On-Site CERCLA Waste Disposal Facility at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, March 2004

Faulting: Site 3A Study

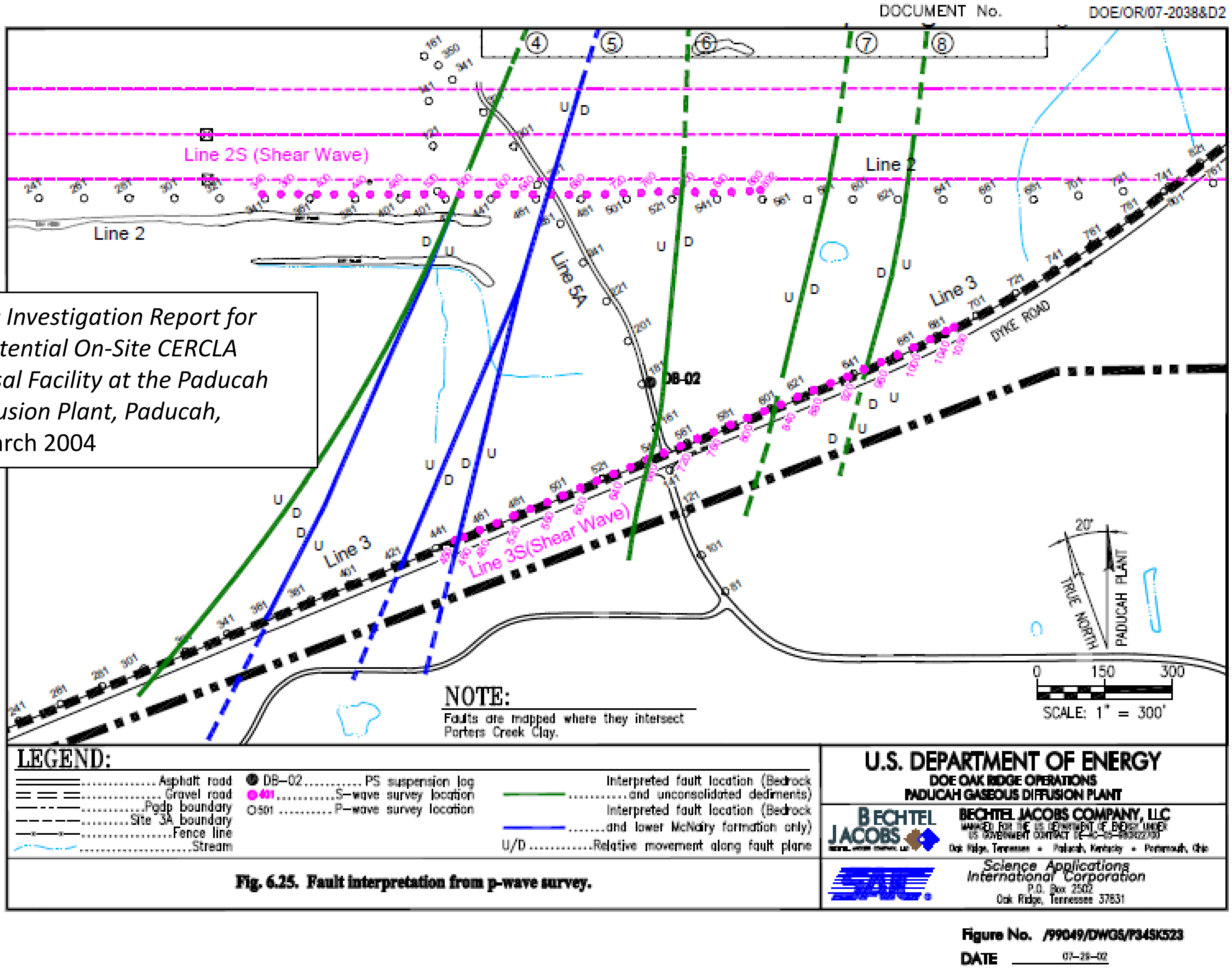


Fig. 6.25. Fault interpretation from p-wave survey.

From *Seismic Investigation Report for Siting of a Potential On-Site CERCLA Waste Disposal Facility at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, March 2004

Summary

- Geology is an important context to understanding the distribution of groundwater contaminants at the Paducah Site.
- The Paducah Gaseous Diffusion Plant (GDP) occurs in the Jackson Purchase - in the northern end of the Mississippi Embayment.
- The “shallow “ geology underlying the GDP complex and the area to the north consists of Quaternary-age continental deposits, associated with the ancestral Tennessee River, and loess (wind-deposited silt units).
- The geology south of the GDP complex is underlain by Eocene- through Paleocene-age (Porters Creek Clay) marine sediments that dip to the south.
- A thick sequence of Cretaceous-age sands, silts, and clays (McNairy Formation) underlies the Jackson Purchase, over Mississippian limestones and older bedrock.
- Pre-Holocene-age faults of the northeast/southwest trending Fluorspar Area Fault Complex occur north of the Paducah Site in Illinois.
- Geophysical surveys have imaged buried faults beneath and adjacent to the Paducah Site.

Summary of Presentation Notes

- Slide 2: Designation of east-west extent of Mississippi Embayment is relative to time reference. Geologists with interest in Paleozoic and older periods limit embayment to western half of region. Geologist with interest in Cretaceous and younger periods include eastern (Coastal Plain) half of region.

- Slide 4: The Quaternary is generally accepted to have begun 11,650 years ago.

- Slide 5: The Paducah Site is underlain by Mississippian limestone. Older bedrock underlies the McNairy Formation to the west of the Paducah Site. Some municipal wells of Metropolis, IL produce water from Mississippian limestone.

- Slide 6: 2.6 to 23.0 million years ago.

- Slide 7: The modern Ohio River course began ~40,000 years ago.

- Slide 7: Quaternary glaciation began 1.3 million years ago. Little evidence remains of the glacial episodes prior to the Illinois Episode (began 300,000 years ago).

- Slide 8: 300,000 to 1.6 million years ago (pre-Illinois glaciation) - deposition of HU5 (RGA) gravel (These and following date assignments are based on Optical Stimulation Luminescence/OSL dates from the C-746-U Landfill Holocene Fault investigation, dates assigned to the Metropolis Formation of Illinois, and the Law of Superposition.)

- Slide 8: 180,000 to 300,000 years ago (interglacial episode) - deposition of HU4 sand upwards(?) through lower HU3 fine sand/silt/clay interval

- Slide 8: Incorrect age assignment.

- Slide 9: 16,000 to 75,000 years ago (Wisconsin glaciation and preceding interglacial period - deposition of HU1 loess

- Slide 9: 125,000 to 180,000 years ago (Illinois glaciation) - deposition of HU2 and(?) upper HU3 interval

- Slide 10: Should be 125,000 to 180,000 years ago

- Slide 10: Should be 300,000 to 5 million years ago

- Slide 10: Terrace gravels

- Slide 11: May be as old as Pliocene (up to 5 million years ago)

- Slide 13: More recent map by KRCEE now available.

- Slide 21: and Tertiary

Attachment 3

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 4
ATLANTA FEDERAL CENTER
61 FORSYTH STREET
ATLANTA, GEORGIA 30303-8960

November 20, 2019

Ms. Tracey Duncan
Federal Facility Agreement Manager
United States Department of Energy
Portsmouth/Paducah Project Site Office
5501 Hobbs Road
Kevil, KY 42053

RE: EPA Request for Groundwater Work Group Collaboration on the McNairy Flow System Conceptual Site Model. Paducah Gaseous Diffusion Plant, Paducah, Kentucky. EPA ID KY8890008982

Reference:

EPA Approval (October 1, 2019): Remedial Investigation/Feasibility Study Work Plan for the C-400 Complex Operable Unit at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky (DOE/LX/07-2433&D2), Primary Document, transmittal dated September 18, 2019 (PPPO-02-5575312-19B).

Dear Ms. Duncan:

The purpose of this letter is to provide EPA's observations and supporting information regarding the McNairy component of the Groundwater Conceptual Site Model (CSM) at the Paducah Gaseous Diffusion Plant (PGDP). EPA's approval letter (Ref. 1) for the C-400 Complex Operable Unit Remedial Investigation/Feasibility Study (RI/FS) Work Plan recommended tri-party collaboration in the upcoming months to achieve a shared understanding of the McNairy Flow System based on currently available data and information. This recommendation was the outcome of EPA's identification of apparent inconsistencies or alternative interpretations regarding key elements of the McNairy CSM based on review of the McNairy information provided by the Department of Energy (DOE) on May 6 through May 21, 2019, the referenced D2 RI/FS Work Plan and cross-walk with historical investigation reports in the Administrative Record for the site cleanup. The enclosed comments are intended for discussion by the PGDP Groundwater Model Work Group in 2Q Fiscal Year (FY) 2020 with the goal of reaching consensus, to the maximum extent possible, on the baseline CSM for the McNairy Flow System in support of the high priority C-400 Complex Operable Unit investigation and data interpretation activities, including reaching real-time tri-party agreement on contingent sampling work scope, during Fiscal Year 2020-2021 field activities.

Please do not hesitate to contact me at 404-562-0847 or corkran.julie@epa.gov if you have any questions about this correspondence.

Sincerely,

Julie L. Corkran, Ph.D.
Federal Facility Agreement Manager
Superfund Division

Enclosure (as stated)

Electronic copy:

Eva Davis, US EPA ORD
Victor Weeks, US EPA R4
Ben Bentkowski, US EPA R4
Eva Davis, US EPA - ORD
Mac McRae, TechLaw Inc
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Brian Begley, KDWM - Frankfort
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Holly Lawrence, TVA
Michael Bottoroff, TVA

United States Environmental Protection Agency (U.S. EPA)
Comments to the Groundwater Model Work Group in Support of Developing a Baseline Conceptual Site Model for the McNairy Formation/Flow System
Paducah Gaseous Diffusion Plant, Paducah, Kentucky
November 19, 2019
EPA ID KY8890008982

References:

1. *Remedial Investigation/Feasibility Study Work Plan for the C-400 Complex Operable Unit at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky (DOE/LX/07-2433&D2), Primary Document, transmittal dated September 18, 2019 (PPPO-02-5575312-19B)*
2. *EPA Approval (October 1, 2019): Remedial Investigation/Feasibility Study Work Plan for the C-400 Complex Operable Unit at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky (DOE/LX/07-2433&D2), Primary Document, transmittal dated September 18, 2019 (PPPO-02-5575312-19B).*
3. *Remedial Investigation Report for WAG 6, May 1999 (DOE/OR-07-1727/V1-4 &D2).*
4. *Northeast Plume Preliminary Characterization Summary Report (aka the 'Phase IV Report'), February 1995 (DOE/OR/07-1339&D1).*
5. *The McNairy Formation in the Area of the Paducah Gaseous Diffusion Plant, September 1996 (KY/EM-148).*
6. *EPA Independent Assessment of Protectiveness (September 30, 2019): 2018 Fourth Synchronous Five-Year Review, Paducah Gaseous Diffusion Plant, Paducah, Kentucky.*

Comments to the PGDP Groundwater Model Work Group in Support of Developing a Baseline Conceptual Site Model for the McNairy Formation/Flow System

1. The 2019 C-400 Remedial Investigation/Feasibility Study Work Plan (Ref. 1) states DOE's intent to move forward absent consensus among the FFA Parties on contingency sampling under certain conditions to be evaluated by DOE (Section 9.3.12 Contingency Sampling, Page 9-70; emphasis added):

   "DOE will propose contingency boring locations, and the FFA parties will participate in the review of analytical results from soil and groundwater samples to assist in locating and conducting contingency borings. <u>In the event the FFA parties cannot reach consensus in locating and conducting the contingency borings, and if delays associated with reaching consensus would impact the ongoing progress of field work, then DOE will make the final determination</u> about locating and conducting the contingency borings (taking into consideration the recommendations from both EPA and KDEP).

   There has been a concerted effort by the Federal Facility Agreement (FFA) Parties to synthesize all of the data presented by DOE, even late into the development of the 2019 C-400 Complex Remedial Investigation/Feasibility Study (RI/FS) Work Plan, factor such data into the Conceptual Site Model (CSM), and identify the data gaps to be filled during the C-400 Complex RI/FS field work. The McNairy Formation/Flow System component of the Groundwater CSM is presented primarily in Sections 4.6.4 Hydrogeology/McNairy Flow

System and 4.10 Conceptual Site Model of the 2019 Work Plan with additional statements regarding the McNairy scattered throughout the Work Plan. However, as discussed in scoping meetings in 2019, there is relatively higher uncertainty among the FFA parties regarding the McNairy Flow System component of the Groundwater CSM. Further, EPA's review of the Work Plan and cross-walk with historical investigation reports identified potential inconsistencies and alternative interpretations regarding the key elements of the McNairy CSM that are not captured in the final approved Work Plan.

It order for the FFA Parties to collaborate in efficient, real-time, review of the analytical results and assist in decision-making in FY2020-21 regarding contingency scope of work (as forecast in Work Plan Section 9.3.12), the three parties must have a clear and shared understanding of areas of agreement, disagreement (if any), uncertainties and the supporting lines of evidence based on currently available data and information – in other words, a Baseline McNairy CSM that is not satisfied by Sections 4.6.4 and 4.10 of the D2 Work Plan. Therefore, consistent with EPA's approval letter for the Work Plan (Ref. 2), the comments below provide EPA's observations and supporting information regarding the McNairy component of the CSM. The enclosed comments are intended for discussion by the PGDP Groundwater Model Work Group with the goal of reaching consensus, to the maximum extent possible, on the baseline CSM for the McNairy in the C-400 Complex area in support of the critical data interpretation and uncertainty management decisions facing the FFA parties later in Fiscal Year 2020-21 when field characterization data become available in support of allocating contingency scope of work identified in the Work Plan. The Groundwater Work Group work product is envisioned as a more complete written CSM (that pulls from the 2019 Work Plan and historical documentation) for the McNairy against which the FFA Parties can benchmark as C-400 Complex RI/FS field activities proceed in support of the real-time decision-making and to track CSM evolution based on new data for incorporation into the draft (D1) RI/FS Report.

2. Figures provided in the 2019 Work Plan that show the locations of the McNairy Formation monitoring wells (e.g., Attachment #1 in Appendix B of the D2 Work Plan) illustrates that of the 15 wells in the McNairy, only four are within the C-400 Complex. Most of the McNairy monitoring wells are more than a half mile away from C-400, and thus provide little to no information on the McNairy hydrologic properties within our area of interest. However, the four McNairy Formation monitoring wells that are in the C-400 Complex boundaries (MW-405-PRT7, MW-406-PRT-7, MW-407-PRT7 and MW-408-PRT7) provide valuable information on contaminants in the McNairy Formation that have not been adequately considered in developing the Work Plan CSM and sampling proposal.

   All four of these wells had at least one sample result that was indicative of the presence of trichloroethene dense nonaqueous phase liquid (TCE DNAPL), and MW-408-PRT7 consistently had TCE groundwater concentrations indicative of DNAPL from 2003 to 2007. Figure 9.15 of the D2 Work Plan shows a proposed boring adjacent to MW-405 as is appropriate for this investigation, however, the figure does not show a proposed soil boring within 50 feet of MW-408. The accumulation of TCE DNAPL at this location may have allowed DNAPL penetration and downward diffusive transport of TCE to a greater extent at this location. This uncertainty and potential data gap should be captured in the Baseline

McNairy CSM. Further, EPA recommends that this location should be prioritized for consideration by the FFA parties for a potential contingency boring that extends into the McNairy Formation to determine the total depth of the contamination at this location.

3. There appears to be a discrepancy in the 2019 Work Plan about the direction of groundwater flow in the McNairy Formation. Water Level Measurements on page 4-41 states, "Potentiometric trends of the RGA and the McNairy Formation are similar at the Paducah Site." This might be taken to infer that there is a groundwater divide in the McNairy as there is in the RGA in the vicinity of C-400. Figure 4.20 relies on data from four McNairy monitoring wells to determine that the groundwater flow direction in the McNairy Formation is to the northeast. McNairy monitoring well MW-356, which is around 4,000 feet northeast of C-400 and screened at an elevation of 254 – 261 feet amsl, has had numerous TCE detections as far back as 1999 and as recently as May 2017, lending credibility to the proposition that groundwater flow in the top portion of the McNairy is to the northeast. As was discussed during the August 20 – 23, 2019, meeting in Lexington and shown on Attachment #1 which was provided to us during the meeting, the proposed plan for investigating the McNairy Formation to depths of 50 feet into the formation includes three transects of borings, in addition to upgradient and downgradient borings, with the upgradient location at boring 400-S04-17, and progressing to the northwest, with boring 400-S1C-32 being the downgradient location. If the general groundwater direction in the McNairy Formation shown in Figure 4.20 is correct on the local scale of building C-400, then the transects of proposed borings to investigate the McNairy Formation, as well as the upgradient and downgradient borings, are not placed properly to characterize the likely direction of transport of contaminants within the McNairy Formation. If the localized groundwater flow direction in the McNairy Formation in the C-400 complex is known to be different from the generalized flow direction shown in Figure 4.20, the supporting groundwater elevation data should be provided to support the Baseline McNairy CSM or the uncertainty clearly captured in the model narrative.

4. Figure 4.21 shows TCE concentrations as a function of depth using data from the Waste Area Group 6 (WAG 6) RI (Ref. 3) and from the Groundwater Monitoring Phase IV Investigation (Ref. 4). This figure <u>does not</u> include the data from the four monitoring wells within the known source zone that show the presence of TCE DNAPL as much as 14 feet into the McNairy Formation (see Comment 2). Nevertheless, this figure in the Work Plan is the basis for the statement, "the vertical limit of TCE migration into the McNairy Formation is approximately 50 ft." Figure 4.39 of the WAG 6 report shows that most of the data on TCE concentrations in the McNairy Formation are at some distance from the known source zone in the vicinity of MW-408-PRT7. Also, the data used to create Figure 4.21 is at least 20 years old. TCE has continued to migrate downward due to diffusion in the dissolved phase during the last 20 years, and it may have also migrated downward as a DNAPL. Thus, the data in this figure is not only outdated, but generally does not come from the area of interest, which is the source zone(s) within the C-400 complex. The data from MW-405-PRT7, MW-406-PRT-7, MW-407-PRT7 and MW-408-PRT7, and the uncertainties noted above, should be incorporated into the Baseline McNairy CSM.

5. Both horizontal and vertical flow rates in the McNairy Formation are calculated on page 4-41 of the 2019 Work Plan. The median horizontal conductivity was determined from slug tests on wells screened in the silts and clays, which yielded hydraulic conductivities indicative of silty clays. Data from the WAG 6 RI, which is from soil borings that were close to the C-400 Complex, shows significant sands (greater than 50 percent) in five of the nine McNairy samples for which grain size measurements were made. These sands may have horizontal hydraulic conductivities that are two orders of magnitude (or more) greater than the median horizontal hydraulic conductivity used in the calculations on page 4-41. In these sandy zones, if they are continuous, TCE may have traveled much greater distances in the 30 years or more since the discharges occurred. This uncertainty should be articulated in the Baseline McNairy CSM.

6. The median vertical hydraulic conductivity was determined from permeameter tests on samples collected during the WAG 6 RI. These results show four orders of magnitude variability. Where there are sand beds of sufficient thickness, the downward advective flow and diffusion of TCE may be significantly greater than the calculated downward flow rate. This uncertainty should be articulated in the Baseline McNairy CSM.

7. The discussion under Water Level Measurements on page 4-41 of the 2019 Work Plan seems to imply that pumping of the extraction wells in the RGA affects the water level measurements in the McNairy Formation at wells within a certain distance of the pumping wells. Has this been confirmed by observations of water levels in the McNairy with and without extraction well pumping? If McNairy water level data with and without extraction well pumping are available, they should be provided to support development of the Baseline McNairy CSM or the uncertainty associated with this issue clearly identified in the model.

8. Page 4-44 under Contaminant Migration states: "partitioning, biological transformation, and abiotic transformation likely are important processes of retardation and degradation of contaminants in the upper and middle members." The WAG 6 data in Table 4.62 of that document shows TCE transformation products detected in only a small percentage of the McNairy groundwater samples: these data do not show transformation in the McNairy to be important. If there are data that support the statement on page 4-44, the data should be provided and incorporated the Baseline McNairy CSM. Alternatively, this statement on page 4-44 identified in the model as an issue having (high) uncertainty.

9. The 2019 Work Plan CSM (see Section 4.6.4 and 4.10) does not provide information on the subsurface structure impacting groundwater and contaminant flow. The Phase IV (Volume 1) Report (Section 2, Page 1) states: *"Faulting is reported in outcrops of the McNairy Formation in Illinois but does not appear to increase permeability of the McNairy underlying PGPD."* Similarly, the 1996 McNairy Formal Report (Ref. 5) states "*Faults are reported in outcrops of the McNairy Formation in Illinois, but faults have not been found at PGDP. The consistent hydraulic conductivity of the upper and middle McNairy members, as evidenced by the water level record of the PGDP wells, suggests faulting has not created preferential permeability pathways. In the absence of secondary permeability created by faulting, there appears little likelihood of contaminant migration in a dissolved phase or as DNAPL through the upper and middle McNairy members*."

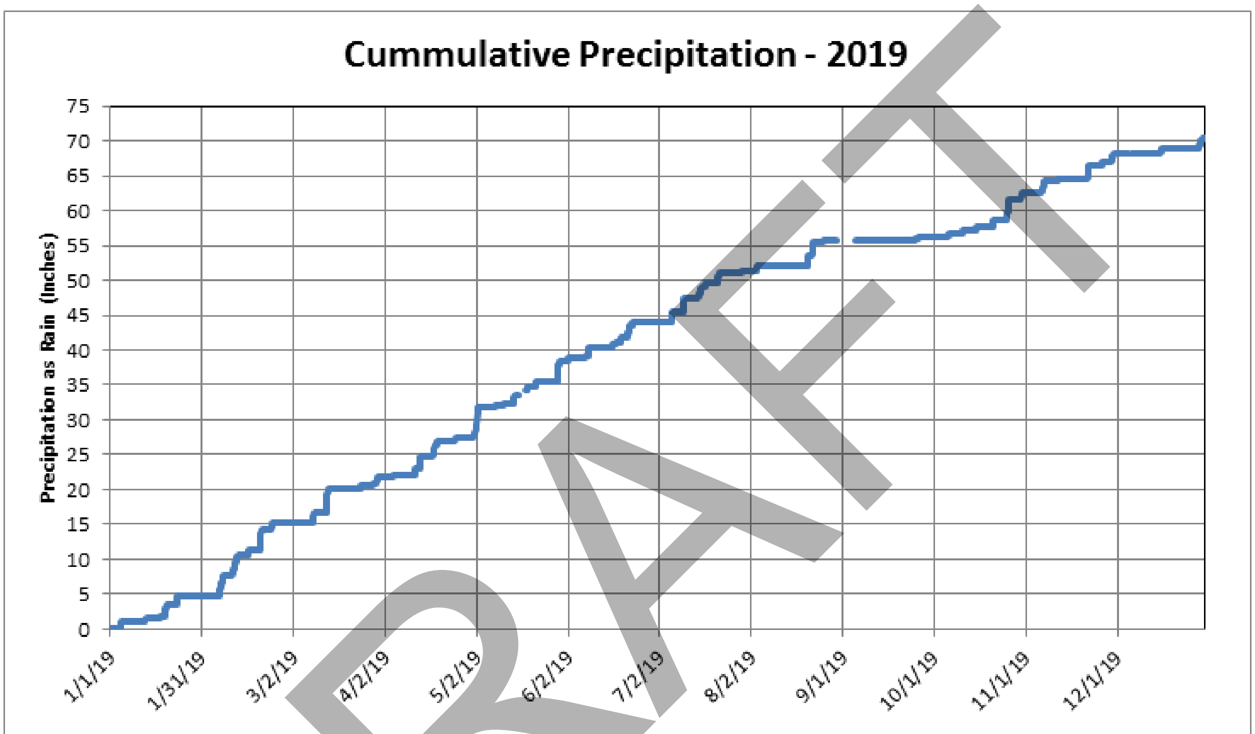
The 2019 Work Plan CSM does not incorporate the regional faulting and displacement information reviewed by the FFA parties in 2018-2019, including confirmed faulting north of PGDP (across Ohio River in Illinois) which likely exists and extends to the south (Ref. 6). Due to the potential for faulting and the potential influence on the subsurface lithologic units, similar to what was identified north in Illinois, uncertainty exists regarding the influence of fault-controlled plume migration within and beyond the PGPD boundary. The 2018-2019 (Five Year Review, Groundwater Model Work Group, and 2019 C-400 RI/FS Work Plan) discussions regarding the potential for fault-controlled plume migration at PGDP culminated in EPA's independent assessment of the Northeast and Northwest plume remedial actions as "protectiveness deferred" pending DOE development, and EPA and KDEP evaluation, of an accurate characterization of site faulting and the potential for fault-controlled plume migration across the Plant and beyond the Plant boundaries. Detailed correlations between lithologic units across the entire Paducah site, incorporating data/information collected during C-400 2019 Work Plan implementation, are to be developed and reported not later than 1Q FY2022.

If there are existing data that support the statements in the 1995 and 1996 reports regarding the permeability of the McNairy underlying PGDP, and the potential for PGDP site-related contaminant migration through preferential pathways, those data should be provided and incorporated into the Baseline McNairy CSM. Alternatively, faulting and the potential for fault-controlled plume migration in the McNairy should be identified in the model as an issue having (high) uncertainty.

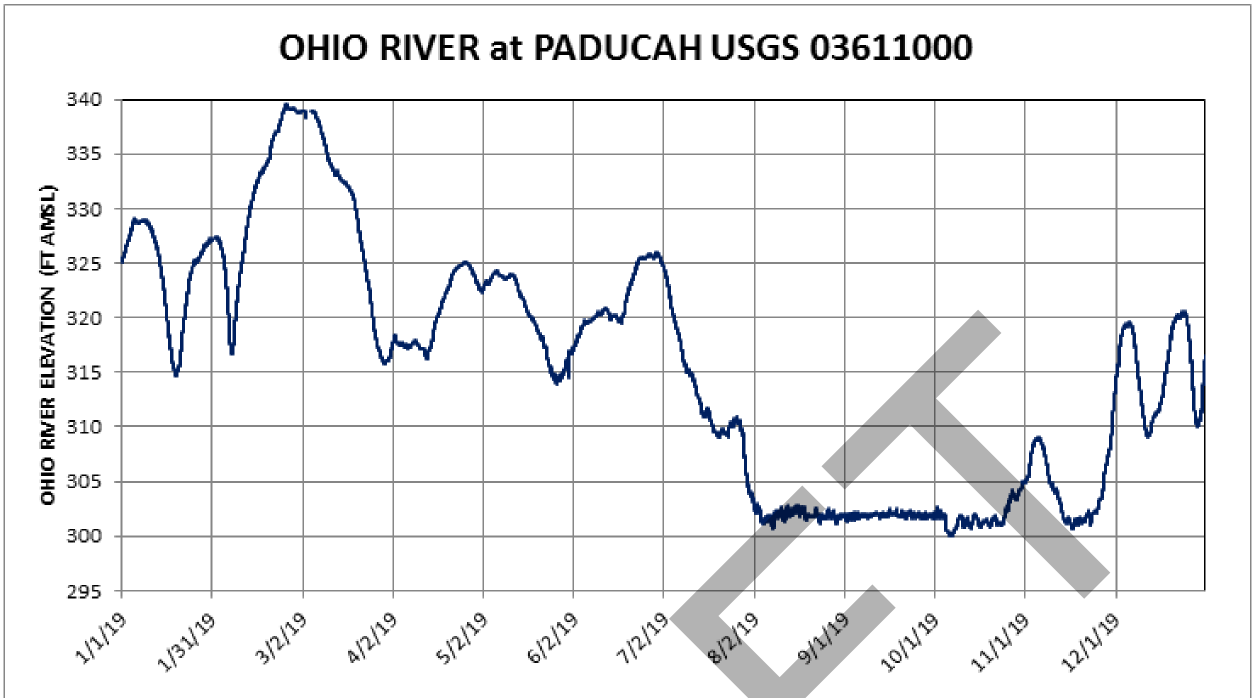
Attachment 4

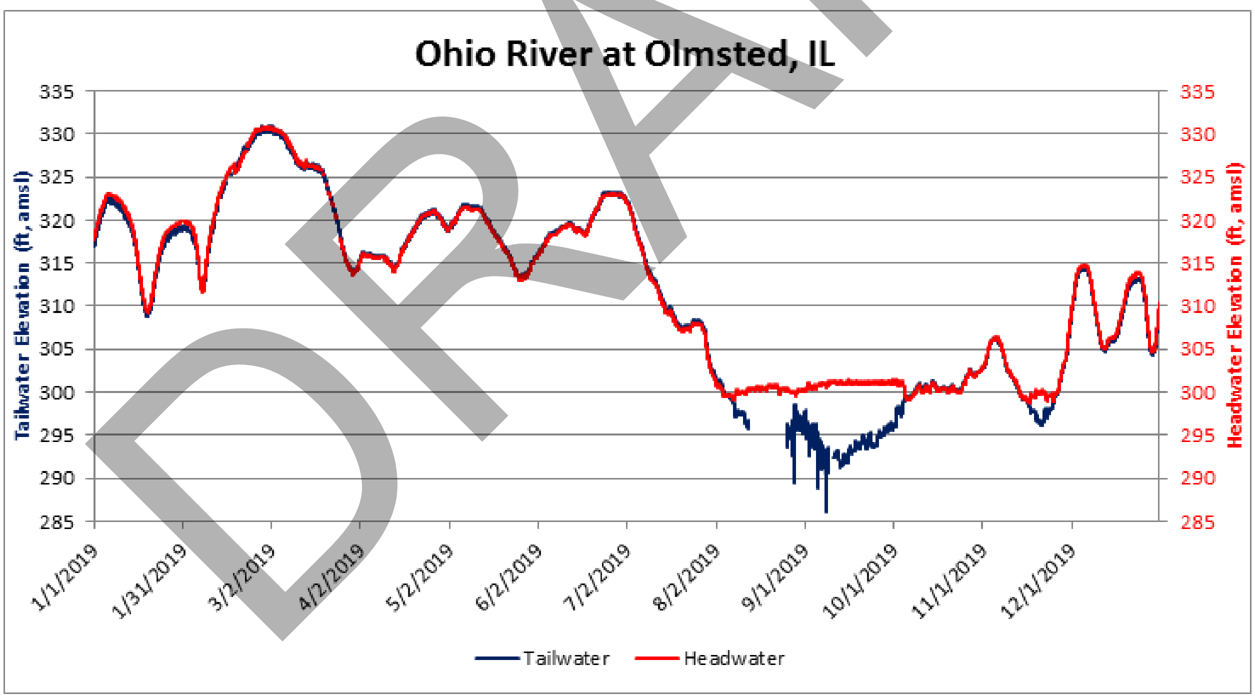
The National Weather Service at Barkley Regional Airport documented 70.27 inches of precipitation during 2019—which is a near-record amount. (74.85 inches of precipitation occurred in 2011.) (By the way, the yearly minimum recorded precipitation occurred one year later in 2012—30.06 inches.)

In comparison, 60.64 inches of precipitation was recorded during 2018, which is considerably greater than the normal amount of 49.08 inches of precipitation (based on the period 1981 through 2019).



The following are Ohio River stage for Paducah and Olmsted.





We now know the "low" river stage for the Ohio River at the Paducah Site (with the Olmsted Dam in operation) must be ~ 301 ft amsl. Last year's low river stage (before dam operation) was 292 ft amsl.

Our latest synoptic water level measurements on December 16-19, 2019, occurred during a period of rising water levels on the Ohio River—which likely impacted groundwater levels at TVA and other wells near the river. (We measured the water level at Metropolis Lake on December 23, 2019, at 316.89 ft amsl.)

APPENDIX F

GROUNDWATER MODELING WORKING GROUP MEETING SUMMARY—APRIL 8, 2020

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ACRONYMS

ABW	abandoned well
AIP	agreement in principal
AKGWA	Assembled Kentucky Groundwater
amsl	above mean sea level
CB	colloidal boroscope
CM	construction monitoring well
CSM	conceptual site model
DNAPL	dense nonaqueous phase liquid
DOE	U.S. Department of Energy
EMP	Environmental Monitoring Plan
EPA	U.S. Environmental Protection Agency
EW	extraction well
FRNP	Four Rivers Nuclear Partnership, LLC
FY	fiscal year
GW	groundwater
HU	hydrogeologic unit
KY	Commonwealth of Kentucky
M1	manual water level collected once per month
M2	manual water level collected twice per month
MW	monitoring well
MWG	Modeling Working Group
N/A	not applicable
PFAS	per- and polyfluoroalkyl substances
PGDP	Paducah Gaseous Diffusion Plant
PT	pressure transducer
PZ	piezometer
RGA	Regional Gravel Aquifer
SWMU	solid waste management unit
TOC	top of casing
TVA	Tennessee Valley Authority
UCRS	Upper Continental Recharge System
VI	vapor intrusion
WAG	waste area grouping
WDA	waste disposal alternatives

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Paducah Site Groundwater Modeling Working Group Meeting Summary—April 8, 2020

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

The following also attended in preparation for the C-400 project:

Austin Buckhalter ✓	Evan Clark	Jason Orr ✓

✓ Indicates member was present.

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

No comments received to January 8, 2020, Meeting Summary (sent to participants on 1/22/2020). This summary will be considered final.

Stefanie Fountain will be new working group chair.

2. FY 2020+ Work Plan/Schedule

The remaining FY 2020+ schedule is below.

Quarterly Meeting (April)	4/8/2020
Quarterly Meeting (July)	7/15/2020
Quarterly Meeting (October)	10/7/2020
Submit Draft Meeting Notes compilation (2019-2020)	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

3. Update on Water Levels

Synoptic water level events now are quarterly; the March event could not be collected due to external circumstances. KY went out with TVA the week of March 23, 2020 for water levels from six of the 11 wells and will send those by letter.

Revised (to correct datum for top of casing) groundwater elevation data for TVA wells collected by KY on December 19, 2019, is provided as Attachment 1. (Note that Attachment 1 is a split table; well references are on the first page.) Additional well information columns are included in this report. The next water measurements summary (for the week of March 23) will be similar."

4. Update on Paducah Site Groundwater Strategy

Deployment of the pressure transducers began the week of December 30, 2019. 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 considered January 2020. FRNP has reviewed KY's AIP monitoring wells sampling schedule and schedule conflicts between sampling and borescope measurements have been resolved.

The Groundwater Strategy field data collection has been paused. The pause started after the first portion of Month 3 data collection and the second portion could not be collected. A determination will be made as to whether to begin with Month 4 or pick back up with Month 3 when the project can be resumed. Pressure transducer measurements were discontinued during the pause due to the level of effort involved in running the transducers (e.g., downloading of data, etc.).

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 be performed in conjunction with the vapor intrusion (VI) project. VI project walkdowns occurred February 11-14, 2020, with a follow-up facility tour on February 20, 2020. Information obtained during the VI project walkdowns will be coordinated with this working group topic (e.g., the sump observed in the basement of C-337 had a sealed base: i.e., concrete floor as opposed to gravel).

6. 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, "Big Picture"' presentation for this meeting is provided as Attachment 3. The additional slide presented on April 8 is included with this meeting summary (Attachment 4).

The group questioned and discussed how a change from the raw water lines to municipal water lines would impact the system and when that might occur. The transition of water sources is under evaluation and no timeline exists for the change. It was discussed that the installation of Olmstead Dam changed RGA flow, and a change from the raw water line to a municipal line would be an altered stress on the RGA.

There was discussion that hydraulic conductivities assigned to the UCRS in the presentation were inconsistent with the CSM developed for the 2016 update of the site groundwater flow model, which would result in faster travel time through the UCRS. Ken Davis responded he was confident that the travel time of a given water molecule was in the decades range. A note was added to the presentation to acknowledge that higher UCRS conductivities were assumed in the groundwater flow model.

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.

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 LeAnne or Stefanie if you need the password to the website.

9. Resurvey of wells

The spreadsheet of resurveyed coordinates and elevations was completed in January 2020. The current schedule is to have that information independently QC reviewed by mid-April 2020. Upload of the information to PEGASIS is expected in June 2020.

No discussion.

10. Projects on the "Watch Topics" List

- **Update on Paducah Site Monitoring Well Abandonment/Replacement**
  Several wells/piezometers are being planned for abandonment as part of plus-up funding. Attachment 5 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 expected to be completed in spring 2020.

  The plan is still to install a monitoring well to replace MW152 and MW153; schedule is uncertain and will be communicated once available.

- **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 discussion.

- **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. On the west side of the new substation, overhead lines will be installed along the existing overhead line corridor. On the east side of the new substation, overhead lines will be installed along the 161kV (very high voltage) lines. Within the next year, the 161kV overhead lines currently in place to C-331 will be taken down. These lines are currently near the C-755 parking lot and between K010 and K011.

  No discussion. To clarify, the lines to be installed will be direct feed lines from TVA and are 161kV lines.

11. Poll MWG Members/Open Discussion

- Ohio River and precipitation graphs.

  The slides presented on April 8 are included with this meeting summary (Attachment 6).

- Discussion of PFAS as a potential watch topic.

  DOE provided an update on the status of the PFAS transmittal and hopes to have a conference call before the end of the month and before the letter goes in. PFAS is not currently planned to be included as a topic for the Groundwater MWG.

Attachment 1

OREISName	Well	Description	Aquifer	Top of Casing	Top of Ground	xconv Easting (Ft)	yconv Northing (Ft)	Status
TVAGW-6D	TVAGW-6D	4" PVC	upper RGA	368.8	365.9	760787.8774	1946731.539	active
TVAGW-5D	TVAGW-5D	4" PVC	upper RGA	368.5	365.7	760131.6259	1947315.953	active
TVAGW-4D	TVAGW-4D	4" PVC	upper RGA	365.8	363	759456.7195	1947561.73	active
TVAGW-3D	TVAGW-3D	4" PVC	upper RGA	363.8	360.9	758982.49	1947793.858	active
TVAGW-2D	TVAGW-2D	4" PVC	upper RGA	370	367.1	759966.7809	1944870.473	active
TVAGW-1D	TVAGW-1D	4" PVC	upper RGA	370.1	367.5	757847.0459	1946203.79	active
TVA-D8A	SHF-D8A	4" PVC	upper RGA	331.82	329	754060.01	1953586.25	active
TVA-D75B	SHF-D75B	2" PVC	upper RGA	353.08	350	753297.07	1955971.69	active
TVA-D74B	SHF-D74B	2" PVC	upper RGA	331.99	329	756125.35	1956489.82	active
TVA-D30B	SHF-D30B	2" PVC	upper RGA	324.61	320.9	757594	1955563.41	active
TVA-D17	SHF-D17	2" PVC	upper RGA	365.43	362.8	758809.17	1950015.71	active
TVA-D11B	SHF-D11B	2" PVC	upper RGA	321.79	319.2	753434.76	1958481.44	active
TVA-D10	SHF-D10	4" PVC	upper RGA	351.74	351	752950.26	1956644.9	active
NA	SHF-201C	4" PVC	upper RGA	323.75	320	746799.24	1960068.889	active
NA	SHF-201B	4" PVC	upper RGA	323.75	320.2	746641.107	1960082.768	active
NA	SHF201A	4" PVC	Upper RGA	323.75	320	747030.226	1960036.252	active
NA	SHF-102G	4" PVC	Upper RGA	362.85	359.1	845764.387	1927473.284	active
TVA River Elevation								

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
58.3	68.3	307.6	297.6	320.31	48.49	12/19/2019_0911	30.06	TOC
60.1	70.1	305.6	295.6	319.86	48.64	12/19/2019_0915	30.06	TOC
57	67.5	306	295.5	319.88	45.92	12/19/2019_0920	30.06	TOC
65.3	75.3	295.6	285.6	319.82	43.98	12/19/2019_0924	30.06	TOC
55.6	65.6	311.5	301.5	323.93	46.07	12/19/2019_0906	30.06	TOC
56	66	311.5	301.5	319.8	50.3	12/19/2019_0942	30.06	TOC
17.5	27.5	311.5	301.5	317.42	14.4	12/19/2019_1046	30.07	TOC
48	58	302	292	314.3	38.78	12/19/2019_1051	30.07	TOC
39	49	290	280	315.08	16.91	12/19/2019_1103	30.07	TOC
39	49	281.9	271.9	313.73	10.88	12/19/2019_1126	30.09	TOC
14	17	348.8	345.8	317.66	47.77	12/19/2019_1134	30.03	TOC
32	42	287.2	277.2	313.85	7.94	12/19/2019_1119	30.10	TOC
36.5	46.5	31.5	304.5	308.51	43.23	12/19/2019_1055	30.07	TOC
44.5	54.5	275.5	265.5	308.3	15.45	12/19/2019_1006	30.11	TOC
32	37	288.2	283.2	308.45	15.3	12/19/2019_1012	30.11	TOC
14.5	24.5	305.5	295.5	308.4	15.35	12/19/2019_1015	30.11	TOC
47.1	57.4	312	301.7	320.7	42.15	12/19/2019_1024	30.07	TOC
					312	12/19/2019_0930	30.06	

Attachment 2

CP2-ES-0006/FR5

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.

Attachment 3

"BIG PICTURE" – PADUCAH SITE GROUNDWATER (Session 2)

Presented by Ken Davis
Groundwater Modeling Working Group
Quarterly Meeting
April 8, 2020
DRAFT

Curriculum

✓ **Geology (January 8, 2020)**
- Geologic Provinces
- Paducah Site and Illinois portion of Joppa Quadrangle

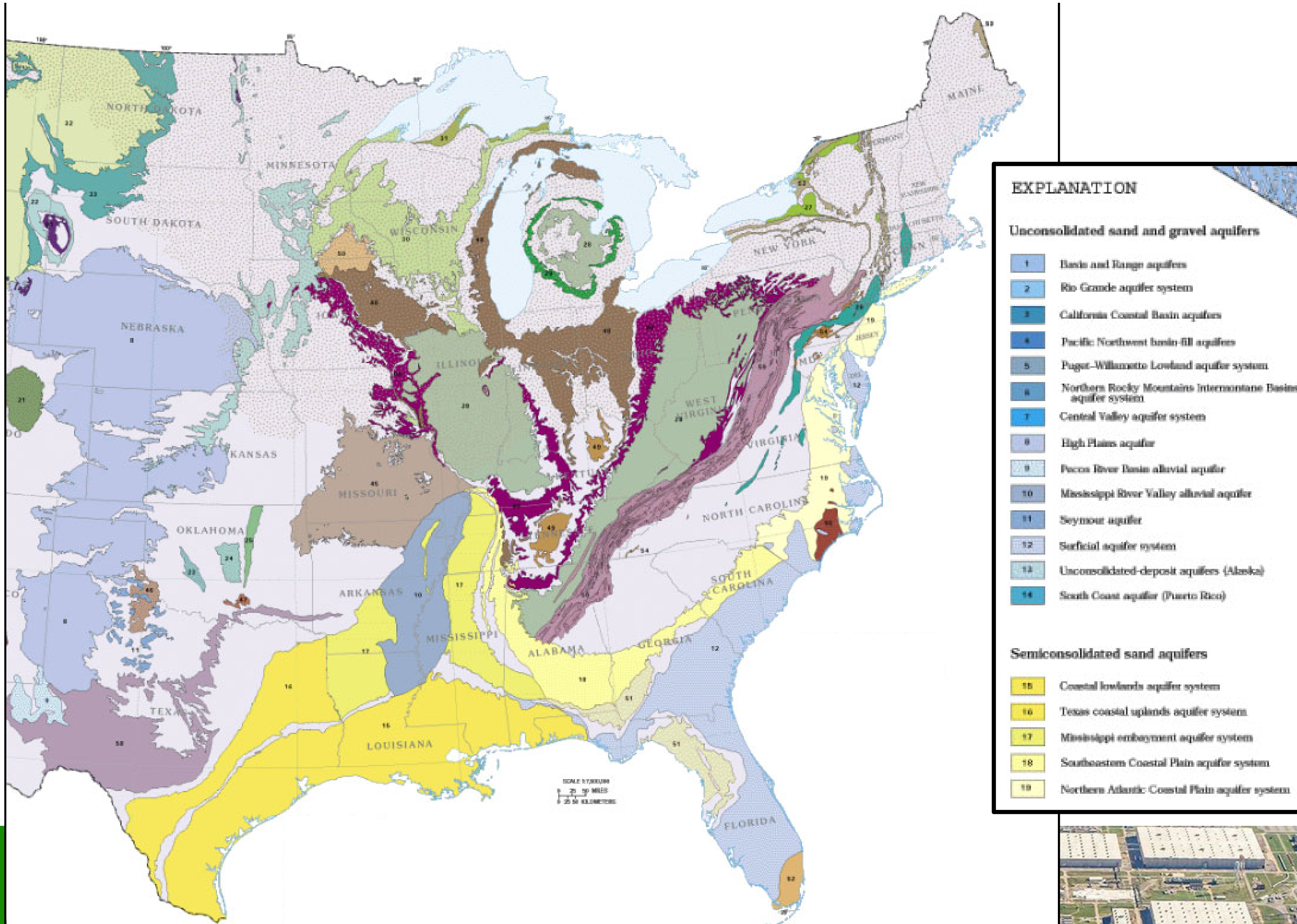
➢ **Paducah Site Groundwater, "Big Picture" (April 8, 2020)**
- Primary features
- Water balance
- Deep groundwater systems (McNairy, Mississippian)

- **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
  - Current GW Strategy
  - Other COPCs

Principal Aquifers of the Eastern and Central U.S.

(Adapted from www.e-education.psu.edu, *Regional Aquifer Systems: Examples…*)



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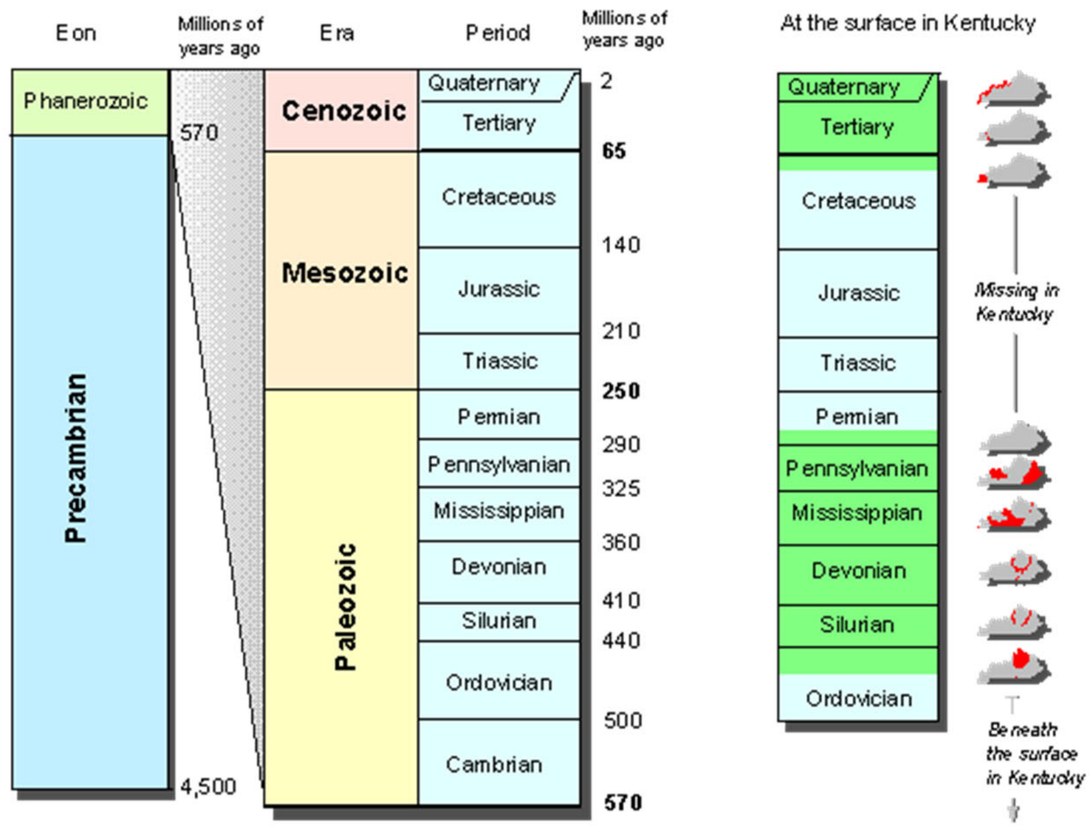
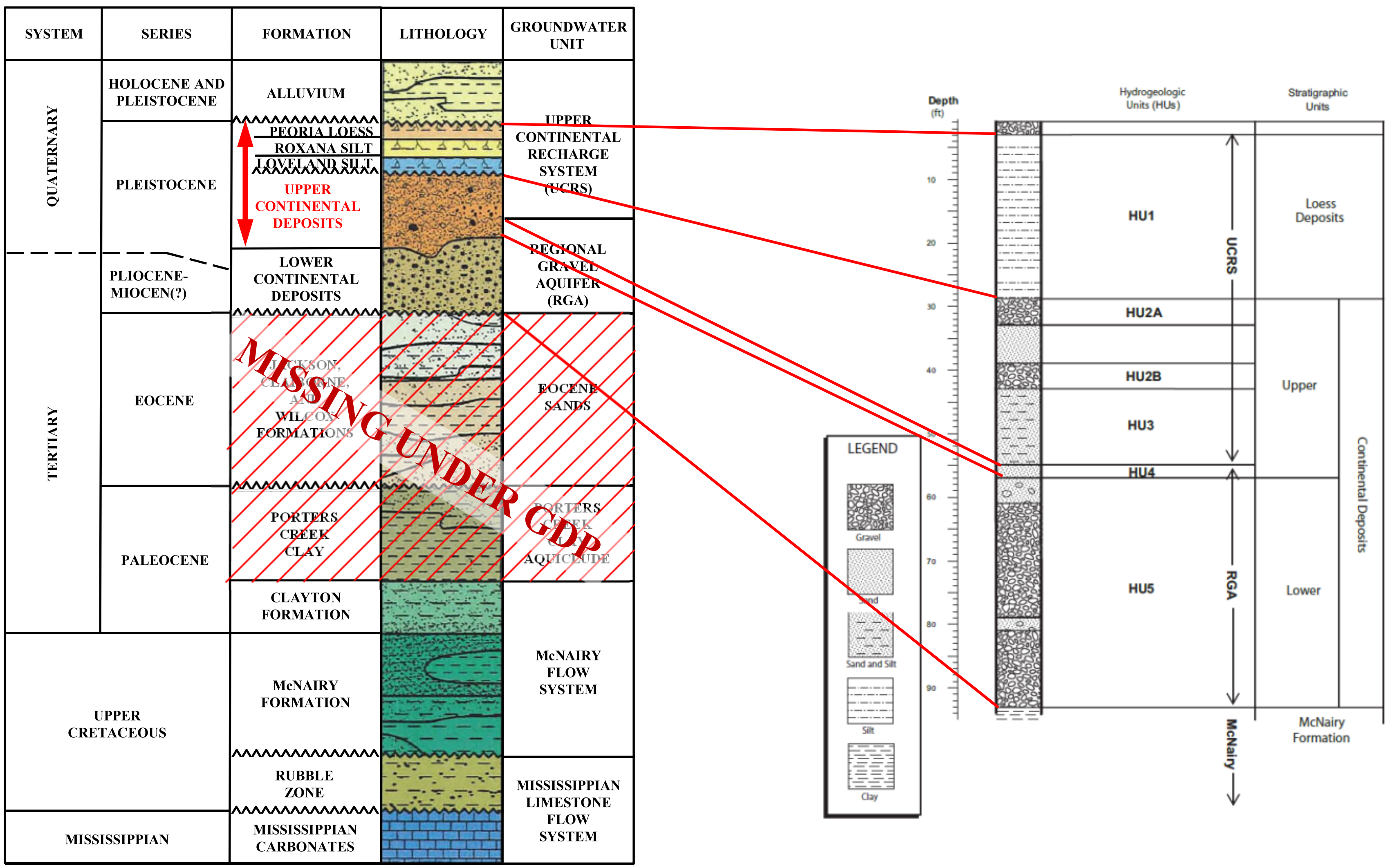
Geologic Time Scale

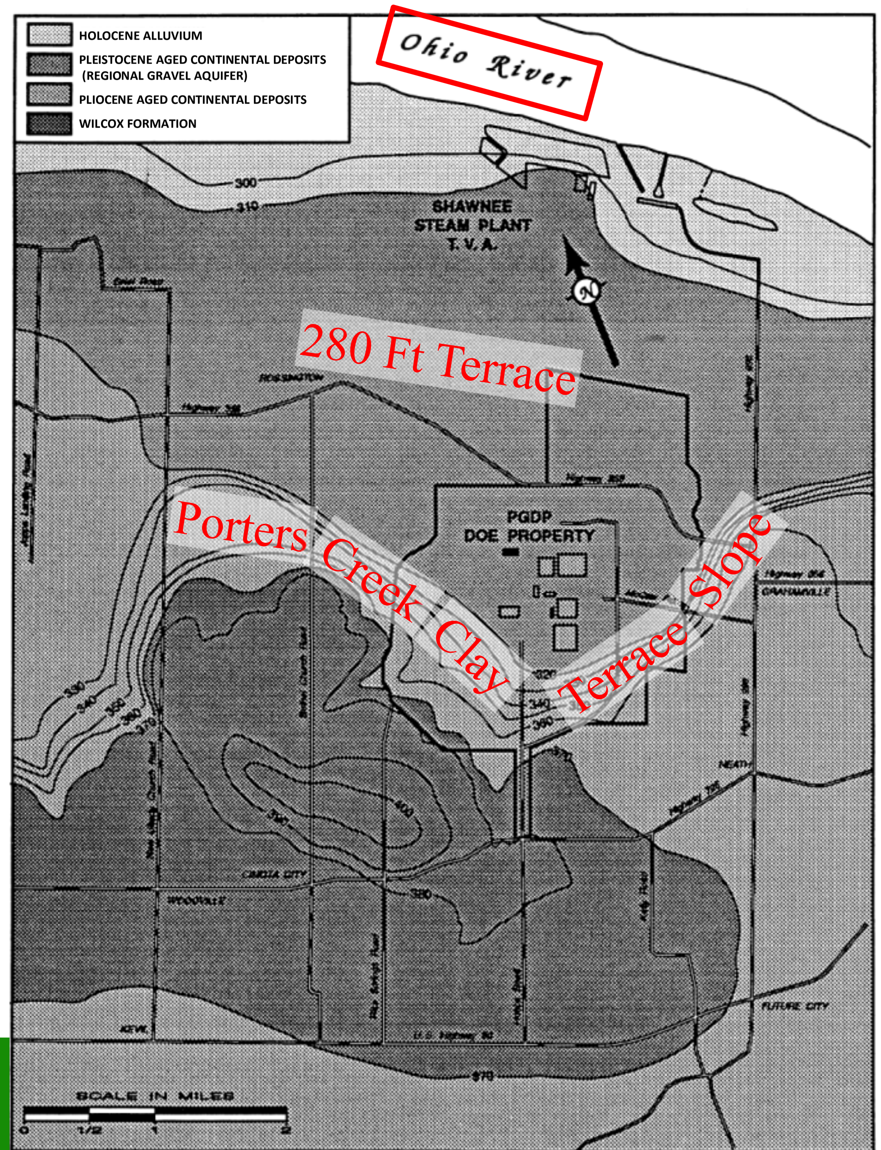


https://www.uky.edu/KGS/geoky/geotime.htm

Stratigraphy vs Hydrogeologic Units (HUs)



Primary Features - RGA



RGA Water Balance

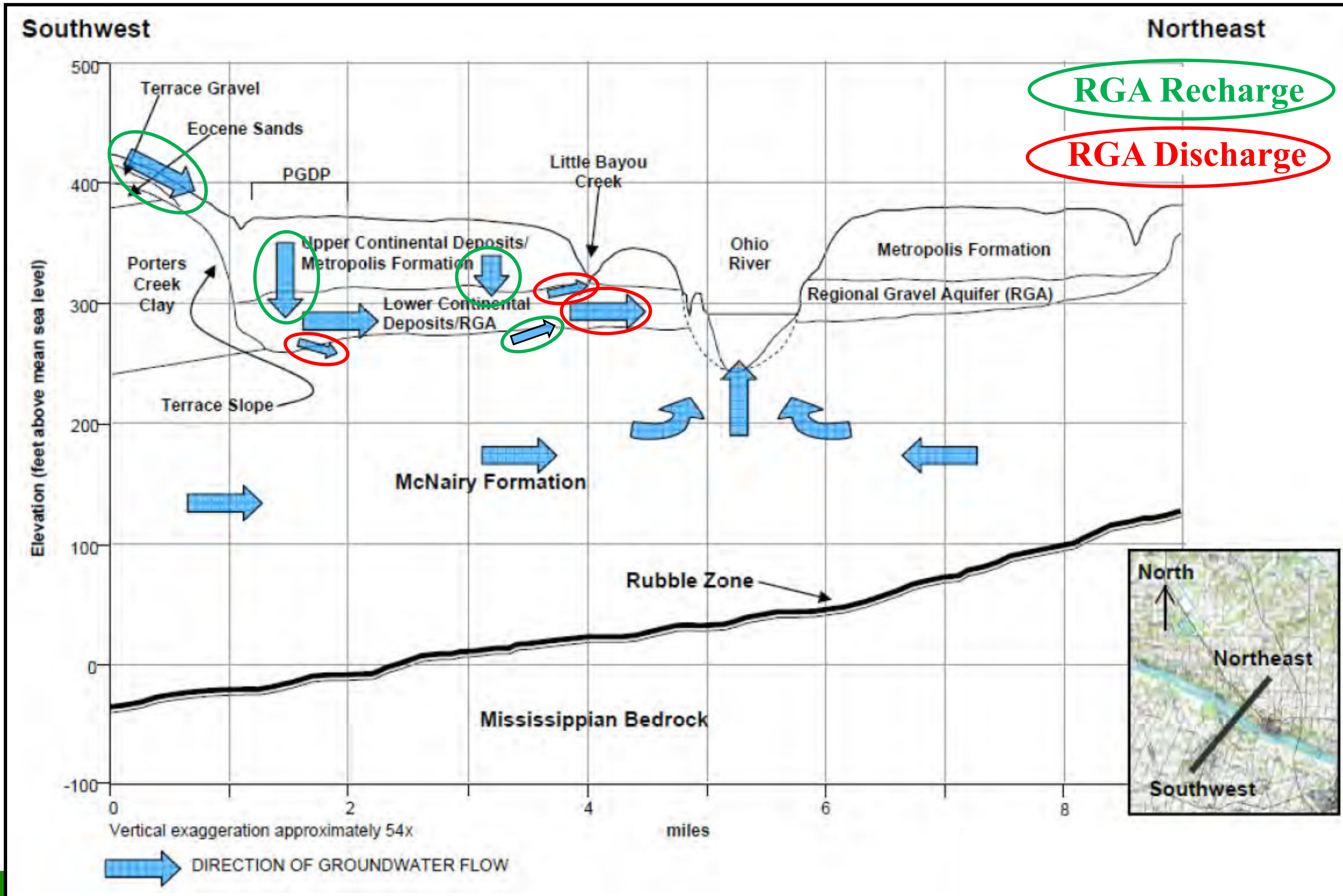


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Figure adapted from *2016 Update of the Paducah Gaseous Diffusion Plant Sitewide Groundwater Flow Model*, July 2017

Recharge

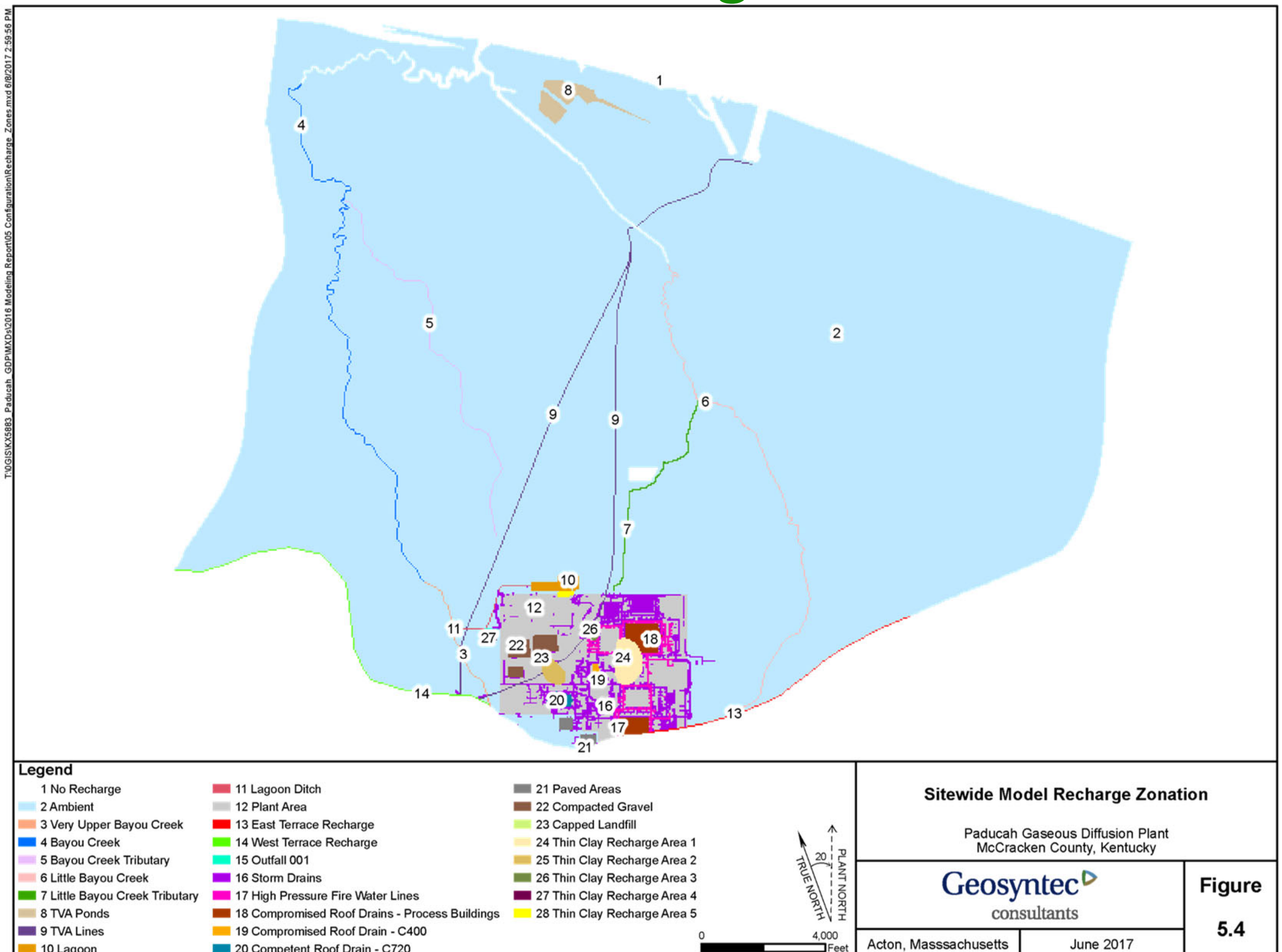
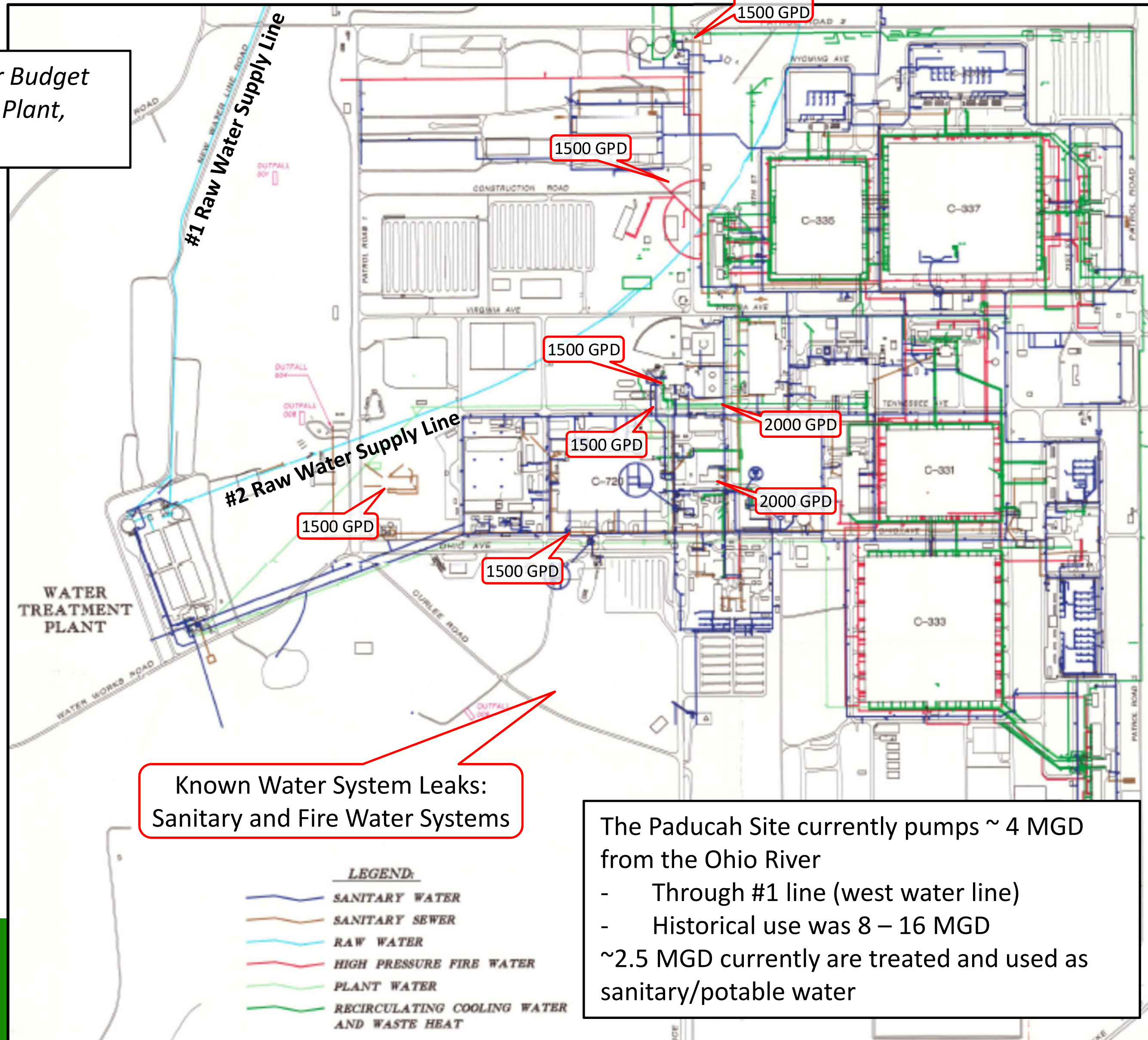


Figure from *2016 Update of the Paducah Gaseous Diffusion Plant Sitewide Groundwater Flow Model*, July 2017

Paducah Site Water System

Figure modified from *Paducah Water Budget Analysis, Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, June 2000



The Paducah Site currently pumps ~ 4 MGD from the Ohio River

- Through #1 line (west water line)
- Historical use was 8 – 16 MGD

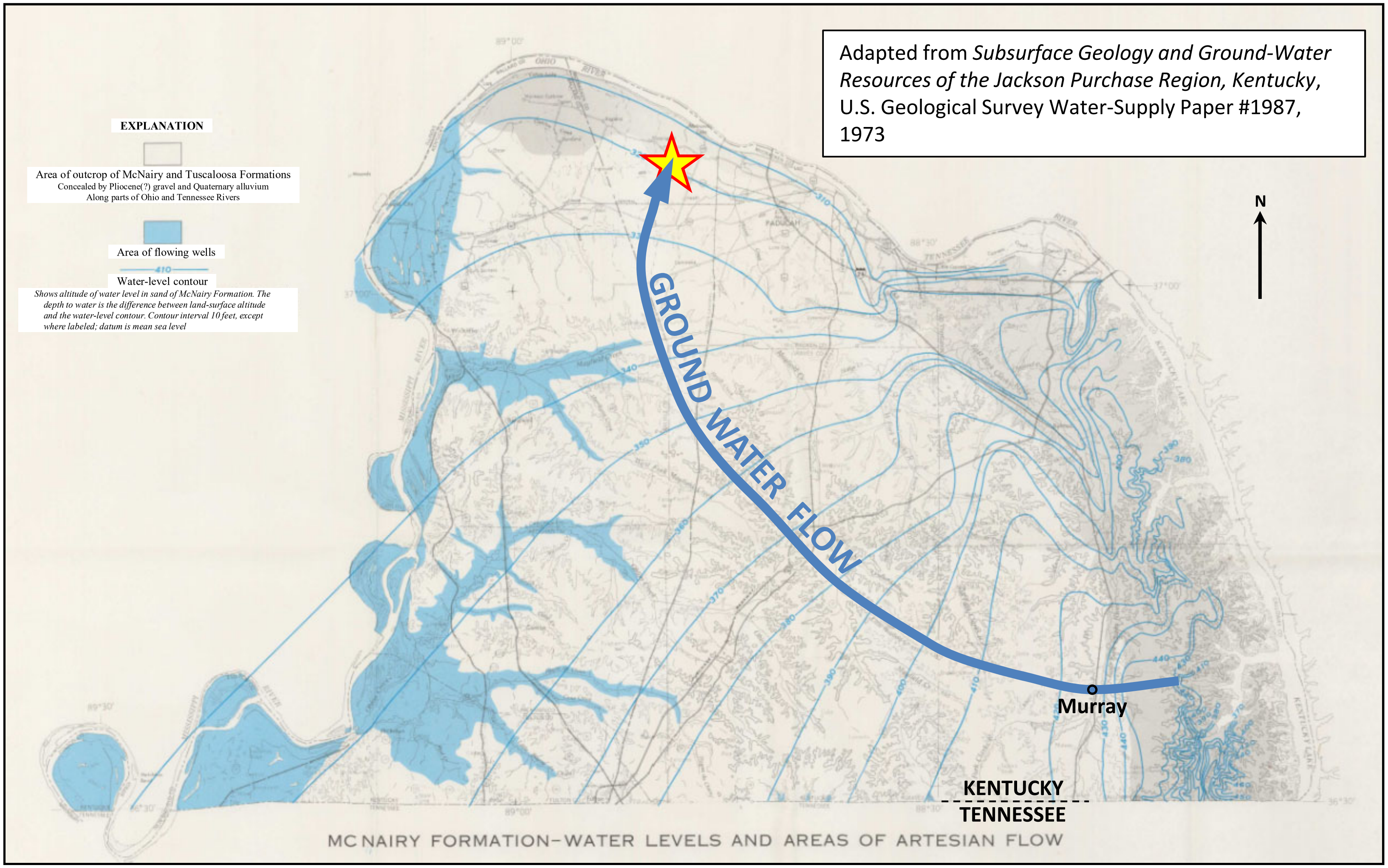
~2.5 MGD currently are treated and used as sanitary/potable water

Deep Groundwater Systems: McNairy

Front of drawing is along Kentucky-Tennessee State line

From *Subsurface Geology and Ground-Water Resources of the Jackson Purchase Region, Kentucky*, U.S. Geological Survey Water-Supply Paper #1987, 1973

Deep Groundwater Systems: McNairy (cont.)



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Deep Groundwater Systems: Mississippian Limestones

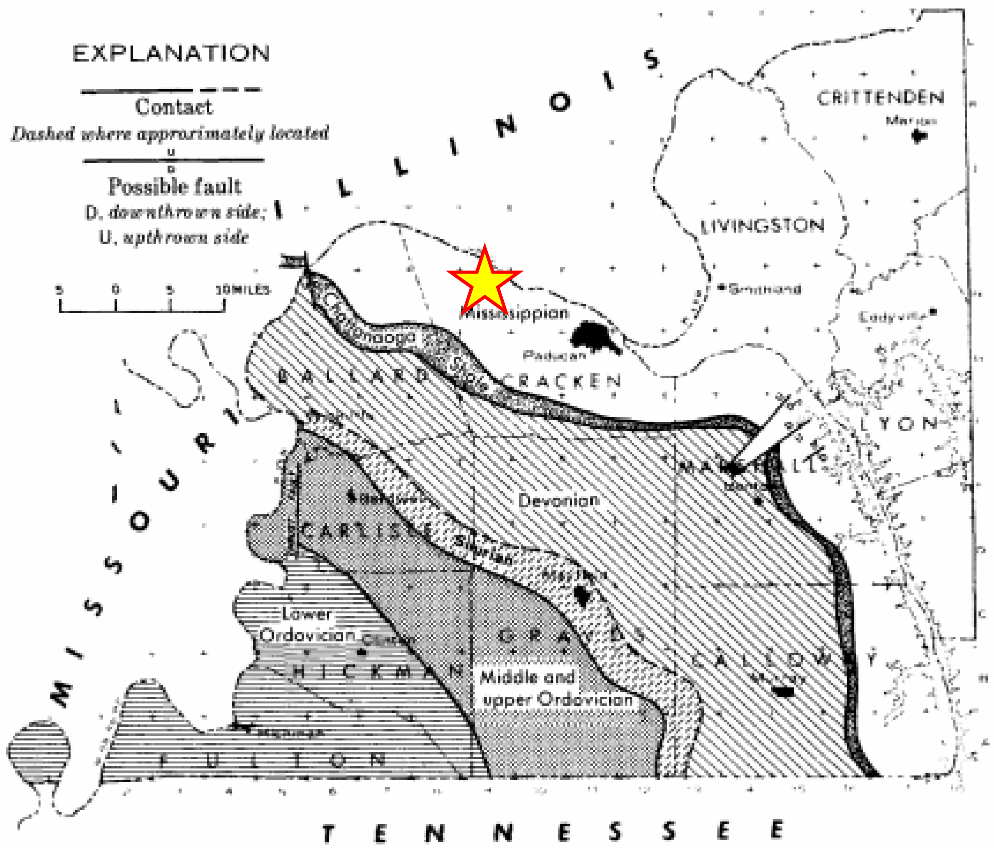


FIGURE 3.—Paleogeologic map of the pre-Cretaceous erosion surface in the Jackson Purchase region. From Schwalb (1969, p. 11); terminology modified.

From *Subsurface Geology and Ground-Water Resources of the Jackson Purchase Region, Kentucky*, U.S. Geological Survey Water-Supply Paper #1987, 1973

Groundwater Hydrology Primer

Water table: 1) the level below which the ground is saturated with water,
2) the upper surface of the zone of saturation

Gradient:

Horizontal: the slope of the water table or potentiometric surface, that is, the change in water level per unit of distance along the direction of maximum head decrease

Vertical: the change of hydraulic potential per unit of depth

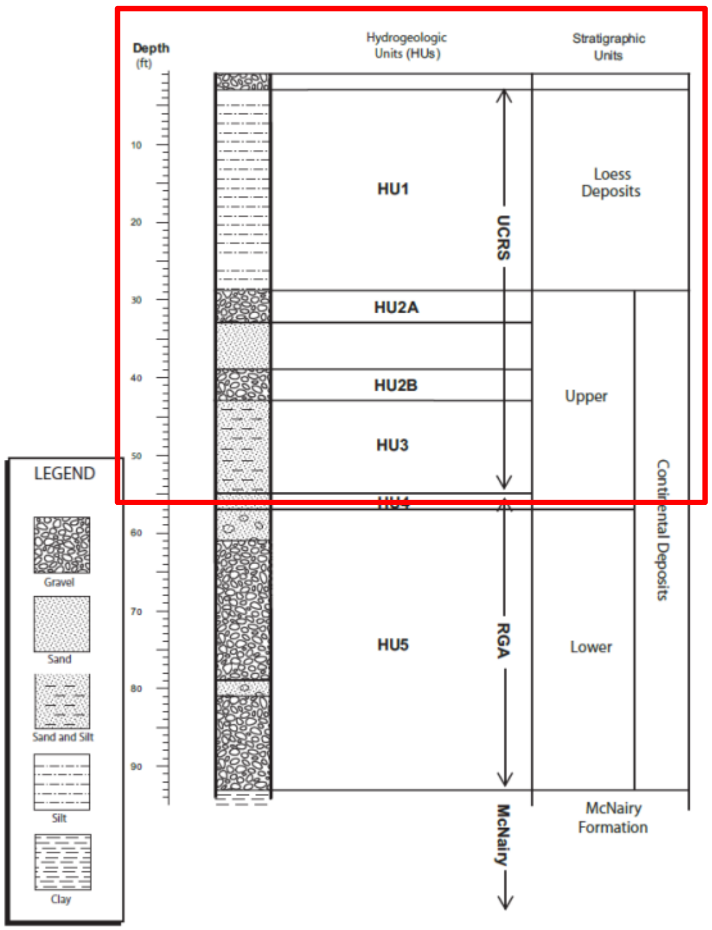
Conductivity: 1) the ability of a soil to transmit fluid through pore spaces and fractures
2) the rate of flow under a unit hydraulic gradient through a unit cross-sectional area of an aquifer

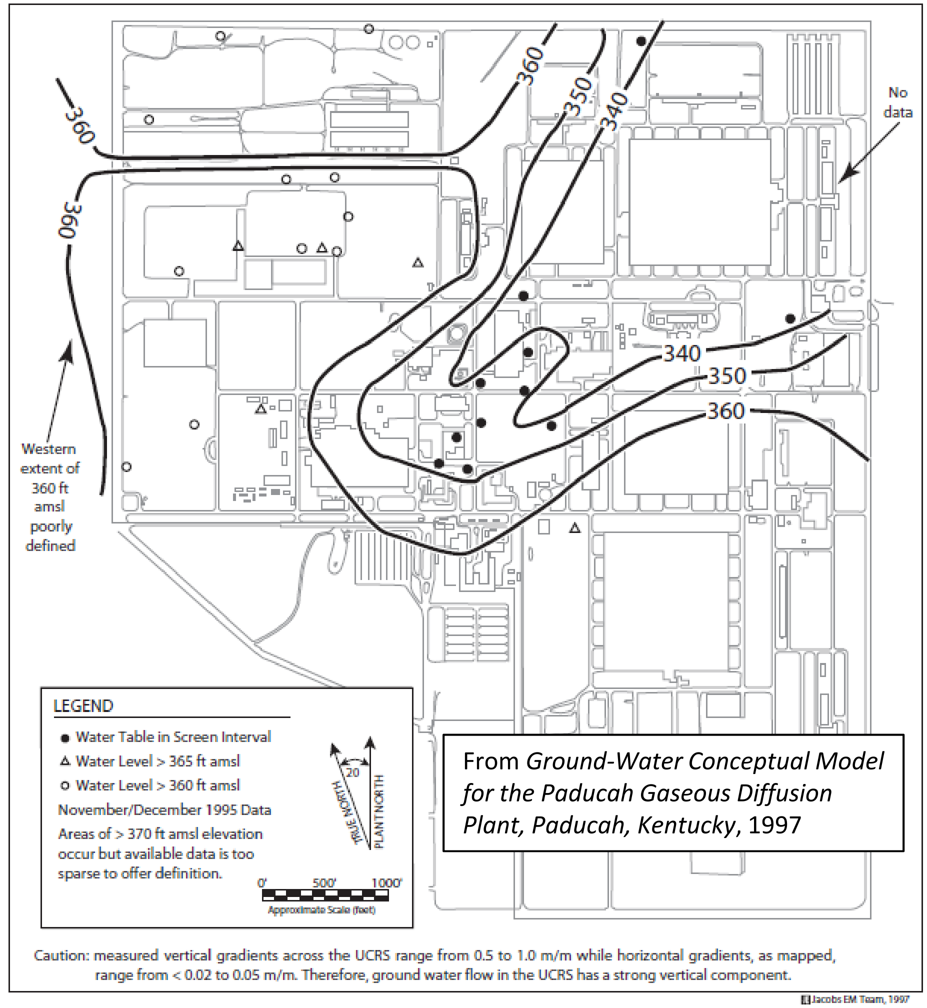
Transmissivity: the product of conductivity and thickness of an aquifer

Porosity: the percentage of the total void space in a soil

Effective Porosity: the percentage of the connected void space in a soil

UCRS (HU1 – HU3): Water Table





UCRS: Vertical Gradients

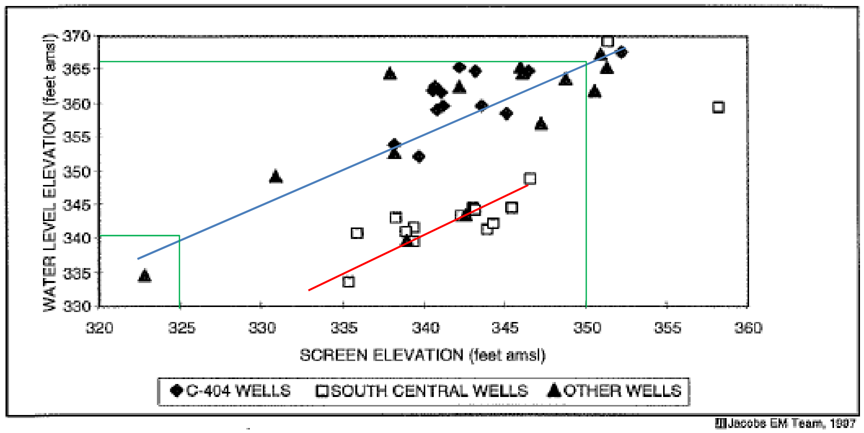
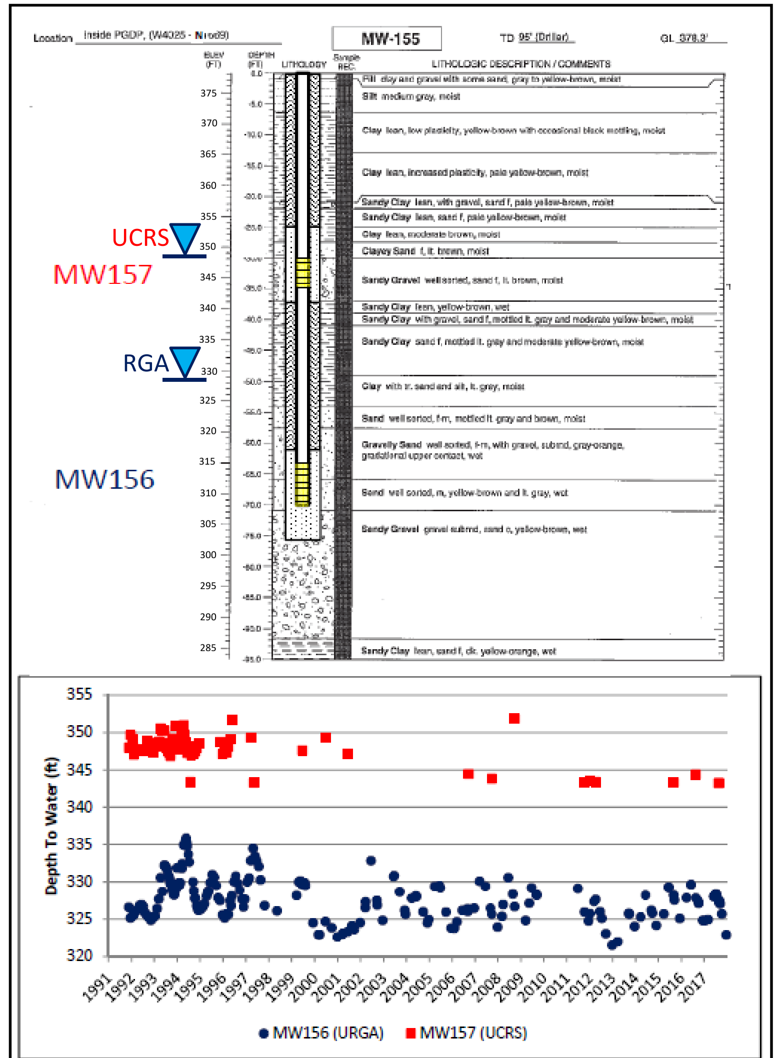


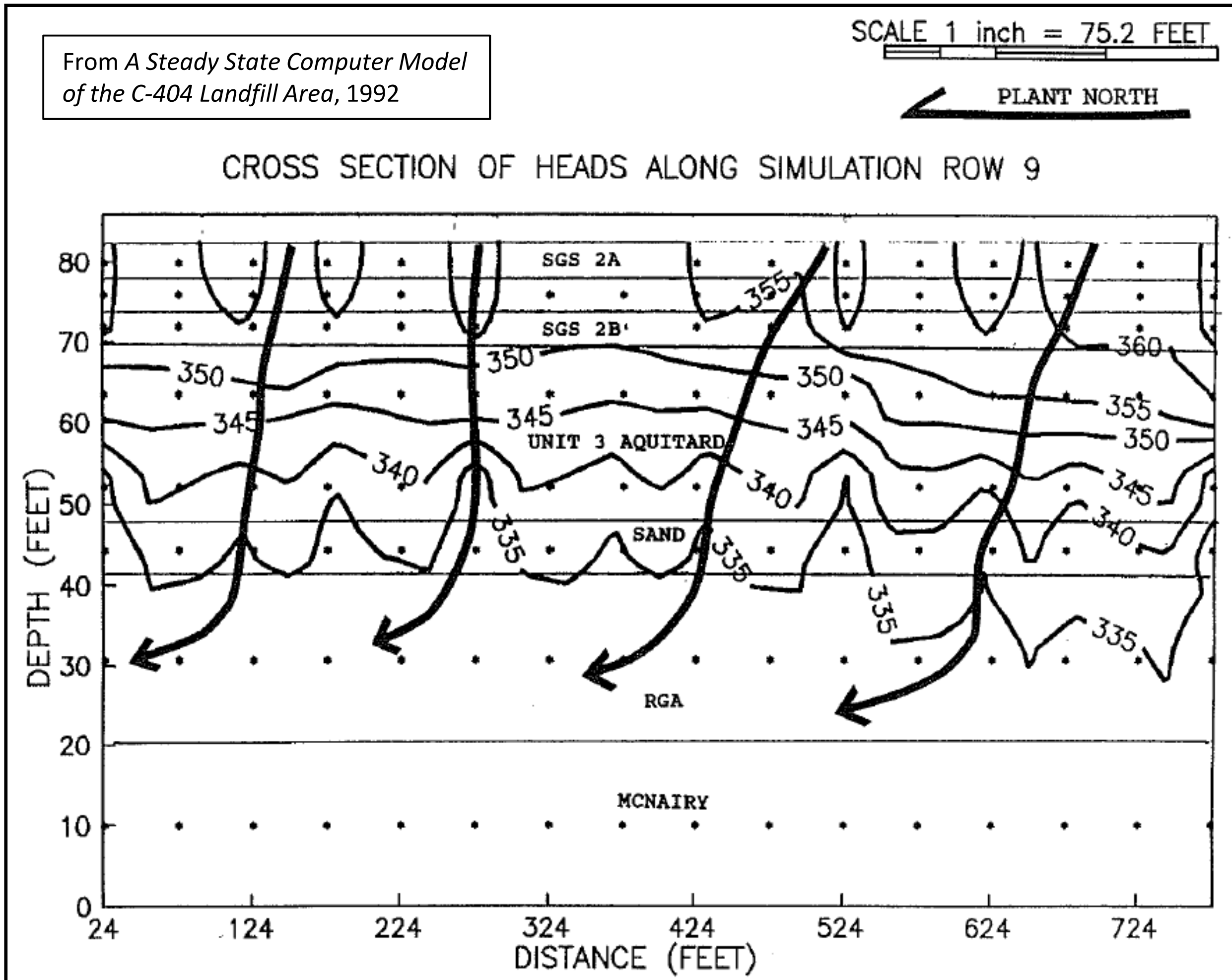
Figure 3-3. Plot of Water Level Versus Well Screen for Upper Continental Recharge System Wells

From *Ground-Water Conceptual Model for the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, 1997



UCRS: Vertical Gradients

From *A Steady State Computer Model of the C-404 Landfill Area*, 1992



UCRS: Hydraulic Conductivity

From *Remedial Investigation Report for the Burial Grounds Operable Unit at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, 2010

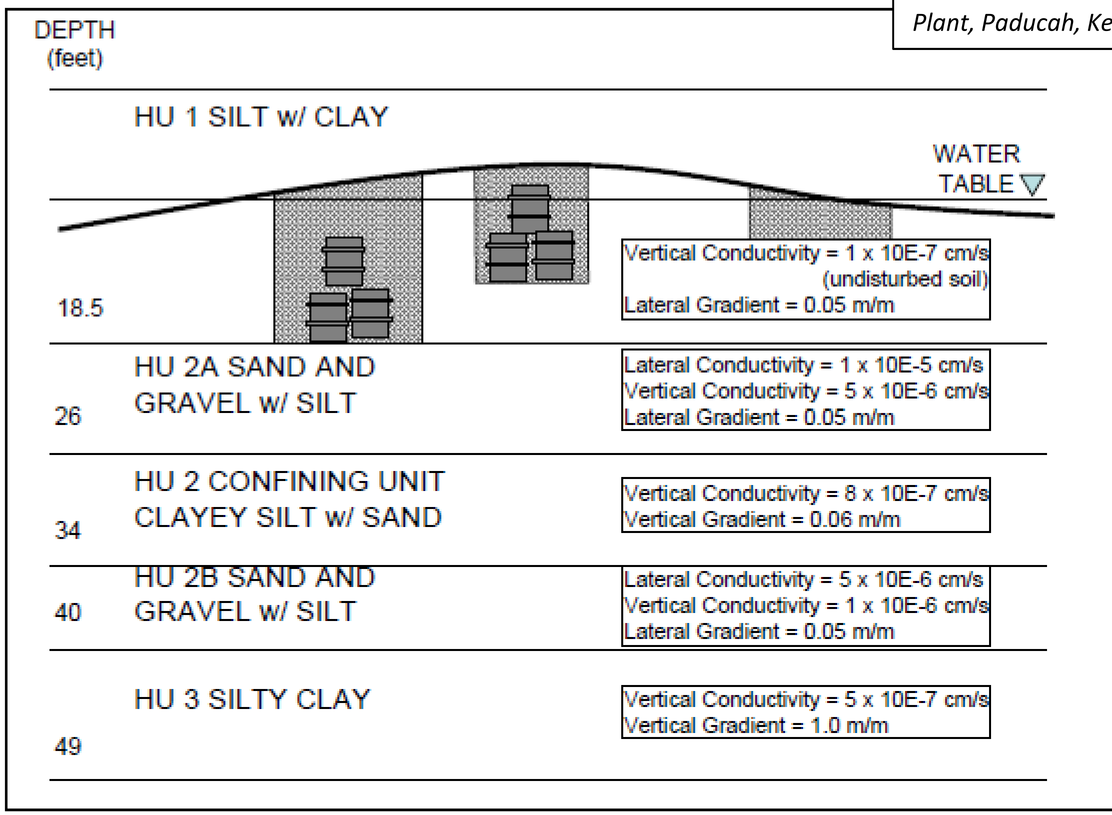


Figure 3.16. Hydrogeologic Setting for SWMU 2

UCRS: Porosity

UCRS Laboratory Geotechnical Data

***Remedial Investigation Report for Waste Area Grouping 6 at Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, Volume 2. Appendices A-H, DOE/OR/07-1727/V2&D2, May 1999**

Sample #	Depth (ft)	HU	Soil Texture	Porosity (%)	Hydraulic Conductivity (cm/s)
026001SA010	10*	1	sandy **SILT** with little clay	35	3.86E-07
026001SA045	44*	3	sandy **CLAY** with some silt	38	6.57E-07
400036SA010	7 - 9.5*	1	**SILT** with some clay	45	2.75E-07
400036SA030	21*	2	**GRAVEL** with little clay	38	3.27E+00
400036SA045	45*	2	**SAND** with some clay and little silt	40	4.67E-06
400038SA010	6 - 8.5	1	--	36	2.07E-05
400038SA030	26 - 28.5	2	**SAND** with some silt and little clay	40	1.12E-01
400038SA045	46 - 48.5	2	**SAND** with some clay and little silt	30	2.04E-05
400207SA045	47 - 49	2	**SAND** with little clay	35	1.02E-03
400208SA010	11 - 13.5	1	**SILT** with little clay	33	2.69E-07
400208SA045	46 - 48	2	**SAND** with little silt and clay	47	5.56E-02
400210SA010	7 - 17	1	**SILT with little clay**	32	1.43E-07
400210SA045	47 - 57	3	sandy **SILT** with some clay	33	1.71E-06
400212SA010	7 - 9.5	1	silty **CLAY**	37	1.71E-08
400212SA030	27 - 29.5	3	**SILT** with some sand and little clay	25	3.90E-06
400212SA045	47 - 49.5	4	**SAND** with little silt	38	8.46E-02
* depth of associated analytical sample					
			highest:	47	3.27E+00
			mean:	36	2.20E-01
			median:	37	4.29E-06
			lowest:	25	1.71E-08

n_e (effective porosity) = fraction of total porosity

UCRS: GW Flow Example

Darcy's Law:

$Q = -KiA$

Q = quantity/time (e.g. m^3/sec)

K = hydraulic conductivity (cm/sec)

i = hydraulic gradient (m/m)

A = cross sectional area (m^2)

$Q/A = -Ki$

$(Q/A)/n_e$ = flow rate (v) (cm/s)

n_e = effective porosity (%)

Vertical Flow @ C-404							
HU	**K (cm/s)**	**i (m/m)**	**Ø**	**v (cm/s)**	**v (ft/d)**	**thickness (ft)**	**time (yr)**
HU1	1.00E-07	-1	0.25	-4.00E-07	-1.13E-03	13	31.39
HU2A	5.00E-06	-1	0.25	-2.00E-05	-5.67E-02	7.5	0.36
HU2 Confining	8.00E-07	-1	0.25	-3.20E-06	-9.07E-03	8	2.41
HU2B	1.00E-06	-1	0.25	-4.00E-06	-1.13E-02	6	1.45
HU3	5.00E-07	-1	0.25	-2.00E-06	-5.67E-03	9	4.35
						Total:	**39.96**

(The 2016 Update of the site groundwater flow model assumes generally higher UCRS conductivities, resulting in shorter time frames for flow through the UCRS.)

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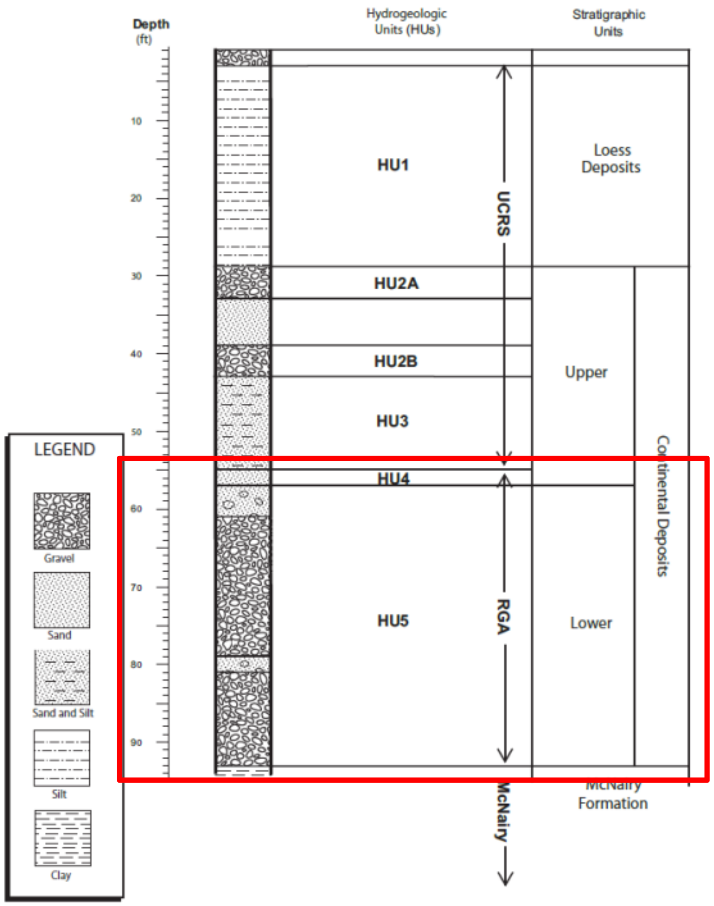
4/8/2020

RGA (HU4 & HU5): Potentiometric Surface



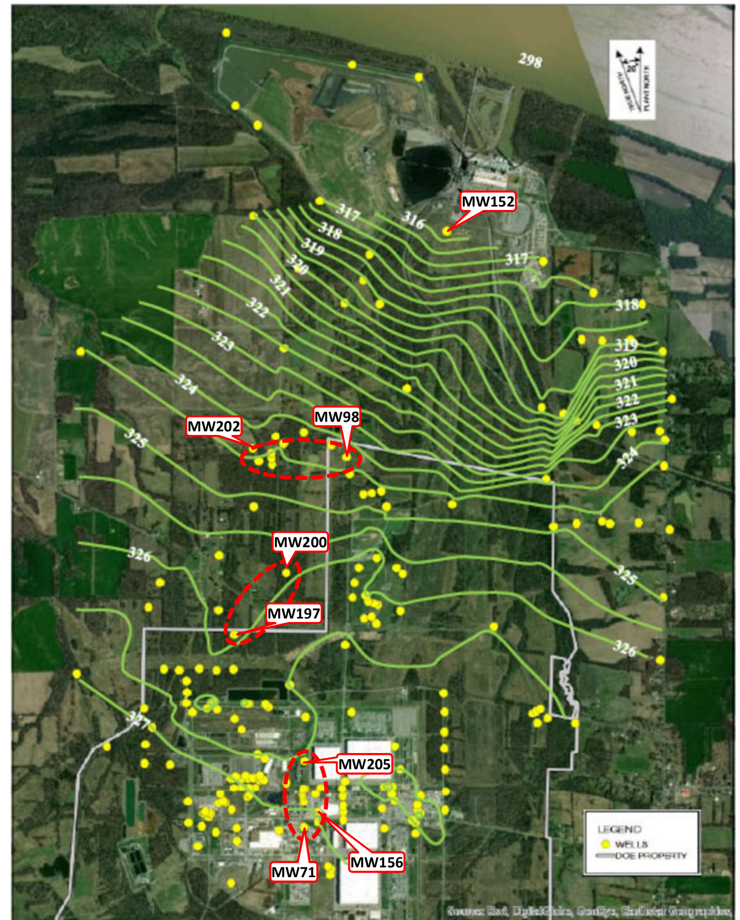
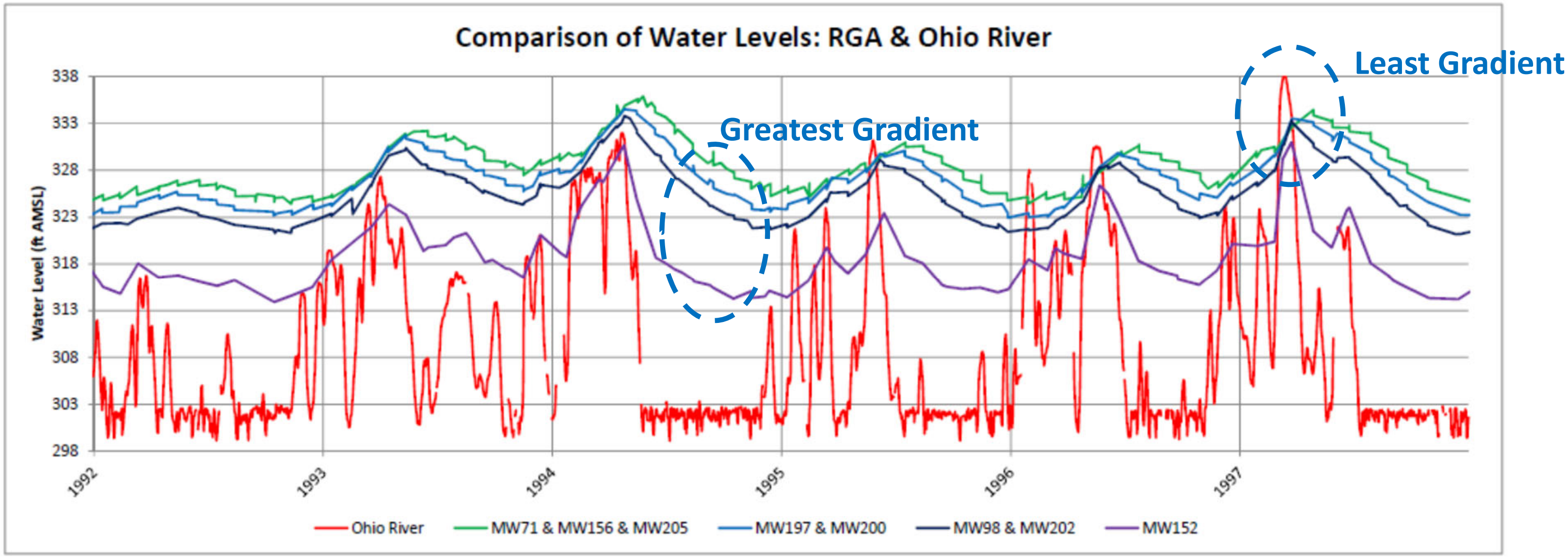


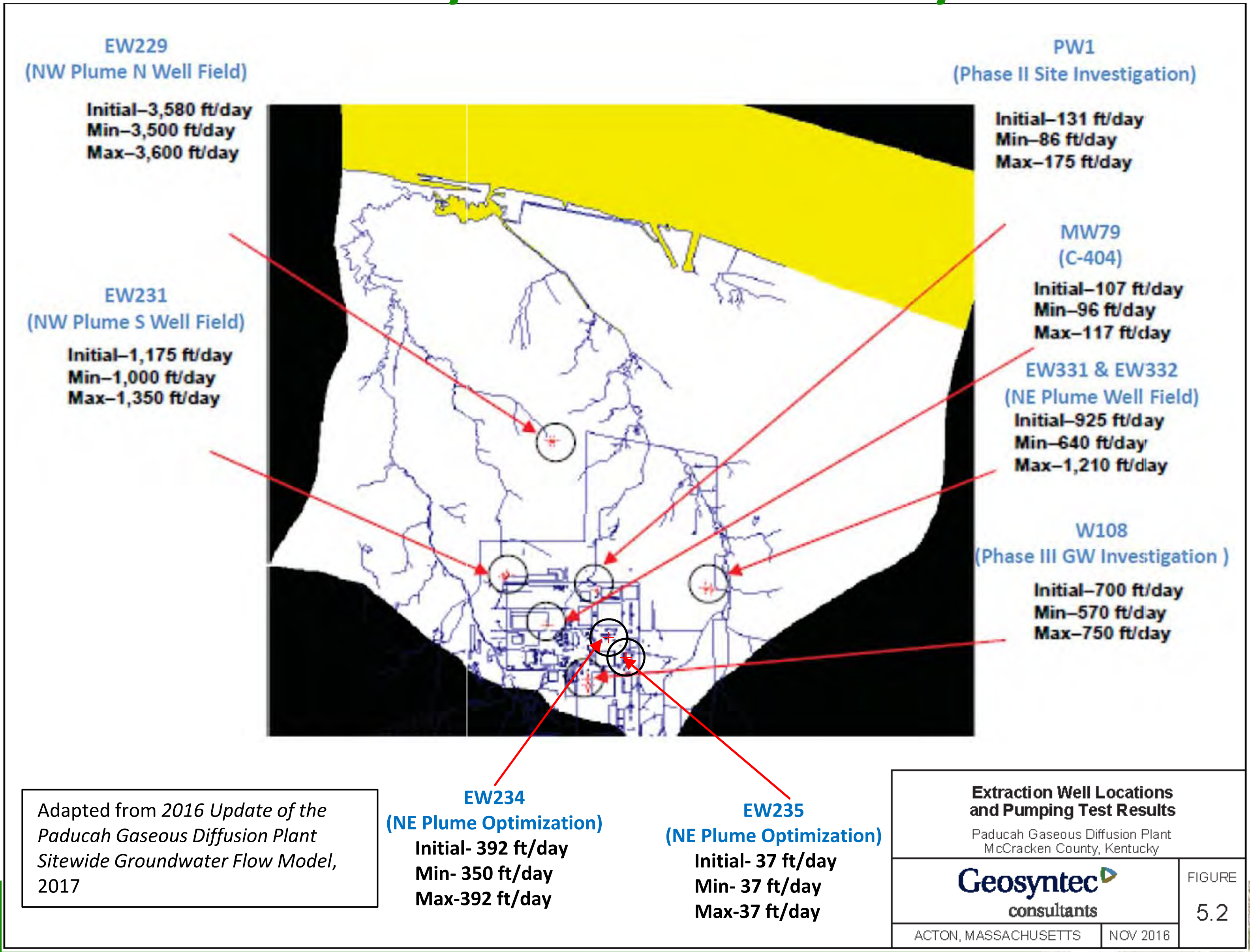
Figure 12. August 2018 RGA Potentiometric Surface Map

RGA: Gradients



- Gradient typically least under industrial facility and greatest near Ohio River
- Varies with season and Ohio River stage
- Common gradient is 10^{-4} m/m

RGA: Hydraulic Conductivity



RGA: Porosity

RGA Laboratory Geotechnical Data

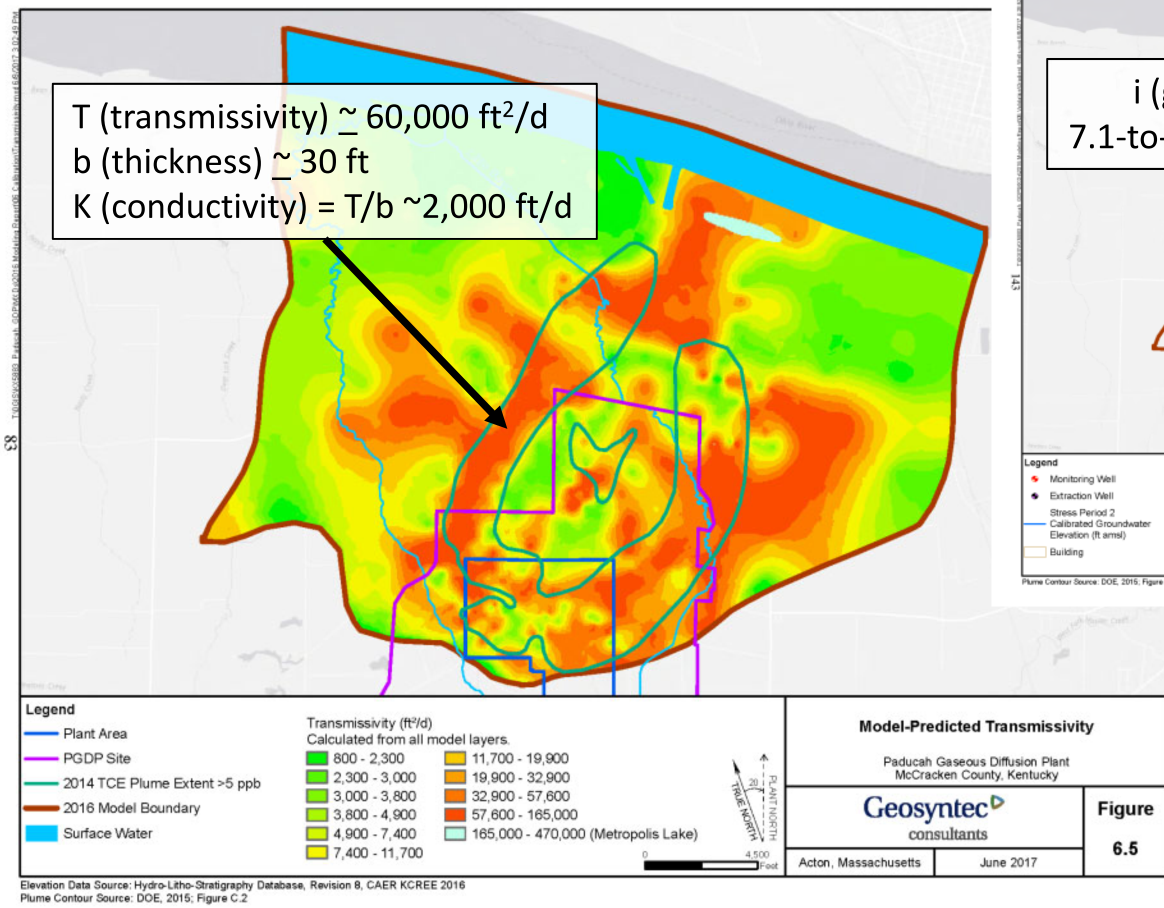
***Remedial Investigation Report for Waste Area Grouping 6 at Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, Volume 2. Appendices A-H, DOE/OR/07-1727/V2&D2, May 1999**

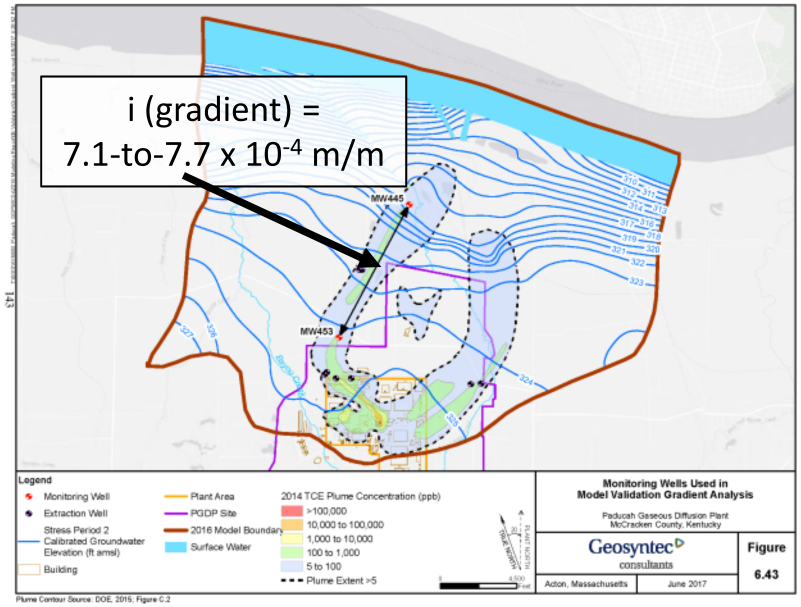
Sample #	Depth (ft)	HU	Soil Texture	Porosity (%)	Hydraulic Conductivity (cm/s)
026001SA056	56*	4	**SAND**	36	1.56E-03
026001SA070	67 - 72*	5	**GRAVEL** with little silt	41	5.69E+00
026001SA080	77 - 82*	5	**GRAVEL** with little silt	41	4.02E+00
400036SA060	62*	5	**GRAVEL** with some silt and little sand	35	5.25E-02
400036SA070	69*	5	**GRAVEL** with some sand and silt	38	4.12E+00
400036SA080	79*	5	**GRAVEL** with some sand and little silt and clay	32	1.32E+00
400036SA090	91*	5	**SAND**	39	1.62E-01
400038SA060	61 - 63	5	**GRAVEL** with little sand and clay	37	1.65E-01
400038SA070	71 - 73	5	**GRAVEL** with little sand and silt	42	5.39E-02
400207SA080	77 - 79	5	**GRAVEL** with some sand and little silt	44	9.40E+00
400208SA060	56 - 58	4	**SAND** with little clay	31	1.17E-03
400208SA070	66 - 68	5	**GRAVEL** with little sand	39	1.44E+00
400210SA060	57 - 62	5	**Gravel** with little sand and silt	27	8.32E-01
400210SA070	62 - 67	5	**Gravel** with little sand and silt	34	7.38E+00
400210SA080	79.5 - 80*	5	**Gravel** with little sand and silt	37	8.49E-01
400210SA090	92 - 92.5*	5	sandy **Gravel** with little clay and silt	36	3.88E-06
400212SA070	67 - 69	5	**GRAVEL** with little sand and silt	40	9.09E-01
400212SA080	77 - 79	5	**GRAVEL** with some sand and little silt	38	1.13E+00
400212SA090	87 - 89		**Gravel** with some sand and little silt	38	8.91E-01
			highest:	44	9.40E+00
			mean:	37	2.02E+00
			median:	38	8.91E-01
			lowest:	27	3.88E-06

* depth of associated analytical sample

The Paducah Site groundwater flow model assumes $n_e = 0.30$

RGA: GW Flow Example



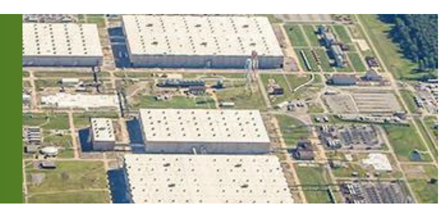


Figures from *2016 Update of the Paducah Gaseous Diffusion Plant Sitewide Groundwater Flow Model*, 2017

-Ki/n_e (effective porosity) = flow rate (v)

v = [(2,000 ft/d) x (7.4 x 10^{-4})]/0.30 = 4.9 ft/d

GW flow velocity in the plumes is thought to average 0.5 – 2 ft/d



SUMMARY

- Groundwater flow in UCRS is primarily vertical.
- Decades are required for groundwater to penetrate UCRS to the RGA.
    - TCE DNAPL penetrated much faster.
- The RGA is the primary route of contaminated groundwater flow offsite.
- The RGA flows northward from the plant to the Ohio River.
- The distance from C-400 to the Ohio River along the trace of the NW Plume is ~ 18,000 ft. At 1-3 ft/day (the common assumption), the groundwater flow travel time is 16 to 49 yrs.

Future Presentations

- ✓ Geology (January 8, 2020)
- ➢ Paducah Site Groundwater, "Big Picture" (April 8, 2020)
- 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)

Attachment 4

Sample #	Avg Depth	HU	Soil Texture	Porosity	Hydraulic Conductivity	
400038SA010	7.25	1	--	36	2.07E-05	
400036SA010	8.25	1	**SILT** with some clay	45	2.75E-07	
400212SA010	8.25	1	silty **CLAY**	37	1.71E-08	SILT with ~35% porosity and
026001SA010	10	1	sandy **SILT** with little clay	35	3.86E-07	hydraulic conductivity of ~3E-07 cm/s
400210SA010	12	1	**SILT** with little clay	32	1.43E-07	
400208SA010	12.25	1	**SIL**T with little clay	33	2.69E-07	
400036SA030	21	2	**GRAVEL** with little clay	38	3.27E+00	
400038SA030	27.25	2	**SAND** with some silt and little clay	40	1.12E-01	
400036SA045	45	2	**SAND** with some clay and little silt	40	4.67E-06	SAND with ~39% porosity and
400208SA045	47	2	**SAND** with little silt and clay	47	5.56E-02	hydraulic conductivity of ~3E-02 cm/s
400038SA045	47.25	2	**SAND** with some clay and little silt	30	2.04E-05	
400207SA045	48	2	**SAND** with little clay	35	1.02E-03	
400212SA030	28.25	3	**SILT** with some sand and little clay	25	3.90E-06	HU2 Confining Unit?
026001SA045	44	3	sandy **CLAY** with some silt	38	6.57E-07	CLAY/SILT with 36% porosity and
400210SA045	52	3	sandy **SILT** with some clay	33	1.71E-06	hydraulic conductivity of ~1E-06 cm/s
400212SA045	48.25	4	**SAND** with little silt	38	8.46E-02	

Yellow highlighting identifies "outliers"

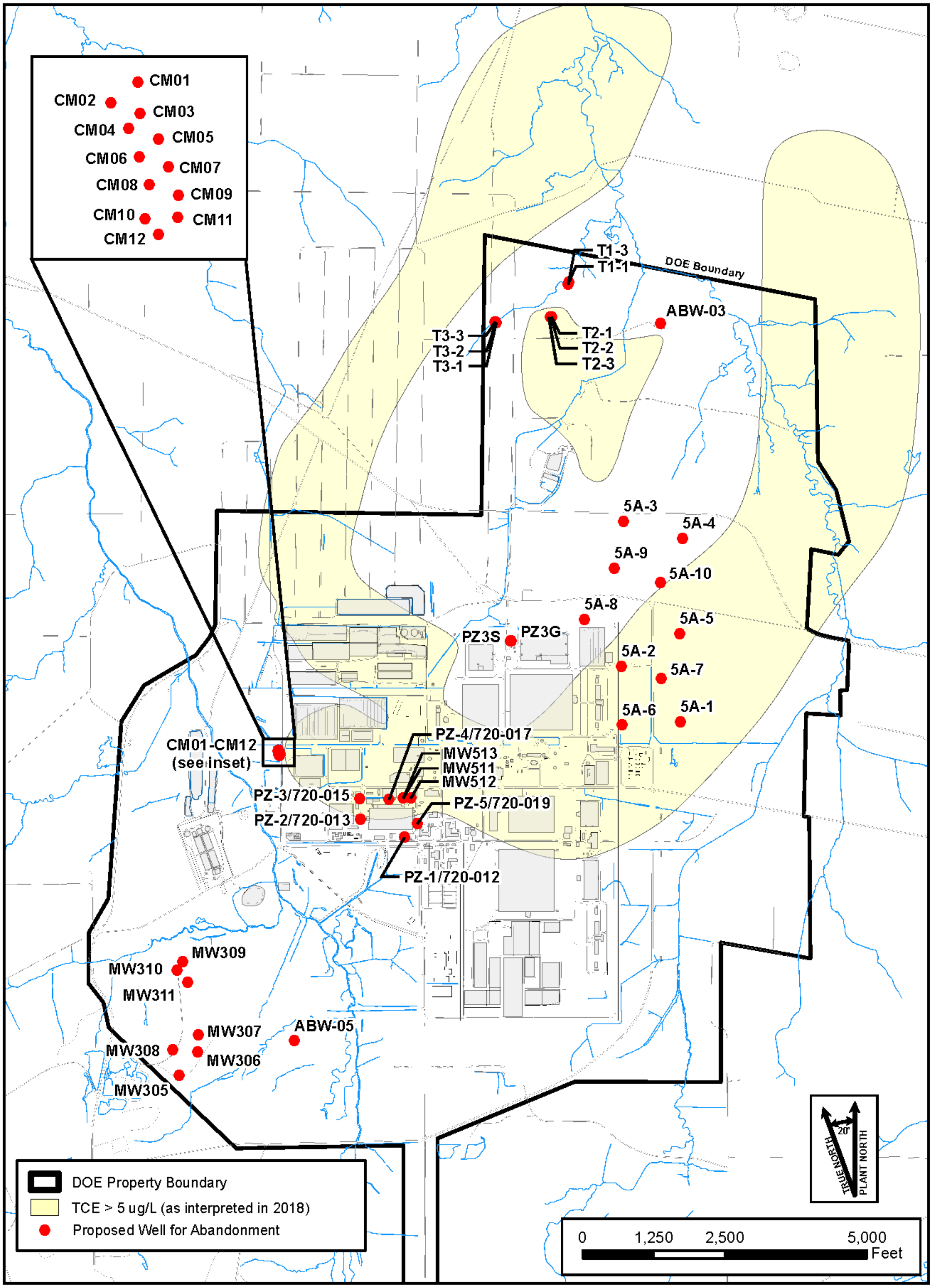
Attachment 5

2020 Well Abandonment Listing

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		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

Well/Piezometer No.	Year Installed	AKGWA #	Project
MW 307	1994	8001-3663	WAGs 1& 7
MW308	1994	8001-2424	WAGs 1& 7
MW309	1994	8001-3664	WAGs 1& 7
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

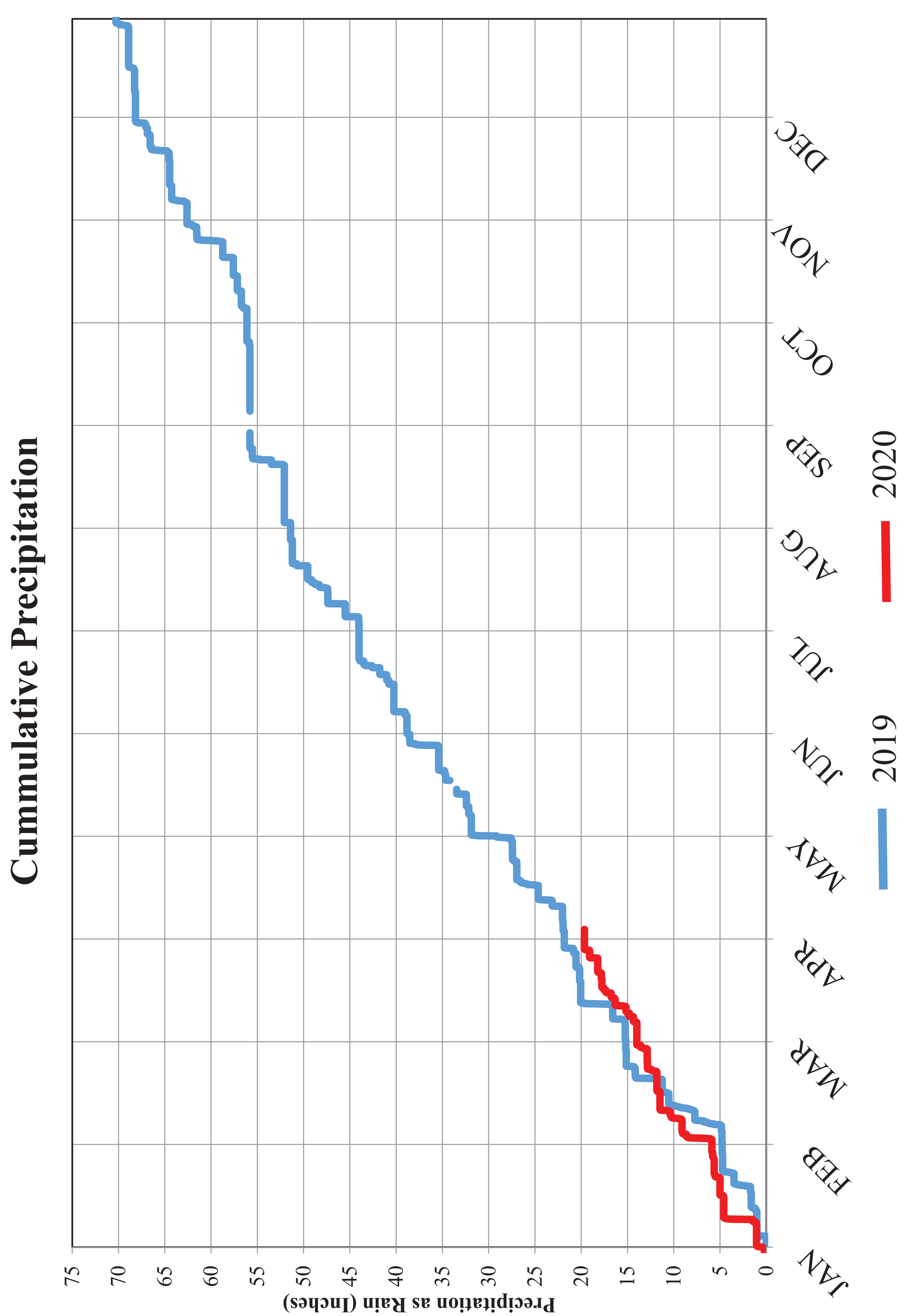
* Additional well/piezometer to be abandoned.

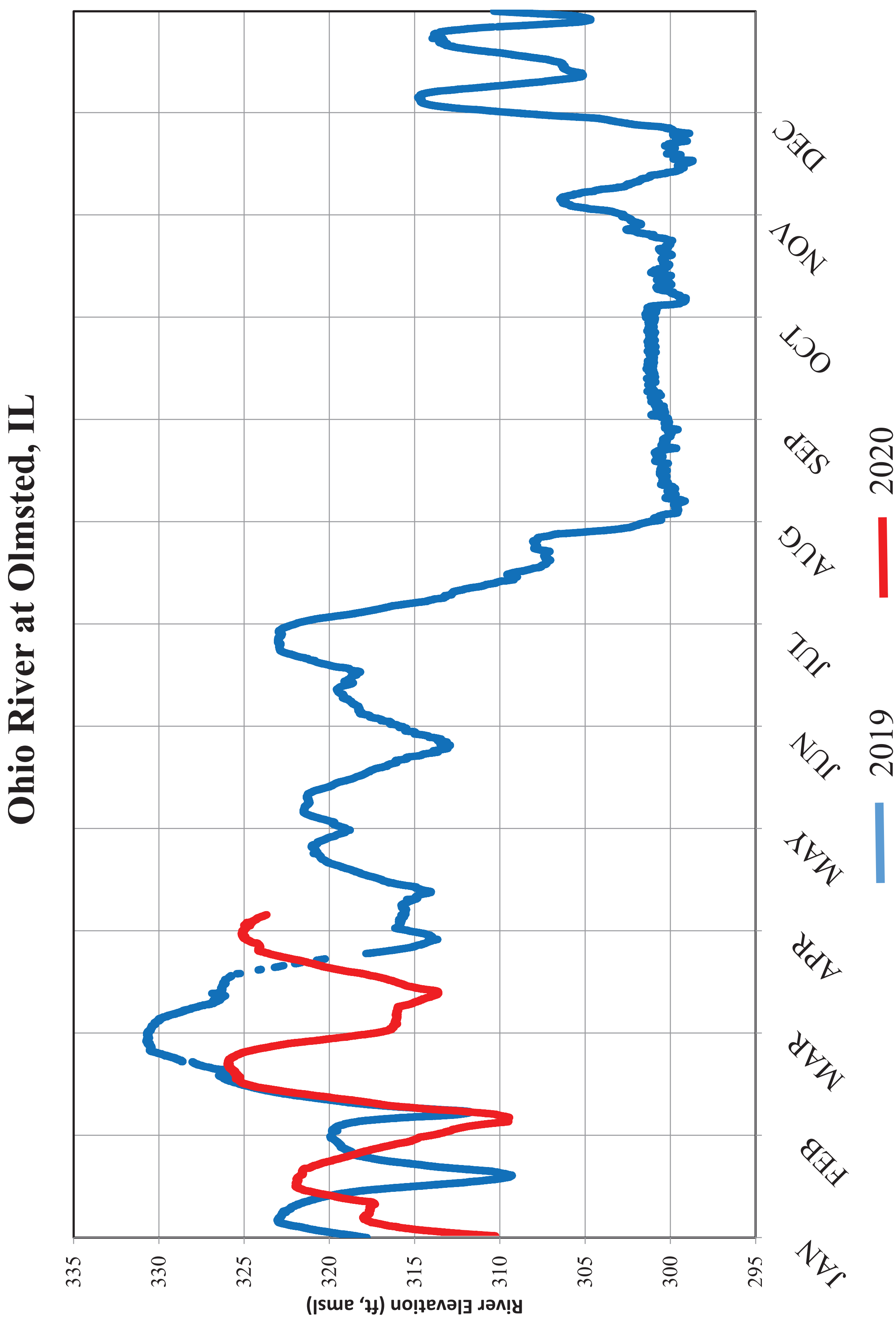


Proposed Well Abandonment

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

Attachment 6


Cummulative Precipitation
Precipitation as Rain (Inches)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
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

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APPENDIX G

GROUNDWATER MODELING WORKING GROUP MEETING SUMMARY—JULY 15, 2020

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ACRONYMS

ABW	abandoned well
AIP	agreement in principal
AKGWA	Assembled Kentucky Groundwater
amsl	above mean sea level
CB	colloidal boroscope
CM	construction monitoring well
COPC	chemical or radionuclide of potential concern
CSM	conceptual site model
DOE	U.S. Department of Energy
DTW	depth to water
EMP	Environmental Monitoring Plan
EPA	U.S. Environmental Protection Agency
EW	extraction well
FRNP	Four Rivers Nuclear Partnership, LLC
FS	feasibility study
FY	fiscal year
GW	groundwater
HU	hydrogeologic unit
KY	Commonwealth of Kentucky
M1	manual water level collected once per month
M2	manual water level collected twice per month
MW	monitoring well
MWG	Modeling Working Group
N/A	not applicable
OU	operable unit
PEGASIS	PPPO Environmental Geographic Analytical Spatial Information System
PGDP	Paducah Gaseous Diffusion Plant
PT	pressure transducer
PZ	piezometer
RGA	Regional Gravel Aquifer
RI	remedial investigation
SWMU	solid waste management unit
TOC	top of casing
TVA	Tennessee Valley Authority
UCRS	Upper Continental Recharge System
UST	underground storage tank
VI	vapor intrusion
WAG	waste area grouping
WDA	waste disposal alternatives

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Paducah Site Groundwater Modeling Working Group
Meeting Summary—July 15, 2020

MWG Member List and Attendees:

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

✓ 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 April 8, 2020, Meeting Summary (sent to participants on 5/4/2020). This summary will be considered final.

No comments were received to the April 8, 2020, Meeting Summary during the meeting. The April 8 summary is now final.

2. FY 2020+ Work Plan/Schedule

The remaining FY 2020+ schedule is below.

Quarterly Meeting (July)	7/15/2020
Quarterly Meeting (October)	10/7/2020
Submit Draft Meeting Notes compilation (2019-2020)	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 group discussed and agreed that the Meeting Notes compilation (2019-2020) would include meeting notes from 2019 through this meeting (July 15, 2020).

3. Update on Water Levels

No change in status since the April 8, 2020 meeting: field data collection activities remain on hold.

Synoptic water level events will be collected quarterly once field data collection activities resume.

Revised groundwater elevation data for TVA wells collected by KY on March 24, 2020, is provided as Attachment 1.

The group discussed the overall potential for field activities to resume. Additional discussion is provided with Item 4.

4. Update on Paducah Site Groundwater Strategy

No change in status since the April 8, 2020 meeting: field data collection activities remain paused.

The pause started after the first portion of Month 3 data collection and the second portion could not be collected. A determination will be made as to whether to begin with Month 4 or pick back up with Month 3 when the project can be resumed. Pressure transducer measurements were discontinued during the pause due to the level of effort involved in running the transducers (e.g., downloading of data, etc.).

Deployment of the pressure transducers began the week of December 30, 2019. 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 considered January 2020. FRNP has reviewed KY's AIP monitoring wells sampling schedule and schedule conflicts between sampling and borescope measurements have been resolved.

The group discussed the overall potential for field activities to resume. FRNP is actively planning the restart of field activities associated with monitoring well abandonment, groundwater strategy and collection of quarterly synoptic water levels. The pressure transducers are being pulled from the field and will be sent offsite for calibration prior to activity resumption calibration and should not need to be calibrated again during the 12 month data collection. Data downloads have been performed routinely (approximately monthly when possible) to assure that data is collected prior to exceeding the storage capacity. FRNP and DOE are evaluating the appropriate month (e.g., Month 1 versus Month 3 or Month 4) to meet project objectives for resumption of data collection. As part of the evaluation, data that is available will be reviewed to understand if data quality objectives are being met or if changes should be made to the plan. ***Resumption of activities and any changes (if determined to be appropriate) will be communicated to the group prior to resuming activities.***

The new roadway and access to MW99/MW477 is anticipated to be completed by TVA this month.

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

No change in status since the April 8, 2020 meeting.

Preliminary information to be collected for the "Installation of piezometers …associated with several of the large process buildings…." white paper will incorporate information learned from the vapor intrusion (VI) project. VI project walkdowns were held February 11-14, 2020, with a follow-up facility tour held February 20, 2020. The VI Work Plan was submitted on May 1, 2020 and is in review.

FRNP and DOE will prepare a draft schedule associated with a white paper addressing this agenda item and will provide the schedule to the MWG for discussion during the October 7 meeting*. The group discussed that this topic is not contingent on the VI project, although it was acknowledged that information obtained from the VI project will be important in this assessment and could have a bearing on the scheduling of this topic. DOE reminded the group that this is an unfunded topic.*

The status of the VI Work Plan was discussed with EPA and KY indicating they are on schedule to provide comments July 30.

6. 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, Continued' presentation for this meeting is provided as Attachment 3.

Ken Davis presented the groundwater curriculum slides to the MWG. The MWG expressed appreciation for the information and effort.

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.

At the request of MWG members, this topic will be retained on the agenda for the October 7 meeting. ***The MWG asked if there is a way to further reduce (temporarily) sources of noise to facilitate new seismic investigations.***

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 lithologic correlation white paper will be 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 D1 C-400 Complex OU RI/FS Report is scheduled to be submitted on December 31, 2021.

DOE discussed that this lithology white paper will be developed with MWG input and that a draft schedule for the paper will be provided for discussion at the October 7 meeting.

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. The wells will be resurveyed upon restart of standard work activities. Upload of the information to PEGASIS will be performed following the surveying and data review. Updated schedules will be provided as details become available.

FRNP is in the process of resuming this activity. The survey effort is being undertaken to ensure consistency in measurement and reduce the potential for measurement errors as well as a uniform accuracy of datum elevations. Upload of the information to PEGASIS will be performed following the surveying and data review. The MWG asked if there will be an evaluation of what impacts there may be to prior reporting. KY requests access to the survey data for use in the AIP data collection. ***A schedule for the surveying effort will be developed and provided to the MWG for discussion during the October 7 meeting.***

10. Projects on the "Watch Topics" List

- **Update on Paducah Site Monitoring Well Abandonment/Replacement**
  Several wells/piezometers are being planned for abandonment as part of plus-up funding. Attachment 4 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.

  The field schedule for the current well abandonment project was discussed with the MWG, with an anticipated field start the week of July 20. The MWG discussed that the CM (Construction Monitoring) wells from the Permeable Treatment Zone Study and as included in Attachment 4 will have the electrodes pulled as part of abandonment; these electrodes are not like the electrodes installed at other projects. The location of the CM wells relative to the boreholes where iron injections occurred was also discussed; these wells are not within that injection area.

- **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 MWG asked if this topic had moved past the "white paper stage." DOE explained that this is a known data need for the sitewide groundwater modeling and that it is included in the groundwater strategy out-year activities. This item will be retained as a "Watch Topic."

  KY reported that their staff had potentially identified a new seep upgradient of LBC5. They are planning to document the seep and will provide that information to the site environmental program.

- **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.

  A status update on the new TVA substation and any plans for additional power line movement or removal will be provided at the October 7 meeting.

11. Poll MWG Members/Open Discussion

Several C-400 Complex Remedial Investigation items were discussed at the conclusion of the MWG meeting. These will be addressed by that project and are not documented here.

Attachment 1

Groundwater Elevation Data for TVA Wells Collected by KY on March 24, 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	328.24	40.56	03/24/2020_0957	29.98	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	327.86	40.64	03/24/2020_0918	30.00	TOC
TVAGW-4D	TVAGW-4D	4" PVC	upper RGA	365.8	363	759456.7195	1947561.73	active	57	67.5	306	295.5	328.71	37.09	03/24/2020_0912	30.00	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	327.85	35.95	03/24/2020_0908	30.00	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	331	39	03/24/2020_0855	30.00	TOC
TVAGW-1D	TVAGW-1D	4" PVC	upper RGA	370.1	367.5	757847.0459	1946203.79	active	56	66	311.5	301.5	327.87	42.23	03/24/2020_0933	30.00	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	326.61	5.21	03/24/2020_1039	29.93	TOC
TVA-D75B	SHF-D75B	2" PVC	upper RGA	353.08	350	753297.07	1955971.69	active	48	58	302	292	325.89	27.19	03/24/2020_1044	29.93	TOC
TVA-D74B	SHF-D74B	2" PVC	upper RGA	331.99	329	756125.35	1956489.82	active	39	49	290	280	326.66	5.33	03/24/2020_1053	29.93	TOC
TVA-D30B	SHF-D30B	2" PVC	upper RGA	324.61	320.9	757594	1955563.41	active	39	49	281.9	271.9	NA	NA	NA	NA	TOC
TVA-D17	SHF-D17	2" PVC	upper RGA	365.43	362.8	758809.17	1950015.71	active	14	17	348.8	345.8	326.03	39.4	03/24/2020_1032	29.93	TOC
TVA-D11B	SHF-D11B	2" PVC	upper RGA	321.79	319.2	753434.76	1958481.44	active	32	42	287.2	277.2	NA	NA	NA	NA	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	324.32	27.42	03/24/2020_1048	29.93	TOC
NA	SHF-201C	4" PVC	upper RGA	323.75	320	746799.24	1960068.889	active	44.5	54.5	275.5	265.5	NA	NA	NA	NA	TOC
NA	SHF-201B	4" PVC	upper RGA	323.75	320.2	746641.107	1960082.768	active	32	37	288.2	283.2	NA	NA	NA	NA	TOC
NA	SHF201A	4" PVC	Upper RGA	323.75	320	747030.226	1960036.252	active	14.5	24.5	305.5	295.5	NA	NA	NA	NA	TOC
NA	SHF-102G	4" PVC	Upper RGA	362.85	359.1	845764.387	1927473.284	active	47.1	57.4	312	301.7	NA	NA	NA	NA	TOC
TVA River Elevation														325.76	3/24/2020_1626	29.80	

LEGEND:
NA: Not Applicable - Denotes data not collected due to localized flooding.
TOC: Top of Casing
DTW: Depth to Water

Attachment 2

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.

Attachment 3

Groundwater Curriculum: Paducah Site Groundwater, Continued

PADUCAH SITE GROUNDWATER, CONTINUED (Session 3)

Presented by Ken Davis
Groundwater Modeling Working Group Quarterly
Meeting
July 15, 2020
DRAFT

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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
  - Current GW Strategy
  - Other COPCs

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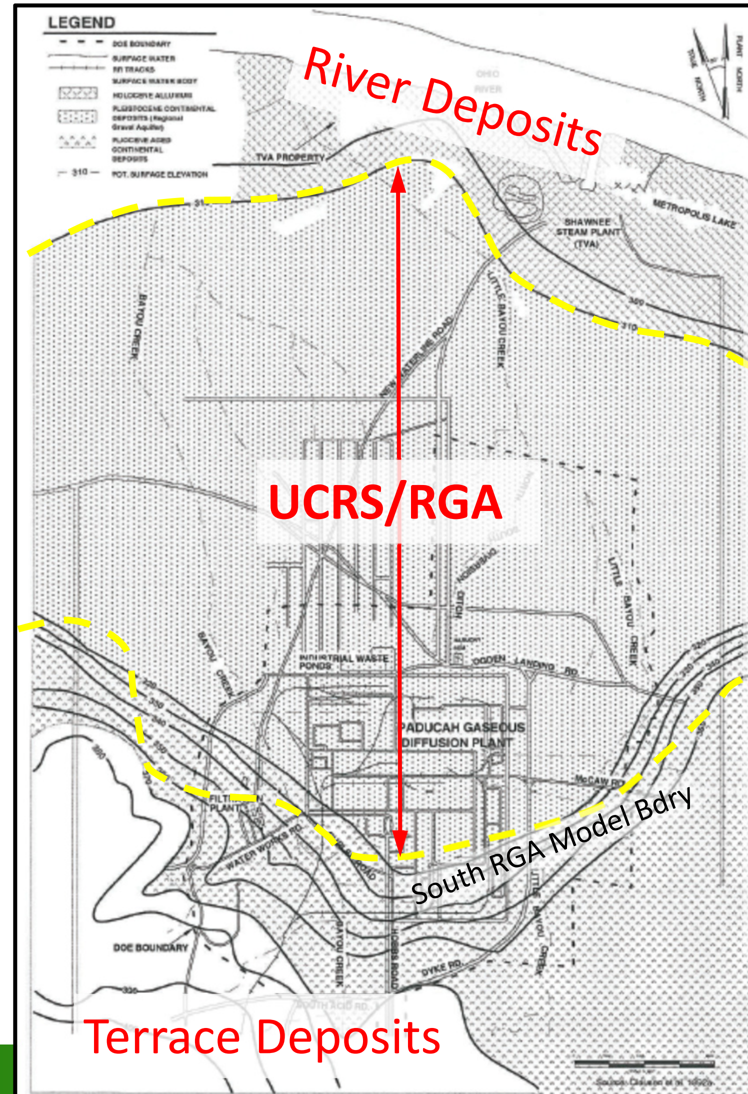
Contents Summary

Slide 4: Groundwater Hydrology Primer
Slides 5 – 19: UCRS
Slides 20 – 25: RGA
Slides 26 – 33: 2016 Update of
Paducah Site Groundwater Flow Model

Paducah Site "Shallow" Groundwater Provinces:

- Terrace Deposits
  (south end of Paducah Site)
- **UCRS/RGA**
  (under gaseous diffusion plant
  and extending north)
- Modern Ohio River Deposits
  (north boundary)



Adapted from Figure 3.5 of *Remedial Investigation Report of Waste Area Grouping 6 at Paducah Gaseous Diffusion Plant, Paducah, Kentucky, 1999*

3

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Groundwater Hydrology Primer

Water table: the level below which the ground is saturated with water

Potentiometric Surface: hypothetical surface representing the level to which groundwater would rise in wells screened in a confined aquifer

Gradient: the slope of the water table or potentiometric surface

Conductivity: the ability of a soil to transmit fluid through pore spaces and fractures

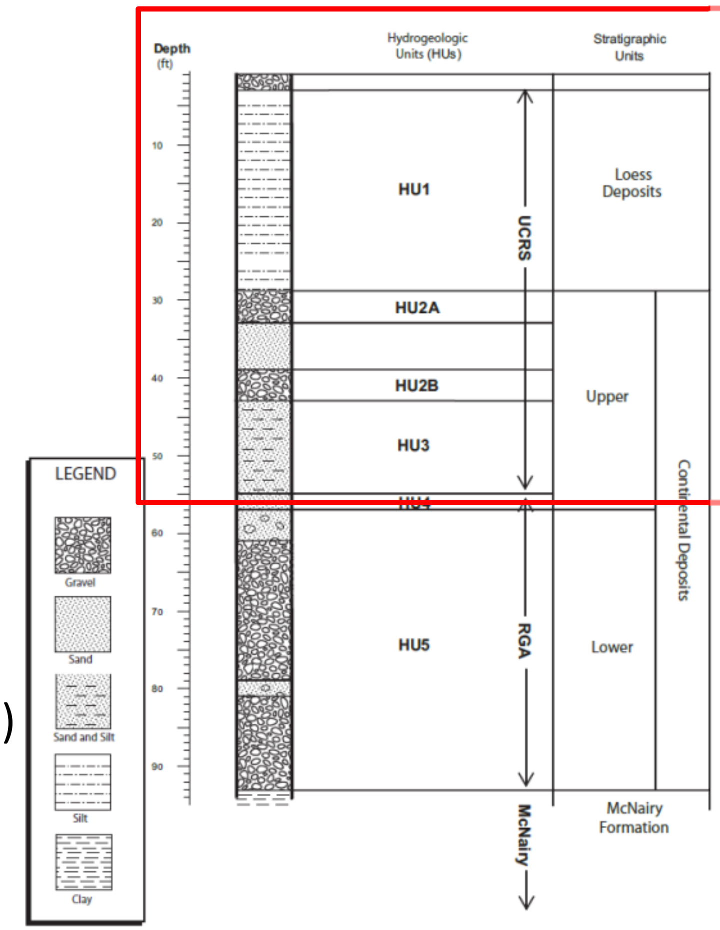
Porosity: the percentage of the total void space in a soil

Effective porosity is the percentage of connected void space in a soil.

4

UCRS: Upper Continental Recharge System
- Paducah-specific: named for Upper Continental Deposits

- Shallow (0 – 55 ft depth) sequence of frigid lake deposits, overlain by loess, under the gaseous diffusion plant and extending north to the Ohio River
- Consists of (from top to bottom – C-400 area common depths):
  - 0 – 28 ft: **HU1** (loess deposits with upper soil horizon)
  - 28 – 43 ft: **HU2** (horizon of common sand and gravel units interbedded with fine sand – locally 2 units)
  - 43 – 55 ft: **HU3** (sequence of interbedded very-fine-to-fine sand, silt, and clay units



5

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UCRS Continued

HU1 (Silt):

- Ubiquitous across Paducah Site
- ~28 ft thick beneath C-400
- Low hydraulic conductivity of matrix but has frequent jointing (filled with silt/clay)
- Water saturation varies by area (commonly unsaturated beneath C-400)

HU2 (Sand and Gravel):

- Thickest near Porters Creek Clay terrace slope (to the south) – thins to the north
- ~15 ft thick beneath C-400
    - Upper (HU2A) and lower (HU2B) horizons locally developed
- Comparatively high hydraulic conductivity (compared to HU1 and HU3)
- Water saturation varies by area (locally unsaturated beneath C-400)

HU3 (Fine/Very Fine Sand and Silt):

- Ubiquitous within local ancestral Tennessee River basin
- ~12 ft thick beneath C-400
- Low hydraulic conductivity (similar to silt)
- Commonly water saturated
    - Horizon of variable storage for RGA flow system

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UCRS Continued

Primary hydraulic function: **transmit percolating water downward to RGA**

Horizontal groundwater flow component appears limited:

- An empirical line of evidence is the “losing” nature of Bayou and Little Bayou Creeks at the Paducah Site
- Few UCRS plumes (slide 9)
- Dominant vertical gradient (slides 11 - 13)
- UCRS modeling of the C-404 and C-747-A Landfills (west plant area)
  - Modeling by Dr. Cary McConnell, 1991 and 1992, respectively

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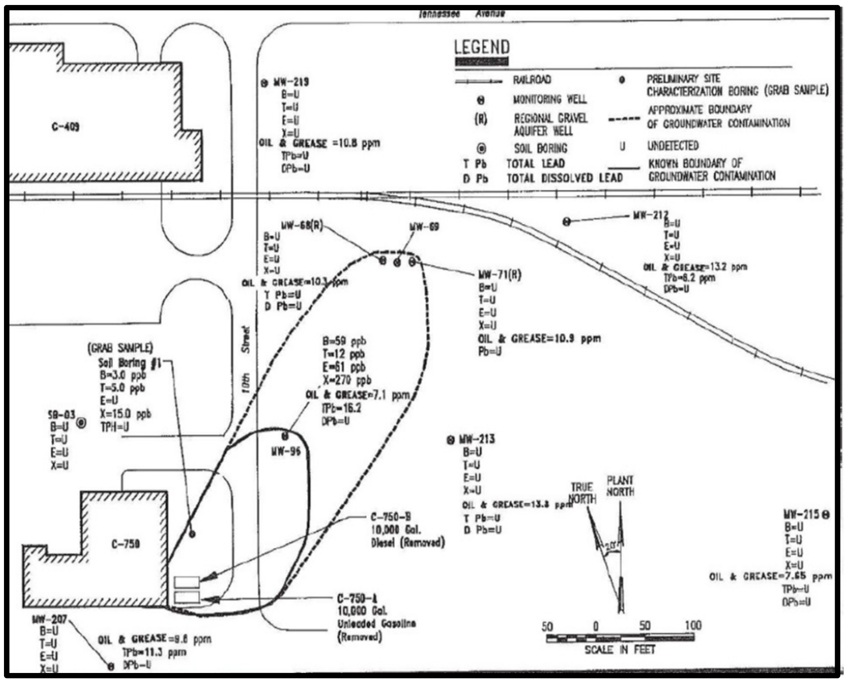
UCRS Continued

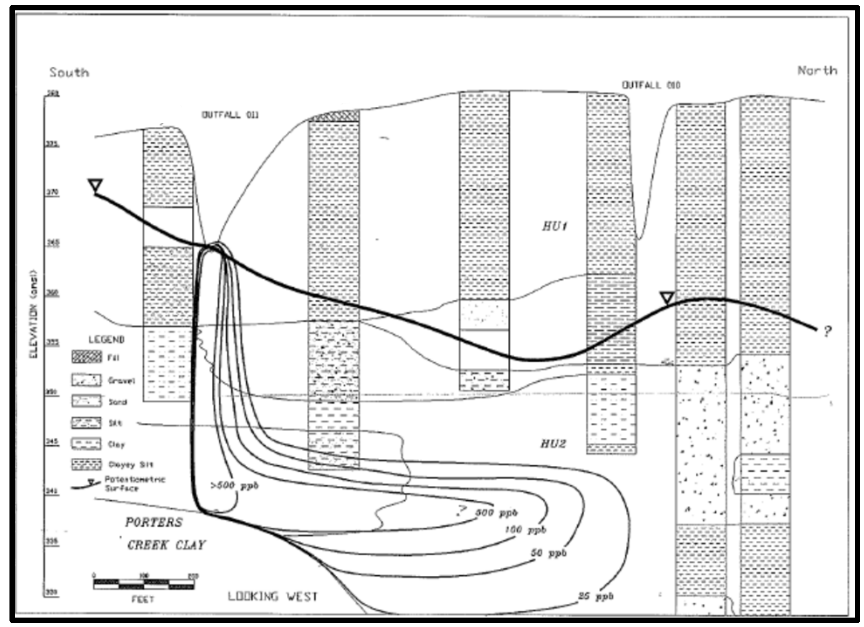
Examples of UCRS lateral flow:

BTEX (LNAPL) plume associated with C-750-C Garage USTs



From *Site Investigation of the Underground Storage Tanks at the C-200, C-710, and C-750 Buildings, Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, 1992

Dissolved TCE plume associated with Outfall 011 source – terrace area



From *Final Site Evaluation Report for the Outfall 010, 011 and 012 Areas, Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, 1995

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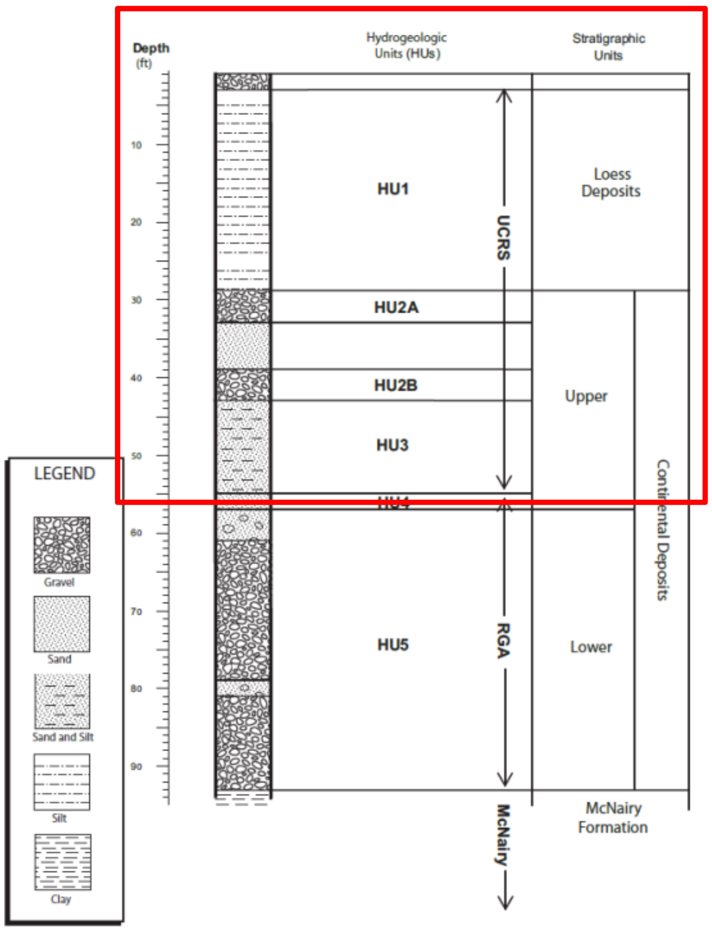
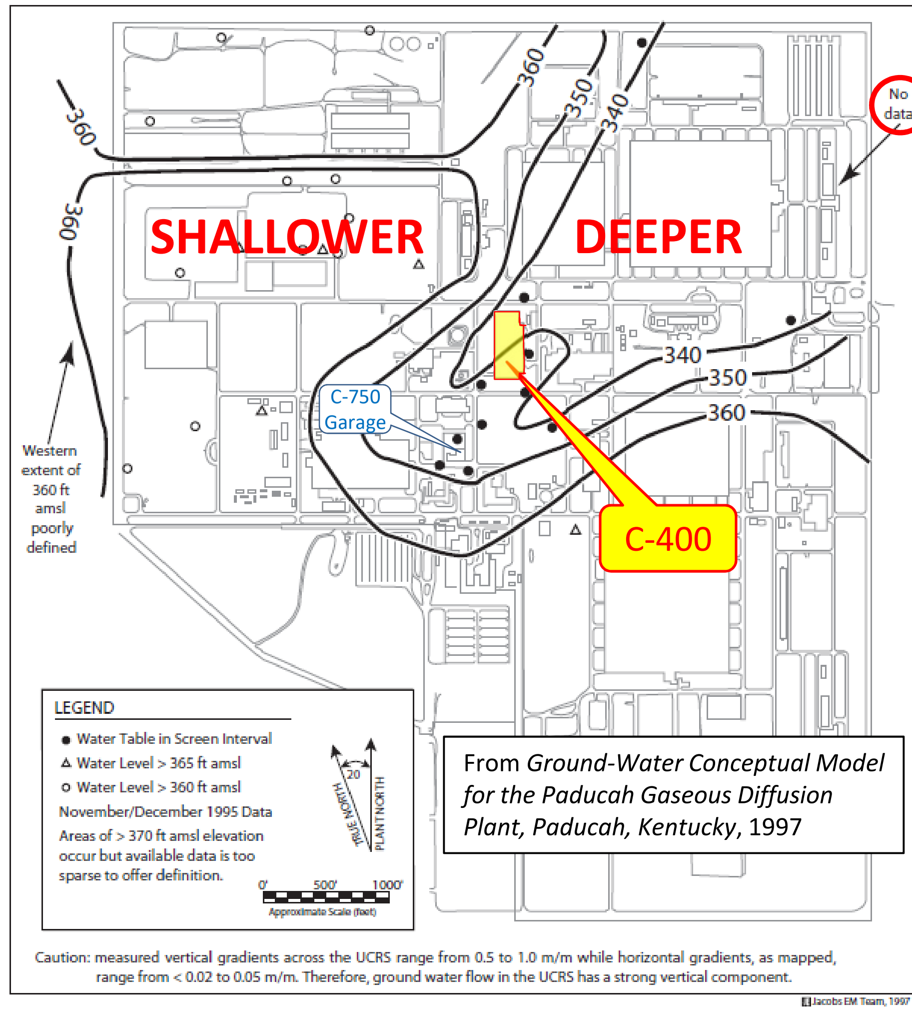
UCRS (HU1 – HU3): Water Table





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UCRS: Vertical Gradients

Two Populations

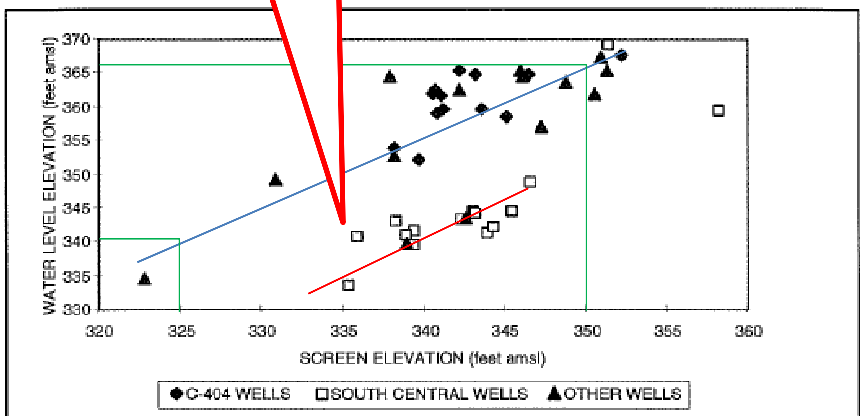
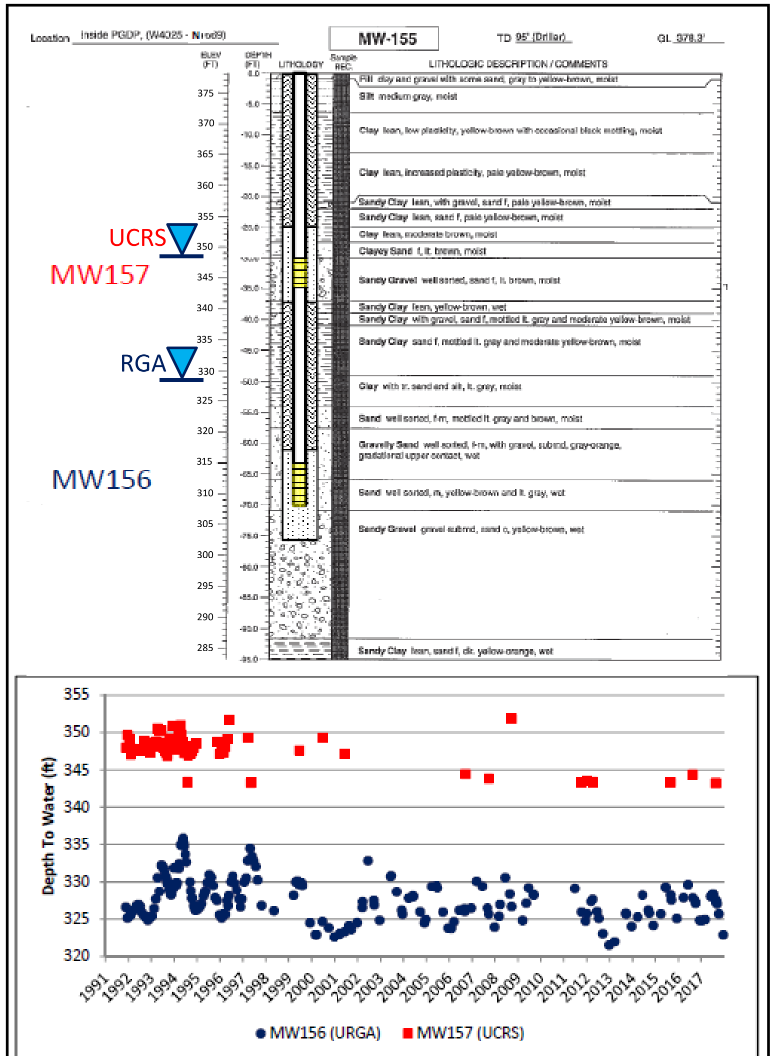


Figure 3-3. Plot of Water Level Versus Well Screen for Upper Continental Recharge System Wells

From *Ground-Water Conceptual Model for the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, 1997



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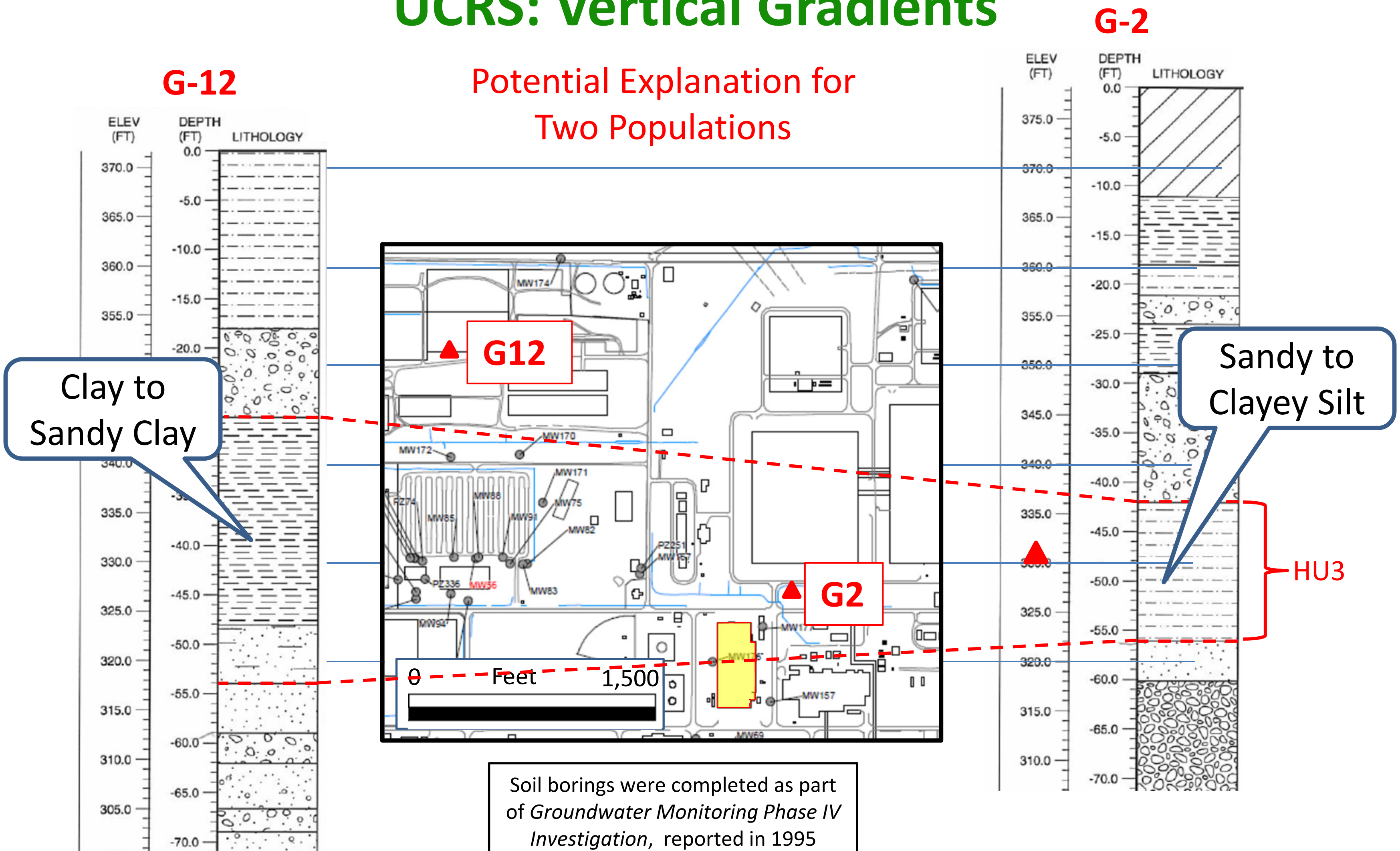
UCRS: Vertical Gradients

Potential Explanation for Two Populations



Soil borings were completed as part of *Groundwater Monitoring Phase IV Investigation*, reported in 1995

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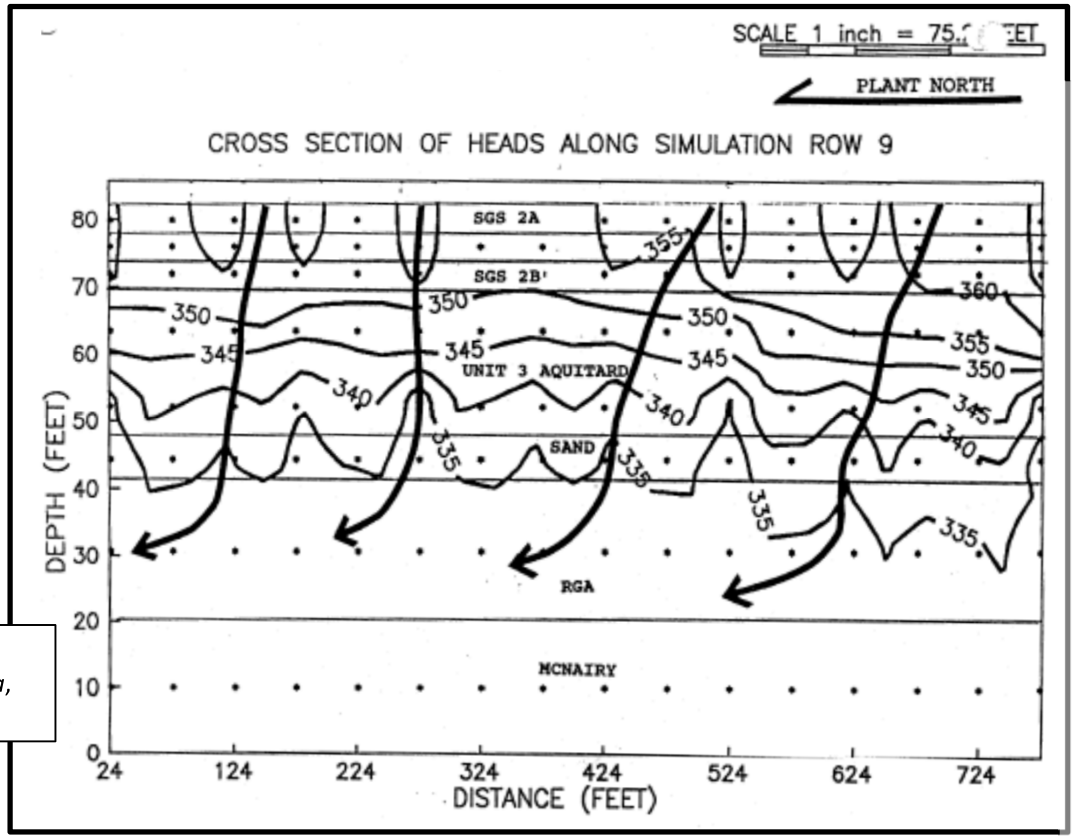
UCRS: Vertical Gradients

- Negative gradient means:
  - Deeper wells will have deeper water levels
    - UCRS challenge: define the depth of the water table
  - Groundwater is flowing downward



From *A Steady State Computer Model of the C-404 Landfill Area*, 1992

- UCRS hydrographs exhibit seasonal cycle
  - May be response to wet season/dry season variations in recharge
  - May be response to fluctuating RGA potentiometric surface

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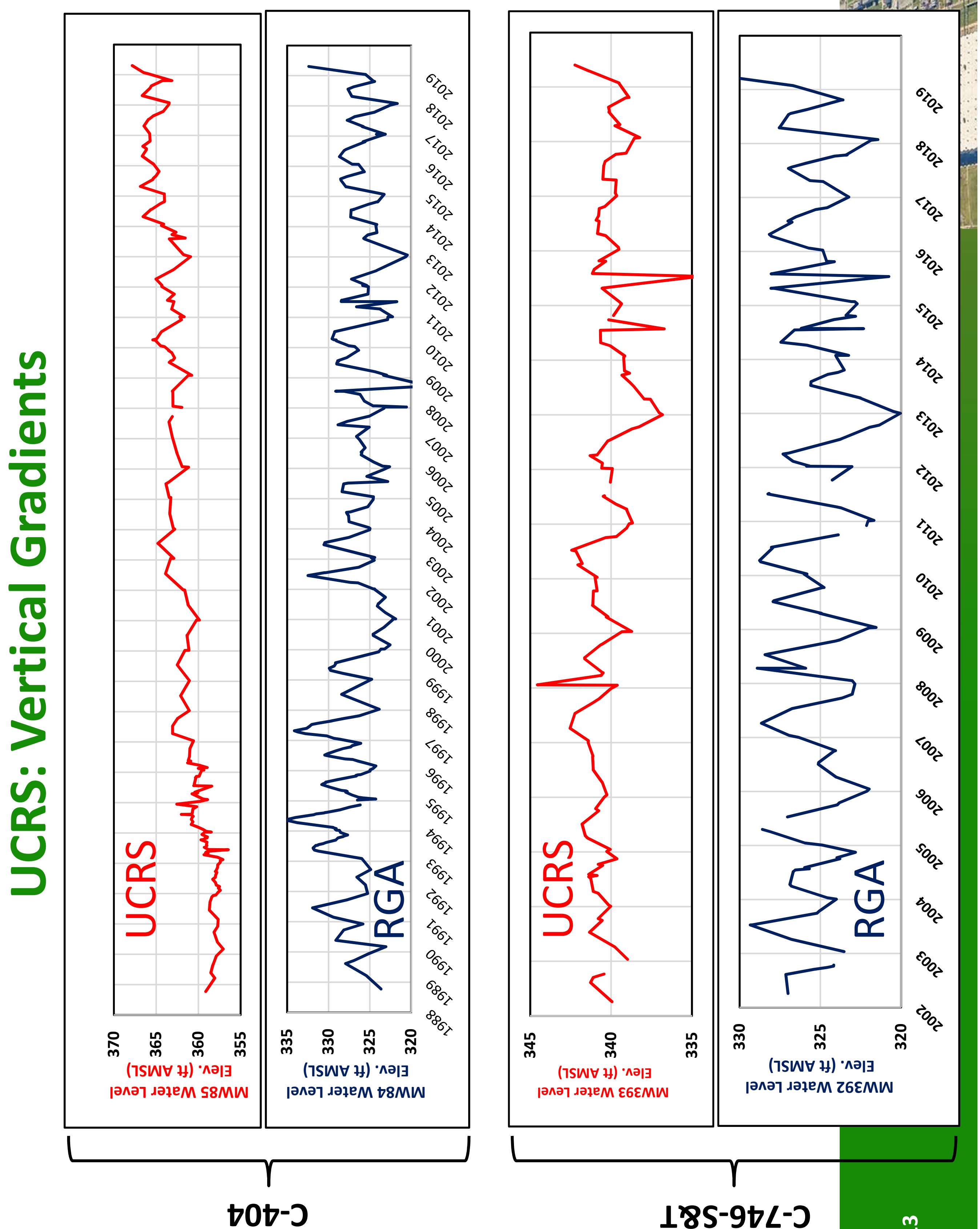
UCRS: Vertical Gradients
UCRS
MW85 Water Level Elev. (ft AMSL)
RGA
MW84 Water Level Elev. (ft AMSL)
C-404
UCRS
MW393 Water Level Elev. (ft AMSL)
RGA
MW392 Water Level Elev. (ft AMSL)
C-746-S&T
13

UCRS: Hydraulic Conductivity

Vertical

- Permeameter (problem of representative sample – does the small sample volume adequately characterize the Hydrologic Unit?)
  - WAG 6 RI report measurements (reported in 1999)

Horizontal

- Well tests (problem of well connection – do well construction and development significantly bias the results?)
  - Slug tests (well placement is biased to high conductivity horizons)
    - Phase I and II Site Investigations (reported in 1991/1992)
  - Pumping test: LASAGNA Demonstration site characterization (reported in 1996)

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UCRS: Hydraulic Conductivity – Vertical (Permeameter)

Sample #	Avg Depth (ft)	HU	Soil Texture	Vertical Hydraulic Conductivity (cm/sec)	Representative Member
400038SA010	7.25	1	--	2.07×10^{-5}	SILT with vertical hydraulic conductivity of ~3×10^{-7} cm/sec
026001SA010	10	1	sandy SILT with little clay	3.86×10^{-7}	
400036SA010	8.25	1	SILT with some clay	2.75×10^{-7}	
400208SA010	12.25	1	SILT with little clay	2.69×10^{-7}	
400210SA010	12	1	SILT with little clay	1.43×10^{-7}	
400212SA010	8.25	1	silty CLAY	1.71×10^{-8}	
400036SA030	21	2	GRAVEL with little clay	3.27×10^{0}	SAND with vertical hydraulic conductivity of ~4×10^{-6} cm/sec (median of 3×10^{-2} cm/sec)
400038SA030	27.25	2	SAND with some silt and little clay	1.12×10^{-1}	
400208SA045	47	2	SAND with little silt and clay	5.56×10^{-2}	
400207SA045	48	2	SAND with little clay	1.02×10^{-3}	
400038SA045	47.25	2	SAND with some clay and little silt	2.04×10^{-5}	
400036SA045	45	2	SAND with some clay and little silt	4.67×10^{-6}	
400212SA030	28.25	~~3~~	SILT with some sand and little clay	3.90×10^{-6}	
400210SA045	52	3	sandy SILT with some clay	1.71×10^{-6}	CLAY/SILT with vertical hydraulic conductivity of ~1×10^{-6} cm/sec
026001SA045	44	3	sandy CLAY with some silt	6.57×10^{-7}	

Adapted from *Remedial Investigation Report for Waste Area Grouping 6 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, 1999

S03211	15	1	SILT with clay	1.9×10^{-8}	Silt with vertical hydraulic conductivity of ~1×10^{-7} cm/sec
S09212	25	2A	SAND AND GRAVEL with silt	5.7×10^{-6}	Sand and Gravel with Silt with vertical hydraulic conductivity of ~5×10^{-6} cm/sec
S17213	42.5	3	silty CLAY	1.1×10^{-8}	Clay with vertical hydraulic conductivity of ~5×10^{-7} cm/sec
S09213	45	3	silty CLAY	1.0×10^{-8}	
S03214	50	3	silty CLAY	2.8×10^{-8}	

Adapted from *Data Summary and Interpretation Report for Interim Remedial Design at Solid Waste Management Unit 2 of Waste Area Grouping 22…*, 1997

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UCRS: Hydraulic Conductivity – Horizontal (Slug Test)

Monitoring Well/ Test Number	Screen Depth	HU	Lithology	Hydraulic Conductivity (cm/sec)
MW195/RHT1	6.0 – 11.0	1	Clay with Sandy Gravel Bed	6.31×10^{-4}
MW195/RHT2				6.93×10^{-4}
MW164/RHT1	42.0 – 47.0	2	Poorly Graded Sand	6.54×10^{-4}
MW189/RHT1	22.5 – 27.5	2(?)	Sandy Lean Clay	4.27×10^{-5}
MW189/RHT2				4.27×10^{-5}
MW162/RHT1	18.0 – 24.0	2	Gravel and Sand	4.30×10^{-5}
MW162/RHT2				2.86×10^{-5}
MW167/RHT1	21.0 – 26.0	2	Well Graded Sand with Gravel	3.65×10^{-5}
MW167/RHT2				3.64×10^{-5}
MW192/RHT1	38.0 – 43.0	2	Poorly Graded Sand	1.95×10^{-5}
MW192/RHT2				3.75×10^{-5}
MW157/RHT1	30.-0 – 35.0	2	Sandy Gravel	2.47×10^{-5}
MW190/RHT1	17.5 – 22.5	2	Poorly Graded Sand with Gravel with Clay	1.16×10^{-5}
MW190/RHT2				1.24×10^{-5}
MW160/RHT1	20.0 – 25.0	2	Sand with Gravel	5.41×10^{-6}
MW160/RHT2				8.45×10^{-5}
MW83/RHT1	30.4 – 40.4	2(?)	Clayey Silty Sand	2.22×10^{-6}
MW82/RHT1	30.8 – 40.8	2(?)	Clayey Silty Sand	1.08×10^{-6}
MW170/RHT1	25.0 – 30.0	2	Well Graded Sand to Clayey Sand	1.63×10^{-7}
MW170/RHT2				9.93×10^{-5}
MW198/RHT1	18.0 – 23.0	2	Clayey Sand	7.45×10^{-7}
MW64/RHT1	27.8 – 32.8	2	Sand	3.56×10^{-7}
MW177/RHT1	39.5 – 44.5	3	Lean Clay	2.81×10^{-4}
MW204/RHT1	49.5 – 54.4	3	Poorly Graded Sand with Gravel	3.01×10^{-5}
MW204/RHT2				3.78×10^{-5}
MW128/RHT1	33.0 – 43.0	3	Silty Clay	7.22×10^{-7}
MW127/RHT1	29.0 – 39.0	3	Silty Clay	2.11×10^{-7}
MW166/RHT1	33.0 – 38.0	3	Lean Clay	1.02×10^{-8}

Median of HU2
Hydraulic Conductivity
= 2.67×10^{-5} cm/sec

Taken from Phase I and Phase II Site Investigation reports… (1991 and 1992)

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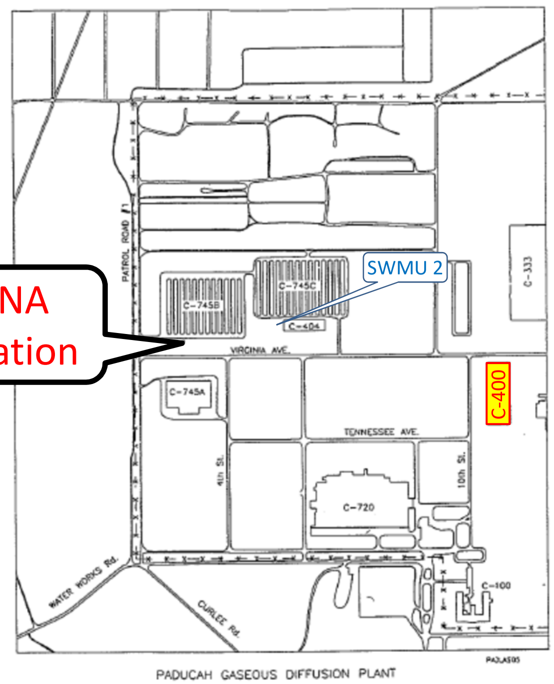
UCRS: Hydraulic Conductivity - Horizontal



Adapted from DNAPL Site Characterization and LASAGNA™ Technology Demonstration… (1996)

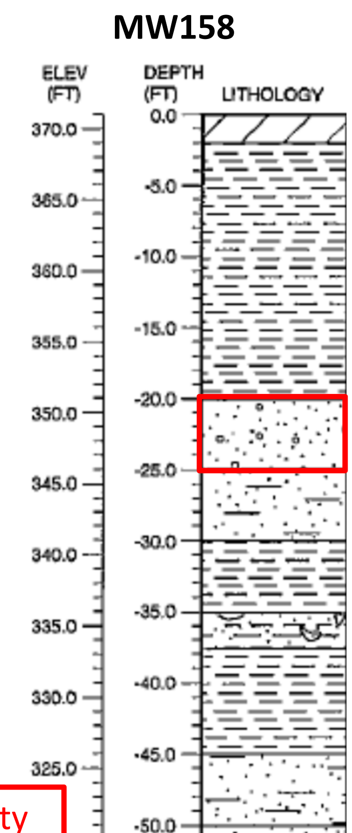


Table 2. Jacob straight-line method of analysis for hydraulic conductivity for the shallow sand and gravel unit at SWMU 91.

Piezometer or Well	Transect Direction	Drawdown Log Cycle (ft)	Transmissivity [A] (ft²/min)	Hydraulic Conductivity[B] (ft/min)	Hydraulic Conductivity[B] (cm/sec)
PE 01 & PE 02	East	0.86	3.63×10^{-5}	7.28×10^{-6}	3.70×10^{-6}
PW 01 & PW 02	West	0.85	3.68×10^{-5}	7.36×10^{-6}	3.74×10^{-6}
PN 01, PN02,	North	0.29	1.08×10^{-4}	2.16×10^{-5}	1.10×10^{-5}
PS 01 & PS02	South	0.08	3.91×10^{-4}	7.72×10^{-5}	3.97×10^{-5}

[A] Transmissivity or T= (2.3 x Q)/(4 x 3.14 x s) with Q or discharge = 1.71×10^{-4} ft³/min
[B] Hydraulic conductivity = T/ thickness of the unit or 5 ft.

Hydraulic Conductivity of 3.7×10^{-6} to 4×10^{-5} cm/sec

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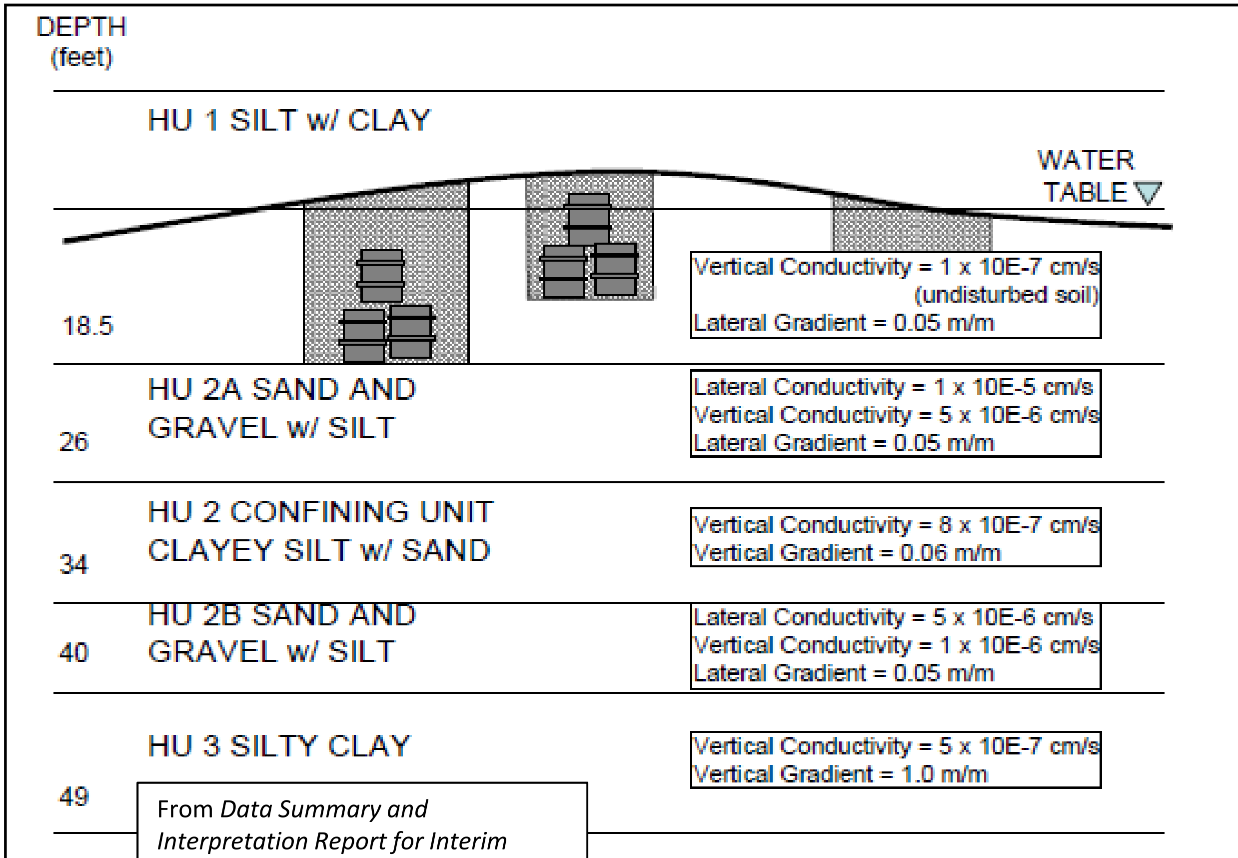
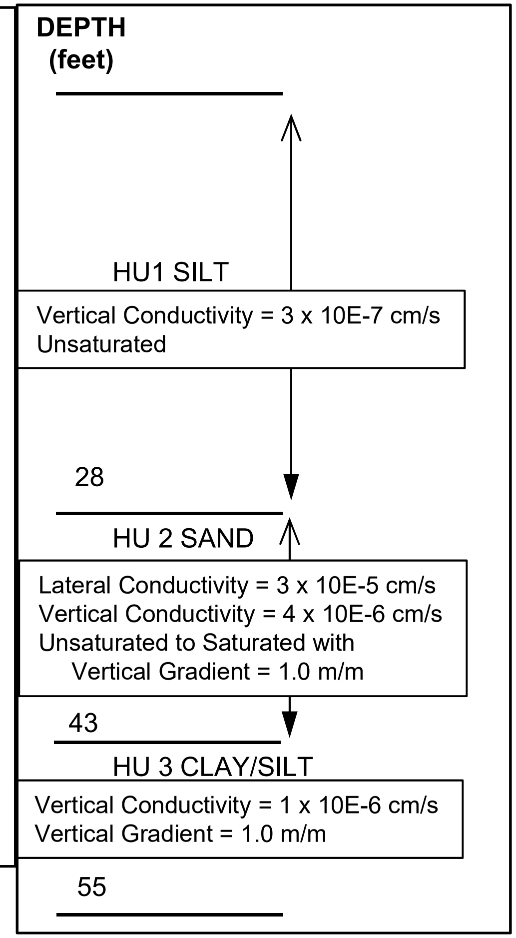
UCRS: Hydraulic Conductivity

SWMU 2



From *Data Summary and Interpretation Report for Interim Remedial Design at Solid Waste Management Unit 2 of Waste Area Grouping 22 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, 1997

C-400



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UCRS: Porosity

Adapted from *Remedial Investigation Report for Waste Area Grouping 6 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, 1999

Sample #	Avg Depth	HU	Soil Texture	Porosity (%)	Representative Member
400210SA010	12	1	SILT with little clay	32	
400208SA010	12.25	1	SILT with little clay	33	
026001SA010	10	1	sandy SILT with little clay	35	SILT with ~35% porosity
400038SA010	7.25	1	--	36	
400212SA010	8.25	1	silty CLAY	37	
400036SA010	8.25	1	SILT with some clay	45	
400212SA030	28.25	~~3~~	SILT with some sand and little clay	25	
400038SA045	47.25	2	SAND with some clay and little silt	30	
400207SA045	48	2	SAND with little clay	35	
400036SA030	21	2	GRAVEL with little clay	38	SAND with ~39% porosity
400038SA030	27.25	2	SAND with some silt and little clay	40	
400036SA045	45	2	SAND with some clay and little silt	40	
400208SA045	47	2	SAND with little silt and clay	47	
400210SA045	52	3	sandy SILT with some clay	33	CLAY/SILT with ~36% porosity
026001SA045	44	3	sandy CLAY with some silt	38	

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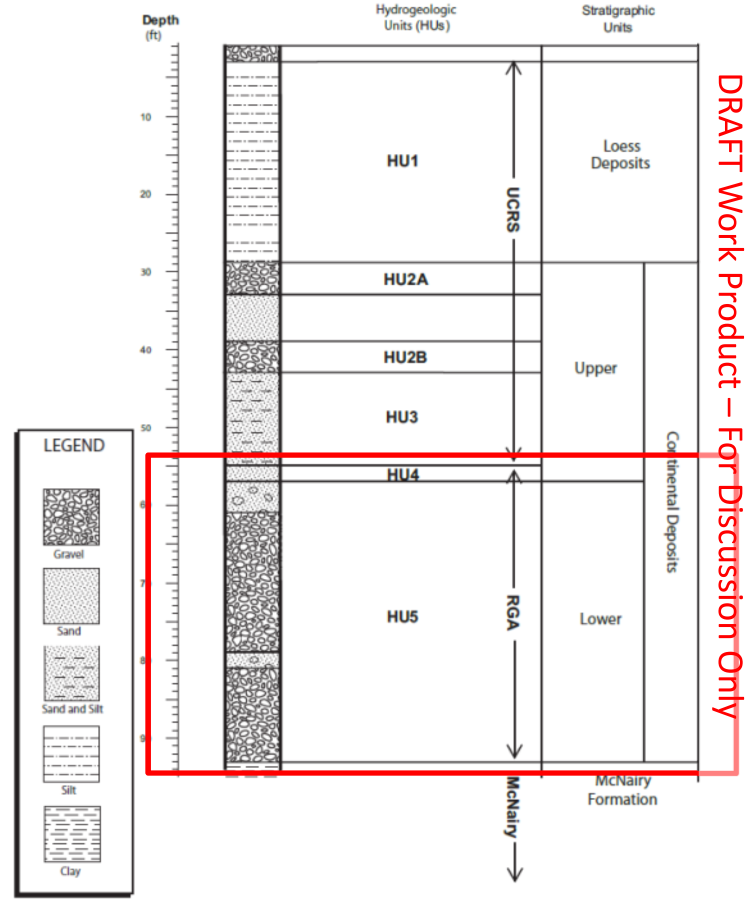
RGA: Regional Gravel Aquifer
- Paducah-specific: named for local function

- Deep (54 – 85 ft depth) thin horizon of lacustrine-facies sand overlying braided stream deposits of ancestral Tennessee River, under the gaseous diffusion plant and extending north to the Ohio River
- Consists of (from top to bottom – C-400 area):
  - 54 – 57 ft: **HU4** (laminated to thin-bedded sand – defined by iron/manganese staining - poorly graded, fine sand horizon, locally present)
  - 57 – 93 ft: **HU5** (weakly bedded deposits of gravelly sand and sandy gravel)



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RGA Continued

HU4 (Fine Sand):

- Intermittently present
- ~3 - 5 ft thick beneath C-400
- High horizontal hydraulic conductivity
- Continuously water saturated beneath C-400

HU5 (Sand and Gravel):

- Thick, continuous, near-massive deposit
- Commonly 20 to 30 ft thick
- High hydraulic conductivity
- Continuously water saturated

Primary hydraulic function: **transmit water north towards Ohio River**

Underlying McNairy Formation (fine sands and silts) forms lower confining layer to the RGA

- Vertical downward gradient results in limited downward flow into McNairy under gaseous diffusion plant

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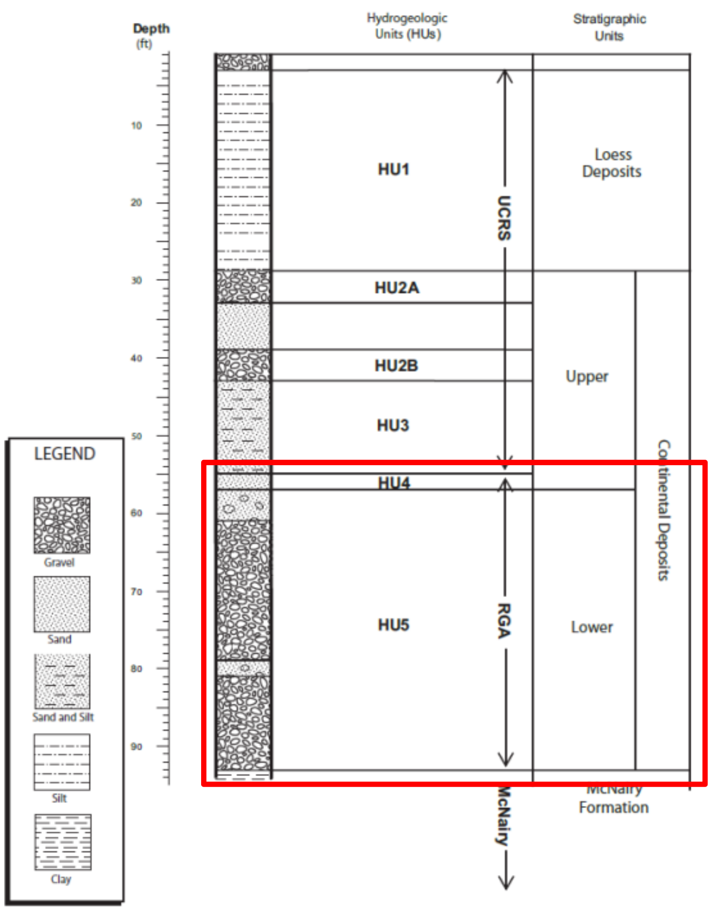
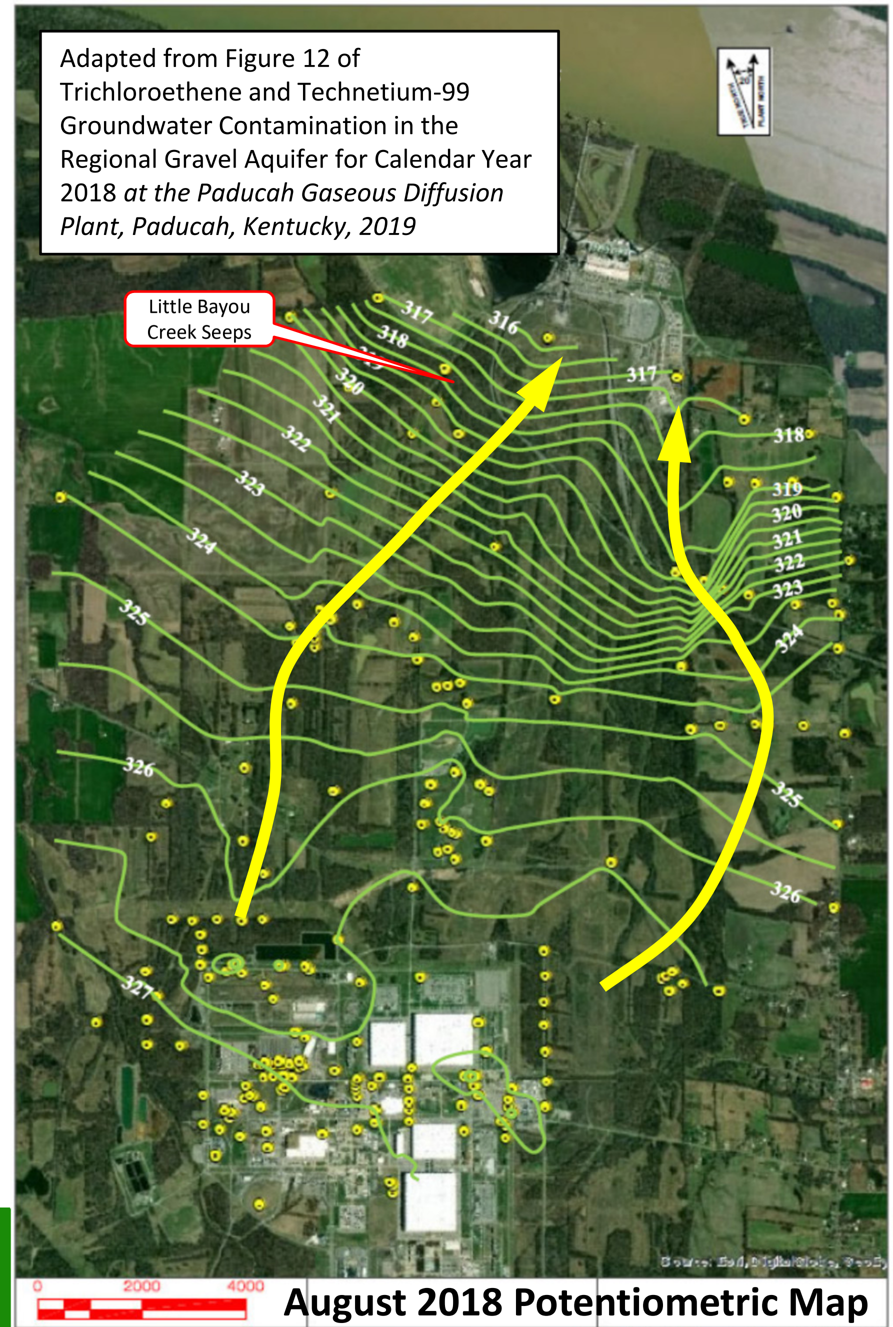
RGA (HU4 & HU5): Potentiometric Surface





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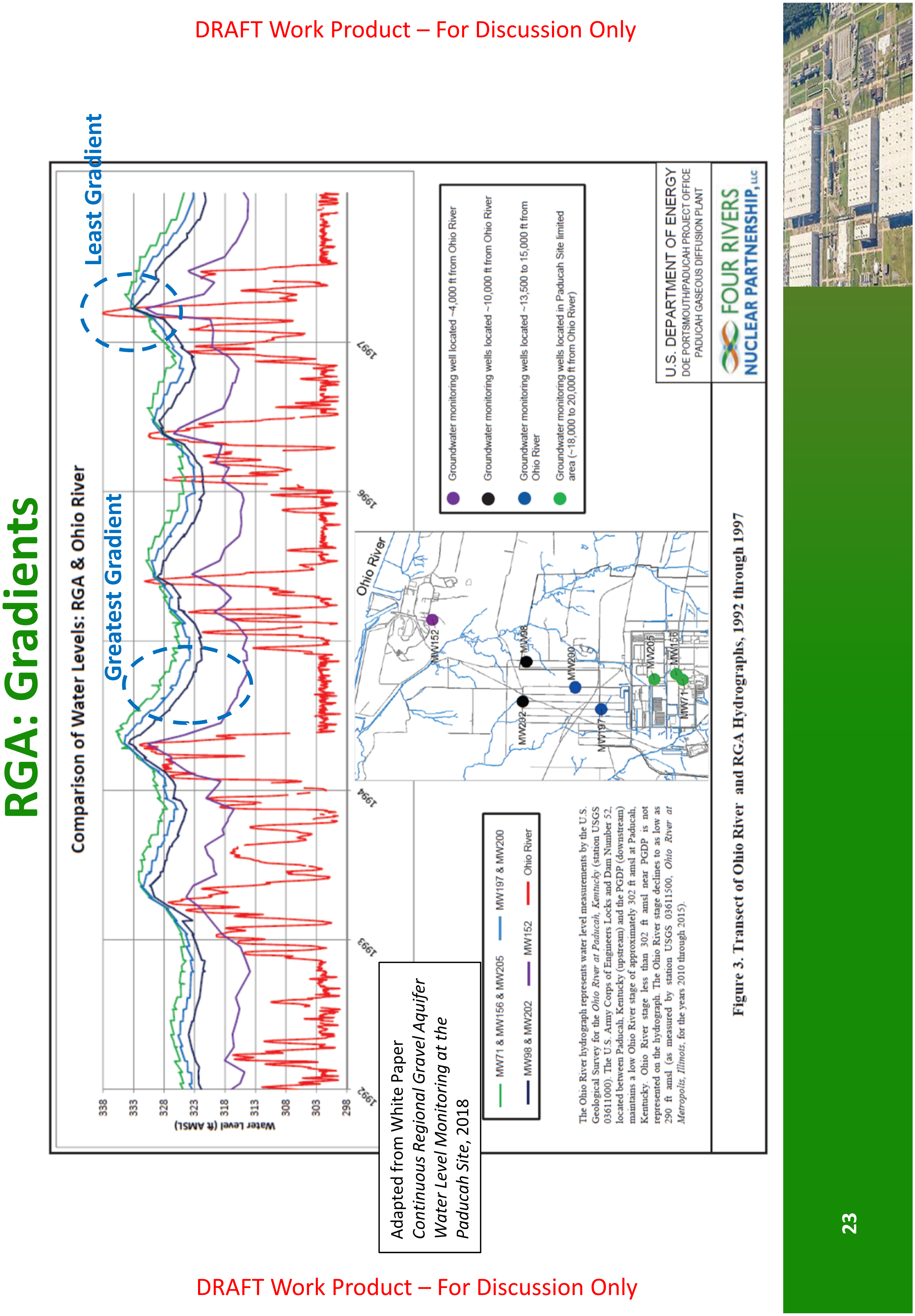
RGA: Gradients
Comparison of Water Levels: RGA & Ohio River
Least Gradient
Greatest Gradient
Water Level (ft AMSL)
338
333
328
323
318
313
308
303
298
1992
1993
1994
1996
1997
MW71 & MW156 & MW205
MW197 & MW200
MW98 & MW202
MW152
Ohio River
Ohio River
MW152
MW98
MW200
MW205
MW156
MW202
MW197
MW71
Groundwater monitoring well located ~4,000 ft from Ohio River
Groundwater monitoring wells located ~10,000 ft from Ohio River
Groundwater monitoring wells located ~13,500 to 15,000 ft from Ohio River
Groundwater monitoring wells located in Paducah Site limited area (~18,000 to 20,000 ft from Ohio River)
The Ohio River hydrograph represents water level measurements by the U.S. Geological Survey for the Ohio River at Paducah, Kentucky (station USGS 03611000). The U.S. Army Corps of Engineers Locks and Dam Number 52, located between Paducah, Kentucky (upstream) and the PGDP (downstream) maintains a low Ohio River stage of approximately 302 ft amsl at Paducah, Kentucky. Ohio River stage less than 302 ft amsl near PGDP is not represented on the hydrograph. The Ohio River stage declines to as low as 290 ft amsl (as measured by station USGS 03611500, Ohio River at Metropolis, Illinois, for the years 2010 through 2015).
Figure 3. Transect of Ohio River and RGA Hydrographs, 1992 through 1997
U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT
FOUR RIVERS NUCLEAR PARTNERSHIP, LLC
Adapted from White Paper
Continuous Regional Gravel Aquifer Water Level Monitoring at the Paducah Site, 2018
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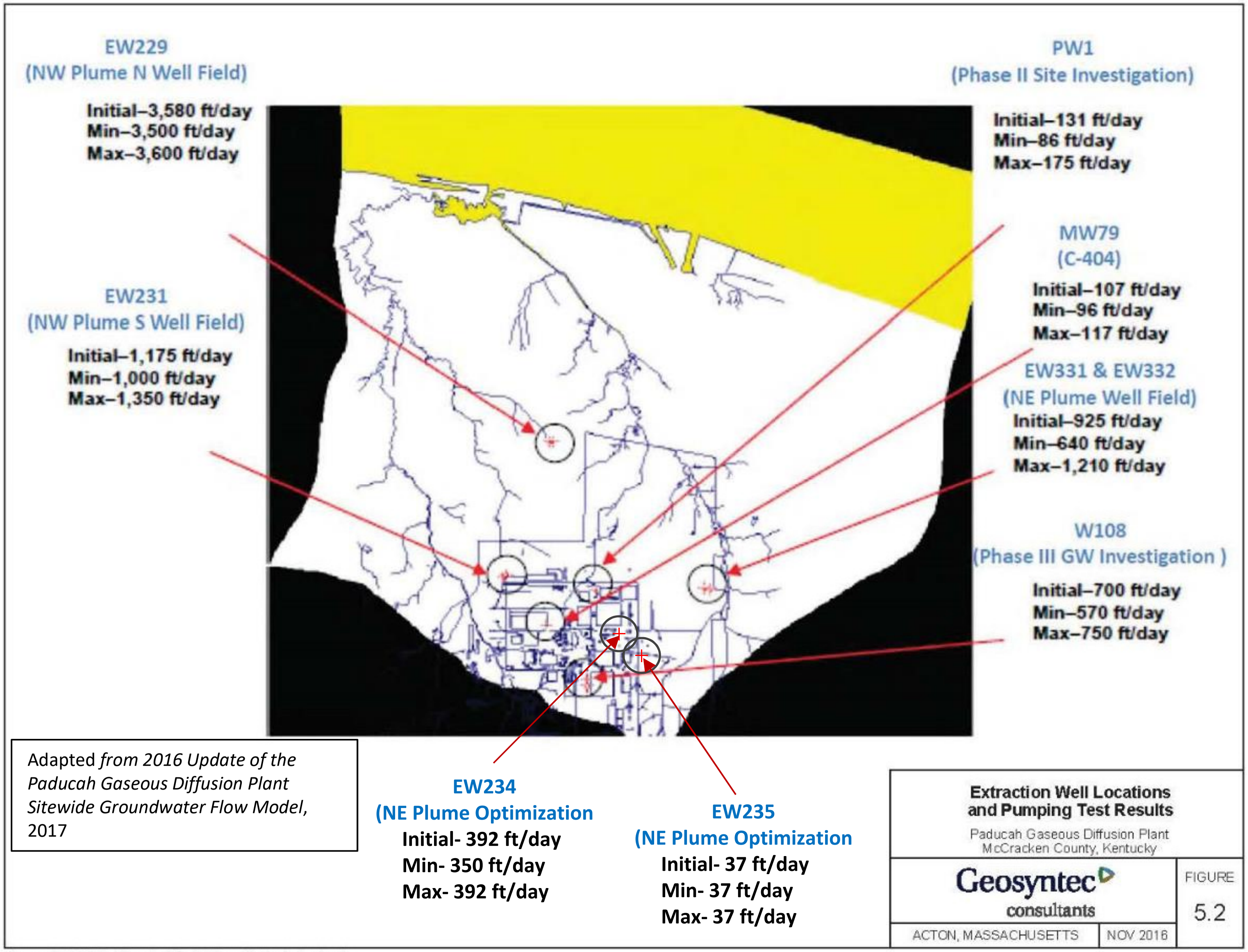
RGA: Hydraulic Conductivity



Source: DOE, 2010; Figure 6.1 (the 2008 model domain is shown)

RGA: Porosity

Sample #	Depth (ft)	HU	Soil Texture	Porosity (%)	Representative Member
400208SA060	56 - 58	4	**SAND with little clay**	31	Sand with porosity of ~34%
026001SA056	56*	4	**SAND**	36	
400210SA060	57 - 62	5	**Gravel with little sand and silt**	27	Gravel with some sand and porosity of ~38%
400036SA080	79*	5	**GRAVEL with some sand and little silt and clay**	32	
400210SA070	62 - 67	5	**Gravel with little sand and silt**	34	
400036SA060	62*	5	**GRAVEL with some silt and little sand**	35	
400210SA090	92 - 92.5*	5	**sandy Gravel with little clay and silt**	36	
400038SA060	61 - 63	5	**GRAVEL with little sand and clay**	37	
400210SA080	79.5 - 80*	5	**Gravel with little sand and silt**	37	
400036SA070	69*	5	**GRAVEL with some sand and silt**	38	
400212SA080	77 - 79	5	**GRAVEL with some sand and little silt**	38	
400212SA090	87 - 89	5	**Gravel with some sand and little silt**	38	
400208SA070	66 - 68	5	**GRAVEL with little sand**	39	
400036SA090	91*	5	**SAND**	39	
400212SA070	67 - 69	5	GRAVEL with little sand and silt	40	
026001SA070	67 - 72*	5	GRAVEL with little silt	41	
026001SA080	77 - 82*	5	GRAVEL with little silt	41	
400038SA070	71 - 73	5	**GRAVEL with little sand and silt**	42	
400207SA080	77 - 79	5	**GRAVEL with some sand and little silt**	44	

* depth of associated analytical sample

Adapted from *Remedial Investigation Report for Waste Area Grouping 6 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, 1999

Average HU4: **34**
Average HU5: **38**
Median HU5: **38**

The Paducah Site groundwater flow model assumes $n_e = 0.30$

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2016 Update of Paducah Site Groundwater Flow Model

Primary Model Revisions:

- Optimized calibration periods, building on calibrations performed prior to 2016;
- Converted the lower reaches of Bayou and Little Bayou Creeks and the Ohio River from drain to river boundary conditions;
- Included groundwater flow originating upgradient of the model from the Terrace Gravel;
- Revised the southern model boundary at the limit of the RGA;
- Updated anthropogenic recharge zonation in the plant area

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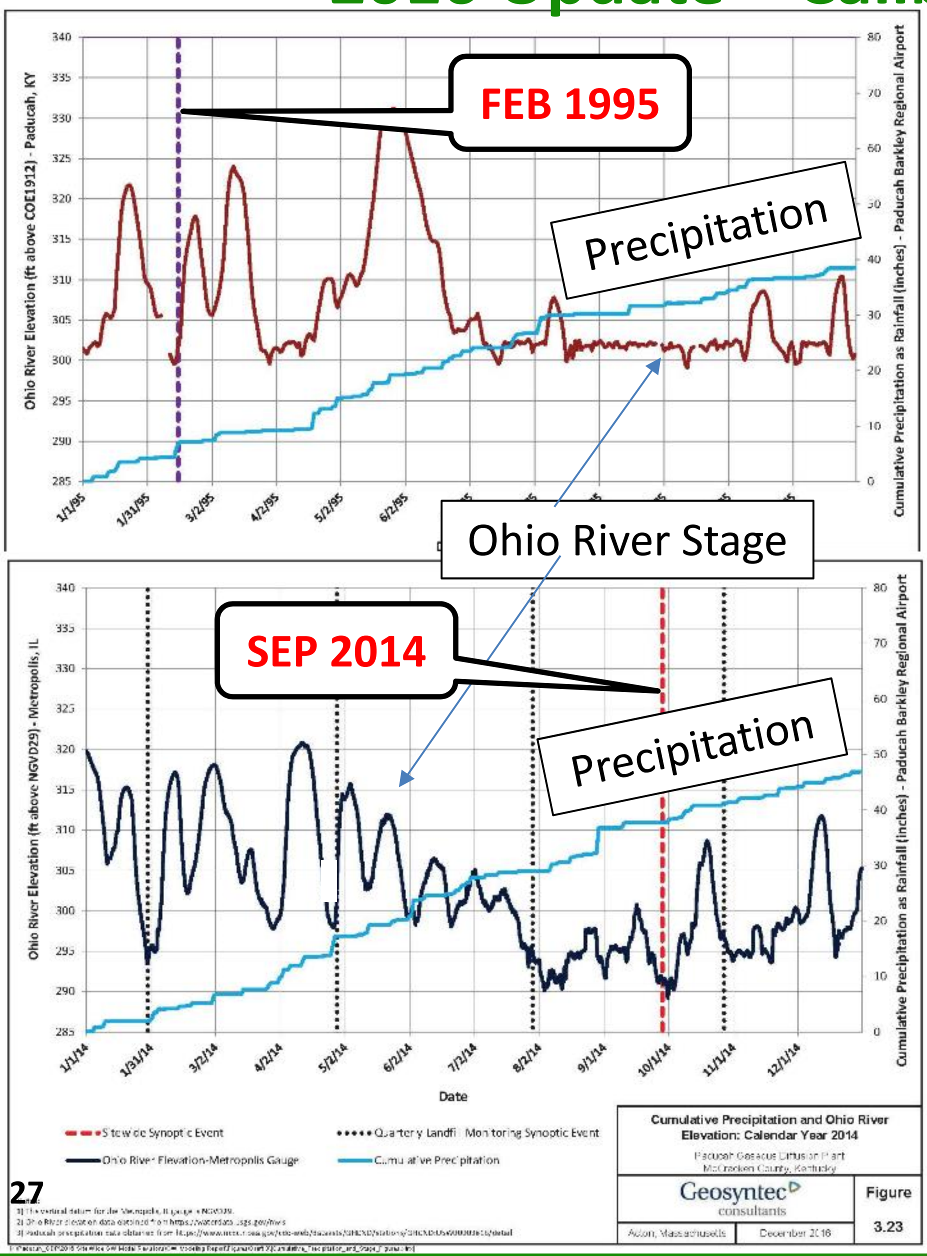
2016 Update – Calibration Periods



Calibrated to **2 Stress Periods**:

- **February 1995** – pre pumping period
  - NW Plume Operations started in August
- **September 2014** – steady state period

Chosen based on:

- Available groundwater elevations
- Precipitation
- Ohio River stage

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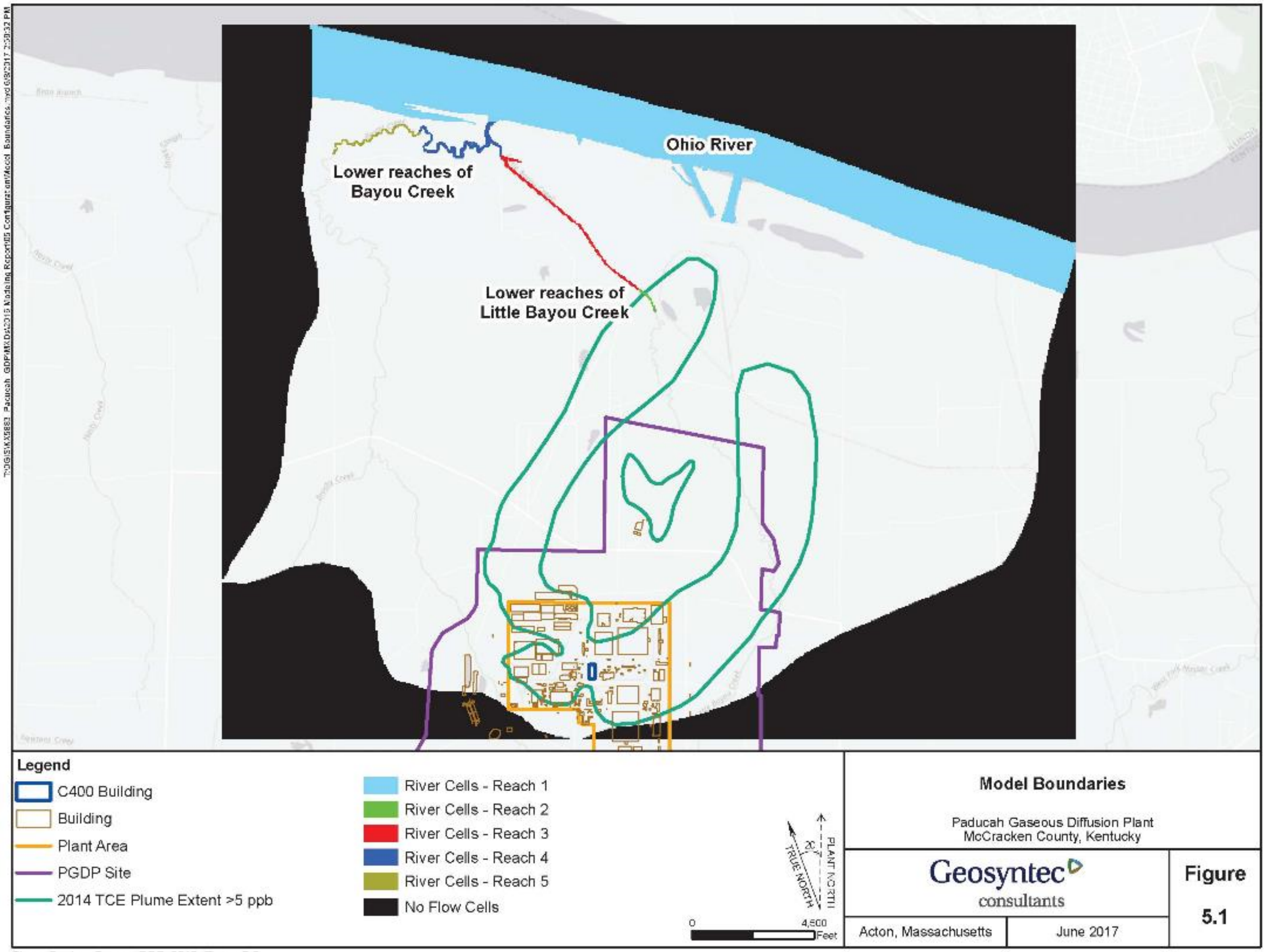
2016 Update – River Boundary Conditions



Plume Contour Source: DOE, 2015; Figure C.2

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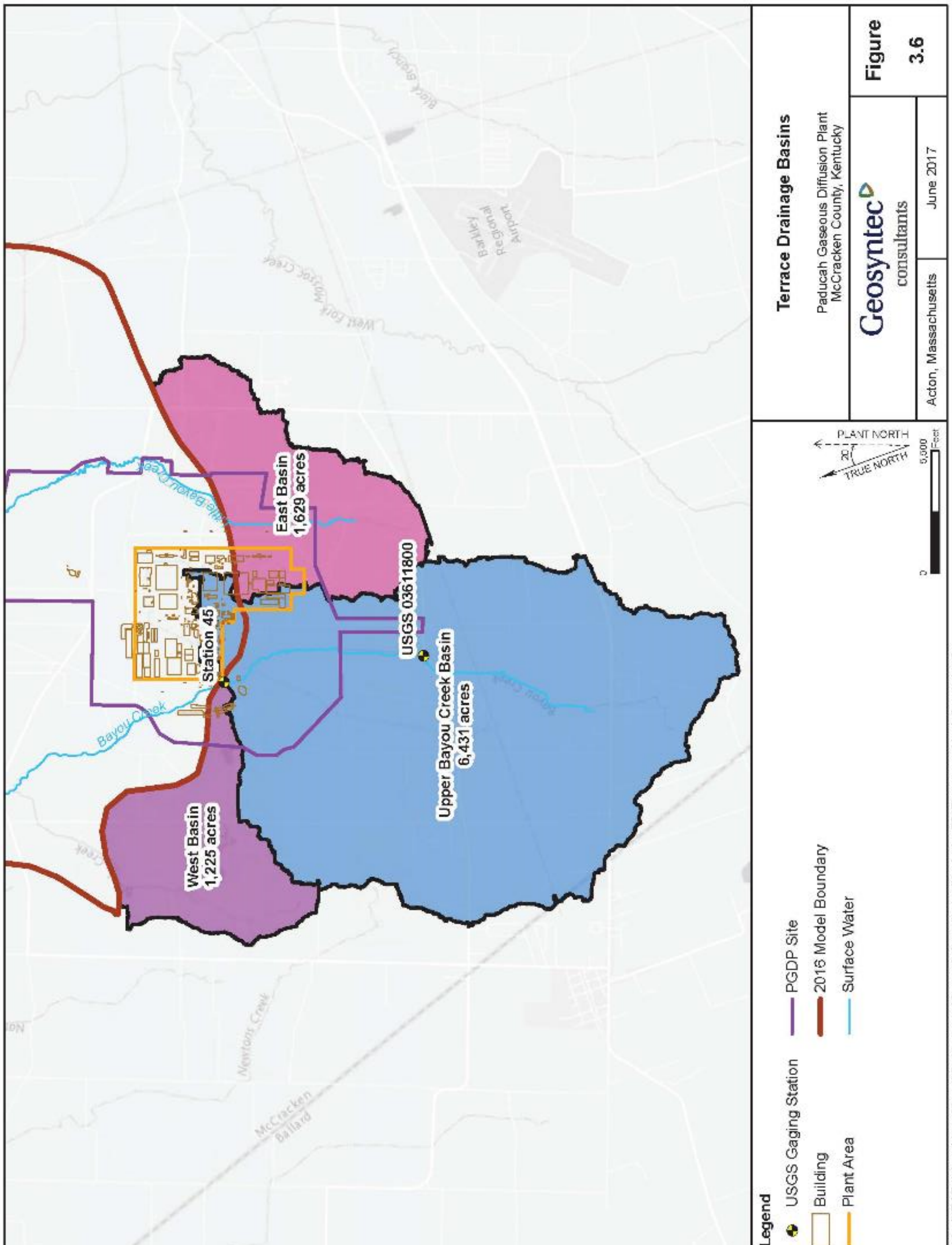
2016 Update – Terrace Gravel Recharge



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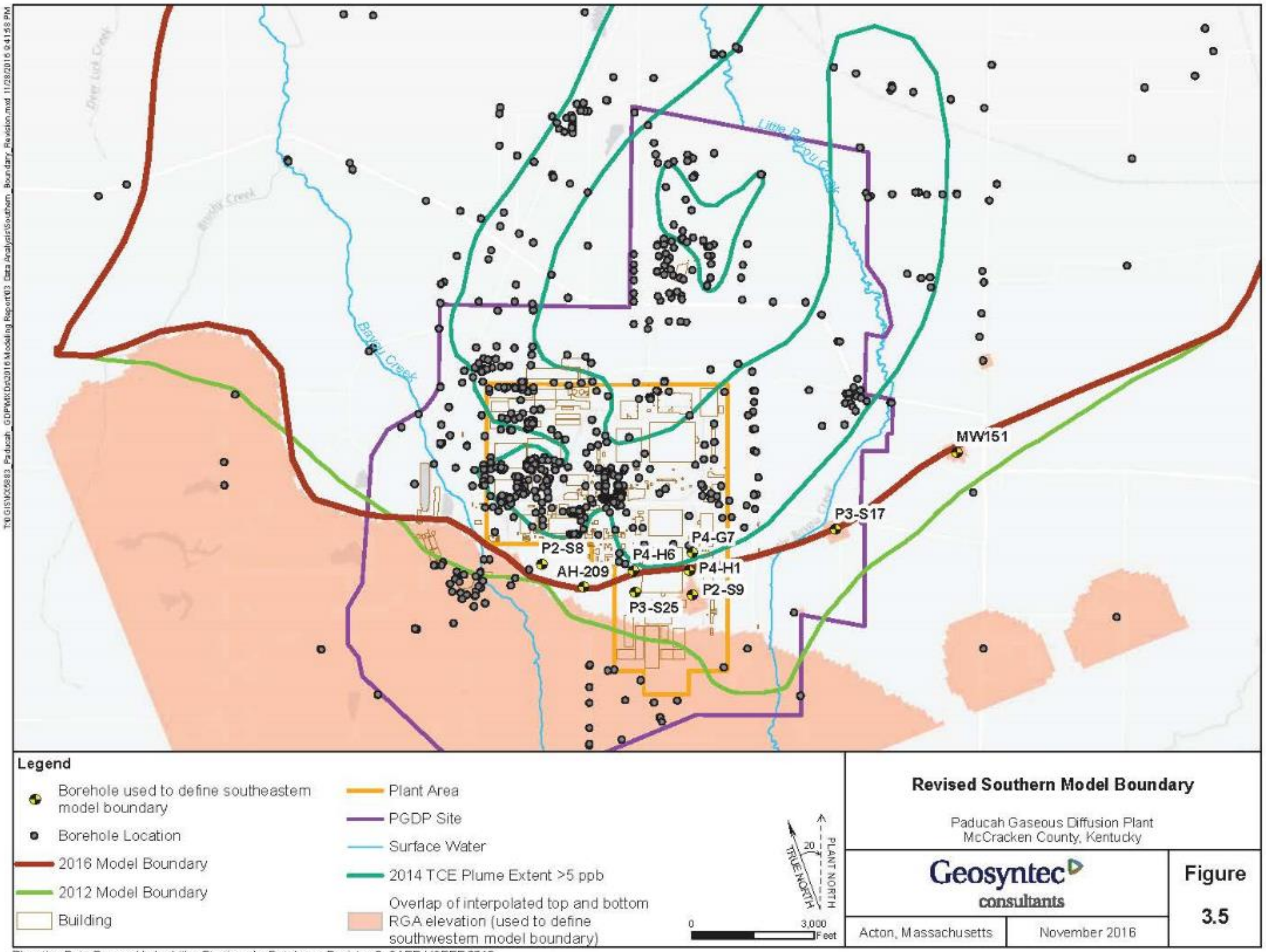
2016 Update – Southern Model Boundary



Elevation Data Source: Hydro-Litho-Stratigraphy Database, Revision 8, CAER KCREE 2016
Plume Contour Source: DOE, 2015a; Figure C.2

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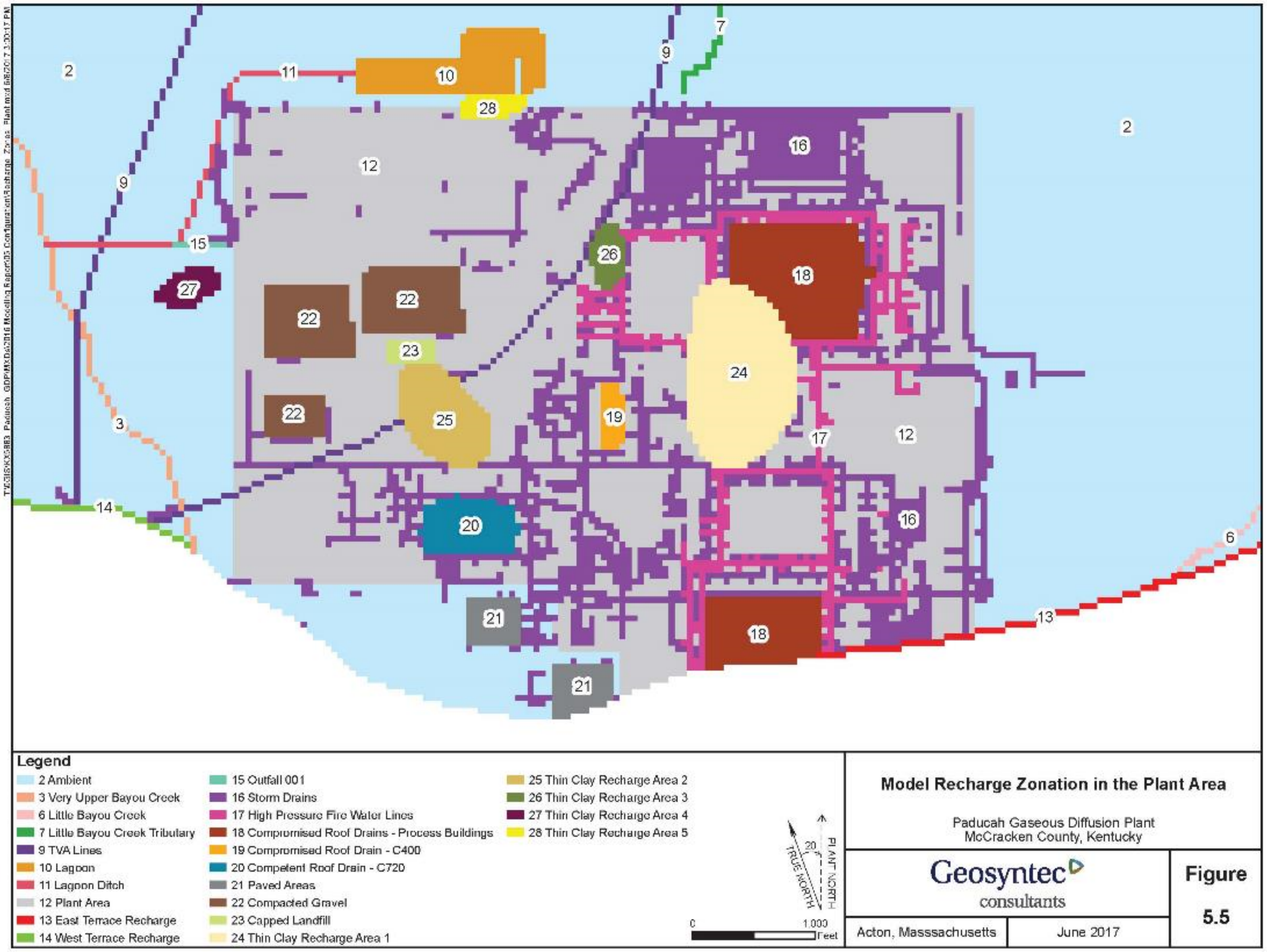
2016 Update – Anthropogenic Recharge Zonation



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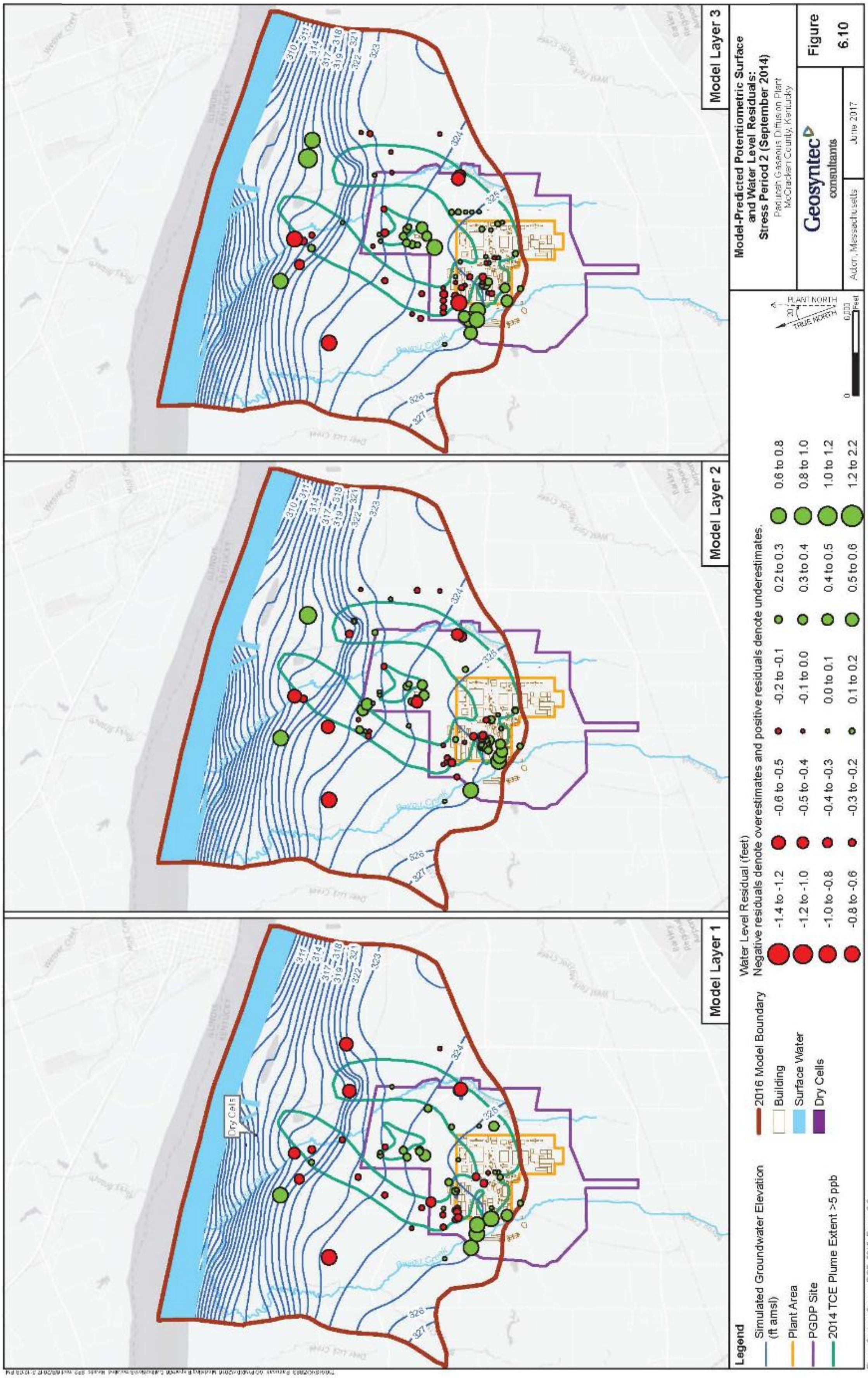
2016 Update – Water Level Match



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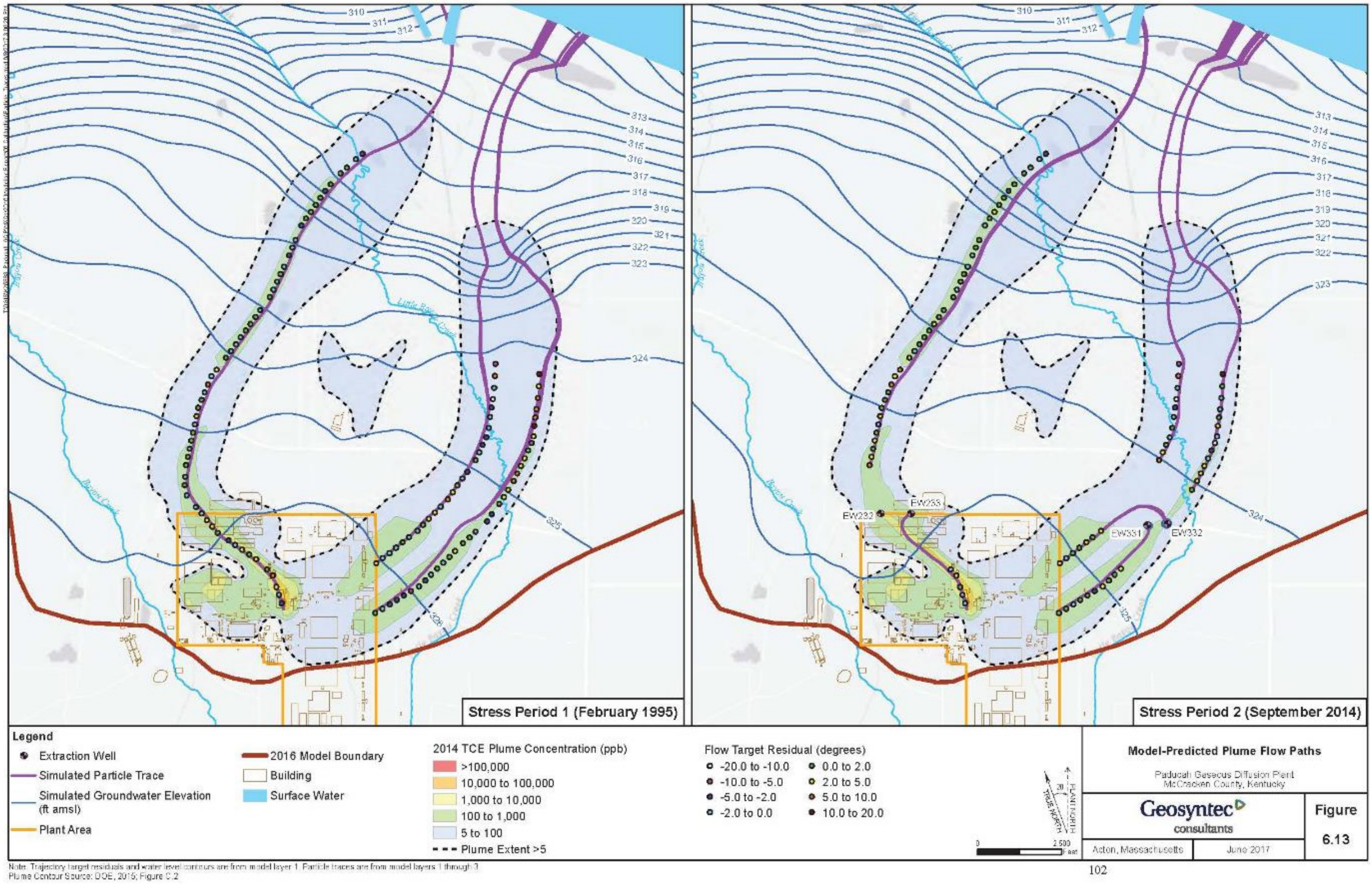
2016 Update – Plume Trajectory Match



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SUMMARY

- UCRS consists of 3 HU members:
    - HU1: loess
    - HU2: sand
    - HU3: clay/silt
- Groundwater flow in UCRS is primarily vertical.
- RGA consists of 2 HU members
    - HU4: sand
    - HU5: gravelly sand
- The RGA is the primary route of contaminated groundwater flow offsite.
- The RGA flows north from the plant towards the Ohio River.
- The 2016 Update of the Groundwater Flow Model reasonably reflects the known hydraulic properties of the UCRS and the RGA.

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Presentation Schedule

- ✓ **Geology (January 8, 2020)**
- ✓ **Paducah Site Groundwater, "Big Picture" (April 8, 2020)**
- ➢ **Paducah Site Groundwater, Continued (July 15, 2020)**
- **Paducah Site Groundwater, Contamination (October 7, 2020)**
  - History
  - "Big Picture" Groundwater Investigations
  - Monitoring Network
  - Plume Maps
  - Remedial/Removal Actions and Treatability Studies
  - Other COPCs
  - Groundwater Strategy
  - Earthcon

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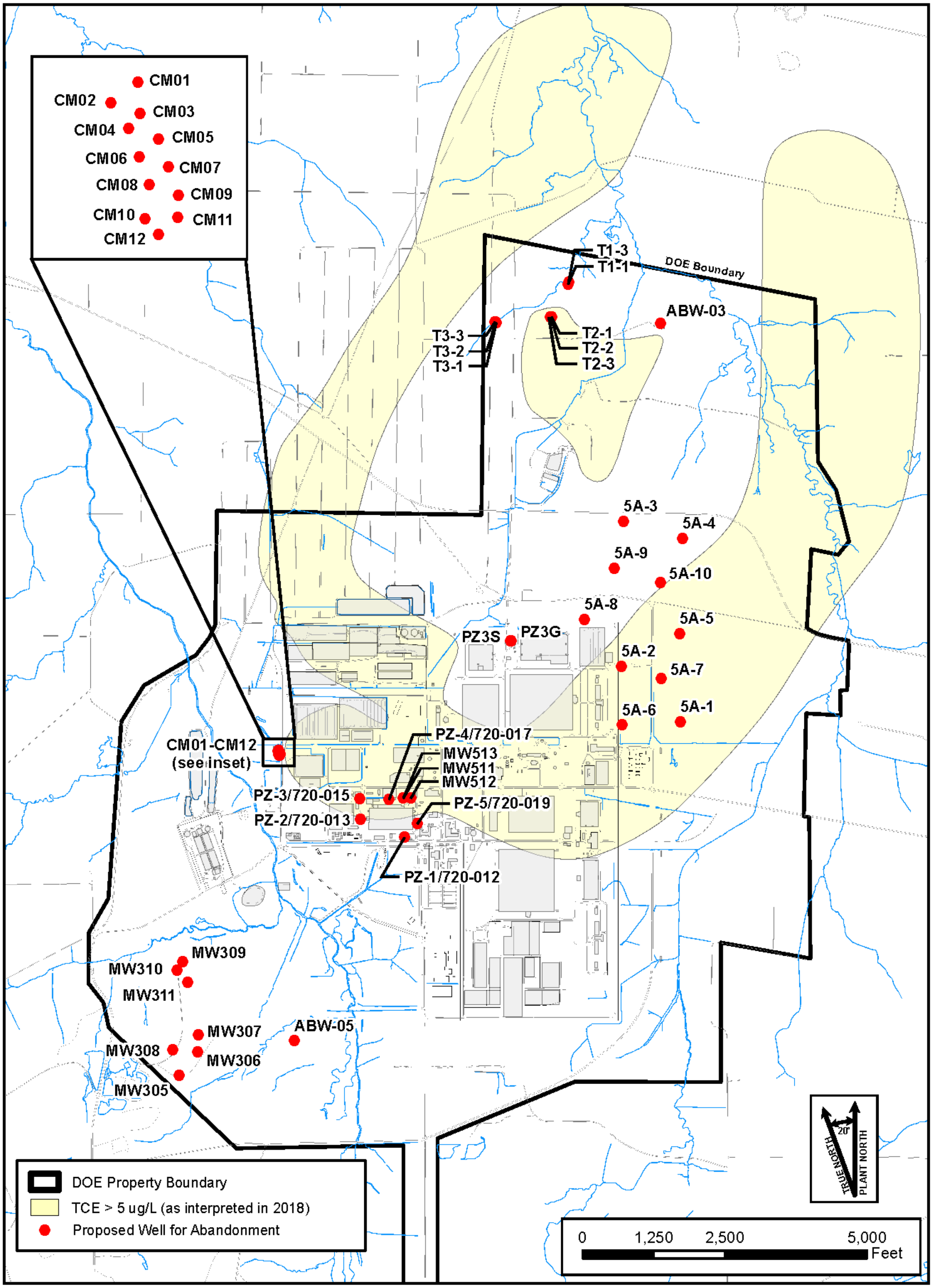
Attachment 4

2020 Well Abandonment Listing

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		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
MW 307	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

* Additional well/piezometer to be abandoned.



Proposed Well Abandonment

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2/24/2020