Pennsylvania Department of Environmental Protection

Remedial Alternatives Analysis

GTAC 7-1-343 – Nockamixon TCE Site

Nockamixon Township, Bucks County, Pennsylvania

July 23, 2024

Remedial Alternatives Analysis

GTAC 7-1-343 – Nockamixon TCE Site
Nockamixon Township, Bucks County, Pennsylvania

Prepared for:
Mr. Dustin A. Armstrong
Pennsylvania Department of Environmental Protection
Hazardous Sites Cleanup Program
Southeast Regional Office
2 East Main Street
Norristown, PA 19401

Prepared by:
Groundwater & Environmental Services, Inc.
440 Creamery Way Suite 500
Exton, PA 19341
TEL: 800-426-9871

July 23, 2024

Timothy Uhler
Principal Project Manager

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
HEATHER MARIE KILTS
ENGINEER
NO. PE081133

Heather Kilts, P.E.
Principal Engineer

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
FRANK JOSEPH DIGNAZIO
GEOLOGIST
No. 003920

Frank DiGnazio, P.G.
Principal Hydrogeologist

By affixing my seal to this document, I am certifying that to the best of my knowledge the information is true and correct. I further certify that I am licensed to practice in the Commonwealth of Pennsylvania and that it is within my professional expertise to verify the correctness of the information.

Table of Contents

1 Introduction 1
1.1 Site Location and Description 1
1.2 Site- Specific Geology and Hydrogeology 2
2 Site Characterization and Remedial Investigation Activities 3
2.1 Site Characterization Activities 3
2.2 DEP Response Actions 4
2.3 Remedial Investigations and Findings 4
2.3.1 Fracture Trace Study 4
2.3.2 Surficial Geophysical Investigation and Results 5
2.3.3 Additional Site Inspection and Initial Surface Water Sampling 6
2.3.4 Surface Water Investigation and Sampling 7
2.3.5 Soil/Rock Core Boring Locations 7
2.3.6 Downhole Geophysics 9
2.3.7 Rock Core Groundwater Sampling 9
2.3.8 Rock Core Downhole Camera Inspection 10
2.4 Nature and Extent of Release 10
2.5 Constituents of Concern 11
2.6 Exposure Pathway Assessment 11
2.6.1 Air Exposure Pathways 11
2.6.2 Groundwater Exposure Pathways 12
2.6.3 Soil Exposure Pathways 12
2.6.4 Surface Water Exposure Pathways 12
2.6.5 Construction Activity Exposure Pathways 12
2.7 Conceptual Site Model 13
3 Remedial Action Objectives 14
3.1 Current Site Characteristics 14
3.2 Applicable or Relevant, and Appropriate Requirements 15
3.3 Remediation Goals 15
3.4 Potentially Applicable Technologies 16
3.5 Evaluation Criteria 17
4 Remedial Alternative Assessment 18

4.1 Source Area Soils 18
4.1.1 No Action 19
4.1.2 Engineering Controls and Institutional Controls 19
4.1.3 Excavation- Off-Site Disposal 19
4.1.4 Excavation- On-Site Treatment 20
4.1.5 Soil Vapor Extraction (SVE) 21
4.1.6 In-Situ Thermal Treatment (ISTT) 22
4.2 Remedial Action Alternatives - Source Area Bedrock Groundwater 23
4.2.1 No Action 24
4.2.2 Engineering Controls and Institutional Controls 24
4.2.3 In-Situ Thermal Treatment (ISTT) 24
4.2.4 In-Situ Chemical Reduction (ISCR) 25
4.2.5 In-Situ Chemical Oxidation 27
4.2.6 Carbon Injection 28
4.2.7 Enhanced Biodegradation 29
4.2.8 Monitored Natural Attenuation 30
4.3 Non-Source Area Bedrock Groundwater 31
4.3.1 No Action 31
4.3.2 Engineering Controls and Institutional Controls 31
4.3.3 Monitored Natural Attenuation 31
5 Evaluation of Alternatives 32
6 Conclusions and Recommendations 33

Figures

Figure 1 Site Location Map
Figure 2 Site Map
Figure 3 Approximate Soil Treatment Areas
Figure 4 Approximate Source Area Bedrock Groundwater Treatment Area

Tables

Table 1 Surface Water Analytical Data Summary
Table 2 Soil - Rock Core Analytical Data Summary
Table 3 Groundwater Analytical Data Summary
Table 4 Point of Entry Treatment System Analytical Data Summary
Table 5 Remedial Alternative Technology Screening
Table 6 -16 Remedial Alternative Cost Estimates

Appendices

Appendix A Advanced Geological Services, Inc. Geophysical Investigation Reports
Appendix B Soil Boring/Rock Core Logs
Appendix C GeoStructures, Inc. Report
Appendix D Waste Disposal Documentation
Appendix E Updated Conceptual Site Model

Acronyms

1,1-DCE	1,1-Dichloroethene
1,4D	1,4-Dioxane
Act 2	Pennsylvania Land Recycling Act
AGS	Advanced Geological Services, Inc.
ARAR	Applicable or Relevant and Appropriate Requirements
bgs	below ground surface
BCHD	Bucks County Health Department
COC	Constituents of Concern
CSM	Conceptual Site Model
CVOC	Chlorinated Volatile Organic Compound
DO	Dissolved Oxygen
DEP	Department of Environmental Protection
EC	Environmental Covenant
ELLE	Eurofins Lancaster Laboratories Environmental
EPA	Environmental Protection Agency
ERD	Enhanced Reductive Dechlorination
ERI	Electrical Resistivity Imaging
FRZ	Fracture Zones
GES	Groundwater & Environmental Services, Inc.
GIS	Geographic Information System
GPS	Global Positioning System
GTAC	General Technical Assistance Contract
HSCA	Hazardous Sites Cleanup Act
IC	Institutional Control
IDW	Investigation Derived Waste
ISCO	In-Situ Chemical Oxidation
ISCR	In-Situ Chemical Reduction
ISTT	In-Situ Thermal Treatment
LiDAR	Light Detection and Ranging
MCL	Maximum Contaminant Level
MDL	Method Detection Limit
MNA	Monitored Natural Attenuation
MSCs	Medium-Specific Concentrations
NAPL	Non-Aqueous Phase Liquid
NPL	National Priority List
OSHA	Occupational Health and Safety Administration
ORP	Oxidation-Reduction Potential
PCE	Tetrachloroethene
POET	Point-of-entry treatment
RAA	Remedial Alternatives Analysis
RAO	Remedial Action Objective
RC	Rock Core
RCS	Requisition for Contractual Services
SAIC	Science Application International Corporation
SHS	Statewide Health Standards

Acronyms (continued)

SWQC	Surface Water Quality Criteria
TOC	Top of Casing
TCE	Trichloroethene
TCH	Thermal Conductive Heating
VI	Vapor Intrusion
VOC	Volatile Organic Compound
ZVI	Zerovalent Iron

1 Introduction

Groundwater & Environmental Services, Inc. (GES) prepared this *Remedial Alternatives Analysis* (RAA) at the request of the Pennsylvania Department of Environmental Protection (DEP) under General Technical Assistance Contract (GTAC) No. 4000023222 in response to Requisition for Contractual Services (RCS), Requisition No. GTAC 7-1-343. The RCS and scope of work were issued to develop and evaluate alternatives and cost estimates for remedial actions at the Nockamixon TCE Site (Site), located in Nockamixon Township, Bucks County, Pennsylvania.

1.1 Site Location and Description

The Site area is rural and comprises undeveloped land, farmland, residences, and businesses, including multiple residential and commercial properties located along Durham Road, Easton Road, Cord Way, Mountain View Drive, Tower Road, Brennan Road, and Park Drive West in Nockamixon Township, Bucks County, Pennsylvania. The source of the groundwater contaminant plume has been identified as a former 77.2-acre farm (Schulberger Farm) located on Brennan Road. A school is located on Durham Road and a quarry is located east of Easton Road. Nockamixon State Park is located to the west and southwest, and the Revere Chemical National Priority List (NPL) Site is located northeast of the Site. A Site Location Map is included as **Figure 1** and a Site Map is included as **Figure 2**.

Groundwater contamination was initially discovered at the Site in 2002 when public water supply sampling was conducted at a restaurant located at the intersection of Durham Road and Easton Road by the Bucks County Health Department (BCHD). Laboratory data indicated that trichloroethene (TCE) was detected in the restaurant supply well. During subsequent potable well sampling conducted by DEP, additional contaminated wells were identified on Durham Road, Easton Road, Cord Way, Mountain View Drive, Tower Road, Brennan Road, and Park Drive West. To date, more than 100 potable wells have been sampled, with 45 of those wells exceeding the Maximum Contaminant Level (MCL) of 5 micrograms per liter (µg/L) for TCE. In addition to TCE, tetrachloroethene (PCE), 1,1-dichloroethene (1,1-DCE), and 1,4-dioxane (1,4D) have also been detected above their respective MCLs or PA Residential Used Aquifer Medium Specific Concentrations (MSCs) in at least one potable well. DEP funded the installation of point-of-entry treatment (POET) systems for 42 of the private well water supplies with concentrations of contaminants which exceeded the MCLs.

Based upon groundwater sampling results, aerial photography analysis, and other investigations, the former Schulberger Farm has been identified as the source of contamination. The 77.2-acre Schulberger Farm, which was subdivided into nine parcels in 1978, housed drums of unknown contents which were removed from the Site in 1980. The source area primarily includes two drum storage areas: one in the north area of the former farm and one in the south. In addition to the drums, evidence suggests that other wastes may have been deposited or buried at the Site. Soil sampling, passive soil gas screening, and active soil gas screening investigations revealed elevated concentrations of chlorinated solvents in the areas where the former drums had been stored.

1.2 Site- Specific Geology and Hydrogeology

The local geologic and hydrogeologic conditions have been examined in a number of site investigation and remedial investigation activities and are described as follows.

Local Geologic Conditions

The work of previous consultants (summarized in the investigation reports listed in **Section 2.1**) described the geology at the Site as comprising bedrock of the Triassic to Jurassic-aged Brunswick and Lockatong Formations overlain by unconsolidated soils. The unconsolidated soils were identified as the Reaville channery silt loam, which is classified as farmland of statewide importance and is characterized as somewhat poorly drained with a very high potential for runoff.

Bedrock at the Site is relatively shallow, particularly in the vicinity of the former drum storage areas. Measured depths to bedrock (soil thicknesses) at the Site have been observed to range from one foot below ground surface (bgs) to 14.5 feet bgs, with an average of 5.8 feet bgs.

Based on a previous assessment completed by GES and included in the Conceptual Site Model (CSM) originally submitted with the Final Remedial Investigation Work Plan and updated in this RAA for the Site, the top of bedrock is observed to dip to the southwest in the northern project area in the vicinity of the suspected source areas and to the west further south in the project area. It should be noted that the north former drum storage area is located on the western edge of the bedrock high, and the south former drum storage area is located slightly down dip from the north drum storage area. A geologic map, published by the Pennsylvania Geological Survey was reviewed to assess bedrock structure in the area. Bedrock strike and dip measurements provided on this Pennsylvania Geological Survey map for the Site vicinity range from a north-south strike with a westerly dip direction to a northwest-southeast strike with a southwesterly dip direction, which are consistent with the observed structure contours for the Site vicinity. This bedrock structure appears to strongly influence groundwater flow and contaminant plume distributions in groundwater.

Local Hydrogeologic Conditions

Unconsolidated soils do not contain a water-bearing zone. At times of heavy recharge, these materials are wet, as water slowly percolates and recharges the bedrock aquifer; however, there is no true overburden aquifer present at the Site. The water table only begins at a significant depth within the bedrock unit.

The Brunswick and Lockatong Formation aquifers have been described by Morin et. al (2000) in a study conducted on seven wells in nearby Lansdale, Pennsylvania, as follows:

The Brunswick Group and the underlying Lockatong Formation are composed of lithified Mesozoic sediments that constitute part of the Newark Basin in southeastern Pennsylvania. These fractured rocks form an important regional aquifer that consists of gradational sequences of shale, siltstone, and sandstone, with fluid transport occurring primarily in fractures.

Additionally, Inners (1980) describes development of secondary porosity features in these rock units in nearby Nockamixon State Park, in the following:

Joints, or naturally occurring, mostly planar fractures, are extremely well developed in the rocks underlying Nockamixon Park. Several distinct groups, consisting of near-vertical fractures that repeat at regular intervals, are present at most outcrops….. Generally, they are spaced less than 12 inches apart in the sedimentary rocks and hornfels and 12 to 48 inches apart in the diabase.

From this information, it is expected that groundwater flow in the bedrock aquifer will be dominated by movement through well-developed and regularly-spaced secondary porosity features, including movement along bedding plane partitions and through joint development. Given that this secondary porosity is well developed and regularly spaced, it is assumed that plume movement in the aquifer will behave similarly to a homogenous aquifer, but with the possibility for some deflections of plume movement associated with the orientation of the secondary porosity features. Irregular plume movement and distribution like what would be associated with a karst environment is not expected here.

Groundwater in the vicinity of the Site has been investigated through the installation of a series of bedrock monitoring wells at 12 locations. A number of the locations include nested well pairs to separate the upper and lower portion of the aquifer. Monitoring wells completed in the shallower upper zone of the bedrock aquifer have depths ranging from 119-196 feet bgs, with an average depth of 149 feet bgs. Monitoring wells completed in the deeper portion of the bedrock aquifer or left as open holes have depths ranging from 187-300 feet bgs, with an average depth of 250 feet bgs.

Additional details related to Site hydrogeology are included in the CSM originally included in the Final Remedial Investigation Work Plan, and updated in this RAA report as detailed in **Section 3**.

2 Site Characterization and Remedial Investigation Activities

Site characterization activities were conducted by multiple firms at the Site from 2009-2020 under the GTAC. All media were determined to be adequately characterized in the data collected during this period. In support of the development of this RAA, additional remedial investigation activities were conducted at the Site from 2021-2023. The site characterization activities and the remedial investigation activities are discussed in more detail in the following sections.

2.1 Site Characterization Activities

Preliminary investigation and site characterization activities were conducted under GTAC at the Site from 2009-2020. Multiple parties, including Science Application International Corporation (SAIC)/Leidos Engineering, LLC (Leidos), TetraTech, Inc., and DEP, performed the site characterization to assess soils, groundwater, and/or indoor air quality at the Site. The site characterization investigation activities and results were detailed in a series of reports as follows:

- Preliminary Investigation Report (July 2010) – SAIC (The Benham Companies, LLC)
- Project Investigation Report (March 2014) - Leidos
- Addendum to March 2014 Project Investigation Reports (June 2014) – Leidos
- Site Characterization Report (December 2015) – TetraTech, Inc.

- Site Characterization Report Addendum 1 (February 2020) – TetraTech, Inc.

The results of the site characterization activities identified the primary constituents of concern (COCs) as chlorinated volatile organic compounds (CVOCs) detected in all media sampled (i.e., groundwater, potable water, soils, vapor).

2.2 DEP Response Actions

Since initiating response action at the Site in September 2009, DEP has conducted two HSCA Interim Response actions to address human health exposure pathways of concern. These actions to address concentrations of COCs in private wells and to address the Vapor Intrusion (VI) pathway are summarized below.

Residential Drinking Water

Under an Interim Response Action initiated in 2011, DEP installed and monitored point-of-entry carbon filtration systems at 42 properties with TCE or PCE exceeding the MCLs. The maintenance of the systems was turned over to the property owners after one year. Institutional controls in the form of Environmental Covenants (ECs) or HSCA 512 Orders have been executed at properties where filter systems were installed.

Vapor Intrusion into Occupied Residences

During the spring/summer of 2018, DEP initiated a prompt interim response to address the VI pathway at the Site. DEP installed VI mitigation systems at two homes. Institutional controls in the form of ECs have been executed to ensure the ongoing operation of the VI mitigation systems. Additional soil gas and indoor air sampling performed in 2019 and 2020 did not reveal further VI concerns. It should be noted that DEP was not provided access to perform indoor air sampling at two additional homes located near the known contaminant source areas.

2.3 Remedial Investigations and Findings

Based on the evaluation of the data and reports provided by DEP, GES recommended and completed remedial investigation activities. Details related to specific methodologies and sampling requirements of these activities were included in the Final Remedial Investigation Work Plan and Sampling Analysis Plan that was submitted to DEP on April 28, 2021. The specific activities that were conducted and the results are summarized below.

2.3.1 Fracture Trace Study

To assist in positioning electrical resistivity imaging (ERI) profile locations, a fracture trace study was conducted in order to identify potential fractures trending through the Site. Fracture trace involves the examination of remotely sensed data (e.g., aerial photographs), topographic maps, and other landform data to identify linear features on the surface that could be representative of subsurface secondary porosity features, such as fractures, faults, and joints that could influence groundwater flow. The fracture trace study for this Site consisted of a desktop study (macro-scale examination of the area using geological and topographic maps) and field verification of the desktop results.

Due to the relatively small scale of the Site and the necessity to strategically locate the ERI profile locations, the desktop study was conducted using Light Detection and Ranging (LiDAR) topographic contours as the primary means to identify potential linear features for field examination. Linear features identified through LiDAR appeared to follow the northwest-southeast bedrock strike direction and the southwest dip direction, suggesting that these linear features may be representative of fractures and joints in the underlying bedrock.

On May 25, 2021, GES conducted a site visit to locate and verify site features identified during the desktop study. GES located the anticipated features and collected global positioning system (GPS) data and orientation of these surface features. The suspected primary fracture feature from the source area and overall linear features orientations correlated with the contamination plume shape. Additionally, GES identified a surface water feature and wetland area to the southwest of the Site, and along the suspected primary fracture/joint feature. This surface water feature/wetland is likely an area of groundwater discharge to surface water. While conducting the desktop fracture trace analysis, GES did identify an additional potential surface feature to the northwest of the primary fracture feature; however, this property was not accessible during the site visit to inspect the area.

2.3.2 Surficial Geophysical Investigation and Results

GES, along with Advanced Geological Services, Inc. (AGS), designed a surficial geophysical investigation and selected ERI profile locations based on the results of the fracture trace analysis. The ERI profiles were established in northeast-southwest and northwest-southeast trending orientations in an attempt to orthogonally intersect the linear site features identified during the fracture-trace study. These orientations would best image any potential secondary porosity features formed along the primary bedrock strike and jointing directions for tracing their progression, if any, across the Site.

From June 24-30, 2021, GES performed oversight of the surficial geophysical investigation. ERI was completed along seven (7) profiles. The profiles were collected using a standard dipole-dipole configuration. The ERI profiles consisted of a series of electrodes spaced 10 to 15 feet apart. The profiles provided a maximum depth of investigation to between approximately 175 feet and 275 feet.

Resistivity methods measure the resistivity structure of subsurface materials using a direct current electrical source. A direct current signal is injected into the ground between two transmitting electrodes. The voltage is then measured between two receiving (potential) electrodes. The measured voltage is converted into apparent resistivity using algorithms that take into account the geometry of the dipole-dipole electrode array.

Apparent resistivity is a function of the porosity, permeability, water content, and ionic makeup of the material. Consequently, soils or rocks that contain a high percentage of clay minerals, such as shale, and a high-water content generally have a low apparent resistivity. On the other hand, a clean sand or sandstone with few free ions will have a relatively high apparent resistivity.

The results of the ERI profiles are included in the ERI Investigation Results Report prepared by

AGS, Inc. (**Appendix A)**. Additional detail on the methodologies and the field implementation of ERI technology is summarized within the AGS report.

GES completed a thorough evaluation of all data collected during the fracture trace study and surficial geophysical investigation to determine bedrock structure and fracture depth and orientation. The ERI profiles corroborated the information obtained from the desktop and field fracture trace study activities. The orientations of the fractures in the bedrock on-Site were confirmed to be consistent with the bedrock strike and jointing along dip directions previously identified (i.e., northwest to southeast and northeast to southwest).

Potential bedrock fracture zones (FRZ) identified during the ERI investigation are identified as FRZ-A through FRZ-H and interpolated as blue dashed lines connecting through the ERI profiles (ERI-1 through ERI-7) in Figure 1 of the AGS, Inc. ERI Investigation Results Report (**Appendix A** of this RAA report). GES imported these imaging results from ERI-1 through ERI-7 into a geographic information system (GIS) and conducted a thorough analysis of the new data with respect to the existing comprehensive site conceptual model dataset (e.g., fracture trace results, groundwater plume results, bedrock surface mapping, etc.) to assess the location and scale of each of the fracture zones. Based on the results of this analysis, it was determined that the most significant fracture features (FRZ-B and FRZ-C) are oriented northeast to southwest, which is consistent with the primary jointing/fracturing direction identified during the desktop and field fracture trace study. Given the expected interconnection of the primary joint/fracture sets, GES concluded that FRZ-B and FRZ-C are the two primary features that are likely transporting groundwater, which is consistent with the localized groundwater flow direction (to the southwest) and eventual downgradient location of the surface water/wetland feature. Additionally, FRZ-B and FRZ-C are assumed to be the main connection between current impacted monitoring wells MW-1 and MW-2. GES recommended rock coring activities aimed at targeting these primary features to assess any residual source material present in the bedrock and to obtain additional downhole geophysical data from the boreholes.

2.3.3 Additional Site Inspection and Initial Surface Water Sampling

GES identified an additional potential surface water feature located near the southern boundary of the former Schulberger farm, which is northwest of the confirmed surface water/wetland feature previously identified and inspected by GES and DEP. DEP coordinated access to this property. This area was discussed in the Technical Memorandum dated January 7, 2022, and is identified on **Figure 2** in this RAA report as the Additional Site Visit Investigation Area.

On March 17, 2022, DEP and GES conducted the site visit to identify any surface water or wetland features present on the property. The result of the site visit was relatively inconclusive due to heavy precipitation at the time; however, additional surface water drainage channels were identified. While on-site for the inspection, GES and DEP traveled to the previously identified wetland-type area and collected a surface water sample (SW-1) from an identified spring/seep. Based on field observations, it was believed that this spring/seep location was a direct discharge of groundwater to surface water. The surface water sample was collected directly into the necessary bottleware, and submitted to Eurofins Lancaster Laboratories Environmental (ELLE)

of Lancaster, Pennsylvania for analysis of volatile organic compounds (VOCs), and 1,4D. The laboratory analytical results from the SW-1 sample indicated concentrations of TCE, PCE, and cis-1,2-dichloroethene above the applicable Chapter 93 Surface Water Quality Criteria (SWQC). All surface water analytical data are included in **Table 1**. The surface water sample locations are identified on **Figure 2**.

2.3.4 Surface Water Investigation and Sampling

Based on the results of the fracture trace study conducted in June 2021 and the results of a subsequent site visit/initial surface water sampling on March 17, 2022, GES recommended collection of surface water samples from the surface water features and wetland areas identified. The exact number and location of samples was not pre-determined and sample locations were selected in the field on June 22, 2022. A total of five (5) additional surface water samples were collected (SW-2 through SW-5, and Hall Pond). The surface water sample locations are identified on **Figure 2**.

The surface water samples were collected directly into the necessary bottleware, and submitted to ELLE for analysis of VOCs via EPA Method 8260C, and 1,4D via 8260SIM. The laboratory analytical results from the SW-2 sample indicated concentrations of TCE, cis-1,2-dichloroethene, and vinyl chloride above the applicable Chapter 93 SWQC. It should be noted that other VOCs were detected at concentrations below the applicable Chapter 93 SWQC in SW-1 and SW-2, and several laboratory detection limits exceeded the applicable Chapter 93 SWQC in all samples. All surface water analytical data are included in **Table 1**.

2.3.5 Soil/Rock Core Boring Locations

GES subcontracted Eichelbergers, Inc. (Eichelbergers) of Mechanicsburg, Pennsylvania to complete the installation of two (2) soil boring/rock cores to assess soil and bedrock for the presence of source impacts. The soil boring/rock coring activities were completed between October 25 and November 14, 2022. The soil/rock core boring locations (RC-1 and RC-2) were strategically placed based on the findings of the surficial geophysical investigation completed in June 2021. The rock core locations are identified on **Figure 2**. Soil boring/rock core locations RC-1 and RC-2 were advanced to a depth of 150 feet bgs and 250 feet bgs, respectively. Please note that RC-1 was intentionally installed within the known source area to identify the presence of free product, if any, in overburden or bedrock.

The soil boring/rock core locations were installed via hollow stem auger drilling and rock coring methodologies. The overburden material was logged and sampled utilizing split-spoon sampling methods, and PQ™ wireline tooling (3.375” diameter) was utilized to advance the rock core boring to the terminal depth.

The composition, color, texture, and moisture content of the soil was monitored during advancement of the soil boring and recorded on a boring/coring log. The soil/rock boring locations were sampled within the overburden at the interval of the highest and/or elevated PID readings, visual observation of impacts, and at the soil/bedrock interface. A total of twelve (12) soil samples plus one duplicate sample were collected: five (5) samples, plus one (1) duplicate from RC-1 and seven (7) samples from RC-2. The soil samples were submitted to ELLE for analysis of VOCs via

Environmental Protection Agency (EPA) Method 8260C. The soil sample results are included in **Table 2**. A copy of the subsurface soil boring/rock core logs are included as **Appendix B**.

Rock coring was initiated upon encountering competent bedrock to define the rock surface and stratigraphy to the depths indicated above. Competent rock was encountered at nine (9) feet bgs in both RC-1 and RC-2. Following extraction of the core, the following information was documented by GES field personnel:

- Total recovery
- Solid recovery
- Rock core descriptions
- Core photographs
- Presence of fractured zones
- Saturation
- Presence/absence of NAPL

Select rock core samples were crushed and submitted to ELLE for laboratory analysis of VOCs via EPA Method 8260C. The rock sample depths are included in **Table 2**. GES field personnel also visually inspected and scanned each rock core with an ultra-violet light (blacklight) for the presence of any free product or non-aqueous phase liquid (NAPL). During the rock coring activities, no free product or NAPL were identified. Copies of the subsurface soil boring/rock core logs are included as **Appendix B**.

Additionally, rock core samples were submitted to GeoStructures, Inc. (GeoStructures) in King of Prussia, Pennsylvania for physical property analysis to determine rippability of the shallow/weathered bedrock zone. The first 10 feet (approximately) of rock core extracted from RC-1 and RC-2 were submitted for this analysis. GeoStructures determined that the shallow/weathered rock was not conducive to excavation via traditional means and classified the two weathered rock zones as ‘hard ripping’ or ‘extremely hard ripping & blasting’. These results indicate that pneumatic hammering and/or blasting would be required to excavate weathered rock in the area of investigation. A copy of GeoStructures report is included as **Appendix C**.

At the completion of each soil/rock core boring, the rock cores were contained in core boxes and properly labeled. Additionally, the boreholes were marked accordingly in the field and horizontal/vertical data were collected via handheld GPS device. Protective steel stickups were installed to allow access to the rock cores for additional future investigation. All cores were transported to the Rutgers University Geological Core Repository in Piscataway, New Jersey for research use not related to the Site. Investigation derived waste (IDW) generated during the soil/rock core boring installation activities was containerized in 55-gallon drums, transported, disposed of off-site at a DEP-approved facility. Lewis Environmental Group (Lewis) of Royersford, Pennsylvania completed the IDW disposal activities, and all drums were disposed of at VLS Lancaster, LLC in Lancaster, Pennsylvania. Copies of the waste manifests are included in **Appendix D**.

2.3.6 Downhole Geophysics

GES subcontracted AGS to conduct a downhole geophysical investigation at RC-1 and RC-2 following the completion of the soil/rock core boring installation to: evaluate the bedrock characteristics in the drilled locations to identify potential water-bearing fracture zones; confirm structural orientation of joints and fractures in the rock; describe lithology; and characterize borehole water flow directions. The downhole geophysical logging utilized the following tools:

- Three-Arm Caliper measuring variations in borehole diameter as a function of depth
- Heat Pulse Flow Meter measuring vertical flow within the borehole
- Fluid Temperature measuring changes in fluid temperature as a function of depth
- Optical Televiewer providing an undistorted 360-degree view of the borehole
- Acoustical Televiewer providing a 360-degree acoustical image of the borehole
- Gamma Ray measuring radioactivity from geologic units encountered in the borehole
- Fluid Resistivity providing fluid column dissolved solids data
- Short and Long Normal Resistivity measuring electrical resistivity of current passing through bedrock material
- Single Point Resistivity used to detect fractures in the borehole following variations in the resistivity of the bedrock

Geophysical logging results were evaluated to determine bedrock characteristics that would assist remedial option evaluation for source area groundwater. Additionally, GES and DEP reviewed the downhole geophysical logs and identified discreet groundwater sampling intervals in each of the two rock core locations. These intervals were selected based on the identified water bearing fractures and will be used to determine vertical dispersion of the bedrock aquifer impacts, including any downward migration from the source area overburden that may be occurring. A copy of the downhole geophysical results report prepared by AGS is included as **Appendix A**.

2.3.7 Rock Core Groundwater Sampling

Based on the evaluation of the downhole geophysical investigation and field observations, GES and DEP determined appropriate groundwater sampling intervals in RC-1 and RC-2, including: 103 feet, 117 feet, 138 feet, and 148 feet in RC-1; and 112 feet, 142 feet, 180 feet, 204 feet, and 246 feet in RC-2. DEP deployed passive diffusion bag samplers at the selected intervals for vertical characterization within the open rock core boreholes. DEP conducted two (2) rounds of groundwater sampling from the rock core locations on January 17 and April 27, 2023.

The groundwater samples were submitted to ELLE for analysis of VOCs via EPA Method 8260C. The laboratory analytical results from the rock core locations and previous annual monitoring well sampling activities are included on **Table 3**. It should be noted that only the VOC parameters that had detections above the laboratory method detection limits (MDLs) were tabulated and evaluated. Overall, the groundwater analytical results were relatively consistent between the two sampling events, and indicated that the highest concentrations above the applicable DEP

groundwater Medium-Specific Concentrations (MSCs) for the COCs occurred within the shallower water bearing zones (RC-1 at 103 feet and 117 feet and RC-2 at 112 feet and 142 feet). However, the samples collected from the deeper water bearing zones within RC-2 exhibited concentrations above the applicable DEP groundwater MSC which indicates a likely downward migration of contamination within the fractured bedrock.

2.3.8 Rock Core Downhole Camera Inspection

GES mobilized to the Site on May 16, 2023 to conduct a downhole camera inspection of the rock core boreholes. This effort was completed to determine if any cascading or seeping water was entering the borehole from the unsaturated portion of the overburden, weathered rock, or shallow water bearing fractures. Given the known shallow impacts to soil and the potential for infiltration through the unsaturated overburden, there exists the possibility for transport of COCs into the boreholes from the unsaturated overburden and entering deeper zones. The results of the downhole camera inspection did indicate seeping water from the soil-bedrock interface, from within the weathered bedrock zones, and from some fractures within competent bedrock. Rock core location RC-1 had seeping water present at approximately 11.65 feet and 51.71 feet below top-of-casing (TOC), and rock core location RC-2 had pooling water observed at 15.65 feet below TOC on a rock ledge within the borehole, and seeping water from 33.5-38.2 feet below TOC. Based on these observations, there is potential downward migration within the boreholes from the overburden and shallow bedrock zone (above the static water table, average of 90 feet below TOC).

2.4 Nature and Extent of Release

As discussed in the previous sections and based on the results of the site characterization and remedial investigation activities, the primary source areas were identified to include two drum storage areas on the Site. The primary COCs identified in all site media are CVOCs. At this time, the distribution of the adsorbed-phase and dissolved-phase impacts have been adequately delineated.

2.5 Constituents of Concern

Human or ecological receptors can be exposed to COCs through four major pathway categories: air, groundwater, soil, and surface water. Based on the history of the Site, combined with the nature and extent of the release, the COCs identified for the Site per media are as follows:

- **Groundwater**: 1,1,2-trichloroethane, 1,1-DCE, cis-1,2-dichloroethene, PCE, and TCE, and 1,4D
- **Surface Water**: cis-1,2-dicholorethene, PCE, TCE, vinyl chloride
- **Drinking Water**: 1,1-DCE, cis-1,2-dichloroethene, PCE, and TCE, and 1,4D
- **Soil**: TCE, PCE

The laboratory analytical data for all media are included on **Table 1** (surface water), **Table 2** (soil/rock), **Table 3** (groundwater), and **Table 4** (drinking water). A more detailed discussion of the extent and distribution of the Site COCs is included in the updated CSM in **Appendix E.**

2.6 Exposure Pathway Assessment

This section evaluates potential current and future exposure pathways for human receptors and sensitive habitats (ecological receptors) to identify pathways pertinent to the Site.

2.6.1 Air Exposure Pathways

- Inhalation of vapors volatilized from subsurface soils to the ambient air: The primary COCs at the Site are CVOCs. The initial VI screening evaluation determined that the CVOC concentrations in soil exceed the residential soil screening values (SV_{SOIL}). Therefore, this pathway is deemed relevant for this Site.
- Inhalation of vapors volatilized from groundwater to the ambient air: The primary COCs at the Site are CVOCs. The initial VI screening evaluation determined that the dissolved CVOC concentrations in groundwater exceed the residential groundwater screening values (SV_{GW}). However, based on the average depth to groundwater at the site and clean water bearing zones present, volatilization from groundwater to ambient air is not likely. Therefore, this pathway is not deemed relevant for this Site.
- Inhalation of vapors volatilized from subsurface soil into an enclosed space: This scenario includes vapors entering basements, crawl spaces, subsurface utility vaults, and in some situations, enclosed buildings. The primary COCs at the Site are CVOCs. The initial VI screening evaluation determined that the adsorbed CVOC concentrations exceed the residential soil screening values (SV_{SOIL}). Therefore, this pathway is deemed relevant for this Site.
- Inhalation of vapors volatilized from groundwater into an enclosed space: This scenario includes vapors entering basements, crawl spaces, subsurface utility vaults, and in some situations, enclosed buildings. The primary COCs at the Site are CVOCs. The initial VI screening evaluation determined that the dissolved CVOC concentrations in groundwater exceed the residential groundwater screening values (SV_{GW}). Based on the average depth

to groundwater downgradient from the source areas and clean water bearing zones present, volatilization from groundwater to an enclosed space is not likely. However, as described above, two vapor intrusion (VI) mitigation systems were installed near the north source area to address elevated TCE concentrations detected in indoor air; therefore, this pathway is deemed relevant for this Site. Please note that the two properties currently with VI mitigation systems have institutional controls in place.

2.6.2 Groundwater Exposure Pathways

- Ingestion of groundwater through a water supply well: Public water is not currently available to the Site and immediately surrounding area. Domestic supply wells located in the Site area were identified as potential receptors during the initial Site investigation activities. The influent concentrations at domestic supply wells currently exceed DEP residential MSCs. This pathway is currently mitigated through the use of engineering controls (point-of-entry treatment) until groundwater concentrations attain the DEP residential SHS. Also, future groundwater use at the Site will be addressed through the use of institutional controls to ensure that groundwater to be used at the Site will be tested and treated, if necessary, for the intended use. As described above, 42 properties currently with POET systems have institutional controls in place. Therefore, this pathway is deemed relevant for this Site.

2.6.3 Soil Exposure Pathways

- Dermal contact and direct ingestion of contaminated soil: Soil analytical data collected during the remedial investigation activities indicates that the primary COCs on-site (CVOCs) were detected in soil at concentrations which exceed their respective Residential Direct Contact MSCs (0-15 feet below grade). Therefore, this pathway is deemed relevant for this Site.

2.6.4 Surface Water Exposure Pathways

- Incidental ingestion and dermal contact with surface water contaminated by groundwater discharge: During remedial investigation activities, several intermittent surface water channels were identified on the topographically downgradient property from the Site (Nockamixon State Park). A series of surface water samples were collected from accessible locations along these channels, and from an identified location of direct discharge from groundwater (SW-1). Surface water analytical data indicate the primary COC (CVOCs) have migrated from groundwater to the surface water at concentrations above the DEP drinking water standards and Chapter 93 SWQC. Therefore, this pathway is deemed relevant for this Site.

2.6.5 Construction Activity Exposure Pathways

- Incidental soil and groundwater ingestion, dermal contact with soil, inhalation of particulates from soil, and inhalation of volatiles from soil and groundwater for a construction/trench worker: Under current and future conditions, construction and excavation workers are assumed to be engaged in subsurface disturbance activities that may extend to 10 feet bgs. Such activities may include utility work, repairs, maintenance,

and construction. A construction/trench worker is assumed to spend the entire duration of the work shift exposed to outdoor ambient air and is assumed to follow the requirements as stated in CFR Title 29 Part 1910.120(g)(5) Personal Protective Equipment Program administered by Occupation Safety and Health Administration (OSHA). Construction/trench workers will also have health and safety plans associated with the work to be performed. These health and safety plans will contain provisions for worker training and procedures for safely handling any contaminated soil and groundwater encountered. Therefore, this pathway will be mitigated through the use of institutional controls during remediation activities and future construction activities at the Site.

2.7 Conceptual Site Model

As part of the preparation of the Final Remedial Investigation Work Plan, the historic data available for the Site were reviewed and used to develop a preliminary CSM of the distribution of impacts to soils, bedrock, and groundwater. The purpose of the preliminary CSM was to provide a basis for identifying data gaps that require additional investigation to complete the delineation of impacts at the Site and for developing possible remedial scenarios for the Site. Based on the findings of the Preliminary CSM, a remedial investigation was conducted at the Site and included the following activities:

- Fracture Trace Study
- Surficial Geophysical Investigation
- Initial Surface Water Sampling
- Soil/Rock Core Boring Installation
- Surface Water Investigation and Sampling
- Rock Core Groundwater Sampling
- Rock Core Downhole Camera Inspection

A detailed discussion of the results of these activities were presented previously in this report. An updated version of the CSM that includes discussion of how the more-recently acquired Remedial Investigation data modify, if at all, or fit in with the previous CSM developed for the Site is presented in detail in **Appendix E** of this report. In summary, the updated CSM concludes the following:

- Unsaturated soils are adequately delineated. Any additional investigation activities required would be to satisfy specific needs related to the assessment of the specific remedial design selected for the Site.
- The extent of persisting source zone impacts in the bedrock matrix to the west/southwest of the source areas may require additional characterization as part of a predesign investigation, depending on the final remedy selected for the Site. It is suspected that DNAPL source materials have followed bedrock dip direction and jointing direction to the west and southwest from the drum disposal areas and that residual source materials are trapped in bedrock secondary porosity features in this area and act as continuing sources of impacts to groundwater.

- The bedrock groundwater plume is well delineated for PCE and 1,1-DCE. Additional delineation may be necessary to determine the full extent of the TCE plume. However, the plumes are observed to be stable and, assuming that there are no potential exposure risks and that a remedy will be attempted in the near future, characterization of the TCE leading edge may be delayed until after the implementation of the remedy.

3 Remedial Action Objectives

The following section presents the development and discussion of the remedial action objectives for the Nockamixon TCE Site, including: a summary of the current site characteristics; the identification of Applicable or Relevant, and Appropriate Requirements (ARARs); the development of remediation goals; identification of potentially applicable technologies; and the development of evaluation criteria.

3.1 Current Site Characteristics

Review of available site characterization and remedial investigation information indicates that there are six (6) potential pathways for exposure to the unsaturated soil, surface water, and bedrock groundwater COCs at the Site:

- Inhalation of vapors volatilized from subsurface soils to the ambient air
- Inhalation of vapors volatilized from subsurface soil into an enclosed space
- Ingestion of groundwater through a water supply well
- Dermal contact and direct ingestion of contaminated soil
- Incidental ingestion and dermal contact with surface water contaminated by groundwater discharge
- Inhalation of vapors volatilized from groundwater into an enclosed space

Based on the above listed potential exposure pathways, various remedial alternatives were screened in order to determine appropriate methods for mitigation of on-site COCs and the associated risks. In order to evaluate the appropriate remedial technologies, the following characteristics were considered:

- The Site area is rural and comprises undeveloped land, farmland, residences, and businesses, including multiple residential and commercial properties.
- The source of the groundwater contaminant plume has been identified as a former 77.2-acre farm (Schulberger Farm) located on Brennan Road.
- Depth to bedrock ranges from 1 foot to 14.5 feet bgs.
- The depth to water at the Site typically ranges from 45 to 171 feet bgs, with an average of approximately 90 feet bgs.
- COCs in unsaturated soil that have been detected above their respective DEP MSC include PCE and TCE.
- COCs in bedrock groundwater that have been detected above their respective DEP MSC include 1,1,2-trichloroethane, 1,1-DCE, cis-1,2-dichloroethene, PCE, TCE, and 1,4D.

Based on the open exposure pathways, and the site characteristics, three main areas of concern (AOCs) were identified for evaluation of remedial alternatives:

- Source area soils
- Source area bedrock groundwater
- Non-source area bedrock groundwater

It should be noted that surface water was not included as an area of concern for remedial alternatives evaluation, as it is anticipated that either remediation of both source area soils and source area bedrock groundwater will eliminate the source of surface water concentrations at the Site, or a risk assessment can be considered to attain a site-specific standard.

3.2 Applicable or Relevant, and Appropriate Requirements

As part of the technology screening evaluation, the list of DEP standards and/or requirements for clean-up related to waste sites in Pennsylvania was reviewed to determine ARARs that are potentially pertinent to this cleanup project. The following ARARs were identified:

- The Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 U.S.C. §9601 et seq.
- The Hazardous Sites Cleanup Act ,35 P.S. § 6020.101 et seq.
- The Land Recycling and Environmental Remediation Standards Act 2, 35 P.S. § 6026.101 et seq.
- The Solid Waste Management Act, 35 P.S. §§ 6018.101-6018.1003
- The Flood Plain Management Act, 32 P.S. § 679.101 et seq.
- The Storm Water Management Act, 32 P.S. § 680.1 et seq.
- The Pennsylvania Safe Drinking Water Act, 35 P.S. § 721.1 et seq.
- The Water Well Drillers License Act, 32 P.S. § 645.1 et seq.
- The Soil Conservation Law, Act of May 15, 1945, P.L. 547, as amended, 3 P.S. 849
- The Pennsylvania Uniform Environmental Covenants Act, 27 Pa. C.S. §§ 6501 – 6517
- The Clean Streams Law, Act of June 22, 1937, P.L. 1987, as amended, 35 P.S. §§ 691.1 – 691.1001
- The Clean Water Act, 33 U.S.C. §1251 *et seq.*
- Resource Conservation and Recovery Act (RCRA)
- The Air Pollution Control Act, Act of January 8, 1960, P.L. 2119, 35 P.S. § 4001, *et seq.*
- Implementing regulations for all above-identified statutes

The above-listed ARARs were utilized as part of the Remedial Alternatives Assessment detailed in **Section 4** of this report. Once an alternative is selected, ARARs will be further defined to include specific applicable requirements and/or criteria.

3.3 Remediation Goals

The development of this RAA is based on the assumption that the appropriate level of cleanup is technically feasible, achieves the cleanup objectives established by the DEP, and is economically reasonable. The primary Remedial Action Objective (RAO) is to implement a remedy that is protective of human health and the environment in the long term.

Specific RAOs for the Site include the following for each AOC:

Source Area Soils

- Remediate the source area soils on-site to eliminate the continuing source from impacting bedrock groundwater
- Reduce or eliminate surface water contact with source area soils which may be further contributing to bedrock groundwater and surface water
- Prevent or eliminate pathway for dermal contact or direct ingestion with source area soils
- Reduce potential vapor intrusion from source area soils in both ambient air and enclosed spaces

Source Area Bedrock Groundwater

- Reduce bedrock groundwater concentrations in the source area to prevent further migration
- Prevent ingestion of contaminated groundwater

Non-Source Area Bedrock Groundwater

- Reduce bedrock groundwater concentrations in the non-source area to prevent further migration
- Prevent ingestion of contaminated groundwater

3.4 Potentially Applicable Technologies

Considering the above-referenced characteristics, the following remedial alternatives were evaluated to determine if they would be an effective remedial strategy for the COCs and associated risks for each of the three AOCs at the Site:

Potential Remedies for Each AOC

Source Area Soils	Source Area Bedrock Groundwater	Non-Source Area Bedrock Groundwater
No Action	No Action	No Action
Engineering Controls and Institutional Controls	*Engineering Controls and Institutional Controls*	*Engineering Controls and Institutional Controls*
Soil Excavation – **Off-site Disposal**	*Groundwater Recovery	Monitored Natural Attenuation
Soil Excavation – On-Site Treatment	In-Situ Thermal Treatment	
Soil Vapor Extraction	In-Situ Chemical Reduction	
In-Situ Thermal Treatment	In-Situ Chemical Oxidation	
*Soil Mixing	Carbon Injection	
	Enhanced Biodegradation	
	Monitored Natural Attenuation	

Notes:
Items that are italicized are likely not appropriate as stand-alone solutions; however, may be necessary during and/or after the selected remedy.
Items that are preceded with an asterisk in the table above were eliminated from further evaluation during the preliminary technology screening evaluation (GES November 17, 2023).

A preliminary technology screening evaluation was completed by GES as outlined in the Memorandum dated November 17, 2023. Based on the results of the preliminary screening evaluation, a subset of the above-listed technologies was retained for further evaluation in this RAA. The technologies that were eliminated from further evaluation are shown with an asterisk preceding them in the above table. Each of the retained remedial alternatives are described and subsequently evaluated in **Section 4.0** of this report. In addition, the "no action", and "engineering controls and institutional controls" remedies are described in **Section 4.0**. The preliminary screening evaluation determined that these remedies are likely not appropriate as stand-alone solutions.

3.5 Evaluation Criteria

Based on the remedial technology screening evaluation, each suitable technology was further evaluated to determine:

- Threshold Criteria:
  - The protection of human health and the environment
  - Compliance with ARARs
- Balancing Criteria:
  - Feasibility of the remedial alternative
  - Effectiveness of the remedial alternative
  - Implementability of the remedial alternative
  - Remedial alternative implementation timeframe

- Permanence of the remedial alternative
- The cost of implementation of the remedial alternative
- Community acceptance of the remedial alternative

A summary of the remedial alternative technology screening balancing criteria for each of the technologies is provided in **Table 5**. The table ranks the following categories as either good, fair, or poor: Feasibility and Effectiveness in Achieving Remedial Goals, Implementability – Technical, Implementability - Administrative, Relative Remedial Timeframe and Permanence, Cost, and Community Acceptance Considerations. For Relative Remedial Timeframe, a ranking of poor indicates a longer timeframe. Similarly, for Cost, a ranking of poor indicates a higher cost. Considerations for community acceptance are listed in **Table 5**; however, they are not ranked as community acceptance of remedial alternatives will be considered during the Hazardous Sites Cleanup Act's (HSCA's) Administrative Record process.

The cost estimate for the implementation of each remedial alternative was generated based on target treatment areas, recent information from similar sites, and/or current accepted industry construction cost information. A summary of the estimated cost for each remedial alternative is included in **Tables 6-16**.

4 Remedial Alternative Assessment

As outlined in **Section 3.1**, three AOCs were identified for the remedial alternative assessment:

- Source area soils
- Source area bedrock groundwater
- Non-source area bedrock groundwater

Further evaluation of each alternative is provided in the following sections. A summary of the remedial alternative technology screening balancing criteria for each of the technologies is provided in **Table 5**. Cost estimates for each technology can be found in **Tables 6-16**.

4.1 Source Area Soils

To be conservative, the soil isoconcentration map for PCE was used to estimate the extent of the highest soil concentration areas as a target for source area soil remediation. The PCE map was used; however, the extent of the TCE isoconcentration map is similar; therefore, this estimate is inclusive of both PCE and TCE concentrations. The current estimated areas are shown on **Figure 3**. These areas, along with the average depth to bedrock (6.5 ft bgs) were used to estimate the volume of soil to be remediated for the purpose of estimated costs for each of the options below. Additional soil delineation may be completed as part of pre-design investigation for each of the options outlined below, to confirm exact dimensions of the source area soils prior to implementation of the final remedy.

4.1.1 No Action

Under the "no action" remedial alternative, no further action would be taken to mitigate the threat of site-related contamination. This alternative serves as a baseline to compare against other alternatives. Contaminants would remain in place in subsurface soils. Therefore, this alternative is not protective of human health and the environment. This alternative would not comply with ARARs or achieve RAOs. This alternative would be feasible and implementable because no action is being taken, but would not be effective in addressing health threats to the public and does not offer a permanent solution. This option would likely not receive community acceptance, as it would not address public health and environmental concerns. There is no cost associated with this alternative.

4.1.2 Engineering Controls and Institutional Controls

One or more engineering controls and/or institutional controls may be needed as part of the selected remedy for the source area soils; however, they would not be used as a stand-alone remedy, as no engineering control or institutional control can achieve all of the RAOs and would not comply with the ARARs listed above.

Surface capping is an engineering control that would reduce or remove the adsorbed-phase source from contacting surface water, and would eliminate the direct contact soil exposure pathway. However, surface capping would require routine long-term inspection/maintenance and would not eliminate or reduce the potential for vapor intrusion. Use of impervious caps is more typical in a commercial or industrial setting, where a cap may be incorporated into large foundations or asphalt parking areas. For these reasons, surface capping is not being considered further for the Site.

In addition, an institutional control, such as an environmental covenant, could prohibit soil disturbance and prevent direct contact with contaminated soil; however, it would not remove or reduce the adsorbed-phase source which is acting as a continuing source for bedrock groundwater impacts. This alternative would not comply with ARARs and would not achieve the RAOs.

Based on the above information, and the results of the preliminary technology screening evaluation (GES November 17, 2023), further analysis of engineering and institutional controls as a stand-alone option is not being completed as part of the RAA.

4.1.3 Excavation- Off-Site Disposal

Excavation with off-site disposal involves physically excavating the impacted soil using mechanical methods, and transporting it off-site for disposal. As stated in **Section 4.1**, the areal extent of the excavation would be consistent with the general areas of PCE and TCE concentrations above DEP residential MSCs in soil; therefore, two excavation areas would be required (the general outline of the areas to be excavated is shown on **Figure 3**. To implement excavation in the identified areas, clearing and grubbing of the areas would first be required. Excavation would be completed down to the depth to bedrock (ranging from 3.5 to 9.5 feet below ground surface). Following the completion of excavation activities, the excavated soil would be transported off-site for disposal, and certified clean fill material would be utilized as backfill to

match existing surface grades. Excavation of impacted soil at the Site would mitigate the risk for direct contact or ingestion of contaminated soils, reduce the potential for vapor intrusion from the soil, and mitigate the risk associated with leaching of contaminants into groundwater and surface water. Therefore, if implemented properly, this alternative is protective of human health and the environment, and would achieve the RAOs for soil. Excavation and off-site disposal can be completed in compliance with the applicable ARARs.

Excavation of contaminated unsaturated soil is feasible and implementable at the Site, as areas to be excavated are relatively shallow and accessible. This is an effective remedial alternative for the Site, as it would result in the removal of the adsorbed-phase concentrations, thereby, removing the ongoing source from further distribution into bedrock groundwater. Some of the potential negative impacts to the residents and surface water include runoff and dust, which can be mitigated with an appropriate plan (i.e., soil and erosion control and fugitive dust control), and by abiding ARARs such as the Clean Water Act, and the Air Pollution Control Act. In addition, the residents could be impacted by the increased traffic in the neighborhood due to frequent trucks leaving with contaminated soil, and the delivery of clean soil. This alternative is permanent, as soil excavation with off-site disposal could be executed in a fashion that results in the elimination of unsaturated soil contaminant mass. The remedial alternative timeframe for this option is relatively short, as the excavation would be completed over the course of several weeks; the total timeframe for this option is 2 years including design, implementation (of which the timeframe is approximately 8 weeks), and reporting. A summary of the remedial alternative technology screening balancing criteria is provided in **Table 5**.

The estimated total cost (assumed to be the removal of approximately 13,500 cubic yards) to implement this alternative is **$3.7 to $4.6 million**. A breakdown of estimated costs for this alternative is provided as **Table 6**. Should additional delineation and/or waste characterization sampling results indicate soils are characteristically hazardous this estimate could increase significantly, potentially making this alternative cost prohibitive.

4.1.4 Excavation- On-Site Treatment

Excavation of soils and treatment on-site results in the soil being mixed with binding agents to render the contaminants inert; thereby removing the ongoing source from continuing distribution into bedrock groundwater, as well as eliminating the potential for direct contact and vapor intrusion from soils. Therefore, if implemented properly, this alternative is protective of human health and the environment, and would achieve the RAOs for soil. Excavation and on-site treatment can be completed in compliance with the applicable ARARs.

As stated in the previous section, the areal extent of the excavation would be consistent with the general areas of PCE and TCE concentrations above DEP residential MSCs in soil; therefore, two excavation areas would be required (a general outline of the areas to be excavated are shown on **Figure 3**). To implement excavation in the identified areas, clearing and grubbing of the areas would first be required. Excavation would be completed down to the top of bedrock (ranging from 3.5 to 9.5 feet below ground surface).

The difference between excavation with off-site disposal and excavation with treatment on-site is that the on-site treatment process will take up a larger footprint of the Site, and the timeframe to

implement the remedy will be longer. The process utilizes mechanical mixing of soils with cementitious binding reagents, to create a solid structure of increased unconfined compressive strength and reduced permeability. This reduces the leaching of unsaturated source zone contaminants by limiting contact between infiltrated surface water and impacted soils. As soil stabilization will result in expansion of the original soil volume, a portion of the excavated soil will still need to be disposed of off-site. In addition, the stabilized soil must be reinstalled below the frost line to protect it from freeze/thaw cycles. Due to the shallow bedrock limiting the depth of the excavation, this may limit the amount of soil that can be reinstalled, or additional clean soil backfill may be required to raise the final elevation of the area excavated to accommodate the need for frost protection. Additional soil delineation may be completed as part of pre-design investigation to confirm exact dimensions of the areas to be excavated.

Excavation and on-site treatment of soils is feasible, implementable, and would be effective due to completely removing and treating the source area soil; preventing the contaminants from leaching from the solid structure created from the treatment process. The potential negative impacts to the residents and surface water are limited to runoff and dust during the excavation construction process, both which can be mitigated by an appropriate plan (i.e., soil and erosion control and fugitive dust control), and by abiding ARARs such as the Clean Water Act, and the Air Pollution Control Act. Compared to excavation with off-site disposal, there would be less truck traffic for soil leaving and being delivered to the Site. However, the overall on-site timeframe for excavation and on-site treatment would be longer than excavation with off-Site disposal, due to the added time to complete the treatment process on-site (mixing and testing). The total remedial alternative timeframe for this option is relatively short, as the excavation would be completed over the course of approximately 12 weeks; the total timeframe for this option is 2 years including design, implementation, and reporting. A summary of the remedial alternative technology screening balancing criteria is provided in **Table 5**.

The estimated cost for on-site treatment via soil stabilization, based on an estimated 13,500 cubic yards of unsaturated soils is **$3.6 to $4.4 million**. The cost of design is higher for this option compared to excavation with disposal; however, the cost of treatment on-site is lower than the cost for off-site disposal, making it more cost effective to treat on-site based on the volume of soil. A breakdown of estimated costs for this alternative is provided as **Table 7**. Should additional delineation and/or waste characterization sampling results indicate soils are characteristically hazardous this estimate could increase significantly, potentially making this alternative cost prohibitive.

4.1.5 Soil Vapor Extraction (SVE)

SVE is a commonly utilized remediation technique for the treatment of contaminated soil in the vadose zone. SVE systems utilize blowers to apply vacuum at extraction wells (either vertical or horizontal), allowing for the recovery of soil vapors from unsaturated soils. As air moves through contaminated soils in the vadose zone, VOCs, including adsorbed-phase organic compounds, are transferred into the vapor stream for recovery. If SVE were completed properly, it would remove the adsorbed-phase mass from soil, achieving the RAOs for soil, while being protective of human health and the environment. SVE can also be completed in compliance with the ARARs.

At the Site, the depth of bedrock in the affected areas is shallow, varying from 3.5 to 9.5 feet bgs; therefore, implementing SVE may be challenging. Contaminated shallow soils will require the SVE wells (either vertical or horizontal) to be screened at relatively shallow intervals within the soil profile, which could result in the SVE wells being prone to short-circuiting to the surface. Additional topsoil or other cover may be added to the surface to reduce short-circuiting. In addition, although installing horizontal wells is likely to be a more efficient approach than vertical wells, due to the size of the impacted areas, this would be difficult due to the varying depth of bedrock. In addition, soils at the Site are known to have poor drainage and high clay content; both conditions could contribute further challenges to recovering soil vapors effectively from the impacted areas.

SVE is a technically feasible remediation technique for addressing the adsorbed-phase concentrations in soil at the Site. However, as outlined above, implementing SVE at the Site could be difficult due to the varying depths of shallow bedrock, the poor soil drainage, and the potential for short circuiting to the surface. Depending on how well these implementing challenges can be addressed, the effectiveness of SVE at the Site is unknown. As there are two separate areas with soil impacts, each area would require a separate SVE system to be pilot tested, designed, and installed, prior to implementation. The two areas could be remediated simultaneously at a higher cost, or sequentially, over a longer timeframe. Some noise is associated with a SVE treatment system; however, if noise is a concern with the nearby residences, sound attenuation can be built into the design of the system. If SVE can be successfully implemented, and if post-remediation soil sampling demonstrates remedial goals have been achieved, the SVE system can be decommissioned and removed from the Site. This alternative is permanent, because, if properly implemented, the adsorbed-phase mass is removed from the soil. However, due to the unknown implementation timeframe for SVE at the Site, this alternative does not rank as well compared to technologies that could be completed over a shorter duration, and with less presence on-site. A summary of the remedial alternative technology screening balancing criteria is provided in **Table 5**.

The estimated cost for implementing SVE in the soil source areas, assuming horizontal wells, and 3 years of operation is approximately **$3.3 to $4.1 million**. These costs include adding backfill to raise the elevation of the remediation area to reduce the potential for short circuiting. If additional SVE operation is required after 3 years, then the additional cost per year is approximately **$125,000**. A breakdown of estimated costs for this alternative is provided as **Table 8**. Due to challenging implementability and unknown effectiveness, this technology is not as likely to be successful as excavation.

4.1.6 In-Situ Thermal Treatment (ISTT)

ISTT consists of heating the subsurface to facilitate volatilization followed by contaminant extraction and treatment. If ISTT is implemented properly, it would be protective of human health and the environment. ISTT would achieve the RAOs for source area soil and meet ARARs.

Based on Site conditions, a Thermal Conductive Heating (TCH) approach would be effective for remediating VOC impacts in unsaturated soil. To complete this, TCH wells would be drilled, and electric heaters would be installed to heat the soil to the required temperature to volatize the

contaminants. During the TCH process, vapors would be captured from the vadose zone utilizing an SVE system. The extracted vapors will be moisture-laden due to the temperature of the vapors and moisture content of the soil; therefore, a vapor-liquid separator will be used to separate condensate from the vapor stream prior to treatment. Condensate would either be treated on-site for discharge or disposed of off-site. Although the groundwater recovery remedy was not retained for addressing source area groundwater during the initial technology screening (GES November 17, 2023), due in part to the limited options for discharging treated groundwater on-site, it is anticipated that obtaining a temporary discharge permit for discharge to the surface may be feasible for this technology, as it is only estimated to operate for a short period of time (approximately 23 weeks). If this technology is chosen as the final remedy, treatment versus disposal of the condensate will be further evaluated at that time.

ISTT is a feasible and implementable technology for the Site, and if completed would be effective in remediating the adsorbed-phase concentrations in soil, making it a permanent solution. ISTT has some implementation challenges. The timeframe during which active remediation would occur on-site (with contractors on-site continuously during construction and operation) is 23 weeks. The implementation of this technology would likely include the need for additional imported topsoil to provide for adequate capture of the volatized contaminants in order to overcome the potential short-circuiting challenges described in the previous section for SVE. As there are two separate areas with soil impacts, each area would require a separate SVE system to be pilot tested, designed, and installed, prior to implementation. The two areas could be remediated simultaneously at a higher cost, or sequentially, over a longer timeframe. During the ISTT process, power to heat the soil would come from the local power grid; therefore, costs include the estimated power drop installation and associated electrical fees for both areas. Prior to selecting this technology, a power study would need to be completed by the design contractor in conjunction with information provided by the local electrical utility to determine if sufficient power could be provided. If electrical power cannot be provided by the utility company, then natural gas- or diesel-powered generators could potentially be used; however, this would likely triple the cost of the energy source. Like an SVE system, some noise is associated with the operation of an ISTT system; however, if noise is a concern with the nearby residences, sound attenuation can be built into the design of the system. A summary of the remedial alternative technology screening balancing criteria is provided in **Table 5**.

The estimated cost for implementing ISTT for the source area soils (assumed to be 13,500 cubic yards), is **$6.1 to $7.5 million.** A breakdown of estimated costs for this alternative is provided as **Table 9**.

4.2 Remedial Action Alternatives - Source Area Bedrock Groundwater

The source area bedrock groundwater treatment area consists of a similar outline of the source area soil, except it is limited to the 77 Brennan Road property, where dissolved-phase concentrations are highest. The current assumed estimated area for source area bedrock groundwater is shown on **Figure 4**. This area, along with the average bedrock groundwater column (90-250 ft bgs) were used to estimate the volume of groundwater to be remediated for the purpose of estimated costs for each of the options below. Additional groundwater delineation may

be completed as part of pre-design investigation for each of the options outlined below, to confirm exact dimensions of the source area bedrock groundwater prior to implementation of the final remedy.

4.2.1 No Action

Under the "no action" remedial alternative, no further action would be taken to mitigate the threat of site-related contamination. This alternative serves as a baseline to compare against other alternatives. Contaminants would remain in place in bedrock groundwater and would continue to have the potential for off-site migration. Therefore, this alternative is not protective of human health and the environment. This alternative would not comply with ARARs or meet the RAOs. This alternative would be feasible and implementable because no action is being taken but would not be effective in addressing health threats to the public and does not offer a permanent solution. This option would likely not receive community acceptance, as it would not address public health and environmental concerns. There is no cost associated with this alternative.

4.2.2 Engineering Controls and Institutional Controls

One or more engineering controls and/or institutional controls may be needed as part of the selected remedy for the source area bedrock groundwater; however, they would not be used as a stand-alone remedy, as no engineering control or institutional control can achieve all of the RAOs and would not comply with the ARARs listed above. Engineering controls and/or institutional controls are currently in place (i.e., POET systems and Environmental Covenants), and may also be needed as part of the selected remedy for the source area bedrock groundwater; however, they would not be used as a stand-alone remedy, as they would not remove or reduce the dissolved-phase source.

Based on the above information, and the results of the preliminary technology screening (GES November 17, 2023), further analysis of engineering and institutional controls as a stand-alone option is not being completed as part of the RAA. However, the summary (above) of the current controls that are in place is presented as background information for future sections.

4.2.3 In-Situ Thermal Treatment (ISTT)

Implementation of ISTT of soils in the source area bedrock groundwater would serve as a viable remedial alternative to reduce the COCs in the dissolved phase. ISTT consists of heating the subsurface to facilitate volatilization followed by contaminant extraction and treatment. If ISTT is implemented properly, it would be protective of human health and the environment. ISTT would achieve the RAOs and meet ARARs for the source area bedrock groundwater by reducing the concentrations and preventing ingestion of contaminated groundwater in the areas treated once remediation is complete.

To complete ISTT in the source area bedrock groundwater, TCH wells would be drilled, and electric heaters would be installed to heat the saturated bedrock to the required temperature to volatize the contaminants. During the TCH process, vapors would be captured from the vadose zone utilizing an SVE system. The extracted vapors will be moisture-laden due to the temperature of the vapors and moisture content of the soil, in addition to the steam generated from the heated groundwater; therefore, a vapor-liquid separator will be used to separate condensate from the

vapor stream prior to treatment. Condensate would either be treated on-site for discharge or disposed of off-site. Although the groundwater recovery remedy was not retained during the initial technology screening (GES November 17, 2023), due in part to the limited options for discharging treated groundwater on-site, it is anticipated that obtaining a temporary discharge permit for discharge to the surface may be feasible for this technology, as it is only estimated to operate for a short period of time (approximately 19 weeks).

If this technology is chosen as the final remedy, treatment versus disposal of the condensate will be further evaluated at that time.

ISTT is a feasible technology for treating source area bedrock groundwater and would be effective in remediating the dissolved-phase concentrations in the source area bedrock groundwater, making the solution permanent. ISTT has some implementation challenges. The timeframe during which active remediation would occur on-site (with contractors on-site continuously during construction and operation) is estimated to be 19 weeks. During the ISTT process, power to heat the bedrock groundwater would come from the local power grid; therefore, costs include the estimated power drop installation and associated electrical fees. Prior to selecting this technology, a power study would need to be completed by the design contractor in conjunction with information provided by the local electrical utility to determine if sufficient power could be provided. If electrical power cannot be provided by the utility company, then natural gas- or diesel-powered generators could potentially be used; however, this would likely triple the cost of the energy source. Like an SVE system, some noise is associated with the operation of an ISTT system; however, if noise is a concern with the nearby residences, sound attenuation can be built into the design of the system. As described above, a large volume of condensate would be generated during the treatment process, and the volume anticipated to be generated from the treatment of bedrock groundwater is significantly higher than for vadose zone soils. If a temporary discharge permit for on-site discharge cannot be obtained, off-site disposal would be cost-prohibitive. For these reasons, the implementability of this option is low. A summary of the remedial alternative technology screening balancing criteria is provided in **Table 5**.

The estimated cost for implementing ISTT for the bedrock groundwater (assumed to be 277,000 cubic yards), is **$47.4 to $58.7 million**. A breakdown of estimated costs for this alternative is provided as **Table 10**. The majority of this cost includes bedrock drilling to install the TCH wells, and the energy to heat and treat to the target treatment depths (estimated to be 90 to 250 ft bgs). It should be noted that this cost does not include the disposal of water, as it would be cost-prohibitive, and this technology is already the most expensive of the technologies evaluated for source area bedrock groundwater.

4.2.4 In-Situ Chemical Reduction (ISCR)

In-situ chemical reduction (ISCR) uses an injection pump to dispense a known volume and concentration of reductive amendments into the subsurface through injection points. The reductive amendments promote the reductive dechlorination reactions to reduce the CVOC concentrations in the dissolved-phase. There are various commercially available amendments, and many of them include a carbon source and zero valent iron, in addition to other nutrients (such as sulfate). Some of these amendments also incorporate enhanced bioremediation; either

by inducing reductive conditions that are amenable to support naturally occurring reductive dechlorinators, or by including the injection of bacterial colonies as part of the injection process. If ISCR is implemented properly, it would be protective of human health and the environment and would achieve the RAOs for the source area bedrock groundwater, by reducing the concentrations and preventing ingestion of contaminated groundwater in the areas treated once remediation is complete. However, 1,4D is not amenable to reduction; therefore, this would need to be taken into consideration before choosing this as the remedy for bedrock groundwater. ISCR can be completed in compliance with the applicable ARARs.

During the ISCR process, there is also the potential for the generation of daughter compounds (such as vinyl chloride); however, most ISCR products are designed to completely reduce the daughter products as well. In addition, as ISCR is an abiotic process, as opposed to enhanced reductive dechlorination (ERD), the production of daughter products should be minimal. There is also the risk for the production of methane due to undesirable colonies of methanogens proliferating in the subsurface. It should be noted that other amendments are commercially available which are designed to reduce the production of methane.

Based on the distance between the target treatment zone and the closest residences (approximately 200 to 250 ft cross-gradient and down-gradient), it is not anticipated that the injection of ISCR amendments will have any adverse effects on potable water quality. If injected reagents were to migrate to any of the residents, any organic carbon present in the amendments would be removed by the activated carbon in the POET system; however, unreacted sulfate would likely pass through. To alleviate concerns regarding this potential for migration, existing and potential sentinel monitoring wells can be used to monitor for any changes in water chemistry between the treatment areas and the residences, to ensure that reagents are not migrating towards the residences.

Prior to selecting ISCR as the remedy for the bedrock groundwater, groundwater monitoring for existing groundwater chemistry parameters [e.g., dissolved oxygen (DO), oxidation-reduction potential (ORP), pH, conductivity, total iron, dissolved iron, sulfate, sulfide, total organic carbon] should be completed to assess the viability of ISCR. In addition, as this technology requires amendments (in the form of liquid solutions) to be injected into the subsurface, an injection feasibility test should be conducted prior to designing a full-scale ISCR program for the Site. Additionally, if ISCR is the chosen technology for the Site, further information from the pilot test and other site characteristics will be used to refine the design for the volume and rate of injections in order to ensure that the majority of the amendments are consumed prior to them migrating close to any of the Site supply wells.

ISCR is a feasible and effective technology for treating the target COCs in groundwater, with the exception of 1,4D. It is a relatively implementable technology for the Site and would result in permanent reduction of the target COCs (with the exception of 1,4D). The implementation timeframe for work at the Site is relatively short (estimated 24 weeks total including 12 weeks for drilling and 10 weeks for injection, and 2 weeks for mob/demob/other). A summary of the remedial alternative technology screening balancing criteria is provided in **Table 5**.

Although 1,4D is not amenable to ISCR, this technology was evaluated, as 1,4D may be able to be addressed by another method (i.e., natural attenuation, engineering and/or institutional controls) in conjunction or following the completion of ISCR. Based on similar sites where ISCR has been conducted, the estimated cost for implementing this remedy, including contingency is approximately **$1.7 to $2.1 million**. A breakdown of estimated costs for this alternative is provided as **Table 11**. This is based on the assumption that 24 injection wells (50-ft spacing) would provide adequate distribution of the amendments into the subsurface, and that the amendments would be injected using a packer system to ensure even distribution through the vertical treatment zone. Costs also assume that after one ten week-long injection event is conducted, five years of monitoring will be conducted to monitor for completion of the reduction process. It is assumed that attainment sampling would also be completed during the final two years of the monitoring period.

4.2.5 In-Situ Chemical Oxidation

In-situ chemical oxidation (ISCO), similar to ISCR, uses an injection pump to dispense a known volume and concentration of oxidants into the subsurface through injection points. This advanced oxidation process breaks down chlorinated compounds including CVOCs and 1,4D in the groundwater into end-products of carbon dioxide and water. If ISCO is implemented properly, it would be protective of human health and the environment and would achieve the RAOs for the source area bedrock groundwater, by reducing the concentrations and preventing ingestion of contaminated groundwater in the areas treated once remediation is complete. ISCO can be completed in compliance with the applicable ARARs.

Various types of commercially available ISCO technologies, such as potassium permanganate or persulfate may be applicable for the Site. As this approach requires the injection of oxidants in the form of a liquid into the subsurface, an injection feasibility test should be conducted prior to designing a full-scale ISCO program for the Site. Based on the distance between the target treatment zone and the closest residences (approximately 200 to 250 ft cross-gradient and down-gradient), it is not anticipated that the injection of ISCO amendments will have any adverse effects on the potable water supplies. To alleviate concerns regarding this potential for migration, monitoring wells can be used to monitor for any changes in water chemistry between the treatment areas and the residences, to ensure that reagents are not migrating towards the residences. Chemical oxidation is a potentially viable remedial alternative for the dissolved-phase Site contaminants, including CVOCs and 1,4D.

ISCO is a technically feasible and implementable technology for treating the bedrock groundwater. Prior to implementation, a pilot test and other site characteristics will be used to refine the design for the volume and rate of injections in order to ensure that the majority of the oxidants are consumed prior to them migrating close to any of the Site potable supply wells. The pilot test will also be completed to confirm that the subsurface will be amenable to injections, to confirm that the volume of amendments required can be injected within a reasonable timeframe. One concern with ISCO is the lasting effectiveness of the amendments in the subsurface, as ISCO amendments typically do not have a long residence time; therefore, concentrations in the dissolved-phase may be reduced and then rebound later due to back diffusion from the bedrock.

For this reason, it was assumed for costing purposes that up to three injection events would be required to reduce the dissolved-phase concentrations and control rebound from back-diffusion. However, there is uncertainty with this, and more injections could be required depending on how much solution can be injected during each event. Therefore, lasting effectiveness and permanence of this solution is possible; however, it may require additional injections and may not be as likely to be achieved within as short of a timeframe as some of the other technologies evaluated for bedrock groundwater. Community acceptance of this option may be lower than some of the other options for source area bedrock groundwater, as it will require several multi-week injection events, and the exact number and timeframe could be higher. A summary of the remedial alternative technology screening balancing criteria is provided in **Table 5**.

The estimated costs for implementing this remedy, including contingency is approximately **$13.7 to $17.5 million**. A breakdown of estimated costs for this alternative is provided as **Table 12**. This estimate is based on the assumption that 24 injection wells (50-ft spacing) would provide adequate distribution of the amendments into the subsurface, and that the amendments would be injected using a packer system to ensure even distribution through the vertical treatment zone. Costs also assume that three 28-week long injection events would be conducted over a three-year period, followed by monitoring for the completion of the oxidation process. It is assumed that attainment sampling would also be completed during the final two years of the monitoring period. The highest contributor to the cost for this option is the oxidant chemical costs, due to the volume required, and the resulting number of weeks required to inject.

4.2.6 Carbon Injection

During carbon injection, activated carbon which is typically impregnated with zerovalent iron (ZVI) and other compounds and nutrients is mixed with water and injected into the subsurface under pressure. Contaminants are adsorbed onto the carbon and subsequently degraded by biological activity. Carbon injection is protective of human health and the environment, as the bedrock groundwater concentrations in the source area would be captured and treated. This technology would address the RAO for bedrock groundwater by reducing the dissolved-phase concentrations in bedrock groundwater. Carbon injection can be completed in compliance with the ARARs.

Carbon injection is a feasible and implementable alternative for the Site. Similar to ISCR, 1,4D is not as amenable to reduction via this technology. However, the 1,4D can at a minimum be adsorbed to the carbon particles (thereby removing 1,4D from the dissolved-phase, but then may not be reduced as readily as other COCs via biological reduction pathways. Based on the minimal 1,4D concentrations, this may be sufficient to reduce the 1,4D concentrations in the groundwater. Prior to implementation, a pilot test and other site characteristics will be used to ensure that that the subsurface will be amenable to injections. Effectiveness of carbon injection for addressing 1,4D can be further investigated during the pilot test phase. Based on the distance between the target treatment zone and the closest residences (approximately 200 to 250 ft cross-gradient and down-gradient), it is not anticipated that the injection of carbon-based amendments will have any adverse effects on the potable water supplies. The injected amendments themselves will not migrate in groundwater, and monitoring wells between the injection area and the residences can be utilized to monitor for changes in groundwater chemistry. The estimated timeframe for

completing a carbon injection program in the source area bedrock groundwater is 7 years, assuming a total of three injections would be completed over a 3-year period, followed by 4 years of monitoring. Each of the three injection events would be completed over an approximate 5-week period. A summary of the remedial alternative technology screening balancing criteria is provided in **Table 5**.

Although 1,4D is not amenable to carbon injection, this technology was evaluated, as 1,4D may be able to be addressed by another method (i.e., natural attenuation, engineering and/or institutional controls) in conjunction or following the completion of the remedy. Based on similar sites where carbon injection has been conducted, the estimated costs for implementing this remedy, including contingency is approximately **$4.9 to $6.2 million**. A breakdown of estimated costs for this alternative is provided as **Table 13**. This estimate is based on the assumption that 24 open rock boreholes (50-ft spacing) would be installed to accommodate the injection of the carbon solution into the subsurface. The carbon solution would be injected using a packer system to ensure even distribution through the vertical treatment zone. It is assumed that two carbon injection events would be completed, each requiring approximately 10 weeks on-site; followed by 4 years of performance monitoring. It is assumed that groundwater attainment sampling would be completed during the performance monitoring period.

4.2.7 Enhanced Biodegradation

Biodegradation is a process in which naturally occurring microorganisms are utilized to metabolize chlorinated compounds, ultimately breaking them down to ethene and ethane. Natural hydrocarbon biodegradation processes can be enhanced through the addition of electron donors or acceptors, VOC degrading bacteria, and/or nutrients. These enhancement products are typically liquids that are injected into the subsurface aquifer at low flow rates. As the solution is injected, it disperses through the aquifer, facilitating bacteria colony growth and enhancing natural hydrocarbon degradation.

Enhanced biodegradation (also referred to as enhanced reductive dechlorination [ERD]) is considered to be a potentially effective for the remediation of CVOCs at the Site; however, 1,4D degradation can be inhibited or slowed in the presence of chlorinated ethenes. Additional groundwater chemistry data is needed to determine the prevailing microbiological process and the appropriate enhancement. It should also be noted that enhanced biodegradation can also occur naturally in conjunction with ISCR, ISCO, and carbon injection technologies, as they will promote conditions for biotic reduction or oxidations to occur.

Completing enhanced biodegradation at the Site is technically feasible, as it involves injecting a solution of amendments and VOC degrading bacteria, similar to ISCR and ISCO. However, the effectiveness of ERD to completely degrade the Site COCs in bedrock groundwater is unknown, especially due to the potential inhibition to degrade 1,4D. The injections would occur in a similar manner to ISCR or ISCO injections, and are therefore implementable at the Site. If complete degradation does occur through ERD, then it would be permanent. The ERD process may take a longer period of time than other options for bedrock groundwater, and similar to ISCO, back-diffusion may occur which would need to be monitored. Additional injections of bacteria and/or

nutrients may be required if this occurs. A summary of the remedial alternative technology screening balancing criteria is provided in **Table 5**.

Although 1,4D is not amenable to ERD, this technology was evaluated, as 1,4D may be able to be addressed by another method (i.e., natural attenuation, engineering and/or institutional controls) in conjunction or following the completion of the remedy. An estimated cost for implementing enhanced biodegradation as a stand-alone remedy is approximately **$1.6 to $2.0 million**. A breakdown of estimated costs for this alternative is provided as **Table 14**. It is assumed that ERD amendments would be injected in a series of 24 injection wells (50-ft spacing), using a packer system to evenly distribute amendments through the vertical treatment zone. As ERD is a slower process than carbon injection, ISCO, or ISCR, additional performance monitoring was assumed, making this total timeframe of this option 10 years, or longer.

4.2.8 Monitored Natural Attenuation

Monitored Natural Attenuation (MNA) is a method that relies on monitoring the natural processes for reduction in Site contaminants over time, which occur from natural physical (dilution, evaporation, sorption), chemical (abiotic reactions), and biological (aerobic/anaerobic microbial) processes. An MNA program typically includes monitoring for stable or decreasing trends in dissolved-phase concentrations, as well as monitoring for parameters that demonstrate natural attenuation processes are occurring. These additional parameters typically include dissolved oxygen (DO), pH, oxidation-reduction potential (ORP), sulfate, iron, manganese, nitrate, and methane. If MNA was successfully completed in the source-area groundwater, it would address the RAOs for bedrock groundwater by reducing the dissolved-phase concentrations in bedrock groundwater. Upon conclusion of the MNA monitoring period Engineering and Institutional Controls may need to remain in place to assure continued attainment of RAOs. MNA can be completed in compliance with the applicable ARARs.

MNA is a feasible option for the Site and is easily implementable. However, as noted in the previous section, 1,4D is not as amenable to natural biodegradation so this option may not be as effective as others evaluated, and it is difficult to predict the timeframe needed to achieve the RAOs. In addition, this option will require monitoring for multiple years; therefore, it is a longer timeframe option than other options evaluated (estimated 15 years minimum). Although less time is needed on-site than for some of the active remediation options, the total duration of the project will be longer than others. If MNA is successfully completed and the RAOs are achieved, then the remedy will be considered permanent. A summary of the remedial alternative technology screening balancing criteria is provided in **Table 5**.

An estimated cost for the MNA approach is approximately **$0.3 to $0.5 million**. A breakdown of estimated costs for this alternative is provided as **Table 15**. This estimate assumes that the source area bedrock groundwater wells would be sampled on a semi-annual basis for up to 15 years (assumed duration of sampling to achieve stable or decreasing dissolved-phase trends). It was assumed that the extent of the source area bedrock groundwater to be monitored would include a maximum of five monitoring wells would be needed, and that the existing monitoring wells MW-1Ss, MW-1Sd, MW-11, and MW-2, and potentially RC-2 would be sufficient for the purpose monitoring the source area bedrock groundwater.

4.3 Non-Source Area Bedrock Groundwater

Non-source area bedrock groundwater consists of the remainder of the Site where COCs in groundwater exceed the applicable DEP MSC.

4.3.1 No Action

Under the “no action” remedial alternative, no further action would be taken to mitigate the threat of site-related contamination. This alternative serves as a baseline to compare against other alternatives. Contaminants would remain in place in bedrock groundwater and would continue to have the potential for off-site migration. Therefore, this alternative is not protective of human health and the environment. This alternative would not comply with ARARs or meet RAOs. This alternative would be feasible and implementable because no action is being taken but would not be effective in addressing health threats to the public and does not offer a permanent solution. There is no cost associated with this alternative.

4.3.2 Engineering Controls and Institutional Controls

One or more engineering controls and/or institutional controls may be needed as part of the selected remedy for the non-source area bedrock groundwater on-site; however, they would not be used as a stand-alone remedy, as no engineering control or institutional control can achieve all of the RAOs listed above. Engineering controls and/or institutional controls are currently in place (i.e., POET systems and Environmental Covenants), and may also be incorporated as part of the selected remedy for the non-source area bedrock groundwater; however, they would not be used as a stand-alone remedy, as they would not remove or reduce the dissolved-phase source. This alternative, as a stand-alone remedial option, would not comply with ARARs because it would not meet applicable DEP MSCs; however, a site-specific standard could be achieved via pathway elimination.

Based on the above information, and the results of the preliminary technology screening (GES November 17, 2023), further analysis of engineering and institutional controls as a stand-alone option is not being completed as part of the RAA. However, the summary above of the current controls that are in place is presented as background information for future sections.

4.3.3 Monitored Natural Attenuation

As mentioned in **Section 4.2.8** above, MNA is a method that relies on monitoring the natural processes for reduction in Site contaminants over time, which occur from natural physical (dilution, evaporation, sorption), chemical (abiotic reactions), and biological (aerobic/anaerobic) processes. An MNA program typically includes monitoring for stable or decreasing trends in dissolved-phase concentrations, as well as monitoring for parameters that demonstrate natural attenuation processes are occurring. These additional parameters typically include DO, pH, ORP, sulfate, iron, manganese, nitrate, and methane. If MNA was successfully completed in the non-source area bedrock groundwater, it would address the RAOs for bedrock groundwater by reducing the dissolved-phase concentrations in bedrock groundwater. Depending on how long MNA is completed, and whether the concentrations are reduced to safe drinking water levels, further evaluation at the completion of the MNA process would be needed to determine if the RAO of preventing the ingestion of impacted groundwater can be achieved. As stated previously,

engineering and institutional controls are already in place to prevent the ingestion of contaminated groundwater and could continue to be implemented during and after the MNA process. MNA can be completed in compliance with the applicable ARARs.

MNA is a feasible option for the non-source area bedrock groundwater and is easily implementable. However, as noted in the previous section, 1,4D is not as amenable to natural biodegradation so this option may not be as effective as others evaluated, and it is difficult to predict the timeframe needed to achieve the RAOs. In addition, this option will require monitoring for multiple years; therefore, it is a longer timeframe option than other options evaluated (estimated 10 years minimum). Although less time is needed on-site than for some of the active remediation options, the total duration of the project will be longer than others. If MNA is successfully completed and the RAOs are achieved, then the remedy will be considered permanent. A summary of the remedial alternative technology screening balancing criteria is provided in **Table 5**.

An estimated cost for the MNA approach for non-source area groundwater is **$0.5 to $0.6 million**. A breakdown of estimated costs for this alternative is provided as **Table 16**. This estimate assumes that the non-source area bedrock groundwater wells would be sampled on a semi-annual basis for up to 10 years (assumed duration of sampling to achieve stable or decreasing dissolved-phase trends). It was assumed that to monitor the non-source area bedrock groundwater, a maximum of twenty monitoring wells would be needed; therefore, costs for the installation of three additional monitoring wells was included.

5 Evaluation of Alternatives

The remedial alternatives presented in **Section 4** have been evaluated with numerous criteria in an effort to determine the appropriate remedy(ies) for the Site. However, comparing each alternative with one another is an essential part of the analysis. Based on the total alternative costs, timeframes (including pre-design, remedy implementation, and long-term operation and maintenance), and effectiveness of each of the alternatives in addressing the identified exposure pathways the following technologies were considered that have the potential to address the risks to human health and the environment as currently conceptualized. **Table 5** includes a comparison of all the evaluation criteria, as well as the estimated cost for each alternative. The table ranks the following categories as either good, fair, or poor: Feasibility and Effectiveness in Achieving Remedial Goals, Implementability – Technical, Implementability - Administrative, Relative Remedial Timeframe and Permanance, Cost, and Community Acceptance Considerations. The rankings were made based on GES' understanding of each technology in comparison to the other technologies on the table. Considerations for community acceptance are listed in **Table 5;** however, as stated previously, they are not ranked as community acceptance of remedial alternatives will be considered during the HSCA's Administrative Record process.

If 1,4D treatment is deemed to be necessary to achieve RAOs, ISTT or ISCO may be the best options as they can directly address 1,4D concentrations. Carbon injection may be able to address some of the 1,4D via carbon adsorption; however, biological reduction process may not be as amenable. Similarly, ERD and MNA may not be as readily amenable to reducing 1,4D

concentrations. However, as 1,4D is currently only slightly above the DEP MSC in two of the monitoring wells, it is possible that 1,4D can be addressed via MNA, or that another technology will be effective on the low-level concentrations.

Only one cross-over technology was evaluated that could potentially address both source area soils and source area bedrock groundwater (ISTT); however, this technology was not rated well for either of these AOCs (and was likely not implementable for bedrock groundwater due to the volume of condensate that would be produced), and there is little cost savings in combining them. MNA was a cross-over technology that ranked well for both source area and non-source area bedrock groundwater, and there would be some cost savings in combining them. However, MNA in the non-source area groundwater would be more likely to effectively achieve the RAOs if the source-area groundwater was first addressed to remove the continuing source from further migration to the non-source area.

6 Conclusions and Recommendations

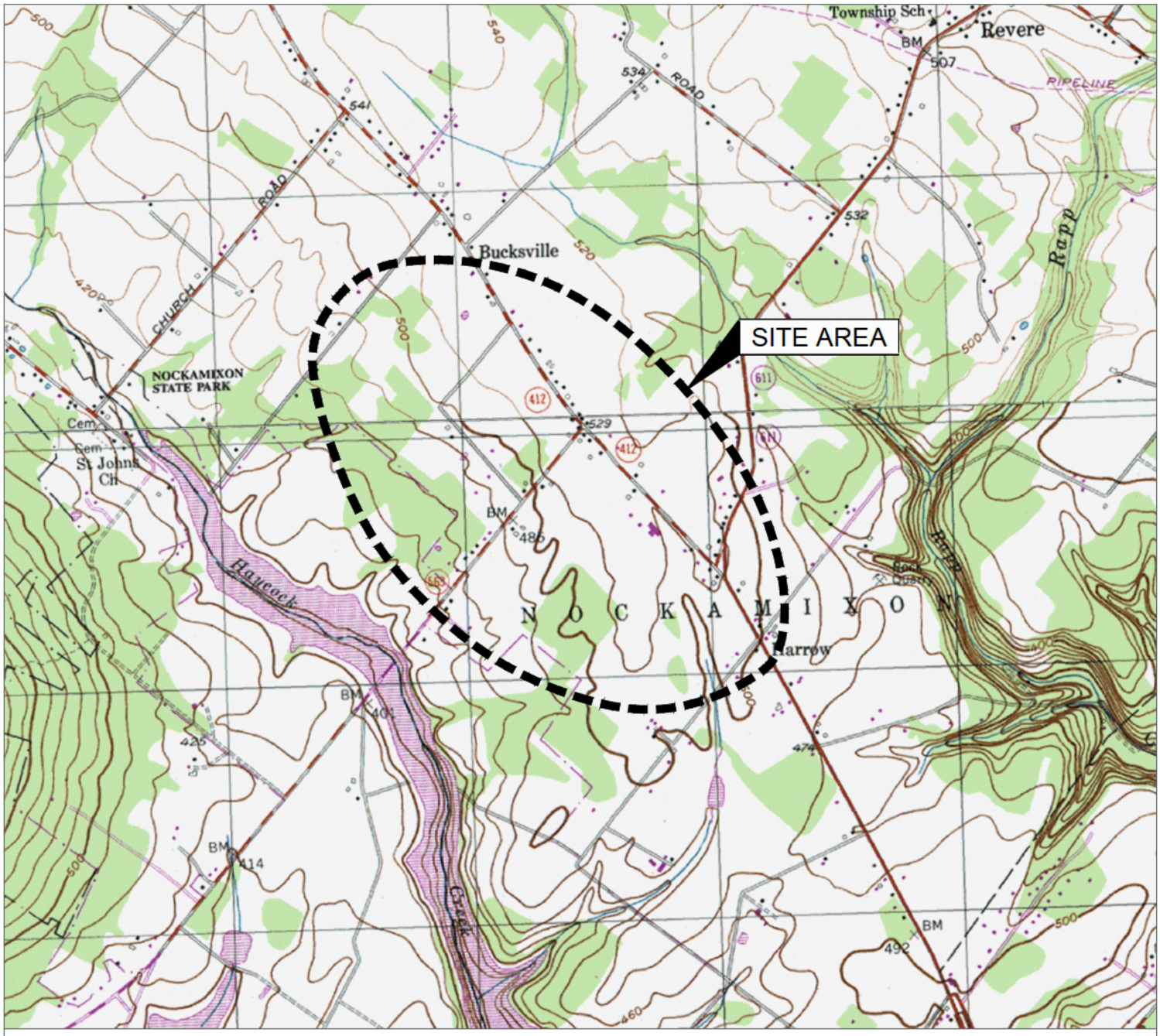
The following is a summary of conclusions based on the information presented in this report.

- The risk assessment indicates that there are six (6) open exposure pathways associated with the unsaturated soil contamination and bedrock groundwater at the Site: inhalation of vapors volatilized from subsurface soils to the ambient air, inhalation of vapors volatilized from subsurface soil into an enclosed space, ingestion of groundwater through a water supply well, dermal contact and direct ingestion of contaminated soil, incidental ingestion and dermal contact with surface water contaminated by groundwater discharge, and inhalation of vapors volatilized from groundwater into an enclosed space.
- Viable remedial technologies for unsaturated soils at the Site include: excavation with off-site disposal, and excavation with on-site treatment.
- Viable remedial technologies for source area bedrock groundwater include: ISCR, carbon injection, and MNA.
- Viable remedial technologies for non-source area bedrock groundwater include: MNA.
- Engineering controls and institutional controls (POET & VI mitigation systems and Environmental Covenants) are currently in place to address exposure risks. These would need to remain in place until RAOs are achieved with the remedial technologies selected.
- Feasibility/pilot testing was deemed to be a required task for implementation of several remedial technologies.
- Only one cross-over technology was evaluated that could potentially address both source area soils and source area bedrock groundwater (ISTT); however, this technology was not well rated for either of these AOCs, and there is little cost savings in combining them.
- MNA was a cross-over technology that ranked well for both source area and non-source area bedrock groundwater, and there would be some cost savings in combining them. However, MNA in the non-source area bedrock groundwater would be more likely to effectively achieve the RAOs if the source area bedrock groundwater was first remediated with something more aggressive (such as the recommended ISCR). In addition, it is possible that after addressing source area soils, the groundwater in the source area will naturally attenuate on its own. Groundwater monitoring should be completed for a period

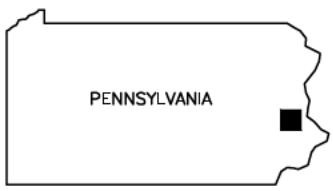
of time after addressing the source area soils prior to determining if an in-situ remedy or MNA is more appropriate for the remaining concentrations.

Figures

Figure 1 – Site Location Map



Source:
USGS 7.5 Minute Series
Topographic Quadrangle, 1997
Riegelsville, Pennsylvania
Bedminster, Pennsylvania
Contour Interval = 20'



QUADRANGLE LOCATION

Site Location Map

Pennsylvania Dept of Environmental Protection
Nockamixon TCE Site
84 Brennan Road, Nockamixon Township
Ottsville, Pennsylvania

Drawn
T.P.
Designed
M.E.T.
Approved
T.F.U.

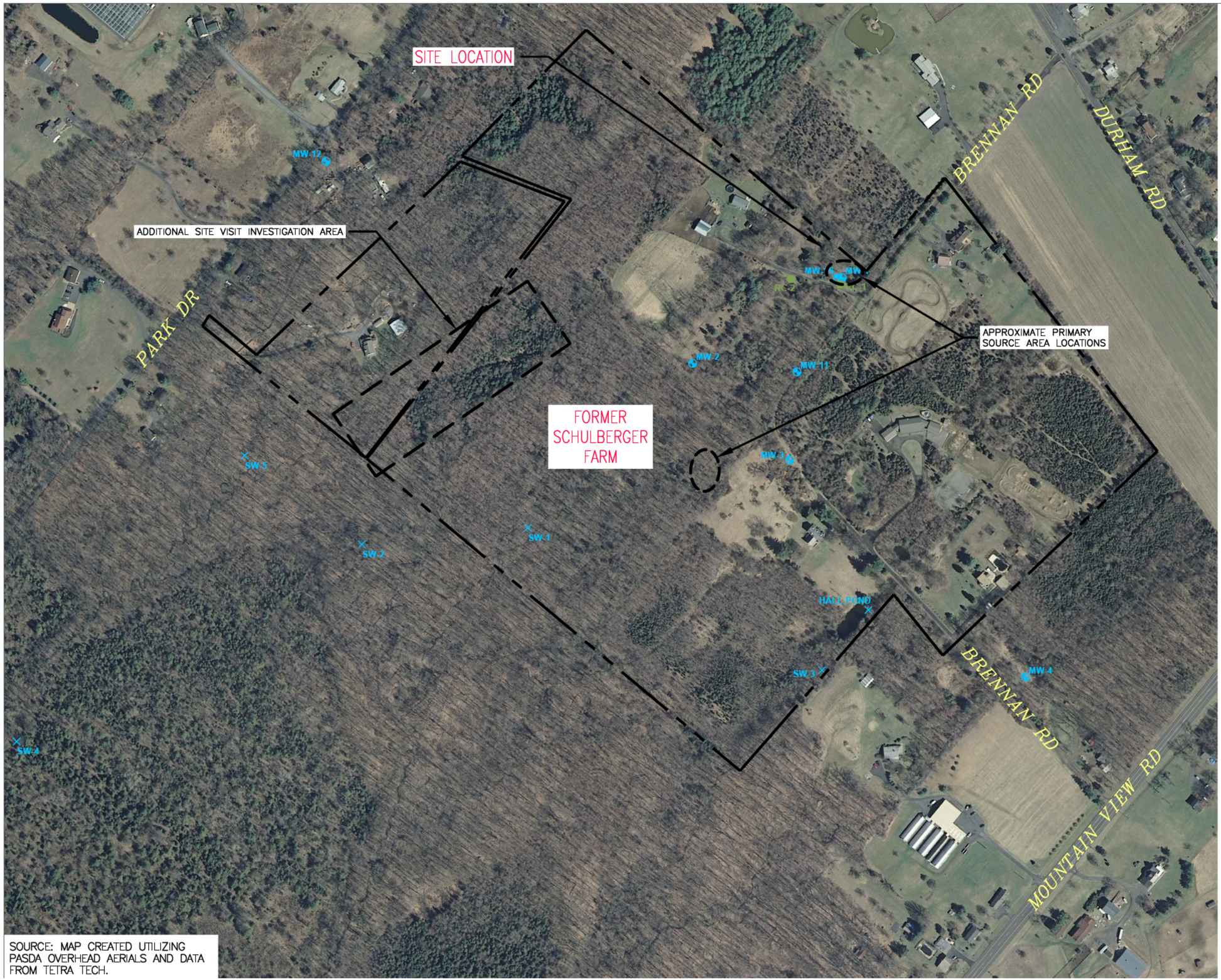
Date
08/27/21
Figure
1

Scale In Feet
0 2,000

Groundwater & Environmental Services, Inc.

N:_Corporate\Graphics-Exton\Exton\PADEP-GTAC-IRRSC\GTAC\GTAC Nockamixon TCE Site\Nockamixon SLM.dwg, SLM

Figure 2 – Site Map



SOURCE: MAP CREATED UTILIZING PASDA OVERHEAD AERIALS AND DATA FROM TETRA TECH.

LEGEND

- FORMER SCHULBERGER FARM PROPERTY
- MONITORING WELL
- SOIL/ROCK CORE BORING LOCATION
- SURFACE WATER SAMPLE

Site Map

Pennsylvania Dept of Environmental Protection
Nockamixon TCE Site
84 Brennan Road, Nockamixon Township
Ottsville, Pennsylvania

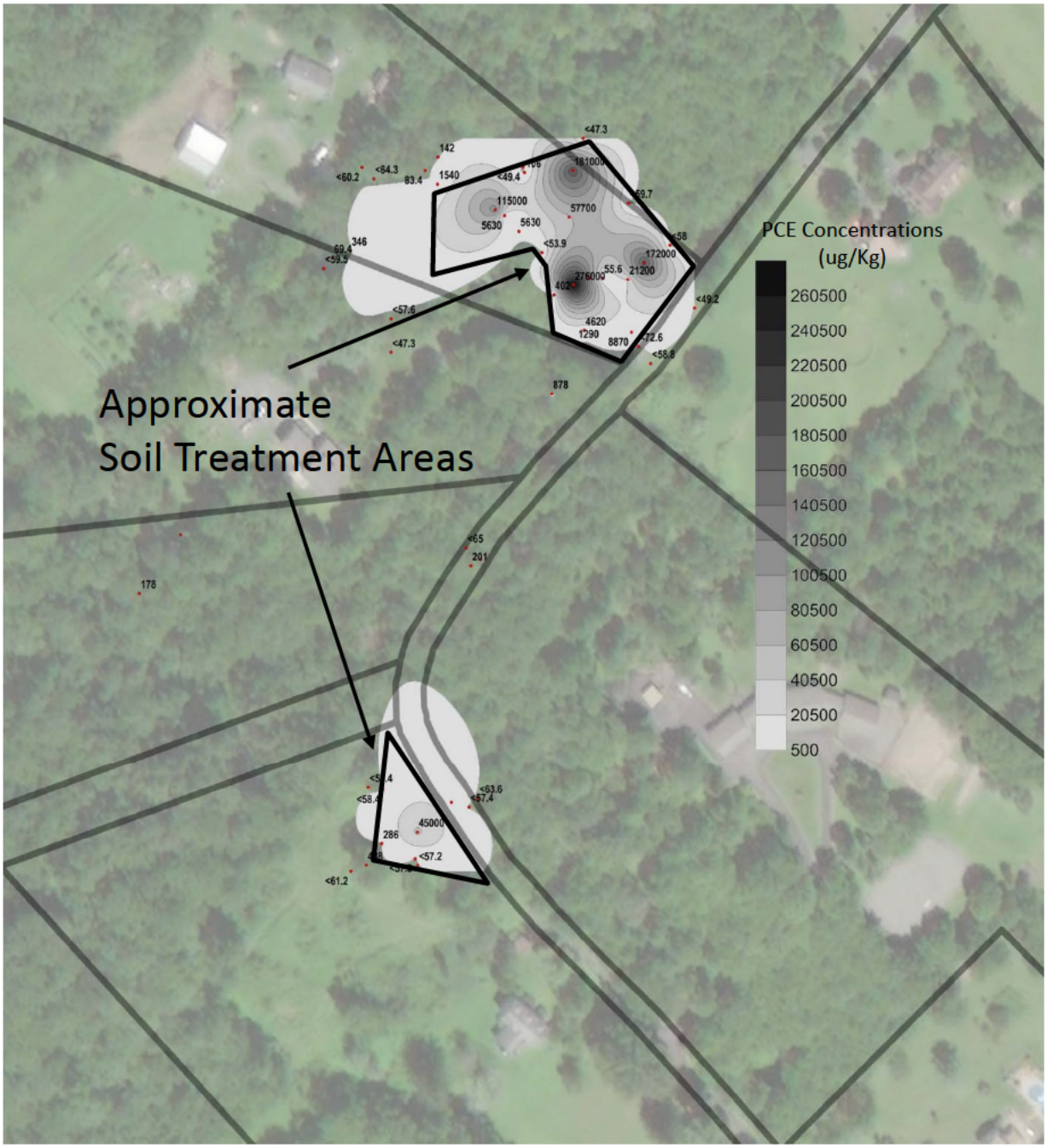
Drawn T.P.
Designed T.F.U.
Approved T.F.U.
Date 11/13/23
Figure 2

Scale In Feet
0 300

Groundwater & Environmental Services, Inc.

N:_Corporate\Graphics-Exton\Exton\PADEP-GTAC-IRRSC\GTAC\GTAC Nockamixon TCE Site\Nockamixon SM.dwg, B(SM 300), TPeters

Figure 3 – Approximate Soil Treatment Areas



Total Estimated Volume of Soil Treatment is 13,500 cubic yards

Approximate Soil Treatment Areas

PA Dept of Environmental Protection
Nockamixon TCE Site
Brennan Road, Nockamixon Township
Ottsville, Pennsylvania

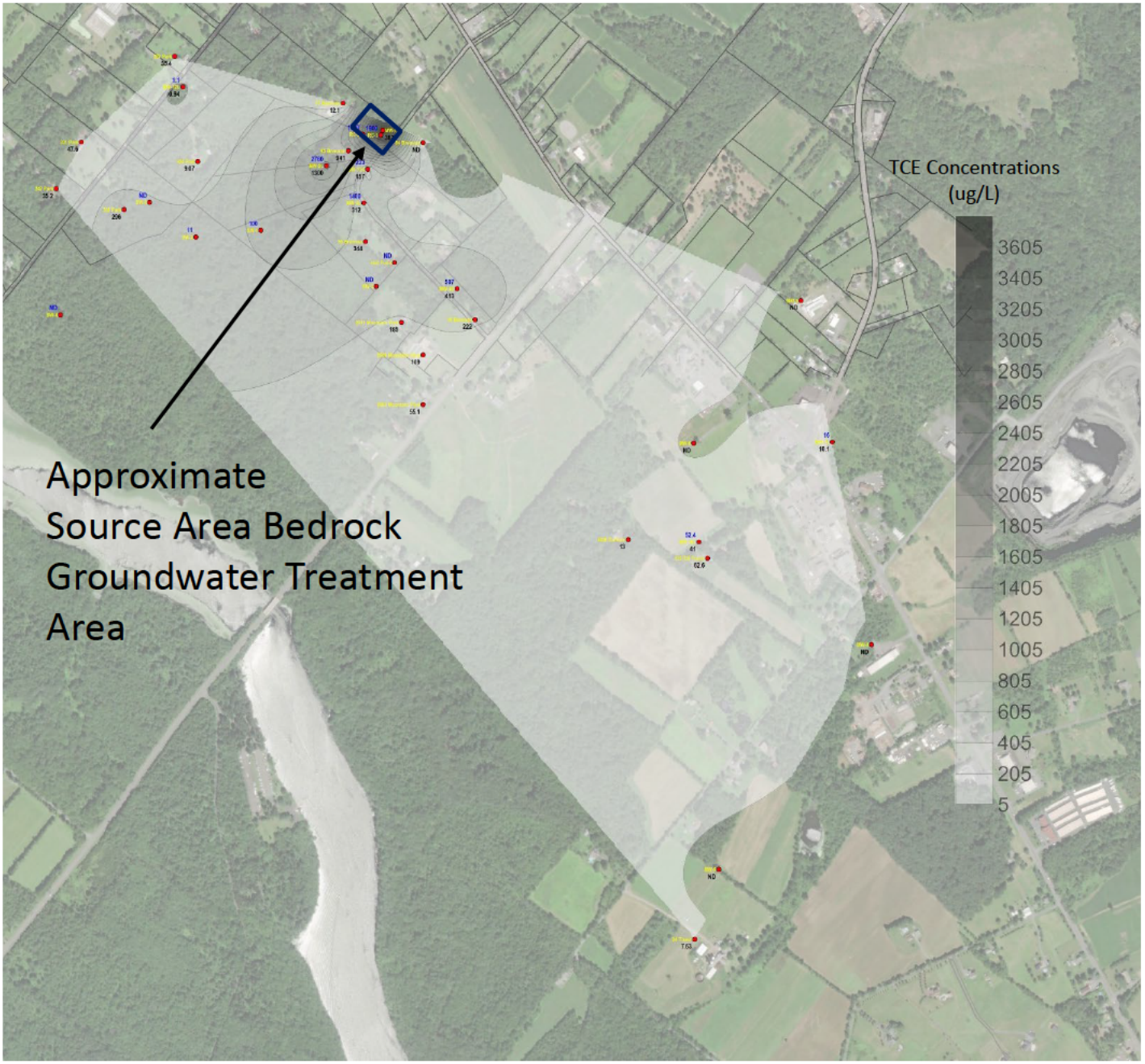
Drawn
H.M.K.
Designed
H.M.K.
Approved
T.F.U.

Date
10/9/23
Figure
3

Scale In Feet
0 Approximate 180

Groundwater & Environmental Services, Inc.

Figure 4 – Approximate Source Area Bedrock Groundwater Treatment Area



Total Area: 60,000 sq ft
Vertical Treatment Column: 90-250 ft bgs

Approximate Source Area Bedrock Treatment Area and TCE Concentration Map

PA Dept of Environmental Protection
Nockamixon TCE Site
Brennan Road, Nockamixon Township
Ottsville, Pennsylvania

Drawn
H.M.K.
Designed
H.M.K.
Approved
T.F.U.

Date
1/7/24
Figure
4

Scale In Feet
0 Approximate 1,250

Groundwater & Environmental Services, Inc.

Tables

Table 1 – Surface Water Analytical Data Summary

Table 1

Surface Water Analytical Data Summary

Sampling Event	Sample Location	Sample Date	1,1,1-Trichloroethane (µg/L)	1,1,2,2-Tetrachloroethane (µg/L)	1,1,2-Trichloroethane (µg/L)	1,1-Dichloroethane (µg/L)	1,1-Dichloroethene (1,1-Dichloroethylene) (µg/L)	1,2,4-Trichlorobenzene (µg/L)	1,2-Dibromo-3-Chloropropane (µg/L)	1,2-Dibromoethane (µg/L)	1,2-Dichlorobenzene (µg/L)	1,2-Dichloroethane (µg/L)	1,2-Dichloropropane (µg/L)	1,3-Dichlorobenzene (µg/L)	1,4-Dichlorobenzene (p-Dichlorobenzene) (µg/L)	1,4-Dioxane (µg/L)	2-Butanone (Ethyl methyl ketone) (µg/L)	2-Hexanone (Methyl n-butyl ketone) (µg/L)	4-Methyl-2-pentanone (Methyl isobutyl ketone) (µg/L)	Acetone (µg/L)	Benzene (µg/L)	Bromodichloromethane (Dichlorobromomethane) (µg/L)	Bromoform (Tribromomethane) (µg/L)	Bromomethane (µg/L)	Carbon disulfide (µg/L)
DEP Chapter 93 Surface Water Quality Fish and Aquatic Life Criteria for Continuous Concentrations			610	210	680	NS	1,500	26	NS	NS	160	3,100	2,200	69	150	NS	32,000	4,300	5,000	86,000	130	NS	370	NS	NS
DEP Chapter 93 Surface Water Quality Fish and Aquatic Life Criteria for Criteria Maximum Concentration			3,000	1,000	3,400	NS	7,500	130	NS	NS	820	15,000	11,000	350	730	NS	230,000	21,000	26,000	450,000	640	NS	1,800	NS	NS
DEP Chapter 93 Surface Water Quality Standards for Human Health			10,000	0.2	0.55	NS	33.0	0.07	NS	NS	1,000	9.9	0.90	7	300	NS	21,000	NS	NS	3,500	0.58	0.95	7.0	NS	NS
DEP Groundwater SHS for a Used, Residential Aquifer			200	0.84	5	31	7	70	0.2	0.05	600	5	5	600	75	6.4	4,000	63	2,800	31,000	5	80	80	10	1,500
March 2022 Sampling Event	SW-1	03/17/22	16	ND<0.30	ND<0.30	1.2	4.0	ND<0.30	ND<0.30	ND<0.20	ND<0.20	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<29 ^c	ND<0.50	ND<0.40	ND<0.50	ND<0.70	ND<0.30	ND<0.20	ND<1.0	ND<0.30	ND<0.30
	Field Blank #1	03/17/22	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.20	ND<0.20	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<29 ^c	ND<0.50	ND<0.40	ND<0.50	ND<0.70	ND<0.30	ND<0.20	ND<1.0	ND<0.30	ND<0.30
	Trip Blank #1	03/11/22	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.20	ND<0.20	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<29 ^c	ND<0.50	ND<0.40	ND<0.50	ND<0.70	ND<0.30	ND<0.20	ND<1.0	ND<0.30	ND<0.30
June 2022 Sampling Event	SW-2	06/22/22	0.91	ND<0.30	ND<0.30	0.99 J	0.88 J	ND<0.30	ND<0.30	ND<0.20	ND<0.20	ND<0.30	ND<0.30	ND<0.30	ND<0.30	0.72	ND<0.50	ND<0.40	ND<0.50	ND<0.70	ND<0.30	ND<0.20	ND<1.0	ND<0.30	ND<0.30
	SW-3	06/22/22	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.20	ND<0.20	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.17	ND<0.50	ND<0.40	ND<0.50	ND<0.70	ND<0.30	ND<0.20	ND<1.0	ND<0.30	ND<0.30
	SW-4	06/22/22	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.20	ND<0.20	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.17	ND<0.50	ND<0.40	ND<0.50	ND<0.70	ND<0.30	ND<0.20	ND<1.0	ND<0.30	ND<0.30
	Duplicate (SW-4)	06/22/22	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.20	ND<0.20	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.17	ND<0.50	ND<0.40	ND<0.50	ND<0.70	ND<0.30	ND<0.20	ND<1.0	ND<0.30	ND<0.30
	SW-6	06/22/22	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.20	ND<0.20	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.17	ND<0.50	ND<0.40	ND<0.50	ND<0.70	ND<0.30	ND<0.20	ND<1.0	ND<0.30	ND<0.30
	Hall Pond	06/22/22	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.20	ND<0.20	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.17	ND<0.50	ND<0.40	ND<0.50	ND<0.70	ND<0.30	ND<0.20	ND<1.0	ND<0.30	ND<0.30
	Field Blank	06/22/22	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.20	ND<0.20	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.17	ND<0.50	ND<0.40	ND<0.50	ND<0.70	ND<0.30	ND<0.20	ND<1.0	ND<0.30	ND<0.30
	Trip Blank	06/10/22	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.20	ND<0.20	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.17	ND<0.50	ND<0.40	ND<0.50	ND<0.70	ND<0.30	ND<0.20	ND<1.0	ND<0.30	ND<0.30

Notes:
DEP: Pennsylvania Department of Environmental Protection
SHS: Statewide Health Standard
N/A: Not applicable
NS: No standard
µg/L: micrograms per liter
J: Result is less than the reporting limit but greater than or equal to the method detection limit and the concentration is an approximate value.
^c: CCV Recovery is outside acceptance limits
ND<#: Indicates analysis was performed for the compound but it was not detected (# is the method detection limit)
Yellow Shaded: Indicates laboratory method detection limits exceed the DEP Chapter 93 Surface Water Quality Fish and Aquatic Life Criteria or Standard for Human Health, or the DEP SHS (when there was no Chapter 93 Surface Water Quality Criteria)
Red Shaded: Indicates concentrations exceed the DEP Chapter 93 Surface Water Quality Fish and Aquatic Life Criteria or Standard for Human Health.
Green Shaded: Indicates a concentration was detected.
Concentrations with no cooresponding Chapter 93 Surface Water Quality Fish and Aquatic Life Criteria or Standard for Human Health were compared to the DEP Groundwater SHS.
The standard for 1,3-dichloropropene was used for both *cis*-1,3-dichloropropene and *trans*-1,3-dichloropropene.

Table 1

Surface Water Analytical Data Summary

Sampling Event	Sample Location	Sample Date	Carbon tetrachloride (µg/L)	Chlorobenzene (µg/L)	Chloroethane (µg/L)	Chloroform (µg/L)	Chloromethane (Methyl Chloride) (µg/L)	cis-1,2-Dichloroethene (cis-1,2-Dichloroethylene) (µg/L)	cis-1,3-Dichloropropene (µg/L)	Cyclohexane	Dibromochloromethane (Chlorodibromomethane) (µg/L)	Dichlorodifluoromethane (Freon 12) (µg/L)	Ethylbenzene	Freon 113	Isopropylbenzene (Cumene) (µg/L)	Methyl acetate	Methyl tert-butyl Ether (MTBE) (µg/L)	Methylcyclohexane	Methylene chloride (µg/L)	Styrene (µg/L)	Tetrachloroethene (Tetrachloroethylene (PCE)) (µg/L)	Toluene (µg/L)	trans-1,2-Dichloroethene (trans-1,2-Dichloroethylene) (µg/L)	trans-1,3-Dichloropropene (µg/L)	Trichloroethene (Trichloroethylene (TCE)) (µg/L)	Trichlorofluoromethane (Fluorotrichloromethane (Freon 11)) (µg/L)	Vinyl chloride (µg/L)	Xylenes, Total (µg/L)
DEP Chapter 93 Surface Water Quality Fish and Aquatic Life Criteria for Continuous Concentrations			560	240	NS	390	5,500	NS	61	NS	NS	NS	580	NS	NS	NS	NS	NS	2,400	NS	140	330	1,400	61	450	NS	NS	210
DEP Chapter 93 Surface Water Quality Fish and Aquatic Life Criteria for Criteria Maximum Concentration			2,800	1,200	NS	1,900	28,000	NS	310	NS	NS	NS	2,900	NS	NS	NS	NS	NS	12,000	NS	700	1,700	6,800	310	2,300	NS	NS	1,100
DEP Chapter 93 Surface Water Quality Standards for Human Health			0.4	100	NS	5.7	NS	12	0.27	NS	0.8	NS	68	NS	NS	NS	NS	NS	20	NS	10	57	100	0.27	0.6	NS	0.02	70,000
DEP Groundwater SHS for a Used, Residential Aquifer			5	100	21,000	80	30	70	6.5	13,000	80	1,000	700	11,000	840	35,000	20	NS	5	100	5	1,000	100	6.5	5	2,000	2	10,000
March 2022 Sampling Event	SW-1	03/17/22	ND<0.30	ND<0.30	ND<0.20	ND<0.30	ND<0.20	110	ND<0.20	ND<1.0	ND<0.20	ND<0.20	ND<0.40	ND<0.30	ND<0.20	ND<0.30	ND<0.20	ND<0.50	ND<0.30	ND<0.30	140	ND<0.20	1.1	ND<0.20	100	ND<0.20	ND<0.20	ND<0.40
	Field Blank #1	03/17/22	ND<0.30	ND<0.30	ND<0.20	3.2	ND<0.20	ND<0.30	ND<0.20	ND<1.0	ND<0.20	ND<0.20	ND<0.40	ND<0.30	ND<0.20	ND<0.30	ND<0.20	ND<0.50	ND<0.30	ND<0.30	ND<0.30	ND<0.20	ND<0.30	ND<0.20	ND<0.30	ND<0.20	ND<0.20	ND<0.40
	Trip Blank #1	03/11/22	ND<0.30	ND<0.30	ND<0.20	ND<0.30	ND<0.20	ND<0.30	ND<0.20	ND<1.0	ND<0.20	ND<0.20	ND<0.40	ND<0.30	ND<0.20	ND<0.30	ND<0.20	ND<0.50	ND<0.30	ND<0.30	ND<0.30	ND<0.20	ND<0.30	ND<0.20	ND<0.30	ND<0.20	ND<0.20	ND<0.40
June 2022 Sampling Event	SW-2	06/22/22	ND<0.30	ND<0.30	ND<0.20	ND<0.30	ND<0.20	25	ND<0.20	ND<1.0	ND<0.20	ND<0.20	ND<0.40	ND<0.30	ND<0.20	ND<0.30	ND<0.20	ND<0.50	ND<0.30	ND<0.30	5.5	0.78 J	ND<0.30	ND<0.20	11	ND<0.20	3.2	ND<0.40
	SW-3	06/22/22	ND<0.30	ND<0.30	ND<0.20	ND<0.30	ND<0.20	ND<0.30	ND<0.20	ND<1.0	ND<0.20	ND<0.20	ND<0.40	ND<0.30	ND<0.20	ND<0.30	ND<0.20	ND<0.50	ND<0.30	ND<0.30	ND<0.30	ND<0.20	ND<0.30	ND<0.20	ND<0.30	ND<0.20	ND<0.20	ND<0.40
	SW-4	06/22/22	ND<0.30	ND<0.30	ND<0.20	ND<0.30	ND<0.20	ND<0.30	ND<0.20	ND<1.0	ND<0.20	ND<0.20	ND<0.40	ND<0.30	ND<0.20	ND<0.30	ND<0.20	ND<0.50	ND<0.30	ND<0.30	ND<0.30	ND<0.20	ND<0.30	ND<0.20	ND<0.30	ND<0.20	ND<0.20	ND<0.40
	Duplicate (SW-4)	06/22/22	ND<0.30	ND<0.30	ND<0.20	ND<0.30	ND<0.20	ND<0.30	ND<0.20	ND<1.0	ND<0.20	ND<0.20	ND<0.40	ND<0.30	ND<0.20	ND<0.30	ND<0.20	ND<0.50	ND<0.30	ND<0.30	ND<0.30	ND<0.20	ND<0.30	ND<0.20	ND<0.30	ND<0.20	ND<0.20	ND<0.40
	SW-6	06/22/22	ND<0.30	ND<0.30	ND<0.20	ND<0.30	ND<0.20	ND<0.30	ND<0.20	ND<1.0	ND<0.20	ND<0.20	ND<0.40	ND<0.30	ND<0.20	ND<0.30	ND<0.20	ND<0.50	ND<0.30	ND<0.30	ND<0.30	ND<0.20	ND<0.30	ND<0.20	ND<0.30	ND<0.20	ND<0.20	ND<0.40
	Hall Pond	06/22/22	ND<0.30	ND<0.30	ND<0.20	ND<0.30	ND<0.20	ND<0.30	ND<0.20	ND<1.0	ND<0.20	ND<0.20	ND<0.40	ND<0.30	ND<0.20	ND<0.30	ND<0.20	ND<0.50	ND<0.30	ND<0.30	ND<0.30	ND<0.20	ND<0.30	ND<0.20	ND<0.30	ND<0.20	ND<0.20	ND<0.40
	Field Blank	06/22/22	ND<0.30	ND<0.30	ND<0.20	1.9	ND<0.20	ND<0.30	ND<0.20	ND<1.0	ND<0.20	ND<0.20	ND<0.40	ND<0.30	ND<0.20	ND<0.30	ND<0.20	ND<0.50	ND<0.30	ND<0.30	ND<0.30	ND<0.20	ND<0.30	ND<0.20	ND<0.30	ND<0.20	ND<0.20	ND<0.40
	Trip Blank	06/10/22	ND<0.30	ND<0.30	ND<0.20	ND<0.30	ND<0.20	ND<0.30	ND<0.20	ND<1.0	ND<0.20	ND<0.20	ND<0.40	ND<0.30	ND<0.20	ND<0.30	ND<0.20	ND<0.50	ND<0.30	ND<0.30	ND<0.30	ND<0.20	ND<0.30	ND<0.20	ND<0.30	ND<0.20	ND<0.20	ND<0.40

Notes:
DEP: Pennsylvania Department of Environmental Protection
SHS: Statewide Health Standard
N/A: Not applicable
NS: No standard
µg/L: micrograms per liter
J: Result is less than the reporting limit but greater than or equal to the method detection limit and the concentration is an approximate value.
^c: CCV Recovery is outside acceptance limits
ND<#: Indicates analysis was performed for the compound but it was not detected (# is the method detection limit)
Yellow Shaded: Indicates laboratory method detection limits exceed the DEP Chapter 93 Surface Water Quality Fish and Aquatic Life Criteria or Standard for Human Health, or the DEP SHS (when there was no Chapter 93 Surface Water Quality Criteria)
Red Shaded: Indicates concentrations exceed the DEP Chapter 93 Surface Water Quality Fish and Aquatic Life Criteria or Standard for Human Health.
Green Shaded: Indicates a concentration was detected.
Concentrations with no cooresponding Chapter 93 Surface Water Quality Fish and Aquatic Life Criteria or Standard for Human Health were compared to the DEP Groundwater SHS.
The standard for 1,3-dichloropropene was used for both *cis* -1,3-dichloropropene and *trans* -1,3-dichloropropene.

Table 2 – Soil - Rock Core Analytical Data Summary

Table 2

Soil and Rock Coring Analytical Data Summary

Sampling Event	Sample ID	Depth (ft)	Sample Date	Soil Condition	1,1,1-Trichloroethane	1,1,2,2-Tetrachloroethane	1,1,2-Trichloroethane	1,1-Dichloroethane	1,1-Dichloroethene (1,1-Dichloroethylene)	1,2,4-Trichlorobenzene	1,2-Dibromo-3-chloropropane	1,2-Dibromoethane (Ethylene Dibromide)	1,2-Dichlorobenzene	1,2-Dichloroethane	1,2-Dichloropropane	1,3-Dichlorobenzene	1,4-Dichlorobenzene (*p*-Dichlorobenzene)	2-Butanone (Methyl ethyl ketone)	2-Hexanone (Methyl *n*-butyl ketone)	4-Methyl-2-Pentanone (Methyl isobutyl ketone)	Acetone	Benzene	Bromodichloromethane	Bromoform (Tribromomethane)	Bromomethane	Carbon Disulfide	Carbon Tetrachloride	Chlorobenzene	Chloroethane	Chloroform
					(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)
DEP Soil to Groundwater Values for Unsaturated/Saturated Soil in a Residential, Used Aquifer					20,000	84	500	3,100	700	27,000/ 7,000	20	5	60,000	500	500	61,000/ 60,000	10,000/ 7,500	400,000	6,300	280,000	3,100,000	500	8,000	8,000	1,000	150,000	500	10,000	2,100,000	8,000
DEP Soil to Groundwater Values for Unsaturated/Saturated Soil in a Non-Residential, Used Aquifer					20,000	430	500	16,000	700	27,000/ 7,000	20	5	60,000	500	500	61,000/ 60,000	10,000/ 7,500	400,000	26,000	780,000	8,800,000	500	8,000	8,000	1,000	620,000	500	10,000	8,800,000	8,000
DEP Residential Direct Contact Numeric Values (0-15 feet)					10,000,000	7,600	3,800	280,000	3,800,000	39,000	29	740	3,800,000	17,000	120	10,000,000	40,000	10,000,000	570,000	10,000,000	10,000,000	57,000	12,000	400,000	95,000	10,000,000	75,000	950,000	10,000,000	19,000
DEP Non-Residential Direct Contact Numeric Values Surface Soil (0-2 feet)					10,000,000	38,000	16,000	1,400,000	10,000,000	160,000	370	3,700	10,000,000	85,000	600	10,000,000	200,000	10,000,000	2,400,000	10,000,000	10,000,000	280,000	60,000	2,000,000	400,000	10,000,000	370,000	3,900,000	10,000,000	96,000
DEP Non-Residential Direct Contact Numeric Values Subsurface Soil (2-15 feet)					10,000,000	44,000	18,000	1,600,000	10,000,000	190,000	420	4,200	10,000,000	98,000	690	10,000,000	230,000	10,000,000	2,700,000	10,000,000	10,000,000	330,000	69,000	2,300,000	460,000	10,000,000	430,000	45,000,000	10,000,000	110,000
Soil Boring Investigation November 2022	RC-1 @ 4'-4.5'	4-4.5	10/26/22	Unsaturated	21	ND<0.46 ^c	ND<0.57	ND<0.57	0.67 J	ND<5.7	ND<0.57 ^c	ND<0.46	ND<0.57	ND<0.69	ND<0.57	ND<0.57	ND<0.46	ND<2.3	ND<1.1 ^c	ND<1.1	23	ND<0.57	ND<0.46	ND<5.7	ND<0.80	ND<0.69	ND<0.57	ND<0.57	ND<1.1	ND<0.69
	RC-1 @ 4'-4.5' (DUPLICATE)	4-4.5	10/26/22	Unsaturated	94	ND<0.44 ^c	ND<0.55	ND<0.55	ND<0.55	ND<5.5	ND<0.44	ND<0.44	ND<0.55	ND<0.66	ND<0.55	ND<0.55	ND<0.44	ND<2.2	ND<1.1 ^c	ND<1.1	18 J	ND<0.55	ND<0.44	ND<5.5	ND<0.77	ND<0.66	ND<0.55	ND<0.55	ND<1.1	ND<0.66
	RC-1 @ 4.75'-5.2'	4.75-5.2	10/26/22	Unsaturated	ND<0.59	ND<0.40 ^c	ND<0.49	ND<0.49	ND<0.49	ND<4.9	ND<0.49 ^c	ND<0.40	ND<0.49	ND<0.59	ND<0.49	ND<0.49	ND<0.40	ND<2.0	ND<0.99 ^c	ND<0.99	15 J	ND<0.49	ND<0.40	ND<4.9	ND<0.69	ND<0.59	ND<0.49	ND<0.49	ND<0.99	ND<0.59
	RC-1 @ 6'-6.5'	6-6.5	10/27/22	Unsaturated	ND<11,000	ND<100	ND<130	ND<130	ND<130	ND<1,30	ND<250	ND<100	ND<130	ND<150	ND<130	ND<130	ND<100	ND<510	ND<250	ND<250	ND<1,500	ND<130	ND<100	ND<1,300	ND<180 *+, ^c	ND<150	ND<510	ND<130	ND<250 ^c, *+	ND<150
	RC-1 @ 8.5'-9'	8.5-9	10/27/22	Unsaturated	71 J	ND<23	ND<29	ND<29	ND<29	ND<290	ND<58	ND<23	ND<29	ND<35	ND<29	ND<29	ND<23	ND<120	ND<58	ND<58	ND<350	ND<29	ND<23	ND<290	ND<41 *+, ^c	ND<35	ND<120	ND<29	ND<58 ^c, *+	ND<35
	RC-1 @ 88'-89'	88-89	11/01/22	Unsaturated	ND<0.53	ND<0.35	ND<0.44	ND<0.44	ND<0.44	ND<4.4	ND<0.44	ND<0.35	ND<0.44	ND<0.53	ND<0.44	ND<0.44	ND<0.35	3.1 J, ^c	ND<0.88 ^c	ND<0.88 ^c	65	ND<0.44	ND<0.35	ND<4.4	ND<0.62	ND<0.53	ND<0.44	ND<0.44	ND<0.88	ND<0.53
	RC-2 @ 1.5'-2'	1.5-2	11/03/22	Unsaturated	ND<0.69	ND<0.46 ^c, *+	ND<0.57	ND<0.57	ND<0.57	ND<5.7	ND<0.57 ^c	ND<0.46	ND<0.57	ND<0.69	ND<0.57	ND<0.57	ND<0.46	ND<2.3	ND<1.1 ^c	ND<1.1 ^c	38	ND<0.57	ND<0.46	ND<5.7	ND<0.80	ND<0.69	ND<0.57	ND<0.57	ND<1.1	ND<0.69
	RC-2 @ 4'-4.5'	4-4.5	11/03/22	Unsaturated	ND<0.69	ND<0.46 ^c, *+	ND<0.57	ND<0.57	ND<0.57	ND<5.7	ND<0.57 ^c	ND<0.46	ND<0.57	ND<0.69	ND<0.57	ND<0.57	ND<0.46	2.5 J	ND<1.1 ^c	ND<1.1 ^c	39	ND<0.57	ND<0.46	ND<5.7	ND<0.80	ND<0.69	ND<0.57	ND<0.57	ND<1.1	ND<0.69
	RC-2 @ 6'-6.5'	6-6.5	11/03/22	Unsaturated	0.75 J	ND<0.43 ^c, *+	ND<0.54	ND<0.54	ND<0.54	ND<5.4	ND<0.54 ^c	ND<0.43	ND<0.54	ND<0.65	ND<0.54	ND<0.54	ND<0.43	3.6 J	ND<1.1 ^c	ND<1.1 ^c	54	ND<0.54	ND<0.43	ND<5.4	ND<0.76	ND<0.65	ND<0.54	ND<0.54	ND<1.1	ND<0.65
	RC-2 @ 8.5'-9'	8.5-9	11/03/22	Unsaturated	ND<0.62	ND<0.41 ^c	ND<0.52	ND<0.52	ND<0.52	ND<5.2	ND<0.52 ^c	ND<0.41	ND<0.52	ND<0.62	ND<0.52	ND<0.52	ND<0.41	ND<2.1	ND<1.0 ^c	ND<1.1 ^c	28	ND<0.52	ND<0.41	ND<5.2	ND<0.72	ND<0.62	ND<0.52	ND<0.52	ND<1.0	ND<0.62
	RC-2 @ 102.5'-103'	102.5-103	11/09/22	Unsaturated	ND<0.56	ND<0.38	ND<0.47	ND<0.47	ND<0.47	ND<4.7	ND<0.47	ND<0.38	ND<0.47	ND<0.56	ND<0.47	ND<0.47	ND<0.38	2.6 J	ND<0.94 ^c	ND<0.94 ^c	22	ND<0.47	ND<0.38	ND<4.7	ND<0.66	ND<0.56	ND<0.47	ND<0.47	ND<0.94	ND<0.56
	RC-2 @ 169.5'-170'	169.5-170	11/16/22	Saturated	ND<0.53	ND<0.35	ND<0.44	ND<0.44	ND<0.44	ND<4.4	ND<0.44 ^c	ND<0.35	ND<0.44	ND<0.53	ND<0.44	ND<0.44	ND<0.35	ND<1.8	ND<0.88 ^c, B	ND<0.88 ^c	64	ND<0.44	ND<0.35	ND<4.4	ND<0.62	ND<0.53	ND<0.44	ND<0.44	ND<0.88	ND<0.53
	RC-2 @ 249.5'-250'	249.5-250	11/16/22	Saturated	ND<0.50	ND<0.34	ND<0.42	ND<0.42	ND<0.42	ND<4.2	ND<0.42 ^c	ND<0.34	ND<0.42	ND<0.50	ND<0.42	ND<0.42	ND<0.34	ND<1.7	ND<0.84 ^c, B	ND<0.84 ^c	5.8 J	ND<0.42	ND<0.34	ND<4.2	ND<0.59	ND<0.50	ND<0.42	ND<0.42	ND<0.84	ND<0.50
DEP Residential Used Aquifer Statewide Health Standards (SHS)					200	0.84	5	31	7	70	0.2	0.05	600	5	5	600	75	4,000	63	2,800	31,000	5	80	80	10	1,500	5	100	21,000	80
Aqueous QA/QC Samples (µg/L)	Field Blank	-	10/26/22	-	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.20	ND<0.20	ND<0.30	ND<0.30	ND<0.68	ND<0.30	ND<0.50	ND<0.85	ND<0.50	1.5 J, ^c	ND<0.30	ND<0.20	ND<1.0 ^c	ND<0.30	ND<0.30	ND<0.30 ^c	ND<0.30	ND<0.20	1.9
	Trip Blank	-	10/26/22	-	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.20	ND<0.20	ND<0.30	ND<0.30	ND<0.68	ND<0.30	ND<0.50	ND<0.85	ND<0.50	0.91 J, ^c	ND<0.30	ND<0.20	ND<1.0 ^c	ND<0.30	ND<0.30	ND<0.30 ^c	ND<0.30	ND<0.20	ND<0.30
	Trip Blank	-	11/01/22	-	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.20	ND<0.20	ND<0.30	ND<0.30	ND<0.68	ND<0.30	ND<0.50	ND<0.85	ND<0.50	ND<0.70 ^c	ND<0.30	ND<0.20	ND<1.0 ^c	ND<0.30	ND<0.30	ND<0.30 ^c	ND<0.30	ND<0.20	ND<0.30
	Trip Blank	-	11/03/22	-	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.20	ND<0.20	ND<0.30	ND<0.30	ND<0.68	ND<0.30	ND<0.50	ND<0.85 ^c	ND<0.50 ^c	ND<0.70	ND<0.30	ND<0.20	ND<1.0 ^c	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.20	ND<0.30
	Trip Blank	-	11/09/22	-	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.20	ND<0.20	ND<0.30	ND<0.30	ND<0.68	ND<0.30	ND<0.50	ND<0.85	ND<0.50	ND<0.70	ND<0.30	ND<0.20	ND<1.0	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.20	ND<0.30
	Equipment Blank	-	11/16/22	-	ND<0.30	ND<0.30	ND<0.30	ND<0.30 ^c	ND<0.30	ND<0.30	ND<0.30	ND<0.20	ND<0.20	ND<0.30	ND<0.30	ND<0.68	ND<0.30	ND<0.50	ND<0.85	ND<0.50	2.8 J	ND<0.30	ND<0.20	ND<1.0	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.20	ND<0.30
	Trip Blank	-	11/16/22	-	ND<0.30	ND<0.30	ND<0.30	ND<0.30 ^c	ND<0.30	ND<0.30	ND<0.30	ND<0.20	ND<0.20	ND<0.30	ND<0.30	ND<0.68	ND<0.30	ND<0.50	ND<0.85	ND<0.50	ND<0.70	ND<0.30	ND<0.20	ND<1.0	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.20	ND<0.30

Notes:
DEP: Pennsylvania Department of Environmental Protection
SHS: Statewide Health Standard
ft: feet
mg/kg: milligrams per kilogram
µg/L: micrograms per liter
NS: No standard
ND< : Indicates analysis was performed for the test but it was not detected. The sample method detection limit is
B: Analyte was found in the blank.
E: Results exceed calibration range
H: Sample was prepped or analyzed beyond the specific holding time.
J: Result is less than the reporting limit but greater than or equal to the method detection limit and the concentration is an approximate value
*+: Laboratory Control Sample (LCS) and/or Laboratory Control Sample Duplicate (LCSD) is outside acceptance limits, high biased.
^c: Continuing calibration vertification (CCV) recovery is outside the acceptance limits
*3: Internal Standard response or retention time outside acceptable limits.
Indicates laboratory method detection limits exceed the applicable DEP Act 2 Standard.
Indicates concentrations exceed the applicable DEP Act 2 Standard.
Indicates a concentration was detected.
The standard for 1,3-dichloropropene was used for both *cis*-1,3-dichloropropene and *trans*-1,3-dichloropropene.

Table 2

Soil and Rock Coring Analytical Data Summary

Sampling Event	Sample ID	Depth (ft)	Sample Date	Soil Condition	Chloromethane (Methyl Chloride)	Cyclohexane	*cis* -1,2-Dichloroethene (*cis* -1,2-Dichloroethylene)	*cis* -1,3-Dichloropropene	Dibromochloromethane (Chlorodibromomethane)	Dichlorodifluoromethane (Freon 12)	Ethylbenzene	Freon 113 (1,1,2-Trichloro-1,2,2-Trifluoroethane)	Isopropylbenzene (Cumene)	Methyl acetate	Methylcyclohexane	Methylene Chloride (Dichloromethane)	Methyl *tert*-butyl ether (MTBE)	Styrene	Tetrachloroethene (Tetrachloroethylene (PCE))	Toluene	Total Xylenes	*trans* -1,2-Dichloroethene (*trans* -1,2-Dichloroethylene)	*trans* -1,3-Dichloropropene	Trichloroethene (Trichloroethylene (TCE))	Trichlorofluoromethane (Fluorotrichloromethane (Freon 11))	Vinyl Chloride
					(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)
DEP Soil to Groundwater Values for Unsaturated/Saturated Soil in a Residential, Used Aquifer					**3,000**	**1,700,000/ 1,300,000**	**7,000**	**650**	**8,000**	**100,000**	**70,000**	**3,400,000/ 1,100,000**	**600,000/ 84,000**	**3,500,000**	**NS**	**500**	**2,000**	**24,000/ 10,000**	**500**	**100,000**	**1,000,000**	**10,000**	**650**	**500**	**200,000**	**200**
DEP Soil to Groundwater Values for Unsaturated/Saturated Soil in a Non-Residential, Used Aquifer					**3,000**	**6,900,000/ 5,300,000**	**7,000**	**2,700**	**8,000**	**100,000**	**70,000**	**10,000,000/ 4,400,000**	**2,500,000/ 350,000**	**9,700,000**	**NS**	**500**	**2,000**	**24,000/ 10,000**	**500**	**100,000**	**1,000,000**	**10,000**	**2,700**	**500**	**200,000**	**200**
DEP Residential Direct Contact Numeric Values (0-15 feet)					**250,000**	**10,000,000**	**440,000**	**110,000**	**220,000**	**1,900,000**	**180,000**	**10,000,000**	**7,600,000**	**10,000,000**	**NS**	**1,300,000**	**1,700,000**	**10,000,000**	**760,000**	**10,000,000**	**1,900,000**	**4,400,000**	**110,000**	**38,000**	**10,000,000**	**930**
DEP Non-Residential Direct Contact Numeric Values Surface Soil (0-2 feet)					**1,200,000**	**10,000,000**	**6,400,000**	**550,000**	**1,100,000**	**8,000,000**	**880,000**	**10,000,000**	**10,000,000**	**10,000,000**	**NS**	**10,000,000**	**8,500,000**	**10,000,000**	**3,200,000**	**10,000,000**	**7,900,000**	**10,000,000**	**550,000**	**160,000**	**10,000,000**	**61,000**
DEP Non-Residential Direct Contact Numeric Values Subsurface Soil (2-15 feet)					**1,400,000**	**10,000,000**	**10,000,00**	**640,000**	**10,000,000**	**9,100,000**	**1,000,000**	**10,000,000**	**10,000,000**	**10,000,000**	**NS**	**10,000,000**	**9,800,000**	**10,000,000**	**3,600,000**	**10,000,000**	**9,100,000**	**10,000,000**	**640,000**	**180,000**	**10,000,000**	**290,000**
Soil Boring Investigation November 2022	RC-1 @ 4'-4.5'	4-4.5	10/26/22	Unsaturated	ND<0.69	ND<0.57	6.2	ND<0.46	ND<0.57	ND<0.69	ND<0.46	ND<0.69	ND<0.46	ND<1.1 ^c	ND<0.69 ^c	ND<2.3	ND<0.57	ND<0.46	420	1.4 J	1.8 J	ND<0.57	ND<0.57	520 E	ND<0.80	ND<0.69
	RC-1 @ 4'-4.5' (DUPLICATE)	4-4.5	10/26/22	Unsaturated	ND<0.66	ND<0.55	4.4 J	ND<0.44	ND<0.55	ND<0.66	0.56 J	ND<0.66	ND<0.44	ND<1.1 ^c	ND<0.66	ND<2.2	ND<0.55	ND<0.44	2,300	1.3 J	2.3 J	ND<0.55	ND<0.55	120	ND<0.77	ND<0.66
	RC-1 @ 4.75'-5.2'	4.75-5.2	10/26/22	Unsaturated	ND<0.59	ND<0.49	8.0	ND<0.40	ND<0.49	ND<0.59	ND<0.40	ND<0.59	ND<0.40	ND<0.99 ^c	ND<0.59	ND<2.0	ND<0.49	ND<0.40	8.4	1.5 J	1.9 J	ND<0.49	ND<0.49	14	ND<0.69	ND<0.59
	RC-1 @ 6'-6.5'	6-6.5	10/27/22	Unsaturated	ND<150	ND<130	ND<1,900	ND<100	ND<510	ND<150 ^c	ND<4,600	ND<150 ^c	ND<7,200	ND<250	870 J	ND<510	ND<130	ND<100	95,000	ND<150	31,000	ND<130	ND<130	48,000	ND<180	ND<150
	RC-1 @ 8.5'-9'	8.5-9	10/27/22	Unsaturated	ND<35	ND<29	150 J	ND<23	ND<120	ND<35 ^c	ND<23	ND<35 ^c	ND<23	ND<58	ND<35	ND<120	ND<29	ND<23	220 J	ND<35	86 J	ND<29	ND<29	250 J	ND<41	ND<35
	RC-1 @ 88'-89'	88-89	11/01/22	Unsaturated	ND<0.53	ND<0.44	8.8	ND<0.35	ND<0.44	ND<0.53 ^c	ND<0.35	ND<0.53	ND<0.35	3.7 J	ND<0.53 ^c	ND<1.8	ND<0.44	ND<0.35	1.8 J	3.6 J	ND<1.2	ND<0.44	ND<0.44	63	ND<0.62	ND<0.53
	RC-2 @ 1.5'-2'	1.5-2	11/03/22	Unsaturated	ND<0.69	ND<0.57	ND<0.57	ND<0.46	ND<0.57	ND<0.69	ND<0.46	ND<0.69	ND<0.46	ND<1.1 *+	ND<0.69 ^c	ND<2.3	ND<0.57	ND<0.46	ND<0.57	1.8 J	ND<1.6	ND<0.57	ND<0.57	ND<0.57	ND<0.80	ND<0.69
	RC-2 @ 4'-4.5'	4-4.5	11/03/22	Unsaturated	ND<0.69	ND<0.57	1.1 J	ND<0.46	ND<0.57	ND<0.69	ND<0.46	ND<0.69	ND<0.46	ND<1.1 *+	ND<0.69 ^c	ND<2.3	ND<0.57	ND<0.46	ND<0.57	2.2 J	ND<1.6	ND<0.57	ND<0.57	ND<0.57	ND<0.80	ND<0.69
	RC-2 @ 6'-6.5'	6-6.5	11/03/22	Unsaturated	ND<0.65	ND<0.54	8.5	ND<0.43	ND<0.54	ND<0.65	ND<0.43	ND<0.65	ND<0.43	ND<1.1 *+	ND<0.65 ^c	ND<2.2	ND<0.54	ND<0.43	1.3 J	2.0 J	ND<1.5	ND<0.54	ND<0.54	4.3 J	ND<0.76	ND<0.65
	RC-2 @ 8.5'-9'	8.5-9	11/03/22	Unsaturated	ND<0.62	ND<0.52	1.2 J	ND<0.41	ND<0.52	ND<0.62	ND<0.41	ND<0.62	ND<0.41	ND<1.0 *+, ^c	ND<0.62	ND<2.1	ND<0.52	ND<0.41	ND<0.52	2.1 J	ND<1.4	ND<0.52	ND<0.52	0.68 J	ND<0.72	ND<0.62
	RC-2 @ 102.5'-103'	102.5-103	11/09/22	Unsaturated	ND<0.56	ND<0.47	ND<0.47	ND<0.38	ND<0.47	ND<0.56	ND<0.38	ND<0.56	ND<0.38	ND<0.94	ND<0.56	ND<1.9	ND<0.47	ND<0.38	ND<0.47	ND<0.56	ND<1.3	ND<0.47	ND<0.47	ND<0.47	ND<0.66	ND<0.56
	RC-2 @ 169.5'-170'	169.5-170	11/16/22	Saturated	ND<0.53	ND<0.44	ND<0.44	ND<0.35	ND<0.44	ND<0.53	ND<0.35	ND<0.53	ND<0.35	ND<0.88 ^c, *+	ND<0.53	ND<1.8	ND<0.44	ND<0.35	ND<0.44	2.7 J	ND<1.2	ND<0.44	ND<0.44	ND<0.44	ND<0.62	ND<0.53
	RC-2 @ 249.5'-250'	249.5-250	11/16/22	Saturated	ND<0.50	ND<0.42	ND<0.42	ND<0.34	ND<0.42	ND<0.50	ND<0.34	ND<0.50	ND<0.34	ND<0.84 ^c, *+	ND<0.50	ND<1.7	ND<0.42	ND<0.34	ND<0.42	ND<0.50	ND<1.2	ND<0.42	ND<0.42	ND<0.42	ND<0.59	ND<0.50
DEP Residential Used Aquifer Statewide Health Standards (SHS)					**30**	**13,000**	**70**	**6.5**	**80**	**1,000**	**700**	**11,000**	**840**	**35,000**	**NS**	**5**	**20**	**100**	**5**	**1,000**	**10,000**	**100**	**6.5**	**5**	**2,000**	**2**
Aqueous QA/QC Samples (µg/L)	Field Blank	-	10/26/22	-	ND<0.55	ND<1.0	ND<0.30	ND<0.20	ND<0.20	ND<0.20	ND<0.40	ND<0.30	ND<0.20	ND<0.30	ND<0.50	ND<0.30	ND<0.20	ND<0.30	ND<0.30	ND<0.20	ND<0.40	ND<0.70	ND<0.20	ND<0.30	ND<0.20	ND<0.20
	Trip Blank	-	10/26/22	-	ND<0.55	ND<1.0	ND<0.30	ND<0.20	ND<0.20	ND<0.20	ND<0.40	ND<0.30	ND<0.20	ND<0.30	ND<0.50	ND<0.30	ND<0.20	ND<0.30	ND<0.30	ND<0.20	ND<0.40	ND<0.70	ND<0.20	ND<0.30	ND<0.20	ND<0.20
	Trip Blank	-	11/01/22	-	ND<0.55	ND<1.0	ND<0.30	ND<0.20	ND<0.20	ND<0.20	ND<0.40	ND<0.30	ND<0.20	ND<0.30	ND<0.50	ND<0.30	ND<0.20	ND<0.30	ND<0.30	ND<0.20	ND<0.40	ND<0.70	ND<0.20	ND<0.30	ND<0.20	ND<0.20
	Trip Blank	-	11/03/22	-	ND<0.55	ND<1.0	ND<0.30	ND<0.20	ND<0.20	ND<0.20	ND<0.40	ND<0.30	ND<0.20	ND<0.30 ^c	ND<0.50	ND<0.30	ND<0.20	ND<0.30	ND<0.30	ND<0.20	ND<0.40	ND<0.70	ND<0.20	ND<0.30	ND<0.20	ND<0.20
	Trip Blank	-	11/09/22	-	ND<0.55	ND<1.0	ND<0.30	ND<0.20	ND<0.20	ND<0.20	ND<0.40	ND<0.30	ND<0.20	ND<0.30 ^c	ND<0.50	ND<0.30	ND<0.20	ND<0.30	ND<0.30	ND<0.20	ND<0.40	ND<0.70	ND<0.20	ND<0.30	ND<0.20	ND<0.20
	Equipment Blank	-	11/16/22	-	ND<0.55 ^c	ND<1.0	ND<0.30	ND<0.20	ND<0.20	ND<0.20	ND<0.40	ND<0.30	ND<0.20	ND<0.30	ND<0.50 ^c	ND<0.30 *+, ^c	ND<0.20	ND<0.30	ND<0.30	ND<0.20	ND<0.40	ND<0.70 ^c	ND<0.20	ND<0.30	ND<0.20 ^c	ND<0.20
	Trip Blank	-	11/16/22	-	ND<0.55 ^c	ND<1.0	ND<0.30	ND<0.20	ND<0.20	ND<0.20	ND<0.40	ND<0.30	ND<0.20	ND<0.30	ND<0.50 ^c	ND<0.30 *+, ^c	ND<0.20	ND<0.30	ND<0.30	ND<0.20	ND<0.40	ND<0.70 ^c	ND<0.20	ND<0.30	ND<0.20 ^c	ND<0.20

Notes:

DEP: Pennsylvania Department of Environmental Protection
SHS: Statewide Health Standard
ft: feet
mg/kg: milligrams per kilogram
µg/L: micrograms per liter
NS: No standard
ND< : Indicates analysis was performed for the test but it was not detected. The sample method detection limit is
B: Analyte was found in the blank.
E: Results exceed calibration range
H: Sample was prepped or analyzed beyond the specific holding time.
J: Result is less than the reporting limit but greater than or equal to the method detection limit and the concentration is an approximate value
*+: Laboratory Control Sample (LCS) and/or Laboratory Control Sample Duplicate (LCSD) is outside acceptance limits, high biased.
^c: Continuing calibration vertification (CCV) recovery is outside the acceptance limits
*3: Internal Standard response or retention time outside acceptable limits.
Indicates laboratory method detection limits exceed the applicable DEP Act 2 Standard.
Indicates concentrations exceed the applicable DEP Act 2 Standard.
Indicates a concentration was detected.
The standard for 1,3-dichloropropene was used for both *cis*-1,3-dichloropropene and *trans*-1,3-dichloropropene.

Table 3 – Groundwater Analytical Data Summary

Table 3
Groundwater Analytical Data Summary

Sample ID	Sample Date	1,1,1-Trichloroethane	1,1,2-Trichloroethane	1,1-Dichloroethane	1,1-Dichloroethene (1,1-Dichloroethylene)	*cis*-1,2-Dichloroethene (*cis*-1,2-Dichloroethylene)	Tetrachloroethene (Tetrachloroethylene (PCE))	*trans*-1,2-Dichloroethene (*trans*-1,2-Dichloroethylene)	Trichloroethene (Trichloroethylene (TCE))	1,4-Dioxane
		(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)
DEP Groundwater SHS for a Used, Residential Aquifer		**200**	**5**	**31**	**7**	**70**	**5**	**100**	**5**	**6.5**
MW-1S Converted to multi - screened well MW-1Ss/1Sd December 2019	09/10/13 *	3.9	ND	ND	1.6	67.2	2.2	ND	295	NA
	12/11/13	0.53	ND	ND	ND	6.6	ND	ND	23.9	NA
	04/07/14	0.72	ND	ND	ND	9.6	ND	ND	34.2	NA
	09/09/15	63.4	5.8	ND	42.5	1,470	104	ND	9,020	NA
	07/06/16	36.4	ND	ND	23.7	704	50	2.4	4,280	NA
	08/30/17	53.4	ND	ND	ND	752	38.2	19.8	2,710	NA
	08/22/18	35.7	ND	ND	17.2	589	53.4	ND	3,190	NA
	10/03/18	NA	NA	NA	NA	NA	NA	NA	NA	37.1
	06/18/19	40.5	ND	ND	25.6	762	50.2	ND	3,820	46.2
MW-1Ss	01/30/20	7.4	ND	ND	ND	167	5.6	ND	561	16.4
	12/03/20	4.4	0.62	ND	2.3	68	2.7	ND	317	11
	11/08/21	4.6	ND	ND	2.2	58.7	2.6	ND	276	7.7
	10/24/22	2.4 J	ND<1.5	ND<1.5	ND<1.5	34	ND<1.5	ND<3.5	160	7.4
	04/27/23	26	0.90 J	1.3	2.5	230	19	1.7 J	570	11
MW-1Sd	01/30/20	ND	ND	ND	ND	51.7	5.6	ND	169	5.1
	12/03/20	0.73	ND	ND	ND	4.7	ND	ND	18.8	2.8
	11/08/21	1.6	ND	ND	0.8	20.1	0.85	ND	39.4	ND
	10/24/22	0.70 J	ND<0.30	ND<0.30	0.50 J	6.6	0.33 J	ND<0.70	18	1.1
	04/27/23	0.83 J	ND<0.30	ND<0.30	0.46 J	11	0.41 J	ND<0.70	32	1.7
MW-1L	01/14/13*	ND	ND	ND	ND	3.5	ND	ND	11.2	NA
	09/09/13*	ND	ND	ND	0.68	4	ND	ND	7	NA
	12/11/13	ND	ND	ND	ND	2.5	ND	ND	4.8	NA
	04/03/14	ND	ND	ND	ND	1.8	ND	ND	ND	NA
	09/09/15	ND	ND	ND	ND	1.2	ND	ND	5.2	NA
	08/30/17	ND	ND	ND	ND	2.7	ND	ND	5.8	NA
	08/22/18	ND	ND	ND	ND	1.9	ND	ND	4.9	NA
	06/18/19	Not Sampled Due to Well Blockage								
MW-2U	01/16/13*	97.3	ND	3.5	112	518	105	3.8	2,110	NA
	09/12/13*	28.7	ND	0.96	26.8	114	33.1	1.4	562	NA
	12/11/13	36.9	ND	4.8	57.4	254	21	3	772	NA
	04/03/14	32.2	ND	4.9	52.2	333	25.2	3.1	1,040	NA
	09/09/15	53	ND	8.9	97.3	685	41.3	5.8	2,010	NA
	07/06/16	7.7	ND	ND	8.6	46.9	5.5	0.51	171	NA
	08/30/17	5.4	ND	ND	6	35.4	5	6.2	116	NA
	08/22/18	6	ND	ND	6.6	35.7	4.6	ND	140	NA
	06/18/19	ND	ND	ND	5.4	23.1	ND	ND	97.2	8.9
	12/03/20	5.5	ND	0.69	6.9	33.1	7.8	ND	102	3.9
	11/08/21	28.4	ND	5.9	74.5	613	75.7	4.5	1,860	3.6
	10/24/22	24	ND<3.0	6.5 J	62	590	70	ND<7.0	1,600	ND<1.7
	04/27/23	3.2 J	ND<3.0	ND<3.0	ND<3.0	14	7.0 J	ND<7.0	51	ND<1.7
MW-2L	01/16/13*	37.1	ND	1.5	42	203	42.4	2.6	822	NA
	09/12/13*	18.6	ND	0.88	17.8	95.2	15.1	1.3	414	NA
	12/11/13	18.7	ND	2.6	30.2	279	3.9	2.4	499	NA
	04/03/14	17.8	ND	3.4	24.4	348	4.6	4.1	654	NA
	09/09/15	28.6	ND	10.4	66.9	508	28.5	ND	1,400	NA
	07/06/16	20.8	ND	10.8	62.6	541	34.6	3.6	1,260	NA
	08/30/17	14	ND	11.7	65	564	30.6	65	1,370	NA
	08/22/18	12.8	ND	10.8	55.8	515	36.6	3.9	1,140	NA
	10/03/18	NA	NA	NA	NA	NA	NA	NA	NA	18.7
	06/18/19	13.7	ND	11	78	558	30.8	ND	1,300	26.2
	12/03/20	26	ND	16.6	130	717	97	8	2,550	35.4
	11/08/21	34.5	ND	14.1	140	858	123	8.2	2,760	32.3
	10/24/22	21 J	ND<15	ND<15	77	680	79	ND<35	1,800	45
	04/27/23	35 J	ND<15	ND<15	120	950	130	ND<35	2,700	49
MW-3U	01/15/13*	12.6	ND	ND	12.4	74	10.6	0.8	277	NA
	09/11/13	12.2	ND	ND	10.6	51.4	10.6	ND	266	NA
	12/11/13	4.4	ND	ND	5.4	56	1.3	0.85	198	NA
	04/03/14	4.4	ND	ND	4.4	24.3	0.85	ND	114	NA
	09/09/15	1.7	ND	ND	2.3	16.9	0.66	ND	43.5	NA
	07/05/16	2.3	ND	ND	2.8	11.2	0.79	ND	47	NA
	08/30/17	1.4	ND	ND	1.4	7.8	0.95	1.4	37	NA
	08/22/18	1.8	ND	ND	1.8	10.2	1.1	ND	38.8	NA
	06/18/19	2.2	ND	ND	2.1	6.5	1	ND	39.4	6.5
	12/03/20	2.6	ND	ND	3	11.4	2.1	ND	58	ND
	11/08/21	5.5	ND	ND	5.8	51.4	8	ND	178	ND
	10/24/22	3.7	ND<0.30	ND<0.30	4	21	6	ND<0.70	110	1.9
	04/27/23	ND<0.30	ND<0.30	ND<0.30	2.6	7.2	1.9	ND<0.70	40	0.76

Table 3
Groundwater Analytical Data Summary

Sample ID	Sample Date	1,1,1-Trichloroethane	1,1,2-Trichloroethane	1,1-Dichloroethane	1,1-Dichloroethene (1,1-Dichloroethylene)	*cis*-1,2-Dichloroethene (*cis*-1,2-Dichloroethylene)	Tetrachloroethene (Tetrachloroethylene (PCE))	*trans*-1,2-Dichloroethene (*trans*-1,2-Dichloroethylene)	Trichloroethene (Trichloroethylene (TCE))	1,4-Dioxane
		(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)
DEP Groundwater SHS for a Used, Residential Aquifer		**200**	**5**	**31**	**7**	**70**	**5**	**100**	**5**	**6.5**
MW-3L	01/15/13*	ND	ND	ND	9.8	55.3	9.9	0.66	244	NA
	09/11/13*	ND	ND	ND	15.6	92.8	19.4	ND	441	NA
	12/11/13	ND	ND	ND	7.2	55.1	2.4	ND	150	NA
	04/03/14	ND	ND	ND	6.9	59.4	3	ND	144	NA
	09/09/15	ND	ND	ND	ND	22.3	ND	ND	67.3	NA
	07/05/16	1.7	ND	ND	2	16.3	0.6	ND	44.9	NA
	08/30/17	6.4	ND	0.8	7.8	74.4	1.6	7.8	162	NA
	08/22/18	12	ND	ND	13.1	112	14.4	0.61	411	NA
	06/18/19	10.9	ND	ND	13.8	91.7	12.7	0.59	312	ND
	12/03/20	6.8	ND	ND	7.8	44.6	8.2	ND	187	2.8
	11/08/21	4.1	ND	ND	4.3	30.2	6.7	ND	95.2	2.8
	10/24/22	4.5	ND<0.30	0.33 J	4.9	33	7.6	ND<0.70	150	2.6
	04/27/23	18	0.58 J	0.86 J	20	160	19	1.4 J	1,400	6.4
MW-4U	01/15/13*	5	ND	ND	3.5	26.8	2.8	ND	132	NA
	09/11/13*	20.7	ND	0.56	14.2	96.1	19.4	1.4	700	NA
	12/11/13	8.2	ND	ND	6.6	57.6	5	ND	373	NA
	04/03/14	7.4	ND	ND	5.6	58.6	4.6	ND	456	NA
	09/09/15	9	ND	ND	9.4	60.6	8	ND	349	NA
	07/05/16	11.5	ND	ND	11	74.1	8.9	ND	359	NA
	08/30/17	8.4	ND	ND	ND	45.7	10.2	6.4	259	NA
	08/22/18	9.9	ND	ND	8.3	60.8	15.4	ND	321	NA
	06/18/19	12.5	ND	ND	13.5	99.2	12.2	ND	413	ND
	12/03/20	8	ND	ND	8.9	58.6	12.3	ND	326	NA
	11/08/21	14.2	ND	0.53	14.4	105	19.8	0.74	507	2.7
	10/26/22	9.6 J	ND<3.0	ND<3.0	11	88	18	ND<7.0	400	4.2
	04/27/23	7.5 J	ND<3.0	ND<3.0	5.6 J	72	15	ND<7.0	300	4.0
MW-4L	09/11/13*	ND	5	ND	6.3	51.4	7	ND	306	NA
	12/12/13	ND	10.2	ND	4.4	56.1	1.1	ND	118	NA
	04/03/14	ND	5.7	ND	2.3	39.8	ND	ND	99	NA
	09/09/15	5.4	ND	ND	5.8	47.3	2	ND	196	NA
	07/05/16	5.8	ND	ND	6	50.6	2.1	ND	164	NA
	09/09/15	2.7	ND	ND	2.7	40	0.7	ND	122	NA
	08/30/17	6.8	ND	ND	ND	43.8	ND	5.5	201	NA
	08/22/18	5.4	ND	ND	4.9	43	2	ND	152	NA
	06/18/19	2.6	ND	ND	3.6	34	1	ND	91.7	3.1
	12/03/20	9.6	ND	ND	10.6	68.5	15.4	ND	383	3.5
	11/08/21	11.6	ND	0.6	11.1	80.1	16	0.58	378	3.3
	10/24/22	8.4 J	ND<3.0	ND<3.0	8.5 J	78	12	ND<7.0	320	4.8
	04/27/23	6.7 J	ND<3.0	ND<3.0	4.9 J	70	13	ND<7.0	280	4.1
MW-5	01/14/13*	ND	ND	ND	ND	ND	ND	ND	ND	NA
	09/09/13*	ND	ND	ND	ND	ND	ND	ND	ND	NA
	12/12/13	ND	ND	ND	ND	ND	ND	ND	ND	NA
	04/03/14	ND	ND	ND	ND	ND	ND	ND	ND	NA
	09/09/15	ND	ND	ND	ND	ND	ND	ND	ND	NA
	06/17/19	ND	ND	ND	ND	ND	ND	ND	ND	ND
	12/03/20	ND	ND	ND	ND	ND	0.52	ND	ND	ND
	11/08/21	ND	ND	ND	ND	ND	0.54	ND	ND	NA
	10/24/22	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.30	0.57 J	ND<0.70	ND<0.30	NA
MW-6	01/14/13*	ND	ND	ND	ND	ND	ND	ND	ND	NA
	090/9/13*	ND	ND	ND	ND	ND	ND	ND	ND	NA
	12/11/13	ND	ND	ND	ND	ND	ND	ND	ND	NA
	04/02/14	ND	ND	ND	ND	ND	ND	ND	ND	NA
	09/09/15	ND	ND	ND	ND	ND	ND	ND	ND	NA
	07/05/16	ND	ND	ND	ND	ND	ND	ND	ND	NA
	06/17/19	ND	ND	ND	ND	ND	ND	ND	ND	ND
	10/22/22	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.70	ND<0.30	NA
MW-7U	01/23/13*	ND	ND	ND	ND	ND	ND	ND	ND	NA
	09/09/13*	ND	ND	ND	ND	ND	ND	ND	ND	NA
	12/12/13	ND	ND	ND	ND	1.3	ND	ND	8.5	NA
	04/02/14	ND	ND	ND	ND	1.7	ND	ND	10.7	NA
	09/09/15	ND	ND	ND	ND	ND	ND	ND	ND	NA
	07/05/16	ND	ND	ND	ND	ND	ND	ND	ND	NA
	06/17/19	ND	ND	ND	ND	ND	ND	ND	ND	ND
	10/24/22	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.70	ND<0.30	NA

Table 3
Groundwater Analytical Data Summary

Sample ID	Sample Date	1,1,1-Trichloroethane	1,1,2-Trichloroethane	1,1-Dichloroethane	1,1-Dichloroethene (1,1-Dichloroethylene)	*cis*-1,2-Dichloroethene (*cis*-1,2-Dichloroethylene)	Tetrachloroethene (Tetrachloroethylene (PCE))	*trans*-1,2-Dichloroethene (*trans*-1,2-Dichloroethylene)	Trichloroethene (Trichloroethylene (TCE))	1,4-Dioxane
		(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)
DEP Groundwater SHS for a Used, Residential Aquifer		**200**	**5**	**31**	**7**	**70**	**5**	**100**	**5**	**6.5**
MW-7L	1/14/13*	ND	ND	ND	ND	0.71	ND	ND	5.7	NA
	9/9/13*	ND	ND	ND	ND	1.2	ND	ND	7.3	NA
	12/12/13	ND	ND	ND	ND	ND	ND	ND	ND	NA
	04/02/13	ND	ND	ND	ND	ND	ND	ND	ND	NA
	09/09/15	ND	ND	ND	ND	1.7	ND	ND	10.1	NA
	07/05/16	ND	ND	ND	ND	1.7	ND	ND	8.1	NA
	08/30/17	ND	ND	ND	ND	1.8	ND	ND	9.3	NA
	08/22/18	ND	ND	ND	ND	1.8	ND	ND	10.2	NA
	06/17/19	ND	ND	ND	ND	1.9	ND	ND	10.1	ND
	12/03/20	ND	ND	ND	0.67	2.8	0.55	ND	14.8	ND
	11/08/21	ND	ND	ND	ND	2.6	0.52	ND	11.9	ND
	10/24/22	0.43 J	ND<0.30	ND<0.30	0.50 J	3.6	0.77 J	ND<0.70	15	NA
	04/27/23	0.39 J	ND<0.30	ND<0.30	0.63 J	3.8	0.72 J	ND<0.70	15	0.41
MW-8	1/14/13*	ND	ND	ND	ND	3.7	ND	ND	ND	NA
	9/9/13*	ND	ND	ND	ND	4.7	ND	ND	ND	NA
	12/12/13	ND	ND	ND	ND	5.7	ND	ND	ND	NA
	04/02/14	ND	ND	ND	ND	6.7	ND	ND	ND	NA
	09/09/15	ND	ND	ND	ND	ND	ND	ND	ND	NA
	07/05/16	ND	ND	ND	ND	ND	ND	ND	ND	NA
	06/17/19	ND	ND	ND	ND	ND	ND	ND	ND	ND
	10/24/22	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.70	ND<0.30	NA
MW-9	1/14/13*	ND	ND	ND	ND	ND	ND	ND	ND	NA
	9/9/13*	ND	ND	ND	ND	ND	ND	ND	ND	NA
	12/12/13	ND	ND	ND	ND	ND	ND	ND	ND	NA
	04/02/14	ND	ND	ND	ND	ND	ND	ND	ND	NA
	09/09/15	ND	ND	ND	ND	ND	ND	ND	ND	NA
	07/05/16	ND	ND	ND	ND	ND	ND	ND	ND	NA
	06/17/19	ND	ND	ND	ND	ND	ND	ND	ND	ND
	10/24/22	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.70	ND<0.30	NA
MW-10L	1/15/13*	2.6	ND	ND	3.2	10.3	2	ND	64.9	NA
	9/11/13*	2.7	ND	ND	2.6	8.5	3.4	ND	72.6	NA
	12/12/13	2	ND	ND	2.3	7.9	2.5	ND	47.9	NA
	04/02/14	1.5	ND	ND	1.9	8	1.6	ND	51.5	NA
	09/09/15	ND	ND	ND	0.98	4.6	ND	ND	19.9	NA
	07/05/16	0.54	ND	ND	0.94	3.7	ND	ND	19	NA
	08/30/17	0.61	ND	ND	0.94	4.2	0.52	0.99	21.7	NA
	08/22/18	1	ND	ND	1.9	7.8	1.1	ND	44.3	NA
	06/17/19	0.92	ND	ND	1.8	7.5	0.86	ND	41	ND
	12/03/20	1.1	ND	ND	2.1	8.6	2.6	ND	52.4	ND
	11/08/21	0.95	ND	ND	1.6	7.3	2.1	ND	38.4	ND
	10/24/22	0.88 J	ND<0.30	ND<0.30	1.6	7.8	2.2	ND<0.70	38	0.53
	04/27/23	0.73 J	ND<0.30	ND<0.30	1.5	8.0	1.6	ND<0.70	36	0.58
MW-11U	9/12/13*	10	ND	ND	9.2	43.4	5.9	ND	146	NA
	12/11/13	6.9	ND	ND	6.9	36.4	3.7	ND	135	NA
	04/03/13	6.1	ND	ND	6.6	42.1	1.4	ND	146	NA
	09/09/15	5.1	ND	ND	6.4	32.6	2	ND	109	NA
	07/05/16	3.2	ND	ND	4.4	24.4	2.3	ND	78.7	NA
	08/30/17	3.8	ND	ND	4.7	25.9	2.7	4.9	66.7	NA
	08/22/18	5.9	ND	ND	8.4	44.6	5.6	ND	149	NA
	06/18/19	5.6	ND	ND	8.4	44.3	6.6	ND	157	4.1
	12/03/20	4.9	ND	ND	8.4	43.3	9	ND	170	2.8
	11/08/21	8.2	ND	ND	11.6	64.5	14.5	ND	233	2.8
	10/24/22	5.3	ND<1.5	ND<1.5	7.2	44	10	ND<3.5	180	3.2
	04/27/23	3.3 J	ND<1.5	ND<1.5	5.0	32	5.9	ND<3.5	110	3.5
MW-11L	9/12/13*	3.4	ND	ND	2.8	13.8	3	ND	57.2	NA
	12/11/13	ND	ND	ND	ND	ND	ND	ND	ND	NA
	04/03/14	ND	ND	ND	ND	ND	ND	ND	ND	NA
	09/09/15	ND	ND	ND	ND	ND	ND	ND	ND	NA
	07/05/16	ND	ND	ND	ND	ND	ND	ND	ND	NA
	08/30/17	ND	ND	ND	ND	ND	ND	ND	ND	NA
	08/22/18	ND	ND	ND	ND	ND	ND	ND	ND	NA
	06/17/19	ND	ND	ND	ND	0.83	ND	ND	0.5	2.6
	12/03/20	5.5	ND	ND	8.6	47.5	9	ND	176	2.8
	11/08/21	7.4	ND	ND	10.6	59.9	12.2	ND	203	2.9
	10/24/22	4.1 J	ND<1.5	ND<1.5	5	34	7.3	ND<3.5	130	3.2
	04/27/23	ND<1.5	ND<1.5	ND<1.5	ND<1.5	1.9 J	ND<1.5	ND<3.5	7.1	ND<0.17

Table 3
Groundwater Analytical Data Summary

Sample ID	Sample Date	1,1,1-Trichloroethane	1,1,2-Trichloroethane	1,1-Dichloroethane	1,1-Dichloroethene (1,1-Dichloroethylene)	*cis*-1,2-Dichloroethene (*cis*-1,2-Dichloroethylene)	Tetrachloroethene (Tetrachloroethylene (PCE))	*trans*-1,2-Dichloroethene (*trans*-1,2-Dichloroethylene)	Trichloroethene (Trichloroethylene (TCE))	1,4-Dioxane
		(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)
DEP Groundwater SHS for a Used, Residential Aquifer		**200**	**5**	**31**	**7**	**70**	**5**	**100**	**5**	**6.5**
MW-12U	9/10/13*	ND	ND	ND	ND	0.81	ND	ND	7.8	NA
	12/11/13	ND	ND	ND	ND	0.78	ND	ND	0.71	NA
	04/02/14	ND	ND	ND	ND	ND	ND	ND	0.97	NA
	09/09/15	ND	ND	ND	ND	ND	ND	ND	0.7	NA
	07/05/16	ND	ND	ND	ND	ND	ND	ND	1.2	NA
	08/30/17	ND	ND	ND	ND	ND	ND	ND	ND	NA
	06/17/19	ND	ND	ND	ND	ND	ND	ND	ND	ND
	10/24/22	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.70	0.3 J	NA
MW-12L	9/10/13*	ND	ND	ND	ND	0.68	ND	ND	4.8	NA
	12/12/13*	ND	ND	ND	ND	ND	ND	ND	5.7	NA
	04/02/14	ND	ND	ND	ND	ND	ND	ND	1.1	NA
	09/09/15	ND	ND	ND	ND	ND	ND	ND	1.3	NA
	07/05/16	ND	ND	ND	ND	ND	ND	ND	0.51	NA
	08/30/17	ND	ND	ND	ND	ND	ND	ND	0.66	NA
	06/17/19	ND	ND	ND	ND	ND	ND	ND	0.94	ND
	10/24/22	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.30	ND<0.70	1.1	NA
RC-1 @ 103'	01/17/23	180	4.7	8.0	11	1,500	100	12	1,500	NA
	04/27/23	110	7.3	6.0	12	1,700	57	23	1,900	NA
RC-1 @ 117'	01/17/23	160	4.3	7.4	8.8	1,600	92	20	1,600	NA
	04/27/23	110	4.6	5.1	8.6	1,200	50	17	1,600	NA
RC-1 @ 138'	01/17/23	3.6 J	ND<3.0	ND<3.0	ND<3.0	20	4.4 J	ND<7.0	32	NA
	04/27/23	4.8	ND<0.30	ND<0.30	0.41 J	52	6.9	ND<0.70	65	NA
RC-1 @ 148'	01/17/23	3.8	ND<0.30	ND<0.30	ND<0.30	24	6.4	ND<0.70	41	NA
	04/27/23	3.5	ND<0.30	ND<0.30	ND<0.30	39	5.1	ND<0.70	47	NA
RC-2 @ 112'	01/17/23	40	1.1	1.7	44	440	36	2.8	1,500	NA
	04/27/23	43	1.3	1.6	55	460 H	44	3.3	1,900 H	NA
RC-2 @ 142'	01/17/23	38	1.0	1.6	42	340	31	2.7	1,100	NA
	04/27/23	22	0.68 J	1.0	34	460	17	2.3	1,700	NA
RC-2 @ 180'	01/17/23	30	0.71 J	1.3	33	330	26	2.0	1,100	NA
	04/27/23	7.4	ND<0.30	ND<0.30	9.1	89	13	ND<0.70	310	NA
RC-2 @ 204'	01/17/23	0.96 J	ND<0.30	ND<0.30	0.65 J	4.3	17	ND<0.70	56	NA
	04/27/23	1.4	ND<0.30	ND<0.30	0.52 J	3.0	15	ND<0.70	120	NA
RC-2 @ 246'	01/17/23	0.78 J	ND<0.30	ND<0.30	0.33 J	2.0	19	ND<0.70	50	NA
	04/27/23	1.1	ND<0.30	ND<0.30	0.35 J	1.7	14	ND<0.70	88	NA

Notes:
DEP: Pennsylvania Department of Environmental Protection
SHS: Statewide Health Standard
µg/L: micrograms per liter
ND: Not detected
ND<#: Indicates analysis was performed for the compound but it was not detected (<# is the method detection limit)
J: Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value
H: Sample was prepped or analyzed beyond the specified holding time. This does not meet regulatory requirements.
Yellow Shaded: Indicates laboratory method detection limit exceeds the DEP Residential Act 2 Standards
Red Shaded: Indicates concentration exceeds the DEP Residential Act 2 Standards
Green Shaded: Indicates a concentration was detected.
* Well purged/sampled using a submersible pump. All others sampled using a passive diffusion bag or hydrasleeve

Table 4 – Point of Entry Treatment System Analytical Data Summary

Table 4

Point-of-Entry Treatment System Analytical Data Summary
Volatile Organic Compound (VOC)

Location	Sample ID	Date	1,1,1-Trichloroethane	1,1,2,2-Tetrachloroethane	1,1,2-Trichloroethane	1,1-Dichloroethane	1,1-Dichloroethene (1,1-Dichloroethylene)	1,2-Dibromo-3-Chloropropane	1,2-Dibromoethane (Ethylene Dibromide)	1,2,4-Trichlorobenzene	1,2-Dichlorobenzene	1,2-Dichloroethane	1,2-Dichloropropane	1,3-Dichlorobenzene	1,4-Dichlorobenzene (p-Dichlorobenzene)	2-Butanone (Methyl ethyl ketone)
			(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)
DEP Groundwater SHS for a Used, Residential Aquifer			**200**	**0.84**	**5**	**31**	**7**	**0.2**	**0.05**	**70**	**600**	**5**	**5**	**600**	**75**	**4,000**
DEP Groundwater SHS for a Used, Non-Residential Aquifer			**200**	**4.3**	**5**	**160**	**7**	**0.2**	**0.05**	**70**	**600**	**5**	**5**	**600**	**75**	**4,000**
55 Brennan Road	Effluent	11/01/2022	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.40!	ND<0.10!	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<2.0
		02/14/2023	ND<0.10	ND<0.10	ND<0.10	0.11 J	ND<0.10	ND<0.40!	ND<0.10!	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<2.0
		05/16/2023	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.40!	ND<0.10!	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<2.0
		08/08/2023	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.40!	ND<0.10!	ND<0.20	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<2.0
	Midfluent	11/01/2022	12	ND<0.10	0.18 J	0.64	22	ND<0.40!	ND<0.10!	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<2.0
		02/14/2023	13	ND<0.10	0.20 J	0.66	22	ND<0.40!	ND<0.10!	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<2.0
		05/16/2023	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.40!	ND<0.10!	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<2.0
		08/08/2023	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.40!	ND<0.10!	ND<0.20	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<2.0
	Influent	11/01/2022	11	ND<0.10	0.36 J	0.50	13	ND<0.40!	ND<0.10!	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<2.0
		02/14/2023	11	ND<0.10	0.31 J	0.48 J	12	ND<0.40!	ND<0.10!	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<2.0
		05/16/2023	10	ND<0.10	0.27 J	0.42 J	11	ND<0.40!	ND<0.10!	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<2.0
		08/08/2023	17	ND<0.10	0.62	0.73	20	ND<0.40!	ND<0.10!	ND<0.20	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<2.0
65 Brennan Road	Effluent	11/02/2022	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.40!	ND<0.10!	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<2.0
		12/08/2022	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.40!	ND<0.10!	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<2.0
		02/14/2023	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.40!	ND<0.10!	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<2.0
		05/16/2023	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.40!	ND<0.10!	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<2.0
		08/08/2023	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.40!	ND<0.10!	ND<0.20	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<2.0
	Effflluent - Duplicate	11/02/2022	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.40!	ND<0.10!	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<2.0
		05/16/2023	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.40!	ND<0.10!	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<2.0
	Midfluent	11/02/2022	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.40!	ND<0.10!	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<2.0
		12/08/2022	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.40!	ND<0.10!	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<2.0
		02/14/2023	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.40!	ND<0.10!	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<2.0
		05/16/2023	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.40!	ND<0.10!	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<2.0
		08/08/2023	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.40!	ND<0.10!	ND<0.20	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<2.0
	Midfluent - Duplicate	08/08/2023	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.40!	ND<0.10!	ND<0.20	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<2.0
	Influent	11/02/2022	16	ND<0.10	0.52	1.0	28	ND<0.40!	ND<0.10!	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<2.0
		12/08/2022	26	ND<0.10	0.90	2.0	46	ND<0.40!	ND<0.10!	ND<0.20	ND<0.10	0.15 J	ND<0.10	ND<0.10	ND<0.10	ND<2.0
		02/14/2023	15	ND<0.10	0.55	1.0	26	ND<0.40!	ND<0.10!	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<2.0
		05/16/2023	25	ND<0.10	0.82	1.7	45	ND<0.40!	ND<0.10!	ND<0.20	ND<0.10	0.14 J	ND<0.10	ND<0.10	ND<0.10	ND<2.0
		08/08/2023	14	ND<0.10	0.55	1.1	29	ND<0.40!	ND<0.10!	ND<0.20	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<2.0
77 Brennan Road	Effluent	12/08/2022	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.40!	ND<0.10!	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<2.0
	Effluent Duplicate	12/08/2022	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.40!	ND<0.10!	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<2.0
	Midfluent	12/08/2022	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.40!	ND<0.10!	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<2.0
	Influent	12/08/2022	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.40!	ND<0.10!	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<2.0
		02/14/2023	0.30 J	ND<0.10	ND<0.10	ND<0.10	0.24 J	ND<0.40!	ND<0.10!	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<2.0
	Influent Duplicate	02/14/2023	0.33 J	ND<0.10	ND<0.10	ND<0.10	0.21 J	ND<0.40!	ND<0.10!	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<2.0
	Barn	12/08/2023	0.36 J	ND<0.10	ND<0.10	ND<0.10	0.27 J	ND<0.40!	ND<0.10!	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<2.0
338 Park Post Road	Effluent	11/01/2022	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.40!	ND<0.10!	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<2.0
		02/14/2023	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.40!	ND<0.10!	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<2.0
		05/16/2023	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.40!	ND<0.10!	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<2.0
		08/08/2023	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.40!	ND<0.10!	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<2.0
	Midfluent	11/01/2022	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.40!	ND<0.10!	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<2.0
		02/14/2023	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.40!	ND<0.10!	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<2.0
		05/16/2023	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.40!	ND<0.10!	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<2.0
		08/08/2023	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.40!	ND<0.10!	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<2.0
	Influent	11/01/2022	13	ND<0.10	0.39 J	0.45 J	24	ND<0.40!	ND<0.10!	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<2.0
		02/14/2023	12	ND<0.10	0.43 J	0.42 J	24	ND<0.40!	ND<0.10!	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<2.0
		05/16/2023	12	ND<0.10	0.42 J	0.39 J	24	ND<0.40!	ND<0.10!	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<2.0
		08/08/2023	9.8	ND<0.10	0.41 J	0.35 J	22	ND<0.40!	ND<0.10!	ND<0.20	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<2.0
	Field Blank	11/01/2022	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
		05/16/2023	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.40!	ND<0.10!	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<2.0
	Trip Blank	11/01/2022	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.40!	ND<0.10!	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<2.0
		12/08/2022	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.40!	ND<0.10!	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<2.0
		02/14/2023	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.40!	ND<0.10!	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<2.0
		05/16/2023	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.40!	ND<0.10!	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<2.0
		08/08/2023	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.40!	ND<0.10!	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<2.0

Notes:

DEP: Pennsylvania Department of Environmental Protection

SHS: Statewide Health Standard

µg/L: micrograms per liter

J: Result is less than the reporting limit (RL) but greater than or equal to the method detection limit (MDL) and the concentration is an approximate value.

!: Laboratory is not accredited for this parameter.

ND: Indicates analysis was performed for the compound but it was not detected (<# is the method detection limit)

NS: No Standard

NA: Not Analyzed

Note: This table includes a subset of recent data (2022-23). Historical data from 2011-22 is available in DEP files

Green Shaded: Indicates a concentration was detected above the laboratory method detection limit.

Yellow Shaded: Indicates laboratory method detection limits exceed the DEP Groundwater Values for groundwater in a Used, Residential Aquifer

Red Shaded: Indicates concentrations exceed the DEP Groundwater Values for groundwater in a Used, Residential Aquifer

Table 4

Point-of-Entry Treatment System Analytical Data Summary
Volatile Organic Compound (VOC)

Location	Sample ID	Date	2-Hexanone (Methyl n-butyl ketone)	4-Methyl-2-Pentanone (Methyl isobutyl ketone)	Acetone	Benzene	Bromodichloromethane	Bromoform (Tribromomethane)	Bromomethane	Carbon disulfide	Carbon tetrachloride	Chlorobenzene	Chloroethane	Chloroform	Chloromethane (Methyl Chloride)	cis-1,2-Dichloroethene (cis-1,2-Dichloroethylene)
			(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)
DEP Groundwater SHS for a Used, Residential Aquifer			**63**	**2,800**	**31,000**	**5**	**80**	**80**	**10**	**1,500**	**5**	**100**	**21,000**	**80**	**30**	**70**
DEP Groundwater SHS for a Used, Non-Residential Aquifer			**260**	**7,800**	**88,000**	**5**	**80**	**80**	**10**	**6,200**	**5**	**100**	**88,000**	**80**	**30**	**70**
55 Brennan Road	Effluent	11/01/2022	ND<0.60	ND<0.60	ND<3.0	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.40	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20	0.12 J
		02/14/2023	ND<0.60	ND<0.60	ND<3.0	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.40	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20	0.17 J
		05/16/2023	ND<0.60	ND<0.60	13	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.40	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20	ND<0.10
		08/08/2023	ND<1.0	ND<0.80	ND<3.0	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.40	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20	ND<0.10
	Midfluent	11/01/2022	ND<0.60	ND<0.60	ND<3.0	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.40	ND<0.10	ND<0.10	ND<0.20	0.35 J	ND<0.20	150
		02/14/2023	ND<0.60	ND<0.60	ND<3.0	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.40	ND<0.10	ND<0.10	ND<0.20	0.32 J	ND<0.20	120
		05/16/2023	ND<0.60	ND<0.60	79	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.40	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20	ND<0.10
		08/08/2023	ND<1.0	ND<0.80	ND<3.0	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.40	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20	ND<0.10
	Influent	11/01/2022	ND<0.60	ND<0.60	ND<3.0	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.40	ND<0.10	ND<0.10	ND<0.20	0.19 J	ND<0.20	52
		02/14/2023	ND<0.60	ND<0.60	ND<3.0	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.40	ND<0.10	ND<0.10	ND<0.20	0.19 J	ND<0.20	49
		05/16/2023	ND<0.60	ND<0.60	61	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.40	ND<0.10	ND<0.10	ND<0.20	0.17 J	ND<0.20	47
		08/08/2023	ND<1.0	ND<0.80	ND<3.0	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.40	ND<0.10	ND<0.10	ND<0.20	0.25 J	ND<0.20	110
65 Brennan Road	Effluent	11/02/2022	ND<0.60	ND<0.60	ND<3.0	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.40	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20	ND<0.10
		12/08/2022	ND<0.60	ND<0.60	ND<3.0	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.40	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20	ND<0.10
		02/14/2023	ND<0.60	ND<0.60	ND<3.0	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.40	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20	ND<0.10
		05/16/2023	ND<0.60	ND<0.60	ND<3.0	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.40	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20	ND<0.10
		08/08/2023	ND<1.0	ND<0.80	ND<3.0	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.40	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20	ND<0.10
	Effllluent - Duplicate	11/02/2022	ND<0.60	ND<0.60	ND<3.0	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.40	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20	ND<0.10
		05/16/2023	ND<0.60	ND<0.60	ND<3.0	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.40	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20	ND<0.10
	Midfluent	11/02/2022	ND<0.60	ND<0.60	ND<3.0	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.40	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20	ND<0.10
		12/08/2022	ND<0.60	ND<0.60	ND<3.0	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.40	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20	ND<0.10
		02/14/2023	ND<0.60	ND<0.60	ND<3.0	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.40	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20	ND<0.10
		05/16/2023	ND<0.60	ND<0.60	ND<3.0	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.40	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20	ND<0.10
		08/08/2023	ND<1.0	ND<0.80	ND<3.0	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.40	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20	ND<0.10
	Midfluent - Duplicate	08/08/2023	ND<1.0	ND<0.80	ND<3.0	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.40	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20	ND<0.10
	Influent	11/02/2022	ND<0.60	ND<0.60	ND<3.0	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.40	ND<0.10	ND<0.10	ND<0.20	0.90	ND<0.20	190
		12/08/2022	ND<0.60	ND<0.60	ND<3.0	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.40	ND<0.10	ND<0.10	ND<0.20	0.40 J	ND<0.20	320
		02/14/2023	ND<0.60	ND<0.60	ND<3.0	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.40	ND<0.10	ND<0.10	ND<0.20	0.42 J	ND<0.20	160
		05/16/2023	ND<0.60	ND<0.60	ND<3.0	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.40	ND<0.10	ND<0.10	ND<0.20	0.37 J	ND<0.20	270
		08/08/2023	ND<1.0	ND<0.80	ND<3.0	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.40	ND<0.10	ND<0.10	ND<0.20	0.29 J	ND<0.20	160
77 Brennan Road	Effluent	12/08/2022	ND<0.60	ND<0.60	ND<3.0	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.40	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20	ND<0.10
	Effluent Duplicate	12/08/2022	ND<0.60	ND<0.60	ND<3.0	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.40	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20	ND<0.10
	Midfluent	12/08/2022	ND<0.60	ND<0.60	ND<3.0	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.40	ND<0.10	ND<0.10	ND<0.20	0.56	ND<0.20	0.40 J
	Influent	12/08/2022	ND<0.60	ND<0.60	ND<3.0	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.40	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20	ND<0.10
		02/14/2023	ND<0.60	ND<0.60	ND<3.0	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.40	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20	1.9
	Influent Duplicate	02/14/2023	ND<0.60	ND<0.60	ND<3.0	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.40	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20	1.9
	Barn	12/08/2023	ND<0.60	ND<0.60	ND<3.0	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.40	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20	2.3
338 Park Post Road	Effluent	11/01/2022	ND<0.60	ND<0.60	ND<3.0	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.40	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20	ND<0.10
		02/14/2023	ND<0.60	ND<0.60	ND<3.0	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.40	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20	ND<0.10
		05/16/2023	ND<0.60	ND<0.60	ND<3.0	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.40	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20	ND<0.10
		08/08/2023	ND<1.0	ND<0.80	ND<3.0	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.40	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20	ND<0.10
	Midfluent	11/01/2022	ND<0.60	ND<0.60	ND<3.0	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.40	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20	ND<0.10
		02/14/2023	ND<0.60	ND<0.60	ND<3.0	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.40	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20	ND<0.10
		05/16/2023	ND<0.60	ND<0.60	ND<3.0	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.40	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20	ND<0.10
		08/08/2023	ND<1.0	ND<0.80	ND<3.0	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.40	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20	ND<0.10
	Influent	11/01/2022	ND<0.60	ND<0.60	ND<3.0	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.40	ND<0.10	ND<0.10	ND<0.20	0.16 J	ND<0.20	23
		02/14/2023	ND<0.60	ND<0.60	ND<3.0	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.40	ND<0.10	ND<0.10	ND<0.20	0.13 J	ND<0.20	16
		05/16/2023	ND<0.60	ND<0.60	ND<3.0	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.40	ND<0.10	ND<0.10	ND<0.20	0.13 J	ND<0.20	16
		08/08/2023	ND<1.0	ND<0.80	ND<3.0	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.40	ND<0.10	ND<0.10	ND<0.20	0.13 J	ND<0.20	15
	Field Blank	11/01/2022	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
		05/16/2023	ND<0.60	ND<0.60	ND<3.0	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.40	ND<0.10	ND<0.10	ND<0.20	0.12 J	ND<0.20	ND<0.10
	Trip Blank	11/01/2022	ND<0.60	ND<0.60	10	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.40	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20	ND<0.10
		12/08/2022	ND<0.60	ND<0.60	16	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.40	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20	ND<0.10
		02/14/2023	ND<0.60	ND<0.60	25	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.40	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20	ND<0.10
		05/16/2023	ND<0.60	ND<0.60	40	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.40	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20	ND<0.10
		08/08/2023	ND<1.0	ND<0.80	130	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.40	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20	ND<0.10

Notes:

DEP: Pennsylvania Department of Environmental Protection

SHS: Statewide Health Standard

µg/L: micrograms per liter

J: Result is less than the reporting limit (RL) but greater than or equal to the method detection limit (MDL) and the concentration is an approximate value.

!: Laboratory is not accredited for this parameter.

ND: Indicates analysis was performed for the compound but it was not detected (<# is the method detection limit)

NS: No Standard

NA: Not Analyzed

Note: This table includes a subset of recent data (2022-23). Historical data from 2011-22 is available in DEP files

Green Shaded: Indicates a concentration was detected above the laboratory method detection limit.

Yellow Shaded: Indicates laboratory method detection limits exceed the DEP Groundwater Values for groundwater in a Used, Residential Aquifer

Red Shaded: Indicates concentrations exceed the DEP Groundwater Values for groundwater in a Used, Residential Aquifer

Table 4

Point-of-Entry Treatment System Analytical Data Summary
Volatile Organic Compound (VOC)

Location	Sample ID	Date	cis-1,3-Dichloropropene (1,3-Dichloropropene)	Dibromochloromethane (Chlorodibromomethane)	Dichlorodifluoromethane (Freon 12)	Ethylbenzene	Freon 113 (1,1,2-Trichloro-1,2,2-trifluoroethane)	Isopropylbenzene (Cumene)	Methyl *tert*-butyl ether	Methylene Chloride (Dichloromethane)	Styrene	Tetrachloroethene (Tetrachloroethylene (PCE))	Toluene	trans-1,2-Dichloroethene (trans-1,2-Dichloroethylene)	trans-1,3-Dichloropropene
			(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)
DEP Groundwater SHS for a Used, Residential Aquifer			**NS**	**80**	**1,000**	**700**	**11,000**	**840**	**20**	**5**	**100**	**5**	**1,000**	**100**	**6.5**
DEP Groundwater SHS for a Used, Non-Residential Aquifer			**NS**	**80**	**1,000**	**700**	**44,000**	**3,500**	**20**	**5**	**100**	**5**	**1,000**	**100**	**27**
55 Brennan Road	Effluent	11/01/2022	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20!	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10
		02/14/2023	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20!	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10
		05/16/2023	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20!	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10
		08/08/2023	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20!	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10
	Midfluent	11/01/2022	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20!	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.10	ND<0.10	0.39 J	ND<0.10
		02/14/2023	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20!	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.10	ND<0.10	0.43 J	ND<0.10
		05/16/2023	ND<0.10	ND<0.10	ND<0.20	0.10 J	ND<0.20!	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10
		08/08/2023	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20!	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10
	Influent	11/01/2022	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20!	ND<0.10	ND<0.10	ND<0.20	ND<0.10	18	ND<0.10	0.53	ND<0.10
		02/14/2023	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20!	ND<0.10	ND<0.10	ND<0.20	ND<0.10	15	ND<0.10	0.43 J	ND<0.10
		05/16/2023	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20!	ND<0.10	ND<0.10	ND<0.20	ND<0.10	13	ND<0.10	0.45 J	ND<0.10
		08/08/2023	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20!	ND<0.10	ND<0.10	0.48 J	ND<0.10	17	ND<0.10	0.99	ND<0.10
65 Brennan Road	Effluent	11/02/2022	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20!	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10
		12/08/2022	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20!	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10
		02/14/2023	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20!	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10
		05/16/2023	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20!	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10
		08/08/2023	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20!	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10
	Effllluent - Duplicate	11/02/2022	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20!	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10
		05/16/2023	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20!	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10
	Midfluent	11/02/2022	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20!	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10
		12/08/2022	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20!	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10
		02/14/2023	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20!	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10
		05/16/2023	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20!	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10
		08/08/2023	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20!	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10
	Midfluent - Duplicate	08/08/2023	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20!	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10
	Influent	11/02/2022	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20!	ND<0.10	ND<0.10	ND<0.20	ND<0.10	39	ND<0.10	0.99	ND<0.10
		12/08/2022	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20!	ND<0.10	ND<0.10	ND<0.20	ND<0.10	37	ND<0.10	1.7	ND<0.10
		02/14/2023	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20!	ND<0.10	ND<0.10	ND<0.20	ND<0.10	30	ND<0.10	0.86	ND<0.10
		05/16/2023	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20!	ND<0.10	ND<0.10	ND<0.20	ND<0.10	38	ND<0.10	1.5	ND<0.10
		08/08/2023	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20!	ND<0.10	ND<0.10	ND<0.20	ND<0.10	29	ND<0.10	0.97	ND<0.10
77 Brennan Road	Effluent	12/08/2022	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20!	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10
	Effluent Duplicate	12/08/2022	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20!	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10
	Midfluent	12/08/2022	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20!	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10
	Influent	12/08/2022	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20!	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10
		02/14/2023	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20!	ND<0.10	ND<0.10	ND<0.20	ND<0.10	0.16 J	ND<0.10	ND<0.10	ND<0.10
	Influent Duplicate	02/14/2023	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20!	ND<0.10	ND<0.10	ND<0.20	ND<0.10	0.17 J	ND<0.10	ND<0.10	ND<0.10
	Barn	12/08/2023	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20!	ND<0.10	ND<0.10	ND<0.20	ND<0.10	0.18 J	ND<0.10	ND<0.10	ND<0.10
338 Park Post Road	Effluent	11/01/2022	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20!	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10
		02/14/2023	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20!	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10
		05/16/2023	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20!	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10
		08/08/2023	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20!	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10
	Midfluent	11/01/2022	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20!	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10
		02/14/2023	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20!	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10
		05/16/2023	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20!	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10
		08/08/2023	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20!	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10
	Influent	11/01/2022	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20!	ND<0.10	ND<0.10	ND<0.20	ND<0.10	45	ND<0.10	0.17 J	ND<0.10
		02/14/2023	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20!	ND<0.10	ND<0.10	ND<0.20	ND<0.10	54	ND<0.10	0.12 J	ND<0.10
		05/16/2023	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20!	ND<0.10	ND<0.10	ND<0.20	ND<0.10	65	ND<0.10	0.11 J	ND<0.10
		08/08/2023	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20!	ND<0.10	ND<0.10	ND<0.20	ND<0.10	66	ND<0.10	0.11 J	ND<0.10
	Field Blank	11/01/2022	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
		05/16/2023	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20!	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10
	Trip Blank	11/01/2022	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20!	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10
		12/08/2022	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20!	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10
		02/14/2023	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20!	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10
		05/16/2023	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20!	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10
		08/08/2023	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.20!	ND<0.10	ND<0.10	ND<0.20	ND<0.10	ND<0.10	ND<0.10	ND<0.10	ND<0.10

Notes:

DEP: Pennsylvania Department of Environmental Protection

SHS: Statewide Health Standard

µg/L: micrograms per liter

J: Result is less than the reporting limit (RL) but greater than or equal to the method detection limit (MDL) and the concentration is an approximate value.

!: Laboratory is not accredited for this parameter.

ND: Indicates analysis was performed for the compound but it was not detected (<# is the method detection limit)

NS: No Standard

NA: Not Analyzed

Note: This table includes a subset of recent data (2022-23). Historical data from 2011-22 is available in DEP files

Green Shaded: Indicates a concentration was detected above the laboratory method detection limit.

Yellow Shaded: Indicates laboratory method detection limits exceed the DEP Groundwater Values for groundwater in a Used, Residential Aquifer

Red Shaded: Indicates concentrations exceed the DEP Groundwater Values for groundwater in a Used, Residential Aquifer

Table 4

Point-of-Entry Treatment System Analytical Data Summary
Volatile Organic Compound (VOC)

Location	Sample ID	Date	Trichloroethene (Trichloroethylene (TCE))	Trichlorofluoromethane (Fluorotrichloromethane (Freon 11))	Vinyl chloride (Chloroethene)	Total Xylenes	1,4-Dioxane
			(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)
DEP Groundwater SHS for a Used, Residential Aquifer			**5**	**2,000**	**2**	**10,000**	**6.5**
DEP Groundwater SHS for a Used, Non-Residential Aquifer			**5**	**2,000**	**2**	**10,000**	**27**
55 Brennan Road	Effluent	11/01/2022	ND<0.10	ND<0.20	0.11 J	ND<0.10	2.6
		02/14/2023	ND<0.10	ND<0.20	0.11 J	ND<0.10	4.2
		05/16/2023	ND<0.10	ND<0.20	ND<0.10	ND<0.10	ND<0.032
		08/08/2023	ND<0.10	ND<0.20	ND<0.10	ND<0.10	ND<0.032
	Midfluent	11/01/2022	2.0	ND<0.20	ND<0.10	ND<0.10	3.0
		02/14/2023	2.8	ND<0.20	ND<0.10	ND<0.10	4.0
		05/16/2023	ND<0.10	ND<0.20	ND<0.10	0.94	ND<0.032
		08/08/2023	ND<0.10	ND<0.20	ND<0.10	ND<0.10	0.16
	Influent	11/01/2022	280	ND<0.20	ND<0.10	ND<0.10	3.0
		02/14/2023	280	ND<0.20	ND<0.10	ND<0.10	2.7
		05/16/2023	320	ND<0.20	ND<0.10	0.82	2.7
		08/08/2023	760	ND<0.20	ND<0.10	ND<0.10	5.3
65 Brennan Road	Effluent	11/02/2022	ND<0.10	ND<0.20	ND<0.10	ND<0.10	ND<0.032
		12/08/2022	ND<0.10	ND<0.20	ND<0.10	ND<0.10	ND<0.032
		02/14/2023	ND<0.10	ND<0.20	ND<0.10	ND<0.10	ND<0.032
		05/16/2023	ND<0.10	ND<0.20	ND<0.10	ND<0.10	ND<0.032
		08/08/2023	ND<0.10	ND<0.20	ND<0.10	ND<0.10	0.12
	Effflluent - Duplicate	11/02/2022	ND<0.10	ND<0.20	ND<0.10	ND<0.10	ND<0.032
		05/16/2023	ND<0.10	ND<0.20	ND<0.10	ND<0.10	ND<0.032
	Midfluent	11/02/2022	ND<0.10	ND<0.20	ND<0.10	ND<0.10	ND<0.032
		12/08/2022	ND<0.10	ND<0.20	ND<0.10	ND<0.10	ND<0.032
		02/14/2023	ND<0.10	ND<0.20	ND<0.10	ND<0.10	ND<0.032
		05/16/2023	ND<0.10	ND<0.20	ND<0.10	ND<0.10	ND<0.032
		08/08/2023	ND<0.10	ND<0.20	ND<0.10	ND<0.10	3.7
	Midfluent - Duplicate	08/08/2023	ND<0.10	ND<0.20	ND<0.10	ND<0.10	3.7
	Influent	11/02/2022	610	ND<0.20	ND<0.10	ND<0.10	6.4
		12/08/2022	790	ND<0.20	ND<0.10	ND<0.10	16
		02/14/2023	580	ND<0.20	ND<0.10	ND<0.10	7.7
		05/16/2023	860	ND<0.20	ND<0.10	ND<0.10	11
		08/08/2023	530	ND<0.20	ND<0.10	ND<0.10	9.2
77 Brennan Road	Effluent	12/08/2022	ND<0.10	ND<0.20	ND<0.10	ND<0.10	0.28
	Effluent Duplicate	12/08/2022	ND<0.10	ND<0.20	ND<0.10	ND<0.10	0.28
	Midfluent	12/08/2022	ND<0.10	ND<0.20	ND<0.10	ND<0.10	0.28
	Influent	12/08/2022	ND<0.10	ND<0.20	ND<0.10	ND<0.10	0.30
		02/14/2023	11	ND<0.20	ND<0.10	ND<0.10	0.22
	Influent Duplicate	02/14/2023	11	ND<0.20	ND<0.10	ND<0.10	0.26
	Barn	12/08/2023	13	ND<0.20	ND<0.10	ND<0.10	0.30
338 Park Post Road	Effluent	11/01/2022	ND<0.10	ND<0.20	ND<0.10	ND<0.10	ND<0.032
		02/14/2023	ND<0.10	ND<0.20	ND<0.10	ND<0.10	ND<0.032
		05/16/2023	ND<0.10	ND<0.20	ND<0.10	ND<0.10	ND<0.032
		08/08/2023	ND<0.10	ND<0.20	ND<0.10	ND<0.10	ND<0.032
	Midfluent	11/01/2022	ND<0.10	ND<0.20	ND<0.10	ND<0.10	ND<0.032
		02/14/2023	ND<0.10	ND<0.20	ND<0.10	ND<0.10	ND<0.032
		05/16/2023	ND<0.10	ND<0.20	ND<0.10	ND<0.10	ND<0.032
		08/08/2023	ND<0.10	ND<0.20	ND<0.10	ND<0.10	ND<0.032
	Influent	11/01/2022	220	ND<0.20	ND<0.10	ND<0.10	3.1
		02/14/2023	180	ND<0.20	ND<0.10	ND<0.10	3.5
		05/16/2023	190	ND<0.20	ND<0.10	ND<0.10	4.1
		08/08/2023	200	ND<0.20	ND<0.10	ND<0.10	3.2
	Field Blank	11/01/2022	NA	NA	NA	NA	ND<0.032
		05/16/2023	ND<0.10	ND<0.20	ND<0.10	ND<0.10	ND<0.032
	Trip Blank	11/01/2022	ND<0.10	ND<0.20	ND<0.10	ND<0.10	NA
		12/08/2022	ND<0.10	ND<0.20	ND<0.10	ND<0.10	NA
		02/14/2023	ND<0.10	ND<0.20	ND<0.10	ND<0.10	NA
		05/16/2023	ND<0.10	ND<0.20	ND<0.10	ND<0.10	NA
		08/08/2023	ND<0.10	ND<0.20	ND<0.10	ND<0.10	ND<0.032

Notes:

DEP: Pennsylvania Department of Environmental Protection

SHS: Statewide Health Standard

µg/L: micrograms per liter

J: Result is less than the reporting limit (RL) but greater than or equal to the method detection limit (MDL) and the concentration is an approximate value.

!: Laboratory is not accredited for this parameter.

ND: Indicates analysis was performed for the compound but it was not detected (<# is the method detection limit)

NS: No Standard

NA: Not Analyzed

Note: This table includes a subset of recent data (2022-23). Historical data from 2011-22 is available in DEP files

Green Shaded: Indicates a concentration was detected above the laboratory method detection limit.

Yellow Shaded: Indicates laboratory method detection limits exceed the DEP Groundwater Values for groundwater in a Used, Residential Aquifer

Red Shaded: Indicates concentrations exceed the DEP Groundwater Values for groundwater in a Used, Residential Aquifer

Table 5 – Remedial Alternative Technology Screening

TABLE 5
REMEDIAL ALTERNATIVE TECHNOLOGY SCREENING

Area of Concern	Technology	Feasibility and Effectiveness in Achieving Remedial Goals	Implementability		Relative Remedial Timeframe and Permanance	Cost	Community Acceptance Considerations	Overall Ranking of Option
			Technical (Constructability, O&M Requirements)	Administrative (Permits, Property Issues)				
Source Area Overburden Soils	**Excavation- Off Site Disposal**	GOOD	GOOD	FAIR	GOOD	GOOD	N/A	**GOOD**
		Technically feasible and effective: near complete removal of COC impacted soils above criteria	Remedy can easily be implemented, and minimal design required.	Requires some tree clearing; Requires regular access to the site for a short period.	Little to no unsaturated COC above criteria following very short term treatment. Overall timeframe for completion is 2 years. Excavation is permanent.	$3.7 to $4.6 Million	Short time frame; however, heavy equipment and traffic necessary. Potential for dust and sediment runoff, but can be controlled.	This option meets remedial goals and can be completed in a short timeframe. The cost is relatively low.
	Excavation- OnSite Treatment	GOOD	FAIR	FAIR	GOOD	GOOD	N/A	**GOOD**
		Technically feasible and effective; near complete treatmtent of COC impacted soils above criteria.	High level design required along with speciality subcontractor.	Requires some tree clearing; Requires regular access to the site for a slightly longer period than for off site disposal, and a larger work and staging area will be required.	Little to no unsaturated COC above criteria following very short term treatment. Overall timeframe for completion is 2 years. Excavation with on-site treatment is permanent.	$3.6 to $4.4 Million	Short time frame, although the time frame is longer than for off site disposal. Heavy equipment and traffic necessary. Potential for dust and sediment runoff, but can be controlled.	This option meets remedial goals and can be completed in a short timeframe, but with an increased design cost and complex implementability for a treatment technology to minimize offsite soil disposal. The majority of the soil would still need to be sent for off-site disposal due to the limited depth of the excavation based on depth to bedrock, and the need to maintain a buffer with the final treated soil below the frostline.
	SVE	POOR	FAIR	FAIR	POOR	FAIR	N/A	**FAIR**
		Technically feasible; however, effectiveness is unknown due to implementability challenges.	High level design required along with speciality subcontractor for horizontal wells, challenges with SVE well installation and construction likely due to shallow bedrock. Short circuiting to the surface also likely; therefore a soil cap would be needed. In addition, poor draining soils and clay could present challenges for SVE.	Requires connection to local power grid, and will require long periods on-site for well installation and system construction. In addition, regular site visits for operation and maintenance of the system would be required.	Due to potential implementability challenges, actual duration is unknown; likely to be three or more years of operation required (resulting in the total duration from design through system decommissioning to be 6 years (or longer)). SVE, if it were successfully implemented, would be permananent.	$3.3 to $4.1 Million; however, unknown if it will be higher due to longer duration of operation	Required time on-site for construction and long-term O&M needs. However, once systems are installed maintenance is less frequent (twice a month). Equipment could be loud; however, sound attenuation can be used.	Due to the implementability challenges, and the unknown effectiveness and total duration of the remediation, this option does not rank well. Although the cost is relatively low, due to the uncertainty of effectiness, and potential for cost to increase from longer duration of O&M, this is not the best option.
	ISTT	GOOD	FAIR	FAIR	FAIR	POOR	N/A	**FAIR**
		Technically feasible, and will be effective if implemented properly.	High level design required along with speciality subcontractor.	Requires regular site access for a moderate period; Air discarge permit required; Temporary water discharge permit required; Installation of above-grade equipment.	Timeframe is 23 weeks of active construction, remediation, and demobilization. The overall project duration is longer than excavation but shorter than SVE. ISTT is permanent.	$6.1 to $7.5 Million	Estimated 23 straight weeks of heavy construction and maintenance. Equipment may be loud when operating; however, sound attenuation can be used.	The technology is feasible and effective, and relatively implementable. However, the duration is long and the community acceptance may be poor. This technology also has a higher cost than excavation or SVE.
Source Area Bedrock Groundwater	**ISTT**	GOOD	FAIR	FAIR	FAIR	POOR	N/A	**FAIR**
		Technically feasible, and will be effective if implemented properly.	High level design required along with speciality subcontractor	Requires regular site access for a moderate period; Air discarge permit required; Temporary water discharge permit required Installation of above-grade equipment.	Timeframe is 19 weeks of active construction, remediation, and demobilization. The overall project duration for on-site work is initially lengthy; however, the overal timeframe from design through completion is short (4 years). ISTT is permanent.	$47.4 to $58.7 Million	Requires an estimated 19 straight weeks of heavy construction and maintenance. Equipment may be loud when operatin; however, sound attenuation can be used.	Although the technology is feasible and effective, and relatively implementable, it is the highest cost option.
	In-Situ Chemical Reduction	FAIR	FAIR	GOOD	GOOD	GOOD	N/A	**GOOD**
		Although technically feasible and effective for VOC reduction, 1,4-dioxane will not be amenable to reduction.	High level design required along with specialty vendor, pilot test required.	Requires regular site access for a short period of time; Installation of injection wells, pilot testing, and Injection Permits.	Timeframe for on-site completion is relatively short (estimated 24 weeks from well construction through injection), and then minimal site access for monitoring thereafter. Total project duration is estimated to be 7 years. Once the remedy is complete, it is permanent.	$1.7 to $2.1 Million	This is one of the shorter duration options for the on site portion of the work (24 weeks), and there is no above-ground system (after the injection is completed).	Overall, ISCR is a viable option for the site; however, only if 1,4-dioxane can be addressed via other methods (i.e., risk based, natural attenuation). This option is relatively inexpensive compared to other in-situ technologies evaluated.
	In-situ Chemical Oxidation	GOOD	FAIR	GOOD	FAIR	FAIR	N/A	**FAIR**
		Although technically feasible, the effectiveness will depend on the ability to inject the required volume of amendments, and may require multiple injections to maintain concentration reductions due to back diffusion.	Design required along with specialty vendor, pilot test required.	Requires regular site access for a short period of time; Installation of injection wells, pilot testing, and Injection Permits.	Will require multiple injection events, and potentially additional injection events if dissolved-phase concentrations rebound. Estimated time for each injection event is very high (28 weeks) due to estimated volume of oxidant required. Overall timeframe for this option from design through attainment monitoring is 8 years or longer.	$13.7 to $17.5 Million	Estimated to require up to 3 multi-week injection events, and the exact number and timeframe could be higher. After injections completed, no above-ground equipment remains on-site.	Although ISCO is technically feasible, and would address all of the site COCs (including 1,4-dioxane), the unknown effectiveness and potential need for multiple injections make this a less desirable option than others. In addition, the cost of this option is higher than some of the other in-situ injection options due to the volume required and high cost of the oxidation chemicals.
	Carbon Injection	FAIR	FAIR	GOOD	GOOD	GOOD	N/A	**GOOD**
		Although technically feasible and effective for VOC reduction, 1,4-dioxane will not be as amenable to biological reduction. However, some reduction of 1,4D from the dissolved-phase is expected as it can initially be adsorbed onto the carbon.	High level design required along with specialty vendor, pilot test required.	Requires regular site access for a short period of time; Installation of injection wells, pilot testing, and Injection Permits.	Timeframe for on-site completion is relatively short (estimated 24 weeks from well construction through injection), and then minimal site access for monitoring thereafter. Total project duration is estimated to be 7 years. Once the remedy is complete, it is permanent.	$4.9 to $6.2 Million	Estimated to be a total of 24 weeks for the on-site portion of the work, and there is no above-ground equipment remaining on-site (after the injection is completed).	Overall, carbon injection is a viable option for the site; however, only if 1,4-dioxane can be addressed via other methods (i.e., risk based, natural attenuation). This option is relatively inexpensive.
	Enhanced Biodegradation	FAIR	FAIR	GOOD	FAIR	GOOD	N/A	**FAIR**
		Although technically feasible and effective for VOC reduction, 1,4-dioxane reduction may be hindered.	High level design required along with specialty vendor, pilot test required.	Requires regular site access for a short period of time; Installation of injection wells, pilot testing, and Injection Permits.	Timeframe for on-site completion is relatively short (estimated 17 weeks from well construction through injection), and then minimal site access for monitoring thereafter. As the ERD process is slower than ISCR, the performance monitoring period is longer. Total project duration is estimated to be 10 years. Once biodegradation is complete, it is permanent.	$1.6 to $2.0 Million	Estimated to be a total of 17 weeks for the on-site portion of the work, and there is no above-ground equipment remaining on-site (after the injection is completed).	Overall, enhanced biodegradation is a viable option for the site; however, only if 1,4-dioxane can be addressed via other methods (i.e., risk based, natural attenuation). However, as this option is similar to ISCR in cost, and would take a longer period of time to monitor for performance and attainment sampling purposes, it is not ranked as well as ISCR.
	Monitored natural attenuation	FAIR	GOOD	GOOD	FAIR	GOOD	N/A	**GOOD**
		Technically feasible and effective for VOC reduction; however, 1,4-dioxane reduction may be hindered.	Easily implementable.	Access needed to properties on a biannual basis, minimal impact for groundwater monitoring.	Duration is unknown, but is estimated to be at least 15 years. Once natural attenuation is complete, it is permanent.	$0.3 to $0.5 Million	Duration is longer than other remedies; however, presence on-site is less than for other remedies.	The overall ranking for this is good, as it would achieve the goals; however, over a longer period of time and less aggressively than a technology that is more guaranteed to reduce the concentrations in the source area bedrock groundwater.
Non-Source Area Bedrock Groundwater	**Monitored natural attenuation**	FAIR	GOOD	GOOD	FAIR	GOOD	N/A	**GOOD**
		Technically feasible and effective for VOC reduction; however, 1,4-dioxane reduction may be hindered.	Easily implementable.	Access needed to properties on a biannual basis, minimal impact for groundwater monitoring.	Duration is unknown, but is estimated to be at least 10 years.	$0.5 to $0.6 Million	Duration is longer than other remedies; however, presence on-site is less than for other remedies.	The overall ranking for this is good, as it is anticipated that addressing the source area bedrock groundwater will aid in the natural attenuation of the non-source area bedrock groundwater, by removing the potential for additional migration to the non-source areas.

Table 6 -16 Remedial Alternative Cost Estimates

Table 6
Source Area Overburden Soils - Excavation - Off Site Disposal Cost Estimate

ASSUMPTIONS

An estimated 13,500 cubic yards of soil to be excavated.
The weight of soil is assumed to be 1.5 tons per cubic yard.
It has been assumed that no dewatering will be needed.
It has been assumed that all soils will be characterized as non-hazardous prior to transport to an approved off-site treatment or disposal facility.
It has been assumed that post-excavation soil samples will indicate remedial action objectives are met.
Costs have been estimated using a combination of vendor quotes and GES' experience at similar sites for similar activities.

REMEDIATION COSTS

PHASE / TASK / SUBTASK	COST/UNIT		SCHEDULE COST/YEAR 1		2		3		4		5		6-10		11-30	
			UNITS	COSTS	UNITS	COSTS	UNITS	COSTS	UNITS	COSTS	UNITS	COSTS	UNITS	COSTS	UNITS	COSTS
Background Investigation																
Regulatory Agency Meeting	$1,500	/meeting	2	$3,000	1	$1,500		$0		$0		$0		$0		$0
Remedial Action Plan & Permitting																
Remedial Design	$30,000	/each	1	$30,000		$0		$0		$0		$0		$0		$0
Permitting	$6,000	/each	1	$6,000		$0		$0		$0		$0		$0		$0
Remedial Action/Cleanup Plan Report	$10,000	/each	1	$10,000		$0		$0		$0		$0		$0		$0
Soil Excavation & Disposal																
Site Preparation (clearing, temp access roads, silt fence)	$68,000	/site		$0	1	$68,000		$0		$0		$0		$0		$0
Excavation	$12	/ton		$0	20250	$243,000		$0		$0		$0		$0		$0
Soil Disposal	$125	/ton		$0	20250	$2,531,250		$0		$0		$0		$0		$0
Fill Material, Backfill, & Soil Cover	$33	/ton		$0	20250	$668,250		$0		$0		$0		$0		$0
Plantings/Site Stabilization	$24,000	/site		$0	1	$24,000		$0		$0		$0		$0		$0
GES oversight and management	$15,000	/week		$0	8	$120,000		$0		$0		$0		$0		$0
Post-Remediation/Closure																
Post-excavation Soil Sampling	$15,000	/event		$0	1	$15,000		$0		$0		$0		$0		$0
Risk Screening/Assessment	$10,000	/event		$0	1	$10,000		$0		$0		$0		$0		$0
TOTAL				$49,000		$3,681,000		$0		$0		$0		$0		$0
CUMULATIVE TOTAL				$49,000		$3,730,000		$3,730,000		$3,730,000		$3,730,000		$3,730,000		$3,730,000
CONTINGENCY (20%)				$9,800		$736,200										
CUMULATIVE TOTAL W/ CONTINGENCY AND INFLATION (3%)				$58,800		$4,608,516		$4,608,516		$4,608,516		$4,608,516		$4,608,516		$4,608,516

Table 7
Source Area Overburden Soils - Excavation - On Site Treatment Cost Estimate

ASSUMPTIONS

An estimated 13,500 cubic yards of soil to be excavated.
The weight of soil is assumed to be 1.5 tons per cubic yard.
It has been assumed that remaining 40% of soils will be treated on-site through ex-situ for soil stabilization, due to the need to maintain treated soils below the frost line, and due to expansion from mixing.
It has been assumed that post-excavation soil samples will indicate remedial action objectives are met.
Costs have been estimated using a combination of vendor quotes and GES' experience at similar sites for similar activities.

REMEDIATION COSTS

PHASE / TASK / SUBTASK	COST/UNIT		SCHEDULE COST/YEAR													
			1		2		3		4		5		6-10		11-30	
			UNITS	COSTS	UNITS	COSTS	UNITS	COSTS	UNITS	COSTS	UNITS	COSTS	UNITS	COSTS	UNITS	COSTS
Background Investigation																
Regulatory Agency Meeting	$1,500	/meeting	2	$3,000	1	$1,500		$0		$0		$0		$0		$0
Remedial Action Plan & Permitting																
Remedial Design	$50,000	/each	1	$50,000		$0		$0		$0		$0		$0		$0
Permitting	$6,000	/each	1	$6,000		$0		$0		$0		$0		$0		$0
Remedial Action/Cleanup Plan Report	$10,000	/each	1	$10,000		$0		$0		$0		$0		$0		$0
Soil Excavation & Disposal																
Site Preparation (clearing, temp access roads, silt fence)	$80,000	/site		$0	1	$80,000		$0		$0		$0		$0		$0
Excavation	$12	/ton		$0	20,250	$243,000		$0		$0		$0		$0		$0
Soil Disposal	$125	/ton		$0	12,150	$1,518,750		$0		$0		$0		$0		$0
Soil Treatment- stabilization	$100	/ton		$0	8,100	$810,000		$0		$0		$0		$0		$0
Treated Soil backfilling	$25	/ton		$0	8,100	$202,500										
Fill Material, Backfill, & Soil Cover	$33	/ton		$0	12,150	$400,950		$0		$0		$0		$0		$0
Plantings/Site Stabilization	$28,080	/site		$0	1	$28,080		$0		$0		$0		$0		$0
GES oversight and management	$15,000	/week		$0	12	$180,000		$0		$0		$0		$0		$0
Post-Remediation/Closure																
Post-excavation Soil Sampling	$15,000	/event		$0	1	$15,000		$0		$0		$0		$0		$0
Risk Screening/Assessment	$10,000	/event		$0	1	$10,000		$0		$0		$0		$0		$0
TOTAL				$69,000		$3,489,780		$0		$0		$0		$0		$0
CUMULATIVE TOTAL				$69,000		$3,558,780		$3,558,780		$3,558,780		$3,558,780		$3,558,780		$3,558,780
CONTINGENCY (20%)				$13,800		$697,956				$0		$0		$0		$0
CUMULATIVE TOTAL W/ CONTINGENCY AND INFLATION (3%)				$82,800		$4,396,168		$4,396,168		$4,396,168		$4,396,168		$4,396,168		$4,396,168

Table 8
Source Area Overburden Soils - SVE Cost Estimate

ASSUMPTIONS

An estimated 13,500 cubic yards of unsaturated soil will be treated using SVE.
Assumes a total of 8 horizontal SVE wells (approximately 300 ft long each) required to cover the treatment areas.
Assumes 3 feet of topsoil will be added to prevent short circuiting to the surface.
Assumes system will operate for three years; however, due to uncertainty of the effectiveness and implementability, more may be needed.
Costs have been estimated using a combination of vendor quotes and GES' experience at similar sites for similar activities.

REMEDIATION COSTS

PHASE / TASK / SUBTASK	COST/UNIT		SCHEDULE COST/YEAR													
			1		2		3		4		5		6-10		11-30	
			UNITS	COSTS	UNITS	COSTS	UNITS	COSTS	UNITS	COSTS	UNITS	COSTS	UNITS	COSTS	UNITS	COSTS
Background Investigation																
Regulatory Agency Meeting	$1,500	/meeting	2	$3,000	4	$6,000	1	$1,500	1	$1,500	1	$1,500	1	$1,500		$0
Remedial Action Plan & Permitting																
Remedial Design	$100,000	/each	1	$100,000		$0		$0		$0		$0		$0		$0
Permitting/Permitting Equivalency	$6,000	/each	1	$6,000		$0		$0		$0		$0		$0		$0
Remedial Action/Cleanup Plan Report	$10,000	/each	1	$10,000		$0		$0		$0		$0		$0		$0
In-situ Soil Treatment & Soil Excavation																
Site Prep	$100,000	/site		$0	1	$100,000		$0		$0		$0		$0		$0
Extra soil backfill	$33	/ton		$0	6,750	$222,750		$0		$0		$0		$0		$0
Pilot Testing	$100,000	/site		$0	1	$100,000		$0		$0		$0		$0		$0
SVE wells	$150,000	/well		$0	8	$1,200,000		$0		$0		$0		$0		$0
SVE Systems	$300,000	/system		$0	2	$600,000		$0		$0		$0		$0		$0
Electric Install	$50,000	/system		$0	2	$100,000		$0		$0		$0		$0		$0
Plantings/Site Stabilization	$20,000	/site		$0	1	$20,000		$0		$0		$0		$0		$0
Oversight and Management	$15,000	/week		$0	25	$375,000		$0		$0		$0		$0		$0
O&M	$125,000	/year		$0		$0	1	$125,000	1	$125,000	1	$125,000		$0		$0
Closure Assessment (unsaturated soils only)																
Soil Attainment Sampling	$15,000	/event		$0		$0		$0		$0		$0	1	$15,000		$0
System decommissioning	$20,000	/event		$0		$0		$0		$0		$0	1	$20,000		$0
Risk Assessment	$10,000	/event		$0		$0		$0		$0		$0	1	$10,000		$0
TOTAL				$119,000		$2,723,750		$126,500		$126,500		$126,500		$45,000		$0
CUMULATIVE TOTAL				$119,000		$2,842,750		$2,969,250		$3,095,750		$3,222,250		$3,267,250		$3,267,250
CONTINGENCY (20%)				$23,800		$544,750		$25,300		$37,950		$37,950		$13,500		$0
CUMULATIVE TOTAL W/ CONTINGENCY AND INFLATION (3%)				$142,800		$3,509,355		$3,670,263		$3,849,514		$4,033,698		$4,100,973		$4,100,973

Table 9
Source Area Overburden Soils - ISTT Cost Estimate

ASSUMPTIONS

An estimated 13,500 cubic yards of unsaturated soil will be treated using ISTT for VOCs.
Assumed 3 ft of soil will be added
Estimated operating time is 23 weeks, added 5 weeks for construction and demo.
Estimated condensate recovery rate is 3.12 gpm. This is approximately 600,000 gallons for duration of project.
It is assumed that the water can be discharged under a temporary discharge permit.
Costs have been estimated using a combination of vendor quotes and GES' experience at similar sites for similar activities.

REMEDIATION COSTS

PHASE / TASK / SUBTASK	COST/UNIT		SCHEDULE COST/YEAR													
			1		2		3		4		5		6-10		11-30	
			UNITS	COSTS	UNITS	COSTS	UNITS	COSTS	UNITS	COSTS	UNITS	COSTS	UNITS	COSTS	UNITS	COSTS
Background Investigation																
Regulatory Agency Meeting	$1,500	/meeting	2	$3,000	4	$6,000	1	$1,500		$0		$0		$0		$0
Remedial Action Plan & Permitting																
Remedial Design	$100,000	/each	1	$100,000		$0		$0		$0		$0		$0		$0
Permitting/Permitting Equivalency	$6,000	/each	1	$6,000		$0		$0		$0		$0		$0		$0
Remedial Action/Cleanup Plan Report	$10,000	/each	1	$10,000		$0		$0		$0		$0		$0		$0
In-situ Soil Treatment & Soil Excavation																
Site Prep	$100,000	/site		$0	1	$100,000		$0		$0		$0		$0		$0
In-situ Thermal Treatment (TCH)	$397	/cubic yard		$0	13,500	$5,360,000		$0		$0		$0		$0		$0
Plantings/Site Stabilization	$20,000	/site		$0	1	$20,000		$0		$0		$0		$0		$0
Oversight and Management	$15,000	/week		$0	28	$420,000		$0		$0		$0		$0		$0
Closure Assessment (unsaturated soils only)																
Soil Attainment Sampling	$15,000	/event		$0		$0	1	$15,000		$0		$0		$0		$0
Risk Assessment	$10,000	/event		$0		$0	1	$10,000		$0		$0		$0		$0
TOTAL				$119,000		$5,906,000		$26,500		$0		$0		$0		$0
CUMULATIVE TOTAL				$119,000		$6,025,000		$6,051,500		$6,051,500		$6,051,500		$6,051,500		$6,051,500
CONTINGENCY (20%)				$23,800		$1,181,200		$5,300		$0		$0				
CUMULATIVE TOTAL W/ INFLATION (3%)				$142,800		$7,442,616		$7,476,324		$7,476,324		$7,476,324		$7,476,324		$7,476,324

Table 10
Source Area Bedrock Groundwater - ISTT Cost Estimate

ASSUMPTIONS

An estimated 355,556 cubic yards of bedrock and groundwater will be treated.
Assumed 3 ft of soil will be added to prevent short-circuiting and allow for vapor-recovery.
Costs assume 19 weeks total for operation, plus 5 weeks for construction and demob. 5,760,000 gallons total.
An estimated 5,760,000 gallons total of condensate would be generated. Costs do not include water disposal, but assume it can be treated and discharged on-site.
The In-situ Thermal Treatment cost below includes well installation, construction, utilities, operation, treatment, and demobilization costs.
Costs have been estimated using a combination of vendor quotes and GES' experience at similar sites for similar activities.
Source area GW attainment monitoring assumes 5 monitoring wells.

REMEDIATION COSTS

PHASE / TASK / SUBTASK	COST/UNIT		SCHEDULE COST/YEAR													
			1		2		3		4		5		6-10		11-30	
			UNITS	COSTS	UNITS	COSTS	UNITS	COSTS	UNITS	COSTS	UNITS	COSTS	UNITS	COSTS	UNITS	COSTS
Background Investigation																
Regulatory Agency Meeting	$1,500	/meeting	2	$3,000	4	$6,000	1	$1,500	1	$1,500	1	$1,500		$0		$0
Remedial Action Plan & Permitting																
Remedial Design	$100,000	/each	1	$100,000		$0		$0		$0		$0		$0		$0
Permitting/Permitting Equivalency	$6,000	/each	1	$6,000		$0		$0		$0		$0		$0		$0
Remedial Action/Cleanup Plan Report	$10,000	/each	1	$10,000		$0		$0		$0		$0		$0		$0
In-situ Soil Treatment & Soil Excavation																
Site Prep	$100,000	/site		$0	1	$100,000		$0		$0		$0		$0		$0
Extra soil backfill	$33	/ton		$0	6,750	$222,750		$0		$0		$0		$0		$0
In-situ Thermal Treatment (TCH)	$131	/cubic yard		$0	355,556	$46,528,021		$0		$0		$0		$0		$0
Plantings/Site Stabilization	$20,000	/site		$0	1	$20,000		$0		$0		$0		$0		$0
Oversight and Management	$15,000	/week		$0	24	$360,000		$0		$0		$0		$0		$0
GW Attainment Monitoring (quarterly)	$3,000	/quarter		$0	4	$12,000	4	$12,000	4	$12,000		$0		$0		$0
Annual Report	$7,500	/year		$0	1	$7,500	1	$7,500	1	$7,500		$0		$0		$0
Closure Assessment (unsaturated soils only)																
Well abandonment	$25,000	/event		$0		$0		$0		$0	1	$25,000		$0		$0
Act 2 Final Report	$12,000	/event		$0		$0		$0		$0	1	$12,000		$0		$0
TOTAL				$119,000		$47,256,271		$21,000		$21,000		$38,500		$0		$0
CUMULATIVE TOTAL				$119,000		$47,375,271		$47,396,271		$47,417,271		$47,455,771		$47,455,771		$47,455,771
CONTINGENCY (20%)				$23,800		$9,451,254		$4,200		$6,300		$11,550		$0		$0
CUMULATIVE TOTAL W/ CONTINGENCY AND INFLATION (3%)				$142,800		$58,551,551		$58,578,263		$58,608,020		$58,664,076		$58,664,076		$58,664,076

Table 11
Source Area Bedrock Groundwater - ISCR Cost Estimate

ASSUMPTIONS

Costs estimated based on treating groundwater in the 60,000 square ft treatment area (GW depth 90-250 ft bgs).
Costs assume Evonik's 143,831 gallons total solution (estimated based on Evonik's Geoform with ELS Liquid Concentrate) to be injected into 24 wells.
Assumed 12 weeks for drilling, 10 weeks for injection, 2 weeks for mob/demob/other.
Assumed water tank deliveries throughout (based on 4000 gallons per delivery, 35 total).
Assumes groundwater attainment sampling will be achieved through ISCR monitoring.
Costs have been estimated using a combination of vendor quotes and GES' experience at similar sites for similar activities.

REMEDIATION COSTS

PHASE / TASK / SUBTASK	COST/UNIT		SCHEDULE COST/YEAR 1		2		3		4		5		6-10		11-30	
			UNITS	COSTS	UNITS	COSTS	UNITS	COSTS	UNITS	COSTS	UNITS	COSTS	UNITS	COSTS	UNITS	COSTS
Background Investigation																
Regulatory Agency Meeting	$1,500	/meeting	2	$3,000	2	$3,000	1	$1,500	1	$1,500	1	$1,500	2	$3,000		$0
Remedial Action Plan & Permitting																
Remedial Design	$30,000	/each	1	$30,000		$0		$0		$0		$0		$0		$0
Permitting	$6,000	/each	1	$6,000		$0		$0		$0		$0		$0		$0
Remedial Action/Cleanup Plan Report	$10,000	/each	1	$10,000		$0		$0		$0		$0		$0		$0
Soil Excavation & Disposal																
Injection Well Install	$12,000	/well		$0	24	$288,000		$0		$0		$0		$0		$0
Sentinel Well Install	$12,000	/well		$0	3	$36,000		$0		$0		$0		$0		$0
ISCR pilot test	$50,000	/event		$0	1	$50,000		$0		$0		$0		$0		$0
ISCR Injection (Chemicals)	$180,000	event		$0	1	$180,000		$0		$0		$0		$0		$0
Water Deliveries	$4,000	/day		$0	35	$140,000		$0		$0		$0		$0		$0
ISCR Injection Equipment	$10,000	/week		$0	10	$100,000		$0		$0		$0		$0		$0
Packer services for injection wells	$20,000	/week		$0	10	$200,000		$0		$0		$0		$0		$0
Oversight (drilling and injection)	$15,000	/week		$0	24	$360,000		$0		$0		$0		$0		$0
ISCR Performance Monitoring	$30,000	/year		$0	1	$30,000	1	$30,000	1	$30,000	1	$30,000	2	$60,000		$0
Plantings/Site Stabilization	$10,000	/site		$0	1	$10,000		$0		$0		$0		$0		$0
Annual Report	$7,500	/year		$0	1	$7,500	1	$7,500	1	$7,500	1	$7,500	2	$15,000		$0
Closure Assessment																
Well abandonment	$30,000	/event		$0		$0		$0		$0		$0	1	$30,000		$0
Act 2 Final Report	$12,000	/report		$0		$0		$0		$0		$0	1	$12,000		$0
TOTAL				$49,000		$1,404,500		$39,000		$39,000		$39,000		$120,000		$0
CUMULATIVE TOTAL				$49,000		$1,453,500		$1,492,500		$1,531,500		$1,570,500		$1,690,500		$1,690,500
CONTINGENCY (20%)				$9,800		$280,900		$7,800		$7,800		$7,800		$24,000		$0
CUMULATIVE TOTAL W/ CONTINGENCY AND INFLATION (3%)				$58,800		$1,794,762		$1,844,370		$1,895,382		$1,947,798		$2,115,558		$2,115,558

Table 12
Source Area Bedrock Groundwater - ISCO Cost Estimate

ASSUMPTIONS

Costs estimated based on treating groundwater in the 60,000 square ft treatment area (GW depth 90-250 ft bgs).
Assumes approximately 82,000 gallons of PersulfOx to be applied during each injection event.
Assumes a total of 24 injection wells will be required (50 ft spacing).
Assumes 12 weeks for drilling, 28 weeks for injections (per event).
Assumes groundwater attainment sampling will be achieved through ISCR monitoring.
Costs have been estimated using a combination of vendor quotes and GES' experience at similar sites for similar activities.

REMEDIATION COSTS

PHASE / TASK / SUBTASK	COST/UNIT		SCHEDULE COST/YEAR 1		2		3		4		5		6-10		11-30	
			UNITS	COSTS	UNITS	COSTS	UNITS	COSTS	UNITS	COSTS	UNITS	COSTS	UNITS	COSTS	UNITS	COSTS
Background Investigation																
Regulatory Agency Meeting	$1,500	/meeting	2	$3,000	2	$3,000	1	$1,500	1	$1,500	1	$1,500	5	$7,500		$0
Remedial Action Plan & Permitting																
Remedial Design	$30,000	/each	1	$30,000		$0		$0		$0		$0		$0		$0
Permitting	$6,000	/each	1	$6,000		$0		$0		$0		$0		$0		$0
Remedial Action/Cleanup Plan Report	$10,000	/each	1	$10,000		$0		$0		$0		$0		$0		$0
Soil Excavation & Disposal																
Injection Well Install	$12,000	/well		$0	24	$288,000		$0		$0		$0		$0		$0
Sentinel Wells	$12,000	/well		$0	3	$36,000		$0		$0		$0		$0		$0
ISCO pilot test	$50,000	/event		$0	1	$50,000		$0		$0		$0		$0		$0
ISCO Injection Chemicals	$2,756,000	event		$0	1	$2,756,000	1	$2,756,000	1	$2,756,000		$0		$0		$0
Well Installation Oversight	$15,000	/week		$0	12	$180,000		$0		$0		$0		$0		$0
ISCO Injection Equipment	$20,000	/week		$0	28	$560,000	28	$560,000	28	$560,000		$0		$0		$0
Packer services for injection wells	$20,000	/week		$0	28	$560,000	28	$560,000	28	$560,000		$0		$0		$0
ISCO Injection Oversight (2 crews simultaneously)	$15,000	/week		$0	28	$420,000	28	$420,000	28	$420,000		$0		$0		$0
ISCO Monitoring	$20,000	/year		$0	1	$20,000	1	$20,000	1	$20,000	1	$20,000	3	$60,000		$0
Plantings/Site Stabilization	$10,000	/site		$0	1	$10,000		$0		$0		$0		$0		$0
Annual Report	$7,500	/year		$0	1	$7,500	1	$7,500	1	$7,500	1	$7,500	3	$22,500		$0
Closure Assessment																
Well abandonment	$30,000	/event		$0		$0		$0		$0		$0	1	$30,000		$0
Act 2 Final Report	$12,000	/report		$0		$0		$0		$0		$0	1	$12,000		$0
TOTAL				$49,000		$4,890,500		$4,323,500		$4,323,500		$27,500		$124,500		$0
CUMULATIVE TOTAL				$49,000		$4,939,500		$9,263,000		$13,586,500		$13,614,000		$13,738,500		$13,738,500
CONTINGENCY (30%)				$9,800		$978,100		$864,700		$864,700		$5,500		$24,900		$0
CUMULATIVE TOTAL W/ CONTINGENCY AND INFLATION (3%)				$58,800		$6,103,458		$11,602,950		$17,258,088		$17,295,048		$17,471,340		$17,471,340

Table 13
Source Area Bedrock Groundwater - Carbon Injection Cost Estimate

ASSUMPTIONS

Costs based on installing a permeable reactive barrier wall along two sides of the 60,000 square foot treatment area.
Assumes 24 injection wells required (50-ft spacing).
Assumes each injection event will take 6 weeks, drilling oversight 12 weeks.
Assumed a total of two injections to be completed (second may only be nutrient supplemental).
Assumes packers will be used to target segmented vertical intervals in each injection well to distrubute solution across the entire treatment depth (included in the Carbon Injection price)
Assumes groundwater attainment sampling will be achieved through performance monitoring.
Costs have been estimated using a combination of vendor quotes and GES' experience at similar sites for similar activities.

REMEDIATION COSTS

PHASE / TASK / SUBTASK	COST/UNIT		SCHEDULE COST/YEAR													
			1		2		3		4		5		6-10		11-30	
			UNITS	COSTS	UNITS	COSTS	UNITS	COSTS	UNITS	COSTS	UNITS	COSTS	UNITS	COSTS	UNITS	COSTS
Background Investigation																
Regulatory Agency Meeting	$1,500	/meeting	2	$3,000	2	$3,000	1	$1,500	1	$1,500	1	$1,500	5	$7,500		$0
Remedial Action Plan & Permitting																
Remedial Design	$30,000	/each	1	$30,000		$0		$0		$0		$0		$0		$0
Permitting	$6,000	/each	1	$6,000		$0		$0		$0		$0		$0		$0
Remedial Action/Cleanup Plan Report	$10,000	/each	1	$10,000		$0		$0		$0		$0		$0		$0
Soil Excavation & Disposal																
Injection Well Install	$12,000	/well		$0	24	$288,000		$0		$0		$0		$0		$0
Carbon Injection Pilot Test	$80,000	/event		$0	1	$80,000		$0		$0		$0		$0		$0
Pre-design geophysics	$20,000	/event		$0	1	$20,000		$0		$0		$0		$0		$0
Carbon Injection	$1,900,000	event		$0	1	$1,900,000	1	$1,900,000		$0		$0		$0		$0
Oversight (well installation)	$15,000	/week		$0	12	$180,000		$0		$0		$0		$0		$0
Oversight (injections)	$15,000	/week		$0	10	$150,000	10	$150,000		$0		$0		$0		$0
Carbon Injection Performance Monitoring	$20,000	/year		$0	1	$20,000	1	$20,000	1	$20,000	1	$20,000	2	$40,000		$0
Plantings/Site Stabilization	$10,000	/site		$0	1	$10,000		$0		$0		$0		$0		$0
Annual Report	$7,500	/year		$0	1	$7,500	1	$7,500	1	$7,500	1	$7,500	2	$15,000		
Closure Assessment																
Well abandonment	$30,000	/event		$0		$0		$0		$0		$0	1	$30,000		$0
Act 2 Final Report	$12,000	/report		$0		$0		$0		$0		$0	1	$12,000		$0
TOTAL				$49,000		$2,658,500		$2,077,500		$27,500		$27,500		$97,000		$0
CUMULATIVE TOTAL				$49,000		$2,707,500		$4,785,000		$4,812,500		$4,840,000		$4,937,000		$4,937,000
CONTINGENCY (30%)				$9,800		$531,700		$415,500		$5,500		$5,500		$19,400		$0
CUMULATIVE TOTAL W/ CONTINGENCY AND INFLATION (3%)				$58,800		$3,344,706		$5,987,286		$6,023,256		$6,060,216		$6,195,822		$6,195,822

Table 14
Source Area Bedrock Groundwater - Enhance Bioremediation (ERD) Cost Estimate

ASSUMPTIONS

Costs estimated based on treating groundwater in the 60,000 square ft treatment area (GW depth 90-250 ft bgs).
Assumes an estimated 100,000 gallons total solution (carbon source and MDB-1 Inoculum) to be injected into 24 wells.
Assumes packers will be used to target segmented vertical intervals in each injection well to distrubute solution across the entire treatment depth.
Assumed 4 weeks for injection, 12 weeks for drilling, 1 weeks for mob/demob/other.
Assumes groundwater attainment sampling will be achieved through performance monitoring.
Costs have been estimated using a combination of vendor quotes and GES' experience at similar sites for similar activities.

REMEDIATION COSTS

PHASE / TASK / SUBTASK	COST/UNIT		SCHEDULE COST/YEAR 1		2		3		4		5		6-10		11-30	
			UNITS	COSTS	UNITS	COSTS	UNITS	COSTS	UNITS	COSTS	UNITS	COSTS	UNITS	COSTS	UNITS	COSTS
Background Investigation																
Regulatory Agency Meeting	$1,500	/meeting	2	$3,000	2	$3,000	1	$1,500	1	$1,500	1	$1,500	2	$3,000		$0
Remedial Action Plan & Permitting																
Remedial Design	$30,000	/each	1	$30,000		$0		$0		$0		$0		$0		$0
Permitting	$6,000	/each	1	$6,000		$0		$0		$0		$0		$0		$0
Remedial Action/Cleanup Plan Report	$10,000	/each	1	$10,000		$0		$0		$0		$0		$0		$0
Soil Excavation & Disposal																
Injection Well Install	$12,000	/well		$0	24	$288,000		$0		$0		$0		$0		$0
Sentinel Well Install	$12,000	well		$0	3	$36,000		$0		$0		$0		$0		$0
ERD pilot test	$30,000	/event		$0	1	$30,000		$0		$0		$0		$0		$0
ERD Injection (Inoculum and carbon source)	$120,000	event		$0	1	$120,000		$0		$0		$0		$0		$0
Water Deliveries	$4,000	/truck		$0	15	$60,000		$0		$0		$0		$0		$0
Injection Equipment	$10,000	/week		$0	12	$120,000		$0		$0		$0		$0		$0
Packer Services (for Injection)	$20,000	/week		$0	12	$240,000		$0		$0		$0		$0		$0
Oversight (drilling and injection)	$15,000	/week		$0	17	$255,000		$0		$0		$0		$0		$0
ERD Performance Monitoring	$30,000	/year		$0	1	$30,000	1	$30,000	1	$30,000	1	$30,000	5	$150,000		$0
Plantings/Site Stabilization	$10,000	/site		$0	1	$10,000		$0		$0		$0		$0		$0
Annual Report	$7,500	/year		$0	1	$7,500	1	$7,500	1	$7,500	1	$7,500	5	$37,500		
Closure Assessment																
Well abandonment	$30,000	/event		$0		$0		$0		$0		$0	1	$30,000		$0
Act 2 Final Report	$12,000	/report		$0		$0		$0		$0		$0	1	$12,000		$0
TOTAL				$49,000		$1,199,500		$39,000		$39,000		$39,000		$232,500		$0
CUMULATIVE TOTAL				$49,000		$1,248,500		$1,287,500		$1,326,500		$1,365,500		$1,598,000		$1,598,000
CONTINGENCY (20%)				$9,800		$239,900		$7,800		$7,800		$7,800		$46,500		$0
CUMULATIVE TOTAL W/ CONTINGENCY AND INFLATION (3%				$58,800		$1,541,382		$1,590,990		$1,642,002		$1,694,418		$2,032,008		$2,032,008

Table 15
Source Area Bedrock Groundwater - MNA Cost Estimate

ASSUMPTIONS

Assumes 5 monitoring wells in and around the source area bedrock groundwater treatment zone would be monitored.
Assumes quarterly monitoring for MNA parameters and site COCs for 15 years.
Costs have been estimated using a combination of vendor quotes and GES' experience at similar sites for similar activities.

REMEDIATION COSTS

PHASE / TASK / SUBTASK	COST/UNIT		SCHEDULE COST/YEAR													
			1		2		3		4		5		6-10		11-30	
			UNITS	COSTS	UNITS	COSTS	UNITS	COSTS	UNITS	COSTS	UNITS	COSTS	UNITS	COSTS	UNITS	COSTS
Background Investigation																
Regulatory Agency Meeting	$1,500	/meeting	2	$3,000	4	$6,000	1	$1,500	1	$1,500	1	$1,500	5	$7,500	5	$7,500
Remedial Action Plan & Permitting																
Remedial Design	$20,000	/each	1	$20,000		$0		$0		$0		$0		$0		$0
Permitting/Permitting Equivalency		/each	1	$0		$0		$0		$0		$0		$0		$0
Remedial Action/Cleanup Plan Report	$10,000	/each	1	$10,000		$0		$0		$0		$0		$0		$0
MNA																
Sampling	$4,500	/quarter		$0	4	$18,000	4	$18,000	4	$18,000	4	$18,000	20	$90,000	20	$90,000
Annual Report	$7,500	/year		$0	1	$7,500	1	$7,500	1	$7,500	1	$7,500	5	$37,500	5	$37,500
Closure Assessment (unsaturated soils only)																
Well abandonment	$20,000	/event		$0		$0		$0		$0		$0		$0	1	$20,000
Act 2 Final Report	$12,000	/event		$0		$0		$0		$0		$0		$0	1	$12,000
Risk Assessment	$10,000	/event		$0		$0		$0		$0		$0		$0	1	$10,000
TOTAL				$33,000		$31,500		$27,000		$27,000		$27,000		$135,000		$177,000
CUMULATIVE TOTAL				$33,000		$64,500		$91,500		$118,500		$145,500		$280,500		$457,500
CONTINGENCY (20%)				$6,600		$6,300		$5,400		$8,100		$8,100		$27,000		$35,400
CUMULATIVE TOTAL W/ CONTINGENCY AND INFLATION (3%)				$39,600		$78,534		$112,878		$151,137		$190,449		$386,469		$643,473

Table 16
Non-Source Area Bedrock Groundwater - MNA Cost Estimate

ASSUMPTIONS

Assumes 5 monitoring wells in and around the source area bedrock groundwater treatment zone would be monitored.
Assumes quarterly monitoring for MNA parameters and site COCs for 10 years.
Assumes that the source area soil and source area bedrock groundwater would be remediated to remove continuing source and assist with natural attenuation in the non-source area.
If source area soil and groundwater is not addressed first, then MNA for non-source area could be more than 10 years.
Costs have been estimated using a combination of vendor quotes and GES' experience at similar sites for similar activities.

REMEDIATION COSTS

PHASE / TASK / SUBTASK	COST/UNIT		SCHEDULE COST/YEAR													
			1		2		3		4		5		6-10		11-30	
			UNITS	COSTS	UNITS	COSTS	UNITS	COSTS	UNITS	COSTS	UNITS	COSTS	UNITS	COSTS	UNITS	COSTS
Background Investigation																
Regulatory Agency Meeting	$1,500	/meeting	2	$3,000	4	$6,000	1	$1,500	1	$1,500	1	$1,500	5	$7,500		$0
Remedial Action Plan & Permitting																
Remedial Design	$20,000	/each	1	$20,000		$0		$0		$0		$0		$0		$0
Permitting/Permitting Equivalency		/each	1	$0		$0		$0		$0		$0		$0		$0
Remedial Action/Cleanup Plan Report	$10,000	/each	1	$10,000		$0		$0		$0		$0		$0		$0
MNA																
Well Installation	$12,000	/well		$0	3	$36,000		$0		$0		$0		$0		$0
Sampling	$13,000	/quarter		$0	4	$52,000	4	$52,000	4	$52,000	4	$52,000	20	$260,000		$0
Well Installation Oversight	$15,000	/week		$0	1	$15,000		$0		$0		$0		$0		$0
Annual Report	$7,500	/year		$0	1	$7,500	1	$7,500	1	$7,500	1	$7,500	5	$37,500		$0
Closure Assessment (unsaturated soils only)																
Well abandonment	$30,000	/event		$0		$0		$0		$0		$0	1	$30,000		$0
Act 2 Final Report	$12,000	/event		$0		$0		$0		$0		$0	1	$12,000		$0
Risk Assessment	$10,000	/event		$0		$0		$0		$0		$0	1	$10,000		$0
TOTAL				$33,000		$116,500		$61,000		$61,000		$61,000		$357,000		$0
CUMULATIVE TOTAL				$33,000		$149,500		$210,500		$271,500		$332,500		$689,500		$689,500
CONTINGENCY (20%)				$6,600		$23,300		$12,200		$18,300		$18,300		$71,400		$0
CUMULATIVE TOTAL W/ CONTINGENCY AND INFLATION (3%)				$39,600		$183,594		$261,186		$347,623		$436,439		$954,803		$954,803

Appendix A – Advanced Geological Services, Inc. Geophysical Investigation Reports

ADVANCED GEOLOGICAL SERVICES
P.O. Box 348
280½ East Main Street
Chillicothe, OH 45601
Offices in PA and CA

July 26, 2021
Reference: 21-183-1

Mr. Timothy Uhler
Groundwater & Environmental Services, Inc.
440 Creamery Way, Suite 500
Exton, PA 19341

Subject: Electrical Resistivity Imaging Investigation Results
GTAC - Nockamixon TCE Site
Nockamixon Township, Bucks County, Pennsylvania

Dear Mr. Uhler:

Advanced Geological Services (AGS) presents this letter report to Groundwater & Environmental Services, Inc. (GES) summarizing the geophysical work completed at GTAC – Nockamixon TCE Site in Nockamixon Township, Bucks County, Pennsylvania. Resistivity data acquisition was completed by AGS on June 24 through June 30, 2021.

The objective of the investigation was to use the electrical resistivity imaging (ERI) method to to identify potential bedrock fractures and and other geologic features that could influence groundwater flow. Previous fracture trace analysis completed by GES indicates that primary fractures within the survey area generally trend either southwest to northeast, or southeast to northwest.

Methods

The ERI method is used to distinguish variations in the electrical resistivity of earth materials. Resistivity is an intrinsic characteristic of an earth material that measured in units of ohm-meters (ohm-m). Generally, within shale/siltstone regimes, unweathered and unsaturated rock will have a moderate to relatively high electrical resistivity, whereas fractured or weathered rock and water saturated shale/siltstone will have low electrical resistivity.

Electrical Resistivity Imaging (ERI)

Electrical resistivity imaging (ERI) profiles were completed along seven transects selected by GES. Four ERI profiles were oriented in the northwest to southeast direction, and three ERI profiles were oriented in the southwest to northeast direction. The orientations and locations of the ERI profiles were selected by GES to intersect the primary bedrock fracture orientations of this site.

Each ERI transect consisted of a series of electrodes spaced 10 apart. The total number of electrodes used in any given transect depended upon the available space. Transect lengths varied in total length from 550 feet to 830 feet. The maximum achievable depth of investigation is a function of total transect length, and varied from approximately 120 feet to approximately 190 feet below ground surface.

Resistivity methods measure the resistivity structure of subsurface materials using a direct current electrical source. A direct current signal is injected into the ground between two transmitting electrodes. The voltage is then measured between two receiving (potential) electrodes. The measured voltage is converted into apparent resistivity using algorithms that take into account the geometry of the dipole-dipole electrode array.

Apparent resistivity is a function of the porosity, permeability, water content, and ionic make up of the material. Consequently, soils or rocks that contain a high percentage of clay minerals, such as shale, and a high water content generally have a low apparent resistivity. On the other hand, a clean sand or sandstone with few free ions will have a relatively high apparent resistivity.

Surface resistivity data were collected using a SuperSting R8 resistivity meter that has integrated 8-channel rapid sampling capabilities. The SuperSting resistivity meter is manufactured by Advances Geosciences, Inc. of Austin Texas. The SuperSting resistivity meter is a self contained battery operated instrument that is capable of monitoring data quality using predetermined statistical parameters, numerical stacking of measured data to increase the signal to noise ratio, spontaneous potential cancellation, and data storage for downloading to a PC.

The 8-channel rapid sampling controller and electrode system used in this investigation consists of the integrated switching system, specially designed cables and up to 84 electrodes, although the total number of electrodes used depended upon the available space. This automatic switching system was pre-programmed to collect data using a dipole-dipole configuration. The "a" spacing, or distance between electrodes, was set to 10 feet. Upon completion of the electrode array set-up, an electrode test was conducted to ensure that all electrodes were correctly attached and that the resistance between the ground and the electrode was within acceptable range. If resistance of a given electrode was abnormally high, the electrode to ground resistance was decreased by wetting the electrode and adjacent soil with water. Upon completion of the electrode test, the resistivity meter was set to automatically sample the dipole-dipole array.

ERI data were analyzed using the commercially available computer program RES2dINV inversion and modeling software. This program mathematically inverts model resistivities and then calculates forward apparent resistivity pseudosection values. The calculated pseudosection apparent resistivities are compared to the observed apparent resistivities. The resistivity model is optimized by an iterative inversion routine until the calculated error is below a pre-determined level, or the percentage change between the previous model and the newly calculated model is below a pre-determined level, or a maximum specified number of iterations have been completed. The resulting model presents resistivity as a function of depth rather than as a function of dipole spacing as is standard for pseudosection presentation.

Results and Discussion

Seven ERI transects, ERI-1 to ERI-7, were completed during this investigation. Locations of the ERI transects are shown on Figure 1, and modeled ERI profiles are shown on Figures 2, 3, and 4. Transects ERI-1 through ERI-4 were oriented northwest to southeast, and ERI-5 through ERI-7 were oriented southwest to northeast, approximately perpendicular to ERI-1 Through ERI-4.

Overall, the resistivity data was of good quality along all transects. Generally the resistivity profiles indicate three distinct horizontal layers, as follows:

1. A shallow low resistivity layer extending from the ground surface to a depth of approximately 10(±) feet caused by the near surface soil and upper weathered bedrock.
2. A high resistivity layer of unsaturated shale/siltstone that extends to a depth of approximately 60 feet.
3. A deeper layer of low resistivity likely indicating the presence of water saturated bedrock.

Near vertical features showing a minor to major decrease in resistivity within, or cross-cutting the horizontal layering can indicate the presence of a potential near vertical bedrock fracture zone. Several potential fracture zones were identified and correlated across the geophysical survey area. It is not possible to accurately determine fracture dip angle from these ERI models. Results from the northwest to southeast oriented profiles, and the southwest to northeast oriented ERI profiles will be discussed briefly below.

Northwest to Southeast Oriented Profiles; ERI-1, ERI-2, ERI-3, and ERI-4

Locations of northwest to southeast ERI profiles and interpreted fracture zones are shown on Figure 1. The individual ERI model profiles are shown on Figure 2 and 3. Five potential fracture zones were identified from northwest to southeast oriented profiles. Potential fractures FRZ-A through FRZ-E are shown on Figure 1 and on the individual ERI model profiles. These fracture zones are oriented southwest to northeast, approximately perpendicular to the resistivity transects. The most prominent southwest to northeast fracture zone is FRZ-A which can be identified in all ERI northwest to southeast profiles, and being most prominent in profile ERI-3.

Fracture zone FRZ-D is also identifiable in profiles ERI-1 through ERI-4. Fracture FRZ-E is located beyond the southeast ends of ERI-2 and ERI-3, but can be identified in profiles ERI-1 and ERI-2.

Fracture zones FRZ-B and FRZ-C can be recognized in both profiles ERI-2 and ERI-3, but are not easily recognized in ERI-1 and ERI-4. It is possible that fractures FRZ-B and FRZ-C are either discontinuous or change in character (e.g. width, aperture, tightness) as they cross the site.

Southwest to Northeast Oriented Profiles; ERI-5, ERI-6, and ERI-7

Three potential fracture zones were identified passing through profiles ERI-5, ERI-6, and ERI-7, the most prominent being FRZ-H (Figures 1 and 6). Fracture zones FRZ-F and FRZ-G are oriented approximately northwest to southeast, whereas fracture FRZ-H is oriented slight more

towards a north-northwest direction. The orientation of FRZ-H suggests that it could intersect FRZ-G at a location located to the southeast of the site.

Summary Discussion

Seven ERI profiles were completed in an approximate grid pattern within the survey area to identify potential bedrock fractures. Resistivity models show the presence of a horizontal low resistivity starting at a depth of approximately 60 feet below the ground surface and continuing to the base of the ERI models. This low resistivity layer is interpreted to be the likely the water saturated bedrock.

Several fracture zones were identified from the modeled ERI profiles and were correlated across the site. Most of the fracture zones were identified from features within the upper 60 to 80 feet of the the profiles, above the interpreted water saturated layer. Given the nature of the fractures occurring in the shale/siltstone bedrock, it is reasonable to assume the fracture zone features identified within the upper 60 to 80 feet penetrate deeper into the formation. If this information is to used to assist with the siting of future wells, it is suggested that locations near the intersection of identified fracture zones be targeted for the highest probability to intersect permeable fractures.

Closing

All geophysical data and field notes collected as a part of this investigation will be retained at the AGS office. The data collection and interpretation methods used in this investigation are consistent with standard practices applied to similar geophysical investigations. The correlation of geophysical responses with probable subsurface features is based on the past results of similar surveys although it is possible that some variation could exist at this site. Intrusive field activities, such as soil borings and/or rock coring, may be needed to further investigate and confirm the presence or absence of identified and interpreted features. Due to the nature of geophysical data, no guarantees can be made or implied regarding the presence or absence of additional objects or targets beyond those identified.

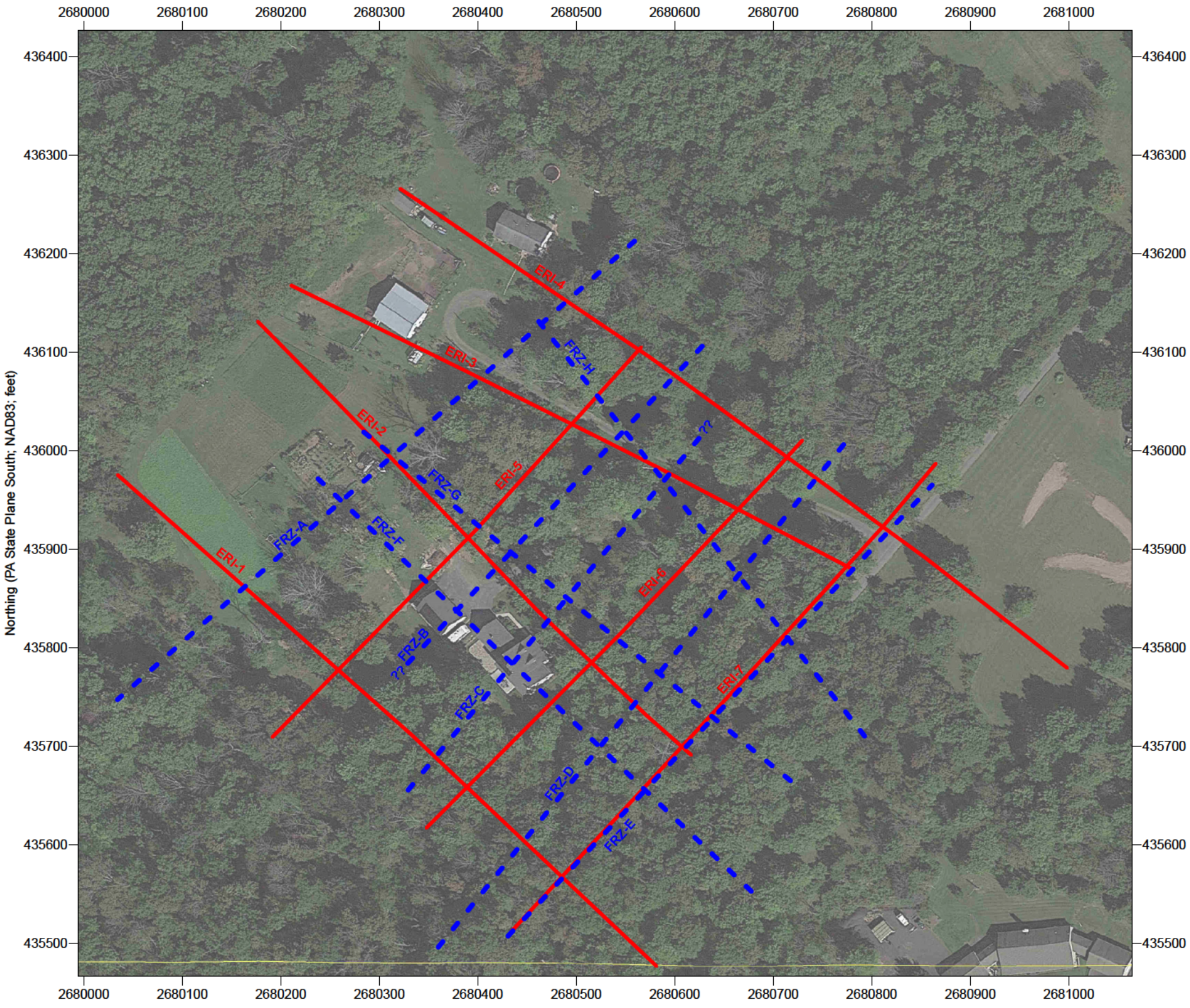
If you have any questions regarding the results of this field investigation, please contact me at 610-722-5500. It was a pleasure working with you on this project and we look forward to being able to provide you with sub-surface imaging services in the future.

Sincerely,

Martin Young
Project Geophysicist

Donald Jagel, P.G.
Principal Geophysicist

attachment: Figures 1 through 4



AERIAL PHOTO FROM GOOGLE EARTH

Legend

ERI-1 — Electrical Resistivity Imaging Profile

FRZ-A — Potential Bedrock Fracture Zone Interpreted from ERI Models

0 60 120 180 240 360

GRAPHIC SCALE IN FEET

TRUE

NOTES:

1) ERI data were collected along transects to determine geologic conditions, and identify potential water bearing features. Data were collected using an AGI Super Sting R8 resistivity meter. A dipole-dipole electrode configuration was used with electrode spacing set at 10 feet.
Data were modeled using RES2DINV. See report text for details and discussion.

2) Feature locations were determined using a sub-meter GPS instrument (GIS quality), are for illustrative purposes only, and were not surveyed by licensed surveyor.

3) The items shown on this figure may not be all inclusive. AGS does not warrant the fact that additional buried features/utilities may be present which could not be identified by AGS personnel during this investigation.

ADVANCED GEOLOGICAL SERVICES
3 MYSTIC LANE
MALVERN, PA 19355
(610) 722-5500

Electrical Resistivity Imaging Survey
Line Location Plot

LOCATION: GTAC Nockamixon TCE Site
Nockamixon, Pennsylvania

CLIENT: Groundwater & Environmental Services

AGS PROJECT #: 21-183-1

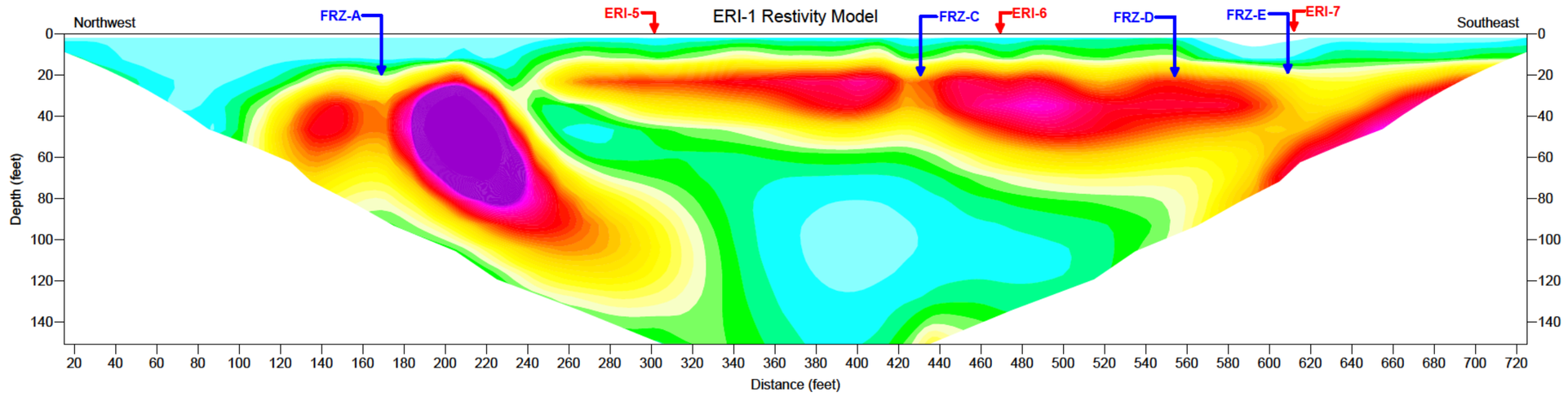
ADVANCED GEOLOGICAL SERVICES, INC.

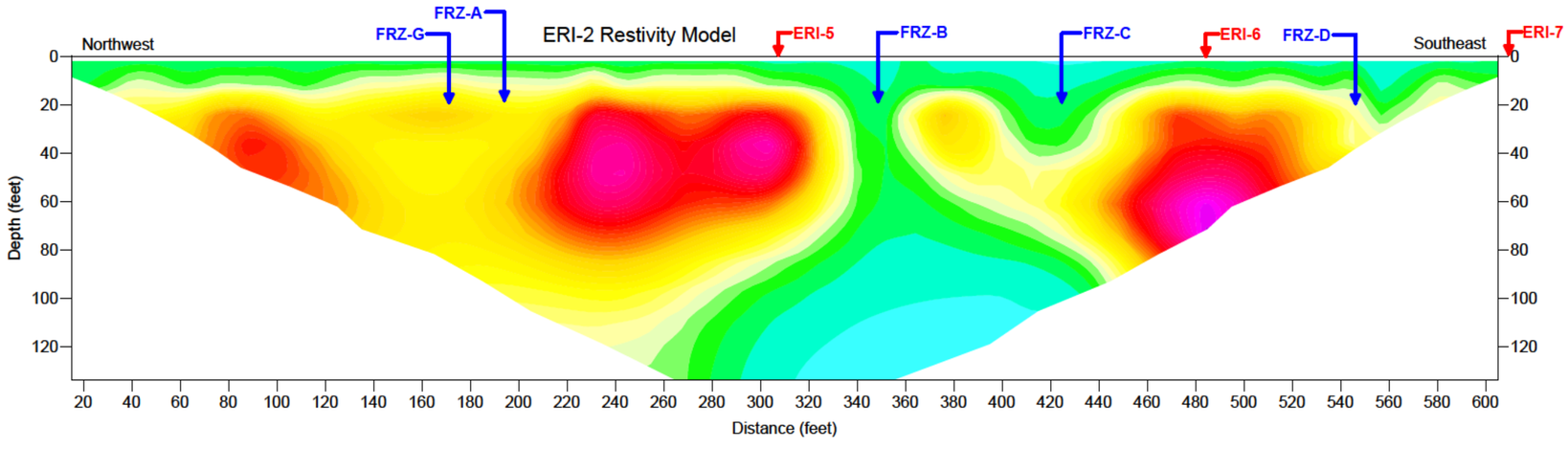
DATE: June 30, 2021

DRAWN BY: M. Young

APPROVED BY: DJ

1



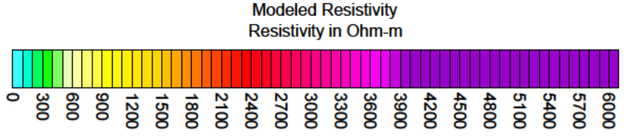


NOTES:

1) ERI data were collected along transects to determine geologic conditions, and identify potential water bearing features. Data were collected using an AGI Super Sting R8 resistivity meter. A dipole-dipole electrode configuration was used with electrode spacing set at 10 feet. Data were modeled using RES2DINV. See report text for details and discussion.

2) Feature locations were determined using a sub-meter GPS instrument (GIS quality), are for illustrative purposes only, and were not surveyed by licensed surveyor.

3) The items shown on this figure may not be all inclusive. AGS does not warrant the fact that additional buried features/utilities may be present which could not be identified by AGS personnel during this investigation.



ADVANCED GEOLOGICAL SERVICES
3 MYSTIC LANE
MALVERN, PA 19355
(610) 722-5500

Electrical Resistivity Imaging Survey
ERI Profiles 1 & 2

LOCATION: GTAC Nockamixon TCE Site
Nockamixon, Pennsylvania

CLIENT: Groundwater & Environmental Services

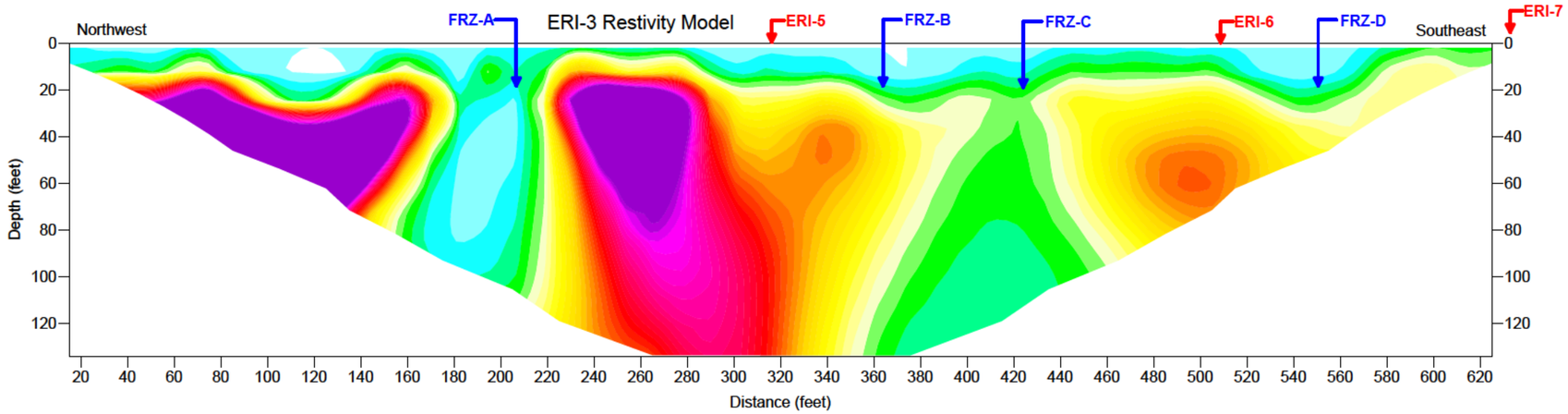
AGS PROJECT #: 21-183-1

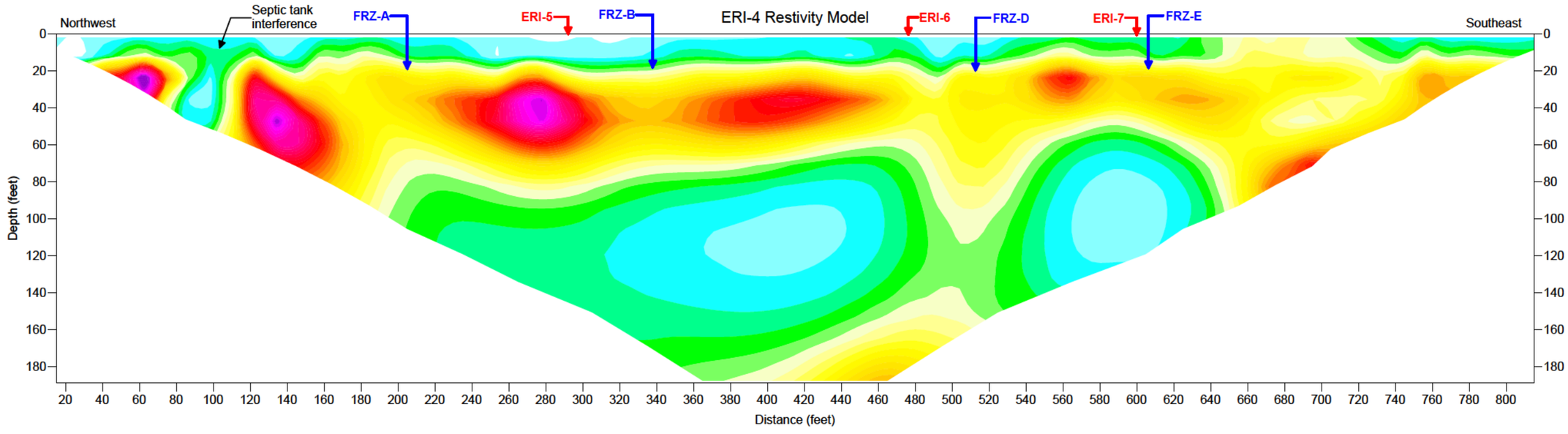
ADVANCED GEOLOGICAL SERVICES, INC.

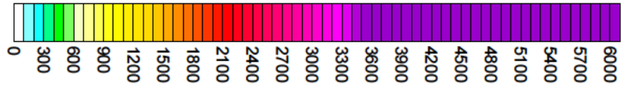
DATE: June 30, 2021

DRAWN BY: M. Young | APPROVED BY: DJ

2







NOTES:

1) ERI data were collected along transects to determine geologic conditions, and identify potential water bearing features. Data were collected using an AGI Super Sting R8 resistivity meter. A dipole-dipole electrode configuration was used with electrode spacing set at 10 feet.
Data were modeled using RES2DINV. See report text for details and discussion.

2) Feature locations were determined using a sub-meter GPS instrument (GIS quality), are for illustrative purposes only, and were not surveyed by licensed surveyor.

3) The items shown on this figure may not be all inclusive. AGS does not warrant the fact that additional buried features/utilities may be present which could not be identified by AGS personnel during this investigation.

ADVANCED GEOLOGICAL SERVICES
3 MYSTIC LANE
MALVERN, PA 19355
(610) 722-5500

Electrical Resistivity Imaging Survey
ERI Profiles 3 & 4

LOCATION: GTAC Nockamixon TCE Site
Nockamixon, Pennsylvania

CLIENT: Groundwater & Environmental Services

AGS PROJECT #: 21-183-1

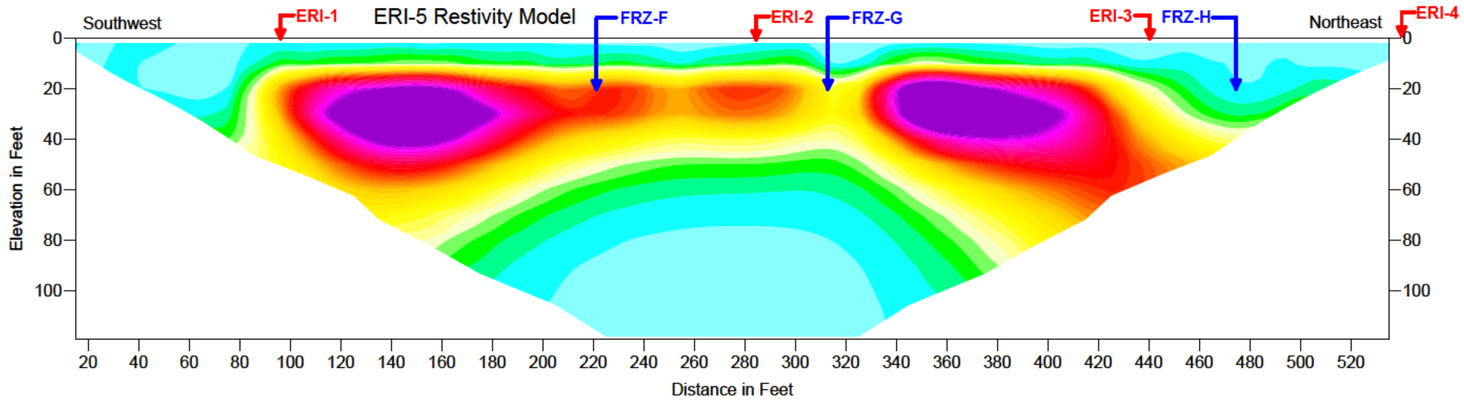
ADVANCED GEOLOGICAL SERVICES, INC.

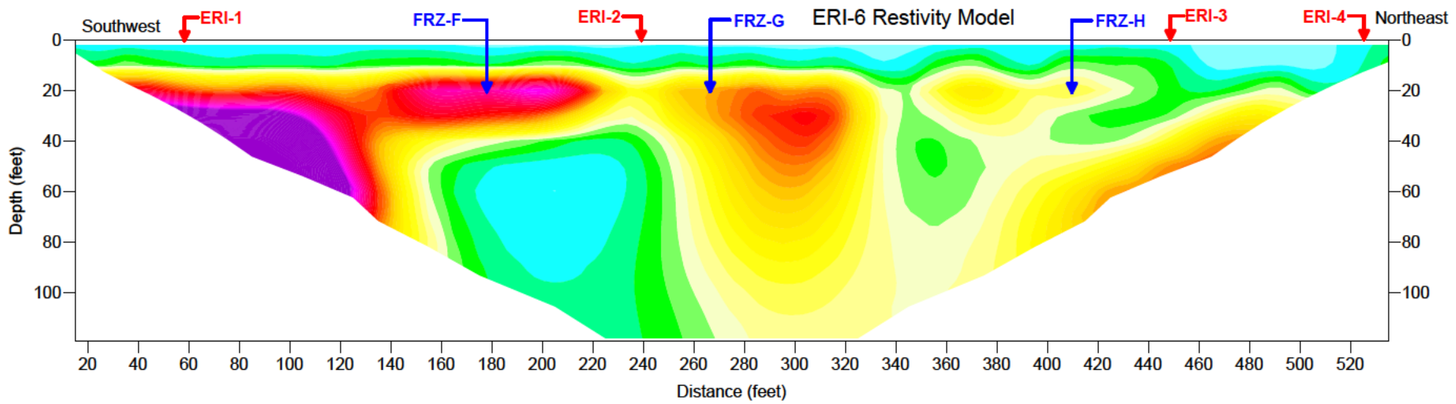
DATE: June 30, 2021

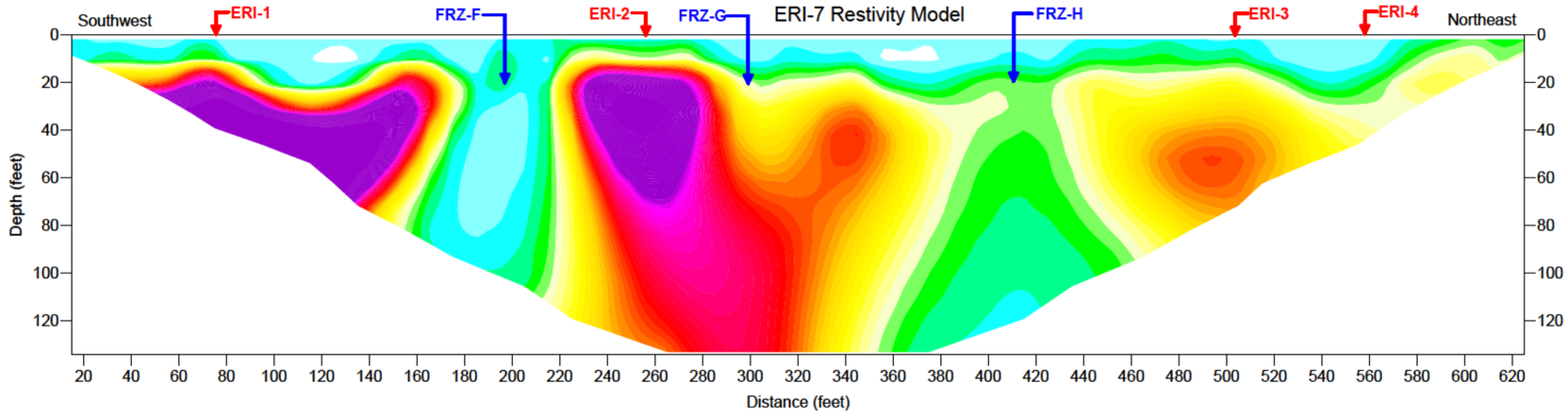
DRAWN BY: M. Young

APPROVED BY: DJ

3





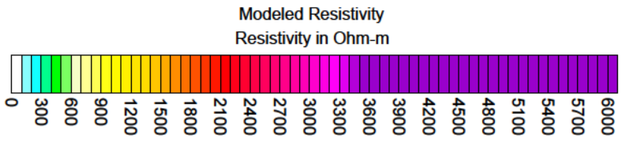


NOTES:

1) ERI data were collected along transects to determine geologic conditions, and identify potential water bearing features. Data were collected using an AGI Super Sting R8 resistivity meter. A dipole-dipole electrode configuration was used with electrode spacing set at 10 feet. Data were modeled using RES2DINV. See report text for details and discussion.

2) Feature locations were determined using a sub-meter GPS instrument (GIS quality), are for illustrative purposes only, and were not surveyed by licensed surveyor.

3) The items shown on this figure may not be all inclusive. AGS does not warrant the fact that additional buried features/utilities may be present which could not be identified by AGS personnel during this investigation.



ADVANCED GEOLOGICAL SERVICES
3 MYSTIC LANE
MALVERN, PA 19355
(610) 722-5500

Electrical Resistivity Imaging Survey
ERI Profiles 5, 6, & 7

LOCATION: GTAC Nockamixon TCE Site
Nockamixon, Pennsylvania

CLIENT: Groundwater & Environmental Services

AGS PROJECT #: 21-183-1

ADVANCED GEOLOGICAL SERVICES, INC.

DATE: June 30, 2021

DRAWN BY: M. Young | APPROVED BY: DJ

4

Advanced Geological Sevices, Inc.
3 Mystic Lane
Malvern, PA 19355
(610) 722-5500 (ph.)

January 27, 2023
AGS Reference: 22-149-1-Rev 1

Mr. Tim Uhler
Groundwater & Environmental Services, Inc.
44 Creamery Way, Suite 500
Exton, PA 19341

Subject: Geophysical Logging Results
GTAC – Nockamixon TCE Site
Nockamixon Township, Pennsylvania

Dear Mr. Uhler:

Advanced Geological Services (AGS) is pleased to present this letter report summarizing the results of borehole geophysical logging completed in newly drilled wells RC-1 and RC-2 that are located off of Brennan Drive in Nockamixon Township, Pennsylvania. Geophysical logging activities were completed on November 15 and 17, 2022.

A suite of logs was collected in wells RC-1 and RC-2 to characterize geologic and hydrogeologic conditions. Logs completed included natural gamma, 16 and 64 inch normal resistivity, single-point resistance, fluid conductivity, fluid temperature, 3-arm caliper, optical televiewer, acoustic televiewer, and heat pulse flowmeter.

1.0 METHODOLOGY

The logs that were run for this investigation include:

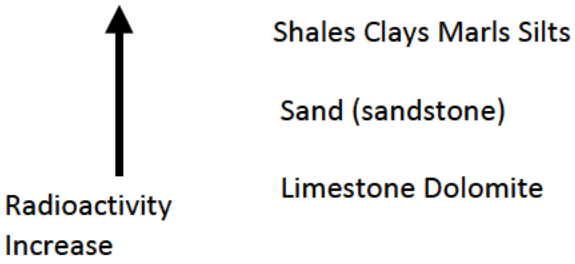
- Multi-Tool Logs:
  - Natural Gamma
  - Fluid Temperature
  - Fluid Conductivity (Fluid Resistivity)
  - 16-inch Normal Resistivity (16N)
  - 64-inch Normal Resistivity (64N)
  - Single Point Resistance (SPR)
- 3-Arm Caliper
- Acoustic Televiewer (ACTV)
- Optical Televiewer (OPTV)
- Heat Pulse Flowmeter (Non-pumping Conditions)

All logs were acquired with a Mount Sopris Matrix logging system. Each of the logs are described briefly below.

1.1. NATURAL GAMMA RAY LOGS

The natural gamma ray log is a passive instrument that measures the amount of naturally occurring radioactivity from geologic units within the borehole. Commonly occurring radioelements include potassium, thorium, and uranium; the two former elements are predominant within a common fine-grained rock sequence. The gamma ray log is also an excellent lithologic indicator because fine-grained clays and shales contain a higher radioelement concentration than limestones or sands. Gamma ray values are often used to assess the percentage of clay materials (indurated or non-indurated) that are present within a formation by utilizing empirically derived equations and sand-shale base line information.

The natural radioactivity range for earth materials is as follows:



1.2. LONG AND SHORT NORMAL ELECTRICAL RESISTIVITY LOGS

Resistivity is a measure of how well an electric current passes through a material. Formation resistivity is an intrinsic property of rocks and depends on the porosity and resistivity of the interstitial fluid and rock matrix.

In sedimentary rocks, the resistivity values of shales is generally lower than the resistivity of sandstone, which is lower than the resistivity of limestone. The resistivity log often shows a picture of the overall depositional sequence in sedimentary environment. Resistivity of unweathered igneous and metamorphic rocks are often extremely high when compared to resistivity in sedimentary rocks, with values that are commonly thousands of ohm-meters.

The normal resistivity logs are generated by non-focused current resistivity instrumentation within the well bore. The ultimate objective of these measurements is to determine the true resistivity of the formation (matrix and fluids). The normal electrode configuration assumes a point source of current from which the voltage drop is measured by a potential electrode in the well. A second set of current and potential electrodes are positioned at a large distance (ground surface) from the downhole electrodes to complete the circuit. The distance between the downhole current electrode and the downhole voltage electrode is either 16 inches or 64 inches. The volume of material measured is approximately two times the electrode separation: 32 inches and 128 inches, respectively. The calculation of resistivity is determined by applying Ohm's Law and known electrode separations.

Since the 64-inch normal utilizes a greater electrode separation, the instrument will measure more deeply into the formation and obtain resistivity values that closely approximate the true formation resistivity. Conversely, the 16-inch normal device will record resistivities that are found in a zone that is at least partially invaded by borehole fluids. In the case where borehole mud pressures are greater than formation water pressures, a comparison of these curves gives an indication of the depth of invasion of borehole fluids and formation permeability. If formation pressures are greater, the true resistivity values are easier to attain due to the lack of influence of the borehole fluids.

1.3. FLUID RESISTIVITY (CONDUCTIVITY) LOGS

A log of fluid resistivity, which is the reciprocal of fluid conductivity, provides data related to the concentration of dissolved solids in the fluid column. Fluid resistivity is measured in units of ohm-meters, which is equivalent to 1/microsiemen/centimeter (1/µS/cm). Although the quality of the fluid column may not reflect the quality of adjacent interstitial fluids, the information can be quite useful when combined with other logs. For example, change in fluid resistivity associated with a water-producing zone that is corroborated by other logs may indicate the inflow of impacted ground water.

1.4. SINGLE-POINT RESISTANCE LOGS

Single point resistance measurements are made by passing a constant current between two electrodes and recording the voltage fluctuations as the probe is moved up the hole. The resistance variations measured in the borehole are primarily due to variations in the immediate vicinity of the downhole electrode.

The resistance log is strongly affected by the resistance of the drilling fluid and variations in borehole diameter. It is extremely useful for detecting fractures in boreholes with relatively constant diameter. In sedimentary environments, the resistance log generally follows the variations in resistivity of the formation. Shales generally exhibit low values, sandstones have intermediate values, while coal and limestone beds have high resistance values.

1.5. TEMPERATURE LOGS

Temperature logs measure the change in fluid temperature within the borehole as a function of depth. The utility of this log is that it can provide information on the location of water-bearing strata or fracture zones within the well. The inherent assumptions of this technique are that the fluids entering the borehole from the water zones are either cooler or warmer than the mud fluids used for drilling purposes. In this case, it is possible to relate a temperature anomaly to a depth range in which waters of different temperature are emanating from a water-bearing or fractured lithologic unit.

Differential temperature (or delta temperature) values can be computed and sometimes presented on the same plot due to their greater sensitivity and improved visual clarity. Temperature anomalies are more easily recognized because differences of only a few degrees translate to large-scale deflections of the differential temperature curve.

1.6. CALIPER LOGS

The caliper log measures variations in borehole size as a function of depth in a well. The log data enables (a) the detection of competent or fractured geologic units, (b) the location of washouts or tight zones, (c) the optimal placement of well screen, sand, and bentonite, and (d) the establishment of appropriate borehole correction factors to be applied to other well log curves. Further, when run in combination with other logs, the caliper log may be an indicator of lithologic makeup and degree of consolidation. The typical caliper response in a fractured, or weathered, unit is a relatively abrupt increase in borehole size.

1.7. ACOUSTIC TELEVIEWER (ACTV) LOGS

The acoustic televiewer log provides an oriented high-resolution image of the borehole using high-resolution ulta-sound waves. The oriented image of the borehole is presented in both amplitude and travel time. ACTV logs cannot be collected in an air-filled borehole, but unlike the OPTV log, ACTV logs can be collected in mud filled holes, water with low or no clarity, or boreholes that have FLUTE liners installed. Results from this tool provide location and orientation information of features such as fractures, lithologic contacts, and cavities. The ACTV digitizes 256 measurements around the borehole every 0.02 feet along the length of the borehole. Since the acquired image is digitized and properly oriented with respect to borehole deviation and tool rotation, it allows data processing to provide accurate strike and dip information of structural features.

1.8. OPTICAL TELEVIEWER (OPTV) LOGS

The optical televiewer log provides an oriented, high-resolution, 360-degree photographic image of the borehole in either an air-filled, or water-filled borehole. The oriented image of the borehole is presented in unwrapped format on the log. Results from this tool provide location, color, and orientation information of features such as fractures, litholoic contacts, cavities and sidewall staining. The acquired image is digitized and properly oriented with respect to borehole deviation and tool rotation. Processing of the resulting image can provide accurate strike and dip information of fractures and other structural features.

1.9. HEAT PULSE FLOWMETER (HPFM) LOGS

The heat pulse flowmeter (HPFM) measures the vertical flow rates within a borehole. The log may be used to identify contributing fracture zones under natural and pumping conditions.

The system operates by heating a wire grid that is located between two thermistors. The heated body of water moves toward one of the thermistors under the effect of the vertical component of flow within the well. Positive and negative values on the log represent upward and downward flow, respectively. The flow is calibrated to gallons/minute (gpm) for the flowmeter tool. The heat pulse flowmeter tool used in this investigation can detect vertical flow rates between 0.03 and 1.0 gpm.

The heat pulse flowmeter can be used in either ambient, non-pumping conditions or in pumped conditions. In a well under natural ambient conditions, water will flow vertically through the well bore as a result of different head conditions at different fractures or water producing zones. If the head levels are the same in fractures penetrated by the well bore there will be no driving force for water to flow vertically within the well bore. While these fractures could potentially produce significant amounts of water if pumped, without a head difference to produce the driving force there will be no flow within the well.

Pumping a well at a low flow rate during the completion of a HPFM log can help to better identify potential water producing fractures, particularly in wells that exhibit no vertical flow under ambient conditions. In a well that already has a relatively high vertical flow rate under ambient conditions, pumping the well may not provide any additional information. This is particularly true if the well experiences upward vertical flow rates under ambient conditions that are already near the upper measurable limit of the HPFM sonde (1 gpm).

Heat pulse flowmeter data were only collected under ambient, or non-pumping conditions during this investigation.

2.0 RESULTS AND DISCUSSION

Two newly drilled wells, RC-1 and RC-2, were logged with a suite of geophysical tools to identify potential water-bearing fracture zones, determine the structural orientation of fractures and to characterize borehole conditions. Both wells were drilled with PQ core, yielding a borehole diameter of approximately 5 inches. Well RC-1 was relatively close to existing wells MW-1S and MW-1D, and well RC-2 was located to the west of RC-1. Both wells had temporary casing installed within the upper 5 to 10 feet of the wells at the time logging was completed.

Attempts were made to collect ambient heat pulse flowmeter data in both RC-1 and RC-2. Unfortunately it was not possible to obtain a stable baseline in either of the wells, which is required to collect valid heat pulse flowmeter data. Two different heat pulse flowmeter tools were used in both of the wells to try to collect data, with the same results in both wells. Functional tests of both of the heat pulse flowmeter tools indicted the tools themselves were operating correctly, so it is unclear why valid data could not be obtained. There is a possibility that the very fine suspended sediment (rock flour) may have coated the thermistors of the instrument and affected their stability. If heat pulse flowmeter data is needed at these well locations, it is suggested that an attempt to collect heat pulse flowmeter data again in the future after the wells have been allowed to settle for a longer period of time.

Review of the well logs indicated a very strong gamma response in well RC-1 at a depth of 66.5 to 69 feet and a similar gamma response in well RC-2 at a depth of 65.5 to 68 feet. This gamma response is a very good marker bed to allow stratigraphic correlation between the two wells.

The findings of each of the wells are discussed briefly below and the geophysical logs are provided as an attachment to the end of this report.

Well RC-1

Depth Datum: Ground surface
Well diameter: 5 inches (PQ core)
Total depth: 150 feet
Casing type: Steel
Casing depth: approx. 5 feet (temporary casing)
Casing stick-up height: 2.25 feet
Static water level: 97.5 feet

Several thin bedding partings and joint fractures are present within well RC-1. The most prominent bedding partings occur at a depth of approximately 90 feet as seen from the caliper and optical televiewer logs. This series of bedding partings is situated above the static water level. The two most prominent open joints are at depths of 115.8 and 116.1 feet. The fluid conductivity increases abruptly at the depth of those joints suggesting that they could be the major water producing zone in this well.

Orientations of the primary identified planar structures identified in well RC-1 are shown on the well log and are provided in Table 1.

Table 1: Well RC-1; Identified Planar Structure Orientations

Mean Depth of Feature (feet)	Dip Azimuth (degrees)	Dip Angle (degrees)	Comments
29.2	320	82	Partially open joint
79.0	281	3	Bedding parting
89.5	327	10	Bedding parting; partially open
90.0	165	7	Bedding parting; partially open
90.4	340	8	Bedding parting; partially open
98.8	47	65	Partially open joint
108.5	14	79	Partially open joint
115.8	17	74	Open joint (likely water-bearing)
116.1	19	76	Open joint (likely water-bearing)
119.7	21	73	Partially open joint
132.9	103	85	Partially open joint
136.6	289	84	Discontinuous fracture
137.4	128	7	Bedding parting; partially open (distinctive resistivity response)
149.0	27	26	Bedding parting

Well RC-2

Depth Datum: Ground surface
Well diameter: 5 inches (PQ core)
Total depth: 251 feet
Casing type: Steel
Casing depth: approx. 10 feet (temporary casing)
Casing stick-up height: 1.4 feet
Static water level: 107.8 feet

Well RC-2 was similar in character to well RC-1, with several thin joints and bedding partings. Although well RC-2 was an open hole and relatively close to well RC-1, the static water level at the time of logging was approximately 10 feet lower than the encountered in well RC-1. Also, whereas the fluid conductivity in RC-1 was low within the upper portion of the water column, the fluid conductivity in well RC-2 was high within the upper portion of the water column, then decreased significantly at a depth of 179.2 feet where an open bedding parting is located. The change in fluid conductivity at 179.2 feet may indicate that this is a water bearing bedding plane parting. The optical televiewer indicated an increase in the amount of suspended sediment below a depth of approximately 182 feet suggesting that there may be little water movement between 182 feet and the bottom of the well.

Orientations of the primary identified planar structures identified in well RC-2 are shown on the well log and are provided in Table 2.

Table 2: Well RC-2; Identified Planar Structure Orientations

Mean Depth of Feature (feet)	Dip Azimuth (degrees)	Dip Angle (degrees)	Comments
14.6	152	14	Bedding parting
18.2	10	76	Partially open joint
35.1	314	84	Discontinuous fracture
55.8	219	66	Filled joint or fracture
67.8	246	23	Bedding parting (strong gamma kick)
91.5	311	83	Filled joint or fracture
103.0	3	71	Partially open joint
104.7	191	20	Bedding parting
109.2	45	60	Partially open joint
112.0	307	83	Filled joint or fracture
117.9	18	75	Partially open joint
120.7	106	75	Filled joint or fracture
128.9	300	84	Filled joint or fracture
129.8	303	82	Filled joint or fracture
133.7	293	83	Filled joint or fracture
141.4	0	0	Bedding parting; partially open (distinctive resistivity response)

Mean Depth of Feature (feet)	Dip Azimuth (degrees)	Dip Angle (degrees)	Comments
145.0	49	74	Partially open joint
171.2	0	0	Bedding parting; partially open
171.6	126	23	Bedding parting; partially open
179.2	285	10	Bedding parting; partially open (likely water bearing)
203.2	289	80	Discontinuous fracture
204.8	300	10	Bedding parting
208.9	297	14	Bedding parting
236.4	149	14	Bedding parting

3.0 SUMMARY AND CLOSING

A suite of geophysical well logs was completed in newly drilled wells RC-1 and RC-2 to help characterize geologic and hydrogeologic conditions. Both wells penetrated several distinct bedding partings that can assist the stratigraphic correlation between the wells. Several thin joints were also visible in both wells above and below the static water levels. Despite RC-1 and RC-2 being relatively close to one another, there was approximately 10 feet difference in the static water levels and each well also had a distinctly different fluid conductivity profile.

The data collection and interpretation methodologies used in this investigation are consistent with standard practices applied to similar geophysical investigations. The correlation of geophysical responses with probable subsurface features is based on the past results of similar surveys although it is possible that some variation could exist at this site.

Please contact us if you have any questions or would like to discuss the logging results. We appreciate your business and look forward to working with you again.

Sincerely,

Donald Jagel

Donald Jagel, P.G.
Principal Geophysicist

Attachments: Well Logs of RC-1 and RC-2

ADVANCED GEOLOGICAL SERVICES

AGS Project No.: 22-149-1

Client: GES

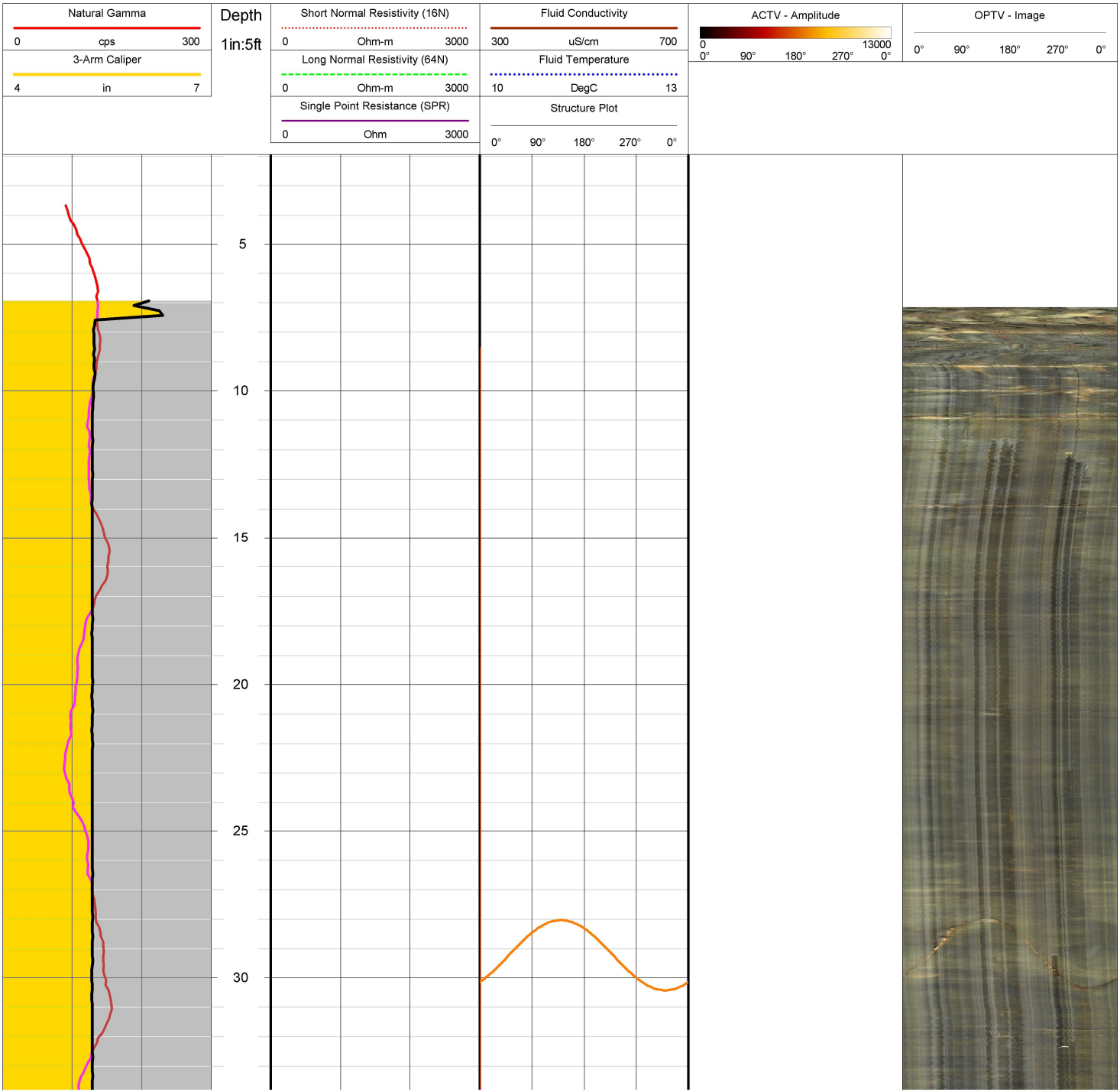
Well ID: RC-1

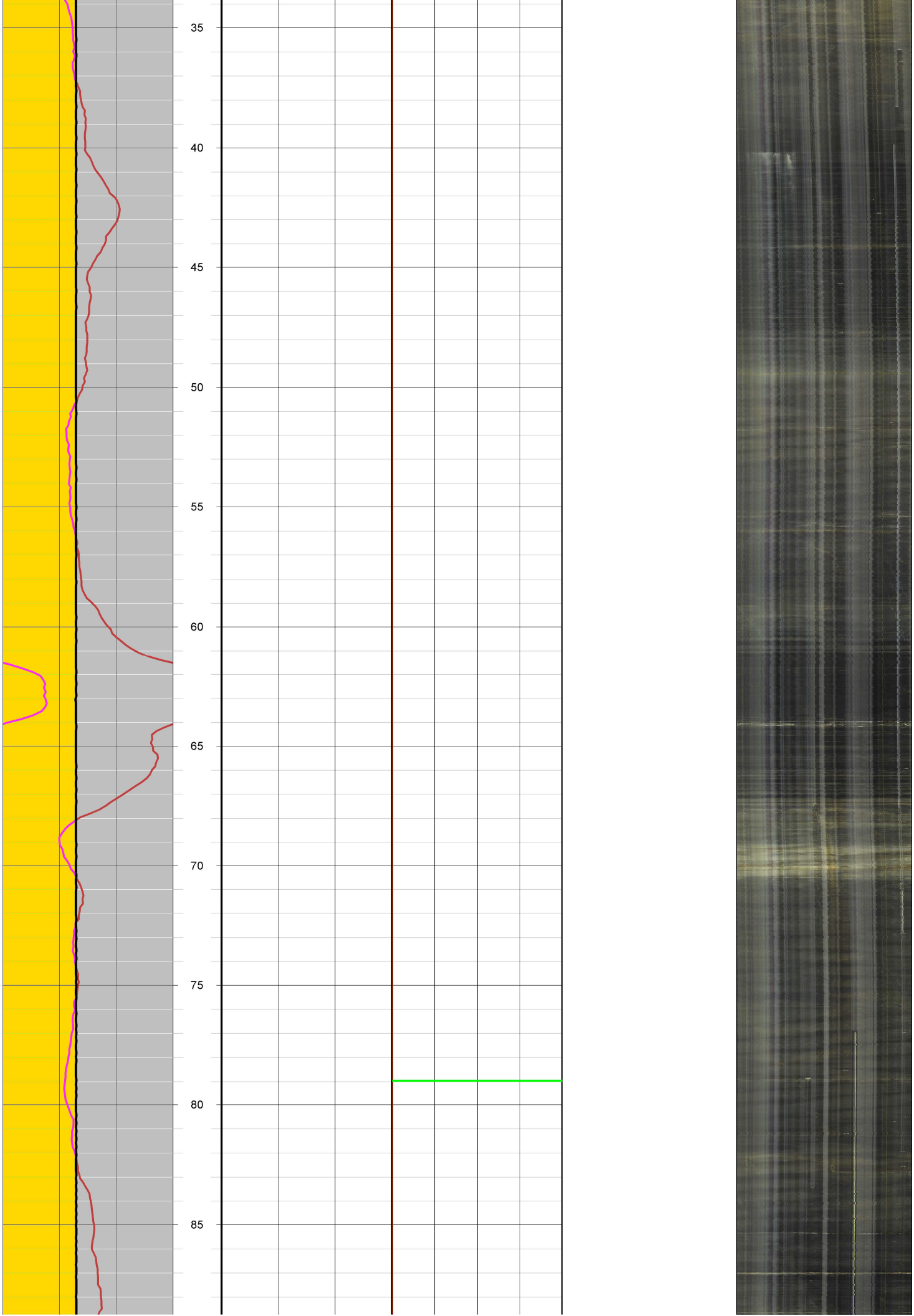
Site: GTAC - Nockamixon TCE Site
Nockamixon Twp., Pennsylvania

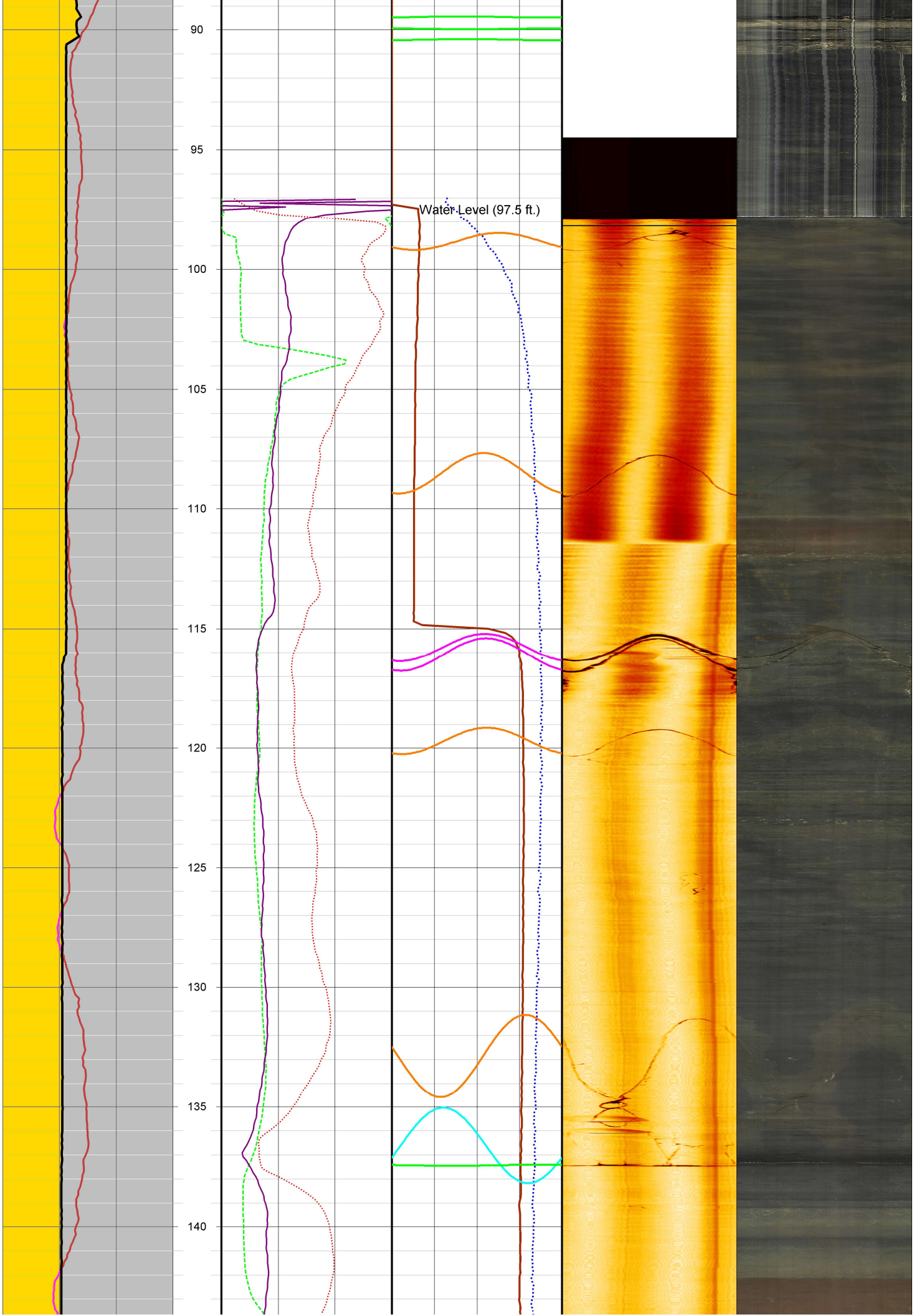
Date: 11/15/2022

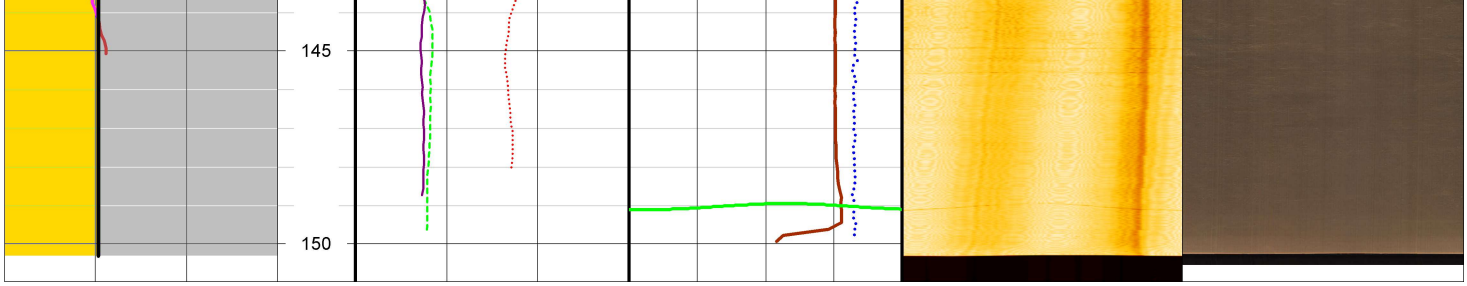
Depth Datum:	Ground Surface
Borehole Dia.:	5 in. (PQ core)
Total Depth:	150 ft.
Casing Type:	Steel
Casing Depth:	approx. 5 ft.
Casing Stickup Ht.:	2.25 ft. (temporary casing)
Water Level:	97.5 ft.

Remarks: Structure Plot Colors: Green = Bedding plane, parting or fracture
Magenta = Open joint or fracture
Orange = partially open joint or fracture
Gray = Filled joint or fracture
Cyan = Discontinuous fracture




35
40
45
50
55
60
65
70
75
80
85


90
95
100
105
110
115
120
125
130
135
140
Water Level (97.5 ft.)


145
150

ADVANCED GEOLOGICAL SERVICES

AGS Project No.: 22-149-1

Client: GES

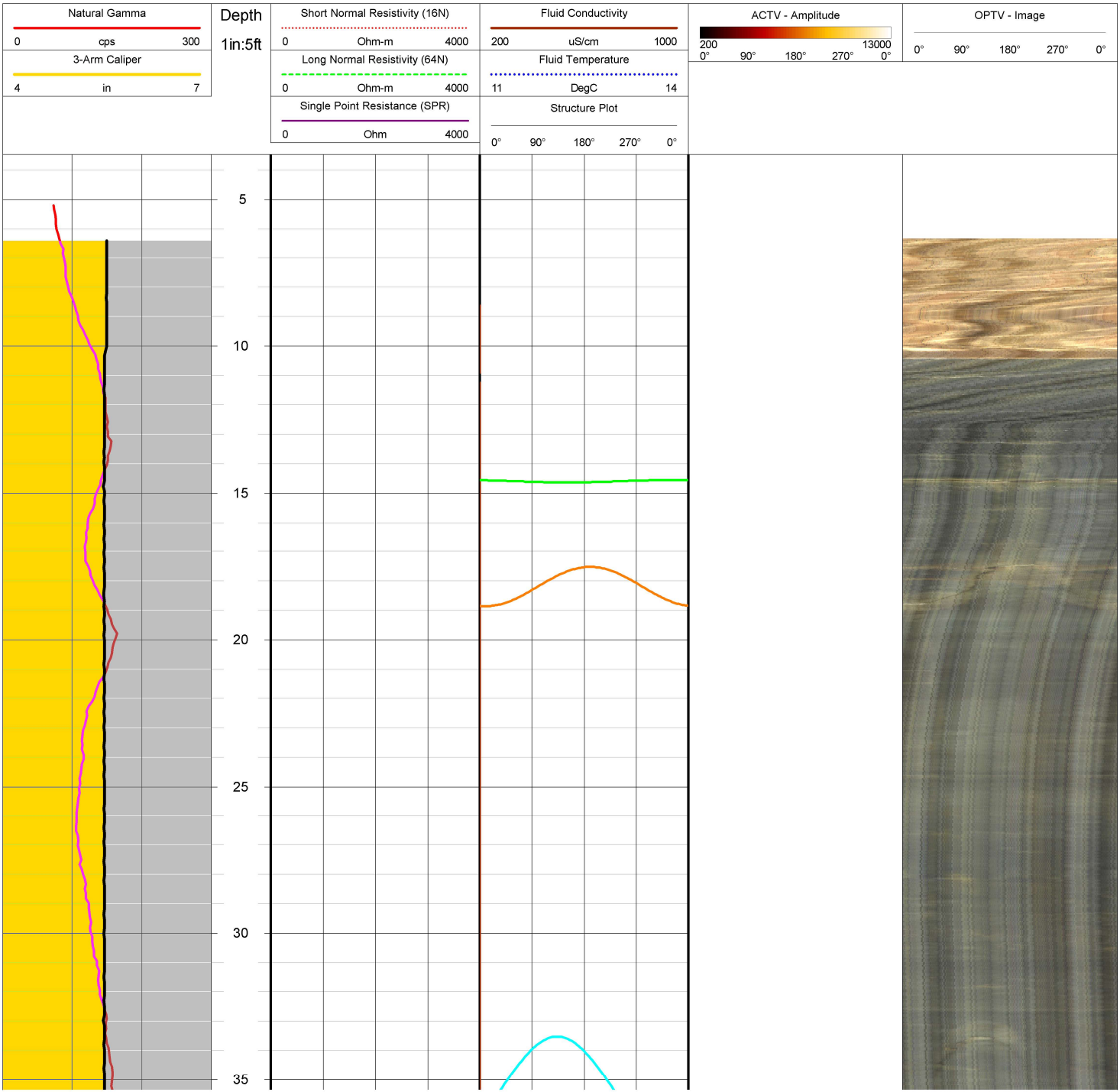
Well ID: RC-2

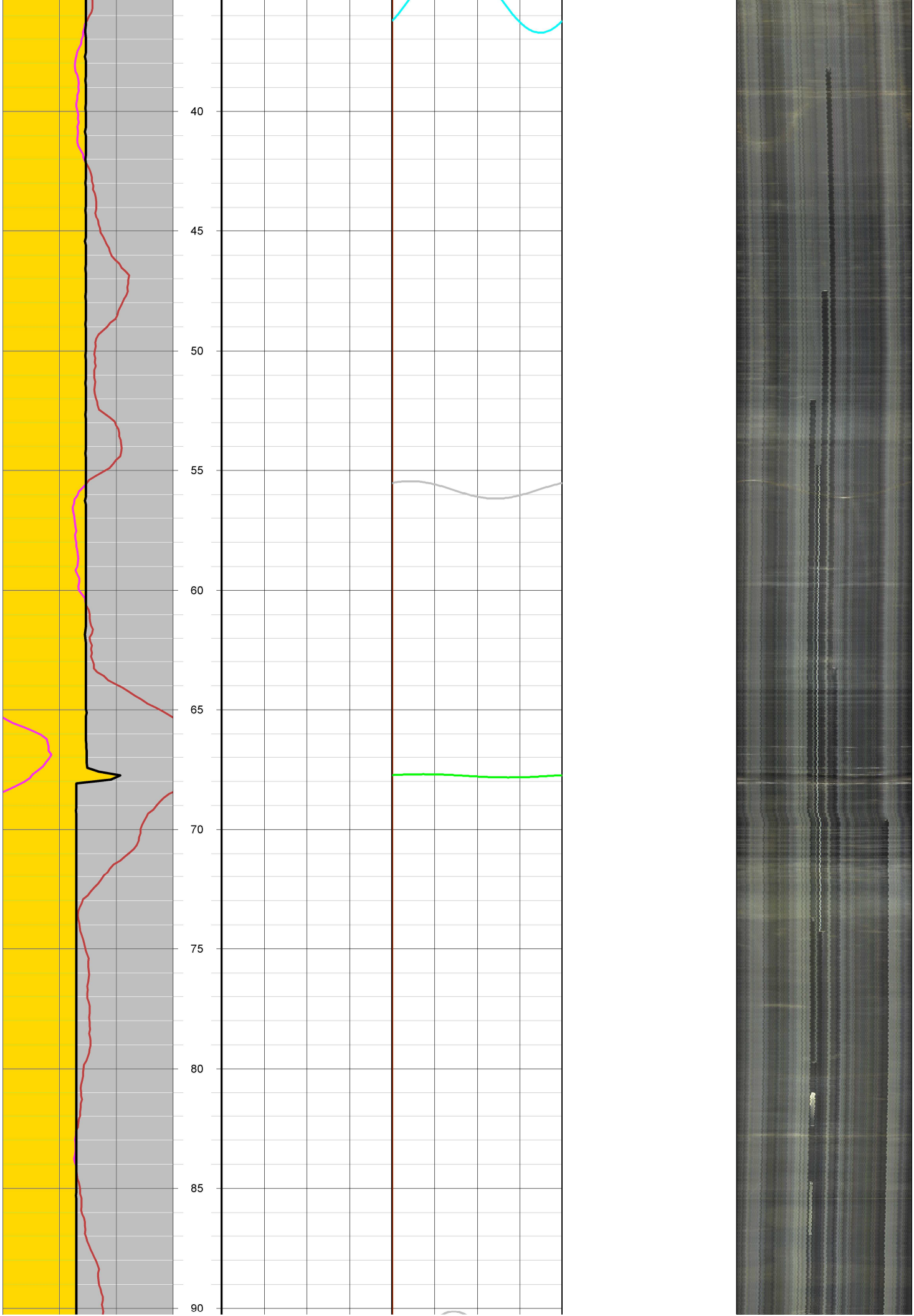
Site: GTAC - Nockamixon TCE Site
Nockamixon Twp., Pennsylvania

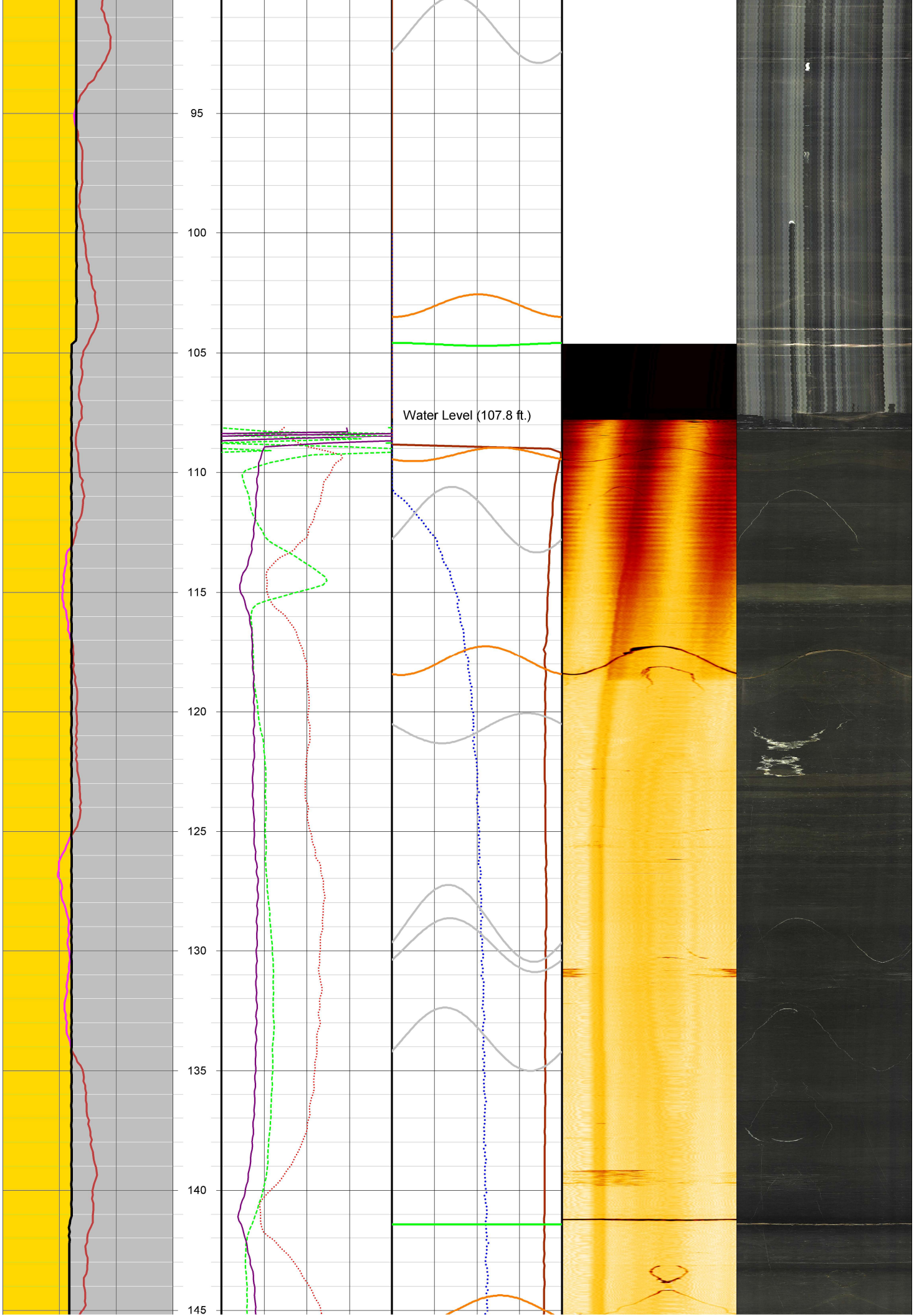
Date: 11/17/2022

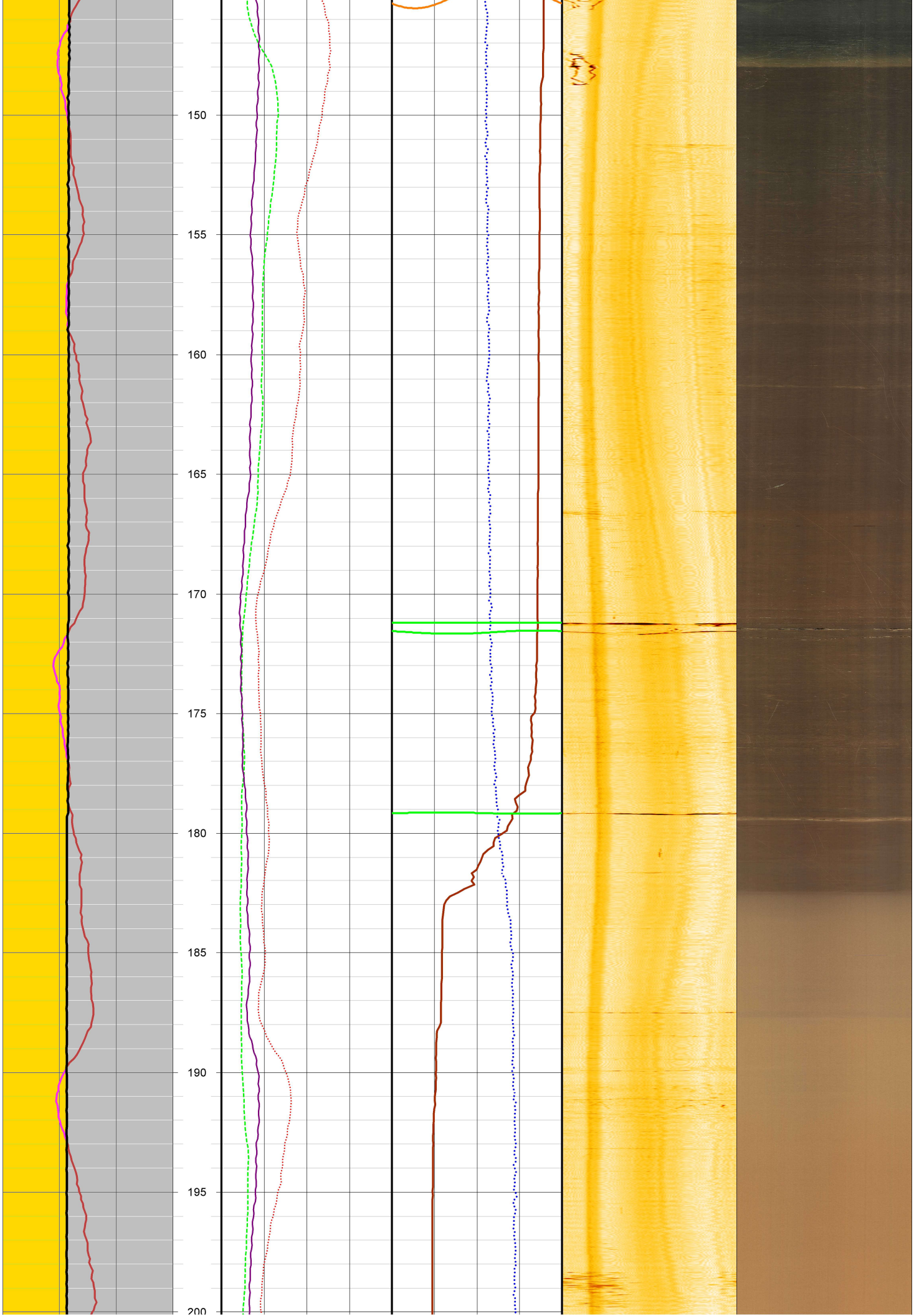
Depth Datum:	Ground Surface
Borehole Dia.:	5 in. (PQ core)
Total Depth:	251 ft.
Casing Type:	Steel
Casing Depth:	approx. 10 ft.
Casing Stickup Ht.:	1.4 ft. (temporary case)
Water Level:	107.8 ft.

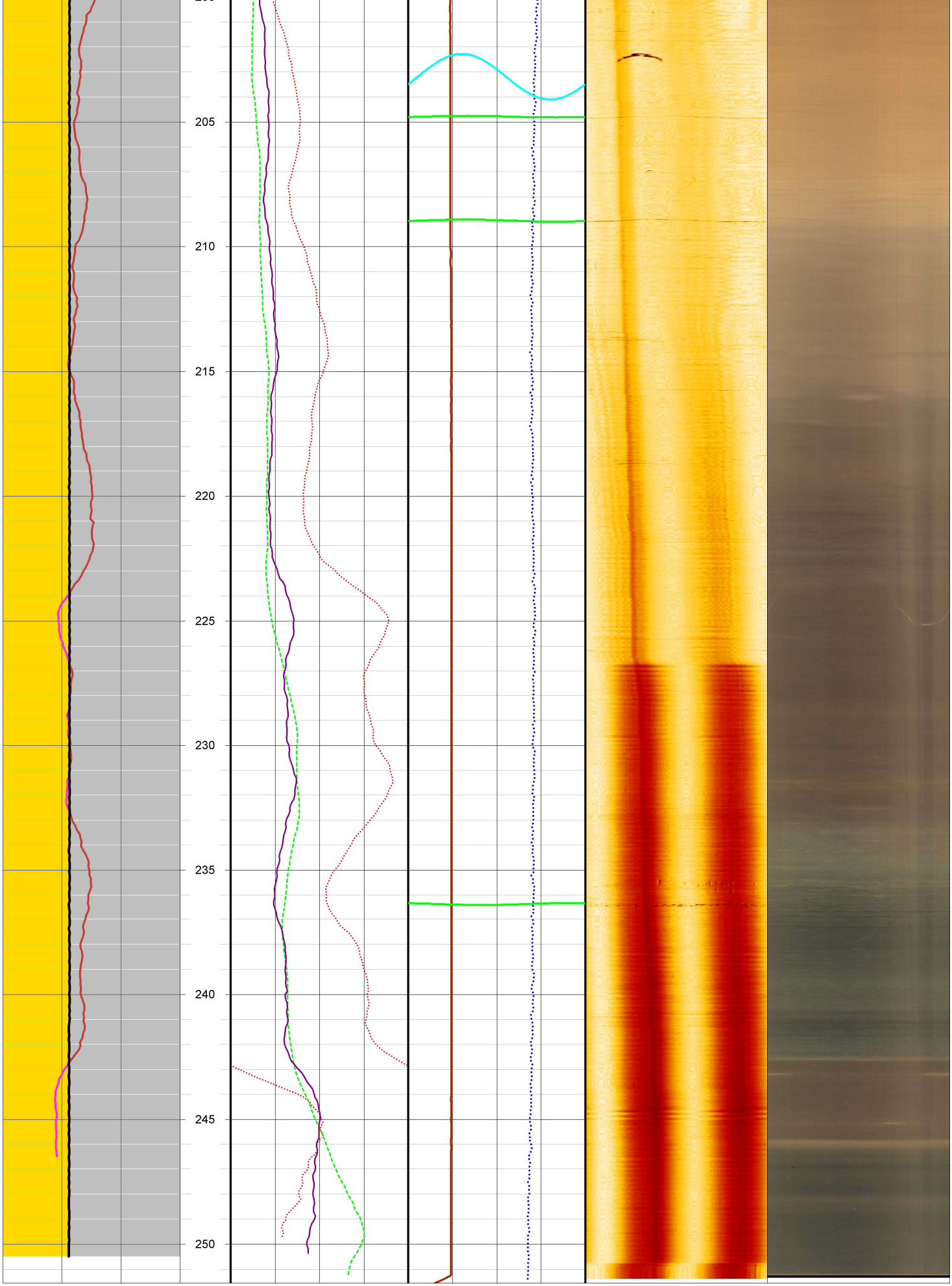
Remarks: Structure Plot Colors: Green = Bedding plane, parting or fracture
Magenta = Open joint or fracture
Orange = partially open joint or fracture
Gray = Filled joint or fracture
Cyan = Discontinuous fracture




40
45
50
55
60
65
70
75
80
85
90


95
100
105
110
115
120
125
130
135
140
145
Water Level (107.8 ft.)


150
155
160
165
170
175
180
185
190
195
200


205
210
215
220
225
230
235
240
245
250

Appendix B – Soil Boring/Rock Core Logs

ROCK CORING LOG

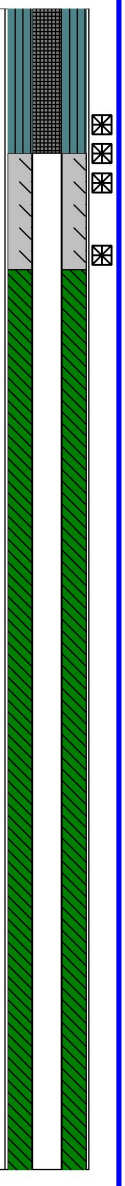
RC-1

Groundwater and Environmental Services, Inc.

PROJECT:	**GTAC Nockamixon TCE Site**	CASING ELEVATION:	**NA**	TOTAL DEPTH:	**150 feet**
ADDRESS:	**77 Brennan Road**	BOREHOLE DIAMETER:	**4"**	WATER DEPTH:	**NA**
	Nockamixon, PA	WELL DIAMETER:	**NA**		

Logged By:	**Daniel Sivco**	Drilling Method:	**Split spoon/Rock Core**
Dates Drilled:	**10/26/-11/2/2022**	Sampling Method:	**Split Spoon (140 lb hammer, 30" drop)**
Drilling Company:	**Eichelbergers, Inc.**	Soil Class. System:	**USCS**
Drill Rig Type:	**Deitrich D-50**	Field Screening:	**PID 11.7 eV Lamp (ppm)**

Depth (feet)	N-Value	Blow Counts	RQD	Field Screening (ppm)	SAMPLE LITHOLOGY (USCS)	Stratigraphy	Comments	COMPLETION DETAILS
0					TOPSOIL: (0-0.5') Topsoil	TOPSOIL	Split spoon refusal at 5.4' bgs	Boring completed with temporary steel stick-up casing with bentonite seal to 5' bgs
2	12	4,8,12		0.0	ML: (0.5'-2.0') Reddish-brown silt, little clay, trace sand, weathered argillite fragments, medium dense, slightly moist	ML		
				0.0				
				0.8				
4	35	10,15,20,28		4.5				
				1.8				
	50	28,45,50/4"		1.6				
				52.8				
6			(5'-10') (17.5%) VERY POOR	11.8	CL: (2'-5') SAA, very dense, increasing weathered argillite fragments with depth	WEATHERED ARGILLITE	Rock core between 5'-150' bgs	
				48.3				
				483.6				
8				46.6	WEATHERED ARGILLITE: (5'-9') Gray weathered argillite, highly fractured with seams of brown silt and clay, odor			
				17.3				
				8.9				
10			(10'-15') (75%) GOOD	18	ARGILLITE: (9'-10') Competent Argillite, fracture at 9.5'	ARGILLITE		Open rock boring from 5' to 150' bgs
				0.8				
12				0.0	ARGILLITE: (10'-15') Gray competent argillite with fractures			
14				0.0				
16			(15'-20') (94%) EX-CELLENT	0.0	ARGILLITE: (15'-30') Gray to dark gray argillite, laminated to thinly bedded, horizontal fractures at 23', 24.5', 80 degree fracture at 27.25'-29', red-brown clay within fracture			
18								
20			(20'-25') (100%) EX-CELLENT					
22								
24				0.0				
26			(25'-30') (91%) EX-CELLENT	0.0				
28				0.0				
30				0.0	ARGILLITE: (30'-40') Gray argillite, laminated to thinly bedded, 80 degree fracture at 30.5'-31.5', horizontal fractures at 43.5, 44', and 44.75'			
32			(30'-35') (100%) EX-CELLENT					
34				0.0				
36			(35'-40') (93%) EX-CELLENT					
38								
40								



General Comments:

bgs - below ground surface

ppm - parts per million

RQD - Rock Quality Designation

Symbol Key:

Apparent Water Level

Lab Sample Location

ROCK CORING LOG

RC-1

Groundwater and Environmental Services, Inc.

PROJECT:	**GTAC Nockamixon TCE Site**	CASING ELEVATION:	**NA**	TOTAL DEPTH:	**150 feet**
ADDRESS:	**77 Brennan Road**	BOREHOLE DIAMETER:	**4"**	WATER DEPTH:	**NA**
	Nockamixon, PA	WELL DIAMETER:	**NA**		

Logged By:	**Daniel Sivco**	Drilling Method:	**Split spoon/Rock Core**
Dates Drilled:	**10/26/-11/2/2022**	Sampling Method:	**Split Spoon (140 lb hammer, 30" drop)**
Drilling Company:	**Eichelbergers, Inc.**	Soil Class. System:	**USCS**
Drill Rig Type:	**Deitrich D-50**	Field Screening:	**PID 11.7 eV Lamp (ppm)**

Depth (feet)	N-Value	Blow Counts	RQD	Field Screening (ppm)	SAMPLE LITHOLOGY (USCS)	Stratigraphy	Comments	COMPLETION DETAILS
42			(40'-45') (93%) EX-CELLENT		ARGILLITE: (40'-50') Gray to dark gray argillite, moderately calcareous, calcite filling in fractures at 46.25', 47', and 48.5'			
44				0.0				
46			(45'-50') (92%) EX-CELLENT	0.0				
48				0.0				
50				0.0				
52			(50'-55') (97%) EX-CELLENT	0.0	ARGILLITE: (50'-60') Gray to blue gray argillite, thinly bedded, moderately calcareous, calcite filling in fracture, trace pyrite within fracture at 54.5', interbedded dark gray siltstone at 59.5'-60', vertical fracture at 55'-59', 30 degree fracture at 59.25'			
54				0.0				
56			(55'-60') (72%) FAIR	0.0				
58				0.0				
60				0.0	ARGILLITE: (60'-65') Blue gray to dark gray argillite with interbedded dark gray siltstone, moderately calcareous, calcite filling in fractures, trace pyrite within fractures, horizontal fractures at 61', 62', 63.5', and 64.5'			
62			(60'-65') (89%) GOOD					
64								
66			(65'-70') (90%) GOOD		ARGILLITE: (65'-70') Blue gray to dark gray argillite with interbedded dark gray siltstone, moderately calcareous, calcite filling in fractures, trace pyrite within fractures, horizontal fractures at 67', 68', and 69'			
68				0.0				
70				0.0				
72			(70'-75') (95%) EX-CELLENT		ARGILLITE: (70'-80') Blue gray argillite, moderately calcareous, calcite and iron staining within fractures, 20 degree fracture at 73', 60 degree fracture at 74.5'			
74				0.0				
76			(75'-80') (100%) EX-CELLENT	0.0				
78				0.0				
80								

General Comments:

bgs - below ground surface

ppm - parts per million

RQD - Rock Quality Designation

Symbol Key:

Apparent Water Level

Lab Sample Location

ROCK CORING LOG

RC-1

Groundwater and Environmental Services, Inc.

PROJECT:	**GTAC Nockamixon TCE Site**	CASING ELEVATION:	**NA**	TOTAL DEPTH:	**150 feet**
ADDRESS:	**77 Brennan Road**	BOREHOLE DIAMETER:	**4"**	WATER DEPTH:	**NA**
	Nockamixon, PA	WELL DIAMETER:	**NA**		

Logged By:	**Daniel Sivco**	Drilling Method:	**Split spoon/Rock Core**
Dates Drilled:	**10/26/-11/2/2022**	Sampling Method:	**Split Spoon (140 lb hammer, 30" drop)**
Drilling Company:	**Eichelbergers, Inc.**	Soil Class. System:	**USCS**
Drill Rig Type:	**Deitrich D-50**	Field Screening:	**PID 11.7 eV Lamp (ppm)**

Depth (feet)	N-Value	Blow Counts	RQD	Field Screening (ppm)	SAMPLE LITHOLOGY (USCS)	Stratigraphy	Comments	COMPLETION DETAILS
82			(80'-85') (93%) EX-CELLENT	0.0	ARGILLITE: (80'-85') SAA, vertical fracture from 81.25'-81.75', 10 degree fractures at 83.75' and 84.25', weathered argillite at 10 degree fractures			
84				0.0				
86			(85'-90') (58%) FAIR	0.0	ARGILLITE: (85'-90') Gray to blue gray argillite, thinly bedded, calcite filling in horizontal fractures at 86', 87', 87.75', heavily fractured at 88.5'-90'			
88				0.0				
90				0.0				
92			(90'-95') (95%) EX-CELLENT	0.0	ARGILLITE: (90'-95') Blue gray argillite, calcareous, thinly bedded, calcite filling in fractures, horizontal fracture at 90.5', 20 degree fracture at 91.5'			
94				0.0				
96			(95'-100') (93%) EX-CELLENT	0.0	ARGILLITE: (95'-109.5') Blue gray argillite, moderately calcareous, thinly bedded, calcite and iron staining in fractures, 10 degree fracture at 96.25', 55 degree fracture at 97.5', horizontal fractures at 100.5', 103.5', and 104'			
98				0.0				
100			(100'-105') (100%) EX-CELLENT					
102								
104								
106			(105'-110') (83%) GOOD					
108								
110			(110'-115') (89%) GOOD		SILTSTONE: (109.5'-111') Red brown siltstone, trace fine-grained pyrite	**SILTSTONE**		
112				0.0	ARGILLITE: (111'-120') Dark gray to blue gray argillite, moderately calcareous, thinly bedded, calcite and iron staining in fractures, 25 degree fracture at 111.5', 70 degree fracture at 114.5', vertical frature at 116'	**ARGILLITE**		
114								
116			(115'-120') (89%) GOOD	0.0				
118				0.0				
120				0.0				

General Comments:
bgs - below ground surface
ppm - parts per million
RQD - Rock Quality Designation

Symbol Key:
Apparent Water Level
Lab Sample Location

ROCK CORING LOG

RC-1

Groundwater and Environmental Services, Inc.

PROJECT:	**GTAC Nockamixon TCE Site**	CASING ELEVATION:	**NA**	TOTAL DEPTH:	**150 feet**
ADDRESS:	**77 Brennan Road**	BOREHOLE DIAMETER:	**4"**	WATER DEPTH:	**NA**
	Nockamixon, PA	WELL DIAMETER:	**NA**		

Logged By:	**Daniel Sivco**	Drilling Method:	**Split spoon/Rock Core**
Dates Drilled:	**10/26/-11/2/2022**	Sampling Method:	**Split Spoon (140 lb hammer, 30" drop)**
Drilling Company:	**Eichelbergers, Inc.**	Soil Class. System:	**USCS**
Drill Rig Type:	**Deitrich D-50**	Field Screening:	**PID 11.7 eV Lamp (ppm)**

Depth (feet)	N-Value	Blow Counts	RQD	Field Screening (ppm)	SAMPLE LITHOLOGY (USCS)	Stratigraphy	Comments	COMPLETION DETAILS
122			(120'-125') (95%) EX-CELLENT	0.0	ARGILLITE: (120'-125') Gray to blue gray argillite, thinly bedded, calcite and fine-grained pyrite in fractures at 120.5', 30 degree frature at 124'			
124				0.0				
126			(125'-130') (100%) EX-CELLENT		ARGILLITE: (125'-141.25') Blue gray argillite, thinly bedded, moderately calcareous, calcite within bedding planes, 75 degree fracture at 130.5'-132.75' with calcite and pyrite within fracture, vertical fracture at 135.5', 75 degree frature at 138.25'-139.25'			
128								
130			(130'-135') (56%) FAIR					
132				0.0				
134				0.0				
136			(135'-140') (83%) GOOD	0.0				
138				0.0				
140								
142			(140'-145') (97%) EX-CELLENT	0.0	SHALE: (141.25'-150') Red brown shale, slightly calcareous, trace calcite, 15 degree fracture at 148'	**SHALE**		
144				0.0				
146			(145'-150') (97%) EX-CELLENT				Boring terminated at 150' bgs	
148				0.0				
150								

General Comments:
bgs - below ground surface
ppm - parts per million
RQD - Rock Quality Designation

Symbol Key:
Apparent Water Level
Lab Sample Location

ROCK CORING LOG

RC-2

Groundwater and Environmental Services, Inc.

PROJECT:	**GTAC Nockamixon TCE Site**	CASING ELEVATION:	**NA**	TOTAL DEPTH:	**250 feet**
ADDRESS:	**77 Brennan Road**	BOREHOLE DIAMETER:	**4"**	WATER DEPTH:	**NA**
	Nockamixon, PA	WELL DIAMETER:	**NA**		

Logged By:	**Daniel Sivco, Brian Hale**	Drilling Method:	**Split spoon/Rock Core**
Dates Drilled:	**11/3-11/16/2022**	Sampling Method:	**Split Spoon (140 lb hammer, 30" drop)**
Drilling Company:	**Eichelbergers, Inc.**	Soil Class. System:	**USCS**
Drill Rig Type:	**Deitrich D-50**	Field Screening:	**PID 11.7 eV Lamp (ppm)**

Depth (feet)	N-Value	Blow Counts	RQD	Field Screening (ppm)	SAMPLE LITHOLOGY (USCS)	Stratigraphy	Comments	COMPLETION DETAILS
0				0.0	TOPSOIL: (0-0.5') Topsoil	**TOPSOIL**	Split spoon refusal at 5.3' bgs	Boring completed with temporary steel stick-up casing with bentonite seal to 5' bgs
2	5	1,2,3,7		0.0	ML: (0.5'-5.0') Light brown silt with clay, few to some weathered argillite fragments, moist, loose	**ML**		
				0.0				
4	48	13,25,23,28		0.0				
	>50	28,25,50/3"		0.0				
6			(5'-10') (58%) FAIR	0.0	WEATHERED ARGILLITE: (5'-9') Weathered argillite, heavily fractured with seams of silt and clay	**WEATHERED ARGILLITE**	Rock core between 5'-250' bgs	
				0.0				
8				0.0				
				0.0	ARGILLITE: (9'-10') Argillite, competent	**ARGILLITE**		
10			(10'-15') (87%) GOOD		ARGILLITE: (10'-25') Blue gray argillite, thinly bedded, moderately calcareous with several horizontal fractures, 55 degree fracture at 12.5'-13', fracture partially filled in with brown silt and clay at 16.5'-17.25', 20 degree fracture at 22.75'			Open rock boring from 5' to 250' bgs
12				0.0				
				0.0				
14								
			(15'-20') (93%) EX-CELLENT	0.0				
16				0.0				
				0.0				
18								
				0.0				
20			(20'-25') (95%) EX-CELLENT					
22				0.0				
				0.0				
24								
26			(25'-30') (95%) EX-CELLENT	0.0	ARGILLITE: (25-35') Gray to blue gray argillite, thinly bedded, moderately calcareous, horizontal fractures at 27.25' and 28.75', calcite and trace iron staining within fractures, near vertical fracture from 32'-34' with trace silt and clay			
				0.0				
28				0.0				
30			(30'-35') (81%) GOOD					
32								
34				0.0				
36			(35'-40') (92%) EX-CELLENT		ARGILLITE: (35'-40') Gray to blue gray argillite, thinly bedded, moderately calcareous, pyrite and calcite within foliations at 36.5', 75 degree fracture at 37'-38.5			
				0.0				
38				0.0				
40								

General Comments:
bgs - below ground surface
ppm - parts per million
RQD - Rock Quality Designation

Symbol Key:
Apparent Water Level
Lab Sample Location

ROCK CORING LOG

RC-2

Groundwater and Environmental Services, Inc.

PROJECT:	**GTAC Nockamixon TCE Site**	CASING ELEVATION:	**NA**	TOTAL DEPTH:	**250 feet**
ADDRESS:	**77 Brennan Road**	BOREHOLE DIAMETER:	**4"**	WATER DEPTH:	**NA**
	Nockamixon, PA	WELL DIAMETER:	**NA**		

Logged By:	**Daniel Sivco, Brian Hale**	Drilling Method:	**Split spoon/Rock Core**
Dates Drilled:	**11/3-11/16/2022**	Sampling Method:	**Split Spoon (140 lb hammer, 30" drop)**
Drilling Company:	**Eichelbergers, Inc.**	Soil Class. System:	**USCS**
Drill Rig Type:	**Deitrich D-50**	Field Screening:	**PID 11.7 eV Lamp (ppm)**

Depth (feet)	N-Value	Blow Counts	RQD	Field Screening (ppm)	SAMPLE LITHOLOGY (USCS)	Stratigraphy	Comments	COMPLETION DETAILS
42			(40'-45') (86%) GOOD		ARGILLITE: (40'-45') Blue gray to dark gray argillite with interbedded dark gray siltstone, moderately calcareous, thinly bedded, calcite within bedding plane			
44								
46			(45'-50') (97%) EX-CELLENT	0.0	SILTSTONE: (45'-50.25') Dark gray siltstone with interbedded argillite, thinly bedded, calcite within bedding planes, horizontal fractures	**SILTSONE**		
48				0.0				
50			(50'-55') (95%) EX-CELLENT	0.0	ARGILLITE: (50.25'-60') Gray to blue gray argillite, thinly bedded, moderately calcareous, calcite and pyrite observed within foliations, 60 degree fracture at 54' with trace clay within fracture	**ARGILLITE**		
52								
54				0.0				
56			(55'-60') (100%) EX-CELLENT					
58								
60				0.0				
62			(60'-65') (84%) GOOD	0.0 0.0	ARGILLITE: (60'-65') Blue gray to dark gray argillite with interbedded siltstone, thinly bedded, moderately calcareous, horizontal fractures, slightly fissile at 64.5'			
64				0.0				
66			(65'-70') (97%) EX-CELLENT		SILTSTONE: (65'-70') Dark gray siltstone with interbedded argillite, moderately calcareous, dark gray shale at 69.75'-70'	**SILTSTONE**		
68				0.0 0.0				
70			(70'-75') (100%) EX-CELLENT	0.0	ARGILLITE: (70'-80') Blue gray argillite, thinly bedded, calcite within bedding planes, moderately calcareous	**ARGILLITE**		
72								
74				0.0				
76			(75'-80') (99%) EX-CELLENT					
78				0.0				
80								

General Comments:
bgs - below ground surface
ppm - parts per million
RQD - Rock Quality Designation

Symbol Key:
Apparent Water Level
Lab Sample Location

ROCK CORING LOG

RC-2

Groundwater and Environmental Services, Inc.

PROJECT:	**GTAC Nockamixon TCE Site**	CASING ELEVATION:	**NA**	TOTAL DEPTH:	**250 feet**
ADDRESS:	**77 Brennan Road**	BOREHOLE DIAMETER:	**4"**	WATER DEPTH:	**NA**
	Nockamixon, PA	WELL DIAMETER:	**NA**		

Logged By:	**Daniel Sivco, Brian Hale**	Drilling Method:	**Split spoon/Rock Core**
Dates Drilled:	**11/3-11/16/2022**	Sampling Method:	**Split Spoon (140 lb hammer, 30" drop)**
Drilling Company:	**Eichelbergers, Inc.**	Soil Class. System:	**USCS**
Drill Rig Type:	**Deitrich D-50**	Field Screening:	**PID 11.7 eV Lamp (ppm)**

Depth (feet)	N-Value	Blow Counts	RQD	Field Screening (ppm)	SAMPLE LITHOLOGY (USCS)	Stratigraphy	Comments	COMPLETION DETAILS
82			(80'-85') (100%) EX-CELLENT		ARGILLITE: (80'-90') Blue gray argillite, thinly bedded, calcite within bedding planes, moderately calcareous, 80 degree fracture at 88.25'-90'			
84				0.0				
86			(85'-90') (77%) GOOD	0.0				
88				0.0				
90				0.0				
92			(90'-95') (83%) GOOD	0.0	ARGILLITE: (90'-95') Gray to blue gray argillite, heavily fractured at 90'-90.5', oblique fraacture at 94'			
94				0.0				
96			(95'-100') (97%) EX-CELLENT		ARGILLITE: (95'-100') Gray to blue gray argillite, moderately calcareous, thinly bedded, 80 degree fracture at 95'-96'			
98								
100				0.0				
102			(100'-105') (73%) FAIR	0.0	ARGILLITE: (100'-105') Blue gray argillite, thinly bedded, heavily fractured, 70 degree fracture at 101'-101.5', vertical fracture at 103'			
104				0.0				
106			(105'-110') (92%) EX-CELLENT	0.0	ARGILLITE: (105'-120') Blue gray argillite, thinly bedded, calcareous, vertical fracture at 105.5', 70 degree fracture at 109' and 116', calcite vein at 119' with pyrite			
108								
110			(110'-115') (100%) EX-CELLENT	0.0				
112				0.0				
114								
116			(115'-120') (100%) EX-CELLENT	0.0				
118				0.0				
120								

General Comments:
bgs - below ground surface
ppm - parts per million
RQD - Rock Quality Designation

Symbol Key:
Apparent Water Level
Lab Sample Location

ROCK CORING LOG

RC-2

Groundwater and Environmental Services, Inc.

PROJECT:	**GTAC Nockamixon TCE Site**	CASING ELEVATION:	**NA**	TOTAL DEPTH:	**250 feet**
ADDRESS:	**77 Brennan Road**	BOREHOLE DIAMETER:	**4"**	WATER DEPTH:	**NA**
	Nockamixon, PA	WELL DIAMETER:	**NA**		

Logged By:	**Daniel Sivco, Brian Hale**	Drilling Method:	**Split spoon/Rock Core**
Dates Drilled:	**11/3-11/16/2022**	Sampling Method:	**Split Spoon (140 lb hammer, 30" drop)**
Drilling Company:	**Eichelbergers, Inc.**	Soil Class. System:	**USCS**
Drill Rig Type:	**Deitrich D-50**	Field Screening:	**PID 11.7 eV Lamp (ppm)**

Depth (feet)	N-Value	Blow Counts	RQD	Field Screening (ppm)	SAMPLE LITHOLOGY (USCS)	Stratigraphy	Comments	COMPLETION DETAILS
122			(120'-125') (96%) EX-CELLENT	0.0	ARGILLITE: (120'-125') Blue gray argillite, thinly bedded, calcareous, calcite vein at 121' with pyrite			
				0.0				
124				0.0				
126			(125'-130') (100%) EX-CELLENT		ARGILLITE: (125'-135') Blue gray argillite, thinly bedded, oblique proto-fractures with calcite at 127.5'-128' and 131'-133'			
128								
130			(130'-135') (100%) EX-CELLENT					
132								
134				0.0				
136			(135'-140') (95%) EX-CELLENT		ARGILLITE: (135'-140') Blue gray to dark gray argillite, moderately calcareous, few interbedded siltstone layers, oblique proto-fracture with calcite at 139'			
138								
140				0.0				
142			(140'-145') (94%) EX-CELLENT	0.0	ARGILLITE: (140'-145.5') Blue gray argillite, calcareous, thinly bedded, 70 degree fracture at 143'			
144				0.0				
146			(145'-150') (95%) EX-CELLENT	0.0	ARGILLITE: (145.5'-155') Red brown argillite, slightly calcareous, thinly bedded, 35 degree fracture at 152'			
148								
150								
152			(150'-155') (98%) EX-CELLENT	0.0				
154				0.0				
156			(155'-160') (93%) EX-CELLENT	0.0	SHALE: (155'-160') Red brown shale, slightly calcareous, fissile, thinly bedded with horizontal fractures	**SHALE**		
158				0.0				
160				0.0				

General Comments:
bgs - below ground surface
ppm - parts per million
RQD - Rock Quality Designation

Symbol Key:
Apparent Water Level
Lab Sample Location

ROCK CORING LOG

RC-2

Groundwater and Environmental Services, Inc.

PROJECT:	**GTAC Nockamixon TCE Site**	CASING ELEVATION:	**NA**	TOTAL DEPTH:	**250 feet**
ADDRESS:	**77 Brennan Road**	BOREHOLE DIAMETER:	**4"**	WATER DEPTH:	**NA**
	Nockamixon, PA	WELL DIAMETER:	**NA**		

Logged By:	**Daniel Sivco, Brian Hale**	Drilling Method:	**Split spoon/Rock Core**
Dates Drilled:	**11/3-11/16/2022**	Sampling Method:	**Split Spoon (140 lb hammer, 30" drop)**
Drilling Company:	**Eichelbergers, Inc.**	Soil Class. System:	**USCS**
Drill Rig Type:	**Deitrich D-50**	Field Screening:	**PID 11.7 eV Lamp (ppm)**

Depth (feet)	N-Value	Blow Counts	RQD	Field Screening (ppm)	SAMPLE LITHOLOGY (USCS)	Stratigraphy	Comments	COMPLETION DETAILS
162			(160'-165') (83%) GOOD	0.0	SHALE: (160'-170') Red brown shale, slightly calcareous, fissile, thinly bedded with horizontal fractures, 70 degree frcture at 163'			
164				0.0				
166			(165'-170') (80%) GOOD					
168								
170				0.0				
172			(170'-175') (92%) EX-CELLENT		ARGILLITE: (170'-180') Red brown argillite with horizontal fractures throughout	**ARGILLITE**		
174								
176			(175'-180') (98%) EX-CELLENT	0.0				
178				0.0				
180			(180'-185') (99%) EX-CELLENT		ARGILLITE: (180'-200') Red brown argillite with horizontal fractures throughout			
182								
184				0.1				
186			(185'-190') (92%) EX-CELLENT					
188				0.2				
190								
192			(190'-195') (84%) GOOD					
194				0.1				
196			(195'-200') (93%) EX-CELLENT					
198								
200								

General Comments:

bgs - below ground surface

ppm - parts per million

RQD - Rock Quality Designation

Symbol Key:

Apparent Water Level

Lab Sample Location

ROCK CORING LOG

RC-2

Groundwater and Environmental Services, Inc.

PROJECT:	GTAC Nockamixon TCE Site	CASING ELEVATION:	NA	TOTAL DEPTH:	250 feet
ADDRESS:	77 Brennan Road	BOREHOLE DIAMETER:	4"	WATER DEPTH:	NA
	Nockamixon, PA	WELL DIAMETER:	NA		

Logged By:	Daniel Sivco, Brian Hale	Drilling Method:	Split spoon/Rock Core
Dates Drilled:	11/3-11/16/2022	Sampling Method:	Split Spoon (140 lb hammer, 30" drop)
Drilling Company:	Eichelbergers, Inc.	Soil Class. System:	USCS
Drill Rig Type:	Deitrich D-50	Field Screening:	PID 11.7 eV Lamp (ppm)

Depth (feet)	N-Value	Blow Counts	RQD	Field Screening (ppm)	SAMPLE LITHOLOGY (USCS)	Stratigraphy	Comments	COMPLETION DETAILS
202			(200'-205') (100%) EX-CELLENT		ARGILLITE: (200'-205') Red brown argillite with horizontal fractures throughout			
204								
206			(205'-210') (98%) EX-CELLENT	0.0	ARGILLITE: (205'-220') Red brown argillite, thinly bedded, slightly calcareous with horizontal fractures throughout, 30 degree fracture at 218'			
208				0.0				
210			(210'-215') (100%) EX-CELLENT	0.0				
212				0.0				
214				0.0				
216			(215'-220') (100%) EX-CELLENT					
218								
220			(220'-225') (100%) EX-CELLENT		SHALE: (220'-221.5') Red brown to purple shale, slightly calcareous, thinly bedded	SHALE		
222					ARGILLITE: (221.5'-231') Red brown argillite, thinly bedded, slightly calcareous, oblique calcite vein at 221.5'-223'	ARGILLITE		
224								
226			(225'-230') (100%) EX-CELLENT					
228								
230			(230'-235') (97%) EX-CELLENT					
232					ARGILLITE: (231'-240') Gray to blue gray argillite, thinly bedded, moderately calcareous, few horizontal fractures			
234								
236			(235'-240') (93%) EX-CELLENT	0.0				
238				0.0				
240					ARGILLITE: (240'-241.25') Gray to blue gray argillite, thinly bedded,			

General Comments:
bgs - below ground surface
ppm - parts per million
RQD - Rock Quality Designation

Symbol Key:
Apparent Water Level
Lab Sample Location

ROCK CORING LOG

RC-2

Groundwater and Environmental Services, Inc.

PROJECT:	**GTAC Nockamixon TCE Site**	CASING ELEVATION:	**NA**	TOTAL DEPTH:	**250 feet**
ADDRESS:	**77 Brennan Road**	BOREHOLE DIAMETER:	**4"**	WATER DEPTH:	**NA**
	Nockamixon, PA	WELL DIAMETER:	**NA**		

Logged By:	**Daniel Sivco, Brian Hale**	Drilling Method:	**Split spoon/Rock Core**
Dates Drilled:	**11/3-11/16/2022**	Sampling Method:	**Split Spoon (140 lb hammer, 30" drop)**
Drilling Company:	**Eichelbergers, Inc.**	Soil Class. System:	**USCS**
Drill Rig Type:	**Deitrich D-50**	Field Screening:	**PID 11.7 eV Lamp (ppm)**

Depth (feet)	N-Value	Blow Counts	RQD	Field Screening (ppm)	SAMPLE LITHOLOGY (USCS)	Stratigraphy	Comments	COMPLETION DETAILS
242			(240'-245') (100%) EX-CELLENT		moderately calcareous ARGILLITE: (241.25'-245') Gray to red brown argillite, moderately calcareous, fine-grained pyrite along bedding planes			
244								
246			(245'-250') (100%) EX-CELLENT	0.0	ARGILLITE: (245'-250') Blue gray argillite, thinly bedded, fine-grained calcite in fracture at 246.25'		Boring terminated at 250' bgs	
248								
250								

General Comments:
bgs - below ground surface
ppm - parts per million
RQD - Rock Quality Designation

Symbol Key:
Apparent Water Level
Lab Sample Location

Appendix C – GeoStructures, Inc. Report

GeoStructures

Bashar S. Qubain, Ph.D., P.E.
Eric J. Seksinsky, P.G., P.E.
Jianchao Li, P.E.

GEOTECHNICAL ENGINEERING CONSULTANTS

Project No. G23-101
January 10, 2023

Mr. Timothy Uhler
Groundwater & Environmental Services, Inc.
440 Creamery Way, Suite 500
Exton, PA 19341

Re: Rock Rippability Analysis
GTAC - Nockamixon TCE Site
Nockamixon Twp., Bucks Co., PA

Dear Mr. Uhler:

GeoStructures, Inc. has completed a rippability analysis for the referenced project per Proposal No. P22-135 dated March 1, 2022. The intent of this report is to assess the rippability of the rock within the depth of concern. Our completed services include laboratory testing, geotechnical analysis, and documentation of our findings and recommendations.

PROJECT DESCRIPTION

The site is located at 84 Brennan Road, 1,000 ft south of the intersection of Durham and Brennan Roads in Nockamixon Township, Bucks County, PA (see Figure 1. Site Location Map). Groundwater in the area has reportedly been impacted by trichloroethylene (TCE) contamination. Filed screening of samples obtained from the test borings showed contamination extending to a depth of 12 ft below grade in RC-1. Contaminated soil and rock are planned to be removed. The depth and extent of the removal area are not yet delineated. It is assumed, however, that the depth of excavation will be about 15 ft carried out within the vicinity of borings RC-1 and RC-2. See attached Geotechnical Investigation Plan of Drawing 1.

TEST BORINGS

Groundwater & Environmental Services, Inc. (GES) supervised the drilling of 2 test borings at the locations marked in Drawing 1 as RC-1 and RC-2. The borings extended to a depth of 150 and 250 ft below grade, respectively. Drilling was carried out by Eichelbergers, Inc. using a Deidrich D-50 drill rig over the timer period of October 26 through November 16, 2022. Rock coring was performed in all of the test borings per ASTM D2113 methods. Detailed documentation of the borings, including soil and rock descriptions, standard penetration test (SPT) blow counts per ASTM D1586, strata divisions, PID readings, etc. are recorded in the test boring logs of Attachment A. Photos of the upper 15 ft of the rock cores are included in Attachment A.

GEOTECHNICAL LABORATORY TESTING

GeoStructures performed unconfined compressive strength testing on 4 selected core specimens per ASTM D7012 for rippability assessment purposes. It is noted that 2 of the specimens did not reach the failure point and the tests were terminated at the machine's load capacity. The results and stress-strain curves are presented in Attachment B.

SUBSURFACE CONDITIONS

Geology and Bedrock

Per the USGS geologic maps (see Figure 2. Site Geologic Map), the site is underlain by of the Brunswick Formation (Trb), which consists of reddish-brown mudstone, siltstone, and shale, containing a few green and brown shale interbeds; red and dark-gray, interbedded argillites near base. A half mile northeast of the site is the geologic contact with the Lockatong Formations which is described as dark-gray to black, thick-bedded argillite containing a few zones of thin-bedded black shale; locally has thin layers of impure limestone and calcareous shale. Cores from the upper 15 ft of the rock are identified as gray to dark, bluish gray, calcareous argillite, which seems to more closely align with the description of the nearby Lockatong Formation rather than the Brunswick rocks. The overburden soils consist of stiff to hard, residual silt and clay with rock fragments, derived from advanced weathering of the argillite.

Rock Mass Characterization. The argillite rock was encountered at a depth of 5 ft. Based on our close visual examination of the cores from RC-1 and RC-2 and the laboratory measured unconfined compressive strength values, the upper 10 ft of the rock mass (to a depth of 15 ft below grade) is categorized into 2 layers that differ mainly in the fracturing and degree of weathering as follows.

1. ***Medium hard, highly to moderately weathered, closely fractured (upper 4 ft of rock mass at RC-1 and upper 1 ft of rock mass at RC-2).*** This condition characterizes the upper 4 ft of the rock mass at RC-1 (depth of 5 to 9 ft below grade) and the upper 1 ft of the rock mass at RC-2 (depth of 5 to 6 ft). It is described as medium hard, highly to moderately weathered, closely fractured (fracture spacing of 0.5 to 2 in. with both horizontal and vertical orientations). Vertical fractures were observed from 6.8-9 ft and 4-5 ft in RC-1 and RC-2 respectively. The fracture faces are stained with iron oxide and coated with light brown silt and clay throughout the layer with more dominant and thicker clay sublayers in the upper 1.8 ft of RC-1 (from 5 to 6.8 ft below grade). The boring logs note high PID readings and product odor within the this fractured and weathered zone of the rock mass.

2. ***Hard, fresh to slightly weathered, medium to very widely fractured.*** This condition characterizes the rock mass at RC-1 from a depth of 9 to 15 ft and the rock mass at RC-2 from a depth of 6 to 15 ft. It is pointed out that our characterization differs from that of the boring logs in that we conclude that the more competent rock starts at a depth of 6 ft rather than 9 ft in RC-2. This zone is described as hard, fresh to slightly weathered, and medium to widely fractured (fracture spacing of 6 in. to 4 ft with only 10° relative dip (nearly horizontal) fractures observed within the 15-ft depth of interest). No vertical fractures evident in the cores. It is worth noting that the natural fracture spacing is slightly less in RC-2 than RC-1, but otherwise the rock is essentially the same hardness in both borings. The laboratory determined, unconfined compressive strength of the intact rock specimens from this zone of the rock mass ranges from 12,173 to 20,000^{+} psi. Accordingly, the rocks are placed in the *hard* category (8,000 to 32,000 psi) per PennDOT Publication 293. The boring logs note low PID readings within this competent rock zone of the rock mass.

Groundwater

The *apparent* depth to groundwater recorded in the boring logs is 90 ft at RC-1 and 105 ft at RC-2.

GEOTECHNICAL ANALYSIS AND CONCLUSIONS

Rippability assessment. Rippability of the rock mass was assessed using the AASHTO Manual of Subsurface Investigations (1988)[1] and the Caterpillar Handbook of Ripping[2]. The assessment utilizes the unconfined compressive strength and hardness of intact rock specimens along with degree of fracturing, weathering, and jointing of the rock mass. The rippability assessment of both rock layers is presented in Table 1. The *rippability rating* of the medium hard, highly to moderately weathered and closely fractured rock is 40 which corresponds to *hard ripping*. The corresponding recommended horsepower is 270 which is comparable to a D8 Caterpillar

1 AASHTO Manual of Subsurface Investigations, AASHTO, 1st Edition,1988.
2 Caterpillar Handbook of Ripping, Caterpillar Inc. 12th Edition, 2000.

tractor. The rippability rating of the second rock layer (hard, fresh to slightly weathered and medium to very widely fractured) is 72 which corresponds to *Extremely hard ripping and blasting*. The corresponding recommended horsepower is 770 which is comparable to a DD9 Caterpillar tractor. It is important to note that this assessment was developed by AASHTO for *open roadway cuts*. Therefore, its applicability to smaller pits and more confined excavations is considered with a prudent degree of conservatism.

In summary, due to its closely spaced fractures in both the horizontal and vertical directions, the upper 4 ft of rock at RC-1 and only the upper 1 ft of rock at RC-2 have been shown by this study to be rippable with assistance with some pneumatic hammering using a large and powerful excavator. The rest of the rock at both locations within the 15-ft deep zone of interest below grade is expected to prove very difficult to extract due to its hardness, wide fracture spacing, and the fact that only horizontal fractures were observed. Accordingly, blasting is expected and pneumatic hammering is only worth attempting in combination with percussion line drilling.

Table 1. Rock Rippability Assessment

Rock Type	**Highly to moderately weathered, closely fractured**		**Fresh to slightly weathered, medium to widely fractured**	
Seismic Velocity[1]	1500 - 1200	12	2150 - 1850	24
Rock Hardness	Medium Hard Rock	2	Hard Rock	5
Rock Weathering	Highly Weathered	3	Moderately Weathered	5
Joint Spacing	Closely	10	Medium	20
Joint Continuity	-	-	-	-
Joint Gouge	< 5 mm	3	Slight Separation	5
Strike and Dip Orientation[2]	Slightly unfavorable	10	Unfavorable	13
Overall Rating	40		72	
Rippability Assessment[3]	Hard Ripping		Extremely Hard Ripping & Blasting	

Notes

1. Seismic velocity is correlated with the overall quality of the rock mass.
2. Strike and dip orientation is rated with aspect of applications of rock excavation.
3. Rippability is assessed as follows: 100 – 90, *blasting required*; 90 – 70, *extremely hard ripping and blasting*; 70 – 50, *very hard ripping*; 50 – 25, *hard ripping*; <25, *easy ripping*.

LIMITATIONS

The findings and recommendations documented in this report are based on the stated project information and the results of 2 test borings and the documented laboratory testing. The subsurface information has been idealized for geotechnical purposes and it is not implied in this report that the conditions as depicted in the test borings are identical to what will be encountered during construction. GeoStructures should be kept informed as the project progresses and the depth and limit of rock excavation are delineated as well as if additional subsurface information become available. GeoStructures should also be apprised during construction if the subsurface conditions vary from our characterization presented herein.

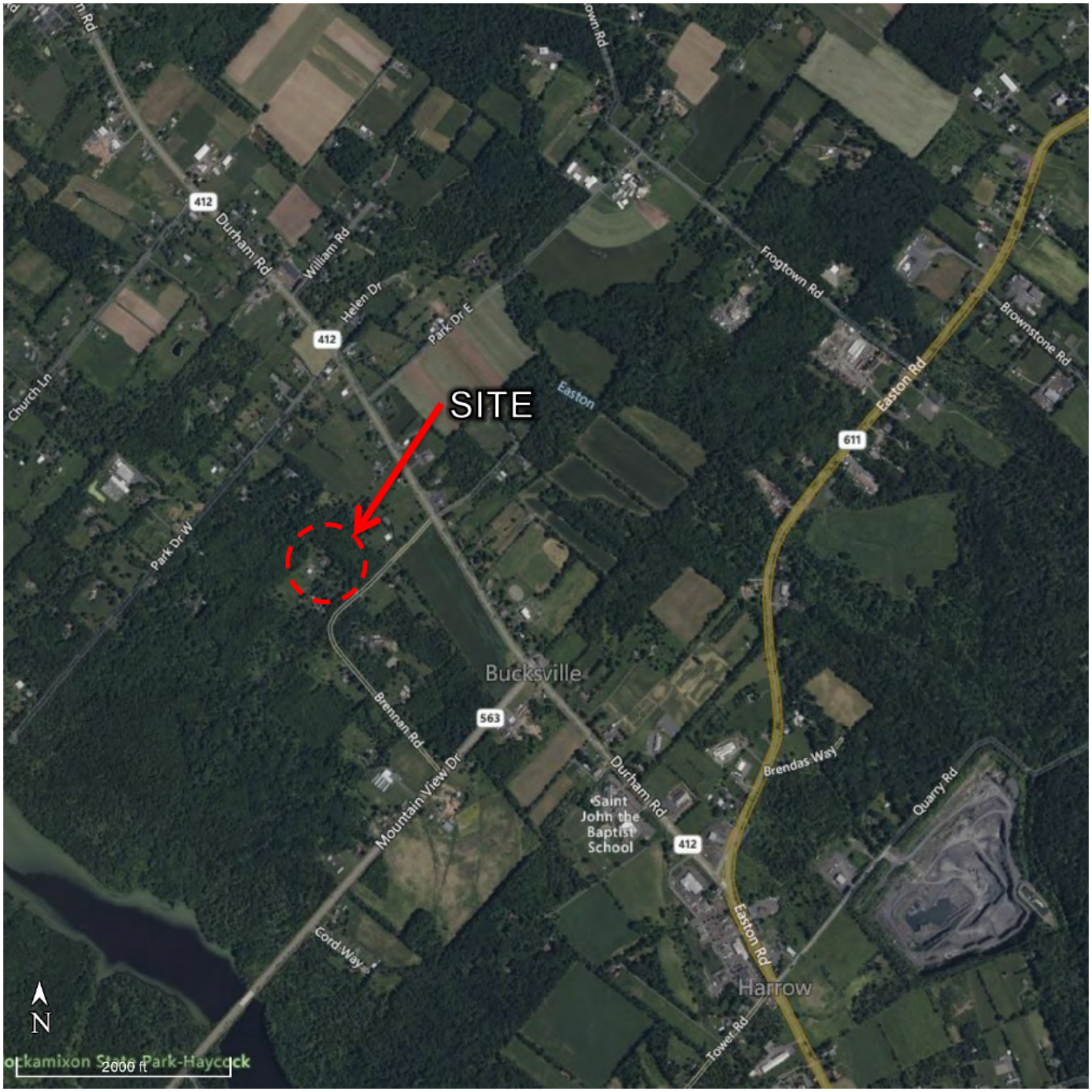
We appreciate the opportunity to provide services to you on this project. If you have any questions, please feel free to call.

Sincerely,

Kamil Nuzha, PE
Project Manager

Eric J. Seksinsky, PG, PE
Associate

Figures and Drawings



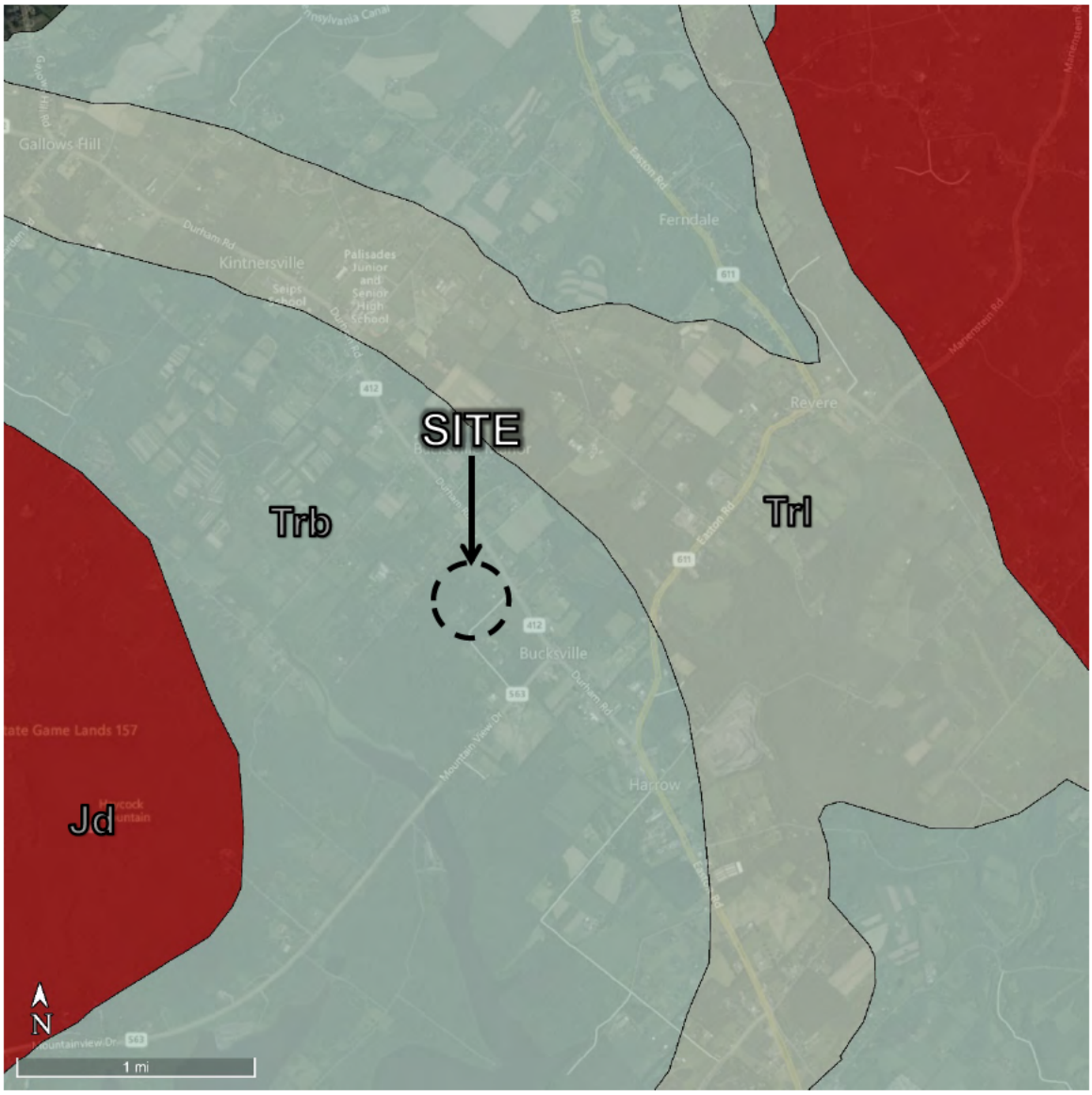
Source:

"Bing Maps in Google Earth." *Bing Maps in Google Earth*. N.p., n.d. Web. 1/4/2023. < http://ge-map-overlays.appspot.com/bing-maps/road >.

GeoStructures

FIGURE 1. SITE LOCATION MAP

GTAC - NOCKAMIXON TCE SITE
NOCKAMIXON TWP., BUCKS CO., PA



Trb: Brunswick Formation: Brunswick Formation - Reddish-brown mudstone, siltstone, and shale, containing a few green and brown shale interbeds; red and dark-gray, interbedded argillites near base. Youngest beds in Brunswick may be Jurassic in age.

Trl: Lockatong Formation (Triassic): Lockatong Formation - Dark-gray to black, thick-bedded argillite containing a few zones of thin-bedded black shale; locally has thin layers of impure limestone and calcareous shale.

Jd: Diabase (Jurassic): Diabase - Medium- to coarse-grained, quartz-normative tholeiite; composed of labradorite and various pyroxenes; occurs as dikes, sheets, and a few small flows.

Sources:

(1) "Bing Maps in Google Earth." *Bing Maps in Google Earth*. N.p., n.d. Web. 1/4/2023. < http://ge-map-overlays.appspot.com/bing-maps/road >.

(2) Bedrock Geologic Map of Pennsylvania by Socolow, A.A. & Berg, T.M., 1980.

(3) http://mrdata.usgs.gov/geology/state/state.php?state=PA

GeoStructures

FIGURE 2. SITE GEOLOGIC MAP

GTAC - NOCKAMIXON TCE SITE
NOCKAMIXON TWP., BUCKS CO., PA

LEGEND

TEST BORING

200' 100' 0 200'

SCALE: 1" = 200'

NOTE: THIS DRAWING IS BASED ON A SITE PLAN PROVIDED BY GES DATED 10/07/2021.

GeoStructures

GEOTECHNICAL INVESTIGATION PLAN

GTAC - NOCKAMIXON TCE SITE
84 BRENNAN RD NOCKAMIXON TWP., OTTSVILLE, PA

SCALE: 1" = 200'	DRAWN BY: KN	PROJECT NO: G23-101
DATE: 1/4/2023	CHECKED BY: KN	DRAWING NO: 1

PLOTTED: 1/4/2023 6:27:43 PM | BY: KAMIL NUZHA | PLOTSTYLE:GSI_HALF-CTB | PLOTTER:DWG TO PDF.PC3
FILE PATH: G:\PROJECT FOLDERS\2023\G23-101 GTAC-NOCKAMIXON\DRAWINGS\GEOTECHNICAL INVESTIGATION PLAN - GTAC.DWG

Appendix A
Test Boring Logs & Rock Core Photos

ROCK CORING LOG

RC-1

Groundwater and Environmental Services, Inc.

PROJECT:	GTAC Nockamixon TCE Site	CASING ELEVATION:	NA	TOTAL DEPTH:	150 feet
ADDRESS:	77 Brennan Road	BOREHOLE DIAMETER:	4"	WATER DEPTH:	NA
	Nockamixon, PA	WELL DIAMETER:	NA		

Logged By:	Daniel Sivco	Drilling Method:	Split spoon/Rock Core
Dates Drilled:	10/26/-11/2/2022	Sampling Method:	Split Spoon (140 lb hammer, 30" drop)
Drilling Company:	Eichelbergers, Inc.	Soil Class. System:	USCS
Drill Rig Type:	Deitrich D-50	Field Screening:	PID 11.7 eV Lamp (ppm)

Depth (feet)	N-Value	Blow Counts	RQD	Field Screening (ppm)	SAMPLE LITHOLOGY (USCS)	Stratigraphy	Comments	COMPLETION DETAILS
0					TOPSOIL: (0-0.5') Topsoil	TOPSOIL	Split spoon refusal at 5.4' bgs	Boring completed with temporary steel stick-up casing with bentonite seal to 5' bgs
2	12	4,8,12		0.0	ML: (0.5'-2.0') Reddish-brown silt, little clay, trace sand, weathered argillite fragments, medium dense, slightly moist	ML		
4	35	10,15,20,28		0.0 0.8 4.5 1.8 1.6				
6	50	28,45,50/4"	(5'-10') (17.5%) VERY POOR	52.8 11.8 48.3 483.6	CL: (2'-5') SAA, very dense, increasing weathered argillite fragments with depth	WEATHERED ARGILLITE	Rock core between 5'-150' bgs	
8				46.6 17.3 8.9	WEATHERED ARGILLITE: (5'-9') Gray weathered argillite, highly fractured with seams of brown silt and clay, odor			
10			(10'-15') (75%) GOOD	18 0.8	ARGILLITE: (9'-10') Competent Argillite, fracture at 9.5'	ARGILLITE		Open rock boring from 5' to 150' bgs
12				0.0	ARGILLITE: (10'-15') Gray competent argillite with fractures			
14				0.0				
16			(15'-20') (94%) EX-CELLENT	0.0	ARGILLITE: (15'-30') Gray to dark gray argillite, laminated to thinly bedded, horizontal fractures at 23', 24.5', 80 degree fracture at 27.25'-29', red-brown clay within fracture			
18								
20			(20'-25') (100%) EX-CELLENT					
22								
24				0.0				
26			(25'-30') (91%) EX-CELLENT	0.0				
28				0.0 0.0				
30			(30'-35') (100%) EX-CELLENT		ARGILLITE: (30'-40') Gray argillite, laminated to thinly bedded, 80 degree fracture at 30.5'-31.5', horizontal fractures at 43.5, 44', and 44.75'			
32								
34				0.0				
36			(35'-40') (93%) EX-CELLENT					
38								
40								

General Comments:
bgs - below ground surface
ppm - parts per million
RQD - Rock Quality Designation

Symbol Key:
Apparent Water Level
Lab Sample Location

ROCK CORING LOG

RC-1

Groundwater and Environmental Services, Inc.

PROJECT:	**GTAC Nockamixon TCE Site**	CASING ELEVATION:	**NA**	TOTAL DEPTH:	**150 feet**
ADDRESS:	**77 Brennan Road**	BOREHOLE DIAMETER:	**4"**	WATER DEPTH:	**NA**
	Nockamixon, PA	WELL DIAMETER:	**NA**		

Logged By:	**Daniel Sivco**	Drilling Method:	**Split spoon/Rock Core**
Dates Drilled:	**10/26/-11/2/2022**	Sampling Method:	**Split Spoon (140 lb hammer, 30" drop)**
Drilling Company:	**Eichelbergers, Inc.**	Soil Class. System:	**USCS**
Drill Rig Type:	**Deitrich D-50**	Field Screening:	**PID 11.7 eV Lamp (ppm)**

Depth (feet)	N-Value	Blow Counts	RQD	Field Screening (ppm)	SAMPLE LITHOLOGY (USCS)	Stratigraphy	Comments	COMPLETION DETAILS
42			(40'-45') (93%) EX-CELLENT		ARGILLITE: (40'-50') Gray to dark gray argillite, moderately calcareous, calcite filling in fractures at 46.25', 47', and 48.5'			
44				0.0				
46			(45'-50') (92%) EX-CELLENT	0.0				
48				0.0				
50			(50'-55') (97%) EX-CELLENT	0.0	ARGILLITE: (50'-60') Gray to blue gray argillite, thinly bedded, moderately calcareous, calcite filling in fracture, trace pyrite within fracture at 54.5', interbedded dark gray siltstone at 59.5'-60', vertical fracture at 55'-59', 30 degree fracture at 59.25'			
52								
54				0.0				
56			(55'-60') (72%) FAIR	0.0				
58				0.0				
60				0.0	ARGILLITE: (60'-65') Blue gray to dark gray argillite with interbedded dark gray siltstone, moderately calcareous, calcite filling in fractures, trace pyrite within fractures, horizontal fractures at 61', 62', 63.5', and 64.5'			
62			(60'-65') (89%) GOOD					
64								
66			(65'-70') (90%) GOOD		ARGILLITE: (65'-70') Blue gray to dark gray argillite with interbedded dark gray siltstone, moderately calcareous, calcite filling in fractures, trace pyrite within fractures, horizontal fractures at 67', 68', and 69'			
68				0.0				
70				0.0				
72			(70'-75') (95%) EX-CELLENT		ARGILLITE: (70'-80') Blue gray argillite, moderately calcareous, calcite and iron staining within fractures, 20 degree fracture at 73', 60 degree fracture at 74.5'			
74				0.0				
76			(75'-80') (100%) EX-CELLENT	0.0				
78								
80				0.0				

General Comments:
bgs - below ground surface
ppm - parts per million
RQD - Rock Quality Designation

Symbol Key:
Apparent Water Level
Lab Sample Location

ROCK CORING LOG

RC-1

Groundwater and Environmental Services, Inc.

PROJECT:	**GTAC Nockamixon TCE Site**	CASING ELEVATION:	**NA**	TOTAL DEPTH:	**150 feet**
ADDRESS:	**77 Brennan Road**	BOREHOLE DIAMETER:	**4"**	WATER DEPTH:	**NA**
	Nockamixon, PA	WELL DIAMETER:	**NA**		

Logged By:	**Daniel Sivco**	Drilling Method:	**Split spoon/Rock Core**
Dates Drilled:	**10/26/-11/2/2022**	Sampling Method:	**Split Spoon (140 lb hammer, 30" drop)**
Drilling Company:	**Eichelbergers, Inc.**	Soil Class. System:	**USCS**
Drill Rig Type:	**Deitrich D-50**	Field Screening:	**PID 11.7 eV Lamp (ppm)**

Depth (feet)	N-Value	Blow Counts	RQD	Field Screening (ppm)	SAMPLE LITHOLOGY (USCS)	Stratigraphy	Comments	COMPLETION DETAILS
82			(80'-85') (93%) EX-CELLENT	0.0	ARGILLITE: (80'-85') SAA, vertical fracture from 81.25'-81.75', 10 degree fractures at 83.75' and 84.25', weathered argillite at 10 degree fractures			
84				0.0				
86			(85'-90') (58%) FAIR	0.0	ARGILLITE: (85'-90') Gray to blue gray argillite, thinly bedded, calcite filling in horizontal fractures at 86', 87', 87.75', heavily fractured at 88.5'-90'			
88				0.0				
90				0.0				
92			(90'-95') (95%) EX-CELLENT	0.0	ARGILLITE: (90'-95') Blue gray argillite, calcareous, thinly bedded, calcite filling in fractures, horizontal fracture at 90.5', 20 degree fracture at 91.5'			
94				0.0				
96			(95'-100') (93%) EX-CELLENT	0.0	ARGILLITE: (95'-109.5') Blue gray argillite, moderately calcareous, thinly bedded, calcite and iron staining in fractures, 10 degree fracture at 96.25', 55 degree fracture at 97.5', horizontal fractures at 100.5', 103.5', and 104'			
98				0.0				
100			(100'-105') (100%) EX-CELLENT					
102								
104								
106			(105'-110') (83%) GOOD					
108								
110			(110'-115') (89%) GOOD		SILTSTONE: (109.5'-111') Red brown siltstone, trace fine-grained pyrite	SILTSTONE		
112				0.0	ARGILLITE: (111'-120') Dark gray to blue gray argillite, moderately calcareous, thinly bedded, calcite and iron staining in fractures, 25 degree fracture at 111.5', 70 degree fracture at 114.5', vertical frature at 116'	ARGILLITE		
114								
116			(115'-120') (89%) GOOD	0.0				
118				0.0				
120				0.0				

General Comments:
bgs - below ground surface
ppm - parts per million
RQD - Rock Quality Designation

Symbol Key:
Apparent Water Level
Lab Sample Location

ROCK CORING LOG

RC-1

Groundwater and Environmental Services, Inc.

PROJECT:	GTAC Nockamixon TCE Site	CASING ELEVATION:	NA	TOTAL DEPTH:	150 feet
ADDRESS:	77 Brennan Road	BOREHOLE DIAMETER:	4"	WATER DEPTH:	NA
	Nockamixon, PA	WELL DIAMETER:	NA		

Logged By:	Daniel Sivco	Drilling Method:	Split spoon/Rock Core
Dates Drilled:	10/26/-11/2/2022	Sampling Method:	Split Spoon (140 lb hammer, 30" drop)
Drilling Company:	Eichelbergers, Inc.	Soil Class. System:	USCS
Drill Rig Type:	Deitrich D-50	Field Screening:	PID 11.7 eV Lamp (ppm)

Depth (feet)	N-Value	Blow Counts	RQD	Field Screening (ppm)	SAMPLE LITHOLOGY (USCS)	Stratigraphy	Comments	COMPLETION DETAILS
122			(120'-125') (95%) EX-CELLENT	0.0	ARGILLITE: (120'-125') Gray to blue gray argillite, thinly bedded, calcite and fine-grained pyrite in fractures at 120.5', 30 degree frature at 124'			
124				0.0				
126			(125'-130') (100%) EX-CELLENT		ARGILLITE: (125'-141.25') Blue gray argillite, thinly bedded, moderately calcareous, calcite within bedding planes, 75 degree fracture at 130.5'-132.75' with calcite and pyrite within fracture, vertical fracture at 135.5', 75 degree frature at 138.25'-139.25'			
128								
130			(130'-135') (56%) FAIR					
132				0.0				
134				0.0				
136			(135'-140') (83%) GOOD	0.0				
138				0.0				
140								
142			(140'-145') (97%) EX-CELLENT	0.0	SHALE: (141.25'-150') Red brown shale, slightly calcareous, trace calcite, 15 degree fracture at 148'	SHALE		
144				0.0				
146			(145'-150') (97%) EX-CELLENT				Boring terminated at 150' bgs	
148				0.0				
150								

General Comments:
bgs - below ground surface
ppm - parts per million
RQD - Rock Quality Designation

Symbol Key:
Apparent Water Level
Lab Sample Location

ROCK CORING LOG

RC-2

Groundwater and Environmental Services, Inc.

PROJECT:	GTAC Nockamixon TCE Site	CASING ELEVATION:	NA	TOTAL DEPTH:	250 feet
ADDRESS:	77 Brennan Road	BOREHOLE DIAMETER:	4"	WATER DEPTH:	NA
	Nockamixon, PA	WELL DIAMETER:	NA		

Logged By:	Daniel Sivco, Brian Hale	Drilling Method:	Split spoon/Rock Core
Dates Drilled:	11/3-11/16/2022	Sampling Method:	Split Spoon (140 lb hammer, 30" drop)
Drilling Company:	Eichelbergers, Inc.	Soil Class. System:	USCS
Drill Rig Type:	Deitrich D-50	Field Screening:	PID 11.7 eV Lamp (ppm)

Depth (feet)	N-Value	Blow Counts	RQD	Field Screening (ppm)	SAMPLE LITHOLOGY (USCS)	Stratigraphy	Comments	COMPLETION DETAILS
0					TOPSOIL: (0-0.5') Topsoil	TOPSOIL	Split spoon refusal at 5.3' bgs	Boring completed with temporary steel stick-up casing with bentonite seal to 5' bgs
2	5	1,2,3,7		0.0	ML: (0.5'-5.0') Light brown silt with clay, few to some weathered argillite fragments, moist, loose	ML		
4	48	13,25,23,28		0.0				
6	>50	28,25,50/3"	(5'-10') (58%) FAIR	0.0	WEATHERED ARGILLITE: (5'-9') Weathered argillite, heavily fractured with seams of silt and clay	WEATHERED ARGILLITE	Rock core between 5'-250' bgs	
8				0.0	ARGILLITE: (9'-10') Argillite, competent	ARGILLITE		
10			(10'-15') (87%) GOOD	0.0	ARGILLITE: (10'-25') Blue gray argillite, thinly bedded, moderately calcareous with several horizontal fractures, 55 degree fracture at 12.5'-13', fracture partially filled in with brown silt and clay at 16.5'-17.25', 20 degree fracture at 22.75'			Open rock boring from 5' to 250' bgs
12				0.0				
14			(15'-20') (93%) EX-CELLENT	0.0				
16				0.0				
18				0.0				
20			(20'-25') (95%) EX-CELLENT	0.0				
22				0.0				
24				0.0				
26			(25'-30') (95%) EX-CELLENT	0.0	ARGILLITE: (25-35') Gray to blue gray argillite, thinly bedded, moderately calcareous, horizontal fractures at 27.25' and 28.75', calcite and trace iron staining within fractures, near vertical fracture from 32'-34' with trace silt and clay			
28				0.0				
30			(30'-35') (81%) GOOD	0.0				
32				0.0				
34				0.0				
36			(35'-40') (92%) EX-CELLENT	0.0	ARGILLITE: (35'-40') Gray to blue gray argillite, thinly bedded, moderately calcareous, pyrite and calcite within foliations at 36.5', 75 degree fracture at 37'-38.5			
38				0.0				
40								

General Comments:
bgs - below ground surface
ppm - parts per million
RQD - Rock Quality Designation

Symbol Key:
Apparent Water Level
Lab Sample Location

ROCK CORING LOG

RC-2

Groundwater and Environmental Services, Inc.

PROJECT:	GTAC Nockamixon TCE Site	CASING ELEVATION:	NA	TOTAL DEPTH:	250 feet
ADDRESS:	77 Brennan Road	BOREHOLE DIAMETER:	4"	WATER DEPTH:	NA
	Nockamixon, PA	WELL DIAMETER:	NA		

Logged By:	Daniel Sivco, Brian Hale	Drilling Method:	Split spoon/Rock Core
Dates Drilled:	11/3-11/16/2022	Sampling Method:	Split Spoon (140 lb hammer, 30" drop)
Drilling Company:	Eichelbergers, Inc.	Soil Class. System:	USCS
Drill Rig Type:	Deitrich D-50	Field Screening:	PID 11.7 eV Lamp (ppm)

Depth (feet)	N-Value	Blow Counts	RQD	Field Screening (ppm)	SAMPLE LITHOLOGY (USCS)	Stratigraphy	Comments	COMPLETION DETAILS
42			(40'-45') (86%) GOOD		ARGILLITE: (40'-45') Blue gray to dark gray argillite with interbedded dark gray siltstone, moderately calcareous, thinly bedded, calcite within bedding plane			
44								
46			(45'-50') (97%) EX-CELLENT	0.0	SILTSTONE: (45'-50.25') Dark gray siltstone with interbedded argillite, thinly bedded, calcite within bedding planes, horizontal fractures	SILTSONE		
48				0.0				
50			(50'-55') (95%) EX-CELLENT	0.0	ARGILLITE: (50.25'-60') Gray to blue gray argillite, thinly bedded, moderately calcareous, calcite and pyrite observed within foliations, 60 degree fracture at 54' with trace clay within fracture	ARGILLITE		
52								
54				0.0				
56			(55'-60') (100%) EX-CELLENT					
58								
60				0.0				
62			(60'-65') (84%) GOOD	0.0	ARGILLITE: (60'-65') Blue gray to dark gray argillite with interbedded siltstone, thinly bedded, moderately calcareous, horizontal fractures, slightly fissile at 64.5'			
64				0.0				
66			(65'-70') (97%) EX-CELLENT		SILTSTONE: (65'-70') Dark gray siltstone with interbedded argillite, moderately calcareous, dark gray shale at 69.75'-70'	SILTSTONE		
68				0.0				
70			(70'-75') (100%) EX-CELLENT	0.0	ARGILLITE: (70'-80') Blue gray argillite, thinly bedded, calcite within bedding planes, moderately calcareous	ARGILLITE		
72								
74				0.0				
76			(75'-80') (99%) EX-CELLENT					
78				0.0				
80								

General Comments:
bgs - below ground surface
ppm - parts per million
RQD - Rock Quality Designation

Symbol Key:
Apparent Water Level
Lab Sample Location

ROCK CORING LOG

RC-2

Groundwater and Environmental Services, Inc.

PROJECT:	GTAC Nockamixon TCE Site	CASING ELEVATION:	NA	TOTAL DEPTH:	250 feet
ADDRESS:	77 Brennan Road	BOREHOLE DIAMETER:	4"	WATER DEPTH:	NA
	Nockamixon, PA	WELL DIAMETER:	NA		

Logged By:	Daniel Sivco, Brian Hale	Drilling Method:	Split spoon/Rock Core
Dates Drilled:	11/3-11/16/2022	Sampling Method:	Split Spoon (140 lb hammer, 30" drop)
Drilling Company:	Eichelbergers, Inc.	Soil Class. System:	USCS
Drill Rig Type:	Deitrich D-50	Field Screening:	PID 11.7 eV Lamp (ppm)

Depth (feet)	N-Value	Blow Counts	RQD	Field Screening (ppm)	SAMPLE LITHOLOGY (USCS)	Stratigraphy	Comments	COMPLETION DETAILS
82			(80'-85') (100%) EX-CELLENT	0.0	ARGILLITE: (80'-90') Blue gray argillite, thinly bedded, calcite within bedding planes, moderately calcareous, 80 degree fracture at 88.25'-90'			
84								
86			(85'-90') (77%) GOOD	0.0				
88				0.0				
90				0.0				
92			(90'-95') (83%) GOOD	0.0	ARGILLITE: (90'-95') Gray to blue gray argillite, heavily fractured at 90'-90.5', oblique fraacture at 94'			
94				0.0				
96			(95'-100') (97%) EX-CELLENT		ARGILLITE: (95'-100') Gray to blue gray argillite, moderately calcareous, thinly bedded, 80 degree fracture at 95'-96'			
98								
100				0.0				
102			(100'-105') (73%) FAIR	0.0	ARGILLITE: (100'-105') Blue gray argillite, thinly bedded, heavily fractured, 70 degree fracture at 101'-101.5', vertical fracture at 103'			
104				0.0				
106			(105'-110') (92%) EX-CELLENT	0.0	ARGILLITE: (105'-120') Blue gray argillite, thinly bedded, calcareous, vertical fracture at 105.5', 70 degree fracture at 109' and 116', calcite vein at 119' with pyrite			
108								
110			(110'-115') (100%) EX-CELLENT	0.0				
112				0.0				
114								
116			(115'-120') (100%) EX-CELLENT	0.0				
118				0.0				
120				0.0				

General Comments:
bgs - below ground surface
ppm - parts per million
RQD - Rock Quality Designation

Symbol Key:
Apparent Water Level
Lab Sample Location

ROCK CORING LOG

RC-2

Groundwater and Environmental Services, Inc.

PROJECT:	GTAC Nockamixon TCE Site	CASING ELEVATION:	NA	TOTAL DEPTH:	250 feet
ADDRESS:	77 Brennan Road	BOREHOLE DIAMETER:	4"	WATER DEPTH:	NA
	Nockamixon, PA	WELL DIAMETER:	NA		

Logged By:	Daniel Sivco, Brian Hale	Drilling Method:	Split spoon/Rock Core
Dates Drilled:	11/3-11/16/2022	Sampling Method:	Split Spoon (140 lb hammer, 30" drop)
Drilling Company:	Eichelbergers, Inc.	Soil Class. System:	USCS
Drill Rig Type:	Deitrich D-50	Field Screening:	PID 11.7 eV Lamp (ppm)

Depth (feet)	N-Value	Blow Counts	RQD	Field Screening (ppm)	SAMPLE LITHOLOGY (USCS)	Stratigraphy	Comments	COMPLETION DETAILS
122			(120'-125') (96%) EX-CELLENT	0.0 0.0	ARGILLITE: (120'-125') Blue gray argillite, thinly bedded, calcareous, calcite vein at 121' with pyrite			
124				0.0				
126			(125'-130') (100%) EX-CELLENT		ARGILLITE: (125'-135') Blue gray argillite, thinly bedded, oblique proto-fractures with calcite at 127.5'-128' and 131'-133'			
128								
130			(130'-135') (100%) EX-CELLENT					
132								
134				0.0				
136			(135'-140') (95%) EX-CELLENT		ARGILLITE: (135'-140') Blue gray to dark gray argillite, moderately calcareous, few interbedded siltstone layers, oblique proto-fracture with calcite at 139'			
138								
140				0.0				
142			(140'-145') (94%) EX-CELLENT	0.0	ARGILLITE: (140'-145.5') Blue gray argillite, calcareous, thinly bedded, 70 degree fracture at 143'			
144				0.0				
146			(145'-150') (95%) EX-CELLENT	0.0	ARGILLITE: (145.5'-155') Red brown argillite, slightly calcareous, thinly bedded, 35 degree fracture at 152'			
148								
150			(150'-155') (98%) EX-CELLENT					
152				0.0				
154				0.0 0.0				
156			(155'-160') (93%) EX-CELLENT		SHALE: (155'-160') Red brown shale, slightly calcareous, fissile, thinly bedded with horizontal fractures	**SHALE**		
158				0.0 0.0				
160								

General Comments:
bgs - below ground surface
ppm - parts per million
RQD - Rock Quality Designation

Symbol Key:
Apparent Water Level
Lab Sample Location

ROCK CORING LOG

RC-2

Groundwater and Environmental Services, Inc.

PROJECT:	GTAC Nockamixon TCE Site	CASING ELEVATION:	NA	TOTAL DEPTH:	250 feet
ADDRESS:	77 Brennan Road	BOREHOLE DIAMETER:	4"	WATER DEPTH:	NA
	Nockamixon, PA	WELL DIAMETER:	NA		

Logged By:	Daniel Sivco, Brian Hale	Drilling Method:	Split spoon/Rock Core
Dates Drilled:	11/3-11/16/2022	Sampling Method:	Split Spoon (140 lb hammer, 30" drop)
Drilling Company:	Eichelbergers, Inc.	Soil Class. System:	USCS
Drill Rig Type:	Deitrich D-50	Field Screening:	PID 11.7 eV Lamp (ppm)

Depth (feet)	N-Value	Blow Counts	RQD	Field Screening (ppm)	SAMPLE LITHOLOGY (USCS)	Stratigraphy	Comments	COMPLETION DETAILS
162			(160'-165') (83%) GOOD	0.0	SHALE: (160'-170') Red brown shale, slightly calcareous, fissile, thinly bedded with horizontal fractures, 70 degree frcture at 163'			
164				0.0				
166			(165'-170') (80%) GOOD					
168								
170				0.0				
172			(170'-175') (92%) EX-CELLENT		ARGILLITE: (170'-180') Red brown argillite with horizontal fractures throughout	ARGILLITE		
174								
176			(175'-180') (98%) EX-CELLENT	0.0				
178				0.0				
180			(180'-185') (99%) EX-CELLENT		ARGILLITE: (180'-200') Red brown argillite with horizontal fractures throughout			
182								
184				0.1				
186			(185'-190') (92%) EX-CELLENT					
188				0.2				
190			(190'-195') (84%) GOOD					
192								
194				0.1				
196			(195'-200') (93%) EX-CELLENT					
198								
200								

General Comments:
bgs - below ground surface
ppm - parts per million
RQD - Rock Quality Designation

Symbol Key:
Apparent Water Level
Lab Sample Location

ROCK CORING LOG

RC-2

Groundwater and Environmental Services, Inc.

PROJECT:	GTAC Nockamixon TCE Site	CASING ELEVATION:	NA	TOTAL DEPTH:	250 feet
ADDRESS:	77 Brennan Road	BOREHOLE DIAMETER:	4"	WATER DEPTH:	NA
	Nockamixon, PA	WELL DIAMETER:	NA		

Logged By:	Daniel Sivco, Brian Hale	Drilling Method:	Split spoon/Rock Core
Dates Drilled:	11/3-11/16/2022	Sampling Method:	Split Spoon (140 lb hammer, 30" drop)
Drilling Company:	Eichelbergers, Inc.	Soil Class. System:	USCS
Drill Rig Type:	Deitrich D-50	Field Screening:	PID 11.7 eV Lamp (ppm)

Depth (feet)	N-Value	Blow Counts	RQD	Field Screening (ppm)	SAMPLE LITHOLOGY (USCS)	Stratigraphy	Comments	COMPLETION DETAILS
202			(200'-205') (100%) EX-CELLENT		ARGILLITE: (200'-205') Red brown argillite with horizontal fractures throughout			
204								
206			(205'-210') (98%) EX-CELLENT	0.0	ARGILLITE: (205'-220') Red brown argillite, thinly bedded, slightly calcareous with horizontal fractures throughout, 30 degree fracture at 218'			
208				0.0				
210			(210'-215') (100%) EX-CELLENT	0.0				
212				0.0				
214				0.0				
216			(215'-220') (100%) EX-CELLENT					
218								
220			(220'-225') (100%) EX-CELLENT		SHALE: (220'-221.5') Red brown to purple shale, slightly calcareous, thinly bedded	SHALE		
222					ARGILLITE: (221.5'-231') Red brown argillite, thinly bedded, slightly calcareous, oblique calcite vein at 221.5'-223'	ARGILLITE		
224								
226			(225'-230') (100%) EX-CELLENT					
228								
230			(230'-235') (97%) EX-CELLENT					
232					ARGILLITE: (231'-240') Gray to blue gray argillite, thinly bedded, moderately calcareous, few horizontal fractures			
234								
236			(235'-240') (93%) EX-CELLENT	0.0				
238				0.0				
240					ARGILLITE: (240'-241.25') Gray to blue gray argillite, thinly bedded,			

General Comments:
bgs - below ground surface
ppm - parts per million
RQD - Rock Quality Designation

Symbol Key:
Apparent Water Level
Lab Sample Location

ROCK CORING LOG

RC-2

Groundwater and Environmental Services, Inc.

PROJECT:	GTAC Nockamixon TCE Site	CASING ELEVATION:	NA	TOTAL DEPTH:	250 feet
ADDRESS:	77 Brennan Road	BOREHOLE DIAMETER:	4"	WATER DEPTH:	NA
	Nockamixon, PA	WELL DIAMETER:	NA		

Logged By:	Daniel Sivco, Brian Hale	Drilling Method:	Split spoon/Rock Core
Dates Drilled:	11/3-11/16/2022	Sampling Method:	Split Spoon (140 lb hammer, 30" drop)
Drilling Company:	Eichelbergers, Inc.	Soil Class. System:	USCS
Drill Rig Type:	Deitrich D-50	Field Screening:	PID 11.7 eV Lamp (ppm)

Depth (feet)	N-Value	Blow Counts	RQD	Field Screening (ppm)	SAMPLE LITHOLOGY (USCS)	Stratigraphy	Comments	COMPLETION DETAILS
242			(240'-245') (100%) EX-CELLENT		moderately calcareous ARGILLITE: (241.25'-245') Gray to red brown argillite, moderately calcareous, fine-grained pyrite along bedding planes			
244								
246			(245'-250') (100%) EX-CELLENT	0.0	ARGILLITE: (245'-250') Blue gray argillite, thinly bedded, fine-grained calcite in fracture at 246.25'		Boring terminated at 250' bgs	
248								
250								

General Comments:
bgs - below ground surface
ppm - parts per million
RQD - Rock Quality Designation

Symbol Key:
Apparent Water Level
Lab Sample Location

Photo 1. Cores of Boring RC-1

Photo 2. Cores of Boring RC-2

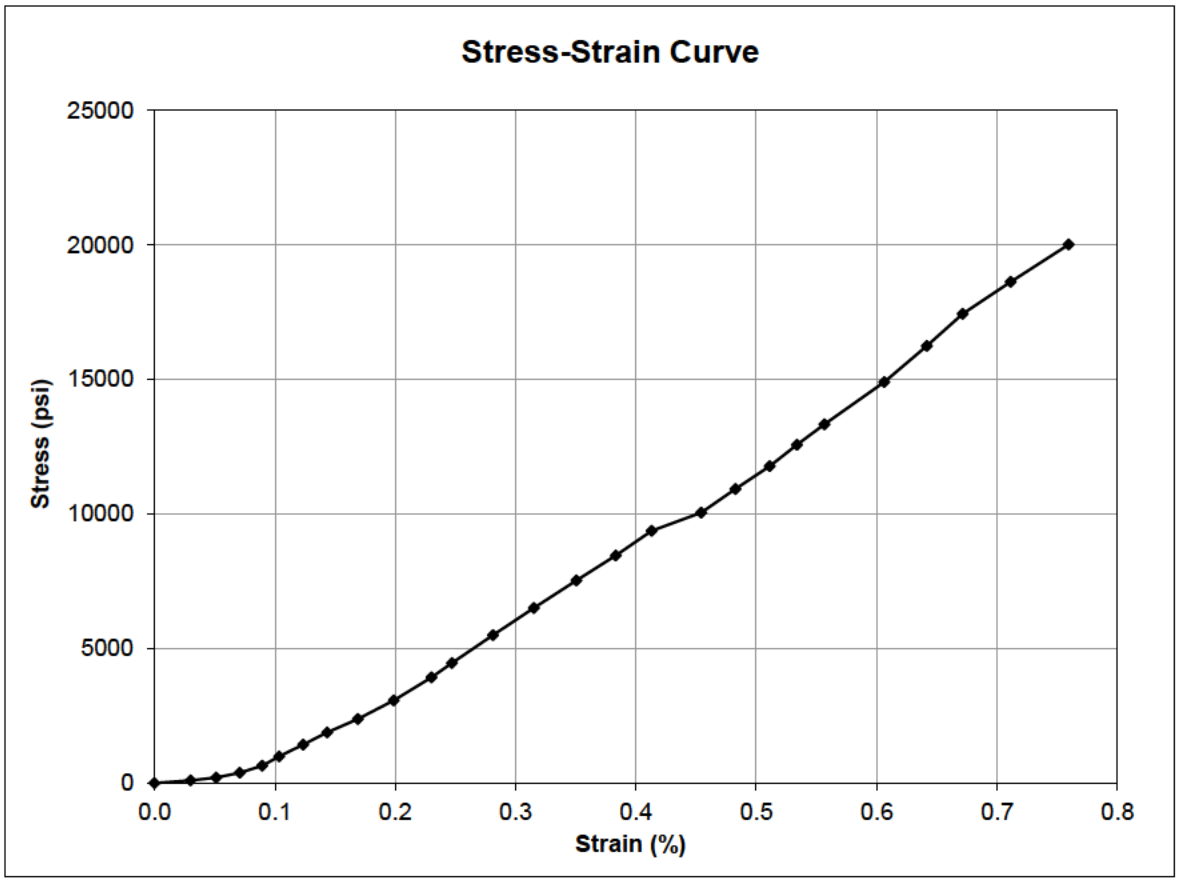
GeoStructures

ROCK CORE BOX PHOTO

GTAC - NOCKAMIXON TCE SITE
NOCKAMIXON TWP., BUCKS CO., PA

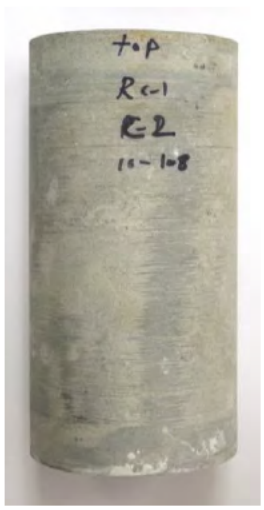
Appendix B
Laboratory Testing Results

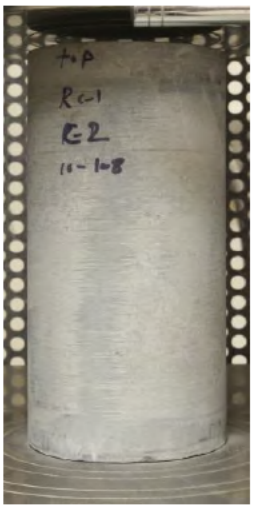
ROCK UNCONFINED COMPRESSION TEST REPORT
(ASTM D7012)



ID / Run	Depth	Diameter (in.)	Height (in.)	Unit weight (pcf)	Compressive Strength (psi)
RC-1 / C-2	10.0 - 10.8	3.32	7.04	162.2	20,014

Photos:





GeoStructures

GTAC - Nockamixon TCE Site, Nockamixon Twp., Bucks Co., PA

GeoStructures Project No.: G23-101

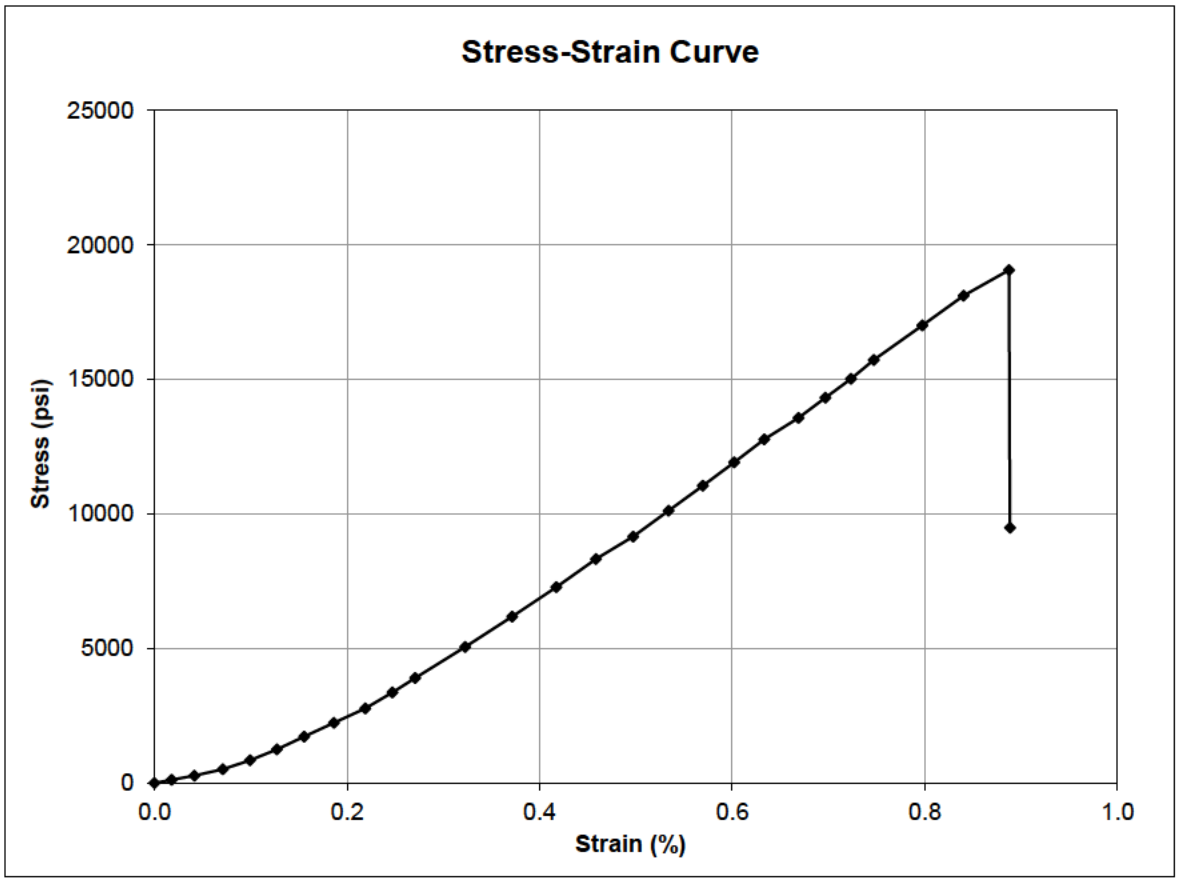
1/9/2023

Ph. 610.265.1818
Fax 610.265.1833

GeoStructures, Inc
1000 West 9th Ave., King of Prussia, PA 19406

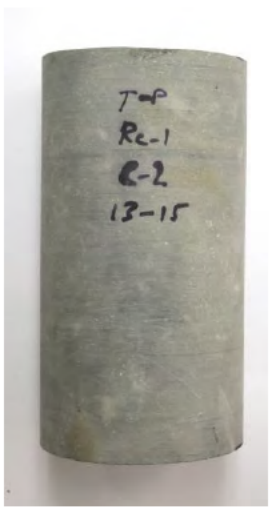
www.geostructures.net

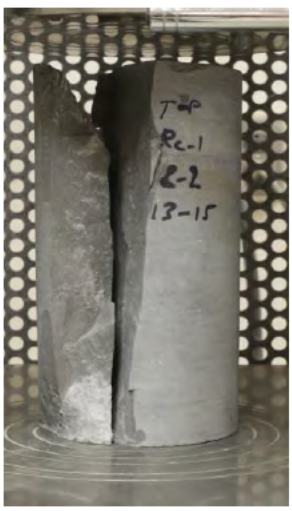
ROCK UNCONFINED COMPRESSION TEST REPORT
(ASTM D7012)



ID / Run	Depth	Diameter (in.)	Height (in.)	Unit weight (pcf)	Compressive Strength (psi)
RC-1 / C-2	13.0 - 15.0	3.32	6.76	165.3	19,066

Photos:





GeoStructures

GTAC - Nockamixon TCE Site, Nockamixon Twp., Bucks Co., PA

GeoStructures Project No.: G23-101

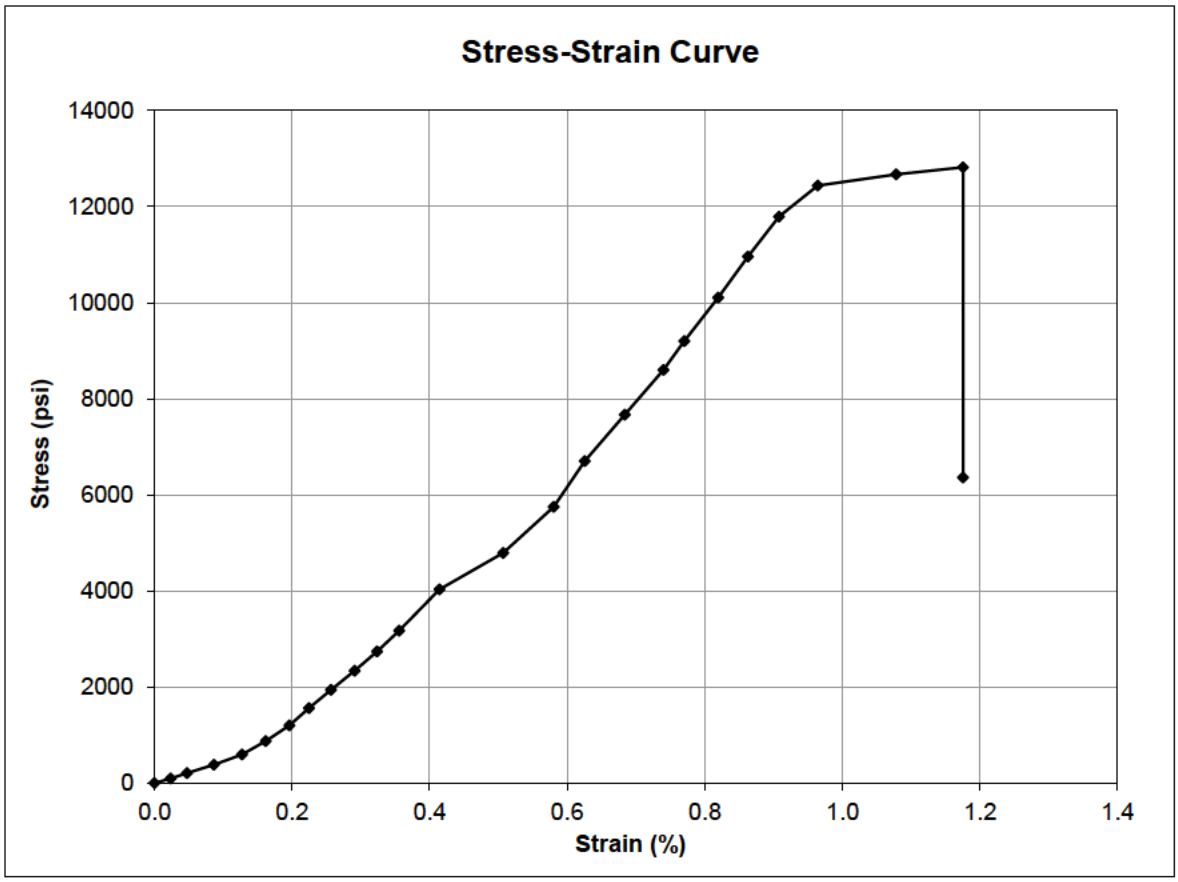
1/9/2023

Ph. 610.265.1818
Fax 610.265.1833

GeoStructures, Inc
1000 West 9th Ave., King of Prussia, PA 19406

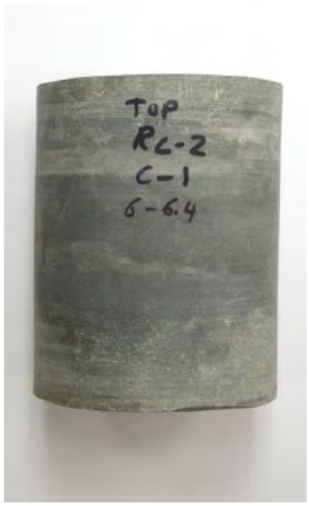
www.geostructures.net

ROCK UNCONFINED COMPRESSION TEST REPORT
(ASTM D7012)



ID / Run	Depth	Diameter (in.)	Height (in.)	Unit weight (pcf)	Corrected Compressive Strength (psi)
RC-2 / C-1	6.0 - 6.4	3.32	4.64	162.2	12,173

Photos:



GeoStructures

GTAC - Nockamixon TCE Site, Nockamixon Twp., Bucks Co., PA

GeoStructures Project No.: G23-101

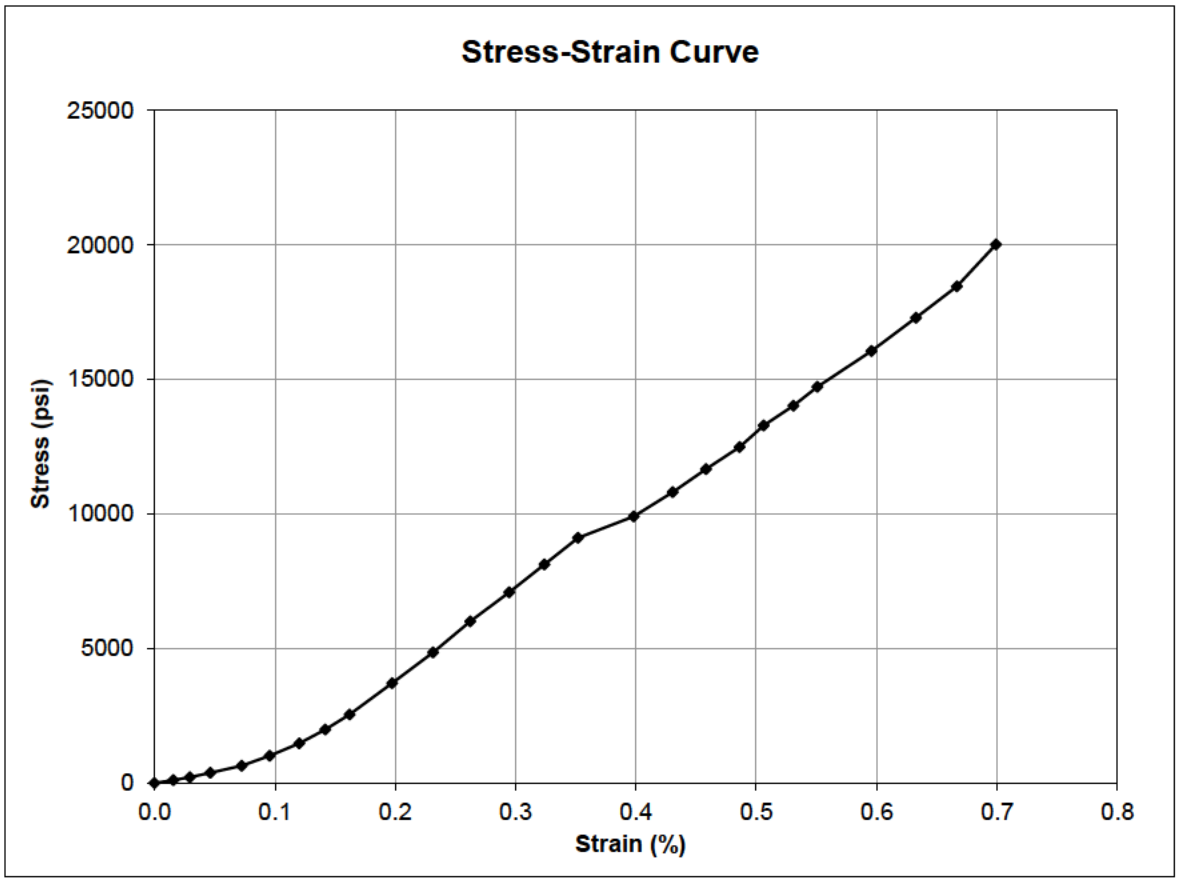
1/9/2023

Ph. 610.265.1818
Fax 610.265.1833

GeoStructures, Inc
1000 West 9th Ave., King of Prussia, PA 19406

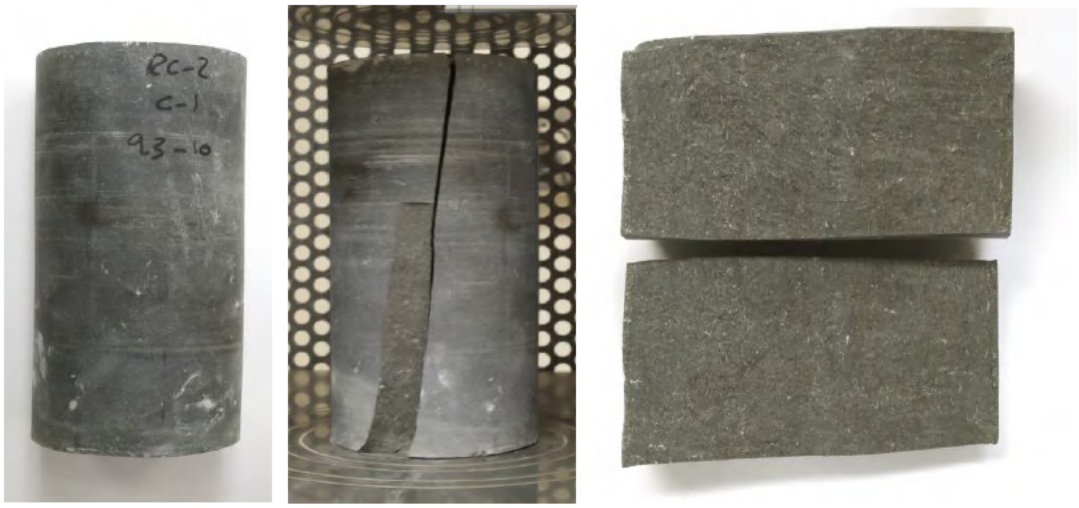
www.geostructures.net

ROCK UNCONFINED COMPRESSION TEST REPORT
(ASTM D7012)



ID / Run	Depth	Diameter (in.)	Height (in.)	Unit weight (pcf)	Compressive Strength (psi)
RC-2 / C-1	9.3 - 10.0	3.32	6.48	169.5	20,013

Photos:



GeoStructures

GTAC - Nockamixon TCE Site, Nockamixon Twp., Bucks Co., PA

GeoStructures Project No.: G23-101

1/6/2023

Ph. 610.265.1818
Fax 610.265.1833

GeoStructures, Inc
1000 West 9th Ave., King of Prussia, PA 19406

www.geostructures.net

Appendix D – Waste Disposal Documentation

NON-HAZARDOUS WASTE MANIFEST

1. Generator ID Number

2. Page 1 of: 1

3. Emergency Response Phone: 800-258-5585

4. Waste Tracking Number: 0008447

5. Generator's Name and Mailing Address
Pennsylvania Department of Environmental Protection
77 Brennan Road
Ottsville, PA 18942
Generator's Phone: 484-250-5723

Generator's Site Address (if different than mailing address): SAME

6. Transporter 1 Company Name: Lewis Environmental, Inc.
U.S. EPA ID Number: PAD987378940

7. Transporter 2 Company Name
U.S. EPA ID Number

8. Designated Facility Name and Site Address
VLS Lancaster, LLC
1076 Old Manheim Pike
Lancaster, PA 17601
Facility's Phone: 717-393-2627
U.S. EPA ID Number: PAD987266749

	9. Waste Shipping Name and Description	10. Containers No.	10. Containers Type	11. Total Quantity	12. Unit Wt./Vol.
1.	Non RCRA/DOT Liquids (Groundwater)	15	DM	775	G
2.					
3.					
4.					

13. Special Handling Instructions and Additional Information

1) 2212-05400-LPT

30057PL

14. GENERATOR'S/OFFEROR'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged, marked and labeled/placarded, and are in all respects in proper condition for transport according to applicable international and national governmental regulations.

Generator's/Offeror's Printed/Typed Name: Christine McCarthy on behalf of DEP
Signature: Christine McCarthy
Month: 02 Day: 00 Year: 2023

INT'L

15. International Shipments ☐ Import to U.S. ☐ Export from U.S. Port of entry/exit:
Transporter Signature (for exports only): Date leaving U.S.

TRANSPORTER

16. Transporter Acknowledgment of Receipt of Materials

Transporter 1 Printed/Typed Name: Dylan Romano
Signature:
Month: 02 Day: 06 Year: 23

Transporter 2 Printed/Typed Name
Signature
Month Day Year

DESIGNATED FACILITY

17. Discrepancy

17a. Discrepancy Indication Space ☐ Quantity ☐ Type ☐ Residue ☐ Partial Rejection ☐ Full Rejection

Manifest Reference Number
U.S. EPA ID Number

17b. Alternate Facility (or Generator)

Facility's Phone
Month Day Year

17c. Signature of Alternate Facility (or Generator)

18. Designated Facility Owner or Operator: Certification of receipt of materials covered by the manifest except as noted in Item 17a

Printed/Typed Name
Signature
Month Day Year

DESIGNATED FACILITY TO GENERATOR

169-BLC-O 5 11977 (Rev. 9/09)

Published by J. J. KELLER & ASSOCIATES, INC.® Neenah, WI • USA • (800) 327-6868 • www.jjkeller.com • Printed in the United States

NON-HAZARDOUS WASTE MANIFEST

1. Generator ID Number

2. Page 1 of: 1

3. Emergency Response Phone: 800-258-5585

4. Waste Tracking Number: 0008448

5. Generator's Name and Mailing Address: Pennsylvania Department of Environmental Protection, 77 Brennan Road, Ottsville, PA 18942

Generator's Site Address (if different than mailing address): SAME

Generator's Phone: 484-250-5723

6. Transporter 1 Company Name: Lewis Environmental, Inc.

U.S. EPA ID Number: PAD987378940

7. Transporter 2 Company Name

U.S. EPA ID Number

8. Designated Facility Name and Site Address: VLS Lancaster, LLC, 1076 Old Manheim Pike, Lancaster, PA 17601

U.S. EPA ID Number: PAD987266749

Facility's Phone: 717-393-2627

	9. Waste Shipping Name and Description	10. Containers No	10. Containers Type	11. Total Quantity	12. Unit Wt./Vol.	
1.	Non RCRA/DOT Liquids (Groundwater)	15	DM	775	G	
2.						
3.						
4.						

13. Special Handling Instructions and Additional Information

1) 2212-05400-LPT

30057PL

14. GENERATOR'S/OFFEROR'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged, marked and labeled/placarded, and are in all respects in proper condition for transport according to applicable international and national governmental regulations.

Generator's/Offeror's Printed/Typed Name: Christine McCarthy on behalf of DEP

Signature: Christine McCarthy

Month: 02 Day: 06 Year: 2023

INTERNATIONAL SHIPMENTS

15. International Shipments: ☐ Import to U.S. ☐ Export from U.S. Port of entry/exit:

Transporter Signature (for exports only): Date leaving U.S.

TRANSPORTER

16. Transporter Acknowledgment of Receipt of Materials

Transporter 1 Printed/Typed Name: Mark Berg

Signature

Month: 02 Day: 06 Year: 2023

Transporter 2 Printed/Typed Name

Signature

Month Day Year

DESIGNATED FACILITY

17. Discrepancy

17a. Discrepancy Indication Space: ☐ Quantity ☐ Type ☐ Residue ☐ Partial Rejection ☐ Full Rejection

Manifest Reference Number:

U.S. EPA ID Number

17b. Alternate Facility (or Generator)

Facility's Phone:

Month Day Year

17c. Signature of Alternate Facility (or Generator)

18. Designated Facility Owner or Operator: Certification of receipt of materials covered by the manifest except as noted in Item 17a

Printed/Typed Name

Signature

Month Day Year

DESIGNATED FACILITY TO GENERATOR

169-BLC-O 5 11977 (Rev. 9/09)

Published by J.J. KELLER & ASSOCIATES, INC.® Neenah, WI • (800) 327-6868 • www.jjkeller.com • Printed in the United States

NON-HAZARDOUS WASTE MANIFEST

1. Generator ID Number

2. Page 1 of: 1

3. Emergency Response Phone: 800-258-5585

4. Waste Tracking Number: 0008450

5. Generator's Name and Mailing Address

Pennsylvania Department of Environmental Protection
77 Brennan Road
Ottsville, PA 18942

Generator's Phone: 484-250-5723

Generator's Site Address (if different than mailing address): SAME

6. Transporter 1 Company Name: Lewis Environmental, Inc

U.S. EPA ID Number: PAD987378940

7. Transporter 2 Company Name

U.S. EPA ID Number

8. Designated Facility Name and Site Address

VLS Lancaster, LLC
1076 Old Manheim Pike
Lancaster, PA 17601

Facility's Phone: 717-393-2627

U.S. EPA ID Number: PAD987266749

	9. Waste Shipping Name and Description	10. Containers No.	Type	11. Total Quantity	12. Unit Wt./Vol.
1.	Non RCRA/DOT Liquids (Groundwater)	15	DM	775	G
2.					
3.					
4.					

13. Special Handling Instructions and Additional Information

1) 2212-05400-LPT

30057PL

14. GENERATOR'S/OFFEROR'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged, marked and labeled/placarded, and are in all respects in proper condition for transport according to applicable international and national governmental regulations.

Generator's/Offeror's Printed/Typed Name: Christine McCarthy on behalf of DEP

Signature: Christine McCarthy

Month: 02 Day: 06 Year: 2023

15. International Shipments: ☐ Import to U.S. ☐ Export from U.S. Port of entry/exit:

Transporter Signature (for exports only): Date leaving U.S.

16. Transporter Acknowledgment of Receipt of Materials

Transporter 1 Printed/Typed Name: Nick Berry

Signature:

Month: 02 Day: 06 Year: 2023

Transporter 2 Printed/Typed Name

Signature

Month Day Year

17. Discrepancy

17a. Discrepancy Indication Space: ☐ Quantity ☐ Type ☐ Residue ☐ Partial Rejection ☐ Full Rejection

Manifest Reference Number

17b. Alternate Facility (or Generator)

U.S. EPA ID Number

Facility's Phone

17c. Signature of Alternate Facility (or Generator)

Month Day Year

18. Designated Facility Owner or Operator: Certification of receipt of materials covered by this manifest except as noted in Item 17a

Printed/Typed Name

Signature

Month Day Year

GENERATOR | INT'L | TRANSPORTER | DESIGNATED FACILITY

Published by JJ KELLER & ASSOCIATES, INC.® Neenah, WI • (800) 327-6868 • www.jjkeller.com • Printed in the U.S.A.

89-BLC-O 5 11977 (Rev. 9/09)

DESIGNATED FACILITY TO GENERATOR

NON-HAZARDOUS WASTE MANIFEST

1. Generator ID Number:

2. Page 1 of: 1

3. Emergency Response Phone: 800-258-5585

4. Waste Tracking Number: 0008449

5. Generator's Name and Mailing Address:
Pennsylvania Department of Environmental Protection
77 Brennan Road
Ottsville, PA 18942

Generator's Site Address (if different than mailing address): SAME

Generator's Phone: 484-250-5723

6. Transporter 1 Company Name: Lewis Environmental, Inc.

U.S. EPA ID Number: PAD987378940

7. Transporter 2 Company Name:

U.S. EPA ID Number:

8. Designated Facility Name and Site Address:
VLS Lancaster, LLC
1076 Old Manheim Pike
Lancaster, PA 17601

U.S. EPA ID Number: PAD987266749

Facility's Phone: 717-393-2627

	9. Waste Shipping Name and Description	10. Containers No	10. Containers Type	11. Total Quantity	12. Unit Wt./Vol.
1	Non RCRA/DOT Liquids (Groundwater)	15	DM	775	G
2					
3.					
4					

GENERATOR

13. Special Handling Instructions and Additional Information:
1) 2212-05400-LPT
30057PL

14. GENERATOR'S/OFFEROR'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged, marked and labeled/placarded, and are in all respects in proper condition for transport according to applicable international and national governmental regulations.

Generator's/Offeror's Printed/Typed Name: Emily McCarthy on behalf of DEP
Signature: Emily McCarthy
Month: 02 Day: 00 Year: 2023

INTL

15. International Shipments: ☐ Import to U.S. ☐ Export from U.S. Port of entry/exit:
Transporter Signature (for exports only): Date leaving U.S.:

TRANSPORTER

16. Transporter Acknowledgment of Receipt of Materials

Transporter 1 Printed/Typed Name: Dylan Romano
Signature: Dylan Romano
Month: 02 Day: 06 Year: 23

Transporter 2 Printed/Typed Name:
Signature:
Month: Day: Year:

DESIGNATED FACILITY

17. Discrepancy

17a. Discrepancy Indication Space: ☐ Quantity ☐ Type ☐ Residue ☐ Partial Rejection ☐ Full Rejection

Manifest Reference Number:

17b. Alternate Facility (or Generator)

U.S. EPA ID Number:

Facility's Phone:

17c. Signature of Alternate Facility (or Generator)
Month: Day: Year:

18. Designated Facility Owner or Operator: Certification of receipt of materials covered by the manifest except as noted in Item 17a

Printed/Typed Name:
Signature:
Month: Day: Year:

169-BLC-O 5 11977 (Rev. 9/09)

DESIGNATED FACILITY TO GENERATOR

SCOTLAND INC.® Neenah, WI • USA • (800) 327 6868 • www.lxsiller.com • Printed in the United States

NON-HAZARDOUS WASTE MANIFEST

1. Generator ID Number

2. Page 1 of 1

3. Emergency Response Phone: 800-258-5585

4. Waste Tracking Number: 0008453

5. Generator's Name and Mailing Address: Pennsylvania Department of Environmental Protection, 77 Brennan Road, Ottsville, PA 18942

Generator's Site Address (if different than mailing address): SAME

Generator's Phone: 484-250-5723

6. Transporter 1 Company Name: Lewis Environmental, Inc.

U.S. EPA ID Number: PAD987378940

7. Transporter 2 Company Name

U.S. EPA ID Number

8. Designated Facility Name and Site Address: VLS Lancaster, LLC, 1076 Old Manheim Pike, Lancaster, PA 17601

Facility's Phone: 717-393-2627

U.S. EPA ID Number: PAD987266749

9. Waste Shipping Name and Description	10. Container(s) No.	10. Container(s) Type	11. Total Quantity	12. Unit Wt./Vol.
1. Non RCRA/DOT Liquids (Groundwater)	15	DM	778	G
2.				
3.				
4.				

13. Special Handling Instructions and Additional Information

1) 2212-05400-LPT

30057PL

14. GENERATOR'S/OFFEROR'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged, marked and labeled/placarded, and are in all respects in proper condition for transport according to applicable international and national governmental regulations.

Generator's/Offeror's Printed/Typed Name: Dustin A. Armstrong for DADEP

Signature: Dustin A. Armstrong

Month: 02 Day: 07 Year: 23

TRANSPORTER INT'L

15. International Shipments: ☐ Import to U.S. ☐ Export from U.S.

Transporter Signature (for exports only):

Port of entry/exit:

Date leaving U.S.:

16. Transporter Acknowledgment of Receipt of Materials

Transporter 1 Printed/Typed Name: Noah Bry

Signature

Month: 02 Day: 07 Year: 23

Transporter 2 Printed/Typed Name

Signature

Month Day Year

17. Discrepancy

17a. Discrepancy Indication Space: ☐ Quantity ☐ Type ☐ Residue ☐ Partial Rejection ☐ Full Rejection

Manifest Reference Number:

DESIGNATED FACILITY

17b. Alternate Facility (or Generator)

U.S. EPA ID Number

Facility's Phone:

17c. Signature of Alternate Facility (or Generator)

Month Day Year

18. Designated Facility Owner or Operator: Certification of receipt of materials covered by the manifest except as noted in Item 17a

Printed/Typed Name

Signature

Month Day Year

Published by J. J. KELLER & ASSOCIATES, INC.® Neenah, WI • USA • (800) 327-6868 • www.jjkeller.com • Printed in the United States

NON-HAZARDOUS WASTE MANIFEST

1. Generator ID Number

2. Page 1 of 1

3. Emergency Response Phone: 800-258-5585

4. Waste Tracking Number: 0008452

5. Generator's Name and Mailing Address: Pennsylvania Department of Environmental Protection, 77 Brennan Road, Ottsville, PA 18942

Generator's Site Address (if different than mailing address): SAME

Generator's Phone: 484-250-5723

6. Transporter 1 Company Name: Lewis Environmental, Inc.

U.S. EPA ID Number: PAD987378940

7. Transporter 2 Company Name

U.S. EPA ID Number

8. Designated Facility Name and Site Address: VLS Lancaster, LLC, 1076 Old Manheim Pike, Lancaster, PA 17601

U.S. EPA ID Number: PAD987266709

Facility's Phone: 717-393-2627

	9. Waste Shipping Name and Description	10. Containers No.	Type	11. Total Quantity	12. Unit Wt./Vol.
1	Non RCRA/DOT Liquids (Groundwater)	15	DM	775	G
2					
3					
4					

13. Special Handling Instructions and Additional Information

1) 2212-05400-LPT

30057PL

14. GENERATOR'S/OFFEROR'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged, marked and labeled/placarded, and are in all respects in proper condition for transport according to applicable international and national governmental regulations.

Generator's/Offeror's Printed/Typed Name: Ex-DADEP Dustin A. Armstrong

Signature

Month: 02 Day: 07 Year: 23

INTL

15. International Shipments ☐ Import to U.S. ☐ Export from U.S. Port of entry/exit:

Transporter Signature (for exports only): Date leaving U.S.:

TRANSPORTER

16. Transporter Acknowledgment of Receipt of Materials

Transporter 1 Printed/Typed Name: Dylan Romano

Signature

Month: 02 Day: 07 Year: 23

Transporter 2 Printed/Typed Name

Signature

Month Day Year

DESIGNATED FACILITY

17. Discrepancy

17a. Discrepancy Indication Space ☐ Quantity ☐ Type ☐ Residue ☐ Partial Rejection ☐ Full Rejection

Manifest Reference Number:

17b. Alternate Facility (or Generator)

U.S. EPA ID Number

Facility's Phone:

17c. Signature of Alternate Facility (or Generator)

Month Day Year

18. Designated Facility Owner or Operator: Certification of receipt of materials covered by the manifest except as noted in Item 17a

Printed/Typed Name

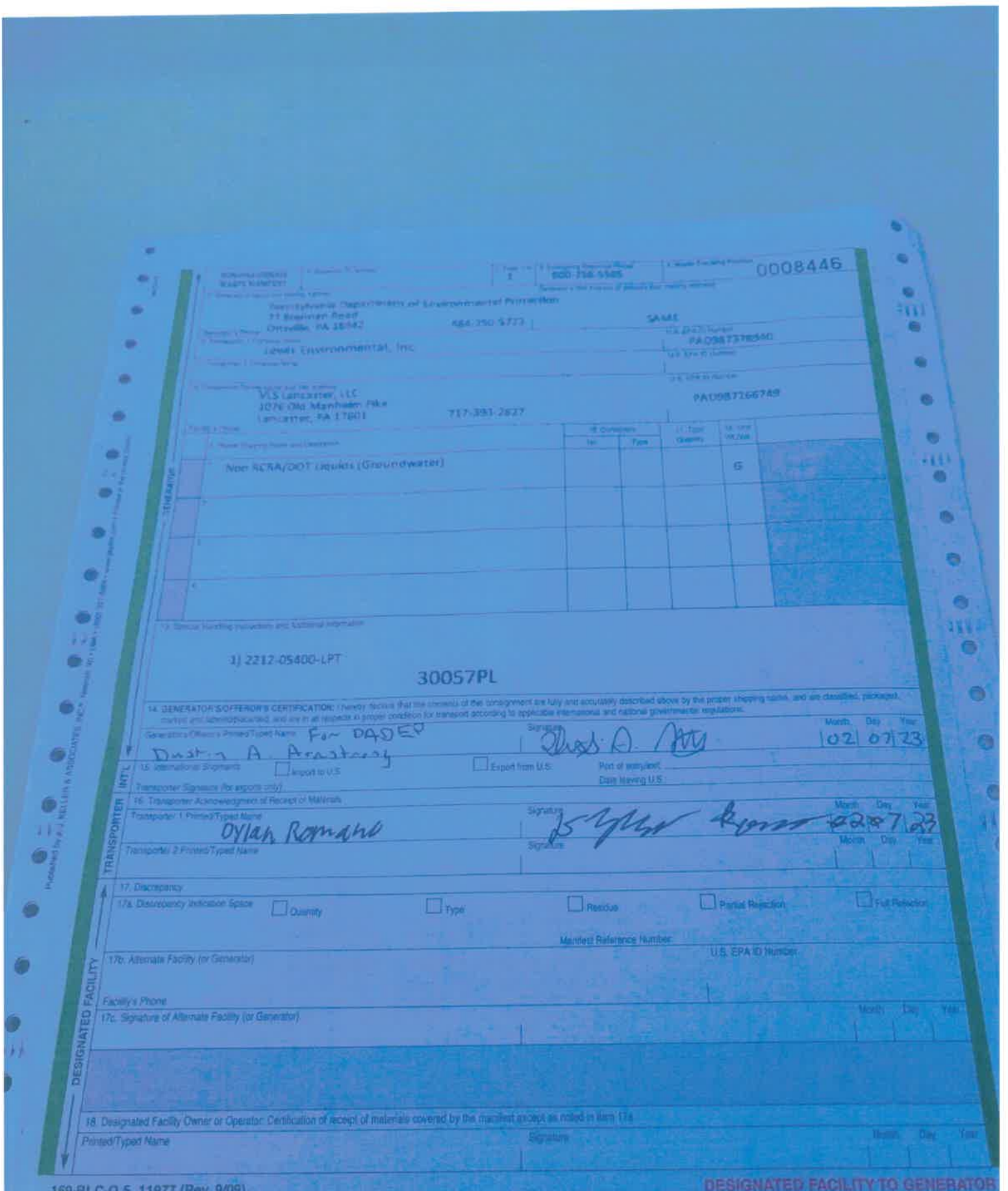
Signature

Month Day Year

169-BLC-O 5 11977 (Rev. 9/09)

DESIGNATED FACILITY TO GENERATOR

Published by J.J. KELLER & ASSOCIATES, INC.® Neenah, WI • 1-800-327-6868 • www.jjkeller.com • Printed in the United States



0008446

Pennsylvania Department of Environmental Protection
11 Bowman Road
Orrville, PA 18542
484-250-5777

SAME

Lewis Environmental, Inc

PAD987378540

VLS Lancaster, LLC
1076 Old Manheim Pike
Lancaster, PA 17601
717-391-2827

PAD087166749

8. Containers No.	Type	11. Total Quantity	12. Unit Wt./Vol.
			G

Non RCRA/DOT Liquids (Groundwater)

13. Special Handling Instructions and Additional Information

1) 2212-05400-LPT

30057PL

14. GENERATOR'S/OFFEROR'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged, marked and labeled/placarded, and are in all respects in proper condition for transport according to applicable international and national governmental regulations.

Generator's Offeror's Printed/Typed Name: For DADEP Dustin A. Armstrong

Signature: Dustin A. Armstrong

Month: 02 Day: 07 Year: 23

TRANSPORTER INT'L

15. International Shipments: ☐ Import to U.S. ☐ Export from U.S. Port of entry/exit:

Transporter Signature (for exports only): Date leaving U.S.:

16. Transporter Acknowledgment of Receipt of Materials

Transporter 1 Printed/Typed Name: Dylan Romano

Signature: Dylan Romano

Month: 02 Day: 07 Year: 23

Transporter 2 Printed/Typed Name

Signature

Month Day Year

DESIGNATED FACILITY

17. Discrepancy

17a. Discrepancy Indication Space: ☐ Quantity ☐ Type ☐ Residue ☐ Partial Rejection ☐ Full Rejection

Manifest Reference Number:

17b. Alternate Facility (or Generator)

U.S. EPA ID Number

Facility's Phone

17c. Signature of Alternate Facility (or Generator)

Month Day Year

18. Designated Facility Owner or Operator: Certification of receipt of materials covered by the manifest except as noted in Item 17a

Printed/Typed Name

Signature

Month Day Year

169-BLC-O 5 11977 (Rev. 9/09)

DESIGNATED FACILITY TO GENERATOR

NON-HAZARDOUS WASTE MANIFEST

1. Generator ID Number

2. Page 1 of 1

3. Emergency Response Phone: 800-258-5585

4. Waste Tracking Number: 0008445

5. Generator's Name and Mailing Address: Pennsylvania Department of Environmental Protection, 77 Brennan Road, Ottsville, PA 18942

Generator's Site Address (if different than mailing address): SAME

Generator's Phone: 484-250-5728

6. Transporter 1 Company Name: Lewis Environmental, Inc.

U.S. EPA ID Number: PAD987378940

7. Transporter 2 Company Name

U.S. EPA ID Number

8. Designated Facility Name and Site Address: VLS Lancaster, LLC, 1076 Old Manheim Pike, Lancaster, PA 17601

U.S. EPA ID Number: PAD987266749

Facility's Phone: 717-393-2627

	9. Waste Shipping Name and Description	10. Containers No.	10. Containers Type	11. Total Quantity	12. Unit Wt./Vol.
1	Non RCRA/DOT Solids (PPE)	10	DM	750	P
2	Non RCRA/DOT Liquids (Groundwater)				G
3	Non RCRA/DOT Solids (Soil)				P
4					

13. Special Handling Instructions and Additional Information

1) 2212-05401-SPT
2) 2212-05400-LPT
3) 2212-05399-SPT

30057PL

14. GENERATOR'S/OFFEROR'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged, marked and labeled/placarded, and are in all respects in proper condition for transport according to applicable international and national governmental regulations.

Generator's/Offeror's Printed/Typed Name: For PADEP Dustin A. Armstrong

Signature: [signature]

Month: 02 Day: 07 Year: 23

INTERNATIONAL SHIPMENTS

15. International Shipments: ☐ Import to U.S. ☐ Export from U.S. Port of entry/exit:

Transporter Signature (for exports only): Date leaving U.S.:

TRANSPORTER

16. Transporter Acknowledgment of Receipt of Materials

Transporter 1 Printed/Typed Name: Mark Bay

Signature: [signature]

Month: 02 Day: 07 Year: 23

Transporter 2 Printed/Typed Name

Signature

Month Day Year

DESIGNATED FACILITY

17. Discrepancy

17a. Discrepancy Indication Space: ☐ Quantity ☐ Type ☐ Residue ☐ Partial Rejection ☐ Full Rejection

Manifest Reference Number:

17b. Alternate Facility (or Generator)

U.S. EPA ID Number

Facility's Phone

17c. Signature of Alternate Facility (or Generator)

Month Day Year

18. Designated Facility Owner or Operator: Certification of receipt of materials covered by the manifest except as noted in Item 17a

Printed/Typed Name

Signature

Month Day Year

DESIGNATED FACILITY TO GENERATOR

169-BLC-O 5 11977 (Rev. 9/09)

Published by J. J. KELLER & ASSOCIATES, INC. Neenah, WI • USA • (800) 327-6868 • www.jjkeller.com • Printed in the United States

Appendix E – Updated Conceptual Site Model

Conceptual Site Model

As part of the preparation of Final Remedial Investigation Work Plan, the historic data available for the site were reviewed and used to develop a preliminary conceptual Site model (CSM) of the distribution of impacts to soils, bedrock, and groundwater. The purpose of the preliminary CSM was to provide a basis for identifying data gaps that require additional investigation to complete the delineation of impacts at the Site and for developing possible remedial scenarios for the Site. Based on the findings of the Preliminary CSM, a remedial investigation was conducted at the Site and included the following activities:

- Fracture Trace Study
- Surficial Geophysical Investigation
- Initial Surface Water Sampling
- Soil/Rock Core Boring Installation
- Surface Water Investigation and Sampling
- Rock Core Groundwater Sampling
- Rock Core Downhole Camera Inspection

A detailed discussion of the results of these activities are discussed in the body text of the Remedial Alternatives Analysis (RAA) Report. The remainder of this document presents the detailed preliminary CSM that was developed for the Final Remedial Investigation Work Plan along with updates and discussion of how the Remedial Investigation data modify, if at all, or fit in with the CSM developed for the Site.

Contaminant Source Area Locations

The Schulberger Farm was used for drum disposal in the past and was identified as the source of the Site constituents of concern (COC) in soils and groundwater. The locations of the specific suspected source areas are shown in **Figure 1,** which primarily includes two drum storage areas: one in the northeast area of the former farm and one in the southwest.

Local Geologic Conditions

The work of previous consultants described the geology at the site as comprising bedrock of the Triassic to Jurassic-aged Brunswick and Lockatong Formations overlain by unconsolidated soils. The unconsolidated overburden soils were identified as the Reaville channery silt loam, which is classified as farmland of statewide importance and is characterized as somewhat poorly drained with a very high potential for runoff.

Bedrock at the site is relatively shallow, particularly in the vicinity of the former drum storage areas. Measured depths to the top of bedrock and the calculated bedrock elevations above mean sea level are presented in **Table 1**. Depths to bedrock (i.e., unconsolidated overburden soil thicknesses) in the vicinity of the suspected source area are shown in **Figure 2**. Based on this table and this figure, depths to bedrock (soil thicknesses) at the Site have been observed to range from one foot below ground surface (bgs) to 14.5 feet bgs, with an average of 5.8 feet bgs.

Structural elevation contours for the top of bedrock are shown in the immediate vicinity of the suspected source areas in **Figure 3** and for the area-wide vicinity of the Site in **Figure 4**. From these figures, the top of bedrock is observed to dip to the southwest in the northern project area in the vicinity of the suspected source areas and to the west further south in the project area. It should be noted that the northeast

former drum storage area is located on the western edge of bedrock high, and the southwest former drum storage area is located slightly down dip from the northeast drum storage area. A geologic map, published by the Pennsylvania Geological Survey, exists for the Site area and is presented in **Figure 5**. Bedrock strike and dip measurements provided on this Pennsylvania Geological Survey map for the Site vicinity range from a north-south strike with a westerly dip direction to a northwest-southeast strike with a southwesterly dip direction, which are consistent with the observed structure contours for the Site vicinity that were presented in **Figure 3** and **Figure 4**. As will be discussed in more detail later in this CSM, this bedrock structure strongly influences groundwater flow and contaminant plume distributions in groundwater.

Local Hydrogeologic Conditions

Unconsolidated overburden soils do not contain a water bearing zone. At times of heavy recharge, these materials are wet, as water slowly percolates and recharges the bedrock aquifer; however, there is no true overburden aquifer present at the site. The water table only begins at a significant depth into the bedrock unit.

The Brunswick and Lockatong Formation aquifers have been described by Morin et. al (2000) in a study conducted on seven wells in nearby Lansdale, Pennsylvania, as follows:

The Brunswick Group and the underlying Lockatong Formation are composed of lithified Mesozoic sediments that constitute part of the Newark Basin in southeastern Pennsylvania. These fractured rocks form an important regional aquifer that consists of gradational sequences of shale, siltstone, and sandstone, with fluid transport occurring primarily in fractures.

Additionally, Inners (1980) describes development of secondary porosity features in these rock units in nearby Nockamixon State Park, in the following:

Joints, or naturally occurring, mostly planar fractures, are extremely well developed in the rocks underlying Nockamixon Park. Several distinct groups, consisting of near-vertical fractures that repeat at regular intervals, are present at most outcrops….. Generally, they are spaced less than 12 inches apart in the sedimentary rocks and hornfels and 12 to 48 inches apart in the diabase.

From this information, it is expected that groundwater flow in the bedrock aquifer will be dominated by movement through well-developed and regularly-spaced secondary porosity features, including movement along bedding plane partitions and through joint development. Given that this secondary porosity is well developed and regularly spaced, it is assumed that plume movement in the aquifer will behave similarly to a homogenous aquifer, but with the possibility for some deflections of plume movement associated with the orientation of the secondary porosity features. Irregular plume movement and distribution like what would be associated with a karst environment is not expected here.

Groundwater in the vicinity of the site has been investigated through the installation of a series of bedrock monitoring wells at 12 locations. A number of the locations include nested well pairs to separate the upper and lower portion of the aquifer. A summary of the construction parameters of these monitoring wells is presented in **Table 2**. Monitoring wells completed in the shallower upper zone of the bedrock aquifer have depths ranging from 119-196 feet bgs, with an average depth of 225 feet bgs. Monitoring wells completed in the deeper portion of the bedrock aquifer or left as open holes have depths ranging from 187-300 feet bgs, with an average depth of 250 feet bgs.

Groundwater levels were measured in the site monitoring wells six times from 2014 through 2019. These measurements were used to calculate groundwater elevations and to produce groundwater elevation isocontour maps. The groundwater level measurements and associated elevation calculations are presented in **Table 3**. Groundwater elevation isocontour maps are presented for the six monitoring periods in the following figures:

- **Figure 6** – March 18, 2014 Groundwater Elevations Contours;
- **Figure 7** – September 9, 2015 Groundwater Elevations Contours;
- **Figure 8** – June 15, 2016 Groundwater Elevations Contours;
- **Figure 9** – August 9, 2017 Groundwater Elevations Contours;
- **Figure 10** – August 22, 2018 Groundwater Elevations Contours; and
- **Figure 11** – May 29, 2019 Groundwater Elevations Contours.

The observed patterns in the groundwater elevation isocontours presented in these figures were consistent over the six monitoring periods. As such, only the most recent round of measurements (i.e., the May 29, 2019 measurements) are used to describe groundwater movement at the site in the following discussion. Groundwater flow direction lines have been added to **Figure 11** based on the assumption that groundwater moves perpendicularly to the elevation contour (a principle that can sometimes be skewed by the orientation of the fracture fabric of a fractured bedrock aquifer). The groundwater elevation contour lines and associated flow direction lines presented in **Figure 11** appear complex upon first look. In most areas of the site, groundwater contour lines are regularly spaced indicating a uniform gradient. However, an area of very tightly spaced elevation contours are observed in the eastern area of the Site vicinity, indicating some type of change in the flow regime. Furthermore, groundwater flow appears to be radially outward from a high groundwater elevation at MW-5 and circling back to a low groundwater elevation at MW-10L.

To investigate these oddities in the groundwater flow field, the May 29, 2019 groundwater elevation contours were superimposed, using geographic information system (GIS) analysis, onto the Pennsylvania Geological Survey map of bedrock geology for the Site, as shown in **Figure 12**. From this figure in can be seen that the Site area is located on the corner of an almost 90 degree geologic structural bend, where rocks in the south and southwest of MW-5 (i.e., including the area of Nockamixon State Park) trend east-west with a dip to the north (Strike Direction 1 in **Figure 12**) and the rocks north of MW-5 trend north-south with a dip to the east (Strike Direction 2 in **Figure 12**). The intersection of these two strike directions coincides directly with the area of tightly spaced groundwater elevation contours. This observation is interpreted as the area of tightly-spaced groundwater elevation contours being an area of compressed and crushed rocks at the fold bend, which likely has decreased hydraulic conductivity in this area (i.e., the compression and/or faulting of the rocks in this bend has sealed off secondary porosity features) and resulted in the increased gradient (i.e., the tighter groundwater elevation contours). On either side of this corner, groundwater elevation contours are observed to be parallel to rock strike and groundwater flow direction is in the direction of rock dip, which is as it would be expected. The groundwater low at MW-10 is likely associated with a fault or other open large secondary porosity feature associated with this corner of the fold. Thus, from **Figure 12**, it can be seen that geologic structure greatly clarifies the groundwater elevation contour patterns observed at the site and is the controlling factor on groundwater movement in the bedrock aquifer in the Site vicinity. This structural control of flow and its effect on plume movement is discussed in more detail later in this CSM (see **Figures 23-26**).

Impacts to Unconsolidated Overburden Soils

A thin (i.e., average of 5.6 feet) layer of unconsolidated soil overburden materials overlie shallow bedrock at the Site. Impacts to these unconsolidated overburden materials were examined in previous investigations through the installation of soil borings and through the collection of soil samples for chemical analysis. The locations and chemical analysis results of the unconsolidated soil investigation samples compared to Pennsylvania Act 2 Residential Used Aquifer Medium-Specific Concentration (MSC) standards are presented in **Figure 13A** and **Figure 13B**. **Figure 13A** simply presents the results spatially at the Site, and **Figure 13B** presents the results in spatial relation to the suspected source area locations.

In an attempt to better visualize and describe the extent of impacts in the unconsolidated overburden soils, tetrachloroethene (PCE) and trichloroethene (TCE) isoconcentration plots of the maximum observed concentrations of these chemicals at the investigation locations were created. More specifically, a summary of the data used in this analysis is presented in **Table 4**, and the results of the analyses are shown in the following figures:

- **Figure 14A** – Tetrachloroethene (PCE) Concentration (ug/Kg) in Overburden Soils;
- **Figure 14B** – Tetrachloroethene (PCE) Concentration (ug/Kg) in Overburden Soils (with Suspected Source Areas Overlay);
- **Figure 15A** – Trichloroethene (TCE) Concentration (ug/Kg) in Overburden Soils; and
- **Figure 15B** – Trichloroethene (TCE) Concentration (ug/Kg) in Overburden Soils (with Suspected Source Areas Overlay).

It should be noted that lowest isoconcentration line shown in each of these figures is the 500 microgram per kilogram (ug/Kg) MSC level for both PCE and TCE. From these figures, two distinct areas of impacts to unconsolidated overburden soils can be observed to exist at the site: one directly underlying the northeast suspected drum storage area; and a second slightly to the east of the southwest suspected drum storage area. The level of impact is significantly higher beneath the northeast suspected drum storage area than in the impacted area near the southwest drum storage area. Both areas of impacts appear to be sufficiently delineated by the previous investigation sampling locations.

It is also worth mentioning that an electromagnetic (EM) resistivity survey was conducted in the vicinity of the northeast suspected drum storage location as part of the previous investigations. The results of this survey are presented in **Figure 16**. From this figure, it is observed that some metallic material (possibly associated with former drum burial) may still exist in the unconsolidated subsurface materials in this area.

Using GIS analysis, the previous soil boring chemical results, the extent of the maximum soil impact isocontours, and the EM survey results were superimposed onto one another. The horizontal limits of these three data layers were used to delineate the area of impacted unconsolidated overburden at the site that may possibility require additional investigation and/or the development of remedial alternatives, as shown in **Figure 17**. As previously stated, the exiting data appear to be sufficient for investigation delineation purposes. It should be noted that two (2) additional boreholes were installed (RC-1 and RC-2) during the remedial investigation activities in the vicinity of the northern most source area. The overburden soil data from samples collected in these boreholes exhibited concentrations comparable to the surrounding soil sample locations. As such, the original CSM interpretation for overburden soils is still valid and does not require modification based on the more-recently acquired remedial investigation data.

Impacts to Overburden Groundwater

As previously mentioned, there is no overburden groundwater aquifer present at the Site.

Impacts to Bedrock Matrix and Bedrock Groundwater

As mentioned above, twelve locations were drilled into bedrock to install monitoring wells. However, the drilling methods used in the installations of these wells did not permit any characterization of the unsaturated or saturated bedrock matrix. This absence of bedrock matrix characterization was considered to be a major data gap of the CSM; and as such, investigation and delineation of potential continuing sources of COC in the bedrock matrix was a primary component of the Work Plan. As such, the remedial investigation included the installation two (2) additional boreholes (RC-1 and RC-2) that included coring and sample collection into the competent bedrock matrix. Select rock core samples were crushed and submitted for laboratory analysis and GES field personnel also visually inspected and scanned each rock core with an ultra-violet light (blacklight) for the presence of any free product or non-aqueous phase liquid (NAPL). During the rock coring activities, no free product or NAPL were identified, and no significant chemical impacts were observed in these samples.

Impacts to bedrock groundwater have been investigated through periodic sampling and analysis of groundwater collected at the Site monitoring wells and from over 100 private supply wells. As part of the development of this CSM, the more recent groundwater data available for calendar year 2019 were used to visualize the extent of the contaminant plumes in bedrock groundwater through the development of isoconcentration plots for TCE, PCE, and cis 1,2 dichloroethene (DCE). Not all wells were sampled contemporaneously in 2019. The monitoring wells were sampled in June 2019, and the private supply wells were sampled at various other time periods, some more than once. For supply wells that had multiple samplings in 2019, an attempt was made to use the sampling date closest to the June 2019 sampling or had the highest detections in the contouring. Also, for well locations with an upper and lower screened interval, the interval with the highest concentration was used in the contouring. All data used in this analysis are presented in **Table 5**, and the results are shown in the following figures:

- **Figure 18A** – Trichloroethene (TCE) Concentrations (ug/L) in Groundwater – 2019;
- **Figure 18B** – Trichloroethene (TCE) Concentrations (ug/L) in Groundwater– 2019 (with suspected source area overlay);
- **Figure 19A** – Tetrachloroethene (PCE) Concentrations (ug/L) in Groundwater – 2019;
- **Figure 19B** – Tetrachloroethene (PCE) Concentrations (ug/L) in Groundwater – 2019 (with suspected source area overlay);
- **Figure 20A** – cis-1,2 Dichloroethene (DCE) Concentrations (ug/L) in Groundwater – 2019**;** and
- **Figure 20B** – cis-1,2 Dichloroethene (DCE) Concentrations (ug/L) in Groundwater – 2019 (with suspected source area overlay).

It should be noted that lowest isoconcentration line shown in each of the figures for TCE and PCE is the 5 microgram per liter (ug/L) Pennsylvania Act 2 MSC level for both PCE and TCE and the Pennsylvania Act 2 MSC level of 70 ug/L for cis 1,2 DCE. From these figures, the highest concentrations of TCE and cis 1,2 DCE impacts to groundwater are located immediately below the northeast suspected drum disposal area and the plumes regularly decrease outward from this location. The highest concentrations of PCE exist at the at the 338 Park property to the west and under the northeast suspected drum disposal area. The PCE plume regularly decreases outward from these two locations. The regularity of the decreasing shape of

the plumes support the idea that the fractured-rock groundwater aquifer is behaving similarly to a homogenous aquifer, as there are no odd plume shape features that would indicate transport control by a specific secondary porosity feature. From these figures, PCE and cis 1,2 DCE are believed to be adequately delineated. The bulk of the TCE plume is also well delineated, but the extent of the MCL limit is not in a few downgradient areas. This complete delineation of the extent of the TCE plume to MCL levels is a current data gap identified in this CSM.

An attempt was made to evaluate the stability of the TCE and PCE plumes through the use of the Mann-Kendall statistical analysis. Monitoring wells and potable water wells with four or more rounds of sampling were analyzed. The individual well TCE Mann-Kendall analyses are presented in **Appendix A,** and the individual well PCE Mann-Kendall analyses are presented in **Appendix B**. The results for both the TCE and PCE plumes are summarized in **Table 6**. The results are presented spatially for TCE in **Figure 21** and for PCE in **Figure 22**.

From **Table 6** and **Figure 21**, the following observations are made from the TCE plume Mann-Kendall analyses:

- 55 wells were analyzed;
- 2 wells were reported as Decreasing;
- 3 wells were reported as Probably Decreasing;
- 24 wells were reported as Stable;
- 20 wells were reported as No Trend
- 3 wells were reported as Probably Increasing; and
- 3 wells were reported as Increasing.

Closer examination of the three “Increasing” and three “Probably Increasing” trend wells revealed that the results are not significant and are not representative of the plume conditions around the wells.

From **Table 6** and **Figure 22**, the following observations are made from the PCE plume Mann-Kendall analyses:

- 55 wells were analyzed;
- 1 well was reported as Decreasing;
- 1 well was reported as Probably Decreasing;
- 30 wells were reported as Stable;
- 19 wells were reported as No Trend
- 1 well was reported as Probably Increasing; and
- 3 wells were reported as Increasing.

Closer examination of the three “Increasing” and the one “Probably Increasing” trend wells revealed that the results are not significant and are not representative of the plume conditions around the wells. Based on the Mann Kendall analysis results, the TCE and PCE groundwater plumes are concluded to be stable.

The effect of bedrock geology on groundwater flow and the distribution of the TCE, PCE, and cis 1,2 DCE bedrock groundwater plumes was further analyzed through GIS analysis. The bedrock elevation contours, strike and dip information obtained from the PA Geological Survey map, and the May 29, 2019

groundwater elevation contours and flow lines were combined into one small scale map presented as presented in **Figure 23**. **Figure 23** is meant to serve as summary of the effects of a complex geologic structural fold in the immediate Site vicinity on groundwater flow, as described in detail above in this CSM. Subsequently in the GIS analysis, the TCE, PCE, and cis 1,2 DCE plume layers were added to the **Figure 23** map layers to examine the effect bedrock structure and groundwater flow conditions on the plume shapes. The results of this analysis are presented in the following figures:

- **Figure 24** – May 29, 2019 Groundwater Elevation Contour Map with Bedrock Elevation Contours and TCE Plume Extents;
- **Figure 25** – May 29, 2019 Groundwater Elevation Contour Map with Bedrock Elevation Contours and PCE Plume Extents; and
- **Figure 26** – May 29, 2019 Groundwater Elevation Contour Map with Bedrock Elevation Contours and cis 1,2 DCE Plume Extents

From these figures it can be seen that bedrock dip and the complex, almost-circular groundwater flow pattern at the site are controlling the overall movement of the dissolved phase plumes. More specifically, at the source area, the plumes initial movements are observed to be to the west and southwest following the dip direction of the bedrock in this area. This direction of movement is expected as TCE, PCE, and DCE are dense non-aqueous phase liquids (DNAPLS) that are denser than water; and therefore, these compounds can have movement controlled by gravity and not necessarily the direction of flow. As such, given the location of the drum disposal areas, it is believed that source materials leaking from these areas likely primarily first moved west along bedrock dip. This belief is supported by the fact that the highest concentration of PCE is now observed on 338 Park property, which is to the west of the northeast drum disposal area. The suspected residual source materials in bedrock to the west of the drum disposal areas continue to dissolve COC mass into groundwater, which creates the east-west trend of the plume shape in this area of the site. The dissolved phase plume is then subjected to the groundwater flow regime which changes direction of the plume and causes it to expand and deflect toward the south and southeast.

From 2020-2023, additional groundwater data were collected from the twelve monitoring well locations and the rock core locations as part of the remedial investigation. Furthermore, during this time period, a fracture trace study was also conducted and identified a number of surface water seeps to the southwest of the source areas that followed linear features interpreted as primary bedrock joint direction and dip direction from the source area. The surface water seeps were also sampled. The maximum concentration results for TCE, PCE, and cis 1,2 DCE observed at any of these locations during the 2020-2023 time period for these groundwater and surface water samples are overlain on the 2019 plume maps as **Figure 27** (TCE), **Figure 28** (PCE), and **Figure 29** (cis 1,2 DCE), respectively. It should be noted that 2019 was the last time period that a complete data set was collected. As such the newly acquired data posted on these figures were not used in the contouring that is shown in the figures; but rather, is posted for comparison to the previous complete round. From these figures, the following observations can be made:

- The maximum 2020-2023 concentrations observed at the plumes leading edges are consistent with the 2019 observations, further supporting the conclusion that the plumes are at equilibrium and not expanding.
- The maximum 2020-2023 concentrations observed at the source areas do fluctuate somewhat but are similar orders of magnitude as observed in 2019. It is known that groundwater levels fluctuate significantly at the Site (i.e., at times >20 feet fluctuations), which would explain

variability in observed groundwater concentrations in this source area of the Site (i.e., variable residence times of groundwater in contact with residually sorbed COCs in the rock matrix result in variations of observed concentrations in groundwater due to more or less contact time between groundwater and the sorbed matrix impacts).

- Two surface water locations (SW-1 and SW-2) had detections of COCs in exceedance of the Chapter 93 Surface Water Quality Criteria. These two locations are located down dip and downgradient to the southwest of the source area along a lineament that is likely a primary bedrock joint. This expression of impact offsite in this direction from the source supports the original CSM interpretation that continuing source impacts are likely in bedrock immediately to the southwest of the source areas.

Although an attempt was made to investigate the bedrock matrix during the remedial investigation through the installation of the two rock cores, bedrock in the area to the west and southwest of the suspected drum disposal areas is still not well investigated. Furthermore, the surface water data collected as part of the remedial investigation support the previous interpretation from plume geometries that residual source material trapped in bedrock secondary porosity features is likely located to the west/southwest of the source area and is acting as a continuing source of COC to groundwater. Given this current hypothesis of the CSM, additional pre-design investigation activities may be needed to more accurately delineate any residual source materials in bedrock in this area, depending on the remedy selected for the Site..

CSM Conclusions

Conclusions made from the development of the CSM include the following:

- Unsaturated soils are adequately delineated. Any additional investigation activities required would be to satisfy specific needs related to the assessment of specific remedial design selected for the Site.
- The extent of persisting source zone impacts in the bedrock matrix to the west/southwest of the source areas may require additional characterization as part of a predesign investigation, depending on the final remedy selected for the Site. It is suspected that DNAPL source materials have followed bedrock dip direction and jointing direction to the west and southwest from the drum disposal areas and that residual source materials are trapped in bedrock secondary porosity features in this area and act as continuing sources of impacts to groundwater.
- The bedrock groundwater plume is well delineated for PCE and DCE and for the majority of TCE. Additional delineation may be necessary of the TCE plume extent to the MCL. However, the plumes are observed to be stable and, assuming that there are no potential exposure risks and that a remedy will be attempted in the near future, characterization of the TCE leading edge may be delayed until after the implementation of the remedy.

References

Inners, J. D., 1980, Nockamixon State Park, Bucks County—Rocks and joints: Pennsylvania Geological Survey, 4th ser., Trail of Geology 16–014.0, 5 p. [Available online.]

Morin, R.H., Senior, L.A., and Decker, E.R., 2000, Fractured-Aquifer Hydrogeology from Geophysical Logs: Brunswick Group and Lockatong Formation, Pennsylvania: GROUNDWATER, v. 38, No. 2, March-April, p 182-192.

Appendix E – Figures

Figure E1: Locations of Suspected Source Areas

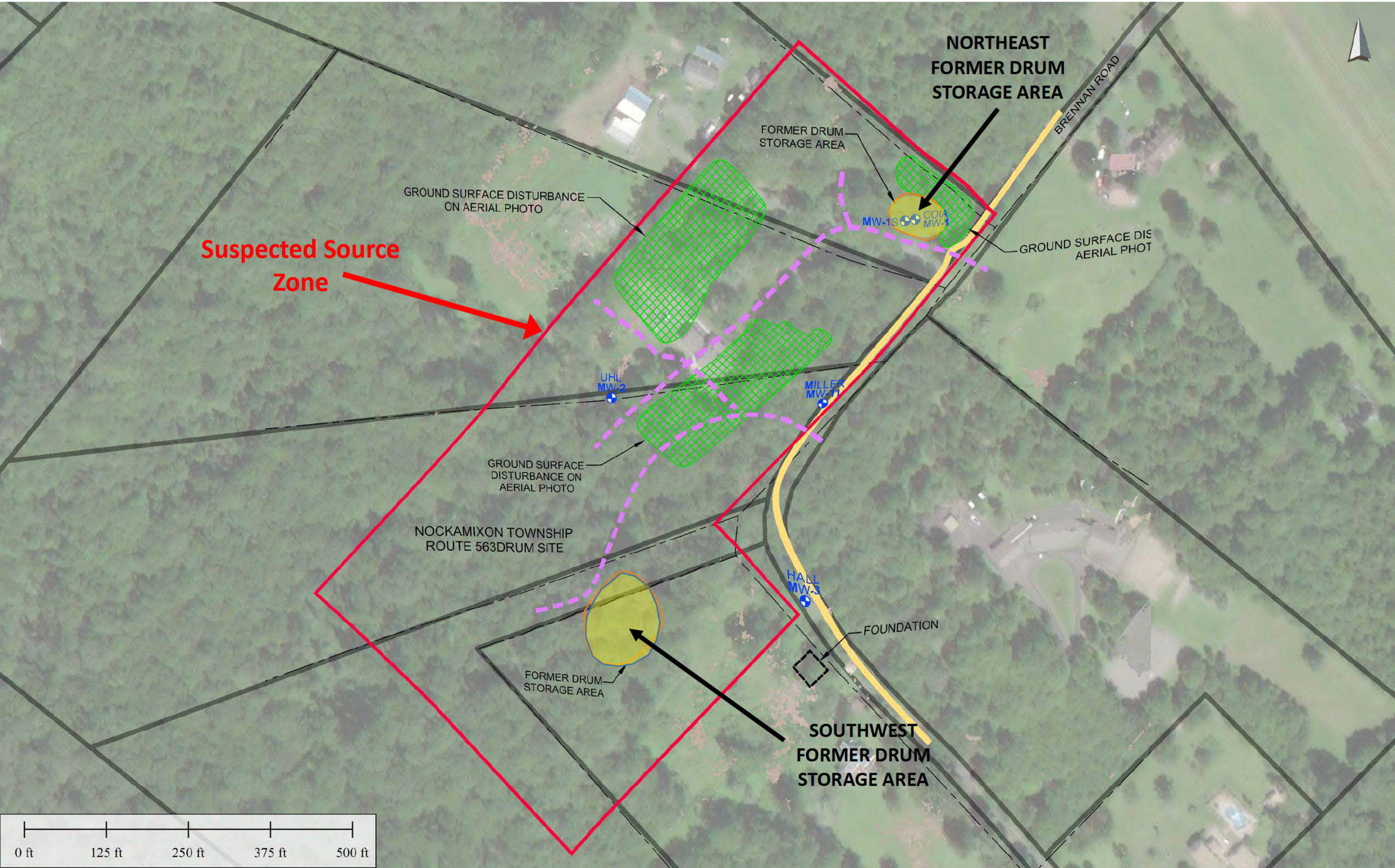


Figure E2: Depths to Bedrock in Suspected Source Zone Area

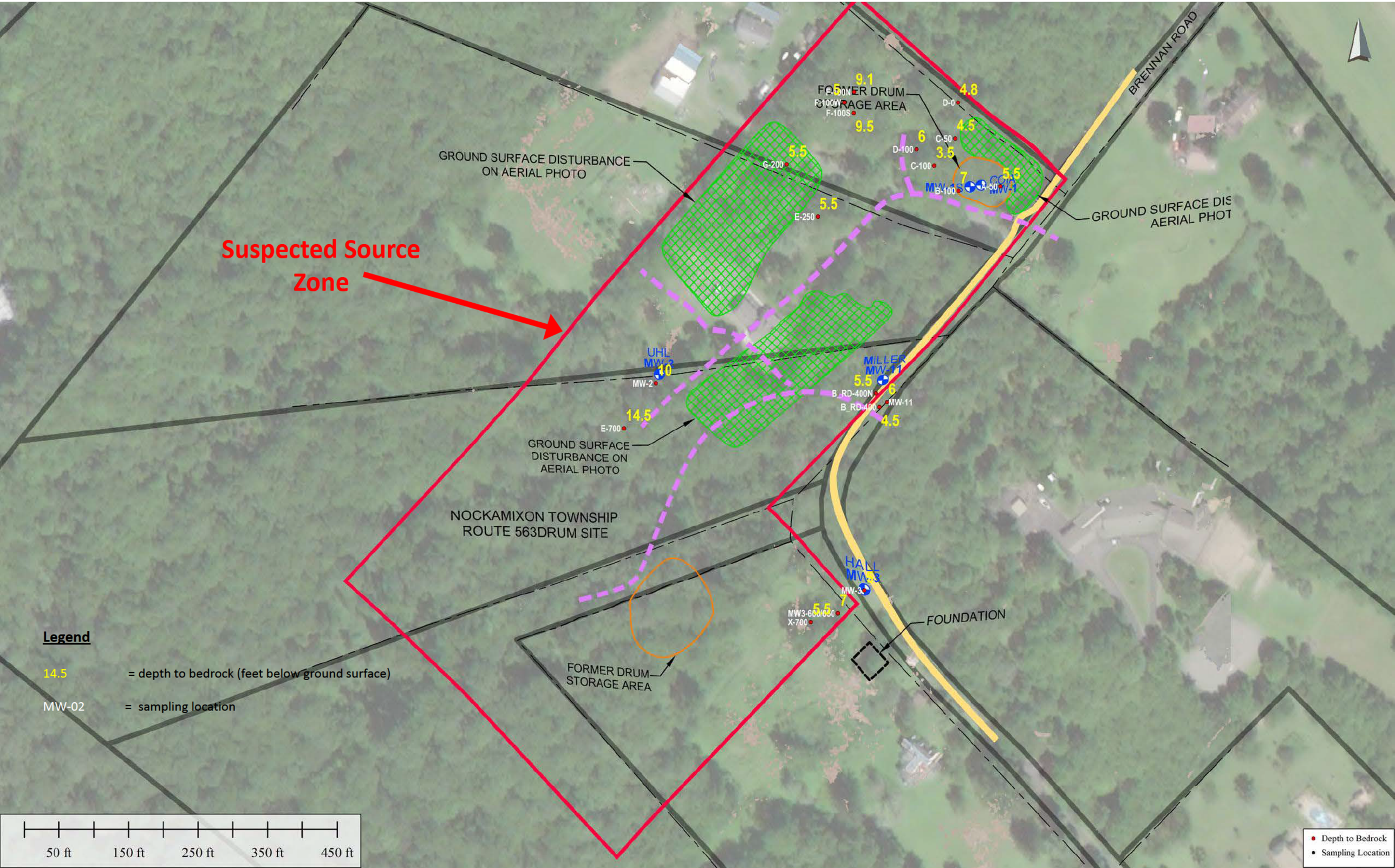


Figure E3: Top of Bedrock Elevation Contours in Suspected Source Zone Area

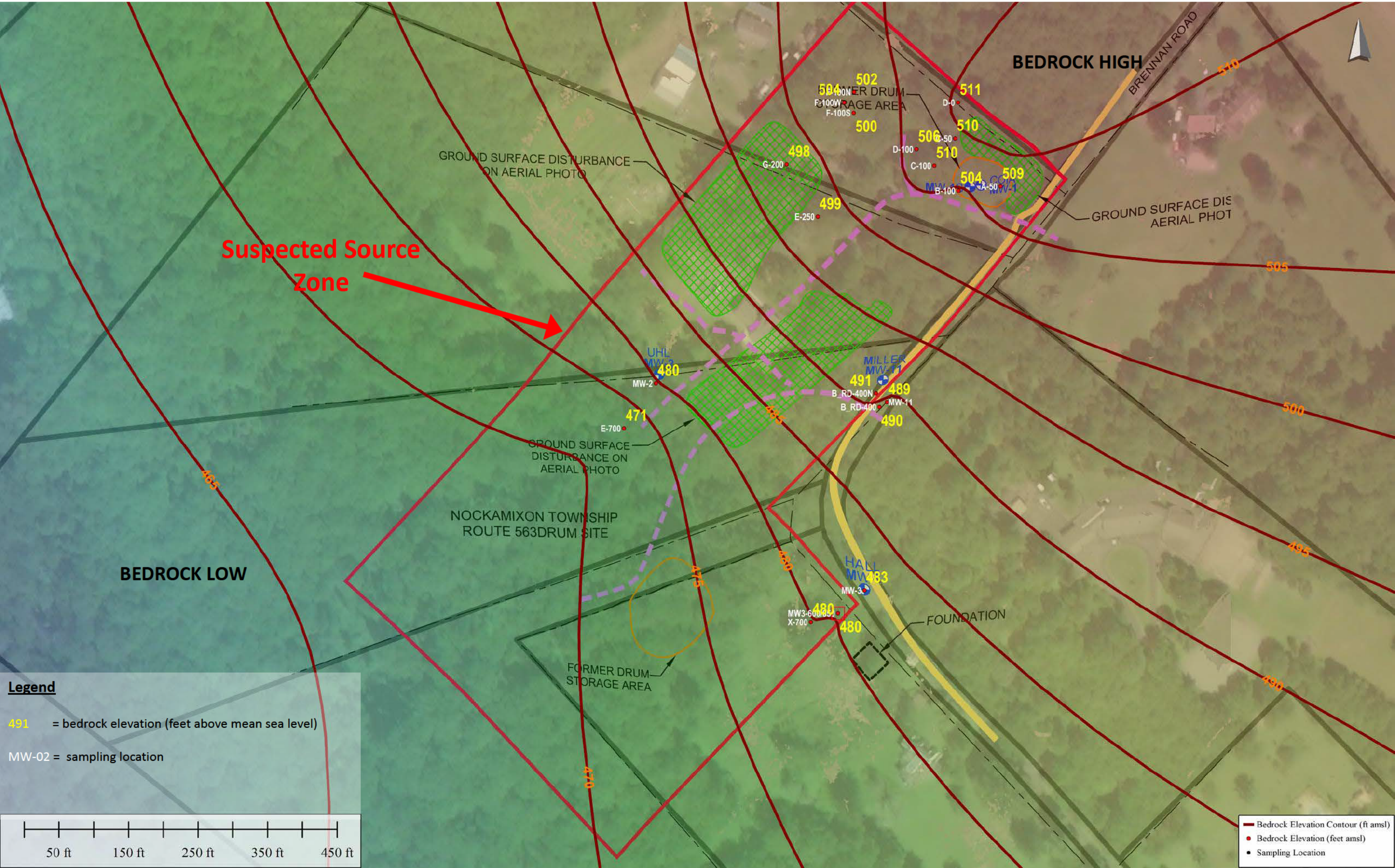


Figure E4: Area-Wide Top of Bedrock Elevation Contours in Site Vicinity

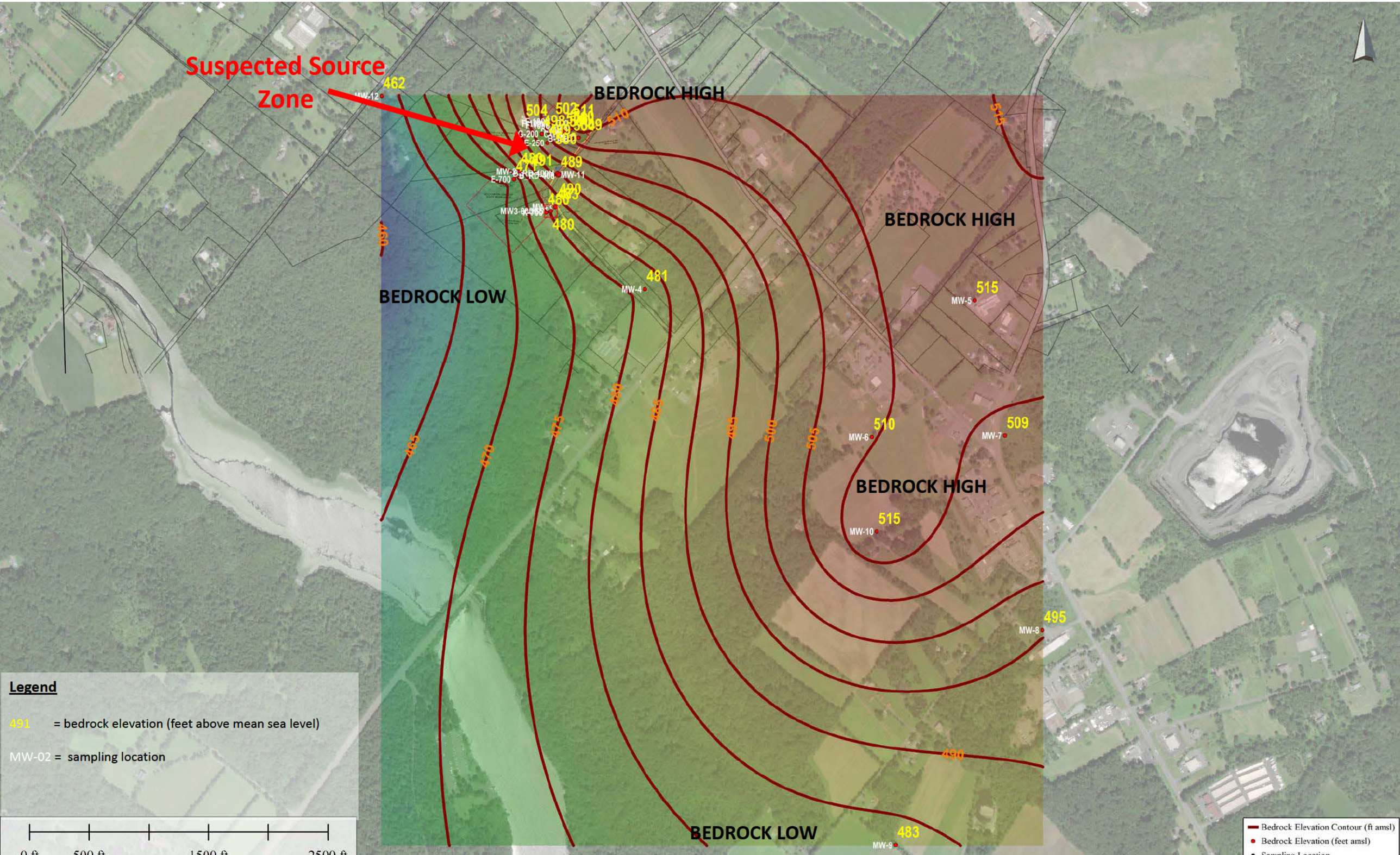


Figure E5: Area-Wide Published Geologic Map

TRIASSIC

Trd

Diabase

Igneous sills and dikes intruding Triassic and older sedimentary rocks

Trqc Trb Trlc

Brunswick lithofacies

Redshales and sandstones grading upward into limestone, Trlc , and quartzite, Trqc , fanglomerates along the northwest margin. Altered to black, hornfels adjacent to diabase intrusives

Trl

Lockatong lithofacies

Gray to black argillite, grades laterally into Brunswick. Altered to black hornfels adjacent to diabase intrusives

Trs

Stockton lithofacies

Red, gray and brown shales and arkoses, with local arkosic conglomerates.

Suspected Source Zone

Haycock Mountain

Haycock Run

Bucksville

Harrow

Trd Trb Trl

0 ft 1000 ft 2000 ft 3000 ft 4000 ft

From: Greenman, D. W., 1955, Ground water resources of Bucks County, Pennsylvania: Pennsylvania Geological Survey, 4th ser., Water Resource Report 11, 67 p. [Available online.]

Figure E6: Groundwater Elevation Contour Map – March 18, 2014

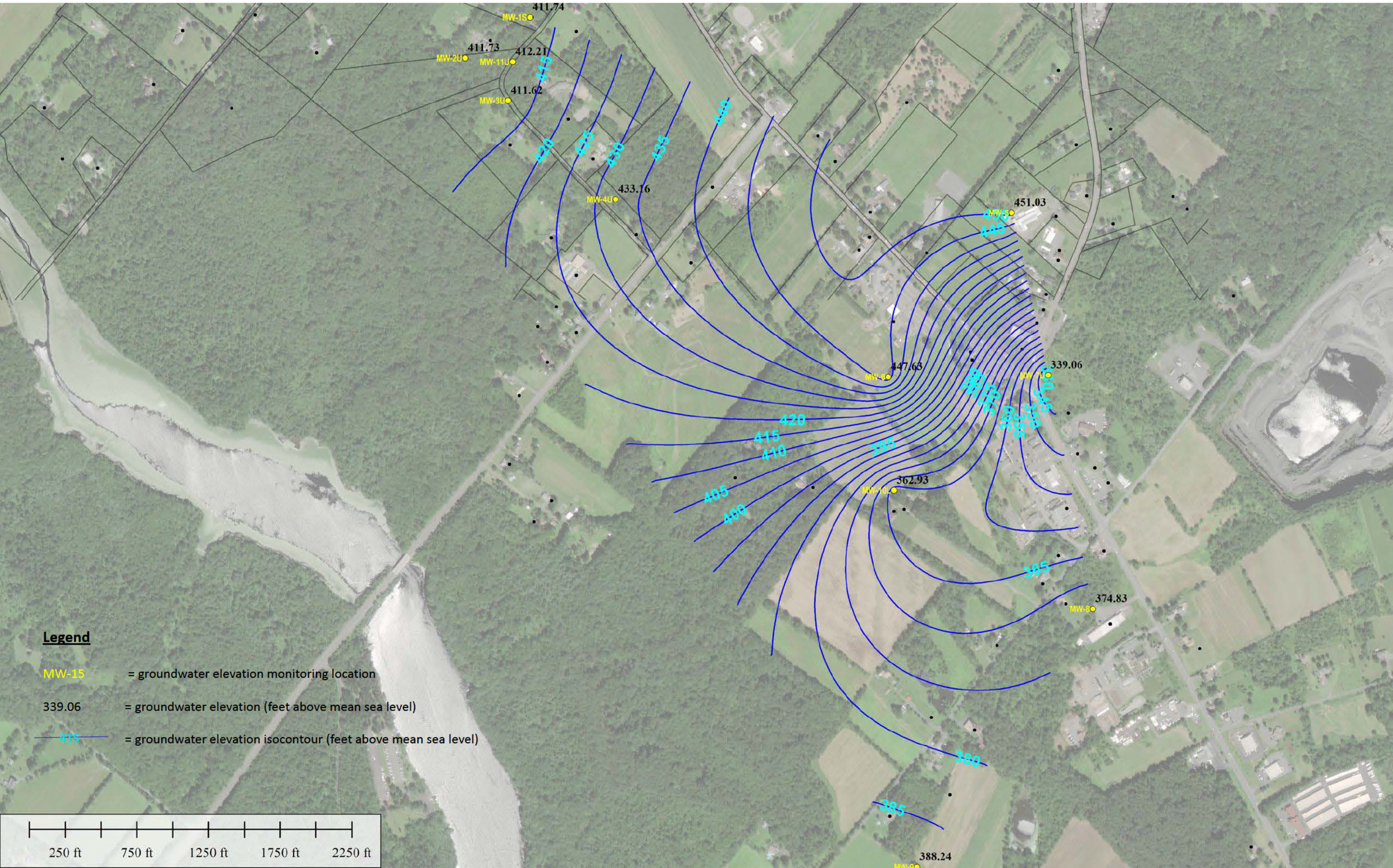


Figure E7: Groundwater Elevation Contour Map – September 9, 2015

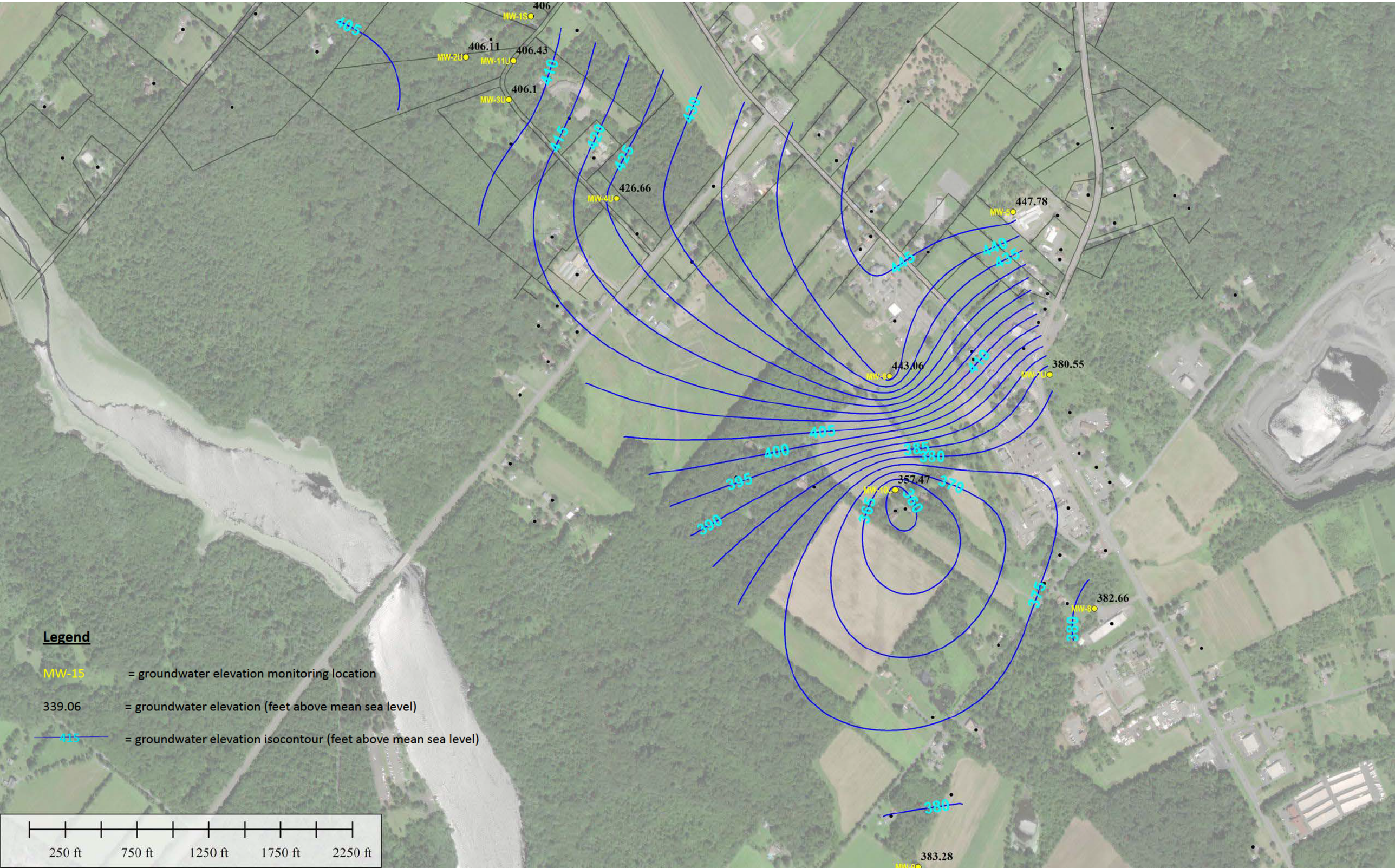


Figure E8: Groundwater Elevation Contour Map – June 15, 2016

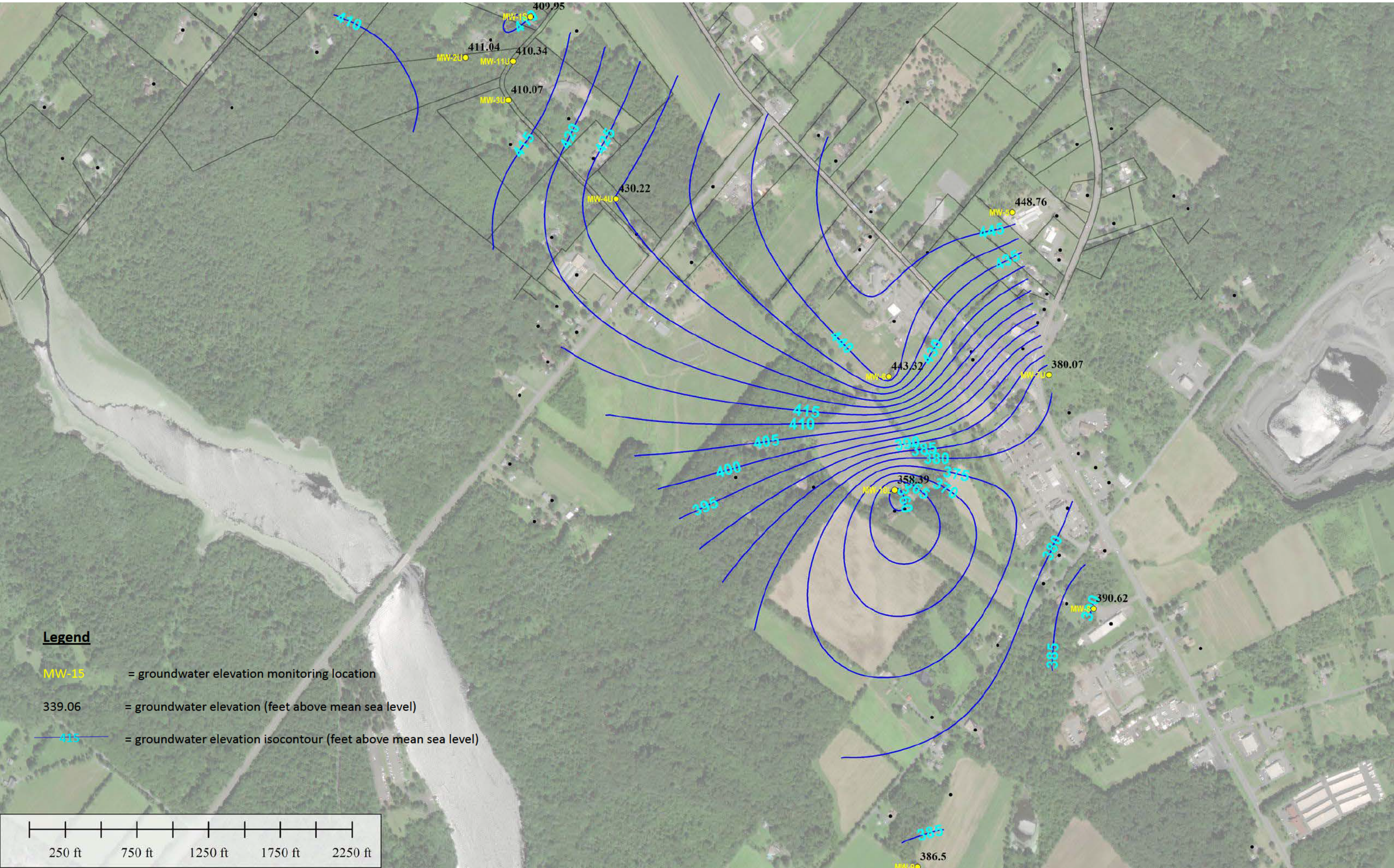


Figure E9: Groundwater Elevation Contour Map – August 9, 2017

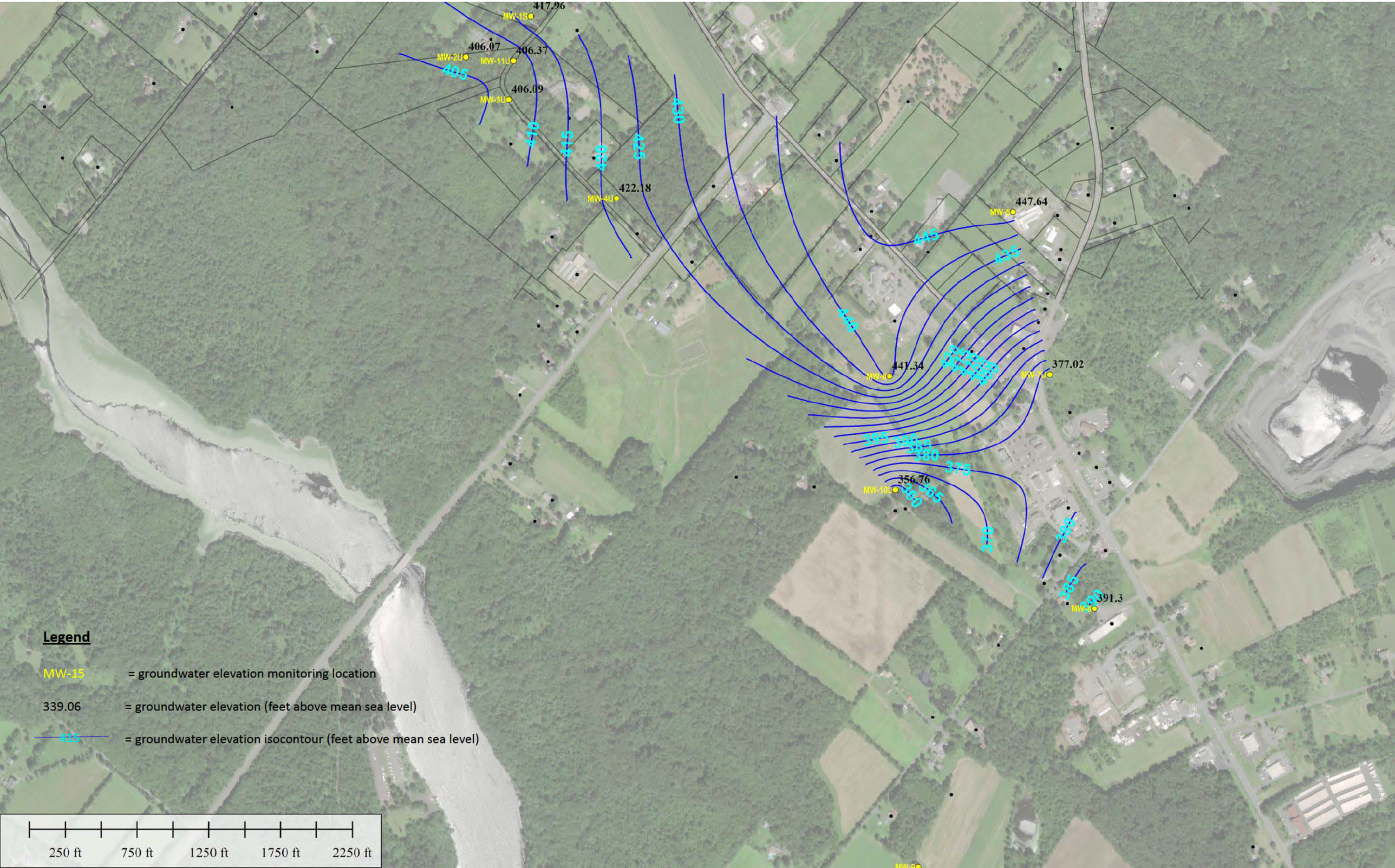


Figure E10: Groundwater Elevation Contour Map – August 22, 2018

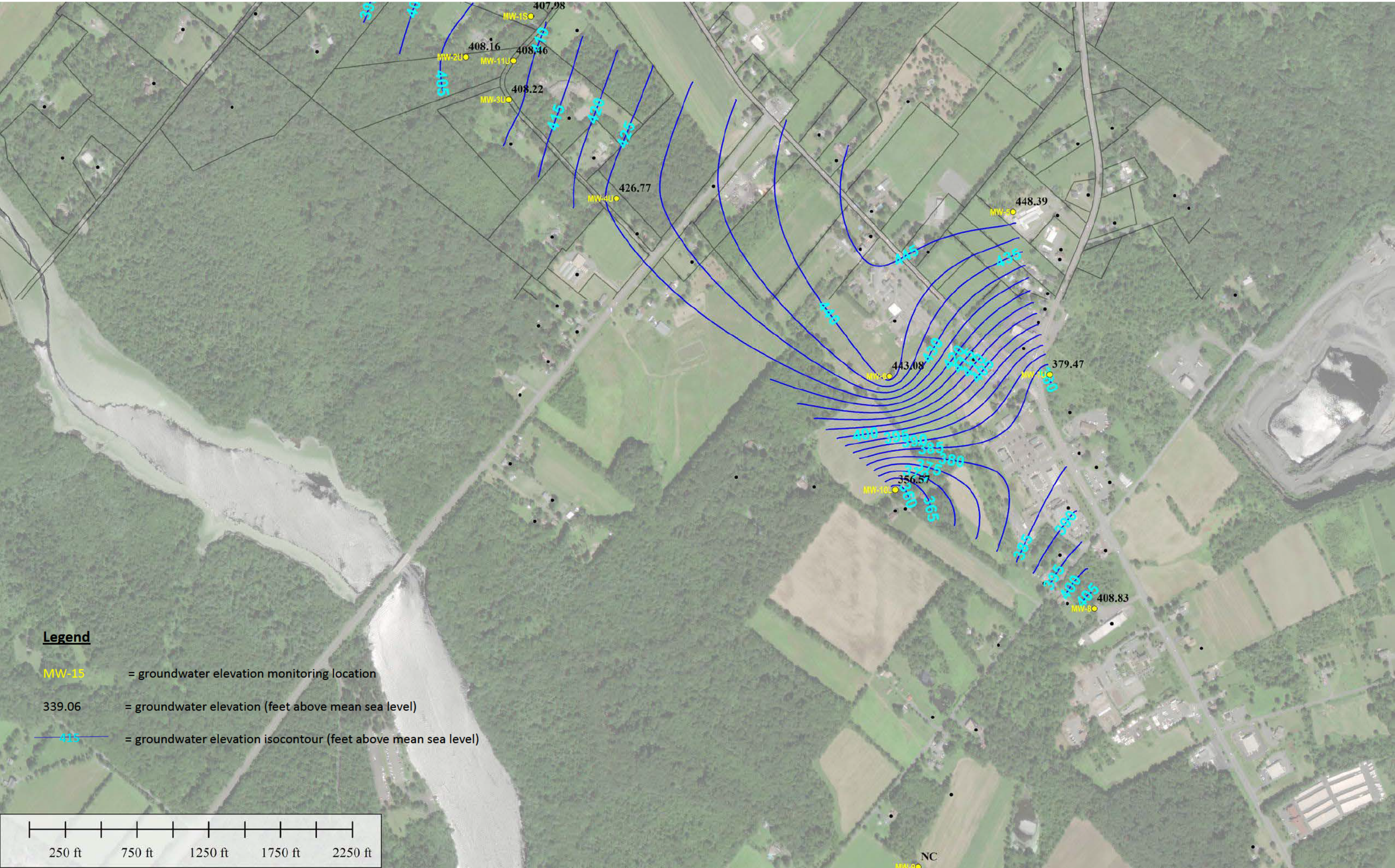


Figure E11: Groundwater Elevation Contour Map – May 29, 2019

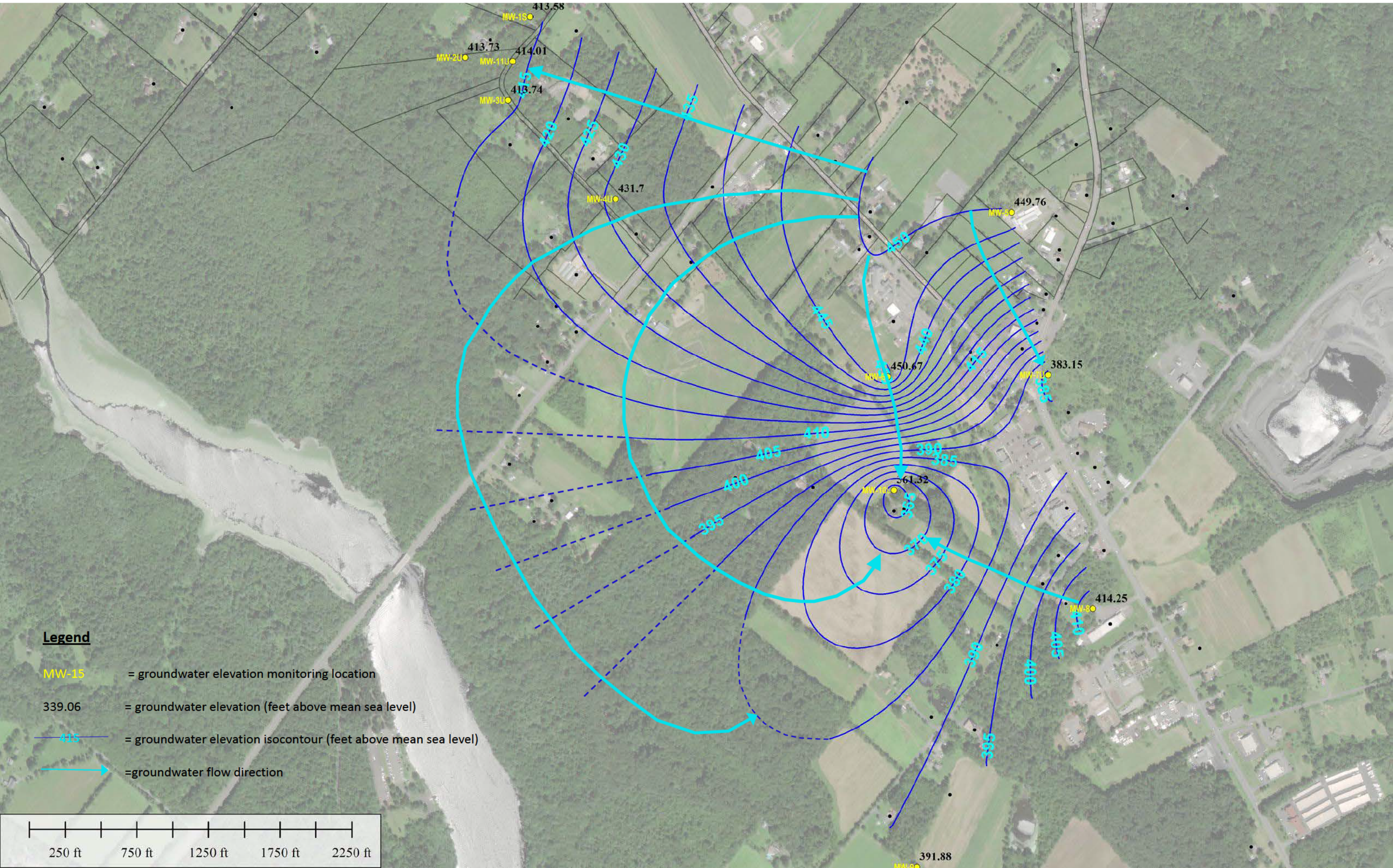


Figure E12: Structural Control of Groundwater Flow (May 29, 2019 Groundwater Elevation Contours)

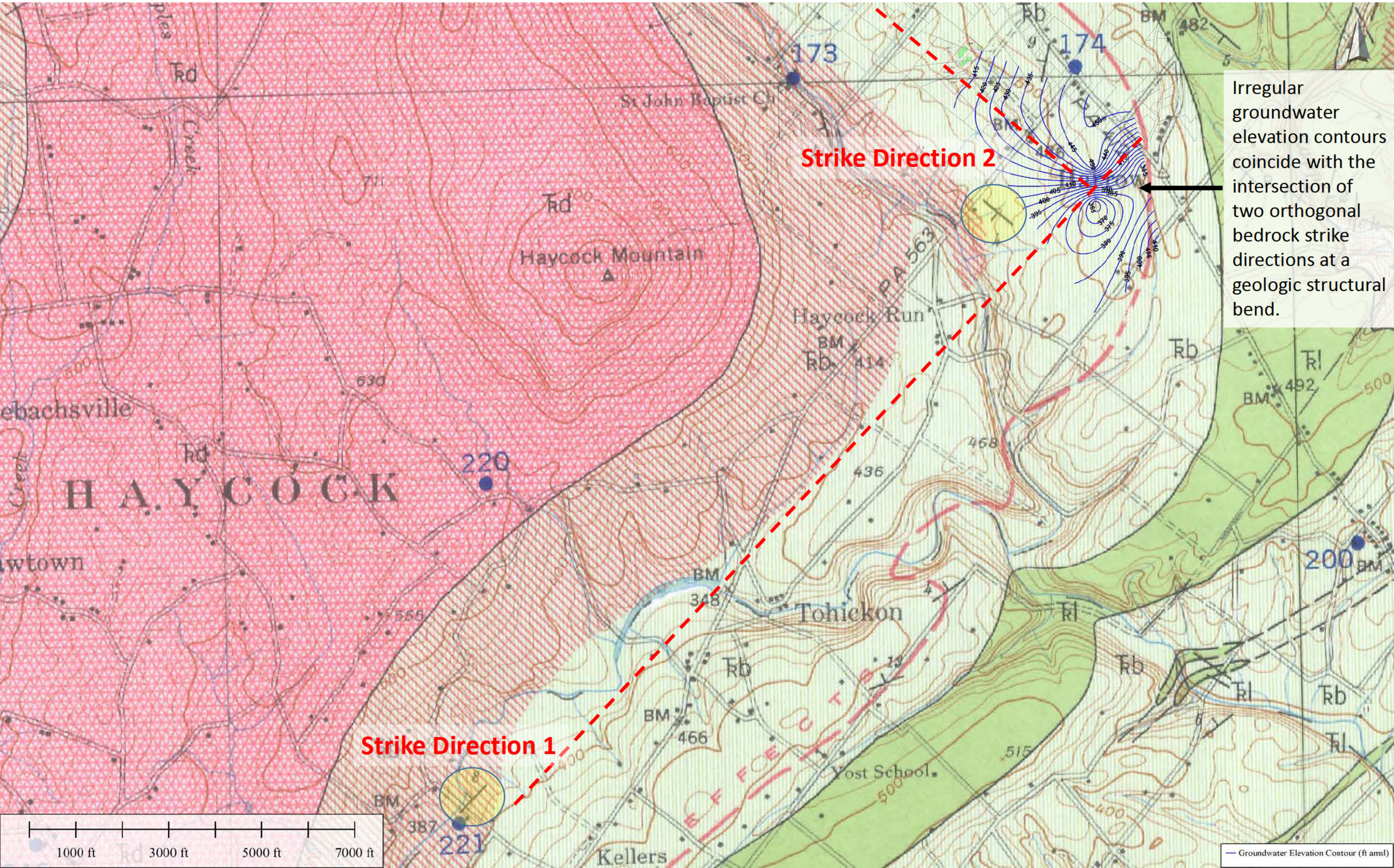


Figure E13A: Summary of Unconsolidated Overburden Soil Sampling Results from Previous Investigations

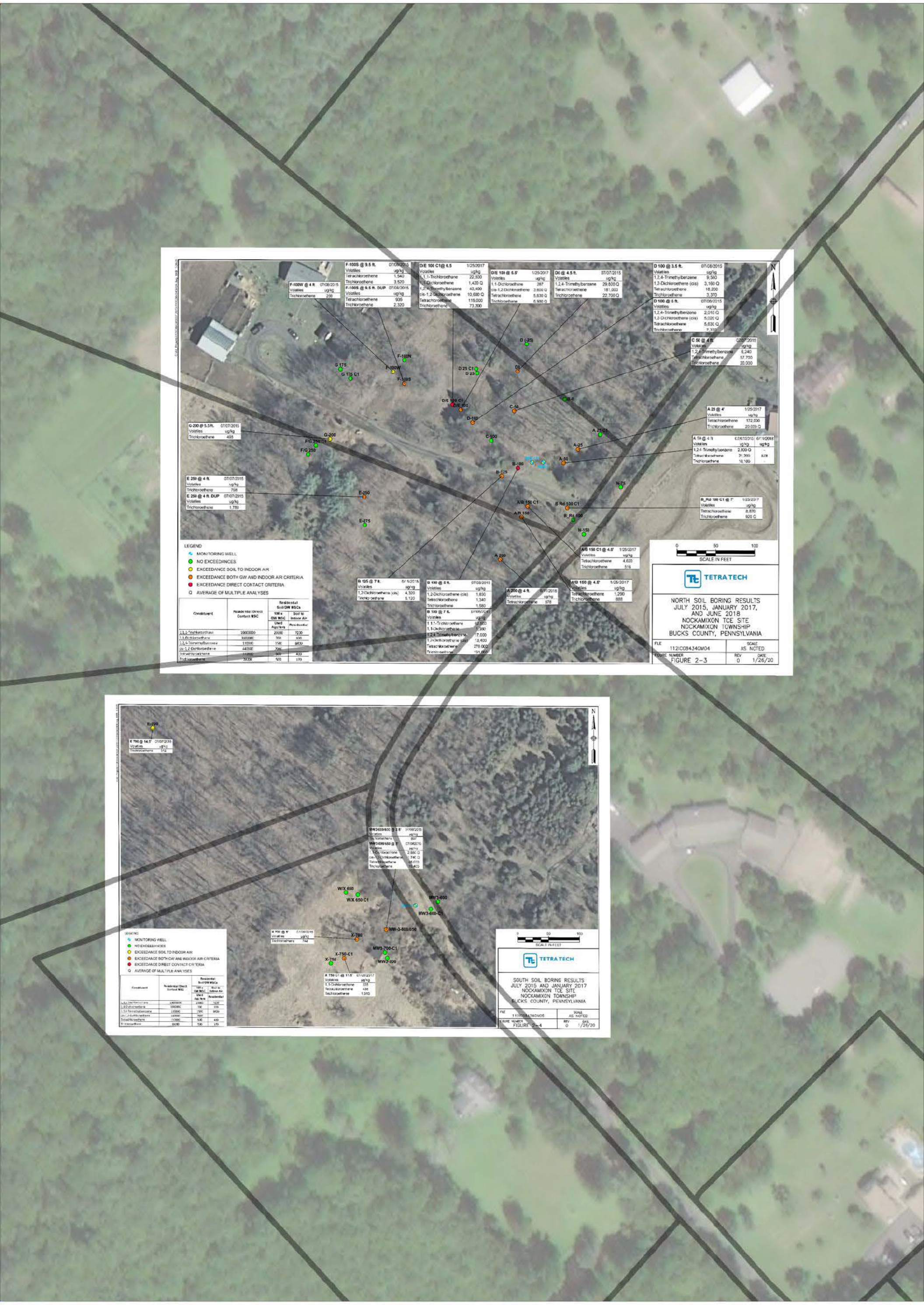


Figure E13B: Summary of Unconsolidated Overburden Soil Sampling Results from Previous Investigations (with Suspected Source Areas Overlay)

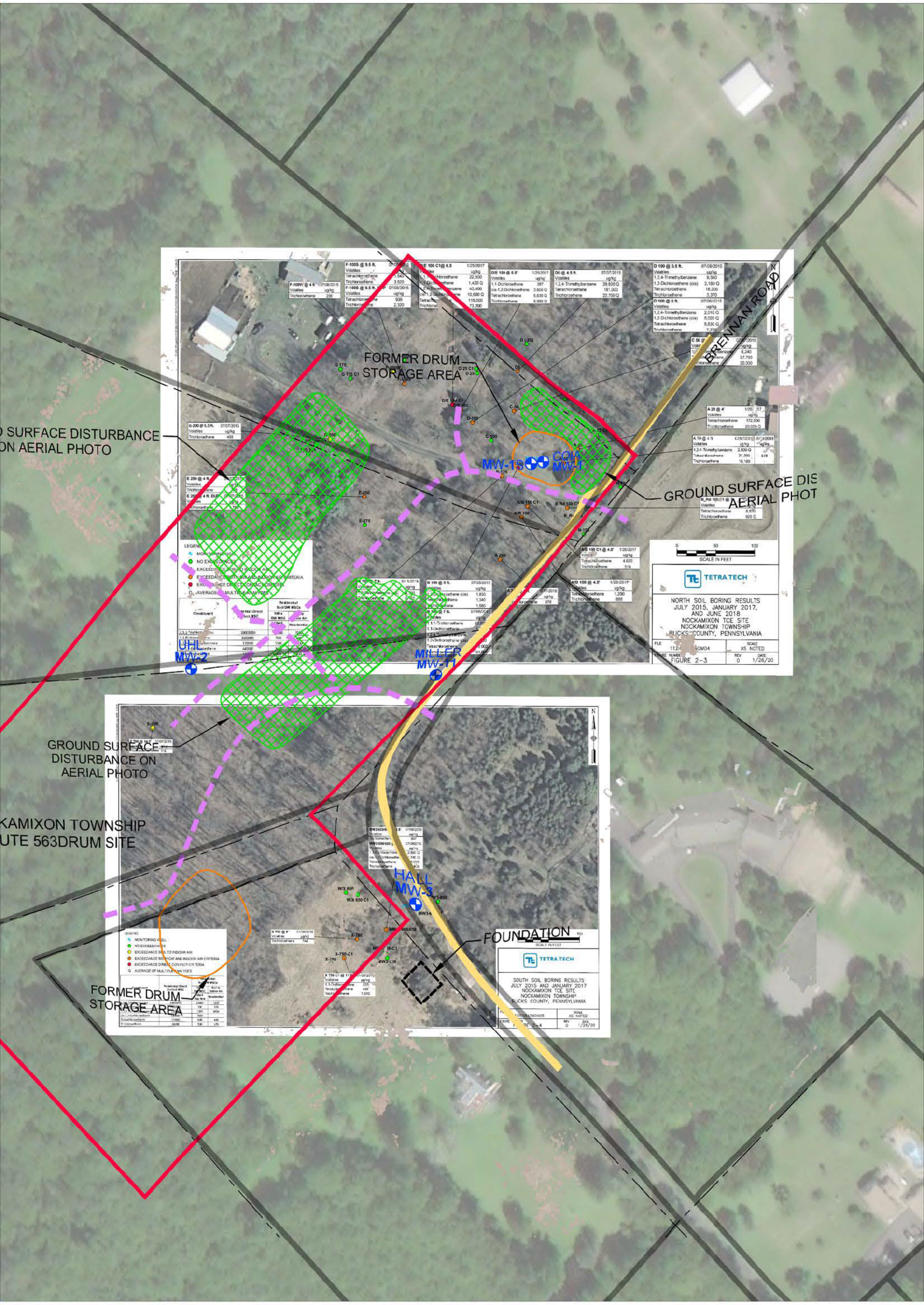


Figure E14A: Tetrachloroethene (PCE) Concentration (ug/Kg) in Overburden Soils

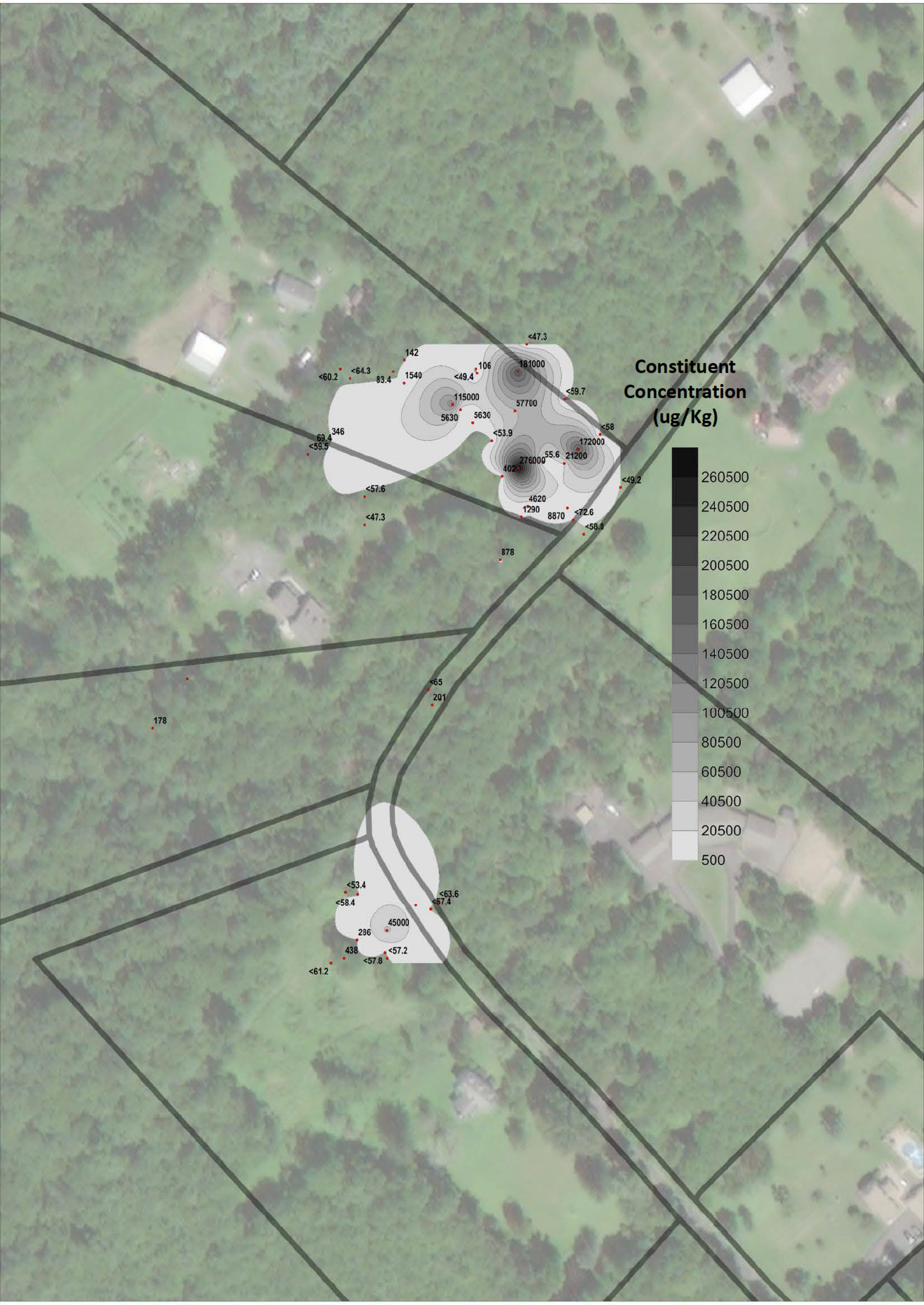


Figure E14B: **Tetrachloroethene (PCE) Concentration (ug/Kg) in Overburden Soils (with Suspected Source Areas Overlay)**

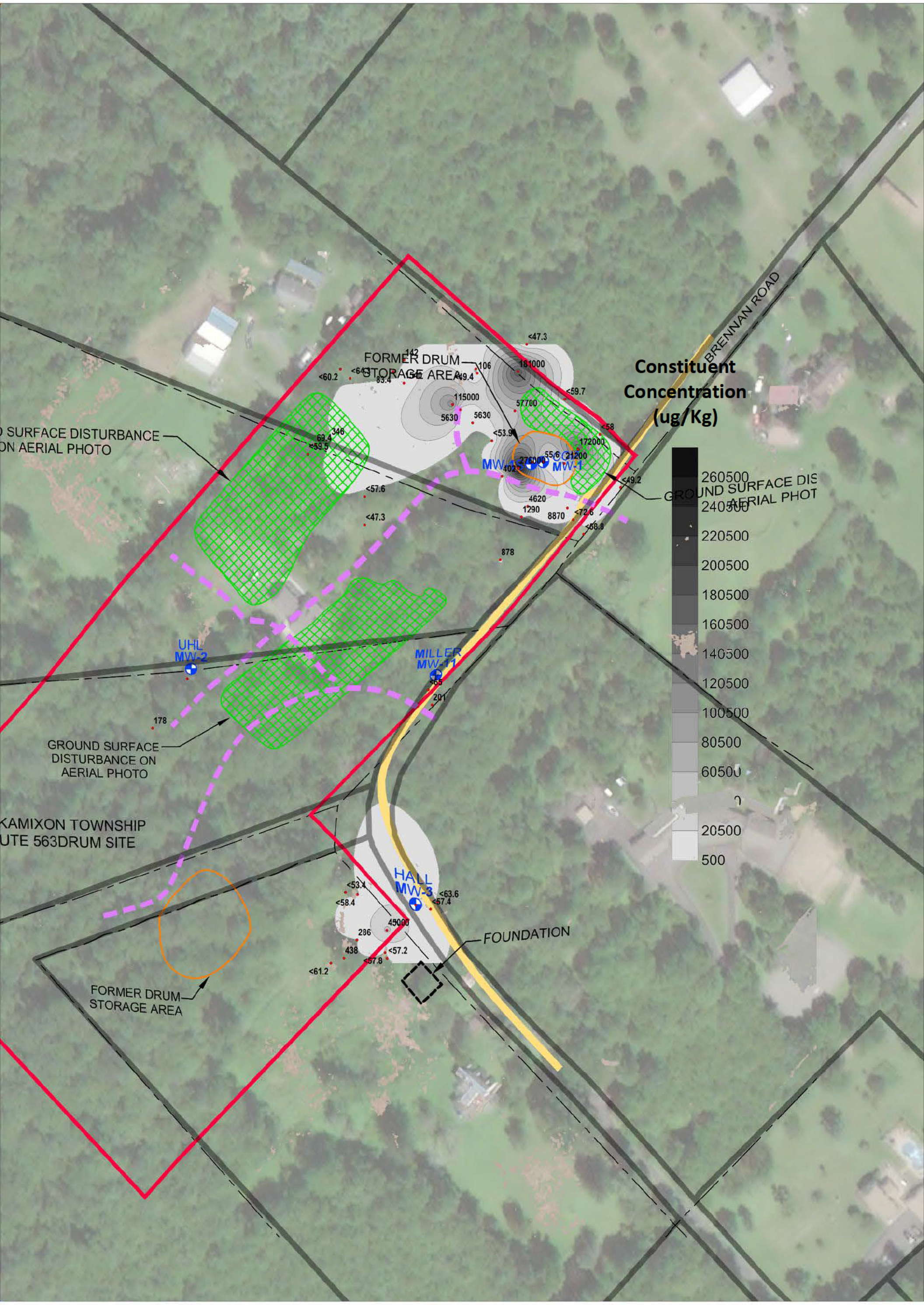


Figure E15A: Trichloroethene (TCE) Concentration (ug/Kg) in Overburden Soils

Figure E15B: **Trichloroethene (TCE) Concentration (ug/Kg) in Overburden Soils (with Suspected Source Areas Overlay)**

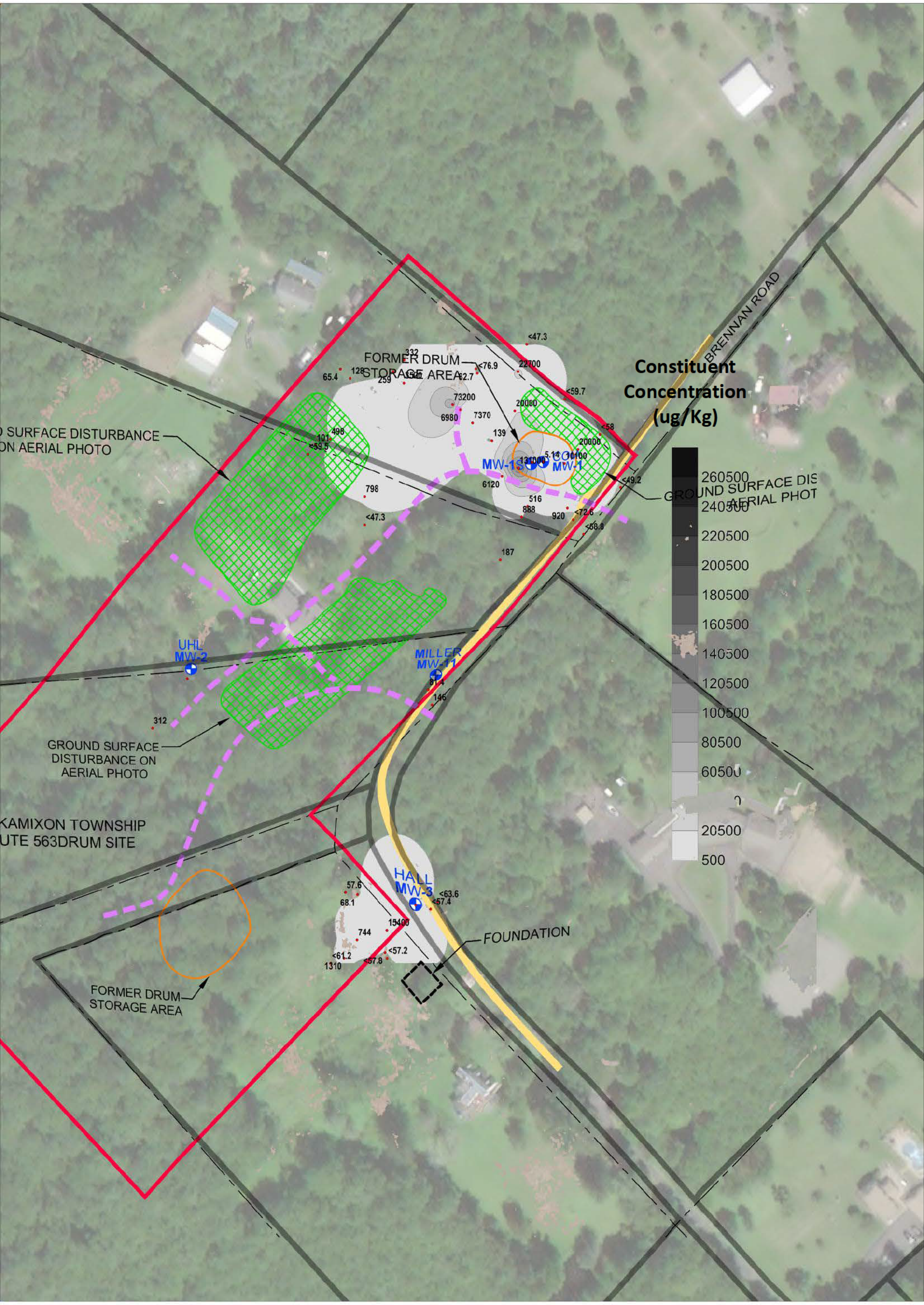


FIGURE E16: EM 31 Reconnaissance Survey

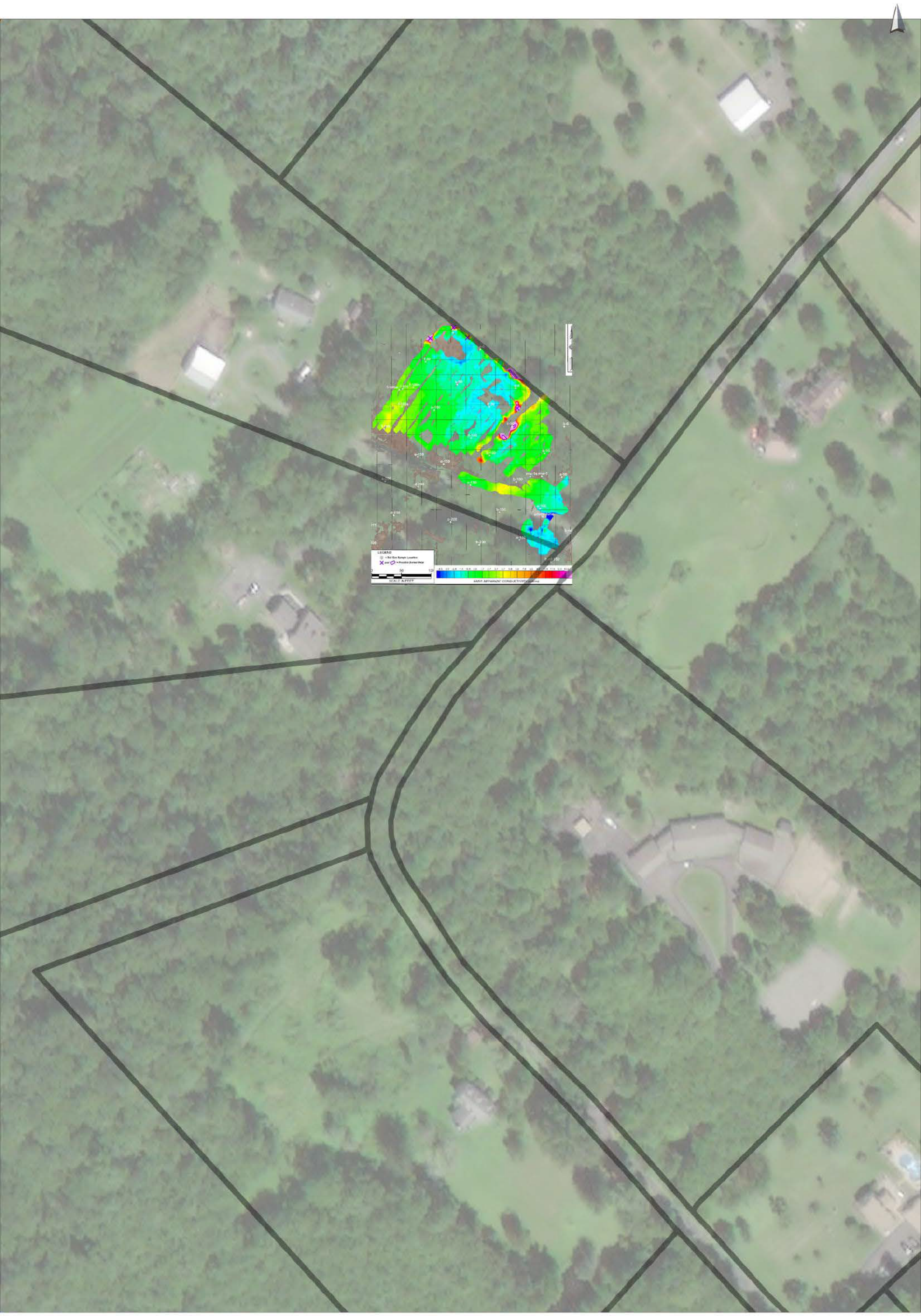
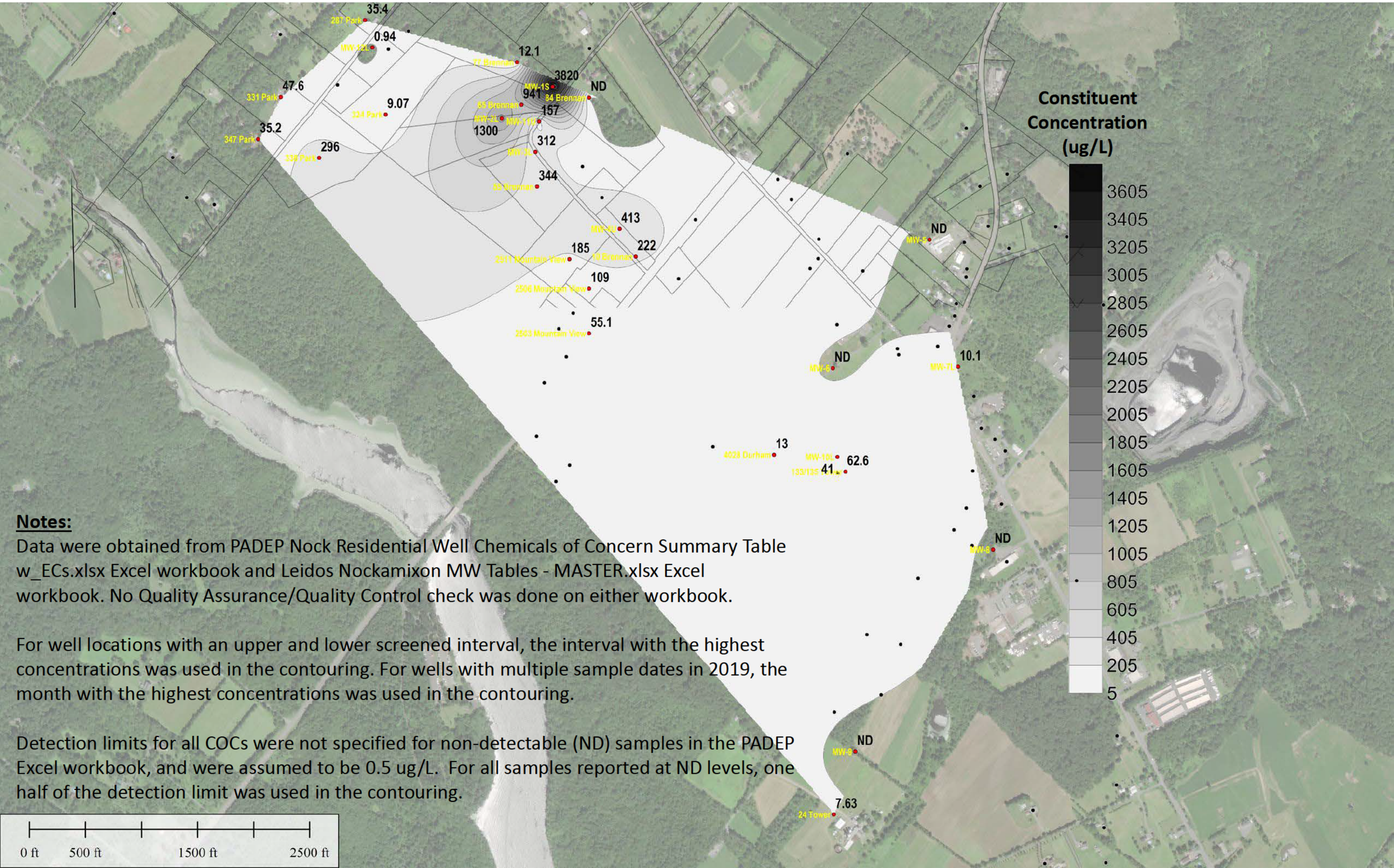


Figure E17: **Areas of Impacted Unconsolidated Overburden Soils Identified for Additional Investigation and/or Remedial Alternatives Assessment**

Figure E18A: Trichloroethene (TCE) Concentrations (ug/L) in Groundwater – 2019



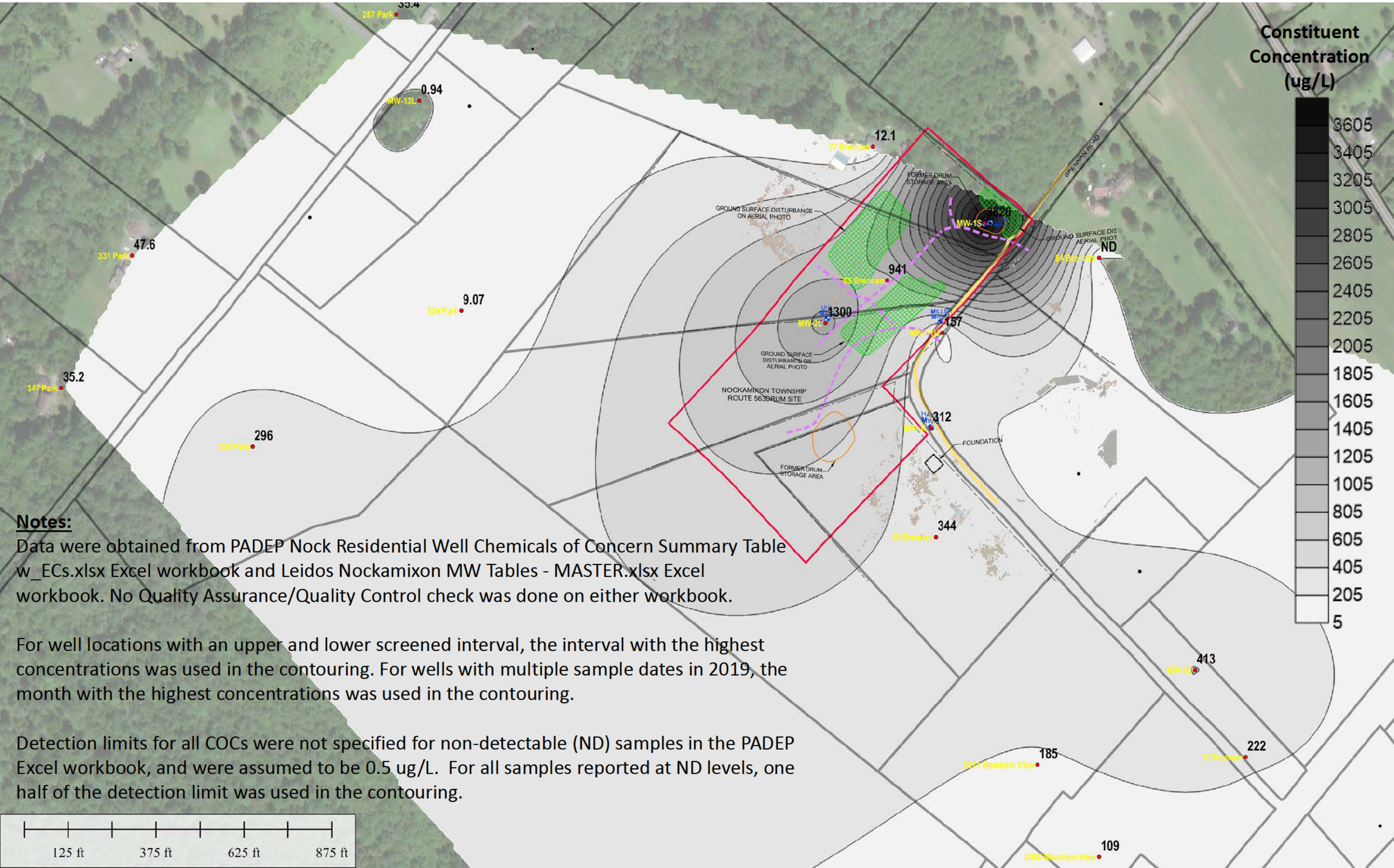
Notes:

Data were obtained from PADEP Nock Residential Well Chemicals of Concern Summary Table w_ECs.xlsx Excel workbook and Leidos Nockamixon MW Tables - MASTER.xlsx Excel workbook. No Quality Assurance/Quality Control check was done on either workbook.

For well locations with an upper and lower screened interval, the interval with the highest concentrations was used in the contouring. For wells with multiple sample dates in 2019, the month with the highest concentrations was used in the contouring.

Detection limits for all COCs were not specified for non-detectable (ND) samples in the PADEP Excel workbook, and were assumed to be 0.5 ug/L. For all samples reported at ND levels, one half of the detection limit was used in the contouring.

Figure E18B: Trichloroethene (TCE) Concentrations (ug/L) in Groundwater– 2019 (with suspected source area overlay)



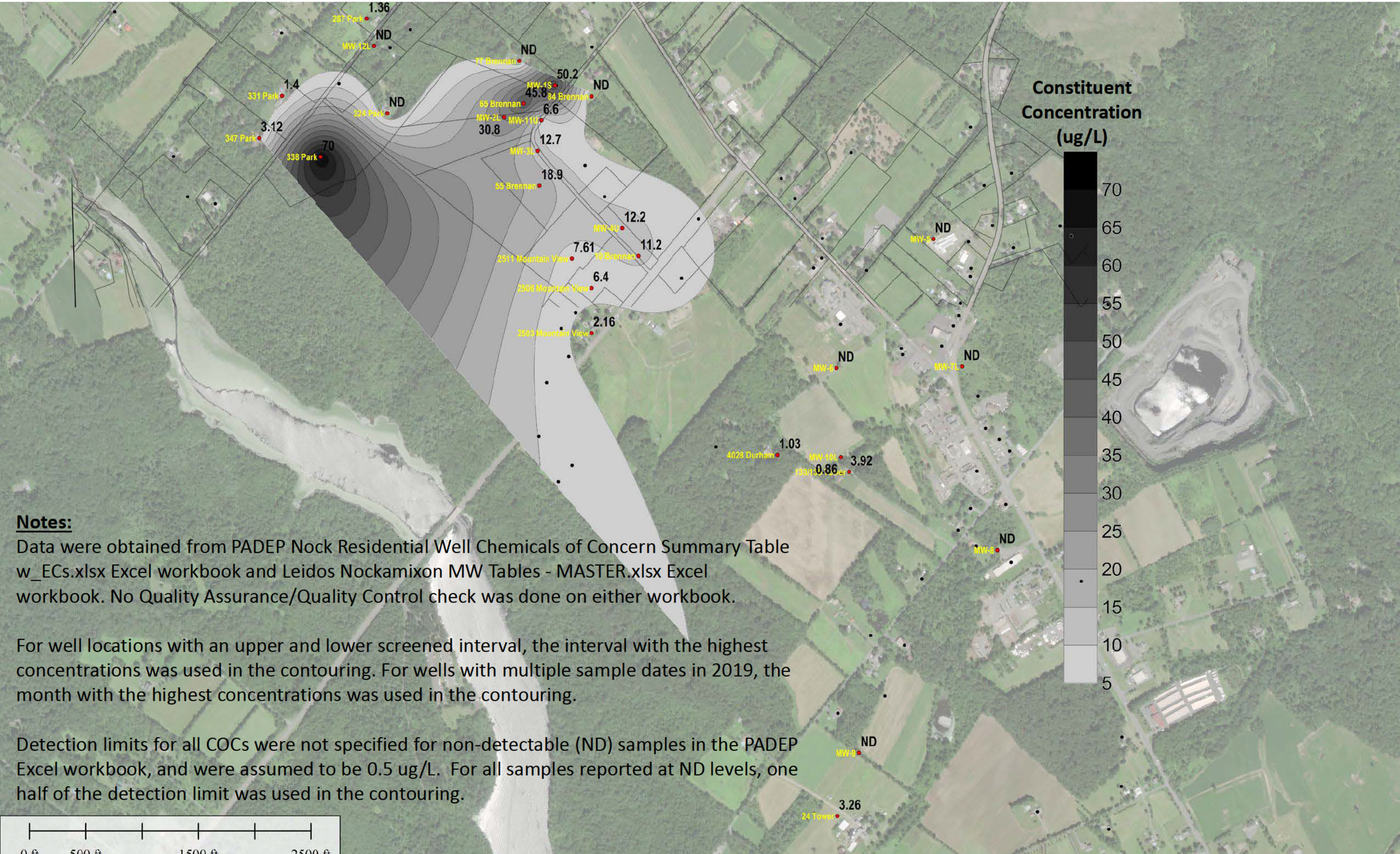
Notes:

Data were obtained from PADEP Nock Residential Well Chemicals of Concern Summary Table w_ECs.xlsx Excel workbook and Leidos Nockamixon MW Tables - MASTER.xlsx Excel workbook. No Quality Assurance/Quality Control check was done on either workbook.

For well locations with an upper and lower screened interval, the interval with the highest concentrations was used in the contouring. For wells with multiple sample dates in 2019, the month with the highest concentrations was used in the contouring.

Detection limits for all COCs were not specified for non-detectable (ND) samples in the PADEP Excel workbook, and were assumed to be 0.5 ug/L. For all samples reported at ND levels, one half of the detection limit was used in the contouring.

Figure E19A: Tetrachloroethene (PCE) Concentrations (ug/L) in Groundwater – 2019



Notes:

Data were obtained from PADEP Nock Residential Well Chemicals of Concern Summary Table w_ECs.xlsx Excel workbook and Leidos Nockamixon MW Tables - MASTER.xlsx Excel workbook. No Quality Assurance/Quality Control check was done on either workbook.

For well locations with an upper and lower screened interval, the interval with the highest concentrations was used in the contouring. For wells with multiple sample dates in 2019, the month with the highest concentrations was used in the contouring.

Detection limits for all COCs were not specified for non-detectable (ND) samples in the PADEP Excel workbook, and were assumed to be 0.5 ug/L. For all samples reported at ND levels, one half of the detection limit was used in the contouring.

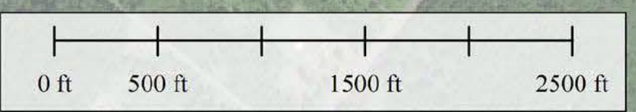
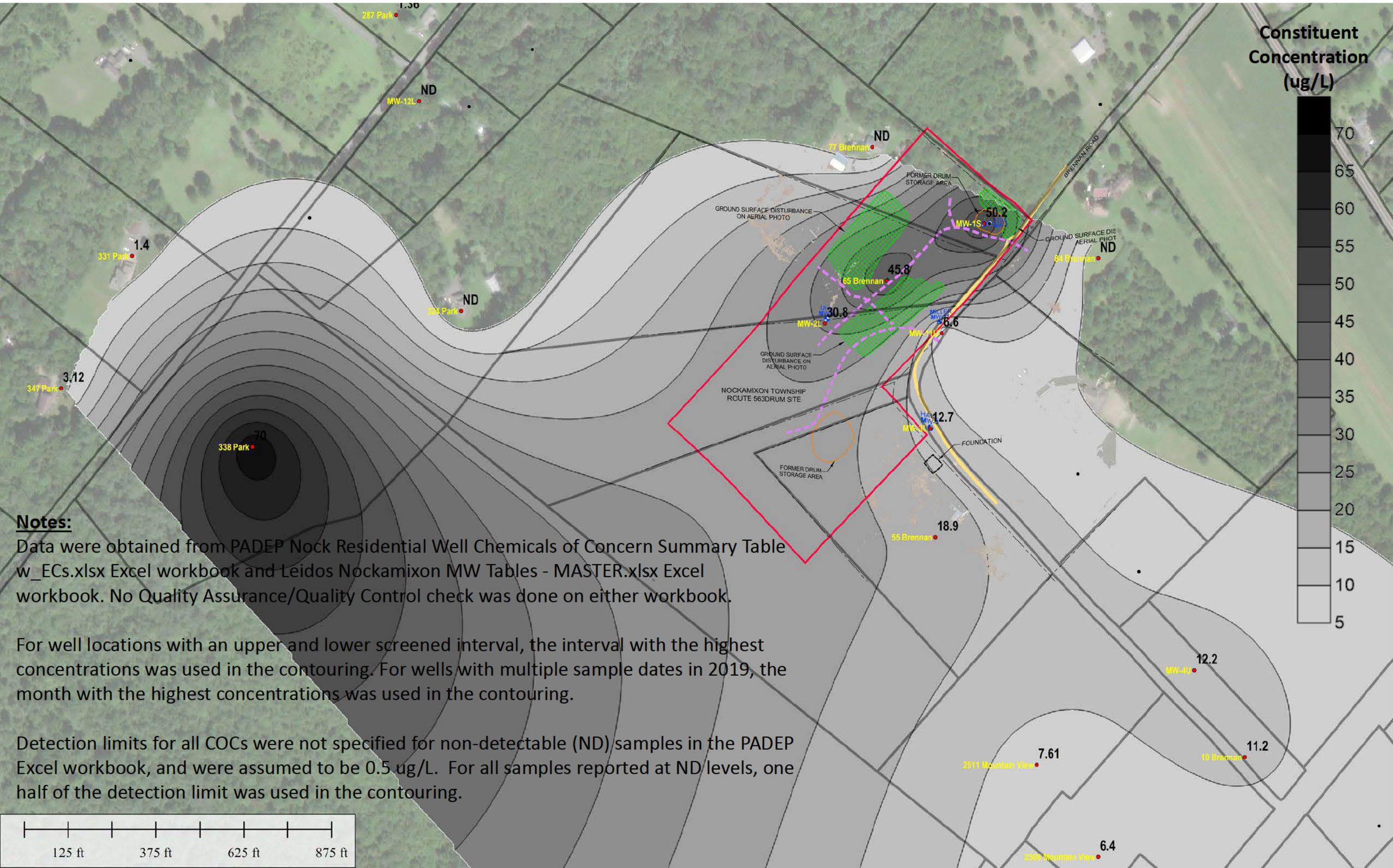


Figure E19B: Tetrachloroethene (PCE) Concentrations (ug/L) in Groundwater – 2019 (with suspected source area overlay)



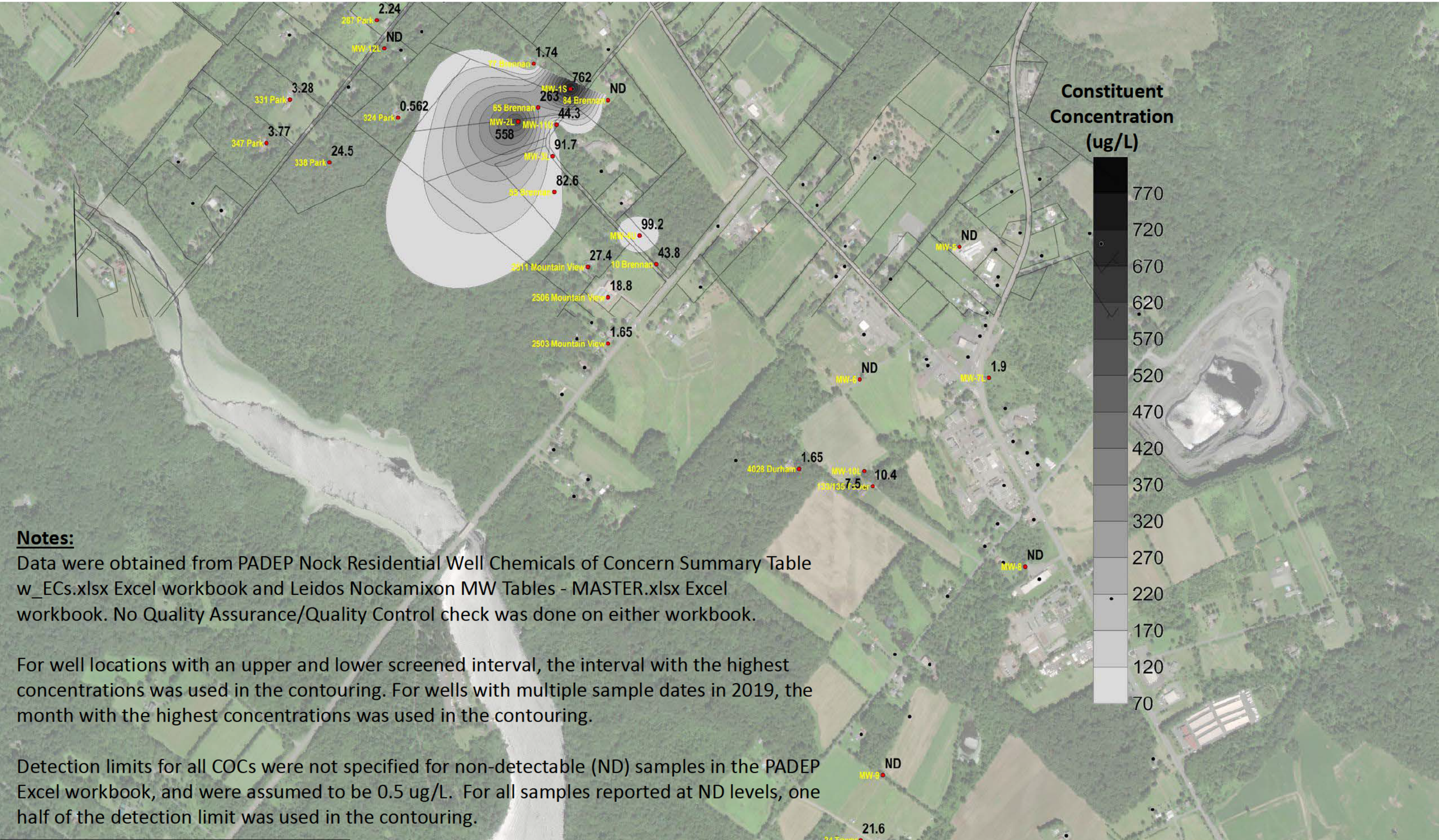
Notes:

Data were obtained from PADEP Nock Residential Well Chemicals of Concern Summary Table w_ECs.xlsx Excel workbook and Leidos Nockamixon MW Tables - MASTER.xlsx Excel workbook. No Quality Assurance/Quality Control check was done on either workbook.

For well locations with an upper and lower screened interval, the interval with the highest concentrations was used in the contouring. For wells with multiple sample dates in 2019, the month with the highest concentrations was used in the contouring.

Detection limits for all COCs were not specified for non-detectable (ND) samples in the PADEP Excel workbook, and were assumed to be 0.5 ug/L. For all samples reported at ND levels, one half of the detection limit was used in the contouring.

Figure E20A: cis-1,2 Dichloroethene (DCE) Concentrations (ug/L) in Groundwater – 2019



Notes:

Data were obtained from PADEP Nock Residential Well Chemicals of Concern Summary Table w_ECs.xlsx Excel workbook and Leidos Nockamixon MW Tables - MASTER.xlsx Excel workbook. No Quality Assurance/Quality Control check was done on either workbook.

For well locations with an upper and lower screened interval, the interval with the highest concentrations was used in the contouring. For wells with multiple sample dates in 2019, the month with the highest concentrations was used in the contouring.

Detection limits for all COCs were not specified for non-detectable (ND) samples in the PADEP Excel workbook, and were assumed to be 0.5 ug/L. For all samples reported at ND levels, one half of the detection limit was used in the contouring.

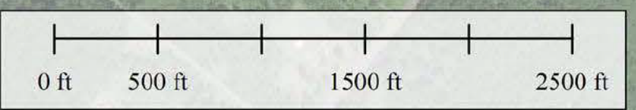
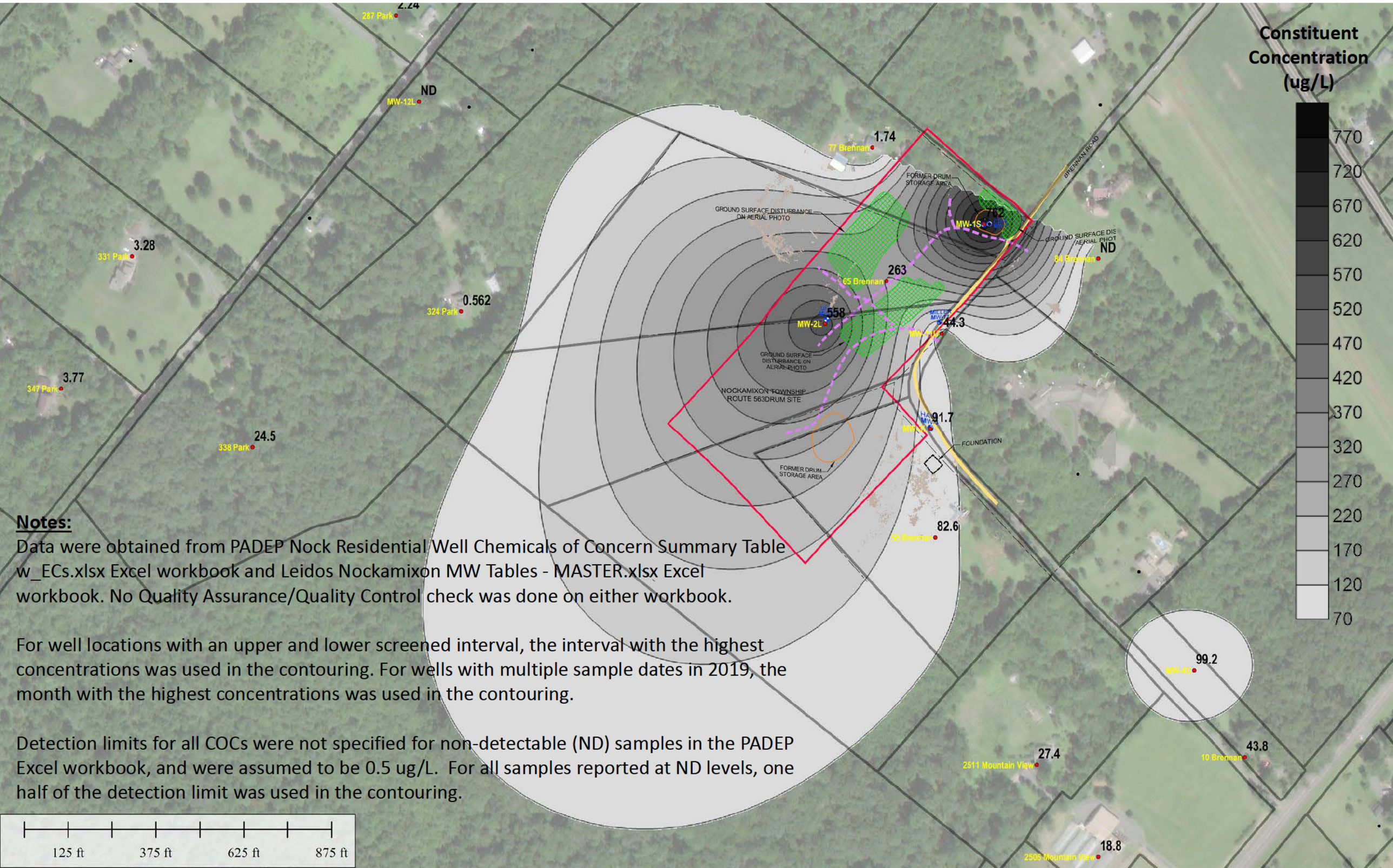


Figure E20A: cis-1,2 Dichloroethene (DCE) Concentrations (ug/L) in Groundwater – 2019 (with suspected source area overlay)



Notes:

Data were obtained from PADEP Nock Residential Well Chemicals of Concern Summary Table w_ECs.xlsx Excel workbook and Leidos Nockamixon MW Tables - MASTER.xlsx Excel workbook. No Quality Assurance/Quality Control check was done on either workbook.

For well locations with an upper and lower screened interval, the interval with the highest concentrations was used in the contouring. For wells with multiple sample dates in 2019, the month with the highest concentrations was used in the contouring.

Detection limits for all COCs were not specified for non-detectable (ND) samples in the PADEP Excel workbook, and were assumed to be 0.5 ug/L. For all samples reported at ND levels, one half of the detection limit was used in the contouring.

FIGURE E21: Mann-Kendall Plume Stability Analysis Results - Trichloroethene (TCE) in Bedrock Groundwater

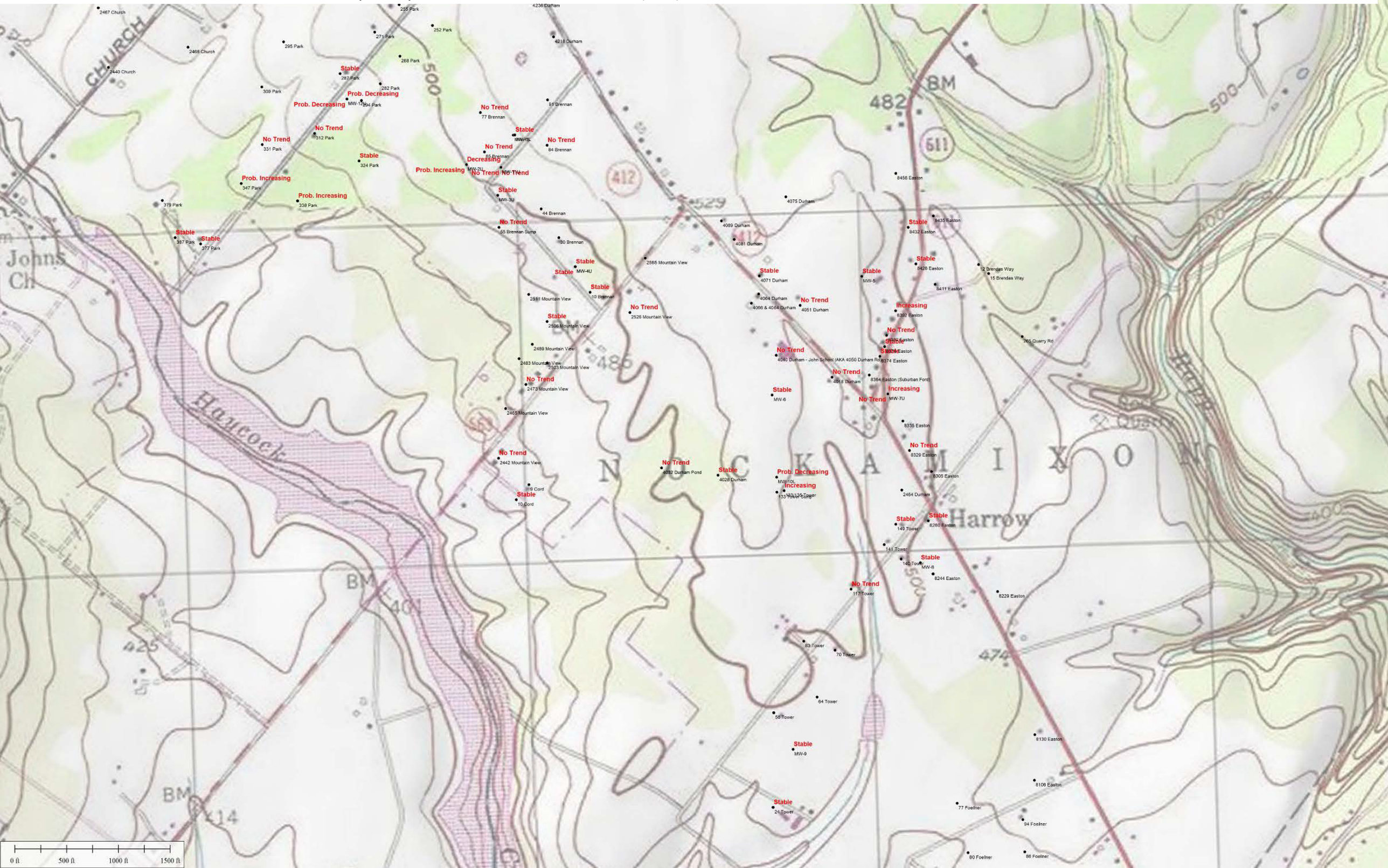


FIGURE E22: Mann-Kendall Plume Stability Analysis Results - Tetrachloroethene (PCE) in Bedrock Groundwater

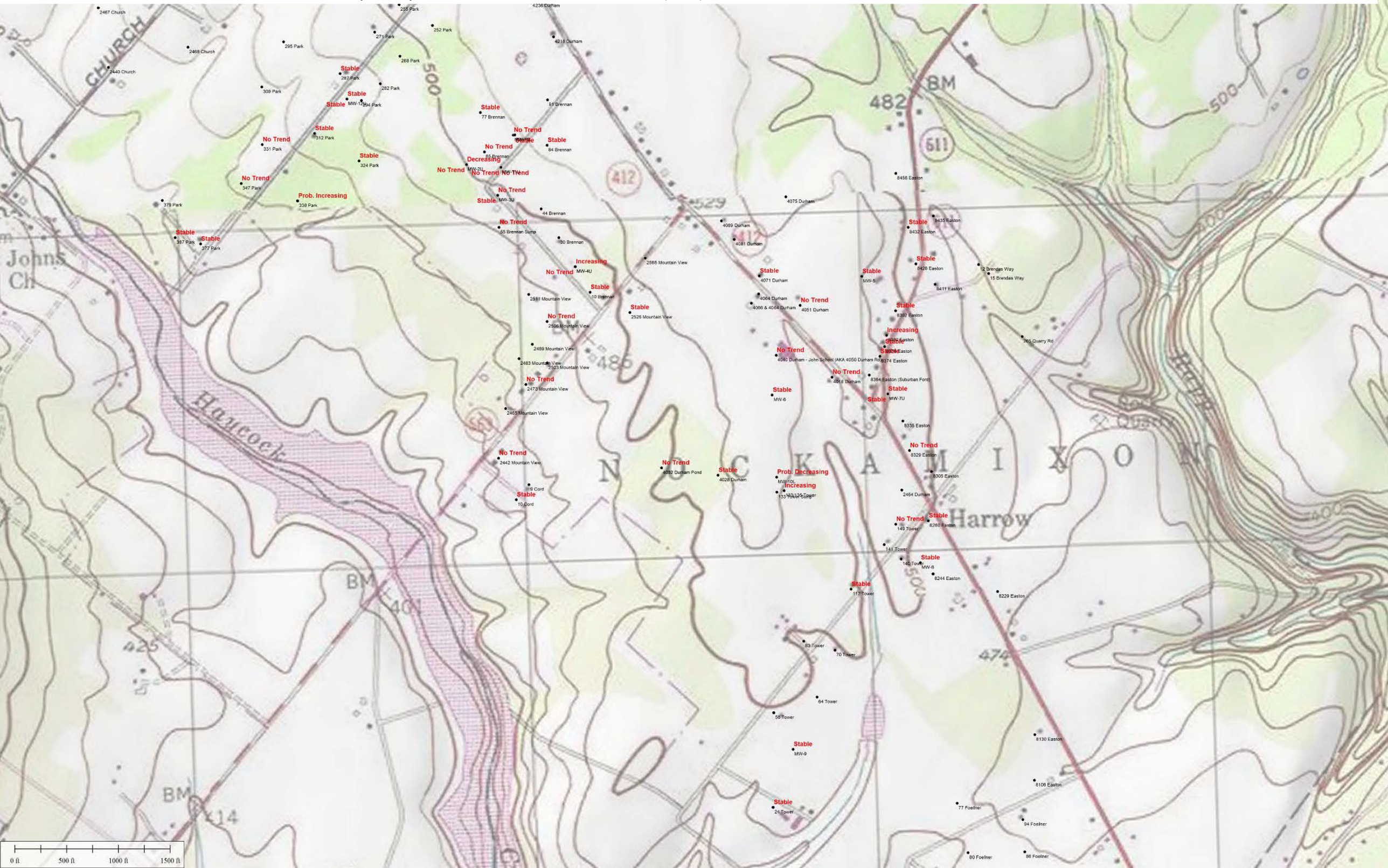


Figure E23: May 29, 2019 Groundwater Elevation Contour Map with Bedrock Elevation Contours

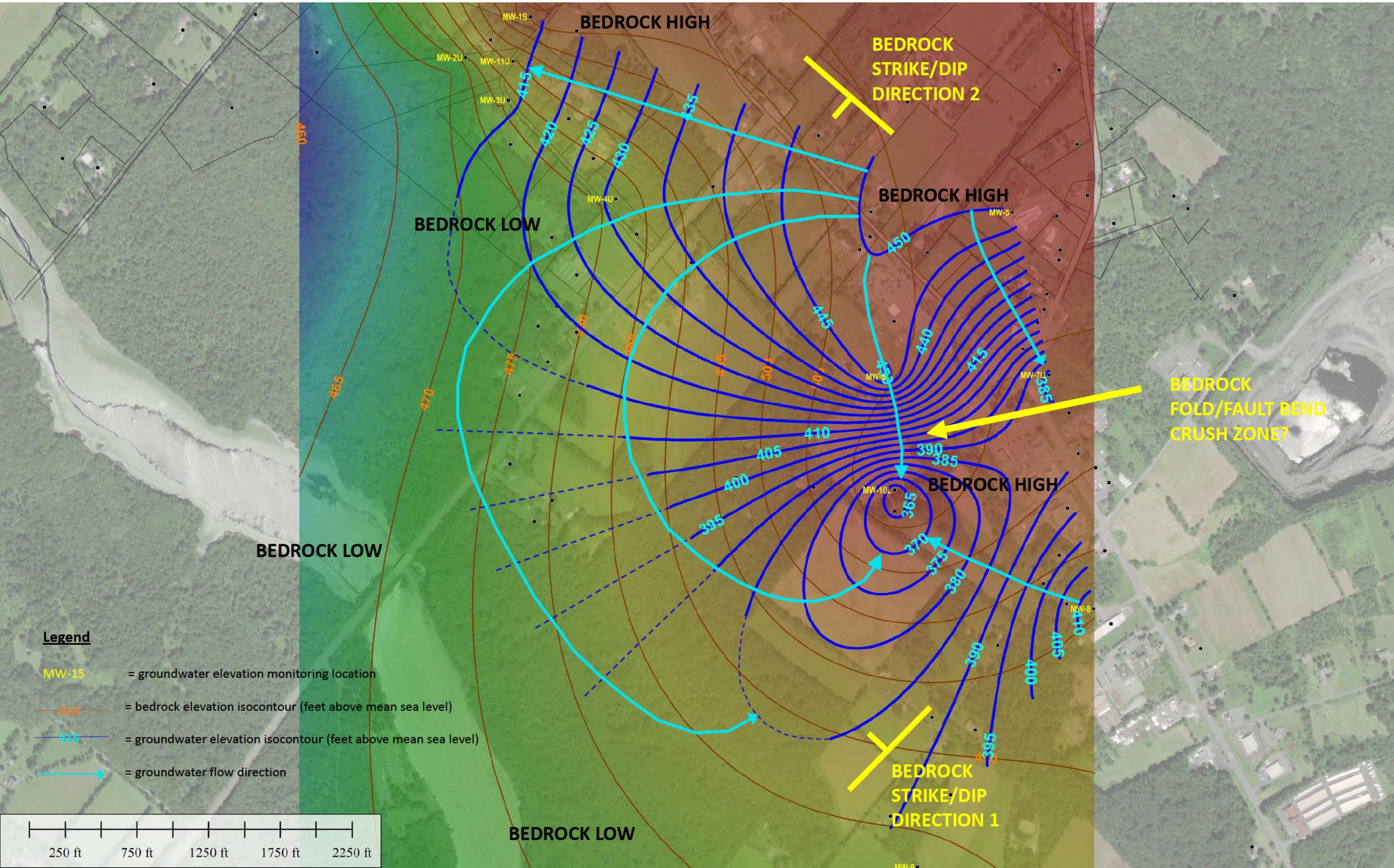


Figure E24: May 29, 2019 Groundwater Elevation Contour Map with Bedrock Elevation Contours and TCE Plume Extents

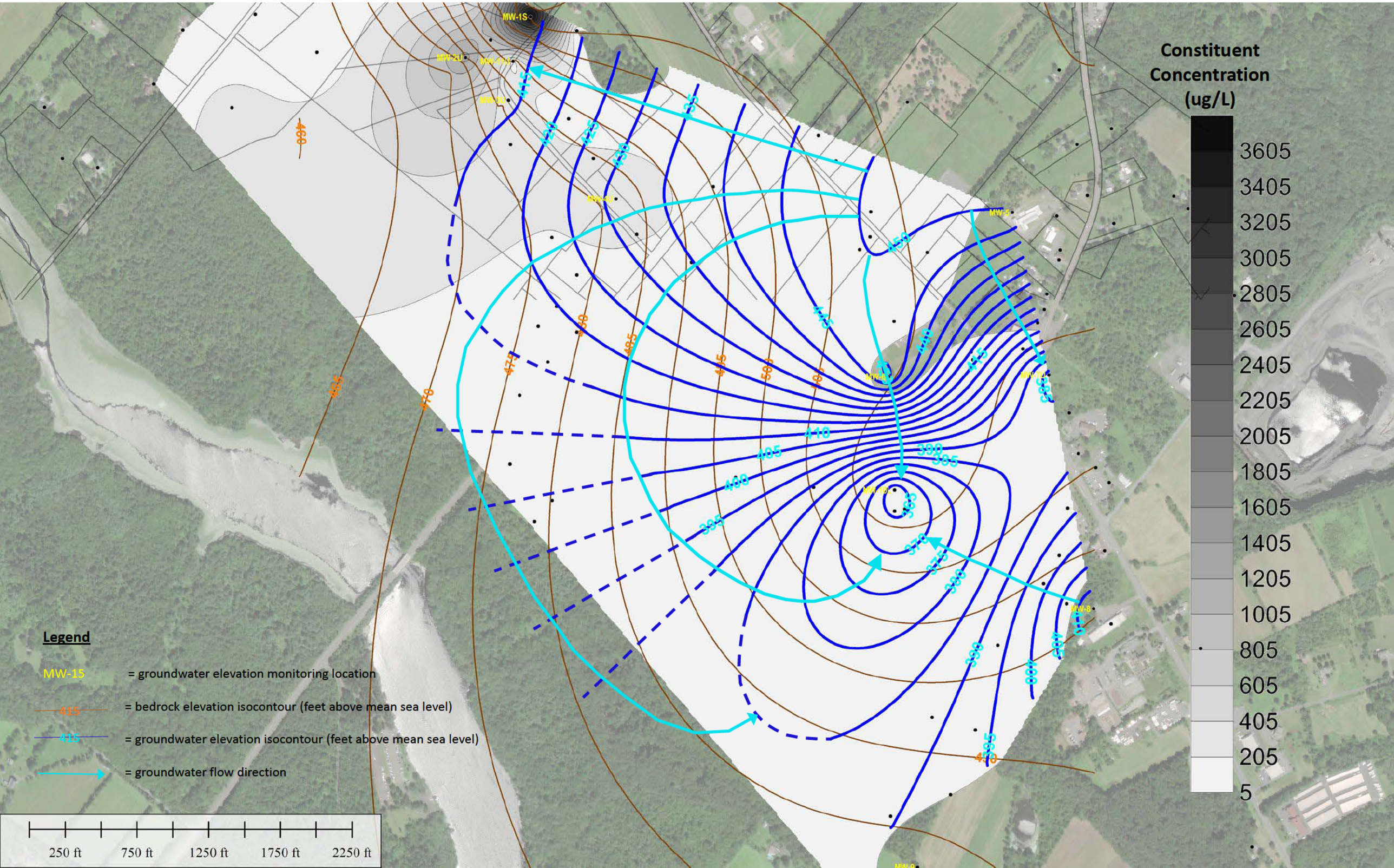


Figure E25: May 29, 2019 Groundwater Elevation Contour Map with Bedrock Elevation Contours and PCE Plume Extents

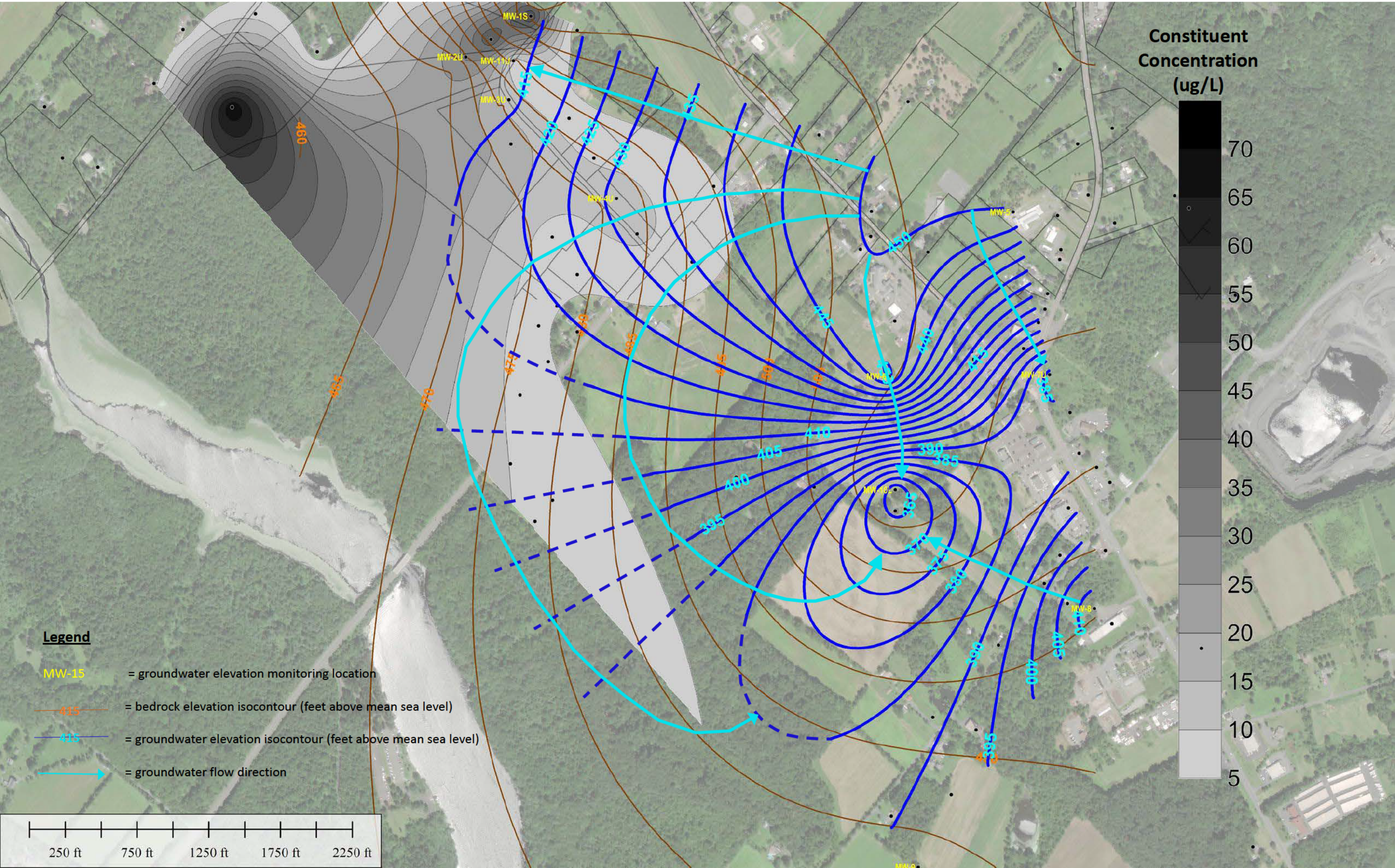


Figure E26: May 29, 2019 Groundwater Elevation Contour Map with Bedrock Elevation Contours and cis 1,2 DCE Plume Extents

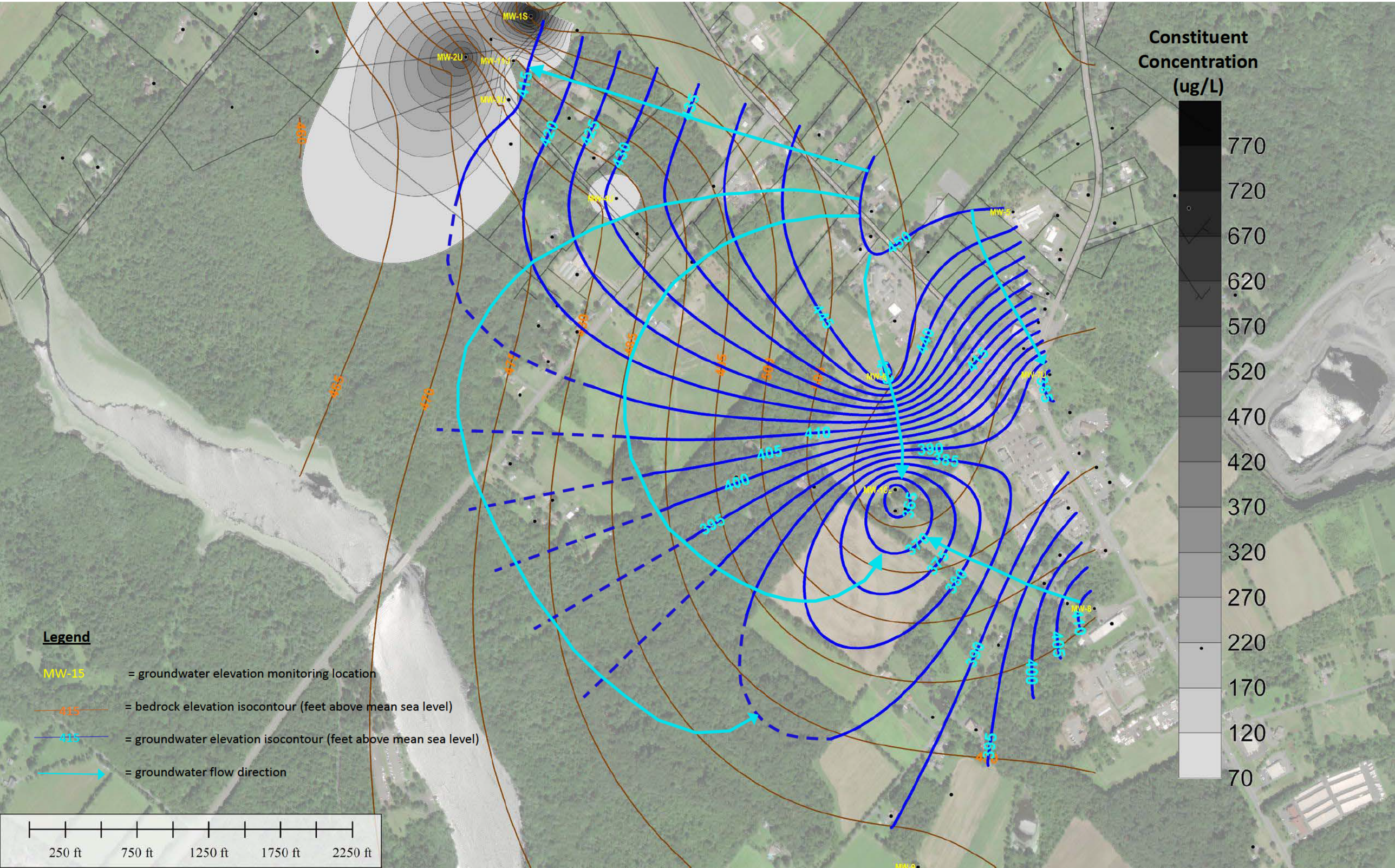
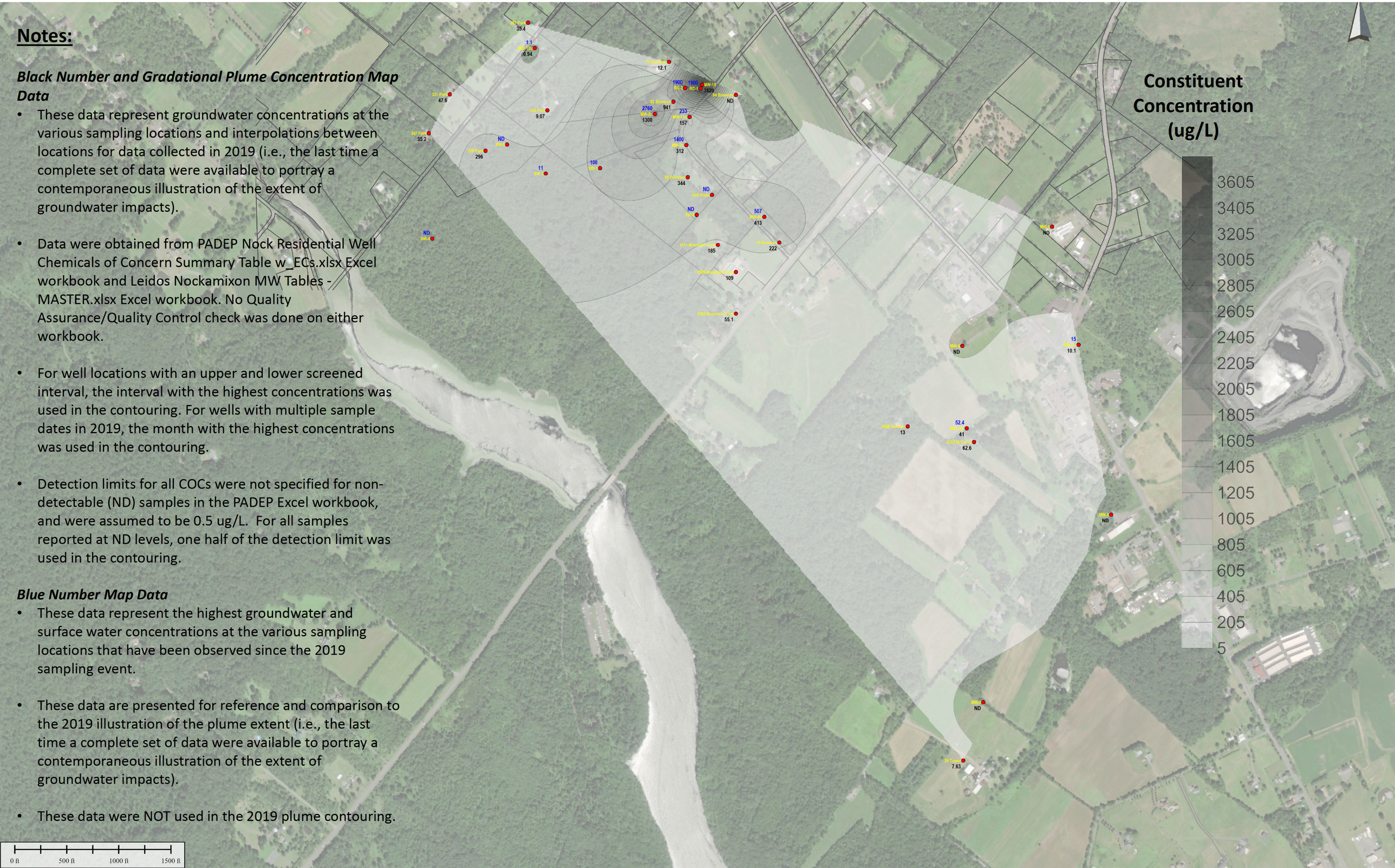


Figure 27A: Trichloroethene (TCE) Concentrations (ug/L) in Groundwater – 2019 (with 2020-2023 Additional Data)



Notes:

Black Number and Gradational Plume Concentration Map Data

- These data represent groundwater concentrations at the various sampling locations and interpolations between locations for data collected in 2019 (i.e., the last time a complete set of data were available to portray a contemporaneous illustration of the extent of groundwater impacts).

- Data were obtained from PADEP Nock Residential Well Chemicals of Concern Summary Table w_ECs.xlsx Excel workbook and Leidos Nockamixon MW Tables - MASTER.xlsx Excel workbook. No Quality Assurance/Quality Control check was done on either workbook.

- For well locations with an upper and lower screened interval, the interval with the highest concentrations was used in the contouring. For wells with multiple sample dates in 2019, the month with the highest concentrations was used in the contouring.

- Detection limits for all COCs were not specified for non-detectable (ND) samples in the PADEP Excel workbook, and were assumed to be 0.5 ug/L. For all samples reported at ND levels, one half of the detection limit was used in the contouring.

Blue Number Map Data

- These data represent the highest groundwater and surface water concentrations at the various sampling locations that have been observed since the 2019 sampling event.

- These data are presented for reference and comparison to the 2019 illustration of the plume extent (i.e., the last time a complete set of data were available to portray a contemporaneous illustration of the extent of groundwater impacts).

- These data were NOT used in the 2019 plume contouring.

Figure 27B: Trichloroethene (TCE) Concentrations (ug/L) in Groundwater – 2019 (with 2020-2023 Additional Data)

Notes:

Black Number and Gradational Plume Concentration Map Data

- These data represent groundwater concentrations at the various sampling locations and interpolations between locations for data collected in 2019 (i.e., the last time a complete set of data were available to portray a contemporaneous illustration of the extent of groundwater impacts).

- Data were obtained from PADEP Nock Residential Well Chemicals of Concern Summary Table w_ECs.xlsx Excel workbook and Leidos Nockamixon MW Tables - MASTER.xlsx Excel workbook. No Quality Assurance/Quality Control check was done on either workbook.

- For well locations with an upper and lower screened interval, the interval with the highest concentrations was used in the contouring. For wells with multiple sample dates in 2019, the month with the highest concentrations was used in the contouring.

- Detection limits for all COCs were not specified for non-detectable (ND) samples in the PADEP Excel workbook, and were assumed to be 0.5 ug/L. For all samples reported at ND levels, one half of the detection limit was used in the contouring.

Blue Number Map Data

- These data represent the highest groundwater and surface water concentrations at the various sampling locations that have been observed since the 2019 sampling event.

- These data are presented for reference and comparison to the 2019 illustration of the plume extent (i.e., the last time a complete set of data were available to portray a contemporaneous illustration of the extent of groundwater impacts).

- These data were NOT used in the 2019 plume contouring.

0 ft 500 ft 1000 ft 1500 ft

BEDROCK HIGH

BEDROCK LOW

BEDROCK STRIKE/DIP DIRECTION 2

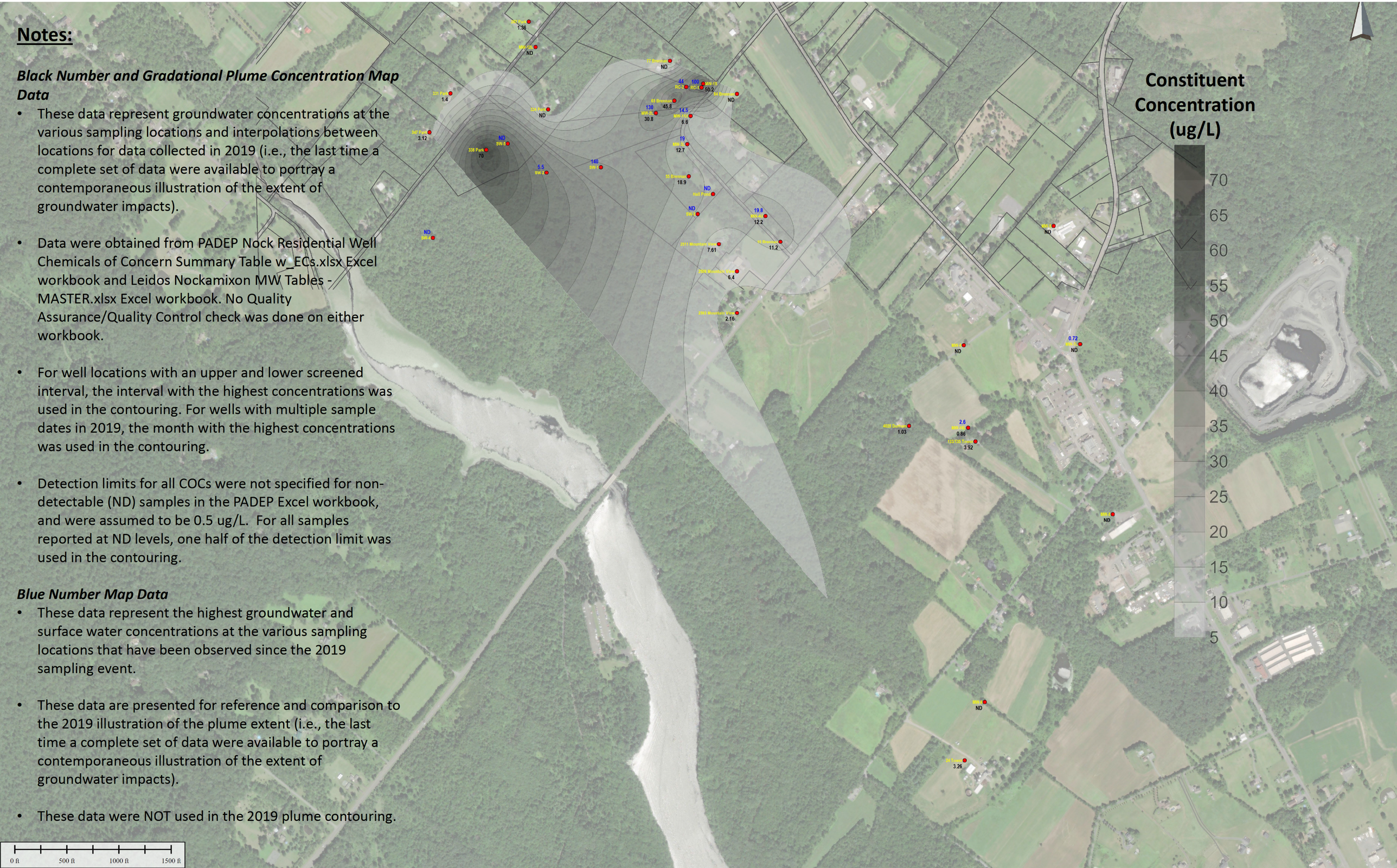
BEDROCK STRIKE/DIP DIRECTION 1

BEDROCK FOLD/FAULT BEND CRUSH ZONE?

Constituent Concentration (ug/L)

3605
3405
3205
3005
2805
2605
2405
2205
2005
1805
1605
1405
1205
1005
805
605
405
205
5

Figure 28A: Tetrachloroethene (PCE) Concentrations (ug/L) in Groundwater – 2019 (with 2020-2023 Additional Data)



Notes:

Black Number and Gradational Plume Concentration Map Data

- These data represent groundwater concentrations at the various sampling locations and interpolations between locations for data collected in 2019 (i.e., the last time a complete set of data were available to portray a contemporaneous illustration of the extent of groundwater impacts).

- Data were obtained from PADEP Nock Residential Well Chemicals of Concern Summary Table w_ECs.xlsx Excel workbook and Leidos Nockamixon MW Tables - MASTER.xlsx Excel workbook. No Quality Assurance/Quality Control check was done on either workbook.

- For well locations with an upper and lower screened interval, the interval with the highest concentrations was used in the contouring. For wells with multiple sample dates in 2019, the month with the highest concentrations was used in the contouring.

- Detection limits for all COCs were not specified for non-detectable (ND) samples in the PADEP Excel workbook, and were assumed to be 0.5 ug/L. For all samples reported at ND levels, one half of the detection limit was used in the contouring.

Blue Number Map Data

- These data represent the highest groundwater and surface water concentrations at the various sampling locations that have been observed since the 2019 sampling event.

- These data are presented for reference and comparison to the 2019 illustration of the plume extent (i.e., the last time a complete set of data were available to portray a contemporaneous illustration of the extent of groundwater impacts).

- These data were NOT used in the 2019 plume contouring.

Figure 28B: Tetrachloroethene (PCE) Concentrations (ug/L) in Groundwater – 2019 (with 2020-2023 Additional Data)

Notes:

Black Number and Gradational Plume Concentration Map Data

- These data represent groundwater concentrations at the various sampling locations and interpolations between locations for data collected in 2019 (i.e., the last time a complete set of data were available to portray a contemporaneous illustration of the extent of groundwater impacts).

- Data were obtained from PADEP Nock Residential Well Chemicals of Concern Summary Table w_ECs.xlsx Excel workbook and Leidos Nockamixon MW Tables - MASTER.xlsx Excel workbook. No Quality Assurance/Quality Control check was done on either workbook.

- For well locations with an upper and lower screened interval, the interval with the highest concentrations was used in the contouring. For wells with multiple sample dates in 2019, the month with the highest concentrations was used in the contouring.

- Detection limits for all COCs were not specified for non-detectable (ND) samples in the PADEP Excel workbook, and were assumed to be 0.5 ug/L. For all samples reported at ND levels, one half of the detection limit was used in the contouring.

Blue Number Map Data

- These data represent the highest groundwater and surface water concentrations at the various sampling locations that have been observed since the 2019 sampling event.

- These data are presented for reference and comparison to the 2019 illustration of the plume extent (i.e., the last time a complete set of data were available to portray a contemporaneous illustration of the extent of groundwater impacts).

- These data were NOT used in the 2019 plume contouring.

BEDROCK HIGH

BEDROCK STRIKE/DIP DIRECTION 2

BEDROCK LOW

BEDROCK HIGH

BEDROCK FOLD/FAULT BEND CRUSH ZONE?

BEDROCK HIGH

BEDROCK LOW

BEDROCK STRIKE/DIP DIRECTION 1

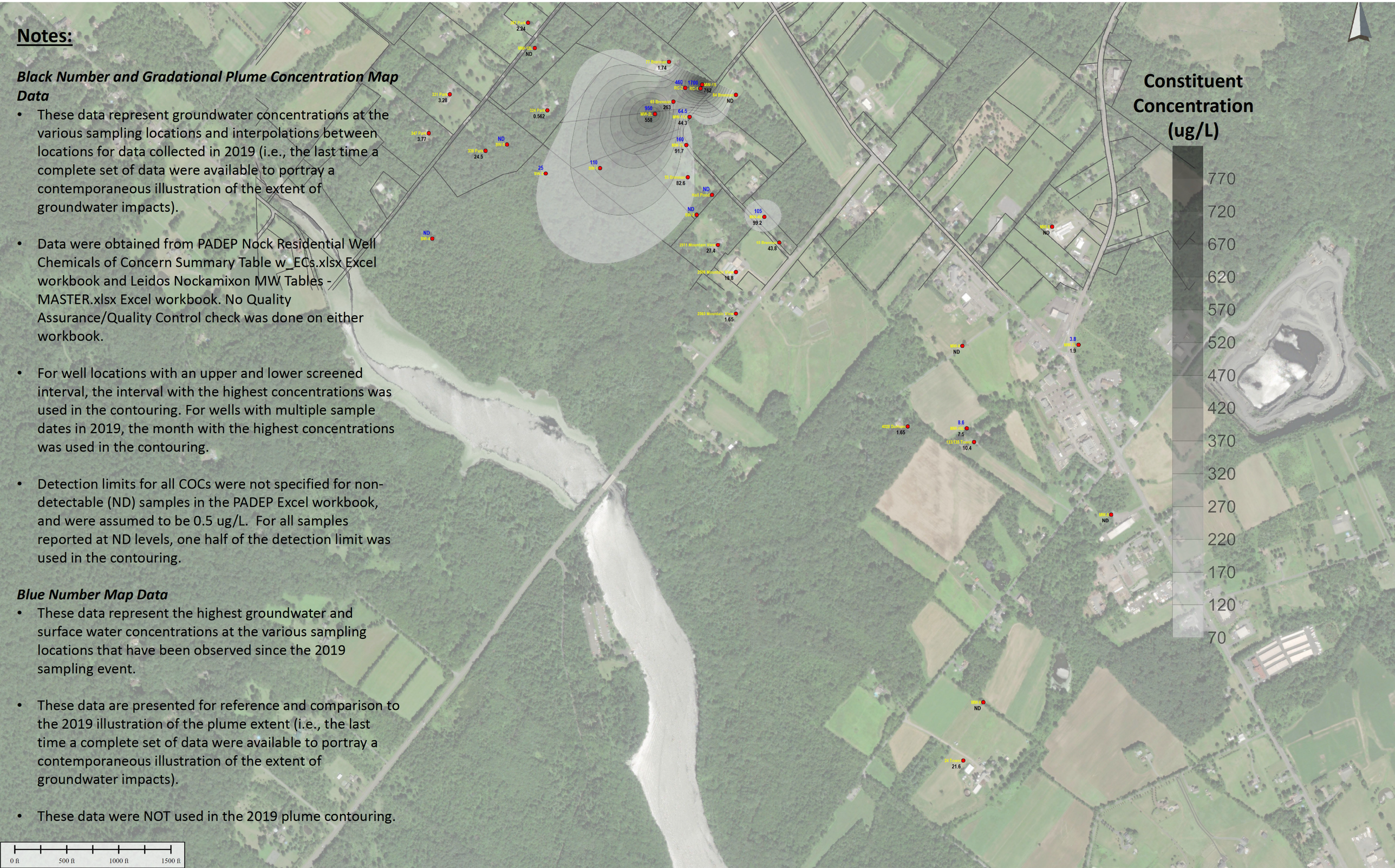
BEDROCK LOW

Constituent Concentration (ug/L)

70
65
60
55
50
40
35
30
25
20
15
10
5

0 ft 500 ft 1000 ft 1500 ft

Figure 29A: cis-1,2 Dichloroethene (DCE) Concentrations (ug/L) in Groundwater – 2019 (with 2020-2023 Additional Data)



Notes:

Black Number and Gradational Plume Concentration Map Data

- These data represent groundwater concentrations at the various sampling locations and interpolations between locations for data collected in 2019 (i.e., the last time a complete set of data were available to portray a contemporaneous illustration of the extent of groundwater impacts).

- Data were obtained from PADEP Nock Residential Well Chemicals of Concern Summary Table w_ECs.xlsx Excel workbook and Leidos Nockamixon MW Tables - MASTER.xlsx Excel workbook. No Quality Assurance/Quality Control check was done on either workbook.

- For well locations with an upper and lower screened interval, the interval with the highest concentrations was used in the contouring. For wells with multiple sample dates in 2019, the month with the highest concentrations was used in the contouring.

- Detection limits for all COCs were not specified for non-detectable (ND) samples in the PADEP Excel workbook, and were assumed to be 0.5 ug/L. For all samples reported at ND levels, one half of the detection limit was used in the contouring.

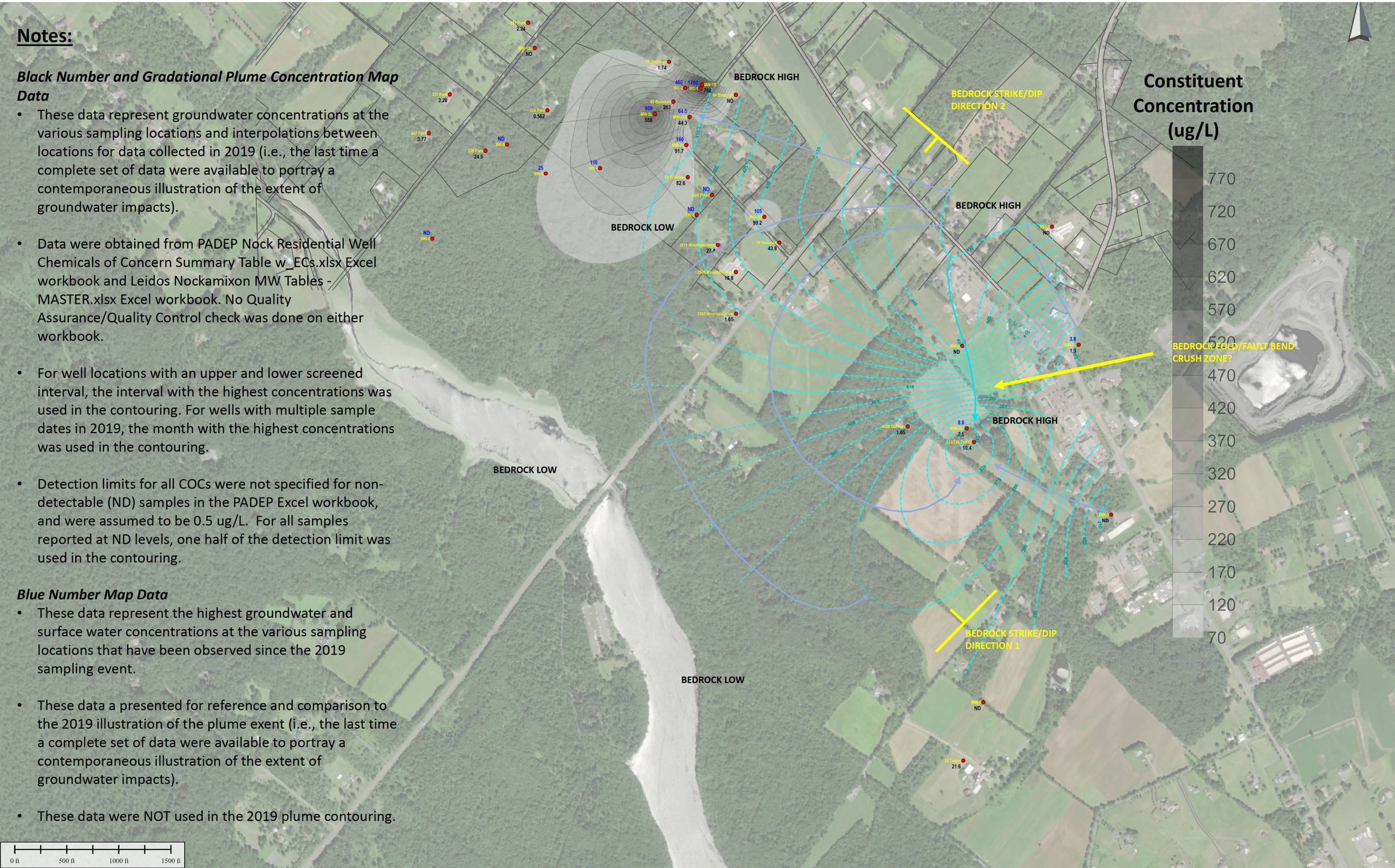
Blue Number Map Data

- These data represent the highest groundwater and surface water concentrations at the various sampling locations that have been observed since the 2019 sampling event.

- These data are presented for reference and comparison to the 2019 illustration of the plume extent (i.e., the last time a complete set of data were available to portray a contemporaneous illustration of the extent of groundwater impacts).

- These data were NOT used in the 2019 plume contouring.

Figure 29B: cis-1,2 Dichloroethene (DCE) Concentrations (ug/L) in Groundwater – 2019 (with 2020-2023 Additional Data)



Notes:

Black Number and Gradational Plume Concentration Map Data

- These data represent groundwater concentrations at the various sampling locations and interpolations between locations for data collected in 2019 (i.e., the last time a complete set of data were available to portray a contemporaneous illustration of the extent of groundwater impacts).

- Data were obtained from PADEP Nock Residential Well Chemicals of Concern Summary Table w_ECs.xlsx Excel workbook and Leidos Nockamixon MW Tables - MASTER.xlsx Excel workbook. No Quality Assurance/Quality Control check was done on either workbook.

- For well locations with an upper and lower screened interval, the interval with the highest concentrations was used in the contouring. For wells with multiple sample dates in 2019, the month with the highest concentrations was used in the contouring.

- Detection limits for all COCs were not specified for non-detectable (ND) samples in the PADEP Excel workbook, and were assumed to be 0.5 ug/L. For all samples reported at ND levels, one half of the detection limit was used in the contouring.

Blue Number Map Data

- These data represent the highest groundwater and surface water concentrations at the various sampling locations that have been observed since the 2019 sampling event.

- These data a presented for reference and comparison to the 2019 illustration of the plume exent (i.e., the last time a complete set of data were available to portray a contemporaneous illustration of the extent of groundwater impacts).

- These data were NOT used in the 2019 plume contouring.

Appendix E – Tables

Table E1: Summary of Top of Bedrock Depths and Elevations

X (SPCS PA North, Feet)	Y (SPCS PA North, Feet)	Sample Location	Ground Surface Elevation (feet amsl)	Depth to Bedrock (feet)	Bedrock Elevation (feet amsl)
2683376.89	129350.69	MW-10	515.525	1	515
2684765.01	128523.73	MW-8	497.221	2	495
2680783.32	132681.74	C-100	513.224	3.5	510
2684451.95	130154.03	MW-7	512.109	3.5	509
2684197.95	131288.15	MW-5	518.546	4	515
2680704.52	132334.57	B_RD-400	494.084	4.5	490
2680813.21	132720.98	C-50	514.023	4.5	510
2680817.57	132772.67	D-0	515.613	4.8	511
2680653.78	132772.67	F-100W	509.423	5	504
2680682.91	132071.01	MW-3	488.033	5	483
2681433.52	131382.67	MW-4	485.884	5	481
2683536.38	126722.12	MW-9	487.902	5	483
2680878.6	132651.85	A-50	514.262	5.5	509
2680699.54	132354.29	B_RD-400N	496.714	5.5	491
2680615.91	132608.31	E-250	504.006	5.5	499
2680570.95	132683.61	G-200	503.487	5.5	498
2680605.86	132025.5	X-700	485.609	5.5	480
2680757.78	132705.41	D-100	512.452	6	506
2683335.54	130142.22	MW-6	515.716	6	510
2680715.29	132341.62	MW-11	494.718	6	489
2679227.82	133001.54	MW-12	467.938	6	462
2680818.19	132645.62	B-100	510.701	7	504
2680645.09	132038.11	MW3-600/650	486.86	7	480
2680668.11	132787.61	F-100N	510.629	9.1	502
2680667.48	132757.72	F-100S	509.65	9.5	500
2680382.94	132368.85	MW-2	489.943	10	480
2680337.13	132303.86	E-700	485.332	14.5	471
			Minimum =	1.0	
			Maximum =	14.5	
			Average =	5.8	

Notes:

SPCS = State Plane Coordinate System

amsl = above mean sea level

Table E2: Summary of Well Construction Information

Latitude	Longitude	Install Date	Well	Ground Surface Elevation (feet amsl)	Well Diameter (inches)	TOSC Elevation (feet amsl)	Steel Casing Length (feet bgs)	Well Depth (feet bgs)	Well Bottom Elevation (feet amsl)	Screen Length (feet)	Screened Interval (feet bgs)	Notes
40.501783	-75.188379	4/30/2012	MW-1	502.71	6	504.76	40	300.00	202.71	--	--	Original Boring
40.501783	-75.188379	12/18/2012	MW-1U	502.71	2	--	--	143.00	359.71	30	113-143	tonite in screen at 114'. No longer usable.
40.501783	-75.188379	12/18/2012	MW-1L	502.71	2	--	--	230.00	272.71	70	170-230	Opening: 0.040 Slot
40.501782	-75.188434	5/16/2013	MW-1S	501.58	6	504.15	40	145.00	356.58	--	--	pen Borehole. MW-1-Upper replacement.
40.501080	-75.190104	5/2/2012	MW-2	479.39	6	481.42	40	250.00	229.39	--	--	Original Boring
40.501080	-75.190104	1/10/2013	MW-2U	479.39	2	--	--	154.00	325.39	20	134-154	Opening: 0.040 Slot
40.501080	-75.190104	1/10/2013	MW-2L	479.39	2	--	--	190.50	288.89	20	170.5-190.5	Opening: 0.040 Slot
40.500218	-75.189037	5/10/2012	MW-3	478.58	6	480.70	40	250.00	228.58	--	--	Original Boring
40.500218	-75.189037	1/9/2013	MW-3U	478.58	2	--	--	119.00	359.58	30	89-119	Opening: 0.040 Slot
40.500218	-75.189037	12/17/2012	MW-3L	478.58	2	--	--	187.00	291.58	20	167-187	Opening: 0.040 Slot
40.498283	-75.186434	5/16/2012	MW-4	480.06	6	482.95	40	300.00	180.06	--	--	Original Boring
40.498283	-75.186434	3/8/2013	MW-4U	480.06	2	--	--	129.00	351.06	80	49-129	Opening: 0.020 Slot
40.498283	-75.186434	3/8/2013	MW-4L	480.06	2	--	--	248.00	232.06	80	168-248	Opening: 0.020 Slot
40.497808	-75.176507	5/7/2012	MW-5	510.42	6	512.96	40	300.00	210.42	--	--	Open Borehole
40.494727	-75.179733	5/9/2012	MW-6	506.95	6	509.27	40	300.00	206.95	--	--	Open Borehole
40.494684	-75.175704	5/8/2012	MW-7	502.72	6	504.35	40	300.00	202.72	--	--	Original Boring
40.494684	-75.175704	1/2/2013	MW-7U	502.72	2	--	--	195.50	307.22	100	95.5-195.5	Opening: 0.040 Slot
40.494684	-75.175704	12/20/2012	MW-7L	502.72	2	--	--	297.00	205.72	30	267-297	Opening: 0.040 Slot
40.490165	-75.174763	5/12/2012	MW-8	487.81	6	489.65	40	300.00	187.81	--	--	Open Borehole
40.485319	-75.179371	5/11/2012	MW-9	478.28	6	480.48	40	250.00	228.28	--	--	Open Borehole (partial obstruction at 93')
40.492570	-75.179665	5/15/2012	MW-10	506.39	6	508.47	40	300.00	206.39	--	--	Original Boring
40.492570	-75.179665	12/20/2012	MW-10U	506.39	2	--	--	149.00	357.39	40	109-149	tonite in screen at 127'. No longer usable.
40.492570	-75.179665	12/18/2012	MW-10L	506.39	2	--	--	215.00	291.39	40	175-215	Opening: 0.040 Slot
40.50098	-75.188923	5/15/2013	MW-11	485.18	6	487.68	40	250.00	235.18	--	--	Original Boring
40.50098	-75.188923	8/23/2013	MW-11U	485.18	2	--	--	145.00	340.18	50	95-145	Opening: 0.020 Slot
40.50098	-75.188923	8/23/2013	MW-11L	485.18	2	--	--	204.00	281.18	40	164-204	Opening: 0.020 Slot
40.50292	-75.194193	5/14/2013	MW-12	458.00	6	460.05	40	300.00	158.00	--	--	Original Boring
40.50292	-75.194193	8/22/2013	MW-12U	458.00	2	--	--	155.00	303.00	90	65-155	Opening: 0.020 Slot
40.50292	-75.194193	8/22/2013	MW-12L	458.00	2	--	--	225.00	233.00	35	190-225	Opening: 0.020 Slot

Notes:

bgs = below ground surface

amsl = above mean sea level

UPPER ZONE WELL STATISTICS

Max =	195.50	359.58
Min =	119.00	303.00
Avg =	225.21	263.21

LOWER ZONE AND OPEN HOLE WELL STATISTICS

Max =	300.00	291.58
Min =	187.00	187.81
Avg =	249.73	240.98

Table E3: Summary of Groundwater Fluid Level Measurements

X (SPSC PA North, Feet)	Y (SPSC PA North, Feet)	Well #	TOC Elevation (feet amsl)	3/18/2014 WL (feet BTOC)	3/18/2014 GW Elev (feet amsl)	9/9/2015 WL (feet BTOC)	9 /9/2015 GW Elev (feet amsl)	6/15/2016 WL (feet BTOC)	6/15/2016 GW Elev (feet amsl)	8/9/2017 WL (feet BTOC)	8/9/2017 GW Elev (feet amsl)	8/22/2018 WL (feet BTOC)	8/22/2018 GW Elev (feet amsl)	5/29/2019 WL (feet BTOC)	5/29/2019 GW Elev (feet amsl)
2680835.89	132653.08	MW-1S	504.15	92.41	411.74	98.15	406	94.2	409.95	86.19	417.96	96.17	407.98	90.57	413.58
2680850.77	132653.43	MW-1L	504.76	80.81	423.95	81.94	422.82	78.35	426.41	77.94	426.82	74.97	429.79	NC	NC
2680382.94	132368.85	MW-2U	481.42	69.69	411.73	75.31	406.11	70.38	411.04	75.35	406.07	73.26	408.16	67.69	413.73
2680382.94	132368.85	MW-2L	481.42	94.45	386.97	96.96	384.46	96	385.42	96.72	384.7	95.01	386.41	93.7	387.72
2680682.91	132071.01	MW-3U	480.7	69.08	411.62	74.6	406.1	70.63	410.07	74.61	406.09	72.48	408.22	66.96	413.74
2680682.91	132071.01	MW-3L	480.7	94.03	386.67	95.9	384.8	95.03	385.67	95.81	384.89	94.08	386.62	92.9	387.8
2681433.52	131382.67	MW-4U	482.95	49.79	433.16	56.29	426.66	52.73	430.22	60.77	422.18	56.18	426.77	51.25	431.7
2681433.52	131382.67	MW-4L	482.95	50.01	432.94	56.15	426.8	52.56	430.39	60.57	422.38	56.03	426.92	51.11	431.84
2684197.95	131288.15	MW-5	512.96	61.93	451.03	65.18	447.78	64.2	448.76	65.32	447.64	64.57	448.39	63.2	449.76
2683335.54	130142.22	MW-6	509.27	61.64	447.63	66.21	443.06	65.95	443.32	67.93	441.34	66.19	443.08	58.6	450.67
2684451.95	130154.03	MW-7U	504.35	165.29	339.06	123.8	380.55	124.28	380.07	127.33	377.02	124.88	379.47	121.2	383.15
2684451.95	130154.03	MW-7L	504.35	113.53	390.82	171.1	333.25	169.66	334.69	170.37	333.98	170	334.35	166.25	338.1
2684765.01	128523.73	MW-8	489.65	114.82	374.83	106.99	382.66	99.03	390.62	98.35	391.3	80.82	408.83	75.4	414.25
2683536.38	126722.12	MW-9	480.48	92.24	388.24	97.2	383.28	93.98	386.5	NC	NC	NC	NC	88.6	391.88
2683376.89	129350.69	MW-10L	508.47	145.54	362.93	151	357.47	150.08	358.39	151.71	356.76	151.9	356.57	147.15	361.32
2680715.29	132341.62	MW-11U	487.88	75.67	412.21	81.45	406.43	77.54	410.34	81.51	406.37	79.42	408.46	73.87	414.01
2680715.29	132341.62	MW-11L	487.88	100.93	386.95	103.13	384.75	102.09	385.79	102.9	384.98	100.45	387.43	98.4	389.48
2679227.82	133001.54	MW-12U	460.05	47.33	412.72	54.3	405.75	49.38	410.67	53.49	406.56	73.96	386.09	45.52	414.53
2679227.82	133001.54	MW-12L	460.05	73.39	386.66	77.88	382.17	75.15	384.9	75.44	384.61	51.39	408.66	72.61	387.44

Notes:

bgs = below ground surface
amsl = above mean sea level
TOC = top of casing
BTOC = below top of casing
WL = water level
amsl = above mean sea level
GW Elev = groundwater elevation
SPCS = state plane coordinate system
= well used in isocontour map production

Table E4: Summary of Maximum Observed PCE and TCE Concentrations in Soil Sampling Locations Used in Isoconcentration Map Preparation

X (SPCS PA North, Feet)	Y (SPCS PA North, Feet)	Sample Location	Sample Depth	Sample Date	Tetrachloroethene (PCE) (ug/Kg)	Trichloroethene (TCE) (ug/Kg)
2680878.6	132651.85	A-50	4'	7/7/2015	21200	10100
2680704.52	132334.57	B_RD-400	1-2.5'	7/8/2015	201	146
2680699.54	132354.29	B_RD-400N	5.5'	7/8/2015	<65	81.4
2680818.19	132645.62	B-100	7'	7/8/2015	276000	131000
2680783.32	132681.74	C-100	3.5'	7/8/2015	<53.9	139
2680813.21	132720.98	C-50	4'	7/7/2015	57700	20000
2680817.57	132772.67	D-0	4.5'	7/7/2015	181000	22700
2680757.78	132705.41	D-100	6'	7/8/2015	5630	7370
2680615.91	132608.31	E-250	4'	7/7/2015	<57.6	798
2680337.13	132303.86	E-700	14.5'	7/7/2015	178	312
2680668.11	132787.61	F-100N	8'	7/8/2015	142	332
2680667.48	132757.72	F-100S	9.5'	7/8/2015	1540	3520
2680653.78	132772.67	F-100W	4'	7/8/2015	83.4	259
2680570.95	132683.61	G-200	5.5'	7/7/2015	346	498
2680645.09	132038.11	MW3-600/650	5'	7/8/2015	45000	15400
2680605.86	132025.5	X-700	5'	7/8/2015	286	744
2680794.14	132525.28	A 200	4'	6/11/2018	878	187
2680925.32	132689.93	A 25 C1	4'	1/25/2017	<58	<58
2680822.14	132581.29	A/B 150	4.5'	1/25/2017	1290	888
2680830.31	132595.29	A/B 150 C1	4.5'	1/25/2017	4620	516
2680896.6	132670.21	A-25	4'	1/25/2017	172000	20000
2680890.21	132577.79	B RD 100	6.5'	1/25/2017	<72.6	<72.6
2680882.43	132593.34	B RD 100 C1	7'	1/25/2017	8870	920
2680879.13	132736.46	B-0	6.5'	6/11/2018	<59.7	<59.7
2680796.28	132634.92	B-125	7'	6/11/2018	402	6120
2680828.97	132808.42	D (-25)	4.5'	1/25/2017	<47.3	<47.3
2680763.93	132770.36	D 25	6'	1/25/2017	106	<76.9
2680762.2	132776.24	D 25 C1	4.5'	1/25/2017	<49.4	82.7
2680742.02	132722.47	D/E 100	5.5'	1/25/2017	5630	6980
2680731.52	132729.08	D/E 100 C1	6.5'	1/25/2017	115000	73200
2680616.01	132571.18	E-275	4.5'	6/11/2018	<47.3	<47.3
2680541.48	132664.15	F/G 250	4.5'	1/26/2017	<59.5	<59.5
2680551.51	132675.57	F/G 250 C1	4.5'	1/26/2017	69.4	101
2680596.83	132763.44	G 175 C1	3'	1/25/2017	<64.3	128
2680584.03	132775.9	G175	4'	1/25/2017	<60.2	65.4
2680850.77	132653.43	MW-1	4.5'	5/1/2012	55.6	5.14
2680702.74	132065.95	MW3 600 C1	5'	1/26/2017	<57.4	<57.4
2680645.57	132001.39	MW3 700	4.5'	1/26/2017	<57.2	<57.2
2680642.85	132008.78	MW3 700 C1	5;	1/26/2017	<57.8	<57.8
2680712.47	132075.68	MW3-600	4.5'	1/26/2017	<63.6	<63.6
2680903.82	132558.73	N-150	4'	6/11/2018	<58.8	<58.8
2680952.44	132620.18	N-75	4'	6/12/2018	<49.2	<49.2
2680590.73	132087.73	W/X 650	7'	1/26/2017	<53.4	57.6
2680606.68	132085.01	W/X 650 C1	5.5'	1/26/2017	<58.4	68.1
2680588.79	132001.78	X 740 C1	11.5'	1/26/2017	438	1310
2680571.67	131994.78	X 750	9.5'	1/26/2017	<61.2	<61.2

Notes:

SPCS = State Plane Coordinate System

ug/Kg = micrograms per kilogram

For sample locations with multiple sampling intervals, the interval with the maximum concentration was used in isoconcentration map preparation.

For samples with concentrations less than the detection limit, 1/2 of the detecion limt was used in isoconcentration map preparation.

Table E5: Calendar Year 2019 Constituent of Interest (COI) Concentration Data in Groundwater Used in Isocontour Mapping

X (SPCS PA North, Feet)	Y (SPCS PA North, Feet)	Location	Date	COI Concentration (ug/L)			Used In Contouring?
				PCE	TCE	cis-1,2-DCE	
2681577.42	131135.7	10 Brennan	2/7/2019	11.2	222	43.8	YES
2680697.16	131761.15	55 Brennan	2/4/2019	17.6	296	66.5	
2680697.16	131761.15	55 Brennan	5/8/2019	18.9	344	82.6	YES
2680697.16	131761.15	55 Brennan	10/15/2019	13.5	241	49.2	
2680558.17	132490.84	65 Brennan	2/4/2019	34	550	152	
2680558.17	132490.84	65 Brennan	5/8/2019	45.8	941	263	YES
2680558.17	132490.84	65 Brennan	9/26/2019	24.7	307	57.1	
2680517.63	132870.17	77 Brennan	6/17/2019	ND	12.1	1.74	YES
2681160.46	132554.55	84 Brennan	5/8/2019	ND	ND	ND	YES
2682810.95	129369.37	4028 Durham	2/4/2019	1.03	13	1.65	YES
2681160.46	130452.33	2503 Mountain View	2/7/2019	2.16	55.1	1.65	YES
2681160.46	130851.93	2506 Mountain View	2/4/2019	6.4	109	18.8	YES
2680985.69	131113.57	2511 Mountain View	2/7/2019	7.61	185	27.4	YES
2679162.48	133246.6	287 Park	2/4/2019	1.36	35.4	2.24	YES
2679347.8	132403.98	324 Park	9/26/2019	ND	9.07	0.562	YES
2678411.35	132560.32	331 Park	12/5/2019	1.4	47.6	3.28	YES
2678754.39	132017.48	338 Park	2/4/2019	79.6	250	18.6	
2678754.39	132017.48	338 Park	11/26/2019	70	296	24.5	YES
2678209.93	132184.71	347 Park	2/4/2019	3.12	35.2	3.77	YES
2683447.99	129218.8	133/135 Tower	2/4/2019	3.92	62.6	10.4	YES
2683343.75	126161.03	24 Tower	2/4/2019	3.26	7.63	21.6	YES
2680835.89	132653.08	MW-1S	6/18/2019	50.2	3820	762	YES
2680382.94	132368.85	MW-2U	6/18/2019	ND	97.2	23.1	
2680382.94	132368.85	MW-2L	6/18/2019	30.8	1300	558	YES
2680682.91	132071.01	MW-3U	6/18/2019	1	39.4	6.5	
2680682.91	132071.01	MW-3L	6/18/2019	12.7	312	91.7	YES
2681433.52	131382.67	MW-4U	6/18/2019	12.2	413	99.2	YES
2681433.52	131382.67	MW-4L	6/18/2019	1	91.7	34	
2684197.95	131288.15	MW-5	6/17/2019	ND	ND	ND	YES
2683335.54	130142.22	MW-6	6/17/2019	ND	ND	ND	YES
2684451.95	130154.03	MW-7U	6/17/2019	ND	ND	ND	
2684451.95	130154.03	MW-7L	6/17/2019	ND	10.1	1.9	YES
2684765.01	128523.73	MW-8	6/17/2019	ND	ND	ND	YES
2683536.38	126722.12	MW-9	6/17/2019	ND	ND	ND	YES
2683376.89	129350.69	MW-10L	6/17/2019	0.86	41	7.5	YES
2680715.29	132341.62	MW-11U	6/18/2019	6.6	157	44.3	YES
2680715.29	132341.62	MW-11L	6/17/2019	ND	0.5	0.83	
2679227.82	133001.54	MW-12U	6/17/2019	ND	ND	ND	
2679227.82	133001.54	MW-12L	6/17/2019	ND	0.94	ND	YES

Notes:

SPCS = State Plane Coordinate System

ug/L = micrograms per liter

ND = Non-detectable Concetration

Table E6: Groundwater Plume Stability - Summary of Mann-Kendall Analyses

X (SPCS PA North, Feet)	Y (SPCS PA North, Feet)	Location	TCE Mann-Kendall Analysis Results	PCE Mann-Kendall Analysis Results
2680382.94	132368.85	MW-2U	Decreasing	Decreasing
2680682.91	132071.01	MW-3U	Decreasing	No Trend
2684523.19	130955.75	8392 Easton	Increasing	Stable
2683447.99	129218.8	133/135 Tower	Increasing	Increasing
2684451.95	130154.03	MW-7L	Increasing	Stable
2680697.16	131761.15	55 Brennan	No Trend	No Trend
2680558.17	132490.84	65 Brennan	No Trend	No Trend
2680517.63	132870.17	77 Brennan	No Trend	Stable
2681160.46	132554.55	84 Brennan	No Trend	Stable
2683911.21	130314.79	4018 Durham	No Trend	No Trend
2682266.58	129438.87	4032 Durham	No Trend	No Trend
2683372.7	130527.62	4040 Durham - John School (AKA 4050 Durham Rd)	No Trend	No Trend
2683604.35	131008.29	4051 Durham	No Trend	No Trend
2684658.36	129606.81	8329 Easton	No Trend	No Trend
2684438.29	130718.73	8382 Easton	No Trend	Increasing
2680693	129533.03	2442 Mountain View	No Trend	No Trend
2680957.76	130243.85	2473 Mountain View	No Trend	No Trend
2681959.56	130939.55	2526 Mountain View	No Trend	Stable
2678916.72	132669.27	312 Park	No Trend	Stable
2678411.35	132560.32	331 Park	No Trend	No Trend
2684096.61	128269.04	117 Tower	No Trend	Stable
2680835.89	132653.08	MW-1S	No Trend	No Trend
2684451.95	130154.03	MW-7U	No Trend	Stable
2680715.29	132341.62	MW-11U	No Trend	No Trend
2680715.29	132341.62	MW-11L	No Trend	No Trend
2683376.89	129350.69	MW-10L	Prob. Decreasing	Prob. Decreasing
2679227.82	133001.54	MW-12U	Prob. Decreasing	Stable
2679227.82	133001.54	MW-12L	Prob. Decreasing	Stable
2678754.39	132017.48	338 Park	Prob. Increasing	Prob. Increasing
2678209.93	132184.71	347 Park	Prob. Increasing	No Trend
2680382.94	132368.85	MW-2L	Prob. Increasing	No Trend
2681577.42	131135.7	10 Brennan	Stable	Stable
2680865.1	129131.93	10 Cord	Stable	Stable
2682810.95	129369.37	4028 Durham	Stable	Stable
2683210.55	131292.06	4071 Durham	Stable	Stable
2684841.05	128929.32	8260 Easton	Stable	Stable
2684374.59	130516.04	8374 Easton	Stable	Stable
2684420.92	130608.7	8378 Easton	Stable	Stable
2684722.06	131407.88	8426 Easton	Stable	Stable
2684647.44	131762.77	8432 Easton	Stable	Stable
2681160.46	130851.93	2506 Mountain View	Stable	No Trend
2679162.48	133246.6	287 Park	Stable	Stable
2679347.8	132403.98	324 Park	Stable	Stable
2677817.81	131601.31	377 Park	Stable	Stable
2677572.25	131662.6	387 Park	Stable	Stable
2684525.16	128894.49	149 Tower	Stable	No Trend
2683343.75	126161.03	24 Tower	Stable	Stable
2680850.77	132653.43	MW-1L	Stable	Stable
2680682.91	132071.01	MW-3L	Stable	Stable
2681433.52	131382.67	MW-4U	Stable	Increasing
2681433.52	131382.67	MW-4L	Stable	No Trend
2684197.95	131288.15	MW-5	Stable	Stable
2683335.54	130142.22	MW-6	Stable	Stable
2684765.01	128523.73	MW-8	Stable	Stable
2683536.38	126722.12	MW-9	Stable	Stable

Notes:

SPCS = State Plane Coordinate System

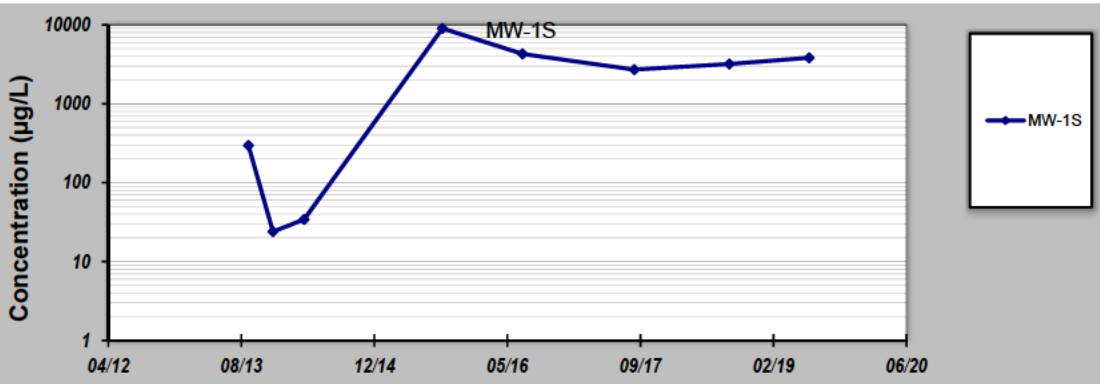
Appendix E – Sub-Appendix E1 & E2

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Trichloroethene (TCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: MW-1S

Sampling Event	Sampling Date	TRICHLOROETHENE (TCE) CONCENTRATION (µg/L)
1	10-Sep-13	295
2	11-Dec-13	24
3	7-Apr-14	34
4	9-Sep-15	9,020
5	6-Jul-16	4,280
6	30-Aug-17	2,710
7	22-Aug-18	3190
8	18-Jun-19	3820
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		1.03
Mann-Kendall Statistic (S):		10
Confidence Factor:		86.2%
Concentration Trend:		No Trend



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

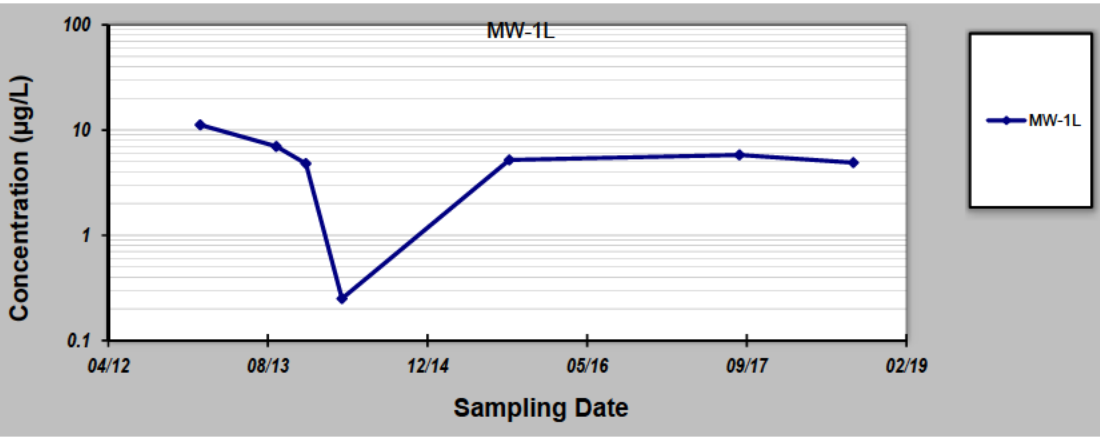
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Trichloroethene (TCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: MW-1L

Sampling Event	Sampling Date	TRICHLOROETHENE (TCE) CONCENTRATION (µg/L)
1	14-Jan-13	11
2	9-Sep-13	7
3	11-Dec-13	5
4	3-Apr-14	0.25
5	9-Sep-15	5
6	30-Aug-17	6
7	22-Aug-18	4.9
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.58
Mann-Kendall Statistic (S):		-7
Confidence Factor:		80.9%
Concentration Trend:		Stable



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

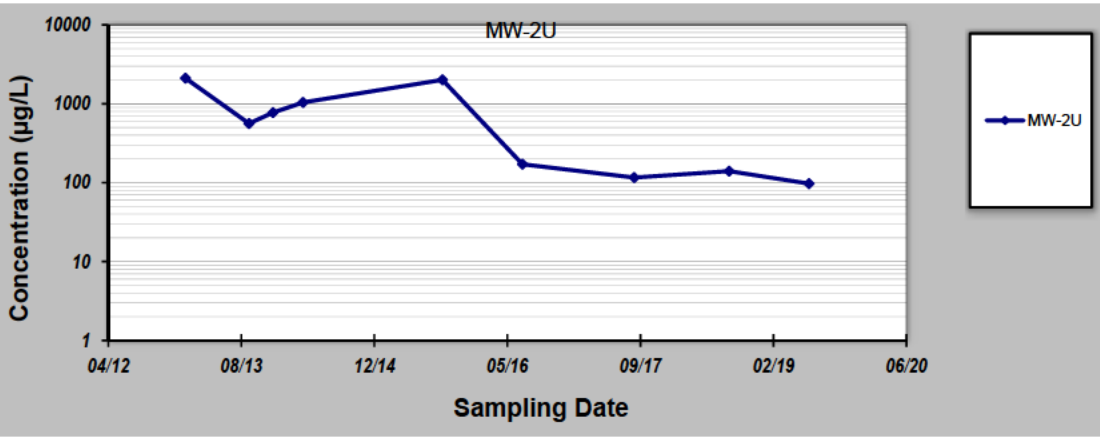
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Trichloroethene (TCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: MW-2U

Sampling Event	Sampling Date	TRICHLOROETHENE (TCE) CONCENTRATION (µg/L)
1	16-Jan-13	2,110
2	12-Sep-13	562
3	11-Dec-13	772
4	3-Apr-14	1,040
5	9-Sep-15	2,010
6	6-Jul-16	171
7	30-Aug-17	116
8	22-Aug-18	140
9	18-Jun-19	97.2
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		1.02
Mann-Kendall Statistic (S):		-22
Confidence Factor:		98.8%
Concentration Trend:		Decreasing



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

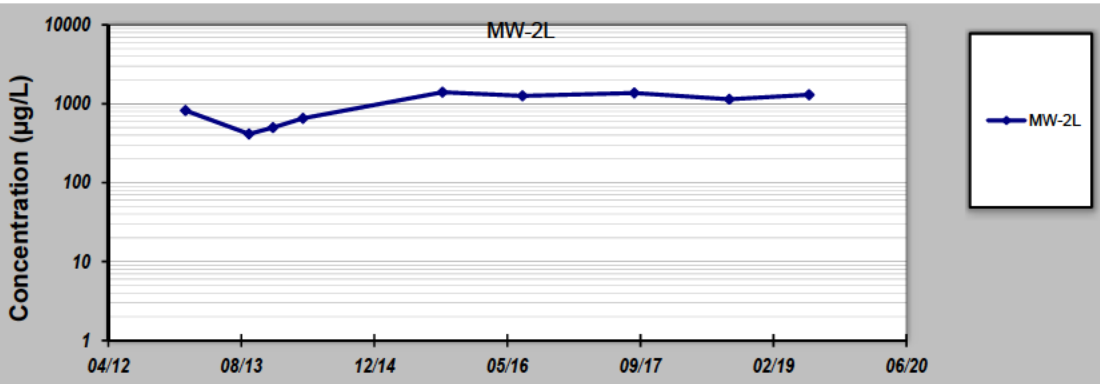
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Trichloroethene (TCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: MW-2L

Sampling Event	Sampling Date	TRICHLOROETHENE (TCE) CONCENTRATION (µg/L)
1	16-Jan-13	822
2	12-Sep-13	414
3	11-Dec-13	499
4	3-Apr-14	654
5	9-Sep-15	1,400
6	6-Jul-16	1,260
7	30-Aug-17	1370
8	22-Aug-18	1140
9	18-Jun-19	1300
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.40
Mann-Kendall Statistic (S):		16
Confidence Factor:		94.0%
Concentration Trend:		Prob. Increasing



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

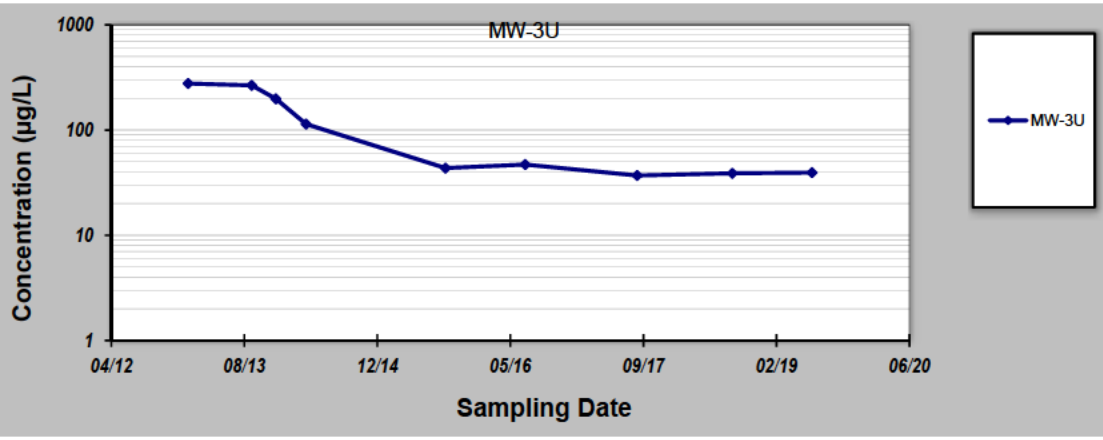
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Trichloroethene (TCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: MW-3U

Sampling Event	Sampling Date	TRICHLOROETHENE (TCE) CONCENTRATION (µg/L)
1	15-Jan-13	277
2	11-Sep-13	266
3	11-Dec-13	198
4	3-Apr-14	114
5	9-Sep-15	44
6	5-Jul-16	47
7	30-Aug-17	37
8	22-Aug-18	38.8
9	18-Jun-19	39.4
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.87
Mann-Kendall Statistic (S):		-28
Confidence Factor:		99.9%
Concentration Trend:		Decreasing



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

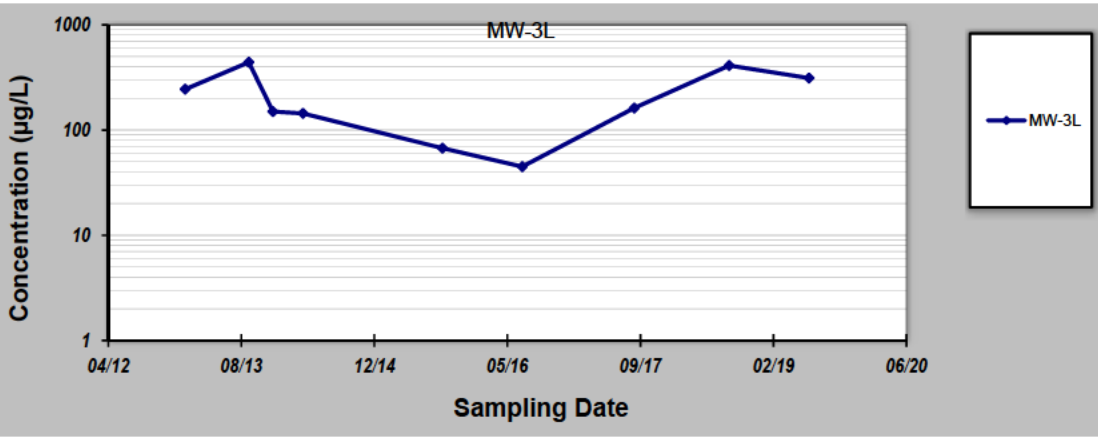
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Trichloroethene (TCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: MW-3L

Sampling Event	Sampling Date	TRICHLOROETHENE (TCE) CONCENTRATION (µg/L)
1	15-Jan-13	244
2	11-Sep-13	441
3	11-Dec-13	150
4	3-Apr-14	144
5	9-Sep-15	67
6	5-Jul-16	45
7	30-Aug-17	162
8	22-Aug-18	411
9	18-Jun-19	312
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.65
Mann-Kendall Statistic (S):		-2
Confidence Factor:		54.0%
Concentration Trend:		Stable



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

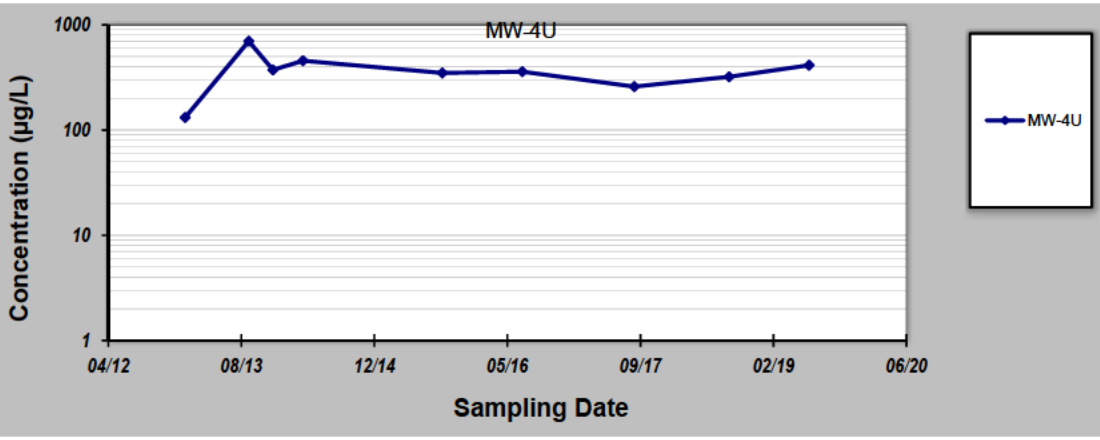
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Trichloroethene (TCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: MW-4U

Sampling Event	Sampling Date	TRICHLOROETHENE (TCE) CONCENTRATION (µg/L)
1	15-Jan-13	132
2	11-Sep-13	700
3	11-Dec-13	373
4	3-Apr-14	456
5	9-Sep-15	349
6	5-Jul-16	359
7	30-Aug-17	259
8	22-Aug-18	321
9	18-Jun-19	413
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.41
Mann-Kendall Statistic (S):		-4
Confidence Factor:		61.9%
Concentration Trend:		Stable



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

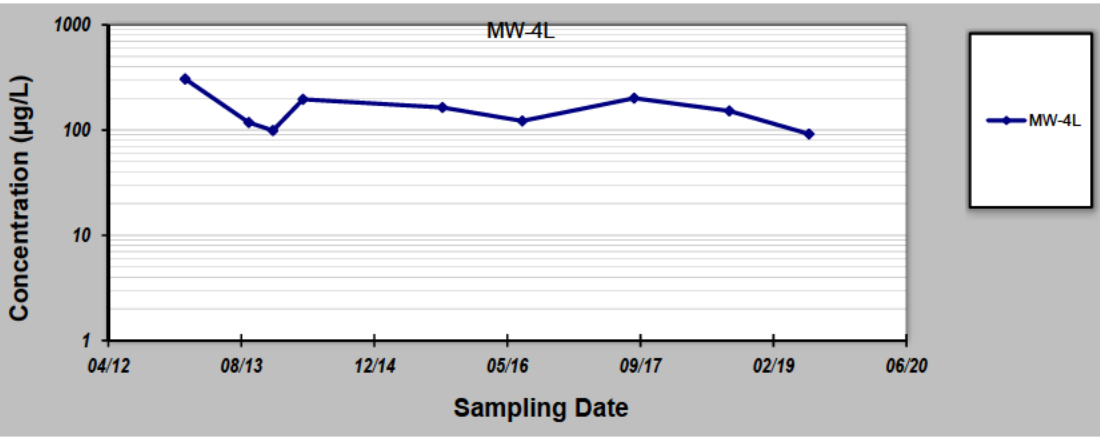
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Trichloroethene (TCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: MW-4L

Sampling Event	Sampling Date	TRICHLOROETHENE (TCE) CONCENTRATION (µg/L)
1	15-Jan-13	306
2	11-Sep-13	118
3	11-Dec-13	99
4	3-Apr-14	196
5	9-Sep-15	164
6	5-Jul-16	122
7	30-Aug-17	201
8	22-Aug-18	152
9	18-Jun-19	91.7
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.42
Mann-Kendall Statistic (S):		-8
Confidence Factor:		76.2%
Concentration Trend:		Stable



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

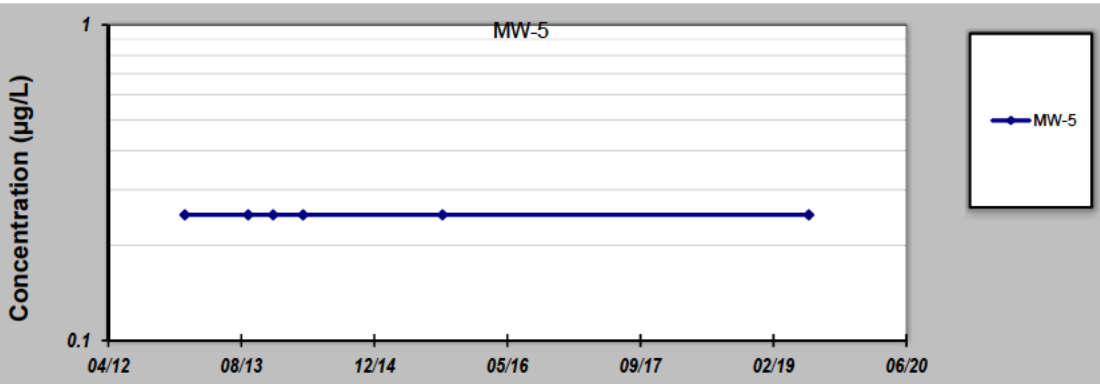
DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Trichloroethene (TCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: MW-5

Sampling Event	Sampling Date	TRICHLOROETHENE (TCE) CONCENTRATION (µg/L)
1	14-Jan-13	0.25
2	9-Sep-13	0.25
3	12-Dec-13	0.25
4	3-Apr-14	0.25
5	9-Sep-15	0.25
6	17-Jun-19	0.25
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.00
Mann-Kendall Statistic (S):		0
Confidence Factor:		39.3%
Concentration Trend:		Stable



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

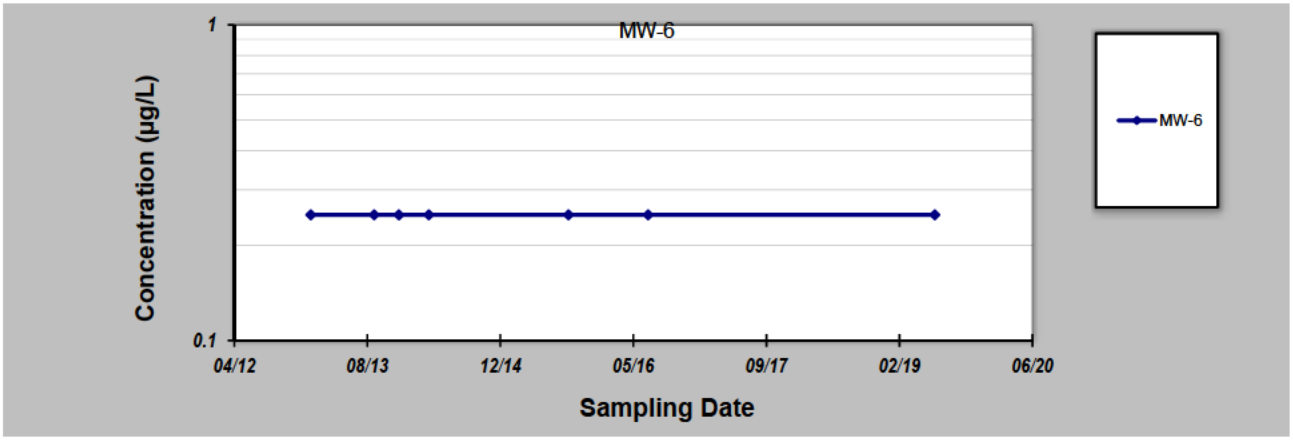
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Trichloroethene (TCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: MW-6

Sampling Event	Sampling Date	TRICHLOROETHENE (TCE) CONCENTRATION (µg/L)
1	14-Jan-13	0.25
2	9-Sep-13	0.25
3	11-Dec-13	0.25
4	2-Apr-14	0.25
5	9-Sep-15	0.25
6	5-Jul-16	0.25
7	17-Jun-19	0.25
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.00
Mann-Kendall Statistic (S):		0
Confidence Factor:		37.9%
Concentration Trend:		Stable



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

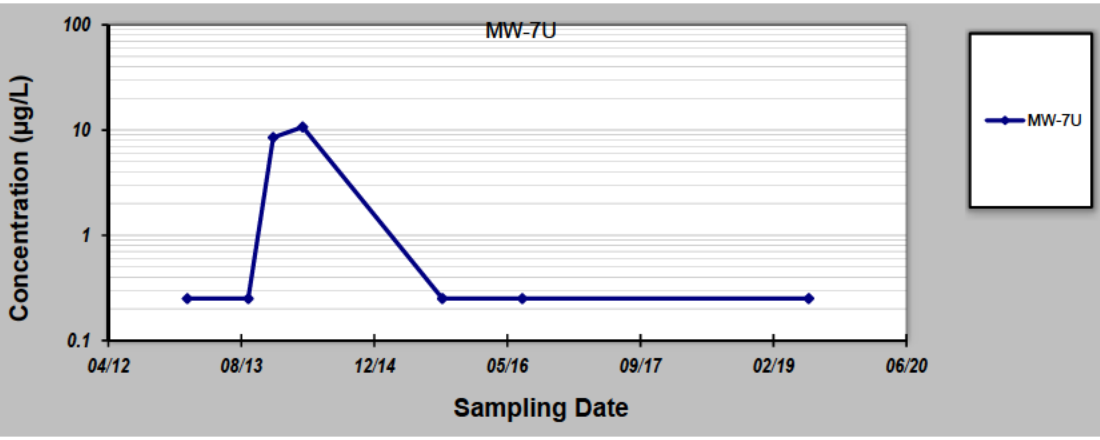
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Trichloroethene (TCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: MW-7U

Sampling Event	Sampling Date	TRICHLOROETHENE (TCE) CONCENTRATION (µg/L)
1	23-Jan-13	0.25
2	9-Sep-13	0.25
3	12-Dec-13	8.50
4	2-Apr-14	10.70
5	9-Sep-15	0.25
6	5-Jul-16	0.25
7	17-Jun-19	0.25
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		1.58
Mann-Kendall Statistic (S):		-1
Confidence Factor:		50.0%
Concentration Trend:		No Trend



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

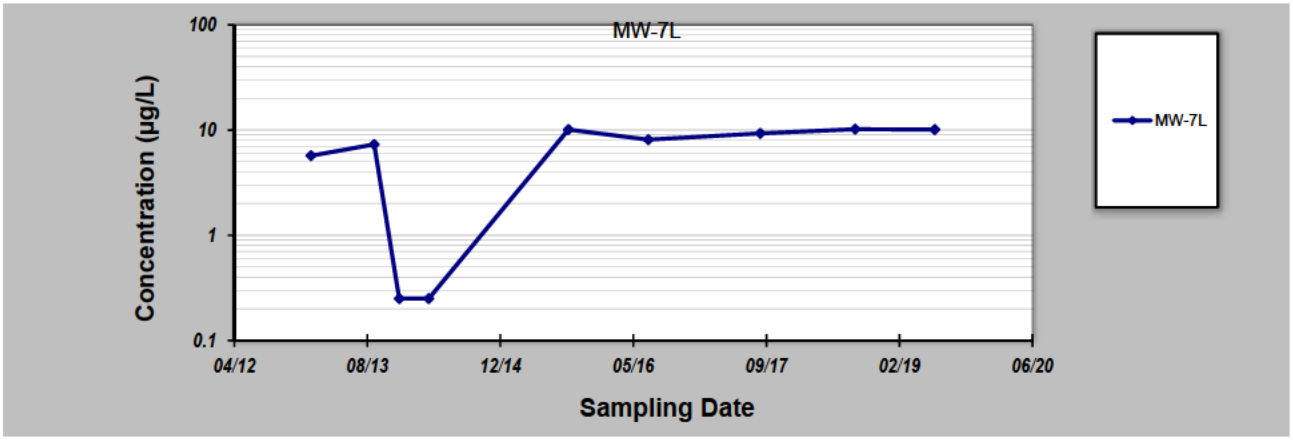
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Trichloroethene (TCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: MW-7L

Sampling Event	Sampling Date	TRICHLOROETHENE (TCE) CONCENTRATION (µg/L)
1	14-Jan-13	5.70
2	9-Sep-13	7.30
3	12-Dec-13	0.25
4	2-Apr-14	0.25
5	9-Sep-15	10.10
6	5-Jul-16	8.10
7	30-Aug-17	9.30
8	22-Aug-18	10.2
9	17-Jun-19	10.1
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.59
Mann-Kendall Statistic (S):		20
Confidence Factor:		97.8%
Concentration Trend:		Increasing



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

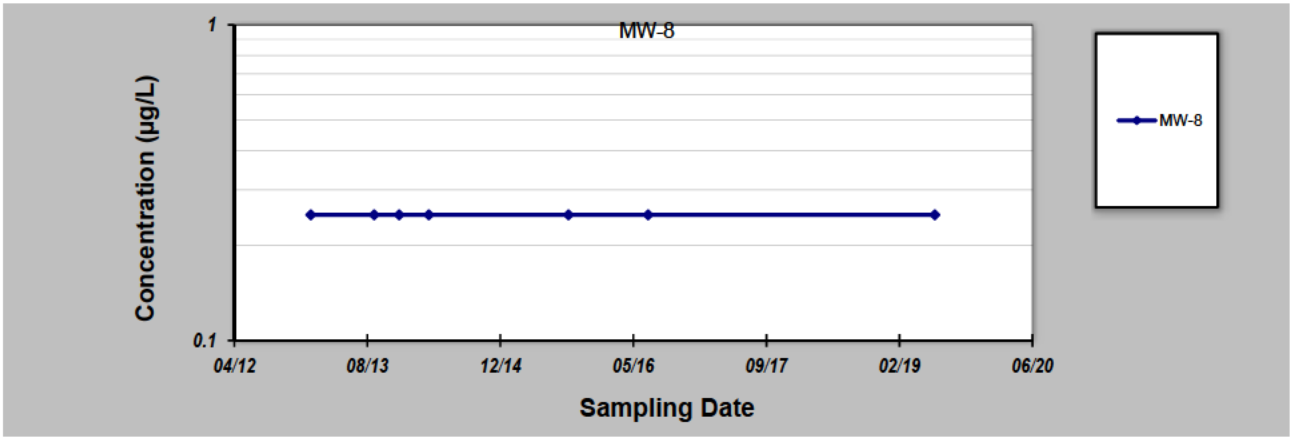
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Trichloroethene (TCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: MW-8

Sampling Event	Sampling Date	TRICHLOROETHENE (TCE) CONCENTRATION (µg/L)
1	14-Jan-13	0.25
2	9-Sep-13	0.25
3	12-Dec-13	0.25
4	2-Apr-14	0.25
5	9-Sep-15	0.25
6	5-Jul-16	0.25
7	17-Jun-19	0.25
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.00
Mann-Kendall Statistic (S):		0
Confidence Factor:		37.9%
Concentration Trend:		Stable



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

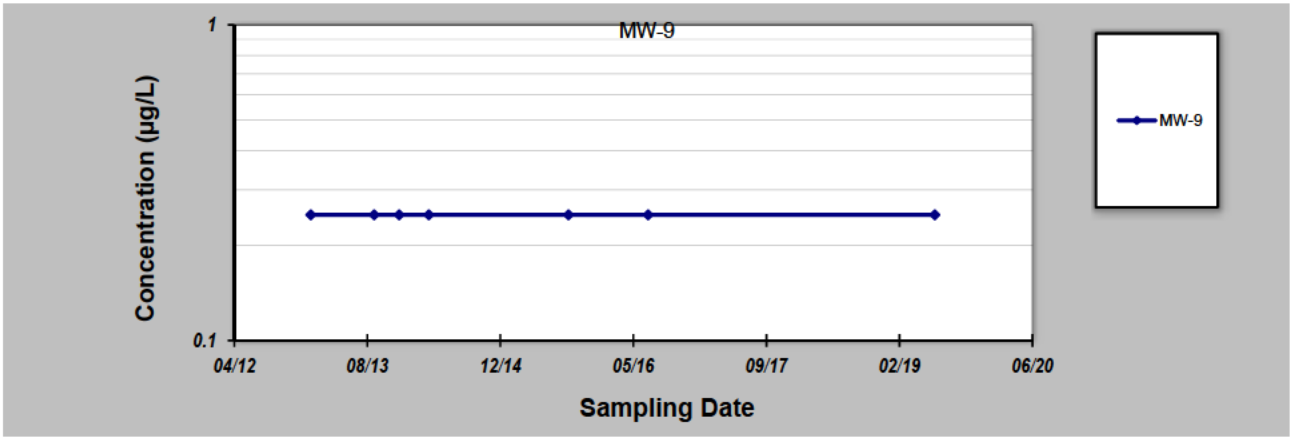
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Trichloroethene (TCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: MW-9

Sampling Event	Sampling Date	TRICHLOROETHENE (TCE) CONCENTRATION (µg/L)
1	14-Jan-13	0.25
2	9-Sep-13	0.25
3	12-Dec-13	0.25
4	2-Apr-14	0.25
5	9-Sep-15	0.25
6	5-Jul-16	0.25
7	17-Jun-19	0.25
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.00
Mann-Kendall Statistic (S):		0
Confidence Factor:		37.9%
Concentration Trend:		Stable



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

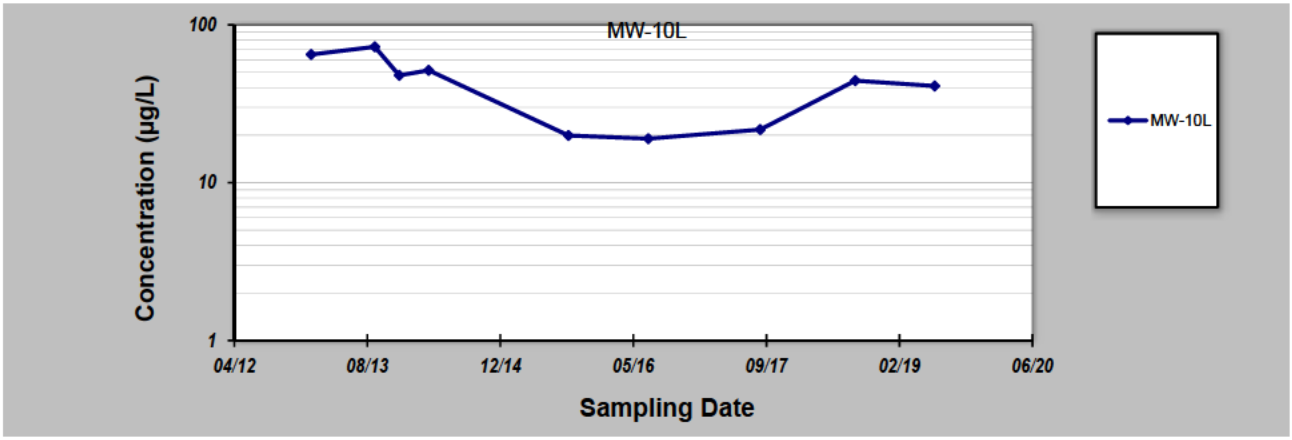
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Trichloroethene (TCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: MW-10L

Sampling Event	Sampling Date	TRICHLOROETHENE (TCE) CONCENTRATION (µg/L)
1	15-Jan-13	64.90
2	11-Sep-13	72.60
3	12-Dec-13	47.90
4	2-Apr-14	51.50
5	9-Sep-15	19.90
6	5-Jul-16	19.00
7	30-Aug-17	21.70
8	22-Aug-18	44.3
9	17-Jun-19	41
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.46
Mann-Kendall Statistic (S):		-16
Confidence Factor:		94.0%
Concentration Trend:		Prob. Decreasing



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

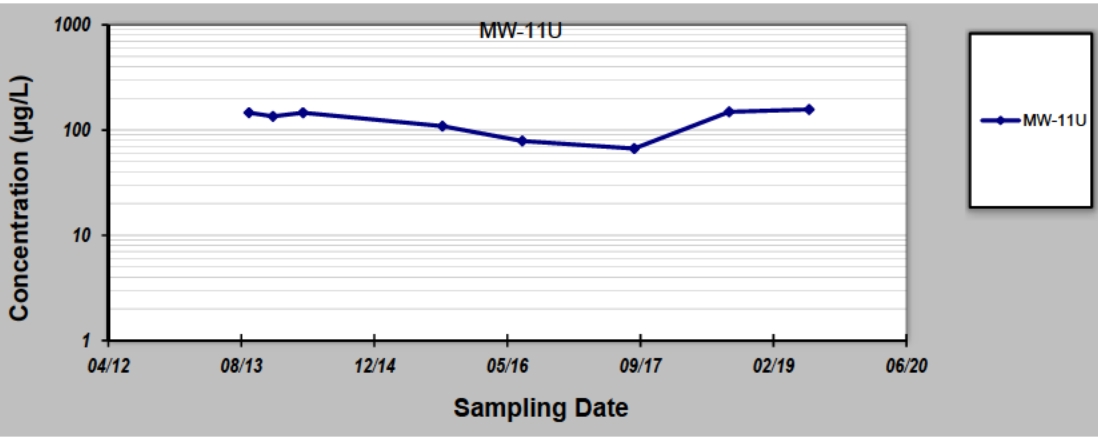
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Trichloroethene (TCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: MW-11U

Sampling Event	Sampling Date	TRICHLOROETHENE (TCE) CONCENTRATION (µg/L)
1	12-Sep-13	146.00
2	11-Dec-13	135.00
3	3-Apr-14	146.00
4	9-Sep-15	109.00
5	5-Jul-16	78.70
6	30-Aug-17	66.70
7	22-Aug-18	149.00
8	18-Jun-19	157
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.28
Mann-Kendall Statistic (S):		1
Confidence Factor:		50.0%
Concentration Trend:		No Trend



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

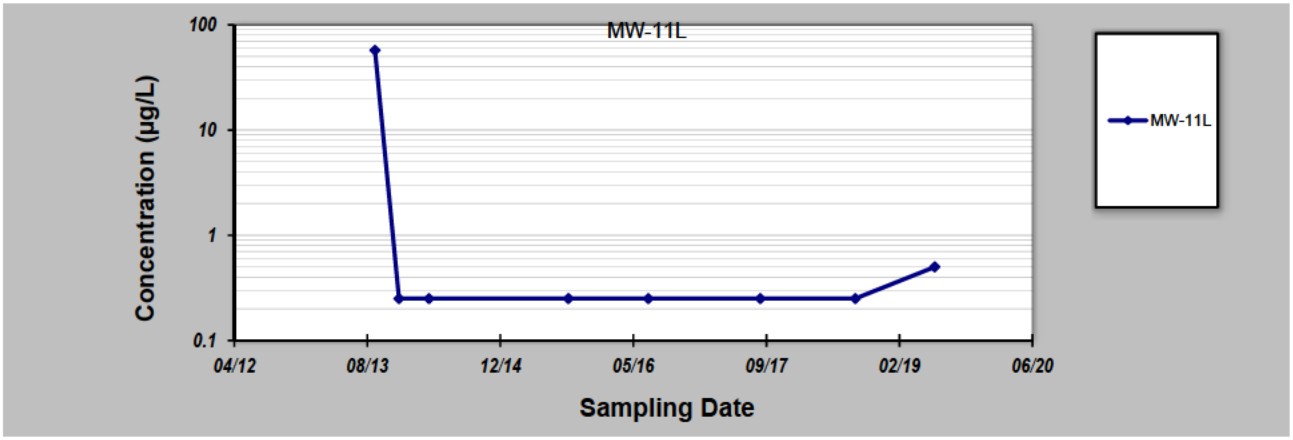
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Trichloroethene (TCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: MW-11L

Sampling Event	Sampling Date	TRICHLOROETHENE (TCE) CONCENTRATION (µg/L)
1	12-Sep-13	57.20
2	11-Dec-13	0.25
3	3-Apr-14	0.25
4	9-Sep-15	0.25
5	5-Jul-16	0.25
6	30-Aug-17	0.25
7	22-Aug-18	0.25
8	17-Jun-19	0.5
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		2.72
Mann-Kendall Statistic (S):		-1
Confidence Factor:		50.0%
Concentration Trend:		No Trend



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

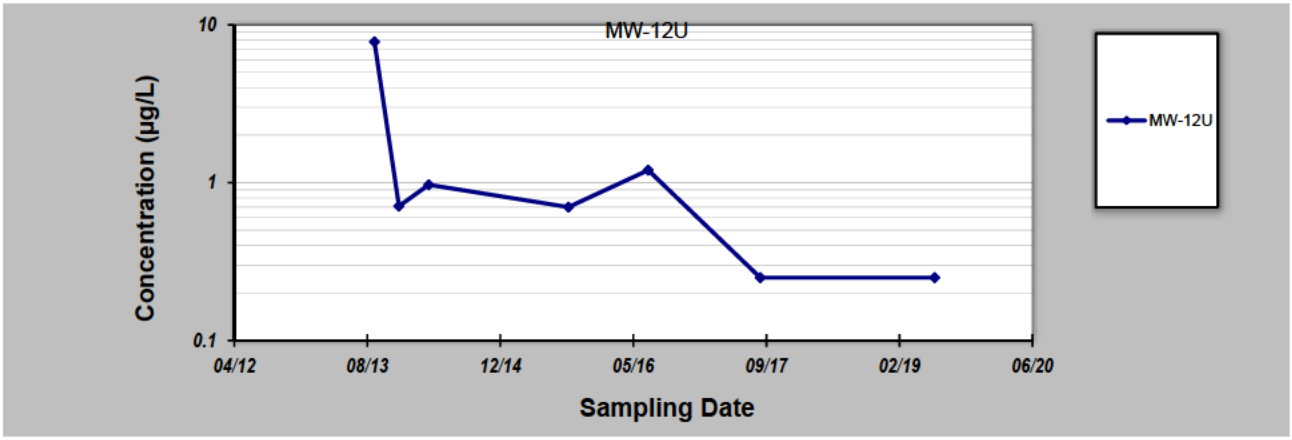
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Trichloroethene (TCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: MW-12U

Sampling Event	Sampling Date	TRICHLOROETHENE (TCE) CONCENTRATION (µg/L)
1	10-Sep-13	7.80
2	11-Dec-13	0.71
3	2-Apr-14	0.97
4	9-Sep-15	0.70
5	5-Jul-16	1.20
6	30-Aug-17	0.25
7	17-Jun-19	0.25
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		1.60
Mann-Kendall Statistic (S):		-12
Confidence Factor:		94.9%
Concentration Trend:		Prob. Decreasing



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

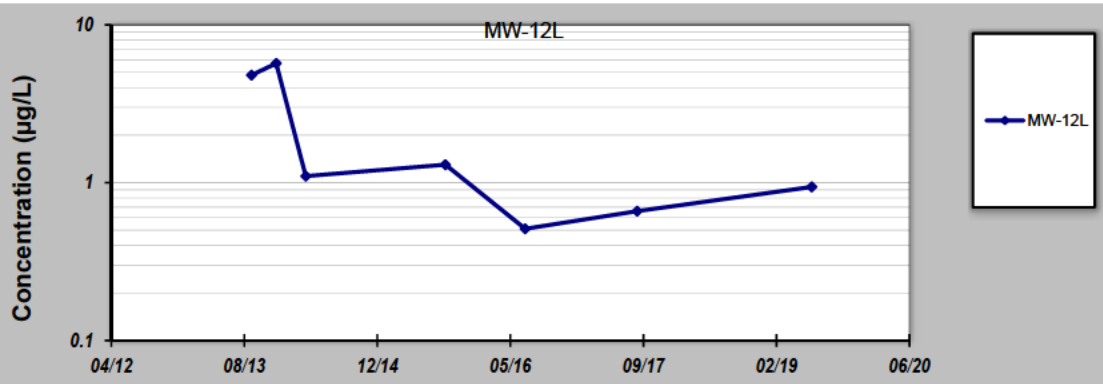
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Trichloroethene (TCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: MW-12L

Sampling Event	Sampling Date	TRICHLOROETHENE (TCE) CONCENTRATION (µg/L)
1	10-Sep-13	4.80
2	12-Dec-13	5.70
3	2-Apr-14	1.10
4	9-Sep-15	1.30
5	5-Jul-16	0.51
6	30-Aug-17	0.66
7	17-Jun-19	0.94
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:	1.00	
Mann-Kendall Statistic (S):	-11	
Confidence Factor:	93.2%	
Concentration Trend:	Prob. Decreasing	



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

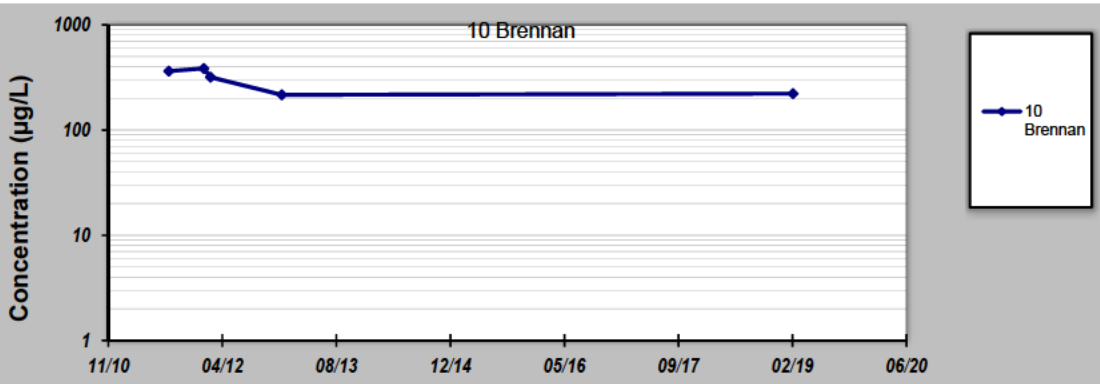
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Trichloroethene (TCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: 10 Brennan

Sampling Event	Sampling Date	TRICHLOROETHENE (TCE) CONCENTRATION (µg/L)
1	10-Aug-11	363
2	11-Jan-12	386
3	9-Feb-12	318
4	18-Dec-12	216
5	7-Feb-19	222
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.26
Mann-Kendall Statistic (S):		-6
Confidence Factor:		88.3%
Concentration Trend:		Stable



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

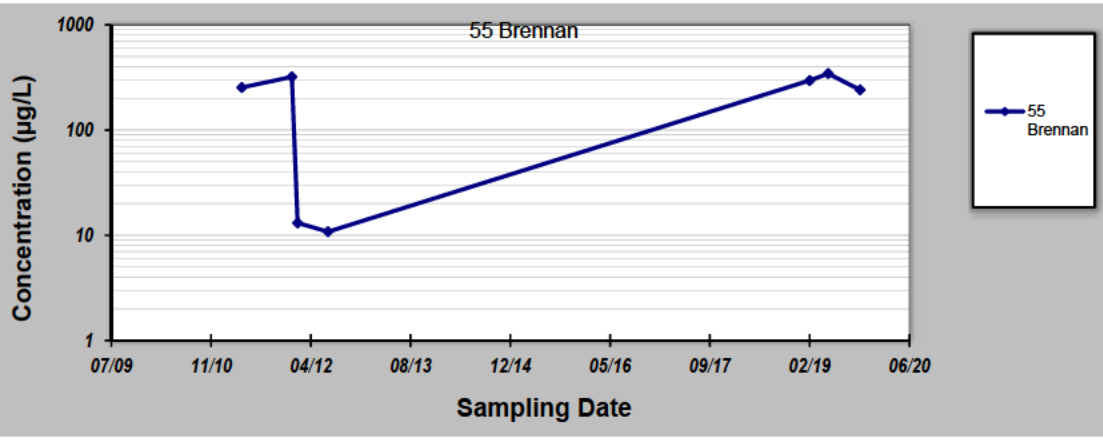
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Trichloroethene (TCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: 55 Brennan

Sampling Event	Sampling Date	TRICHLOROETHENE (TCE) CONCENTRATION (µg/L)
1	21-Apr-11	254
2	28-Dec-11	320
3	26-Jan-12	13
4	26-Jun-12	11
5	4-Feb-19	296
6	8-May-19	344
7	15-Oct-19	241
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.67
Mann-Kendall Statistic (S):		1
Confidence Factor:		50.0%
Concentration Trend:		No Trend



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

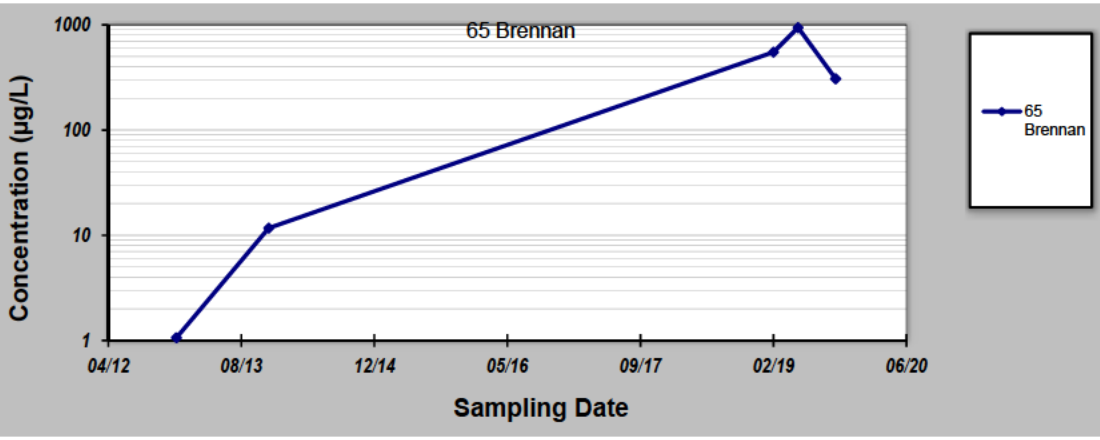
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Trichloroethene (TCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: 65 Brennan

Sampling Event	Sampling Date	TRICHLOROETHENE (TCE) CONCENTRATION (µg/L)
1	13-Dec-12	1.06
2	25-Nov-13	11.70
3	4-Feb-19	550.00
4	8-May-19	941.00
5	26-Sep-19	307.00
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		1.09
Mann-Kendall Statistic (S):		6
Confidence Factor:		88.3%
Concentration Trend:		No Trend



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

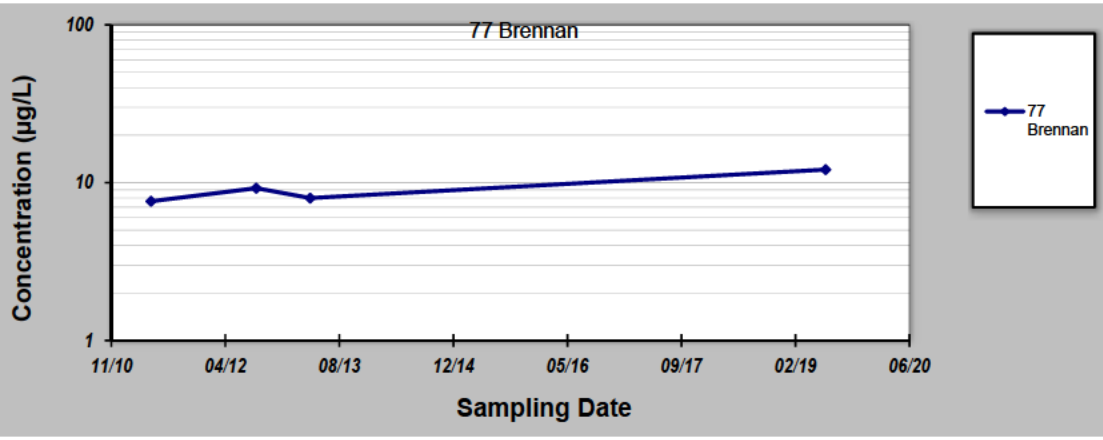
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Trichloroethene (TCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: 77 Brennan

Sampling Event	Sampling Date	TRICHLOROETHENE (TCE) CONCENTRATION (µg/L)
1	11-May-11	7.62
2	15-Aug-12	9.23
3	8-Apr-13	7.99
4	17-Jun-19	12.10
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.22
Mann-Kendall Statistic (S):		4
Confidence Factor:		83.3%
Concentration Trend:		No Trend



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

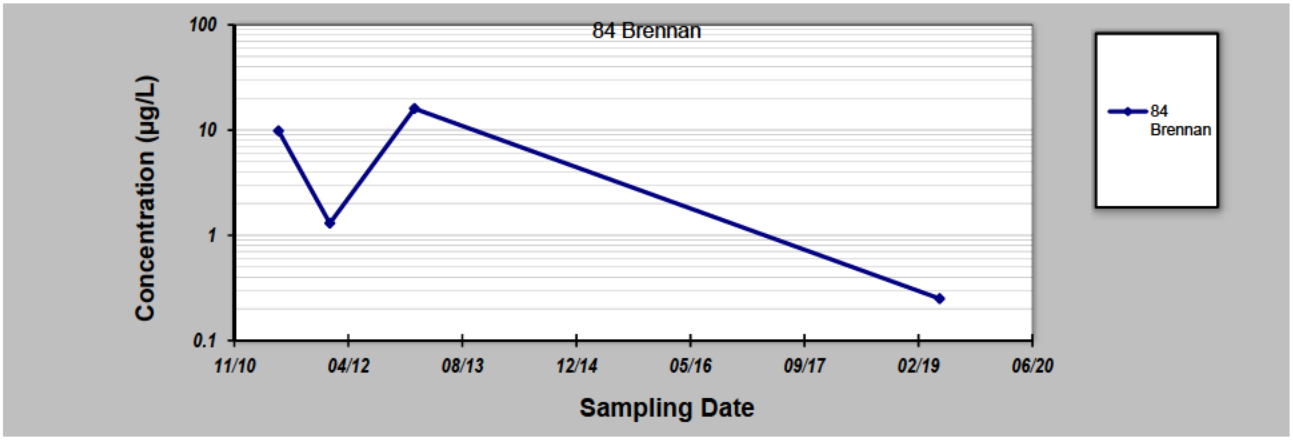
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Trichloroethene (TCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: 84 Brennan

Sampling Event	Sampling Date	TRICHLOROETHENE (TCE) CONCENTRATION (µg/L)
1	31-May-11	9.85
2	11-Jan-12	1.30
3	16-Jan-13	16.00
4	8-May-19	0.25
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		1.09
Mann-Kendall Statistic (S):		-2
Confidence Factor:		62.5%
Concentration Trend:		No Trend



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

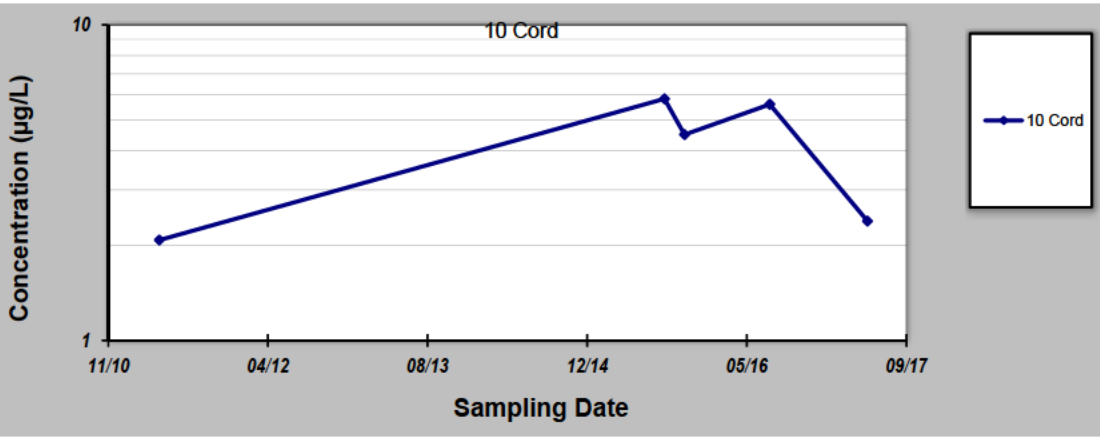
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Trichloroethene (TCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: 10 Cord

Sampling Event	Sampling Date	TRICHLOROETHENE (TCE) CONCENTRATION (µg/L)
1	27-Apr-11	2.08
2	26-Aug-15	5.83
3	28-Oct-15	4.49
4	21-Jul-16	5.60
5	23-May-17	2.39
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.43
Mann-Kendall Statistic (S):		0
Confidence Factor:		40.8%
Concentration Trend:		Stable



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

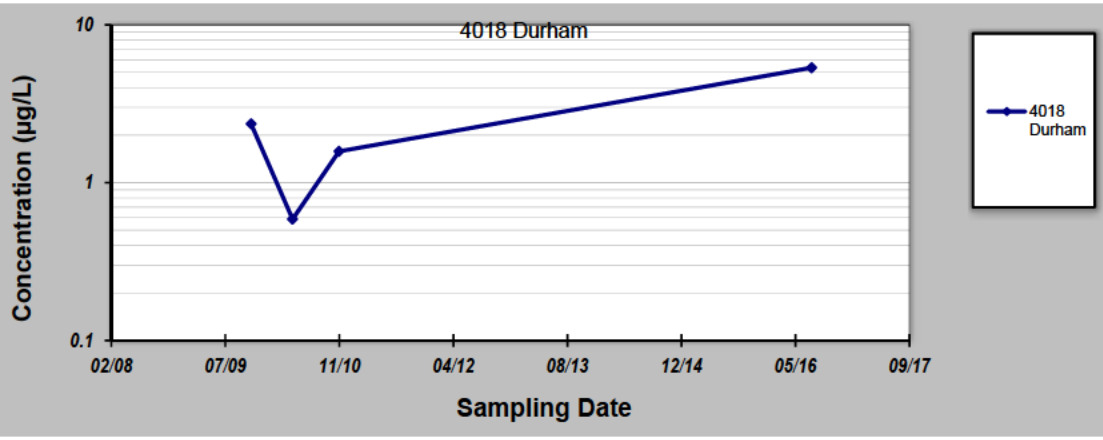
DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Trichloroethene (TCE)
Conducted By:	FJD	Concentration Units:	µg/L
Sampling Point ID:	4018 Durham		

Sampling Event	Sampling Date	TRICHLOROETHENE (TCE) CONCENTRATION (µg/L)
1	27-Oct-09	2.36
2	27-Apr-10	0.59
3	17-Nov-10	1.58
4	20-Jul-16	5.35
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.83
Mann-Kendall Statistic (S):		2
Confidence Factor:		62.5%
Concentration Trend:		No Trend



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

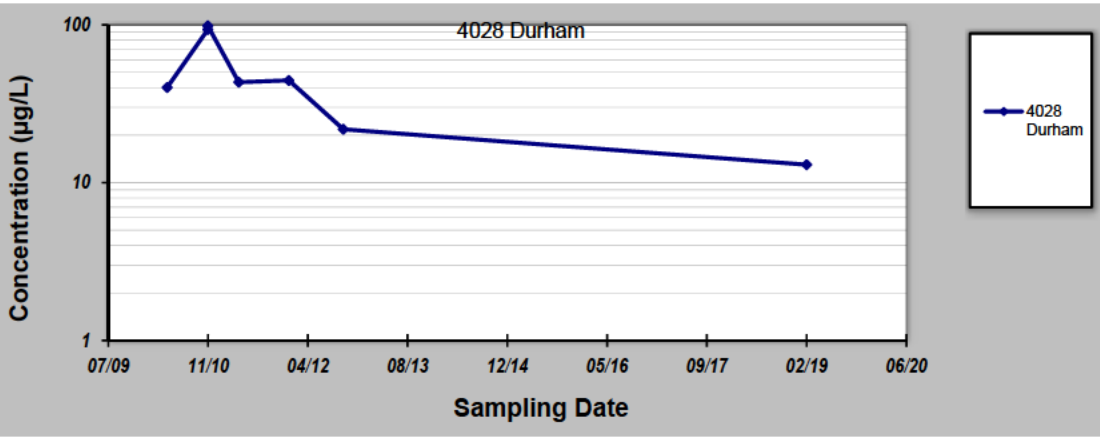
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Trichloroethene (TCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: 4028 Durham

Sampling Event	Sampling Date	TRICHLOROETHENE (TCE) CONCENTRATION (µg/L)
1	27-Apr-10	40.10
2	17-Nov-10	93.40
3	17-Nov-10	98.60
4	21-Apr-11	43.30
5	28-Dec-11	44.50
6	26-Sep-12	21.80
7	4-Feb-19	13.00
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.65
Mann-Kendall Statistic (S):		-9
Confidence Factor:		88.1%
Concentration Trend:		Stable



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

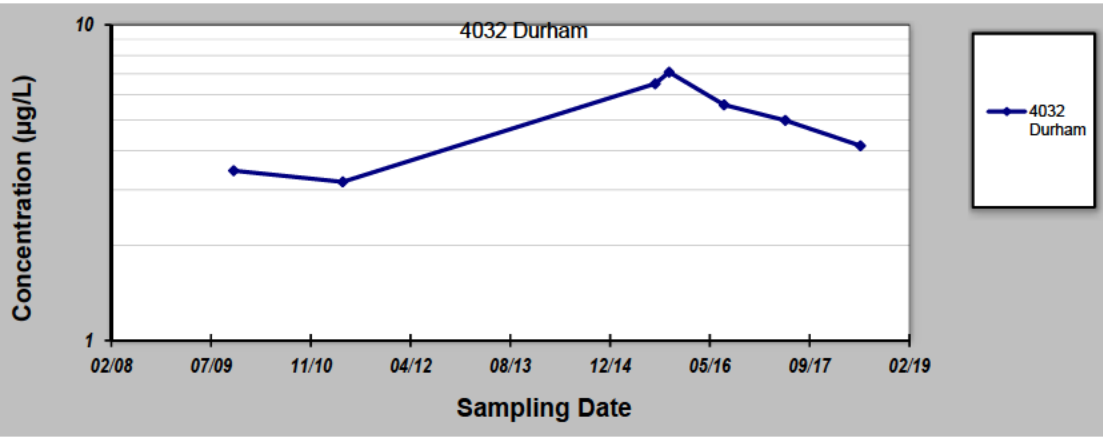
DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Trichloroethene (TCE)
Conducted By:	FJD	Concentration Units:	µg/L
Sampling Point ID:	4032 Durham		

Sampling Event	Sampling Date	TRICHLOROETHENE (TCE) CONCENTRATION (µg/L)
1	27-Oct-09	3.45
2	27-Apr-11	3.18
3	10-Aug-15	6.51
4	19-Oct-15	7.08
5	20-Jul-16	5.58
6	23-May-17	4.98
7	4-Jun-18	4.14
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.30
Mann-Kendall Statistic (S):		1
Confidence Factor:		50.0%
Concentration Trend:		No Trend



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

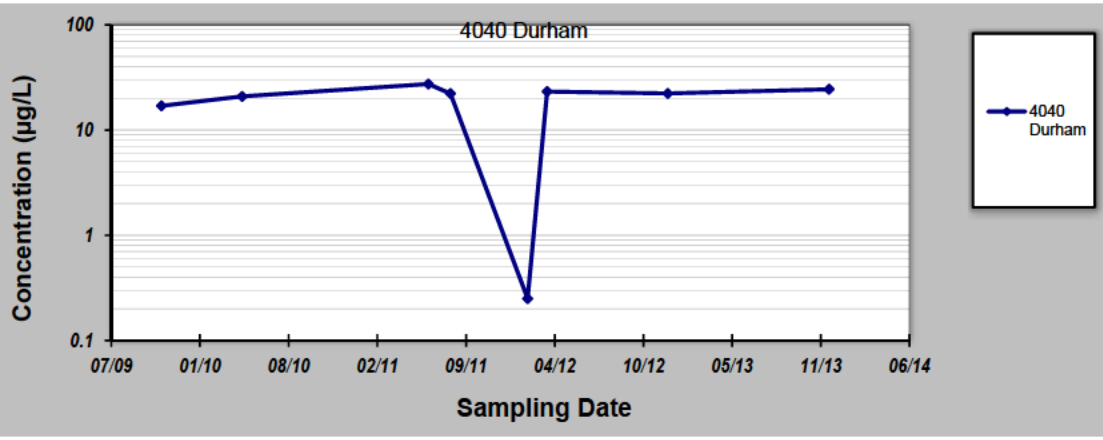
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Trichloroethene (TCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: 4040 Durham

Sampling Event	Sampling Date	TRICHLOROETHENE (TCE) CONCENTRATION (µg/L)
1	27-Oct-09	17.00
2	27-Apr-10	20.90
3	21-Jun-11	27.40
4	10-Aug-11	22.20
5	31-Jan-12	0.25
6	15-Mar-12	23.20
7	12-Dec-12	22.30
8	11-Dec-13	24.4
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.43
Mann-Kendall Statistic (S):		10
Confidence Factor:		86.2%
Concentration Trend:		No Trend



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

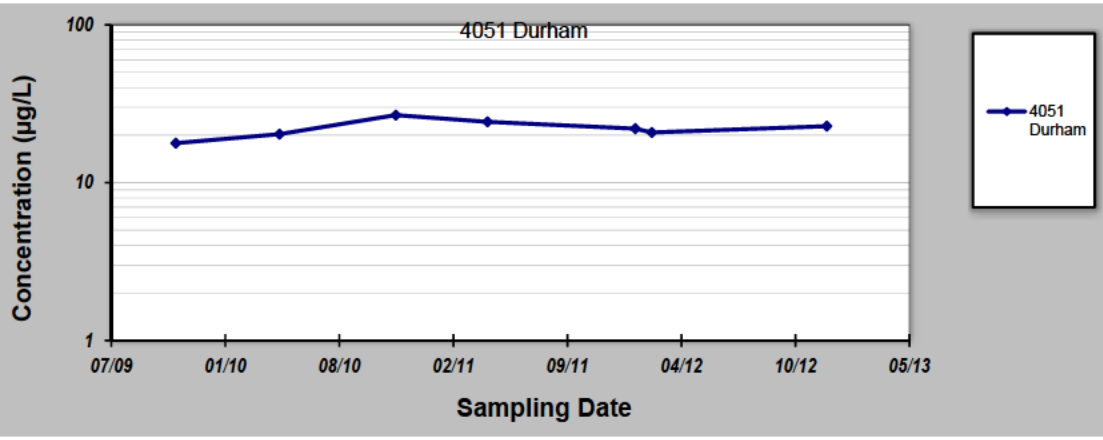
DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Trichloroethene (TCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: 4051 Durham

Sampling Event	Sampling Date	TRICHLOROETHENE (TCE) CONCENTRATION (µg/L)
1	27-Oct-09	17.80
2	27-Apr-10	20.30
3	17-Nov-10	26.80
4	27-Apr-11	24.30
5	11-Jan-12	22.00
6	9-Feb-12	20.80
7	12-Dec-12	22.80
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.13
Mann-Kendall Statistic (S):		5
Confidence Factor:		71.9%
Concentration Trend:		No Trend



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

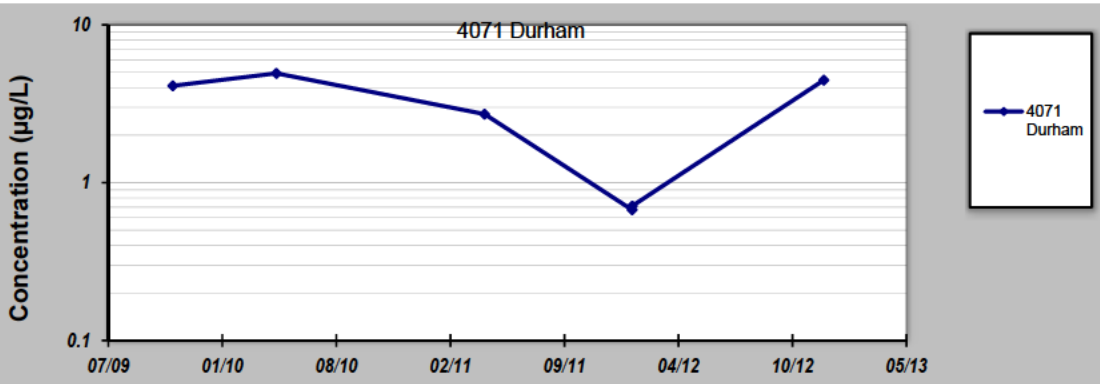
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Trichloroethene (TCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: 4071 Durham

Sampling Event	Sampling Date	TRICHLOROETHENE (TCE) CONCENTRATION (µg/L)
1	27-Oct-09	4.11
2	27-Apr-10	4.93
3	27-Apr-11	2.72
4	11-Jan-12	0.67
5	11-Jan-12	0.71
6	12-Dec-12	4.46
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.64
Mann-Kendall Statistic (S):		-3
Confidence Factor:		64.0%
Concentration Trend:		Stable



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

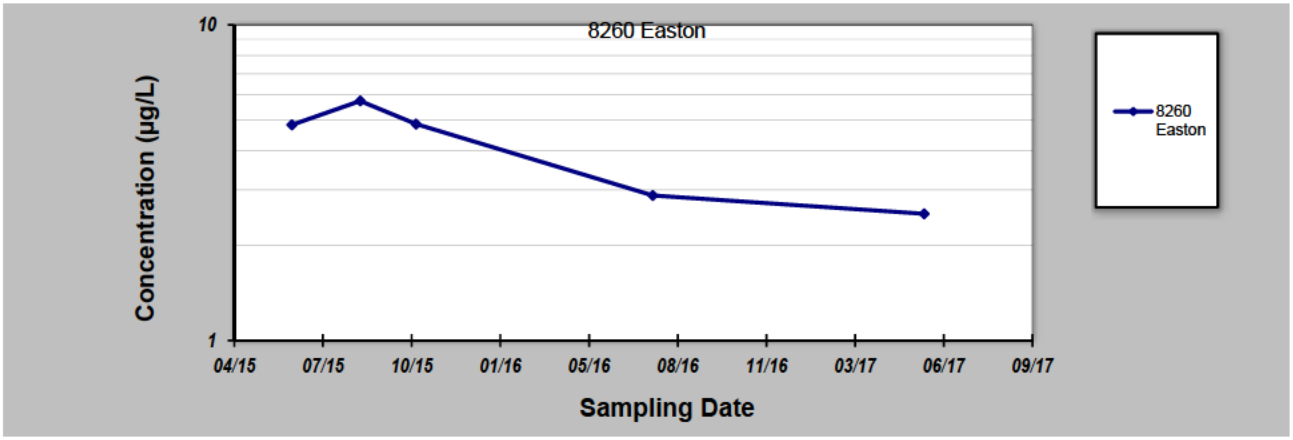
DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Trichloroethene (TCE)
Conducted By:	FJD	Concentration Units:	µg/L
Sampling Point ID:	8260 Easton		

Sampling Event	Sampling Date	TRICHLOROETHENE (TCE) CONCENTRATION (µg/L)
1	10-Jun-15	4.82
2	26-Aug-15	5.74
3	28-Oct-15	4.85
4	21-Jul-16	2.88
5	23-May-17	2.52
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.33
Mann-Kendall Statistic (S):		-6
Confidence Factor:		88.3%
Concentration Trend:		Stable



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

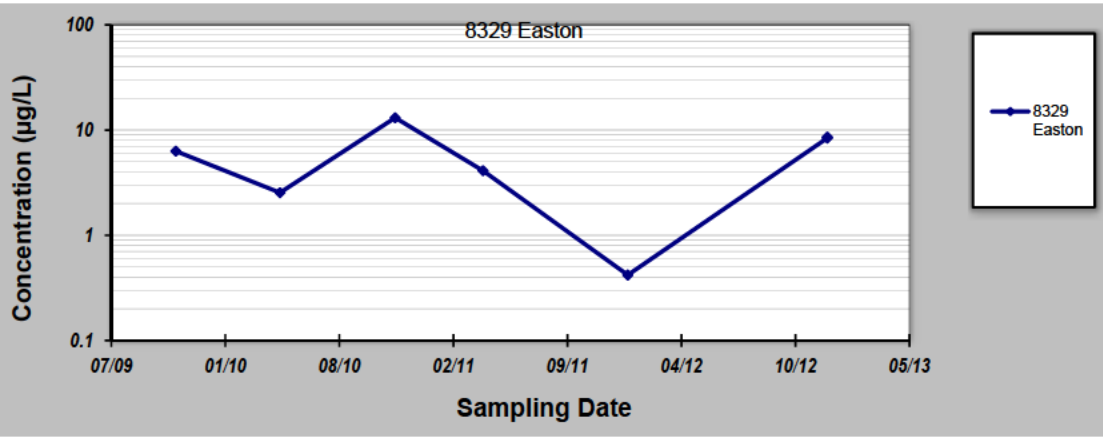
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Trichloroethene (TCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: 8329 Easton

Sampling Event	Sampling Date	TRICHLOROETHENE (TCE) CONCENTRATION (µg/L)
1	27-Oct-09	6.31
2	28-Apr-10	2.54
3	16-Nov-10	13.10
4	19-Apr-11	4.11
5	29-Dec-11	0.42
6	13-Dec-12	8.39
7	13-Dec-12	8.56
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.69
Mann-Kendall Statistic (S):		3
Confidence Factor:		61.4%
Concentration Trend:		No Trend



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

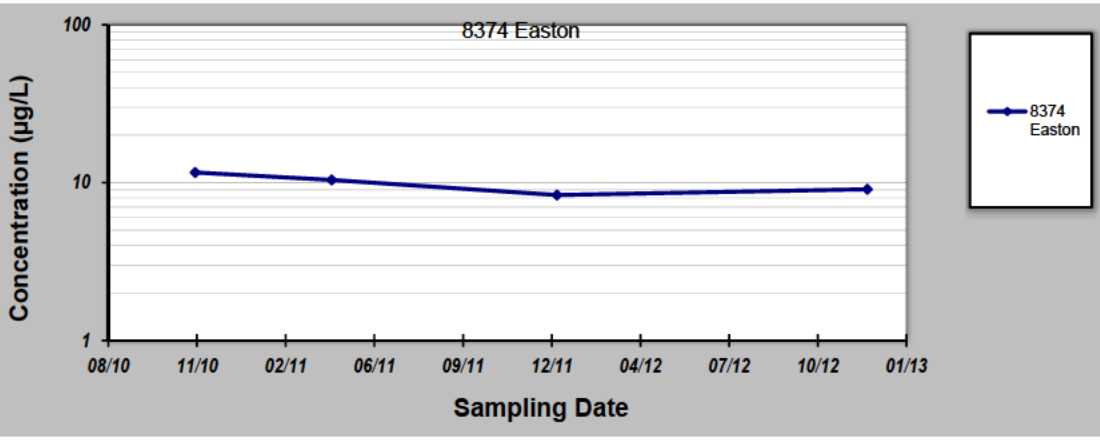
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Trichloroethene (TCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: 8374 Easton

Sampling Event	Sampling Date	TRICHLOROETHENE (TCE) CONCENTRATION (µg/L)
1	16-Nov-10	11.60
2	19-Apr-11	10.40
3	29-Dec-11	8.35
4	13-Dec-12	9.08
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.15
Mann-Kendall Statistic (S):		-4
Confidence Factor:		83.3%
Concentration Trend:		Stable



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

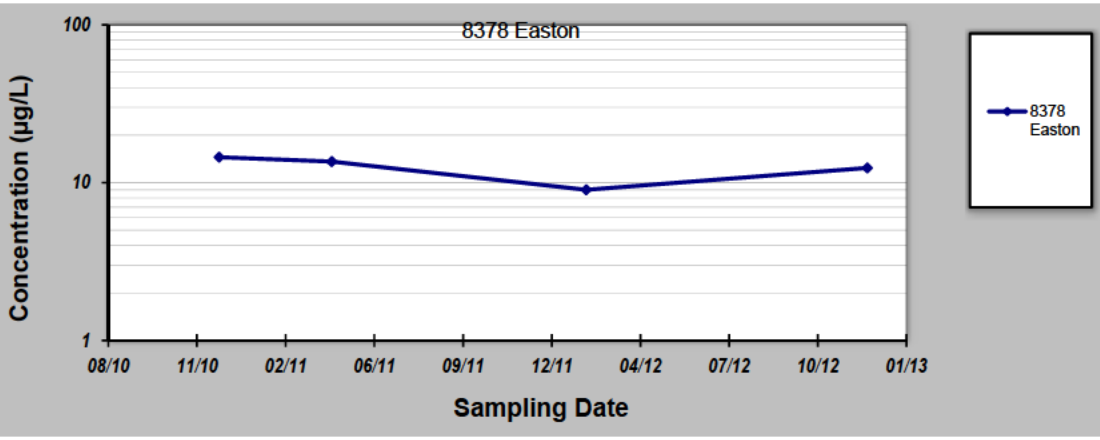
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Trichloroethene (TCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: 8378 Easton

Sampling Event	Sampling Date	TRICHLOROETHENE (TCE) CONCENTRATION (µg/L)
1	13-Dec-10	14.50
2	19-Apr-11	13.60
3	31-Jan-12	9.01
4	13-Dec-12	12.40
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.19
Mann-Kendall Statistic (S):		-4
Confidence Factor:		83.3%
Concentration Trend:		Stable



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

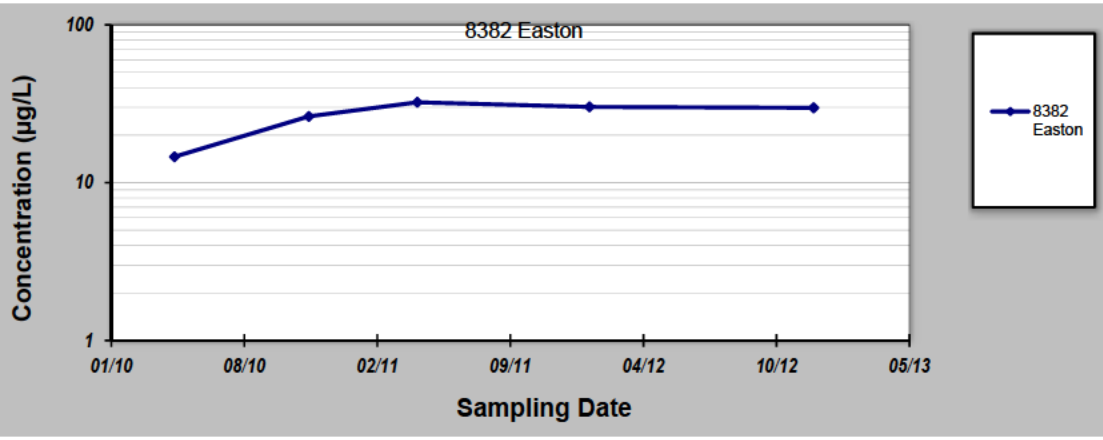
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Trichloroethene (TCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: 8382 Easton

Sampling Event	Sampling Date	TRICHLOROETHENE (TCE) CONCENTRATION (µg/L)
1	27-Apr-10	14.60
2	15-Nov-10	26.30
3	27-Apr-11	32.30
4	11-Jan-12	30.20
5	13-Dec-12	29.80
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.27
Mann-Kendall Statistic (S):		4
Confidence Factor:		75.8%
Concentration Trend:		No Trend



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

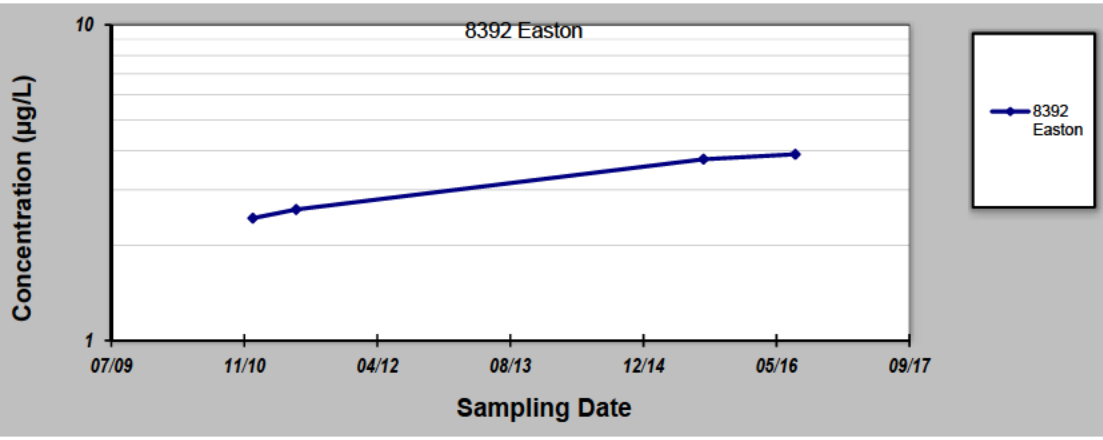
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Trichloroethene (TCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: 8392 Easton

Sampling Event	Sampling Date	TRICHLOROETHENE (TCE) CONCENTRATION (µg/L)
1	20-Dec-10	2.44
2	1-Jun-11	2.60
3	10-Aug-15	3.75
4	20-Jul-16	3.89
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.24
Mann-Kendall Statistic (S):		6
Confidence Factor:		95.8%
Concentration Trend:		Increasing



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

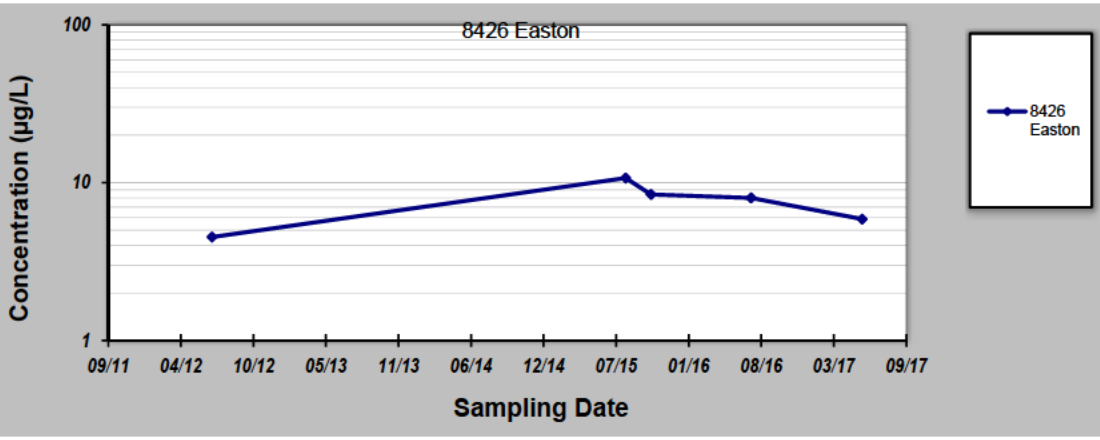
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Trichloroethene (TCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: 8426 Easton

Sampling Event	Sampling Date	TRICHLOROETHENE (TCE) CONCENTRATION (µg/L)
1	26-Jun-12	4.52
2	10-Aug-15	10.70
3	19-Oct-15	8.42
4	21-Jul-16	8.00
5	23-May-17	5.88
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.32
Mann-Kendall Statistic (S):		-2
Confidence Factor:		59.2%
Concentration Trend:		Stable



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

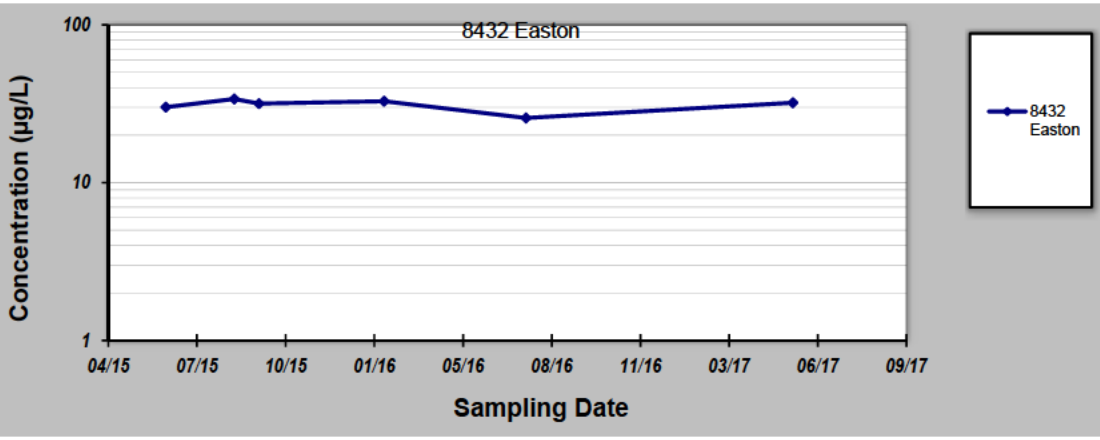
DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Trichloroethene (TCE)
Conducted By:	FJD	Concentration Units:	µg/L
Sampling Point ID:	8432 Easton		

Sampling Event	Sampling Date	TRICHLOROETHENE (TCE) CONCENTRATION (µg/L)
1	10-Jun-15	30.10
2	26-Aug-15	33.90
3	23-Sep-15	31.70
4	11-Feb-16	32.80
5	20-Jul-16	25.70
6	17-May-17	32.10
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.09
Mann-Kendall Statistic (S):		-1
Confidence Factor:		50.0%
Concentration Trend:		Stable



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

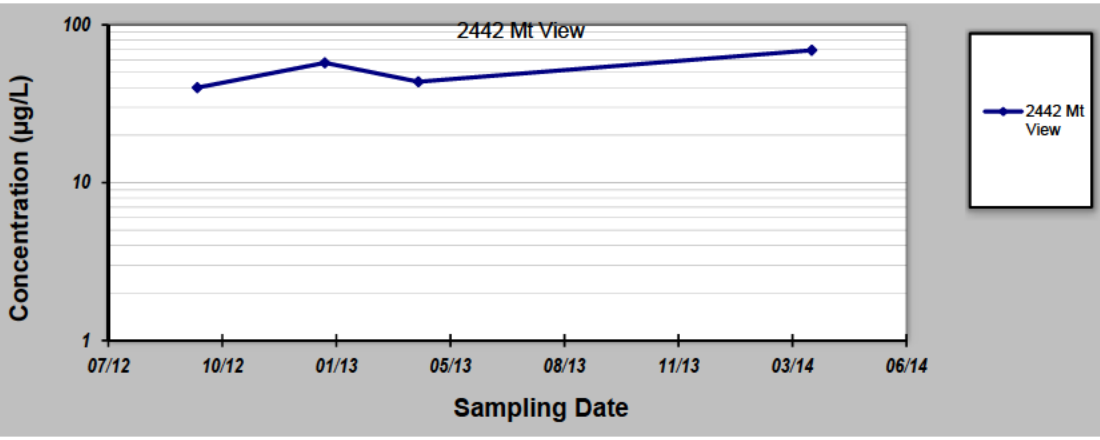
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Trichloroethene (TCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: 2442 Mt View

Sampling Event	Sampling Date	TRICHLOROETHENE (TCE) CONCENTRATION (µg/L)
1	26-Sep-12	40.00
2	16-Jan-13	57.50
3	8-Apr-13	43.60
4	19-Mar-14	69.00
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.25
Mann-Kendall Statistic (S):		4
Confidence Factor:		83.3%
Concentration Trend:		No Trend



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

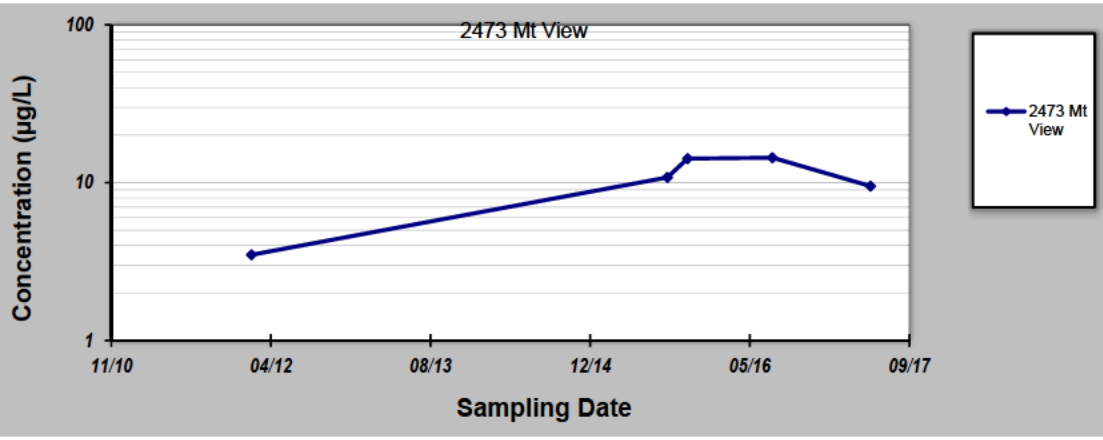
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Trichloroethene (TCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: 2473 Mt View

Sampling Event	Sampling Date	TRICHLOROETHENE (TCE) CONCENTRATION (µg/L)
1	31-Jan-12	3.49
2	26-Aug-15	10.80
3	28-Oct-15	14.20
4	20-Jul-16	14.40
5	23-May-17	9.51
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.42
Mann-Kendall Statistic (S):		4
Confidence Factor:		75.8%
Concentration Trend:		No Trend



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

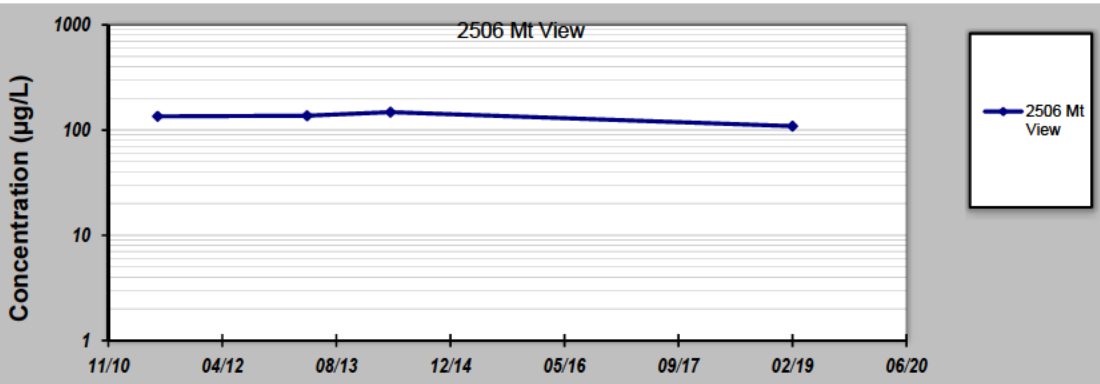
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Trichloroethene (TCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: 2506 Mt View

Sampling Event	Sampling Date	TRICHLOROETHENE (TCE) CONCENTRATION (µg/L)
1	22-Jun-11	135.00
2	8-Apr-13	137.00
3	9-Apr-14	148.00
4	4-Feb-19	109.00
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.12
Mann-Kendall Statistic (S):		0
Confidence Factor:		37.5%
Concentration Trend:		Stable



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

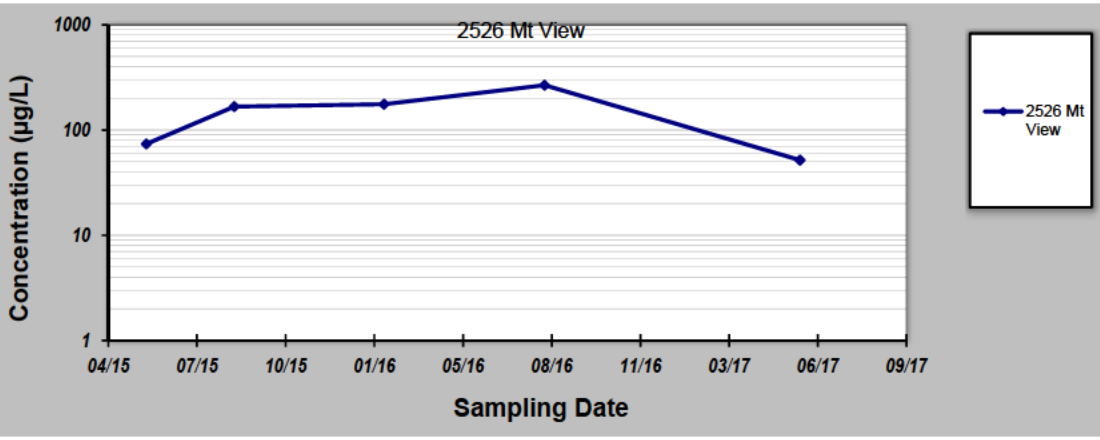
DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Trichloroethene (TCE)
Conducted By:	FJD	Concentration Units:	µg/L
Sampling Point ID:	2526 Mt View		

Sampling Event	Sampling Date	TRICHLOROETHENE (TCE) CONCENTRATION (µg/L)
1	19-May-15	73.80
2	26-Aug-15	167.00
3	11-Feb-16	176.00
4	10-Aug-16	267.00
5	25-May-17	51.80
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.59
Mann-Kendall Statistic (S):		2
Confidence Factor:		59.2%
Concentration Trend:		No Trend



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

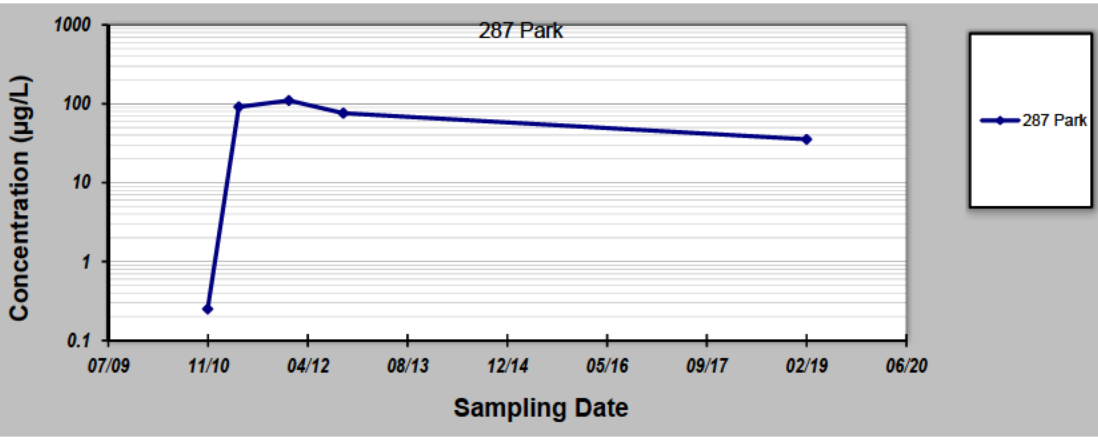
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Trichloroethene (TCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: 287 Park

Sampling Event	Sampling Date	TRICHLOROETHENE (TCE) CONCENTRATION (µg/L)
1	16-Nov-10	0.25
2	21-Apr-11	91.30
3	28-Dec-11	110.00
4	26-Sep-12	76.00
5	4-Feb-19	35.40
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.71
Mann-Kendall Statistic (S):		0
Confidence Factor:		40.8%
Concentration Trend:		Stable



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

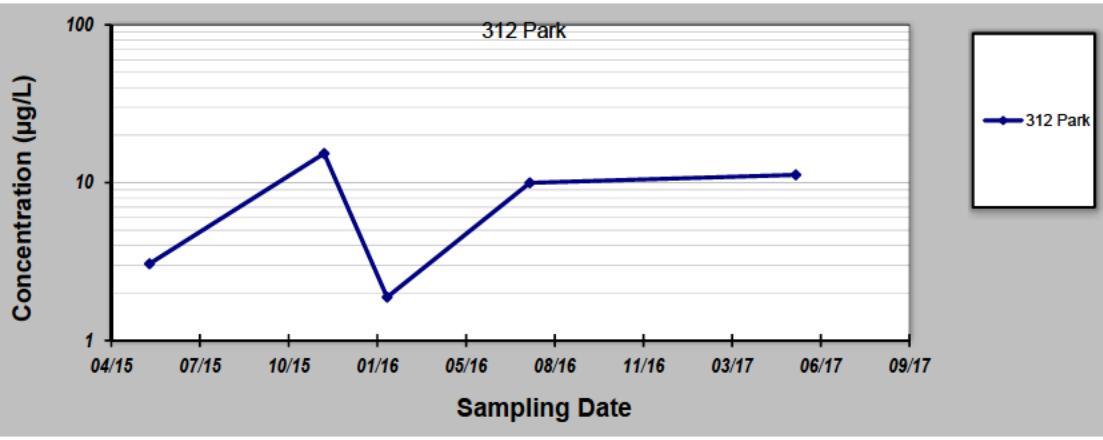
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Trichloroethene (TCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: 312 Park

Sampling Event	Sampling Date	TRICHLOROETHENE (TCE) CONCENTRATION (µg/L)
1	19-May-15	3.06
2	2-Dec-15	15.30
3	11-Feb-16	1.88
4	21-Jul-16	9.97
5	17-May-17	11.20
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.69
Mann-Kendall Statistic (S):		2
Confidence Factor:		59.2%
Concentration Trend:		No Trend



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

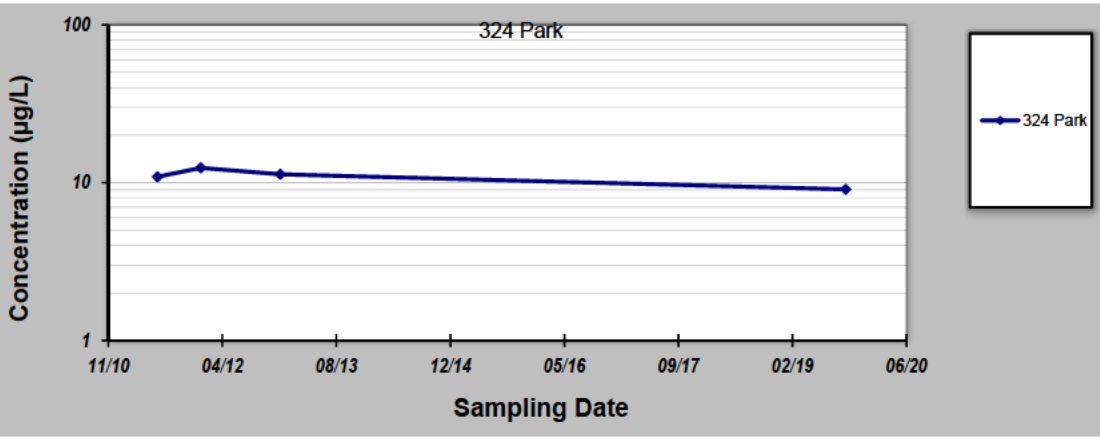
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Trichloroethene (TCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: 324 Park

Sampling Event	Sampling Date	TRICHLOROETHENE (TCE) CONCENTRATION (µg/L)
1	22-Jun-11	10.90
2	29-Dec-11	12.40
3	12-Dec-12	11.30
4	26-Sep-19	9.07
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.13
Mann-Kendall Statistic (S):		-2
Confidence Factor:		62.5%
Concentration Trend:		Stable



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

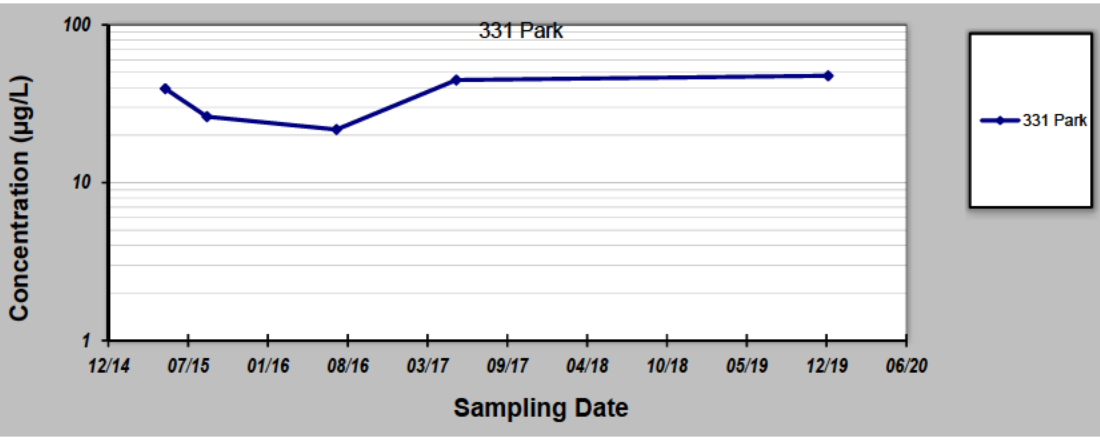
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Trichloroethene (TCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: 331 Park

Sampling Event	Sampling Date	TRICHLOROETHENE (TCE) CONCENTRATION (µg/L)
1	19-May-15	39.40
2	31-Aug-15	26.20
3	21-Jul-16	21.70
4	17-May-17	44.70
5	5-Dec-19	47.60
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.32
Mann-Kendall Statistic (S):		4
Confidence Factor:		75.8%
Concentration Trend:		No Trend



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

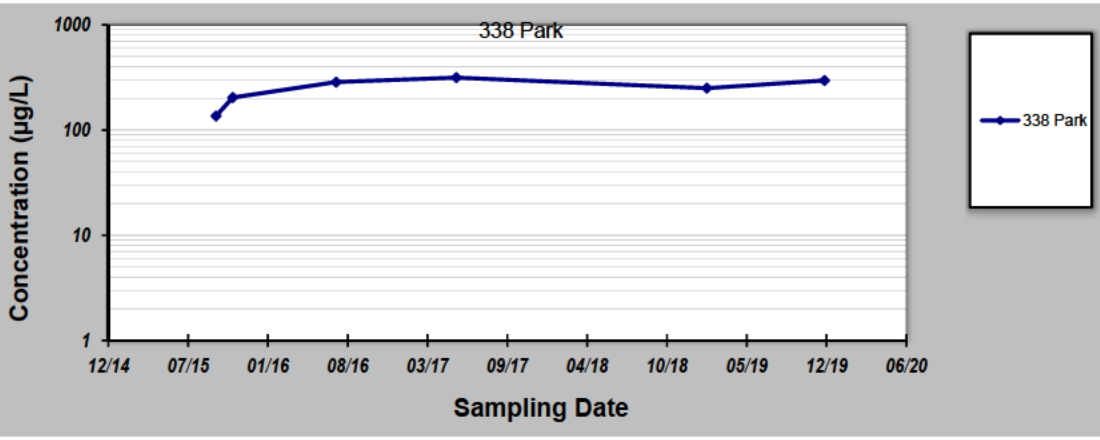
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Trichloroethene (TCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: 338 Park

Sampling Event	Sampling Date	TRICHLOROETHENE (TCE) CONCENTRATION (µg/L)
1	23-Sep-15	136.00
2	4-Nov-15	204.00
3	20-Jul-16	286.00
4	17-May-17	315.00
5	4-Feb-19	250.00
6	26-Nov-19	296.00
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.27
Mann-Kendall Statistic (S):		9
Confidence Factor:		93.2%
Concentration Trend:		Prob. Increasing



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

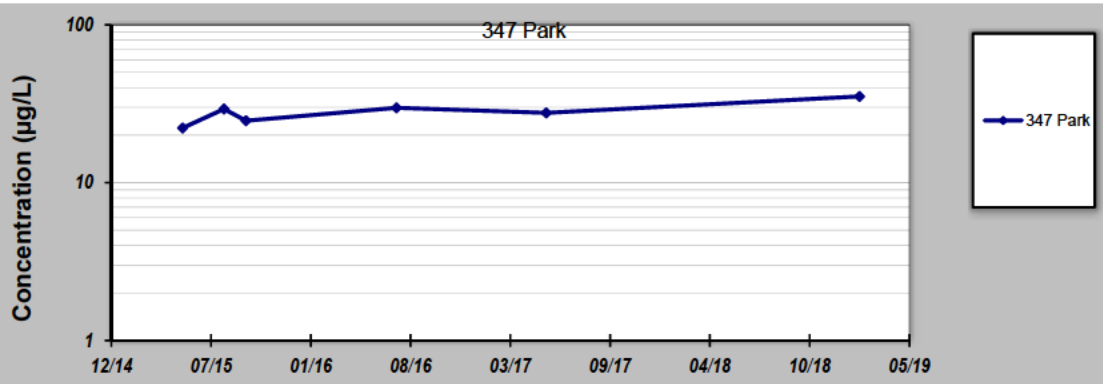
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Trichloroethene (TCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID:	347 Park

Sampling Event	Sampling Date	TRICHLOROETHENE (TCE) CONCENTRATION (µg/L)
1	19-May-15	22.20
2	10-Aug-15	29.30
3	23-Sep-15	24.70
4	21-Jul-16	29.80
5	17-May-17	27.70
6	4-Feb-19	35.20
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.16
Mann-Kendall Statistic (S):		9
Confidence Factor:		93.2%
Concentration Trend:		Prob. Increasing



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

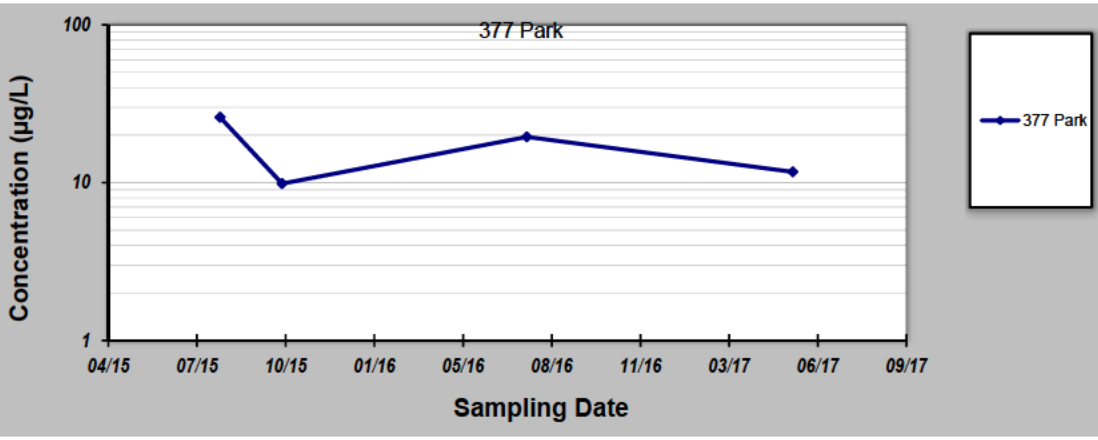
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Trichloroethene (TCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID:	377 Park

Sampling Event	Sampling Date	TRICHLOROETHENE (TCE) CONCENTRATION (µg/L)
1	10-Aug-15	26.00
2	19-Oct-15	9.86
3	21-Jul-16	19.50
4	17-May-17	11.70
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.44
Mann-Kendall Statistic (S):		-2
Confidence Factor:		62.5%
Concentration Trend:		Stable



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

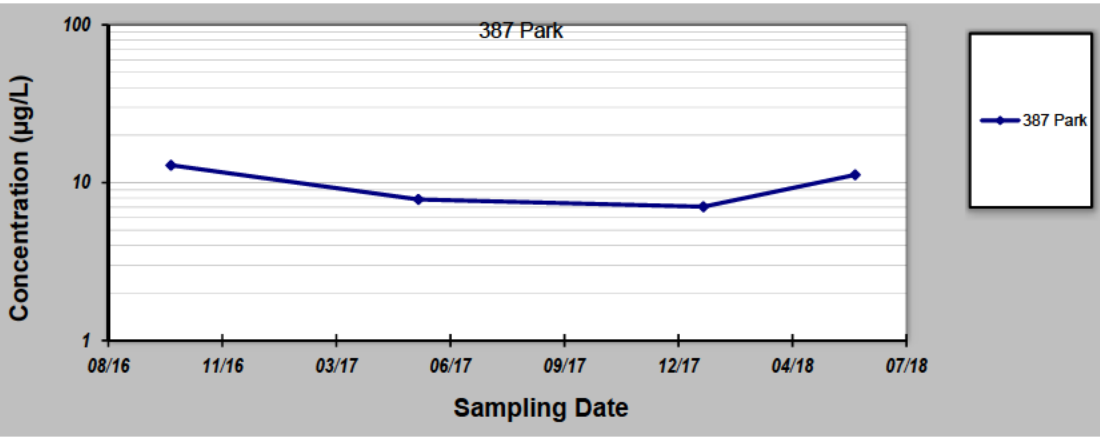
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Trichloroethene (TCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: 387 Park

Sampling Event	Sampling Date	TRICHLOROETHENE (TCE) CONCENTRATION (µg/L)
1	12-Oct-16	12.90
2	17-May-17	7.83
3	22-Jan-18	7.04
4	4-Jun-18	11.20
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.28
Mann-Kendall Statistic (S):		-2
Confidence Factor:		62.5%
Concentration Trend:		Stable



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

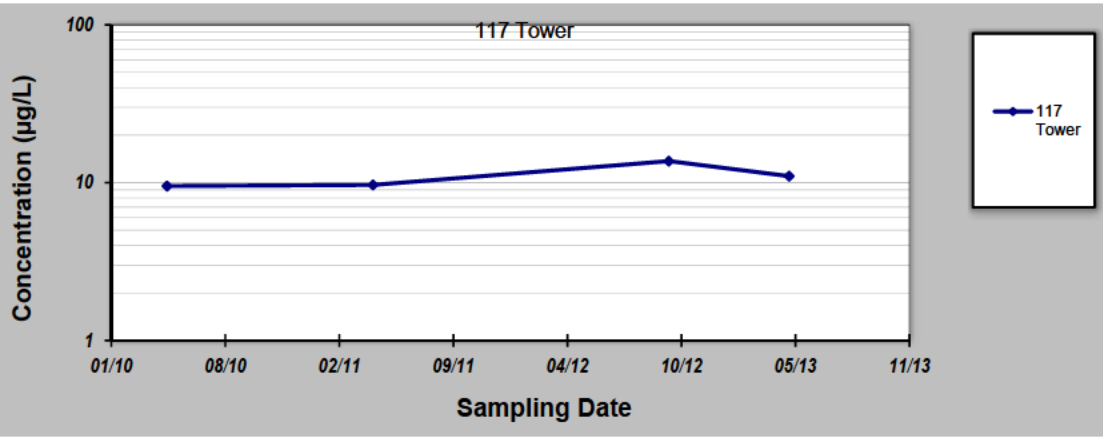
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Trichloroethene (TCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: 117 Tower

Sampling Event	Sampling Date	TRICHLOROETHENE (TCE) CONCENTRATION (µg/L)
1	30-Apr-10	9.52
2	26-Apr-11	9.67
3	26-Sep-12	13.70
4	25-Apr-13	11.00
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.18
Mann-Kendall Statistic (S):		4
Confidence Factor:		83.3%
Concentration Trend:		No Trend



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

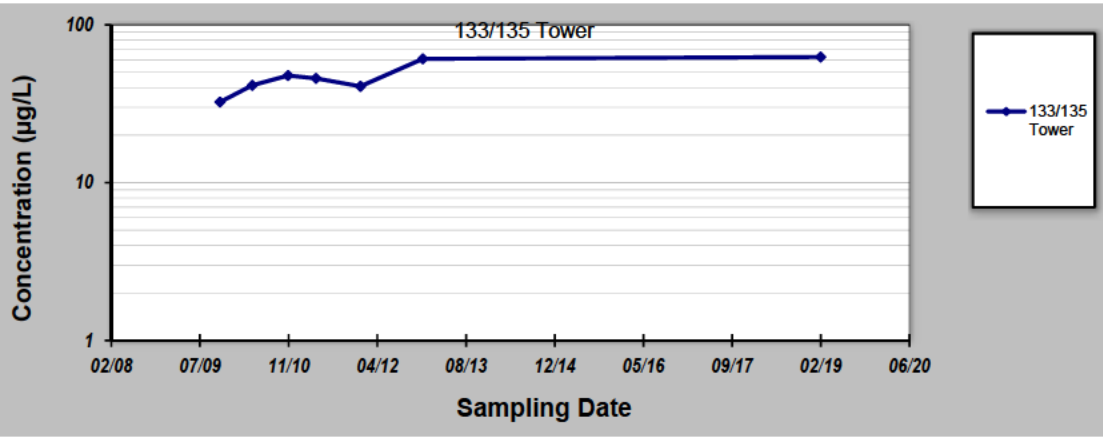
DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Trichloroethene (TCE)
Conducted By:	FJD	Concentration Units:	µg/L
Sampling Point ID:	133/135 Tower		

Sampling Event	Sampling Date	TRICHLOROETHENE (TCE) CONCENTRATION (µg/L)
1	27-Oct-09	32.40
2	27-Apr-10	41.40
3	15-Nov-10	47.70
4	21-Apr-11	45.80
5	28-Dec-11	40.80
6	13-Dec-12	60.9
7	4-Feb-19	62.6
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.23
Mann-Kendall Statistic (S):		13
Confidence Factor:		96.5%
Concentration Trend:		Increasing



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

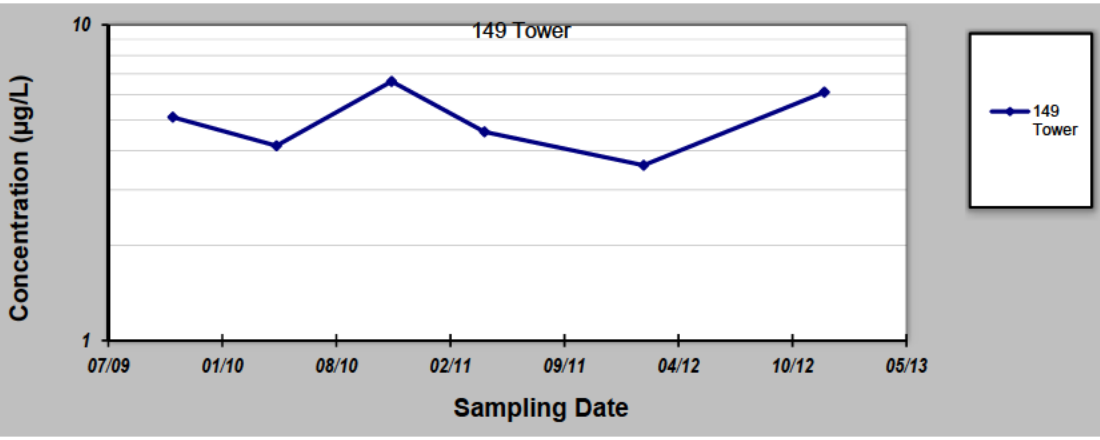
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Trichloroethene (TCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: 149 Tower

Sampling Event	Sampling Date	TRICHLOROETHENE (TCE) CONCENTRATION (µg/L)
1	27-Oct-09	5.10
2	27-Apr-10	4.14
3	15-Nov-10	6.62
4	27-Apr-11	4.58
5	31-Jan-12	3.59
6	13-Dec-12	6.12
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.23
Mann-Kendall Statistic (S):		-1
Confidence Factor:		50.0%
Concentration Trend:		Stable



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

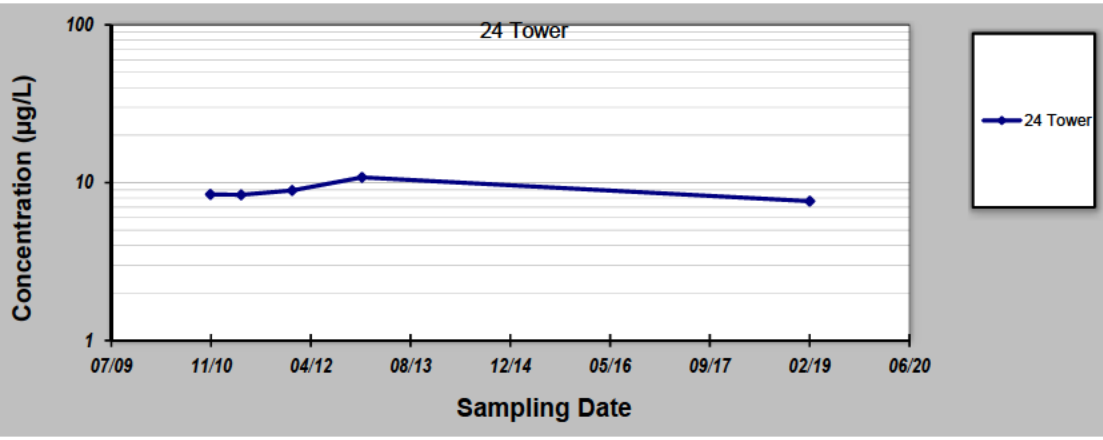
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Trichloroethene (TCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: 24 Tower

Sampling Event	Sampling Date	TRICHLOROETHENE (TCE) CONCENTRATION (µg/L)
1	15-Nov-10	8.43
2	18-Apr-11	8.38
3	29-Dec-11	8.92
4	13-Dec-12	10.80
5	4-Feb-19	7.63
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.14
Mann-Kendall Statistic (S):		0
Confidence Factor:		40.8%
Concentration Trend:		Stable



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

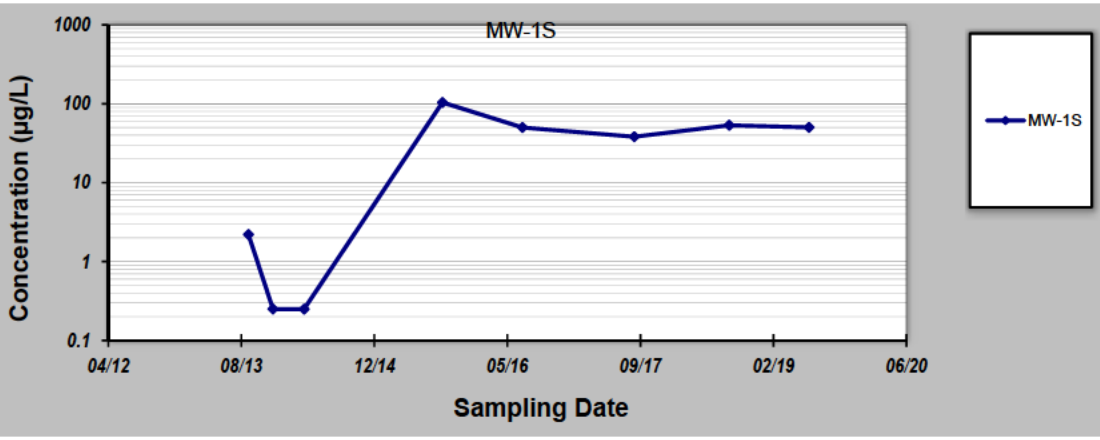
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Tetrachloroethene (PCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: MW-1S

Sampling Event	Sampling Date	TETRACHLOROETHENE (PCE) CONCENTRATION (µg/L)
1	10-Sep-13	2
2	11-Dec-13	0.25
3	7-Apr-14	0.25
4	9-Sep-15	104
5	6-Jul-16	50
6	30-Aug-17	38
7	22-Aug-18	53.4
8	18-Jun-19	50.2
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.96
Mann-Kendall Statistic (S):		11
Confidence Factor:		88.7%
Concentration Trend:		No Trend



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

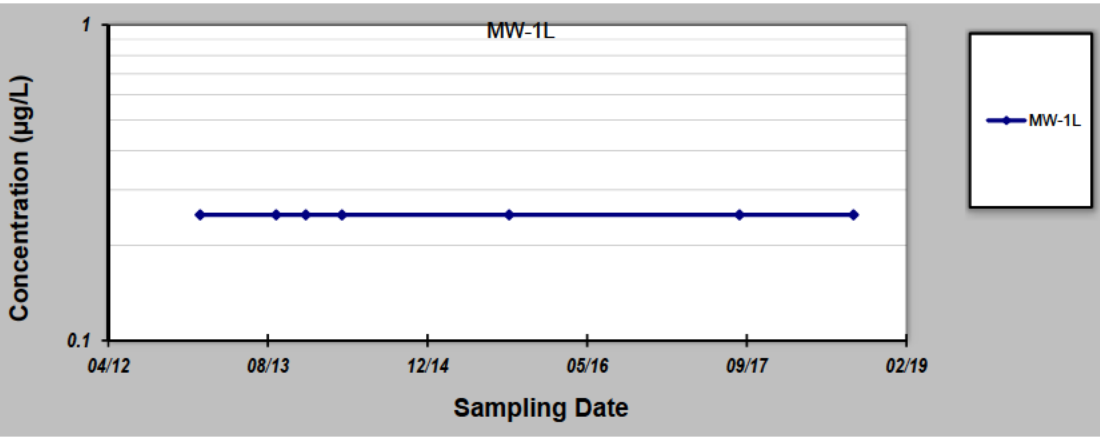
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Tetrachloroethene (PCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: MW-1L

Sampling Event	Sampling Date	TETRACHLOROETHENE (PCE) CONCENTRATION (µg/L)
1	14-Jan-13	0.25
2	9-Sep-13	0.25
3	11-Dec-13	0.25
4	3-Apr-14	0.25
5	9-Sep-15	0.25
6	30-Aug-17	0.25
7	22-Aug-18	0.25
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.00
Mann-Kendall Statistic (S):		0
Confidence Factor:		37.9%
Concentration Trend:		Stable



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

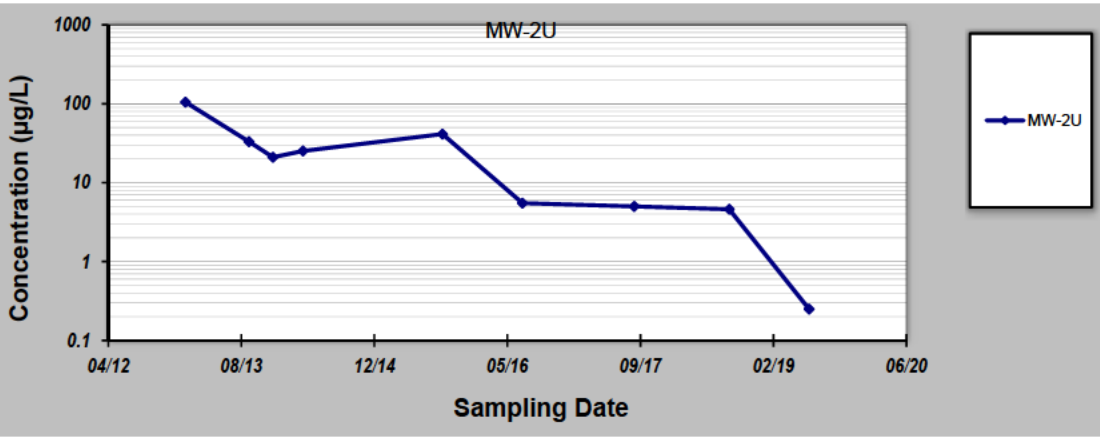
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Tetrachloroethene (PCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: MW-2U

Sampling Event	Sampling Date	TETRACHLOROETHENE (PCE) CONCENTRATION (µg/L)
1	16-Jan-13	105
2	12-Sep-13	33
3	11-Dec-13	21
4	3-Apr-14	25
5	9-Sep-15	41
6	6-Jul-16	6
7	30-Aug-17	5
8	22-Aug-18	4.6
9	18-Jun-19	0.25
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		1.22
Mann-Kendall Statistic (S):		-28
Confidence Factor:		99.9%
Concentration Trend:		Decreasing



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

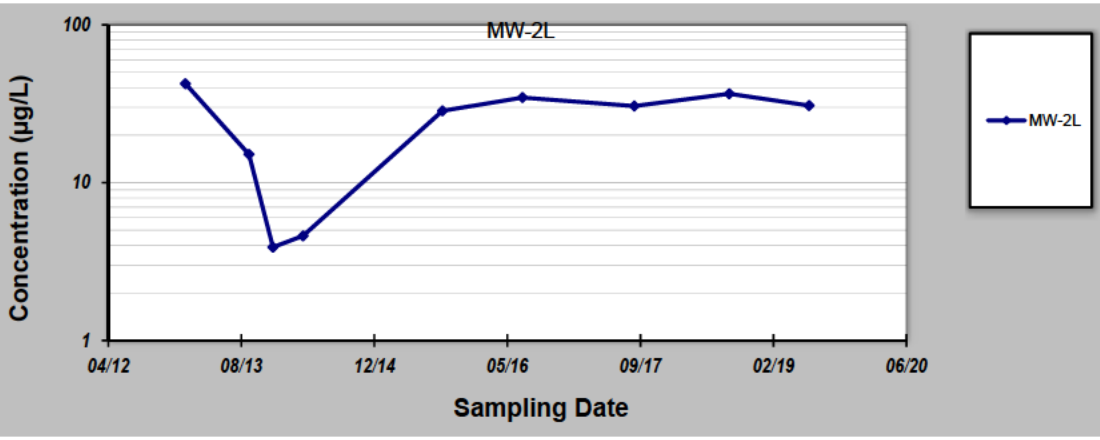
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Tetrachloroethene (PCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: MW-2L

Sampling Event	Sampling Date	TETRACHLOROETHENE (PCE) CONCENTRATION (µg/L)
1	16-Jan-13	42
2	12-Sep-13	15
3	11-Dec-13	4
4	3-Apr-14	5
5	9-Sep-15	29
6	6-Jul-16	35
7	30-Aug-17	30.6
8	22-Aug-18	36.6
9	18-Jun-19	30.8
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.55
Mann-Kendall Statistic (S):		10
Confidence Factor:		82.1%
Concentration Trend:		No Trend



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

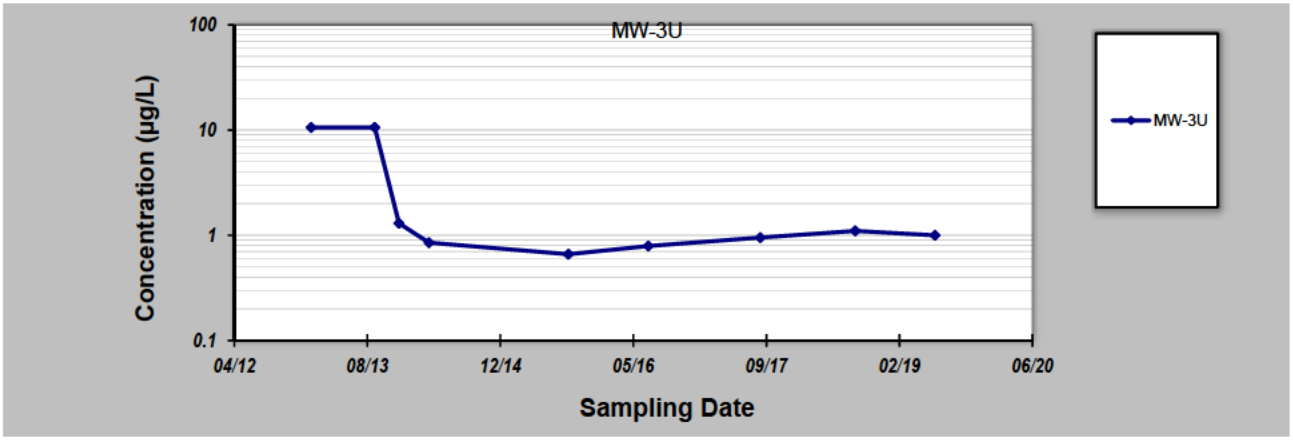
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Tetrachloroethene (PCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: MW-3U

Sampling Event	Sampling Date	TETRACHLOROETHENE (PCE) CONCENTRATION (µg/L)
1	15-Jan-13	11
2	11-Sep-13	11
3	11-Dec-13	1
4	3-Apr-14	1
5	9-Sep-15	1
6	5-Jul-16	1
7	30-Aug-17	0.95
8	22-Aug-18	1.1
9	18-Jun-19	1
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		1.38
Mann-Kendall Statistic (S):		-11
Confidence Factor:		84.6%
Concentration Trend:		No Trend



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

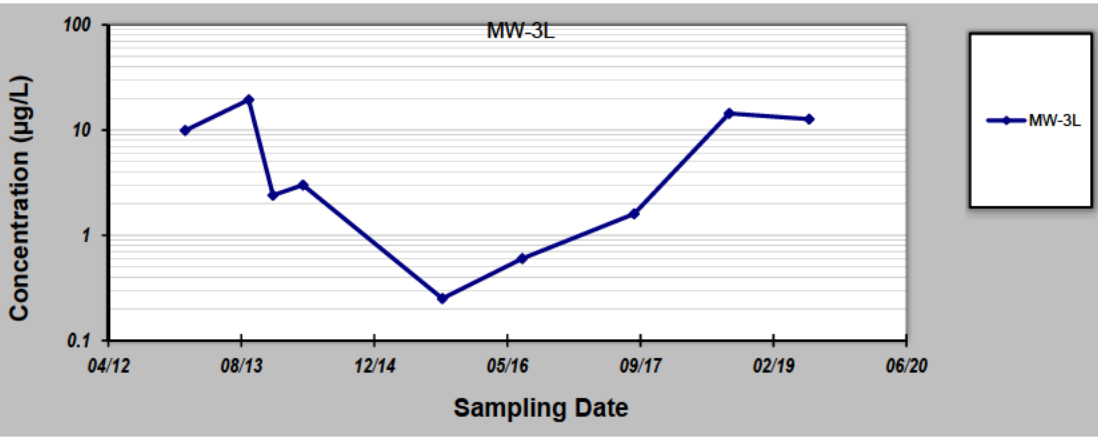
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Tetrachloroethene (PCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: MW-3L

Sampling Event	Sampling Date	TETRACHLOROETHENE (PCE) CONCENTRATION (µg/L)
1	15-Jan-13	10
2	11-Sep-13	19
3	11-Dec-13	2
4	3-Apr-14	3
5	9-Sep-15	0.25
6	5-Jul-16	1
7	30-Aug-17	1.6
8	22-Aug-18	14.4
9	18-Jun-19	12.7
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.99
Mann-Kendall Statistic (S):		-2
Confidence Factor:		54.0%
Concentration Trend:		Stable



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

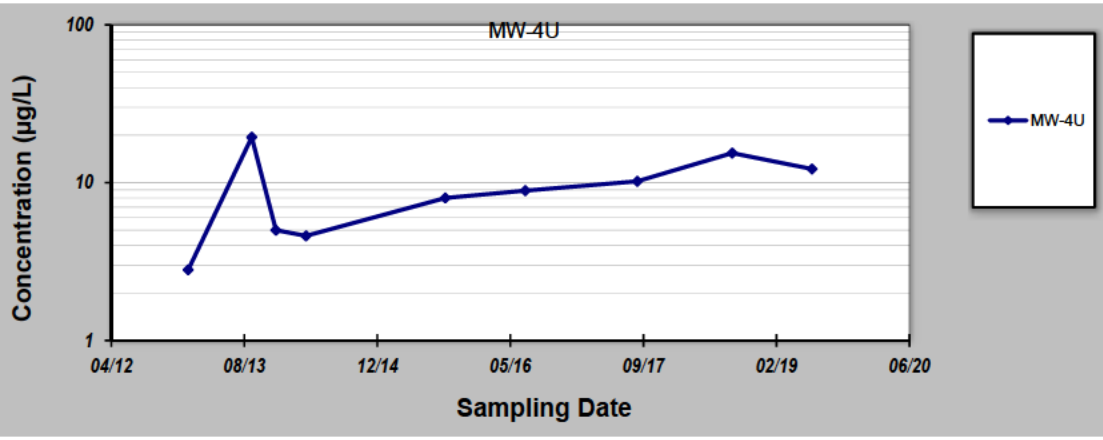
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Tetrachloroethene (PCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: MW-4U

Sampling Event	Sampling Date	TETRACHLOROETHENE (PCE) CONCENTRATION (µg/L)
1	15-Jan-13	3
2	11-Sep-13	19
3	11-Dec-13	5
4	3-Apr-14	5
5	9-Sep-15	8
6	5-Jul-16	9
7	30-Aug-17	10.2
8	22-Aug-18	15.4
9	18-Jun-19	12.2
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.56
Mann-Kendall Statistic (S):		18
Confidence Factor:		96.2%
Concentration Trend:		Increasing



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

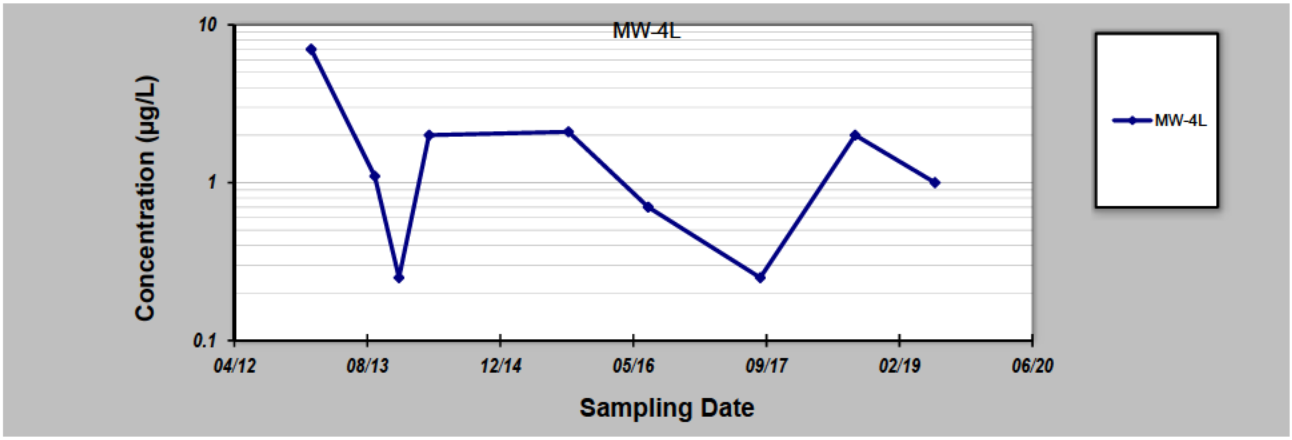
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Tetrachloroethene (PCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: MW-4L

Sampling Event	Sampling Date	TETRACHLOROETHENE (PCE) CONCENTRATION (µg/L)
1	15-Jan-13	7
2	11-Sep-13	1
3	11-Dec-13	0.25
4	3-Apr-14	2
5	9-Sep-15	2
6	5-Jul-16	1
7	30-Aug-17	0.25
8	22-Aug-18	2
9	18-Jun-19	1
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		1.14
Mann-Kendall Statistic (S):		-8
Confidence Factor:		76.2%
Concentration Trend:		No Trend



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

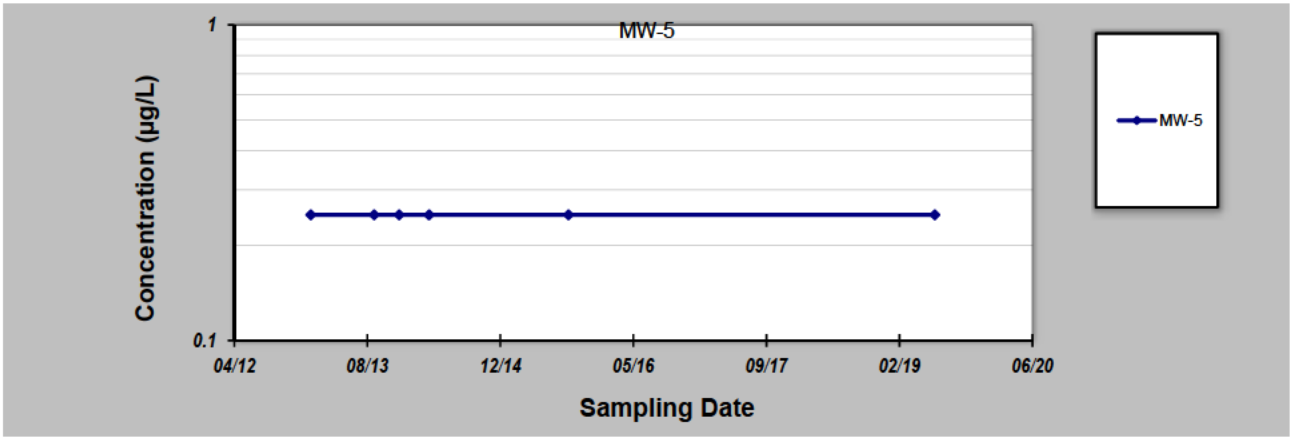
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Tetrachloroethene (PCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: MW-5

Sampling Event	Sampling Date	TETRACHLOROETHENE (PCE) CONCENTRATION (µg/L)
1	14-Jan-13	0.25
2	9-Sep-13	0.25
3	12-Dec-13	0.25
4	3-Apr-14	0.25
5	9-Sep-15	0.25
6	17-Jun-19	0.25
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.00
Mann-Kendall Statistic (S):		0
Confidence Factor:		39.3%
Concentration Trend:		Stable



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

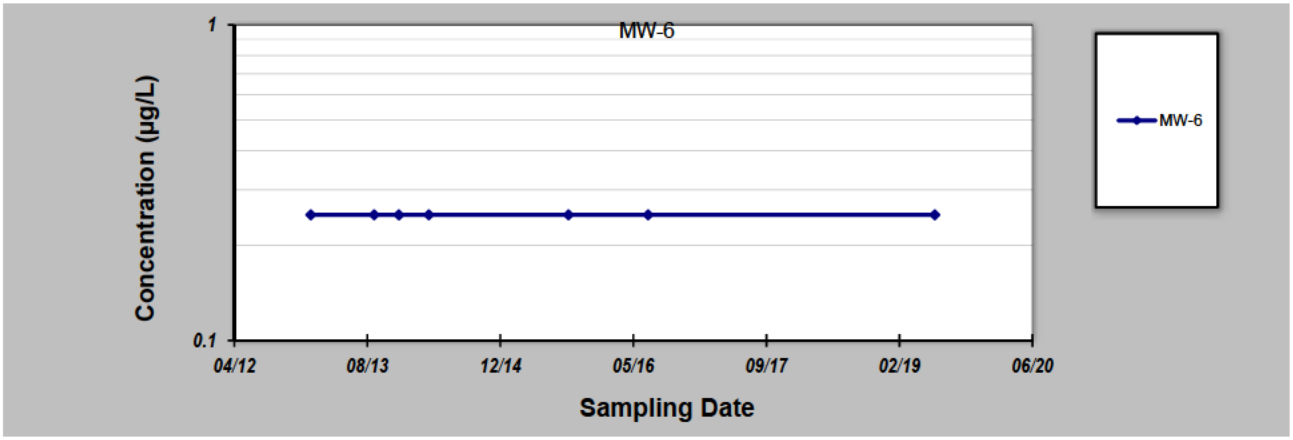
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Tetrachloroethene (PCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: MW-6

Sampling Event	Sampling Date	TETRACHLOROETHENE (PCE) CONCENTRATION (µg/L)
1	14-Jan-13	0.25
2	9-Sep-13	0.25
3	11-Dec-13	0.25
4	2-Apr-14	0.25
5	9-Sep-15	0.25
6	5-Jul-16	0.25
7	17-Jun-19	0.25
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.00
Mann-Kendall Statistic (S):		0
Confidence Factor:		37.9%
Concentration Trend:		Stable



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

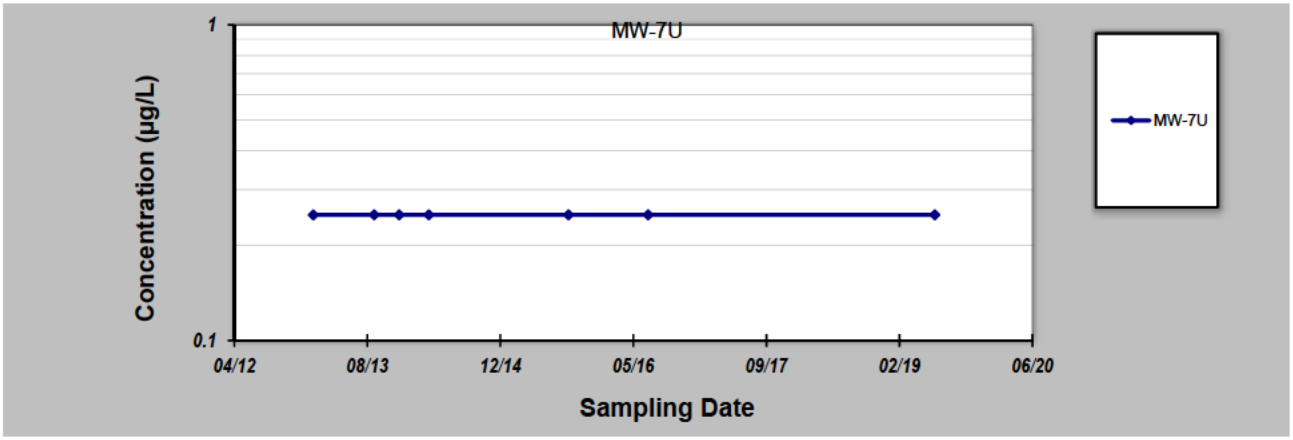
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Tetrachloroethene (PCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: MW-7U

Sampling Event	Sampling Date	TETRACHLOROETHENE (PCE) CONCENTRATION (µg/L)
1	23-Jan-13	0.25
2	9-Sep-13	0.25
3	12-Dec-13	0.25
4	2-Apr-14	0.25
5	9-Sep-15	0.25
6	5-Jul-16	0.25
7	17-Jun-19	0.25
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.00
Mann-Kendall Statistic (S):		0
Confidence Factor:		37.9%
Concentration Trend:		Stable



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

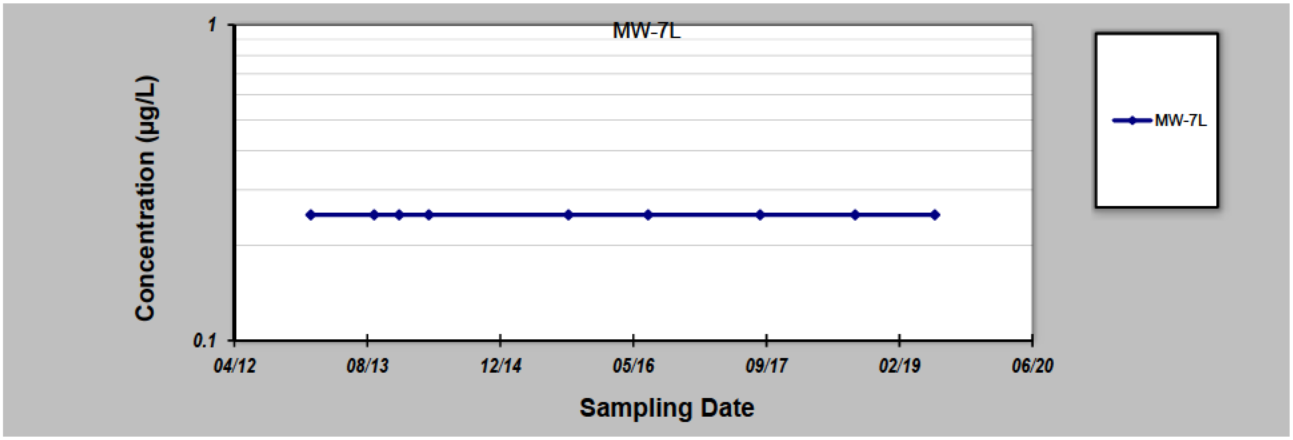
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Tetrachloroethene (PCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: MW-7L

Sampling Event	Sampling Date	TETRACHLOROETHENE (PCE) CONCENTRATION (µg/L)
1	14-Jan-13	0.25
2	9-Sep-13	0.25
3	12-Dec-13	0.25
4	2-Apr-14	0.25
5	9-Sep-15	0.25
6	5-Jul-16	0.25
7	30-Aug-17	0.25
8	22-Aug-18	0.25
9	17-Jun-19	0.25
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.00
Mann-Kendall Statistic (S):		0
Confidence Factor:		46.0%
Concentration Trend:		Stable



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

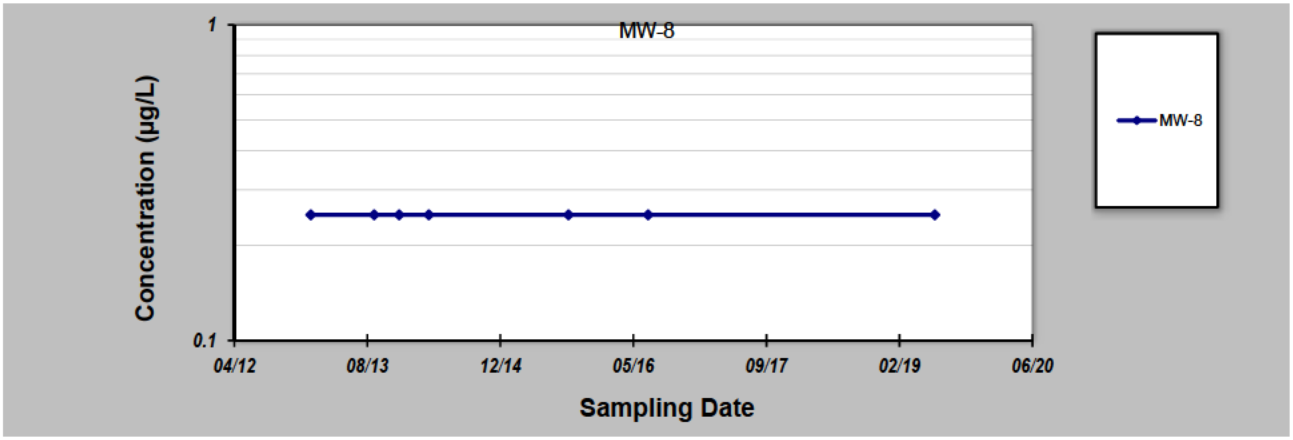
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Tetrachloroethene (PCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: MW-8

Sampling Event	Sampling Date	TETRACHLOROETHENE (PCE) CONCENTRATION (µg/L)
1	14-Jan-13	0.25
2	9-Sep-13	0.25
3	12-Dec-13	0.25
4	2-Apr-14	0.25
5	9-Sep-15	0.25
6	5-Jul-16	0.25
7	17-Jun-19	0.25
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.00
Mann-Kendall Statistic (S):		0
Confidence Factor:		37.9%
Concentration Trend:		Stable



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

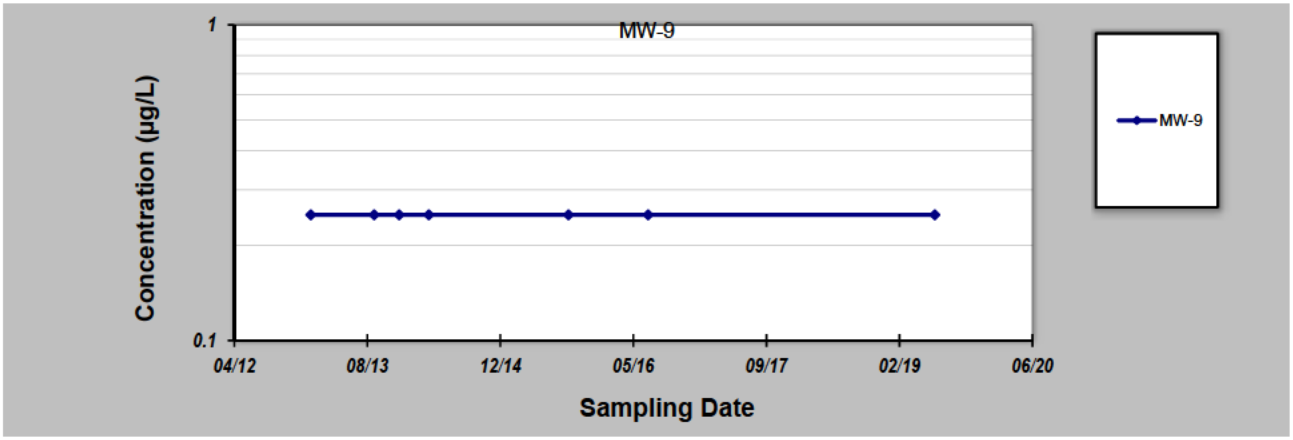
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Tetrachloroethene (PCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: MW-9

Sampling Event	Sampling Date	TETRACHLOROETHENE (PCE) CONCENTRATION (µg/L)
1	14-Jan-13	0.25
2	9-Sep-13	0.25
3	12-Dec-13	0.25
4	2-Apr-14	0.25
5	9-Sep-15	0.25
6	5-Jul-16	0.25
7	17-Jun-19	0.25
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.00
Mann-Kendall Statistic (S):		0
Confidence Factor:		37.9%
Concentration Trend:		Stable



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

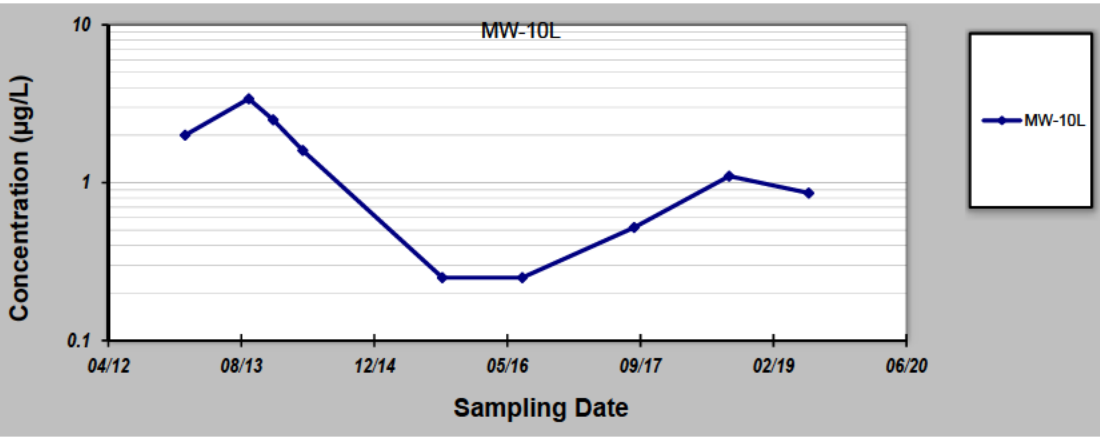
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Tetrachloroethene (PCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: MW-10L

Sampling Event	Sampling Date	TETRACHLOROETHENE (PCE) CONCENTRATION (µg/L)
1	15-Jan-13	2.00
2	11-Sep-13	3.40
3	12-Dec-13	2.50
4	2-Apr-14	1.60
5	9-Sep-15	0.25
6	5-Jul-16	0.25
7	30-Aug-17	0.52
8	22-Aug-18	1.1
9	17-Jun-19	0.86
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.78
Mann-Kendall Statistic (S):		-15
Confidence Factor:		92.5%
Concentration Trend:		Prob. Decreasing



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

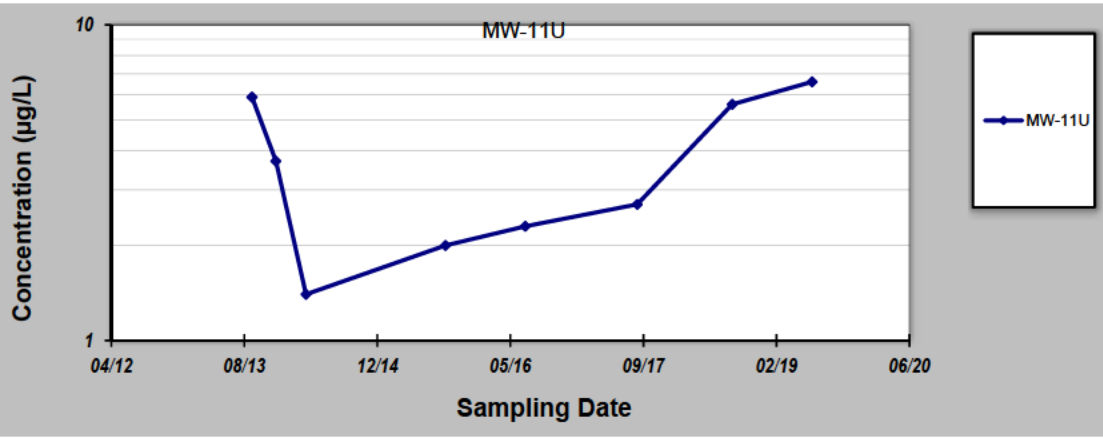
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Tetrachloroethene (PCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: MW-11U

Sampling Event	Sampling Date	TETRACHLOROETHENE (PCE) CONCENTRATION (µg/L)
1	12-Sep-13	5.90
2	11-Dec-13	3.70
3	3-Apr-14	1.40
4	9-Sep-15	2.00
5	5-Jul-16	2.30
6	30-Aug-17	2.70
7	22-Aug-18	5.60
8	18-Jun-19	6.6
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.53
Mann-Kendall Statistic (S):		8
Confidence Factor:		80.1%
Concentration Trend:		No Trend



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

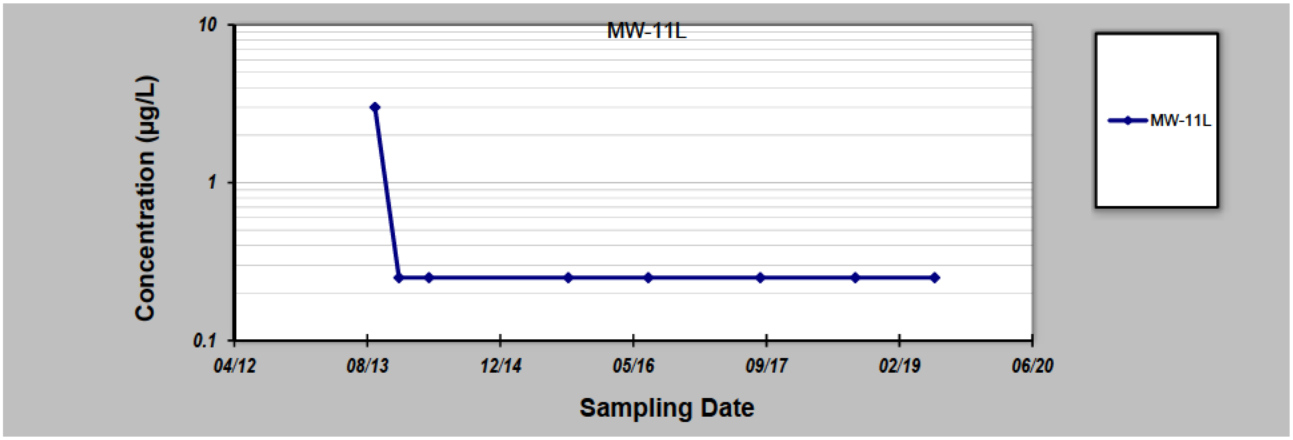
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Tetrachloroethene (PCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: MW-11L

Sampling Event	Sampling Date	TETRACHLOROETHENE (PCE) CONCENTRATION (µg/L)
1	12-Sep-13	3.00
2	11-Dec-13	0.25
3	3-Apr-14	0.25
4	9-Sep-15	0.25
5	5-Jul-16	0.25
6	30-Aug-17	0.25
7	22-Aug-18	0.25
8	17-Jun-19	0.25
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		1.64
Mann-Kendall Statistic (S):		-7
Confidence Factor:		76.4%
Concentration Trend:		No Trend



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

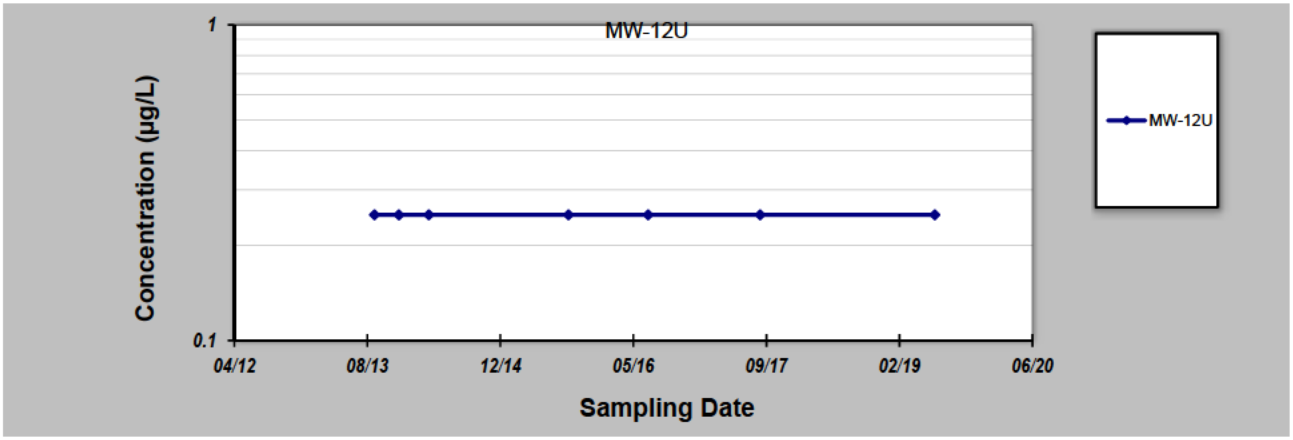
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Tetrachloroethene (PCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: MW-12U

Sampling Event	Sampling Date	TETRACHLOROETHENE (PCE) CONCENTRATION (µg/L)
1	10-Sep-13	0.25
2	11-Dec-13	0.25
3	2-Apr-14	0.25
4	9-Sep-15	0.25
5	5-Jul-16	0.25
6	30-Aug-17	0.25
7	17-Jun-19	0.25
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.00
Mann-Kendall Statistic (S):		0
Confidence Factor:		37.9%
Concentration Trend:		Stable



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

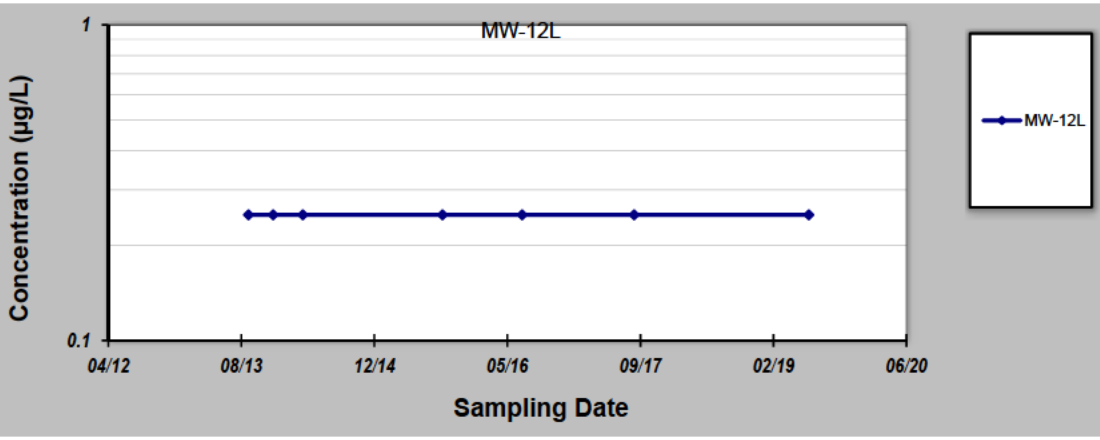
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Tetrachloroethene (PCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: MW-12L

Sampling Event	Sampling Date	TETRACHLOROETHENE (PCE) CONCENTRATION (µg/L)
1	10-Sep-13	0.25
2	12-Dec-13	0.25
3	2-Apr-14	0.25
4	9-Sep-15	0.25
5	5-Jul-16	0.25
6	30-Aug-17	0.25
7	17-Jun-19	0.25
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.00
Mann-Kendall Statistic (S):		0
Confidence Factor:		37.9%
Concentration Trend:		Stable



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

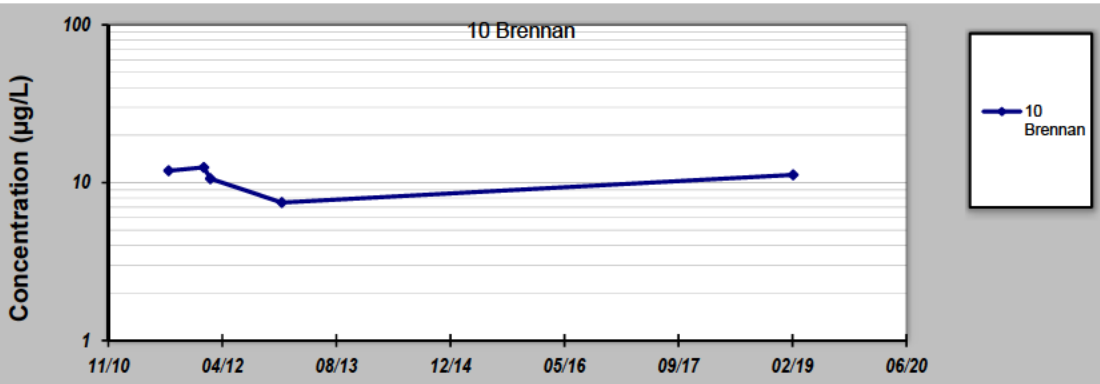
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Tetrachloroethene (PCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: 10 Brennan

Sampling Event	Sampling Date	TETRACHLOROETHENE (PCE) CONCENTRATION (µg/L)
1	10-Aug-11	12
2	11-Jan-12	13
3	9-Feb-12	11
4	18-Dec-12	7
5	7-Feb-19	11
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.18
Mann-Kendall Statistic (S):		-4
Confidence Factor:		75.8%
Concentration Trend:		Stable



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

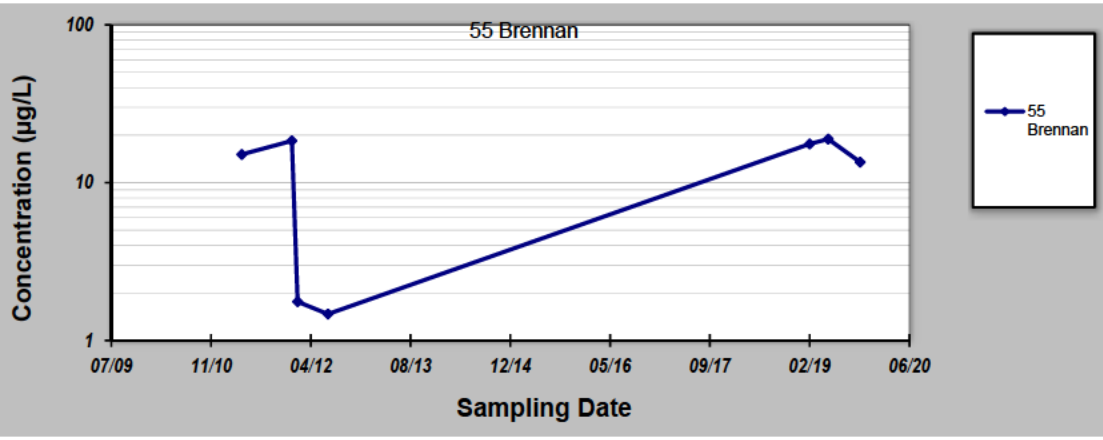
DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Tetrachloroethene (PCE)
Conducted By:	FJD	Concentration Units:	µg/L
Sampling Point ID:	55 Brennan		

Sampling Event	Sampling Date	TETRACHLOROETHENE (PCE) CONCENTRATION (µg/L)
1	21-Apr-11	15.1
2	28-Dec-11	18.4
3	26-Jan-12	1.76
4	26-Jun-12	1.47
5	4-Feb-19	17.6
6	8-May-19	18.9
7	15-Oct-19	13.5
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.61
Mann-Kendall Statistic (S):		1
Confidence Factor:		50.0%
Concentration Trend:		No Trend



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

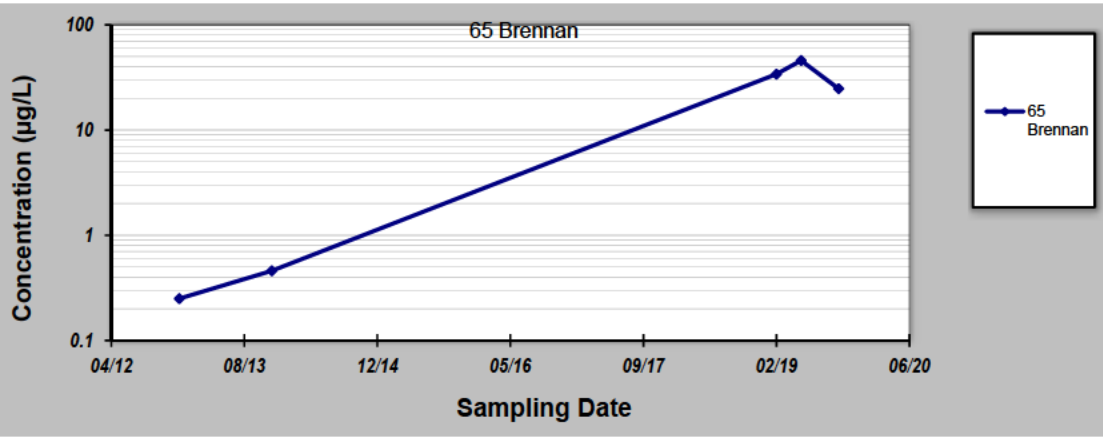
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Tetrachloroethene (PCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: 65 Brennan

Sampling Event	Sampling Date	TETRACHLOROETHENE (PCE) CONCENTRATION (µg/L)
1	13-Dec-12	0.25
2	25-Nov-13	0.46
3	4-Feb-19	34
4	8-May-19	45.8
5	26-Sep-19	24.7
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.97
Mann-Kendall Statistic (S):		6
Confidence Factor:		88.3%
Concentration Trend:		No Trend



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

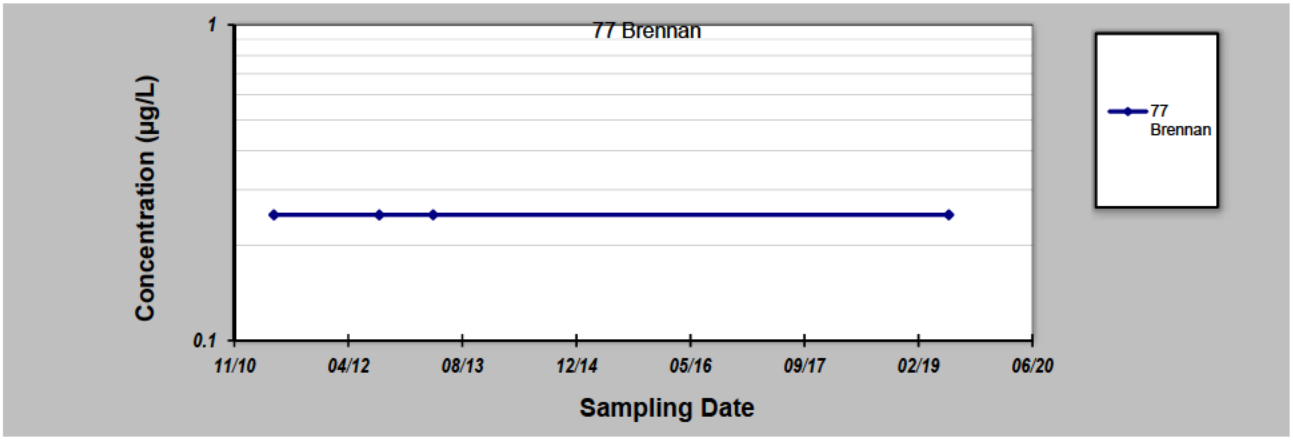
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Tetrachloroethene (PCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: 77 Brennan

Sampling Event	Sampling Date	TETRACHLOROETHENE (PCE) CONCENTRATION (µg/L)
1	11-May-11	0.25
2	15-Aug-12	0.25
3	8-Apr-13	0.25
4	17-Jun-19	0.25
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.00
Mann-Kendall Statistic (S):		0
Confidence Factor:		37.5%
Concentration Trend:		Stable



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

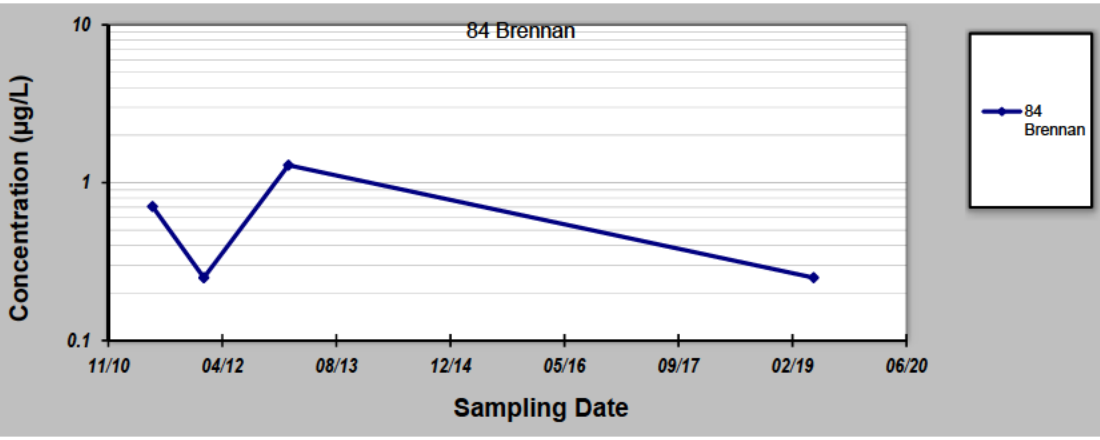
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Tetrachloroethene (PCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: 84 Brennan

Sampling Event	Sampling Date	TETRACHLOROETHENE (PCE) CONCENTRATION (µg/L)
1	31-May-11	0.71
2	11-Jan-12	0.25
3	16-Jan-13	1.29
4	8-May-19	0.25
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.79
Mann-Kendall Statistic (S):		-1
Confidence Factor:		50.0%
Concentration Trend:		Stable



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

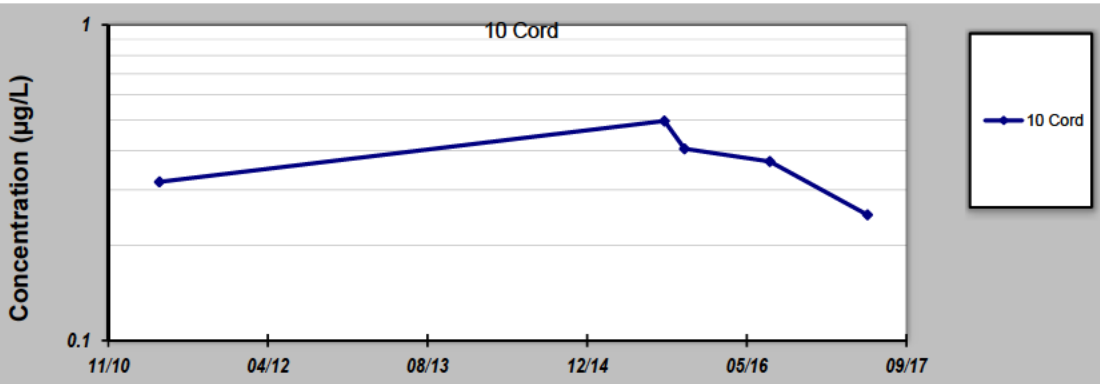
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Tetrachloroethene (PCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: 10 Cord

Sampling Event	Sampling Date	TETRACHLOROETHENE (PCE) CONCENTRATION (µg/L)
1	27-Apr-11	0.318
2	26-Aug-15	0.496
3	28-Oct-15	0.405
4	21-Jul-16	0.369
5	23-May-17	0.25
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.25
Mann-Kendall Statistic (S):		-4
Confidence Factor:		75.8%
Concentration Trend:		Stable



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

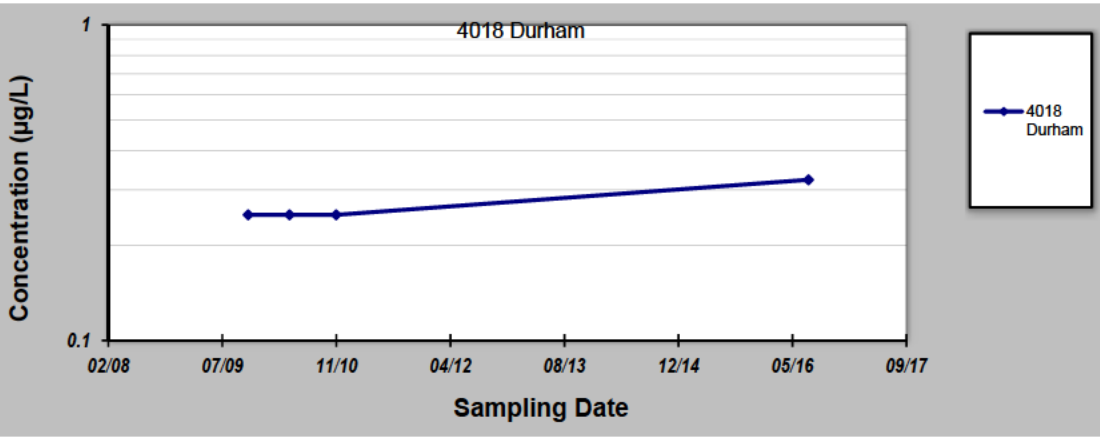
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Tetrachloroethene (PCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: 4018 Durham

Sampling Event	Sampling Date	TETRACHLOROETHENE (PCE) CONCENTRATION (µg/L)
1	27-Oct-09	0.25
2	27-Apr-10	0.25
3	17-Nov-10	0.25
4	20-Jul-16	0.323
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.14
Mann-Kendall Statistic (S):		3
Confidence Factor:		72.9%
Concentration Trend:		No Trend



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

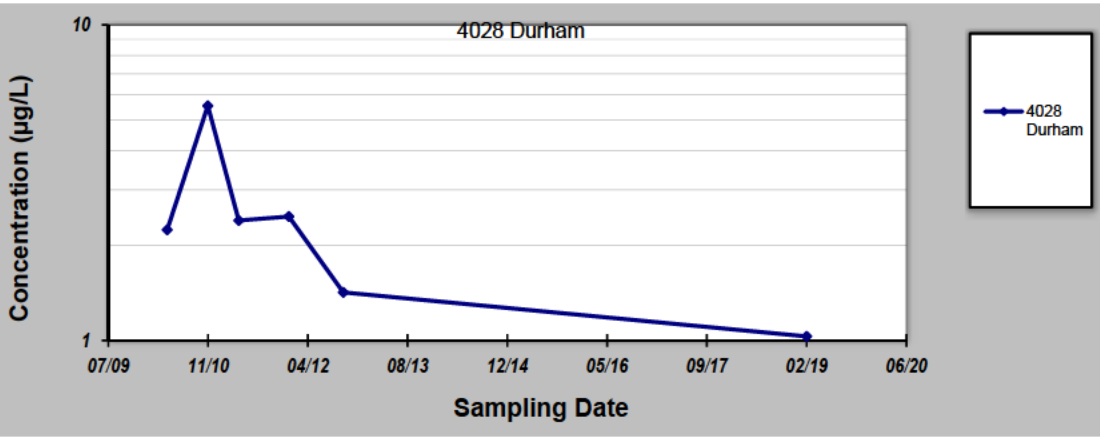
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Tetrachloroethene (PCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: 4028 Durham

Sampling Event	Sampling Date	TETRACHLOROETHENE (PCE) CONCENTRATION (µg/L)
1	27-Apr-10	2.24
2	17-Nov-10	5.54
3	21-Apr-11	2.40
4	28-Dec-11	2.47
5	26-Sep-12	1.42
6	4-Feb-19	1.03
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.63
Mann-Kendall Statistic (S):		-7
Confidence Factor:		86.4%
Concentration Trend:		Stable



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

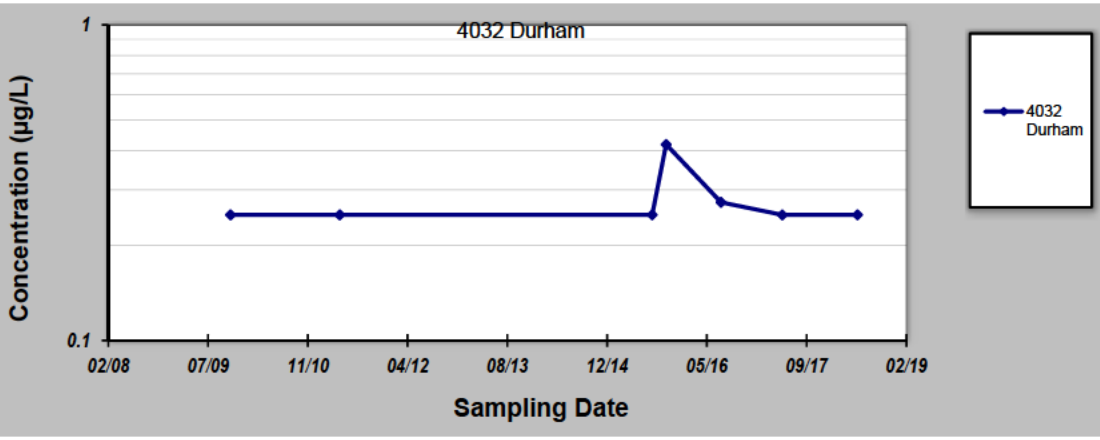
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Tetrachloroethene (PCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: 4032 Durham

Sampling Event	Sampling Date	TETRACHLOROETHENE (PCE) CONCENTRATION (µg/L)
1	27-Oct-09	0.25
2	27-Apr-11	0.25
3	10-Aug-15	0.25
4	19-Oct-15	0.418
5	20-Jul-16	0.274
6	23-May-17	0.25
7	4-Jun-18	0.25
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.23
Mann-Kendall Statistic (S):		1
Confidence Factor:		50.0%
Concentration Trend:		No Trend



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

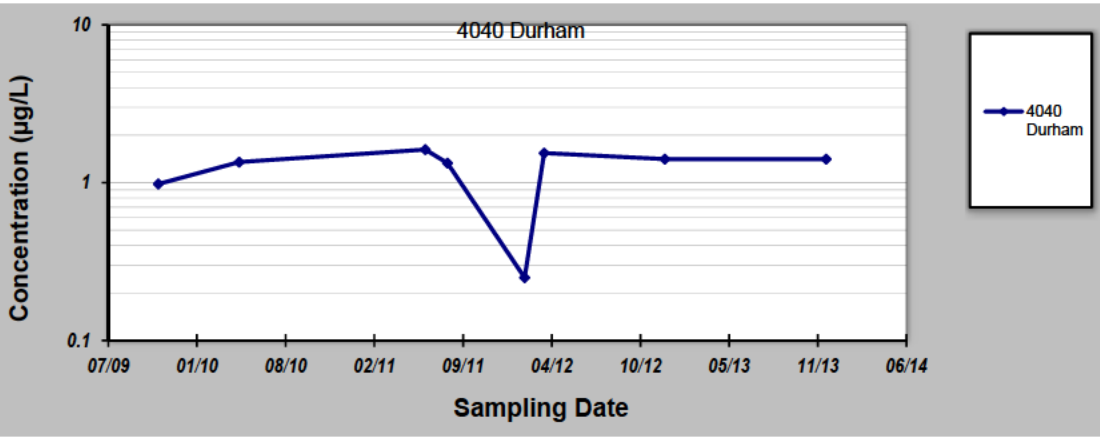
DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Tetrachloroethene (PCE)
Conducted By:	FJD	Concentration Units:	µg/L
Sampling Point ID:	4040 Durham		

Sampling Event	Sampling Date	TETRACHLOROETHENE (PCE) CONCENTRATION (µg/L)
1	27-Oct-09	0.981
2	27-Apr-10	1.35
3	21-Jun-11	1.62
4	10-Aug-11	1.33
5	31-Jan-12	0.25
6	15-Mar-12	1.54
7	12-Dec-12	1.41
8	11-Dec-13	1.41
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.36
Mann-Kendall Statistic (S):		5
Confidence Factor:		68.3%
Concentration Trend:		No Trend



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

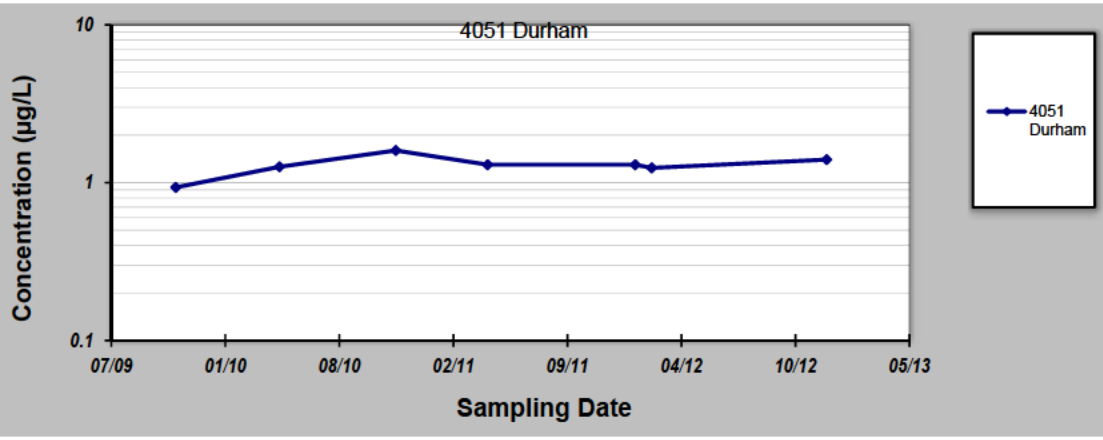
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Tetrachloroethene (PCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: 4051 Durham

Sampling Event	Sampling Date	TETRACHLOROETHENE (PCE) CONCENTRATION (µg/L)
1	27-Oct-09	0.933
2	27-Apr-10	1.26
3	17-Nov-10	1.6
4	27-Apr-11	1.3
5	11-Jan-12	1.3
6	9-Feb-12	1.24
7	12-Dec-12	1.4
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.15
Mann-Kendall Statistic (S):		6
Confidence Factor:		76.4%
Concentration Trend:		No Trend



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

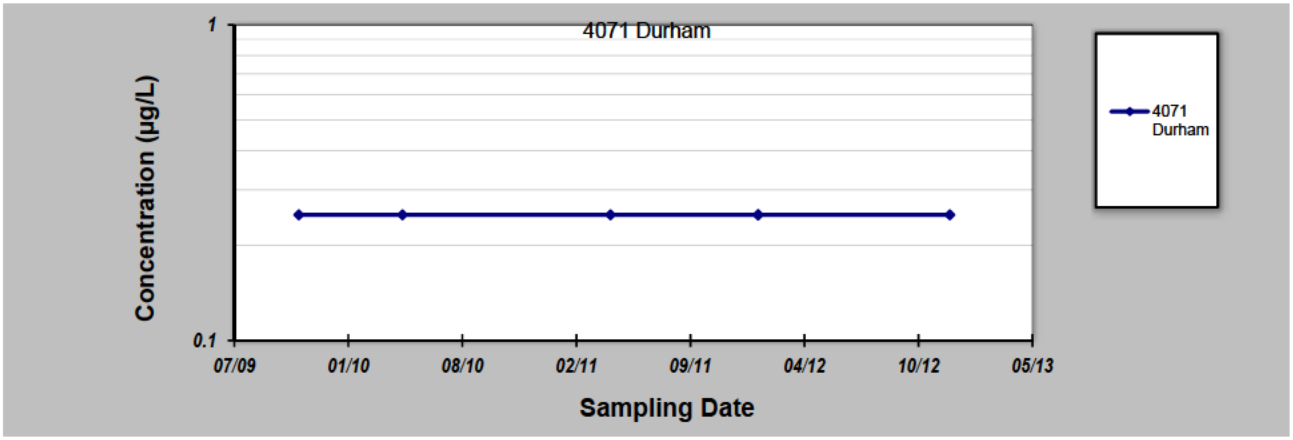
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Tetrachloroethene (PCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: 4071 Durham

Sampling Event	Sampling Date	TETRACHLOROETHENE (PCE) CONCENTRATION (µg/L)
1	27-Oct-09	0.25
2	27-Apr-10	0.25
3	27-Apr-11	0.25
4	11-Jan-12	0.25
5	11-Jan-12	0.25
6	12-Dec-12	0.25
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.00
Mann-Kendall Statistic (S):		0
Confidence Factor:		39.3%
Concentration Trend:		Stable



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

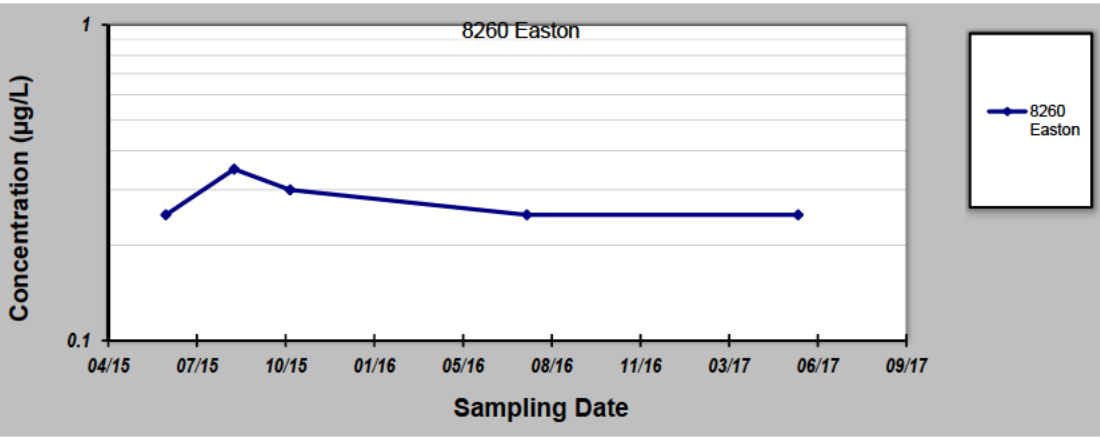
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Tetrachloroethene (PCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: 8260 Easton

Sampling Event	Sampling Date	TETRACHLOROETHENE (PCE) CONCENTRATION (µg/L)
1	10-Jun-15	0.25
2	26-Aug-15	0.349
3	28-Oct-15	0.3
4	21-Jul-16	0.25
5	23-May-17	0.25
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.16
Mann-Kendall Statistic (S):		-3
Confidence Factor:		67.5%
Concentration Trend:		Stable



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

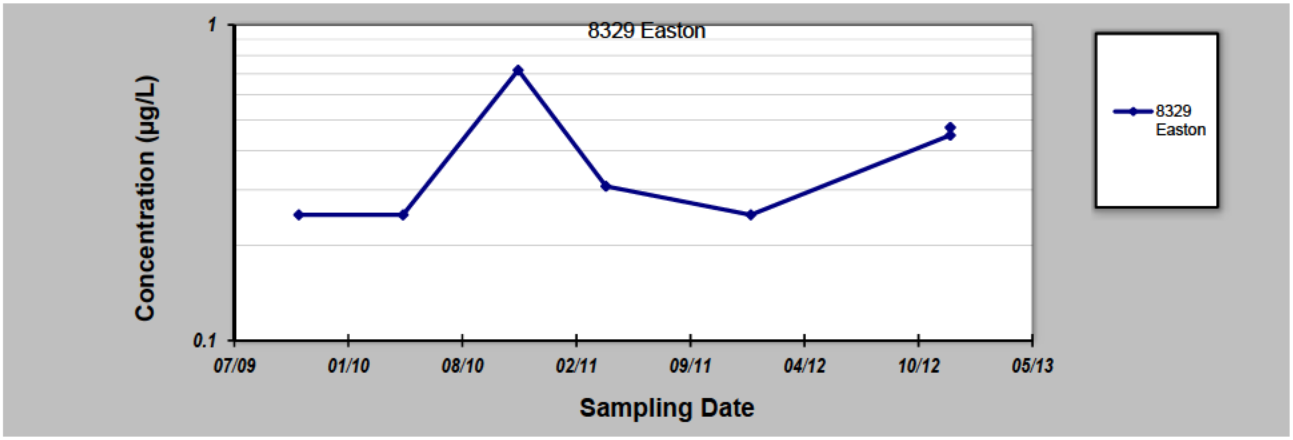
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Tetrachloroethene (PCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: 8329 Easton

Sampling Event	Sampling Date	TETRACHLOROETHENE (PCE) CONCENTRATION (µg/L)
1	27-Oct-09	0.25
2	28-Apr-10	0.25
3	16-Nov-10	0.719
4	19-Apr-11	0.308
5	29-Dec-11	0.25
6	13-Dec-12	0.447
7	13-Dec-12	0.473
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.45
Mann-Kendall Statistic (S):		8
Confidence Factor:		84.5%
Concentration Trend:		No Trend



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

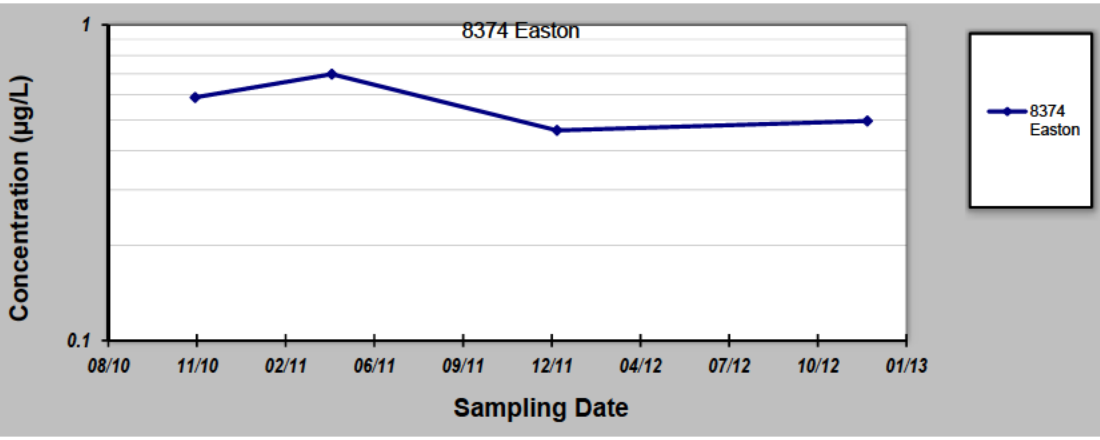
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Tetrachloroethene (PCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: 8374 Easton

Sampling Event	Sampling Date	TETRACHLOROETHENE (PCE) CONCENTRATION (µg/L)
1	16-Nov-10	0.589
2	19-Apr-11	0.698
3	29-Dec-11	0.463
4	13-Dec-12	0.496
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.19
Mann-Kendall Statistic (S):		-2
Confidence Factor:		62.5%
Concentration Trend:		Stable



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

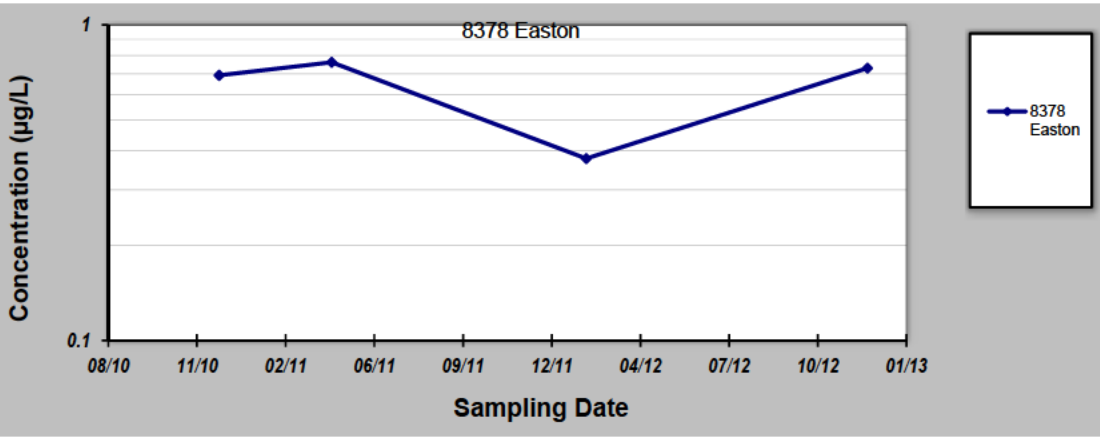
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Tetrachloroethene (PCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: 8378 Easton

Sampling Event	Sampling Date	TETRACHLOROETHENE (PCE) CONCENTRATION (µg/L)
1	13-Dec-10	0.692
2	19-Apr-11	0.761
3	31-Jan-12	0.377
4	13-Dec-12	0.729
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.28
Mann-Kendall Statistic (S):		0
Confidence Factor:		37.5%
Concentration Trend:		Stable



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

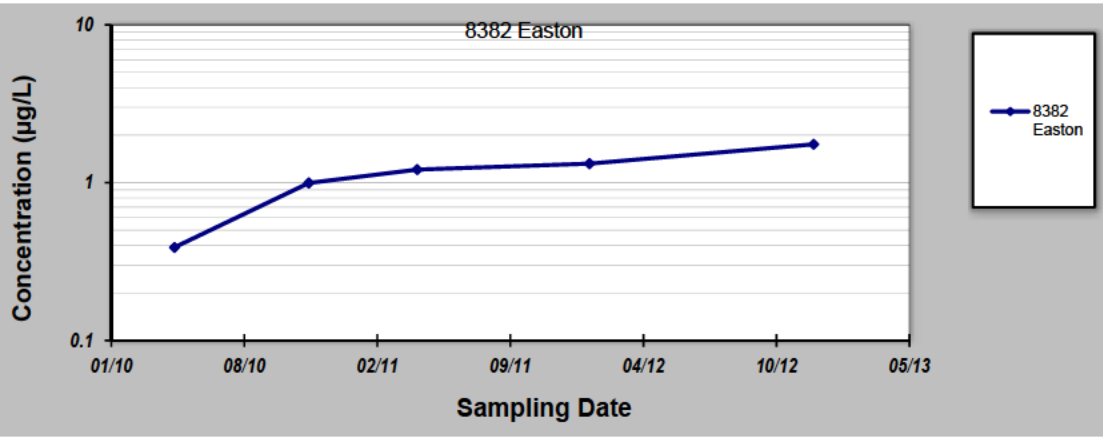
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Tetrachloroethene (PCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: 8382 Easton

Sampling Event	Sampling Date	TETRACHLOROETHENE (PCE) CONCENTRATION (µg/L)
1	27-Apr-10	0.389
2	15-Nov-10	0.995
3	27-Apr-11	1.21
4	11-Jan-12	1.32
5	13-Dec-12	1.75
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.44
Mann-Kendall Statistic (S):		10
Confidence Factor:		99.2%
Concentration Trend:		Increasing



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

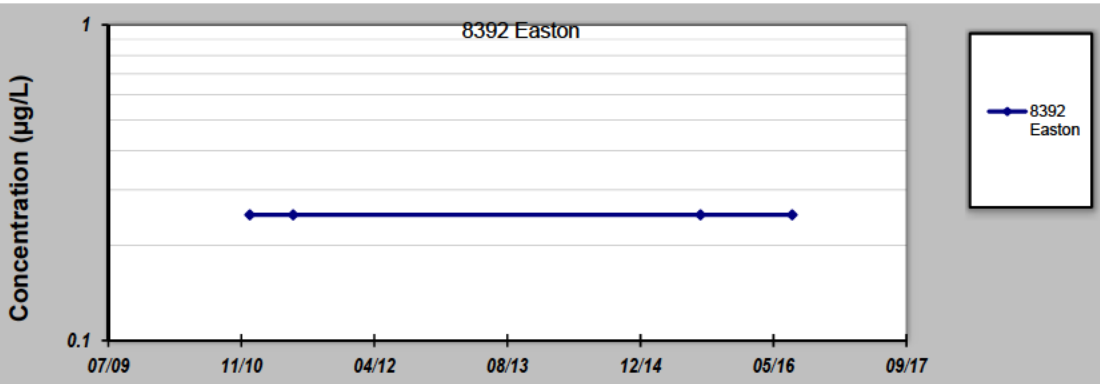
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Tetrachloroethene (PCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: 8392 Easton

Sampling Event	Sampling Date	TETRACHLOROETHENE (PCE) CONCENTRATION (µg/L)
1	20-Dec-10	0.25
2	1-Jun-11	0.25
3	10-Aug-15	0.25
4	20-Jul-16	0.25
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.00
Mann-Kendall Statistic (S):		0
Confidence Factor:		37.5%
Concentration Trend:		Stable



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

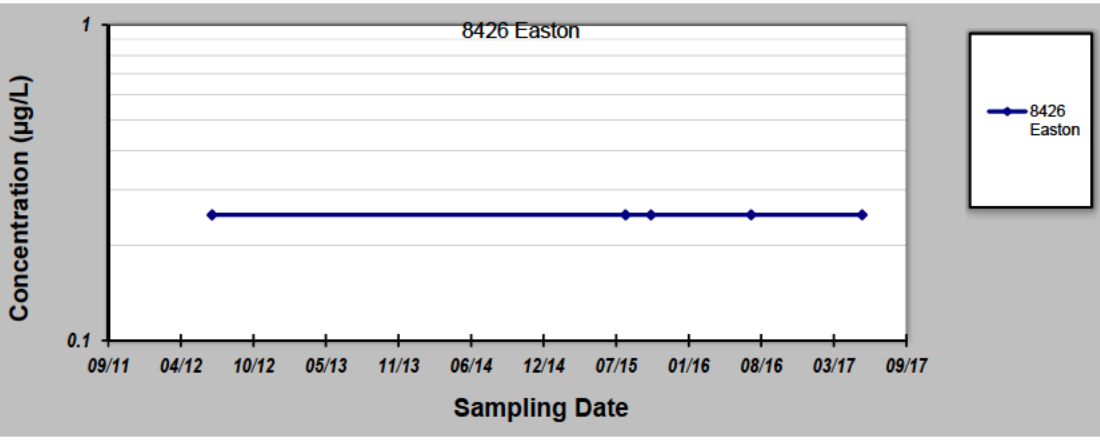
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Tetrachloroethene (PCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: 8426 Easton

Sampling Event	Sampling Date	TETRACHLOROETHENE (PCE) CONCENTRATION (µg/L)
1	26-Jun-12	0.25
2	10-Aug-15	0.25
3	19-Oct-15	0.25
4	21-Jul-16	0.25
5	23-May-17	0.25
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.00
Mann-Kendall Statistic (S):		0
Confidence Factor:		40.8%
Concentration Trend:		Stable



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

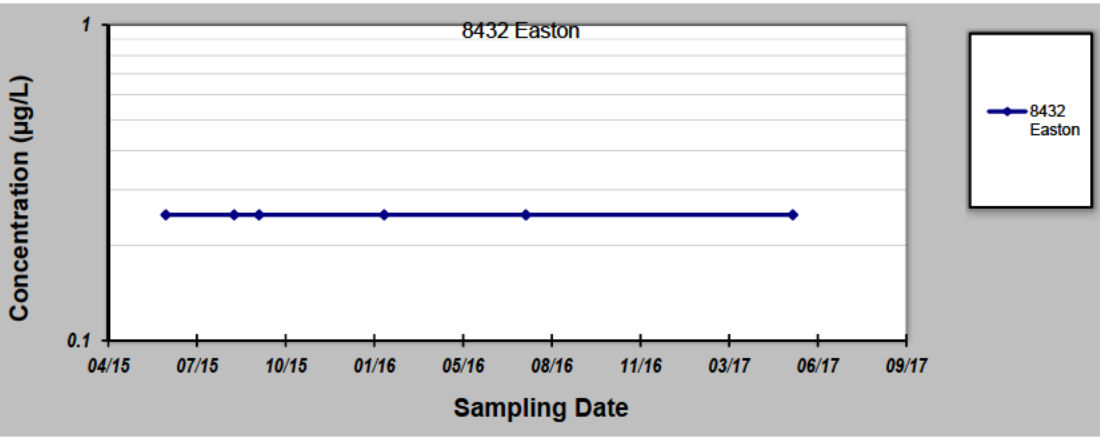
DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Tetrachloroethene (PCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: 8432 Easton

Sampling Event	Sampling Date	TETRACHLOROETHENE (PCE) CONCENTRATION (µg/L)
1	10-Jun-15	0.25
2	26-Aug-15	0.25
3	23-Sep-15	0.25
4	11-Feb-16	0.25
5	20-Jul-16	0.25
6	17-May-17	0.25
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.00
Mann-Kendall Statistic (S):		0
Confidence Factor:		39.3%
Concentration Trend:		Stable



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

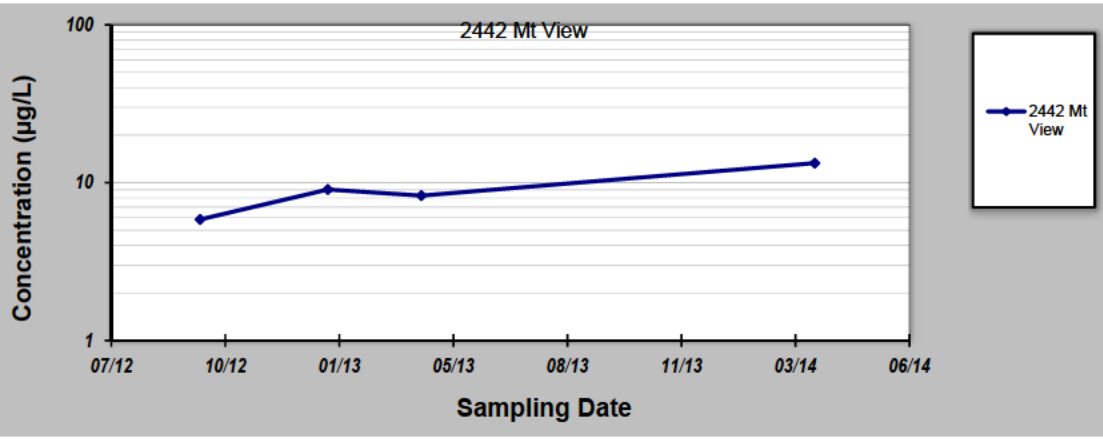
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Tetrachloroethene (PCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: 2442 Mt View

Sampling Event	Sampling Date	TETRACHLOROETHENE (PCE) CONCENTRATION (µg/L)
1	26-Sep-12	5.85
2	16-Jan-13	9.05
3	8-Apr-13	8.28
4	19-Mar-14	13.3
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.34
Mann-Kendall Statistic (S):		4
Confidence Factor:		83.3%
Concentration Trend:		No Trend



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

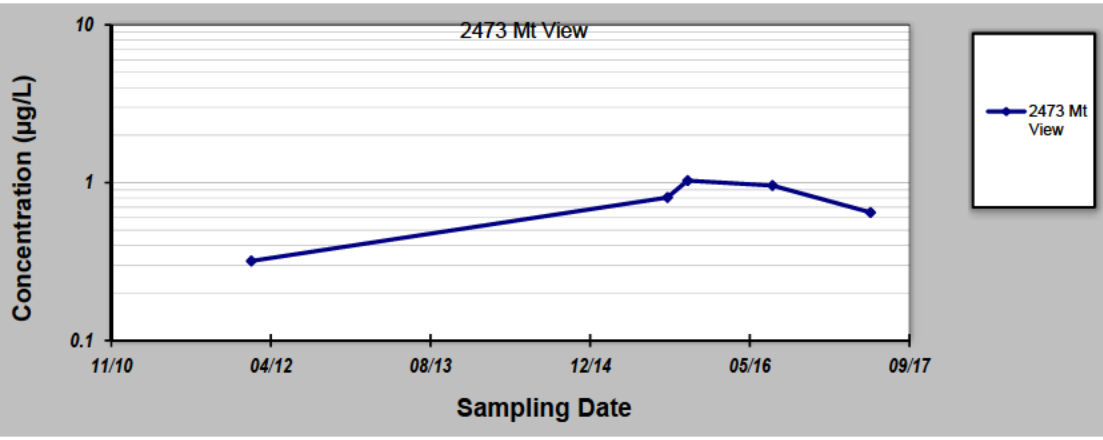
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Tetrachloroethene (PCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: 2473 Mt View

Sampling Event	Sampling Date	TETRACHLOROETHENE (PCE) CONCENTRATION (µg/L)
1	31-Jan-12	0.319
2	26-Aug-15	0.805
3	28-Oct-15	1.03
4	20-Jul-16	0.958
5	23-May-17	0.648
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.38
Mann-Kendall Statistic (S):		2
Confidence Factor:		59.2%
Concentration Trend:		No Trend



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

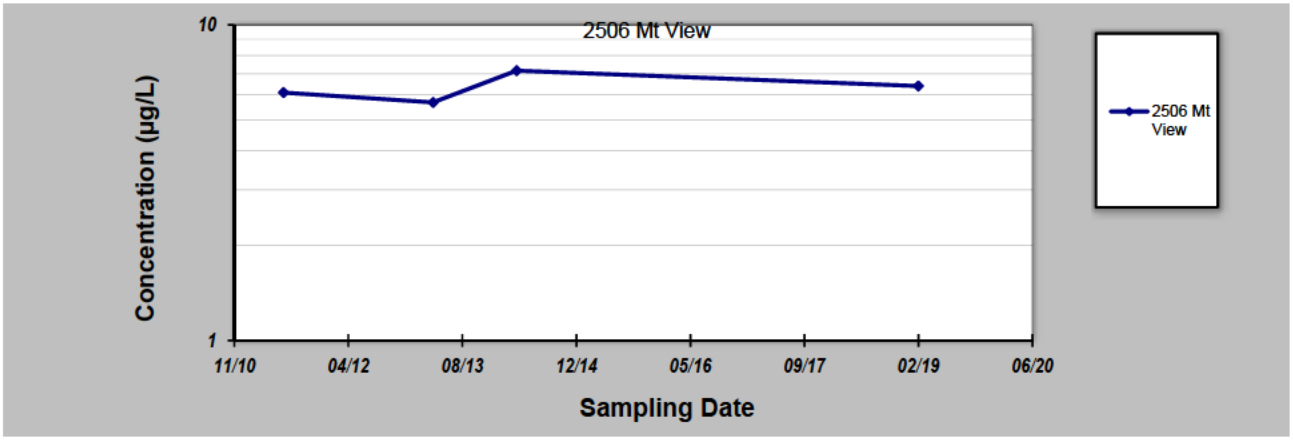
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Tetrachloroethene (PCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: 2506 Mt View

Sampling Event	Sampling Date	TETRACHLOROETHENE (PCE) CONCENTRATION (µg/L)
1	22-Jun-11	6.1
2	8-Apr-13	5.68
3	9-Apr-14	7.16
4	4-Feb-19	6.4
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.10
Mann-Kendall Statistic (S):		2
Confidence Factor:		62.5%
Concentration Trend:		No Trend



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

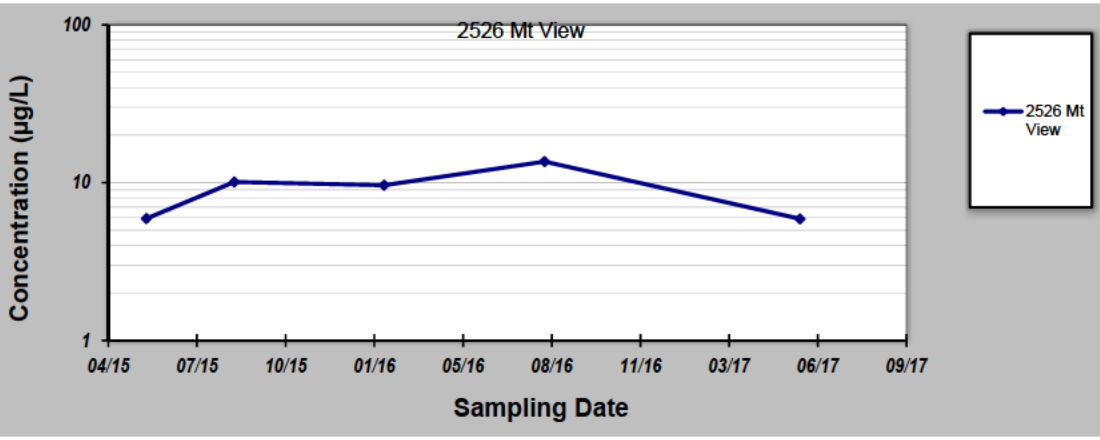
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Tetrachloroethene (PCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: 2526 Mt View

Sampling Event	Sampling Date	TETRACHLOROETHENE (PCE) CONCENTRATION (µg/L)
1	19-May-15	5.92
2	26-Aug-15	10.1
3	11-Feb-16	9.63
4	10-Aug-16	13.6
5	25-May-17	5.90
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.36
Mann-Kendall Statistic (S):		0
Confidence Factor:		40.8%
Concentration Trend:		Stable



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

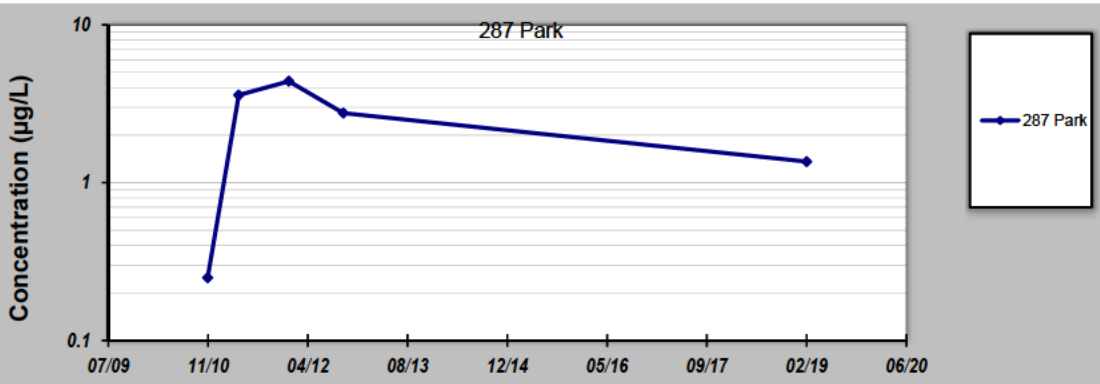
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Tetrachloroethene (PCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID:	287 Park

Sampling Event	Sampling Date	TETRACHLOROETHENE (PCE) CONCENTRATION (µg/L)
1	16-Nov-10	0.25
2	21-Apr-11	3.59
3	28-Dec-11	4.39
4	26-Sep-12	2.76
5	4-Feb-19	1.36
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.68
Mann-Kendall Statistic (S):		0
Confidence Factor:		40.8%
Concentration Trend:		Stable



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

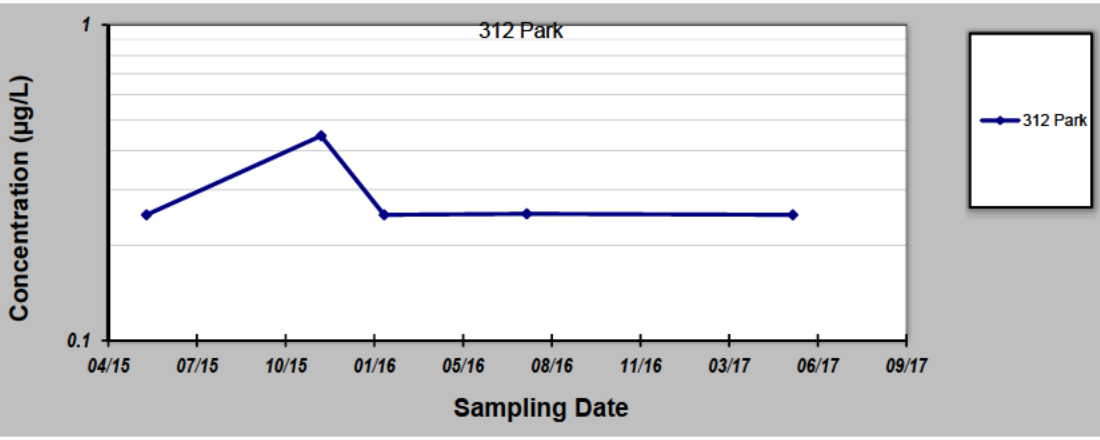
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Tetrachloroethene (PCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: 312 Park

Sampling Event	Sampling Date	TETRACHLOROETHENE (PCE) CONCENTRATION (µg/L)
1	19-May-15	0.25
2	2-Dec-15	0.445
3	11-Feb-16	0.25
4	21-Jul-16	0.252
5	17-May-17	0.25
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.30
Mann-Kendall Statistic (S):		-1
Confidence Factor:		50.0%
Concentration Trend:		Stable



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

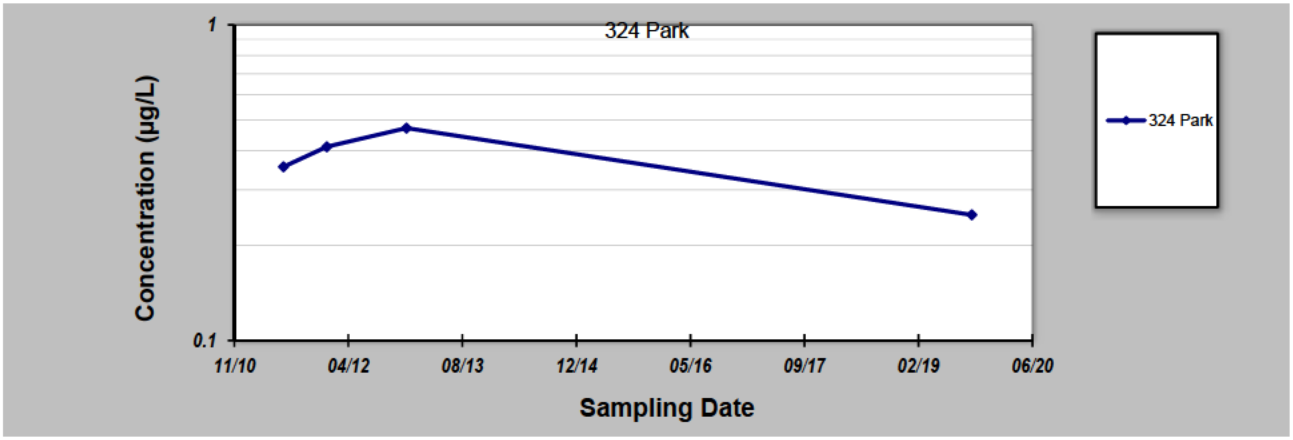
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Tetrachloroethene (PCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: 324 Park

Sampling Event	Sampling Date	TETRACHLOROETHENE (PCE) CONCENTRATION (µg/L)
1	22-Jun-11	0.355
2	29-Dec-11	0.411
3	12-Dec-12	0.471
4	26-Sep-19	0.25
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.25
Mann-Kendall Statistic (S):		0
Confidence Factor:		37.5%
Concentration Trend:		Stable



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

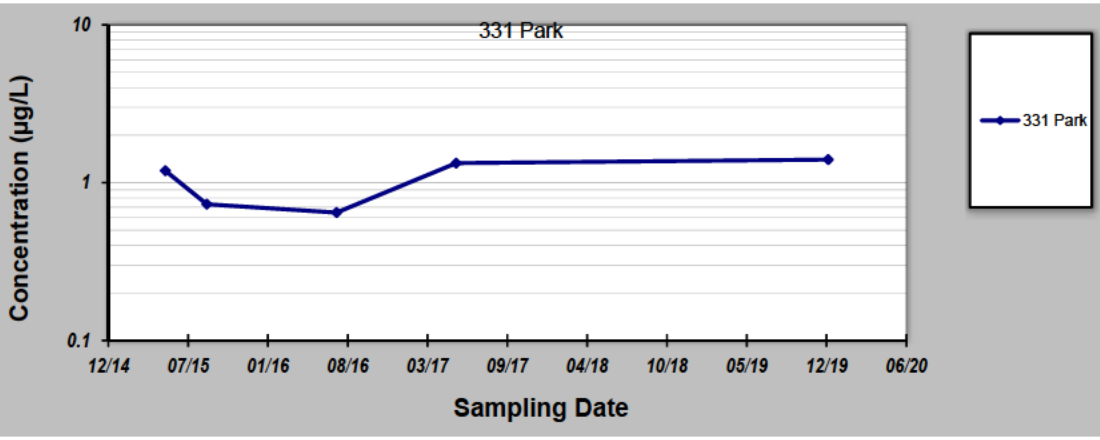
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Tetrachloroethene (PCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: 331 Park

Sampling Event	Sampling Date	TETRACHLOROETHENE (PCE) CONCENTRATION (µg/L)
1	19-May-15	1.19
2	31-Aug-15	0.73
3	21-Jul-16	0.646
4	17-May-17	1.33
5	5-Dec-19	1.4
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.33
Mann-Kendall Statistic (S):		4
Confidence Factor:		75.8%
Concentration Trend:		No Trend



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

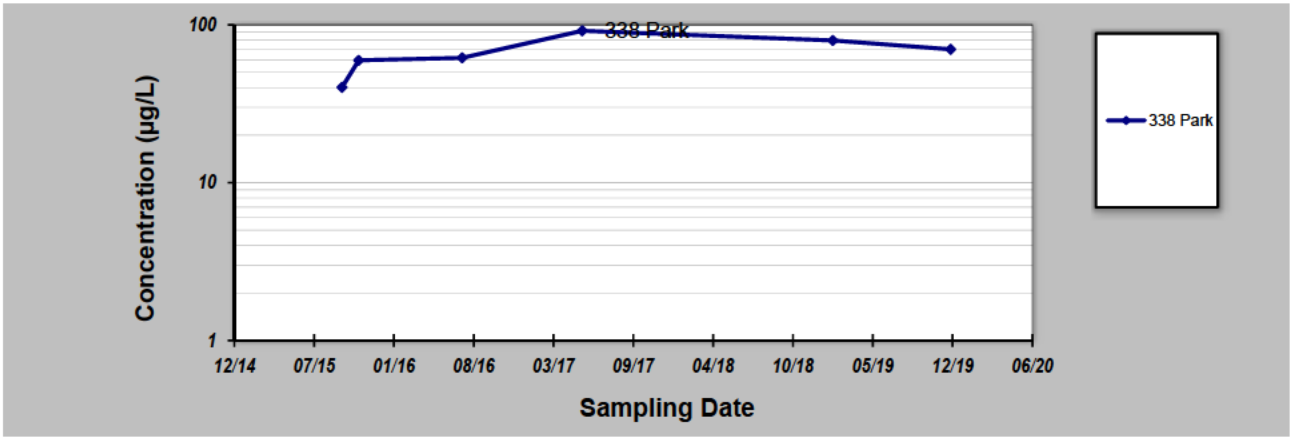
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Tetrachloroethene (PCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID:	338 Park

Sampling Event	Sampling Date	TETRACHLOROETHENE (PCE) CONCENTRATION (µg/L)
1	23-Sep-15	40.2
2	4-Nov-15	59.6
3	20-Jul-16	61.8
4	17-May-17	91.7
5	4-Feb-19	79.6
6	26-Nov-19	70
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.26
Mann-Kendall Statistic (S):		9
Confidence Factor:		93.2%
Concentration Trend:		Prob. Increasing



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

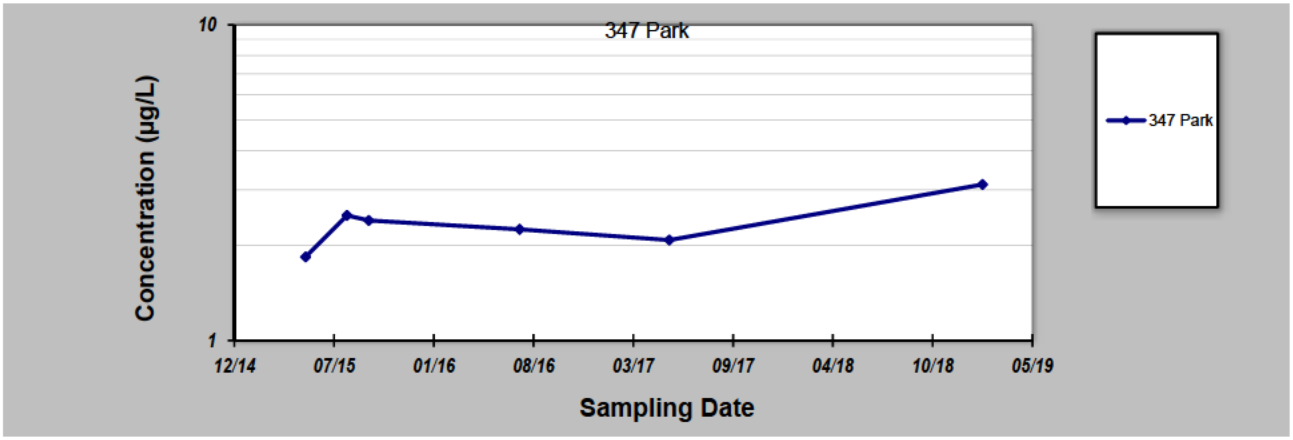
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Tetrachloroethene (PCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID:	347 Park

Sampling Event	Sampling Date	TETRACHLOROETHENE (PCE) CONCENTRATION (µg/L)
1	19-May-15	1.84
2	10-Aug-15	2.49
3	23-Sep-15	2.4
4	21-Jul-16	2.25
5	17-May-17	2.08
6	4-Feb-19	3.12
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.19
Mann-Kendall Statistic (S):		3
Confidence Factor:		64.0%
Concentration Trend:		No Trend



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

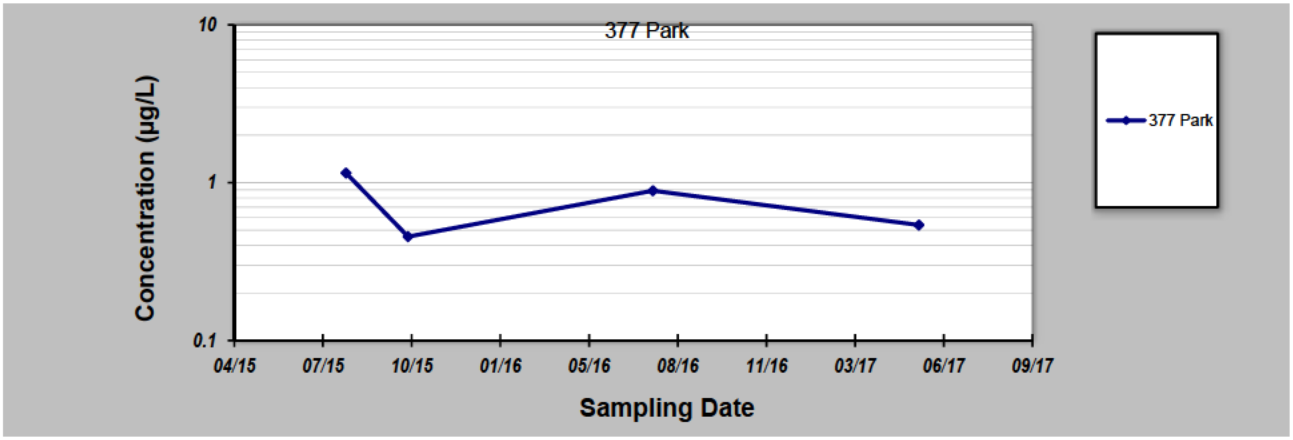
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Tetrachloroethene (PCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: 377 Park

Sampling Event	Sampling Date	TETRACHLOROETHENE (PCE) CONCENTRATION (µg/L)
1	10-Aug-15	1.15
2	19-Oct-15	0.455
3	21-Jul-16	0.889
4	17-May-17	0.539
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.42
Mann-Kendall Statistic (S):		-2
Confidence Factor:		62.5%
Concentration Trend:		Stable



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

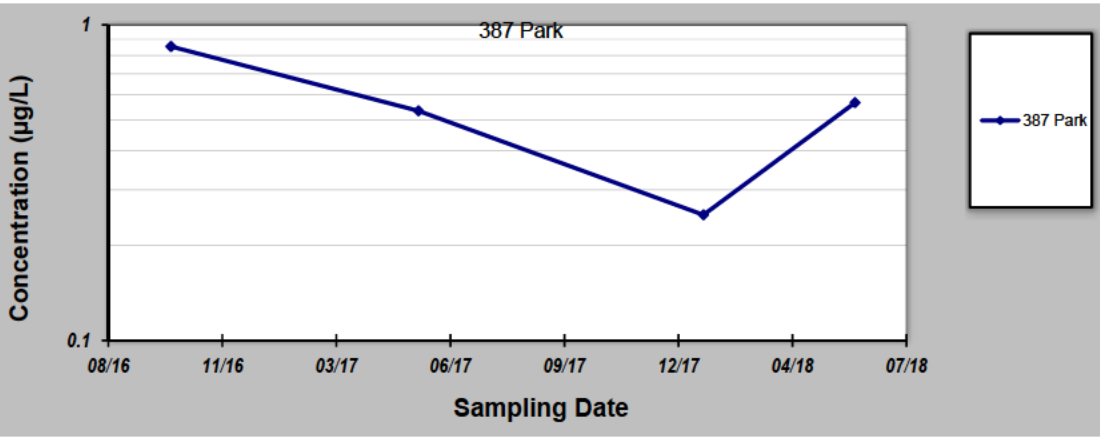
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Tetrachloroethene (PCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: 387 Park

Sampling Event	Sampling Date	TETRACHLOROETHENE (PCE) CONCENTRATION (µg/L)
1	12-Oct-16	0.854
2	17-May-17	0.534
3	22-Jan-18	0.25
4	4-Jun-18	0.567
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.45
Mann-Kendall Statistic (S):		-2
Confidence Factor:		62.5%
Concentration Trend:		Stable



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

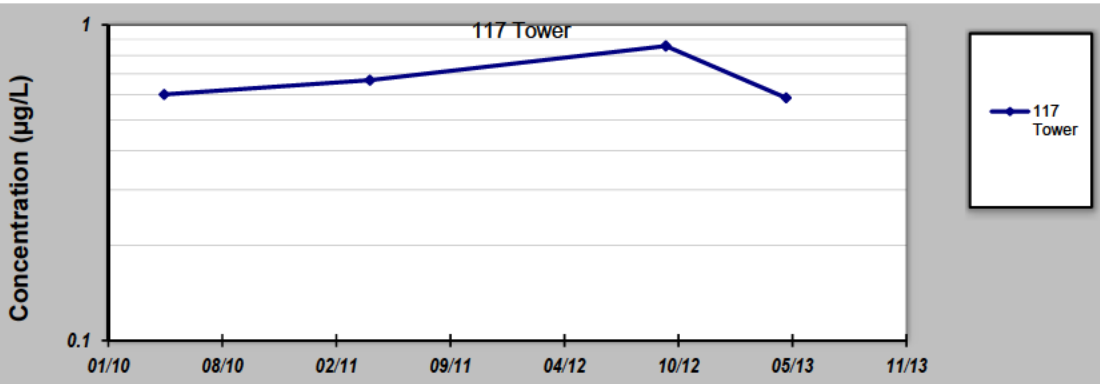
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Tetrachloroethene (PCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: 117 Tower

Sampling Event	Sampling Date	TETRACHLOROETHENE (PCE) CONCENTRATION (µg/L)
1	30-Apr-10	0.602
2	26-Apr-11	0.668
3	26-Sep-12	0.857
4	25-Apr-13	0.587
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.18
Mann-Kendall Statistic (S):		0
Confidence Factor:		37.5%
Concentration Trend:		Stable



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

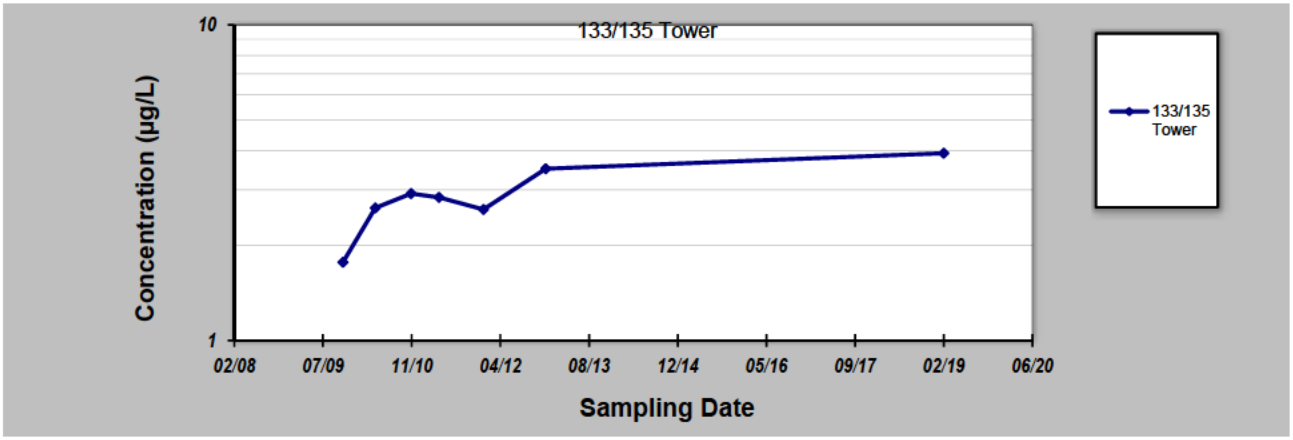
DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Tetrachloroethene (PCE)
Conducted By:	FJD	Concentration Units:	µg/L
Sampling Point ID:	133/135 Tower		

Sampling Event	Sampling Date	TETRACHLOROETHENE (PCE) CONCENTRATION (µg/L)
1	27-Oct-09	1.77
2	27-Apr-10	2.63
3	15-Nov-10	2.92
4	21-Apr-11	2.84
5	28-Dec-11	2.60
6	13-Dec-12	3.5
7	4-Feb-19	3.92
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.24
Mann-Kendall Statistic (S):		13
Confidence Factor:		96.5%
Concentration Trend:		Increasing



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

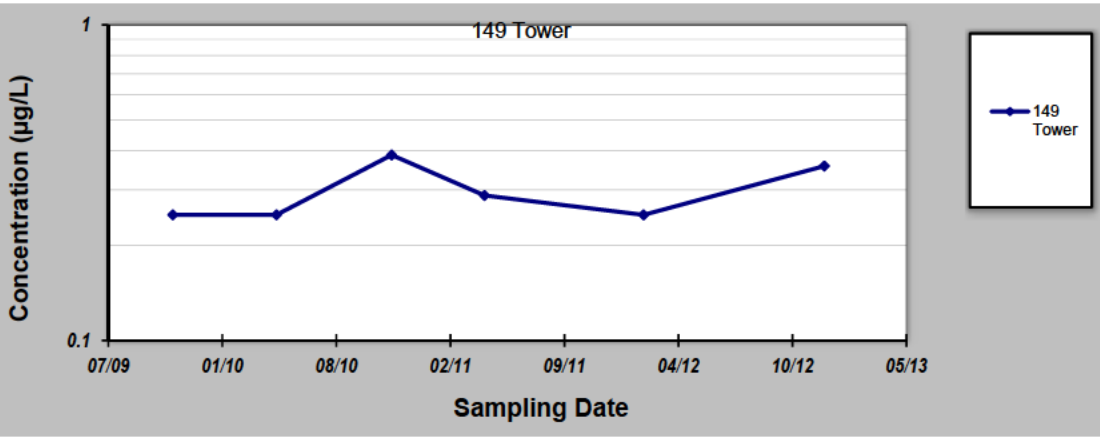
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Tetrachloroethene (PCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: 149 Tower

Sampling Event	Sampling Date	TETRACHLOROETHENE (PCE) CONCENTRATION (µg/L)
1	27-Oct-09	0.25
2	27-Apr-10	0.25
3	15-Nov-10	0.387
4	27-Apr-11	0.288
5	31-Jan-12	0.25
6	13-Dec-12	0.357
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.20
Mann-Kendall Statistic (S):		4
Confidence Factor:		70.3%
Concentration Trend:		No Trend



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

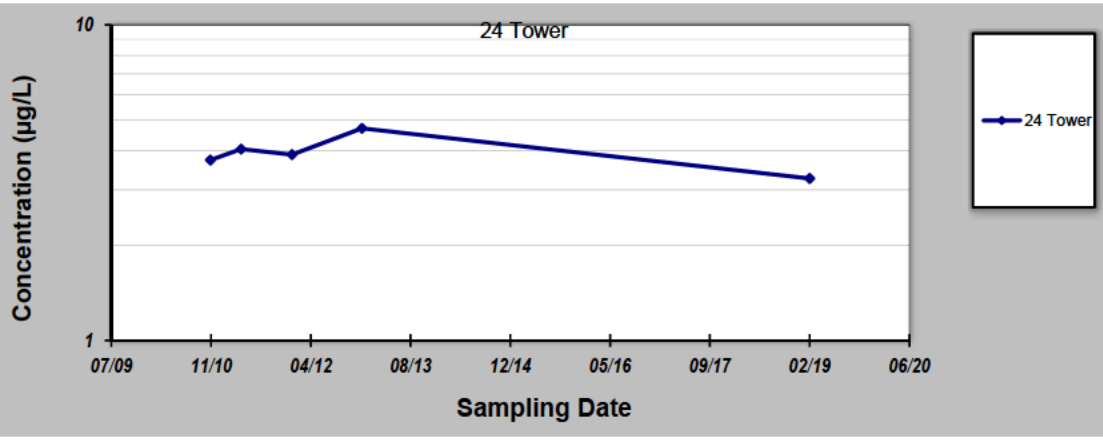
*GSI Environmental Inc., **www**.gsi-net.com*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	18-Jul-20	Job ID:	
Facility Name:	Nockamixon	Constituent:	Tetrachloroethene (PCE)
Conducted By:	FJD	Concentration Units:	µg/L

Sampling Point ID: 24 Tower

Sampling Event	Sampling Date	TETRACHLOROETHENE (PCE) CONCENTRATION (µg/L)
1	15-Nov-10	3.73
2	18-Apr-11	4.04
3	29-Dec-11	3.88
4	13-Dec-12	4.7
5	4-Feb-19	3.26
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Coefficient of Variation:		0.13
Mann-Kendall Statistic (S):		0
Confidence Factor:		40.8%
Concentration Trend:		Stable



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

*GSI Environmental Inc., **www**.gsi-net.com*