Groundwater & Environmental Services, Inc.

WESTERN PENNSYLVANIA OFFICE

November 14, 2016

Ms. Kammy Halterman
Pennsylvania Department of Environmental Protection
Northwest Regional Office
230 Chestnut Street
Meadville, PA 16335

RE: **Site Characterization Report Addendum/Remedial Action Plan**
Kwik Fill Station #M-209
PADEP ID #61-23779
5574 Route 8
Barkeyville, Pennsylvania

Dear Ms. Halterman:

On behalf of our client, United Refining Company of Pennsylvania (UPA), enclosed please find a *Site Characterization Report Addendum and Remedial Action Plan* (SCRA/RAP) for the above-referenced facility.

Groundwater and Environmental Services, Inc. (GES) would appreciate the opportunity to meet with PADEP prior to or during review of the report. The intent of the meeting is to discuss the current conceptual site model, proposed supplemental characterization activities and proposed remedial actions and ensure a mutual understanding of the project goals and objectives.

If you have any questions, please contact GES at (800) 267-2549 or Mr. Scott C. Wonsettler, P.G., the UPA Environmental Manager at (814) 726-4863.

Sincerely,

GROUNDWATER & ENVIRONMENTAL SERVICES, INC.

Joseph Hinkle, E.I.T.
Project Manager
Ext. 3622

cc: UPA – S. Wonsettler
PADEP – K. Shimko
ICF International – G. Hawk
File

Facility Name:	UPA Kwik Fill Station #M-209, Barkeyville
Facility Address:	5574 Route 8, Barkeyville, PA
Responsible Party :	United Refining Company of PA
RP Mailing Address:	814 Lexington Avenue
	Warren, PA 16365

Storage Tank Facility ID#: 61-23779

Corrective Action Process Report /Plan Cover Sheet

CHAPTER 245
STORAGE TANK ACT

- ☐ **Site Characterization Report – Section 245.310(b)**
- ☐ **Site Characterization Report – Site-Specific Standard**
- ✓ **Site Characterization Report – Statewide Health or Background Standard**
- ☐ **Site Characterization Report PLUS – Statewide Health Standard**
- ✓ **Remedial Action Plan – Statewide Health or Background Standard**
- ☐ **Remedial Action Plan – Site Specific Standard**
- ☐ **Remedial Action Progress Report**
- ☐ **Remedial Action Completion Report – Statewide Health or Background Standard**
- ☐ **Remedial Action Completion Report – Site-Specific Standard**
- ☐ **Post Remediation Care Plan Report**
- ☐ **Environmental Covenant**

(check all that apply to the enclosed submission)

SITE CHARACTERIZATION REPORT ADDENDUM
and
REMEDIAL ACTION PLAN

(Pennsylvania Code, Title 25, Chapter 245)

Kwik Fill Station #M-209
PADEP Facility ID #61-23779
USTIF Claim #2015-0054(F)
5574 State Route 8
Barkeyville, Pennsylvania
Venango County

Prepared for:

United Refining Company of Pennsylvania
Retail Environmental Department
814 Lexington Avenue, P.O. Box 688
Warren, Pennsylvania 16365

Prepared by:

GROUNDWATER & ENVIRONMENTAL SERVICES, INC.
301 Commerce Park Drive
Cranberry Township, Pennsylvania 16066

November 2016

SITE CHARACTERICATION REPORT ADDENDUM
and
REMEDIAL ACTION PLAN

(Title 25 PA Code, Chapter 245)

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Prepared by:

Groundwater & Environmental Services, Inc.
301 Commerce Park Drive
Cranberry Township, Pennsylvania 16066

Prepared by:

Joseph E. Hinkle, E.I.T.
Remediation Specialist

Reviewed by:

Scott L. Merritt, P.E.
Senior Project Engineer

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
SCOTT L. MERRITT
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Erin M. Letrick, P.G.
Project Geologist

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
ERIN MARIE LETRICK
GEOLOGIST
No. PG005044

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.

November 2016

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ABBREVIATIONS AND ACRONYMS

Act 2	Pennsylvania Land Recycling Act, Title 25, 25 PA Code Chapter 250
APH	adsorbed phase hydrocarbons
AS	air sparge
bgs	below ground surface
CFR	Code of Federal Regulations
COC	constituents of concern
CSM	conceptual site model
CWF	cold water fishery
DPH	dissolved phase hydrocarbons
facility	Kwik Fill Station #M-209, 5574 State Route 8, Barkeyville, Pennsylvania
FeB	Frenchtown Silt Loam
ft	feet
ft/ft	feet per foot
GES	Groundwater & Environmental Services, Inc.
gpm	gallon per minute
HAZWOPER	Hazardous Waste and Emergency Response
HIT	high intensity targeted
Hp	horsepower
IDW	Investigation-Derived Waste
in. Hg	inches of mercury
in. w.c.	inches of water column
K	hydraulic conductivity
LNAPL	light non-aqueous phase liquid
LPS	Loss Prevention System
LRP	liquid ring pump
MNA	Monitored Natural Attenuation
MSC	medium-specific concentration
MSL	Mean Sea Level
MTBE	methyl tert-butyl ether
MW	monitoring well
NOCR	Notification of Confirmed Release
NORR	Notification of Reportable Release
NR	non-residential
NWI	National Wetland Inventory
NWRO	Northwest Regional Office
OSHA	Occupational Safety and Health Administration
PA	Pennsylvania
PADCNR	Pennsylvania Department of Conservation and Natural Resources
PADEP	Pennsylvania Department of Environmental Protection
PaGWIS	Pennsylvania Groundwater Information System
PD	positive displacement
PID	photoionization detector
POC	Point of compliance
ppm	parts per million
ppmv	parts per million (volume)

ABBREVIATIONS AND ACRONYMS (continued)

PVC	poly-vinyl chloride
QAPP	Quality Assurance Project Plan
QD	Quick Domenico
R	residential
RACR	Remedial Action Completion Report
RAP	Remedial Action Plan
RAPR	Remedial Action Progress Report
ROI	radius of influence
SAP	Sampling and Analysis Plan
scfm	standard cubic feet per minute
SCR	Site Characterization Report
SHS	Statewide Health Standard
SVE	soil vapor extraction
TPE	total phase extraction
µg/L	micrograms per Liter
U/NR	used aquifer, non-residential
U/R	used aquifer, residential
UPA	United Refining Company of Pennsylvania
UST	underground storage tank
VEGE	vacuum enhanced groundwater extraction
VOC	volatile organic compound

EXECUTIVE SUMMARY

Groundwater & Environmental Services, Inc. (GES) was contracted by United Refining Company of Pennsylvania (UPA) to complete site characterization for an active Kwik Fill retail petroleum facility located at 5574 State Route 8 in Barkeyville, Venango County, Pennsylvania (Kwik Fill Station #M-209, PADEP ID #61-23779) (facility). Results of site characterization activities were summarized in a *Site Characterization Report* (SCR) submitted to the Pennsylvania Department of Environmental Protection - Northwest Regional Office (PADEP-NWRO) in September 2016 (GES, 2016).

During a third party inspection on April 14, 2015, ponded product/stained backfill was observed in diesel dispensers #1/2 and 7/8. No active leak was observed at the time of the inspection, and the source of the product was undetermined. A verbal *Notification of Reportable Release* (NORR) was made to the PADEP-NWRO by UPA on April 15, 2015, and a written NORR was submitted to PADEP by UPA on April 15, 2015, describing the reportable release (UPA, 2015). Corrective action activities were initiated consistent with the requirements of 25 PA Code § 245 (Administration of the Storage Tank and Spill Prevention Program, Subchapter D) (PADEP, 2001) and Act 2 (Pennsylvania Land Recycling Act, 25 PA Code § 250).

Site characterization activities were initiated in August 2015, and assessment/delineation of site soil and groundwater continued through August 2016. Two water-bearing zones were observed during site characterization activities, a shallow overburden aquifer and a deep overburden aquifer. A total of thirteen shallow (MW-1 through MW-9, MW-10S, MW-11, MW-14, and MW-15) and four deep (MW-10D, MW-12, MW-13, and MW-16) overburden groundwater monitoring wells were installed. Soil screening and sampling was performed during monitoring well installation and at 11 soil boring locations (SB-1 through SB-11).

Site topography slopes sharply to the west separating the upper paved portion of the site where the 2015 diesel release occurred from the lower area of the site near the on-site stormwater retention pond by approximately 35 feet in elevation. The shallow overburden aquifer was observed below the upper paved portion of the site, upgradient of the retention pond at a maximum depth of 27.35 feet below ground surface (bgs). The deep overburden aquifer was observed at a minimum depth of approximately 39.38 feet bgs below the upper paved portion of the site and at a minimum depth of approximately 8.79 feet bgs downgradient of the paved portion of the facility near the retention pond. Site characterization activities indicate the subsurface of the upper portion of the site, to a maximum depth of approximately 45 feet bgs, consists of unconsolidated fill material overlying layers of clay, silty clay, sandy clay, gravelly clay, clayey sand and sandy gravel. Bedrock was encountered in monitoring well MW-10D at approximately 41 feet bgs and consisted of weathered sandstone. Downgradient facility lithology near the retention pond is similar with the exception of the unconsolidated fill. Facility lithology in the lower portion of the site was observed to a maximum depth of 20 feet bgs. Bedrock (weathered sandstone) was observed at approximately 19 feet bgs in monitoring well MW-12 and at approximately 15 feet bgs in groundwater monitoring well MW-13.

Adsorbed phase hydrocarbon (APH) impacts were observed in site subsurface (>2 feet bgs) soil in the vicinity of diesel dispensers #1/2 and 7/8 (release areas) and near the retention pond (downgradient). Diesel constituents were detected in soil between 2 and 14 feet bgs at concentrations above current Act 2 Statewide Health Standard (SHS) used aquifer, non-residential (U/NR), medium-specific concentrations (MSCs).

Groundwater monitoring wells have been gauged and/or sampled at the facility since October 2015. Dissolved phase hydrocarbon (DPH) impacts were observed in the shallow overburden aquifer near the release areas (diesel dispensers #1/2 and 7/8) and to the west (downgradient) at concentrations above current U/NR MSCs. DPH impacts were detected in groundwater in the deep overburden aquifer west (downgradient) of the release areas (diesel dispensers #1/2 and 7/8) at concentrations above current U/NR MSCs. Light non-aqueous phase liquid (LNAPL) has not been detected at the site since groundwater gauging was initiated in October 2015. The most recent site groundwater gauging and sampling event was conducted in August 2016. Based on current and future land use of the site and the distance to off-site residential receptors, the data were compared only to current applicable U/NR MSCs. Dissolved phase benzene, methyl tert-butyl ether (MTBE), naphthalene, and 1,2,4-trimethylbenzene were detected at concentrations above current U/NR MSCs. Fate and transport modeling results using conservative assumptions indicate that based on the current conceptual site model (CSM) dissolved phase constituents will not migrate to downgradient receptors at concentrations above current U/NR MSCs.

Soil gas sampling activities have not been performed at the facility to date. However, APH and DPH impacts observed during site characterization activities were evaluated by comparing the analytical data from soil and groundwater samples collected to the PA Default Residential (R) and Non-Residential (NR) Screening Values for volatilization to indoor air. Based on the assessment, migration of soil gas from APH impacts to potential receptors is a concern and will be further evaluated during future site activities (i.e., active remediation). Migration of soil gas generated from existing DPH impacts is not a concern based on the assessment; however, DPH impacts were identified in facility groundwater, so further vapor intrusion assessment will be completed to confirm potential groundwater vapor inhalation pathways are not a concern. Mitigation of APH and DPH impacts is required, and are addressed in this *Site Characterization Report Addendum/Remedial Action Plan* (SCRA/RAP).

Historical documented unleaded gasoline releases occurred at the facility in 1996 and 1997, and according to the *Remedial Action Completion Report* (RACR) submitted by GSC/Kleinfelder in June 2006, residual DPH and APH impacts remained in facility soil and groundwater at concentrations above current U/NR MSCs (GSC/Kleinfelder, 2006). Based on remaining historical impacts, two areas of concern have been identified for APH and DPH impacts observed during current site characterization activities. APH and DPH impacts related to historical releases are referred to as Area of Concern 1 (AOC 1). APH and DPH impacts related to the 2015 diesel release are referred to as Area of Concern 2 (AOC 2). A CSM was developed based on evaluation of site characterization observations and data related to the 2015 diesel release. Results of the SCM were presented in the September 2016 SCR (GES, 2016) and were used to evaluate potential remediation technologies to address APH and DPH impacts. Based on the CSM, a total phase extraction (TPE) feasibility test was completed in November 2016 to evaluate the technology's efficacy to remediate APH and DPH impacts in the area of the 2015 diesel release to selected Act 2 standard (i.e., SHS, U/NR MSCs). Results of the TPE feasibility test indicate that TPE could be an effective technology to remediate APH and DPH impacts related to the 2015 diesel release. The following report summarizes site characterization conclusions, describes the current CSM, discusses AOC 2 plume fate and transport modeling, summarizes remedial feasibility testing methods and results, discusses the proposed remedial strategy and how the selected approach will reduce DPH impacts, presents a proposed schedule and reporting requirements and planned activities. Groundwater and soil attainment demonstration criteria are also presented in the report. The current Act 2 attainment goal for site soil and groundwater is SHS, U/NR MSCs.

1.0 INTRODUCTION

Ponded product and stained backfill was observed in diesel dispensers #1/2 and 7/8 during a third party inspection in April 2015. In response, corrective action activities were initiated consistent with the requirements of 25 PA Code § 245 and Act 2 (25 PA Code § 250). The following report provides facility background, a brief summary of site characterization activities, a remedial action plan to demonstrate attainment of the Act 2 Statewide Health Standard for diesel fuel constituents in site soil and groundwater and assessing vapor intrusion. The report also presents planned activities to collect site data to complete data gaps.

2.0 FACILITY LOCATION AND DESCRIPTION

2.1 Location

The facility is located at 5574 State Route 8, Barkeyville, Venango County, Pennsylvania. **Figure 1** (Site Location Map) illustrates the location of the facility on a U.S. Geological Survey (USGS) 7.5-Minute Topographic Quadrangle, Barkeyville, Pennsylvania (1980).

The facility is located in a mixed commercial and residential area. The facility is bordered to the north, beyond Stevenson Road, by a commercial property (Barkeyville Travel Center), to the east, beyond State Route 8, by commercial properties (Gahr's Truck and Tire Service and Heath Oil, Inc.) and residential properties, to the south by residential properties and undeveloped land, and to the west by undeveloped land. **Figure 2** (Local Area Map) illustrates the facility and adjacent properties.

2.2 Description

According to the Venango County Recorder of Deeds, the property is owned by UPA and has operated as a retail petroleum facility since at least 1980. The facility occupies an irregular-shaped parcel (Parcel ID #31,001.-026..-000) that measures approximately 2,300 feet along the northern property boundary, approximately 2,200 feet along the western property boundary, approximately 1,200 feet along the southern property boundary and approximately 2,500 feet along the eastern property boundary (**Figure 2**). The subject parcel encompasses approximately 93.4 acres.

Facility features include a single-story, slab-on-grade convenience store (Kwik Fill station #M-209), a two-story, slab-on-grade motel/restaurant, four 10,000-gallon steel underground storage tanks (USTs), and six associated product dispensers located on six concrete islands. According to the Regulated Storage Tank List for the PADEP-NWRO, the four steel USTs (#001, #002, #003 and #004) were installed at the facility in December 1972. All four USTs have steel piping and impressed current cathodic protection. Each UST contains and dispenses diesel fuel. Facility features are illustrated on **Figure 3** (Site Map). Photographs are provided in **Appendix A.**

An additional single-story, slab-on-grade unleaded gasoline/diesel fuel retail convenience store (Kwik Fill station #M-229), three USTs (two 10,000-gallon USTs containing unleaded gasoline and one 10,000-gallon UST containing diesel fuel) and three associated bi-product dispensers located on three concrete islands are also located beyond the motel/restaurant on the property to the east (upgradient) of the truck stop operations (station #M-209).

A sewage treatment plant operates in the northwestern portion of the parcel beyond the parking lot. The plant is located approximately 0.16 miles west (downgradient) of the facility along Stevenson Road.

The facility lot is comprised of asphalt and concrete with grassy areas along the northern, eastern, southern, and western property boundaries. Based on current grading at the facility, surface water runoff in the asphalt-paved and concrete areas is directed towards multiple stormwater catch basins located in the northern and central portions of the facility which all direct surface water runoff to the west. Approximately 200 feet west of the diesel station building and 10 feet west of the asphalt-grass boundary along the western portion of the facility, site topography decreases sharply by approximately 35 feet in elevation. Subsurface stormwater lines connecting the stormwater catch basins run beyond the western parking lot boundary downgradient to the west to a stormwater retention pond.

Overhead electric lines run along the northern property boundary parallel with Stevenson Road. Electric service enters the facility from a utility pole near the intersection of State Route 8 and Stevenson Road where a series of utility poles and overhead lines connect the main service lines to the motel/restaurant, station and light poles surrounding the lot. An overhead telephone line runs from the motel/restaurant to light poles surrounding the motel/restaurant and connects to the main service line along State Route 8.

Seventeen groundwater monitoring wells (MW-1 through MW-9, MW-10D, MW-10S and MW-11 through MW-16) are located on-site. Observations during site characterization activities identified an overburden aquifer with two water-bearing zones (shallow and deep). Monitoring wells MW-1 through MW-9, MW-10S, MW-11, MW-14 and MW-15 monitor the shallow overburden aquifer. Monitoring wells MW-10D, MW-12, MW-13 and MW-16 monitor the deep overburden aquifer. **Figure 3** illustrates the location of relevant facility features and a portion of the approximate property boundary. The entire, approximate property boundary is illustrated on **Figure 2**.

2.3 Sensitive Receptor Evaluation

An evaluation of sensitive receptors was presented in the September 2016 SCR (GES, 2016); results of the receptor survey are summarized in the following:

- Utilizing the Pennsylvania Department of Conservation and Natural Resources (PADCNR) *Ground Water Information System (PaGWIS v.3.0)*, one domestic well and four industrial withdrawal wells was identified within ½-mile of the facility.
- The PaGWIS database also identified an abandoned well north of Interstate 80, four monitoring wells on the Heath Oil property and four on-site monitoring wells (associated with the 2015 diesel release).
- The PADEP eMap database identified eight additional withdrawal wells (one domestic, two public supply and five industrial) within a ½-mile radius of the facility.
- Potable water is supplied the facility and surrounding area by the Borough of Barkeyville.
- Correspondence with Borough of Barkeyville personnel in September 2016, confirmed that an ordinance exists that requires all properties in the Borough of Barkeyville to connect to the community water supply and prohibits all private drinking water sources.
- Potential sensitive receptors include:
    - the subject property including station buildings M #209 and M #229 and the motel/restaurant building;
    - residential properties located to the south (sidegradient) beyond the southern parking lot boundary between 100 feet and one mile from the facility;
    - commercial and residential properties located to the east (upgradient) beyond State Route 8 between 200 feet and one mile from the facility;
    - commercial and residential properties located to the north (sidegradient) beyond Stevenson Road between 150 feet and one mile from the facility;
    - commercial and residential properties located to the west (downgradient) beyond the western parking lot boundary at a minimum of 0.30 miles from the facility;
    - retention pond located to the west (downgradient) approximately 150 feet beyond the western parking lot boundary;
    - unnamed pond located to the northwest (downgradient) beyond Stevenson Road approximately 400 feet from the facility;
    - unnamed tributary of the North Branch of Slippery Rock Creek located to the west (downgradient) approximately 0.20 miles from the facility;
    - sewage treatment plant located to the west (downgradient) approximately 700 feet beyond the western parking lot boundary;

  - North Branch of Slippery Rock Creek located to the west (downgradient) approximately 0.25 miles from the facility; and
  - unnamed pond located to the west (downgradient) approximately 0.25 miles from the facility near North Branch of Slippery Rock Creek.
- The nearest downgradient surface body of water is an unnamed pond located approximately 400 feet northwest of the facility beyond Stevenson Road. The pond is listed on the National Wetland Inventory (NWI) (US EPA - My Waters Mapper). The unnamed pond may be a stormwater retention pond for the adjacent Barkeyville Travel Center truck stop.
- A stormwater retention pond for the Kwik Fill facility is located approximately 200 feet west of the dispenser islands.
- The North Branch of Slippery Rock Creek is located approximately 0.25 miles west of the facility. The waters of the North Branch of Slippery Rock Creek (Ohio River Basin) are designated as a cold water fishery (CWF) by PADEP (25 PA Code § 93) (PADEP, 2016).
- The US EPA My Waters Mapper identified another unnamed pond on the NWI directly west (downgradient) of the facility near the North Branch of Slippery Rock Creek.
- An ecological assessment was not warranted based on the constituents of concern (COC) at the facility (diesel constituents only), and lack of observed soil/sediment impacts and exposure pathways.
- Vapor intrusion assessment is planned to be completed following active remediation.
- The facility is currently an active retail petroleum facility and there are no known plans for sale or redevelopment of the property at this time.

Additional details relative to potential sensitive receptors were provided in the September 2016 SCR (GES, 2016).

2.4 Physical Setting

2.4.1 Topography and Drainage

The facility is located at an elevation of approximately 1,430 feet above mean sea level (MSL). Local topography slopes toward an intermittent, unnamed tributary to the North Branch of Slippery Rock Creek, at an elevation of approximately 1,360 feet above MSL. The unnamed tributary is located approximately 0.20 miles west of the facility and flows to the southwest where it meets the North Branch of Slippery Rock Creek.

The facility lot is comprised of asphalt and concrete with grassy areas along the northern, eastern, southern, and western property boundaries. Approximately 200 feet west of the diesel station building and 10 feet west of the asphalt-grass boundary along the western portion of the facility, site topography decreases sharply by approximately 35 feet in elevation. Surface water runoff in the asphalt-paved and concrete areas is directed towards multiple storm water catch basins located in the northern and central portions of the facility, which all direct surface water runoff to the west. Underground stormwater lines connecting the stormwater catch basins run beyond the western parking lot boundary downgradient to the west to a stormwater retention pond.

2.4.2 Stratigraphy

Regional Soil Lithology

Soil type at the facility was evaluated using current U.S. Department of Agriculture Natural Resources Conservation Service Website data. Information obtained from the website indicates that facility soils belong to the Frenchtown Silt Loam (FeB) association. The FeB association consists of Frenchtown and

similar soils and approximately 10% of minor components, and 3 to 8 percent slopes. Frenchtown Silt loam is poorly drained.

Regional Bedrock Geology

The facility is situated within the Pittsburgh Low Plateau Section-Prototypical area of the Appalachian Plateau Physiographic Province. The Prototypical Area is characterized by broad, rolling interfluves separated by relatively narrow, steep-walled, moderately incised valleys (Shultz, 1999).

The underlying bedrock at the site belongs to the Allegheny Formation (Berg, T.M. et. al., 1980). The Formation consists of cyclic, sequences of sandstone, shale, limestone, clay and coal; includes valuable clay deposits and Vanport Limestone; commercially valuable Freeport, Kittanning, and Brookeville-Clarion coals are present in varying proportions.

Facility Lithology

Site characterization activities indicate the subsurface of the upper portion of the site, to a depth of approximately 45 feet bgs, unconsolidated fill material overlying layers of clay, silty clay, sandy clay, gravelly clay, clayey sand and sandy gravel. Bedrock was encountered in monitoring well MW-10D at approximately 41 feet bgs and consisted of weathered sandstone. Facility lithology downgradient of the diesel station building near the retention pond is similar with the exception of the unconsolidated fill. Facility lithology in the lower portion of the site was observed to a maximum depth of 20 feet bgs. Bedrock (weathered sandstone) was observed at approximately 19 feet bgs in monitoring well MW-12 and at approximately 15 feet bgs in monitoring well MW-13. Soil borings logs, well construction diagrams and cross-sections were provided in the September 2016 SCR (GES, 2016).

2.4.3 Hydrology

Surface Water

The facility is located at an elevation of approximately 1,430 feet above MSL. Local topography slopes toward an intermittent, unnamed tributary to the North Branch of Slippery Rock Creek, at an elevation of approximately 1,360 feet above MSL. The unnamed tributary is located approximately 0.20 miles west of the facility and flows to the southwest where it meets the North Branch of Slippery Rock Creek.

The North Branch of Slippery Rock Creek is located approximately 0.25 miles west of the facility and flows southeast then west/southwest toward Slippery Rock Creek. The North Branch of Slippery Rock Creek is located in the North Branch of Slippery Rock Creek Watershed (Watershed HUC12) and is located within the Connoquenessing Subbasin (Subbasin HUC8). The waters within the Connoquenessing Subbasin are located within the Ohio River Basin (US EPA - My Waters Mapper).

Groundwater

Groundwater was gauged and/or sampled during seven separate monitoring and sampling events between October 2015 and August 2016. Groundwater monitoring data are summarized in **Table 1** (Groundwater Data Summary). **Figure 4** (Groundwater Contour Map [Shallow Overburden Aquifer], August 15, 2016) and **Figure** 5 (Groundwater Contour Map [Deep Overburden Aquifer], August 15, 2016) illustrates groundwater flow for the most recent groundwater gauging event in August 2016 for the shallow and deep overburden aquifers. Well construction details are summarized in **Table 2** (Well Construction Summary).

3.0 FACILITY HISTORY

3.1 1996 Reportable Release - Unleaded Gasoline

In November 1996, a plus product line failed annual tightness testing and was subsequently removed from service. UPA initiated corrective action activities in January 1997. Initial site characterization activities included installation of eight soil borings and four groundwater monitoring wells which confirmed that unleaded gasoline constituents were present in facility soil and groundwater at concentrations above PADEP 1996 standards for UST closure site assessments north of the station building and dispenser islands east of the station building. LNAPL recovery was also initiated at the facility. A verbal *Notification of Confirmed Release* (NOCR) was called into the PADEP on January 20, 1997 followed by a written NORR submitted on February 10, 1997. In June 1997, additional site characterization activities were completed including the installation of six soil borings, three groundwater monitoring wells, and seven drive points and additional LNAPL recovery events. Additional site characterization activities identified soil and groundwater impacts above PADEP standards.

3.2 1997 Reportable Release - Unleaded Gasoline

A premium product line failed during annual line testing in October 1997. Additional site characterization activities were completed at the facility from November 1997 through January 2004. A total of thirty-eight soil borings, twenty-one groundwater monitoring wells, seven extraction wells, and seven drive points were installed at the facility as part of site characterization activities. Site characterization activities confirmed that unleaded gasoline constituents were present in facility soil and groundwater at concentrations above U/NR MSCs around the dispenser islands, north of the restaurant/motel building, and north, east, and west of the retention pond downgradient of the station building.

Pilot testing was completed in November 1997, and approximately 700 gallons of LNAPL were recovered via dual phase extraction activities. A remediation system was installed at the facility to mitigate soil and groundwater impacts identified and operated from November 1998 through January 2004. Site-specific standards were chosen as the remedial goals for the facility. A baseline risk assessment was completed which concluded that no unacceptable risk was present for identified receptors via complete and potentially complete exposure pathways. Ecological screening determined that no additional ecological evaluation is required in accordance with PA Code § 250.311(c). A *Comprehensive Site Characterization/Risk Assessment Report* was submitted to PADEP in May 2004 (GSC/Kleinfelder, 2004) and subsequently approved, with modifications, in November 2004. PADEP requested additional data related to the diesel USTs removed in April 1998.

3.3 UST Closure Activities - April 1998

During an internal inspection of the USTs in April 1998, several holes were observed in one of the steel USTs. Seven diesel USTs were removed in February 1999. It is not known if UST closure activities were performed at that time, and no record of a NORR submittal to PADEP was identified. Additional site characterization activities were performed in October 2005 with the completion of 12 soil borings in the former diesel UST area and collection of soil samples for the 1999 diesel UST closure per PADEP's request. Soil samples collected during the additional soil boring investigation indicated diesel constituent concentrations in soil were either not detected or detected at concentrations below applicable U/NR MSCs.

Following the completion of the additional soil boring investigation around the diesel UST field, four soil gas monitoring points were installed at the facility and sampled in November and December 2005. Soil gas sampling confirmed unleaded gasoline constituent concentrations were below PADEP R-NR soil gas screening criteria (MSC_{SG}). An *Additional Site Characterization/Remedial Action Completion Report* (ASC/RACR) was submitted by GSC/Kleinfelder and approved by PADEP in June 2006 (GSC/Kleinfelder, 2006). The selected remedial closure standards for the historical releases noted above were a combination of Statewide Health Standards and Site-Specific Standards (SSS). Total xylenes, MTBE, naphthalene, isopropylbenzene, benzo(a)anthracene, benzo(a)pyrene, fluorene, and phenanthrene in facility soil were demonstrated to be in attainment with the SHS. Benzene, toluene, and ethylbenzene in facility soil were demonstrated to be in attainment with the SSS. For facility groundwater, benzene, toluene, ethylbenzene, total xylenes, MTBE, naphthalene, and isopropylbenzene were demonstrated to be in attainment with the SHS. As noted in the 2006 RACR, residual concentrations of benzene, toluene, and ethylbenzene remain in facility soil, and residual concentrations of benzene and MTBE in facility groundwater (GSC/Kleinfelder, 2006). Following approval of the ASC/RACR, a *Post Remedial Care Plan* (PRCP) was initiated at the facility and consisted of annual site inspections to document that groundwater is not being utilized within areas of remaining soil and groundwater exceedances of the SHS.

3.4 Site Characterization Summary

Site characterization and monitoring activities were initiated at the site in August 2015 and are ongoing. The following summarizes key findings discussed in September 2016 SCR (GES, 2016).

- Subsurface soil is composed of unconsolidated fill material consisting of clay with varying amounts of silt, sand, and gravel (weathered sandstone) underlain predominantly by clay with lenses of sand and gravel with varying amounts of clay and silt.
- Soil samples collected from soil borings SB-1, SB-5, SB-8, SB-10 and groundwater monitoring wells MW-1, MW-3, MW-4 and MW-16 identified diesel constituents in subsurface soil at concentrations above current U/NR MSCs from approximately 2 to 14 feet bgs. Analytical results for soil samples collected during site characterization activities related to the 2015 diesel release are summarized in **Table 3** (Soil Data Summary) relative to current U/NR MSCs. Soil boring locations completed in 2015 are illustrated on **Figure 6** (Soil Boring Location Map). Soil boring logs and well construction diagrams were provided in the September 2016 SCR (GES, 2016).
- Observations during site characterization activities identified an overburden aquifer with two water-bearing zones (shallow and deep). Approximately 200 feet west of the diesel station building and 10 feet west of the asphalt-grass boundary along the western portion of the facility, the site topography decreases sharply, separating the upper portion of the site where the 2015 release occurred from the lower portion of the site near the retention pond by approximately 35 feet in elevation. The shallow overburden aquifer was observed below the upper paved portion of the site, upgradient of the retention pond at a maximum depth of 27.35 feet bgs. The deep overburden aquifer was observed at a minimum depth of approximately 39.38 feet bgs below the upper paved portion of the site and at a minimum depth of approximately 8.79 feet bgs downgradient of the paved portion of the facility near the retention pond.
- Groundwater gauging during site characterization activities identified consistent radial flow with primary flow components to the west/southwest and northwest for the shallow overburden aquifer and to the northwest for the deep overburden aquifer (**Figure 4** and **Figure 5**). During the most recent gauging event conducted in August 2016, groundwater depths in the shallow overburden

aquifer ranged from 7.31 feet bgs (MW-5) to 27.35 feet bgs (MW-9) with an average depth of 14.82 feet bgs. Groundwater depths in the deep overburden aquifer ranged from 39.38 feet bgs (MW-10D) to 44.31 feet bgs (MW-10D) with an average depth of 41.72 feet bgs in the upper paved portion of the facility and from 8.79 feet bgs (MW-13) to 13.39 feet bgs (MW-16) with an average of 11.04 feet bgs downgradient near the retention pond.

- Groundwater samples collected from groundwater monitoring wells MW-1, MW-3, MW-6, MW-8, MW-10S, and MW-11 monitoring the shallow overburden aquifer confirmed the presence of diesel constituents in facility groundwater from dispenser island #1/2 to the western edge of the paved area at the facility west of the diesel station building. Based on the August 2016 sampling data, dissolved phase benzene, MTBE, and 1,2,4-trimethylbenzene are currently the only COCs identified at concentrations above current U/NR MSCs in the shallow overburden aquifer. Groundwater analytical data are summarized in **Table 1**.
- Groundwater samples collected from groundwater monitoring wells MW-10D, MW-12, MW-13, and MW-16 monitoring the deep overburden aquifer confirmed the presence of diesel constituents in groundwater from the western edge of the upper paved portion of the facility west of the diesel station building downgradient to the retention pond. Based on the August 2016 sampling data, dissolved phase benzene, MTBE, naphthalene, and 1,2,4-trimethylbenzene are currently the only COCs identified at concentrations above current U/NR MSCs in the deep overburden aquifer. Groundwater analytical data are summarized in **Table 1**.
- Due to the presence of historical APH and DPH impacts remaining in facility soil and groundwater as documented in the 2006 RACR (GSC/Kleinfelder, 2006), two areas of concern were proposed based on the evaluation of site characterization activities completed to date. DPH and APH impacts identified during site characterization activities related to historical releases at the facility are generally defined as AOC 1, and impacts related to the 2015 diesel release are generally defined as AOC 2. Based on details of the April 2015 diesel release and evaluation of existing site data, APH and DPH impacts in AOC 2 appear isolated near the dispenser islands and are confined within the shallow overburden clay aquifer. APH and DPH impacts identified west of the dispenser islands and downgradient near the retention pond appear to be related to historical releases (AOC 1).
- Current maximum adsorbed phase benzene, ethylbenzene, 1,2,4-trimethylbenzene, and 1,3,5-trimethylbenzene concentrations in soil exceed respective PADEP default vapor intrusion screening values for residential and non-residential settings. Based on APH and DPH impacts identified in facility soil and groundwater in AOC 2, further vapor intrusion assessment and mitigation will be completed to confirm potential vapor inhalation pathways are not a concern at the facility.
- Based on the planned activities provided in the September 2016 SCR and planned remediation, fate and transport modeling was not performed as part of the September 2016 SCR (GES, 2016) for DPH impacts identified in both the shallow and deep overburden aquifers. Planned activities included installation of groundwater monitoring wells downgradient of monitoring wells MW-12, MW-13 and MW-16 to further delineate DPH impacts and allow for fate and transport modelling of current conditions in the deep overburden aquifer (previous fate and transport modelling had been completed in the June 2006 RACR [GSC/Kleinfelder, 2006]). Prior to installation of the downgradient monitoring wells, a meeting with PADEP was proposed to discuss planned activities and determine if additional actions were necessary before submittal of the RAP; however, PADEP stated that review of the SCR would not be completed until the RAP (this report) was submitted. Therefore, proposed planned activities in the September 2016 SCR were not completed and fate and transport modelling was completed and is presented in this report for DPH impacts in the deep overburden aquifer (**Section 4.0**).
- Investigation-derived waste (IDW) (i.e., soil cuttings) was containerized and transported off-site for proper disposal at an approved waste facility. Following receipt of analytical results, purge water

from well development and groundwater sampling activities was process through granular activated carbon prior to on-site discharge in an area already known to be impacted by DPH.

Adsorbed phase benzene, MTBE and 1,2,4-trimethylbenzene were detected in facility subsurface (>2 feet bgs) soil between 2 to 12 feet bgs at concentrations above current U/NR MSCs for unsaturated soil (**Table 3)**. The approximate extent of benzene, MTBE and 1,2,4-trimethylbenzene in AOC 1 and AOC 2 are illustrated on **Figure 7A (**Benzene Soil Isoconcentration Map, August 2015 - June 2016 [2-15 feet bgs]), **Figure 7B** (MTBE Soil Isoconcentration Map, August 2015 - June 2016 [2-15 feet bgs]) and **Figure 7C** (1,2,4-TMB Soil Isoconcentration Map, August 2015 - June 2016 [2-15 feet bgs]), respectively. Based on the location and extent of the 2015 diesel release and approximate limits of identified APH impacts near dispenser islands #1/2 and 7/8, the APH impacts observed at monitoring well MW-16 are considered to be related to historical releases documented in the 2006 RACR (GSC/Kleinfelder, 2006). The unsaturated, periodically saturated and permanently saturated soil intervals will be further evaluated and established in more detail as additional seasonal groundwater elevation data is collected.

Groundwater analytical data from sampling events completed between October 2015 and August 2016 identified diesel constituents in facility groundwater at concentrations above current U/NR MSCs including benzene, MTBE, naphthalene, and 1,2,4-trimethylbenzene (**Table 1**). The approximate extent of benzene, MTBE, naphthalene, and 1,2,4-trimethylbenzene in the overburden aquifers, based on the August 2016 groundwater sampling event, are illustrated on **Figure 8A** (Benzene Groundwater Isoconcentration Map, August 15, 216), **Figure 8B** (MTBE Groundwater Isoconcentration Map, August 15, 216), **Figure 8C** (Naphthalene Groundwater Isoconcentration Map, August 15, 216) and **Figure 8D** (1,2,4-TMB Groundwater Isoconcentration Map, August 15, 216), respectively.

As noted in the September 2016 SCR (GES, 2016) a vapor intrusion assessment is planned to be completed at the site to assess potential vapor intrusion pathways.

Given APH and DPH impacts and the current Act 2 attainment goal for site groundwater is SHS U/NR MSCs, active remediation is necessary to reduce COC concentrations. A feasibility test was completed in November 2016 to evaluate potential remedial technologies to address remaining DPH impacts. Methodology and results of the feasibility test are summarized in **Section 5.0**.

4.0 FATE AND TRANSPORT ASSESSMENT

Fate and transport modeling was conducted using current site-specific data to evaluate the potential migration of dissolved phase hydrocarbon impacts in deep overburden groundwater in the western portion of the site. The migration assessment was based on the distribution of dissolved phase benzene, naphthalene, and 1,2,4-TMB reported above applicable U/NR MSCs in the deep overburden aquifer during the August 2016 sampling events. Dissolved phase MTBE was also reported above U/NR MSCs in on-site deep overburden monitoring well MW-10D; however, MTBE is not considered a constituent of concern relative to the April 2015 diesel release, and it was not included in the current fate and transport model.

Historical data indicates groundwater flow in AOC 1 is to the west (Kleinfelder, 2006). Current data illustrates groundwater flow to the northwest. Due to the size of the property and the distance to the downgradient property boundary to the west, it was determined a more conservative fate and transport model could be presented with current groundwater data and the localized groundwater flow direction currently observed in the western-most portion of the site. Fate and transport modeling can be updated, as needed, based on the accumulation of additional groundwater data, installation of additional monitoring wells, and/or as site conditions change. Details of the site conceptualization and modeling analyses are described in the following sections.

4.1.1 Facility Groundwater Conceptualization

Based on the data collected between September 2015 and August 2016, groundwater in the deep overburden aquifer occurs at depths ranging from 7.74 (MW-13, 4/14/2016) to 44.31 (MW-10D, 8/15/2016) feet bgs with an average depth of 19.01 feet bgs. Groundwater exhibits a general flow to the northwest with an average hydraulic gradient of 0.03 feet per foot (ft/ft) based on the two most recent groundwater monitoring events. **Figure 5** illustrates the current groundwater flow pattern observed in August 2016.

4.1.2 Modeling Approach

Potential deep overburden groundwater impacts to downgradient receptors (groundwater monitoring well MW-13 and the downgradient property boundary) were modeled using the PADEP-approved Quick Domenico (QD) groundwater modeling program. The QD model provided a steady state analytical solution based on first order decay of constituent concentrations, retardation and three-dimensional dispersion. Site-specific parameters, such as concentration, source width and source thickness, and various aquifer parameters, such as f_{oc}, bulk density, porosity, hydraulic conductivity and gradient, were input into the model along with contaminant specific literature values for K_{oc} and decay rate. Where site-specific parameters were not available, literature-based values were entered into the model based on information obtained from 25 PA Code § 250, Table 5A (PADEP, 2016).

Fate and transport models were completed using the maximum benzene, naphthalene, and 1,2,4-trimethylbenzene concentrations observed in the deep overburden aquifer during the groundwater sampling event on August 15, 2016:

- Benzene calibration (MW-16 to MW-13),
- Naphthalene calibration (MW-16 to MW-13),
- 1,2,4-TMB calibration (MW-16 to MW-13),
- Benzene concentration at downgradient property boundary in 5 and 30 years,
- Distance to benzene U/NR MSC,

- Naphthalene concentration at POC monitoring well MW-13 in 5 and 30 years,
- Distance to naphthalene U/NR MSC,
- 1,2,4-TMB concentration at downgradient POC monitoring well MW-13 in 5 and 30 years, and
- Distance to 1,2,4-TMB U/NR MSC.

4.1.3 QD Model Input Parameters

In the modeling effort, parameter input values were defined from site data whenever possible. When site-specific data were not available, literature values were utilized. The model assumed equilibrium between the groundwater and the aquifer matrix. A summary of input values including rational for input values are summarized on **Table A-1** through **Table A-3** in **Appendix A** (Fate and Transport Assessment).

Dissolved Species: The modeling analyses simulated the transport of benzene, naphthalene, and 1,2,4-trimethylbenzene in the aquifer as the only dissolved diesel fuel constituents with reported concentrations above current U/NR MSCs in the deep overburden aquifer during the most recent sampling event in August 2016.

Constituent Concentrations: Benzene, naphthalene, and 1,2,4-trimethylbenzene concentrations detected during the most recent groundwater sampling event in in deep monitoring wells MW-13 and MW-16 in August 2016 were used to run the models after calibration.

Aquifer and Source Conditions: Groundwater flow representative of measured facility conditions was simulated in the modeling effort. A steady state, uniform flow field was generated based on facility hydrologic conditions.

Transport Conditions: Hydrodynamic dispersion is the term applied to the combined effects of mechanical dispersion and molecular diffusion in causing a plume to spread within a groundwater system. For this modeling effort, the original longitudinal, lateral, and vertical dispersivities were established through calibration of the models to site-specific field and literature data and were estimated along the approximate centerline of the plume in the current source area, as data were available.

QD models were calibrated for the source area using current benzene, naphthalene, and 1,2,4-trimethylbenzene data. Model calibration was completed where upgradient dissolved phase concentrations were greater than downgradient dissolved phase concentrations in the general direction of groundwater flow (northwest), when possible. Calibration input values for benzene, naphthalene, and 1,2,4-trimethylbenzene are included in **Appendix A**.

4.1.4 Model Uncertainty/Variability

The lithology of the facility subsurface is composed of unconsolidated fill material consisting of clay with varying amounts of silt, sand, and gravel to a maximum depth of approximately 7 feet bgs. The fill material is underlain predominantly by layers of clay, silty clay, sandy clay, gravelly clay, clayey sand and sandy gravel to a maximum observed depth of 41 feet bgs (GES, 2016). Bedrock was not encountered in the shallow overburden aquifer during drilling activities. Weathered sandstone was encountered in the deep overburden aquifer at approximately 41 feet bgs at groundwater monitoring well MW-10D and at depths ranging from 15 to 19 feet bgs in the deep overburden aquifer near the retention pond (GES, 2016). Based on variability in the aquifer lithology, a range of hydraulic conductivity (K values) were input into the models appropriate for the overburden and bedrock lithologies (Freeze and Cherry, 1979). Approximate K values of 0.28, 2.8, and 28.8 feet per day (ft/day) were input into the

model. Results for each model were similar, therefore models utilizing the mid-range K value are most appropriate to present based on site lithology.

As discussed above, modeling input parameters were defined from site-specific data whenever possible. To calibrate the model, book value lambda values were used for benzene and naphthalene. A conservative value of 0 was input into the model for the lambda value for 1,2,4-trimethylbenzene as the model would not calibrate using the PADEP book value. Based on the biodegradation uncertainty, these models should be considered approximations of future fate and transport at the site.

Although historical data suggests regional groundwater flow is to the west, current groundwater flow in the western portion of the site was determined to be toward the northwest based on the August 2016 sampling event. Modeling was based on current groundwater data to the closest available POC monitoring well and downgradient property boundary as a conservative estimate.

4.1.5 QD Model Results

After calibration, the QD model was used to predict naphthalene and 1,2,4-trimethylbenzene concentrations at the downgradient point of compliance (POC) well MW-13 in 5 and 30 years and benzene concentrations at the property boundary downgradient of MW-13 in 5 and 30 years. The distance at which the dissolved phase plumes meet applicable U/NR MSCs in 5 and 30 years were also evaluated. Modeling results are as follows:

5-Year Model

Constituent	Initial Modeled Concentration (µg/L)	Concentration at Receptor (µg/L)	Distance to U/NR MSC (feet)
Benzene	27.1	3	76.7
Naphthalene	136	3	8.3
1,2,4-TMB	1,100	0	29.7

µg/L – micrograms per Liter

30-Year Model

Constituent	Initial Modeled Concentration (µg/L)	Concentration at Receptor (µg/L)	Distance to U/NR MSC (feet)
Benzene	27.1	4	76.7
Naphthalene	136	4	8.5
1,2,4-TMB	1,100	19	76.4

µg/L – micrograms per Liter

Modeling results indicate that based on the current CSM dissolved phase constituents will not migrate to the downgradient receptor (i.e., MW-13 or the downgradient property boundary) at concentrations above current U/NR MSCs. The QD models are presented in **Appendix A**.

5.0 REMEDIAL FEASIBILITY STUDY

A remedial feasibility study was performed by GES at the facility on November 2, 2016. The study was performed to evaluate various remedial technologies that could be viable in addressing on-site APH and DPH impacts. The study included recovery of groundwater and soil vapor from designated extraction wells while monitoring hydraulic and pneumatic influences in observations wells. The following table provides a brief summary of the feasibility study methodologies and observed influences:

Remedial Technology	Stage	Groundwater Extraction Rate (gpm)	Hydraulic ROI (feet)	Applied Vacuum (in. w.c.)	Pneumatic ROI (feet)	Air Flow Rate (scfm)	Influent PID (ppm)
TPE at MW-3	1	0.27	85	263.74	61	74.0	188.8
TPE at MW-1	2	0.59	56	222.69	32	101.1	128.17

gpm - gallons per minute
ROI - radius of influence
in. w.c. - inches of water column
scfm - standard cubic feet per minute
PID - photoionization detector
ppm - parts per million (volume)

5.1 Remedial Feasibility Study Methodologies

The feasibility study was performed at monitoring wells MW-1 and MW-3 utilizing a mobile vacuum vehicle. The TPE study consisted of connecting a 1-inch diameter drop tube to the truck-mounted vacuum pump for simultaneous recovery of soil vapor and groundwater from the selected extraction well.

Applied vacuum, airflow rates, and volatile organic compound (VOC) concentrations were monitored at the extraction points during each study. Applied vacuum readings were monitored with truck-mounted vacuum gauges. Airflow readings were estimated utilizing manufacturer specification sheets for the vacuum pump (manual air flow readings could not be collected due to groundwater recovery). VOC concentrations were monitored with a calibrated photoionization detector (PID).

Induced influences (e.g., vacuum response and groundwater level fluctuations) were manually recorded in designated observation wells surrounding the extraction well. Vacuum response was recorded using magnehilic gauges, calibrated in inches of water column (in. w.c.), connected to the observation wells. Water level fluctuations were recorded in the observation wells using an electronic interface probe capable of measuring to an accuracy of 0.01 feet.

Remedial feasibility study data are summarized in **Appendix B** (Remedial Feasibility Study Data and Engineering Calculations). Analytical reports from the vapor and water samples (collected during various steps throughout the study) are provided in **Appendix C** (Remedial Feasibility Study Laboratory Analytical Reports, 2016).

5.2 Stage 1, TPE at MW-3

Prior to initiating the study at monitoring well MW-3 on November 2, 2016, static groundwater elevations were gauged in the extraction well and surrounding monitoring wells. Once depths to groundwater were obtained, a drop tube was installed in monitoring well MW-3 so that the drop-tube inlet was one foot above the bottom of the monitoring well (approximately 19 feet bgs). Hydraulic and pneumatic influences were recorded as described previously at monitoring wells MW-4, MW-5 and MW-8, which are 46 feet, 79 feet and 35 feet, respectively, from monitoring well MW-3.

An average well vacuum of 19.4 inches of mercury (in. Hg) (263.74 in. w.c.) was then applied to monitoring well MW-3 for 205 minutes during Stage 1 of the TPE study. Soil vapors were recovered at an estimated flow rate of 74 standard cubic feet per minute (scfm) and influent PID readings averaged 188.8 parts per million (ppm) during Stage 1. Approximately 55 gallons of groundwater were recovered from monitoring well MW-3 during Stage 1, resulting in a groundwater recovery rate of 0.27 gallons per minute (gpm).

Collected hydraulic and pneumatic data were analyzed through linear regression to determine a radius of influence (ROI) for each, utilizing 0.10 feet of groundwater drawdown and 0.10 in. w.c. of vacuum response, respectively, as a baseline. Observations of less than 0.10 feet of groundwater drawdown and 0.10 in. w.c. were deemed natural fluctuations. Groundwater drawdown and vacuum response calculations are summarized in **Appendix B**.

During Stage 1, notable hydraulic influences (i.e., greater than or equal to 0.10 feet of groundwater drawdown) were observed in monitoring wells MW-4 and MW-5 and a hydraulic ROI of 85 feet is estimated for this step. Notable pneumatic influence (i.e., greater than or equal to 0.10 in. w.c. of vacuum response) was observed in monitoring wells MW-4, MW-5 and MW-8. A pneumatic ROI of 61 feet is estimated. Groundwater drawdown and vacuum response data from Stage 1 are provided in the following table:

Observation Well	Distance from Extraction Well *(feet)*	Hydraulic Response in Observation Well *(feet)*	Pneumatic Response In Observation Well *(in w.c.)*
MW-3	0	9.42	263.74
MW-8	35	0.00	0.20
MW-4	46	0.47	0.10
MW-5	79	0.1	0.10

in. w.c. - inches of water column

During Stage 1 of the study, pre- and post-study groundwater samples and an influent soil vapor sample were collected for laboratory analysis. The influent soil vapor sample was collected at the mid-point of the test (i.e., approximately 2 hours). Groundwater samples were analyzed for the revised (March 2008) PADEP short list of diesel constituents. Influent soil vapor samples were analyzed for benzene, toluene, ethylbenzene, total xylenes, MTBE, 1,2,4-TMB, 1,3,5-TMB and total C_4-C_{10} hydrocarbons. Analytical results are attached as **Appendix C** and analytical data from this stage are presented in the following tables:

TPE Stage 1 (263.74 in. w.c.) at MW-3 Groundwater Analytical Results		
Volatile Organic Compounds	**Pre-Study Concentrations (µg/L)**	**Post-Study Concentrations (µg/L)**
Benzene	96.4	107
Toluene	7.2	24.3
Ethylbenzene	51.4	17.8
MTBE	7.5	8.6
Isopropylbenzene	5.5	19.7
Naphthalene	46.7	19.5
1,2,4-TMB	87.7	71
1,3,5-TMB	16.7	9.1

in. w.c. - inches of water column
µg/L - micrograms per liter
MTBE - methyl tert-butyl ether
TMB - trimethylbenzene

TPE Stage 1 (263.74 in. w.c.) at MW-3 Vapor Analytical Results	
Volatile Organic Compounds	**Influent Concentrations (ppmv)**
Benzene	3.57
Toluene	2.60
Ethylbenzene	0.539
Total Xylenes	2.79
MTBE	<0.277
1,2,4-TMB	0.311
1,3,5-TMB	<0.203
Total C_4-C_{10} Hydrocarbons	113

in. w.c. - inches of water column
ppmv - parts per million (volume)
MTBE - methyl tert-butyl ether
TMB - trimethylbenzene

5.3 Stage 2, TPE at MW-1

Following the TPE study at monitoring well MW-3, a drop tube was installed in monitoring well MW-1 with the drop-tube inlet approximately one foot above the bottom of the well (approximately 19 feet bgs). Hydraulic and pneumatic influences were recorded as described previously, at monitoring wells MW-2, and MW-14, which are 45 feet and 33 feet, respectively, from monitoring well MW-1.

An average well vacuum of 16.38 in. Hg (222.69 in. w.c.) was then applied to monitoring well MW-1 for 232 minutes during Stage 2 of the TPE study. Soil vapors were recovered at an estimated flow rate of 101 scfm and influent PID readings averaged 128.17 ppm during Stage 2. Approximately 138 gallons of groundwater were recovered from monitoring well MW-1 during Stage 2, resulting in a groundwater recovery rate of 0.59 gpm.

During Stage 2, notable hydraulic influences were observed in monitoring well MW-14 and a hydraulic ROI of 56 feet is estimated for this step. Notable pneumatic influences were observed in monitoring well MW-14 during Stage 2. A pneumatic ROI of 32 feet is estimated for this step. Groundwater drawdown

and vacuum response calculations are summarized in **Appendix C**. Groundwater drawdown and vacuum response data from Stage 2 are provided in the following table:

Observation Well	Distance from Extraction Well *(feet)*	Hydraulic Response in Observation Well *(feet)*	Pneumatic Response In Observation Well *(in w.c.)*
MW-1	0	4.46	222.69
MW-14	33	0.48	0.10
MW-2	45	0.00	0.00

in. w.c. - inches of water column

Pre- and post-study groundwater samples and an influent soil vapor sample were collected for laboratory analysis, during Stage 2, as described in **Section 5.2**. Analytical results are attached as **Appendix C** and analytical data from this stage are presented in the following tables:

TPE Stage 2 (222.69 in. w.c.) at MW-1 Groundwater Analytical Results		
Volatile Organic Compounds	**Pre-Study Concentrations (µg/L)**	**Post-Study Concentrations (µg/L)**
Benzene	195	20.2
Toluene	<1.0	61.5
Ethylbenzene	11.4	16
MTBE	1.9	2.2
Isopropylbenzene	<1.0	<1.0
Naphthalene	<2.0	17.4
1,2,4-TMB	<1.0	28.0
1,3,5-TMB	<1.0	6.0

in. w.c. - inches of water column
µg/L - micrograms per liter
MTBE - methyl tert-butyl ether
TMB - trimethylbenzene

TPE Stage 2 (222.69 in. w.c.) at MW-1 Vapor Analytical Results	
Volatile Organic Compounds	**Influent Concentrations (ppmv)**
Benzene	<0.313
Toluene	0.357
Ethylbenzene	<0.230
Total Xylenes	<0.461
MTBE	<0.277
1,2,4-TMB	<0.203
1,3,5-TMB	<0.203
Total C_4-C_{10} Hydrocarbons	10.5

in. w.c. - inches of water column
ppmv - parts per million (volume)
MTBE - methyl tert-butyl ether
TMB - trimethylbenzene

6.0 REMEDIAL OPTIONS EVALUATION

Remedial technologies considered as potentially viable in addressing APH and DPH impacts are discussed in the following sections.

6.1 Soil

Following removal of the ponded product observed in diesel dispensers #1/2 and 7/8, any continuing source of diesel impacts to site soil should have been removed. Based on site characterization findings, current impacts in facility soil include benzene, MTBE, and 1,2,4-trimethylbenzene in the vicinity of soil sample locations MW-1, MW-3, MW-4, MW-16, SB-1, SB-5, SB-8, and SB-10 ranging in depth from 2 to 14 feet bgs. The following alternatives are considered for remediation of these soil impacts:

- *No Action:* Eighty-one soil samples were analyzed for diesel constituents during various characterization activities conducted from August 2015 to June 2016. Exceedances of potentially applicable soil MSCs were identified at locations MW-1, MW-3, MW-4, MW-16, SB-1, SB-5, SB-8, and SB-10 at depths ranging from 2 to 14 feet bgs. Based on these results, active remediation appears necessary.

- *Soil Excavation (Ex Situ Treatment)*: This option requires the excavation and removal of impacted soil for off-site treatment/disposal. Excavation can be effective to complete APH source removal in a relatively short time frame. Due to the location of the impacts related to the release (between 2 to 14 feet bgs) being mostly beneath the dispenser area, an in-situ remediation option will be considered for soil impacts.

- *Soil Vapor Extraction (SVE):* SVE is an in-situ remedial technology that is effective in removing volatile constituents from the vadose or unsaturated zone. SVE utilizes a blower (regenerative, positive displacement, or liquid ring pump) to extract soil vapors from the pore space of the soil matrix. The effectiveness of an SVE system is determined by two major factors: permeability of the soil and volatility of the constituent to be extracted. Permeability of the soil determines the rate at which soil vapors can be removed. Soils that tend to be fine-grained (i.e., clays and silts) are less likely to allow sufficient vapor flow than coarse-grained soils (i.e., sands and gravels). The composition of the impacted soil is unconsolidated fill material underlain by varying amounts of clay, silty clay, sandy clay, gravelly clay, clayey sand and sandy gravel.

The volatility of the constituent to be removed determines the rate or degree at which the constituent will vaporize from the adsorbed phase to the vapor phase. Vapor pressure is a key factor to determining the volatility of a constituent. In general, vapor pressures greater than 0.5 millimeters of mercury (mm Hg) are generally considered amenable for soil vapor extraction. The vapor pressure for diesel range organic compounds varies from 75 mm Hg for benzene to 7.1 mm Hg for ethylbenzene. Because the impacts are diesel-range organic compounds, SVE could be effective at achieving VPH and APH mass reduction in on-site unsaturated soil; however, SVE alone would not address potentially saturated APH impacts or DPH impacts. Based on results of the November 2016 feasibility study, the average pneumatic ROI was estimated to be 46.5 feet. SVE could be an effective remedial technology to remediate APH impacts if conjunction with groundwater extraction.

- *Natural Attenuation:* Natural attenuation relies upon natural subsurface processes to reduce constituent concentrations to below current Act 2 MSCs. This option typically requires long-term sampling and data evaluation to establish constituent reduction and degradation by-product trends.

Natural attenuation is eliminated from current consideration due to the elevated APH impacts and potential on-/off-site and downgradient receptors.

6.2 Groundwater

DPH impacts identified to date in facility groundwater include benzene, MTBE, naphthalene, and 1,2,4-trimethylbenzene at concentrations above U/NR MSCs at groundwater monitoring wells MW-1, MW-3, MW-6, MW-7, MW-8, MW-10S, MW-10D, MW-11, MW-12, MW-13, and MW-16. The DPH plume related to the 2015 diesel release appears to be limited to the area sidegradient and downgradient of dispensers #1/2 and 7/8. The following alternatives are considered for remediation of these impacts:

- *Groundwater Extraction:* Groundwater extraction is a practical remedial technology to gain hydraulic control and to retard downgradient migration of DPH. However, groundwater pump-and-treat remediation technology may lead to many years of system operation and maintenance before MSCs are attained. In addition pump-and-treat remediation would not address the observed APH impacts.

- *Dual Phase Extraction:* Dual phase extraction or vacuum enhanced groundwater extraction (VEGE) combines both SVE and pump-and-treat remedial technologies. The application of a vacuum to an extraction well creates pressure gradients that enhance total fluid flow towards the extraction well. Conventional dual-phase/VEGE extraction systems use a submersible pump to extract liquids from the well and a surface blower to extract vapors. A dual-phase/VEGE remedial system removes vapor and groundwater independently using one of several methodologies.

The first option involves the use of low vacuums (<50 in w.c.) and submersible pumps (pneumatic or electric). Low vacuum dual-phase/VEGE systems are most effective in high yielding, high transmissivity formations. The second dual-phase/VEGE option involves the use of mid-range vacuums (50–100 in w.c.) and submersible pumps. Mid-range vacuum dual-phase/VEGE systems are most effective in medium yielding, medium transmissivity formations. The third type of dual-phase/VEGE system involves the use of a high vacuum (>100 in w.c.) positive displacement (PD) blower and submersible pumps. PD blowers are capable of vacuum levels approaching 18 in. Hg.

A conventional dual-phase/VEGE extraction system could be effective in hydraulically controlling and capturing DPH at this site. However, given that the DPH plume appears to be stable (i.e., not expanding) the capital costs associated with installation of a full scale dual-phase/VEGE extraction system are not warranted at this time.

- *Total Phase Extraction (TPE):* TPE typically utilizes a single blower to extract groundwater and soil vapor simultaneously through the same extraction pipe. Liquid ring pumps (LRPs) and PD blowers are capable of high vacuum levels (approaching 30 in. Hg for LRPs, and 18 in. Hg for PD blowers) and are most effective in low yield (<1.0 gpm/well) formations. A TPE system utilizes a drop tube inside the well to extract total fluids. A pitless adapter attached to the extraction well connects the drop tube to a piping network. During conveyance of the extracted fluids through the piping network, turbulence causes dissolved phase VOCs to partition to the vapor-phase. The total fluids enter the equipment compound and are separated inside a vapor/liquid separator.

A typical TPE system is designed to handle groundwater recovery rates less than one gpm per extraction well and vapor flow rates less than 20 scfm per extraction well. Dual phase/VEGE systems which utilize

submersible pumps and surface blowers are more appropriately designed to handle groundwater recovery rates greater than one gpm per well.

Based on data from a November 2016 vacuum extraction pilot test, TPE may be an effective means to remediate APH and DPH impacts in the shallow overburden aquifer. Feasibility study data indicated that application of vacuum resulted in an average hydraulic ROI of 70.5 feet and recovered a total of 193 gallons of groundwater. The average groundwater recovery rate was 0.43 gpm. The estimated soil vapor recovery rates were above the typical ranges for TPE remediation; however, actual soil vapor flow rates are assumed to be in the typical range of TPE based on the observed lithology.

Based on results of the November 2016 feasibility study, TPE is a viable option to address APH and DPH impacts related to the 2015 diesel release. However, as noted previously, installation of a full scale remediation system is not warranted due to capital costs associated with equipment procurement and installation (i.e., trenching, system build, etc.), the DPH plume appears to be stable and APH impacts are located mostly beneath the dispenser islands (i.e., potential damage to subsurface product piping during install) Therefore, TPE via mobile vacuum truck is the recommended remedial technology to address APH and DPH impacts related to the 2015 diesel release.

- *Air Sparge/Soil Vapor Extraction (AS/SVE):* Air sparging involves the delivery of air into the saturated zone to volatilize DPH and APH constituents. Typically, the volatilized constituents are removed from the vadose zone by an SVE system. The effectiveness of air sparging primarily depends on two key factors, vapor/dissolved phase partitioning and permeability of the soil.

AS/SVE may be effective at remediation APH and DPH impacts at this facility; however, due to the varying clay lithology at the site, short circuiting (i.e., preferential pathway) to more permeable layers may occur. As a result, this remedial technology is not considered a viable remedial option at this time. A more passive form of remediation (low flow oxygen injection) may be considered as a polishing step following active remediation.

- *Oxidation:* Oxidants, such as ozone, peroxides and oxygen may be added to the groundwater to promote both biological activity and chemical oxidation. The oxidation process breaks the chemical bonds of organic compounds and renders innocuous by-products, depending on the strength of the oxidant. Introduction of oxidants into facility groundwater may be a viable option to remediate DPH in the overburden aquifer; however, oxidation is not selected as a remedial strategy at this time. Due to the proximity to subsurface features (i.e., UST field, product piping, etc.), oxidation is eliminated as a potential polishing technology.

- *In-Situ Bioremediation:* Bioremediation involves the introduction of nutrients, such as nitrogen and phosphorus, and oxygen to the groundwater to enhance microbial growth. Remedial feasibility testing will be required to determine if subsurface conditions are favorable for injection; however, bioremediation is not being considered at this time. Bioremediation may be re-evaluated following active remediation via the mobile vacuum truck, as a polishing technology.

- *Monitored Natural Attenuation (MNA)*: Natural attenuation relies upon natural subsurface microbiological and chemical processes to reduce constituent concentrations to below MSCs. This option typically requires long-term sampling and data evaluation to establish constituent reduction and degradation by-product trends. Benzene is currently one of the primary COCs in site groundwater and is widely considered to be susceptible to natural bio-chemical degradation in subsurface environments. Based on the susceptibility of benzene to natural attenuation processes MNA appears to be a potentially

viable remedial alternative for site groundwater following reduction of DPH concentrations by a more aggressive/active remedial approach and will be re-evaluated following active remediation.

7.0 REMEDIAL APPROACH

Based on the results of soil boring, groundwater sampling, and the feasibility study, the most applicable remedial approach is to complete one-day (8-hour) High Intensity Targeted (HIT) remediation events utilizing a mobile vacuum truck (i.e., mobile TPE events) to address APH and DPH impacts related to the 2015 diesel release (i.e., shallow overburden aquifer).

7.1 Planned Activities

Following approval of the RAP, four proposed SVE wells (SVE-1 through SVE-4) will be installed at the locations illustrated on **Figure 9A** (Proposed Pneumatic Radius of Influence Map) to address APH impacts in the vicinity of dispenser #1/2 and #7/8. **Figure 9B** (Proposed Hydraulic Radius of Influence Map) illustrates existing monitoring wells that are proposed to be used during HIT events for groundwater extraction. Each proposed SVE well will be constructed of 4-inch diameter schedule 40 poly-vinyl chloride (PVC) casing and 0.020-inch machine slotted screen at the approximate intervals and depths specified in the following table:

Proposed Well	Diameter (inches)	Well Depth (feet bgs)	Screen Interval (feet)
SVE-1	4	8	3-8
SVE-2	4	8	3-8
SVE-3	4	8	3-8
SVE-4	4	8	3-8

bgs = below ground surface

7.2 HIT Remediation Events

HIT remediation events will be scheduled on a twice per month basis for twelve consecutive months (i.e., one year). Following twelve consecutive months of HIT remediation events, site groundwater analytical data will be evaluated to determine if the HIT schedule will be modified. If subsequent groundwater monitoring data confirms DPH concentrations have decreased significantly, a modified HIT remediation event schedule may be proposed.

Each HIT remediation event will be conducted for six hours on either Group A or B and two hours on Group C (see table below), or until the groundwater holding tank on the vacuum truck is full. During each event, groundwater and soil vapor will be extracted from existing monitoring wells and proposed SVE wells using a 425 horsepower (Hp) wet or dry vacuum according to the table below (the groupings are based on the 2015 diesel release locations [dispenser #1/2 and #7/8] and current extent of APH and DPH in site soil and groundwater, respectively):

Group	Groundwater Extraction Wells	SVE Extraction Wells	Operational Time During HIT Event (hours)
A	MW-1	MW-1, SVE-1 and SVE-2	6
B	MW-3 and MW-4	MW-3 and MW-4	6
C	NA	SVE-3 and SVE-4	2

Extraction wells in the referenced groups will be connected via a manifold to extract groundwater and soil vapors from extraction wells in the referenced groups simultaneously (i.e., all wells in group will have vacuum applied simultaneously). A 1¼-inch diameter drop tube will be placed into the referenced groundwater extraction wells (MW-1, MW-3 and MW-4) approximately one foot above the bottom of the well to extract total fluids (i.e., groundwater and soil vapors) during HIT events. Vacuum will be applied to the referenced SVE extraction wells (SVE-1 through SVE-4) at the well head. Recovered groundwater will be contained within a 3,000-gallon holding tank mounted on the mobile vacuum truck. Extracted vapors will proceed through the top of the tank (refer to **Section 7.4.1**).

If the concentrations of DPH continue to remain elevated following at least one year of HIT remediation events, the selected remedial approach will be re-evaluated and modified as necessary.

7.3 HIT Remediation Event Monitoring

During each HIT remediation event, a pre- and post-HIT groundwater sample will be collected from each groundwater extraction well and an influent vapor sample will be collected from the total fluids stream entering the vacuum truck. Pre- and post-HIT groundwater samples will be submitted for laboratory analysis of benzene, toluene, ethylbenzene, total xylenes, MTBE, isoproylbenzene, naphthalene, 1,2,4-TMB and 1,3,5-TMB. Influent soil vapor samples will be submitted for laboratory analysis of benzene, toluene, ethylbenzene, total xylenes, MTBE, 1,2,4-TMB, 1,3,5-TMB and C_4-C_{10} hydrocarbons. The analytical results and the estimated volume removal of both soil vapors and groundwater will be used to estimate the hydrocarbon mass recovery during each HIT remediation event. The hydrocarbon mass removal and APH and DPH concentrations will indicate the effectiveness of the remedial approach and be utilized to optimize additional HIT events, as necessary.

7.4 HIT Permitting

7.4.1 Air Discharge Permit

Groundwater and soil vapor remediation activities have been listed as exempt from permitting by the Air Quality Division of PADEP under 25 PA CODE 127.14 (a)(8), paragraph 43 (PADEP, 1994). Exemption status requires treatment of discharged vapor to the atmosphere of less than one ton per year of total C_4-C_{10} hydrocarbons.

7.4.2 Water Discharge Permit

Extracted fluids will be contained in the tank of the mobile vacuum truck. The vacuum truck will transport extracted groundwater to an approved treatment/disposal facility utilizing a non-hazardous waste manifest; therefore, a water discharge permit will not be required.

7.5 Reporting

Quarterly *Remedial Action Progress Reports* (RAPRs) will be prepared describing facility activities and remedial progress. The reports will include data on the HIT remediation events and other pertinent information such as a narrative description of site conditions and findings, data tables summarizing hydrocarbon extraction concentrations, hydrocarbon mass removal, and analytical results from HIT remediation event sampling. Specific data trends will be noted and discussed, and appropriate figures and/or charts will be prepared to illustrate site conditions.

8.0 REQUIRED PLANS

The following summarizes site-specific plans relating to 25 PA Code §245.311(a)(2) requirements. A site-specific *Sampling and Analysis and Quality Assurance Project Plan* (SAP/QAPP) was provided in the September 2016 SCR (GES, 2016).

8.1 Health and Safety Plan

Field work performed during remediation activities will be conducted according to the specifications of a site-specific Health and Safety Plan (HASP) that meets the requirements of the Occupational Safety and Health Administration's (OSHA) Hazardous Waste and Emergency Response (HAZWOPER) standard, as described in 29 Code of Federal Regulations (CFR) 1910.120 and 29 CFR 1926.65.

GES communicates safety rules to staff through formal field training, monthly health and safety meetings, site-specific HASPs, and incident bulletins detailing root causes and corrective actions. In addition, GES provides in-house Loss Prevention System (LPS), OSHA refresher, supervisor training and mandatory yearly and random drug and alcohol testing. All GES subcontractors are pre-approved to meet GES health and safety training, OSHA Hazardous training, and mandatory drug and alcohol testing requirements. A complete site-specific HASP was included in the Sampling and Analysis Plan/Quality Assurance Project Plan (SAP/QAPP) submitted with GES' August 2015 SCR (GES, 2015).

8.2 Waste Management Plan

Impacted groundwater generated during HIT remediation events will be containerized in the tank of the mobile vacuum truck and transported off-site for disposal under non-hazardous waste manifest. Recovered soil vapors will be discharged to the atmosphere in accordance with the exemption previously referenced (**Section 7.4**).

8.3 Quality Assurance

Sample collection, preservation and handling, and quality assurance/control procedures for remedial action phase of the project will be consistent with those in the SAP/QAPP submitted with GES' September 2016 SCR.

9.0 REMEDIAL GOALS

The targeted goal for groundwater and soil remediation at this site is attainment of SHS, as specified in Act 2, The Land Recycling and Environmental Remediation Standards Act. However, if concentrations of residual hydrocarbons do not continually decrease after completion of HIT remediation events for a sufficient period or the COC concentrations in groundwater reach asymptotic levels above SHS, the remedial approach will be re-evaluated and modified as necessary.

10.0 REMEDIAL ACTION COMPLETION

10.1 Groundwater Attainment Demonstration

When U/NR MSCs have been achieved at the point of compliance and DPH concentrations in the source area monitoring wells (e.g., MW-1, MW-3) have been reduced and stabilized, the HIT remediation events will be suspended and groundwater monitoring will be initiated to demonstrate attainment. Groundwater attainment samples will be collected and analyzed for the revised (March 2008) PADEP short list of diesel constituents. If groundwater attainment sampling results indicate DPH concentrations are consistently increasing or unstable, supplemental remedial action alternatives will be evaluated and recommended, as appropriate. Otherwise, groundwater attainment sampling results will be continually evaluated relative to the attainment demonstration methodology and criteria described in 25 PA Code Chapter 250 - Subchapter G (PADEP, 2011) until attainment has been demonstrated.

Results and evaluation of the quarterly groundwater monitoring events will provided to PADEP in quarterly RAPRs.

10.2 Soil Attainment Demonstration

Soil samples will be collected following discontinuation of remedial action(s) to document that facility unsaturated soils meet applicable SHS MSCs. Samples will be collected using a systematic random sampling grid from the defined area and analyzed for the revised (March 2008) PADEP short list of diesel constituents. If a systematic grid is not feasible due to isolated impacts or structural limitations, a modified soil attainment sampling plan will be submitted to PADEP for review and approval. Soil attainment analytical data will be statistically evaluated using one of the methods contained in 25 PA Code Chapter 250 Subchapter G (PADEP, 2011) to demonstrate that site soils meet applicable MSCs. If the soil data fails the statistical evaluation, then additional site characterization and/or remedial action will be considered, as necessary.

10.3 Remedial Action Completion Report

Results of groundwater and soil attainment demonstrations will be provided to PADEP in a *Remedial Action Completion Report* (RACR). The RACR will contain information as required by 25 PA Code Chapter 250.312 (PADEP, 2011).

10.4 Site Decommissioning Requirements

Following PADEP approval of the RACR and receipt of liability relief for the site, the existing remedial system will be decommissioned, the groundwater monitoring wells will be abandoned in accordance with acceptable procedures, and the facility will be restored as necessary as possible to pre-existing conditions. A letter documenting the well abandonment procedures and forms, remedial system decommissioning and site restoration status will be provided to PADEP and UPA.

11.0 SCHEDULE

The following schedule is proposed for implementing the RAP:

Activity/Milestones	Est. Duration *(weeks)*	Est. Elapsed Time *(days)*	Est. Completion Date
Submit RAP to PADEP	0	0	November 15, 2016
PADEP review and approval of RAP	12	60	January 14, 2017
Scheduling/Coordination	3	81	February 4, 2017
Install SVE wells	1	88	February 11, 2017
Complete first HIT remediation event	2	102	February 25, 2017

This RAP will be submitted to PADEP for review and approval. The above schedule is based on previous project experience and a deemed approved date of January 14, 2017. Rationale and considerations for the proposed schedule are provided below:

- The schedule allows for 60 days for PADEP review and the RAP.
- Upon PADEP approval of the RAP, the following activities will be completed in preparation for RAP implementation:
  - Waste profiling and management coordination.
  - Coordination with subcontractor to provide equipment to complete the HIT remediation events.
  - Coordinate with subcontractor to install two proposed SVE wells.
- HIT remediation events are estimated to begin in late-February 2017.

The above rationale and considerations are based on the following assumptions:

- PADEP will unconditionally approve the RAP within the 60 day review period.
- Inclement weather resulting in significant snow pack and/or frozen ground will not delay proposed SVE well installation and HIT remediation events starting in February 2017.

If unforeseen delays and/or the above assumptions are observed, a revised schedule will be discussed with PADEP.

12.0 REFERENCES

Berg, T.M., Geyer, A.R., Edmunds, W.E., and other, compilers. 1980. *Geologic Map of Pennsylvania*. Pennsylvania Geological Survey.

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Pennsylvania Department of Environmental Protection, December 2001. Pennsylvania Code, Title 25, Chapter 245: Administration of the Storage Tank and Spill Prevention Program, Subchapter D.

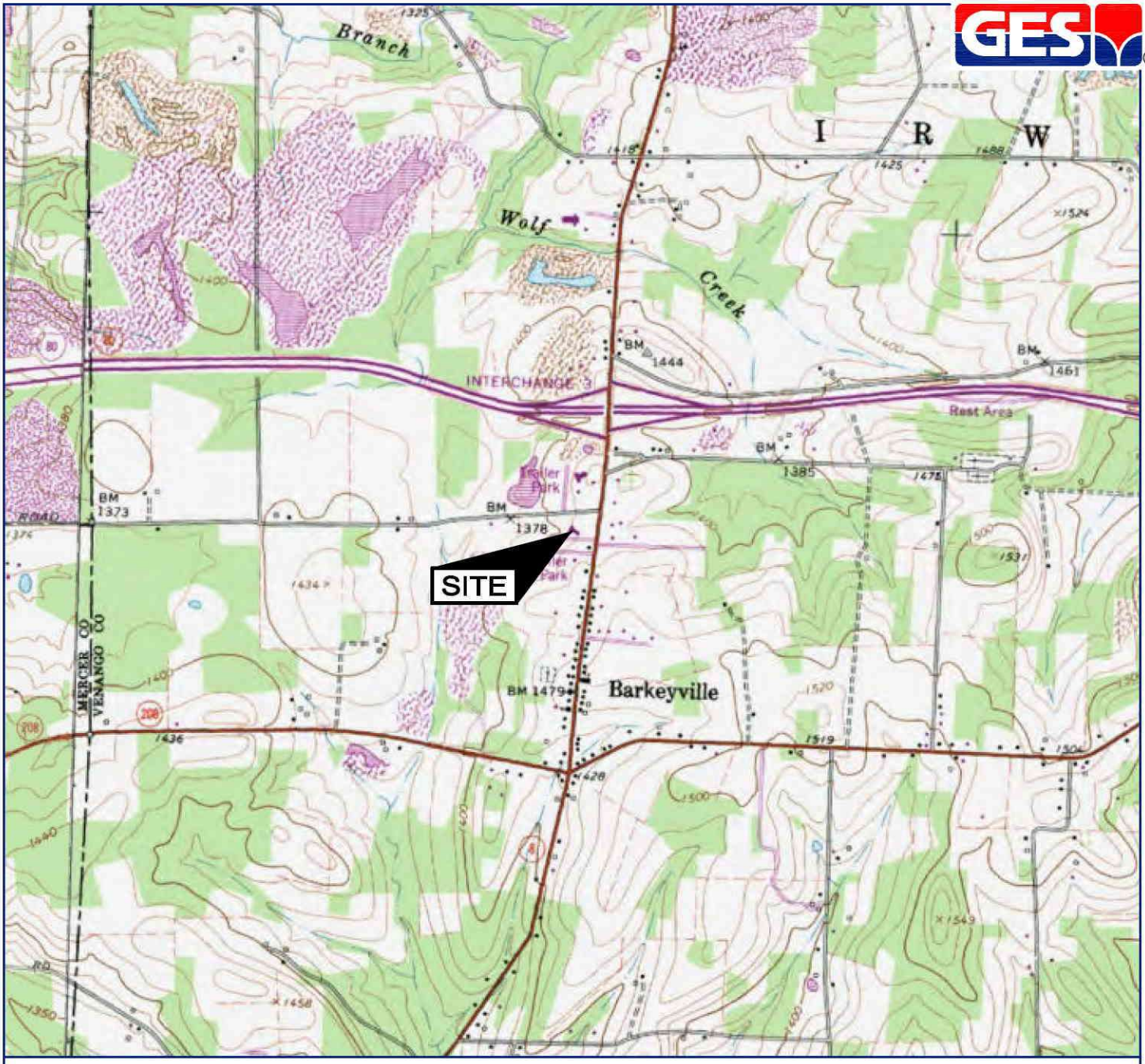
Pennsylvania Department of Environmental Protection, January 2011. Pennsylvania Code, Title 25, Chapter 250: Administration of Land Recycling Program.

Pennsylvania Department of Conservation and Natural Resources (PADCNR) Website: < http://www.dcnr.state.pa.us/topogeo/>. Accessed July 2015.

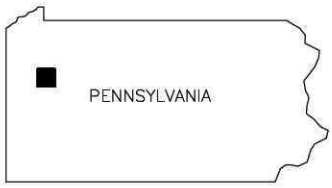
Pennsylvania Groundwater Well Inventory System (PaGWIS) Website: <http://www.dcnr.state.pa.us/topogeo/groundwater/pagwis/records/index.htm >. Accessed July 2015.

Shultz, Charles H., editor. 1999. *The Geology of Pennsylvania*. Pennsylvania Geological Survey.

United Refining Company of Pennsylvania. April 2015. *Notification of Reportable Release*.



SOURCE: USGS 7.5 MINUTE SERIES
TOPOGRAPHIC QUADRANGLE 1980
BARKEYVILLE, PENNSYLVANIA
CONTOUR INTERVAL = 20'



QUADRANGLE LOCATION

DRAFTED BY: TP (EXTON)	SITE LOCATION MAP
CHECKED BY: JH	KWIK FILL STATION #M-209 5574 STATE ROUTE 8 BARKEYVILLE, PENNSYLVANIA
REVIEWED BY: EL	Groundwater & Environmental Services, Inc. 301 COMMERCE PARK DRIVE, CRANBERRY TOWNSHIP, PA 16066
NORTH	SCALE IN FEET: 0 — 2000 / DATE: 08-05-15 / FIGURE: 1

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LEGEND

	PROPERTY BOUNDARY (approx.)
R	RESIDENTIAL PROPERTY
C	COMMERCIAL PROPERTY
V	VACANT PROPERTY

DRAFTED BY: TP	LOCAL AREA MAP
CHECKED BY: LB	KWIK FILL STATION #M-209 5574 STATE ROUTE 8 BARKEYVILLE, PENNSYLVANIA
REVIEWED BY: JH	Groundwater & Environmental Services, Inc. 301 COMMERCE PARK DRIVE, CRANBERRY TOWNSHIP, PA 16066
NORTH	SCALE IN FEET: 0 APPROXIMATE 300 / DATE: 09-19-16 / FIGURE: 2

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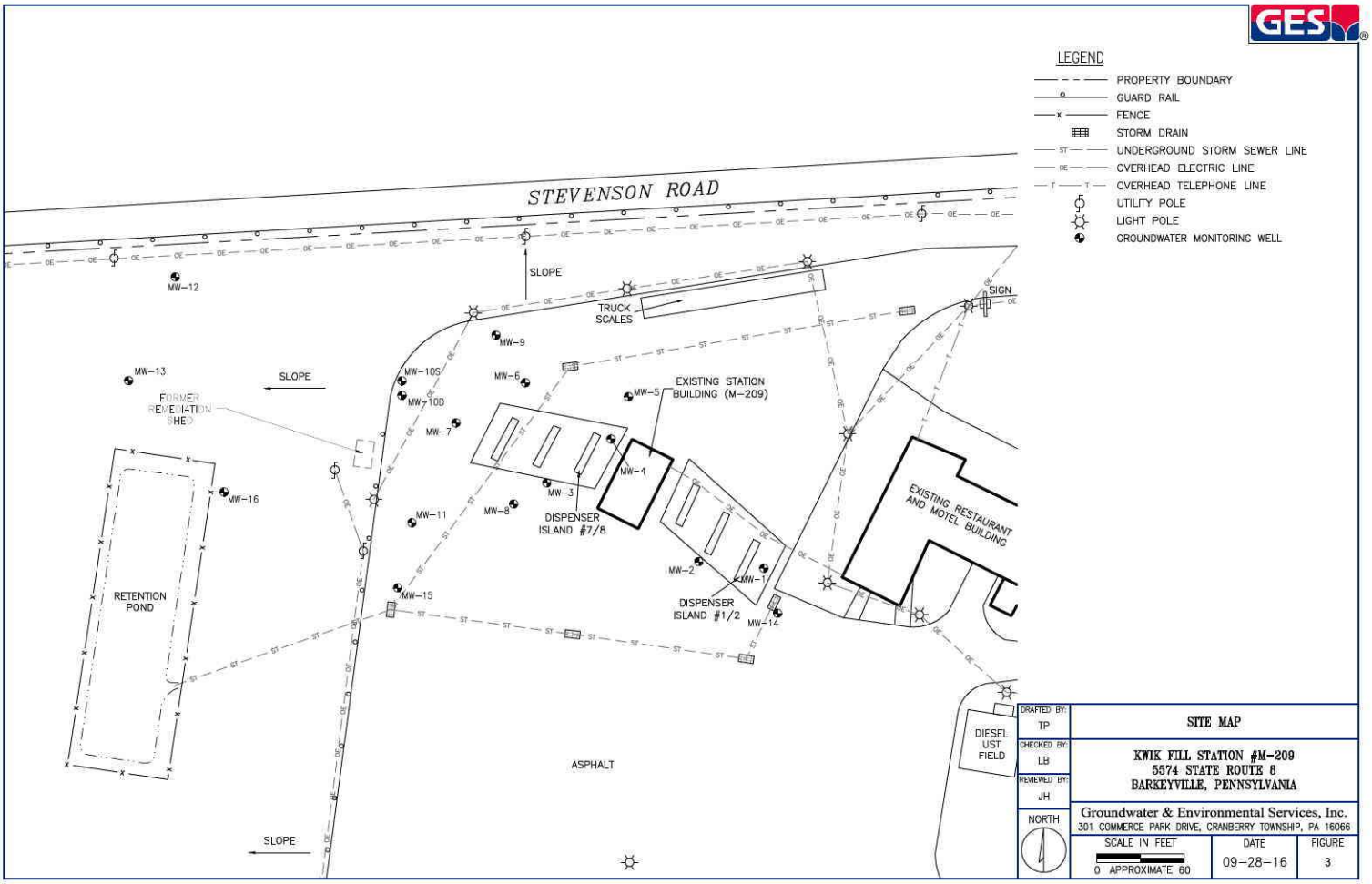

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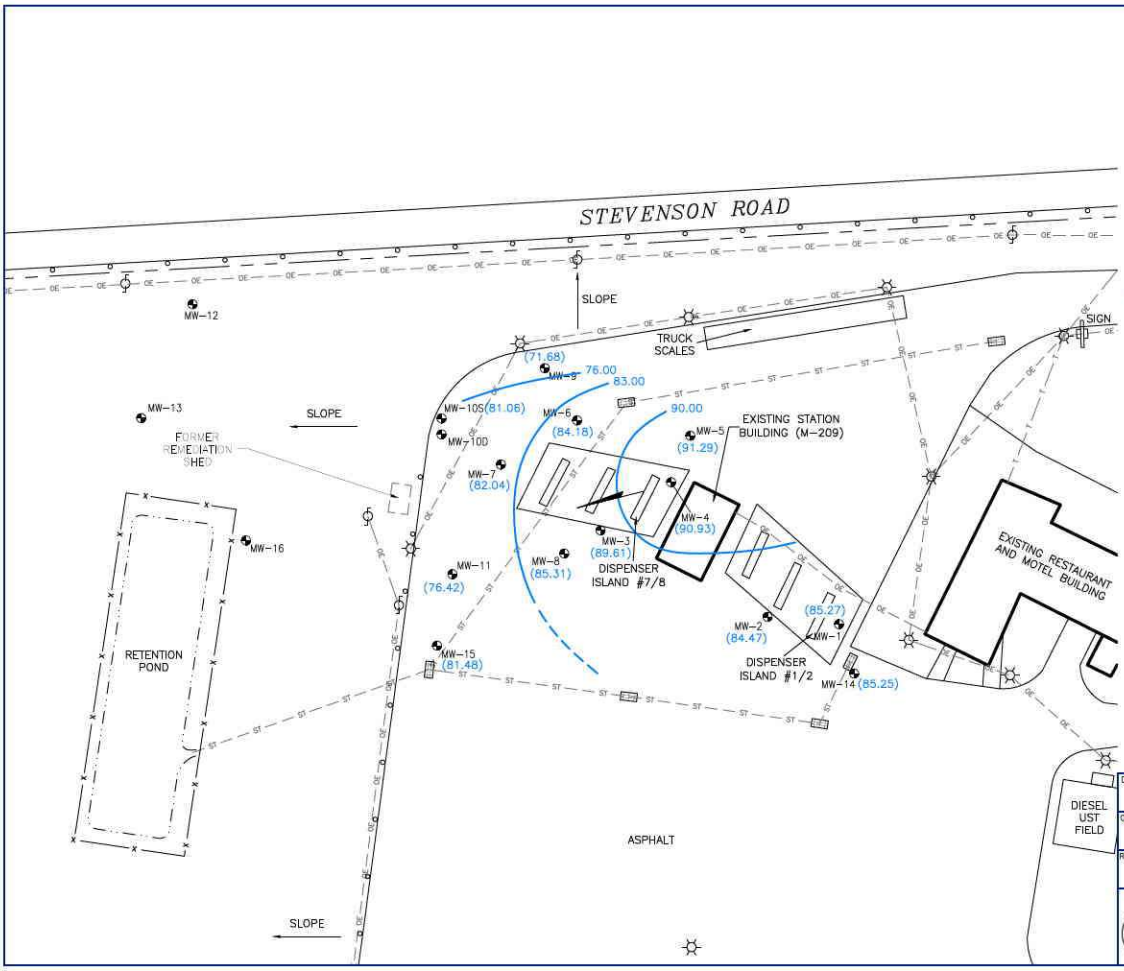

LEGEND

- PROPERTY BOUNDARY
- GUARD RAIL
- FENCE
- STORM DRAIN
- UNDERGROUND STORM SEWER LINE
- OVERHEAD ELECTRIC LINE
- OVERHEAD TELEPHONE LINE
- UTILITY POLE
- LIGHT POLE
- GROUNDWATER MONITORING WELL
- GROUNDWATER FLOW DIRECTION
- 90.00 GROUNDWATER CONTOUR (feet)
- CONTOURS DASHED WHERE INFERRED
- (91.29) GROUNDWATER ELEVATION (feet)
- CONTOUR INTERVAL 7.0 (feet)

NOTES:

1) GROUNDWATER MONITORING WELLS MW-10D, MW-12, MW-13, AND MW-16 MONITOR THE DEEP OVERBURDEN AQUIFER AND WERE NOT USED TO GENERATE GROUNDWATER CONTOURS.

2) DUE TO WELL CONSTRUCTION DIFFERENCES MW-15 WAS NOT USED TO GENERATE GROUNDWATER CONTOURS.

DRAFTED BY: TP	GROUNDWATER CONTOUR MAP (SHALLOW OVERBURDEN AQUIFER) AUGUST 15, 2016
CHECKED BY: LB	KWIK FILL STATION #M-209 5574 STATE ROUTE 8 BARKEYVILLE, PENNSYLVANIA
REVIEWED BY: JH	Groundwater & Environmental Services, Inc. 301 COMMERCE PARK DRIVE, CRANBERRY TOWNSHIP, PA 16066
NORTH	SCALE IN FEET: 0 APPROXIMATE 60 / DATE: 09-28-16 / FIGURE: 4

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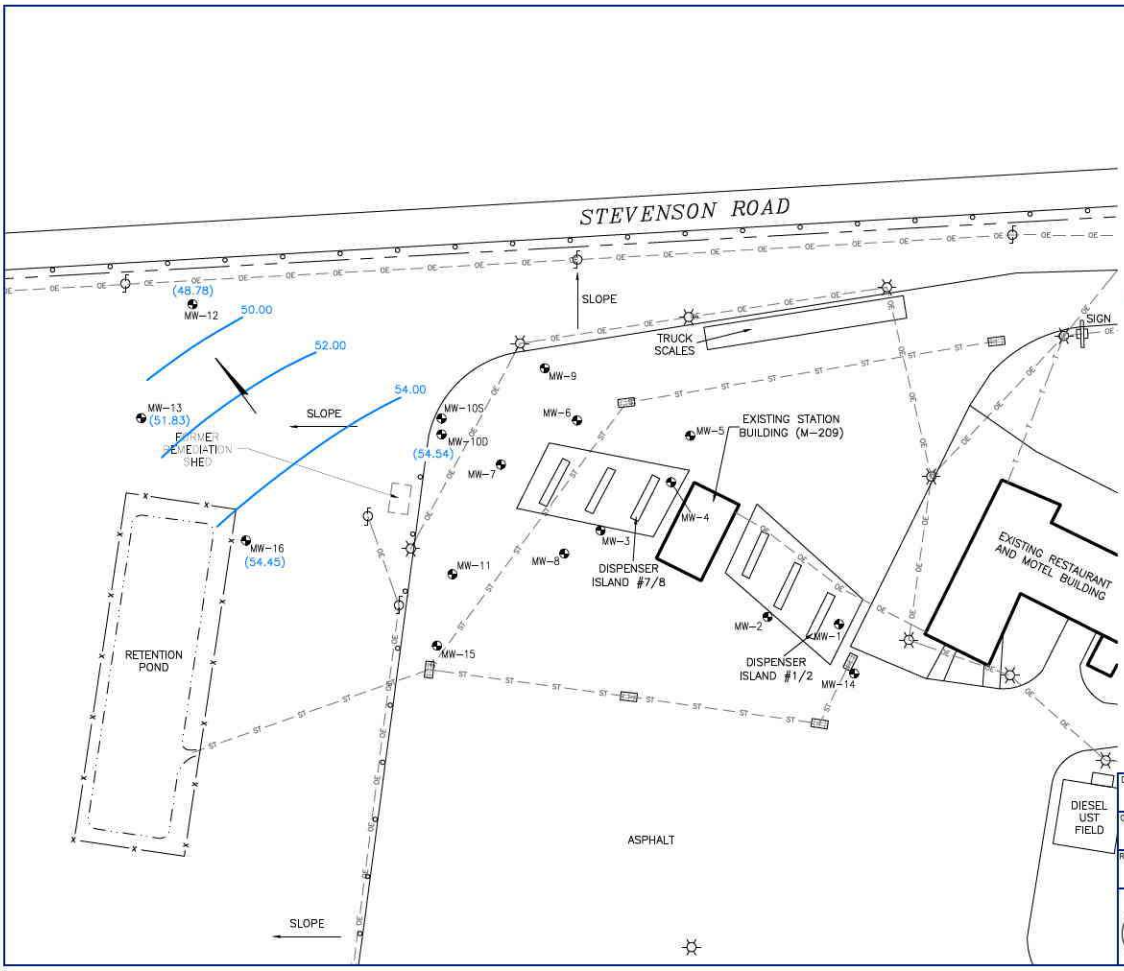

LEGEND

- PROPERTY BOUNDARY
- GUARD RAIL
- FENCE
- STORM DRAIN
- UNDERGROUND STORM SEWER LINE
- OVERHEAD ELECTRIC LINE
- OVERHEAD TELEPHONE LINE
- UTILITY POLE
- LIGHT POLE
- GROUNDWATER MONITORING WELL
- GROUNDWATER FLOW DIRECTION
- 54.00 GROUNDWATER CONTOUR (feet)
  CONTOURS DASHED WHERE INFERRED
- (54.54) GROUNDWATER ELEVATION (feet)
  CONTOUR INTERVAL 2.0 (feet)

NOTES:

1) GROUNDWATER MONITORING WELLS MW-1 THROUGH MW-9, MW-10S, MW-11, AND MW-14 MONITOR THE SHALLOW OVERBURDEN AQUIFER AND WERE NOT USED TO GENERATE GROUNDWATER CONTOURS.

2) DUE TO WELL CONSTRUCTION DIFFERENCES MW-15 WAS NOT USED TO GENERATE GROUNDWATER CONTOURS.

DRAFTED BY: TP	GROUNDWATER CONTOUR MAP (DEEP OVERBURDEN AQUIFER) AUGUST 15, 2016
CHECKED BY: LB	KWIK FILL STATION #M-209 5574 STATE ROUTE 8 BARKEYVILLE, PENNSYLVANIA
REVIEWED BY: JH	Groundwater & Environmental Services, Inc. 301 COMMERCE PARK DRIVE, CRANBERRY TOWNSHIP, PA 16066
NORTH	SCALE IN FEET: 0 APPROXIMATE 60 / DATE: 09-28-16 / FIGURE: 5

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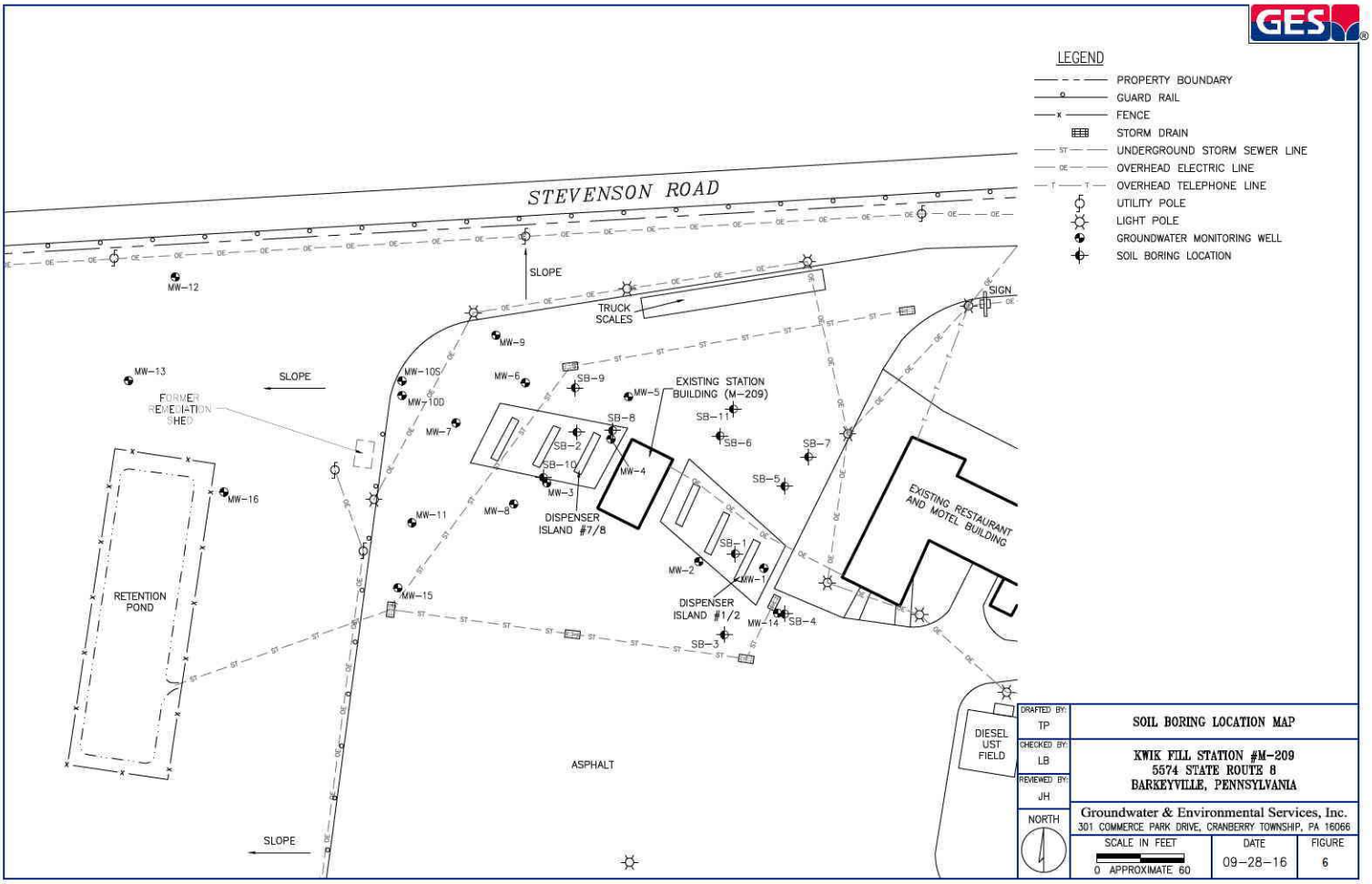

DRAFTED BY: TP	SOIL BORING LOCATION MAP
CHECKED BY: LB	KWIK FILL STATION #M-209 5574 STATE ROUTE 8 BARKEYVILLE, PENNSYLVANIA
REVIEWED BY: JH	Groundwater & Environmental Services, Inc. 301 COMMERCE PARK DRIVE, CRANBERRY TOWNSHIP, PA 16066
NORTH	SCALE IN FEET: 0 APPROXIMATE 60 / DATE: 09-28-16 / FIGURE: 6

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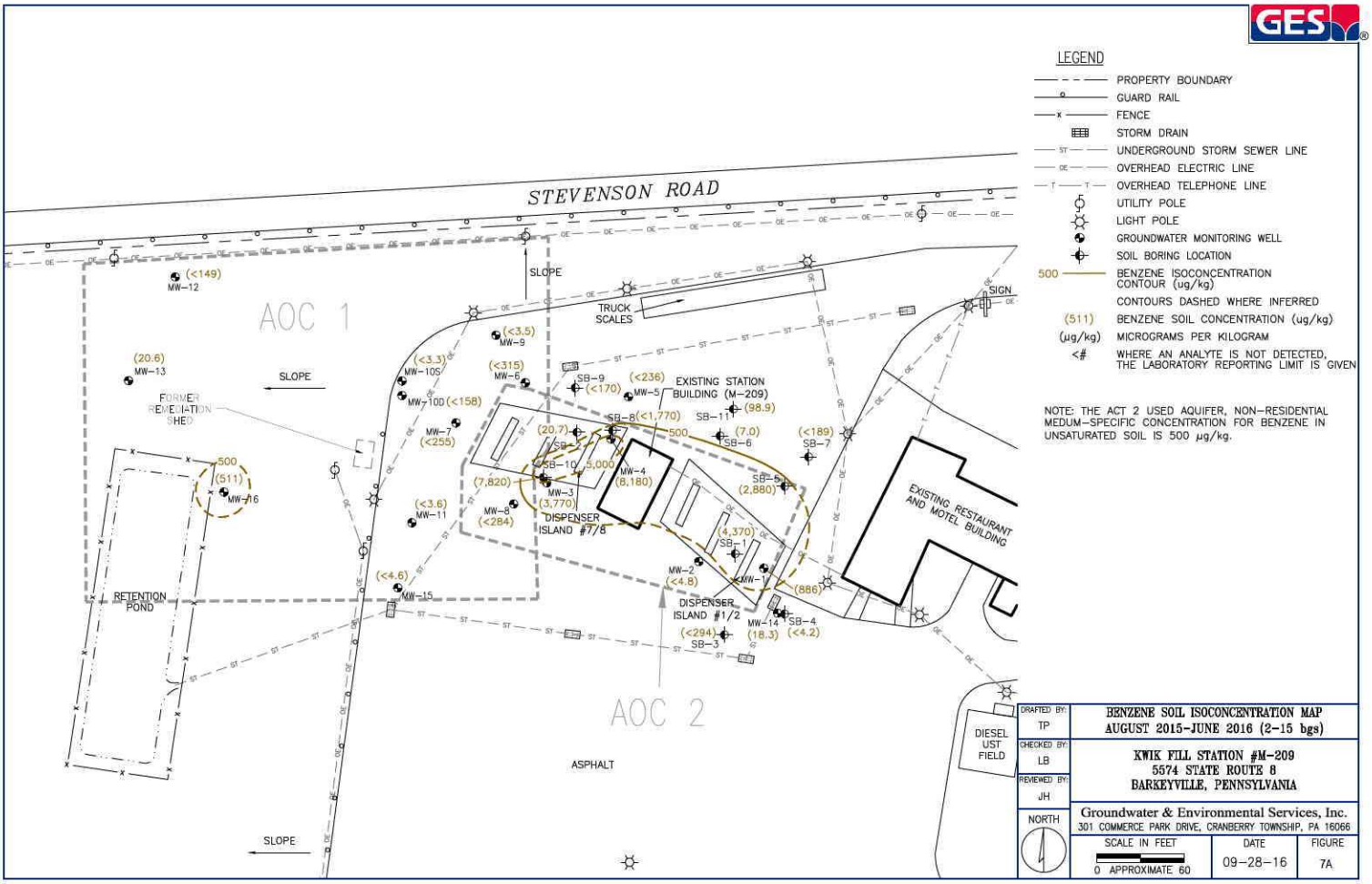

LEGEND

- PROPERTY BOUNDARY
- GUARD RAIL
- FENCE
- STORM DRAIN
- UNDERGROUND STORM SEWER LINE
- OVERHEAD ELECTRIC LINE
- OVERHEAD TELEPHONE LINE
- UTILITY POLE
- LIGHT POLE
- GROUNDWATER MONITORING WELL
- SOIL BORING LOCATION
- 500 — BENZENE ISOCONCENTRATION CONTOUR (ug/kg)
- CONTOURS DASHED WHERE INFERRED
- (511) BENZENE SOIL CONCENTRATION (ug/kg)
- (µg/kg) MICROGRAMS PER KILOGRAM
- <# WHERE AN ANALYTE IS NOT DETECTED, THE LABORATORY REPORTING LIMIT IS GIVEN

NOTE: THE ACT 2 USED AQUIFER, NON-RESIDENTIAL MEDUM-SPECIFIC CONCENTRATION FOR BENZENE IN UNSATURATED SOIL IS 500 µg/kg.

DRAFTED BY: TP	BENZENE SOIL ISOCONCENTRATION MAP AUGUST 2015-JUNE 2016 (2-15 bgs)
CHECKED BY: LB	KWIK FILL STATION #M-209 5574 STATE ROUTE 8 BARKEYVILLE, PENNSYLVANIA
REVIEWED BY: JH	Groundwater & Environmental Services, Inc. 301 COMMERCE PARK DRIVE, CRANBERRY TOWNSHIP, PA 16066
NORTH	SCALE IN FEET: 0 APPROXIMATE 60 / DATE: 09-28-16 / FIGURE: 7A

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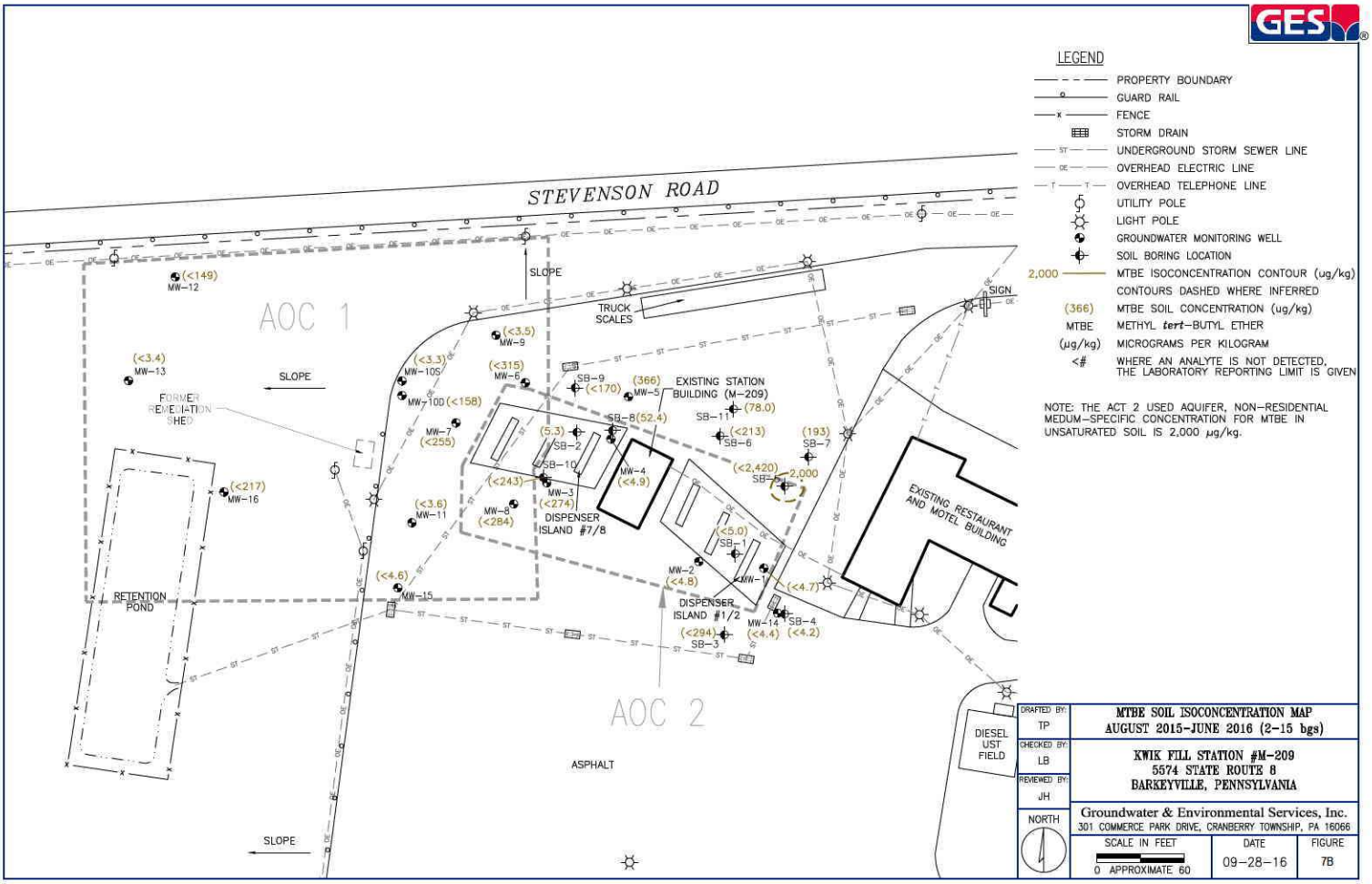


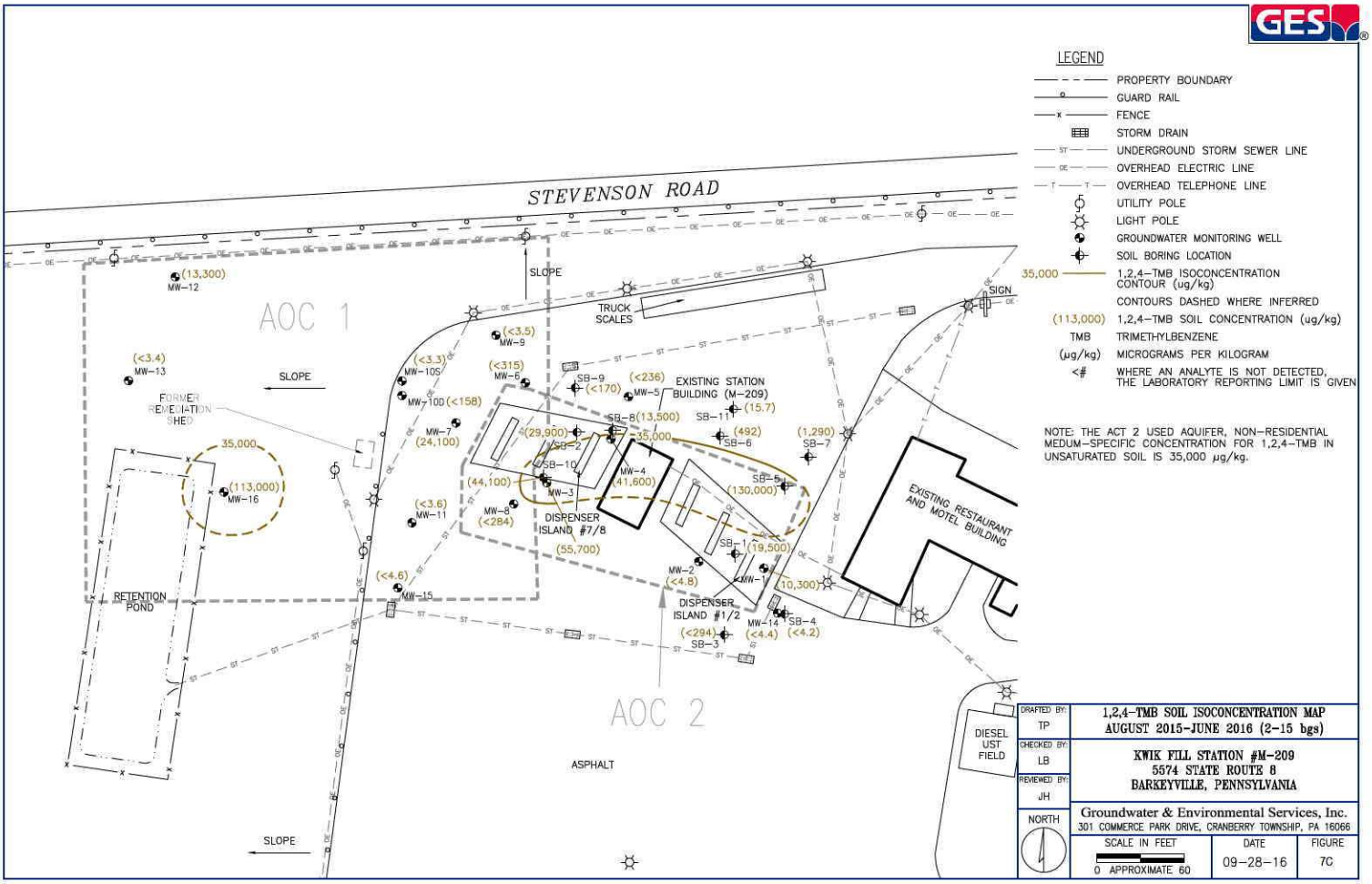
LEGEND

- PROPERTY BOUNDARY
- GUARD RAIL
- FENCE
- STORM DRAIN
- UNDERGROUND STORM SEWER LINE
- OVERHEAD ELECTRIC LINE
- OVERHEAD TELEPHONE LINE
- UTILITY POLE
- LIGHT POLE
- GROUNDWATER MONITORING WELL
- SOIL BORING LOCATION
- 2,000 — MTBE ISOCONCENTRATION CONTOUR (ug/kg)
- CONTOURS DASHED WHERE INFERRED
- (366) MTBE SOIL CONCENTRATION (ug/kg)
- MTBE METHYL *tert*-BUTYL ETHER
- (µg/kg) MICROGRAMS PER KILOGRAM
- <# WHERE AN ANALYTE IS NOT DETECTED, THE LABORATORY REPORTING LIMIT IS GIVEN

NOTE: THE ACT 2 USED AQUIFER, NON-RESIDENTIAL MEDUM-SPECIFIC CONCENTRATION FOR MTBE IN UNSATURATED SOIL IS 2,000 µg/kg.

DRAFTED BY: TP	**MTBE SOIL ISOCONCENTRATION MAP AUGUST 2015-JUNE 2016 (2-15 bgs)**
CHECKED BY: LB	**KWIK FILL STATION #M-209 5574 STATE ROUTE 8 BARKEYVILLE, PENNSYLVANIA**
REVIEWED BY: JH	Groundwater & Environmental Services, Inc. 301 COMMERCE PARK DRIVE, CRANBERRY TOWNSHIP, PA 16066
NORTH	SCALE IN FEET: 0 APPROXIMATE 60 / DATE: 09-28-16 / FIGURE: 7B

M:\Graphics\0700-Pittsburgh\URCK\wk Fill\M-209_228 Barkeyville\M-209_228 Barkeyville SM.dwg, B(SM 60), tpeters



LEGEND

- PROPERTY BOUNDARY
- GUARD RAIL
- FENCE
- STORM DRAIN
- UNDERGROUND STORM SEWER LINE
- OVERHEAD ELECTRIC LINE
- OVERHEAD TELEPHONE LINE
- UTILITY POLE
- LIGHT POLE
- GROUNDWATER MONITORING WELL
- SOIL BORING LOCATION
- 35,000 — 1,2,4-TMB ISOCONCENTRATION CONTOUR (ug/kg)
- CONTOURS DASHED WHERE INFERRED
- (113,000) 1,2,4-TMB SOIL CONCENTRATION (ug/kg)
- TMB TRIMETHYLBENZENE
- (µg/kg) MICROGRAMS PER KILOGRAM
- <# WHERE AN ANALYTE IS NOT DETECTED, THE LABORATORY REPORTING LIMIT IS GIVEN

NOTE: THE ACT 2 USED AQUIFER, NON-RESIDENTIAL MEDUM-SPECIFIC CONCENTRATION FOR 1,2,4-TMB IN UNSATURATED SOIL IS 35,000 µg/kg.

DRAFTED BY: TP
CHECKED BY: LB
REVIEWED BY: JH

1,2,4-TMB SOIL ISOCONCENTRATION MAP
AUGUST 2015-JUNE 2016 (2-15 bgs)

KWIK FILL STATION #M-209
5574 STATE ROUTE 8
BARKEYVILLE, PENNSYLVANIA

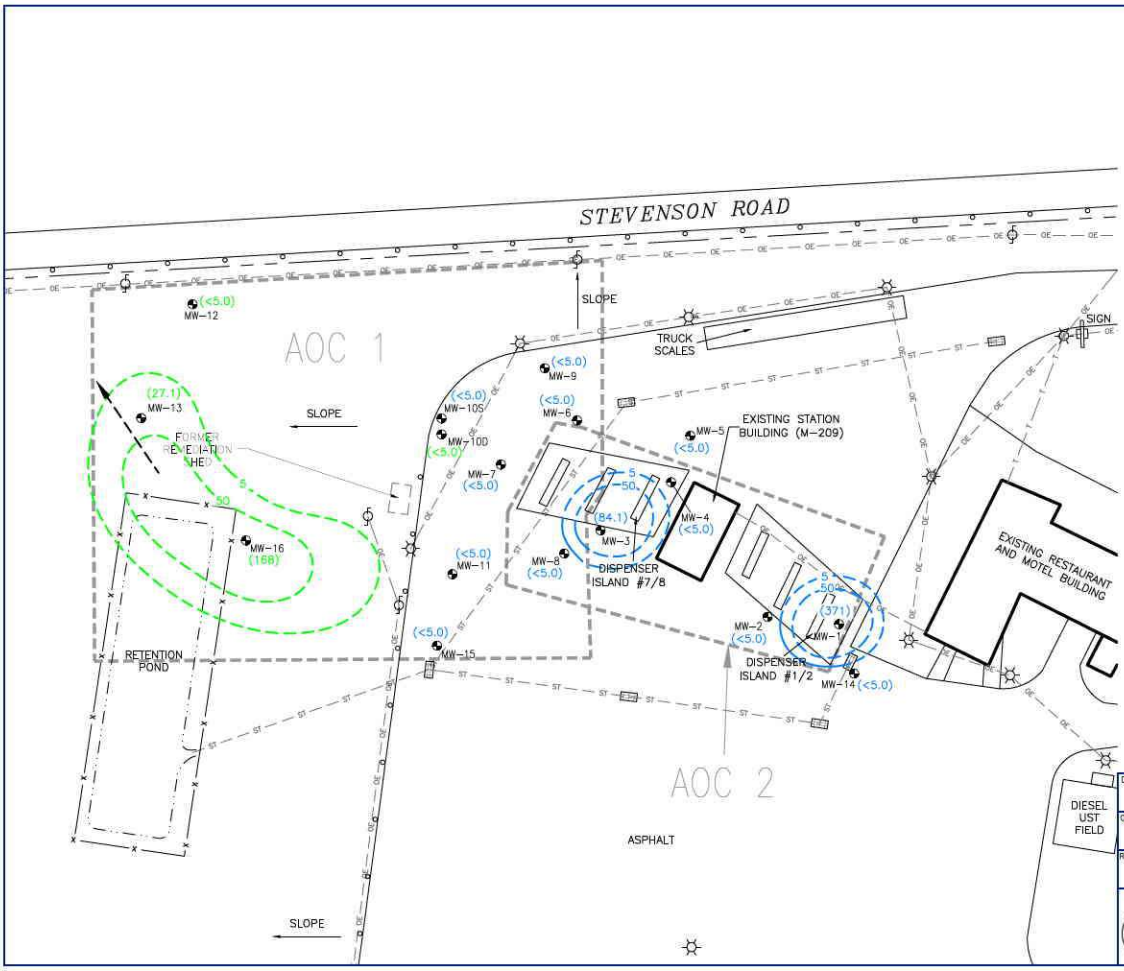
Groundwater & Environmental Services, Inc.
301 COMMERCE PARK DRIVE, CRANBERRY TOWNSHIP, PA 16066

NORTH

SCALE IN FEET: 0 APPROXIMATE 60

DATE: 09-28-16

FIGURE: 7C



LEGEND

- PROPERTY BOUNDARY
- GUARD RAIL
- FENCE
- STORM DRAIN
- UNDERGROUND STORM SEWER LINE
- OVERHEAD ELECTRIC LINE
- OVERHEAD TELEPHONE LINE
- UTILITY POLE
- LIGHT POLE
- GROUNDWATER MONITORING WELL
- 5 — BENZENE ISOCONCENTRATION CONTOUR SHALLOW OVERBURDEN AQUIFER (µg/L)
- 5 — BENZENE ISOCONCENTRATION CONTOUR DEEP OVERBURDEN AQUIFER (µg/L)
- CONTOURS DASHED WHERE INFERRED
- (371) BENZENE CONCENTRATION SHALLOW OVERBURDEN AQUIFER (µg/L)
- (168) BENZENE CONCENTRATION DEEP OVERBURDEN AQUIFER (µg/L)
- (µg/L) MICROGRAMS PER LITER
- <# WHERE AN ANALYTE IS NOT DETECTED, THE LABORATORY REPORTING LIMIT IS GIVEN
- ASSUMED CENTERLINE OF PLUME

NOTE: THE ACT 2 USED AQUIFER, NON-RESIDENTIAL MEDUM-SPECIFIC CONCENTRATION FOR BENZENE IN GROUNDWATER IS 5 µg/L.

DRAFTED BY: TP
CHECKED BY: LB
REVIEWED BY: JH

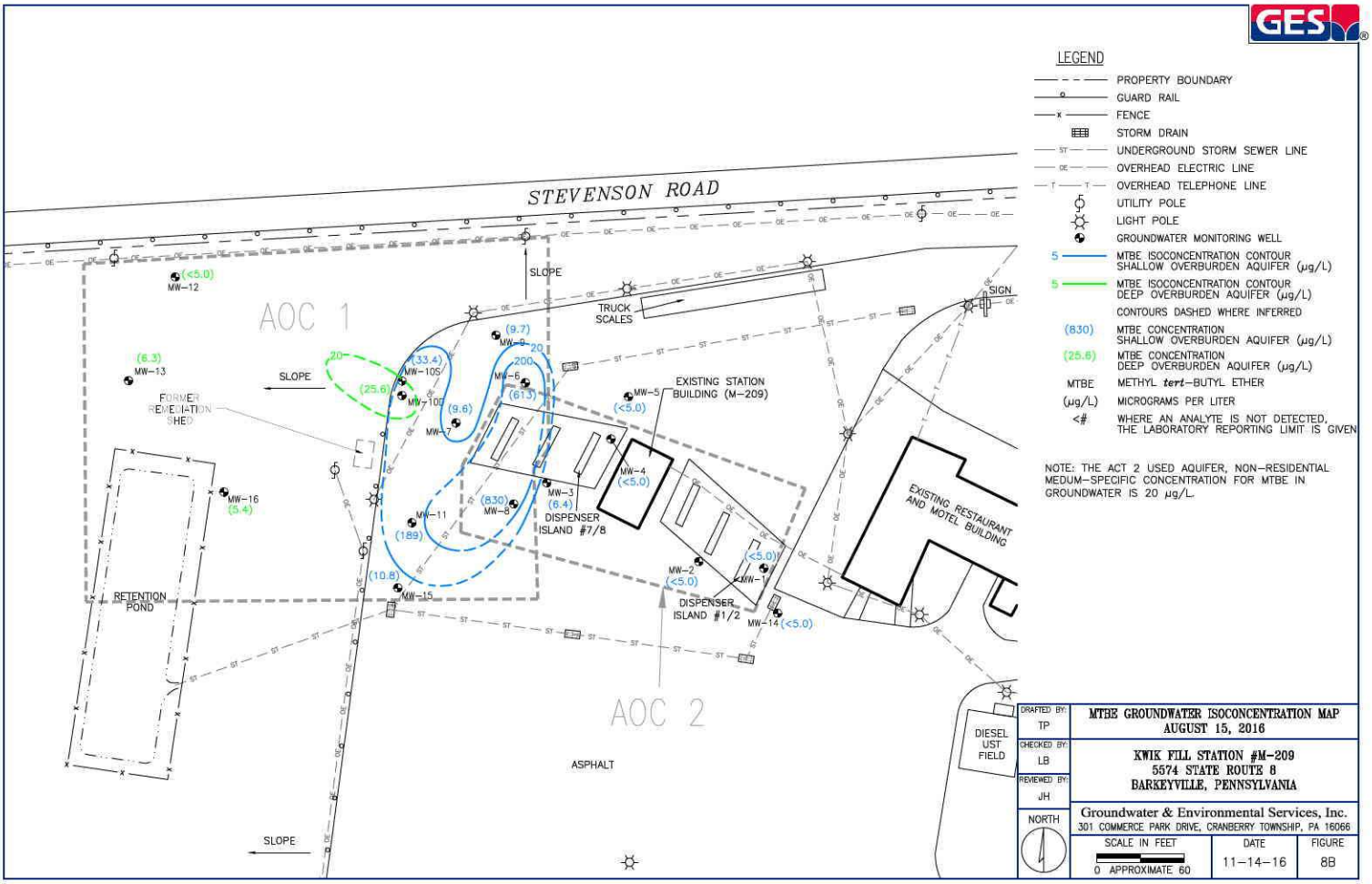
BENZENE GROUNDWATER ISOCONCENTRATION MAP
AUGUST 15, 2016

KWIK FILL STATION #M-209
5574 STATE ROUTE 8
BARKEYVILLE, PENNSYLVANIA

Groundwater & Environmental Services, Inc.
301 COMMERCE PARK DRIVE, CRANBERRY TOWNSHIP, PA 16066

SCALE IN FEET: 0 APPROXIMATE 60
DATE: 11-14-16
FIGURE: 8A

M:\Graphics\0700-Pittsburgh\URCK\wk Files\M-209_2Q16 Barkeyville\M-209_2Q16 Barkeyville SM.dwg, B(SM 60), tpeters



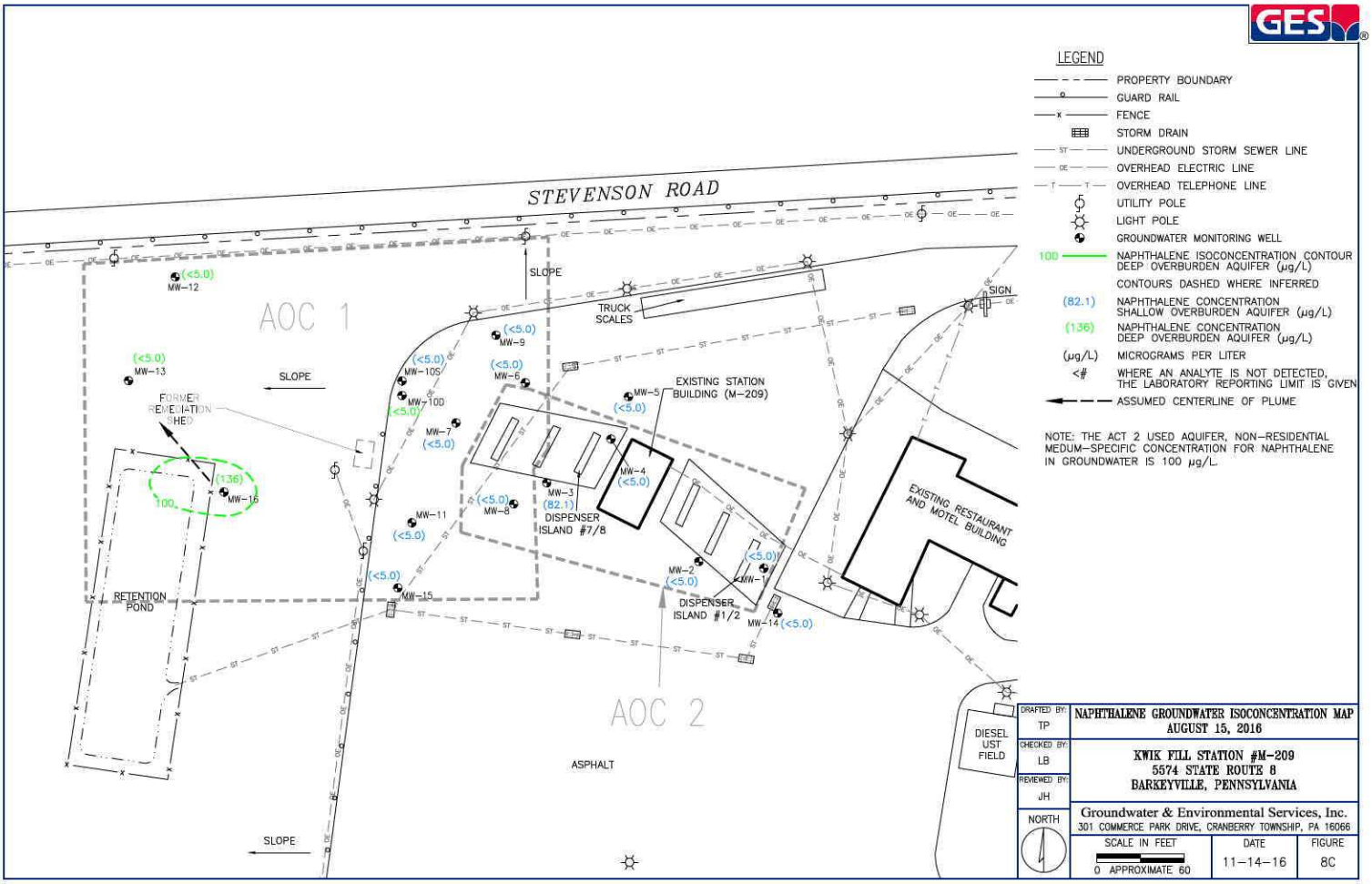
LEGEND

- PROPERTY BOUNDARY
- GUARD RAIL
- FENCE
- STORM DRAIN
- UNDERGROUND STORM SEWER LINE
- OVERHEAD ELECTRIC LINE
- OVERHEAD TELEPHONE LINE
- UTILITY POLE
- LIGHT POLE
- GROUNDWATER MONITORING WELL
- 5 — MTBE ISOCONCENTRATION CONTOUR SHALLOW OVERBURDEN AQUIFER (µg/L)
- 5 — MTBE ISOCONCENTRATION CONTOUR DEEP OVERBURDEN AQUIFER (µg/L)
- CONTOURS DASHED WHERE INFERRED
- (830) MTBE CONCENTRATION SHALLOW OVERBURDEN AQUIFER (µg/L)
- (25.6) MTBE CONCENTRATION DEEP OVERBURDEN AQUIFER (µg/L)
- MTBE — METHYL *tert*-BUTYL ETHER
- (µg/L) — MICROGRAMS PER LITER
- <# — WHERE AN ANALYTE IS NOT DETECTED, THE LABORATORY REPORTING LIMIT IS GIVEN

NOTE: THE ACT 2 USED AQUIFER, NON-RESIDENTIAL MEDUM-SPECIFIC CONCENTRATION FOR MTBE IN GROUNDWATER IS 20 µg/L.

DRAFTED BY: TP	**MTBE GROUNDWATER ISOCONCENTRATION MAP AUGUST 15, 2016**
CHECKED BY: LB	**KWIK FILL STATION #M-209**
REVIEWED BY: JH	**5574 STATE ROUTE 8**
	BARKEYVILLE, PENNSYLVANIA
NORTH	Groundwater & Environmental Services, Inc. 301 COMMERCE PARK DRIVE, CRANBERRY TOWNSHIP, PA 16066
SCALE IN FEET: 0 APPROXIMATE 60	DATE: 11-14-16
	FIGURE: 8B

M:\Graphics\700-Pittsburgh\URCK\wk Fill\M-209_228 Barkeyville\M-209_228 Barkeyville SM.dwg, B (SM 60), tpeters



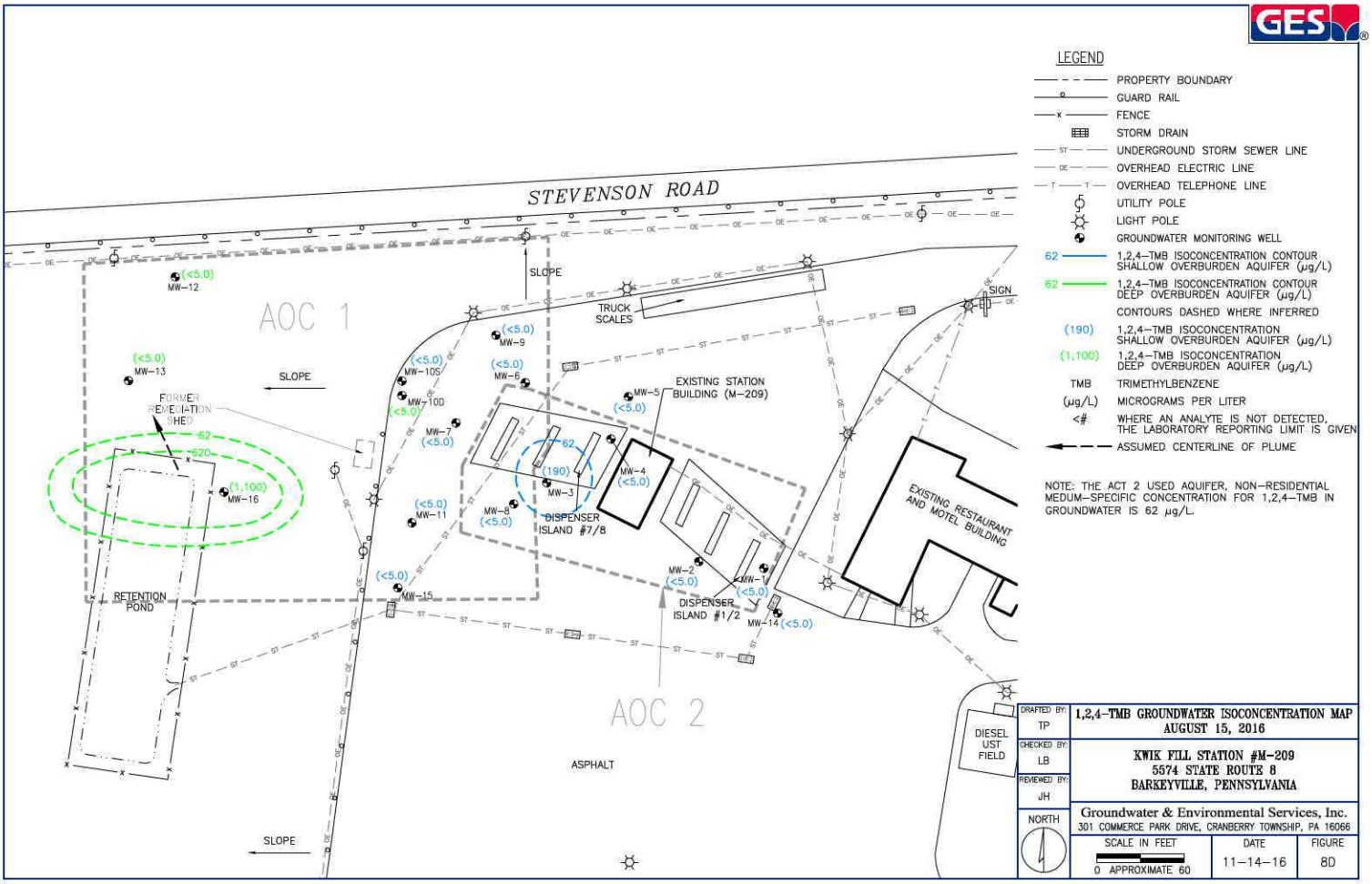
LEGEND

- PROPERTY BOUNDARY
- GUARD RAIL
- FENCE
- STORM DRAIN
- UNDERGROUND STORM SEWER LINE
- OVERHEAD ELECTRIC LINE
- OVERHEAD TELEPHONE LINE
- UTILITY POLE
- LIGHT POLE
- GROUNDWATER MONITORING WELL
- 100 — NAPHTHALENE ISOCONCENTRATION CONTOUR DEEP OVERBURDEN AQUIFER (µg/L)
- CONTOURS DASHED WHERE INFERRED
- (82.1) NAPHTHALENE CONCENTRATION SHALLOW OVERBURDEN AQUIFER (µg/L)
- (136) NAPHTHALENE CONCENTRATION DEEP OVERBURDEN AQUIFER (µg/L)
- (µg/L) MICROGRAMS PER LITER
- <# WHERE AN ANALYTE IS NOT DETECTED, THE LABORATORY REPORTING LIMIT IS GIVEN
- ASSUMED CENTERLINE OF PLUME

NOTE: THE ACT 2 USED AQUIFER, NON-RESIDENTIAL MEDUM-SPECIFIC CONCENTRATION FOR NAPHTHALENE IN GROUNDWATER IS 100 µg/L.

DRAFTED BY: TP	NAPHTHALENE GROUNDWATER ISOCONCENTRATION MAP AUGUST 15, 2016
CHECKED BY: LB	KWIK FILL STATION #M-209 5574 STATE ROUTE 8 BARKEYVILLE, PENNSYLVANIA
REVIEWED BY: JH	Groundwater & Environmental Services, Inc. 301 COMMERCE PARK DRIVE, CRANBERRY TOWNSHIP, PA 16066
NORTH	SCALE IN FEET: 0 APPROXIMATE 60 / DATE: 11-14-16 / FIGURE: 8C

M:\Graphics\0700-Pittsburgh\URCW\wk Files\M-209_228 Barkeyville\M-209_228 Barkeyville SM.dwg, B(SM 60), tpeters



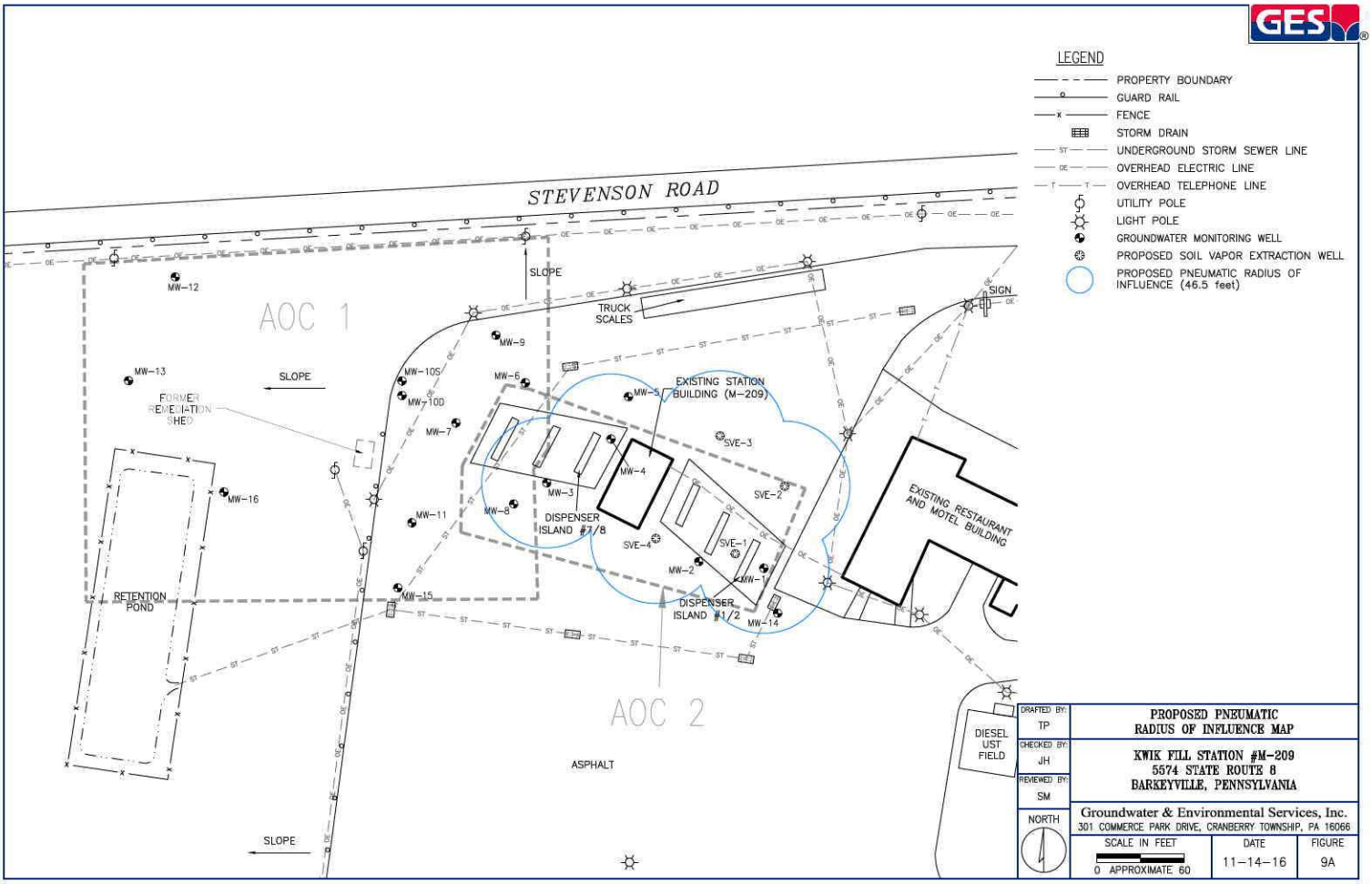
LEGEND

- PROPERTY BOUNDARY
- GUARD RAIL
- FENCE
- STORM DRAIN
- UNDERGROUND STORM SEWER LINE
- OVERHEAD ELECTRIC LINE
- OVERHEAD TELEPHONE LINE
- UTILITY POLE
- LIGHT POLE
- GROUNDWATER MONITORING WELL
- 62 — 1,2,4-TMB ISOCONCENTRATION CONTOUR SHALLOW OVERBURDEN AQUIFER (µg/L)
- 62 — 1,2,4-TMB ISOCONCENTRATION CONTOUR DEEP OVERBURDEN AQUIFER (µg/L)
- CONTOURS DASHED WHERE INFERRED
- (190) 1,2,4-TMB ISOCONCENTRATION SHALLOW OVERBURDEN AQUIFER (µg/L)
- (1,100) 1,2,4-TMB ISOCONCENTRATION DEEP OVERBURDEN AQUIFER (µg/L)
- TMB TRIMETHYLBENZENE
- (µg/L) MICROGRAMS PER LITER
- <# WHERE AN ANALYTE IS NOT DETECTED, THE LABORATORY REPORTING LIMIT IS GIVEN
- ASSUMED CENTERLINE OF PLUME

NOTE: THE ACT 2 USED AQUIFER, NON-RESIDENTIAL MEDUM-SPECIFIC CONCENTRATION FOR 1,2,4-TMB IN GROUNDWATER IS 62 µg/L.

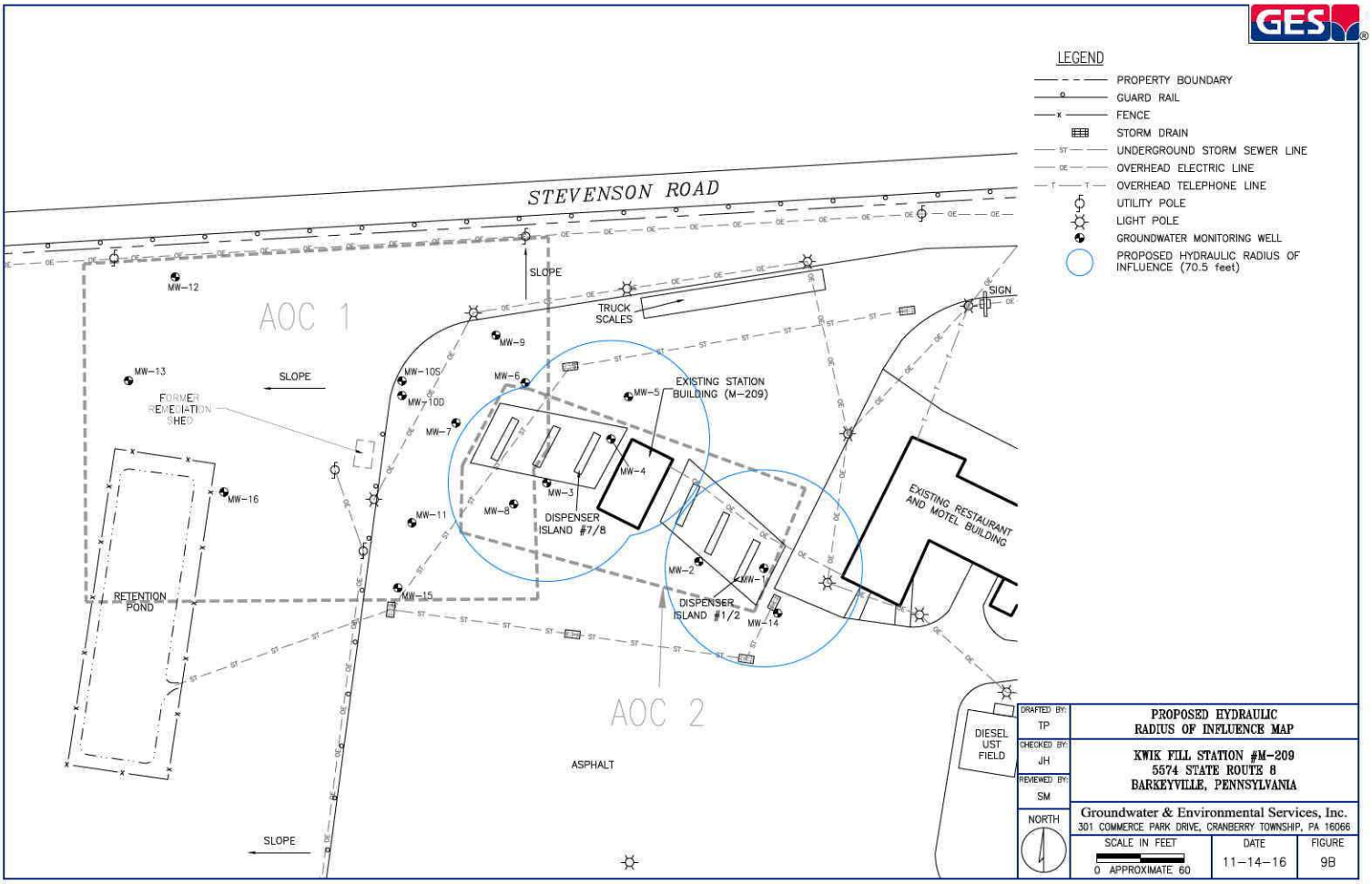
DRAFTED BY: TP	1,2,4-TMB GROUNDWATER ISOCONCENTRATION MAP AUGUST 15, 2016
CHECKED BY: LB	KWIK FILL STATION #M-209 5574 STATE ROUTE 8 BARKEYVILLE, PENNSYLVANIA
REVIEWED BY: JH	Groundwater & Environmental Services, Inc. 301 COMMERCE PARK DRIVE, CRANBERRY TOWNSHIP, PA 16066
NORTH	SCALE IN FEET: 0 APPROXIMATE 60 / DATE: 11-14-16 / FIGURE: 8D

M:\Graphics\0700-Pittsburgh\URCK\wk Fill\M-209_228 Barkeyville\M-209_228 Barkeyville SM.dwg, B (SM 60), tpeters



DRAFTED BY: TP	PROPOSED PNEUMATIC RADIUS OF INFLUENCE MAP
CHECKED BY: JH	KWIK FILL STATION #M-209 5574 STATE ROUTE 8 BARKEYVILLE, PENNSYLVANIA
REVIEWED BY: SM	Groundwater & Environmental Services, Inc. 301 COMMERCE PARK DRIVE, CRANBERRY TOWNSHIP, PA 16066
	DATE: 11-14-16
	FIGURE: 9A

M:\Graphics\0700-Pittsburgh\URCW\wk File\M-209_228 Barkeyville\M-209_228 Barkeyville SM.dwg, B(SM 60), tpeters



DRAFTED BY: TP	PROPOSED HYDRAULIC RADIUS OF INFLUENCE MAP
CHECKED BY: JH	KWIK FILL STATION #M-209 5574 STATE ROUTE 8 BARKEYVILLE, PENNSYLVANIA
REVIEWED BY: SM	Groundwater & Environmental Services, Inc. 301 COMMERCE PARK DRIVE, CRANBERRY TOWNSHIP, PA 16066
SCALE IN FEET	DATE: 11-14-16
	FIGURE: 9B

M:\Graphics\0700-Pittsburgh\URCK\wk Fill\M-209_228 Barkeyville\M-209_228 Barkeyville SM.dwg, B(SM 60), tpeters

Table 1

GROUNDWATER DATA SUMMARY

United Refining Company
Kwik Fill Station #M-209
5574 Route 8
Barkeyville, PA

Well	Date	Casing Elevation	Depth to Water	Water Elevation	Benzene	Toluene	Ethylbenzene	MTBE	Isopropylbenzene	Naphthalene	1,2,4-TMB	1,3,5-TMB
			PA Act 2 U/NR MSCs		**5**	**1,000**	**700**	**20**	**3,500**	**100**	**62**	**1,200**
MW-1	10/30/15	100.00	14.15	85.85	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
	12/28/15	100.00	12.06	87.94	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
	01/28/16	100.00	13.44	86.56	**40.0 M1**	25.0 M1	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
	04/14/16	100.00	10.83	89.17	**96.4**	53.5	7.9	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
	05/23/16	100.00	13.58	86.42	**333**	21.1	36.5	< 5.0	5.3	< 5.0	14.7	< 5.0
	07/14/16	100.00	14.18	85.82	**59.7**	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
	08/15/16	100.00	14.73	85.27	**371**	< 5.0	26.8	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
MW-2	10/30/15	99.18	14.04	85.14	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
	12/28/15	99.18	13.28	85.90	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
	01/28/16	99.18	14.28	84.90	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
	04/14/16	99.18	12.79	86.39	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
	05/23/16	99.18	13.64	85.54	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
	07/14/16	99.18	14.09	85.09	< 5.0	< 5.0	< 5.0	6.0	< 5.0	< 5.0M1	< 5.0	< 5.0
	08/15/16	99.18	14.71	84.47	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
MW-3	10/30/15	98.83	8.45	90.38	**17.2**	< 5.0	< 5.0	**113**	< 5.0	9.0	24.7	9.9
	12/28/15	98.83	8.59	90.24	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	6.1	< 5.0
	01/28/16	98.83	9.37	89.46	**58.5**	< 5.0	< 5.0	18.2	< 5.0	< 5.0	6.2	< 5.0
	04/14/16	98.83	8.02	90.81	**227**	48.3	36.6	17.0	< 5.0	25.5	**80.0**	28.8
	05/23/16	98.83	9.10	89.73	**260**	23.7	50.6	8.5	9.2	33.7	**140**	45.0
	07/14/16	98.83	9.05	89.78	**164**	9.0	48.9	6.3	6.4	61.8	**129**	43.5
	08/15/16	98.83	9.22	89.61	**84.1**	10.4	68.7	6.4	8.4	82.1	**190**	59.7
MW-4	10/30/15	98.86	6.63	92.23	**8.3**	< 5.0	14.9	6.7	< 5.0	9.3	< 5.0	< 5.0
	12/28/15	98.86	5.42	93.44	< 5.0	< 5.0	< 5.0	7.0	< 5.0	< 5.0	< 5.0	< 5.0
	01/28/16	98.86	7.11	91.75	< 5.0	< 5.0	< 5.0	8.8	< 5.0	< 5.0	< 5.0	< 5.0
	04/14/16	98.86	6.82	92.04	**10.3**	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
	05/23/16	98.86	7.60	91.26	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
	07/14/16	98.86	7.71	91.15	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
	08/15/16	98.86	7.93	90.93	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
MW-5	12/28/15	98.60	5.98	92.62	< 5.0	< 5.0	< 5.0	**22.6**	< 5.0	< 5.0	< 5.0	< 5.0
	01/28/16	98.60	7.95	90.65	< 5.0	< 5.0	< 5.0	**55.8**	< 5.0	< 5.0	< 5.0	< 5.0
	04/14/16	98.60	6.44	92.16	< 5.0	< 5.0	< 5.0	**50.4**	< 5.0	< 5.0	< 5.0	< 5.0
	05/23/16	98.60	7.41	91.19	< 5.0	< 5.0	< 5.0	18.3	< 5.0	< 5.0	< 5.0	< 5.0
	07/14/16	98.60	7.52	91.08	< 5.0	< 5.0	< 5.0	7.3	< 5.0	< 5.0	< 5.0	< 5.0
	08/15/16	98.60	7.31	91.29	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0

Table 1

GROUNDWATER DATA SUMMARY

United Refining Company
Kwik Fill Station #M-209
5574 Route 8
Barkeyville, PA

Well	Date	Casing Elevation	Depth to Water	Water Elevation	Benzene	Toluene	Ethylbenzene	MTBE	Isopropylbenzene	Naphthalene	1,2,4-TMB	1,3,5-TMB
			PA Act 2 U/NR MSCs		**5**	**1,000**	**700**	**20**	**3,500**	**100**	**62**	**1,200**
MW-6	12/28/15	98.29	17.91	80.38	< 5.0	< 5.0	< 5.0	**1,850**	< 5.0	< 5.0	< 5.0	< 5.0
	01/28/16	98.29	16.34	81.95	< 5.0	< 5.0	< 5.0	**827**	< 5.0	< 5.0	< 5.0	< 5.0
	04/14/16	98.29	15.47	82.82	< 5.0	< 5.0	< 5.0	**598**	< 5.0	< 5.0	< 5.0	< 5.0
	05/23/16	98.29	15.33	82.96	< 5.0	< 5.0	< 5.0	**484**	< 5.0	< 5.0	< 5.0	< 5.0
	07/14/16	98.29	15.46	82.83	< 5.0	< 5.0	< 5.0	**550**	< 5.0	< 5.0	< 5.0	< 5.0
	08/15/16	98.29	14.11	84.18	< 5.0	< 5.0	< 5.0	**613**	< 5.0	< 5.0	< 5.0	< 5.0
MW-7	12/28/15	97.65	15.28	82.37	**5.2**	< 5.0	< 5.0	**262**	< 5.0	< 5.0	5.1	< 5.0
	01/28/16	97.65	14.12	83.53	< 5.0	< 5.0	< 5.0	**70.7**	5.4	< 5.0	15.0	7.3
	04/14/16	97.65	13.66	83.99	< 5.0	< 5.0	8.0	9.6	13.6	< 5.0	**81.4**	< 5.0
	05/23/16	97.65	13.52	84.13	< 5.0	< 5.0	12.3	8.3	12.5	< 5.0	**74.1**	< 5.0
	07/14/16	97.65	13.61	84.04	< 5.0	< 5.0	6.3	7.5	27.5	< 5.0	**212**	< 5.0
	08/15/16	97.65	15.61	82.04	< 5.0	< 5.0	< 5.0	9.6	8.1	< 5.0	34.3	< 5.0
MW-8	12/28/15	98.13	DRY	NA	-	-	-	-	-	-	-	-
	01/28/16	98.13	DRY	NA	-	-	-	-	-	-	-	-
	04/14/16	98.13	DRY	NA	-	-	-	-	-	-	-	-
	05/23/16	98.13	DRY	NA	-	-	-	-	-	-	-	-
	07/14/16	98.13	12.85	85.28	< 5.0	< 5.0	16.1	**633**	< 5.0	8.9	< 5.0	< 5.0
	08/15/16	98.13	12.82	85.31	< 5.0	< 5.0	5.2	**830**	< 5.0	< 5.0	< 5.0	< 5.0
MW-9	04/14/16	99.03	28.16	70.87	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
	05/23/16	99.03	28.68	70.35	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
	07/14/16	99.03	28.44	70.59	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
	08/15/16	99.03	27.35	71.68	< 5.0	< 5.0	< 5.0	9.7	< 5.0	< 5.0	< 5.0	< 5.0
MW-10D	04/14/16	98.85	39.38	59.47	< 5.0	< 5.0	< 5.0	**23.4**	< 5.0	< 5.0	< 5.0	< 5.0
	05/23/16	98.85	39.49	59.36	< 5.0	< 5.0	< 5.0	15.6	< 5.0	< 5.0	< 5.0	< 5.0
	07/14/16	98.85	43.69	55.16	< 5.0	< 5.0	< 5.0	9.1	< 5.0	< 5.0	< 5.0	< 5.0
	08/15/16	98.85	44.31	54.54	< 5.0	< 5.0	< 5.0	**25.6**	< 5.0	< 5.0	< 5.0	< 5.0
MW-10S	04/14/16	98.77	16.64	82.13	< 5.0	< 5.0	< 5.0	**146**	< 5.0	< 5.0	< 5.0	< 5.0
	05/23/16	98.77	16.67	82.10	< 5.0	< 5.0	< 5.0	**78.7**	< 5.0	< 5.0	< 5.0	< 5.0
	07/14/16	98.77	16.79	81.98	< 5.0	< 5.0	< 5.0	**281**	< 5.0	< 5.0	< 5.0	< 5.0
	08/15/16	98.77	17.71	81.06	< 5.0	< 5.0	< 5.0	**33.4**	< 5.0	< 5.0	< 5.0	< 5.0
MW-11	04/14/16	97.23	22.25	74.98	< 5.0	< 5.0	< 5.0	**641**	< 5.0	< 5.0	< 5.0	< 5.0
	05/23/16	97.23	20.01	77.22	< 5.0	< 5.0	< 5.0	**390**	< 5.0	< 5.0	< 5.0	< 5.0
	07/14/16	97.23	20.15	77.08	< 5.0	< 5.0	< 5.0	**37.7**	< 5.0	< 5.0	< 5.0	< 5.0
	08/15/16	97.23	20.81	76.42	< 5.0	< 5.0	< 5.0	**189**	< 5.0	< 5.0	< 5.0	< 5.0
MW-12	04/14/16	59.71	9.62	50.09	< 5.0	< 5.0	< 5.0	9.8	< 5.0	< 5.0	< 5.0	< 5.0
	05/23/16	59.71	9.86	49.85	**6.1**	< 5.0	6.5	< 5.0	13.9	< 5.0	< 5.0	5.3
	07/14/16	59.71	9.93	49.78	**5.6**	< 5.0	< 5.0	< 5.0	25.2	< 5.0	< 5.0	< 5.0
	08/15/16	59.71	10.93	48.78	< 5.0	< 5.0	< 5.0	< 5.0	26.7	< 5.0	< 5.0	< 5.0

Table 1

GROUNDWATER DATA SUMMARY

United Refining Company
Kwik Fill Station #M-209
5574 Route 8
Barkeyville, PA

Well	Date	Casing Elevation	Depth to Water	Water Elevation	Benzene	Toluene	Ethylbenzene	MTBE	Isopropylbenzene	Naphthalene	1,2,4-TMB	1,3,5-TMB
			PA Act 2 U/NR MSCs		**5**	**1,000**	**700**	**20**	**3,500**	**100**	**62**	**1,200**
MW-13	04/14/16	60.62	7.74	52.88	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
	05/23/16	60.62	8.02	52.60	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
	07/14/16	60.62	8.08	52.54	**15.6**	< 5.0	< 5.0	6.4	< 5.0	< 5.0	< 5.0	< 5.0
	08/15/16	60.62	8.79	51.83	**27.1**	< 5.0	< 5.0	6.3	< 5.0	< 5.0	< 5.0	< 5.0
MW-14	07/14/16	100.20	14.20	86.00	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
	08/15/16	100.20	14.95	85.25	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
MW-15	07/14/16	96.90	15.11	81.79	< 5.0	< 5.0	< 5.0	8.4	< 5.0	< 5.0	< 5.0	< 5.0
	08/15/16	96.90	15.42	81.48	< 5.0	< 5.0	< 5.0	10.8	< 5.0	< 5.0	< 5.0	< 5.0
MW-16	07/14/16	67.84	12.84	55.00	**226**	176	456	5.6	51.8	**165**	**1,740**	646
	08/15/16	67.84	13.39	54.45	**168**	218	423	5.4	46.5	**136**	**1,100**	329

NOTES

All laboratory results and U/NR MSCs are reported in micrograms per liter.
Elevation and depth to water measurements are reported in feet.
U/R MSC = Used Aquifer/Residential Medium-Specific Concentration
BOLD = Indicates exceedance of applicable Act 2 MSC
<# = Less than laboratory reporting limit of #
Laboratory analytical data qualifiers are referenced above, following the analytical result. Refer to laboratory report appendices for qualifier descriptions.

MTBE = Methyl tert-butyl ether
TMB = Trimethylbenzene

Table 2

WELL CONSTRUCTION SUMMARY

United Refining Company
Kwik Fill Station #M-209
5574 Route 8
Barkeyville, PA

Well	Date Installed	Current Top of Casing Elevation[1] (feet)	Well Diameter (inches)	Total Depth (feet)	Total PVC Screen Length (feet)	Total PVC Riser Length (feet)
MW-1	09/08/15	100.00	4	20	15	5
MW-2	09/08/15	99.18	4	20	15	5
MW-3	09/04/15	98.83	4	20	15	5
MW-4	09/04/15	98.86	4	20	15	5
MW-5	12/01/15	98.60	4	20	15	5
MW-6	12/01/15	98.29	4	20	15	5
MW-7	11/30/15	97.65	4	20	15	5
MW-8	11/30/15	98.13	4	20	15	5
MW-9	02/19/16	99.03	4	30	25	5
MW-10D	02/23/16	98.85	2	40	10	30
MW-10S	02/22/16	98.77	4	25	20	5
MW-11	02/22/16	97.23	4	30	25	5
MW-12	02/18/16	59.71	4	19	15	7
MW-13	02/18/16	60.62	4	15	10	8
MW-14	06/22/16	100.20	4	24	20	4
MW-15	06/22/16	96.90	4	35	20	15
MW-16	06/21/16	67.84	2	20	15	8

NOTES:
PVC - poly-vinyl chloride

1) Top of casing elevations relative to an on-site benchmark.
2) Monitoring wells MW-12, MW-13 and MW-16 were completed above ground surface.

Table 3

SOIL DATA SUMMARY

United Refining Company
Kwik Fill Station #M-209
5574 State Route 8
Barkeyville, PA

Soil Sample ID	Date	Depth (ft)	PID (ppm)	Benzene (µg/kg)	Toluene (µg/kg)	Ethylbenzene (µg/kg)	MTBE (µg/kg)	Isopropylbenzene (µg/kg)	Naphthalene (µg/kg)	1,2,4-TMB (µg/kg)	1,3,5-TMB (µg/kg)
PA Act 2 U/NR MSC (0 - 2 ft) (Unsaturated)[1]				**500**	**100,000**	**70,000**	**2,000**	**2,500,000**	**25,000**	**35,000**	**210,000**
PA Act 2 U/NR MSC (2 - 15 ft) (Unsaturated)[1]				**500**	**100,000**	**70,000**	**2,000**	**2,500,000**	**25,000**	**35,000**	**210,000**
MW-1	09/01/15	3-4	422	**886**	3,800	2,060	<4.7	89.0	2,940	10,300	3,210
MW-1	09/01/15	6-7	93.2	37.4	23.0	19.6	<4.2	7.6	19.1	39.8	12.2
MW-1	09/03/15	10-11	10.4	32.9	<3.9	<3.9	<3.9	<3.9	<3.9	<3.9	<3.9
MW-2	09/02/15	1-2	12.9	<4.8	<4.8	<4.8	<4.8	<4.8	<4.8	<4.8	<4.8
MW-2	09/03/15	18-19	5.5	<4.8	<4.8	<4.8	<4.8	<4.8	<4.8	<4.8	<4.8
MW-3	08/31/15	6-7	>15,000	**3,770**	10,400	12,100	<274	3,570	21,700	**55,700**	17,300
MW-3	09/03/15	8-9	559.7	**2,260**	<232	1,470	<4.4	<4.4	697	2,000	610
MW-3	09/03/15	10-11	449.5	**3,150**	31.2	1,880	<4.8	1,100	114	12,200	43.9
MW-4	08/31/15	7-8	>15,000	**1,750**	9,980	2,710	<4.4	72.2	2,840	6,550	2,070
MW-4	09/03/15	10-11	680.9	**8,180**	20,300	22,600	<4.9	3,580	10,800	**41,600**	11,800
MW-5	11/24/15	3-4	109.4	<230	<230	<230	<230	<230	<230	<230	<230
MW-5	12/01/15	10-11	172.1	<203	<203	<203	<203	<203	<203	<203	<203
MW-5	12/01/15	12-13	8.9	<236	<236	<236	366	<236	<236	<236	<236
MW-6	11/24/15	3-4	4.7	<4.8	<4.8	<4.8	<4.8	<4.8	<4.8	<4.8	<4.8
MW-6	12/01/15	9-10	12.8	<315	<315	702	<315	<315	<315	<315	<315
MW-6	12/01/15	14-15	1.9	<214	<214	<214	<214	<214	<214	<214	<214
MW-7	11/24/15	4-5	142.5	<233	<233	<233	<233	<233	2,630	1,860	682
MW-7	11/30/15	14-15	365.3	<255	<255	490	<255	881	1,230	24,100	8,990
MW-7	11/30/15	19-20	11.0	<256	<256	<256	356	<256	<256	<256	<256
MW-8	11/25/15	4-5	5.0	<211	<211	<211	<211	<211	<211	<211	<211
MW-8	11/30/15	10-11	324.4	<284	<284	<284	<284	<284	<284	<284	<284
MW-8	11/30/15	18-19	3.9	<248	<248	820	<248	353	999	5,980	2,150
MW-9	02/15/16	4-5	1.5	<3.5	<3.5	<3.5	<3.5	<3.5	<3.5	<3.5	<3.5
MW-9	02/18/16	15-17	15.5	<3.2	<3.2	3.6	<3.2	<3.2	4.6	69.9	20.3
MW-9	02/18/16	17-19	3.0	<3.3	<3.3	<3.3	<3.3	<3.3	<3.3	<3.3	<3.3
MW-10D	02/17/16	4-5	3.8	<158	<158	<158	<158	<158	<158	<158	<158
MW-10D	02/23/16	17-19	69.2	189	262	<173	<173	<173	<173	475	<173
MW-10D	02/23/16	27-29	40.9	<3.7	<3.7	<3.7	581	<3.7	<3.7	<3.7	<3.7
MW-10D	02/23/16	29-31	10.2	<3.3	<3.3	<3.3	219	<3.3	<3.3	<3.3	<3.3
MW-10S	02/17/16	4-5	3.4	<3.3	<3.3	<3.3	<3.3	<3.3	<3.3	<3.3	<3.3
MW-10S	02/22/16	23-25	40.3	23.6	<3.6	<3.6	928	<3.6	<3.6	<3.6	<3.6
MW-10S	02/22/16	25-27	32.1	36.4	<3.4	<3.4	828	<3.4	<3.4	<3.4	<3.4
MW-11	02/17/16	4-5	2.7	<3.6	<3.6	<3.6	<3.6	<3.6	<3.6	<3.6	<3.6
MW-11	02/22/16	17-19	44.2	12.5	<3.1	<3.1	3.0	<3.1	4.5	29.3	3.3
MW-11	02/22/16	23-25	27.6	6.0	<3.6	<3.6	31.6	<3.6	<3.6	<3.6	<3.6

Table 3

SOIL DATA SUMMARY

United Refining Company
Kwik Fill Station #M-209
5574 State Route 8
Barkeyville, PA

Soil Sample ID	Date	Depth (ft)	PID (ppm)	Benzene (µg/kg)	Toluene (µg/kg)	Ethylbenzene (µg/kg)	MTBE (µg/kg)	Isopropylbenzene (µg/kg)	Naphthalene (µg/kg)	1,2,4-TMB (µg/kg)	1,3,5-TMB (µg/kg)
PA Act 2 U/NR MSC (0 - 2 ft) (Unsaturated)[1]				**500**	**100,000**	**70,000**	**2,000**	**2,500,000**	**25,000**	**35,000**	**210,000**
PA Act 2 U/NR MSC (2 - 15 ft) (Unsaturated)[1]				**500**	**100,000**	**70,000**	**2,000**	**2,500,000**	**25,000**	**35,000**	**210,000**
MW-12	02/17/16	4-5	0.0	<3.8	<3.8	<3.8	<3.8	<3.8	<3.8	<3.8	<3.8
MW-12	02/18/16	9-11	15.3	<3.3	<3.3	7.6	<3.3	6.0	4.9	49.0	9.2
MW-12	02/18/16	11-13	50.0	<149	<149	584	<149	670	754	13,300	4,410
MW-13	02/17/16	3-4	0.0	<3.4	<3.4	<3.4	<3.4	<3.4	<3.4	<3.4	<3.4
MW-13	02/17/16	9-11	20.8	<3.1	<3.1	<3.1	<3.1	<3.1	<3.1	<3.1	<3.1
MW-13	02/17/16	11-13	11.3	20.6	<3.3	<3.3	<3.3	<3.3	<3.3	<3.3	<3.3
MW-14	06/21/16	4-5	1.4	<4.2	<4.2	<4.2	<4.2	<4.2	<4.2	<4.2	<4.2
MW-14	06/22/16	14-15	3.7	18.3	<4.4	<4.4	<4.4	<4.4	<4.4	<4.4	<4.4
MW-14	06/22/16	19-20	0.8	<4.6	<4.6	<4.6	<4.6	<4.6	<4.6	<4.6	<4.6
MW-15	06/20/16	4-5	0.7	<4.6	<4.6	<4.6	<4.6	<4.6	<4.6	<4.6	<4.6
MW-15	06/22/16	15-16	78.6	<4.5	11.9	28.8	<4.5	9.7	12.5	157	44.5
MW-15	06/22/16	26-27	7.7	8.1	<3.3	<3.3	113	<3.3	<3.3	<3.3	<3.3
MW-16	06/21/16	4-5	54.5	56.0	9.4	71.6	<5.9	31.0	<5.9	36.4	134
MW-16	06/21/16	13-14	512.3	**511**	4,070	21,300	<217	4,750	9,170	**113,000**	39,600
MW-16	06/21/16	17-18	5.8	33.9	68.3	59.6	<4.1	5.5	9.7	98.7	26.6
SB-1	09/02/15	2-3	500	**4,370**	20,200	7,480	<5.0	1,060	5,890	19,500	<5.0
SB-1	09/02/15	5-6	38.1	52.2	15.7	11.3	<4.7	<4.7	10.5	25.0	9.1
SB-1	09/03/15	16-17	6.9	21.5	13.4	<6.9	<6.9	<6.9	<6.9	<6.9	<6.9
SB-2	09/01/15	5-6	296	<270	445	2,760	<270	1,540	15,300	29,900	7,760
SB-2	09/03/15	10-11	54.1	20.7	10.9	7.2	5.3	<5.1	14.6	15.0	5.9
SB-3	11/23/15	3-4	3.8	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5
SB-3	12/02/15	7-8	25.2	<294	<294	458	<294	<294	<294	<294	<294
SB-3	12/02/15	13-14	0.1	<4.2	<4.2	<4.2	<4.2	<4.2	<4.2	<4.2	<4.2
SB-4	11/23/15	3-4	3.8	<4.2	<4.2	<4.2	<4.2	<4.2	<4.2	<4.2	<4.2
SB-4	12/02/15	19-20	7.8	<222	<222	<222	<222	<222	<222	<222	<222
SB-5	11/24/15	3-4	1,289	**<2,420**	76,000	38,700	**<2,420**	5,350	10,400	**130,000**	46,900
SB-5	12/01/15	6-7	616.6	**2,880**	9,160	14,700	323	1,360	4,710	27,500	8,000
SB-5	12/01/15	12-13	4.0	<227	<227	<227	287	<227	<227	<227	<227
SB-6	11/24/15	4-5	14.9	7.0	<4.5	<4.5	<4.5	<4.5	4.7	<4.5	<4.5
SB-6	12/01/15	9-10	105.1	<213	<213	<213	<213	<213	<213	492	227
SB-6	12/01/15	20-21	5.3	<295	<295	<295	<295	<295	<295	<295	<295
SB-7	02/15/16	3-4	272.9	<189	674	<440	<189	<189	319	1,290	401
SB-7	02/19/16	5-7	28.3	<3.6	<3.6	58.4	<3.6	14.7	12.6	62.1	5.9
SB-7	02/19/16	9-11	16.2	<3.5	<3.5	<3.5	193	<3.5	<3.5	<3.5	<3.5

Table 3

SOIL DATA SUMMARY

United Refining Company
Kwik Fill Station #M-209
5574 State Route 8
Barkeyville, PA

Soil Sample ID	Date	Depth (ft)	PID (ppm)	Benzene (µg/kg)	Toluene (µg/kg)	Ethylbenzene (µg/kg)	MTBE (µg/kg)	Isopropylbenzene (µg/kg)	Naphthalene (µg/kg)	1,2,4-TMB (µg/kg)	1,3,5-TMB (µg/kg)
PA Act 2 U/NR MSC (0 - 2 ft) (Unsaturated)[1]				**500**	**100,000**	**70,000**	**2,000**	**2,500,000**	**25,000**	**35,000**	**210,000**
PA Act 2 U/NR MSC (2 - 15 ft) (Unsaturated)[1]				**500**	**100,000**	**70,000**	**2,000**	**2,500,000**	**25,000**	**35,000**	**210,000**
SB-8	02/17/16	5-6	423.5	**<1,770**	<1,770	<1,770	<1,770	<1,770	9,250	13,500	3,690
SB-8	02/19/16	11-13	65.5	<149	<149	<149	<149	<149	<149	985	<149
SB-8	02/19/16	13-14	49.0	39.0	<3.1	<3.1	52.4	<3.1	6.5	36.1	4.6
SB-9	02/17/16	4-5	4.0	<170	<170	<170	<170	<170	<170	<170	<170
SB-9	02/19/16	5-7	6.5	<3.3	<3.3	<3.3	<3.3	<3.3	<3.3	<3.3	<3.3
SB-9	02/19/16	7-9	4.5	<3.3	<3.3	<3.3	<3.3	<3.3	<3.3	<3.3	<3.3
SB-10	06/20/16	7-8	533.4	**627**	<243	969	<243	866	5,170	10,800	4,570
SB-10	06/22/16	11-12	472.3	**7,820**	1,460	14,700	<225	3,000	7,270	**44,100**	6,280
SB-10	06/22/16	15-16	3.2	<5.2	<5.2	<5.2	1,250	<5.2	<5.2	<5.2	<5.2
SB-11	06/21/16	3-4	1.5	<4.6	<4.6	<4.6	<4.6	<4.6	<4.6	<4.6	<4.6
SB-11	06/22/16	5-7	68.5	<4.1	<4.1	<4.1	<4.1	<4.1	<4.1	4.6	<4.1
SB-11	06/22/16	11-13	12.7	98.9	<4.9	<4.9	78.0	<4.9	<4.9	15.7	<4.9

NOTES:

BOLD	Indicates exceedance of applicable Act 2 U/NR MSC	PID	photoionization detector
<#	Less than laboratory reporting limit of #	ppm	parts per million
ft	feet below ground surface	MTBE	methyl tert-butyl ether
µg/kg	micrograms per kilogram	TMB	trimethylbenzene

[1)] PADEP Act 2 Statewide Health Standard, Used Aquifer (U) /Non-Residential (NR) Medium-Specific Concentration (MSC), 25 PA Code Chapter 250, Rev. 2016.

APPENDIX A

Fate and Transport Assessment

Table A-1

Fate and Transport Model Input Values for Benzene

United refining COmpany
Kwik Fill Station #M-209
5574 State Route 8
Barkeyville, PA

Parameter	Description	Input Value	Rationale For Use
Source Concentration (mg/L) - Benzene	Maximum dissolved phase concentration in groundwater acting as an infinite source	0.168	Benzene concentration in monitoring well MW-16 (8/15/16) was calibrated to monitoring well MW-13 (8/15/16). Input values were used where the upgradient benzene concentration was greater than the downgradient well.
Source Concentration (mg/L) - Model Run	Maximum dissolved phase concentration in groundwater acting as an infinite source	27.1	Benzene concentration observed in MW-13 during the most recent sampling event (8/15/16).
Ax (ft)	Longitudinal Dispersivity	85	Calibrated using the QD model and site-specific data.
Ay (ft)	Transverse Dispersivity	0.1	Calibrated using the QD model and site-specific data.
Az (ft)	Vertical Dispersivity	0.01	Calibrated using the QD model and site-specific data.
Lambda (day-1)	First Order Decay Constant	0.00096	Degradation coefficient obtained from PA Code 25, Chapter 250, Table 5 (converted to day-1).
Source Width (ft)	Width of area of identified groundwater impacts	85	Estimated width of current dissolved phase benzene plume based on the August 15, 2016 benzene groundwater isoconcentration map.
Source Thickness (ft)	The maximum depth range of contamination in the aquifer at the source (i.e., below the seasonally high water table)	6.61	Approximate estimated thickness of smear zone and saturated zone at source based on the difference between the minimum and the maximum depth range at the source observed in monitoring well MW-16 on July 14, 2016.
Time (days) - Calibration	Time the source is active	7,227	The time in days between the calibrated benzene value in monitoring well MW-16 and MW-13 (8/15/2016) and the estimated date of the release (11/1/2006).
Time (days) - Model Run	Time that the solution is desired	1,825/10,950	The time during which the plume would be expected to be in steady-state conditions (5 and 30 years), assuming a continuing source.
Hydraulic Conductivity (ft/day)	Soil permeability	0.28 to 28.8 ft/day	Overburden lithology is composed of layers of clay, silty clay, sandy clay, gravelly clay, clayey sand and sandy gravel. Due to variability of the aquifer soil, a range of K values was input into the model for clay, silt and sand, respectively using book values from Freeze and Cherry, 1979. Slug test data was not collected during site characterization activities.
Hydraulic Gradient (ft/ft)	Slope of water table	0.03	Average value calculated from groundwater sampling data collected on 7/14/2016 and 8/15/2016.
Porosity (dec. frac.)	Effective porosity	0.2	Arithmetic mean book value for clay accounting for the presence of silt. Book values obtained from McWhorter and Sunada, 1977.
Soil Bulk Density (gm/cm^3)	Dry weight of soil/volume	2.6	Site-specific data collected during site characterization activities.
KOC	Organic Carbon Partition Coefficient	58	Book value obtained from PA Code 25, Chapter 250, Table 5.
Fraction Organic Carbon	Fraction of Organic Carbon	0.0261	Site-specific data collected during site characterization activities.
Distance from source area (MW-13) to receptor (ft)	Site-specific field data	100	Distance from MW-13 to the downgradient property boundary.

Table A-2

Fate and Transport Input Values for Naphthalene

United Refining Company
Kwik Fill Station #M-209
5574 State Route 8
Barkeyville, PA

Parameter	Description	Input Value	Rationale For Use
Source Concentration (mg/L) - Naphthalene	Maximum dissolved phase concentration in groundwater acting as an infinite source	0.136	Naphthalene concentration in monitoring well MW-16 (8/15/16) was calibrated to monitoring well MW-13 (8/15/16). Input values were used where the upgradient Naphthalene concentration was greater than the downgradient well.
Source Concentration (mg/L) - Model Run	Maximum dissolved phase concentration in groundwater acting as an infinite source	0.136	Naphthalene concentration observed in MW-16 during the most recent sampling event (8/15/16).
Ax (ft)	Longitudinal Dispersivity	1,515	Calibrated using the QD model and site-specific data.
Ay (ft)	Transverse Dispersivity	0.1	Calibrated using the QD model and site-specific data.
Az (ft)	Vertical Dispersivity	0.01	Calibrated using the QD model and site-specific data.
Lambda (day-1)	First Order Decay Constant	0.00268	Degradation coefficient obtained from PA Code 25, Chapter 250, Table 5 (converted to day-1).
Source Width (ft)	Width of area of identified groundwater impacts	38	Estimated width of current dissolved phase naphthalene plume based on the August 15, 2016 naphthalene groundwater isoconcentration map.
Source Thickness (ft)	The maximum depth range of contamination in the aquifer at the source (i.e., below the seasonally high water table)	6.61	Approximate estimated thickness of smear zone and saturated zone at source based on the difference between the minimum depth to groundwater observed during the groundwater monitoring period at the source and the maximum depth range at the source.
Time (days) - Calibration	Time the source is active	7,227	The time in days between the calibrated naphthalene value in monitoring well MW-16 and MW-13 (8/15/2016) and the estimated date of the release (11/1/2006).
Time (days) - Model Run	Time that the solution is desired	1,825/10,950	The time during which the plume would be expected to be in steady-state condition (5 and 30 years), assuming a continuing source.
Hydraulic Conductivity (ft/day)	Soil permeability	0.28 to 28.8 ft/day	Overburden lithology is composed of layers of clay, silty clay, sandy clay, gravelly clay, clayey sand and sandy gravel. Due to variability of the aquifer soil, a range of K values was input into the model for clay, silt and sand, respectively using book values from Freeze and Cherry, 1979. Slug test data was not collected during site characterization activities.
Hydraulic Gradient (ft/ft)	Slope of water table	0.03	Average value calculated from groundwater sampling data collected on 7/14/2016 and 8/15/2016.
Porosity (dec. frac.)	Effective porosity	0.2	Arithmetic mean book value for sand accounting for the presence of gravel. Book values obtained from McWhorter and Sunada, 1977.
Soil Bulk Density (gm/cm^3)	Dry weight of soil/volume	2.6	Site-specific data collected during site characterization activities.
KOC	Organic Carbon Partition Coefficient	950	Book value obtained from PA Code 25, Chapter 250, Table 5.
Fraction Organic Carbon	Fraction of Organic Carbon	0.0261	Site-specific data collected during site characterization activities.
Distance from source area (MW-16) to receptor (ft)	Site-specific field data	100	Distance from MW-16 to the downgradient receptor (MW-13).

Table A-3

Fate and Transport Model Input Values for 1,2,4-TMB

United Refining Company
Kwik Fill Station #M-209
5574 State Route 8
Barkeyville, PA

Parameter	Description	Input Value	Rationale For Use
Source Concentration (mg/L) - 1,2,4-TMB	Maximum dissolved phase concentration in groundwater acting as an infinite source	1.1	1,2,4-TMB concentration in monitoring well MW-16 (8/15/16) was calibrated to monitoring well MW-13 (8/15/16). Input values were used where the upgradient 1,2,4-TMB concentration was greater than the downgradient well.
Source Concentration (mg/L) - Model Run	Maximum dissolved phase concentration in groundwater acting as an infinite source	1.1	1,2,4-TMB concentration observed in MW-16 during the most recent sampling event (8/15/16).
Ax (ft)	Longitudinal Dispersivity	160	Calibrated using the QD model and site-specific data.
Ay (ft)	Transverse Dispersivity	0.1	Calibrated using the QD model and site-specific data.
Az (ft)	Vertical Dispersivity	0.01	Calibrated using the QD model and site-specific data.
Lambda (day-1)	First Order Decay Constant	0	Degradation coefficient obtained assumed to be zero. Utilizing book values (Chapter 250, Table 5A) would not allow for calibration of the model. Using 0 as the source decay is a conservative assumption.
Source Width (ft)	Width of area of identified groundwater impacts	78	Estimated width of current dissolved phase 1,2,4-TMB plume based on the August 15, 2016 groundwater isoconcentration map.
Source Thickness (ft)	The maximum depth range of contamination in the aquifer at the source (i.e., below the seasonally high water table)	6.61	Approximate estimated thickness of smear zone and saturated zone at source based on the difference between the minimum depth to groundwater observed during the groundwater monitoring period at the source and the maximum depth range at the source.
Time (days) - Calibration	Time the source is active	7,227	The time in days between the calibrated 1,2,4-TMB value in monitoring well MW-16 and MW-13 (8/15/2016) and the estimated date of the release (11/1/2006).
Time (days) - Model Run	Time that the solution is desired	1,825/10,950	The time during which the plume would be expected to be in steady-state conditions (5 and 30 years), assuming a continuing source.
Hydraulic Conductivity (ft/day)	Soil permeability	0.28 to 28.8 ft/day	Overburden lithology is composed of layers of clay, silty clay, sandy clay, gravelly clay, clayey sand and sandy gravel. Due to variability of the aquifer soil, a range of K values was input into the model for clay, silt and sand, respectively using book values from Freeze and Cherry, 1979. Slug test data was not collected during site characterization activities.
Hydraulic Gradient (ft/ft)	Slope of water table	0.03	Average value calculated from groundwater sampling data collected on 7/14/2016 and 8/15/2016.
Porosity (dec. frac.)	Effective porosity	0.2	Arithmetic mean book value for sand accounting for the presence of gravel. Book values obtained from McWhorter and Sunada, 1977.
Soil Bulk Density (gm/cm^3)	Dry weight of soil/volume	2.6	Site-specific data collected during site characterization activities.
KOC	Organic Carbon Partition Coefficient	2200	Book value obtained from PA Code 25, Chapter 250, Table 5.
Fraction Organic Carbon	Fraction of Organic Carbon	0.0261	Site-specific data collected during site characterization activities.
Distance from source area (MW-16) to receptor (ft)	Site-specific field data	100	Distance from MW-16 to the downgradient receptor (MW-13).

Figure A-1

QD Model Calibration - Benzene

United Refining Company
Kwik Fill Station #M-209
5574 State Route 8
Barkeyville, PA

ADVECTIVE TRANSPORT WITH THREE DIMENSIONAL DISPERSION,1ST ORDER DECAY and RETARDATION - WITH CALIBRATION TOOL

Project: UPA #M-209 Barkeyville, PA
Date: 11/11/2016 Prepared by: Joe Hinkle
Contaminant: Benzene - Calibration

NEW QUICK_DOMENICO.XLS

SPREADSHEET APPLICATION OF "AN ANALYTICAL MODEL FOR MULTIDIMENSIONAL TRANSPORT OF A DECAYING CONTAMINANT SPECIES" P.A. Domenico (1987) Modified to Include Retardation

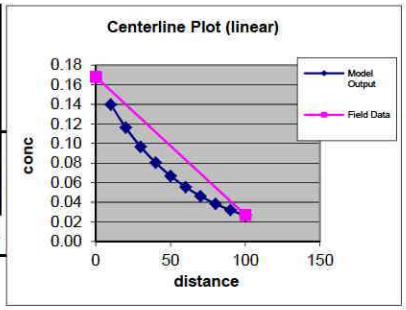
SOURCE CONC (MG/L)	Ax (ft)	Ay (ft)	Az (ft) >=.001	LAMBDA day-1	SOURCE WIDTH (ft)	SOURCE THICKNESS (ft)	Time (days) (days)
0.168	8.50E+01	1.00E-01	1.00E-02	0.00096	85	6.61	7227

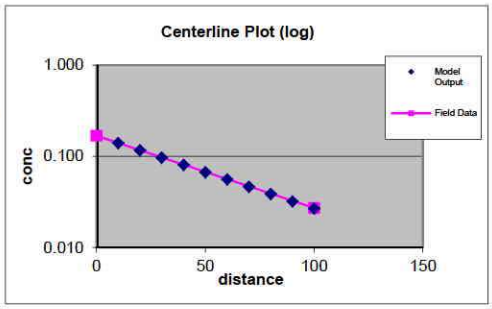
Hydraulic Cond (ft/day)	Hydraulic Gradient (ft/ft)	Porosity (dec. frac.)	Soil Bulk Density (g/cm^3)	KOC	Frac. Org. Carb.	Retard-ation (R)	V (=K*i/n*R) (ft/day)
2.80E+00	0.03	0.2	2.6	58	2.61E-02	20.6794	0.020310067

Point Concentration

x(ft)	y(ft)	z(ft)
100	0	0

	x(ft)	y(ft)	z(ft)
Conc. At	100	0	0
at	7227	days =	
			0.027
			mg/l





AREAL MODEL	CALCULATION DOMAIN
Length (ft)	100
Width (ft)	85

	10	20	30	40	50	60	70	80	90	100
85	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
42.5	0.070	0.058	0.048	0.040	0.033	0.028	0.023	0.019	0.016	0.013
0	0.140	0.116	0.097	0.080	0.067	0.056	0.046	0.038	0.032	0.027
-42.5	0.070	0.058	0.048	0.040	0.033	0.028	0.023	0.019	0.016	0.013
-85	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data:	**Centerline C Concentration**			0.168	0.0271					
	Distance from Source			0	100					

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Benzene-QD model.xls

Figure A-2

QD Model Calibration - Napthalene

United Refining Company
Kwik Fill Station #M-209
5574 State Route 8

ADVECTIVE TRANSPORT WITH THREE DIMENSIONAL DISPERSION,1ST ORDER DECAY and RETARDATION - WITH CALIBRATION TOOL

Project:	UPA #M-209 Barkeyville, PA						
Date:	11/11/2016	Prepared by:	Joe Hinkle				
		Contaminant:	Naphthalene - Calibration				

NEW QUICK_DOMENICO.XLS

SPREADSHEET APPLICATION OF "AN ANALYTICAL MODEL FOR MULTIDIMENSIONAL TRANSPORT OF A DECAYING CONTAMINANT SPECIES" P.A. Domenico (1987) Modified to Include Retardation

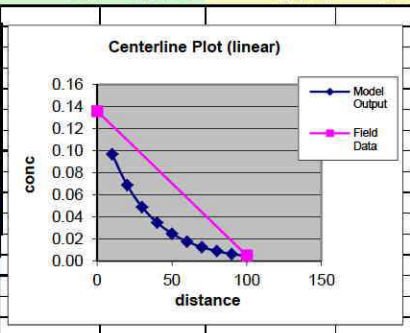
SOURCE CONC (MG/L)	Ax (ft)	Ay (ft)	Az (ft) >=.001	LAMBDA day-1	SOURCE WIDTH (ft)	SOURCE THICKNESS (ft)	Time (days) (days)
0.136	1.52E+03	1.00E-01	1.00E-03	0.00268	38	6.61	7227

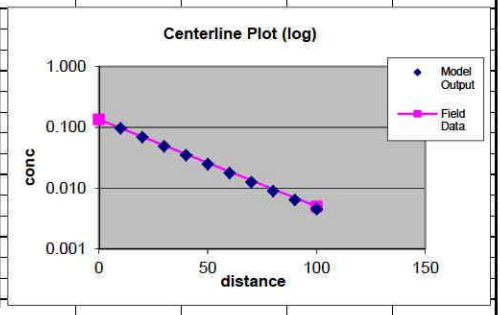
Hydraulic Cond (ft/day)	Hydraulic Gradient (ft/ft)	Porosity (dec. frac.)	Soil Bulk Density (g/cm^3)	KOC	Frac. Org. Carb.	Retard-ation (R)	V (=K*i/n*R) (ft/day)
2.80E+00	0.03	0.2	2.6	950	2.61E-02	323.335	0.001298962

Point Concentration

x(ft)	y(ft)	z(ft)
100	0	0

	x(ft)	y(ft)	z(ft)
Conc. At	100	0	0
at	7227	days =	
			0.004
			mg/l





AREAL MODEL	CALCULATION DOMAIN
Length (ft)	100
Width (ft)	38

	10	20	30	40	50	60	70	80	90	100
38	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
19	0.047	0.033	0.023	0.016	0.011	0.008	0.005	0.004	0.003	0.002
0	0.094	0.065	0.045	0.031	0.022	0.015	0.011	0.007	0.005	0.004
-19	0.047	0.033	0.023	0.016	0.011	0.008	0.005	0.004	0.003	0.002
-38	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data:	Centerline C Concentration			0.136	0.004					
	Distance from Source			0	100					

Figure A-3

QD Model Calibration - 1,2,4-TMB

United Refining Company
Kwik Fill Station #M-209
5574 State Route 8
Barkeyville, PA

ADVECTIVE TRANSPORT WITH THREE DIMENSIONAL DISPERSION,1ST ORDER DECAY and RETARDATION - WITH CALIBRATION TOOL

Project: UPA #M-209 Barkeyville, PA
Date: 11/11/2016 Prepared by: Joe Hinkle
Contaminant: 1,2,4-TMB - Calibration

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SPREADSHEET APPLICATION OF "AN ANALYTICAL MODEL FOR MULTIDIMENSIONAL TRANSPORT OF A DECAYING CONTAMINANT SPECIES" P.A. Domenico (1987) Modified to Include Retardation

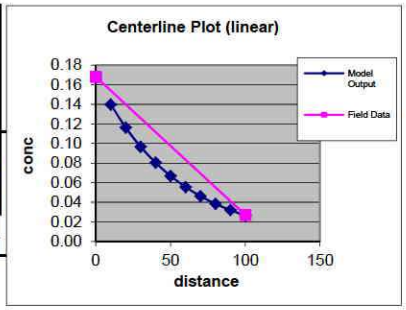
SOURCE CONC (MG/L)	Ax (ft)	Ay (ft)	Az (ft) >=.001	LAMBDA day-1	SOURCE WIDTH (ft)	SOURCE THICKNESS (ft)	Time (days) (days)
1.1	1.60E+02	1.00E-01	1.00E-02	0	78	6.61	7227

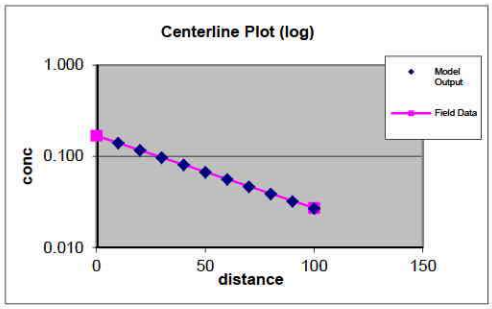
Hydraulic Cond (ft/day)	Hydraulic Gradient (ft/ft)	Porosity (dec. frac.)	Soil Bulk Density (g/cm^3)	KOC	Frac. Org. Carb.	Retard-ation (R)	V (=K*i/n*R) (ft/day)
2.80E+00	0.03	0.2	2.6	2200	2.61E-02	747.46	0.000561903

Point Concentration

x(ft)	y(ft)	z(ft)
100	0	0

	x(ft)	y(ft)	z(ft)
Conc. At	100	0	0
at	7227	days =	
			0.004
			mg/l





AREAL MODEL	CALCULATION DOMAIN
Length (ft)	100
Width (ft)	78

	10	20	30	40	50	60	70	80	90	100
78	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
39	0.239	0.181	0.130	0.088	0.056	0.033	0.019	0.010	0.005	0.002
0	0.478	0.362	0.259	0.175	0.111	0.066	0.037	0.019	0.009	0.004
-39	0.239	0.181	0.130	0.088	0.056	0.033	0.019	0.010	0.005	0.002
-78	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Field Data:									
Centerline C Concentration	1.1	0.004							
Distance from Source	0	100							

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1,2,4-TMB-QD model.xls

Figure A-4

QD Model - Benzene Concentration at Property Boundary (5 Yr)

United Refining Company
Kwik Fill Station #M-209
5574 State Route 8
Barkeyville, PA

ADVECTIVE TRANSPORT WITH THREE DIMENSIONAL DISPERSION,1ST ORDER DECAY and RETARDATION - WITH CALIBRATION TOOL

Project: UPA #M-209 Barkeyville, PA
Date: 11/11/2016 Prepared by: Joe Hinkle
Contaminant: Benzene - Concentration at Property Boundary in 5 years

NEW QUICK_DOMENICO.XLS

SPREADSHEET APPLICATION OF "AN ANALYTICAL MODEL FOR MULTIDIMENSIONAL TRANSPORT OF A DECAYING CONTAMINANT SPECIES" P.A. Domenico (1987)
Modified to Include Retardation

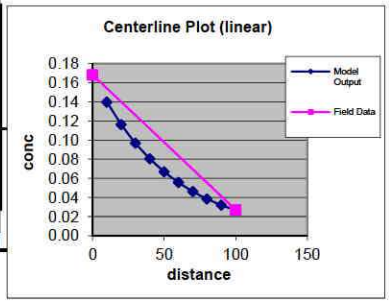
SOURCE CONC (MG/L)	Ax (ft)	Ay (ft)	Az (ft) >=.001	LAMBDA day-1	SOURCE WIDTH (ft)	SOURCE THICKNESS (ft)	Time (days) (days)
0.0271	8.50E+01	1.00E-01	1.00E-02	0.00096	85	6.61	1825

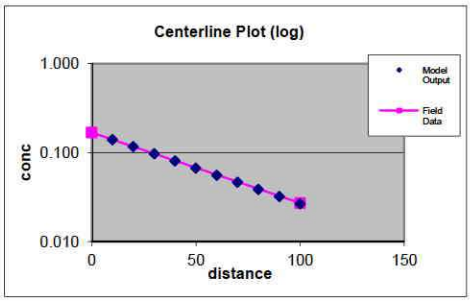
Hydraulic Cond (ft/day)	Hydraulic Gradient (ft/ft)	Porosity (dec. frac.)	Soil Bulk Density (g/cm^{-3})	KOC	Frac. Org. Carb.	Retard-ation (R)	V (=K*i/n*R) (ft/day)
2.80E+00	0.03	0.06	2.6	58	2.61E-02	66.598	0.021021652

Point Concentration

x(ft)	y(ft)	z(ft)
100	0	0

	x(ft)	y(ft)	z(ft)
Conc. At	100	0	0
at	1825	days =	
			0.003
			mg/l





AREAL MODEL	CALCULATION DOMAIN
Length (ft)	100
Width (ft)	85

	10	20	30	40	50	60	70	80	90	100
85	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
42.5	0.011	0.009	0.007	0.006	0.005	0.004	0.003	0.003	0.002	0.002
0	0.022	0.018	0.015	0.012	0.010	0.008	0.007	0.005	0.004	0.003
-42.5	0.011	0.009	0.007	0.006	0.005	0.004	0.003	0.003	0.002	0.002
-85	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data:	Centerline C Concentration									
	Distance from Source									

Figure A-5

QD Model - Benzene Distance to U/NR MSC (5 Yr)

United Refining Company
Kwik Fill Station #M-209
5574 State Route 8
Barkeyville, PA

ADVECTIVE TRANSPORT WITH THREE DIMENSIONAL DISPERSION,1ST ORDER DECAY and RETARDATION - WITH CALIBRATION TOOL

Project: UPA #M-209 Barkeyville, PA
Date: 11/11/2016 Prepared by: Joe Hinkle
Contaminant: Benzene - Distance to U/NR MSC in 5 years

NEW QUICK_DOMENICO.XLS

SPREADSHEET APPLICATION OF "AN ANALYTICAL MODEL FOR MULTIDIMENSIONAL TRANSPORT OF A DECAYING CONTAMINANT SPECIES" P.A. Domenico (1987)
Modified to Include Retardation

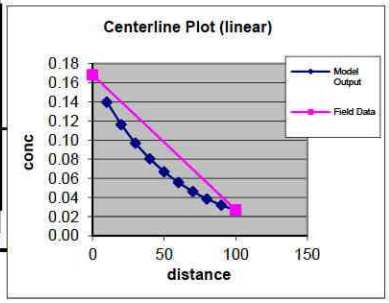
SOURCE CONC (MG/L)	Ax (ft)	Ay (ft)	Az (ft) >=.001	LAMBDA day-1	SOURCE WIDTH (ft)	SOURCE THICKNESS (ft)	Time (days) (days)
0.0271	8.50E+01	1.00E-01	1.00E-02	0.00096	85	6.61	1825

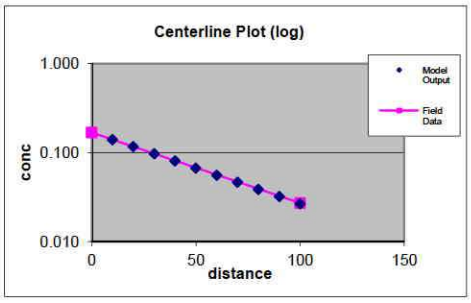
Hydraulic Cond (ft/day)	Hydraulic Gradient (ft/ft)	Porosity (dec. frac.)	Soil Bulk Density (g/cm^{-3})	KOC	Frac. Org. Carb.	Retard-ation (R)	V (=K*i/n*R) (ft/day)
2.80E+00	0.03	0.2	2.6	58	2.61E-02	20.6794	0.020310067

Point Concentration

x(ft)	y(ft)	z(ft)
76.7	0	0

	x(ft)	y(ft)	z(ft)
Conc. At	76.7	0	0
at	1825	days =	
			0.005
			mg/l





AREAL MODEL	CALCULATION DOMAIN
Length (ft)	100
Width (ft)	85

	10	20	30	40	50	60	70	80	90	100
85	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
42.5	0.011	0.009	0.007	0.006	0.005	0.004	0.003	0.003	0.002	0.002
0	0.022	0.018	0.015	0.012	0.010	0.008	0.006	0.005	0.004	0.003
-42.5	0.011	0.009	0.007	0.006	0.005	0.004	0.003	0.003	0.002	0.002
-85	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Field Data: Centerline C Concentration
Distance from Source

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Benzene-QD model.xls

Figure A-6

QD Model - Naphthalene Concentration at MW-13 (5 Yr)

United Refining Company
Kwik Fill Station #M-209
5574 State Route 8
Barkeyville, PA

ADVECTIVE TRANSPORT WITH THREE DIMENSIONAL DISPERSION,1ST ORDER DECAY and RETARDATION - WITH CALIBRATION TOOL

Project: UPA #M-209 Barkeyville, PA
Date: 11/11/2016 Prepared by: Joe Hinkle
Contaminant: Naphthalene Concentration at MW-13 in 5 years

NEW QUICK_DOMENICO.XLS

SPREADSHEET APPLICATION OF "AN ANALYTICAL MODEL FOR MULTIDIMENSIONAL TRANSPORT OF A DECAYING CONTAMINANT SPECIES" P.A. Domenico (1987)
Modified to Include Retardation

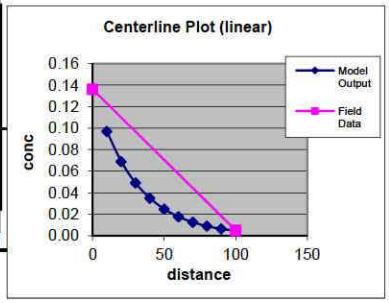
SOURCE CONC (MG/L)	Ax (ft)	Ay (ft)	Az (ft) >=.001	LAMBDA day-1	SOURCE WIDTH (ft)	SOURCE THICKNESS (ft)	Time (days) (days)
0.136	1.52E+03	1.00E-01	1.00E-02	0.00268	38	6.61	1825

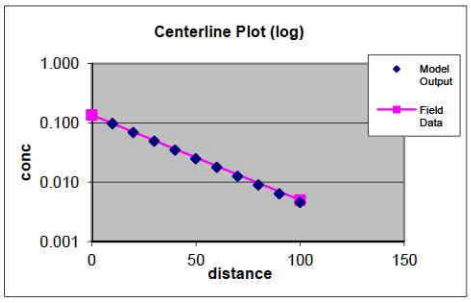
Hydraulic Cond (ft/day)	Hydraulic Gradient (ft/ft)	Porosity (dec. frac.)	Soil Bulk Density (g/cm^{-3})	KOC	Frac. Org. Carb.	Retard-ation (R)	V (=K*i/n*R) (ft/day)
2.80E+00	0.03	0.2	2.6	950	2.61E-02	323.335	0.001298962

Point Concentration

x(ft)	y(ft)	z(ft)
100	0	0

	x(ft)	y(ft)	z(ft)
Conc. At	100	0	0
at	1825	days =	
			0.003
			mg/l





AREAL MODEL	CALCULATION DOMAIN
Length (ft)	100
Width (ft)	38

	10	20	30	40	50	60	70	80	90	100
38	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
19	0.047	0.033	0.023	0.016	0.011	0.008	0.005	0.004	0.002	0.002
0	0.094	0.065	0.045	0.031	0.022	0.015	0.010	0.007	0.005	0.003
-19	0.047	0.033	0.023	0.016	0.011	0.008	0.005	0.004	0.002	0.002
-38	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Field Data: Centerline C Concentration
Distance from Source

Figure A-7

QD Model - Naphthalene Distance to U/NR MSC (5 Yr)

United Refining Company
Kwik Fill Station #M-209
5574 State Route 8
Barkeyville, PA

ADVECTIVE TRANSPORT WITH THREE DIMENSIONAL DISPERSION,1ST ORDER DECAY and RETARDATION - WITH CALIBRATION TOOL

Project: UPA #M-209 Barkeyville, PA
Date: 11/11/2016 Prepared by: Joe Hinkle
Contaminant: Naphthalene - Distance to U/NR MSC in 5 years

NEW QUICK_DOMENICO.XLS

SPREADSHEET APPLICATION OF "AN ANALYTICAL MODEL FOR MULTIDIMENSIONAL TRANSPORT OF A DECAYING CONTAMINANT SPECIES" P.A. Domenico (1987)
Modified to Include Retardation

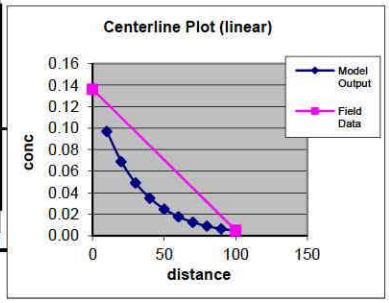
SOURCE CONC (MG/L)	Ax (ft)	Ay (ft)	Az (ft) >=.001	LAMBDA day-1	SOURCE WIDTH (ft)	SOURCE THICKNESS (ft)	Time (days) (days)
0.136	1.52E+03	1.00E-01	1.00E-02	0.00268	38	6.61	1825

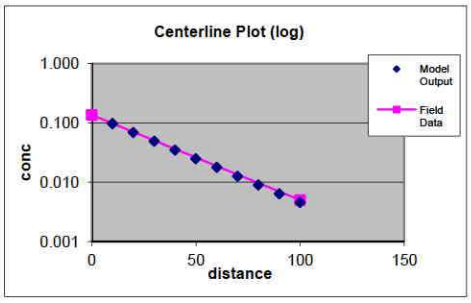
Hydraulic Cond (ft/day)	Hydraulic Gradient (ft/ft)	Porosity (dec. frac.)	Soil Bulk Density (g/cm^{-3})	KOC	Frac. Org. Carb.	Retard-ation (R)	V (=K*i/n*R) (ft/day)
2.80E+00	0.03	0.2	2.6	950	2.61E-02	323.335	0.001298962

Point Concentration

x(ft)	y(ft)	z(ft)
8.3	0	0

	x(ft)	y(ft)	z(ft)
Conc. At	8.3	0	0
at	1825	days =	
			0.100
			mg/l





AREAL MODEL	CALCULATION DOMAIN
Length (ft)	100
Width (ft)	38

	10	20	30	40	50	60	70	80	90	100
38	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
19	0.047	0.033	0.023	0.016	0.011	0.008	0.005	0.004	0.002	0.002
0	0.094	0.065	0.045	0.031	0.022	0.015	0.010	0.007	0.005	0.003
-19	0.047	0.033	0.023	0.016	0.011	0.008	0.005	0.004	0.002	0.002
-38	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Field Data: Centerline C Concentration
Distance from Source

Figure A-8

QD Model - 1,2,4-TMB Concentration at MW-13 (5 Yr)

United Refining Company
Kwik Fill Station #M-209
5574 State Route 8
Barkeyville, PA

ADVECTIVE TRANSPORT WITH THREE DIMENSIONAL DISPERSION,1ST ORDER DECAY and RETARDATION - WITH CALIBRATION TOOL

Project: UPA #M-209 Barkeyville, PA
Date: 11/11/2016 Prepared by: Joe Hinkle
Contaminant: 1,2,4-Trimethylbenzene Concentration at MW-13 in 5 years

NEW QUICK_DOMENICO.XLS

SPREADSHEET APPLICATION OF "AN ANALYTICAL MODEL FOR MULTIDIMENSIONAL TRANSPORT OF A DECAYING CONTAMINANT SPECIES" P.A. Domenico (1987)
Modified to Include Retardation

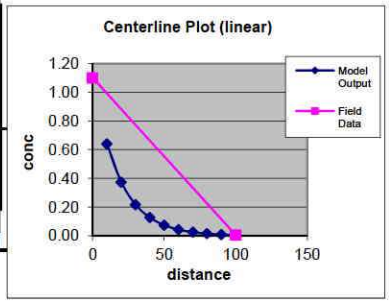
SOURCE CONC (MG/L)	Ax (ft)	Ay (ft)	Az (ft) >=.001	LAMBDA day-1	SOURCE WIDTH (ft)	SOURCE THICKNESS (ft)	Time (days) (days)
1.1	1.60E+02	1.00E-01	1.00E-02	0	78	6.61	1825

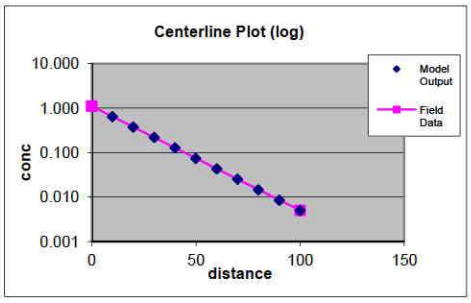
Hydraulic Cond (ft/day)	Hydraulic Gradient (ft/ft)	Porosity (dec. frac.)	Soil Bulk Density (g/cm^{-3})	KOC	Frac. Org. Carb.	Retard-ation (R)	V (=K*i/n*R) (ft/day)
2.80E+00	0.03	0.2	2.6	2200	2.61E-02	747.46	0.000561903

Point Concentration

x(ft)	y(ft)	z(ft)
100	0	0

	x(ft)	y(ft)	z(ft)
Conc. At	100	0	0
at	1825	days =	
			0.000
			mg/l





AREAL MODEL	CALCULATION DOMAIN
Length (ft)	100
Width (ft)	78

	10	20	30	40	50	60	70	80	90	100
78	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
39	0.171	0.081	0.030	0.009	0.002	0.000	0.000	0.000	0.000	0.000
0	0.341	0.162	0.060	0.017	0.004	0.001	0.000	0.000	0.000	0.000
-39	0.171	0.081	0.030	0.009	0.002	0.000	0.000	0.000	0.000	0.000
-78	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Field Data:	Centerline C Concentration									
	Distance from Source									

Figure A-9

QD Model - 1,2,4-TMB Distance to U/NR MSC (5 Yr)

United Refining Company
Kwik Fill Station #M-209
5574 State Route 8
Barkeyville, PA

ADVECTIVE TRANSPORT WITH THREE DIMENSIONAL DISPERSION,1ST ORDER DECAY and RETARDATION - WITH CALIBRATION TOOL

Project: UPA #M-209 Barkeyville, PA
Date: 11/11/2016 Prepared by: Joe Hinkle
Contaminant: 1,2,4-Trimethylbenzene - Distance to U/NR MSC in 5 years

NEW QUICK_DOMENICO.XLS

SPREADSHEET APPLICATION OF "AN ANALYTICAL MODEL FOR MULTIDIMENSIONAL TRANSPORT OF A DECAYING CONTAMINANT SPECIES" P.A. Domenico (1987)
Modified to Include Retardation

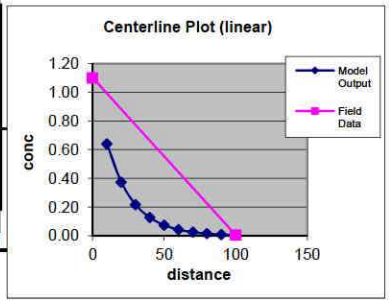
SOURCE CONC (MG/L)	Ax (ft)	Ay (ft)	Az (ft) >=.001	LAMBDA day-1	SOURCE WIDTH (ft)	SOURCE THICKNESS (ft)	Time (days) (days)
1.1	1.60E+02	1.00E-01	1.00E-02	0	78	6.61	1825

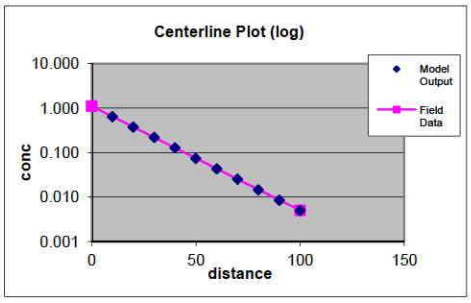
Hydraulic Cond (ft/day)	Hydraulic Gradient (ft/ft)	Porosity (dec. frac.)	Soil Bulk Density (g/cm^{-3})	KOC	Frac. Org. Carb.	Retard-ation (R)	V (=K*i/n*R) (ft/day)
2.80E+00	0.03	0.2	2.6	2200	2.61E-02	747.46	0.000561903

Point Concentration

x(ft)	y(ft)	z(ft)
29.7	0	0

	x(ft)	y(ft)	z(ft)
Conc. At	29.7	0	0
at	1825	days =	
			0.062
			mg/l





AREAL MODEL	CALCULATION DOMAIN
Length (ft)	100
Width (ft)	70

	10	20	30	40	50	60	70	80	90	100
70	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
35	0.340	0.159	0.057	0.016	0.003	0.001	0.000	0.000	0.000	0.000
0	0.341	0.162	0.060	0.017	0.004	0.001	0.000	0.000	0.000	0.000
-35	0.340	0.159	0.057	0.016	0.003	0.001	0.000	0.000	0.000	0.000
-70	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data:	Centerline C Concentration									
	Distance from Source									

L:\Projects\UPA\Sites\Barkeyville M-209\Fate and Transport Modeling\QD Models\
1,2,4-TMB-QD model.xls

Figure A-10

QD Model - Benzene Concentration at Property Boundary (30 Yr)

United Refining Company
Kwik Fill Station #M-209
5574 State Route 8
Barkeyville, PA

ADVECTIVE TRANSPORT WITH THREE DIMENSIONAL DISPERSION,1ST ORDER DECAY and RETARDATION - WITH CALIBRATION TOOL

Project: UPA #M-209 Barkeyville, PA
Date: 11/11/2016 Prepared by: Joe Hinkle
Contaminant: Benzene - Concentration at Property Boundary in 30 years

NEW QUICK_DOMENICO.XLS

SPREADSHEET APPLICATION OF "AN ANALYTICAL MODEL FOR MULTIDIMENSIONAL TRANSPORT OF A DECAYING CONTAMINANT SPECIES" P.A. Domenico (1987)
Modified to Include Retardation

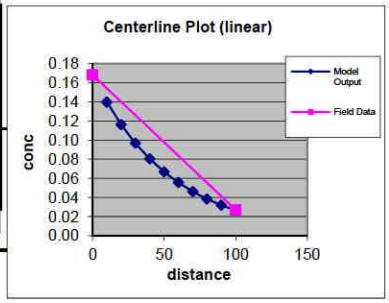
SOURCE CONC (MG/L)	Ax (ft)	Ay (ft)	Az (ft) >=.001	LAMBDA day-1	SOURCE WIDTH (ft)	SOURCE THICKNESS (ft)	Time (days) (days)
0.0271	8.50E+01	1.00E-01	1.00E-02	0.00096	85	6.61	10950

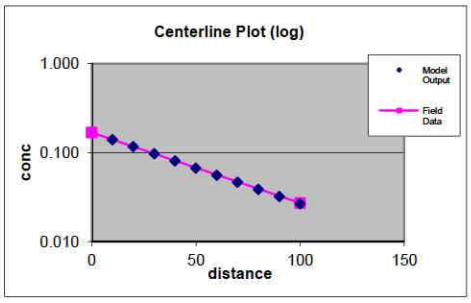
Hydraulic Cond (ft/day)	Hydraulic Gradient (ft/ft)	Porosity (dec. frac.)	Soil Bulk Density (g/cm^{-3})	KOC	Frac. Org. Carb.	Retard-ation (R)	V (=K*i/n*R) (ft/day)
2.80E+00	0.03	0.2	2.6	58	2.61E-02	20.6794	0.020310067

Point Concentration

x(ft)	y(ft)	z(ft)
100	0	0

	x(ft)	y(ft)	z(ft)
Conc. At	100	0	0
at	10950	days =	
			0.004
			mg/l





AREAL MODEL	CALCULATION DOMAIN
Length (ft)	100
Width (ft)	85

	10	20	30	40	50	60	70	80	90	100
85	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
42.5	0.011	0.009	0.008	0.006	0.005	0.004	0.004	0.003	0.003	0.002
0	0.023	0.019	0.016	0.013	0.011	0.009	0.007	0.006	0.005	0.004
-42.5	0.011	0.009	0.008	0.006	0.005	0.004	0.004	0.003	0.003	0.002
-85	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data:	Centerline C Concentration									
	Distance from Source									

Figure A-11

QD Model - Benzene Distance to U/NR MSC (30 Yr)

United Refining Company
Kwik Fill Station #M-209
5574 State Route 8
Barkeyville, PA

ADVECTIVE TRANSPORT WITH THREE DIMENSIONAL DISPERSION,1ST ORDER DECAY and RETARDATION - WITH CALIBRATION TOOL

Project: UPA #M-209 Barkeyville, PA
Date: 11/11/2016 Prepared by: Joe Hinkle
Contaminant: Benzene - Distance to U/NR MSC in 30 years

NEW QUICK_DOMENICO.XLS

SPREADSHEET APPLICATION OF "AN ANALYTICAL MODEL FOR MULTIDIMENSIONAL TRANSPORT OF A DECAYING CONTAMINANT SPECIES" P.A. Domenico (1987) Modified to Include Retardation

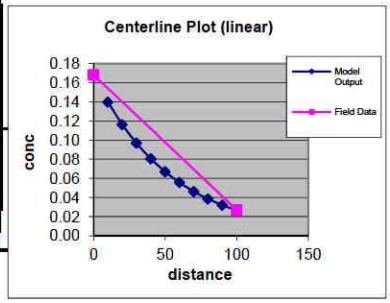
SOURCE CONC (MG/L)	Ax (ft)	Ay (ft)	Az (ft) >=.001	LAMBDA day-1	SOURCE WIDTH (ft)	SOURCE THICKNESS (ft)	Time (days) (days)
0.0271	8.50E+01	1.00E-01	1.00E-02	0.00096	85	6.61	1825

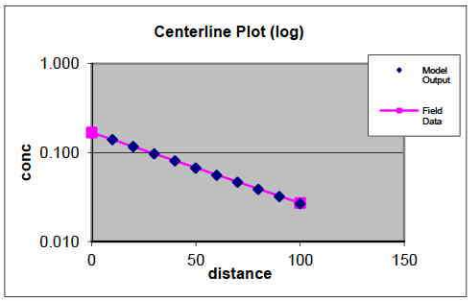
Hydraulic Cond (ft/day)	Hydraulic Gradient (ft/ft)	Porosity (dec. frac.)	Soil Bulk Density (g/cm^3)	KOC	Frac. Org. Carb.	Retard-ation (R)	V (=K*i/n*R) (ft/day)
2.80E+00	0.03	0.2	2.6	58	2.61E-02	20.6794	0.020310067

Point Concentration

x(ft)	y(ft)	z(ft)
76.7	0	0

	x(ft)	y(ft)	z(ft)
Conc. At	76.7	0	0
at	1825	days =	
			0.005
			mg/l





AREAL MODEL	CALCULATION DOMAIN
Length (ft)	100
Width (ft)	85

	10	20	30	40	50	60	70	80	90	100
85	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
42.5	0.011	0.009	0.007	0.006	0.005	0.004	0.003	0.003	0.002	0.002
0	0.022	0.018	0.015	0.012	0.010	0.008	0.006	0.005	0.004	0.003
-42.5	0.011	0.009	0.007	0.006	0.005	0.004	0.003	0.003	0.002	0.002
-85	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data:	Centerline C Concentration									
	Distance from Source									

Figure A-12

QD Model - Naphthalene Concentration at MW-13 (30 Yr)

United Refining Company
Kwik Fill Station #M-209
5574 State Route 8
Barkeyville, PA

ADVECTIVE TRANSPORT WITH THREE DIMENSIONAL DISPERSION,1ST ORDER DECAY and RETARDATION - WITH CALIBRATION TOOL

Project: UPA #M-209 Barkeyville, PA
Date: 11/11/2016 Prepared by: Joe Hinkle
Contaminant: Naphthalene Concentration at MW-13 in 30 years

NEW QUICK_DOMENICO.XLS

SPREADSHEET APPLICATION OF "AN ANALYTICAL MODEL FOR MULTIDIMENSIONAL TRANSPORT OF A DECAYING CONTAMINANT SPECIES" P.A. Domenico (1987)
Modified to Include Retardation

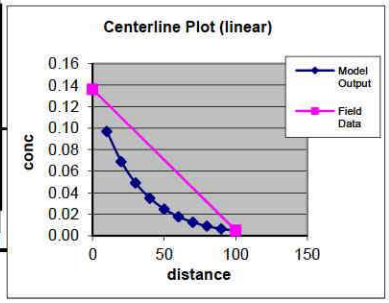
SOURCE CONC (MG/L)	Ax (ft)	Ay (ft)	Az (ft) >=.001	LAMBDA day-1	SOURCE WIDTH (ft)	SOURCE THICKNESS (ft)	Time (days) (days)
0.136	1.52E+03	1.00E-01	1.00E-02	0.00268	38	6.61	10950

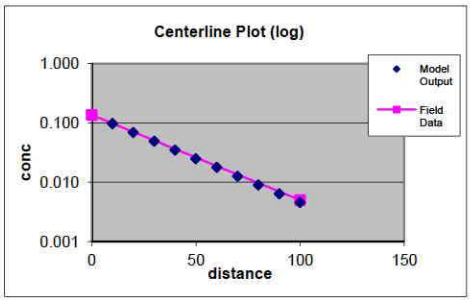
Hydraulic Cond (ft/day)	Hydraulic Gradient (ft/ft)	Porosity (dec. frac.)	Soil Bulk Density (g/cm^{-3})	KOC	Frac. Org. Carb.	Retard-ation (R)	V (=K*i/n*R) (ft/day)
2.80E+00	0.03	0.2	2.6	950	2.61E-02	323.335	0.001298962

Point Concentration

x(ft)	y(ft)	z(ft)
100	0	0

	x(ft)	y(ft)	z(ft)
Conc. At	100	0	0
at	10950	days =	
			0.004
			mg/l





AREAL MODEL	CALCULATION DOMAIN
Length (ft)	100
Width (ft)	38

	10	20	30	40	50	60	70	80	90	100
38	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
19	0.047	0.033	0.023	0.016	0.011	0.008	0.005	0.004	0.003	0.002
0	0.094	0.065	0.045	0.031	0.022	0.015	0.011	0.007	0.005	0.004
-19	0.047	0.033	0.023	0.016	0.011	0.008	0.005	0.004	0.003	0.002
-38	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data:	Centerline C Concentration									
	Distance from Source									

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Naphthalene-QD model.xls

Figure A-13

QD Model - Naphthalene Distance to U/NR MSC (30 Yr)

United Refining Company
Kwik Fill Station #M-209
5574 State Route 8
Barkeyville, PA

ADVECTIVE TRANSPORT WITH THREE DIMENSIONAL DISPERSION,1ST ORDER DECAY and RETARDATION - WITH CALIBRATION TOOL

Project: UPA #M-209 Barkeyville, PA
Date: 11/11/2016 Prepared by: Joe Hinkle
Contaminant: Naphthalene - Distance to U/NR MSC in 30 years

NEW QUICK_DOMENICO.XLS

SPREADSHEET APPLICATION OF "AN ANALYTICAL MODEL FOR MULTIDIMENSIONAL TRANSPORT OF A DECAYING CONTAMINANT SPECIES" P.A. Domenico (1987)
Modified to Include Retardation

SOURCE CONC (MG/L)	Ax (ft)	Ay (ft)	Az (ft) >=.001	LAMBDA day-1	SOURCE WIDTH (ft)	SOURCE THICKNESS (ft)	Time (days) (days)
0.136	1.52E+03	1.00E-01	1.00E-02	0.00268	38	6.61	10950

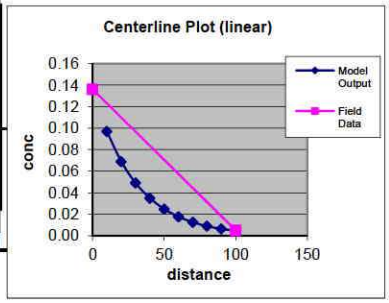
Hydraulic Cond (ft/day)	Hydraulic Gradient (ft/ft)	Porosity (dec. frac.)	Soil Bulk Density (g/cm^3)	KOC	Frac. Org. Carb.	Retard-ation (R)	V (=K*i/n*R) (ft/day)
2.80E+00	0.03	0.2	2.6	950	2.61E-02	323.335	0.001298962

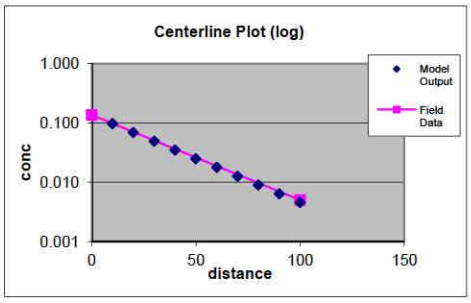
Point Concentration

x(ft)	y(ft)	z(ft)
8.5	0	0

	x(ft)	y(ft)	z(ft)
Conc. At	8.5	0	0
at	10950	days =	

0.100 mg/l





AREAL MODEL	CALCULATION DOMAIN
Length (ft)	100
Width (ft)	38

	10	20	30	40	50	60	70	80	90	100
38	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
19	0.047	0.033	0.023	0.016	0.011	0.008	0.005	0.004	0.003	0.002
0	0.094	0.065	0.045	0.031	0.022	0.015	0.011	0.007	0.005	0.004
-19	0.047	0.033	0.023	0.016	0.011	0.008	0.005	0.004	0.003	0.002
-38	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Field Data: Centerline C Concentration
Distance from Source

Figure A-14

QD Model - 1,2,4-TMB Concentration at MW-13 (30 Yr)

United Refining Company
Kwik Fill Station #M-209
5574 State Route 8
Barkeyville, PA

ADVECTIVE TRANSPORT WITH THREE DIMENSIONAL DISPERSION,1ST ORDER DECAY and RETARDATION - WITH CALIBRATION TOOL

Project: UPA #M-209 Barkeyville, PA
Date: 11/11/2016 Prepared by: Joe Hinkle
Contaminant: 1,2,4-Trimethylbenzene Concentrationat MW-13 in 30 years

NEW QUICK_DOMENICO.XLS

SPREADSHEET APPLICATION OF "AN ANALYTICAL MODEL FOR MULTIDIMENSIONAL TRANSPORT OF A DECAYING CONTAMINANT SPECIES" P.A. Domenico (1987)
Modified to Include Retardation

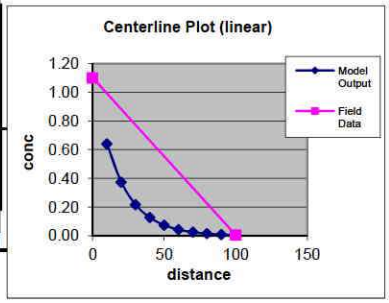
SOURCE CONC (MG/L)	Ax (ft)	Ay (ft)	Az (ft) >=.001	LAMBDA day-1	SOURCE WIDTH (ft)	SOURCE THICKNESS (ft)	Time (days) (days)
1.1	1.60E+02	1.00E-01	1.00E-02	0	78	6.61	10950

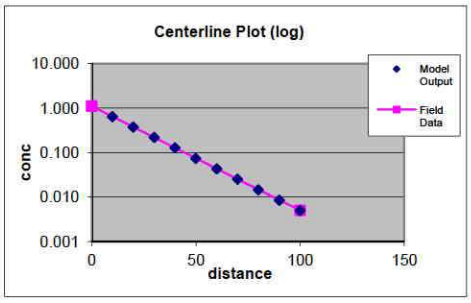
Hydraulic Cond (ft/day)	Hydraulic Gradient (ft/ft)	Porosity (dec. frac.)	Soil Bulk Density (g/cm^{-3})	KOC	Frac. Org. Carb.	Retard-ation (R)	V (=K*i/n*R) (ft/day)
2.80E+00	0.03	0.2	2.6	2200	2.61E-02	747.46	0.000561903

Point Concentration

x(ft)	y(ft)	z(ft)
100	0	0

	x(ft)	y(ft)	z(ft)
Conc. At	100	0	0
at	10950	days =	
			0.019
			mg/l





AREAL MODEL	CALCULATION DOMAIN
Length (ft)	100
Width (ft)	78

	10	20	30	40	50	60	70	80	90	100
78	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
39	0.256	0.208	0.163	0.123	0.089	0.062	0.041	0.026	0.016	0.009
0	0.512	0.415	0.325	0.245	0.178	0.124	0.083	0.053	0.032	0.019
-39	0.256	0.208	0.163	0.123	0.089	0.062	0.041	0.026	0.016	0.009
-78	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data:	**Centerline C Concentration**									
	Distance from Source									

L:\Projects\UPA\Sites\Barkeyville M-209\Fate and Transport Modeling\QD Models\
1,2,4-TMB-QD model.xls

Figure A-15

QD Model - 1,2,4-TMB Distance to U/NR MSC (30 Yr)

United Refining Company
Kwik Fill Station #M-209
5574 State Route 8
Barkeyville, PA

ADVECTIVE TRANSPORT WITH THREE DIMENSIONAL DISPERSION,1ST ORDER DECAY and RETARDATION - WITH CALIBRATION TOOL

Project: UPA #M-209 Barkeyville, PA
Date: 11/11/2016 Prepared by: Joe Hinkle
Contaminant: 1,2,4-Trimethylbenzene - Distance to U/NR MSC in 30 years

NEW QUICK_DOMENICO.XLS

SPREADSHEET APPLICATION OF "AN ANALYTICAL MODEL FOR MULTIDIMENSIONAL TRANSPORT OF A DECAYING CONTAMINANT SPECIES" P.A. Domenico (1987)
Modified to Include Retardation

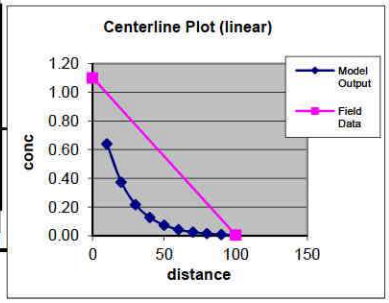
SOURCE CONC (MG/L)	Ax (ft)	Ay (ft)	Az (ft) >=.001	LAMBDA day-1	SOURCE WIDTH (ft)	SOURCE THICKNESS (ft)	Time (days) (days)
1.1	1.60E+02	1.00E-01	1.00E-02	0	78	6.61	10950

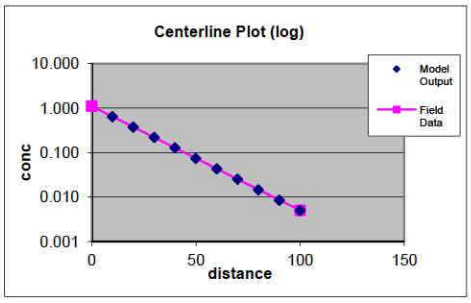
Hydraulic Cond (ft/day)	Hydraulic Gradient (ft/ft)	Porosity (dec. frac.)	Soil Bulk Density (g/cm^{-3})	KOC	Frac. Org. Carb.	Retard-ation (R)	V (=K*i/n*R) (ft/day)
2.80E+00	0.03	0.2	2.6	2200	2.61E-02	747.46	0.000561903

Point Concentration

x(ft)	y(ft)	z(ft)
76.4	0	0

	x(ft)	y(ft)	z(ft)
Conc. At	76.4	0	0
at	10950	days =	
			0.062
			mg/l





AREAL MODEL	CALCULATION DOMAIN
Length (ft)	100
Width (ft)	78

	10	20	30	40	50	60	70	80	90	100
78	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
39	0.256	0.208	0.163	0.123	0.089	0.062	0.041	0.026	0.016	0.009
0	0.512	0.415	0.325	0.245	0.178	0.124	0.083	0.053	0.032	0.019
-39	0.256	0.208	0.163	0.123	0.089	0.062	0.041	0.026	0.016	0.009
-78	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Field Data:	Centerline C Concentration								
	Distance from Source								

APPENDIX B

Remedial Feasibility Study Data and Engineering Calculations

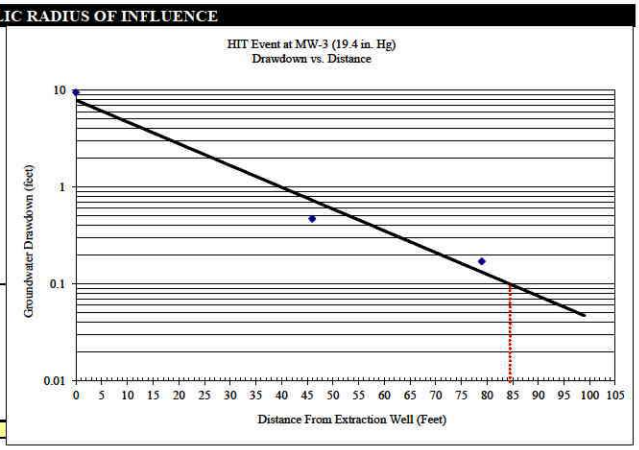
ESTIMATED RADIUS-OF-INFLUENCE
UPA Kwik Fill Station #M-209
5574 State Route 8
Barkeyville, PA
Test Date: November 2, 2016

HYDRAULIC RADIUS OF INFLUENCE

Extraction Well	**MW-3**
T Start:	8:30
T Finish:	11:55
T Data:	11:55

	Distance from MW-3 *(Feet)*	Change in Water Elevation *(Feet)*
MW-3	0.00	9.42
MW-8	35.00	0
MW-4	46.00	0.47
MW-5	79.00	0.17

Test Type:	HIT at MW-3	
Blower Type:	Gardner Denver Rotary Claw Blower	
Applied Well Vac:	19.40	in Hg
Gallons Pumped:	55.00	total gallons
Test Length:	205.00	mins
Pumping Rate:	0.27	gpm
PID Average:	188.80	ppm
Flow Rate Average:	74.0	scfm
Radius of Influence:	85	feet

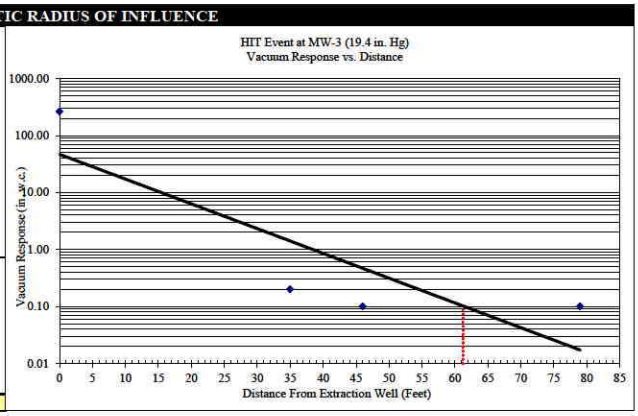


PNEUMATIC RADIUS OF INFLUENCE

Extraction Well:	**MW-3**
T Start:	8:30
T Finish	11:55
T Data	11:55

	Distance from MW-3 *(Feet)*	Vacuum Response *(in w.c.)*
MW-3	0.00	263.74
MW-8	35.00	0.20
MW-4	46.00	0.10
MW-5	79.00	0.10

Test Type:	HIT at MW-3	
Blower Type:	Gardner Denver Rotary Claw Blower	
Applied Well Vac:	19.40	in Hg
Gallons Pumped:	55.00	total gallons
Test Length:	205.00	mins
Pumping Rate:	0.27	gpm
PID Average:	188.80	ppm
Flow Rate Average:	74.0	scfm
Radius of Influence:	61	feet



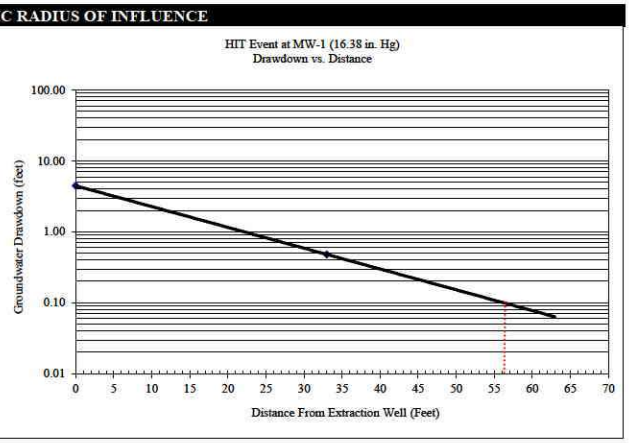
ESTIMATED RADIUS-OF-INFLUENCE
UPA Kwik Fill Station #M-209
5574 State Route 8
Barkeyville, PA
Test Date: November 2, 2016

HYDRAULIC RADIUS OF INFLUENCE

Extraction Well	**MW-1**
T Start:	12:22
T Finish:	16:10
T Data:	16:10

	Distance from MW-1 *(Feet)*	Change in Water Elevation *(Feet)*
MW-1	0.00	4.46
MW-14	33.00	0.48
MW-2	45.00	0.00

Test Type:	HIT at MW-1
Blower Type:	Gardner Denver Rotary Claw Blower
Applied Well Vac:	16.38 in Hg
Gallons Pumped:	138.00 total gallons
Test Length:	232.00 mins
Pumping Rate:	0.59 gpm
PID Average:	128.17 ppmv
Flow Rate Average:	101.0 scfm
Radius of Influence:	56 feet

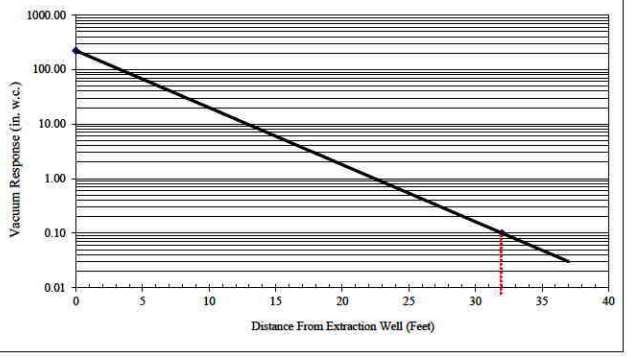


PNEUMTATIC RADIUS OF INFLUENCE

Extraction Well	**MW-1**
T Start:	12:22
T Finish:	16:10
T Data:	16:10

	Distance from MW-1 *(Feet)*	Vacuum Response *(in. w.c.)*
MW-1	0.00	222.69
MW-9	32.00	0.10
MW-12	50.00	0.00

Test Type:	HIT at MW-4
Blower Type:	Gardner Denver Rotary Claw Blower
Applied Well Vac:	16.38 in Hg
Gallons Pumped:	138.00 total gallons
Test Length:	232.00 mins
Pumping Rate:	0.59 gpm
PID Average:	128.17 ppmV
Flow Rate Average:	101.0 scfm
Radius of Influence:	32 feet



APPENDIX C

Remedial Feasibility Study Laboratory Analytical Reports, 2016

Pace Analytical Services, LLC
1638 Roseytown Road - Suites 2,3,4
Greensburg, PA 15601
(724)850-5600

November 08, 2016

Mr. Joe Hinkle
Groundwater & Environmental Services
301 Commerce Park Drive
Cranberry Twp, PA 16066

RE: Project: UPA Barkeyville
Pace Project No.: 30201397

Dear Mr. Hinkle:
Enclosed are the analytical results for sample(s) received by the laboratory on November 03, 2016. The results relate only to the samples included in this report. Results reported herein conform to the most current, applicable TNI/NELAC standards and the laboratory's Quality Assurance Manual, where applicable, unless otherwise noted in the body of the report.

If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Rachel D Christner

Rachel Christner
rachel.christner@pacelabs.com
Project Manager

Enclosures

cc: Ms. Joan Amodeo, Groundwater and Environmental Services, Inc.
Lauren Bidwell, Groundwater & Environmental Services, Inc.
Mr. Justin Paul, Groundwater & Environmental Sesrvices, Inc.

REPORT OF LABORATORY ANALYSIS

Pace Analytical Services, LLC
1638 Roseytown Road - Suites 2,3,4
Greensburg, PA 15601
(724)850-5600

CERTIFICATIONS

Project: UPA Barkeyville
Pace Project No.: 30201397

Pennsylvania Certification IDs

1638 Roseytown Rd Suites 2,3&4, Greensburg, PA 15601
L-A-B DOD-ELAP Accreditation #: L2417
Alabama Certification #: 41590
Arizona Certification #: AZ0734
Arkansas Certification
California Certification #: 04222CA
Colorado Certification
Connecticut Certification #: PH-0694
Delaware Certification
Florida/TNI Certification #: E87683
Georgia Certification #: C040
Guam Certification
Hawaii Certification
Idaho Certification
Illinois Certification
Indiana Certification
Iowa Certification #: 391
Kansas/TNI Certification #: E-10358
Kentucky Certification #: 90133
Louisiana DHH/TNI Certification #: LA140008
Louisiana DEQ/TNI Certification #: 4086
Maine Certification #: PA00091
Maryland Certification #: 308
Massachusetts Certification #: M-PA1457
Michigan/PADEP Certification
Missouri Certification #: 235
Montana Certification #: Cert 0082
Nebraska Certification #: NE-05-29-14
Nevada Certification #: PA014572015-1
New Hampshire/TNI Certification #: 2976
New Jersey/TNI Certification #: PA 051
New Mexico Certification #: PA01457
New York/TNI Certification #: 10888
North Carolina Certification #: 42706
North Dakota Certification #: R-190
Oregon/TNI Certification #: PA200002
Pennsylvania/TNI Certification #: 65-00282
Puerto Rico Certification #: PA01457
Rhode Island Certification #: 65-00282
South Dakota Certification
Tennessee Certification #: TN2867
Texas/TNI Certification #: T104704188-14-8
Utah/TNI Certification #: PA014572015-5
USDA Soil Permit #: P330-14-00213
Vermont Dept. of Health: ID# VT-0282
Virgin Island/PADEP Certification
Virginia/VELAP Certification #: 460198
Washington Certification #: C868
West Virginia DEP Certification #: 143
West Virginia DHHR Certification #: 9964C
Wisconsin Certification
Wyoming Certification #: 8TMS-L

Pace Analytical Services, LLC
1638 Roseytown Road - Suites 2,3,4
Greensburg, PA 15601
(724)850-5600

ANALYTICAL RESULTS

Project: UPA Barkeyville
Pace Project No.: 30201397

Sample: MW-3 Pre Hit **Lab ID: 30201397001** Collected: 11/02/16 07:30 Received: 11/03/16 10:20 Matrix: Water

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
8260B MSV	Analytical Method: EPA 8260B							
Benzene	**96.4**	ug/L	1.0	1		11/04/16 17:48	71-43-2	
Ethylbenzene	**51.4**	ug/L	1.0	1		11/04/16 17:48	100-41-4	
Isopropylbenzene (Cumene)	**5.5**	ug/L	1.0	1		11/04/16 17:48	98-82-8	
Methyl-tert-butyl ether	**7.5**	ug/L	1.0	1		11/04/16 17:48	1634-04-4	
Naphthalene	**46.7**	ug/L	2.0	1		11/04/16 17:48	91-20-3	
Toluene	**7.2**	ug/L	1.0	1		11/04/16 17:48	108-88-3	
1,2,4-Trimethylbenzene	**87.7**	ug/L	1.0	1		11/04/16 17:48	95-63-6	
1,3,5-Trimethylbenzene	**16.7**	ug/L	1.0	1		11/04/16 17:48	108-67-8	
Surrogates								
Toluene-d8 (S)	97	%	84-115	1		11/04/16 17:48	2037-26-5	
4-Bromofluorobenzene (S)	99	%	81-119	1		11/04/16 17:48	460-00-4	
1,2-Dichloroethane-d4 (S)	106	%	77-126	1		11/04/16 17:48	17060-07-0	
Dibromofluoromethane (S)	99	%	70-130	1		11/04/16 17:48	1868-53-7	

Pace Analytical Services, LLC
1638 Roseytown Road - Suites 2,3,4
Greensburg, PA 15601
(724)850-5600

ANALYTICAL RESULTS

Project: UPA Barkeyville
Pace Project No.: 30201397

Sample: MW-1 Pre Hit **Lab ID: 30201397002** Collected: 11/02/16 12:18 Received: 11/03/16 10:20 Matrix: Water

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
8260B MSV	Analytical Method: EPA 8260B							
Benzene	**195**	ug/L	1.0	1		11/04/16 18:15	71-43-2	
Ethylbenzene	**11.4**	ug/L	1.0	1		11/04/16 18:15	100-41-4	
Isopropylbenzene (Cumene)	ND	ug/L	1.0	1		11/04/16 18:15	98-82-8	
Methyl-tert-butyl ether	**1.9**	ug/L	1.0	1		11/04/16 18:15	1634-04-4	
Naphthalene	ND	ug/L	2.0	1		11/04/16 18:15	91-20-3	
Toluene	ND	ug/L	1.0	1		11/04/16 18:15	108-88-3	
1,2,4-Trimethylbenzene	ND	ug/L	1.0	1		11/04/16 18:15	95-63-6	
1,3,5-Trimethylbenzene	ND	ug/L	1.0	1		11/04/16 18:15	108-67-8	
Surrogates								
Toluene-d8 (S)	98	%	84-115	1		11/04/16 18:15	2037-26-5	
4-Bromofluorobenzene (S)	99	%	81-119	1		11/04/16 18:15	460-00-4	
1,2-Dichloroethane-d4 (S)	104	%	77-126	1		11/04/16 18:15	17060-07-0	
Dibromofluoromethane (S)	93	%	70-130	1		11/04/16 18:15	1868-53-7	

Pace Analytical Services, LLC
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Greensburg, PA 15601
(724)850-5600

ANALYTICAL RESULTS

Project: UPA Barkeyville
Pace Project No.: 30201397

Sample: MW-3 Post Hit **Lab ID: 30201397003** Collected: 11/02/16 14:05 Received: 11/03/16 10:20 Matrix: Water

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
8260B MSV	Analytical Method: EPA 8260B							
Benzene	**107**	ug/L	1.0	1		11/04/16 18:42	71-43-2	
Ethylbenzene	**17.8**	ug/L	1.0	1		11/04/16 18:42	100-41-4	
Isopropylbenzene (Cumene)	**19.7**	ug/L	1.0	1		11/04/16 18:42	98-82-8	
Methyl-tert-butyl ether	**8.6**	ug/L	1.0	1		11/04/16 18:42	1634-04-4	
Naphthalene	**19.5**	ug/L	2.0	1		11/04/16 18:42	91-20-3	
Toluene	**24.3**	ug/L	1.0	1		11/04/16 18:42	108-88-3	
1,2,4-Trimethylbenzene	**71.0**	ug/L	1.0	1		11/04/16 18:42	95-63-6	
1,3,5-Trimethylbenzene	**9.1**	ug/L	1.0	1		11/04/16 18:42	108-67-8	
Surrogates								
Toluene-d8 (S)	99	%	84-115	1		11/04/16 18:42	2037-26-5	
4-Bromofluorobenzene (S)	98	%	81-119	1		11/04/16 18:42	460-00-4	
1,2-Dichloroethane-d4 (S)	105	%	77-126	1		11/04/16 18:42	17060-07-0	
Dibromofluoromethane (S)	98	%	70-130	1		11/04/16 18:42	1868-53-7	

Pace Analytical Services, LLC
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Greensburg, PA 15601
(724)850-5600

ANALYTICAL RESULTS

Project: UPA Barkeyville
Pace Project No.: 30201397

Sample: MW-1 Post Hit **Lab ID: 30201397004** Collected: 11/02/16 16:35 Received: 11/03/16 10:20 Matrix: Water

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
8260B MSV	Analytical Method: EPA 8260B							
Benzene	**20.2**	ug/L	1.0	1		11/04/16 19:09	71-43-2	
Ethylbenzene	**16.0**	ug/L	1.0	1		11/04/16 19:09	100-41-4	
Isopropylbenzene (Cumene)	ND	ug/L	1.0	1		11/04/16 19:09	98-82-8	
Methyl-tert-butyl ether	**2.2**	ug/L	1.0	1		11/04/16 19:09	1634-04-4	
Naphthalene	**17.4**	ug/L	2.0	1		11/04/16 19:09	91-20-3	
Toluene	**61.5**	ug/L	1.0	1		11/04/16 19:09	108-88-3	
1,2,4-Trimethylbenzene	**28.0**	ug/L	1.0	1		11/04/16 19:09	95-63-6	
1,3,5-Trimethylbenzene	**6.0**	ug/L	1.0	1		11/04/16 19:09	108-67-8	
Surrogates								
Toluene-d8 (S)	97	%	84-115	1		11/04/16 19:09	2037-26-5	
4-Bromofluorobenzene (S)	98	%	81-119	1		11/04/16 19:09	460-00-4	
1,2-Dichloroethane-d4 (S)	104	%	77-126	1		11/04/16 19:09	17060-07-0	
Dibromofluoromethane (S)	96	%	70-130	1		11/04/16 19:09	1868-53-7	

Pace Analytical Services, LLC
1638 Roseytown Road - Suites 2,3,4
Greensburg, PA 15601
(724)850-5600

QUALITY CONTROL DATA

Project: UPA Barkeyville
Pace Project No.: 30201397

QC Batch: 239210 Analysis Method: EPA 8260B
QC Batch Method: EPA 8260B Analysis Description: 8260B MSV UST-WATER
Associated Lab Samples: 30201397001, 30201397002, 30201397003, 30201397004

METHOD BLANK: 1175463 Matrix: Water
Associated Lab Samples: 30201397001, 30201397002, 30201397003, 30201397004

Parameter	Units	Blank Result	Reporting Limit	Analyzed	Qualifiers
1,2,4-Trimethylbenzene	ug/L	ND	1.0	11/04/16 11:02	
1,3,5-Trimethylbenzene	ug/L	ND	1.0	11/04/16 11:02	
Benzene	ug/L	ND	1.0	11/04/16 11:02	
Ethylbenzene	ug/L	ND	1.0	11/04/16 11:02	
Isopropylbenzene (Cumene)	ug/L	ND	1.0	11/04/16 11:02	
Methyl-tert-butyl ether	ug/L	ND	1.0	11/04/16 11:02	
Naphthalene	ug/L	ND	2.0	11/04/16 11:02	
Toluene	ug/L	ND	1.0	11/04/16 11:02	
1,2-Dichloroethane-d4 (S)	%	107	77-126	11/04/16 11:02	
4-Bromofluorobenzene (S)	%	97	81-119	11/04/16 11:02	
Dibromofluoromethane (S)	%	103	70-130	11/04/16 11:02	
Toluene-d8 (S)	%	95	84-115	11/04/16 11:02	

LABORATORY CONTROL SAMPLE: 1175464

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
1,2,4-Trimethylbenzene	ug/L	20	18.5	92	75-128	
1,3,5-Trimethylbenzene	ug/L	20	18.9	94	74-125	
Benzene	ug/L	20	18.4	92	69-115	
Ethylbenzene	ug/L	20	18.3	91	71-116	
Isopropylbenzene (Cumene)	ug/L	20	18.9	94	79-121	
Methyl-tert-butyl ether	ug/L	20	22.3	112	83-140	
Naphthalene	ug/L	20	19.6	98	64-140	
Toluene	ug/L	20	18.0	90	70-115	
1,2-Dichloroethane-d4 (S)	%			104	77-126	
4-Bromofluorobenzene (S)	%			102	81-119	
Dibromofluoromethane (S)	%			104	70-130	
Toluene-d8 (S)	%			99	84-115	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 1175465 1175466

Parameter	Units	30201223001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Qual
1,2,4-Trimethylbenzene	ug/L	ND	20	20	20.3	21.8	101	109	69-121	7	
1,3,5-Trimethylbenzene	ug/L	ND	20	20	20.3	22.2	102	111	68-118	9	
Benzene	ug/L	ND	20	20	21.5	22.8	107	114	63-123	6	
Ethylbenzene	ug/L	ND	20	20	20.7	22.2	104	111	70-120	7	
Isopropylbenzene (Cumene)	ug/L	ND	20	20	20.4	22.4	102	112	71-129	9	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

REPORT OF LABORATORY ANALYSIS

Pace Analytical Services, LLC
1638 Roseytown Road - Suites 2,3,4
Greensburg, PA 15601
(724)850-5600

QUALITY CONTROL DATA

Project: UPA Barkeyville
Pace Project No.: 30201397

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 1175465 1175466

Parameter	Units	30201223001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Qual
Methyl-tert-butyl ether	ug/L	6.5	20	20	29.1	28.3	113	109	63-143	3	
Naphthalene	ug/L	ND	20	20	20.8	22.9	104	114	55-122	9	
Toluene	ug/L	ND	20	20	20.5	22.5	103	112	66-124	9	
1,2-Dichloroethane-d4 (S)	%						104	106	77-126		
4-Bromofluorobenzene (S)	%						98	99	81-119		
Dibromofluoromethane (S)	%						101	102	70-130		
Toluene-d8 (S)	%						101	100	84-115		

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

REPORT OF LABORATORY ANALYSIS

Pace Analytical Services, LLC
1638 Roseytown Road - Suites 2,3,4
Greensburg, PA 15601
(724)850-5600

QUALIFIERS

Project: UPA Barkeyville
Pace Project No.: 30201397

DEFINITIONS

DF - Dilution Factor, if reported, represents the factor applied to the reported data due to dilution of the sample aliquot.

ND - Not Detected at or above adjusted reporting limit.

J - Estimated concentration above the adjusted method detection limit and below the adjusted reporting limit.

MDL - Adjusted Method Detection Limit.

PQL - Practical Quantitation Limit.

RL - Reporting Limit.

S - Surrogate

1,2-Diphenylhydrazine decomposes to and cannot be separated from Azobenzene using Method 8270. The result for each analyte is a combined concentration.

Consistent with EPA guidelines, unrounded data are displayed and have been used to calculate % recovery and RPD values.

LCS(D) - Laboratory Control Sample (Duplicate)

MS(D) - Matrix Spike (Duplicate)

DUP - Sample Duplicate

RPD - Relative Percent Difference

NC - Not Calculable.

SG - Silica Gel - Clean-Up

U - Indicates the compound was analyzed for, but not detected.

N-Nitrosodiphenylamine decomposes and cannot be separated from Diphenylamine using Method 8270. The result reported for each analyte is a combined concentration.

Pace Analytical is TNI accredited. Contact your Pace PM for the current list of accredited analytes.

TNI - The NELAC Institute.

Pace Analytical Services, LLC
1638 Roseytown Road - Suites 2,3,4
Greensburg, PA 15601
(724)850-5600

QUALITY CONTROL DATA CROSS REFERENCE TABLE

Project: UPA Barkeyville
Pace Project No.: 30201397

Lab ID	Sample ID	QC Batch Method	QC Batch	Analytical Method	Analytical Batch
30201397001	**MW-3 Pre Hit**	EPA 8260B	239210		
30201397002	**MW-1 Pre Hit**	EPA 8260B	239210		
30201397003	**MW-3 Post Hit**	EPA 8260B	239210		
30201397004	**MW-1 Post Hit**	EPA 8260B	239210		

Pace Analytical®
www.pacelabs.com

Ed G
8043 958 3638

CHAIN-OF-CUSTODY / Analytical Request Document

The Chain-of-Custody is a LEGAL DOCUMENT. All relevant fields must be completed accurately.

Page: 1 of 1

2072885

Section A
Required Client Information:

Company:	CES
Address:	301 Commerce Park Drive, Cranberry Twp PA 16066
Email To:	jhinkle@cesonline.com
Phone: 800-262-2349	Fax: 724-779-4117
Requested Due Date/TAT:	Std

Section B
Required Project Information:

Report To:	Joe Hinkle
Copy To:	Joe Hinkle
Purchase Order No.:	
Project Name:	PA Barkeyville
Project Number:	

Section C
Invoice Information:

Attention:	
Company Name:	
Address:	
Pace Quote Reference:	
Pace Project Manager:	
Pace Profile #:	

REGULATORY AGENCY

- NPDES
- GROUND WATER
- DRINKING WATER
- UST
- RCRA
- OTHER ______

Site Location STATE: PA

WO#:30201397

Section D
Required Client Information

SAMPLE ID
(A-Z, 0-9 / ,-)
Sample IDs MUST BE UNIQUE

Matrix Codes MATRIX	CODE
Drinking Water	DW
Water	WT
Waste Water	WW
Product	P
Soil/Solid	SL
Oil	OL
Wipe	WP
Air	AR
Tissue	TS
Other	OT

Requested Analysis Filtered (Y/N)

ITEM #	SAMPLE ID	MATRIX CODE (see valid codes to left)	SAMPLE TYPE (G=GRAB C=COMP)	COLLECTED COMPOSITE START DATE	COMPOSITE START TIME	COMPOSITE END/GRAB DATE	COMPOSITE END/GRAB TIME	SAMPLE TEMP AT COLLECTION	# OF CONTAINERS	Unpreserved	H_2SO_4	HNO_3	HCl	NaOH	$Na_2S_2O_3$	Methanol	Other	Analysis Test: PA Diesel new list	Residual Chlorine (Y/N)	Pace Project No./ Lab I.D.
1	MW-3 Pre HVT	WT	G			11-2-16	0730		3				X					X		001
2	MW-1 Pre HVT	WT	G			11-2-16	1218		3				X					X		002
3	MW-3 Post HVT	WT	G			11-2-16	1405		3				X					X		003
4	MW-1 Post HVT	WT	G			11-2-16	~~1635~~ 1635		3				X					X		004
5																				
6																				
7																				
8																				
9																				
10																				
11																				
12																				

ADDITIONAL COMMENTS	RELINQUISHED BY / AFFILIATION	DATE	TIME	ACCEPTED BY / AFFILIATION	DATE	TIME	Temp in °C	Received on Ice (Y/N)	Custody Sealed Cooler (Y/N)	Samples Intact (Y/N)
Lab detection limit	[signature]	11-2-16	1800	FedEx	11-2-16	1800				
Gasis E00 Required				[signature]	11-3-16	1020	21	Y	Y	Y

ORIGINAL

SAMPLER NAME AND SAMPLER SIGNATURE

PRINT Name of SAMPLER: Robert McNeer

SIGNATURE of SAMPLER: [signature] DATE Signed (MM/DD/YY): 11-2-16

*Important Note: By signing this form you are accepting Pace's NET 30 day payment terms and agreeing to late charges of 1.5% per month for any invoices not paid within 30 days.

F-ALL-Q-020rev.07, 15-May-2007

Sample Condition Upon Receipt Pittsburgh

Pace Analytical

Client Name: CES Project # 30201397

Courier: ☒ Fed Ex ☐ UPS ☐ USPS ☐ Client ☐ Commercial ☐ Pace Other _____

Tracking #: 809395803638

Custody Seal on Cooler/Box Present: ☒ yes ☐ no Seals intact: ☒ yes ☐ no

Thermometer Used 7 Type of Ice: (Wet) Blue None

Cooler Temperature Observed Temp 2.3 °C Correction Factor: -0.2 °C Final Temp: 2.1 °C

Temp should be above freezing to 6°C

Date and Initials of person examining contents: 11/3/16

Comments:	Yes	No	N/A	
Chain of Custody Present:	X			1.
Chain of Custody Filled Out:	X			2.
Chain of Custody Relinquished:	X			3.
Sampler Name & Signature on COC:	X			4.
Sample Labels match COC:	X			5.
-Includes date/time/ID/Analysis Matrix: WT				
Samples Arrived within Hold Time:	X			6.
Short Hold Time Analysis (<72hr remaining):		X		7.
Rush Turn Around Time Requested:	X			8.
Sufficient Volume:	X			9.
Correct Containers Used:	X			10.
-Pace Containers Used:	X			
Containers Intact:	X			11.
Filtered volume received for Dissolved tests			X	12.
All containers needing preservation have been checked.			X	13.
All containers needing preservation are found to be in compliance with EPA recommendation.			X	
exceptions: (VOA), coliform, TOC, O&G, Phenolics				Initial when completed: HL Date/time of preservation
				Lot # of added preservative
Headspace in VOA Vials (>6mm):		X		14.
Trip Blank Present:		X		15.
Trip Blank Custody Seals Present			X	
Rad Aqueous Samples Screened > 0.5 mrem/hr			X	Initial when completed: Date:

Client Notification/ Resolution:

Person Contacted: _____ Date/Time: _____ Contacted By: _____

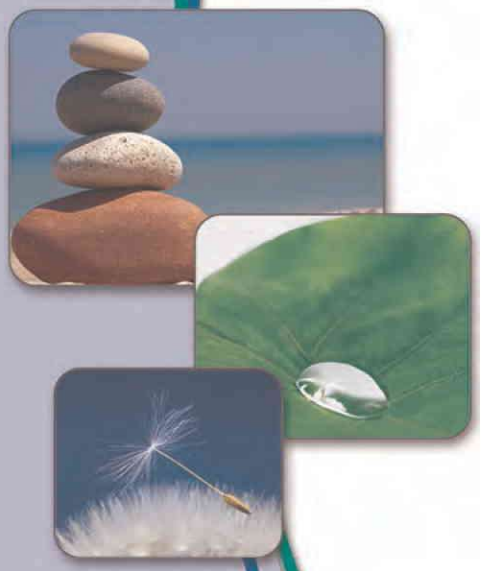
Comments/ Resolution: _____

Note: Whenever there is a discrepancy affecting North Carolina compliance samples, a copy of this form will be sent to the North Carolina DEHNR Certification Office (i.e. out of hold, incorrect preservative, out of temp, incorrect containers)

***PM review** is documented electronically in LIMS. When the Project Manager closes the SRF Review schedule in LIMS. The review is in the Status section of the Workorder Edit Screen.

TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING



ANALYTICAL REPORT

TestAmerica Laboratories, Inc.
TestAmerica Nashville
2960 Foster Creighton Drive
Nashville, TN 37204
Tel: (615)726-0177

TestAmerica Job ID: 490-115323-1
Client Project/Site: UPA Barkeyville

For:
Groundwater & Environmental Services Inc
301 Commerce Park Drive
Cranberry Township, Pennsylvania 16066

Attn: Joseph E Hinkle

Cathy Gartner

Authorized for release by:
11/8/2016 2:02:06 PM

Cathy Gartner, Project Manager I
(615)301-5041
cathy.gartner@testamericainc.com

Table of Contents

Sample Summary

Client: Groundwater & Environmental Services Inc
Project/Site: UPA Barkeyville

TestAmerica Job ID: 490-115323-1

Lab Sample ID	Client Sample ID	Matrix	Collected	Received
490-115323-1	MW-3 Influent	Air - Tedlar Bag	11/02/16 10:30	11/03/16 09:08
490-115323-2	MW-1 Influent	Air - Tedlar Bag	11/02/16 14:30	11/03/16 09:08

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CNF	Contains no Free Liquid
DER	Duplicate error ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision level concentration
MDA	Minimum detectable activity
EDL	Estimated Detection Limit
MDC	Minimum detectable concentration
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
NC	Not Calculated
ND	Not detected at the reporting limit (or MDL or EDL if shown)
PQL	Practical Quantitation Limit
QC	Quality Control
RER	Relative error ratio
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)

Client: Groundwater & Environmental Services Inc
Project/Site: UPA Barkeyville

TestAmerica Job ID: 490-115323-1

Client Sample ID: MW-3 Influent
Date Collected: 11/02/16 10:30
Date Received: 11/03/16 09:08

Lab Sample ID: 490-115323-1
Matrix: Air - Tedlar Bag

Method: EPA-18 - Volatile Organic Compounds

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,2,4-Trimethylbenzene	**1.53**		1.00	1.00	mg/m3			11/04/16 10:05	1
1,3,5-Trimethylbenzene	ND		1.00	1.00	mg/m3			11/04/16 10:05	1
Benzene	**11.4**		1.00	1.00	mg/m3			11/04/16 10:05	1
Ethylbenzene	**2.34**		1.00	1.00	mg/m3			11/04/16 10:05	1
Methyl tert-butyl ether	ND		1.00	1.00	mg/m3			11/04/16 10:05	1
Toluene	**9.79**		1.00	1.00	mg/m3			11/04/16 10:05	1
Total Hydrocarbons	**463**		10.0	10.0	mg/m3			11/04/16 10:05	1
Xylenes, Total	**12.1**		2.00	2.00	mg/m3			11/04/16 10:05	1

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,2,4-Trimethylbenzene	**0.311**		0.203	0.203	ppm v/v			11/04/16 10:05	1
1,3,5-Trimethylbenzene	ND		0.203	0.203	ppm v/v			11/04/16 10:05	1
Benzene	**3.57**		0.313	0.313	ppm v/v			11/04/16 10:05	1
Ethylbenzene	**0.539**		0.230	0.230	ppm v/v			11/04/16 10:05	1
Methyl tert-butyl ether	ND		0.277	0.277	ppm v/v			11/04/16 10:05	1
Toluene	**2.60**		0.265	0.265	ppm v/v			11/04/16 10:05	1
Total Hydrocarbons	**113**		2.45	2.45	ppm v/v			11/04/16 10:05	1
Xylenes, Total	**2.79**		0.461	0.461	ppm v/v			11/04/16 10:05	1

Client: Groundwater & Environmental Services Inc
Project/Site: UPA Barkeyville

TestAmerica Job ID: 490-115323-1

Client Sample ID: MW-1 Influent
Date Collected: 11/02/16 14:30
Date Received: 11/03/16 09:08

Lab Sample ID: 490-115323-2
Matrix: Air - Tedlar Bag

Method: EPA-18 - Volatile Organic Compounds

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,2,4-Trimethylbenzene	ND		1.00	1.00	mg/m3			11/04/16 10:31	1
1,3,5-Trimethylbenzene	ND		1.00	1.00	mg/m3			11/04/16 10:31	1
Benzene	ND		1.00	1.00	mg/m3			11/04/16 10:31	1
Ethylbenzene	ND		1.00	1.00	mg/m3			11/04/16 10:31	1
Methyl tert-butyl ether	ND		1.00	1.00	mg/m3			11/04/16 10:31	1
Toluene	**1.34**		1.00	1.00	mg/m3			11/04/16 10:31	1
Total Hydrocarbons	**42.9**		10.0	10.0	mg/m3			11/04/16 10:31	1
Xylenes, Total	ND		2.00	2.00	mg/m3			11/04/16 10:31	1

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,2,4-Trimethylbenzene	ND		0.203	0.203	ppm v/v			11/04/16 10:31	1
1,3,5-Trimethylbenzene	ND		0.203	0.203	ppm v/v			11/04/16 10:31	1
Benzene	ND		0.313	0.313	ppm v/v			11/04/16 10:31	1
Ethylbenzene	ND		0.230	0.230	ppm v/v			11/04/16 10:31	1
Methyl tert-butyl ether	ND		0.277	0.277	ppm v/v			11/04/16 10:31	1
Toluene	**0.357**		0.265	0.265	ppm v/v			11/04/16 10:31	1
Total Hydrocarbons	**10.5**		2.45	2.45	ppm v/v			11/04/16 10:31	1
Xylenes, Total	ND		0.461	0.461	ppm v/v			11/04/16 10:31	1

Method: EPA-18 - Volatile Organic Compounds

Lab Sample ID: MB 660-175822/7
Matrix: Air - Tedlar Bag
Analysis Batch: 175822

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,2,4-Trimethylbenzene	ND		1.00	1.00	mg/m3			11/04/16 08:58	1
1,3,5-Trimethylbenzene	ND		1.00	1.00	mg/m3			11/04/16 08:58	1
Benzene	ND		1.00	1.00	mg/m3			11/04/16 08:58	1
Ethylbenzene	ND		1.00	1.00	mg/m3			11/04/16 08:58	1
Methyl tert-butyl ether	ND		1.00	1.00	mg/m3			11/04/16 08:58	1
Toluene	ND		1.00	1.00	mg/m3			11/04/16 08:58	1
Total Hydrocarbons	ND		10.0	10.0	mg/m3			11/04/16 08:58	1
Xylenes, Total	ND		2.00	2.00	mg/m3			11/04/16 08:58	1

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,2,4-Trimethylbenzene	ND		0.203	0.203	ppm v/v			11/04/16 08:58	1
1,3,5-Trimethylbenzene	ND		0.203	0.203	ppm v/v			11/04/16 08:58	1
Benzene	ND		0.313	0.313	ppm v/v			11/04/16 08:58	1
Ethylbenzene	ND		0.230	0.230	ppm v/v			11/04/16 08:58	1
Methyl tert-butyl ether	ND		0.277	0.277	ppm v/v			11/04/16 08:58	1
Toluene	ND		0.265	0.265	ppm v/v			11/04/16 08:58	1
Total Hydrocarbons	ND		2.45	2.45	ppm v/v			11/04/16 08:58	1
Xylenes, Total	ND		0.461	0.461	ppm v/v			11/04/16 08:58	1

Lab Sample ID: LCS 660-175822/4
Matrix: Air - Tedlar Bag
Analysis Batch: 175822

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
1,2,4-Trimethylbenzene	20.0	18.83		mg/m3		94	50 - 150
1,3,5-Trimethylbenzene	20.0	23.14		mg/m3		116	50 - 150
Benzene	20.0	21.32		mg/m3		107	50 - 150
Ethylbenzene	20.0	21.70		mg/m3		109	50 - 150
Methyl tert-butyl ether	20.0	15.97		mg/m3		80	50 - 150
Toluene	20.0	20.65		mg/m3		103	50 - 150
Xylenes, Total	60.0	69.80		mg/m3		116	50 - 150

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
1,2,4-Trimethylbenzene	4.07	3.830		ppm v/v		94	50 - 150
1,3,5-Trimethylbenzene	4.07	4.707		ppm v/v		116	50 - 150
Benzene	6.26	6.674		ppm v/v		107	50 - 150
Ethylbenzene	4.61	4.997		ppm v/v		109	50 - 150
Methyl tert-butyl ether	5.55	4.431		ppm v/v		80	50 - 150
Toluene	5.31	5.481		ppm v/v		103	50 - 150
Xylenes, Total	13.8	16.07		ppm v/v		116	50 - 150

Lab Sample ID: 490-115323-2 DU
Matrix: Air - Tedlar Bag
Analysis Batch: 175822

Client Sample ID: MW-1 Influent
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	DU Result	DU Qualifier	Unit	D	RPD	RPD Limit
1,2,4-Trimethylbenzene	ND		ND		mg/m3		NC	30
1,3,5-Trimethylbenzene	ND		ND		mg/m3		NC	30

Method: EPA-18 - Volatile Organic Compounds (Continued)

Lab Sample ID: 490-115323-2 DU
Matrix: Air - Tedlar Bag
Analysis Batch: 175822

Client Sample ID: MW-1 Influent
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier		DU Result	DU Qualifier	Unit	D			RPD	RPD Limit
Benzene	ND			ND		mg/m3				NC	30
Ethylbenzene	ND			ND		mg/m3				NC	30
Methyl tert-butyl ether	ND			ND		mg/m3				NC	30
Toluene	1.34			1.378		mg/m3				3	30
Total Hydrocarbons	42.9			46.64		mg/m3				8	30
Xylenes, Total	ND			ND		mg/m3				NC	30

Analyte	Sample Result	Sample Qualifier		DU Result	DU Qualifier	Unit	D			RPD	RPD Limit
1,2,4-Trimethylbenzene	ND			ND		ppm v/v				NC	30
1,3,5-Trimethylbenzene	ND			ND		ppm v/v				NC	30
Benzene	ND			ND		ppm v/v				NC	30
Ethylbenzene	ND			ND		ppm v/v				NC	30
Methyl tert-butyl ether	ND			ND		ppm v/v				NC	30
Toluene	0.357			0.3656		ppm v/v				3	30
Total Hydrocarbons	10.5			11.40		ppm v/v				8	30
Xylenes, Total	ND			ND		ppm v/v				NC	30

Air - GC/MS VOA

Analysis Batch: 175822

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
490-115323-1	MW-3 Influent	Total/NA	Air - Tedlar Bag	EPA-18	
490-115323-2	MW-1 Influent	Total/NA	Air - Tedlar Bag	EPA-18	
MB 660-175822/7	Method Blank	Total/NA	Air - Tedlar Bag	EPA-18	
LCS 660-175822/4	Lab Control Sample	Total/NA	Air - Tedlar Bag	EPA-18	
490-115323-2 DU	MW-1 Influent	Total/NA	Air - Tedlar Bag	EPA-18	

Client Sample ID: MW-3 Influent

Lab Sample ID: 490-115323-1

Date Collected: 11/02/16 10:30

Matrix: Air - Tedlar Bag

Date Received: 11/03/16 09:08

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	EPA-18		1	175822	11/04/16 10:05	ECC	TAL TAM

Client Sample ID: MW-1 Influent

Lab Sample ID: 490-115323-2

Date Collected: 11/02/16 14:30

Matrix: Air - Tedlar Bag

Date Received: 11/03/16 09:08

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	EPA-18		1	175822	11/04/16 10:31	ECC	TAL TAM

Laboratory References:

TAL TAM = TestAmerica Tampa, 6712 Benjamin Road, Suite 100, Tampa, FL 33634, TEL (813)885-7427

Method Summary

Client: Groundwater & Environmental Services Inc
Project/Site: UPA Barkeyville

TestAmerica Job ID: 490-115323-1

Method	Method Description	Protocol	Laboratory
EPA-18	Volatile Organic Compounds	EPA	TAL TAM

Protocol References:

EPA = US Environmental Protection Agency

Laboratory References:

TAL TAM = TestAmerica Tampa, 6712 Benjamin Road, Suite 100, Tampa, FL 33634, TEL (813)885-7427

Certification Summary

Client: Groundwater & Environmental Services Inc
Project/Site: UPA Barkeyville

TestAmerica Job ID: 490-115323-1

Laboratory: TestAmerica Nashville

All certifications held by this laboratory are listed. Not all certifications are applicable to this report.

Authority	Program	EPA Region	Certification ID	Expiration Date
A2LA	A2LA		NA: NELAP & A2LA	12-31-17
A2LA	ISO/IEC 17025		0453.07	12-31-17
Alaska (UST)	State Program	10	UST-087	07-24-17
Arizona	State Program	9	AZ0473	05-05-17
Arkansas DEQ	State Program	6	88-0737	04-25-17
California	State Program	9	2938	10-31-16 *
Connecticut	State Program	1	PH-0220	12-31-17
Florida	NELAP	4	E87358	06-30-17
Georgia	State Program	4	N/A	12-31-17
Illinois	NELAP	5	200010	12-09-16 *
Iowa	State Program	7	131	04-01-18
Kansas	NELAP	7	E-10229	11-30-16 *
Kentucky (UST)	State Program	4	19	06-30-17
Kentucky (WW)	State Program	4	90038	12-31-16 *
Louisiana	NELAP	6	30613	06-30-17
Maine	State Program	1	TN00032	11-03-17
Maryland	State Program	3	316	03-31-17
Massachusetts	State Program	1	M-TN032	06-30-17
Minnesota	NELAP	5	047-999-345	12-31-16 *
Mississippi	State Program	4	N/A	06-30-17
Montana (UST)	State Program	8	NA	02-24-20
Nevada	State Program	9	TN00032	07-31-17
New Hampshire	NELAP	1	2963	10-09-17
New Jersey	NELAP	2	TN965	06-30-17
New York	NELAP	2	11342	03-31-17
North Carolina (WW/SW)	State Program	4	387	12-31-16 *
North Dakota	State Program	8	R-146	06-30-17
Ohio VAP	State Program	5	CL0033	07-10-17
Oklahoma	State Program	6	9412	08-31-17
Oregon	NELAP	10	TN200001	04-27-17
Pennsylvania	NELAP	3	68-00585	06-30-17
Rhode Island	State Program	1	LAO00268	12-30-16 *
South Carolina	State Program	4	84009 (001)	02-18-17
South Carolina (Do Not Use - DW)	State Program	4	84009 (002)	12-16-17
Tennessee	State Program	4	2008	02-23-17
Texas	NELAP	6	T104704077	08-31-17
USDA	Federal		P330-13-00306	12-01-16 *
Utah	NELAP	8	TN00032	07-31-17
Virginia	NELAP	3	460152	06-14-17
Washington	State Program	10	C789	07-19-17
West Virginia DEP	State Program	3	219	02-28-17
Wisconsin	State Program	5	998020430	08-31-17
Wyoming (UST)	A2LA	8	453.07	12-31-17

Laboratory: TestAmerica Tampa

All certifications held by this laboratory are listed. Not all certifications are applicable to this report.

Authority	Program	EPA Region	Certification ID	Expiration Date
Florida	NELAP	4	E84282	06-30-17
Georgia	State Program	4	905	06-30-17

* Certification renewal pending - certification considered valid.

Laboratory: TestAmerica Tampa (Continued)

All certifications held by this laboratory are listed. Not all certifications are applicable to this report.

Authority	Program	EPA Region	Certification ID	Expiration Date
USDA	Federal		P330-14-00159	05-07-17

TestAmerica Nashville
2960 Foster Creighton Drive
Nashville, TN 37204
Phone (615) 726-0177 Fax (615) 726-3404

Chain of Custody Record

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

Client Information	Sampler: Robert Manous	Lab PM: Gartner, Cathy	Carrier Tracking No(s): 6526 3848 4085	COC No: 490-42610-9503.1
Client Contact: ~~Caitlin Conte~~ Joe Hinkle	Phone: 724-316-7992	E-Mail: cathy.gartner@testamericainc.com		Page: Page 1 of 1
Company: Groundwater & Environmental Services Inc				Job #:

Address: 301 Commerce Park Drive	Due Date Requested: STD	Analysis Requested	Preservation Codes:
City: Cranberry Township	TAT Requested (days): STD		A - HCL, B - NaOH, C - Zn Acetate, D - Nitric Acid, E - NaHSO4, F - MeOH, G - Amchlor, H - Ascorbic Acid, I - Ice, J - DI Water, K - EDTA, L - EDA, M - Hexane, N - None, O - AsNaO2, P - Na2O4S, Q - Na2SO3, R - Na2S2O3, S - H2SO4, T - TSP Dodecahydrate, U - Acetone, V - MCAA, W - ph 4-5, Z - other (specify)
State, Zip: PA, 16066			
Phone: 800-267-2549(Tel) 724-779-4617(Fax)	PO #: Purchase Order not required		
Email: ~~cconte~~ JHinkle @gesonline.com	WO #:		Other:
Project Name: UPA Barkeyville	Project #: 49001235		
Site: UPA Barkeyville	SSOW#:		

Sample Identification	Sample Date	Sample Time	Sample Type (C=comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	EPA_18 - (MOD) EPA 18 BTEX/MTBE/TPH/TMBs	GRO/MTBE, 124-TMB's	Total Number of containers	Special Instructions/Note:
			Preservation Code			N				
MW-3 Influent	11-2-16	1030	G	A			X	X		
MW-1 Influent	11-2-16	1430	G	A			X	X		

490-115323 Chain of Custody

Loc: 490
115323

Possible Hazard Identification	Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☒ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown ☐ Radiological	☐ Return To Client ☐ Disposal By Lab ☐ Archive For ____ Months
Deliverable Requested: I, II, III, IV, Other (specify)	Special Instructions/QC Requirements:

Empty Kit Relinquished by:	Date: 08-08-16	Time: 1645	Method of Shipment: FX

Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
	11-2-16 / 1500	GES	FedEx	11-2-16 / 1500	FedEx
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
				11-3-16 @ 0845	TA TPA
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company

Custody Seals Intact: Δ Yes Δ No	Custody Seal No.:	Cooler Temperature(s) °C and Other Remarks: 22.4 / 22.6 CW-09

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11/8/2016

Login Sample Receipt Checklist

Client: Groundwater & Environmental Services Inc

Job Number: 490-115323-1

Login Number: 115323
List Number: 1
Creator: Gartner, Cathy

List Source: TestAmerica Nashville

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.		
The cooler's custody seal, if present, is intact.		
Sample custody seals, if present, are intact.		
The cooler or samples do not appear to have been compromised or tampered with.		
Samples were received on ice.		
Cooler Temperature is acceptable.		
Cooler Temperature is recorded.		
COC is present.		
COC is filled out in ink and legible.		
COC is filled out with all pertinent information.		
Is the Field Sampler's name present on COC?		
There are no discrepancies between the containers received and the COC.		
Samples are received within Holding Time (excluding tests with immediate HTs)		
Sample containers have legible labels.		
Containers are not broken or leaking.		
Sample collection date/times are provided.		
Appropriate sample containers are used.		
Sample bottles are completely filled.		
Sample Preservation Verified.		
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs		
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").		
Multiphasic samples are not present.		
Samples do not require splitting or compositing.		
Residual Chlorine Checked.		