2019 Washington Street, East
Charleston, WV 25305
Telephone: 304-558-2306
General Fax: 304-558-6026
Bid Fax: 304-558-3970

West Virginia Purchasing Division

The following documentation is an electronically-submitted vendor response to an advertised solicitation from the *West Virginia Purchasing Bulletin* within the Vendor Self-Service portal at *wvOASIS.gov*. As part of the State of West Virginia's procurement process, and to maintain the transparency of the bid-opening process, this documentation submitted online is publicly posted by the West Virginia Purchasing Division at *WVPurchasing.gov* with any other vendor responses to this solicitation submitted to the Purchasing Division in hard copy format.

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Welcome, Lu Anne Cottrill

Procurement | Budgeting | Accounts Receivable | Accounts Payable

Solicitation Response(SR) | **Dept:** 0313 | **ID:** ESR07232000000000370 | **Ver.:** 1 | **Function:** New | **Phase:** Final

Modified by batch , 07/29/2020

Header 4

List View

General Information | Contact | Default Values | Discount | Document Information

Procurement Folder: 713506

Procurement Type: Central Master Agreement

Vendor ID: VS0000022883

Legal Name: Strategic Risk Services, LLC

Alias/DBA:

Total Bid: $50,400.00

Response Date: 07/23/2020

Response Time: 13:19

SO Doc Code: CRFQ

SO Dept: 0313

SO Doc ID: DEP2100000002

Published Date: 7/14/20

Close Date: 7/29/20

Close Time: 13:30

Status: Closed

Solicitation Description: Open-end contract for Environmental Risk Assessment

Total of Header Attachments: 4

Total of All Attachments: 4

Purchasing Division
2019 Washington Street East
Post Office Box 50130
Charleston, WV 25305-0130

State of West Virginia
Solicitation Response

Proc Folder : 713506

Solicitation Description : Open-end contract for Environmental Risk Assessment

Proc Type : Central Master Agreement

Date issued	Solicitation Closes	Solicitation Response	Version
	2020-07-29 13:30:00	SR 0313 ESR07232000000000370	1

VENDOR
VS0000022883 Strategic Risk Services, LLC

Solicitation Number: CRFQ 0313 DEP2100000002

Total Bid : $50,400.00 **Response Date:** 2020-07-23 **Response Time:** 13:19:42

Comments:

FOR INFORMATION CONTACT THE BUYER
Joseph E Hager III
(304) 558-2306
joseph.e.hageriii@wv.gov

Signature on File **FEIN #** **DATE**

All offers subject to all terms and conditions contained in this solicitation

Line	Comm Ln Desc	Qty	Unit Issue	Unit Price	Ln Total Or Contract Amount
1	Risk or hazard assessment	700.00000	HOUR	$72.000000	$50,400.00

Comm Code	Manufacturer	Specification	Model #
77101501			

Extended Description : Environmental Risk Assessor Open end contract for service, bid sheet represents an estimated number of hours for bidding purposes to establish a contracted set price per hour.

Comments: Performance period as per Work Directive.

JOHN J. MAHFOOD

Senior Technical Advisor

EDUCATION

M.S. Health Aspects of Water Quality (1987)-University of Pittsburgh
B.S. Chemistry (1980)-University of Pittsburgh

FIELDS OF SPECIALIZATION

Public Health and Ecological Risk Assessments
Environmental Impact Assessments
Evaluation of Remedial Alternatives
Project Management
Analytical Chemistry
Indoor Air Quality and Vapor Intrusion
Environmental Education
PCB MegaRule
Residential Evaluations
Toxicological Assessments
Evaluation of Regulatory Criteria
Development of Alternative Criteria
Probabilistic Modeling
Statistical Analysis of Data
Property Re-Use Scenarios
Environmental Covenants/Land Use Covenants

EXPERIENCE SUMMARY

Mr. Mahfood has over 40 years of combined environmental experience in project management, human health risk assessment, property re-use scenarios and analytical chemistry. He has focused on the technical requirements under Pennsylvania's Land Recycling and Environmental Remediation Standards Act (Act 2) including the latest issues associated with potential vapor intrusion and indoor air quality. Mr. Mahfood has completed over 400 risk assessments throughout his career. Mr. Mahfood has also worked on a variety of state led voluntary remediation programs across the United States including Ohio, North Carolina, South Carolina, Idaho, Louisiana, Massachusetts, and West Virginia. He has also worked on various federal programs across the country, including Superfund and both Air Force and Navy programs. Mr. Mahfood has also worked as the lead risk assessment specialist/project manager on over 70 former manufactured gas plant (MGP) sites in the United States. Mr. Mahfood has provided environmental health assessments to the natural gas and electric power industry for over 30 years.

Mr. Mahfood has worked on many sites where he has developed a variety of strategic approaches for site closure utilizing unique aspect and tools of quantitative risk assessment. Many of Mr. Mahfood's clients have relied on his site-specific data evaluation methods and procedures that reduce the need for further remediation. More recently, Mr. Mahfood has utilized various quantitative methods for deriving exposure point concentrations for the construction/utility worker scenarios in un-deeded right of ways, including segmentation of the utility corridors. Mr. Mahfood has also recently been utilizing refined fate and transport assessments to establish whether potential downgradient exposure to groundwater impacts exist. Recently, Mr. Mahfood has proposed alternative approaches to limiting exposure within a utility right-of-way in order to reduce the need for costly remediation.

Mr. Mahfood has also been focusing his technical efforts on how deed restrictions and land use covenants can support the redevelopment of properties without placing significant burden on the property owner and how it affects the property value for future sale.

Mr. Mahfood has recently worked with the West Virginia Department of Environmental Protection (WVDEP), Division of Land Restoration, to assist in the review of human health and ecological risk assessments associated with the voluntary remediation and redevelopment program. Mr. Mahfood served as the technical lead for this contract under The Mahfood Group LLC® with the associated work having focused on the following:

- Review of public health and ecological risk assessments
- Assist and coordinate development of technical topics for use in the review of quantitative risk assessments under the program

- Interact with both WVDEP project managers and risk assessors to assist in project coordination including scope of work development and review for the site assessments
- Perform site visits in support of the technical review
- Perform quantitative reviews of all calculations, fate and transport assumptions and modeling
- Review of conceptual site model (CSM) design
- Develop technical comments to be addressed by the entity submitting the risk assessment report
- Coordinate with the consulting firm submitting the risk assessment report to expedite and streamline technical responses
- Perform toxicological evaluations on emerging chemicals
- Assist in developing soil attainment criteria for the underground and aboveground storage tank program

Mr. Mahfood has also worked with the WVDEP to update their underground and aboveground storage tank program by integrating a new approach to streamline the soil closure portion of the program and remove sites more efficiently. Mr. Mahfood has also assisted WVDEP with updating technical spreadsheets that were utilized to derive WVDEP regulatory screening values.

Mr. Mahfood has also conducted Phase I Environmental Site Assessments, Interim Remedial Measures, and Phase II Field Investigations at former MGP facilities. These projects included all aspects of agency negotiations to solicit a phased approach outlined in a decision flow diagram. He has coordinated all activities associated with the removal of coal tar material from above ground and below ground gas holders and associated MGP structures. Mr. Mahfood has also been responsible for conducting quantitative risk assessments at many different types of industrial/commercial facilities across the country, including both RCRA and Superfund sites. In addition, Mr. Mahfood has assisted many clients on projects related to either bulk storage facilities or large gas compressor stations.

SELECTED PROJECT EXPERIENCE

- Mr. Mahfood was responsible for oversight and management of a residual risk assessment that evaluated potential impacts to an adjacent right-of-way. Due to increasing plume trends observed in the vicinity of the source area, a post-remedial care plan was necessary to monitor future plume migration to off-site areas. This post-remedial care plan incorporated periodic sampling of select monitoring wells based on a complex hydrogeologic CSM. A site-specific series of groundwater monitoring criterion were developed for both on-site and off-site receptors (both direct contact and vapor intrusion) in order to assess future groundwater results to confirm continued attainment of PADEP risk benchmark criteria.

- Mr. Mahfood developed a complex conceptual site model supported by a statistical analysis to demonstrate attainment of the background standard under Act 2. MTBE was demonstrated to be migrating from an upgradient source onto a site with a separate UST release. The analysis utilized upper tolerance limits to show that the concentrations in the site background reference well were not exceeded in any point of compliance wells at the site. This evaluation required a complex hydrogeologic model to demonstrate the extensive MTBE plume migration within a specific aquifer.

- Mr. Mahfood has recently coordinated and developed a site-specific CSM to address chlorinated compounds within a groundwater matrix. This included development of a portion of the hydrogeologic CSM to explain the attenuative capacity of the site-specific subsurface conditions limiting constituent migration off-site to a residential area.

- Mr. Mahfood has lent his expertise in toxicological evaluations for a variety of site-specific closures under various state regulatory programs.

- Mr. Mahfood has completed the conceptualization and implementation of a post-remedial care plan to address potential intrusive activity exposure within a right-of-way. This included a complete statistical analysis of groundwater analytical data to support the derivation of remedial goals that will be utilized for long-term monitoring.

- Mr. Mahfood has recently managed the installation of a groundwater recovery trench system adjacent to a wetland in order to mitigate oil-impacted groundwater migrating to the wetlands and adjacent surface water features. Also, as part of this project, Mr. Mahfood is assessing various environmental media utilizing C8-C40 semi-quantitative molecular characterization.

- Mr. Mahfood was the lead risk assessor for a project where historical environmental impacts within the subsurface have migrated to adjacent offsite residential properties. The environmental impacts are at least 25 below ground surface and are likely not impacting the current commercial facility. However, the offsite impacts adjacent to the commercial facility are much shallower (3 to 5 feet below ground surface) and were found to be present beneath the residential properties. This could have consequences with respect to future residential use. The project is in the final stages of a comprehensive environmental investigation. In addition, the potential for off-site residential exposure has been mitigated through a series of interim remedial actions. Further supplemental assessment is currently being conducted to address potential direct contact exposures (which include within public right-of-way) and remaining vapor intrusion pathways.

- Mr. Mahfood was the lead risk assessment specialist on a bulk chemical facility in Pennsylvania. The facility has had many historic releases of various types of chemicals over time. The facility is approximately 30 acres in size and presents a unique challenge in how data is manipulated to present potential chemical exposure from these releases. A comprehensive conceptual site model is being development which will allow for the partitioning of data in order to create realistic and cost-effective exposure scenarios. This type of approach will limit any unnecessary remedial activities and still comply with state regulatory requirements.

- Mr. Mahfood has developed and implemented a post remedial care program to monitor sites that have been closed under various regulatory programs. This post remedial care program consists of information/data collection to ensure that post remedial care obligations are being met. The information is archived into a data base and reports are submitted to the appropriate agency on a regular basis.

- Environmental covenants (EC)/Land Use Covenants (LUC) are a critical part of site closure under many state led remediation projects. Mr. Mahfood has developed and implemented the necessary institutional controls for site closure and has prepared many EC/LUC as part of post remedial care obligations. These types of projects require a complete understanding of existing local ordinances and how they affect the current and future use of the property.

- Mr. Mahfood has worked on a former manufacturing/plating facility where PCB sediment migration in drainage ditches was a potential issue. A historic review of the plant operations was completed to focus in on the potential sources of PCBs on the facility. With a refined strategic approach for sampling, PCBs were shown to attenuate to near acceptable levels, and biological issues associated with the sediment were of less concern when incorporating a biological assessment of the sediment. Therefore, the only remaining issue was to evaluate potential residual exposures to sediment for a trespasser.

- Mr. Mahfood has worked on a bulk petroleum storage facility outside the United States, which presents a unique set of issues related to applicable guidance and criteria for completion of the quantitative risk assessment. An in-depth analysis of potential exposure scenarios was completed for the local community and a preliminary conceptual site model was developed using numerous alternative guidance documents and methods for obtaining environmental field data to be used in the quantitative risk assessment.

- Mr. Mahfood has worked within the electric power generation industry assisting his clients on the latest issues associated with coal fired power plants, including toxicological evaluations of coal fired power plant bi-products and ash material. He has also been involved in a variety of issues associated with electric substations.

- Mr. Mahfood has worked on various aspects associated with the gas industry and related impacts for development of natural gas compressor stations, including the development of site specific clean up criteria when Act 2 criteria are not available.

- A former industrial plant encompassing approximately 16 acres was evaluated by Mr. Mahfood utilizing the site-specific standard under Pennsylvania's Act 2 program which affords a property owner the option to assess site specific risks using various current and potential future use scenarios. The site was divided into three future development parcels. Each parcel was addressed separately with site specific scenarios. One primary issue with the site was the diffuse groundwater discharge to surface water with impacts of chlorinated solvents and an identified preferential pathway also leading to the surface water via an historic catch basin system. Based on the results of the risk assessment a series of remedial action objectives were developed by Mr. Mahfood giving the property owner cost effective alternatives to address the surface water issues.

- Mr. Mahfood was the lead consultant for developing and implementing a PCB monitoring program for a Pennsylvania utility under the federal PCB MegaRule Program Part 761. Responsibilities included developing sampling protocols, establishing a data base management system, working with the utility to update their natural gas pipeline system data base identifying PCB locations and developing system wide protocols for implementing mitigation measures.

- Mr. Mahfood has performed quantitative risk assessments on a variety of sites with mercury impacts. These evaluations focused on manometer repair buildings, compressor stations, and various other types of units where mercury impacts occurred (e.g. Superfund Sites). Of special interest for some of the projects was a complete understanding of how mercury may migrate within the structures (and external to the structures) where repairs took place (especially those facilities with wooden floors). Mercury migration as it is considered in quantitative risk assessments was very important in order to not underestimate the potential for receptors to be exposed outside the primary release area.

- Mr. Mahfood has worked as the lead risk assessor on numerous petroleum/underground storage tank sites located in both Pennsylvania and West Virginia under their respective voluntary programs. These assessments focused the use of risk assessment on addressing environmental impacts in order to place these sites back into use. Preliminary conceptual site modeling was paramount in converging the investigative activities to address those areas of the site that could create the most significant risk and then will help to develop specific remedial action objectives to mitigate any risk benchmark exceedances. Most of the site conceptual models addressed nonresidential use; however, several of the sites needed to address future residential use and recreational use as part of the risk assessment.

- Mr. Mahfood has focused a considerable amount of time on vapor intrusion and indoor air quality. He has worked closely with a nationally recognized air laboratory to develop and refine soil gas sampling procedures and indoor air sampling methodologies utilizing his combined public health and chemistry background with specific focus on residential indoor air.

- Mr. Mahfood conducted a risk assessment on a former MGP located in Wilmington, NC. Investigative activities for this site were conducted under an Administrative Order on Consent (AOC). Current use of the site included a senior housing facility, a public boat ramp, and an abandoned industrial facility. The surrounding area includes residential properties. The site contained the typical MGP residual source areas. Because a portion of the MGP site is currently used and the other portion is being considered for future development, a variety of future use exposure scenarios were developed to focus the risk assessment. By incorporating reasonable future use scenarios at the beginning of the process and working together with the various interested parties, a significant cost savings can be realized for this site.

- One of Mr. Mahfood's latest projects involved the West Virginia Voluntary Remediation Program (VRP). The site is located in Kenova, West Virginia along the Ohio River. The site was a former industrial facility that housed a variety of industrial activities over the years. Mr. Mahfood was acting as both Sr. Project Manager and Sr. Risk Assessment Specialist on the project. The site has many unique characteristics including the involvement of multiple VRP's due to environmental impacts on adjacent properties, some of which have migrated and consequently impacted the site. Activities involving Mr. Mahfood's experience at the site included multiple years of assessment and remediation. Beginning with a strategy meeting with the WVDEP, a unique approach was developed to address impacts at the site. This approach included addressing the soil and groundwater impacts (vapor intrusion from shallow perched zones) first. This approach enabled progression of the site investigation activities related to the soil independent of the deep groundwater issues which were a result of other entities and are being addressed under separate VRP's.

A risk-based approach was utilized at the beginning of the project to develop a CSM which focused the program on soil and the perched groundwater (vapor intrusion only). This process was helpful in centering the remedial investigation efforts on the end use and producing analytical data necessary for the site-specific risk assessment. As part of the baseline risk assessment (BRA) for the site, Mr. Mahfood developed reasonable scenarios which addressed both current site situations and the future use based on knowledge of the surrounding area and the interest of adjacent property owners in the site. The BRA used both default and site-specific inputs and assumptions which resulted in a conservative approach in order to develop potential remedial action objectives (RAOs). The BRA results indicated the need to address surface soil due to excess lead in two small areas of the site.

Therefore, Mr. Mahfood oversaw the preparation of a Remedial Action Plan (RAP) that was prepared and implemented to reduce the surface soil lead concentration to an acceptable level as demonstrated by the conduct of a residual risk assessment (RRA). Mr. Mahfood worked closely with the WVDEP project manager in order to delineate the remediation area and to collect post excavation samples necessary for use in the RRA.

In the conduct of this risk assessment process along with other risk assessments performed by Mr. Mahfood, he has utilized the most recent accepted methodologies in developing CSMs, fate and transport evaluation, receptor analysis, statistical analysis, quantitative assessment and uncertainty analysis. This project recently received a No Further Action Letter from the WVDEP.

- Mr. Mahfood was a program manager for a multi-site MGP program being conducted under a Consent Order and Agreement (COA) in accordance with Pennsylvania's Land Recycling and Environmental Remediation Standards Act (commonly known as Act 2). Mr. Mahfood's responsibility included managing 8-10 MGP sites on an annual basis under this program. Project activities have included Phase I activities, Remedial Investigations, Risk Assessments, Interim Remedial Activities, Cleanup Plans and Final Report documentation.

  As part of this program, generic documents (e.g., Generic Work Plan, Generic QAPP and Generic HASP) have been developed. These generic plans facilitate the use of generic procedures on a site-specific basis. The client realizes a significant cost savings by utilizing these types of generic documents.

  As an important element of the multi-site program, Mr. Mahfood participated in program meetings with the Pennsylvania Department of Environmental Protection (PADEP) once a year to discuss program and technical issues. These meetings included five of the six PADEP regions and PADEP's central office. These meetings acted as the forum to discuss technical issues before they become problematic on a particular project (or program wide).

  Under this program, Mr. Mahfood completed management of a site investigation and cleanup where a detailed delineation of a basal confining unit was performed in order to determine the potential for coal tar migration. This activity enabled the placement of a product recovery system in an area where coal tar accumulation was most prominent. In addition, delineation of this unit also was useful for the placement of piezometers to monitor potential migration during recovery efforts and show that the coal tar was not migrating to the point of compliance (i.e., property boundary).

The site activities have also included project objectives which have focused on reuse, including benefits for the site owner, local municipality and the local community. Mr. Mahfood has conducted a site-specific risk assessment for this property which incorporated very specific end use activities including a little league baseball field and supporting facilities (e.g. parking lot). Based on the risk assessment findings, it was determined that an engineered control along with deed restrictions on intrusive activities and an incomplete pathway for groundwater use would satisfy Act 2 requirements for closure and offer this site for reuse to the local community. This site has recently been closed under Act 2 and a relief of liability has been granted. The site was also designated as one of PADEP's "Showcase Sites" under the Land Recycling Program.

- Mr. Mahfood was project manager for the investigation and interim remedial action (IRA) phases and senior risk assessment specialist for a former manufactured gas plant site located in Pennsylvania. This site was also evaluated under the multi-site program. The site is adjacent to a recreational surface water body and a boat ramp to access the river. Based on the results of the IRA (which included the removal of approximately 700 tons of coal tar from a below grade gas holder) and the risk assessment, the final remedy for the site included an engineered cover and natural attenuation. The natural attenuation portion was supported by groundwater modeling activities to demonstrate that there was no direct impact to the adjacent surface water body. The results of these activities invited the local municipality to purchase the property and designate the site as "green space" to help encourage additional recreational use of the river. This site received a relief of liability under Act 2.

- Mr. Mahfood was project manager and lead risk assessor for an MGP site where purifier waste was identified as the primary MGP waste. This material was distributed along the surface of the site. He led the initial investigation activities to determine the vertical and horizontal extent of the purifier waste. Based on the site investigation, Mr. Mahfood coordinated hot spot removal of certain areas exceeding applicable Act 2 medium-specific standards and performed a residual risk assessment demonstrating acceptable site-specific risks. Subsequent to the removal and risk assessment activities, the area was returned to beneficial use as a parking lot for the local gas company. A relief of liability was granted for this site under Act 2.

- Mr. Mahfood was the lead risk assessment specialist for two site-specific risk assessments utilizing both U.S. EPA Region 4 and State of North Carolina Guidance for a manufactured gas plant site located in North Carolina. The site consisted of two separate parcels where very different conceptual site models were developed to account for the distinct differences in current and potential future site use. The results of the risk assessment showed that for the one parcel only surgical soil removal would be necessary to meet site use and acceptable risk levels. While the other parcel met acceptable risk levels and no remedial alternative was necessary. A key element of both risk assessments was the development of a risk-based approach with consideration of potential current and future use and the use of reasonable exposure scenarios.

- Mr. Mahfood has completed the risk assessment on a former MGP site in North Carolina where the future development will be for recreational boating activities. Based on the planned future use, Mr. Mahfood was able to develop site-specific exposure scenarios which will limit removal of historic MGP materials to those contained in below grade structures (e.g. below grade holder and tar wells).

- Mr. Mahfood worked on a site-specific risk assessment in North Carolina where historic manufactured gas plant operations were conducted and more recently the site was used as a dry cleaner. The complicating factor with this site was the combined constituent list of manufactured gas plant residuals and dry cleaner chemicals. An office currently occupies a small portion of the site; however, the remainder of the site is unoccupied (with some vacant structures). The risk-based approach plays a very important role for redevelopment of the property. Redevelopment plans are incorporated into the risk-based approach therefore, enabling the refinement of a conceptual site model and the development of realistic potential exposure input parameters based on the future use, especially when considering potential exposure pathways such as vapor intrusion.

- As a Senior Environmental Risk Analyst, Mr. Mahfood has performed public health environmental assessments for industrial clients as part of remedial investigations and the development of various risk-based approaches. The types of sites include: coke plants, manufactured gas plants, wood treating plants, and coal tar refineries. He has provided expertise in the development of potential human exposure and environmental pathways and fate and transport analysis of site related chemicals in the environment.

- Mr. Mahfood has been involved in probabilistic cost modeling for various confidential clients. He has worked on and developed input parameters and methods for describing various probability distributions for use in the modeling.

- Mr. Mahfood was lead risk assessor for an industrial site where he compared the benefits of performing a deterministic risk assessment versus a probabilistic risk assessment and weighed the cost of each against a favorable outcome in order to show that implementation of a remedy was not necessary. This assessment was conducted under the Ohio VAP and saved the client approximately $500,000 dollars in remediation costs.

- Mr. Mahfood historically focused his efforts on evaluating the potential for reuse of "waste" material as a product for retail sale. He performed a risk assessment under Pennsylvania's Residual Waste Regulations to establish wood ash as a coproduct for various commercial uses (e.g., as a soil amendment, road base material). The activities associated with this risk assessment required a complete understanding of the manufacturing process which generated the wood ash, potential reuse markets, chemical breakdown of the material, potential use scenarios and a unique understanding of use specific exposure parameters.

- The following technical specialties support Mr. Mahfood's efforts acting as both project manager and risk assessment specialist for many of his projects. They include public health risk and environmental impact assessments, utilizing deterministic assessments and probabilistic analysis, chemical/analytical program development, contaminant fate and transport and statistical analysis. Mr. Mahfood performed qualitative and quantitative health risk and environmental assessments for superfund remedial investigations and feasibility studies. One of his Superfund projects included a risk assessment for a car battery reclamation site where lead was the major environmental concern. This assessment not only included an evaluation of potential exposure to lead, but an assessment of how the lead would migrate in the environment based on the acidic conditions as a result of the battery acid.

- Mr. Mahfood has been responsible for the preparation of sampling and analysis plans, including budgeting and scheduling of associated analytical activities. Mr. Mahfood's background in analytical chemistry has assisted him in selecting the appropriate analytical methods necessary to accomplish project quality objectives and to assure attainment of chemical criteria.

- Mr. Mahfood has also completed public health and environmental assessments for uncontrolled waste sites and developed comprehensive validation procedures for the evaluation of analytical data on several remedial investigations for the U.S. Department of Defense. These sites included Air Force bases, with a focus on the risk associated with exposure to the various areas where training activities were completed (e.g., burn pits).

- As a Chemist, Mr. Mahfood coordinated the analysis and data review of water and soil samples under Superfund protocol for the analysis of pesticides, herbicides and PCBs. Mr. Mahfood has a complete analytical background in the analysis of industrial wastes by gas chromatography, including volatile compounds, PCBs, herbicides, base/neutral, and acids. He has also analyzed water samples for inorganic ions by ion chromatography and performed a variety of wet chemical analyses for inorganic constituents.

- Mr. Mahfood has developed quality control procedures, including routine quality control charts along with a complete statistical analysis to monitor and review test results on a daily basis. He has also performed analysis on other media such as acid mine drainage, industrial effluents, home drinking water and coal samples.

PARTIAL LIST OF SELECTED PUBLICATIONS/PRESENTATIONS

Hale, J.R., J.J. Mahfood, and R.J. Hickman, 1999. *Evaluating Natural Attenuation of Dissolved Coal Gasification Derivatives in Shallow Unconfined Aquifers.* Presented at the IGT Twelfth International Symposium on Environmental Biotechnologies and Site Remediation Technologies & Utility Industry Environmental Issues, Challenges, and Solutions. December 1999.

Hasel, Michael, J.J. Mahfood, Anthony Mazzoni. A Case Study for Cost Effective Control of MGP Site Remediation Risks with a Fabric Structure in a Residential Setting. Presented at the Gas Technology Conference & Exhibition, Orlando, Florida. January 30-February 2, 2005.

Hayes, Heidi, J.J. Mahfood, B. Shamory. Comparison of EPA Compendium Methods TO-15 and TO-17 for the Measurement of Naphthalene in Soil Gas. Presented at Business of Brownfields Conference, April 17-18, 2008.

Hoff, Richard F., John J. Mahfood, Amanda L. McGuinness. Sustainable Benefits of Urban Farming as a Potential Brownfields Remedy. Business of Brownfields Conference, Pittsburgh, PA. April 2010.

Hoff, Richard F., Tammi Halapin, John J. Mahfood. Effects of Changing Regulatory Paradigms on Brownfield Viability and Sustainability. Business of Brownfields Conference, Pittsburgh, PA. April 2009.

Hoff, Richard F., Tammi Halapin, John J. Mahfood. Practical Considerations in Sustainability. Business of Brownfields Conference, Pittsburgh, PA. April 2009.

Kotun, RJ., and J.J. Mahfood, 1994. Deriving a Practical and Cost-Effective Soil Remedial Goal for Carcinogenic PAHs. Presented at Superfund 1994, December 1994.

Kupchella, L., A. Syty, and J.J. Mahfood, 1983. Improved Apparatus for Rapid Mercury Determination by Cold Vapor Atomic Absorption Spectroscopy. Journal of the Association of Official Analytical Chemists, September 1983, Volume 66, pp. 1117-1120.

Mahfood, J.J., Andrew Swales, 2011. Karst Geology, Vapor Intrusion and Human Health Risk Assessment – Fundamental Issues to Consider. Growing Communities on Karst 2011 and the Great Valley Water Resources Science Forum, September 2011.

Mahfood, J.J., Mary Washko, 2010. Risk Assessment and a Multi-Phased Approach to Investigating TCE Plume in Karst. Growing Communities on Karst 2010 and the Great Valley Water Resources Science Forum, September 2010.

Mahfood, J.J., B.D. Shamory, H. Hayes, 2007. Vapor Intrusion Pathways, Evaluating Naphthalene. Presented at the Business of Brownfields Conference, April, 2007.

Mahfood, J.J., M. Ferlin, R. Contrael, Dougherty, A. Lopez, D. Shier, 2006. Stratified Soil Gas Sampling at an MGP Site for Use in a Quantitative Risk Assessment, A Case Study. Presented at Gas Technology Conference and Exhibition, Orlando, Florida, October 2006.

Mahfood, J.J., Richard E. Baker, Jr., Jennifer M. Malle. Utilizing a Risk-Based Approach to Reduce Soil Excavation Costs. Presented at the Gas Technology Conference & Exhibition, Orlando, Florida. January 30-February 2, 2005.

Mahfood, J.J., D.J. Wingerd, and R.J. Kotun, 1994. A Decision Flow Chart for Cleanup of Multiple Manufactured Gas Plant Sites. Presented at HMCRI Federal Environmental Restoration III and Waste Minimization II Conference and Exhibition, New Orleans, LA, April 1994.

Malle, J.M., J.J. Mahfood, and A.C. Swales, 2001. Co-Product Determination-Applying State Residual Waste Regulations for Re-Use of Fly-Bottom Ash Material as a Retail Product. Presented at the Gas Technology Institute 14th Annual International Conference. December 2-6, 2001.

Shamory, Craig S., J.J. Mahfood, Andrew C. Swales. An Innovative Method for Presenting and Evaluating the Hydrogeologic and Exposure Aspects of a Risk-Based Site Closure. Presented at the Gas Technology Conference & Exhibition, Orlando, Florida. January 30-February 2, 2005.

Shamory, Brett, Smith, Lisa, 2015. Evaluation of Virginia DEQ Trench Model for Construction/Utility Worker Exposure Pathway Risk Assessment. Presented at the Pennsylvania Brownfields Conference. 2015. Co-contributor – John J. Mahfood.

Shosky Jr., D.J., J.J. Mahfood, R.A. Brown, and M. Jackson, Jr., 1995. Emerging Technologies for Recycling MGP Sites. Pollution Engineering, June 1995, Volume 27, Number 6, pp. 62-66.

Swales, A.C., J.J. Mahfood, J.R. Hale, E. Meyer, and M.J. Hasel, 2000. Remediation, Restoration, Re-Use: Accomplishing the Three R's of MGP Site Revitalization. Presented at the Gas Technology Institute Thirteenth International Symposium on Site Remediation Technologies & Environmental Management Practices in the Utility Industry. December 4-7, 2000.

Shaw, Bruce, L. Smith, and J. J. Mahfood, 2014. Risk Assessment to Support Multi-Phase Brownfields Redevelopment. Presented at the 2014 West Virginia Brownfields Conference. September 11 and 12, 2014.

Urbassik, Mark, Smith, Lisa, 2012. A Different Paradigm for Brownfield Assessments/Remediation. Presented at the Pennsylvania Brownfields Conference. 2012. Co-authored by John J. Mahfood.

EDUCATION

B.S. Environmental Science (2009) - Summa Cum Laude
California University of Pennsylvania

TRAINING

OSHA HAZWOPER Course (40 hr Initial / 8 hr Refresher Annually)
ASTM E1527 Phase I Training
PADEP Vapor Intrusion Guidance Training – 2017

FIELDS OF SPECIALIZATION

Human Health and Ecological Risk Assessments
Conceptual Site Model Development
Vapor Intrusion Assessment
Statistical Evaluation of Analytical Data/ Data Management
Environmental Covenants/Land Use Covenants

EXPERIENCE SUMMARY

Ms. Poppelreiter has over nine years of environmental consulting experience as a former employee of The Mahfood Group, LLC® and is currently an employee of Strategic Risk Services, LLC. Areas of expertise include conceptual site model development, vapor intrusion assessments, quantitative human health risk assessments, ecological assessments, and third-party reviews of risk assessment reports. She has focused on the technical requirements under Pennsylvania's Land Recycling and Environmental Remediation Standards Act (Act 2), but is also very familiar with the West Virginia Voluntary Remediation and Redevelopment Act (VRRA) program, Ohio Voluntary Action Program (VAP) program, and the Massachusetts Contingency Plan (MCP). Ms. Poppelreiter has completed a multitude of risk assessments under Act 2 Chapters 245 and 250 ranging from small underground storage tank (UST) sites to former manufactured gas plant (MGP) sites to large, chlorinated sites with no comments from the PADEP. Her experience also extends beyond the baseline risk assessment, assisting with remedial action objectives, post-remedial care plans, and environmental covenants/land use covenants.

SELECTED WORK/PROJECT EXPERIENCE

Ms. Poppelreiter has sufficient experience in statistical evaluation of analytical data, procedures for screening of analytical data against appropriate media-specific criteria (i.e. various federal and state criteria), toxicity assessments, quantitative risk assessments, and development of complex conceptual site models in order to efficiently and effectively close sites under various state standards. She has assisted in the development of site investigation reports, baseline and residual risk assessments, cleanup/remedial action plans, and final reports. In addition, she has completed the 40-hr online OSHA HAZWOPER training and a training course for ASTM E1527 Phase I ESA.

Ms. Poppelreiter has taken the lead on many risk assessment reports. She has a solid understanding of the equations, parameters, and calculations necessary to complete a risk assessment using models from Pennsylvania as well as other states such as Virginia. She is familiar with the most recent chemical properties and toxicity criteria available through a hierarchy of resources. She is also familiar with using on-line search tools such as the PA Groundwater Information System (PaGWIS) online database and the Pennsylvania Natural Diversity Inventory (PNDI) environmental review tool. She is competent in utilizing ProUCL, a comprehensive statistical software package, in order to perform statistical analyses of analytical data to develop exposure point concentrations. She has performed numerous risk calculations and has written comprehensive reports for a multitude of risk assessments.

Ms. Poppelreiter has utilized a number of various fate and transport models to estimate exposure point concentrations. These include the Johnson and Ettinger (J&E) model (to estimate indoor air concentrations), the Virginia Department of Environmental Quality (VA DEQ) trench model (to estimate trench air concentrations from groundwater), and groundwater transport models such as BIOSCREEN, Quick Domenico, and SWLOAD/PENTOXSD. She has assisted in developing a model that represents a wet basement and a sump scenario in order to estimate indoor air concentrations in which groundwater conditions limited the use of the J&E model. The VA DEQ trench model was creatively incorporated to this site-specific situation.

Ms. Poppelreiter has also completed third-party reviews of human health and ecological risk assessment reports under West Virginia's voluntary remediation program. She is knowledgeable about the West Virginia VRRA rules and regulations and has commented on a multitude of site assessment reports and risk assessment reports to provide constructive feedback on properly following the VRP guidance. Ms. Poppelreiter has worked closely with WVDEP project managers in regards to writing and resolving technical comments. She has also participated in various site visits in support of completing site characterization activities that fulfill the WVDEP requirements to prepare a human health and ecological risk assessment.

Ms. Poppelreiter has assisted with the re-development of WVDEP's Leaking Underground Storage Tank (LUST) and Leaking Aboveground Storage Tank (LAST) program in regards to development of soil screening standards. The purpose was to develop updated soil screening standards that will allow efficient screening of sites through the LUST/LAST program, but still be health protective. The proposed soil screening standards were developed primarily based on risk-based methods that are protective of both direct contact and vapor intrusion exposure pathways. She had prepared a conceptual flow chart of steps that guides a remediator through the soil screening process and identified what limiting factors prevent the use of the proposed soil screening standards. Ms. Poppelreiter has also assisted WVDEP with updating technical spreadsheets that were utilized to derive WVDEP regulatory screening values.

Ms. Poppelreiter has participated in a complex risk assessment for a site in which a catch basin served as a preferential pathway and discharged into a culvert, which then discharged into an adjacent stream. Assessment of a recreational user of the stream and the stream itself was strategically evaluated in two parts. One part was the direct discharge from the culvert and the other part was diffuse discharge of groundwater upstream of the culvert discharge point. A site-specific surface water concentration was back-calculated for the recreational user under several scenarios (varying dermal exposure) in order to determine an acceptable surface water concentration that would be below an acceptable risk benchmark.

Ms. Poppelreiter has worked on a large site under the residual waste program that involved a complex hydrogeologic conceptual site model. Numerous conservative assumptions were used to select constituents of interests to further evaluate the potential for constituents in groundwater to migrate to various surface water features. The results of complex groundwater fate and transport modeling processes were used to develop final surface water constituents of interest that were further evaluated in the conceptual site model and quantitative risk assessment. Each surface water feature was evaluated separately based on its unique physical characteristics and potential exposure scenarios, including direct contact with surface water and ingestion of fish.

Ms. Poppelreiter has assisted in a residual risk assessment for a former MGP site. A residual risk assessment was conducted in order to derive remedial goals that would reduce the overall hazard index and cancer risk to acceptable levels for each receptor at the site. This required each receptor and exposure pathway to be evaluated in order to determine which pathway(s) contributed the most risk and as a result was chosen as the basis of the remedial action goals that were calculated. These remedial goals were calculated to be protective of all receptors evaluated at the site.

Ms. Poppelreiter has performed statistical analyses on quarterly groundwater data under a National Pollutant Discharge Elimination System (NPDES) Permit. This analysis utilized the tolerance interval procedure to calculate tolerance limits based on the background well data and compared data from four compliance monitoring wells in order to determine if there is a statistically significant increase in concentration over the background well.

Ms. Poppelreiter has also had experience in the field participating in perimeter air monitoring during an interim response action excavation and assisting in collecting waste water disposal samples. She is familiar with the use of air monitoring equipment such as photoionization detector (PID) devices. She has also had a significant part of an on-going annual PCB (polychlorinated biphenyls) sampling program in which liquid samples were collected from accumulation in components from natural gas distribution pipeline systems across western Pennsylvania and tested for PCBs. Ms. Poppelreiter has worked closely with analytical laboratories to have samples from various media analyzed, starting from development of the analytical scope of work to management of the final lab results.

Ms. Poppelreiter has performed research on alternative methods for estimating trench air concentrations for a construction worker/utility worker scenario. This included site-specific modifications to existing trench air models (e.g. VADEQ model) based on USEPA Region 8 documents. Modifications to the trench dimensions and air exchange rate play a significant role in estimating trench air concentrations. This evaluation also included utilization of soil gas data and utilization of direct air measurements collected within a trench via Summa canisters. Alternative methods based on Andelman studies were also considered during this evaluation.

Ms. Poppelreiter has prepared a risk assessment for a petroleum refinery and chemical storage terminal located outside of the United States. Extensive research on local bye-laws and environmental protection acts was conducted to build the regulatory framework under which to prepare the risk assessment. Regulations from USEPA, Florida, Hawaii, and Puerto Rico were also considered. The risk assessment was completed to support the facility's long-term vision for remediation of historical releases of crude oil and petroleum products beneath the terminal.

Ms. Poppelreiter has worked on many sites where she has developed a variety of strategic approaches for site closure utilizing unique aspect and tools of quantitative risk assessment. She has utilized site-specific data evaluation methods and procedures that reduced the need for further remediation. Ms. Poppelreiter has employed various quantitative methods for deriving exposure point concentrations for the construction/utility worker scenarios in un-deeded right of ways, including segmentation of the utility corridors.

Ms. Poppelreiter is currently participating in a project where historical environmental impacts within the subsurface have migrated to adjacent off-site residential properties. The environmental impacts on-site are at least 25 ft below ground surface and are likely not impacting the current commercial facility. However, the off-site impacts adjacent to the commercial facility are much shallower (3 to 5 ft below ground surface) and may potentially be beneath the residential properties. This could have consequences with respect to future residential use. The project is in the final stages of a comprehensive environmental investigation. In addition, the potential for off-site residential exposure has been mitigated through a series of interim remedial actions. Further supplemental assessment is currently being conducted to address potential direct contact exposures (which include within public right-of-ways) and remaining vapor intrusion pathways.

Ms. Poppelreiter has worked as the lead risk assessor on numerous petroleum/underground storage tank sites located in both Pennsylvania and West Virginia under their respective voluntary programs. These assessments focus the use of risk assessment on addressing environmental impacts in order to place these sites back into use. A solid conceptual site model is crucial in determining the areas of the site and types of receptors that could create the most significant risk. Most of the site conceptual models addressed nonresidential use; however, several of the sites needed to address future residential use and recreational use as part of the risk assessment.

Ms. Poppelreiter has prepared a Method 3 Risk Characterization Report following regulatory requirements and guidelines for the Massachusetts Contingency Plan. The Method 3 Risk Characterization Report assessed the conditions of a petroleum retail facility and potential exposures in order to determine that no significant risk of harm to human health, public welfare, safety, or environmental exist at the site.

Ms. Poppelreiter has prepared a property-specific risk assessment report for a former dry cleaner facility under the Ohio VAP. The risk assessment originally evaluated the site under a commercial scenario when the former dry cleaner was a vacant space. However, the vacant former dry cleaner was then converted into a child day-care facility. The change in use of the property required a re-evaluation of the use of the facility (i.e. residential use) and a re-evaluation of potential receptors (e.g. children, parents, day care workers, etc.) that may be exposed to chlorinated vapors beneath the building.

Ms. Poppelreiter has also been responsible for developing and updating generic work plan documents for a multi-site consent order and agreement (COA) in the state of Pennsylvania. She also was responsible for several annual plans under various COAs that summarize activities completed from the ending year and projected activities for the following year. Points are accrued for each activity as a means of tracking financial spending on the sites under the COA, which is reported to PADEP each year. Ms. Poppelreiter has attended annual meetings with entities under the COAs, including PADEP project managers.

Ms. Poppelreiter has experience training entry level employees on the risk assessment process, including following appropriate regulatory guidance procedures, understanding the screening process for selection of constituents of interest, evaluation of applicable receptors and exposure pathways, and calculating quantitative risks.

Ms. Poppelreiter has taken part in public presentations that outreached to the general public as well as environmental professionals. For example, she gave a powerpoint presentation at the 2012 PA Brownfields Conference on the conservative nature of risk assessments based on conservative assumptions, parameters, and other factors that additively produce an overall conservative risk assessment. She has also presented at the 2014 WV Brownfields Conference on the complex nature of preferential pathways to surface water, and she has presented at the 2015 PA Brownfields Conference discussing an evaluation of the VADEQ trench model and exploring site-specific alternatives.

Ms. Poppelreiter has experience preparing environmental covenants (ECs) for dozens of properties based on the institutional and/or engineering controls required for the property. This includes researching the property's tax parcel information, preparing a description of contamination and remedy, and summarizing activity and use limitations.

SELECTED PRESENTATIONS

Urbassik, Mark, L. Smith, 2012. A Different Paradigm for Brownfield Assessments/Remediation. Presented at the 2012 Pennsylvania Brownfields Conference. Co-authored by John J. Mahfood.

Shaw, Bruce, L. Smith, and J. J. Mahfood, 2014. Risk Assessment to Support Multi-Phase Brownfields Redevelopment. Presented at the 2014 West Virginia Brownfields Conference. September 11 and 12, 2014.

Shamory, Brett, L. Smith, 2015. Evaluation of Virginia DEQ Trench Model for Construction/Utility Worker Exposure Pathway Risk Assessment. Presented at the 2015 Pennsylvania Brownfields Conference. Co-authored by John J. Mahfood and Chad Hunter.

KEMRON
ENVIRONMENTAL SERVICES
108 Craddock Way, Suite 5 • Poca, WV 25159 • TEL 304-755-0999 • FAX 304-755-0990

June 2, 2020

Mr. Mike Sutphin
Project Manager
West Virginia Department of Environmental Protection
Office of Environmental Remediation
1159 Nick Rahall Greenway
Fayetteville, WV 25840
michael.s.sutphin@wv.gov

Re: Revised Human Health and Ecological Risk Assessment Report
Former 7-Eleven Facility #135
44 Main Street
Rainelle, Greenbrier County, West Virginia
WV ID# 1-301286; Leak ID# 92-119-L13; UECA

Dear Mr. Sutphin,

On behalf of Fortune Brands Home & Security (Fortune Brands), KEMRON Environmental Services, Inc. (KEMRON) hereby submits to the West Virginia Department of Environmental Protection (WVDEP) two (2) copies of the attached *Revised Human Health and Ecological Risk Assessment Report* for the above-referenced facility. Additionally, one (1) copy of the attached report has been submitted to the WVDEP Charleston office for filing purposes.

The attached revised risk assessment demonstrates that the estimated risks to potentially exposed receptors at the Site are below the acceptable cancer risk ranges established by both West Virginia and the United States Environmental Protection Agency (EPA). Non-cancer hazard risks are also below the accepted hazard quotient of 1.0.

A Land Use Covenant will be recorded on the property deed that will restrict future Site use to Commercial, preclude groundwater extraction, and limit any future building construction to a slab-on-grade floor utilizing a vapor barrier or vapor mitigation system to prevent exposure to soil and groundwater during excavation activities and to avoid potential vapor intrusion.
The future use of the Site is anticipated to remain solely as Commercial in nature. Additionally, a Land Use Covenant will be prepared for the Site restricting future use of the Site to remain Commercial in nature. Therefore, the future anticipated on-site receptors include only Construction/Utility Workers.

Estimated carcinogenic risks and noncarcinogenic hazard indices (HI) for on-Site Commercial/Industrial Workers are below the WVDEP industrial benchmark values of 1×10^{-5} and 1, respectively.

If you have any questions or comments concerning this report, please feel free to contact me at (304) 755-0999.

Sincerely,
KEMRON Environmental Services, Inc.

Abdo D. Chaber, LRS
Senior Project Manager

Attachment

cc: Mr. Dennis McKinney, Fortune Brands
Mr. Montgomery Bennett, Haley & Aldrich, Inc.
Mr. Greg Rogers, Zek, Inc. (grogers@rtrogers.com)
WVDEP File Copy (depoerfilecopy@wv.gov)

Revised Human Health and Ecological Risk Assessment Report

Former 7-Eleven Facility #135
44 Main Street
Rainelle, Greenbrier County, West Virginia

Prepared for:

Mr. Dennis McKinney
Fortune Brands Home & Security
520 Lake Cook Road
Deerfield, Illinois 60015

Prepared by:

The Mahfood Group LLC®
1061 Waterdam Plaza Drive, Suite 201
McMurray, Pennsylvania 15317

WV ID No. 1-301286

LEAK ID No. 92-119-L13

TMG Project No. 17057-001

March 2020

Abdo D. Chaber, LRS
Senior Project Manager
KEMRON Environmental Services, Inc.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ATTACHMENTS

Executive Summary

This document presents the human health and ecological risk assessment for the Former 7-Eleven Facility #135 (site) in Rainelle, West Virginia. The risk assessment was completed following the West Virginia Department of Environmental Protection (WVDEP) rules, regulations, and guidelines outlined in the Title 60 Code of State Regulations, Series 3 Voluntary Remediation and Redevelopment Rule (referred to as the "Rule" in this report) [WVDEP 2018], the West Virginia Voluntary Remediation Program Guidance Manual [WVDEP 2019a], and the User Guide for Risk Assessment of Petroleum Releases [WVDEP 1999].

As specified in Section 60-3-8.2.d of the Rule [WVDEP 2018] and Section 3.5.1 in the WV VRP Guidance Manual [WVDEP 2019a], at least ten percent of the analytical data utilized in the risk assessment has been validated in accordance with standard EPA protocols. The most recent De Minimis values (effective June 1, 2017) [WVDEP 2017] were utilized to screen the analytical data. Soil analytical data were screened against the WVDEP industrial soil, residential soil, and migration to groundwater De Minimis standards. Groundwater analytical data were screened against the WVDEP groundwater De Minimis standards and the USEPA commercial and residential vapor intrusion screening level (VISL) target groundwater concentrations. Based on the screened analytical data, constituents of concern (COC) were retained in groundwater for applicable direct contact and vapor intrusion exposures for on-site receptors and in groundwater for direct contact exposures for off-site receptors. There was also a residential direct contact COC retained in soil for on-site and off-site receptors. No commercial direct contact COC were retained in soil.

Migration routes were retained based on the detection of constituents in the media and the potential for those constituents to migrate within the media or to other media. The retained migration routes included:

- <u>On-Site Surface/Subsurface Soil</u>: volatilization of constituents to outdoor air and indoor air and leaching from surface/subsurface soil to groundwater;
- <u>On-Site Groundwater</u>: volatilization of constituents to outdoor air and indoor air and migration from on-site groundwater to off-site groundwater; and,
- <u>Off-Site Groundwater</u>: volatilization of constituents to outdoor air and indoor air.

Based on the current use and anticipated future use of the site, the most likely receptors were evaluated. Potential exposure pathways were evaluated for each receptor. Those exposure pathways that were determined to be a complete exposure pathway were retained for the quantitative risk assessment, except for those exposure pathways that will be made incomplete by means of an institutional/engineering control in a land use covenant (LUC). The receptors and exposure pathways retained for the quantitative risk assessment are:

- On-Site Construction Worker and Utility Worker – Dermal contact with and inhalation of volatiles in trench air from exposed groundwater within a trench (during intrusive activities); and,

- On-Site Maintenance Worker – Inhalation of volatiles from unexposed groundwater to outdoor air (without intrusive activities).

Groundwater is not currently used at the site and therefore potable use exposure pathways were not retained for current site receptors. Potable use exposure pathways for off-site receptors were not retained because these properties are also supplied by potable water provided by the Town of Rainelle.

Note that the dermal contact and inhalation of volatiles from exposed groundwater exposure pathways were also retained for an off-site construction worker and utility worker in the James River and Kanawha Turnpike right-of-way (ROW), both on the northern side (adjacent to the on-site property) and on the southern side (south/southwest of the on-site property). However, the quantitative analysis for the on-site construction/utility worker was completed and is protective of the off-site construction/utility workers in the James River and Kanawha Turnpike ROW.

The site will be restricted to commercial/industrial use only; therefore, residential receptors were not evaluated in this risk assessment. Note that future potable use of groundwater (i.e. ingestion, dermal contact, and inhalation of volatiles) for on-site receptors were considered as potentially complete exposure pathways but will be addressed with an institutional control (i.e. restrict groundwater use on the property). Lastly, potential vapor intrusion of constituents in groundwater to indoor air in a future on-site building was considered a potentially complete exposure pathway, but will be addressed with an institutional and/or engineering control (e.g. require installation of a vapor barrier or vapor mitigation system).

An ecological screening was completed for the site. The "Checklist to Determine the Applicable Remediation Standards, Part 1: Ecological Standards", provided in Attachment 5 of the WV VRP Guidance Manual [WVDEP 2019a], was used in the ecological screening process. The checklist follows the ecological De Minimis screening evaluation outlined in Section 60-3-9.5 of the Rule [WVDEP 2018]. The ecological checklist indicated "no further ecological evaluation is required" for the site. An evaluation of site conditions concluded that it is unlikely that the site would serve as a habitat for terrestrial species and discharge of site-related constituents via diffuse groundwater flow does not reach the nearest surface water body above surface water quality criteria.

Exposure point concentrations (EPCs) for groundwater were derived for the source area and the entire on-site property. EPCs for the source area were upper confidence levels (UCLs) of the mean concentration derived using the 8 most recent groundwater samples (i.e. collected between December 2010 and August 2016) from on-site groundwater monitoring well MW-3/MW-3R. EPCs for the entire site were UCLs of the mean concentration using the 8 most recent groundwater samples from all on-site groundwater monitoring wells (i.e., MW-1 through MW-3/3R). Applicable chemical properties (where available) were selected using the June 2014 WVDEP-Approved Chemical Specific Data (available online at WVDEP's website). Otherwise, alternative sources were used to obtain chemical properties. Due to the fact that the June 2014 WVDEP-Approved Chemical Specific Data table [WVDEP 2014] is an outdated table with older toxicity values, the most recent toxicity values were obtained following the hierarchy of sources presented in Section 60-3-8.1.c.1 in the Rule [WVDEP 2018].

Receptor-specific exposure assumptions were selected using WVDEP recommended values, when available. Otherwise, alternative sources were used, such as recommended values from other state program guidance or USEPA guidance, or professional judgment (based on site-specific information). The estimated total carcinogenic risks and noncarcinogenic hazard indices (HI) for all quantitatively evaluated receptors are at or below the WVDEP industrial benchmark values of $1{\times}10^{-5}$ and 1, respectively.

Note that if any of the exposure assumptions and/or assessment change in the future for this site, the results of this risk assessment analysis do not apply. The Mahfood Group LLC® is not responsible for the misinterpretation or misuse of this risk assessment executive summary. It is recommended that the user of this risk assessment read through the entire risk assessment report.

1 Introduction

This document presents the human health and ecological risk assessment for the Former 7-Eleven Facility #135 (site) in Rainelle, West Virginia. The site is currently under the West Virginia Uniform Environmental Covenants Act (UECA) Program and Leaking Underground Storage Tank (LUST) program (WVDEP Leak ID #92-119-L13). The risk assessment was completed following the WVDEP rules, regulations, and guidelines outlined in the Title 60 Code of State Regulations, Series 3 Voluntary Remediation and Redevelopment Rule (i.e. the Rule) [WVDEP 2018]; the West Virginia Voluntary Remediation Program Guidance Manual [WVDEP 2019a]; and the User Guide for Risk Assessment of Petroleum Releases [WVDEP 1999].

A human health and ecological Risk Assessment Report (RAR) has been prepared to complete the requirements of the WVDEP UECA and LUST programs for a retail petroleum facility (i.e. 7-Eleven Facility #135). The RAR assessed the residual risk under a nonresidential scenario at the site following a petroleum release. The purpose of this RAR is to evaluate the potential risks to human health and the environmental from exposure to site-related constituents. The RAR was prepared based on the characterization results presented in the August 2017 Supplemental Site Assessment Report [KEMRON 2017]. The Supplemental Site Assessment Report was approved by WVDEP on October 31, 2017.

This report is organized into ten sections including this section (the Introduction). The subsequent sections include:

- Section 2: This section presents the location and description of the site, and site history including previous site investigations and remedial actions.
- Section 3: This section presents the analytical results and selection of constituents of concern.
- Section 4: This section presents the conceptual site model (CSM) for the site. The site CSM consists of a groundwater use discussion, hydrogeologic CSM, groundwater fate and transport modeling, human health CSM, and an ecological screening.

- Section 5: This section presents the procedures that were used to develop exposure point concentrations for the direct contact exposure pathways.

- Section 6: This section presents constituent-specific parameters used in the site-specific risk assessment including chemical properties, toxicological values, and permeability constants.

- Section 7: This section presents the absorbed dose equations for the dermal contact exposure pathway, exposure concentration equations for the inhalation exposure pathway, and assumptions used to calculate constituent exposure parameters.

- Section 8: This section presents the calculated risks and hazard indices.

- Section 9: This section presents an uncertainty analysis regarding the risk assessment.

- Section 10: This section contains the references cited in this document.

Various tables, figures, and attachments are also presented as part of this document and are referenced where appropriate in the text.

2 Site Background and Setting

This section presents a description of the site location and current site features, and a history of the site including previous site investigations and remedial actions.

2.1 Current Site Location and Description

The former 7-Eleven Facility #135 (site) is a retail petroleum gasoline station and convenience store located at 44 Main Street in Rainelle, Greenbrier County, West Virginia. The property is located on the U.S. Geological Survey Map of the Charleston, West Virginia Quadrangle at 37° 58' 08.17" North and 80° 45' 59.08" West at an elevation of approximately 2,408 feet above mean sea level, as shown on **Figure 1**. The site is approximately 0.45 acres in size. The facility is currently operated as the K&S Mini Mart and consists of a commercial brick building with an underground storage tank (UST) system. The UST system consists of one (1) dispenser island, two (2) gasoline USTs, and associated piping. The current UST system has been used exclusively for gasoline storage. The majority of the ground surface is paved with asphalt and concrete. The general topography for the site is flat with topographic highs to the north and south of the site. **Figure 2** presents the site map that shows current site features. The current use of the site is commercial/industrial and is anticipated to remain commercial/industrial in the future.

The site is bounded to the north/northwest by Main Street (U.S. Route 60), to the south/southwest by James River and Kanawha Turnpike, and to the east by a vacant lot and Rainelle water building. A paved parking lot and commercial building (i.e. Heilig Myers Store) are located north and across Main Street. A commercial property (i.e. Western Auto Store) is located south/southwest of the site across James River and Kanawha Turnpike. The site is serviced by the public water supply provided by the town of Rainelle. Site-specific information on underground utility lines is unknown. However, it was assumed that underground utilities at the site and in the adjacent road right-of-ways (ROWs) are likely to be approximately 6 feet below ground surface (ft-bgs) or less based on typical underground utility line depths and the relatively shallow depth to groundwater at the site (approximately 5.5 ft-bgs on average). Groundwater on-site predominantly flows in the southwest direction. The closest surface water feature to the site is Sewell Creek which is located approximately 0.1 miles (i.e. approximately 500 feet) west of the site.

2.2 Site History

The site history presented here was originally provided in the WVDEP-approved August 2017 Supplemental Site Assessment Report [KEMRON 2017]. Fortune Brands Home & Security (Fortune Brands) has entered the site into the UECA program in an effort to obtain No Further Action (NFA) status for WVDEP Leak #92-119-L13.

On July 3, 2001, KEMRON supervised the advancement of five (5) environmental soil borings utilizing Geoprobe® direct-push technology to depths ranging from 12 to 16 ft-bgs. The purpose of these investigations was to evaluate the extent of petroleum hydrocarbon impacts in soil and groundwater downgradient (south) of the site. Laboratory analytical results for the July 3, 2001 soil sampling event indicated adsorbed-phase constituent concentrations were below the applicable West Virginia LUST Soil Cleanup Guidelines in all soil samples collected.

Following soil sample collection, groundwater samples were collected from each Geoprobe® boring using a peristaltic pump and polyethylene tubing inserted through the Geoprobe® rods. Laboratory analytical results for groundwater samples obtained from the Geoprobe® borings on July 3, 2001 indicated that benzene concentrations detected in the groundwater sample collected from SB-2 (69 µg/L), located off the western tip of the site at the intersection of James River and Kanawha Turnpike and U.S. Route 60, exceeded the West Virginia LUST Groundwater Protection Standard (5 µg/L).

On July 17, 2001, KEMRON oversaw the installation of three (3) off-site monitoring wells designated as MW-4 through MW-6 to evaluate the presence or absence of dissolved-phase petroleum hydrocarbons downgradient of the site.

In an effort to address petroleum hydrocarbon impacts at the facility, KEMRON performed enhanced soil vapor extraction utilizing a vacuum truck to evacuate impacted groundwater and vapors from monitoring well MW-3 on a monthly basis from September 2001 through January 2002. Due to the ineffectiveness of this technology at the site as evidenced by limited vacuum radius of influence, KEMRON discontinued well vacuum events in January 2002 and began utilizing sodium persulfate oxidizing compound for in-situ chemical oxidation in groundwater monitoring wells MW-2 and MW-3. In addition, KEMRON began sodium persulfate addition at monitoring well MW-4 in December 2002. Sodium persulfate addition was discontinued after the fourth quarter 2007.

On October 11, 2005, KEMRON mobilized to the site to oversee the installation of extraction well EXT-1, in accordance with the WVDEP's requirement for an additional extraction well downgradient of monitoring well MW-3. Vacuum extraction activities were initiated at the site on November 30, 2005 using KEMRON's mobile treatment unit (MTU), equipped with dual-phase, high vacuum extraction (DPHVE) technology. MTU events were conducted monthly to extract dissolved-phase and vapor-phase petroleum hydrocarbons from the subsurface in the vicinity of monitoring well MW-3. MTU vacuum extraction events were halted in the second quarter 2009 pending acceptance of the site into the UECA program.

On June 21 and 22, 2016, KEMRON performed supplemental off-site investigation activities at the site consisting of the advancement of four (4) environmental soil borings and the reinstallation of groundwater monitoring well MW-3R. On August 16, 2016, groundwater samples were collected from monitoring wells MW-1, MW-2, MW-3R, MW-5, and MW-6 to provide information on the presence/absence of dissolved-phase constituents in the groundwater on-site and off-site. Note that MW-4 was not sampled during the August 2016 sampling event because it appeared that MW-4 had been paved over and was not able to be located. During delineation activities, it was noted that existing monitoring well MW-3 had been destroyed. Due to this, monitoring well MW-3R was installed directly adjacent to the former MW-3. The monitoring well MW-3R was advanced to a depth of approximately 14 ft-bgs. According to boring logs completed for this investigation, stratigraphy at the site generally consists of asphalt surface cover followed by either sand or sandy clay extending to the termination depth of eight (8) ft-bgs. Bedrock was not encountered during this investigation.

Laboratory analytical results for soil and groundwater samples collected during Supplemental Site Assessment activities indicated that residual adsorbed and dissolved-phase constituent concentrations were detected in excess of applicable West Virginia De Minimis Standards or exhibited elevated reporting limits that exceeded the applicable West Virginia De Minimis standards.

3 Analytical Results and Selection of Constituents of Concern

This section presents the analytical results for soil (**Table 3-1**) and groundwater (**Table 3-2**). **Tables 3-1** and **3-2** present comparisons of the data to applicable screening values to identify constituents of concern (COC) for the site. The screening criteria used in the analytical data comparisons were selected in accordance with procedure outlined in the WV VRP Guidance Manual [WVDEP 2019a] and instructions provided in the De Minimis and Relevant Benchmark table [WVDEP 2019b] available on WVDEP's website. **Table 3-3** presents a summary of the analytical data and identifies which samples were retained for use in the risk assessment.

Based on the samples retained for use in the selection of COC from **Table 3-3**, a statistical summary of the minimum and maximum detection limits, minimum and maximum concentrations, location of maximum concentrations, and frequency of detection for each constituent analyzed for in soil (**Table 3-4**) and groundwater (**Table 3-5**) were completed and are also presented in this section. As specified in Section 60-3-8.2.d of the Rule [WVDEP 2018] and Section 3.5.1 in the WV VRP Guidance Manual [WVDEP 2019a], at least ten percent of the analytical data utilized in the risk assessment has been validated in accordance with standard EPA protocols. The data validation reports were presented in the Supplemental Site Assessment Report [KEMRON 2017]. The January 2002 scenarios decision tree provided by the WVDEP (available at WVDEP's website: http://www.dep.wv.gov/dlr/oer/voluntarymain/Pages/default.aspx) was consulted for the screening of analytical data and selection of COC.

3.1 Analytical Data

Soil

In June 2016, four soil borings were installed (i.e. MW-3A through MW-3D) to better evaluate the presence and/or absence of adsorbed-phase constituents in the vicinity of monitoring well MW-3R (i.e. located between the UST area and canopy area). Note that MW-3R replaced MW-3, which was destroyed. Ten soil samples were collected in June 2016 from on-site locations MW-3A through MW-3D and MW-3R. These ten soil samples included 5 surface soil samples and 5 subsurface soil samples. **Table 3-1** presents the soil analytical results for benzene, toluene, ethylbenzene, total xylenes, total BTEX, and methyl-tert butyl ether (MTBE). The analytical data presented in **Table 3-1** presents a comparison to industrial soil, residential soil, and migration to groundwater West Virginia De Minimis levels. In accordance with Section 4.4.1 of the WV VRP Guidance Manual [WVDEP 2019a], although the site is currently commercial/industrial land use and future land use will be restricted to commercial/industrial, the soil data was screened against WVDEP residential soil De Minimis standards to support the need for a land use covenant. The most recent De Minimis values were utilized (effective June 1, 2017) [WVDEP 2017] to screen the analytical data. **Figure 3** shows the analytical results from on-site soil samples and indicates any exceedances of the residential soil, industrial soil, or migration to groundwater De Minimis screening values.

Soil samples were collected from surface soil (0-2 ft-bgs) and subsurface soil (2-10 ft-bgs) from the unsaturated and saturated zones. The average depth to groundwater at MW-3R is approximately 5.5 ft-bgs, which is based on groundwater elevation data collected from MW-3R and MW-3 between December 2010 and August 2016. Therefore, soil samples collected at 6 ft-bgs and greater are saturated soil samples. **Table 3-3** presents a summary of the on-site soil sample locations and indicates if the sample is retained or not retained for use in the risk assessment. The maximum depth at which soil is considered available for direct contact exposure for on-site receptors is 10 ft-bgs. Therefore, as indicated on **Table 3-3**, all soil samples were used in this risk assessment.

The release was a subsurface release from the on-site UST system. Therefore, the only way off-site adjacent roads and properties south/southwest of the site could be affected by this release is by constituent migration in on-site groundwater to off-site groundwater. To evaluate the James River and Kanawha Turnpike ROW, which is adjacent to the south/southwestern property boundary, soil samples collected along the south/southwestern property boundary were conservatively used. These soil samples included surface soil samples CE-MW-3B (0-2’)-003 and CE-MW-3D (0-2’)-008 and subsurface soil samples CE-MW-3B (6-8’)-004 and CE-MW-3D (6-8’)-009.

Table 3-4 presents a statistical summary of on-site surface soil (0-2 ft-bgs) and subsurface soil (2-10 ft-bgs) analytical data (based on the retained soil samples from **Table 3-3**), which includes the minimum and maximum detection limits, minimum and maximum detected concentrations, location of maximum concentrations, and frequency of detection for each constituent analyzed in soil. In addition, the maximum concentrations are compared to the industrial soil, residential soil, and migration to groundwater De Minimis screening levels. As shown in **Table 3-4**, there were no exceedances of the industrial soil De Minimis screening values. However, there were exceedances of the migration to groundwater De Minimis screening values in surface and subsurface soil. Benzene exceeded a migration to groundwater screening value in both surface and subsurface soil. Ethylbenzene and total xylenes exceeded their migration to groundwater screening values in subsurface soil only. However, constituents that only exceeded migration to groundwater screening values were not retained as a direct contact COC in soil and were evaluated using groundwater analytical data. There was also an exceedance of the residential soil de minimis standard for ethylbenzene in subsurface soil. Based on the exceedance of the residential soil de minimis standard for ethylbenzene, future land use will be restricted to commercial/industrial.

Groundwater

Groundwater analytical data has been collected at the site from January 1994 until August 2016 from on-site monitoring wells MW-1 through MW-3 and from August 2001 to August 2016 from off-site monitoring wells MW-4 through MW-6. However, during delineation activities, it was noted that existing monitoring well MW-3 had been destroyed. Therefore, MW-3R was installed directly adjacent to the former MW-3. Table 1 in **Attachment 1** presents the cumulative groundwater analytical data collected from MW-1 through MW-6, and MW-3R between January 1994 and August 2016. This cumulative groundwater data table is provided for informational purposes only. Only the 8 most recent post-remediation groundwater samples were used in this risk assessment.

Remediation activities have occurred at the site. These activities included the following:

- an enhanced soil vapor extraction system utilizing a vacuum truck (September 2001 through January 2002).
- sodium persulfate oxidizing compound for in-situ chemical oxidation in groundwater (January 2002 to the fourth quarter 2007).

- a mobile treatment unit, equipped with dual-phase, high vacuum extraction technology (November 2005 to the second quarter of 2009).

Therefore, groundwater analytical data collected after the second quarter of 2009 (i.e. after the June 30, 2009 event) are considered post-remediation groundwater samples.

For this risk assessment, the 8 most recent post-remediation groundwater samples collected between December 2010 and August 2016 were used. The groundwater analytical data were screened against the West Virginia De Minimis groundwater standards. The most recent De Minimis values were utilized (effective June 1, 2017) [WVDEP 2017] to screen the analytical data. **Table 3-2** presents the 8 most recent post-remediation groundwater analytical results (i.e. collected between December 2010 and August 2016) along with comparisons to the groundwater De Minimis screening values. **Figure 4** presents the analytical results from on-site and off-site groundwater sample locations for the August 2016 sampling event and indicates any exceedance of the groundwater De Minimis screening values.

Table 3-3 presents a summary of the groundwater sample locations and indicates if the samples are retained or not retained for the risk evaluation. As indicated on **Table 3-3**, all groundwater samples collected between December 2010 and August 2016 from on-site and off-site monitoring wells were retained for use in this risk assessment. As shown in **Table 3-3**, no samples were collected from MW-3 on 12/29/10 and MW-4 on 8/16/16 because the wells were not able to be located. Therefore, MW-3/3R and MW-4 only have seven sampling events collected between December 2010 and August 2016.

The site is surrounded by commercial properties. The site is bounded by Main Street to the north/northwest, a vacant lot to the east, Rainelle water building to the southeast, and James River and Kanawha Turnpike to the south/southwest. In addition, there are commercial buildings located south/southwest of the site and across James River and Kanawha Turnpike and north across Main Street. Groundwater predominantly flows to the southwest direction across James River and Kanawha Turnpike. As a result, there is the potential for off-site receptors in the James River and Kanawha Turnpike ROW and downgradient properties (i.e. Western Auto Store) to be exposed to site-related constituents in groundwater. The following on-site and off-site groundwater monitoring wells were used to evaluate the off-site ROW and off-site property:

- **James River and Kanawha Turnpike ROW**: On-site groundwater monitoring wells MW-2 and MW-3/MW-3R, located closest to the southern property boundary, and off-site monitoring wells MW-4, MW-5, and MW-6, located on the southern side of the James River and Kanawha Turnpike ROW, were used to evaluate off-site receptors in the northern and southern sides of the James River and Kanawha Turnpike ROW.

- **Western Auto Store**: Off-site monitoring wells MW-4, MW-5, and MW-6, located in the southern James River and Kanawha Turnpike ROW, were used to evaluate off-site receptors at the Western Auto Store (i.e. downgradient of groundwater flow at the site).

Table 3-5 presents a statistical summary of the groundwater analytical data which includes the minimum and maximum detection limits, minimum and maximum detected concentrations, location of maximum concentrations, and frequency of detection for each constituent analyzed in on-site and off-site groundwater. In addition, the maximum concentrations are compared to the WVDEP groundwater De Minimis levels. As shown in **Table 3-5**, the following constituents exceeded groundwater De Minimis levels:

- benzene in on-site groundwater only; and,

- MTBE in on-site and off-site groundwater.

In addition, the 8 most recent post-remediation groundwater analytical data presented in **Table 3-2** were also compared to the United States Environmental Protection Agency (USEPA) Office of Solid Waste and Emergency Response (OSWER) Commercial and Residential Vapor Intrusion Screening Level (VISL) target groundwater concentrations [USEPA 2019a] (based on November 2019 USEPA Regional Screening Levels [RSLs]) to evaluate vapor intrusion. The commercial VISL target groundwater concentrations were based on a target risk of $1x10^{-5}$ and target hazard quotient (HQ) of 1. The residential VISL target groundwater concentrations were based on a target risk of $1x10^{-6}$ and target HQ of

1. **Attachment 2** presents the USEPA VISL Calculator spreadsheet used to select commercial and residential VISL target groundwater screening values. **Table 3-5** presents a comparison of the maximum concentrations in on-site and off-site groundwater to the USEPA commercial and residential VISL target groundwater concentrations. As shown in **Table 3-5**, benzene exceeded a commercial VISL in on-site groundwater only. Benzene and ethylbenzene exceeded a residential VISL in on-site groundwater only. Based on exceedances of residential groundwater VISLs, future on-site land use will be restricted to commercial/industrial. There were no groundwater VISL exceedances in off-site groundwater.

Data Validation

Analytical data generated during assessment activities at the site was validated by KEMRON's QA/QC Analytical Quality Associates, Inc. (AQA). The data validation entailed a general review for completeness of all analytical data deliverables and a detailed review of 10% of all analytical data generated during site assessment activities. Copies of the Data Validation Reports were included in the August 2017 Supplemental Site Assessment Report [KEMRON 2017]. According to the Supplemental Site Assessment Report [KEMRON 2017], based on the conclusions presented in AQA's Data Validation Report, the analytical data provided by Pace in Greensburg, Pennsylvania for the soil samples collected meets the EPA SW-846 quality control requirements. However, upon completion of the review it was noted that the four 8260 surrogates for soil sample CE-MW-3R-(0-2)-013 were above the upper control limits. This appears to be due to sample matrix interference with the surrogates and has no impacts on the reported results. For groundwater, based on the conclusions presented in AQA's Data Validation Report, the analytical data provided by Pace in Greensburg, Pennsylvania for the groundwater samples collected meets the EPA SW-846 quality control requirements.

3.2 Selection of Constituents of Concern

The selection of constituents of concern was conducted in accordance with Section 3.9 of the WV VRP Guidance Manual [WVDEP 2019a] and Section 2 in the User Guide for Risk Assessment of Petroleum Releases [WVDEP 1999]. As stated in Section 3.9 of the WV VRP Guidance Manual [WVDEP 2019a], chemicals detected in at least one sample in a given medium at the site should be considered chemicals of potential concern (COPCs) and should be carried through the screening assessment or risk assessment unless there is a specific, justifiable rationale for dropping the contaminant from the risk characterization. The final list of contaminants that will be carried through the risk assessment is referred to as the constituents of concern (COC). Constituents of concern were selected for the direct contact ("direct contact COC") exposure pathways and vapor intrusion ("vapor intrusion COC") exposure pathways for the on-site and off-site receptors. The selection process was done using the analytical data and comparisons presented above in Section 3.1.

Direct Contact COC

Direct contact COC were selected based on the comparisons described above for soil and groundwater. A summary of direct contact COC retained in on-site soil and groundwater is shown in **Table 3-6**. A summary of direct contact COC retained in off-site soil and groundwater is shown in **Table 3-7**. Although the site will be restricted to commercial/industrial use, any constituent that exceeded residential screening criteria was conservatively retained as a COC for industrial receptors.

On-Site (Industrial Land Use):

- Surface Soil: Any detected constituent that exceeded an industrial or residential soil De Minimis standard in on-site surface soil samples collected between 0-2 ft-bgs was selected as a direct contact COC in on-site surface soil. As shown in **Table 3-6**, there were no direct contact COC retained in on-site surface soil.

- Subsurface Soil (2-6 ft-bgs): Any detected constituent that exceeded an industrial or residential soil De Minimis standard in on-site subsurface soil samples collected between 2-6 ft-bgs was selected as a direct contact COC in on-site subsurface soil. As shown in **Table 3-6**, there were no direct contact COC retained in on-site subsurface soil (2-6 ft-bgs).

- Subsurface Soil (2-10 ft-bgs): Any detected constituent that exceeded an industrial or residential soil De Minimis standard in on-site subsurface soil samples collected between 2-10 ft-bgs was selected as a direct contact COC in on-site subsurface soil. As shown in **Table 3-6**, ethylbenzene exceeded the residential soil de minimis standard and was retained as a COC in subsurface soil (2-10 ft-bgs).

- Groundwater: Any detected constituent in the 8 most recent post-remediation groundwater samples (i.e. collected between December 2010 and August 2016) from on-site monitoring wells that exceeded a groundwater De Minimis standard was selected as a direct contact COC in on-site groundwater. As shown in **Table 3-6**, there were two direct contact COC retained in on-site groundwater (i.e. benzene and MTBE).

Off-Site (Industrial Land Use):

The site is surrounded by roads and commercial properties. Groundwater predominantly flows to the southwest direction across James River and Kanawha Turnpike. Downgradient areas include the James River and Kanawha Turnpike ROW adjacent the south/southwestern property boundary and a commercial building (i.e. Western Auto Store) south/southwest of the site and across James River and Kanawha Turnpike.

James River and Kanawha Turnpike Northern ROW (south/southwest of the site)

- Surface Soil: Any detected constituent that exceeded an industrial or residential soil De Minimis standard in on-site surface soil samples CE-MW-3B (0-2')-003 and CE-MW-3D (0-2')-008 (located closest to the northern James River and Kanawha Turnpike ROW) was selected as a direct contact COC in surface soil for the northern James River and Kanawha Turnpike ROW (south/southwest of the site). As shown in **Table 3-7**, there were no direct contact COC retained in surface soil for the northern James River and Kanawha Turnpike ROW.

- Subsurface Soil: Any detected constituent that exceeded an industrial or residential soil De Minimis standard in on-site subsurface soil samples CE-MW-3B (6-8')-004 and CE-MW-3D (6-8')-009 (located closest to the northern James River and Kanawha Turnpike ROW) was selected as a direct contact COC in subsurface soil for the northern James River and Kanawha Turnpike ROW. As shown in **Table 3-7**, ethylbenzene exceeded the residential soil De

Minimis standard and was retained as a COC in subsurface soil for the northern James River and Kanawha Turnpike ROW.

- Groundwater: Any detected constituent in the 8 most recent post-remediation groundwater samples (i.e. collected between December 2010 and August 2016) from on-site monitoring wells MW-2, MW-3, and MW-3R (located along the southern property boundary and closest to the northern James River and Kanawha Turnpike ROW) that exceeded a groundwater De Minimis standard was selected as a direct contact COC for the northern James River and Kanawha Turnpike ROW. As shown in **Table 3-7**, there were two direct contact COC retained in groundwater for the northern James River and Kanawha Turnpike ROW (i.e. benzene and MTBE).

James River and Kanawha Turnpike Southern ROW (south/southwest of the site)

- Groundwater: Any detected constituent in the 8 most recent post-remediation groundwater samples (i.e. collected between December 2010 and August 2016) from off-site monitoring wells MW-4, MW-5, and MW-6 (located within the southern James River and Kanawha southern ROW) that exceeded a groundwater De Minimis standard was selected as a direct contact COC for the southern James River and Kanawha Turnpike southern ROW. As shown in **Table 3-7**, there was one direct contact COC retained in groundwater for the southern James River and Kanawha Turnpike ROW (i.e. MTBE).

Vapor Intrusion COC

Vapor intrusion COC were selected based on the groundwater analytical data comparison described above. A summary of vapor intrusion COC retained in on-site and off-site groundwater are shown in **Tables 3-6 and 3-7**, respectively.

On-Site (Industrial Land Use):

- Groundwater: To evaluate the current on-site building, the 8 most recent post-remediation groundwater samples (i.e. collected between December 2010 and August 2016) from on-site monitoring well MW-1 (located closest to the current on-site building) was used to select vapor intrusion COC. Any detected site-related constituent that exceeded a USEPA commercial or residential VISL target groundwater concentration in MW-1 was retained as a vapor intrusion COC for the current on-site building. As shown in **Table 3-6**, there were no vapor intrusion COC retained in groundwater for the current on-site building.

In addition, there is potential for a future building to be constructed on-site. Therefore, to evaluate a future on-site building, the 8 most recent post-remediation groundwater samples (i.e. collected between December 2010 and August 2016) from all on-site monitoring wells were used to select vapor intrusion COC. Any detected site-related constituent in on-site monitoring wells that exceeded a USEPA commercial or residential VISL target groundwater concentration was retained as a vapor intrusion COC for a future on-site building. As shown in **Table 3-6**, there were two vapor intrusion COC retained in groundwater for a future on-site building (i.e. benzene and ethylbenzene).

Off-Site (Industrial Land Use):

- Groundwater: To evaluate the off-site commercial building (i.e. Western Auto Store) south/southwest of the site and downgradient of groundwater flow, the 8 most recent post-remediation groundwater samples (i.e. collected between December 2010 and August 2016) from off-site monitoring wells MW-4, MW-5, and MW-6 (located closest to and upgradient of the Western Auto Store) were used to select vapor intrusion COC. Any detected site-related constituent that exceeded a USEPA commercial or residential VISL target groundwater concentration in MW-4, MW-5, or MW-6 was retained as a vapor intrusion COC for the off-site commercial building. As shown in **Table 3-7**, there were no vapor intrusion COC retained in groundwater for the off-site commercial building (i.e. Western Auto Store).

4 Conceptual Site Model

This section presents the conceptual site model developed for the site and includes a groundwater use discussion, hydrogeologic CSM, groundwater fate and transport modeling, human health CSM, and an ecological screening assessment.

4.1 Groundwater Use

There were exceedances of the groundwater De Minimis screening levels in on-site monitoring wells. The Former 7-Eleven Facility #135 property is currently connected to a public water supply. Public water is supplied to the site by the town of Rainelle Water Department. There are currently no potable wells at the on-site property. Therefore, there are currently no complete groundwater use exposure pathways for on-site receptors. However, there is no known ordinance in the town of Rainelle that prohibits that installation of private potable wells or requires connection to the public water supply. Therefore, future groundwater use exposure pathways may potentially be complete in the future on-site. Although future use of groundwater for potable purposes on-site is unlikely because the on-site property is currently connected to the public water supply, an LUC will be prepared that will prohibit the use of groundwater for potable purposes on the Former 7-Eleven Facility property #135, which will make future groundwater use exposure pathways incomplete.

Groundwater at the site flows to the southwest across the James River and Kanawha Turnpike. There were exceedances of the groundwater De Minimis screening level for MTBE in off-site monitoring wells MW-6 and MW-4. The maximum MTBE concentration from the 8 most recent sampling events from off-site monitoring wells MW-4 and MW-6 was 29.0 µg/L (4/3/12 sampling event from MW-4), which exceeded the groundwater De Minimis screening value of 14 µg/L. The off-site properties immediately downgradient of the Former 7-Eleven Facility #135 property (e.g., Western Auto Store) are currently connected to a public water supply provided by the town of Rainelle Water Department, which was confirmed by KEMRON via telephone. Therefore, currently there are no complete potable groundwater use exposure pathways at the off-site properties.

According to information provided by KEMRON [Personal correspondence 2018a], the town of Rainelle gets its water from a groundwater source that is located west/southwest of the site. A potable well search was completed for off-site properties surrounding the Former 7-Eleven Facility #135 property. According to an EDR (Environmental Data Resources) report provided by KEMRON, water wells were identified east, south, and southwest of the site. The EDR report is included in **Attachment 3**. Note that although the EDR search is not centered around the Former 7-Eleven Facility #135 property, the on-site property is still included within the radius of the search.

According to the EDR search map, there is a cluster of water wells located just south of the site (location "F" on the map) and east of the site (location "G" on the map). According to KEMRON [personal correspondence 2018b], the well with the designation as F17 is located across the James River and Kanawha Turnpike due east of the off-site Western Auto Store and is owned by the town of Rainelle. KEMRON spoke to the manager of the water plant for the town of Rainelle, and according to the manager, this well is used as a backup to their main water supply [personal correspondence 2018c]. The manager stated that the well is seldom used and, as of now, it is not capable of being used because the pipe that goes from the well to the water plant is crushed and needs replaced [personal correspondence 2018c]. According to the Rainelle water plant manager, the well was originally completed into consolidated bedrock to an unknown depth deeper than 120 feet with the overburden cased off. The pump is currently set at a depth of 120 feet and is situated above an older pump that could not be removed. Given the depth of the pump within consolidated bedrock and the fact that the overburden is cased off from the bedrock, it is unlikely that the backup public supply well would draw constituents present in the overburden groundwater at the site.

The well designated as G18 is located approximately 450 feet east of the site and is owned by the USGS [personal correspondence 2018b]. The wells designated as G19 and G20 are located approximately 540 feet east/southeast of the site across the James River and Kanawha Turnpike and are also owned by the USGS [personal correspondence 2018b]. According to KEMRON, these well are monitoring wells [personal correspondence 2018b].

According to the EDR search map, there are also well designations "D" and "E" located southwest and downgradient of the site. According to KEMRON [personal correspondence 2019a], the well located at the "E" designation on the EDR search map is a production well for the town of Rainelle. This production well is approximately 440 feet southwest and downgradient of MW-6 and installed at a depth of approximately 150 ft-bgs [Personal correspondence 2019c]. According to KEMRON [personal correspondence 2019b], the town of Rainelle water department indicated that the well that is located in the "D" designation area of the EDR search map is a former production well that is currently not used and will not be used in the future.

Although the public supply wells are likely hydraulically isolated from the site release based on the depth of installation, groundwater fate and transport modeling using the BIOSCREEN model was completed to determine if dissolved-phased MTBE concentrations from the source area (i.e. MW-3/3R) may potentially migrate to the off-site Rainelle production well above the groundwater De Minimis screening level of 14 µg/L. See Section 4.3 for the BIOSCREEN modelling discussion.

4.2 Geologic and Hydrogeologic Conceptual Site Model

The following presents the site's geologic and hydrogeologic conceptual site model. The geologic and hydrogeologic conceptual site model was developed based on information provided by KEMRON.

4.2.1 Site Geology and Hydrogeology

Stratigraphy at the site generally consists of asphalt surface cover followed by a silty/sandy clay layer beginning from ground surface and extending to depths ranging from 10 to 12 ft-bgs. Beneath this silty/sandy clay layer is a coarse grain sand and gravel mixture extending to the terminus of each boring. Bedrock was not encountered during this investigation.

On August 16, 2016, monitoring wells MW-1 through MW-3R, MW-5, and MW-6 were gauged with an electronic oil/water interface probe to determine water table elevations. Well gauging data collected during the August 16, 2016 gauging event were used in conjunction with surveyed wellhead elevations to develop a groundwater potentiometric surface map. Groundwater depth ranged from 5.20 ft-bgs in monitoring well MW-5 to 6.61 ft-bgs in monitoring well MW-6. Groundwater elevation data for the 8 most recent post-remediation groundwater sampling events is included in **Table 3-2**. **Figure 5** presents the August 16, 2016 potentiometric surface map, which indicates that groundwater flow at the site was generally toward the southwest with a relatively flat hydraulic gradient of 0.0070 ft/ft (MW-2 to MW-6). Sewell creek is located approximately 0.1 miles (i.e. approximately 500 feet) west of the site.

4.3 BIOSCREEN Modeling

Due to the potential for dissolved-phase MTBE to continue to migrate from the source area (i.e., MW-3/3R) in the downgradient direction toward the public supply well located southwest of the site, BIOSCREEN fate and transport modeling was utilized to determine the potential for the dissolved-phase MTBE plume to reach the downgradient public supply well. BIOSCREEN is based on the Domenico analytical solute transport model and can simulate solute transport without decay and with biodegradation. The conventional method of simulating biodegradation in dissolved hydrocarbon plumes is through modeling "solute transport with first-order decay" [USEPA 1996]. Note that the first-order decay model is conservative in that it does not assume any biodegradation of dissolved constituents in the source area [USEPA 1996].

A groundwater potentiometric surface map prepared utilizing groundwater gauging data collected on August 16, 2016 indicates that site groundwater flow is generally towards the southwest. Based on a potable well search, the closest downgradient potable well is a production well for the City of Rainelle located southwest of the site approximately 550 feet from MW-3/MW-3R. The BIOSCREEN evaluation was used to determine the potential for MTBE in groundwater to migrate from the source area (MW-3/3R) to the off-site potable production well utilizing calibration from downgradient off-site monitoring well MW-6.

4.3.1 Model Inputs

When appropriate, default values provided within the United States Environmental Protection Agency BIOSCREEN Natural Attenuation Decision Support System User's Manual [USEPA 1996] were used as input in the model for MTBE. Input parameters for the model, including those derived from site-specific data, are indicated below. A table summarizing the input parameters for the fate and transport evaluation of MTBE is included as Table 1 in **Attachment 4**.

As recommended by the USEPA BIOSCREEN guidance document [USEPA 1996], several parameters were adjusted in order to calibrate the model to most closely reflect the field analytical data between MW-3/3R and off-site downgradient monitoring well MW-6. The primary calibration parameter was the first-order decay coefficient, followed by the hydraulic conductivity (K) and the effective porosity (n), which are both based on the lithology. Note that this model conservatively utilizes input parameters based on a sand/gravel lithology. Although these parameters are more conservative to utilize in the model, it is unlikely that the thin lens of sand/gravel encountered at the site is continuous in the downgradient direction. See Uncertainty Analysis (Section 9) for further discussion.

Seepage Velocity (Vs) (ft/yr)

The seepage velocity is the actual interstitial groundwater velocity, equaling Darcy velocity divided by effective porosity. The seepage velocity was calculated in the BIOSCREEN model using site-specific hydraulic conductivity, hydraulic gradient, and porosity.

Hydraulic Conductivity (K) (cm/sec)

The hydraulic conductivity is the horizontal hydraulic conductivity of the saturated porous medium. Based on groundwater monitoring well logs, the well screens are located within the silty/sandy clay layer and the coarse grain sand and gravel mixture layer. The hydraulic conductivity value used in the BIOSCREEN model is $1x10^{-2}$ cm/sec, which is within the range of default values for clean sand presented in the USEPA's BIOSCREEN User's Manual [USEPA 1996]. This parameter was adjusted in order to calibrate the model to most closely reflect field analytical data.

Hydraulic Gradient (i) (ft/ft)

The hydraulic gradient is the slope of the potentiometric surface. In unconfined aquifers, this is equivalent to the slope of the water table. The site-specific value (0.0175 ft/ft) used in the BIOSCREEN model is the average hydraulic gradient of six quarters of gauging data at the site. The gradient was calculated between groundwater monitoring wells MW-3 and MW-6.

Effective Porosity (n) (dimensionless)

The effective porosity is the dimensionless ratio of the volume of interconnected voids to the bulk volume of the aquifer matrix. Based on groundwater monitoring well logs, the well screens are located within the silty/sandy clay layer and the coarse grain sand and gravel mixture layer. The porosity value used in the BIOSCREEN model, 0.20 or 20%, is within the range of values for coarse sand presented in the USEPA's BIOSCREEN User's Manual [USEPA 1996]. This parameter was adjusted in order to calibrate the model to most closely reflect field analytical data.

Longitudinal Dispersivity (Alpha x) (ft), Transverse Dispersivity (Alpha y) (ft), and Vertical Dispersivity (Alpha z) (ft)

Dispersion refers to the process whereby a plume will spread out in a longitudinal direction (along the direction of groundwater flow), transversely (perpendicular to groundwater flow), and vertically downwards due to mechanical mixing in the aquifer and chemical diffusion. Alpha x and alpha y were calculated in the BIOSCREEN model based on the estimated plume length. The alpha z value of $1x10^{-99}$ ft was used in the BIOSCREEN model, which is the default value presented in the USEPA's BIOSCREEN User's Manual [USEPA 1996] based on a conservative estimate.

Estimated Plume Length (Lp) (ft)

The estimated plume length is the estimated length in feet of the existing or hypothetical groundwater plume being modeled . The estimated plume length used in the BIOSCREEN model is a site-specific value of 180 feet. This value was estimated through a series of model iterations where the centerline of the plume reaches the de minimis standard of 14 µg/L.

Retardation Factor (R) (unitless)

The retardation factor relates to the rate at which dissolved contaminants moving through an aquifer can be reduced by sorption of contaminants to the solid aquifer matrix. The degree of retardation depends on both aquifer and constituent properties. The retardation factor is the ratio of the groundwater seepage velocity to the rate the organic chemicals migrate in the groundwater. The retardation factor was calculated in the BIOSCREEN model based on the soil bulk density, partition coefficient, and fraction of organic carbon.

Soil Bulk Density (rho) (kg/L or g/cm^3)

The soil bulk density is the bulk density of the aquifer matrix related to porosity and pure solids density. The soil bulk density value used in the BIOSCREEN model, 1.58 kg/L, is a site-specific value based on geotechnical analytical results from geotechnical samples collected in June 2016.

Organic Carbon Partition Coefficient (Koc) (L/kg)

The organic carbon partition coefficient is the chemical-specific partition coefficient between soil organic carbon and the aqueous phase. Larger values indicate greater affinity of contaminants for the organic carbon faction of soil. The organic carbon partition coefficient value used for MTBE in the BIOSCREEN model is 11.6 L/kg. This is the default value provided in the WVDEP Chemical Properties Database, last updated June 5, 2014.

Fraction Organic Carbon (foc) (unitless)

The fraction organic carbon is the fraction of the aquifer soil matrix comprised of natural organic carbon in uncontaminated areas. More natural organic carbon means higher adsorption of organic constituents on the aquifer matrix. The fraction organic carbon value used in the BIOSCREEN model, 0.036, is a site-specific value based on geotechnical analytical results from geotechnical samples collected in June 2016.

First-Order Decay Coefficient (lambda) (1/year)

The first-order decay coefficient is the rate coefficient describing first-order decay process for dissolved constituents. This value equals 0.693 divided by the half-life of the contaminant in groundwater. The first-order decay coefficient was calculated in the BIOSCREEN model based on the solute half-life.

Solute half-life (t-half) (years)

The solute half-life is the time in years for dissolved plume concentrations to decay by one half as contaminants migrate through the aquifer. The solute half-life value used in the BIOSCREEN model, 0.15 years, is within the range of literature referenced values for MTBE from the Handbook of Environmental Degradation Rates [Howard et. al. 1991].

Modeled Area Length (ft) and Modeled Area Width (ft)

The modeled area length and width are the physical dimensions in feet of the rectangular area to be modeled. According to the USEPA's BIOSCREEN User's Manual [USEPA 1996], values should be slightly larger than the final plume dimensions or should extend to the downgradient point of concern (e.g. point of exposure). A modeled area of length of 550 feet was a site-specific value based on the dimension from the source area to the closest downgradient potable water supply. A modeled area width of 180 feet was a site-specific value based on the dimension perpendicular to the direction of groundwater flow (i.e. southwest) estimated to depict modeled plume dispersion.

Simulation Time (years)

The simulation time is the time in years for which concentrations are to be calculated. For steady-state simulations, a large value such as 1,000 years would be sufficient for most sites per the USEPA's BIOSCREEN User's Manual [USEPA 1996]. Therefore, the default value of 1,000 years was used in the BIOSCREEN model.

Source Thickness in Saturated Zone (ft)

According to the USEPA's BIOSCREEN User's Manual [USEPA 1996], the Domenico (1987) model assumes a vertical plane source of constant concentration. For many fuel spill sites, the thickness of this source zone is only 5-20 feet, as petroleum fuels are light non-aqueous phase liquids (NAPLs) that float on the water table. The source thickness value of 10 feet was used in the BIOSCREEN model, which is a site-specific value that was based on the smear-zone and approximate water column height in each well.

Source Zone Width (ft)

According to the USEPA's BIOSCREEN User's Manual [USEPA 1996], the Domenico (1987) model assumes a vertical plane source of constant concentration. BIOSCREEN expands the simple one source-zone approach by allowing up to five source zones with different concentrations to account for spatial variations in the source area. The source zone width used in the BIOSCREEN model was a site-specific value of 60 feet. This value was determined using the dimension perpendicular to the direction of groundwater flow and was based on an MTBE isopleth generated for the site.

Source Zone Concentration (mg/L)

BIOSCREEN requires source zone concentrations that correspond to the source area width. An upper confidence level (UCL) of the mean groundwater concentration for MTBE (i.e. 0.1533 mg/L) using the 8 most recent sampling events collected between March 2011 and August 2016 from MW-3/3R (i.e. source area well) was used in the BIOSCREEN model. The ProUCL dataset and output spreadsheets are included in **Attachment 4**.

Source Half-Life (years)

According to the USEPA's BIOSCREEN User's Manual [USEPA 1996], the Domencio (1987) model assumes the source is infinite (i.e. the source concentrations are constant). In BIOSCREEN, however, an approximation for a declining source concentration is available. The source half-life is calculated in the BIOSCREEN model based on the soluble mass in source NAPL, soil.

Soluble Mass in Source NAPL, Soil (kg)

According to the USEPA's BIOSCREEN User's Manual [USEPA 1996], the best estimate of dissolvable organics in the source zone is obtained by adding the mass of dissolvable organics on soils, free-phase NAPLs, and residual NAPLs. This quantity is used to estimate the rate that the source zone concentration declines. However, for constant-source simulations, either a very large number for soluble mass in the source zone may be entered (e.g. 1,000,000 kg) or "infinite" may be entered into the model. In the BIOSCREEN model for this site, an "infinite" number was assumed for soluble mass in the source zone for a conservative constant-source simulation.

Field Data for Comparison (Concentration [mg/L] and Distance from Source [ft])

Monitoring well MW-6 located off-site and downgradient of MW-3/3R was utilized as field data for comparative purposes. Based on the direction of groundwater flow at the site (i.e., southwest), this monitoring well is likely located close to the centerline of the plume. MW-6 is located approximately 115 ft downgradient of the source area; however, MW-6 was conservatively assumed to be 110 ft downgradient in the BIOSCREEN model input spreadsheet due to modeling constraints. A UCL of the mean groundwater concentration for MTBE (i.e. 0.023 mg/L) using the 8 most recent sampling events collected between December 2010 and August 2016 from MW-6 was used in the BIOSCREEN model as the field concentration at MW-6. The ProUCL dataset and output spreadsheets for MW-6 are included in **Attachment 4**. The input parameters are summarized in Table 1 of **Attachment 4** and the BIOSCREEN model output is attached herein in **Attachment 4**.

4.3.2 Sensitivity Analysis

As specified in the Rule (Section 60-3-8.1.d.2), sensitivity analyses of models and data used as model parameters shall be included in risk assessments. Sensitivity analyses shall be based on the range of conditions which have historically occurred or may be likely to occur at the site. Therefore, a sensitivity analysis of the BIOSCREEN model was completed. Two separate runs of the BIOSCREEN model were completed for the sensitivity analysis: a minimum scenario (least conservative) and a maximum scenario (most conservative). The minimum scenario uses parameters that would be less conservative such as using hydrogeologic and absorption parameters that are based on the silty/sandy clay lithologic zone of the site. The maximum scenario uses parameters that would be the most conservative such as using hydrogeologic and absorption parameters that are based on the sand/gravel lithologic zone of the site. The input values for the minimum and maximum sensitivity analysis scenarios are presented in Table 1 in **Attachment 4**. The rationale for these input values is also provided in Table 1. In general, if a range of values for a particular parameter was available, the minimum and maximum values of that range were used in the sensitivity analysis. Otherwise, the single site-specific or default value was used in both scenarios of the sensitivity analysis.

The results of the sensitivity analysis show that MTBE has a potentially wide range of distance that it may travel depending on the lithologic unit through which groundwater is primarily migrating. Under the minimum scenario (assuming migration through clay), MTBE may migrate as little as 55 feet before attenuating below the WVDEP groundwater de minimis standard (14 µg/L). Under the maximum scenario (assuming migration through sand/gravel), MTBE may migrate as far as 6,020 feet before attenuating below the WVDEP groundwater de minimis standard (14 µg/L).

4.3.3 Evaluation Results

The BIOSCREEN evaluation was completed using model parameters determined using site-specific conditions and the 8 most recent groundwater sampling events. The dissolved-phase COC evaluated in the assessment of groundwater fate and transport at the Former 7-Eleven Facility #135 in Rainelle, WV was MTBE.

MTBE was detected in on-site and off-site groundwater at concentrations that exceed its corresponding West Virginia Groundwater De Minimis screening level and therefore was chosen to be evaluated using fate and transport modeling. The fate and transport evaluation utilized a UCL dissolved-phase MTBE concentration from groundwater samples collected between March 2011 and August 2016. The fate and transport evaluation was completed to evaluate the potential for dissolved-phase MTBE concentrations to migrate to the closest off-site potable water supply southwest of the site (well "E"). It should be noted that fate and transport modeling should only be used to evaluate a steady dissolved-phase contaminant plume.

Because there is no WVDEP drinking water standard available for MTBE, in recent discussions with WVDEP, it was determined that the applicable standard to be used to demonstrate attainment at the off-site potable supply well (well "E") is the groundwater de minimis standard of 14 µg/L [Personal correspondence 2019c].

The BIOSCREEN evaluation results are presented below for the actual inputs, minimum scenario (least conservative), and maximum scenario (most conservative). Model results are presented in **Attachment 4**.

Sand and Gravel (Actual Inputs)

- The estimated concentration at the first downgradient receptor (well "E" from the EDR map) is nondetect. The "E" well is 550 ft downgradient of the source area (i.e., MW-3/3R).

Sandy Clay (Minimum Scenario)

- The estimated concentration at 55 ft downgradient from MW-3/3R is nondetect. This does not reach the downgradient "E" well.

Sand and Gravel (Maximum Scenario)

- The estimated concentration at the first downgradient receptor (well "E" from the EDR map) is approximately 47 µg/L (modeled from MW-3/3R). The "E" well is 550 ft downgradient from MW-3/3R. The maximum distance modeled to achieve the de minimis standard of 14 µg/L was 6,020 ft.

The results of the BIOSCREEN under the calibrated "actual" and sandy clay "minimum" scenarios indicate that the plume does not reach the off-site potable supply well (well "E"). However, the maximum scenario indicates that MTBE may migrate as far as 6,020 feet downgradient before reaching the de minimis standard. Based on the field analytical results, the most conservative scenario that assumes migration entirely through sand/gravel does not accurately reflect actual site conditions. Although there is a lens of sand/gravel, the model suggests that the majority of migration does not occur exclusively in this zone, and there are likely periods of migration through other lithologies that result in greater attenuation. Therefore, it was concluded that based on the calibrated "actual" BIOSCREEN model results, dissolved-phase MTBE concentrations are not likely to reach the nearest off-site potable well above the WVDEP groundwater De Minimis standard.

4.4 Human Health Conceptual Site Model

The CSM is a comprehensive view of the site that integrates the various components of the overall environmental setting, including: site geology, hydrogeology, and hydrology; the current distribution and migration of site-related constituents; and potential receptors (both current and future) that may contact site-related constituents through potential exposure pathways associated with various site activities.

The CSM process was completed in accordance with Section 3.3.5 of the WV VRP Guidance Manual [WVDEP 2019a], Section 60-3-8.4.b.1 of the Rule [WVDEP 2018], and Section 5 of the User Guide for Risk Assessment of Petroleum Releases [WVDEP 1999]. The overall CSM can be broken down into a hydrogeologic component (e.g., evaluation of transport pathways) and a human health and ecological risk component (e.g., evaluation of exposure pathways). The CSM identifies those potentially complete transport and exposure pathways which must be either eliminated by the implementation of engineering controls and/or institutional controls (e.g., land use covenants) or further evaluated in a site-specific risk assessment to determine whether site-specific standard (SSS) benchmarks are met in accordance with Section 4.6.2 in the WV VRP Guidance Manual [WVDEP 2019a] and Section 60-3-9.4.a and 60-3-9.4.b in the Rule [WVDEP 2018]. The CSM presented in this report follows in general the key elements presented in the Generic CSM Human Receptor Pathway Analysis Diagram on Figure A-1 in the User Guide for Risk Assessment of Petroleum Releases [WVDEP 1999].

Potential constituent migration routes and potential receptors are assessed in this section in order to determine whether potentially complete exposure pathways exist at the site. As stated in Section 4.1 in the WV VRP Guidance Manual [WVDEP 2019a], an exposure pathway is considered complete if all four of the following elements exist: 1) a source and mechanism of a chemical release to the environment; 2) an environmental receiving or transport mechanism (i.e., soil or groundwater) or pathway (i.e., air vapor and/or particulates, surface water, and sediment) for the released chemical; 3) a point of potential contact with the environmental medium/pathway of concern; and, 4) an exposure route (i.e., ingestion, dermal contact, inhalation) at the receptor contact point.

4.4.1 Potential Constituent Migration Routes

The most likely constituent migration routes were evaluated for soil and groundwater based on the detection of constituents in the media and the potential for those detected constituents to migrate within the media or to other media. The evaluation of migration routes is based on the detection of constituents and is independent of whether those constituents exceed applicable screening criteria or not. The rationales for retaining or not retaining each migration route for receptor-specific evaluation are presented in **Table 4-1**.

The potential constituent migration routes retained for receptor-specific evaluation include:

On-Site Surface and Subsurface Soil

- Volatilization of constituents from on-site surface and subsurface soil to soil gas and subsequent seepage of soil gas into a building (indoor air);
- Volatilization of constituents from on-site surface and subsurface soil to outdoor air; and,
- Leaching of constituents from on-site surface soil to subsurface soil and then to groundwater.

On-Site Groundwater

- Volatilization of constituents from on-site groundwater to outdoor air;
- Volatilization of constituents from on-site groundwater to soil gas and subsequent seepage of soil gas into a building (indoor air); and,
- Migration of constituents in on-site groundwater to off-site groundwater.

Off-Site Groundwater

- Volatilization of constituents from off-site groundwater to outdoor air; and,
- Volatilization of constituents from off-site groundwater to soil gas and subsequent seepage of soil gas into a building (indoor air).

4.4.2 Potential Receptors and Exposure Pathways

This section identifies potential receptors and their associated exposure pathways. Potential receptors were selected to represent individuals who are most likely now or in the future to come into contact with COC in soil and groundwater at the site. As part of the exposure pathway analysis, all reasonable potential exposure pathways have been assessed.

Based on the retained potential constituent migration routes, the following most likely receptors were evaluated:

Current/Future Receptors:

- On-Site Indoor Worker
- Off-Site Indoor Worker in the Western Auto Store

Future Receptors:

- On-Site Maintenance Worker
- On-Site Construction/Utility Worker
- Off-Site Construction/Utility Worker in the Northern James River and Kanawha Turnpike ROW
- Off-Site Construction/Utility Worker in the Southern James River and Kanawha Turnpike ROW

Based on the potential receptors listed above, descriptions of the retained receptors are provided below. Exposure pathways were retained based on the potential sources of COC, migration potential of COC, and the activities of the receptor. **Figure 6** presents the human health receptor CSM in flow chart form which presents a summary of the exposure pathways considered for each receptor and whether or not those pathways were retained.

On-Site Maintenance Worker

The site historically and currently operates as a petroleum retail facility and convenience store. The on-site property is triangular in shape and approximately 0.45 acres. The majority of the site is paved with asphalt and concrete. The on-site maintenance worker is an individual who performs work activities outdoors. Activities conducted by this receptor would be general property maintenance, which may include landscaping, cutting grass, or other activities to maintain the property. Due to the fact that the site is currently under roof or covered with asphalt and/or concrete, a current maintenance worker was not evaluated. However, the asphalt and/or concrete may be removed in the future. Therefore, a future on-site maintenance worker was evaluated.

This receptor is expected to spend the majority of their time outdoors. Therefore, the inhalation of volatiles to indoor air (via vapor intrusion) is not applicable for this receptor and was evaluated under the on-site indoor worker scenario.

Based on the activities of the future on-site maintenance worker, this receptor is expected to be in direct contact with surface soil only during minimal intrusive activities (maximum excavation depth 2 ft-bgs). There were no site-related constituents retained as direct contact COC in on-site surface soil samples (0-2 ft-bgs). Therefore, incidental ingestion, dermal contact, and inhalation of volatiles from surface soil exposure pathways were not retained for this receptor.

Based on the maximum excavation depth of 2 ft-bgs for the future on-site maintenance worker, it is unlikely this receptor would come into direct contact with subsurface soil (i.e. 2 ft-bgs and greater) or groundwater (average depth to groundwater on-site is approximately 5.5 ft-bgs) during minimal intrusive activities. Therefore, incidental ingestion and dermal contact exposure pathways for soil, and incidental ingestion and dermal contact exposure pathways for groundwater (intrusive activities) are not applicable to this receptor.

There is the potential for site-related constituents in subsurface soil (>2 ft-bgs) to volatilize from unexposed subsurface soil to outdoor air without intrusive activities. Although there was a site-related constituent retained as a direct contact COC (i.e. ethylbenzene) in on-site subsurface soil sample CE-MW-3D-(6-8)-009 collected at 6-8 ft-bgs, a quantitative assessment of exposure to this COC via the inhalation of volatiles from subsurface soil to outdoor air without intrusive activities was not completed. This is because this subsurface soil sample is located in the saturated zone based on groundwater levels measured in MW-3 and MW-3R (i.e. ranges from approximately 4.5 to 7 ft-bgs with an average depth of approximately 5.5 ft-bgs in the 8 most recent sampling events). Exposure to volatile constituents in the saturated zone was evaluated using groundwater analytical data. In addition, ethylbenzene was the only constituent that exceeded a soil De Minimis standard (i.e. no other constituents exceeded soil De Minimis standards), and ethylbenzene only exceeded the standard in one soil sample. Furthermore, the ethylbenzene concentration in subsurface soil only exceeded the residential soil De Minimis standard, not the industrial soil De Minimis standard. Therefore, the inhalation of volatiles from unexposed subsurface soil to outdoor air exposure pathway was not retained for this receptor.

The average depth to groundwater on-site is approximately 5.5 ft-bgs. There were site-related volatile constituents retained as direct contact COC in the 8 most recent post-remediation groundwater samples (i.e. collected between December 2010 and August 2016) from on-site monitoring wells. Therefore, the potential exists for these constituents to volatilize from unexposed groundwater to outdoor air without intrusive activities if the paved areas are removed in the future. Therefore, the inhalation of volatiles from unexposed groundwater to outdoor air without intrusive activities was quantitatively retained for a future on-site maintenance worker.

The Former 7-Eleven Facility #135 property is currently connected to a public water supply. Potable water is supplied by the town of Rainelle Water Department. Therefore, there are currently no complete groundwater use exposure pathways for on-site receptors. It is unlikely a potable well will be installed on the on-site property in the future because the on-site property is connected to public water. However, there is no known ordinance in the town of Rainelle that prohibits the installation and use of a private potable well. Therefore, an LUC will be prepared that will prohibit the use groundwater for potable purposes on the Former 7-Eleven Facility #135 property. As a result, groundwater use exposure pathways for the future on-site maintenance worker were qualitatively retained but not quantitatively evaluated.

In summary, the following exposure pathway was retained for quantitative evaluation for a future on-site maintenance worker:

- Inhalation of volatiles emitted from unexposed groundwater to outdoor air (without intrusive activities).

A summary of the exposure pathways considered for the on-site maintenance worker and whether or not those pathways were retained is shown in **Figure 6**.

On-Site Indoor Worker

The site historically and currently operates as a petroleum retail facility and convenience store. The current on-site building is a one-story slab-on-grade building that is used as the station building/convenience store. The on-site indoor worker is an individual who performs work activities indoors. The primary activity conducted by a current and future on-site indoor worker is retail/office work. Currently the site is an active gasoline service station and convenience store and is expected to remain an active gas station and convenience store in the future. Therefore, a current and future on-site indoor worker was evaluated for the existing on-site building, and a future on-site indoor worker was evaluated for a future building that may be constructed on-site.

Based on the activities of this individual, this receptor is expected to spend the majority of their time indoors. Therefore, the outdoor direct contact soil exposure pathways (i.e. incidental ingestion, dermal contact, and the inhalation of particulates and volatiles to outdoor air from soil) and groundwater exposure pathways (i.e. incidental ingestion, dermal contact, and the inhalation of volatiles to outdoor air from groundwater) were not applicable for this receptor. However, there is the potential for this receptor to be exposed to site-related constituents that volatilize to indoor air (via vapor intrusion) from groundwater.

To evaluate the vapor intrusion pathway for the current on-site building, groundwater analytical data was used. The current on-site building is upgradient of groundwater flow from the UST area (i.e. groundwater flows southwest and the on-site building is northeast of the UST area). On-site groundwater monitoring well MW-1 (located closest to the western side of the on-site building, between the building and the UST area) was used to evaluate the current on-site building. MTBE was the only site-related constituent detected in the 8 most recent post-remediation groundwater samples (i.e. collected between December 2010 and August 2016) from MW-1. However, MTBE did not exceed a USEPA commercial or residential VISL target groundwater concentration and therefore, no vapor intrusion COC were retained for the current on-site building. As a result, the inhalation of volatiles from groundwater to indoor air via vapor intrusion was not retained for a current or future indoor worker in the current on-site building.

There is also the potential for a future building to be constructed on-site. There were two vapor intrusion COC (i.e. benzene and ethylbenzene) retained in the 8 most recent post-remediation groundwater samples (i.e. collected between December 2010 and August 2016) from on-site monitoring well MW-3/MW-3R (i.e. located near the source area). Therefore, a future building that may be constructed on-site closer to the former source area (i.e. area of MW-3/MW-3R) was considered. The site is comprised of an approximately 0.45-acre triangular shaped parcel and is bounded by James River and Kanawha Turnpike (south/southwest) and Main Street (north/northwest). Therefore, it is unlikely a future building will be built closer to the source area (i.e. MW-3/MW-3R) due to the size and shape of the property. However, as a conservative measure, an institutional control will be placed on the site (e.g. require installation of vapor barrier or mitigation system), which will make the vapor intrusion pathway incomplete for a future on-site indoor worker in a future building that may be constructed on-site. Therefore, this exposure pathway was qualitatively retained, but not quantitatively evaluated.

The Former 7-Eleven Facility #135 property is currently connected to a public water supply. Potable water is supplied by the town of Rainelle Water Department. Therefore, there are currently no complete groundwater use exposure pathways for on-site receptors. As a result, groundwater use exposure pathways for the current on-site indoor worker were not retained. It is unlikely a potable well will be installed on the on-site property in the future because the on-site property is connected to public water. However, there is no known ordinance in the town of Rainelle that prohibits the installation and use of a private potable well. Therefore, an LUC will be prepared that will prohibit the use groundwater for potable purposes on the Former 7-Eleven Facility #135 property. As a result, groundwater use exposure pathways for the future on-site indoor worker were qualitatively retained but not quantitatively evaluated.

In summary, there are no exposure pathways retained for quantitative analysis for the current and future on-site indoor worker. A summary of the exposure pathways considered for the on-site indoor worker and whether or not those pathways were retained is shown in **Figure 6**.

On-Site Construction Worker and Utility Worker

The on-site construction worker is an individual who would be involved in future construction and/or excavation activities on-site. This may include installation of new utility lines, major repairs to existing utility lines, installation of building footers, etc., which may result in exposure lasting more than one day. The on-site utility worker is an individual who would be involved with repairing and maintaining utility lines on-site. The utility worker is not expected to be involved in the installation of new lines as this is assumed to be performed by a construction worker.

The typical maximum excavation depths that WVDEP considers for a construction worker and utility worker are 10 ft-bgs and 4 ft-bgs, respectively. However, it was assumed the depth of current underground utility lines is 6 ft-bgs or less based on typical underground utility line depths and the relatively shallow depth to groundwater at the site (approximately 5.5 ft-bgs on average). Due to the shallow depth to groundwater, it is less likely that future utilities would be installed deeper than 6 ft-bgs and it is less likely that future buildings with a basement deeper than 6 ft-bgs would be installed. Therefore, based on the work activities of the on-site construction worker and on-site utility worker, it is assumed that these receptors could be involved in excavation activities to a maximum depth of approximately 6 ft-bgs.

Based on the maximum excavation depth for the on-site construction and utility worker, these receptors may come into direct contact with subsurface soil to a maximum depth of 6 ft-bgs. There were no exceedances of the WVDEP industrial or residential soil De Minimis standards in on-site surface soil samples (0-2 ft-bgs) or subsurface soil samples (2-6 ft-bgs). As a result, no direct contact COC were retained in on-site soil between 0-6 ft-bgs. There was a WVDEP residential soil De Minimis standard exceedance for ethylbenzene in sample CE-MW-3D-(6-8')-009 collected at 6-8 ft-bgs. Based on the maximum excavation depth for these receptors (6 ft-bgs), it is not expected for these receptors to come into contact with this soil sample. Therefore, incidental ingestion and dermal contact with soil exposure pathways were not retained for these receptors. In addition, CE-MW-3D-(6-8')-009 collected at 6-8 ft-bgs is located in the saturated zone based on groundwater levels measured in MW-3 and MW-3R (i.e. ranges from approximately 4.5 to 7 ft-bgs with an average depth of approximately 5.5 ft-bgs in the 8 most recent sampling events). Exposure to volatile constituents in the saturated zone was evaluated using groundwater analytical data. In addition, ethylbenzene was the only constituent that exceeded a soil De Minimis standard (i.e. no other constituents exceeded soil De Minimis standards), and ethylbenzene only exceeded the standard in one soil sample. Furthermore, the ethylbenzene concentration in subsurface soil only exceeded the residential soil De Minimis standard, not the industrial soil De Minimis standard. Therefore, the inhalation of volatiles from soil exposure pathway was not retained for these receptors.

The average depth to groundwater on-site is approximately 5.5 ft-bgs, which is based on groundwater elevation data collected between December 2010 and August 2016 from all on-site groundwater monitoring wells. These receptors are expected to excavate to a maximum excavation depth of approximately 6 ft-bgs based on assumed depth of current utility lines (6 ft-bgs or less). Therefore, these receptors are expected to be in direct contact with groundwater during intrusive activities. There were site-related constituents retained as direct contact COC in the 8 most recent post-remediation groundwater samples (i.e. collected between December 2010 and August 2016) from on-site monitoring wells. Therefore, the dermal contact and inhalation of volatiles (from exposed groundwater within a trench) exposure pathways were retained for these receptors. Incidental ingestion of groundwater is unlikely because the trench will need to be dewatered before intrusive activities can occur within the trench. Although the trench is dewatered, there is still assumed to be approximately 1-2 inches of water located at the bottom of the trench. Therefore, direct contact with groundwater via dermal contact is likely to occur within the trench. However, the potential to incidentally ingest groundwater in a dewatered trench is unlikely.

In summary, the following exposure pathways were retained for quantitative evaluation for the future on-site construction worker and on-site utility worker:

- Dermal contact and inhalation of volatiles emitted from exposed groundwater to trench air (during intrusive activities).

A summary of the exposure pathways considered for the on-site construction worker and on-site utility worker and whether or not those pathways were retained is provided in **Figure 6**.

Off-Site Construction and Utility Worker in the James River and Kanawha Turnpike Northern and Southern ROWs (South/Southwest of the Site)

The off-site construction worker is an individual who would be involved in future construction and/or excavation activities in the James River and Kanawha Turnpike northern and southern ROWs. This may include installation of new utility lines, major repairs to existing utility lines, etc., which may result in exposure lasting more than one day. The off-site utility worker is an individual who would be involved with repairing and maintaining utility lines in the James River and Kanawha Turnpike northern and southern ROWs. The utility worker is not expected to be involved in the installation of new lines as this is assumed to be performed by a construction worker.

Northern ROW

The James River and Kanawha Turnpike northern ROW is located adjacent to the south/southwest on-site property boundary. Based on the expected work activities of the off-site construction worker and utility worker in the James River and Kanawha Turnpike northern ROW and expected depth of underground utilities in the ROW (i.e. approximately 6 ft-bgs or less), these receptors are expected to be involved in excavation activities to a maximum depth of 6 ft-bgs or to the water table. The average depth to groundwater in the northern ROW is approximately 5.5 ft-bgs, which is based on groundwater elevation data from collected between December 2010 and April 2012 from MW-3 and August 2016 from MW-3R. As a result, these receptors may come into direct contact with subsurface soil to a maximum depth of 6 ft-bgs. On-site soil samples located closest to the northern ROW (i.e. CE-MW-3B (0-2')-003, CE-MW-3D (0-2')-008, CE-MW-3B (6-8')-004, and CE-MW-3D (6-8')-009 were conservatively used to evaluate soil conditions in the northern ROW. There were no exceedances of the WVDEP industrial soil De Minimis standards in on-site soil samples located closest to the northern ROW. There was a WVDEP residential soil De Minimis standard exceedance for ethylbenzene in sample CE-MW-3D-(6-8')-009 collected at 6-8 ft-bgs. Based on the maximum excavation depth for these receptors (6 ft-bgs), it is not expected for these receptors to come into contact with this soil sample. Therefore, incidental ingestion and dermal contact with soil exposure pathways were not retained for these receptors. In addition, CE-MW-3D-(6-8')-009 collected at 6-8 ft-bgs is located in the saturated zone based on groundwater levels measured in MW-3 and MW-3R (i.e. ranges from approximately 4.5 to 7 ft-bgs with an average depth of approximately 5.5 ft-bgs in the 8 most recent sampling events). Exposure to volatile constituents in the saturated zone was evaluated using groundwater analytical data. In addition, ethylbenzene was the only constituent that exceeded a soil De Minimis standard (i.e. no other constituents exceeded soil De Minimis standards), and ethylbenzene only exceeded the standard in one soil sample. Furthermore, the ethylbenzene concentration in subsurface soil only exceeded the residential soil De Minimis standard, not the industrial soil De Minimis standard. Therefore, the inhalation of volatiles from soil exposure pathway was not retained for these receptors.

The average depth to groundwater in the northern ROW is assumed to be approximately 5.5 ft-bgs based on measured groundwater levels in MW-3 and MW-3R. Therefore, based on the average depth to groundwater in the northern ROW and the assumed depth of current utility lines (6 ft-bgs or less), these receptors are expected to excavate to a maximum excavation depth of approximately 6 ft-bgs or the water table. Therefore, these receptors are expected to be in direct contact with groundwater during intrusive activities. There were site-related constituents retained as direct contact COC in the 8 most recent post-remediation groundwater samples (i.e. collected between December 2010 and August 2016) from on-site monitoring well MW-3/MW-3R (located closest to and upgradient of the northern ROW). Therefore, the dermal contact and inhalation of volatiles (from exposed groundwater within a trench) exposure pathways were retained for these receptors. Incidental ingestion of groundwater is unlikely because the trench will need to be dewatered before intrusive activities can occur within the trench. Although the trench is dewatered, there is still assumed to be approximately 1-2 inches of water located at the bottom of the trench. Therefore, direct contact with groundwater via dermal contact is likely to occur within the trench. However, the potential to incidentally ingest groundwater in a dewatered trench is unlikely.

Southern ROW

The James River and Kanawha Turnpike southern ROW is located south/southwest of the site (adjacent to the off-site Western Auto Store) and downgradient of groundwater flow. As a result, constituents related to the on-site subsurface release can only reach the James River and Kanawha Turnpike southern ROW by means of groundwater migration.

Therefore, soil exposure pathways were not evaluated for the off-site construction and utility worker in the James River and Kanawha Turnpike southern ROW.

The depth to groundwater in the southern ROW ranges from 4.52 ft-bgs at MW-5 to 9.50 ft-bgs at MW-6 with an average depth of approximately 6.5 ft-bgs (based on groundwater elevation data collected between December 2010 and August 2016 from off-site wells MW-4, MW-5, and MW-6). Therefore, based on the depth to groundwater in the southern ROW (ranges from 4.52 ft-bgs to 9.50 ft-bgs) and the assumed depth of current utility lines (6 ft-bgs or less), these receptors are expected to excavate to a maximum excavation depth of approximately 6 ft-bgs or the water table. As a result, these receptors are expected to be in direct contact with groundwater during intrusive activities. There was a site-related constituent retained as a direct contact COC in the 8 most recent post-remediation groundwater samples (i.e. collected between December 2010 and August 2016) from off-site groundwater monitoring well MW-4 and MW-6 (located within the southern ROW).

Incidental ingestion of groundwater is unlikely because the trench will need to be dewatered before intrusive activities can occur within the trench. Although the trench is dewatered, there is still assumed to be approximately 1-2 inches of water located at the bottom of the trench. Therefore, direct contact with groundwater via dermal contact is likely to occur within the trench. However, the potential to incidentally ingest groundwater in a dewatered trench is unlikely. In addition, volatile constituents have the potential to volatilize from exposed groundwater within a trench to trench air during intrusive activities. Therefore, the dermal contact and inhalation of volatiles (from exposed groundwater within a trench) exposure pathways were retained for these receptors.

Summary

In summary, the following exposure pathways were retained for the future off-site construction worker and off-site utility worker in the James River and Kanawha Turnpike northern and southern ROWs:

- Dermal contact and inhalation of volatiles emitted from exposed groundwater to trench air (during intrusive activities).

A summary of the exposure pathways considered for the off-site construction worker and off-site utility worker in the James River and Kanawha Turnpike northern and southern ROWs and whether or not those pathways were retained is provided in **Figure 6**. However, a quantitative analysis will be completed for the on-site construction worker and utility worker for the dermal contact with and inhalation of volatiles from exposed groundwater exposure pathways and will be protective of the off-site construction worker and utility worker in the James River and Kanawha Turnpike northern and southern ROWs. See Section 9 (Uncertainty Analysis) for further discussion. As a result, the groundwater exposure pathways for the future off-site construction worker and utility workers in the James River and Kanawha Turnpike northern and southern ROWs were retained qualitatively, but not quantitatively evaluated.

Off-Site Indoor Worker in the Western Auto Store (South/Southwest of the Site)

A commercial building is located south/southwest of the site across James River and Kanawha Turnpike and downgradient of groundwater flow. This building contains three garage bays on the eastern side of the building, which are attached to a two-story building. The off-site indoor worker is an individual who performs work activities at the Western Auto Store. The primary activity conducted would be car maintenance in the three garage bays and retail work in the two-story building. A current and future off-site indoor worker in the existing Western Auto Store was evaluated. Constituents related to the on-site subsurface release can only reach the off-site Western Auto Store by means of groundwater migration. Therefore, soil exposure pathways were not evaluated for the off-site indoor worker in the Western Auto Store.

Based on the activities of this individual, this receptor is expected to spend the majority of their time indoors. Therefore, the outdoor direct contact groundwater exposure pathways (i.e. incidental ingestion, dermal contact, and the inhalation of volatiles to outdoor air from groundwater) were not applicable for this receptor. However, there is the potential for this receptor to be exposed to site-related volatile constituents that volatilize to indoor air (via vapor intrusion).

Groundwater analytical data from off-site monitoring wells MW-4, MW-5, and MW-6 (located closest to and upgradient of the Western Auto Store) were used to evaluate vapor intrusion. There were no site-related constituents in these off-site monitoring wells that exceeded USEPA commercial or residential VISL target groundwater concentrations. As a result, no vapor intrusion COC were retained in groundwater for the off-site Western Auto Store. Therefore, the inhalation of volatiles from groundwater to indoor air via vapor intrusion exposure pathway was not retained for the off-site indoor worker in the Western Auto Store.

MTBE exceeded the WVDEP groundwater de minimis standard in off-site monitoring wells MW-4 and MW-6. The Former 7-Eleven Facility #135 property and immediate surrounding area are currently connected to a public water supply provided by the town of Rainelle Water Department. The public water supply is drawn from a hydraulically-isolated groundwater source. It is likely that the public water supply will continue to be used in the future. Therefore, there are no complete groundwater use exposure pathways for a current and future off-site indoor worker in the Western Auto Store and these pathways were not retained.

In summary, there were no exposure pathways retained for quantitative calculation of risks and hazard indices for the current and future off-site indoor worker at the off-site Western Auto Store property. A summary of the exposure pathways considered for the current and future off-site indoor worker in the Western Auto Store and whether or not those pathways were retained is provided in **Figure 6**.

4.4.3 Summary of Incomplete Pathways via Institutional Controls

Based on the receptor and exposure pathway analysis above, a number of exposure pathways will be considered incomplete by means of implementing various institutional controls. The following is a summary of the receptor(s) and pathways that will be considered incomplete via implementation of the forthcoming proposed institutional controls:

- Ingestion, dermal contact, and inhalation of volatiles from groundwater via potable use for all on-site receptors;

- Inhalation of volatiles from the subsurface to indoor air via vapor intrusion for a future on-site indoor worker in a future on-site building that is constructed closer to the former source area (i.e. MW-3/MW-3R); and,

- Any direct contact and vapor intrusion exposures to groundwater or soil via on-site future residential land use scenarios.

The institutional controls shall be constituted via a land use covenant, which will be documented in the Final Report.

4.5 Ecological Assessment Summary

In order to comply with Section 60-3-8.5 of the Rule [WVDEP 2018], potential impacts to ecological receptors were evaluated. The "Checklist to Determine the Applicable Remediation Standards, Part 1: Ecological Standards", provided in Attachment 5 of the WV VRP Guidance Manual [WVDEP 2019a], was used in the ecological screening process. The checklist follows the ecological De Minimis screening evaluation outlined in Section 60-3-9.5 of the Rule [WVDEP 2018]. In particular, Section 60-3-9.5.a of the Rule recommends that the following parameters should be considered when evaluating whether or not to perform an ecological risk assessment:

A. Evaluate whether a complete exposure pathway exists. If no complete exposure pathways exists because either the contamination is restricted in movement or there are no ecological receptors of concern, then no ecological risks exists (e.g. if the majority of the site is paved with roads and buildings, no pathway exists);

B. Some sites may be screened out and not require evaluation given their size, estimated risk to ecological receptors, or lack of valued ecological receptors, including threatened or endangered species;

C. Local conditions should be considered for assessing whether a site is degrading an aquatic environment. In cases where the site does not present an ecological risk over and above "local conditions" and further release of contaminants into the aquatic environment has been stopped, there will not be a need for further evaluation;

D. Define what level of ecological resource is considered valued; and,

E. If for each contaminated media, harm is readily apparent and a condition of significant risk of harm to the site biota and habitats clearly exists, further ecological risk characterization would be redundant and is not required. The applicant can then proceed directly to the remedy evaluation.

The first step in determining whether a complete exposure pathway exists was performed using the "Checklist to Determine the Applicable Remediation Standards, Part 1:

Ecological Standards", which is presented in **Attachment 5** (Ecological Checklist). As shown in the ecological checklist, "no further ecological evaluation is required" for the site. A description of the local conditions is presented below.

Local conditions:

- The site historically and currently operates as a petroleum retail facility and convenience store. The on-site property is triangular in shape and approximately 0.45 acres. The majority of the site is paved with asphalt and concrete. The current on-site building is a one-story slab-on-grade building that is used as the station building/convenience store. The site is bounded to the north/northwest by Main Street, to the south/southwest by James River and Kanawha Turnpike, and to the east by a vacant lot and Rainelle water building. Based on this evaluation of active land use, current site conditions would not support viable ecological habitats.

- Groundwater flows in the southwest direction. The nearest surface water body is Sewell Creek, which is approximately 700 feet southwest of the site in the downgradient groundwater flow direction. Off-site groundwater monitoring well MW-6 (located southwest of the site and closest downgradient well to Sewell Creek) was used to evaluate the potential for constituents to migrate to Sewell Creek. Site-related constituents at MW-6 were nondetect with the exception of MTBE, which exceeded the groundwater De Minimis screening value. There is no surface water screening criteria available for MTBE; therefore, the groundwater De Minimis screening value was used to evaluate the potential migration to surface water. Based on the results of the BIOSCREEN modeling using the actual input values (as discussed in Section 4.3), the MTBE plume is not expected to migrate more than 220 ft downgradient from MW-3/3R above the WVDEP groundwater De Minimis screening level of 14 µg/L.

Due to the fact that it is unlikely that the site would serve as a habitat for terrestrial species and discharge of site-related constituents via diffuse groundwater flow is not expected to reach the nearest surface water body above surface water quality criteria, it can be concluded that there is no complete exposure pathway and the initial screening was adequate to determine that no substantial ecological risk exists.

5 Exposure Point Concentrations

This section presents the procedures that were used to develop EPCs for the COC identified at the site as previously presented in **Tables 3-6** and **3-7** in Section 3. The EPCs are relevant to the migration routes and exposure pathways retained for evaluation in Section 4, as presented in **Table 4-1** and **Figure 6**, respectively.

5.1 Exposure Point Concentrations for the Direct Contact Exposure Pathways

In theory, the concentrations in each medium are expected to decrease with time through biodegradation, volatilization, leaching, and other transformation processes. Therefore, the appropriate concentration for estimating exposure to a particular receptor is an average concentration over the exposure period. However, the change in source concentration with time is difficult to assess. For this analysis, source concentrations are treated as being constant (stable) for the foreseeable future, which is a conservative assumption.

The source concentration is defined as a measured concentration within a specific medium (e.g. groundwater) or modeled from one medium to “a like” medium (e.g. source groundwater to downgradient groundwater, or groundwater to surface water). The exposure point concentration is derived by multiplying the source concentration by a transfer factor. For exposure scenarios where the receptor is directly exposed to the medium where the concentration was measured (e.g. groundwater) or modeled to “a like” medium (e.g. groundwater to surface water), the transfer factor is equal to 1.0. For exposure scenarios where the receptor is exposed to a medium different than where the concentration was measured or modeled to “a like” medium (e.g. concentration is measured in groundwater and exposure is to air), the transfer factor is estimated through modeling. This modeled transfer factor is chemical-specific and medium-specific.

5.1.1 Media-Specific Source Concentrations

Source concentrations for groundwater were derived using analytical data representative of current site conditions. These source concentrations were derived using the following procedure, which is consistent with procedures presented in the USEPA ProUCL 5.1 Users Guide [USEPA 2015]:

- The distribution of each constituent in each dataset was determined by running the goodness-of-fit test in ProUCL. If a constituent could be represented by a normal distribution, it was classified as following a normal distribution. If a constituent could not be represented by a normal distribution, but could be represented by a gamma distribution, it was classified as following a gamma distribution. If a constituent could not be represented by a normal distribution or gamma distribution, but could be represented by a lognormal distribution, it was classified as following a lognormal distribution. If a constituent could not be represented by a normal distribution, gamma distribution or lognormal distribution, it was classified as nonparametric (i.e. not following any particular distribution).

- Depending on the distribution that a constituent was determined to follow, a 95 percent upper confidence level (95%UCL) of the mean concentration was calculated using ProUCL.

- The source concentrations were determined to be the lesser of the recommended UCL or the maximum detected concentration.

In general, the robustness of a dataset (e.g. the number of samples) typically controls the acceptable statistical derivation of a UCL. Typically, datasets containing eight samples or more are used to derive a 95% UCL. For datasets containing less than eight samples, the maximum detected concentrations may be used as the source concentrations.

Groundwater

Source concentrations for groundwater were derived using analytical data representative of current site conditions. The last remediation activity to occur at the site was an MTU equipped with dual-phase, high vacuum extraction technology. MTU events were conducted monthly to extract dissolved-phase and vapor-phase petroleum hydrocarbons from the subsurface in the vicinity of MW-3. MTU operations were halted in the second quarter of 2009. Therefore, groundwater analytical data collected after the second quarter of 2009 (i.e. June 30, 2009) are considered post-remediation groundwater samples. As a result, the 8 most recent post-remediation groundwater samples collected between December 2010 and August 2016 were used in this risk assessment.

Due to the presence of an area of isolated higher concentrations in the vicinity of the source area (i.e., MW-3/3R), the on-site construction worker was evaluated under two different scenarios. The first scenario conservatively assumes that the receptor would perform excavation activities exclusively in the source area. The second scenario assumes that excavation activities are equally likely in all areas of the site. Based on the exposure scenario of a utility worker (i.e., returning to the site for one day each year), it was conservatively assumed that the utility worker would return to perform work exclusively in the source area each year. In addition, it was conservatively assumed that the on-site maintenance worker would spend the majority of their time in the vicinity of the source area. See the Uncertainty Analysis (Section 9) for further discussion on the conservative nature of this evaluation.

To quantitatively evaluate an on-site construction worker performing excavation activities exclusively in the source area and an on-site utility worker and on-site maintenance worker, groundwater analytical data collected between December 2010 and August 2016 from on-site monitoring well MW-3 and MW-3R (which replaced MW-3) were used to derive source concentrations for COC. A 95% UCL of the mean concentration was derived for each groundwater direct contact COC. Note that MW-3 was not sampled in December 2010 because the well was not able to be located due to the presence of ice and snow. Therefore, only 7 groundwater sampling events were used to derive the 95% UCLs.

To quantitatively evaluate an on-site construction worker performing excavation activities across the entirety of the site, groundwater analytical data collected between December 2010 and August 2016 from all on-site monitoring wells (i.e., MW-1, MW-2, and MW-3/3R) were used to derive source concentrations for COC. A 95% UCL of the mean concentration was derived for each groundwater direct contact COC.

Attachment 6 presents the groundwater datasets and statistical analysis for development of the source concentrations in on-site groundwater. **Table 5-1** presents a summary of the source concentrations in on-site groundwater for direct contact exposure pathways.

5.1.2 Receptor-Specific Source Concentrations

The selection of source concentrations for each receptor is based on the potentially complete exposure pathways for that receptor. The following describes the selected source concentrations in groundwater for each receptor based on the retained exposure pathways.

Groundwater

The selection of groundwater concentrations is receptor-specific and is based on the complete exposure pathways for each receptor.

Based on the assumed depth of the underground utility lines (approximately 6 ft-bgs or less) and average depth to groundwater on-site (approximately 5.5 ft-bgs), the on-site construction worker and utility worker are expected to excavate to a maximum depth of approximately 6 ft-bgs or to the water table. Therefore, these receptors are expected to be in direct contact with groundwater during intrusive activities (i.e. dermal contact and inhalation of volatiles from exposed groundwater within a trench).

As discussed above, the on-site construction workers were evaluated under two scenarios: The first scenario conservatively assumes that the receptor would perform excavation activities exclusively in the source area. The second scenario assumes that excavation activities are equally likely in all areas of the site. Therefore, two sets of source concentrations for dermal contact with groundwater and inhalation of volatiles from groundwater exposure pathways are utilized: groundwater UCLs derived from monitoring wells MW-1, MW-2, and MW-3/3R (i.e., entire site) and groundwater UCLs derived from monitoring well MW-3/3R (i.e., source area).

Based on the exposure scenario of a utility worker (i.e., returning to the site for one day each year), it was conservatively assumed that the utility worker would return to perform work exclusively in the source area each year. Therefore, the source concentrations for dermal contact with groundwater and inhalation of volatiles from groundwater exposure pathways are the UCLs conservatively derived for overburden groundwater from monitoring well MW-3/3R (i.e., source area).

Based on the maximum excavation depth of the on-site maintenance worker (approximately 2 ft-bgs) and the average depth to groundwater on-site (approximately 5.5 ft-bgs), the future on-site maintenance worker is not expected to be in direct contact with groundwater. Therefore, the source concentrations for inhalation of volatiles from groundwater exposure pathway are the UCLs conservatively derived for overburden groundwater from monitoring well MW-3/3R (i.e., source area).

Table 5-1 presents a summary of the source concentrations for the on-site construction workers in the source area and across the entire site, the on-site utility worker, and the on-site maintenance worker for the COC retained in groundwater for the direct contact exposure pathways.

5.2 Calculation of Exposure Point Concentrations for the Direct Contact Exposure Pathways

EPCs are calculated for each direct contact COC by multiplying the selected source concentrations by a transfer factor. For the dermal contact pathway, which involves actual contact with groundwater, the transfer factor is 1.0 [USEPA 2004]. For the exposure pathways involving inhalation of constituents emitted from groundwater to outdoor (ambient) air, the transfer factor relates measured concentrations in groundwater to estimated concentrations in outdoor air.

For volatilization of constituents from groundwater to outdoor air without intrusive activities, transfer factors are calculated using a model presented by the American Society for Testing and Materials (ASTM) Standard Guidance [ASTM 2015] and are presented in **Attachment 7** of this document. For volatilization of constituents from exposed groundwater to outdoor air within a trench (i.e. trench air), transfer factors were calculated following an approach suggested by the Virginia Department of Environmental Quality (VA DEQ) Voluntary Remediation Program [VA DEQ 2019] while also following an approach suggested by USEPA Region 8 [USEPA 1999] for the air changes per hour (ACH) and are presented in **Attachment 7** of this document. The exposure point concentrations for direct contact exposure pathways are presented in the risk calculation spreadsheets presented in Section 8 of this document.

6 Constituent-Specific Parameters

This section presents constituent-specific parameters used in the quantitative risk assessment including chemical properties, toxicological values, and permeability constants.

6.1 Chemical Properties

Table 6-1 presents the chemical properties required to complete the site-specific risk calculations for the direct contact exposure pathways. This table also references the source for each chemical property. The "WVDEP-Approved Chemical Specific Data" table dated June 2014 [WVDEP 2014] was used to select chemical properties, which is available on WVDEP's website (https://www.dep.wv.gov/dlr/oer/voluntarymain/Pages/default.aspx). If a certain chemical property was not provided in WVDEP's approved chemical specific data table, other databases were used.

6.2 Toxicological Values

COC are quantitatively evaluated on the basis of their cancer and/or noncancer potential. Cancer slope factors (CSFs) and inhalation unit risks (IURs) are the toxicity values used to evaluate cancer health effects in humans. The reference doses (RfDs) and reference concentrations (RfCs) are the toxicity values used to evaluate noncancer (e.g., systemic) health hazards in humans.

CSFs and IURs are presented in **Table 6-2** for the direct contact COC. RfDs and RfCs for chronic effects associated with long-term exposures are provided in **Table 6-3** for the direct contact COC. Due to the fact that the June 2014 WVDEP-Approved Chemical Specific Data table [WVDEP 2014] is an outdated table with older toxicity values, the most recent toxicity values were obtained following the hierarchy of sources presented in Section 60-3-8.1.c.1 in the Rule [WVDEP 2018]:

- Tier 1: Integrated Risk Information System (IRIS), available through the USEPA website (http://www.epa.gov/IRIS/).
- Tier 2: Provisional Peer Reviewed Toxicity Values (PPRTVs). Information regarding the PPRTVs is available through the PPRTV online library

(http://hhpprtv.ornl.gov/) and the Risk Assessment Information System (RAIS) website (http://rais.ornl.gov).

- Tier 3: Other Toxicity Values

Tier 3 of the hierarchy includes several sources of toxicity values that are commonly consulted by the USEPA when a relevant toxicity value is not available from either IRIS or the PPRTV database. They may include:

- The Agency for Toxic Substances and Disease Registry (ATSDR) Minimal Risk Levels (MRLs), available at http://www.atsdr.cdc.gov/mrls/index.html.
- The California Environmental Protection Agency toxicity values, available at http://www.oehha.ca.gov/risk/chemicalDB/index.asp.
- PPRTV screening values from certain PPRTV assessment appendices. Information regarding the PPRTV Screening Values is available through the PPRTV online library (http://hhpprtv.ornl.gov/).
- The EPA Superfund Health Effects Assessment Summary Tables (HEAST).

RfDs and RfCs for subchronic effects associated with short-term exposures are provided in **Table 6-4** for the direct contact COC. These values were obtained from the PPRTVs (available through the RAIS website), the ATSDR MRLs, or HEAST tables. If values were not available from these sources, then the RfDs and RfCs for chronic effects were used. The PPRTV value was selected first as the subchronic value (if available) since it is Tier 2 on the USEPA hierarchy. If PPRTV values were not available, then values from Tier 3 sources, ATSDR and HEAST, were reviewed and the most recent value presented in any of these sources was selected as the subchronic value.

Generally, it is assumed that subchronic toxicity values would be greater than the toxicity value associated with chronic exposure. However, the final selection of a subchronic toxicity value is dependent upon a number of factors, including the confidence of the value, the age of the study utilized, the conservative nature of selecting the chronic vs. subchronic value and whether the value is current or archived. Note that the only receptors assumed to have subchronic exposures were the on-site and off-site construction workers.

In accordance with USEPA Risk Assessment Guidance for Superfund (RAGS) Part E [USEPA 2004], oral-to-dermal conversion factors were used to convert oral slope factors and reference doses to dermal slope factors and reference doses. The conversion factors used are presented in **Tables 6-2, 6-3,** and **6-4**.

Tumor type/critical effect and target organ information (when available) for several of the COC are presented in **Table 6-5** (CSFs and IURs), **Table 6-6** (chronic RfDs and RfCs), and **Table 6-7** (subchronic RfDs and RfCs).

6.3 Permeability Constants

Permeability constants (*PC*) are used to evaluate dermal contact with water. These constants describe the rate at which constituents are absorbed through skin that is in contact with water. In this evaluation, organic constituent permeability constants are calculated from equations presented in RAGS Part E [USEPA 2004]. The permeability coefficients were obtained or calculated from RAGS Part E [USEPA 2004] or obtained from the USEPA RSL Chemical-Specific Parameters Supporting Table [USEPA 2019b]. Parameters used to calculate permeability constants are presented in **Table 6-8**.

For organic constituents, the permeability constant depends on the exposure time (*ET*). As described in RAGS Part E [USEPA 2004], absorption of the constituent is faster for a shorter duration as the rate of absorption decreases as time goes by due to the skin becoming saturated with the constituent. The equations presented below to calculate permeability constants for organic constituents were developed from Equations 3.2 and 3.3 presented in RAGS Part E [USEPA 2004].

If the exposure time is less than or equal to the time to reach steady-state (*tstar*), then the permeability constant is calculated using the equation:

$$PC = \frac{2 * FA * K_p * \sqrt{\frac{6 * Tau-ev * ET}{\pi}}}{ET}$$

If the exposure time is greater than the time to reach steady-state, then the permeability constant is calculated using the equation:

$$PC = \frac{FA * K_p * \left[\frac{ET}{1+B} + 2 * Tau - ev * \left(\frac{1+3B+3B^2}{(1+B)^2} \right) \right]}{ET}$$

where:

PC = permeability constant (cm/hr)

FA = fraction of chemical absorbed from water (unitless) – used for highly lipophillic constituents

K_p = dermal permeability coefficient of constituent in water (cm/hr)

ET = exposure time per event (hr/event)

Tau-ev = lag time per event (hr/event)

B = dimensionless ratio of the permeability coefficient of a constituent through the stratum corneum relative to its permeability coefficient across the viable epidermis (unitless)

Permeability coefficients for several constituents are available in RAGS Part E [USEPA 2004]. For an organic constituent where a K_p value is not available, it can be calculated using the equation [USEPA 2004]:

$$\log K_p = -2.80 + 0.66 * \log K_{ow} - 0.0056 * MW$$

where:

K_p = dermal permeability coefficient of constituent in water (cm/hr)

K_{ow} = octanol-water partition coefficient (unitless)

MW = molecular weight (g/mole)

Values for the parameters *Tau-ev*, *B*, *tstar,* and *FA* for several organic constituents are available in RAGS Part E [USEPA 2004]. For organic constituents where values are not available, RAGS Part E [USEPA 2004] provides equations or procedures for calculating values for these parameters.

A value for the parameter *Tau-ev* can be calculated using the equation:

$$Tau-ev = 0.105 * 10^{(0.0056 * MW)}$$

where:

Tau-ev = lag time per event (hr/event)

MW = molecular weight (g/mole)

A value for the parameter *B* can be calculated using the equation:

$$B = K_p * \frac{\sqrt{MW}}{2.6}$$

where:

B = dimensionless ratio of the permeability coefficient of a constituent through the stratum corneum relative to its permeability coefficient across the viable epidermis (unitless)

K_p = dermal permeability coefficient of constituent in water (cm/hr)

MW = molecular weight (g/mole)

If the value for the parameter *B* is less than or equal to 0.6, then a value for *tstar* can be calculated using the equation:

$$tstar = 2.4 * Tau - ev$$

where:

tstar = time to reach steady-state (hr)

Tau-ev = lag time per event (hr/event)

If the value for the parameter *B* is greater than 0.6, then a value for *tstar* can be calculated using the equation:

$$tstar = 6 * Tau - ev * \left(b - \sqrt{b^2 - c^2}\right)$$

where:

$$b = \frac{2 * (1 + B)^2}{\pi} - c$$

$$c = \frac{1 + 3B + 3B^2}{3 * (1 + B)}$$

tstar = time to reach steady-state (hr)

Tau-ev = lag time per event (hr/event)

B = dimensionless ratio of the permeability coefficient of a constituent through the stratum corneum relative to its permeability coefficient across the viable epidermis (unitless)

The parameter *FA* is assumed to be 1.0 if there are no values for this parameter in RAGS Part E [USEPA 2004]. This is a conservative assumption.

The calculated permeability constants are presented in **Table 6-9** for the on-site construction and on-site utility worker for the dermal contact with groundwater during intrusive activities exposure pathway.

7 Absorbed Dose and Exposure Concentration Equations and Assumptions

This section presents the assumptions used to calculate the absorbed dose for the dermal contact exposure pathway and the exposure concentrations for the inhalation exposure pathway (volatiles) for the following receptors and exposure pathways:

- Direct contact (dermal contact and inhalation of volatiles) with exposed groundwater for the on-site construction workers (source area and entire site) and on-site utility worker during intrusive activities; and,
- Direct contact (inhalation of volatiles) with unexposed groundwater for the on-site maintenance worker during non-intrusive activities.

These exposure pathways are the focus of this section, which is divided into three parts: the first part presents the absorbed dose equations for the dermal contact exposure pathway; the second part presents the exposure concentration equations for the inhalation exposure pathway (volatiles); and the third part presents the receptor-specific assumptions used.

7.1 Absorbed Dose Equations

This section presents the absorbed dose equations for the exposure pathways identified above. General reference is made to RAGS Part A for all intake equations.

7.1.1 Dermal Contact with Groundwater

The absorbed dose from dermal contact with groundwater is estimated using the equation:

$$I_{derm-gw} = CW_{scr} * TF_w * PC * IF_{derm-gw}$$

where:

$I_{derm-gw}$ = absorbed dose from dermal contact with groundwater (mg/kg-day)

CW_{scr} = constituent source concentration in groundwater (mg/L)

TF_w = transfer factor that translate the source concentrations to EPCs (unitless)

PC = permeability constant (cm/hr)

IF_{derm-w} = intake factor for dermal contact with groundwater (L-hr/cm-kg-day)

A constituent EPC in groundwater is calculated by multiplying a constituent source concentration in groundwater (CW_{src}) by a transfer factor (TF_w). Determination of the constituent source concentrations was presented in Section 5 of this document for each medium and receptor. The variable TF_w accounts for processes, such as biodegradation, that can reduce the source concentration over an extended period of time. In this evaluation, the value of TF_w for each constituent was conservatively set to 1.0, which implies that no biodegradation is occurring. The concentration of a constituent dissolved in water may be limited by its solubility. Therefore, the calculated EPC in water is compared to the solubility of the constituent. If the calculated EPC is less than the solubility of the constituent, then the calculated EPC is utilized in the risk calculation. However, if the calculated EPC is greater than the solubility, then the solubility is utilized as the EPC in the risk calculation. The permeability constant (*PC*) is constituent-specific and describes the rate at which the constituent moves from water through the skin. The value of *PC* for each constituent is presented in **Table 6-9** for the on-site construction workers and utility worker.

Based on Exhibit 6-13 of RAGS Part A [USEPA 1989], the intake factor (IF_{derm-w}) accounts for all constituent-independent parameters and is estimated using the equation:

$$IF_{derm-gw} = \frac{SA * ET * EF * ED * CF}{BW * AT}$$

where:

IF_{derm-w} = intake factor for dermal contact with groundwater (L-hr/cm-kg-day)

SA = exposed skin surface area (cm^2)

ET = exposure time (hours/day)

EF = exposure frequency (days/year)

ED = exposure duration (years)

CF = conversion factor (1×10^{-3} L/cm^3)

BW = body weight (kg)

AT = averaging time (days)

The skin surface area (*SA*) exposed to groundwater is the product of the total body surface area and the fraction of body exposed. The fraction of the body exposed is dependent on the nature of the activity being conducted and the age and type of the individuals involved. The exposure time (*ET*), exposure frequency (*EF*), exposure duration (*ED*), and body weight (*BW*) are receptor-specific as defined in the intake assumptions for each receptor. The averaging time (*AT*) for carcinogenic effects (AT_c) is 25,550 days (based on a lifetime of 70 years) and applies to all receptors [USEPA 1991]. The averaging time for noncarcinogenic effects (AT_{nc}) is exposure-based and is described under the intake assumptions for specific receptors.

7.2 Exposure Concentration Equations

When estimating risk via inhalation, it is recommended that the concentration of the constituents in air be used as the exposure metric (e.g. µg/m^3) rather than the inhalation intake of a constituent in air based on inhalation rate and body weight [USEPA 2009]. This section presents the exposure concentration equations for the inhalation exposure pathway (volatiles) from groundwater.

Based on Equation 6 of RAGS Part F [USEPA 2009], the exposure concentration for estimating inhalation of volatiles is estimated using the following equation:

$$EC = \frac{CA_a * ET * EF * ED}{AT}$$

where:

EC = exposure concentration (µg/m^3)

CA_a = constituent concentration in air (µg/m^3)

ET = exposure time (hours/day)

EF = exposure frequency (days/year)

ED	=	exposure duration (years)
AT	=	averaging time (hours)

The exposure time (ET), exposure frequency (EF), and exposure duration (ED) are described in the intake assumptions for specific receptors. The averaging time (AT) for carcinogenic effects (AT_c) is 613,200 hours (based on a lifetime of 70 years) and applies to all receptors [USEPA 2009]. The averaging time for noncarcinogenic effects (AT_{nc}) is exposure based and is described under the intake assumptions for specific receptors.

The constituent concentration in air (CA_a) is calculated using the equation:

$$CA_a = C_{src} * TF_a$$

where:

CA_a	=	constituent concentration in air (µg/m^3)
C_{src}	=	constituent source concentration in groundwater (µg/L)
TF_a	=	transfer factor that translates the source concentration in groundwater to an air concentration (L/m^3)

Determination of the constituent source concentrations (C_{src}) was presented in Section 5 of this report for each medium and receptor. The variable TF_a accounts for processes, such as volatilization and air dispersion, which translate the source concentration into an air concentration. The transfer factors used for inhalation of volatiles in ambient air are chemical-specific and are presented in **Attachment 7**.

7.3 Receptor-Specific Exposure Assumptions

This section presents receptor-specific exposure assumptions for each receptor. The receptor-specific exposure assumptions quantify activity patterns and body characteristics for each of the receptors such as the amount of time a receptor may spend at the site and the frequency the receptor visits the site. The receptor-specific exposure assumptions were selected using WVDEP recommended values, when available. The WVDEP exposure assumptions were selected from Appendix C (Section C.3.1 – Exposure Parameters) of the VRP Guidance Manual [WVDEP 2019a]. Otherwise, alternative sources were used, such as recommended values from other state program guidance or USEPA guidance, or professional judgment (based on site-specific information) to select appropriate receptor-specific exposure assumptions.

7.3.1 On-Site Construction Worker

The exposure scenario for the on-site construction worker was discussed in Section 4.4.2. As discussed in Section 5.1.2, due to the presence of an area of isolated higher concentrations in the vicinity of MW-3/3R, this receptor was evaluated under two different exposure scenarios. The first scenario conservatively assumes that the receptor would perform excavation activities exclusively in the source area. The second scenario assumes that excavation activities are equally likely in all areas of the site. This section presents the applicable exposure parameters that correlate to the retained exposure pathways for the on-site construction worker. **Tables 7-1a and 7-1b** presents the exposure parameters for the on-site construction worker in the source area and across the entire site, respectively. Note that the exposure pathways and parameters are the same, with the exception of the exposure frequency.

Although WVDEP provides exposure parameters for an industrial scenario, site-specific exposure assumptions were used specifically for a construction worker for a few of the exposure parameters. These site-specific exposure assumptions were compared to regulations in other states for guidance. The Illinois Environmental Protection Agency (Illinois EPA) has developed intake assumptions for a construction worker. The Illinois EPA assumes intensive subsurface excavation activity occurs for about 6 weeks during construction projects and therefore uses an exposure frequency (*EF*) of 30 days/year (5 days/week for 6 weeks) and exposure duration (*ED*) of one year to evaluate construction workers [IPCB 2013]. Therefore, an *EF* of 30 days/year was utilized to evaluate an on-site construction worker performing excavation activities across the entirety of the site. Note that this exposure frequency is highly conservative due to size and use of the site (i.e. a 0.45-acre property used as a retail petroleum gasoline station and convenience store). To quantitatively evaluate a construction worker performing excavation work exclusively in the source zone around MW-3/3R (approximately 20’ x 20’), the *EF* was adjusted to 5 days/year. The Illinois EPA *ED* of 1 year [IPCB 2013] was used for the on-site construction worker under both scenarios. An exposure time (*ET*) of 8 hours/day was selected, which is a WVDEP default value for an industrial scenario [WVDEP 2019a].

The exposed surface area (*SA*) for dermal contact with groundwater for the on-site construction worker was estimated to be 2,550 cm^2 based on the values presented in Table 7-12 in the USEPA Exposure Factors Handbook: 2011 Edition [USEPA 2011] for mean body surface area exposed for an adult male, which corresponds to forearms and hands. The body weight (*BW*) for the on-site construction worker was set at 80 kg based on the WVDEP default values for an adult [WVDEP 2019a].

The averaging time for carcinogenic effects (AT_c) was set at 25,550 days [USEPA 1991] for the dermal exposure pathway and 613,200 hours [USEPA 2009] for the inhalation pathway. Following USEPA methodology for assessing a construction worker, which assumes a subchronic exposure scenario for a construction worker [USEPA 2019b], the averaging time for noncarcinogenic effects (AT_{nc}) was set at 42 days [IPCB 2013] for the dermal exposure pathway and 1,008 hours [IPCB 2013] for the inhalation exposure pathway. The AT_{nc} values are based on a construction period of 6 weeks/year at 7 days/week for 1 year [IPCB 2013].

7.3.2 On-Site Utility Worker

The exposure scenario for the on-site utility worker was discussed in Section 4.4.2. This section presents the applicable exposure parameters that correlate to the retained exposure pathways for the on-site utility worker. **Table 7-2** presents the exposure parameters for the on-site utility worker.

Although WVDEP provides exposure parameters for an industrial scenario, site-specific exposure assumptions were utilized specifically for a utility worker for a few of the exposure parameters. These site-specific exposure assumptions were compared to regulations in other states for guidance. The Massachusetts Department of Environmental Protection (MADEP) has determined that an exposure frequency (*EF*) of 1 day/year is reasonable for a utility worker where significant subsurface lines exist [MADEP 1995]. Therefore, the EF was set to 1 day/year. The exposure duration (*ED*) was set to 25 years, which is the WVDEP default for an industrial scenario [WVDEP 2019a]. An exposure time (*ET*) of 8 hours/day was selected, which is a WVDEP default value for an industrial scenario [WVDEP 2019a].

The exposed surface area (*SA*) for dermal contact with groundwater for the on-site utility worker was estimated to be 2,550 cm^2 based on the values presented in Table 7-12 in the USEPA Exposure Factors Handbook: 2011 Edition [USEPA 2011] for mean body surface area exposed for an adult male, which corresponds to forearms and hands. The body weight (*BW*) for the on-site utility worker was set at 80 kg and is based on the latest WVDEP default values for an adult [WVDEP 2019a].

The averaging time for carcinogenic effects (AT_c) was set at 25,550 days [USEPA 1991] for the dermal exposure pathway and 613,200 hours [USEPA 2009] for the inhalation exposure pathway. The averaging time for noncarcinogenic effects (AT_{nc}) was set at 9,125 days [USEPA 1989] for the dermal exposure pathway and 219,000 hours [USEPA 2009] for the inhalation exposure pathway.

7.3.3 On-Site Maintenance Worker

The exposure scenario for the on-site maintenance worker was discussed in Section 4.4.2. This section presents the applicable exposure parameters that correlate to the retained exposure pathways for the on-site maintenance worker. **Table 7-3** presents the exposure parameters for the on-site maintenance worker.

The exposure duration *(ED)* was set to 25 years for the on-site maintenance worker, which is the WVDEP default assumption for an adult commercial/industrial exposure [WVDEP 2019a]. The exposure frequency *(EF)* was selected to be 72 days/year for the maintenance worker based on the professional judgment of 3 days a week for 6 months, which is assuming exposure during warm months of the year (May through October). An exposure time (*ET*) of 4 hours/day was selected for the time spent outdoors for the maintenance worker based on professional judgment. The averaging time for carcinogenic effects (AT_c) and noncarcinogenic effects (AT_{nc}) was set at 613,200 hours [USEPA 2009] and 219,000 hours [USEPA 2009], respectively, for the inhalation exposure pathway.

8 Risk Characterization

In this section of the risk assessment, the potential human health risks for complete exposure pathways are assessed. Potential risks due to exposures to COC in groundwater from the site are evaluated by integrating exposure assessments and toxicity data into quantitative expressions of cancer risk and noncancer health hazards. This section presents the risk calculation framework used to quantify risk for the direct contact exposure pathways.

8.1 Risk Calculation Framework

Two types of potential direct contact human health effects were calculated in this risk assessment: carcinogenic effects and noncarcinogenic effects. Carcinogenic effects are evaluated by calculating a cancer risk. Cancer risks are estimated as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to the potential carcinogen (i.e. incremental or excess individual lifetime cancer risk). Carcinogenic risks for the ingestion and dermal contact exposure pathways are estimated using the equation [USEPA 1989]:

$$Risk = Intake * CSF$$

where:

Intake = intake or absorbed dose of a constituent (mg/kg-day)

CSF = cancer slope factor of a constituent $(mg/kg\text{-}day)^{-1}$

Carcinogenic risks for the inhalation exposure pathway (volatiles) are estimated using the equation [USEPA 2009]:

$$Risk = EC * IUR$$

where:

EC = exposure concentration $(\mu g/m^3)$

IUR = inhalation unit risk factor $(\mu g/m^3)^{-1}$

For each exposure pathway, this calculation is performed for each COC considered to be a potential carcinogen, and the risks are summed across all COC and exposure pathways to obtain the total risk for a specific receptor.

Potential noncarcinogenic effects are evaluated by calculating a hazard index (HI). For a single constituent and exposure pathway, a hazard quotient (HQ) is calculated. For the dermal contact exposure pathway, the HQ is calculated using the equation [USEPA 1989]:

$$HQ = \frac{Intake}{RfD}$$

where:

Intake = intake or absorbed dose of a constituent (mg/kg-day)

RfD = reference dose of a constituent (mg/kg-day)

For the inhalation exposure pathway (volatiles), the HQ is calculated using the equation [USEPA 2009]:

$$HQ = \frac{EC}{RfC * CF}$$

where:

EC = exposure concentration (µg/m^3)

RfC = reference concentration (mg/m^3)

CF = conversion factor (1000 µg/mg)

For each exposure pathway, this calculation is performed for each COC and the hazard quotients are summed across all COC and exposure pathways to obtain the total HI for a specific receptor.

8.2 Risk Results

Calculations of cancer risks and noncancer HIs for the on-site construction workers (source area and entire site), on-site utility worker, and on-site maintenance worker are presented in **Tables 8-1a** through **8-3**, respectively. In accordance with Section 60-3-9.4.a and 60-3-9.4.b in the Rule [WVDEP 2018] and Section 4.6.2 in the WV VRP Guidance Manual [WVDEP 2019a], the risk benchmark value for industrial receptors is $1x10^{-5}$. As presented in **Table 8-4**, the estimated total cancer risks for all receptors are below the WVDEP risk benchmark value of $1x10^{-5}$ (industrial). In addition, the estimated total noncancer HIs are at or below the WVDEP HI benchmark value of 1 for all receptors.

Note that if any of the exposure assumptions and/or assessment change in the future for this site, the results of this analysis do not apply.

9 Uncertainty Analysis

The risk assessment process presented in this document uses a considerable number of conservative assumptions to ensure that potential risks are not underestimated. During the risk assessment process, uncertainty and variability are inherent in the estimation of risks based on specific calculation input variables such as:

- Identification of COC;
- Fate and Transport Modeling;
- Receptors and exposure pathways;
- Exposure point concentrations;
- Exposure parameters;
- Toxicological values; and,
- Risk characterization.

A qualitative review is presented in this section describing some of the variables as applicable to the risk analysis and their potential effect on the final risk estimates, which overall result in a high degree of confidence that potential site-related risks are not underestimated.

9.1 Identification of COC

Identification of COC relies, in part, on the information provided by the sampling and analytical program. Uncertainty in this regard is reduced as much as possible by the following appropriate sample collection, handling, and analytical procedures and by intentionally sampling on a bias to ensure worst-case samples are collected and potential site-related risk estimates are not underestimated. Additionally, quality assurance sampling and analysis protocols are followed to obtain characterization data that is as representative, precise, and accurate as possible to be used for risk assessment purposes.

9.2 Fate and Transport Modeling

The BIOSCREEN model was used to estimate the distance from MW-3/3R at which dissolved-phase MTBE concentrations would attenuate below the WVDEP groundwater De Minimis standard of 14 µg/L. This fate and transport modeling was completed primarily to determine if dissolved-phase MTBE would reach the off-site downgradient public water production well owned by the Town of Rainelle. The BIOSCREEN model was calibrated using field data from downgradient monitoring well MW-6 and completed using site-specific information when available; otherwise, conservative default input parameters were utilized. In addition, a sensitivity analysis was completed using a range of input parameters to determine the sensitivity of the BIOSCREEN model and how the input parameters may affect the overall results of the modelling.

Several of the input parameters utilized in the BIOSCREEN model are based on ranges provided for sand. Thus, the BIOSCREEN model assumes that groundwater is migrating through a permeable sand and gravel lens continuously to the downgradient public water production well (well “E”). However, it is unlikely that this sand and gravel lens is continuous for 550 feet from the site to the public supply well. It is more likely that the overburden groundwater also travels through less permeable zones.

In addition, the BIOSCREEN analysis is modeling groundwater migration in the overburden zone. In communications with the WVDEP and the town of Rainelle water department, the water department indicated that the withdrawal well is drawing from a deep bedrock aquifer (approximately 150 ft-bgs) [Personal correspondence 2019c]. It is unlikely that the modeled overburden groundwater and bedrock aquifer are in communication and the public supply well is hydraulically isolated.

9.3 Exposure Assessment

There are three major areas of uncertainty associated with exposure assessment, including: 1) receptors and exposure pathways; 2) calculation of EPCs; and 3) exposure parameter values used to estimate chemical intake.

9.3.1 Receptors and Exposure Pathways

Defining the probable current and future land use of the site carries with it some degree of uncertainty. Evaluating and understanding this uncertainty is important during the selection of potential receptors and exposure pathways. For this evaluation, the potential receptors and exposure pathways were based on current site conditions (nonresidential) and the assumption that the site will continue to be used for nonresidential use, limiting the uncertainty associated with these parameters.

In this risk assessment, a construction worker and utility worker were evaluated. There is potential for a construction worker and utility worker to perform construction/maintenance activities on-site. In addition, there is the potential for a construction worker and utility worker to perform construction/maintenance activities in the off-site James River and Kanawha Turnpike ROW, which is located south/southwest and downgradient of groundwater flow at the site. Based on the groundwater flow direction at the site (i.e. southwest), site-related constituents have the potential to migrate off-site to the James River and Kanawha Turnpike ROW. The quantitative evaluations of the on-site construction worker in the source area and the on-site utility worker are protective of an off-site construction and utility worker based on the following rationale.

Direct contact groundwater COC were retained for the on-site construction/utility worker (i.e. benzene and MTBE), off-site construction/utility worker in the northern ROW (i.e. benzene and MTBE), and off-site construction/utility worker in the southern ROW (i.e. MTBE). The on-site construction/utility workers and off-site construction/utility workers in the northern and southern James River and Kanawha Turnpike ROW are expected to excavate to a maximum depth of 6 ft-bgs. The average depth to groundwater on-site, in the northern ROW, and in the southern ROW is 5.5 ft-bgs, 5.5 ft-bgs, and 6.5 ft-bgs, respectively. Note that groundwater in the southern ROW ranges from 4.5 ft-bgs to 9.5 ft-bgs. Therefore, the on-site construction/utility worker and off-site construction/utility workers in the northern and southern James River and Kanawha Turnpike ROWs are expected to be in direct contact with groundwater during intrusive activities. As a result, dermal contact and inhalation of volatiles from exposed groundwater exposure pathways were retained for the on-site construction/utility workers and off-site construction/utility workers in the James River and Kanawha Turnpike northern and southern ROWs. This means that the on-site and off-site construction/utility workers have similar exposure scenarios.

Benzene and MTBE were retained as direct contact COC in both on-site groundwater and off-site groundwater for the northern James River and Kanawha Turnpike ROW based primarily on WVDEP groundwater De Minimis exceedances in MW-3/MW-3R. Note only MTBE was retained as a direct contact COC in off-site groundwater for the southern James River and Kanawha Turnpike ROW based on WVDEP groundwater De Minimis exceedances in MW-4 and MW-6. In addition, the on-site construction/utility workers working in the vicinity of the source zone is expected to be in direct contact with higher concentrations of site-related constituents than the off-site construction/utility workers because the COC groundwater concentrations are highest in on-site monitoring well MW-3/MW-3R, and dissolved-phase constituents are expected to attenuate as groundwater migrates from on-site to off-site areas. Based on the similar exposure scenario and similar direct contact COC retained in groundwater, the quantitative evaluation for the on-site construction worker (source area) and on-site utility worker was completed and would be protective of the off-site construction/utility workers in the northern and southern James River and Kanawha Turnpike ROWs.

The risk calculations for the on-site construction worker in the source area and the on-site utility worker used a 95% UCL, which was derived using groundwater analytical data from MW-3/MW-3R only. The 95% UCLs derived for benzene and MTBE were compared to the maximum concentrations in the James River and Kanawha Turnpike southern ROW. The maximum MTBE concentration was 29 µg/L from MW-4, which is significantly less than the 95% UCL of 153 µg/L. Benzene was not detected in the southern ROW and therefore, not retained as a COC. In addition, MW-3/MW-3R was used to evaluate the northern ROW and, therefore, the UCLs derived for on-site also represent groundwater concentrations in the northern ROW.

Note that the exposure frequency of 5 days/year utilized to evaluate the on-site construction worker in the source area is protective of an off-site construction worker in the right-of-way. Given the assumed activities of this receptor (i.e., installation of new utilities), this receptor is expected to be continually moving along the right-of-way laying new lines. Given the high traffic encountered within a right-of-way and the mobile nature of installing new utilities lines (as compared to performing repairs), an off-site construction worker in the right-of-way is unlikely to spend greater than 5 days/year in the area of the plume. The total risks and HIs for the on-site construction worker in the source area and utility worker are below WVDEP benchmarks. Therefore, the quantitative assessment for the on-site construction/utility workers is protective of the off-site construction/utility workers in the James River and Kanawha Turnpike northern and southern ROWs.

9.3.2 Exposure Point Concentrations

Using current media concentrations to reflect future concentrations adds another uncertainty to this risk assessment. Groundwater concentrations of COC are expected to decrease over time because historic sources at the site were removed. Additionally, site-specific petroleum hydrocarbons tend to be biodegraded readily under aerobic conditions in unsaturated soil zones. Use of current data to assess the risks over chronic time periods is likely to overestimate risks.

Risk assessments typically evaluate mean concentrations over an exposure area, considering all exposures within that area as equally possible. Risks associated with exposures are then assessed by evaluating those mean concentrations with exposure factors and the appropriate exposure/toxicity values. Typically, the EPC for a specific chemical in a particular medium is based on the 95% UCL on the mean concentrations.

The EPCs utilized to evaluate the on-site maintenance worker and on-site utility worker were highly conservative. The groundwater dataset used to derive a UCL for benzene and MTBE included analytical data collected between December 2010 and August 2016 from on-site monitoring well MW-3/MW-3R (located closest to the source area). This monitoring well had the highest concentrations of all site monitoring wells. In addition, on-site wells MW-1 and MW-2 had no exceedances of the WVDEP groundwater De Minimis standards with the exception of one minor exceedance of MTBE at MW-1 (19.4 µg/L) in August 2011. These receptors have the potential to be exposed to volatile constituents across the entirety of the property. However, using a UCL based solely on analytical data from MW-3/MW-3R conservatively assumes that these receptors would spend all of their time within the vicinity of MW-3/MW-3R. Therefore, conservatively using analytical data from MW-3/MW-3R only to derive UCLs could potentially overestimate the risk results for the on-site maintenance worker and on-site utility worker. The analytical dataset from MW-3/MW-3R included 7 groundwater sampling events collected between December 2010 and August 2016. It is recognized that the dataset used to derive UCLs is small (i.e. less than the 8-10 samples as recommended in the ProUCL

User's Guide [USEPA 2015]). However, the UCLs for benzene (i.e. 91 µg/L) and MTBE (i.e. 153 µg/L) are very similar to the maximum concentrations from MW-3/MW-3R for benzene (i.e. 107 µg/L) and MTBE (i.e. 194 µg/L). Therefore, even if the maximum concentrations for benzene and MTBE were used in the quantitative risk calculations, the overall risk results would not change and the total risk and total HI calculated for the on-site construction worker (source area) and on-site utility worker would still be below WVDEP benchmark criteria.

9.3.3 Exposure Parameters

Uncertainty is associated with the exposure parameter values used; however, assumptions are chosen to be conservative so as not to underestimate risk. For example, assumptions are made for the exposure time, frequency, and duration of potential chemical exposures, as well as for the quantity of material ingested, inhaled, or absorbed. In general, assumptions are made based on reasonable maximum exposures and, in most cases, values are specified by WVDEP, USEPA or other state guidance documents, or site-specific information.

The current and future use of the site is a gas station/convenience store, and the site is approximately 0.45 acres in size. Therefore, based on these site-specific conditions, two exposure frequencies were utilized based on two potential exposure scenarios of an on-site construction worker. For potential excavation work that is limited to the vicinity of the source area (i.e., MW-3/3R), an exposure frequency of 5 days/year (professional judgment) and exposure duration of 1 year [IPCB 2013] was were used. To evaluate a construction worker whose excavation activities extend across the entirety of the site, an exposure frequency of 30 days/year [IPCB 2013] and exposure duration of 1 year [IPCB 2013] were used in this risk assessment for the on-site construction worker. The exposure frequency of 30 days/year assumes that the receptor is in direct contact with groundwater during the entire construction period, which is highly conservative given the size and current use of the site. This conservative exposure parameter likely overestimates the calculated risks/hazards for an on-site construction worker working across the entire site.

9.4 Toxicity Values

A potentially large source of uncertainty is inherent in the derivation of the toxicity values (e.g., RfDs, RfCs, CSFs, and IURs). In many cases, data are extrapolated from animals to sensitive human subpopulations by the application of uncertainty factors to an estimated no-observed-adverse-effect-level (NOAEL) or lowest-observed-adverse-effect-level (LOAEL) for noncancer health effects. While designed to be protective, it is likely in many cases that uncertainty factors overestimate the magnitude of differences that may exist between humans and animals, and among humans.

As discussed in the *Guidelines for Carcinogen Risk Assessment* [USEPA 2005], derivation of CSFs and IURs often involves linear extrapolation of effects at high doses to potential effects at lower doses commonly seen in environmental exposure settings. It is probable that the shape of the dose response curve for carcinogenesis varies with different chemicals and mechanisms of action. It is likely that the assumption of linearity is conservative and yields CSFs and IURs that are unlikely to lead to underestimation of risks.

In this risk assessment report, construction workers are evaluated assuming a subchronic exposure. According to RAGS Part A [USEPA 1989], chronic RfDs pertain to lifetime or other long-term exposures and may be overly protective if used to evaluate the potential for adverse health effects resulting from substantially less-than-lifetime exposures (e.g. subchronic exposures). Therefore, subchronic RfDs are recommended for evaluating subchronic exposures. RAGS Part F [USEPA 2009] also provides guidance on deriving exposure concentrations and hazard indices based on the appropriate exposure duration (i.e. chronic, subchronic, or acute exposure).

9.5 Risk Characterization

There is also uncertainty in assessing risks associated with a mixture of chemicals. In this assessment, the effects of exposure to each contaminant present have initially been considered separately. However, these substances occur together at the site, and individuals may be exposed to mixtures of the chemicals. Predictions of how these mixtures of chemicals will interact must be based on an understanding of the mechanisms of such interactions. Individual chemicals may interact in the body, yielding a new toxic component or causing different effects at different target organs.

Suitable data are not currently available to rigorously characterize the effects of chemical mixtures. Consequently, as recommended by USEPA, chemicals present at the site are assumed to act additively, and potential health risks are evaluated by summing excess lifetime cancer risks and calculating HIs for noncancer health effects [USEPA 1989]. This approach to assessing risk associated with mixtures of chemicals assumes that there are no synergistic or antagonistic interactions among the chemicals and that all chemicals have the same toxic endpoint and mechanisms of action. To the extent that these assumptions are correct, the actual risks could be underestimated or overestimated.

9.6 Overall Uncertainty Analysis

Based on the above uncertainty analysis, the risk assessment employed multiple conservative assumptions, which, when combined, produce an additive conservative effect throughout the process, resulting in an overestimation of the potential risk. As a result of the uncertainties described above, this risk assessment should not be construed as presenting absolute risks or hazards. Rather, it is a conservative analysis intended to indicate the potential for adverse impacts to occur based on reasonable maximum exposure that is well above the average but still within the range of possible exposures.

Statement of Limitations

This document is prepared solely for the Former 7-Eleven Facility #135 (site) in Rainelle, Greenbrier County, West Virginia. This report was prepared based on the information supplied by KEMRON Environmental Services, Inc. (KEMRON). The results of the risk assessment presented in this report apply to the existing and reasonably foreseeable site conditions at the time of this assessment. This risk assessment is based only on the current site conditions from the historic on-site release(s) defined by the analytical data and does not assess potential future releases. Changes in the conditions of the property may occur with time due to natural processes or works of man at the site or on adjacent properties. Changes in applicable standards and toxicity criteria may also occur as a result of legislation or the broadening of knowledge. As a result, if any of the exposure assumptions and/or assessment change in the future for this site, the results of this risk assessment analysis do not apply. Based on the evolving nature of risk assessments, this risk assessment shall be submitted to the appropriate regulatory agency within a reasonable timeframe (e.g. approximately 3 months from the completion date of this document) to ensure that the most recent risk assessment methodologies and guidelines have been used at the time this risk assessment was completed. The Mahfood Group LLC® is not responsible for the misinterpretation or misuse of this risk assessment analysis.

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Tables

Table 3-1
Adsorbed-Phase Analytical Results and Comparison to Screening Values
Risk Assessment Report
Former 7-Eleven Facility #135 - 44 Main Street
Rainelle, West Virginia

Data Point	Sample Date	Depth Interval (feet)	Benzene (µg/Kg)			Toluene (µg/Kg)			Ethylbenzene (µg/Kg)			Total Xylenes (µg/Kg)			Total BTEX (µg/Kg)			MTBE (µg/Kg)		
WV Industrial Soil DeMinimis Standard [1]				57,000			820,000			280,000			260,000			Nav			2,300,000	
WV Residential Soil DeMinimis Standard [2]				1,200			820,000			6,200			260,000			Nav			50,000	
WV Migration to Water DeMinimis Standard [3]				**3**			**690**			**780**			**9,900**			**Nav**			**3**	
CE-MW-3A-(0-2)-001	06/21/16	0'-2'	<	4		<	4.0		<	4.0		<	12.1		<	24.1		<	4.0	
CE-MW-3A-(2-4)-001	06/21/16	2'-4'		**5**	J	<	6		<	6		<	19		<	37.2	J	<	6.4	
CE-MW-3B-(0-2)-003	06/21/16	0'-2'	<	6		<	6		<	5.5		<	16.6		<	33		<	5.5	
CE-MW-3B-(6-8)-004	06/21/16	6'-8'		**463**			174	J		**4,440**			6,450			11,527	J	<	284	
CE-MW-3C-(0-2)-005	06/21/16	0'-2'		**4.0**	J	<	8		<	8		<	24		<	43	J	<	7.9	
CE-MW-3C-(6-8)-006	06/21/16	6'-8'		**630**			133	J		**3,300**			1,430			5,493	J	<	261	
CE-MW-3D-(0-2)-008	06/21/16	0'-2'		**3**	J	<	5			3.7	J	<	15.1		<	26.8	J	<	5	
CE-MW-3D-(6-8)-009	06/21/16	6'-8'		**216**	J		236	J		**15,900**			**24,700**			41,052	J	<	345	
CE-MW-3R-(0-2)-013	06/22/16	0'-2'	<	585		<	585			296	J		1,240	J	<	2,706	J	<	585	
CE-MW-3R-(8-10)-014	06/22/16	8'-10'	<	285		<	285			**1,160**			1,300		<	3,030		<	285	

Notes
[1] Indicates the applicable West Virginia (WVDEP) Industrial Soil DeMinimis screening values, June 2017
[2] Indicates the applicable West Virginia (WVDEP) Residential Soil DeMinimis screening values, June 2017
[3] Indicates the applicable West Virginia (WVDEP) migration to groundwater DeMinimis screening values, June 2017
µg/Kg - Micrograms per kilogram
MTBE - Methyl tertiary-butyl ether
Nav - not available
J - Detected below laboratory detection limits
Shaded values indicates value exceeded the WVDEP industrial soil DeMinimis Screening value. As shown in the table there were no exceedance of the industrial soil DeMinimis screening values.
Underlined values indicates value exceeded the WVDEP residential soil DeMinimis Screening value.
Bolded values indicates value exceeded the WVDEP migration to groundwaer DeMinimis screening Value

Table 3-2
8 Most Recent Post-Remediation Dissolved-Phase Analytical Results and Comparison to Screening Values
Risk Assessment Report
Former 7-Eleven Facility #135 - 44 Main Street
Rainelle, West Virginia

Well ID Number [1]	Sample Date	Top of Casing Elevation (feet)	Groundwater Elevation (feet)	Groundwater Depth (feet)		Benzene (µg/L)		Toluene (µg/L)		Ethylbenzene (µg/L)		Total Xylene (µg/L)		MTBE (µg/L)		TPH (GRO) (µg/L)		TPH (DRO) (µg/L)
WEST VIRGINIA GROUNDWATER DE MINIMIS STANDARDS [2]						**5**		**1,000**		**700**		**10,000**		**14**		**Nav**		**Nav**
USEPA COMMERCIAL VISL (ug/L) [3]						69		80,700		152		1,620		19,700		Nav		Nav
USEPA RESIDENTIAL VISL (ug/L) [4]						1.59		19,200		3.49		385		450		Nav		Nav
MW-1	08/16/16	97.81	91.99	5.82	<	1	<	1	<	1	<	3		13.2		NST		NST
	04/03/12	97.81	92.43	5.38	<	1	<	1	<	1	<	3	<	2	<	500	<	120
	01/17/12	97.81	91.99	5.82	<	1	<	1	<	1	<	3		0.9 J	<	500	<	110
	10/31/11	97.81	91.34	6.47	<	1	<	1	<	1	<	3	<	2	<	500	<	110
	08/18/11	97.81	90.19	7.62	<	1	<	1	<	1	<	3		**19.4**	<	500		3,050
	06/20/11	97.81	91.18	6.63	<	1	<	1	<	1	<	3	<	2	<	500	<	150
	03/28/11	97.81	92.60	5.21	<	1	<	1	<	1	<	3		13.7	<	500	<	130
	12/29/10	97.81	91.17	6.64	<	1	<	1	<	1	<	3		7.5	<	500	<	120
MW-2	08/16/16	97.61	91.96	5.65	<	1	<	1	<	1	<	3	<	2		NST		NST
	04/03/12	97.61	92.32	5.29	<	1	<	1	<	1	<	3	<	2	<	500	<	120
	01/17/12	97.61	92.03	5.58	<	1	<	1	<	1	<	3	<	2	<	500	<	110
	10/31/11	97.61	90.92	6.69	<	1	<	1	<	1	<	3	<	2	<	500	<	110
	08/18/11	97.61	90.54	7.07	<	1	<	1	<	1	<	3	<	2	<	500	<	130
	06/20/11	97.61	91.16	6.45	<	1	<	1	<	1	<	3	<	2	<	500	<	150
	03/28/11	97.61	92.58	5.03	<	1	<	1	<	1	<	3	<	2	<	500	<	130
	12/29/10	97.61	91.10	6.51	<	1	<	1	<	1	<	3	<	2	<	500	<	120
MW-3R	08/16/16	97.12	91.91	5.21		**91.2**		6		121.0		137		**17.6**		NST		NST
MW-3	04/03/12	97.24	92.50	4.74		**54.8**		4.8		17.0		38.1		**108**		2,070	<	120
	01/17/12	97.24	92.09	5.15		**80.2**		8.1		21.6		47.6		**134**		2,090		880
	10/31/11	97.24	91.39	5.85		**75.0**		8.4		22.8		38.0		**120**		2,190		1,010
	08/18/11	97.24	90.28	6.96		**107**		11.2		25.9		57.7		**194**		1,840		2,400
	06/20/11	97.24	91.21	6.03		**74.5**		6.5		35.1		40.8		**139**		2,590		670
	03/28/11	97.24	92.70	4.54		**44.4**		3.4		33.0		30.3	<	2		2,050		340
	12/29/10 [5]	97.24	NRT	NRT		NST		NST		NST		NST		NST		NST		NST
MW-4	8/16/16 [6]	97.73	NG	NG		NST		NST		NST		NST		NST		NST		NST
	04/03/12	97.73	91.14	6.59	<	1	<	1	<	1	<	3		**29.0**		820	<	120
	01/17/12	97.73	91.11	6.62	<	1	<	1	<	1	<	3		**16.1**		470 J	<	120
	10/31/11	97.73	90.17	7.56	<	1		1.9	<	1	<	3		6.6	<	500	<	110
	08/18/11	97.73	89.17	8.56	<	1	<	1	<	1	<	3	<	2	<	500		1,230
	06/20/11	97.73	90.45	7.28	<	1	<	1	<	1	<	3		5.1		530	<	130
	03/28/11	97.73	91.83	5.9	<	1	<	1	<	1	<	3	<	2	<	500	<	120
	12/29/10	97.73	90.51	7.22	<	1	<	1	<	1	<	3	<	2		350 J		690
MW-5	08/16/16	96.85	91.65	5.20	<	1	<	1	<	1	<	3	<	2		NST		NST
	04/03/12	96.85	92.09	4.76	<	1	<	1	<	1	<	3	<	2	<	500	<	120
	01/17/12	96.85	91.75	5.1	<	1	<	1	<	1	<	3	<	2	<	500		1,140
	10/31/11	96.85	88.44	8.41	<	1	<	1	<	1	<	3	<	2	<	500		110
	08/18/11	96.85	90.10	6.75	<	1	<	1	<	1	<	3	<	2	<	500		2,870
	06/20/11	96.85	90.86	5.99	<	1	<	1	<	1	<	3	<	2	<	500		1,730
	03/28/11	96.85	92.33	4.52	<	1	<	1	<	1	<	3		0.5 J	<	500	<	130
	12/29/10	96.85	90.87	5.98	<	1	<	1	<	1	<	3	<	2	<	500	<	120
MW-6	08/16/16	98.01	91.40	6.61	<	1	<	1	<	1	<	3		**20.9**		NST		NST
	04/03/12	98.01	90.81	7.20	<	1	<	1	<	1	<	3		**22.6**	<	500	<	120
	01/17/12	98.01	90.92	7.09	<	1	<	1	<	1	<	3		**18.6**	<	500	<	110
	10/31/11	98.01	92.14	5.87	<	1	<	1	<	1	<	3		**20.4**	<	500	<	110
	08/18/11	98.01	88.51	9.5	<	1	<	1	<	1	<	3	<	2	<	500	<	140
	06/20/11	98.01	90.21	7.8	<	1	<	1	<	1	<	3		**24.7**		400 J	<	140
	03/28/11	98.01	92.09	5.92	<	1	<	1	<	1	<	3	<	2	<	500	<	130
	12/29/10	98.01	90.12	7.89	<	1	<	1	<	1	<	3		**23.6**	<	500	<	120

Notes:
ug/L - micrograms per liter
[1] This table presents the 8 most recent post-remediation groundwater sampling events that were used in this risk assessment. To see results from all groundwater samples collected at this site see Attachment 1.
[2] Indicates the applicable West Virginia Department of Environmental Protection (WVDEP) De Minimis screening level for groundwater based on Table 60-3B, June 2017.
[3] Indicates the applicable United States Environmental Protection Agency (USEPA) commercial vapor intrusion screening level (VISL) target groundwater concentrations based on a target risk of $1.0x10^{-5}$ and HQ of 1.0, based on November 2019 regional screening levels (RSLs).
[4] Indicates the applicable United States Environmental Protection Agency (USEPA) residential vapor intrusion screening level (VISL) target groundwater concentrations based on a target risk of $1.0x10^{-6}$ and HQ of 1.0, based on November 2019 regional screening levels (RSLs).
[5] MW-3 was not sampled in December 2010 because the well was not able to be located due to the presence of ice and snow.
[6] MW-4 was not sampled in August 2016 because it appeared it had been paved over and the well was not able to be located.
NST - no sample taken
NRT - no reading taken
NA - not analyzed
Nav - not available
<MQL - not detected at the minimum detected limit
J - analyte detected below the laboratory quantitation limit
Bolded values indicate an exceedance of the WVDEP groundwater DeMinimis screening values
Shaded values indicate an exceedance of the USEPA commerical VISL target groundwater concentration
Underlined values indicate an exceedance of the USEPA residential VISL target groundwater concentration

Table 3-3
Analytical Sample Summary
Risk Assessment Report
Former 7-Eleven Facility #135 - 44 Main Street
Rainelle, West Virginia

Sample Name	Sample Depth (ft-bgs)	Sample Date(s)	On-Site vs. Off-Site	Analytical Parameters: Benzene	Toluene	Ethylbenzene	Total Xylenes	MTBE	Total BTEX	TPH-DRO	TPH-GRO	Sample Retained for Risk Evaluation? (Yes or No)	Rationale
Surface Soil													
CE-MW-3A (0-2)-001	0-2'	6/21/16	on-site	X	X	X	X	X	X			**Yes**	
CE-MW-3B (0-2)-003	0-2'	6/21/16	on-site	X	X	X	X	X	X			**Yes**	
CE-MW-3C (0-2)-005	0-2'	6/21/16	on-site	X	X	X	X	X	X			**Yes**	
CE-MW-3D (0-2)-008	0-2'	6/21/16	on-site	X	X	X	X	X	X			**Yes**	
CE-MW-3R (0-2)-013	0-2'	6/22/16	on-site	X	X	X	X	X	X			**Yes**	
Subsurface Soil													
CE-MW-3A (2-4)-001	2-4'	6/21/16	on-site	X	X	X	X	X	X			**Yes**	
CE-MW-3B (6-8)-004	6-8'	6/21/16	on-site	X	X	X	X	X	X			**Yes**	
CE-MW-3C (6-8)-006	6-8'	6/21/16	on-site	X	X	X	X	X	X			**Yes**	
CE-MW-3D (6-8')-009	6-8'	6/21/16	on-site	X	X	X	X	X	X			**Yes**	
CE-MW-3R (8-10)-014	8-10'	6/22/16	on-site	X	X	X	X	X	X			**Yes**	
Overburden Groundwater [1]													
MW-1	---	12/29/10; 3/28/11; 6/20/11; 8/18/11; 10/31/11; 1/17/12; 4/3/12; 8/16/16	on-site	X	X	X	X	X		X	X	**Yes**	
MW-2	---	12/29/10; 3/28/11; 6/20/11; 8/18/11; 10/31/11; 1/17/12; 4/3/12; 8/16/16	on-site	X	X	X	X	X		X	X	**Yes**	
MW-3	---	3/28/11; 6/20/11; 8/18/11; 10/31/11; 1/17/12; 4/3/12	on-site	X	X	X	X	X		X	X	**Yes**	No sample was taken from MW-3 during the 12/29/10 sampling event because the well was not able to be located.
MW-3R	---	8/16/16	on-site	X	X	X	X	X		X	X	**Yes**	MW-3 was destroyed and therefore, MW-3R was installed adjacent to MW-3. Therefore, MW-3 and MW-3R are treated as one location in this risk assessment.
MW-4	---	12/29/10; 3/28/11; 6/20/11; 8/18/11; 10/31/11; 1/17/12; 4/3/12	off-site	X	X	X	X	X		X	X	**Yes**	No sample was taken from MW-4 during the 8/16/16 sampling event because the well was not able to be located.
MW-5	---	12/29/10; 3/28/11; 6/20/11; 8/18/11; 10/31/11; 1/17/12; 4/3/12; 8/16/16	off-site	X	X	X	X	X		X	X	**Yes**	
MW-6	---	12/29/10; 3/28/11; 6/20/11; 8/18/11; 10/31/11; 1/17/12; 4/3/12; 8/16/16	off-site	X	X	X	X	X		X	X	**Yes**	

Notes:
ft-bgs - feet below ground surface
BTEX - benzene, toluene, ethylbenzene, and total xylenes
MTBE - methyl tertiary butyl ether
TPH-GRO - total petroleum hydrocarbons - gasoline range organics
TPH-DRO - total petroleum hydrocarbons - diesel range organics
[1] The last remediation activity (i.e. mobile treatment unit with a dual-phase, high vacuum extraction system) at the site occurred from November 2005 until the 2nd quarter of 2009. Therefore, the 8 most recent post-remediation groundwater samples (i.e. collected between December 2010 and August 2016) from each monitoring well were used in this risk evaluation. The specific sample dates for each well are listed above.

Table 3-4
Selection of Direct Contact Constituents of Concern for Surface and Subsurface Soil
Risk Assessment Report
Former 7-Eleven Facility #135 - 44 Main Street
Rainelle, West Virginia

Chemical of Potential Concern (COPC)	CAS No.	Minimum Detection Limit	Maximum Detection Limit	Minimum Detected Concentration	Maximum Detected Concentration	Maximum Detected Concentration Location	Frequency of Detection	Industrial Direct Contact De Minimis Standard (ug/kg) [3]	Residential Direct Contact De Minimis Standard (ug/kg) [4]	Migration to Groundwater De Minimis Standard (ug/kg) [5]	Maximum Detected Concentration Greater Than Industrial Direct Contact De Minimis Standard?	Maximum Detected Concentration Greater Than Residential Direct Contact DeMinimis Standard?	Maximum Detected Concentration Greater Than Migration to Groundwater De Minimis Standard?	Chemical Retained as an Industrial Direct Contact COC?	Chemical Retained as a Residential Direct Contact COC?
Surface Soil (0-2 ft-bgs) [1]															
Volatile Organic Compounds (ug/kg)															
Benzene	71-43-2	4.0	585	3.0 J	4.0 J	CE-MW-3C-(0-2)-005	2/5	57,000	1,200	2.6	No	No	**Yes**	No	No
Toluene	108-88-3	4.0	585	ND	ND	---	0/5	820,000	820,000	690	No	No	No	No	No
Ethylbenzene	100-41-4	4.0	8.0	3.7 J	296 J	CE-MW-3R-(0-2)-013	2/5	280,000	6,200	780	No	No	No	No	No
Xylenes (total)	1330-20-7	12.1	24	1,240 J	1,240 J	CE-MW-3R-(0-2)-013	1/5	260,000	260,000	9,900	No	No	No	No	No
Total BTEX	---	24.1	2,706 J	ND	ND	---	0/5	Nav	Nav	Nav	---	---	---	---	---
Methyl tert-butyl ether (MTBE)	1634-04-4	4	585	ND	ND	---	0/5	2,300,000	50,000	3.2	No	No	No	No	No
Subsurface Soil (2-10 ft-bgs) [2]															
Volatile Organic Compounds (ug/kg)															
Benzene	71-43-2	285	285	5.0 J	630	CE-MW-3C-(6-8)-006	4/5	57,000	1,200	2.6	No	No	**Yes**	No	No
Toluene	108-88-3	6.0	285	133 J	236 J	CE-MW-3D-(6-8)-009	3/5	820,000	820,000	690	No	No	No	No	No
Ethylbenzene	100-41-4	6.0	6.0	1,160	15,900	CE-MW-3D-(6-8)-009	4/5	280,000	6,200	780	No	**Yes**	**Yes**	No	**Yes**
Xylenes (total)	1330-20-7	19	19	1,300	24,700	CE-MW-3D-(6-8)-009	4/5	260,000	260,000	9,900	No	No	**Yes**	No	No
Total BTEX	---	37.2 J	3,030	5,493 J	41,052 J	CE-MW-3D-(6-8)-009	3/5	Nav	Nav	Nav	---	---	---	---	---
Methyl tert-butyl ether (MTBE)	1634-04-4	6.4	345	ND	ND	---	0/5	2,300,000	50,000	3.2	No	No	No	No	No

Notes:

"---" - not applicable for that constituent
COC - constituent of concern
J - detected below the laboratory detection limit
ug/kg - micrograms per kilograms
ND - not detected
Nav - not available

[1] On-site surface soil (0-2 ft-bgs) samples include CE-MW-3A (0-2')-001, CE-MW-3B (0-2')-003, CE-MW-3C (0-2')-005, CE-MW-3D (0-2')-008, and CE-MW-3R (0-2')-013.

[2] On-site subsurface soil (2-10 ft-bgs) samples include CE-MW-3A (2-4')-001, CE-MW-3B (6-8')-004, CE-MW-3C (6-8')-006, CE-MW-3D (6-8')-009, and CE-MW-3R (8-10')-014.

[3] Indicates the applicable West Virginia Department of Environmental Protection (WVDEP) industrial soil De Minimis screening value based on Table 60-3B, June 2017

[4] Indicates the applicable West Virginia Department of Environmental Protection (WVDEP) residential soil De Minimis screening value based on Table 60-3B, June 2017

[5] Indicates the applicable West Virginia Department of Environmental Protection (WVDEP) migration to groundwater De Minimis screening value based on Table 60-3B, June 2017

Table 3-5
Selection of Direct Contact and Vapor Intrusion Constituents of Concern for On-Site and Off-Site Groundwater

Risk Assessment Report
Former 7-Eleven - 44 Main Street
Rainelle, West Virginia

Chemical of Potential Concern (COPC) [1]	CAS No.	Minimum Detection Limit	Maximum Detection Limit	Minimum Detected Concentration	Maximum Detected Concentration	Maximum Detected Concentrations Location	Frequency of Detection	Groundwater De Minimis Standard (ug/L) [4]	USEPA Commercial VISL [5] (ug/L)	USEPA Residential VISL [6] (ug/L)	Maximum Detected Concentration Greater Than Groundwater De Minimis Standard?	Maximum Detected Concentration Greater Than USEPA Commercial Groundwater VISL?	Maximum Detected Concentration Greater Than USEPA Residential Groundwater VISL?	Chemical Retained as a Groundwater Direct Contact COC?	Chemical Retained as a Commercial Groundwater Vapor Intrusion COC?	Chemical Retained as a Residential Groundwater Vapor Intrusion COC?
On-Site [2]																
Volatile Organic Compounds (ug/L)																
Benzene	71-43-2	1.0	1.0	44.4	107	MW-3 (8/18/11)	7/23	5	69	1.59	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Toluene	108-88-3	1.0	1.0	3.4	11.2	MW-3 (8/18/11)	7/23	1,000	80,700	19,200	No	No	No	No	No	No
Ethylbenzene	100-41-4	1.0	1.0	17	121	MW-3R (8/16/16)	7/23	700	152	3.49	No	No	**Yes**	No	No	**Yes**
Xylenes (total)	1330-20-7	3.0	3.0	30.3	137	MW-3R (8/16/16)	7/23	10,000	1,620	385	No	No	No	No	No	No
Methyl tert-butyl ether (MTBE)	1634-04-4	2.0	2.0	0.9 J	194	MW-3 (8/18/11	11/23	14	19,700	450	**Yes**	No	No	**Yes**	No	No
Total Petroleum Hydrocarbons (TPH) (ug/L)																
TPH-GRO	GRO	500	500	1840	2,590	MW-3 (6/20/11)	6/20	Nav	Nav	Nav	---	---	---	---	---	---
TPH-DRO	DRO	110	150	340	3,050	MW-1 (8/18/11)	6/20	Nav	Nav	Nav	---	---	---	---	---	---
Off-Site [3]																
Volatile Organic Compounds (ug/L)																
Benzene	71-43-2	1.0	1.0	ND	ND	---	0/23	5	69	1.59	No	No	No	No	No	No
Toluene	108-88-3	1.0	1.0	1.9	1.9	MW-4 (10/31/11)	1/23	1,000	80,700	19,200	No	No	No	No	No	No
Ethylbenzene	100-41-4	1.0	1.0	ND	ND	---	0/23	700	152	3.49	No	No	No	No	No	No
Xylenes (total)	1330-20-7	3.0	3.0	ND	ND	---	0/23	10,000	1,620	385	No	No	No	No	No	No
Methyl tert-butyl ether (MTBE)	1634-04-4	2.0	2.0	0.5 J	29	MW-4 (4/3/12)	11/23	14	19,700	450	**Yes**	No	No	**Yes**	No	No
Total Petroleum Hydrocarbons (TPH) (ug/L)																
TPH-GRO	GRO	500	500	350 J	820	MW-4 (4/3/12)	5/21	Nav	Nav	Nav	---	---	---	---	---	---
TPH-DRO	DRO	110	140	110	2,870	MW-5 (8/18/11)	6/21	Nav	Nav	Nav	---	---	---	---	---	---

Notes:

"---" - not applicable for that constituent
COC - constituent of concern
J - analyte detected below the laboratory quantitation limit
Nav - not available
ND - not detected
ug/L - micrograms per liter

[1] Table is based on the 8 most recent post-remediation groundwater data from each monitoring well (i.e. collected between December 2010 and August 2016).

[2] On-site monitoring wells include MW-1, MW-2, MW-3 and MW-3R. Note that during delineation activities, it was noted that the existing monitoring well MW-3 had been destroyed. Therefore, MW-3R was installed directly adjacent to the former MW-3.

[3] Off-site monitoring wells include MW-4, MW-5, and MW-6, which are located south of the site (i.e. across James River and Kanawha Turnpike) and downgradient of groundwater flow (southwest).

[4] Indicates the applicable West Virginia Department of Environmental Protection (WVDEP) De Minimis screening level for groundwater based on Table 30-3B, June 2017

[5] Indicates the applicable United States Environmental Protection Agency (USEPA) commercial vapor intrusion screening level (VISL) target groundwater concentration based on a target risk of $1.0x10^{-5}$ and HQ of 1.0, based on November 2019 RSLs

[6] Indicates the applicable United States Environmental Protection Agency (USEPA) residential vapor intrusion screening level (VISL) target groundwater concentration based on a target risk of $1.0x10^{-6}$ and HQ of 1.0, based on November 2019 RSLs

Table 3-6
Summary of On-Site Direct Contact and Vapor Intrusion Constituents of Concern
Risk Assessment Report
Former 7-Eleven Facility #135- 44 Main Street
Rainelle, West Virginia

Constituent of Concern (COC)	On-Site					
	Direct Contact				Vapor Intrusion	
	Surface Soil [1]	Subsurface Soil [2]	Subsurface Soil [3]	Groundwater [4]	Overburden Groundwater	
	0-2 ft-bgs	2-6 ft-bgs	2-10 ft-bgs	Overburden	Current [5]	Future [6]
Volatile Organic Compounds						
Benzene	---	---	---	GW	---	VI_{NR} / VI_R
Toluene	---	---	---	---	---	---
Ethylbenzene	---	---	S_R	---	---	VI_R
Xylenes, Total	---	---	---	---	---	---
Methyl tert-butyl ether (MTBE)	---	---	---	GW	---	---

Notes:
"---" indicates constituent was not retained as a COC for the identified medium
S_R - Indicates an exceedance of the WVDEP residential soil de minimis standard, June 2017
GW - Indicates an exceedance of the WVDEP groundwater de minimis standard, June 2017
VI_R - Indicates an exceedance of the USEPA residential VISL (based on a target risk of $1.0x10^{-6}$ and HQ of 1.0), November 2019.
VI_{NR} - Indicates an exceedance of the USEPA commercial VISL (based on a target risk of $1.0x10^{-5}$ and HQ of 1.0), November 2019
ft-bgs - feet below ground surface
[1] There were no site-related constituents in on-site surface soil (0-2 ft-bgs) that exceeded a WVDEP De Minimis industrial or residential soil screening value. Therefore, no direct contact COC were retained on-site surface soil.
[2] Any site-related constituent in on-site subsurface soil (2-6 ft-bgs) that exceeded a WVDEP De Minimis industrial or residential soil screening value was retained as a direct contact COC in on-site subsurface soil (2-6 ft-bgs).
[3] Any site-related constituent in on-site subsurface soil (2-10 ft-bgs) that exceeded a WVDEP De Minimis industrial or residential soil screening value was retained as a direct contact COC in on-site subsurface soil (2-10 ft-bgs).
[4] Any site-related constituent in the 8 most recent post-remediation groundwater samples (i.e. collected between December 2010 and August 2016) from on-site monitoring wells MW-1, MW-2, MW-3, and MW-3R that exceeded a WVDEP groundwater De Minimis screening value was retained as a direct contact groundwater COC in on-site groundwater.
[5] There were no site-related constituents in the 8 most recent post-remediation groundwater sampling events (i.e. collected between December 2010 and August 2016) from MW-1 (located closest to the current on-site building) that exceeded a USEPA commercial or residential VISL target groundwater concentration. Therefore, no vapor intrusion COC were retained in groundwater for the current on-site building.
[6] Any site-related constituent in the 8 most recent post-remediation groundwater sampling events (i.e. collected between December 2010 and August 2016) from all on-site monitoring wells (i.e. MW-1, MW-2, MW-3, and MW-3R) that exceeded a USEPA commercial or residential VISL target groundwater concentration was retained as a vapor intrusion COC for a future building that may be built on-site.

Table 3-7
Summary of Off-Site Direct Contact and Vapor Intrusion Constituents of Concern
Risk Assessment Report
Former 7-Eleven Facility #135 - 44 Main Street
Rainelle, West Virginia

Constituent of Concern (COC)	Off-Site				
	Direct Contact				Vapor Intrusion
	Northern James River and Kanawha Turnpike ROW (South/Southwest of the Site)			Southern James River and Kanawha Turnpike ROW (South/Southwest of the Site)	Western Auto Store (South/Southwest of the Site)
	Surface Soil [1]	Subsurface Soil [2]	Groundwater [3]	Groundwater [4]	Groundwater [5]
	0-2 ft-bgs	2-10 ft-bgs	Overburden	Overburden	Overburden
Volatile Organic Compounds					
Benzene	---	---	GW	---	---
Toluene	---	---	---	---	---
Ethylbenzene	---	S_R	---	---	---
Xylenes, Total	---	---	---	---	---
Methyl tert-butyl ether (MTBE)	---	---	GW	GW	---

Notes:
"---" indicates constituent was not retained as a COC for the identified medium
S_R - Indicates an exceedance of the WVDEP residential soil de minimis standard, June 2017
GW - Indicates an exceedance of the WVDEP groundwater de minimis standard, June 2017
ft-bgs - feet below ground surface
ROW - right-of-way

[1] There were no site-related constituents in on-site surface soil samples CE-MW-3B (0-2')-003 and CE-MW-3D (0-2')-008 (located closest to the northern James River and Kanawha Turnpike ROW) that exceeded a WVDEP De Minimis industrial or residential soil screening value. Therefore, no direct contact COC were retained in surface soil for the northern James River and Kanawha Turnpike ROW.

[2] Any site-related constituent in on-site subsurface soil samples CE-MW-3B (6-8')-004 and CE-MW-3D (6-8')-009 (located closest to the northern James River and Kanawha Turnpike ROW) that exceeded a WVDEP De Minimis industrial or residential soil screening value was retained as a direct contact COC in off-site subsurface soil for the northern James River and Kanawha Turnpike ROW.

[3] On-site monitoring wells MW-2, MW-3 and MW-3R (located closest to and upgradient of the northern James River and Kanawha Turnpike ROW) were used to evaluate the northern James River and Kanawha Turnpike ROW. Any site-related constituent in the 8 most recent post-remediation groundwater samples (i.e. collected between December 2010 and August 2016) from MW-2, MW-3, and MW-3R that exceeded a WVDEP groundwater De Minimis screening value was retained as a direct contact COC in groundwater for the northern James River and Kanawha ROW.

[4] Off-site monitoring wells MW-4, MW-5, and MW-6 (located within the southern James River and Kanawha Turnpike ROW and downgradient of groundwater flow) were used to evaluate the southern James River and Kanawha Turnpike ROW. Any site-related constituent in the 8 most recent post-remediation groundwater samples (i.e. collected between December 2010 and August 2016) from MW-4, MW-5, and MW-6 that exceeded a WVDEP groundwater De Minimis screening value was retained as a direct contact COC for the southern James River and Kanawha ROW.

[5] Off-site monitoring wells MW-4, MW-5, and MW-6 (located south of the site and upgradient of the off-site Western Auto Store) were used to evaluate the Western Auto Store. There were no site-related constituents in the 8 most recent post-remediation groundwater samples (i.e. collected between December 2010 and August 2016) from MW-4, MW-5, and MW-6 that exceeded a USEPA commercial or residential VISL target groundwater concentration. Therefore, no vapor intrusion COC were retained in groundwater for the Western Auto Store.

Table 4-1
Potential Constituent Migration Routes
Risk Assessment Report
Former 7-Eleven Facility #135 - 44 Main Street
Rainelle, West Virginia

On-Site or Off-Site	Media	Constituent Migration Route (Transport Mechanism)	Description	Retained/ Not Retained	Rationale
On-Site	**Suface/ Subsurface Soil**	Surface and Subsurface Soil to Indoor Air (Volatilization)	Volatilization of constituents from on-site surface and subsurface soil to soil gas and subsequent seepage of soil gas into a building (indoor air)	**Retained**	The site historically and currently operates as a petroleum retail facility and convenience store. The on-site property is triangular in shape and approximately 0.45 acres. The current on-site building is a one-story slab-on-grade building that is used as the station building/convenience store. The site is paved with concrete and/or asphalt or under roof. However, the pavement may be partially or fully removed in the future. There were site-related constituents detected in on-site surface and subsurface soil samples. Therefore, these migration routes were retained.
		Surface and Subsurface Soil to Outdoor Air (Volatilization)	Volatilization of constituents from on-site surface and subsurface soil to outdoor air		
		Surface and Subsurface Soil to Groundwater	Leaching of constituents from on-site surface soil to subsurface soil and then to groundwater		
	Groundwater	Groundwater to Outdoor Air (Volatilization)	Volatilization of constituents from on-site groundwater to outdoor air	**Retained**	The on-site property is triangular in shape and approximately 0.45 acres. The current on-site building is a one-story slab-on-grade building that is used as the station building/convenience store. The site is paved with concrete and/or asphalt or under roof. However, the pavement may be partially or fully removed in the future. There were site-related constituents detected in the 8 most recent post-remediation groundwater samples (i.e. collected between December 2010 and August 2016) from on-site monitoring wells. Therefore, these migration routes were retained.
		Groundwater to Indoor Air (Volatilization)	Volatilization of constituents from on-site groundwater to soil gas and subsequent seepage of soil gas into a building (indoor air)		
		On-Site Groundwater to Off-Site Groundwater	Migration of constituents in on-site groundwater to off-site groundwater	**Retained**	On-site groundwater predominantly flows to the southwest. On-site monitoring wells MW-2 and MW-3R (i.e. MW-3R replaced MW-3) are the furthest downgradient wells on-site and located along the south/western property boundary (i.e. MW-2) and southern property boundary (i.e. MW-3/MW-3R). There were no site-related constituents detected in the 8 most recent post-remediation groundwater samples (i.e. collected between December 2010 and August 2016) from MW-2. However, there were site-related constituents detected in MW-3 and MW-3R. Therefore, the potential exists for these constituents to continue to migrate from on-site groundwater to off-site groundwater as indicated by detections of constituents in off-site downgradient wells MW-4, MW-5, and MW-6. Therefore, this migration route was retained.
Off-Site	**Groundwater**	Groundwater to Outdoor Air (Volatilization)	Volatilization of constituents from off-site groundwater to outdoor air	**Retained**	On-site groundwater predominantly flows to the southwest. Areas located downgradient of groundwater flow include the James River and Kanawha Turnpike, which bounds the site to the south/southwest, and commercial properties further south across the James River and Kanawha Turnpike. Off-site monitoring wells MW-4, MW-5, and MW-6 are located in the southern James River and Kanawha Turnpike ROW and downgradient of groundwater flow. There were detections of site-related constituents in the 8 most recent post-remediation groundwater samples (i.e. collected between December 2010 and August 2016) from MW-4, MW-5, and MW-6. Therefore, these migration routes were retained.
		Groundwater to Indoor Air (Volatilization)	Volatilization of constituents from off-site groundwater to soil gas and subsequent seepage of soil gas into a building (indoor air)		
		Off-Site Groundwater to Off-Site Surface Water	Migration of constituents in off-site groundwater to off-site surface water	Not Retained	On-site groundwater predominantly flows to the southwest. The closest surface water feature to the site is Sewell Creek which is located approximately 0.1 miles (approximately 500 feet) west of the site. There were detections of MTBE in the 8 most recent groundwater sampling events from off-site monitoring well MW-6 (located the furthest downgradient of groundwater flow). The maximum MTBE concentration was 24.7 ug/L during the 6/20/11 sampling event, which is just above the WVDEP groundwater De Minimis screening value of 14 ug/L. Note there is no WVDEP surface water screening criteria for MTBE. MTBE concentrations are expected to attenuate as the groundwater continues to migrate from MW-6. Therefore, based on the distance to the creek and the MTBE concentrations in MW-6 that only slightly exceeded the WVDEP groundwater De Minimis screening value, this migration route was not retained because MTBE concentrations are expected to be below the applicable De Minimis screening value at Sewell Creek. In addition, BIOSCREEN modeling was completed, which supports the fact that MTBE concentrations are expected to be non-detect before reaching the Sewell Creek.

Table 5-1
On-Site Source Concentrations for Constituents of Concern
Risk Assessment Report
Former 7-Eleven Facility # 135 - 44 Main Street
Rainelle, West Virginia

Constituent of Concern (COC)	On-Site							
	Source Concentration by Media				Source Concentration by Receptor and Exposure Pathway		
	Direct Contact				Construction and Utility Worker - Source Area	Construction Worker - Entire Site	Maintenance Worker
					Groundwater [2]	Groundwater [3]	Groundwater [4]
	Overburden Groundwater - Source Area (MW-3/3R) [1]		Overburden Groundwater - Entire Site (MW-1, MW-2, MW-3/3R) [1]		Dermal Contact and Inhalation of Volatiles	Dermal Contact and Inhalation of Volatiles	Inhalation of Volatiles
	(mg/L)		(mg/L)		(mg/L)	(mg/L)	(mg/L)
Volatile Organic Compounds							
Benzene	0.091	95% UCL	0.03747	95% UCL	0.091	0.03747	0.091
Methyl tert-butyl ether (MTBE)	0.153	95% UCL	0.07331	95% UCL	0.153	0.07331	0.153

Notes:

mg/L - milligrams per liter

[1] Source concentrations are UCLs produced using Pro UCL 5.1. The 8 most recent post-remediation groundwater samples (i.e. collected between December 2010 and August 2016) were used to derive a UCL for each groundwater COC for the source area (i.e., MW-3/3R) and the entire site (i.e., MW-1, MW-2, and MW-3/3R).

[2] These receptors are expected to be in direct contact with groundwater in the source zone (i.e., MW-3/3R) based on the maximum excavation depth (i.e. 6 ft-bgs) and average depth to groundwater (i.e. approximately 5.5 ft-bgs). Therefore, the source concentrations for dermal contact and inhalation of volatiles from exposed groundwater to trench air during intrusive activities are the UCLs derived from monitoring well MW-3/3R.

[3] These receptors are expected to be in direct contact with groundwater across the entire site based on the maximum excavation depth (i.e. 6 ft-bgs) and average depth to groundwater (i.e. approximately 5.9 ft-bgs). Therefore, the source concentrations for dermal contact and inhalation of volatiles from exposed groundwater to trench air during intrusive activities are the UCLs derived from on-site monitoring wells MW-1, MW-2, and MW-3/3R.

[4] This receptor is not expected to come into direct contact with groundwater based on a maximum excavation depth of 2 ft-bgs and average depth to groundwater on-site (approximately 5.5 ft-bgs in the source area and 5.9 ft-bgs across the entire site). However, there is potential for site-related volatile constituents to volatilize from unexposed groundwater to outdoor air without intrusive activities. Therefore, the source concentrations for the inhalation of volatiles from unexposed groundwater to outdoor air exposure pathway are the greater of the UCLs derived for on-site groundwater in the source area and across the entire site.

Table 6-1
Chemical Properties
Risk Assessment Report
Former 7-Eleven Facility #135 - 44 Main Street
Rainelle, West Virginia

Chemical	CAS No.	Molecular Weight Value (g/mol)	Molecular Weight Source	Melting Point Value (°C)	Melting Point Source	Boiling Point Value (°C)	Boiling Point Source
Volatile Organic Compounds							
Benzene	71-43-2	78	WVDEP	5.5	WVDEP	80	RAIS
Methyl tert-butyl ether (MTBE)	1634-04-4	88	WVDEP	-109	WVDEP	55	RAIS

Notes:

g/mol - grams per mole

°C - degrees Celsius

Sources:

WVDEP - West Virginia Department of Environmental Protection. Approved Chemical Specific Data, June 2014

RAIS - Risk Assessment Information System Website (http://www.rais.ornal.gov) (Accessed on February 8, 2019)

Table 6-1
Chemical Properties
Risk Assessment Report
Former 7-Eleven Facility #135 - 44 Main Street
Rainelle, West Virginia

Chemical	CAS No.	Water Solubility Value (mg/L)	Water Solubility Source	Vapor Pressure Value (mm Hg)	Vapor Pressure Source	Octanol-Water Part. Coef. (K_{ow}) Value (L/L)	Octanol-Water Part. Coef. (K_{ow}) Source
Volatile Organic Compounds							
Benzene	71-43-2	1.8E+03	WVDEP	9.5E+01	RAIS	1.3E+02	RAIS
Methyl tert-butyl ether (MTBE)	1634-04-4	5.1E+04	WVDEP	2.5E+02	RAIS	8.7E+00	RAIS

Notes:

mg/L - milligrams per liter

mm Hg - millimeters of mercury

L/L - liters per liter

Sources:

WVDEP - West Virginia Department of Environmental Protection. Approved Chemical Specific Data, June 2014

RAIS - Risk Assessment Information System Website (http://www.rais.ornal.gov) (Accessed on February 8, 2019)

Table 6-1
Chemical Properties
Risk Assessment Report
Former 7-Eleven Facility #135 - 44 Main Street
Rainelle, West Virginia

		Organic Carbon Part. Coef. (K_{oc})		Henry's Law Constant	
Chemical	**CAS No.**	**Value (mg/Kg / mg/L)**	**Source**	**Value (atm-m³/mol)**	**Source**
Volatile Organic Compounds					
Benzene	71-43-2	1.5E+02	WVDEP	5.6E-03	WVDEP
Methyl tert-butyl ether (MTBE)	1634-04-4	1.2E+01	WVDEP	5.9E-04	WVDEP

Notes:

mg/Kg / mg/L - milligrams per kilogram per milligram per liter

atm - m^3/mol - atmosphere cubic meter per mole

Sources:

WVDEP - West Virginia Department of Environmental Protection. Approved Chemical Specific Data, June 2014

Table 6-1
Chemical Properties
Risk Assessment Report
Former 7-Eleven Facility #135 - 44 Main Street
Rainelle, West Virginia

Chemical	CAS No.	Vapor Phase Diffusivity Value (cm^2/s)	Vapor Phase Diffusivity Source	Water Phase Diffusivity Value (cm^2/s)	Water Phase Diffusivity Source
Volatile Organic Compounds					
Benzene	71-43-2	9.0E-02	WVDEP	1.0E-05	WVDEP
Methyl tert-butyl ether (MTBE)	1634-04-4	7.5E-02	WVDEP	8.6E-06	WVDEP

Notes:

cm^2/s - centimeters squared per second

Sources:

WVDEP - West Virginia Department of Environmental Protection. Approved Chemical Specific Data, June 2014

Table 6-2
Cancer Slope Factors and Inhalation Unit Risks
Risk Assessment Report
Former 7-Eleven Facility #135 - 44 Main Street
Rainelle, West Virginia

		Oral CSF		Dermal CSF			IUR	
		General		Oral to Derm. Conv. Fact.		CSF	General	
Chemical	**CAS No.**	**$(mg/kg\text{-}day)^{-1}$**	**Source**	**(unitless)**	**Source**	**$(mg/kg\text{-}day)^{-1}$**	**$(ug/m^3)^{-1}$**	**Source**
Volatile Organic Compounds								
Benzene	71-43-2	5.5E-02	I	1	RAGS E	5.5E-02	7.8E-06	I
Methyl tert-butyl ether (MTBE)	1634-04-4	1.8E-03	C	1	RAGS E	1.8E-03	2.6E-07	C

Notes:

CSF - Cancer Slope Factor — $(mg/kg\text{-}day)^{-1}$ - per milligram per kilogram per day

IUR - Inhalation Unit Risk — $(\mu g/m^3)^{-1}$ - per microgram per cubic meter

Sources:

C - California EPA Cancer Potency Factor

I - Integrated Risk Information System (IRIS)

Table 6-3
Chronic Reference Doses and Reference Concentrations
Risk Assessment Report
Former 7-Eleven Facility #135 - 44 Main Street
Rainelle, West Virginia

		Oral RfD		Dermal RfD			Inhalation RfC	
		General		Oral to Derm. Conv. Fact.		RfD	RfC	
Chemical	**CAS No.**	**(mg/kg-day)**	**Source**	**(unitless)**	**Source**	**(mg/kg-day)**	**(mg/m³)**	**Source**
Volatile Organic Compounds								
Benzene	71-43-2	4.0E-03	I	1	RAGS E	4.0E-03	3.0E-02	I
Methyl tert-butyl ether (MTBE)	1634-04-4	---				---	3.0E+00	I

Notes:

RfD - Reference Dose

RfC - Reference Concentration

mg/kg-day - milligram per kilogram per day

mg/m^3 - milligram per cubic meter

Sources:

I - Integrated Risk Information System (IRIS)

Table 6-4
Subchronic Reference Doses and Reference Concentrations
Risk Assessment Report
Former 7-Eleven Facility #135 - 44 Main Street
Rainelle, West Virginia

		Oral RfD		Dermal RfD			Inhalation RfC	
		General		Oral to Derm. Conv. Fact.		RfD	RfC	
Chemical	**CAS No.**	**(mg/kg-day)**	**Source**	**(unitless)**	**Source**	**(mg/kg-day)**	**(mg/m³)**	**Source**
Volatile Organic Compounds								
Benzene	71-43-2	1.0E-02	PPRTV	1	RAGS E	1.0E-02	8.0E-02	PPRTV
Methyl tert-butyl ether (MTBE)	1634-04-4	3.0E-01	ATSDR	1	RAGS E	3.0E-01	2.5E+00	ATSDR

Notes:

RfD - Reference Dose mg/kg-day - milligram per kilogram per day

RfC - Reference Concentration mg/m^3 - milligram per cubic meter

Sources:

ATSDR - Intermediate Minimal Risk Level (MRL) from the Agency for Toxic Substances and Disease Registry

PPRTV - EPA Provisional Peer Reviewed Toxicity Value

RAGS-E - Risk Assessment Guidance for Superfund (RAGS) Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)

Table 6-5
Cancer Slope Factors/Inhalation Unit Risks - Tumor Type or Target Organ
Risk Assessment Report
Former 7-Eleven Facility #135 - 44 Main Street
Rainelle, West Virginia

Chemical	CAS No.	Oral Tumor Type or Target Organ	Inhalation Tumor Type or Target Organ
Volatile Organic Compounds			
Benzene	71-43-2	leukemia; blood	leukemia; blood
Methyl tert-butyl ether (MTBE)	1634-04-4	leukemia and lymphomas (combined) (female)	leydig interstitial cell tumors (male); testes / hepatocellular carcinomas (male); liver / adenomas and carcinomas (female)

Sources used include:
IRIS - Integrated Risk Information System (http://www.epa.gov/IRIS/)
RAIS - Risk Assessment Information System website (http://www.rais.ornl.gov) (Accessed on February 8, 2019)
California Environmental Protection Agency (http://www.oehha.ca/gov/risk)

Table 6-6
Chronic Reference Doses/Reference Concentrations - Critical Effect or Target Organ
Risk Assessment Report
Former 7-Eleven Facility #135 - 44 Main Street
Rainelle, West Virginia

Chemical	CAS No.	Oral Critical Effect or Target Organ	Inhalation Critical Effect or Target Organ
Volatile Organic Compounds			
Benzene	71-43-2	decreased lymphocyte count; blood and immune system	decreased lymphocyte count; blood and immune system
Methyl tert-butyl ether (MTBE)	1634-04-4	---	increased liver and kidney weights, increased severity of spontaneous renal lesions (females), increased prostration (females), swollen periocular tissue (males and females); liver and kidney

Sources used include:
IRIS - Integrated Risk Information System (http://www.epa.gov/IRIS/)
RAIS - Risk Assessment Information System website (http://www.rais.ornl.gov) (Accessed on February 8, 2019)
California Environmental Protection Agency (http://www.oehha.ca/gov/risk)

Table 6-7
Subchronic Reference Doses/Reference Concentrations - Critical Effect or Target Organ
Risk Assessment Report
Former 7-Eleven Facility #135 - 44 Main Street
Rainelle, West Virginia

Chemical	CAS No.	Oral Critical Effect or Target Organ	Inhalation Critical Effect or Target Organ
Volatile Organic Compounds			
Benzene	71-43-2	decreased lymphocyte count; blood and immune system	decreased lymphocyte count; blood and immune system
Methyl tert-butyl ether (MTBE)	1634-04-4	decreased BUN values; hepatic	hypoactivity, lack of startle response, blepharospasm; neurological

Notes:
Nav - not available
Sources used include:
IRIS - Integrated Risk Information System (http://www.epa.gov/IRIS/)
RAIS - Risk Assessment Information System website (http://www.rais.ornl.gov) (Accessed on March 18, 2020)
California Environmental Protection Agency (http://www.oehha.ca/gov/risk)

Table 6-8
Parameters Used to Calculate Permeability Constants for COC in Groundwater
Risk Assessment Report
Former 7-Eleven Facility #135 - 44 Main Street
Rainelle, West Virginia

Chemical	CAS No.	Molecular Weight (g/mol) Value	Molecular Weight Basis	Octanol-Water Partition Coefficient (K_{ow}) (unitless) Value	Octanol-Water Partition Coefficient (K_{ow}) Basis	Kp (cm/hr) Value	Kp Basis
Volatile Organic Compounds							
Benzene	71-43-2	78	RAIS	1.3E+02	RAIS	1.5E-02	USEPA 2019
Methyl tert-butyl ether (MTBE)	1634-04-4	88	RAIS	8.7E+00	RAIS	2.1E-03	USEPA 2019

Sources:
RAIS - Risk Assessment Information System Website (http://www.rais.ornl.gov) (Accessed on February 8, 2019)
WVDEP - West Virginia Department of Environmental Protection. Approved Chemical Specific Data, June 2014
USEPA 2019, United States Environmental Protection Agency - Oak Ridge National Laboratory, Chemical Properties Table, November 2019

Table 6-8
Parameters Used to Calculate Permeability Constants for COC in Groundwater
Risk Assessment Report
Former 7-Eleven Facility #135 - 44 Main Street
Rainelle, West Virginia

		B		Tau-ev		tstar		FA	
		(unitless)		(hr)		(hr)		(unitless)	
Chemical	**CAS No.**	**Value**	**Basis**	**Value**	**Basis**	**Value**	**Basis**	**Value**	**Basis**
Volatile Organic Compounds									
Benzene	71-43-2	5.1E-02	USEPA 2019	2.9E-01	USEPA 2019	6.9E-01	USEPA 2019	1.0E+00	USEPA 2019
Methyl tert-butyl ether (MTBE)	1634-04-4	7.6E-03	USEPA 2019	3.3E-01	USEPA 2019	7.9E-01	USEPA 2019	1.0E+00	USEPA 2019

Sources:
Est. RAGS-E - Value is the estimated value presented in RAGS Part E.
Assumed - Conservative assumption
USEPA 2019, United States Environmental Protection Agency - Oak Ridge National Laboratory, Chemical Properties Table, November 2019

Table 6-9
Calculation of Permeability Constants for an On-Site Construction Worker and On-Site Utility Worker
Risk Assessment Report
Former 7-Eleven Facility #135 - 44 Main Street
Rainelle, West Virginia

Exposure Time per Event (ET) = 8 hrs/event

							Permeability Constant		
Chemical	**Kp (cm/hr)**	**B (unitless)**	**Tau-ev (hr/event)**	**tstar (hr)**	**FA (unitless)**	**Organic? Enter "Y" or "N"**	**ET <= tstar (cm/hr)**	**ET > tstar (cm/hr)**	**Selected (cm/hr)**
Volatile Organic Compounds									
Benzene	1.5E-02	5.1E-02	2.9E-01	6.9E-01	1.0E+00	Y	7.9E-03	1.5E-02	1.5E-02
Methyl tert-butyl ether (MTBE)	2.1E-03	7.6E-03	3.3E-01	7.9E-01	1.0E+00	Y	1.2E-03	2.3E-03	2.3E-03

Table 7-1a

Summary of Exposure Assumptions for On-Site Construction Worker (Source Area)

Risk Assessment Report

Former 7-Eleven Facility #135 - 44 Main Street

Rainelle, West Virginia

Parameter			Value	Units	Comments/References	Intake Equation
Averaging Times						
Dermal						
AT (c)	Carcinogenic Effects	=	25,550	days	averaging time for a carcinogen based on lifetime of 70 years (lifetime in years x 365 days/year) (USEPA 1991)	
AT (nc)	Noncarcinogenic Effects	=	42	days	default assumption based on a construction period of 6 weeks/year at 7 days/week for 1 year (IPCB 2013)	
Inhalation						
AT (c)	Carcinogenic Effects	=	613,200	hours	averaging time for a carcinogen based on lifetime of 70 years (lifetime in years x 365 days/year x 24 hours/day) (USEPA 2009)	
AT (nc)	Noncarcinogenic Effects	=	1,008	hours	default assumption based on a construction period of 6 weeks/year at 7 days/week for 1 year x 24 hours/day (IPCB 2013)	
Exposure Assumptions Associated with Direct Contact with Groundwater						
Dermal Contact with Groundwater						
SA	Exposed Surface Area	=	2,550	cm²	mean body surface area exposed for adult male (corresponds to forearms and hands) (USEPA 2011)	
ET	Exposure Time	=	8	hours/day	default assumption for an adult industrial exposure (WVDEP 2019)	
EF	Exposure Frequency	=	5	days/year	assumes 1 week of construction in contact with exposed groundwater in the source zone at 5 days/week during the 30 days construction period (IPCB 2013)	
ED	Exposure Duration	=	1	years	construction occurs over a one year period (IPCB 2013)	
CF	Conversion Factor	=	1.0E-03	L/cm³	---	$I_{derm-w} = CW_{src} * TF_w * PC * IF_{derm-w}$
BW	Body Weight	=	80	kg	default assumption for an adult (WVDEP 2019)	
IF_{derm-w} *(c)*	Absorbed Dose (Carcinogenic)	=	4.99E-05	L-hr/cm-kg-day	calculated; $EPC_{adj} = (CW_{src} * TF_w)$ or solubility	$IF_{derm-w} = \frac{SA * ET * EF * ED * CF}{BW * AT}$
IF_{derm-w} *(nc)*	Absorbed Dose (Noncarcinogenic)	=	3.04E-02	L-hr/cm-kg-day	calculated; If $EPC < solubility$, then choose EPC.	
CW_{src}	Source Concentration in GW	=	chem-spec.	mg/L	measured value; If $EPC > solubility$, then choose solubility.	
TF_w	Transfer Factor	=	1	unitless	conservative assumption	
PC	Permeability Constant	=	chem-spec.	cm/hr	chemical - specific	$Risk = I_{derm-w} * CSF_D \quad HI = \frac{I_{derm-w}}{RfD_D}$
I_{derm-w}	Intake for Dermal Contact with Groundwater	=	chem-spec.	mg/kg-day	chemical - specific	
CSF_D	Dermal Cancer Slope Factor	=	chem-spec.	$(mg/kg\text{-}day)^{-1}$	chemical - specific	
RfD_D	Dermal Reference Dose	=	chem-spec.	mg/kg-day	chemical - specific	
Inhalation of Constituents Emitted from Groundwater to Trench Air						
ET	Exposure Time	=	8	hours/day	default assumption for an adult industrial exposure (WVDEP 2019)	
EF	Exposure Frequency	=	5	days/year	assumes 1 week of construction in contact with exposed groundwater in the source zone at 5 days/week during the 30 day construction period (IPCB 2013)	
ED	Exposure Duration	=	1	years	construction occurs over a one year period (IPCB 2013)	
EC_c	Exposure Concentration (Carcinogenic)	=	chem-spec.	$\mu g/m^3$	calculated	$EC = \frac{CA_a * ET * EF * ED}{AT}$
EC_{nc}	Exposure Concentration (Noncarcinogenic)	=	chem-spec.	$\mu g/m^3$	calculated	
VF	Volatilization Factor	=	chem-spec.	L/m³	calculated using the groundwater volatilization model (VA DEQ 2019)	
CA_a	Concentration in Trench Air	=	chem-spec.	µg/m³	calculated value	$CA_a = C_{src} * VF$
C_{src}	Source Concentration in Groundwater	=	chem-spec.	µg/L	measured value	
CF	Conversion Factor	=	1.0E+03	µg/mg	---	$Risk = EC_c * IUR \quad HI = \frac{EC_{nc}}{RfC * CF}$
IUR	Inhalation Unit Risk	=	chem-spec.	$(\mu g/m^3)^{-1}$	chemical - specific	
RfC	Reference Concentration	=	chem-spec.	(mg/m^3)	chemical - specific	

Table 7-1b
Summary of Exposure Assumptions for On-Site Construction Worker (Entire Site)
Risk Assessment Report
Former 7-Eleven Facility #135 - 44 Main Street
Rainelle, West Virginia

Parameter			Value	Units	Comments/References	Intake Equation
Averaging Times						
Dermal						
AT (c)	Carcinogenic Effects	=	25,550	days	averaging time for a carcinogen based on lifetime of 70 years (lifetime in years x 365 days/year) (USEPA 1991)	
AT (nc)	Noncarcinogenic Effects	=	42	days	default assumption based on a construction period of 6 weeks/year at 7 days/week for 1 year (IPCB 2013)	
Inhalation						
AT (c)	Carcinogenic Effects	=	613,200	hours	averaging time for a carcinogen based on lifetime of 70 years (lifetime in years x 365 days/year x 24 hours/day) (USEPA 2009)	
AT (nc)	Noncarcinogenic Effects	=	1,008	hours	default assumption based on a construction period of 6 weeks/year at 7 days/week for 1 year x 24 hours/day (IPCB 2013)	
Exposure Assumptions Associated with Direct Contact with Groundwater						
Dermal Contact with Groundwater						
SA	Exposed Surface Area	=	2,550	cm²	mean body surface area exposed for adult male (corresponds to forearms and hands) (USEPA 2011)	
ET	Exposure Time	=	8	hours/day	default assumption for an adult industrial exposure (WVDEP 2019)	
EF	Exposure Frequency	=	30	days/year	assumes 6 weeks of construction in contact with exposed groundwater at 5 days/week during the 30 days construction period (IPCB 2013)	
ED	Exposure Duration	=	1	years	construction occurs over a one year period (IPCB 2013)	
CF	Conversion Factor	=	1.0E-03	L/cm³	---	$I_{derm-w} = CW_{src} * TF_w * PC * IF_{derm-v}$
BW	Body Weight	=	80	kg	default assumption for an adult (WVDEP 2019)	
IF_{derm-w} *(c)*	Absorbed Dose (Carcinogenic)	=	2.99E-04	L-hr/cm-kg-day	calculated	$EPC_{adj} = (CW_{src} * TF_w)$ or solubility
IF_{derm-w} *(nc)*	Absorbed Dose (Noncarcinogenic)	=	1.82E-01	L-hr/cm-kg-day	calculated	$IF_{derm-w} = \frac{SA * ET * EF * ED * CF}{BW * AT}$
CW_{src}	Source Concentration in GW	=	chem-spec.	mg/L	measured value	If EPC < solubility, then choose EPC.
TF_w	Transfer Factor	=	1	unitless	conservative assumption	If EPC > solubility, then choose solubility.
PC	Permeability Constant	=	chem-spec.	cm/hr	chemical - specific	
I_{derm-w}	Intake for Dermal Contact with Groundwater	=	chem-spec.	mg/kg-day	chemical - specific	$Risk = I_{derm-w} * CSF_D$ $\quad HI = \frac{I_{derm-w}}{RfD_D}$
CSF_D	Dermal Cancer Slope Factor	=	chem-spec.	$(mg/kg\text{-}day)^{-1}$	chemical - specific	
RfD_D	Dermal Reference Dose	=	chem-spec.	mg/kg-day	chemical - specific	
Inhalation of Constituents Emitted from Groundwater to Trench Air						
ET	Exposure Time	=	8	hours/day	default assumption for an adult industrial exposure (WVDEP 2019)	
EF	Exposure Frequency	=	30	days/year	assumes 6 weeks of construction in contact with exposed groundwater at 5 days/week during the 30 day construction period (IPCB 2013)	
ED	Exposure Duration	=	1	years	construction occurs over a one year period (IPCB 2013)	$EC = \frac{CA_a * ET * EF * ED}{AT}$
EC_c	Exposure Concentration (Carcinogenic)	=	chem-spec.	$\mu g/m^3$	calculated	
EC_{nc}	Exposure Concentration (Noncarcinogenic)	=	chem-spec.	$\mu g/m^3$	calculated	
TF_{a-vol}	Transfer Factor	=	chem-spec.	L/m³	calculated using the groundwater volatilization model (VA DEQ 2019)	$CA_a = C_{src} * TF_{a-vol}$
CA_a	Concentration in Trench Air	=	chem-spec.	μg/m³	calculated value	
C_{src}	Source Concentration in Groundwater	=	chem-spec.	μg/L	measured value	
CF	Conversion Factor	=	1.0E+03	μg/mg	---	$Risk = EC_c * IUR$ $\quad HI = \frac{EC_{nc}}{RfC * CF}$
IUR	Inhalation Unit Risk	=	chem-spec.	$(\mu g/m^3)^{-1}$	chemical - specific	
RfC	Reference Concentration	=	chem-spec.	(mg/m^3)	chemical - specific	

Table 7-2
Summary of Exposure Assumptions for On-Site Utility Worker
Risk Assessment Report
Former 7-Eleven Facility #135 - 44 Main Street
Rainelle, West Virginia

Parameter			Value	Units	Comments/References	Intake Equation
Averaging Times						
Dermal						
AT (c)	Carcinogenic Effects	=	25,550	days	averaging time for a carcinogen based on lifetime of 70 years (lifetime in years x 365 days/year) (USEPA 1991)	
AT (nc)	Noncarcinogenic Effects	=	9,125	days	averaging time for a noncarcinogen (ED in years x 365 days/year) (USEPA 1989)	
Inhalation						
AT (c)	Carcinogenic Effects	=	613,200	hours	averaging time for a carcinogen based on lifetime of 70 years (lifetime in years x 365 days/year x 24 hours/day) (USEPA 2009)	
AT (nc)	Noncarcinogenic Effects	=	219,000	hours	averaging time for a noncarcinogen (ED in years x 365 days/year x 24 hours/day) (USEPA 2009)	
Exposure Assumptions Associated with Direct Contact with Groundwater						
Dermal Contact with Groundwater						
SA	Exposed Surface Area	=	2,550	cm^2	mean body surface area exposed for adult male (corresponds to forearms and hands) (USEPA 2011)	
ET	Exposure Time	=	8	hrs/day	default assumption for an industrial exposure (WVDEP 2019)	$I_{derm-w} = CW_{src} * TF_w * PC * IF_{derm-w}$
EF	Exposure Frequency	=	1	days/year	assumes exposure to groundwater occurs one day per year (MADEP 1995)	
ED	Exposure Duration	=	25	years	default assumption for an industrial exposure (WVDEP 2019)	
CF	Conversion Factor	=	1.0E-03	L/cm^3	--- $EPC_{adj} = (CW_{src} * TF_w)$ or solubility	$IF_{derm-w} = \frac{SA * ET * EF * ED * CF}{BW * AT}$
BW	Body Weight	=	80	kg	default assumption for an adult (WVDEP 2019) If EPC < solubility, then choose EPC. If EPC > solubility, then choose solubility.	
IF_{derm-w} *(c)*	Absorbed Dose (Carcinogenic)	=	2.50E-04	L-hr/cm-kg-day	calculated	
IF_{derm-w} *(nc)*	Absorbed Dose (Noncarcinogenic)	=	6.99E-04	L-hr/cm-kg-day	calculated	
CW_{src}	Source Concentration in GW	=	chem-spec.	mg/L	measured value	$Risk = I_{derm-w} * CSF_D \quad HI = \frac{I_{derm-w}}{RfD_D}$
TF_w	Transfer Factor	=	1	unitless	conservative assumption	
PC	Permeability Constant	=	chem-spec.	cm/hr	chemical - specific	
Inhalation of Constituents Emitted from Groundwater to Trench Air						
ET	Exposure Time	=	8	hours/day	default assumption for an industrial exposure (WVDEP 2019)	
EF	Exposure Frequency	=	1	days/year	assumes exposure to groundwater occurs one day per year (MADEP 1995)	
ED	Exposure Duration	=	25	years	default assumption for an industrial exposure (WVDEP 2019)	$EC = \frac{CA_a * ET * EF * ED}{AT}$
EC_c	Exposure Concentration (Carcinogenic)	=	chem-spec.	$\mu g/m^3$	calculated	
EC_{nc}	Exposure Concentration (Noncarcinogenic)	=	chem-spec.	$\mu g/m^3$	calculated	
VF	Volatilization Factor	=	chem-spec.	L/m^3	calculated using the groundwater volatilization model (VA DEQ 2019)	$CA_a = C_{src} * VF$
CA_a	Concentration in Trench Air	=	chem-spec.	$\mu g/m^3$	calculated value	
CF	Conversion Factor	=	1.0E+03	μg/mg	---	
IUR	Inhalation Unit Risk	=	chem-spec.	$(\mu g/m^3)^{-1}$	chemical - specific	$Risk = EC_c * IUR \quad HI = \frac{EC_{nc}}{RfC * CF}$
RfC	Reference Concentration	=	chem-spec.	(mg/m^3)	chemical - specific	
C_{src}	Source Concentration in Groundwater	=	chem-spec.	μg/L	measured value	

Table 7-3
Summary of Exposure Assumptions for On-Site Maintenance Worker
Risk Assessment Report
Former 7-Eleven Facility #135 - 44 Main Street
Rainelle, West Virginia

Parameter			Value	Units	Comments/References	Intake Equation
Averaging Times						
Inhalation						
AT (c)	Carcinogenic Effects	=	613,200	hours	averaging time for a carcinogen based on lifetime of 70 years (lifetime in years x 365 days/year x 24 hours/day) (USEPA 2009)	
AT (nc)	Noncarcinogenic Effects	=	219,000	hours	averaging time for a noncarcinogen (ED in years x 365 days/year x 24 hours/day) (USEPA 2009)	
Exposure Assumptions Associated with Direct Contact with Groundwater						
Inhalation of Constituents Emitted from Groundwater to Outdoor Air						
ET	Exposure Time	=	4	hours/day	time spent outdoors (professional judgment)	
EF	Exposure Frequency	=	72	days/year	based on 3 days a week for 6 months (assumes warm months; May - Oct.) (professional judgment)	
ED	Exposure Duration	=	25	years	default assumption for an adult commercial/industrial exposure (WVDEP 2019)	$EC = \frac{CA_a * ET * EF * ED}{AT}$
EC_c	Exposure Concentration (Carcinogenic)	=	chem-spec.	$\mu g/m^3$	calculated	
EC_{nc}	Exposure Concentration (Noncarcinogenic)	=	chem-spec.	$\mu g/m^3$	calculated	
VF_{wamb}	Volatilization Factor	=	chem-spec.	L/m^3	calculated using the groundwater volatilization model (ASTM 2015)	$CA_a = C_{src} * VF_{wamb}$
CA_a	Concentration in Outdoor Air	=	chem-spec.	$\mu g/m^3$	calculated value	
C_{src}	Source Concentration in Groundwater	=	chem-spec.	µg/L	measured value	
CF	Conversion Factor	=	1.0E+03	µg/mg	---	$Risk = EC_c * IUR$ $HI = \frac{EC_{nc}}{RfC * CF}$
IUR	Inhalation Unit Risk	=	chem-spec.	$(\mu g/m^3)^{-1}$	chemical - specific	
RfC	Reference Concentration	=	chem-spec.	(mg/m^3)	chemical - specific	

Table 8-1a
Calculation of Risks and Hazard Indices for On-Site Construction Worker (Source Area)
Risk Assessment Report
Former 7-Eleven Facility #135 - 44 Main Street
Rainelle, West Virginia

Dermal Contact with Groundwater

Constituent of Concern	Source Concentration for Groundwater CW_{src} (mg/L)	Transfer Factor TF_w (unitless)	Exposure Point Concentration for Groundwater EPC_w (mg/L)	Solubility in Water S (mg/L)	Adjusted Exposure Point Concentration for Groundwater EPC_{w-adj} (mg/L)	Permeability Constant PC (cm/hr)	Calculation of Risk: IF_{derm-w} (c) = 4.99E-05 L-hr/cm-kg-day — Dermal Absorbed Dose (Cancer) I_{derm-w} (c) (mg/kg-day)	Dermal Cancer Slope Factor for Groundwater CSF_D (mg/kg-day)$^{-1}$	Risk from Dermal Contact with Groundwater R_{derm-w} (unitless)	Calculation of Hazard Index: IF_{derm-w} (nc) = 3.04E-02 L-hr/cm-kg-day — Dermal Absorbed Dose (Noncancer) I_{derm-w} (nc) (mg/kg-day)	Dermal Reference Dose for Groundwater RfD_D (mg/kg-day)	Hazard Index from Dermal Contact with Groundwater HI_{derm-w} (unitless)
Volatile Organic Compounds												
Benzene	0.091	1	9.1E-02	1.8E+03	9.1E-02	1.5E-02	7.0E-08	5.5E-02	4E-09	4.2E-05	1.0E-02	4E-03
Methyl tert-butyl ether (MTBE)	0.153	1	1.5E-01	5.1E+04	1.5E-01	2.3E-03	1.7E-08	1.8E-03	3E-11	1.1E-05	3.0E-01	4E-05

Total Risk for Pathway = **4E-09**

Total HI for Pathway = **4E-03**

Table 8-1a
Calculation of Risks and Hazard Indices for On-Site Construction Worker (Source Area)
Risk Assessment Report
Former 7-Eleven Facility #135 - 44 Main Street
Rainelle, West Virginia

Inhalation of Chemicals Volatilized to Trench Air from Exposed Groundwater

Constituent of Concern	Source Concentration for Groundwater C_{src} (µg/L)	Volatilization Factor VF (L/m³)	Outdoor Air Concentration CA_a (µg/m³)	Calculation of Risk: Exposure Concentration (Cancer) EC_c (µg/m³)	Calculation of Risk: Inhalation Unit Risk Factor IUR (µg/m³)⁻¹	Calculation of Risk: Risk from Inhal. of Chem. Vol. from Groundwater $R_{inhal-v}$ (unitless)	Calculation of Hazard Index: Exposure Concentration (Noncancer) EC_{nc} (µg/m³)	Calculation of Hazard Index: Reference Concentration RfC_I (mg/m³)	Calculation of Hazard Index: Hazard Index from Inhal. of Chem. Vol. from Groundwater $HI_{inhal-v}$ (unitless)
Volatile Organic Compounds									
Benzene	91	9.4E+00	8.5E+02	5.5E-02	7.8E-06	4E-07	3.4E+01	8.0E-02	4E-01
Methyl tert-butyl ether (MTBE)	153	8.1E+00	1.2E+03	8.1E-02	2.6E-07	2E-08	4.9E+01	2.5E+00	2E-02

Total Risk for Pathway = **5E-07**   Total HI for Pathway = **4E-01**

Table 8-1b
Calculation of Risks and Hazard Indices for On-Site Construction Worker (Entire Site)
Risk Assessment Report
Former 7-Eleven Facility #135 - 44 Main Street
Rainelle, West Virginia

Dermal Contact with Groundwater

Constituent of Concern	Source Concentration for Groundwater CW_{src} (mg/L)	Transfer Factor TF_w (unitless)	Exposure Point Concentration for Groundwater EPC_w (mg/L)	Solubility in Water S (mg/L)	Adjusted Exposure Point Concentration for Groundwater $EPC_{w\text{-}adj}$ (mg/L)	Permeability Constant PC (cm/hr)	Calculation of Risk: $IF_{derm\text{-}w}$ (c) = 2.99E-04 L-hr/cm-kg-day Dermal Absorbed Dose (Cancer) $I_{derm\text{-}w}$ (c) (mg/kg-day)	Dermal Cancer Slope Factor for Groundwater CSF_D $(mg/kg\text{-}day)^{-1}$	Risk from Dermal Contact with Groundwater $R_{derm\text{-}w}$ (unitless)	Calculation of Hazard Index: $IF_{derm\text{-}w}$ (nc) = 1.82E-01 L-hr/cm-kg-day Dermal Absorbed Dose (Noncancer) $I_{derm\text{-}w}$ (nc) (mg/kg-day)	Dermal Reference Dose for Groundwater RfD_D (mg/kg-day)	Hazard Index from Dermal Contact with Groundwater $HI_{derm\text{-}w}$ (unitless)
Volatile Organic Compounds												
Benzene	0.03747	1	3.7E-02	1.8E+03	3.7E-02	1.5E-02	1.7E-07	5.5E-02	1E-08	1.1E-04	1.0E-02	1E-02
Methyl tert-butyl ether (MTBE)	0.07331	1	7.3E-02	5.1E+04	7.3E-02	2.3E-03	5.0E-08	1.8E-03	9E-11	3.0E-05	3.0E-01	1E-04

Total Risk for Pathway = **1E-08** Total HI for Pathway = **1E-02**

Table 8-1b
Calculation of Risks and Hazard Indices for On-Site Construction Worker (Entire Site)
Risk Assessment Report
Former 7-Eleven Facility #135 - 44 Main Street
Rainelle, West Virginia

Inhalation of Chemicals Volatilized to Trench Air from Exposed Groundwater

Constituent of Concern	Source Concentration for Groundwater C_{src} (µg/L)	Transfer Factor TF_a (L/m^3)	Outdoor Air Concentration CA_a (µg/m^3)	Calculation of Risk: Exposure Concentration (Cancer) EC_c (µg/m^3)	Calculation of Risk: Inhalation Unit Risk Factor IUR (µg/m^3)$^{-1}$	Calculation of Risk: Risk from Inhal. of Chem. Vol. from Groundwater $R_{inhal-v}$ (unitless)	Calculation of Hazard Index: Exposure Concentration (Noncancer) EC_{nc} (µg/m^3)	Calculation of Hazard Index: Reference Concentration RfC_I (mg/m^3)	Calculation of Hazard Index: Hazard Index from Inhal. of Chem. Vol. from Groundwater $HI_{inhal-v}$ (unitless)
Volatile Organic Compounds									
Benzene	37.47	9.4E+00	3.5E+02	1.4E-01	7.8E-06	1E-06	8.3E+01	8.0E-02	1E+00
Methyl tert-butyl ether (MTBE)	73.31	8.1E+00	5.9E+02	2.3E-01	2.6E-07	6E-08	1.4E+02	2.5E+00	6E-02

Total Risk for Pathway = **1E-06**   Total HI for Pathway = **1E+00**

Table 8-2
Calculation of Risks and Hazard Indices for On-Site Utility Worker
Risk Assessment Report
Former 7-Eleven Facility #135 - 44 Main Street
Rainelle West Virginia

Dermal Contact with Groundwater

Constituent of Concern	Source Concentration for Groundwater CW_{src} (mg/L)	Transfer Factor TF_w (unitless)	Exposure Point Concentration for Groundwater EPC_w (mg/L)	Solubility in Water S (mg/L)	Adjusted Exposure Point Concentration for Groundwater $EPC_{w\text{-}adj}$ (mg/L)	Permeability Constant PC (cm/hr)	Calculation of Risk: $IF_{derm\text{-}w}$ (c) = 2.50E-04 L-hr/cm-kg-day — Dermal Absorbed Dose (Cancer) $I_{derm\text{-}w}$ (c) (mg/kg-day)	Dermal Cancer Slope Factor for Groundwater CSF_D $(mg/kg\text{-}day)^{-1}$	Risk from Dermal Contact with Groundwater $R_{derm\text{-}w}$ (unitless)	Calculation of Hazard Index: $IF_{derm\text{-}w}$ (nc) = 6.99E-04 L-hr/cm-kg-day — Dermal Absorbed Dose (Noncancer) $I_{derm\text{-}w}$ (nc) (mg/kg-day)	Dermal Reference Dose for Groundwater RfD_D (mg/kg-day)	Hazard Index from Dermal Contact with Groundwater $HI_{derm\text{-}w}$ (unitless)
Volatile Organic Compounds												
Benzene	0.091	1	9.1E-02	1.8E+03	9.1E-02	1.5E-02	3.5E-07	5.5E-02	2E-08	9.8E-07	4.0E-03	2E-04
Methyl tert-butyl ether (MTBE)	0.153	1	1.5E-01	5.1E+04	1.5E-01	2.3E-03	8.6E-08	1.8E-03	2E-10	2.4E-07	---	---

Total Risk for Pathway = **2E-08**

Total HI for Pathway = **2E-04**

Table 8-2
Calculation of Risks and Hazard Indices for On-Site Utility Worker
Risk Assessment Report
Former 7-Eleven Facility #135 - 44 Main Street
Rainelle West Virginia

Inhalation of Chemicals Volatilized to Trench Air from Exposed Groundwater

Constituent of Concern	Source Concentration for Groundwater C_{src} (ug/L)	Volatilization Factor *VF* (L/m^3)	Outdoor Air Concentration CA_a (ug/m^3)	Calculation of Risk: Exposure Concentration (Cancer) EC_c (ug/m^3)	Calculation of Risk: Inhalation Unit Risk Factor *IUR* (ug/m^3)$^{-1}$	Calculation of Risk: Risk from Inhal. of Chem. Vol. from Groundwater $R_{inhal-v}$ (unitless)	Calculation of Hazard Index: Exposure Concentration (Noncancer) EC_{nc} (ug/m^3)	Calculation of Hazard Index: Reference Concentration RfC_I (mg/m^3)	Calculation of Hazard Index: Hazard Index from Inhal. of Chem. Vol. from Groundwater $HI_{inhal-v}$ (unitless)
Volatile Organic Compounds									
Benzene	91	9.4E+00	8.5E+02	2.8E-01	7.8E-06	2E-06	7.8E-01	3.0E-02	3E-02
Methyl tert-butyl ether (MTBE)	153	8.1E+00	1.2E+03	4.0E-01	2.6E-07	1E-07	1.1E+00	3.0E+00	4E-04

Total Risk for Pathway = **2E-06**   Total HI for Pathway = **3E-02**

Table 8-3
Calculation of Risks and Hazard Indices for On-Site Maintenance Worker
Risk Assessment Report
Former 7-Eleven Facility #135 - 44 Main Street
Rainelle, West Virginia

Inhalation of Chemicals Volatilized to Outdoor Air from Unexposed Groundwater

Constituent of Concern	Source Concentration for Groundwater C_{src} (µg/L)	Volatilization Factor VF_{wamb} (L/m^3)	Outdoor Air Concentration CA_a (µg/m^3)	Calculation of Risk: Exposure Concentration (Cancer) EC_c (µg/m^3)	Calculation of Risk: Inhalation Unit Risk Factor IUR (ug/m^3)$^{-1}$	Calculation of Risk: Risk from Inhal. of Chem. Vol. from Groundwater $R_{inhal-v}$ (unitless)	Calculation of Hazard Index: Exposure Concentration (Noncancer) EC_{nc} (µg/m^3)	Calculation of Hazard Index: Reference Concentration RfC_I (mg/m^3)	Calculation of Hazard Index: Hazard Index from Inhal. of Chem. Vol. from Groundwater $HI_{inhal-v}$ (unitless)
Volatile Organic Compounds									
Benzene	91	1.2E-04	1.1E-02	1.3E-04	7.8E-06	1E-09	3.7E-04	3.0E-02	1E-05
Methyl tert-butyl ether (MTBE)	153	3.9E-05	6.0E-03	7.0E-05	2.6E-07	2E-11	2.0E-04	3.0E+00	7E-08

Total Risk for Pathway = **1E-09** Total HI for Pathway = **1E-05**

Table 8-4
Summary of Direct Contact Risks and Hazard Indices
Risk Assessment Report
Former 7-Eleven Facility #135 - 44 Main Street
Rainelle, West Virginia

Risks

Receptor	Direct Contact				*Total Risk*
	Groundwater				
	Dermal Contact	Inhalation of Volatiles (Unexposed)	Inhalation of Volatiles (Exposed)	*Total Groundwater*	
Industrial (risk benchmark of $1x10^{-5}$)					
On-Site Maintenance Worker	---	1E-09	---	*1E-09*	*1E-09*
On-Site Construction Worker - Source Area	4E-09	---	5E-07	*5E-07*	*5E-07*
On-Site Construction Worker - Entire Site	1E-08	---	1E-06	*1E-06*	*1E-06*
On-Site Utility Worker	2E-08	---	2E-06	*2E-06*	*2E-06*

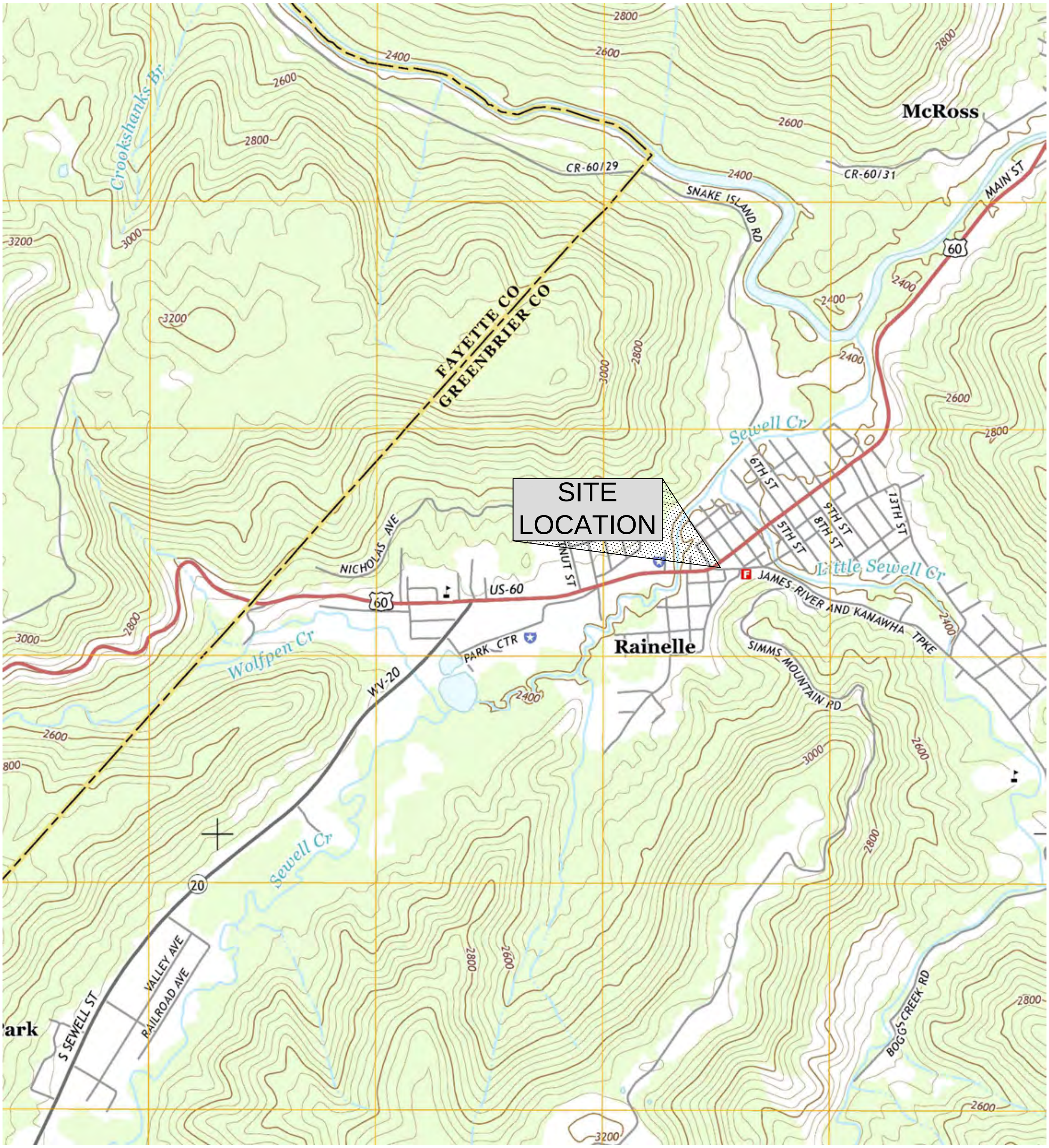
Hazard Indices

Receptor	Direct Contact				*Total Hazard Index*
	Groundwater				
	Dermal Contact	Inhalation of Volatiles (Unexposed)	Inhalation of Volatiles (Exposed)	*Total Groundwater*	
Industrial (hazard index benchmark of 1.0)					
On-Site Maintenance Worker	---	1E-05	---	*1E-05*	*1E-05*
On-Site Construction Worker - Source Area	4E-03	---	4E-01	*4E-01*	*4E-01*
On-Site Construction Worker - Entire Site	1E-02	---	1E+00	*1E+00*	*1E+00*
On-Site Utility Worker	2E-04	---	3E-02	*3E-02*	*3E-02*

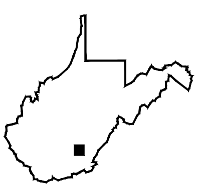
Notes:

Bolded values exceed the WVDEP industrial risk benchmark value of $1x10^{-5}$ or the hazard index benchmark of 1.

Figures



USGS 7.5-Minute Topographic Map; Rainelle, WV Quadrangle 2014; Scale: 1:24,000



WEST VIRGINIA

Latitude: N 37° 58' 8.11"
Longitude: W 80° 45' 59.04"

0 1000 2000

SCALE IN FEET

KEMRON ENVIRONMENTAL SERVICES

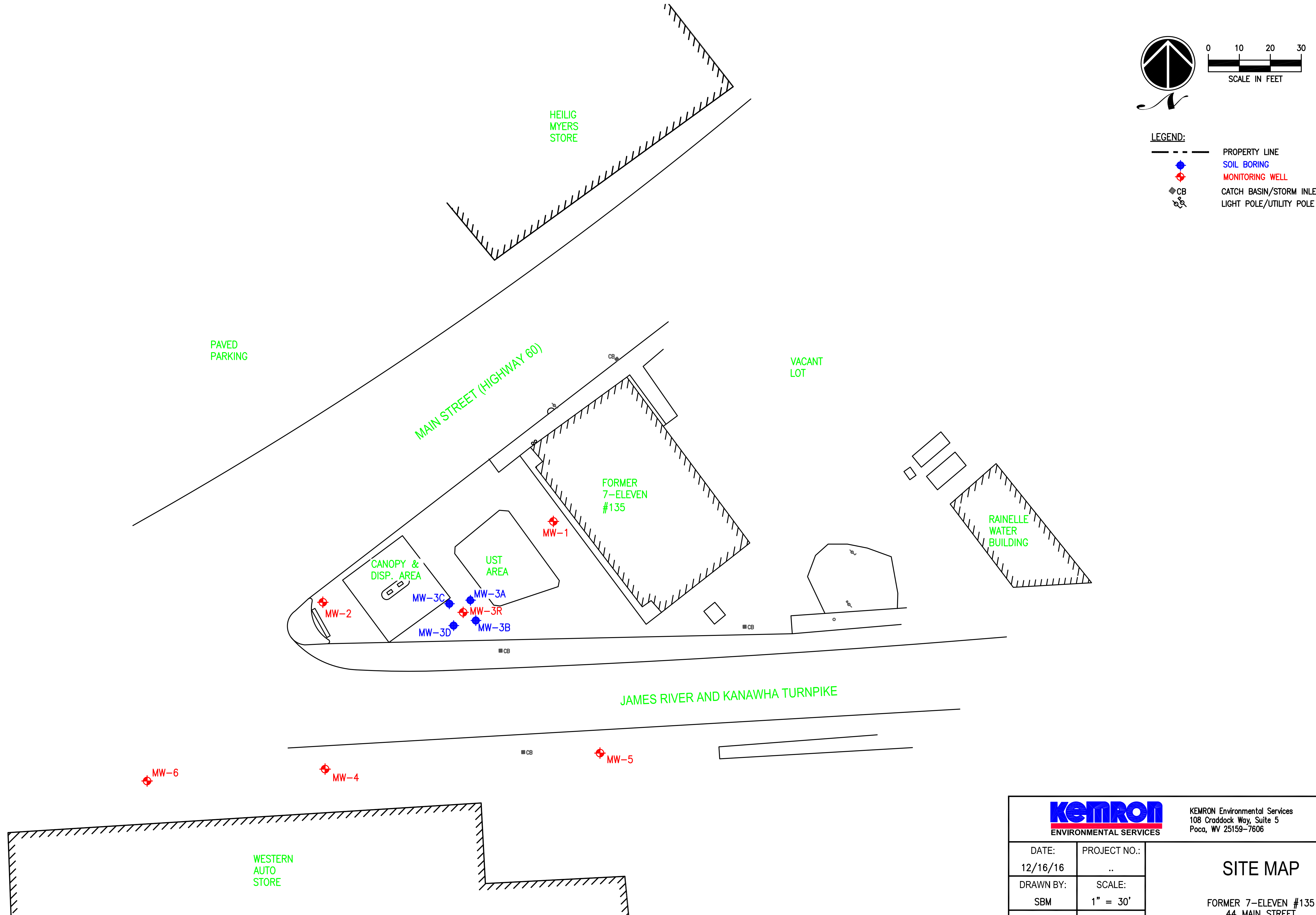
KEMRON Environmental Services
108 Craddock Way, Suite 5
Poca, WV 25159-7606

DATE:	PROJECT NO.:
12/16/16	..
DESIGNED:	SCALE:
SBM	1" = 2000'
CHECKED:	FIGURE NO.:
ADC	1

SITE LOCATION MAP

FORMER 7-ELEVEN #135
44 MAIN STREET
RAINELLE, GREENBRIER COUNTY, WEST VIRGINIA

Former7-Eleven 135-SLM.dwg 7/25/16



KEMRON ENVIRONMENTAL SERVICES

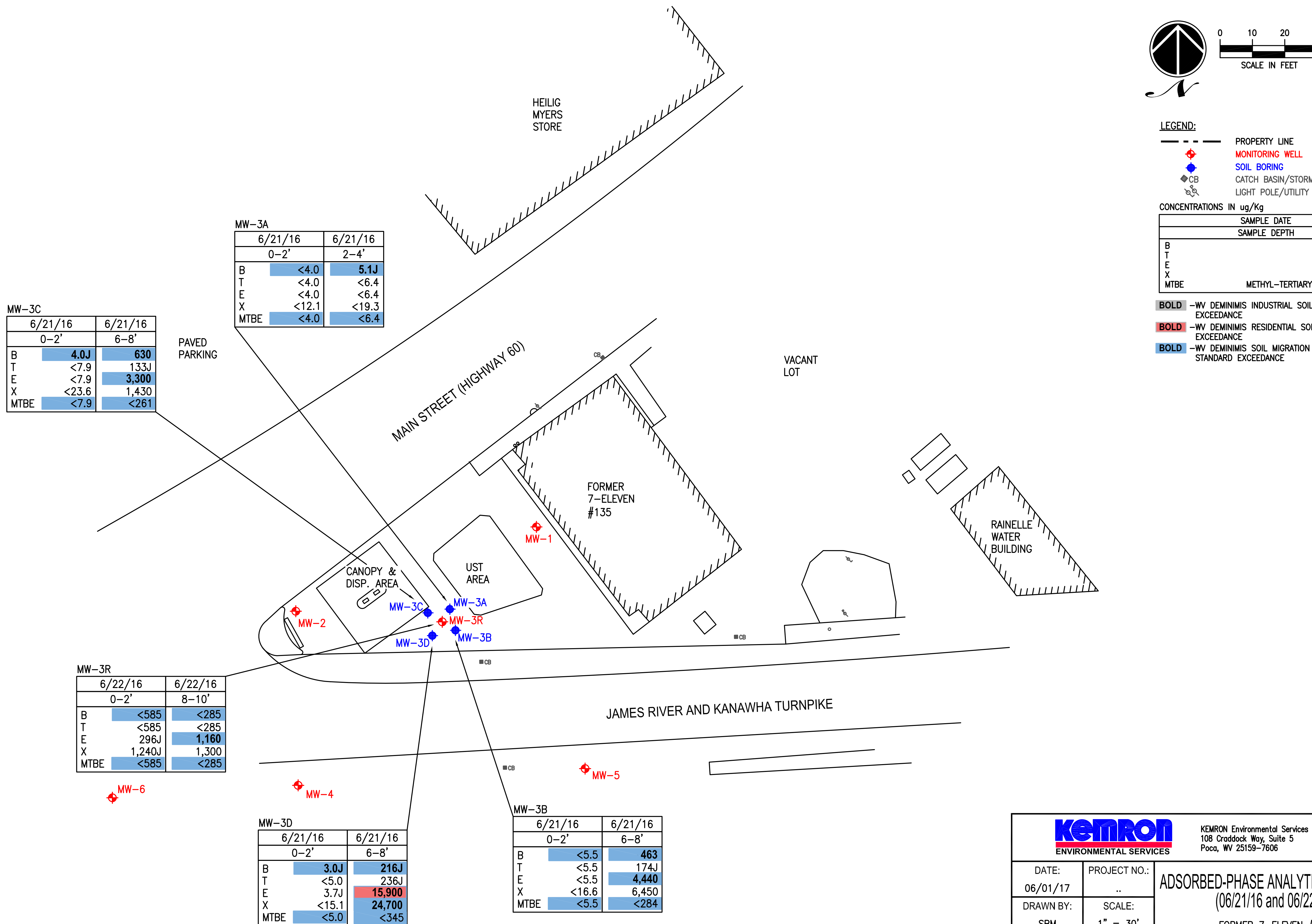
KEMRON Environmental Services
108 Craddock Way, Suite 5
Poca, WV 25159-7606

DATE:	PROJECT NO.:
12/16/16	..
DRAWN BY:	SCALE:
SBM	1" = 30'
CHECKED:	FIGURE NO.:
ADC	2

SITE MAP

FORMER 7-ELEVEN #135
44 MAIN STREET
RAINELLE, GREENBRIER COUNTY, WEST VIRGINIA

Former7-Eleven 135-01.dwg 7/25/16



MW-3A

	6/21/16	6/21/16
	0-2'	2-4'
B	<4.0	**5.1J**
T	<4.0	<6.4
E	<4.0	<6.4
X	<12.1	<19.3
MTBE	<4.0	<6.4

MW-3C

	6/21/16	6/21/16
	0-2'	6-8'
B	**4.0J**	**630**
T	<7.9	133J
E	<7.9	**3,300**
X	<23.6	1,430
MTBE	<7.9	<261

MW-3R

	6/22/16	6/22/16
	0-2'	8-10'
B	<585	<285
T	<585	<285
E	296J	**1,160**
X	1,240J	1,300
MTBE	<585	<285

MW-3D

	6/21/16	6/21/16
	0-2'	6-8'
B	**3.0J**	**216J**
T	<5.0	236J
E	3.7J	**15,900**
X	<15.1	**24,700**
MTBE	<5.0	<345

MW-3B

	6/21/16	6/21/16
	0-2'	6-8'
B	<5.5	**463**
T	<5.5	174J
E	<5.5	**4,440**
X	<16.6	6,450
MTBE	<5.5	<284

LEGEND:

- PROPERTY LINE
- MONITORING WELL
- SOIL BORING
- CB CATCH BASIN/STORM INLET
- LIGHT POLE/UTILITY POLE

CONCENTRATIONS IN ug/Kg

SAMPLE DATE	
SAMPLE DEPTH	
B	BENZENE
T	TOLUENE
E	ETHYLBENZENE
X	XYLENES
MTBE	METHYL-TERTIARY-BUTYL-ETHER

BOLD -WV DEMINIMIS INDUSTRIAL SOIL STANDARD EXCEEDANCE

BOLD -WV DEMINIMIS RESIDENTIAL SOIL STANDARD EXCEEDANCE

BOLD -WV DEMINIMIS SOIL MIGRATION TO GROUNDWATER STANDARD EXCEEDANCE

KEMRON ENVIRONMENTAL SERVICES

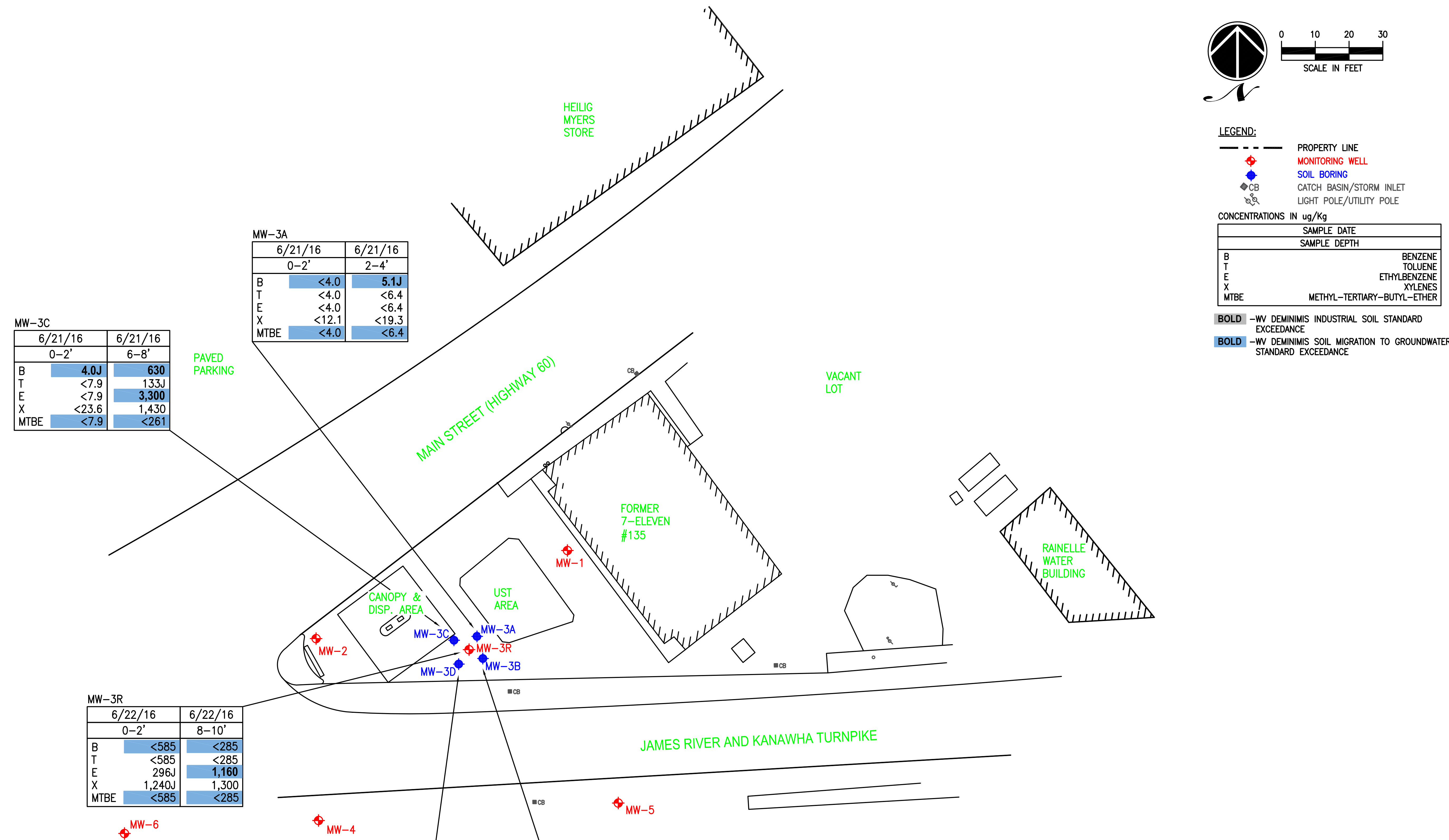
KEMRON Environmental Services
108 Craddock Way, Suite 5
Poca, WV 25159-7606

DATE:	PROJECT NO.:
06/01/17	..
DRAWN BY:	SCALE:
SBM	1" = 30'
CHECKED:	FIGURE NO.:
ADC	3

ADSORBED-PHASE ANALYTICAL RESULTS (06/21/16 and 06/22/16)

FORMER 7-ELEVEN #135
44 MAIN STREET
RAINELLE, GREENBRIER COUNTY, WEST VIRGINIA

Former7-Eleven 135-01.dwg
7/25/16



MW-3A

	6/21/16	6/21/16
	0–2'	2–4'
B	<4.0	**5.1J**
T	<4.0	<6.4
E	<4.0	<6.4
X	<12.1	<19.3
MTBE	<4.0	<6.4

MW-3C

	6/21/16	6/21/16
	0–2'	6–8'
B	**4.0J**	**630**
T	<7.9	133J
E	<7.9	**3,300**
X	<23.6	1,430
MTBE	<7.9	<261

MW-3R

	6/22/16	6/22/16
	0–2'	8–10'
B	<585	<285
T	<585	<285
E	296J	**1,160**
X	1,240J	1,300
MTBE	<585	<285

MW-3D

	6/21/16	6/21/16
	0–2'	6–8'
B	**3.0J**	**216J**
T	<5.0	236J
E	3.7J	**15,900**
X	<15.1	**24,700**
MTBE	<5.0	<345

MW-3B

	6/21/16	6/21/16
	0–2'	6–8'
B	<5.5	**463**
T	<5.5	174J
E	<5.5	**4,440**
X	<16.6	6,450
MTBE	<5.5	<284

KEMRON ENVIRONMENTAL SERVICES

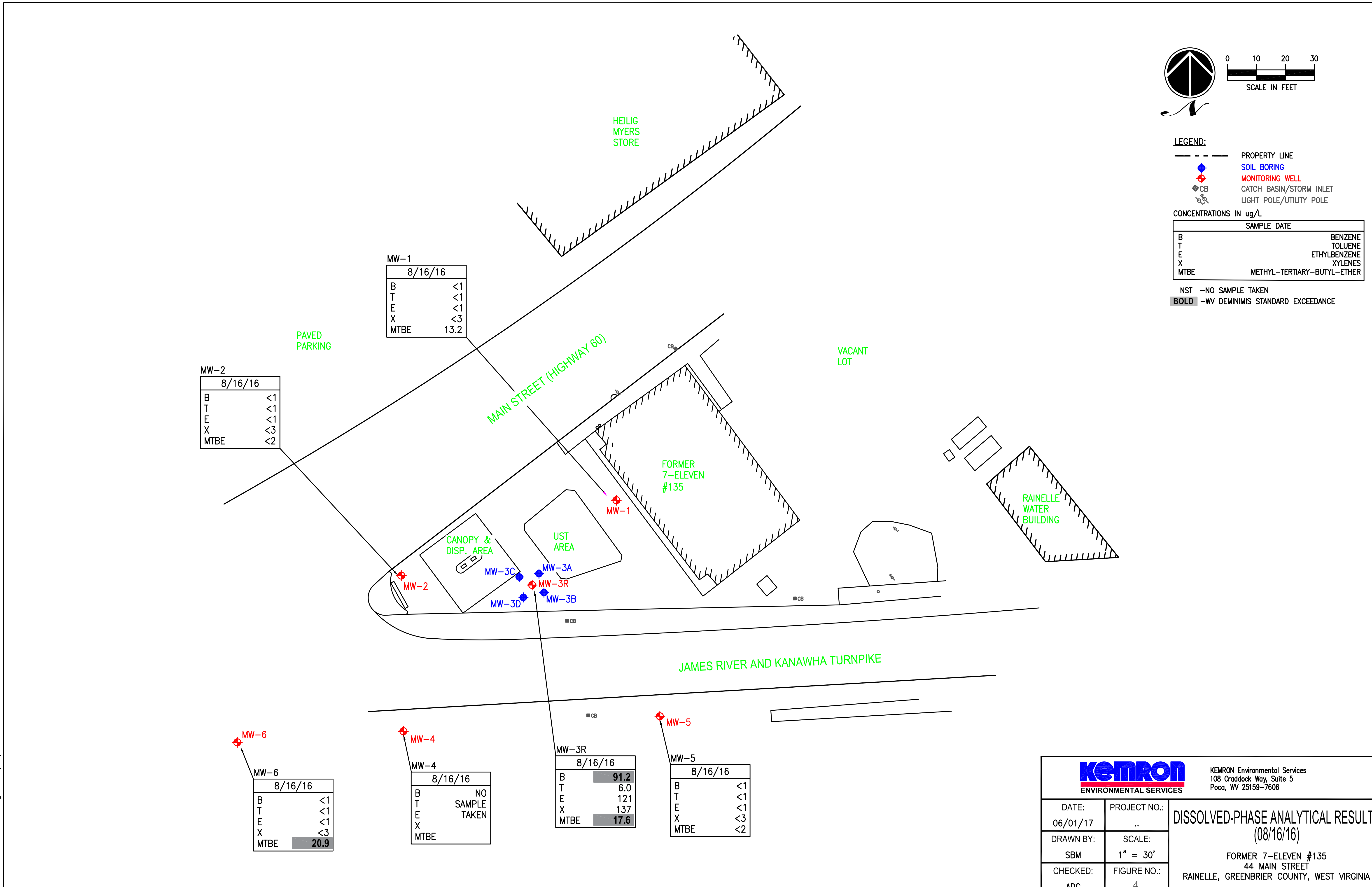
KEMRON Environmental Services
108 Craddock Way, Suite 5
Poca, WV 25159-7606

DATE:	PROJECT NO.:
06/01/17	..
DRAWN BY:	SCALE:
SBM	1" = 30'
CHECKED:	FIGURE NO.:
ADC	3

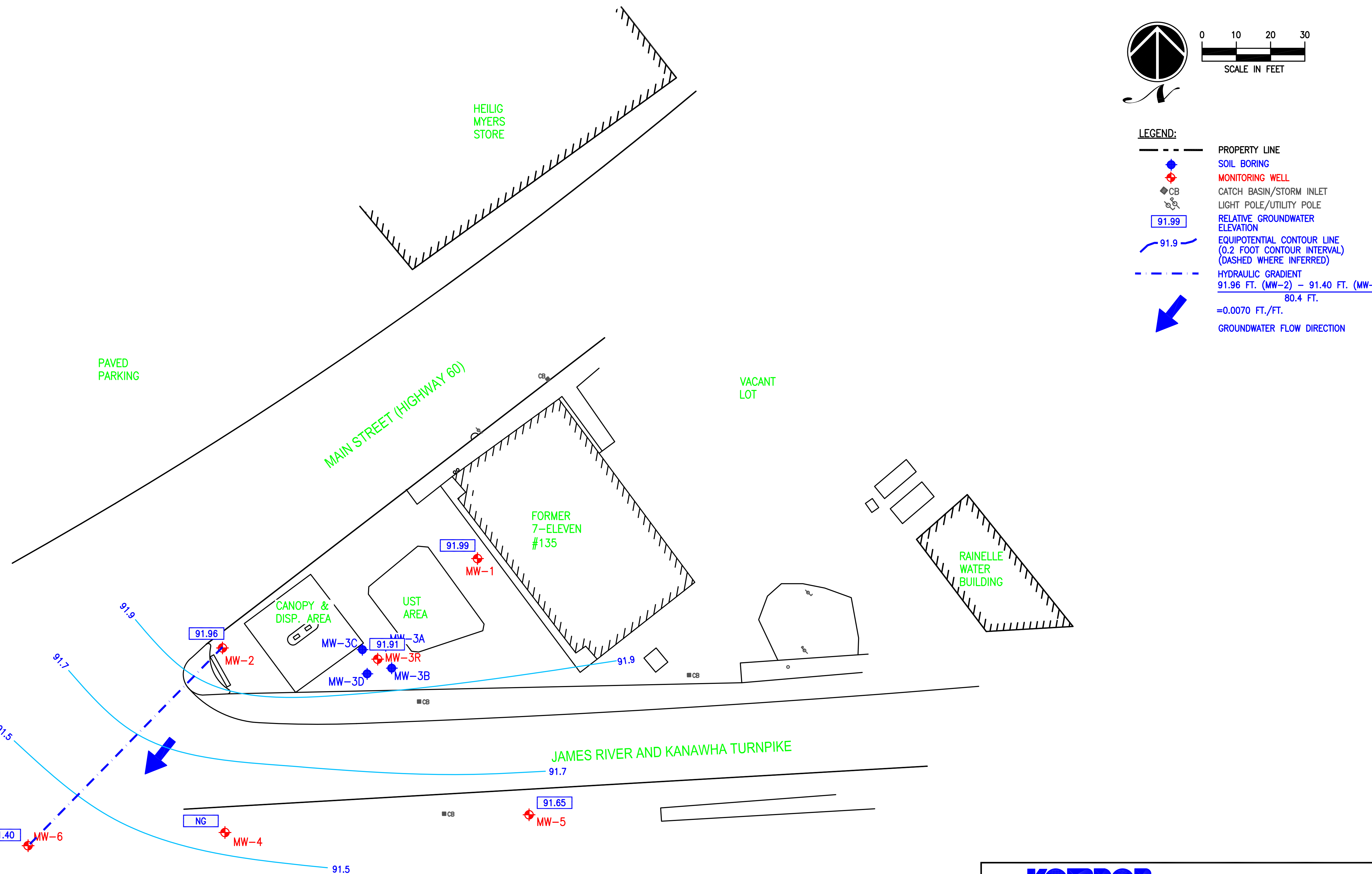
ADSORBED-PHASE ANALYTICAL RESULTS (06/21/16 and 06/22/16)

FORMER 7-ELEVEN #135
44 MAIN STREET
RAINELLE, GREENBRIER COUNTY, WEST VIRGINIA

Former7-Eleven 135-01.dwg 7/25/16



Former7-Eleven 135-01.dwg 7/25/16



KEMRON ENVIRONMENTAL SERVICES

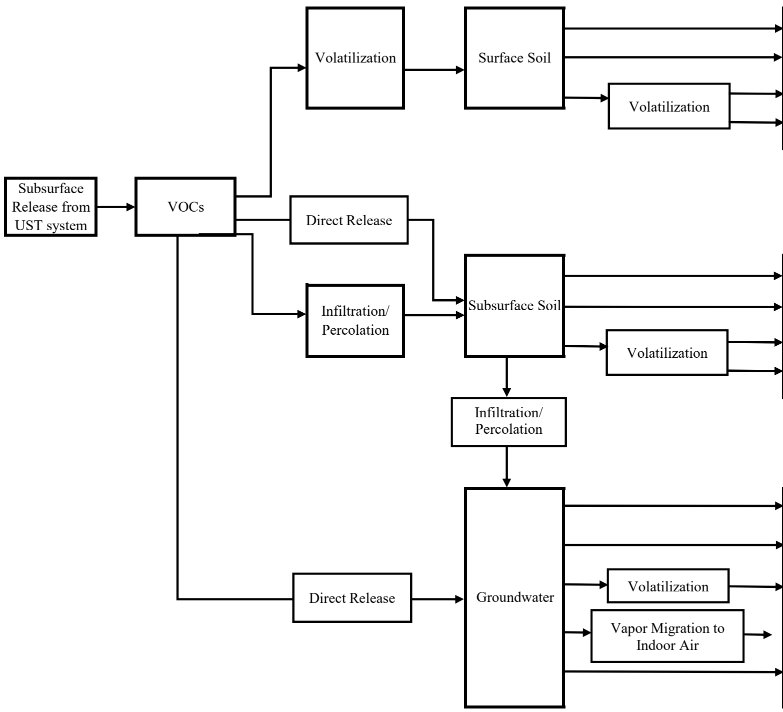
KEMRON Environmental Services
108 Craddock Way, Suite 5
Poca, WV 25159-7606

DATE:	PROJECT NO.:	GROUNDWATER POTENTIOMETRIC SURFACE (08/16/16)
12/16/16	..	
DRAWN BY:	SCALE:	FORMER 7-ELEVEN #135
SBM	1" = 30'	44 MAIN STREET
CHECKED:	FIGURE NO.:	RAINELLE, GREENBRIER COUNTY, WEST VIRGINIA
ADC	5	

Former7-Eleven 135-01.dwg 7/25/16

Figure 6
Conceptual Site Model For Potential Human Health Receptors
Risk Assessment Report
Former 7-Eleven Facility #135 - 44 Main Street
Rainelle, West Virginia

Primary Source	Migration Route Analysis: Constituents	Transport Mechanism to Media	Media	Transport Mechanism to Receptor



Exposure Pathway	Receptors: On-Site, Future, Maintenance Worker	On-Site, Current/ Future, Indoor Worker - Current Building	On-Site, Future, Indoor Worker - Future Building	On-Site, Future, Construction Worker	On-Site, Future, Utility Worker	Off-Site Northern James River and Kanawha Turnpike ROW, Future, Construction Worker	Off-Site Northern James River and Kanawha Turnpike ROW, Future, Utility Worker	Off-Site Southern James River and Kanawha Turnpike ROW, Future, Construction Worker	Off-Site Southern James River and Kanawha Turnpike ROW, Future, Utility Worker	Off-Site Western Auto Store, Current/ Future, Indoor Worker
Surface Soil:										
Incidental Ingestion	NR	---	---	NR	NR	NR	NR	NS	NS	---
Dermal Contact	NR	---	---	NR	NR	NR	NR	NS	NS	---
Inhalation of Volatiles (Outdoor/Trench Air)	NR	---	---	NR	NR	NR	NR	NS	NS	---
Inhalation of Volatiles (Indoor Air)	---	---	---	---	---	---	---	---	---	---
Subsurface Soil:										
Incidental Ingestion	---	---	---	NR	NR	NR	NR	NS	NS	---
Dermal Contact	---	---	---	NR	NR	NR	NR	NS	NS	---
Inhalation of Volatiles (Outdoor/Trench Air)	NR	---	---	NR	NR	NR	NR	NS	NS	---
Inhalation of Volatiles (Indoor Air)	---	---	---	---	---	---	---	---	---	---
Groundwater:										
Incidental Ingestion (Intrusive Activities)	---	---	---	NR	NR	NR	NR	NR	NR	---
Dermal Contact (Intrusive Activities)	---	---	---	**Quant**	**Quant**	**Qual** [1]	**Qual** [1]	**Qual** [1]	**Qual** [1]	---
Inhalation of Volatiles (Outdoor/Trench Air)	**Quant**	---	---	**Quant**	**Quant**	**Qual** [1]	**Qual** [1]	**Qual** [1]	**Qual** [1]	---
Inhalation of Volatiles (Indoor Air)	---	NR	**Qual**	---	---	---	---	---	---	NR
Ingestion, Dermal Contact, and Inhalation of Volatiles (Potable Use)	**Qual**	NR	**Qual**	---	---	---	---	---	---	NR

Notes:
Quant - exposure pathway is complete and was retained for quantitative risk analysis for that medium for the receptor.
Qual - exposure pathway was retained qualitatively for that medium for the receptor because the exposure pathway is potentially complete, however the pathway will be made incomplete through an engineering control and/or institutional control.
NR - indicates that the exposure pathway is not retained for that medium for the receptor.
NS - no samples
"---" - indicates that the exposure pathway is not applicable to the receptor.
[1] The quantitative risk analysis for the on-site construction/utility workers is a conservative analysis that would be protective of the off-site construction/utility workers in the James Rivera and Kanawha Turnpike northern and southern ROWs.

Attachment 1

Cumulative Groundwater Data

Attachment 1
Table 1
Dissolved-Phase Analytical Results
Risk Assessment Report
Former 7-Eleven Facility #135 - 44 Main Street
Rainelle, West Virginia

Well ID Number	Sample Date	Top of Casing Elevation (feet)	Groundwater Elevation (feet)	Groundwater Depth (feet)		Benzene (µg/L)		Toluene (µg/L)		Ethylbenzene (µg/L)		Total Xylene (µg/L)		MTBE (µg/L)		TPH (GRO) (µg/L)		TPH (DRO) (µg/L)
WEST VIRGINIA GROUNDWATER DE MINIMIS STANDARDS [1]						5		1,000		700		10,000		14		Nav		Nav
USEPA COMMERCIALVISL (ug/L) [2]						69.3		80,700		152.0		1,620		19,700		Nav		Nav
MW-1	08/16/16	97.81	91.99	5.82	<	1	<	1	<	1	<	3		13.2		NST		NST
	04/03/12	97.81	92.43	5.38	<	1	<	1	<	1	<	3	<	2	<	500	<	120
	01/17/12	97.81	91.99	5.82	<	1	<	1	<	1	<	3		0.9 J	<	500	<	110
	10/31/11	97.81	91.34	6.47	<	1	<	1	<	1	<	3	<	2	<	500	<	110
	08/18/11	97.81	90.19	7.62	<	1	<	1	<	1	<	3		**19.4**	<	500		3,050
	06/20/11	97.81	91.18	6.63	<	1	<	1	<	1	<	3	<	2	<	500	<	150
	03/28/11	97.81	92.60	5.21	<	1	<	1	<	1	<	3		13.7	<	500	<	130
	12/29/10	97.81	91.17	6.64	<	1	<	1	<	1	<	3		7.5	<	500	<	120
	09/13/10	97.81	90.64	7.17	<	1	<	1	<	1	<	3		13.4	<	500	<	110
	06/30/10	97.81	91.69	6.12	<	1	<	1	<	1	<	3		**16.6**	<	500		3,230
	02/02/10	97.81	92.70	5.11	<	1	<	1	<	1	<	3		13.6	<	500		300
	11/03/09	97.81	91.74	6.07	<	1	<	1	<	1	<	3		0.6	<	500	<	120
	08/18/09	97.81	92.10	5.71	<	1	<	1	<	1	<	3	<	2	<	500	<	100
	06/30/09	97.81	91.23	6.58	<	5	<	5	<	5	<	5		**22.3**	<	100	<	510
	03/09/09	97.81	91.08	6.73	<	5	<	5	<	5	<	5		11.0	<	100	<	515
	11/24/08	97.81	88.82	8.99	<	5	<	5	<	5	<	5		**26.0**	<	100	<	500
	08/20/08	97.81	90.29	7.52	<	5	<	5	<	5	<	5		**28.1**	<	100	<	532
	05/29/08	97.81	92.35	5.46	<	5	<	5	<	5	<	5		**72.4**	<	100	<	538
	03/03/08	97.81	92.36	5.45	<	5	<	5	<	5	<	5		**19.8**	<	100	<	532
	12/17/07	97.81	92.16	5.65	<	1	<	1	<	1	<	1		6.75	<	100	<	556
	08/20/07	97.81	91.01	6.80	<	1	<	1	<	1	<	1		**22.7**	<	100	<	521
	05/16/07	97.81	91.77	6.04	<	1	<	1	<	1	<	1		**71.8**	<	100	<	510
	02/22/07	97.81	91.45	6.36	<	1	<	1	<	1	<	1		**50.1**	<	100	<	510
	11/29/06	97.81	85.08	12.73	<	5	<	5	<	5	<	5		**419.0**	<	100		1,380
	08/15/06	97.81	91.45	6.36	<	1	<	1	<	1	<	1		**45.3**	<	100		578
	05/23/06	97.81	91.29	6.52	<	1	<	1	<	1	<	1		**1140.0**	<	100		619
	03/02/06	97.81	91.83	5.98	<	1	<	1	<	1	<	1		**116.0**	<	100		550
	11/10/05	97.81	90.85	6.96	<	1	<	1	<	1	<	1		6.20	<	100		687
	08/05/05	97.81	91.08	6.73	<	1	<	1	<	1	<	1		**62.2**	<	100	<	500
	05/17/05	97.81	92.45	5.36	<	1	<	1	<	1	<	1		**22.7**	<	100	<	500
	03/30/05	97.81	93.23	4.58	<	1	<	1	<	1	<	1		**17.4**	<	100	<	510
	12/08/04	97.81	91.84	5.97	<	1	<	1	<	1	<	1		12	<	100	<	510
	09/09/04	97.81	89.01	8.80	<	1	<	1	<	1	<	1		**17.7**	<	100		832
	06/07/04	97.81	91.77	6.04	<	1	<	1	<	1	<	1		13.3	<	100	<	1,050
	03/10/04	97.81	92.53	5.28	<	1	<	1	<	1	<	1		**42.8**	<	100	<	1,110
	12/02/03	97.81	92.89	4.92	<	1	<	1	<	1	<	1		**324.0**	<	100		1,140
	09/10/03	97.81	91.72	6.09	<	1	<	1	<	1	<	1		6.04	<	100		734
	06/10/03	97.81	92.36	5.45	<	1	<	1	<	1	<	1		2.1	<	100		646
	02/24/03	97.81	93.63	4.18	<	1	<	1	<	1	<	1		1.14	<	100		2,690
	12/09/02	97.81	92.41	5.40	<	1	<	1	<	1	<	1		1.65	<	100		1,150
	07/30/02	97.81	90.41	7.40	<	1	<	1	<	1	<	1		4.14	<	100		1,170
	05/13/02	97.81	92.22	5.59	<	1	<	1	<	1	<	1		1.4	<	100		1,490
	02/11/02	97.81	89.28	8.53	<	1	<	1	<	1	<	1		1.8	<	100		800
	11/13/01	97.81	86.64	11.17	<	1	<	1	<	1	<	1		8.7	<	100		870
	08/15/01	97.81	90.15	7.66	<	1	<	1	<	1	<	1		3.8	<	100		690
	06/15/01	97.81	91.39	6.42	<	1	<	1	<	1	<	1		2.7	<	100		1,400
	04/24/01	99.57	91.91	7.66	<	1	<	1	<	1	<	1		6.6	<	100		1,300
	04/23/96	99.57	93.18	6.39	<	5	<	5	<	5	<	5		NST	<	100	<	50
	02/14/95	99.57	91.68	7.89	<	0.2	<	0.2	<	0.2	<	0.2		NST	<	100	<	110
	11/09/94	99.57	88.83	10.74		NST		NST		NST		NST		NST		NST		NST
	07/06/94	99.57	NRT	NRT		NST		NST		NST		NST		NST		NST		NST
	03/25/94	99.57	93.27	6.3		<MQL		<MQL		<MQL		<MQL		NST		<MQL		<MQL
	01/03/94	99.57	NRT	NRT		NST		NST		NST		NST		NST		NST		NST

Attachment 1
Table 1
Dissolved-Phase Analytical Results
Risk Assessment Report
Former 7-Eleven Facility #135 - 44 Main Street
Rainelle, West Virginia

Well ID Number	Sample Date	Top of Casing Elevation (feet)	Groundwater Elevation (feet)	Groundwater Depth (feet)	Benzene (µg/L)	Toluene (µg/L)	Ethylbenzene (µg/L)	Total Xylene (µg/L)	MTBE (µg/L)	TPH (GRO) (µg/L)	TPH (DRO) (µg/L)
WEST VIRGINIA GROUNDWATER DE MINIMIS STANDARDS [1]					5	1,000	700	10,000	14	Nav	Nav
USEPA COMMERCIALVISL (ug/L) [2]					69.3	80,700	152.0	1,620	19,700	Nav	Nav
MW-2	08/16/16	97.61	91.96	5.65	< 1	< 1	< 1	< 3	< 2	NST	NST
	04/03/12	97.61	92.32	5.29	< 1	< 1	< 1	< 3	< 2	< <500	< 120
	01/17/12	97.61	92.03	5.58	< 1	< 1	< 1	< 3	< 2	< <500	< 110
	10/31/11	97.61	90.92	6.69	< 1	< 1	< 1	< 3	< 2	< <500	< 110
	08/18/11	97.61	90.54	7.07	< 1	< 1	< 1	< 3	< 2	< <500	< 130
	06/20/11	97.61	91.16	6.45	< 1	< 1	< 1	< 3	< 2	< <500	< 150
	03/28/11	97.61	92.58	5.03	< 1	< 1	< 1	< 3	< 2	< <500	< 130
	12/29/10	97.61	91.10	6.51	< 1	< 1	< 1	< 3	< 2	< <500	< 120
	09/13/10	97.61	90.57	7.04	< 1	< 1	< 1	< 3	< 2	< <500	< 120
	06/30/10	97.61	91.69	5.92	< 1	< 1	< 1	< 3	< 2	< <500	140
	02/02/10	97.61	92.73	4.88	< 1	< 1	< 1	< 3	< 2	< <500	< 120
	11/03/09	97.61	91.20	6.41	< 1	< 1	< 1	< 3	< 2	< <500	< 120
	08/18/09	97.61	91.88	5.73	< 1	< 1	< 1	< 3	< 2	< <500	< 100
	06/30/09	97.61	91.71	5.90	< 5	< 5	< 5	< 5	< 5	< 100	< 532
	03/09/09	97.61	91.01	6.60	< 5	< 5	< 5	< 5	< 5	< 100	< 521
	11/24/08	97.61	88.64	8.97	< 5	< 5	< 5	< 5	< 5	< 100	< 500
	08/20/08	97.61	90.47	7.14	< 5	< 5	< 5	< 5	< 5	< 100	< 510
	05/29/08	97.61	91.95	5.66	< 5	< 5	< 5	< 5	< 5	< 100	< 510
	03/03/08	97.61	92.15	5.46	< 5	< 5	< 5	< 5	< 5	< 100	< 510
	12/17/07	97.61	84.86	12.75	< 1	< 1	< 1	< 1	< 1	< 100	< 538
	08/20/07	97.61	90.73	6.88	< 1	< 1	< 1	< 1	< 5	< 100	< 526
	05/16/07	97.61	91.61	6.00	< 1	< 1	< 1	< 1	< 1	< 100	< 500
	02/22/07	97.61	91.34	6.27	1.54	< 1	< 1	< 1	< 1	< 100	< 500
	11/29/06	97.61	85.14	12.47	< 1	< 1	< 1	< 1	< 1	< 100	< 510
	08/15/06	97.61	91.25	6.36	< 1	< 1	< 1	1.51	< 1	< 100	< 515
	05/23/06	97.61	91.17	6.44	< 1	< 1	< 1	< 1	< 1	< 100	< 526
	03/02/06	97.61	92.41	5.20	< 1	< 1	< 1	< 1	< 1	< 100	< 510
	11/10/05	97.61	90.21	7.40	< 1	< 1	< 1	7.42	< 1	< 100	< 500
	08/05/05	97.61	90.86	6.75	< 1	< 1	< 1	< 1	< 1	200	< 518
	05/17/05	97.61	92.01	5.60	< 1	< 1	< 1	< 1	< 1	218	< 500
	03/30/05	97.61	92.99	4.62	1.50	< 1	< 1	< 1	< 1	188	< 510
	12/08/04	97.61	91.51	6.10	3.49	< 1	< 1	< 1	< 1	111	603
	09/09/04	97.61	87.81	9.80	1.32	< 1	< 1	< 1	< 1	< 100	506
	06/07/04	97.61	91.14	6.47	3.89	< 1	< 1	< 1	< 1	210	< 1,080
	03/10/04	97.61	92.01	5.60	**6.91**	< 1	< 1	< 1	< 1	207	< 1,040
	12/02/03	97.61	92.41	5.20	3.39	< 1	< 1	< 1	< 1	159	< 1,050
	09/10/03	97.61	91.32	6.29	4.44	< 1	< 1	4.84	< 1	110	< 500
	06/10/03	97.61	92.01	5.60	**6.64**	< 1	< 1	< <1	1	237	564
	02/24/03	97.61	93.01	4.60	**7.93**	< 1	< 1	1.98	< 1	175	783
	12/09/02	97.61	91.77	5.84	**19**	< 1	< 1	3.51	< 1	214	666
	07/30/02	97.61	89.35	8.26	**9.03**	< 1	< 1	< 1	< 1	< 100	655
	05/13/02	97.61	90.88	6.73	**131**	1.66	2.10	7.66	2.55	908	781
	02/11/02	97.24	88.38	8.86	**81**	1.9	2.2	14	3.8	380	680
	11/13/01	97.05	DRY	DRY	NST	NST	NST	NST	NST	NST	NST
	08/15/01	97.05	DRY	DRY	NST	NST	NST	NST	NST	NST	NST
	06/15/01	97.05	DRY	DRY	NST	NST	NST	NST	NST	NST	NST
	04/24/01	99.36	94.29	5.07	< 1	< 1	< 1	< 1	< 1	< 100	6,900
	04/23/96	99.36	92.99	6.37	**401**	40	187	385	NST	320	6,100
	02/14/95	99.36	91.18	8.18	**440**	173	26	282	NST	2,250	124
	11/09/94	99.36	88.67	10.69	**436**	14	160	468	NST	5,000	ND
	07/06/94	99.36	89.92	9.44	**498**	25	238	699	NST	5,500	7,000
	03/25/94	99.36	93.68	5.68	**918**	**2,191**	**1,085**	4185	NST	19,400	6,070
	01/03/94	99.36	NRT	NRT	**500**	41	300	684	NST	9,100	8,000
MW-3A	08/16/16	97.12	91.91	5.21	**91.2**	**6**	**121.0**	**137**	**17.6**	NST	NST

Attachment 1
Table 1
Dissolved-Phase Analytical Results
Risk Assessment Report
Former 7-Eleven Facility #135 - 44 Main Street
Rainelle, West Virginia

Well ID Number	Sample Date	Top of Casing Elevation (feet)	Groundwater Elevation (feet)	Groundwater Depth (feet)	Benzene (µg/L)	Toluene (µg/L)	Ethylbenzene (µg/L)	Total Xylene (µg/L)	MTBE (µg/L)	TPH (GRO) (µg/L)	TPH (DRO) (µg/L)
WEST VIRGINIA GROUNDWATER DE MINIMIS STANDARDS [1]					5	1,000	700	10,000	14	Nav	Nav
USEPA COMMERCIALVISL (ug/L) [2]					69.3	80,700	152.0	1,620	19,700	Nav	Nav
MW-3	04/03/12	97.24	92.50	4.74	**54.8**	4.8	17.0	38.1	**108**	2,070	< 120
	01/17/12	97.24	92.09	5.15	**80.2**	8.1	21.6	47.6	**134**	2,090	880
	10/31/11	97.24	91.39	5.85	**75.0**	8.4	22.8	38.0	**120**	2,190	1,010
	08/18/11	97.24	90.28	6.96	**107**	11.2	25.9	57.7	**194**	1,840	2,400
	06/20/11	97.24	91.21	6.03	**74.5**	6.5	35.1	40.8	**139**	2,590	670
	03/28/11	97.24	92.70	4.54	**44.4**	3.4	33.0	30.3	< 2	2,050	340
	12/29/10	97.24	NRT	NRT	NST	NST	NST	NST	NST	NST	NST
	09/13/10	97.24	90.72	6.52	**57.9**	6.3	47.3	66.2	**136**	2,140	360
	06/30/10	97.24	91.76	5.48	**30.3**	2.4	20.6	22.8	**118**	860	140
	02/02/10	97.24	92.82	4.42	**39.8**	7.4	67.2	58.4	**69.0**	1,970	560
	11/03/09	97.24	91.82	5.42	**48.1**	3.6	70.7	75.4	**158**	2,000	310
	08/18/09	97.24	92.21	5.03	**69.6**	17.0	77.8	82.8	**226**	9,900	1,730
	06/30/09	97.24	91.44	5.80	**145**	8.72	164	120	**200**	2,210	< 500
	03/09/09	97.24	91.19	6.05	**55.0**	< 5	70.6	35.1	**178**	1,110	< 500
	11/24/08	97.24	88.84	8.40	**11.1**	< 5	37.0	22.9	**77.6**	861	580
	08/20/08	97.24	90.29	6.95	**29.8**	< 12.5	72.8	32.5	**456**	1,480	1,170
	05/29/08	97.24	91.93	5.31	**24.1**	< 5	40.8	11.6	**342**	1,050	604
	03/03/08	97.24	92.09	5.15	**6.38**	< 5	18.4	< 5	**119**	723	< 521
	12/17/07	97.24	92.24	5.00	< 1	< 1	< 1	< 1	**50.6**	< 100	< 532
	08/20/07	97.24	90.76	6.48	**25.8**	< 5	44.3	8.87	**908**	992	< 526
	05/16/07	97.24	91.54	5.70	**12.5**	< 10	36.4	17	**1,230**	919	695
	02/22/07	97.24	91.22	6.02	**5.08**	1.85	< 1	< 1	**167**	328	884
	11/29/06	97.24	84.84	12.40	< 50	< 50	< 50	< 50	**2,320**	669	5,690
	08/15/06	97.24	91.36	5.88	**34.4**	8.48	15.5	< 1	**4,430**	1,350	1,440
	05/23/06	97.24	91.04	6.20	**57.7**	9.39	22.8	< 1	**5,540**	< <5,000	2,290
	03/02/06	97.24	91.95	5.29	**31**	9.51	36.2	9.08	**2,790**	1,250	1,350
	11/10/05	97.24	90.42	6.82	**130**	15.2	143	34.6	**2,310**	2,290	1,600
	08/05/05	97.24	90.87	6.37	**135**	19	130	22.7	**3,410**	1,620	1,320
	05/17/05	97.24	92.04	5.20	**123**	6.25	126	10.3	**2,230**	2,450	1,930
	03/30/05	97.24	92.95	4.29	**6.31**	< 5	< 5	< 5	**605**	375	< 532
	12/08/04	97.24	91.46	5.78	**220**	< 10	124	36.3	**1,600**	2,610	< 5,180
	09/09/04	97.24	88.18	9.06	**65.1**	< 50	50	< 50	**932**	2,720	3,320
	06/07/04	97.24	91.25	5.99	**277**	10.1	192	37.4	**953**	3,120	3,600
	03/10/04	97.24	92.07	5.17	**273**	18.8	278	83.5	**642**	3,770	3,100
	12/02/03	97.24	92.75	4.49	**68.5**	7.23	197	86	**229**	2,490	1,570
	09/10/03	97.24	91.35	5.89	**58.2**	< 10	< 10	< 10	**1,020**	1,370	3,380
	06/10/03	97.24	92.02	5.22	**209**	8.28	197	83	**274**	3,870	1,900
	02/24/03	97.24	93.11	4.13	**110**	7.48	142	90.2	**868**	2,390	2,830
	12/09/02	97.24	91.98	5.26	**222**	33.7	307	317	**403**	3,990	3,850
	07/30/02	97.24	89.53	7.71	**342**	105	222	136	**31.7**	5,270	4,760
	05/13/02	97.24	91.88	5.36	**347**	387	645	1510	< 100	10,800	5,300
	02/11/02	97.24	89.15	8.09	**230**	230	430	900	**43**	9,200	8,700
	11/13/01	97.24	86.66	10.58	**760**	180	**810**	1,900	14	15,000	5,400
	08/15/01	97.24	90.07	7.17	**510**	92	**940**	1,800	< 10	15,000	3,800
	06/15/01	97.24	91.25	5.99	**410**	77	**750**	1,600	**120**	11,000	5,200
	04/24/01	99.10	92.16	6.94	**540**	95	690	1,600	< 25	12,000	3,400
	04/23/96	99.10	93.08	6.02	**169**	106	181	867	NST	1,000	8,100
	02/14/95	99.10	91.55	7.55	**775**	**1,165**	**1,270**	6,595	NST	19,600	933
	11/09/94	99.10	87.81	11.29	**658**	751	518	3,290	NST	22,500	2340
	07/06/94	99.10	90.00	9.10	**876**	**1,150**	**1,310**	3,770	NST	15,000	25700
	03/25/94	99.10	92.85	6.25	**355**	65	221	652	NST	<MQL	<MQL
	01/03/94	99.10	NRT	NRT	**415**	**1,420**	**1,170**	3,470	NST	21,900	26,100

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Rainelle, West Virginia

Well ID Number	Sample Date	Top of Casing Elevation (feet)	Groundwater Elevation (feet)	Groundwater Depth (feet)		Benzene (µg/L)		Toluene (µg/L)		Ethylbenzene (µg/L)		Total Xylene (µg/L)		MTBE (µg/L)		TPH (GRO) (µg/L)		TPH (DRO) (µg/L)
WEST VIRGINIA GROUNDWATER DE MINIMIS STANDARDS [1]						5		1,000		700		10,000		14		Nav		Nav
USEPA COMMERCIALVISL (ug/L) [2]						69.3		80,700		152.0		1,620		19,700		Nav		Nav
MW-4	08/16/16	97.73	NG	NG		NST		NST		NST		NST		NST		NST		NST
	04/03/12	97.73	91.14	6.59	<	1	<	1	<	1	<	3		**29.0**		820	<	120
	01/17/12	97.73	91.11	6.62	<	1	<	1	<	1	<	3		**16.1**		470 J	<	120
	10/31/11	97.73	90.17	7.56	<	1		1.9	<	1	<	3		6.6	<	500	<	110
	08/18/11	97.73	89.17	8.56	<	1	<	1	<	1	<	3	<	2	<	500		1,230
	06/20/11	97.73	90.45	7.28	<	1	<	1	<	1	<	3		5.1		530	<	130
	03/28/11	97.73	91.83	5.9	<	1	<	1	<	1	<	3	<	2	<	500	<	120
	12/29/10	97.73	90.51	7.22	<	1	<	1	<	1	<	3	<	2		350 J		690
	09/13/10	97.73	90.05	7.68	<	1		4.2	<	1	<	3	<	2	<	500		1,140
	06/30/10	97.73	NG	NG	<	10.0	<	10.0	<	10.0	<	30.0	<	20.0	<	500		129
	02/02/10	97.73	91.84	5.89	<	1	<	1	<	1	<	3		8.0	<	500		210
	11/03/09	97.73	90.95	6.78	<	1		0.5		0.7	<	3	<	2	<	500	<	120
	08/18/09	97.73	91.55	6.18	<	1	<	1	<	1	<	3		1.1	<	500	<	100
	06/30/09	97.73	90.88	6.85	<	5	<	5	<	5	<	5		**14.1**		225	<	515
	03/09/09	97.73	90.30	7.43	<	5	<	5	<	5	<	5		**17.0**		185	<	521
	11/24/08	97.73	88.05	9.68	<	5	<	5	<	5	<	5	<	5	<	100	<	500
	08/20/08	97.73	89.50	8.23	<	5	<	5	<	5	<	5		**17.4**		197	<	510
	05/29/08	97.73	91.00	6.73	<	5	<	5	<	5	<	5		**31.3**		737	<	532
	03/03/08	97.73	90.76	6.97	<	5	<	5	<	5	<	5		**29.6**		574	<	556
	12/17/07	97.73	90.43	7.30	<	1	<	1	<	1		1.74		**26.8**		437	<	568
	08/20/07	97.73	90.17	7.56	<	1	<	1	<	1	<	1		6.47	<	100	<	556
	05/16/07	97.73	90.85	6.88	<	1	<	1	<	1	<	1		**25.6**		424	<	500
	02/22/07	97.73	90.67	7.06	<	1	<	1	<	1	<	1		**13.5**		243	<	500
	11/29/06	97.73	83.52	14.21	<	1	<	1	<	1	<	1		**13.7**		358	<	521
	08/15/06	97.73	90.70	7.03	<	1	<	1	<	1	<	1		**13.3**		343	<	526
	05/23/06	97.73	90.25	7.48	<	1	<	1	<	1	<	1		**15.8**		422	<	510
	03/02/06	97.73	90.90	6.83		1.41	<	1	<	1		5.10		**16.9**		519	<	500
	12/19/05	97.73	89.58	8.15	<	1		1.22	<	1	<	1		**14.1**		385	<	500
	08/05/05	97.73	89.62	8.11		**5.96**	<	1	<	1		3.78		**15.1**		520	<	521
	05/17/05	97.73	90.08	7.65		4.11	<	1	<	1		4.74		**21.3**		715	<	500
	03/30/05	97.73	91.40	6.33		1.98	<	1	<	1		3.18		**22.7**		757	<	515
	12/08/04	97.73	90.56	7.17	<	1	<	1	<	1	<	1		10.5		318	<	500
	09/09/04	97.73	87.72	10.01	<	1	<	1	<	1	<	1		2.86		115		629
	06/07/04	97.73	89.82	7.91	<	1	<	1	<	1	<	1		8.69		358	<	1,050
	03/10/04	97.73	90.70	7.03		2.24	<	1	<	1		1.31		**22.4**		840	<	1,080
	12/02/03	97.73	91.15	6.58		2.92	<	1	<	1		2.46		**22.1**		831	<	1,040
	09/10/03	97.73	90.37	7.36		1.24	<	1	<	1	<	1		**15.4**		601	<	562
	06/10/03	97.73	91.37	6.36		3.39	<	1	<	1	<	1		**15**		758	<	538
	02/24/03	97.73	92.13	5.60		**8.68**	<	1		1.2		4.15		**19.5**		419		508
	12/09/02	97.73	90.95	6.78		**8.69**	<	1	<	1		2.26		**19.3**		424		579
	07/30/02	97.73	88.30	9.43		**16.1**	<	1	<	1		4.17		**20.5**		500		539
	05/13/02	97.73	90.06	7.67		**14.1**	<	1	<	1		1.92		**21.3**		506		715
	02/11/02	97.73	86.15	11.58		4.2	<	1	<	1		4.2		**19**		400	<	540
	11/13/01	97.73	85.39	12.34		1.6	<	1	<	1	<	1		**19**		380	<	500
	08/15/01	97.73	89.31	8.42	<	1	<	1	<	1	<	1	<	1	<	100	<	530

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Well ID Number	Sample Date	Top of Casing Elevation (feet)	Groundwater Elevation (feet)	Groundwater Depth (feet)	Benzene (µg/L)	Toluene (µg/L)	Ethylbenzene (µg/L)	Total Xylene (µg/L)	MTBE (µg/L)	TPH (GRO) (µg/L)	TPH (DRO) (µg/L)
WEST VIRGINIA GROUNDWATER DE MINIMIS STANDARDS [1]					**5**	**1,000**	**700**	**10,000**	**14**	**Nav**	**Nav**
USEPA COMMERCIALVISL (ug/L) [2]					**69.3**	**80,700**	**152.0**	**1,620**	**19,700**	**Nav**	**Nav**
MW-5	08/16/16	96.85	91.65	5.20	< 1	< 1	< 1	< 3	< 2	NST	NST
	04/03/12	96.85	92.09	4.76	< 1	< 1	< 1	< 3	< 2	< 500	< 120
	01/17/12	96.85	91.75	5.1	< 1	< 1	< 1	< 3	< 2	< 500	1,140
	10/31/11	96.85	88.44	8.41	< 1	< 1	< 1	< 3	< 2	< 500	110
	08/18/11	96.85	90.10	6.75	< 1	< 1	< 1	< 3	< 2	< 500	2,870
	06/20/11	96.85	90.86	5.99	< 1	< 1	< 1	< 3	< 2	< 500	1,730
	03/28/11	96.85	92.33	4.52	< 1	< 1	< 1	< 3	0.5 J	< 500	< 130
	12/29/10	96.85	90.87	5.98	< 1	< 1	< 1	< 3	< 2	< 500	< 120
	09/13/10	96.85	90.35	6.50	< 1	< 1	< 1	< 3	< 2	< 500	2,120
	06/30/10	96.85	91.44	5.41	< 1	< 1	< 1	< 3	< 2	< 500	2,400
	02/02/10	96.85	92.46	4.39	< 1	< 1	< 1	< 3	< 2	< 500	440
	11/03/09	96.85	91.43	5.42	< 1	< 1	< 1	< 3	0.8	< 500	< 120
	08/18/09	96.85	91.88	4.97	< 1	< 1	< 1	< 3	12	< 500	280
	06/30/09	96.85	90.95	5.90	< 5	< 5	< 5	< 5	< 5	< 100	< 532
	03/09/09	96.85	90.76	6.09	< 5	< 5	< 5	< 5	< 5	< 100	637
	11/24/08	96.85	88.42	8.43	< 5	< 5	< 5	< 5	< 5	< 100	< 549
	08/20/08	96.85	89.93	6.92	< 5	< 5	< 5	< 5	< 5	< 100	< 543
	05/29/08	96.85	91.80	5.05	< 5	< 5	< 5	< 5	< 5	< 100	< 510
	03/03/08	96.85	92.00	4.85	< 5	< 5	< 5	< 5	< 5	< 100	< 510
	12/17/07	96.85	91.15	5.70	< 1	< 1	< 1	< 1	11.0	< 100	< 538
	08/20/07	96.85	90.63	6.22	< 1	< 1	< 1	< 1	10.6	< 100	< 532
	05/16/07	96.85	91.50	5.35	< 1	< 1	< 1	< 1	**25.1**	< 100	< 510
	02/22/07	96.85	91.26	5.59	< 1	< 1	< 1	< 1	**73.5**	< 100	< 500
	11/29/06	96.85	84.66	12.19	< 1	< 1	< 1	< 1	2.32	< 100	729
	08/15/06	96.85	91.29	5.56	< 1	< 1	< 1	< 1	6.34	< 100	1,320
	05/23/06	96.85	90.96	5.89	< 1	< 1	< 1	< 1	**14.3**	< 100	981
	03/02/06	96.85	91.81	5.04	< 1	< 1	< 1	< 1	**23.3**	< 100	649
	11/10/05	96.85	90.20	6.65	< 1	< 1	< 1	< 1	**286**	< 100	578
	08/05/05	96.85	90.62	6.23	< 1	< 1	< 1	< 1	**56.9**	< 100	< 500
	05/17/05	96.85	91.89	4.96	< 1	< 1	< 1	< 1	**19.4**	117	< 500
	03/30/05	96.85	92.61	4.24	< 5	< 5	< 5	< 5	**292**	< 100	< 510
	12/08/04	96.85	91.38	5.47	< 1	< 1	< 1	< 1	2	< 100	767
	09/09/04	96.85	88.42	8.43	< 1	< 1	< 1	< 1	< 1	< 100	1,060
	06/07/04	96.85	91.17	5.68	< 1	< 1	< 1	< 1	2.48	< 100	< 1,050
	03/10/04	96.85	89.90	6.95	< 1	< 1	< 1	< 1	< 1	< 100	1,230
	12/02/03	96.85	92.52	4.33	< 1	< 1	< 1	< 1	7.63	< 100	< 1,040
	09/10/03	96.85	91.27	5.58	< 1	< 1	< 1	< 1	< 1	< 100	663
	06/10/03	96.85	92.07	4.78	< 1	< 1	< 1	< 1	< 1	< 100	658
	02/24/03	96.85	93.03	3.82	< 1	< 1	< 1	< 1	2.27	< 100	< 510
	12/09/02	96.85	91.97	4.88	< 1	< 1	< 1	< 1	< 1	< 100	< 500
	07/30/02	96.85	89.68	7.17	< 1	< 1	< 1	< 1	< 1	< 100	777
	05/13/02	96.85	91.60	5.25	< 1	< 1	< 1	< 1	< 1	< 100	2,140
	02/11/02	96.85	88.51	8.34	< 1	< 1	< 1	< 1	< 1	< 100	< 540
	11/13/01	96.85	86.34	10.51	< 1	< 1	< 1	< 1	1.4	< 100	680
	08/15/01	96.85	89.72	7.13	< 1	< 1	< 1	< 1	1.1	< 100	600

Attachment 1
Table 1
Dissolved-Phase Analytical Results
Risk Assessment Report
Former 7-Eleven Facility #135 - 44 Main Street
Rainelle, West Virginia

Well ID Number	Sample Date	Top of Casing Elevation (feet)	Groundwater Elevation (feet)	Groundwater Depth (feet)	Benzene (µg/L)		Toluene (µg/L)		Ethylbenzene (µg/L)		Total Xylene (µg/L)		MTBE (µg/L)		TPH (GRO) (µg/L)		TPH (DRO) (µg/L)	
WEST VIRGINIA GROUNDWATER DE MINIMIS STANDARDS [1]					5		1,000		700		10,000		14		Nav		Nav	
USEPA COMMERCIALVISL (ug/L) [2]					69.3		80,700		152.0		1,620		19,700		Nav		Nav	
MW-6	08/16/16	98.01	91.40	6.61	<	1	<	1	<	1	<	3		**20.9**		NST		NST
	04/03/12	98.01	90.81	7.20	<	1	<	1	<	1	<	3		**22.6**	<	500	<	120
	01/17/12	98.01	90.92	7.09	<	1	<	1	<	1	<	3		**18.6**	<	500	<	110
	10/31/11	98.01	92.14	5.87	<	1	<	1	<	1	<	3		**20.4**	<	500	<	110
	08/18/11	98.01	88.51	9.5	<	1	<	1	<	1	<	3	<	2	<	500	<	140
	06/20/11	98.01	90.21	7.8	<	1	<	1	<	1	<	3		**24.7**		400 J	<	140
	03/28/11	98.01	92.09	5.92	<	1	<	1	<	1	<	3	<	2	<	500	<	130
	12/29/10	98.01	90.12	7.89	<	1	<	1	<	1	<	3		**23.6**	<	500	<	120
	09/13/10	98.01	89.34	8.67	<	1	<	1	<	1	<	3		**52.0**	<	500	<	130
	06/30/10	98.01	90.84	7.17	<	1	<	1	<	1	<	3		**64.1**	<	500	<	130
	02/02/10	98.01	91.96	6.05	<	1	<	1	<	1	<	3		**44.6**	<	500		190
	11/03/09	98.01	90.67	7.34	<	1	<	1	<	1	<	3	<	2	<	500	<	120
	08/18/09	98.01	91.42	6.59	<	1	<	1	<	1	<	3		14		640	<	110
	06/30/09	98.01	90.26	7.75	<	5	<	5	<	5	<	5		**20.6**	<	100	<	521
	03/09/09	98.01	89.42	8.59	<	5	<	5	<	5	<	5		8.98	<	100	<	510
	11/24/08	98.01	86.82	11.19	<	5	<	5	<	5	<	5		**19.4**	<	100	<	510
	08/20/08	98.01	88.63	9.38	<	5	<	5	<	5	<	5		**67.9**	<	100	<	500
	05/29/08	98.01	91.03	6.98	<	5	<	5	<	5	<	5		**85.4**		152	<	510
	03/03/08	98.01	90.74	7.27	<	5	<	5	<	5	<	5		**25.5**		137	<	510
	12/17/07	98.01	90.81	7.20	<	1	<	1	<	1	<	1		7.80	<	100	<	541
	08/20/07	98.01	89.36	8.65	<	1	<	1	<	1	<	1		**18.3**	<	100	<	524
	05/16/07	98.01	90.44	7.57	<	1	<	1	<	1	<	1		9.12	<	100	<	500
	02/22/07	98.01	90.05	7.96	<	1	<	1	<	1	<	1		1.69	<	100	<	500
	11/29/06	98.01	83.50	14.51	<	1	<	1	<	1	<	1		7.1	<	100	<	510
	08/15/06	98.01	90.09	7.92	<	1	<	1	<	1	<	1		**48.4**		151	<	510
	05/23/06	98.01	89.88	8.13	<	1	<	1	<	1	<	1		**18.3**		159	<	510
	03/02/06	98.01	90.30	7.71	<	1	<	1	<	1	<	1		10.3	<	100	<	500
	11/10/05	98.01	88.15	9.86	<	1	<	1	<	1	<	1		5.72	<	100	<	505
	08/05/05	98.01	88.96	9.05	<	1	<	1	<	1	<	1		11		113	<	500
	05/17/05	98.01	89.74	8.27	<	1	<	1	<	1	<	1		**242**	<	100	<	510
	03/30/05	98.01	90.84	7.17	<	1	<	1	<	1	<	1		33		140	<	510
	12/08/04	98.01	89.70	8.31	<	1	<	1	<	1	<	1		**18.4**		127	<	515
	09/09/04	98.01	87.77	10.24	<	1	<	1	<	1	<	1		5.46	<	100	<	500
	06/07/04	98.01	89.61	8.40	<	1	<	1	<	1	<	1		8.66		105	<	1,000
	03/10/04	98.01	93.24	4.77	<	1	<	1	<	1	<	1		11.1		156	<	1,000
	12/02/03	98.01	91.18	6.83	<	1	<	1	<	1	<	1		7.37		138	<	1,050
	09/10/03	98.01	89.86	8.15	<	1	<	1	<	1	<	1		8.27		152	<	568
	06/10/03	98.01	90.56	7.45	<	1	<	1	<	1	<	1		5.24		127	<	529
	02/24/03	98.01	91.93	6.08	<	1	<	1	<	1	<	1		1.64	<	100	<	500
	12/09/02	98.01	89.42	8.59	<	1	<	1	<	1	<	1	<	1	<	100	<	500
	07/30/02	98.01	88.59	9.42	<	1	<	1	<	1	<	1	<	1	<	100	<	500
	05/13/02	98.01	89.47	8.54	<	1	<	1	<	1	<	1	<	1	<	100	<	500
	02/11/02	98.01	85.46	12.55	<	1	<	1	<	1	<	1	<	1	<	100	<	550
	11/13/01	98.01	85.31	12.70	<	1	<	1	<	1	<	1	<	1	<	100	<	520
	08/15/01	98.01	90.88	7.13	<	1	<	1	<	1	<	1		1.1	<	100		600

Notes:
ug/L - micrograms per liter
[1] Indicates the applicable West Virginia Department of Environmental Protection (WVDEP) DeMinimis screening level for groundwater based on Table 60-3B, June 2017.
[2] Indicates the applicable United States Environmental Protection Agency (USEPA) commercial vapor intrusion screening level (VISL) target groundwater concentrations based on a target risk of $1.0x10^{-5}$ and HQ of 1.0, based on November 2019 RSLs.
NST - no sample taken
NRT - no reading taken
NA - not analyzed
<MQL - not detected at the minimum detected limit
J - analyte detected below the laboratory quantitation limit

Attachment 2

USEPA VISL Calculator

Default VISL Results
Commercial Equation Inputs

Output generated 20MAR2020:13:30:37

Variable	Value
Exposure Scenario	Commercial
Temperature for Groundwater Vapor Concentration C	25
THQ (target hazard quotient) unitless	1
TR (target risk) unitless	1E-05
AT_w (averaging time - composite worker)	365
EF_w (exposure frequency - composite worker) day/yr	250
ED_w (exposure duration - composite worker) yr	25
ET_w (exposure time - composite worker) hr	8
LT (lifetime) yr	70
AF_{gw} (Attenuation Factor Groundwater) unitless	0.001
AF_{ss} (Attenuation Factor Sub-Slab) unitless	0.03

Commercial Vapor Intrusion Screening Levels (VISL)

Key: I = IRIS; P = PPRTV; O = OPP; A = ATSDR; C = Cal EPA; X = PPRTV Screening Level; H = HEAST; D = DWSHA; W = TEF applied; E = RPF applied; U = user provided; G = see RSL User's Guide Section 5; CA = cancer; NC = noncancer.

Chemical	CAS Number	Does the chemical meet the definition for volatility? (HLC>1E-5 or VP>1)	Does the chemical have inhalation toxicity data? (IUR and/or RfC)	Is Chemical Sufficiently Volatile and Toxic to Pose Inhalation Risk Via Vapor Intrusion from Soil Source? ($C_{vp} > C_{i,a}$,Target?)	Is Chemical Sufficiently Volatile and Toxic to Pose Inhalation Risk Via Vapor Intrusion from Groundwater Source? ($C_{hc} > C_{i,a}$,Target?)	Target Indoor Air Concentration (TCR=1E-05 or THQ=1) MIN($C_{ia,c}$,$C_{ia,nc}$) (µg/m³)	Toxicity Basis	Target Sub-Slab and Near-source Soil Gas Concentration (TCR=1E-05 or THQ=1) C_{sg},Target (µg/m³)	Target Groundwater Concentration (TCR=1E-05 or THQ=1) C_{gw},Target (µg/L)	Is Target Groundwater Concentration < MCL? (C_{gw} < MCL?)
Benzene	71-43-2	Yes	Yes	Yes	Yes	1.57E+01	CA	5.24E+02	6.93E+01	No (5)
Ethylbenzene	100-41-4	Yes	Yes	Yes	Yes	4.91E+01	CA	1.64E+03	1.52E+02	Yes (700)
Methyl tert-Butyl Ether (MTBE)	1634-04-4	Yes	Yes	Yes	Yes	4.72E+02	CA	1.57E+04	1.97E+04	--
Toluene	108-88-3	Yes	Yes	Yes	Yes	2.19E+04	NC	7.30E+05	8.07E+04	No (1000)
Xylenes	1330-20-7	Yes	Yes	Yes	Yes	4.38E+02	NC	1.46E+04	1.62E+03	Yes (10000)

Chemical	Pure Phase Vapor Concentration C_{vp}\ (25 ℃)\ (µg/m³)	Maximum Groundwater Vapor Concentration C_{hc}\ (µg/m³)	Temperature for Maximum Groundwater Vapor Concentration (℃)	Lower Explosive Limit LEL (% by volume)	LEL Ref	IUR $(ug/m^3)^{-1}$	IUR Ref	RfC (mg/m³)	RfC Ref	Mutagenic Indicator	Carcinogenic VISL TCR=1E-05 $C_{ia,c}$ (µg/m³)	Noncarcinogenic VISL THQ=1 $C_{ia,nc}$ (µg/m³)
Benzene	3.98E+08	4.06E+08	25	1.20	CRC89	7.80E-06	I	3.00E-02	I	No	1.57E+01	1.31E+02
Ethylbenzene	5.48E+07	5.44E+07	25	0.80	CRC89	2.50E-06	C	1.00E+00	I	No	4.91E+01	4.38E+03
Methyl tert-Butyl Ether (MTBE)	1.19E+09	1.22E+09	25	2.00	YAWS	2.60E-07	C	3.00E+00	I	No	4.72E+02	1.31E+04
Toluene	1.41E+08	1.43E+08	25	1.10	CRC89	-		5.00E+00	I	No	-	2.19E+04
Xylenes	4.56E+07	2.87E+07	25	-		-		1.00E-01	I	No	-	4.38E+02

Chemical Properties
Output generated 20MAR2020:13:30:37

Chemical	CAS Number	Does the chemical meet the definition for volatility? (HLC>1E-5 or VP>1)	Does the chemical have inhalation toxicity data? (IUR and/or RfC)	MW	MW Ref	Vapor Pressure VP (mm Hg)	VP Ref	S (mg/L)	S Ref	MCL (ug/L)	HLC (atm-m^3/mole)
Benzene	71-43-2	Yes	Yes	78.115	PHYSPROP	9.48E+01	PHYSPROP	1.79E+03	PHYSPROP	5	5.55E-03
Ethylbenzene	100-41-4	Yes	Yes	106.17	PHYSPROP	9.60E+00	PHYSPROP	1.69E+02	PHYSPROP	700	7.88E-03
Methyl tert-Butyl Ether (MTBE)	1634-04-4	Yes	Yes	88.151	PHYSPROP	2.50E+02	PHYSPROP	5.10E+04	PHYSPROP	-	5.87E-04
Toluene	108-88-3	Yes	Yes	92.142	PHYSPROP	2.84E+01	PHYSPROP	5.26E+02	PHYSPROP	1000	6.64E-03
Xylenes	1330-20-7	Yes	Yes	106.17	PHYSPROP	7.99E+00	PHYSPROP	1.06E+02	PHYSPROP	10000	6.63E-03

Chemical	Henry's Law Constant (unitless)	H` and HLC Ref	Henry's Law Constant Used in Calcs (unitless)	Normal Boiling Point BP (K)	BP Ref	Critical Temperature TC (K)	TC Ref	Enthalpy of vaporization at the normal boiling point $\Delta H_{v,b}$\ (cal/mol)	$\Delta H_{v,b}$\ Ref	Lower Explosive Limit LEL (% by volume)	LEL Ref
Benzene	2.27E-01	PHYSPROP	2.27E-01	353.15	PHYSPROP	5.62E+02	CRC89	7.34E+03	CRC89	1.2	CRC89
Ethylbenzene	3.22E-01	PHYSPROP	3.22E-01	409.25	PHYSPROP	6.17E+02	CRC89	8.50E+03	CRC89	0.8	CRC89
Methyl tert-Butyl Ether (MTBE)	2.40E-02	PHYSPROP	2.40E-02	328.15	PHYSPROP	4.97E+02	CRC89	6.68E+03	CRC89	2	YAWS
Toluene	2.71E-01	PHYSPROP	2.71E-01	383.75	PHYSPROP	5.92E+02	CRC89	7.93E+03	Weast	1.1	CRC89
Xylenes	2.71E-01	PHYSPROP	2.71E-01	411.65	PHYSPROP	6.20E+02	YAWS	8.52E+03	Weast	-	

Default VISL Results
Resident Equation Inputs

Output generated 20MAR2020:13:29:48

Variable	Value
Exposure Scenario	Resident
Temperature for Groundwater Vapor Concentration C	25
ED_{res} (exposure duration) years	26
TR (target risk) unitless	1E-06
THQ (target hazard quotient) unitless	1
LT (lifetime) years	70
EF_{res} (exposure frequency) days/year	350
ED_{0-2} (mutagenic exposure duration first phase) years	2
ED_{2-6} (mutagenic exposure duration second phase) years	4
ED_{6-16} (mutagenic exposure duration third phase) years	10
ED_{16-26} (mutagenic exposure duration fourth phase) years	10
EF_{0-2} (mutagenic exposure frequency first phase) days/year	350
EF_{2-6} (mutagenic exposure frequency second phase) days/year	350
EF_{6-16} (mutagenic exposure frequency third phase) days/year	350
EF_{16-26} (mutagenic exposure frequency fourth phase) days/year	350
ET_{res} (exposure time) hours/day	24
ET_{0-2} (mutagenic exposure time first phase) hours/day	24
ET_{2-6} (mutagenic exposure time second phase) hours/day	24
ET_{6-16} (mutagenic exposure time third phase) hours/day	24
ET_{16-26} (mutagenic exposure time fourth phase) hours/day	24
AF_{gw} (Attenuation Factor Groundwater) unitless	0.001
AF_{ss} (Attenuation Factor Sub-Slab) unitless	0.03

Resident Vapor Intrusion Screening Levels (VISL)

Key: I = IRIS; P = PPRTV; O = OPP; A = ATSDR; C = Cal EPA; X = PPRTV Screening Level; H = HEAST; D = DWSHA; W = TEF applied; E = RPF applied; U = user provided; G = see RSL User's Guide Section 5; CA = cancer; NC = noncancer.

Chemical	CAS Number	Does the chemical meet the definition for volatility? (HLC>1E-5 or VP>1)	Does the chemical have inhalation toxicity data? (IUR and/or RfC)	Is Chemical Sufficiently Volatile and Toxic to Pose Inhalation Risk Via Vapor Intrusion from Soil Source? (C_{vp} > $C_{i,a}$,Target?)	Is Chemical Sufficiently Volatile and Toxic to Pose Inhalation Risk Via Vapor Intrusion from Groundwater Source? (C_{hc} > $C_{i,a}$,Target?)	Target Indoor Air Concentration (TCR=1E-06 or THQ=1) MIN($C_{ia,c}$,$C_{ia,nc}$) (μg/m³)	Toxicity Basis	Target Sub-Slab and Near-source Soil Gas Concentration (TCR=1E-06 or THQ=1) C_{sg},Target (μg/m³)	Target Groundwater Concentration (TCR=1E-06 or THQ=1) C_{gw},Target (μg/L)	Is Target Groundwater Concentration < MCL? (C_{gw} < MCL?)
Benzene	71-43-2	Yes	Yes	Yes	Yes	3.60E-01	CA	1.20E+01	1.59E+00	Yes (5)
Ethylbenzene	100-41-4	Yes	Yes	Yes	Yes	1.12E+00	CA	3.74E+01	3.49E+00	Yes (700)
Methyl tert-Butyl Ether (MTBE)	1634-04-4	Yes	Yes	Yes	Yes	1.08E+01	CA	3.60E+02	4.50E+02	--
Toluene	108-88-3	Yes	Yes	Yes	Yes	5.21E+03	NC	1.74E+05	1.92E+04	No (1000)
Xylenes	1330-20-7	Yes	Yes	Yes	Yes	1.04E+02	NC	3.48E+03	3.85E+02	Yes (10000)

Chemical	Pure Phase Vapor Concentration C_{vp}\ (25 ℃)\ (μg/m³)	Maximum Groundwater Vapor Concentration C_{hc}\ (μg/m³)	Temperature for Maximum Groundwater Vapor Concentration (℃)	Lower Explosive Limit LEL (% by volume)	LEL Ref	IUR (ug/m³)⁻¹	IUR Ref	RfC (mg/m³)	RfC Ref	Mutagenic Indicator	Carcinogenic VISL TCR=1E-06 $C_{ia,c}$ (μg/m³)	Noncarcinogenic VISL THQ=1 $C_{ia,nc}$ (μg/m³)
Benzene	3.98E+08	4.06E+08	25	1.20	CRC89	7.80E-06	I	3.00E-02	I	No	3.60E-01	3.13E+01
Ethylbenzene	5.48E+07	5.44E+07	25	0.80	CRC89	2.50E-06	C	1.00E+00	I	No	1.12E+00	1.04E+03
Methyl tert-Butyl Ether (MTBE)	1.19E+09	1.22E+09	25	2.00	YAWS	2.60E-07	C	3.00E+00	I	No	1.08E+01	3.13E+03
Toluene	1.41E+08	1.43E+08	25	1.10	CRC89	-		5.00E+00	I	No	-	5.21E+03
Xylenes	4.56E+07	2.87E+07	25	-		-		1.00E-01	I	No	-	1.04E+02

Chemical Properties
Output generated 20MAR2020:13:29:48

Chemical	CAS Number	Does the chemical meet the definition for volatility? (HLC>1E-5 or VP>1)	Does the chemical have inhalation toxicity data? (IUR and/or RfC)	MW	MW Ref	Vapor Pressure VP (mm Hg)	VP Ref	S (mg/L)	S Ref	MCL (ug/L)	HLC (atm-m³/mole)
Benzene	71-43-2	Yes	Yes	78.115	PHYSPROP	9.48E+01	PHYSPROP	1.79E+03	PHYSPROP	5	5.55E-03
Ethylbenzene	100-41-4	Yes	Yes	106.17	PHYSPROP	9.60E+00	PHYSPROP	1.69E+02	PHYSPROP	700	7.88E-03
Methyl tert-Butyl Ether (MTBE)	1634-04-4	Yes	Yes	88.151	PHYSPROP	2.50E+02	PHYSPROP	5.10E+04	PHYSPROP	-	5.87E-04
Toluene	108-88-3	Yes	Yes	92.142	PHYSPROP	2.84E+01	PHYSPROP	5.26E+02	PHYSPROP	1000	6.64E-03
Xylenes	1330-20-7	Yes	Yes	106.17	PHYSPROP	7.99E+00	PHYSPROP	1.06E+02	PHYSPROP	10000	6.63E-03

Chemical	Henry's Law Constant (unitless)	H\` and HLC Ref	Henry's Law Constant Used in Calcs (unitless)	Normal Boiling Point BP (K)	BP Ref	Critical Temperature TC (K)	TC Ref	Enthalpy of vaporization at the normal boiling point $\Delta H_{v,b}$\ (cal/mol)	$\Delta H_{v,b}$\ Ref	Lower Explosive Limit LEL (% by volume)	LEL Ref
Benzene	2.27E-01	PHYSPROP	2.27E-01	353.15	PHYSPROP	5.62E+02	CRC89	7.34E+03	CRC89	1.2	CRC89
Ethylbenzene	3.22E-01	PHYSPROP	3.22E-01	409.25	PHYSPROP	6.17E+02	CRC89	8.50E+03	CRC89	0.8	CRC89
Methyl tert-Butyl Ether (MTBE)	2.40E-02	PHYSPROP	2.40E-02	328.15	PHYSPROP	4.97E+02	CRC89	6.68E+03	CRC89	2	YAWS
Toluene	2.71E-01	PHYSPROP	2.71E-01	383.75	PHYSPROP	5.92E+02	CRC89	7.93E+03	Weast	1.1	CRC89
Xylenes	2.71E-01	PHYSPROP	2.71E-01	411.65	PHYSPROP	6.20E+02	YAWS	8.52E+03	Weast	-	

Attachment 3

EDR Report

GEOCHECK® - PHYSICAL SETTING SOURCE SUMMARY

HYDROLOGIC INFORMATION

Surface water can act as a hydrologic barrier to groundwater flow. Such hydrologic information can be used to assist the environmental professional in forming an opinion about the impact of nearby contaminated properties or, should contamination exist on the target property, what downgradient sites might be impacted.

Refer to the Physical Setting Source Map following this summary for hydrologic information (major waterways and bodies of water).

FEMA FLOOD ZONE

Target Property County	FEMA Flood Electronic Data
GREENBRIER, WV	YES - refer to the Overview Map and Detail Map

Flood Plain Panel at Target Property: 5402280001A

Additional Panels in search area: 5400400120B

NATIONAL WETLAND INVENTORY

NWI Quad at Target Property	NWI Electronic Data Coverage
RAINELLE	YES - refer to the Overview Map and Detail Map

HYDROGEOLOGIC INFORMATION

Hydrogeologic information obtained by installation of wells on a specific site can often be an indicator of groundwater flow direction in the immediate area. Such hydrogeologic information can be used to assist the environmental professional in forming an opinion about the impact of nearby contaminated properties or, should contamination exist on the target property, what downgradient sites might be impacted.

AQUIFLOW®

Search Radius: 1.000 Mile.

EDR has developed the AQUIFLOW Information System to provide data on the general direction of groundwater flow at specific points. EDR has reviewed reports submitted by environmental professionals to regulatory authorities at select sites and has extracted the date of the report, groundwater flow direction as determined hydrogeologically, and the depth to water table.

MAP ID	LOCATION FROM TP	GENERAL DIRECTION GROUNDWATER FLOW
Not Reported		

GROUNDWATER FLOW VELOCITY INFORMATION

Groundwater flow velocity information for a particular site is best determined by a qualified environmental professional using site specific geologic and soil strata data. If such data are not reasonably ascertainable, it may be necessary to rely on other sources of information, including geologic age identification, rock stratigraphic unit and soil characteristics data collected on nearby properties and regional soil information. In general, contaminant plumes move more quickly through sandy-gravelly types of soils than silty-clayey types of soils.

GEOLOGIC INFORMATION IN GENERAL AREA OF TARGET PROPERTY

Geologic information can be used by the environmental professional in forming an opinion about the relative speed at which contaminant migration may be occurring.

ROCK STRATIGRAPHIC UNIT

Era:	Paleozoic
System:	Mississippian
Series:	Mississippian
Code:	M *(decoded above as Era, System & Series)*

GEOLOGIC AGE IDENTIFICATION

Category: Stratified Sequence

Geologic Age and Rock Stratigraphic Unit Source: P.G. Schruben, R.E. Arndt and W.J. Bawiec, Geology of the Conterminous U.S. at 1:2,500,000 Scale - a digital representation of the 1974 P.B. King and H.M. Beikman Map, USGS Digital Data Series DDS - 11 (1994).

DOMINANT SOIL COMPOSITION IN GENERAL AREA OF TARGET PROPERTY

The U.S. Department of Agriculture's (USDA) Soil Conservation Service (SCS) leads the National Cooperative Soil Survey (NCSS) and is responsible for collecting, storing, maintaining and distributing soil survey information for privately owned lands in the United States. A soil map in a soil survey is a representation of soil patterns in a landscape. Soil maps for STATSGO are compiled by generalizing more detailed (SSURGO) soil survey maps. The following information is based on Soil Conservation Service STATSGO data.

Soil Component Name:	ATKINS
Soil Surface Texture:	silty clay loam
Hydrologic Group:	Class D - Very slow infiltration rates. Soils are clayey, have a high water table, or are shallow to an impervious layer.
Soil Drainage Class:	Poorly. Soils may have a saturated zone, a layer of low hydraulic conductivity, or seepage. Depth to water table is less than 1 foot.

Hydric Status: Soil meets the requirements for a hydric soil.

Corrosion Potential - Uncoated Steel:	HIGH
Depth to Bedrock Min:	> 60 inches
Depth to Bedrock Max:	> 60 inches

Soil Layer Information							
	Boundary			Classification			
Layer	Upper	Lower	Soil Texture Class	AASHTO Group	Unified Soil	Permeability Rate (in/hr)	Soil Reaction (pH)
1	0 inches	10 inches	silty clay loam	Silt-Clay Materials (more than 35 pct. passing No. 200), Silty Soils.	FINE-GRAINED SOILS, Silts and Clays (liquid limit less than 50%), silt.	Max: 2.00 Min: 0.60	Max: 5.50 Min: 4.50
2	10 inches	34 inches	silty clay loam	Silt-Clay Materials (more than 35 pct. passing No. 200), Silty Soils.	COARSE-GRAINED SOILS, Sands, Sands with fines, Silty Sand.	Max: 2.00 Min: 0.06	Max: 5.50 Min: 4.50
3	34 inches	60 inches	stratified	Granular materials (35 pct. or less passing No. 200), Silty, or Clayey Gravel and Sand.	COARSE-GRAINED SOILS, Sands, Sands with fines, Silty Sand.	Max: 6.00 Min: 0.20	Max: 5.50 Min: 4.50

OTHER SOIL TYPES IN AREA

Based on Soil Conservation Service STATSGO data, the following additional subordinant soil types may appear within the general area of target property.

Soil Surface Textures: silt loam
fine sandy loam

Surficial Soil Types: silt loam
fine sandy loam

Shallow Soil Types: channery - silty clay loam
extremely channery - silt loam

Deeper Soil Types: silt loam
weathered bedrock
unweathered bedrock
sandy loam

LOCAL / REGIONAL WATER AGENCY RECORDS

EDR Local/Regional Water Agency records provide water well information to assist the environmental professional in assessing sources that may impact ground water flow direction, and in forming an opinion about the impact of contaminant migration on nearby drinking water wells.

GEOCHECK® - PHYSICAL SETTING SOURCE SUMMARY

WELL SEARCH DISTANCE INFORMATION

DATABASE	SEARCH DISTANCE (miles)
Federal USGS	1.000
Federal FRDS PWS	Nearest PWS within 1 mile
State Database	1.000

FEDERAL USGS WELL INFORMATION

MAP ID	WELL ID	LOCATION FROM TP
A1	USGS2261426	0 - 1/8 Mile SSE
A2	USGS2261422	0 - 1/8 Mile SSE
B3	USGS2261427	0 - 1/8 Mile SW
A4	USGS2261423	0 - 1/8 Mile SE
B5	USGS2261421	1/8 - 1/4 Mile SSW
6	USGS2261420	1/8 - 1/4 Mile SSE
C7	USGS2261418	1/4 - 1/2 Mile SW
C8	USGS2261416	1/4 - 1/2 Mile SW
D10	USGS2261431	1/2 - 1 Mile East
E13	USGS2261186	1/2 - 1 Mile East
E14	USGS2261185	1/2 - 1 Mile East
E15	USGS2261187	1/2 - 1 Mile East
F16	USGS2261188	1/2 - 1 Mile East
G18	USGS2261190	1/2 - 1 Mile East
G19	USGS2261192	1/2 - 1 Mile East
G20	USGS2261191	1/2 - 1 Mile East

FEDERAL FRDS PUBLIC WATER SUPPLY SYSTEM INFORMATION

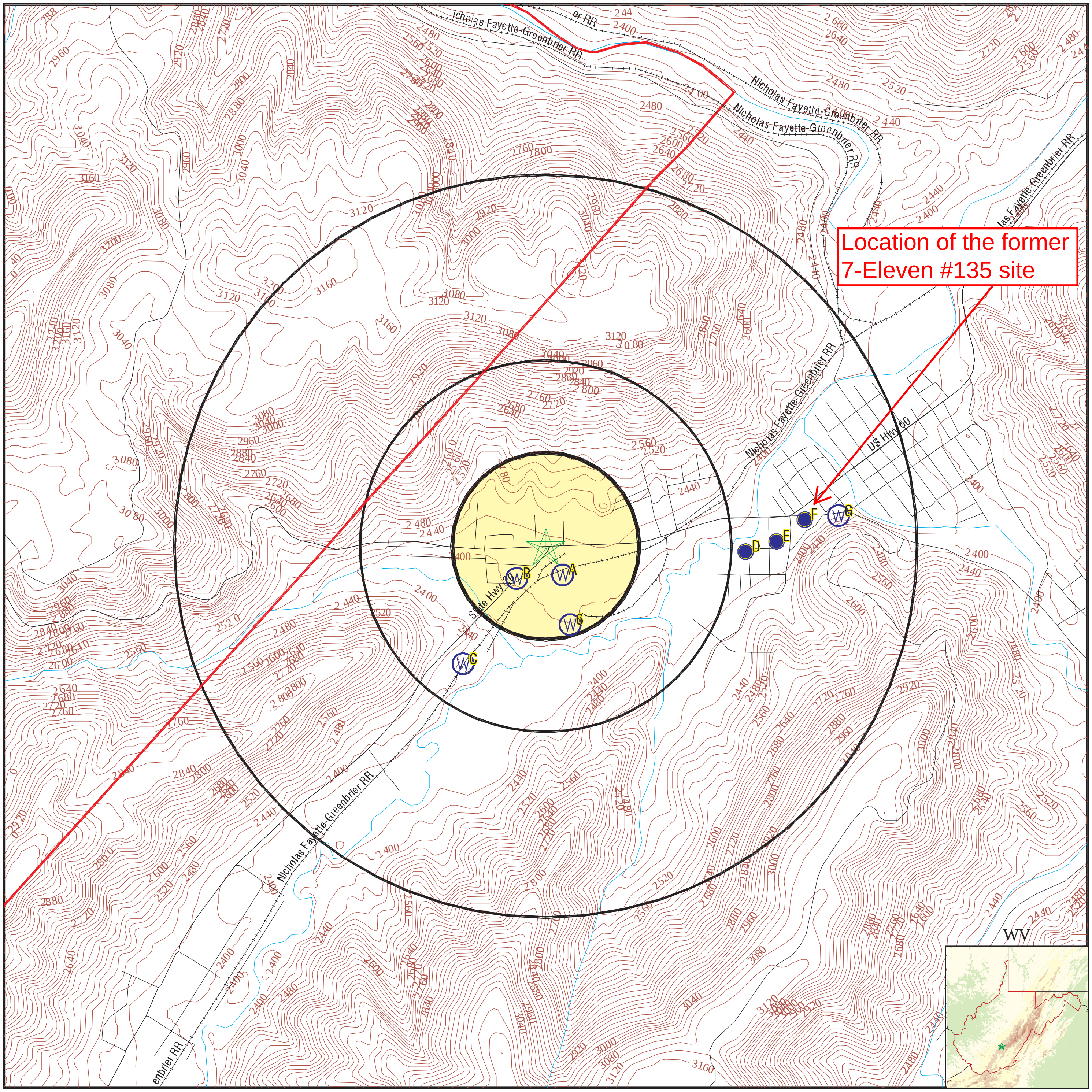
MAP ID	WELL ID	LOCATION FROM TP
E12	WV3301309	1/2 - 1 Mile East

Note: PWS System location is not always the same as well location.

STATE DATABASE WELL INFORMATION

MAP ID	WELL ID	LOCATION FROM TP
D9	WVWELL0705	1/2 - 1 Mile East
E11	WVWELL0385	1/2 - 1 Mile East
F17	WVWELL1658	1/2 - 1 Mile East

PHYSICAL SETTING SOURCE MAP - 2085935.2s



- County Boundary
- Major Roads
- Contour Lines
- Earthquake epicenter, Richter 5 or greater
- Water Wells
- Public Water Supply Wells
- Cluster of Multiple Icons

0 1/4 1/2 1 Miles

- Groundwater Flow Direction
- G I Indeterminate Groundwater Flow at Location
- G V Groundwater Flow Varies at Location
- Oil, gas or related wells

SITE NAME:	Former SSA Facility #3963	CLIENT:	Kemron Environmental Services
ADDRESS:	626 Kanawha Avenue	CONTACT:	W. Jeffrey Cavender
	Rainelle WV 25962	INQUIRY #:	2085935.2s
LAT/LONG:	37.9676 / 80.7791	DATE:	November 27, 2007 1:28 pm

Map ID Direction Distance Elevation	Database	EDR ID Number
A1 **SSE** **0 - 1/8 Mile** **Lower**	**FED USGS**	**USGS2261426**

Agency cd:	USGS	Site no:	375800080464401
Site name:	Grb-0017		
Latitude:	375800		
Longitude:	0804644	Dec lat:	37.9667833
Dec lon:	-80.77870123	Coor meth:	M
Coor accr:	S	Latlong datum:	NAD27
Dec latlong datum:	NAD83	District:	54
State:	54	County:	025
Country:	US	Land net:	Not Reported
Location map:	Not Reported	Map scale:	Not Reported
Altitude:	2425.00		
Altitude method:	Interpolated from topographic map		
Altitude accuracy:	20		
Altitude datum:	National Geodetic Vertical Datum of 1929		
Hydrologic:	Gauley. West Virginia. Area = 1420 sq.mi.		
Topographic:	Valley flat		
Site type:	Ground-water other than Spring	Date construction:	19480101
Date inventoried:	Not Reported	Mean greenwich time offset:	EST
Local standard time flag:	Y		
Type of ground water site:	Single well, other than collector or Ranney type		
Aquifer Type:	Not Reported		
Aquifer:	Not Reported		
Well depth:	128	Hole depth:	Not Reported
Source of depth data:	Not Reported		
Project number:	Not Reported		
Real time data flag:	0	Daily flow data begin date:	0000-00-00
Daily flow data end date:	0000-00-00	Daily flow data count:	0
Peak flow data begin date:	0000-00-00	Peak flow data end date:	0000-00-00
Peak flow data count:	0	Water quality data begin date:	0000-00-00
Water quality data end date:	0000-00-00	Water quality data count:	0
Ground water data begin date:	0000-00-00	Ground water data end date:	0000-00-00
Ground water data count:	0		

Ground-water levels, Number of Measurements: 0

A2 **SSE** **0 - 1/8 Mile** **Lower**	**FED USGS**	**USGS2261422**

Agency cd:	USGS	Site no:	375758080464301
Site name:	Grb-0015		
Latitude:	375758		
Longitude:	0804643	Dec lat:	37.96622776
Dec lon:	-80.77842343	Coor meth:	M
Coor accr:	S	Latlong datum:	NAD27
Dec latlong datum:	NAD83	District:	54
State:	54	County:	025
Country:	US	Land net:	Not Reported
Location map:	Not Reported	Map scale:	Not Reported

Altitude:	2425.00		
Altitude method:	Interpolated from topographic map		
Altitude accuracy:	50		
Altitude datum:	National Geodetic Vertical Datum of 1929		
Hydrologic:	Gauley. West Virginia. Area = 1420 sq.mi.		
Topographic:	Not Reported		
Site type:	Ground-water other than Spring	Date construction:	Not Reported
Date inventoried:	Not Reported	Mean greenwich time offset:	EST
Local standard time flag:	Y		
Type of ground water site:	Single well, other than collector or Ranney type		
Aquifer Type:	Not Reported		
Aquifer:	Not Reported		
Well depth:	125	Hole depth:	Not Reported
Source of depth data:	Not Reported		
Project number:	Not Reported		
Real time data flag:	0	Daily flow data begin date:	0000-00-00
Daily flow data end date:	0000-00-00	Daily flow data count:	0
Peak flow data begin date:	0000-00-00	Peak flow data end date:	0000-00-00
Peak flow data count:	0	Water quality data begin date:	0000-00-00
Water quality data end date:	0000-00-00	Water quality data count:	0
Ground water data begin date:	0000-00-00	Ground water data end date:	0000-00-00
Ground water data count:	0		

Ground-water levels, Number of Measurements: 0

B3
SW
0 - 1/8 Mile
Lower

FED USGS **USGS2261427**

Agency cd:	USGS	Site no:	375800080465101
Site name:	Grb-0018		
Latitude:	375800		
Longitude:	0804651	Dec lat:	37.96678328
Dec lon:	-80.78064574	Coor meth:	M
Coor accr:	S	Latlong datum:	NAD27
Dec latlong datum:	NAD83	District:	54
State:	54	County:	025
Country:	US	Land net:	Not Reported
Location map:	Not Reported	Map scale:	Not Reported
Altitude:	2425.00		
Altitude method:	Interpolated from topographic map		
Altitude accuracy:	20		
Altitude datum:	National Geodetic Vertical Datum of 1929		
Hydrologic:	Gauley. West Virginia. Area = 1420 sq.mi.		
Topographic:	Valley flat		
Site type:	Ground-water other than Spring	Date construction:	19470101
Date inventoried:	Not Reported	Mean greenwich time offset:	EST
Local standard time flag:	Y		
Type of ground water site:	Single well, other than collector or Ranney type		
Aquifer Type:	Not Reported		
Aquifer:	Not Reported		
Well depth:	119	Hole depth:	Not Reported
Source of depth data:	Not Reported		
Project number:	Not Reported		
Real time data flag:	Not Reported	Daily flow data begin date:	Not Reported
Daily flow data end date:	Not Reported	Daily flow data count:	Not Reported
Peak flow data begin date:	Not Reported	Peak flow data end date:	Not Reported

Peak flow data count:	Not Reported	Water quality data begin date:	Not Reported
Water quality data end date:	Not Reported	Water quality data count:	Not Reported
Ground water data begin date:	Not Reported	Ground water data end date:	Not Reported
Ground water data count:	Not Reported		

Ground-water levels, Number of Measurements: 0

A4
SE
0 - 1/8 Mile
Lower

FED USGS USGS2261423

Agency cd:	USGS	Site no:	375759080464001
Site name:	Grb-0016		
Latitude:	375759		
Longitude:	0804640	Dec lat:	37.96650555
Dec lon:	-80.77759008	Coor meth:	M
Coor accr:	S	Latlong datum:	NAD27
Dec latlong datum:	NAD83	District:	54
State:	54	County:	025
Country:	US	Land net:	Not Reported
Location map:	Not Reported	Map scale:	Not Reported
Altitude:	2425.00		
Altitude method:	Interpolated from topographic map		
Altitude accuracy:	50		
Altitude datum:	National Geodetic Vertical Datum of 1929		
Hydrologic:	Gauley. West Virginia. Area = 1420 sq.mi.		
Topographic:	Not Reported		
Site type:	Ground-water other than Spring	Date construction:	Not Reported
Date inventoried:	Not Reported	Mean greenwich time offset:	EST
Local standard time flag:	Y		
Type of ground water site:	Single well, other than collector or Ranney type		
Aquifer Type:	Not Reported		
Aquifer:	Not Reported		
Well depth:	125	Hole depth:	Not Reported
Source of depth data:	Not Reported		
Project number:	Not Reported		
Real time data flag:	0	Daily flow data begin date:	0000-00-00
Daily flow data end date:	0000-00-00	Daily flow data count:	0
Peak flow data begin date:	0000-00-00	Peak flow data end date:	0000-00-00
Peak flow data count:	0	Water quality data begin date:	0000-00-00
Water quality data end date:	0000-00-00	Water quality data count:	0
Ground water data begin date:	0000-00-00	Ground water data end date:	0000-00-00
Ground water data count:	0		

Ground-water levels, Number of Measurements: 0

B5
SSW
1/8 - 1/4 Mile
Lower

FED USGS USGS2261421

Agency cd:	USGS	Site no:	375757080465001
Site name:	Grb-0014		
Latitude:	375757		
Longitude:	0804650	Dec lat:	37.96594996
Dec lon:	-80.78036793	Coor meth:	M
Coor accr:	S	Latlong datum:	NAD27
Dec latlong datum:	NAD83	District:	54
State:	54	County:	025
Country:	US	Land net:	Not Reported
Location map:	Not Reported	Map scale:	Not Reported
Altitude:	2425.00		
Altitude method:	Interpolated from topographic map		
Altitude accuracy:	20		
Altitude datum:	National Geodetic Vertical Datum of 1929		
Hydrologic:	Gauley. West Virginia. Area = 1420 sq.mi.		
Topographic:	Valley flat		
Site type:	Ground-water other than Spring	Date construction:	19480101
Date inventoried:	Not Reported	Mean greenwich time offset:	EST
Local standard time flag:	Y		
Type of ground water site:	Single well, other than collector or Ranney type		
Aquifer Type:	Not Reported		
Aquifer:	Not Reported		
Well depth:	138	Hole depth:	Not Reported
Source of depth data:	Not Reported		
Project number:	Not Reported		
Real time data flag:	0	Daily flow data begin date:	0000-00-00
Daily flow data end date:	0000-00-00	Daily flow data count:	0
Peak flow data begin date:	0000-00-00	Peak flow data end date:	0000-00-00
Peak flow data count:	0	Water quality data begin date:	0000-00-00
Water quality data end date:	0000-00-00	Water quality data count:	0
Ground water data begin date:	0000-00-00	Ground water data end date:	0000-00-00
Ground water data count:	0		

Ground-water levels, Number of Measurements: 0

6
SSE
1/8 - 1/4 Mile
Lower

FED USGS **USGS2261420**

Agency cd:	USGS	Site no:	375752080464101
Site name:	Grb-0013		
Latitude:	375752		
Longitude:	0804641	Dec lat:	37.96456112
Dec lon:	-80.77786782	Coor meth:	M
Coor accr:	S	Latlong datum:	NAD27
Dec latlong datum:	NAD83	District:	54
State:	54	County:	025
Country:	US	Land net:	Not Reported
Location map:	Not Reported	Map scale:	Not Reported
Altitude:	2425.00		
Altitude method:	Interpolated from topographic map		
Altitude accuracy:	50		
Altitude datum:	National Geodetic Vertical Datum of 1929		
Hydrologic:	Gauley. West Virginia. Area = 1420 sq.mi.		
Topographic:	Not Reported		
Site type:	Ground-water other than Spring	Date construction:	Not Reported
Date inventoried:	Not Reported	Mean greenwich time offset:	EST

Local standard time flag:	Y		
Type of ground water site:	Single well, other than collector or Ranney type		
Aquifer Type:	Not Reported		
Aquifer:	Not Reported		
Well depth:	125	Hole depth:	Not Reported
Source of depth data:	Not Reported		
Project number:	Not Reported		
Real time data flag:	Not Reported	Daily flow data begin date:	Not Reported
Daily flow data end date:	Not Reported	Daily flow data count:	Not Reported
Peak flow data begin date:	Not Reported	Peak flow data end date:	Not Reported
Peak flow data count:	Not Reported	Water quality data begin date:	Not Reported
Water quality data end date:	Not Reported	Water quality data count:	Not Reported
Ground water data begin date:	Not Reported	Ground water data end date:	Not Reported
Ground water data count:	Not Reported		

Ground-water levels, Number of Measurements: 0

C7
SW
1/4 - 1/2 Mile
Lower

FED USGS **USGS2261418**

Agency cd:	USGS	Site no:	375747080465901
Site name:	Grb-0156		
Latitude:	375747		
Longitude:	0804659	Dec lat:	37.96317218
Dec lon:	-80.78286794	Coor meth:	M
Coor accr:	S	Latlong datum:	NAD27
Dec latlong datum:	NAD83	District:	54
State:	54	County:	025
Country:	US	Land net:	Not Reported
Location map:	RAINELLE	Map scale:	24000
Altitude:	2380.00		
Altitude method:	Interpolated from topographic map		
Altitude accuracy:	20		
Altitude datum:	National Geodetic Vertical Datum of 1929		
Hydrologic:	Gauley. West Virginia. Area = 1420 sq.mi.		
Topographic:	Valley flat		
Site type:	Ground-water other than Spring	Date construction:	Not Reported
Date inventoried:	Not Reported	Mean greenwich time offset:	EST
Local standard time flag:	Y		
Type of ground water site:	Single well, other than collector or Ranney type		
Aquifer Type:	Not Reported		
Aquifer:	BLUESTONE AND PRINCETON FORMATIONS		
Well depth:	119	Hole depth:	119
Source of depth data:	owner		
Project number:	445404000		
Real time data flag:	0	Daily flow data begin date:	0000-00-00
Daily flow data end date:	0000-00-00	Daily flow data count:	0
Peak flow data begin date:	0000-00-00	Peak flow data end date:	0000-00-00
Peak flow data count:	0	Water quality data begin date:	1981-12-18
Water quality data end date:	1981-12-18	Water quality data count:	1
Ground water data begin date:	1980-01-16	Ground water data end date:	1980-01-16
Ground water data count:	1		

Ground-water levels, Number of Measurements: 1

Date	Feet below Surface	Feet to Sealevel
1980-01-16	20.66	

C8
SW
1/4 - 1/2 Mile
Lower

FED USGS **USGS2261416**

Agency cd:	USGS	Site no:	375746080470101
Site name:	Grb-0190		
Latitude:	375746		
Longitude:	0804701	Dec lat:	37.9628944
Dec lon:	-80.78342351	Coor meth:	M
Coor accr:	S	Latlong datum:	NAD27
Dec latlong datum:	NAD83	District:	54
State:	54	County:	025
Country:	US	Land net:	Not Reported
Location map:	RAINELLE	Map scale:	24000
Altitude:	2380.00		
Altitude method:	Interpolated from topographic map		
Altitude accuracy:	20		
Altitude datum:	National Geodetic Vertical Datum of 1929		
Hydrologic:	Gauley. West Virginia. Area = 1420 sq.mi.		
Topographic:	Valley flat		
Site type:	Ground-water other than Spring	Date construction:	Not Reported
Date inventoried:	Not Reported	Mean greenwich time offset:	EST
Local standard time flag:	Y		
Type of ground water site:	Single well, other than collector or Ranney type		
Aquifer Type:	Not Reported		
Aquifer:	BLUESTONE AND PRINCETON FORMATIONS		
Well depth:	137	Hole depth:	Not Reported
Source of depth data:	owner		
Project number:	445404000		
Real time data flag:	0	Daily flow data begin date:	0000-00-00
Daily flow data end date:	0000-00-00	Daily flow data count:	0
Peak flow data begin date:	0000-00-00	Peak flow data end date:	0000-00-00
Peak flow data count:	0	Water quality data begin date:	1981-12-18
Water quality data end date:	1981-12-18	Water quality data count:	1
Ground water data begin date:	1981-12-18	Ground water data end date:	1981-12-18
Ground water data count:	1		

Ground-water levels, Number of Measurements: 1

Date	Feet below Surface	Feet to Sealevel
1981-12-18	21.83	

D9
East
1/2 - 1 Mile
Lower

WV WELLS **WVWELL0705**

Id number:	2016	Pwsid:	WV3301309
Sys name:	RAINELLE WATER DEPT		
Facility id:	563942		
Fac name:	WELL #6		
City:	RAINELLE	County:	GREENBRIER
Act status:	A	Water type:	Groundwater
Owner type:	Local	Daily prod:	0
Sys popula:	1865	Sys type:	Community
Latitude:	37.967222	Longitude:	-80.769444
Elevation:	0	Updated:	Not Reported
Wdate:	Not Reported		
Descriptio:	Not Reported		
User initi:	Not Reported	Gudi statu:	No
Sourcetype:	Not Reported	Whp radius:	500
Prod gpd:	0	Conv facto:	0
Calc pop:	0	Seasonbegi:	Not Reported
Season end:	Not Reported	Facility type:	Well

D10
East
1/2 - 1 Mile
Lower

FED USGS **USGS2261431**

Agency cd:	USGS	Site no:	375803080460901
Site name:	Grb-0208		
Latitude:	375803		
Longitude:	0804609	Dec lat:	37.96761676
Dec lon:	-80.76897873	Coor meth:	M
Coor accr:	S	Latlong datum:	NAD27
Dec latlong datum:	NAD83	District:	54
State:	54	County:	025
Country:	US	Land net:	Not Reported
Location map:	RAINELLE	Map scale:	24000
Altitude:	2390.00		
Altitude method:	Interpolated from topographic map		
Altitude accuracy:	20		
Altitude datum:	National Geodetic Vertical Datum of 1929		
Hydrologic:	Gauley. West Virginia. Area = 1420 sq.mi.		
Topographic:	Valley flat		
Site type:	Ground-water other than Spring	Date construction:	19840101
Date inventoried:	Not Reported	Mean greenwich time offset:	EST
Local standard time flag:	Y		
Type of ground water site:	Single well, other than collector or Ranney type		
Aquifer Type:	Not Reported		
Aquifer:	Not Reported		
Well depth:	200	Hole depth:	200
Source of depth data:	Not Reported		
Project number:	445405800		
Real time data flag:	0	Daily flow data begin date:	0000-00-00
Daily flow data end date:	0000-00-00	Daily flow data count:	0
Peak flow data begin date:	0000-00-00	Peak flow data end date:	0000-00-00
Peak flow data count:	0	Water quality data begin date:	1999-04-27
Water quality data end date:	1999-04-27	Water quality data count:	1
Ground water data begin date:	0000-00-00	Ground water data end date:	0000-00-00
Ground water data count:	0		

Ground-water levels, Number of Measurements: 0

Map ID
Direction
Distance
Elevation

Database | EDR ID Number

E11
East
1/2 - 1 Mile
Lower

WV WELLS **WVWELL0385**

Id number:	1617	Pwsid:	WV3301309
Sys name:	RAINELLE WATER DEPT		
Facility id:	563942		
Fac name:	WELL #5		
City:	RAINELLE	County:	GREENBRIER
Act status:	A	Water type:	Groundwater
Owner type:	Local	Daily prod:	0
Sys popula:	1865	Sys type:	Community
Latitude:	37.9675	Longitude:	-80.768056
Elevation:	0	Updated:	Not Reported
Wdate:	Not Reported		
Descriptio:	Not Reported		
User initi:	Not Reported	Gudi statu:	No
Sourcetype:	Not Reported	Whp radius:	500
Prod gpd:	0	Conv facto:	0
Calc pop:	0	Seasonbegi:	Not Reported
Season end:	Not Reported	Facility type:	Well

E12
East
1/2 - 1 Mile
Lower

FRDS PWS **WV3301309**

PWS ID:	WV3301309	PWS Status:	Not Reported
Date Initiated:	Not Reported	Date Deactivated:	Not Reported
PWS Name:	RAINELLE WATER DEPT BOX 709 309 OHIO AVENUE RAINELLE, WV 25962		

Source: Ground water
Treatment Objective: PARTICULATE REMOVAL   Process: FILTERED

Addressee / Facility: Mailing
RAINELLE WATER DEPT
BOX 709
RAINELLE, WV 25962

Facility Latitude:	37 58 3.0000	Facility Longitude:	80 46 5.0000
City Served:	Not Reported		
Treatment Class:	Mixed (treated and untreated)	Population:	1865

PWS currently has or had major violation(s) or enforcement: YES

VIOLATIONS INFORMATION:

Violation ID:	9400001	Source ID:	Not Reported	PWS Phone:	Not Reported
Vio. beginning Date:	07/01/93	Vio. end Date:	12/31/93	Vio. Period:	006 Months
Num required Samples:	Not Reported	Number of Samples Taken:		Not Reported	
Analysis Result:	Not Reported	Maximum Contaminant Level:		Not Reported	
Analysis Method:	Not Reported				
Violation Type:	Initial Water Quality Parameter WQP M&R				
Contaminant:	LEAD & COPPER RULE				
Vio. Awareness Date:	Not Reported				

ENFORCEMENT INFORMATION:

Truedate:	09/30/2006	Pwsid:	WV3301309
Pwsname:	RAINELLE WATER DEPT		
Retpopsrvd:	2178	Pwstypecod:	C
Vioid:	1V00	Contaminant:	7000
Viol. Type:	CCR Complete Failure to Report		
Complperbe:	7/1/2000 0:00:00		
Complperen:	7/20/2000 0:00:00	Enfdate:	7/20/2000 0:00:00
Enf action:	Fed Compliance Achieved		
Violmeasur:	0		

Truedate:	03/31/2007	Pwsid:	WV3301309
Pwsname:	RAINELLE WATER DEPT		
Retpopsrvd:	2178	Pwstypecod:	C
Vioid:	1V00	Contaminant:	7000
Viol. Type:	CCR Complete Failure to Report		
Complperbe:	7/1/2000 0:00:00		
Complperen:	7/20/2000 0:00:00	Enfdate:	7/20/2000 0:00:00
Enf action:	Fed Compliance Achieved		
Violmeasur:	0		

Truedate:	03/31/2007	Pwsid:	WV3301309
Pwsname:	RAINELLE WATER DEPT		
Retpopsrvd:	2178	Pwstypecod:	C
Vioid:	1V01	Contaminant:	7000
Viol. Type:	CCR Complete Failure to Report		
Complperbe:	7/1/2001 0:00:00		
Complperen:	7/9/2001 0:00:00	Enfdate:	7/9/2001 0:00:00
Enf action:	Fed Compliance Achieved		
Violmeasur:	0		

Truedate:	09/30/2006	Pwsid:	WV3301309
Pwsname:	RAINELLE WATER DEPT		
Retpopsrvd:	2178	Pwstypecod:	C
Vioid:	1V01	Contaminant:	7000
Viol. Type:	CCR Complete Failure to Report		
Complperbe:	7/1/2001 0:00:00		
Complperen:	7/9/2001 0:00:00	Enfdate:	7/9/2001 0:00:00
Enf action:	Fed Compliance Achieved		
Violmeasur:	0		

Truedate:	09/30/2006	Pwsid:	WV3301309
Pwsname:	RAINELLE WATER DEPT		
Retpopsrvd:	2178	Pwstypecod:	C
Vioid:	3804	Contaminant:	7000
Viol. Type:	CCR Complete Failure to Report		
Complperbe:	7/1/2004 0:00:00		
Complperen:	8/18/2004 0:00:00	Enfdate:	8/4/2004 0:00:00
Enf action:	State Formal NOV Issued		
Violmeasur:	Not Reported		

Truedate:	03/31/2007	Pwsid:	WV3301309
Pwsname:	RAINELLE WATER DEPT		
Retpopsrvd:	2178	Pwstypecod:	C
Vioid:	3804	Contaminant:	7000
Viol. Type:	CCR Complete Failure to Report		
Complperbe:	7/1/2004 0:00:00		
Complperen:	8/18/2004 0:00:00	Enfdate:	8/4/2004 0:00:00
Enf action:	State Formal NOV Issued		
Violmeasur:	Not Reported		

Truedate:	03/31/2007	Pwsid:	WV3301309
Pwsname:	RAINELLE WATER DEPT		
Retpopsrvd:	2178	Pwstypecod:	C
Vioid:	3804	Contaminant:	7000
Viol. Type:	CCR Complete Failure to Report		
Complperbe:	7/1/2004 0:00:00		
Complperen:	8/18/2004 0:00:00	Enfdate:	8/18/2004 0:00:00
Enf action:	State Compliance Achieved		
Violmeasur:	Not Reported		

Truedate:	09/30/2006	Pwsid:	WV3301309
Pwsname:	RAINELLE WATER DEPT		
Retpopsrvd:	2178	Pwstypecod:	C
Vioid:	3804	Contaminant:	7000
Viol. Type:	CCR Complete Failure to Report		
Complperbe:	7/1/2004 0:00:00		
Complperen:	8/18/2004 0:00:00	Enfdate:	8/18/2004 0:00:00
Enf action:	State Compliance Achieved		
Violmeasur:	Not Reported		

Truedate:	09/30/2006	Pwsid:	WV3301309
Pwsname:	RAINELLE WATER DEPT		
Retpopsrvd:	2178	Pwstypecod:	C
Vioid:	4005	Contaminant:	COLIFORM (TCR)
Viol. Type:	Monitoring, Routine Major (TCR)		
Complperbe:	2/1/2005 0:00:00		
Complperen:	2/28/2005 0:00:00	Enfdate:	3/24/2005 0:00:00
Enf action:	State Public Notif Requested		
Violmeasur:	Not Reported		

Truedate:	09/30/2006	Pwsid:	WV3301309
Pwsname:	RAINELLE WATER DEPT		
Retpopsrvd:	2178	Pwstypecod:	C
Vioid:	4005	Contaminant:	COLIFORM (TCR)
Viol. Type:	Monitoring, Routine Major (TCR)		
Complperbe:	2/1/2005 0:00:00		
Complperen:	2/28/2005 0:00:00	Enfdate:	3/4/2005 0:00:00
Enf action:	State Compliance Achieved		
Violmeasur:	Not Reported		

Truedate:	09/30/2006	Pwsid:	WV3301309
Pwsname:	RAINELLE WATER DEPT		
Retpopsrvd:	2178	Pwstypecod:	C
Vioid:	4005	Contaminant:	COLIFORM (TCR)
Viol. Type:	Monitoring, Routine Major (TCR)		
Complperbe:	2/1/2005 0:00:00		
Complperen:	2/28/2005 0:00:00	Enfdate:	3/24/2005 0:00:00
Enf action:	State Formal NOV Issued		
Violmeasur:	Not Reported		

Truedate:	03/31/2007	Pwsid:	WV3301309
Pwsname:	RAINELLE WATER DEPT		
Retpopsrvd:	2178	Pwstypecod:	C
Vioid:	4005	Contaminant:	COLIFORM (TCR)
Viol. Type:	Monitoring, Routine Major (TCR)		
Complperbe:	2/1/2005 0:00:00		
Complperen:	2/28/2005 0:00:00	Enfdate:	3/24/2005 0:00:00
Enf action:	State Public Notif Requested		
Violmeasur:	Not Reported		

Truedate:	03/31/2007	Pwsid:	WV3301309
Pwsname:	RAINELLE WATER DEPT		
Retpopsrvd:	2178	Pwstypecod:	C
Vioid:	4005	Contaminant:	COLIFORM (TCR)
Viol. Type:	Monitoring, Routine Major (TCR)		
Complperbe:	2/1/2005 0:00:00		
Complperen:	2/28/2005 0:00:00	Enfdate:	3/24/2005 0:00:00
Enf action:	State Formal NOV Issued		
Violmeasur:	Not Reported		

Truedate:	03/31/2007	Pwsid:	WV3301309
Pwsname:	RAINELLE WATER DEPT		
Retpopsrvd:	2178	Pwstypecod:	C
Vioid:	4005	Contaminant:	COLIFORM (TCR)
Viol. Type:	Monitoring, Routine Major (TCR)		
Complperbe:	2/1/2005 0:00:00		
Complperen:	2/28/2005 0:00:00	Enfdate:	3/4/2005 0:00:00
Enf action:	State Compliance Achieved		
Violmeasur:	Not Reported		

Truedate:	03/31/2007	Pwsid:	WV3301309
Pwsname:	RAINELLE WATER DEPT		
Retpopsrvd:	2178	Pwstypecod:	C
Vioid:	4406	Contaminant:	NITRATE
Viol. Type:	3		
Complperbe:	1/1/2005 0:00:00		
Complperen:	12/31/2005 0:00:00	Enfdate:	6/2/2006 0:00:00
Enf action:	State Public Notif Received		
Violmeasur:	Not Reported		

Truedate:	03/31/2007	Pwsid:	WV3301309
Pwsname:	RAINELLE WATER DEPT		
Retpopsrvd:	2178	Pwstypecod:	C
Vioid:	4406	Contaminant:	NITRATE
Viol. Type:	3		
Complperbe:	1/1/2005 0:00:00		
Complperen:	12/31/2005 0:00:00	Enfdate:	2/4/2006 0:00:00
Enf action:	State Public Notif Requested		
Violmeasur:	Not Reported		

Truedate:	03/31/2007	Pwsid:	WV3301309
Pwsname:	RAINELLE WATER DEPT		
Retpopsrvd:	2178	Pwstypecod:	C
Vioid:	4406	Contaminant:	NITRATE
Viol. Type:	3		
Complperbe:	1/1/2005 0:00:00		
Complperen:	12/31/2005 0:00:00	Enfdate:	2/4/2006 0:00:00
Enf action:	State Formal NOV Issued		
Violmeasur:	Not Reported		

Truedate:	03/31/2007	Pwsid:	WV3301309
Pwsname:	RAINELLE WATER DEPT		
Retpopsrvd:	2178	Pwstypecod:	C
Vioid:	4406	Contaminant:	NITRATE
Viol. Type:	3		
Complperbe:	1/1/2005 0:00:00		
Complperen:	12/31/2005 0:00:00	Enfdate:	2/23/2006 0:00:00
Enf action:	State Compliance Achieved		
Violmeasur:	Not Reported		

Truedate:	09/30/2006	Pwsid:	WV3301309
Pwsname:	RAINELLE WATER DEPT		
Retpopsrvd:	2178	Pwstypecod:	C
Vioid:	4406	Contaminant:	NITRATE
Viol. Type:	3		
Complperbe:	1/1/2005 0:00:00		
Complperen:	12/31/2005 0:00:00	Enfdate:	6/2/2006 0:00:00
Enf action:	State Public Notif Received		
Violmeasur:	Not Reported		

Truedate:	09/30/2006	Pwsid:	WV3301309
Pwsname:	RAINELLE WATER DEPT		
Retpopsrvd:	2178	Pwstypecod:	C
Vioid:	4406	Contaminant:	NITRATE
Viol. Type:	3		
Complperbe:	1/1/2005 0:00:00		
Complperen:	12/31/2005 0:00:00	Enfdate:	2/4/2006 0:00:00
Enf action:	State Public Notif Requested		
Violmeasur:	Not Reported		

Truedate:	09/30/2006	Pwsid:	WV3301309
Pwsname:	RAINELLE WATER DEPT		
Retpopsrvd:	2178	Pwstypecod:	C
Vioid:	4406	Contaminant:	NITRATE
Viol. Type:	3		
Complperbe:	1/1/2005 0:00:00		
Complperen:	12/31/2005 0:00:00	Enfdate:	2/4/2006 0:00:00
Enf action:	State Formal NOV Issued		
Violmeasur:	Not Reported		

Truedate:	09/30/2006	Pwsid:	WV3301309
Pwsname:	RAINELLE WATER DEPT		
Retpopsrvd:	2178	Pwstypecod:	C
Vioid:	4406	Contaminant:	NITRATE
Viol. Type:	3		
Complperbe:	1/1/2005 0:00:00		
Complperen:	12/31/2005 0:00:00	Enfdate:	2/23/2006 0:00:00
Enf action:	State Compliance Achieved		
Violmeasur:	Not Reported		

Truedate:	09/30/2006	Pwsid:	WV3301309
Pwsname:	RAINELLE WATER DEPT		
Retpopsrvd:	2178	Pwstypecod:	C
Vioid:	4606	Contaminant:	7500
Viol. Type:	PN Violation for NPDWR Violation		
Complperbe:	3/24/2006 0:00:00		
Complperen:	12/31/2025 0:00:00	Enfdate:	No Enf Action as of
Enf action:	1/18/2007 0:00:00		
Violmeasur:	Not Reported		

Truedate:	03/31/2007	Pwsid:	WV3301309
Pwsname:	RAINELLE WATER DEPT		
Retpopsrvd:	2178	Pwstypecod:	C
Vioid:	4606	Contaminant:	7500
Viol. Type:	PN Violation for NPDWR Violation		
Complperbe:	3/24/2006 0:00:00		
Complperen:	12/31/2025 0:00:00	Enfdate:	No Enf Action as of
Enf action:	7/24/2007 0:00:00		
Violmeasur:	Not Reported		

Truedate:	03/31/2007	Pwsid:	WV3301309
Pwsname:	RAINELLE WATER DEPT		
Retpopsrvd:	2178	Pwstypecod:	C
Vioid:	4807	Contaminant:	2456
Viol. Type:	Monitoring and Reporting Stage 1		
Complperbe:	1/1/2006 0:00:00		
Complperen:	12/31/2006 0:00:00	Enfdate:	2/9/2007 0:00:00
Enf action:	State Formal NOV Issued		
Violmeasur:	Not Reported		

Truedate:	03/31/2007	Pwsid:	WV3301309
Pwsname:	RAINELLE WATER DEPT		
Retpopsrvd:	2178	Pwstypecod:	C
Vioid:	4807	Contaminant:	2456
Viol. Type:	Monitoring and Reporting Stage 1		
Complperbe:	1/1/2006 0:00:00		
Complperen:	12/31/2006 0:00:00	Enfdate:	2/9/2007 0:00:00
Enf action:	State Public Notif Requested		
Violmeasur:	Not Reported		

System Name:	RAINELLE WATER DEPT		
Violation Type:	CCR Complete Failure to Report		
Contaminant:	7000		
Compliance Period:	7/1/2000 0:00:00 - 7/20/2000 0:00:00		
Violation ID:	1V00		
Enforcement Date:	7/20/2000 0:00:00	Enf. Action:	Fed Compliance Achieved

System Name:	RAINELLE WATER DEPT		
Violation Type:	CCR Complete Failure to Report		
Contaminant:	7000		
Compliance Period:	7/1/2000 0:00:00 - 7/20/2000 0:00:00		
Violation ID:	1V00		
Enforcement Date:	7/20/2000 0:00:00	Enf. Action:	Fed Compliance Achieved

System Name:	RAINELLE WATER DEPT		
Violation Type:	CCR Complete Failure to Report		
Contaminant:	7000		
Compliance Period:	7/1/2001 0:00:00 - 7/9/2001 0:00:00		
Violation ID:	1V01		
Enforcement Date:	7/9/2001 0:00:00	Enf. Action:	Fed Compliance Achieved

System Name:	RAINELLE WATER DEPT		
Violation Type:	CCR Complete Failure to Report		
Contaminant:	7000		
Compliance Period:	7/1/2001 0:00:00 - 7/9/2001 0:00:00		
Violation ID:	1V01		
Enforcement Date:	7/9/2001 0:00:00	Enf. Action:	Fed Compliance Achieved

System Name:	RAINELLE WATER DEPT		
Violation Type:	CCR Complete Failure to Report		
Contaminant:	7000		
Compliance Period:	7/1/2004 0:00:00 - 8/18/2004 0:00:00		
Violation ID:	3804		
Enforcement Date:	8/18/2004 0:00:00	Enf. Action:	State Compliance Achieved

System Name:	RAINELLE WATER DEPT		
Violation Type:	CCR Complete Failure to Report		
Contaminant:	7000		
Compliance Period:	7/1/2004 0:00:00 - 8/18/2004 0:00:00		
Violation ID:	3804		
Enforcement Date:	8/4/2004 0:00:00	Enf. Action:	State Formal NOV Issued

ENFORCEMENT INFORMATION:

System Name: RAINELLE WATER DEPT
Violation Type: CCR Complete Failure to Report
Contaminant: 7000
Compliance Period: 7/1/2004 0:00:00 - 8/18/2004 0:00:00
Violation ID: 3804
Enforcement Date: 8/4/2004 0:00:00 Enf. Action: State Formal NOV Issued

System Name: RAINELLE WATER DEPT
Violation Type: CCR Complete Failure to Report
Contaminant: 7000
Compliance Period: 7/1/2004 0:00:00 - 8/18/2004 0:00:00
Violation ID: 3804
Enforcement Date: 8/18/2004 0:00:00 Enf. Action: State Compliance Achieved

System Name: RAINELLE WATER DEPT
Violation Type: Monitoring, Routine Major (TCR)
Contaminant: COLIFORM (TCR)
Compliance Period: 2/1/2005 0:00:00 - 2/28/2005 0:00:00
Violation ID: 4005
Enforcement Date: 3/24/2005 0:00:00 Enf. Action: State Formal NOV Issued

System Name: RAINELLE WATER DEPT
Violation Type: Monitoring, Routine Major (TCR)
Contaminant: COLIFORM (TCR)
Compliance Period: 2/1/2005 0:00:00 - 2/28/2005 0:00:00
Violation ID: 4005
Enforcement Date: 3/24/2005 0:00:00 Enf. Action: State Public Notif Requested

System Name: RAINELLE WATER DEPT
Violation Type: Monitoring, Routine Major (TCR)
Contaminant: COLIFORM (TCR)
Compliance Period: 2/1/2005 0:00:00 - 2/28/2005 0:00:00
Violation ID: 4005
Enforcement Date: 3/4/2005 0:00:00 Enf. Action: State Compliance Achieved

System Name: RAINELLE WATER DEPT
Violation Type: Monitoring, Routine Major (TCR)
Contaminant: COLIFORM (TCR)
Compliance Period: 2/1/2005 0:00:00 - 2/28/2005 0:00:00
Violation ID: 4005
Enforcement Date: 3/4/2005 0:00:00 Enf. Action: State Compliance Achieved

System Name: RAINELLE WATER DEPT
Violation Type: Monitoring, Routine Major (TCR)
Contaminant: COLIFORM (TCR)
Compliance Period: 2/1/2005 0:00:00 - 2/28/2005 0:00:00
Violation ID: 4005
Enforcement Date: 3/24/2005 0:00:00 Enf. Action: State Public Notif Requested

System Name: RAINELLE WATER DEPT
Violation Type: Monitoring, Routine Major (TCR)
Contaminant: COLIFORM (TCR)
Compliance Period: 2/1/2005 0:00:00 - 2/28/2005 0:00:00
Violation ID: 4005
Enforcement Date: 3/24/2005 0:00:00 Enf. Action: State Formal NOV Issued

System Name: RAINELLE WATER DEPT
Violation Type: 3
Contaminant: NITRATE
Compliance Period: 1/1/2005 0:00:00 - 12/31/2005 0:00:00
Violation ID: 4406
Enforcement Date: 6/2/2006 0:00:00 Enf. Action: State Public Notif Received

ENFORCEMENT INFORMATION:

System Name: RAINELLE WATER DEPT
Violation Type: 3
Contaminant: NITRATE
Compliance Period: 1/1/2005 0:00:00 - 12/31/2005 0:00:00
Violation ID: 4406
Enforcement Date: 6/2/2006 0:00:00 Enf. Action: State Public Notif Received

System Name: RAINELLE WATER DEPT
Violation Type: 3
Contaminant: NITRATE
Compliance Period: 1/1/2005 0:00:00 - 12/31/2005 0:00:00
Violation ID: 4406
Enforcement Date: 2/23/2006 0:00:00 Enf. Action: State Compliance Achieved

System Name: RAINELLE WATER DEPT
Violation Type: 3
Contaminant: NITRATE
Compliance Period: 1/1/2005 0:00:00 - 12/31/2005 0:00:00
Violation ID: 4406
Enforcement Date: 2/4/2006 0:00:00 Enf. Action: State Formal NOV Issued

System Name: RAINELLE WATER DEPT
Violation Type: 3
Contaminant: NITRATE
Compliance Period: 1/1/2005 0:00:00 - 12/31/2005 0:00:00
Violation ID: 4406
Enforcement Date: 2/23/2006 0:00:00 Enf. Action: State Compliance Achieved

System Name: RAINELLE WATER DEPT
Violation Type: 3
Contaminant: NITRATE
Compliance Period: 1/1/2005 0:00:00 - 12/31/2005 0:00:00
Violation ID: 4406
Enforcement Date: 2/4/2006 0:00:00 Enf. Action: State Formal NOV Issued

System Name: RAINELLE WATER DEPT
Violation Type: 3
Contaminant: NITRATE
Compliance Period: 1/1/2005 0:00:00 - 12/31/2005 0:00:00
Violation ID: 4406
Enforcement Date: 2/4/2006 0:00:00 Enf. Action: State Public Notif Requested

System Name: RAINELLE WATER DEPT
Violation Type: 3
Contaminant: NITRATE
Compliance Period: 1/1/2005 0:00:00 - 12/31/2005 0:00:00
Violation ID: 4406
Enforcement Date: 2/4/2006 0:00:00 Enf. Action: State Public Notif Requested

System Name: RAINELLE WATER DEPT
Violation Type: PN Violation for NPDWR Violation
Contaminant: 7500
Compliance Period: 3/24/2006 0:00:00 - 12/31/2025 0:00:00
Violation ID: 4606
Enforcement Date: No Enf Action as of Enf. Action: 10/17/2006 0:00:00

System Name: RAINELLE WATER DEPT
Violation Type: PN Violation for NPDWR Violation
Contaminant: 7500
Compliance Period: 3/24/2006 0:00:00 - 12/31/2025 0:00:00
Violation ID: 4606
Enforcement Date: 4/12/2007 0:00:00 Enf. Action: Not Reported

ENFORCEMENT INFORMATION:

System Name:	RAINELLE WATER DEPT		
Violation Type:	Monitoring and Reporting Stage 1		
Contaminant:	2456		
Compliance Period:	1/1/2006 0:00:00 - 12/31/2006 0:00:00		
Violation ID:	4807		
Enforcement Date:	4/12/2007 0:00:00	Enf. Action:	Not Reported

CONTACT INFORMATION:

Name:	RAINELLE WATER DEPT	Population:	2178
Contact:	MCKENZIE, EUGENE	Phone:	304-438-7191
Address:	Not Reported		
Address 2:	P O BOX 648 RAINELLE, WV 25962		

E13
East
1/2 - 1 Mile
Lower

FED USGS **USGS2261186**

Agency cd:	WV002	Site no:	375804080460402
Site name:	Grb-0279		
Latitude:	375804		
Longitude:	0804604	Dec lat:	37.96789455
Dec lon:	-80.76758981	Coor meth:	M
Coor accr:	U	Latlong datum:	NAD27
Dec latlong datum:	NAD83	District:	54
State:	54	County:	025
Country:	US	Land net:	Not Reported
Location map:	Not Reported	Map scale:	Not Reported
Altitude:	Not Reported		
Altitude method:	Not Reported		
Altitude accuracy:	Not Reported		
Altitude datum:	Not Reported		
Hydrologic:	Gauley. West Virginia. Area = 1420 sq.mi.		
Topographic:	Not Reported		
Site type:	Ground-water other than Spring	Date construction:	Not Reported
Date inventoried:	19931104	Mean greenwich time offset:	EST
Local standard time flag:	Y		
Type of ground water site:	Multiple wells (a group of wells that are pumped through a single header)		
Aquifer Type:	Confined single aquifer		
Aquifer:	BLUESTONE AND PRINCETON FORMATIONS		
Well depth:	Not Reported	Hole depth:	Not Reported
Source of depth data:	Not Reported		
Project number:	54007		
Real time data flag:	Not Reported	Daily flow data begin date:	Not Reported
Daily flow data end date:	Not Reported	Daily flow data count:	Not Reported
Peak flow data begin date:	Not Reported	Peak flow data end date:	Not Reported
Peak flow data count:	Not Reported	Water quality data begin date:	Not Reported
Water quality data end date:	Not Reported	Water quality data count:	Not Reported
Ground water data begin date:	Not Reported	Ground water data end date:	Not Reported
Ground water data count:	Not Reported		

Ground-water levels, Number of Measurements: 0

Map ID Direction Distance Elevation	Database	EDR ID Number
E14 **East** **1/2 - 1 Mile** **Lower**	**FED USGS**	**USGS2261185**

Agency cd:	USGS	Site no:	375804080460401
Site name:	Grb-0196		
Latitude:	375804		
Longitude:	0804604	Dec lat:	37.96789455
Dec lon:	-80.76758981	Coor meth:	M
Coor accr:	S	Latlong datum:	NAD27
Dec latlong datum:	NAD83	District:	54
State:	54	County:	025
Country:	US	Land net:	Not Reported
Location map:	RAINELLE	Map scale:	24000
Altitude:	2380.00		
Altitude method:	Interpolated from topographic map		
Altitude accuracy:	20		
Altitude datum:	National Geodetic Vertical Datum of 1929		
Hydrologic:	Gauley. West Virginia. Area = 1420 sq.mi.		
Topographic:	Valley flat		
Site type:	Ground-water other than Spring	Date construction:	Not Reported
Date inventoried:	Not Reported	Mean greenwich time offset:	EST
Local standard time flag:	Y		
Type of ground water site:	Single well, other than collector or Ranney type		
Aquifer Type:	Not Reported		
Aquifer:	BLUESTONE AND PRINCETON FORMATIONS		
Well depth:	250	Hole depth:	250
Source of depth data:	other reported		
Project number:	445404000		
Real time data flag:	Not Reported	Daily flow data begin date:	Not Reported
Daily flow data end date:	Not Reported	Daily flow data count:	Not Reported
Peak flow data begin date:	Not Reported	Peak flow data end date:	Not Reported
Peak flow data count:	Not Reported	Water quality data begin date:	Not Reported
Water quality data end date:	Not Reported	Water quality data count:	Not Reported
Ground water data begin date:	Not Reported	Ground water data end date:	Not Reported
Ground water data count:	Not Reported		

Ground-water levels, Number of Measurements: 0

Map ID Direction Distance Elevation	Database	EDR ID Number
E15 **East** **1/2 - 1 Mile** **Lower**	**FED USGS**	**USGS2261187**

Agency cd:	USGS	Site no:	375805080460301
Site name:	Grb-0197		
Latitude:	375805		
Longitude:	0804603	Dec lat:	37.96817233
Dec lon:	-80.76731203	Coor meth:	M
Coor accr:	S	Latlong datum:	NAD27
Dec latlong datum:	NAD83	District:	54
State:	54	County:	025
Country:	US	Land net:	Not Reported
Location map:	RAINELLE	Map scale:	24000

Altitude:	2380.00		
Altitude method:	Interpolated from topographic map		
Altitude accuracy:	20		
Altitude datum:	National Geodetic Vertical Datum of 1929		
Hydrologic:	Gauley. West Virginia. Area = 1420 sq.mi.		
Topographic:	Valley flat		
Site type:	Ground-water other than Spring	Date construction:	Not Reported
Date inventoried:	Not Reported	Mean greenwich time offset:	EST
Local standard time flag:	Y		
Type of ground water site:	Single well, other than collector or Ranney type		
Aquifer Type:	Not Reported		
Aquifer:	BLUESTONE AND PRINCETON FORMATIONS		
Well depth:	120	Hole depth:	Not Reported
Source of depth data:	owner		
Project number:	445404000		
Real time data flag:	Not Reported	Daily flow data begin date:	Not Reported
Daily flow data end date:	Not Reported	Daily flow data count:	Not Reported
Peak flow data begin date:	Not Reported	Peak flow data end date:	Not Reported
Peak flow data count:	Not Reported	Water quality data begin date:	Not Reported
Water quality data end date:	Not Reported	Water quality data count:	Not Reported
Ground water data begin date:	Not Reported	Ground water data end date:	Not Reported
Ground water data count:	Not Reported		

Ground-water levels, Number of Measurements: 0

F16
East
1/2 - 1 Mile
Lower

FED USGS **USGS2261188**

Agency cd:	USGS	Site no:	375807080460001
Site name:	Grb-0019		
Latitude:	375807		
Longitude:	0804600	Dec lat:	37.96872789
Dec lon:	-80.76647868	Coor meth:	M
Coor accr:	S	Latlong datum:	NAD27
Dec latlong datum:	NAD83	District:	54
State:	54	County:	025
Country:	US	Land net:	Not Reported
Location map:	Not Reported	Map scale:	Not Reported
Altitude:	2425.00		
Altitude method:	Interpolated from topographic map		
Altitude accuracy:	20		
Altitude datum:	National Geodetic Vertical Datum of 1929		
Hydrologic:	Gauley. West Virginia. Area = 1420 sq.mi.		
Topographic:	Valley flat		
Site type:	Ground-water other than Spring	Date construction:	19510101
Date inventoried:	Not Reported	Mean greenwich time offset:	EST
Local standard time flag:	Y		
Type of ground water site:	Single well, other than collector or Ranney type		
Aquifer Type:	Not Reported		
Aquifer:	Not Reported		
Well depth:	85.0	Hole depth:	Not Reported
Source of depth data:	Not Reported		
Project number:	Not Reported		
Real time data flag:	0	Daily flow data begin date:	0000-00-00
Daily flow data end date:	0000-00-00	Daily flow data count:	0
Peak flow data begin date:	0000-00-00	Peak flow data end date:	0000-00-00

Peak flow data count:	0	Water quality data begin date:	0000-00-00
Water quality data end date:	0000-00-00	Water quality data count:	0
Ground water data begin date:	1961-01-01	Ground water data end date:	1961-01-01
Ground water data count:	1		

Ground-water levels, Number of Measurements: 1

Date	Feet below Surface	Feet to Sealevel
1961-01-01	57.00	

F17
East
1/2 - 1 Mile
Lower

WV WELLS **WVWELL1658**

Id number:	66	Pwsid:	WV3301309
Sys name:	RAINELLE WATER DEPT		
Facility id:	563942		
Fac name:	WELL #3		
City:	RAINELLE	County:	GREENBRIER
Act status:	A	Water type:	Groundwater
Owner type:	Local	Daily prod:	0
Sys popula:	1865	Sys type:	Community
Latitude:	37.968611	Longitude:	-80.766111
Elevation:	0	Updated:	Not Reported
Wdate:	Not Reported		
Descriptio:	Not Reported		
User initi:	Not Reported	Gudi statu:	No
Sourcetype:	Not Reported	Whp radius:	500
Prod gpd:	0	Conv facto:	0
Calc pop:	0	Seasonbegi:	Not Reported
Season end:	Not Reported	Facility type:	Well

G18
East
1/2 - 1 Mile
Lower

FED USGS **USGS2261190**

Agency cd:	USGS	Site no:	375808080455401
Site name:	Grb-0271		
Latitude:	375808		
Longitude:	0804554	Dec lat:	37.96900569
Dec lon:	-80.76481197	Coor meth:	M
Coor accr:	S	Latlong datum:	NAD27
Dec latlong datum:	NAD83	District:	54
State:	54	County:	025
Country:	US	Land net:	Not Reported
Location map:	RAINELLE	Map scale:	24000
Altitude:	2390.		
Altitude method:	Interpolated from topographic map		
Altitude accuracy:	20		
Altitude datum:	National Geodetic Vertical Datum of 1929		
Hydrologic:	Gauley. West Virginia. Area = 1420 sq.mi.		
Topographic:	Flat surface		
Site type:	Ground-water other than Spring	Date construction:	Not Reported
Date inventoried:	Not Reported	Mean greenwich time offset:	EST

Local standard time flag:	Y		
Type of ground water site:	Single well, other than collector or Ranney type		
Aquifer Type:	Not Reported		
Aquifer:	Not Reported		
Well depth:	130.	Hole depth:	130.
Source of depth data:	memory		
Project number:	445405800		
Real time data flag:	Not Reported	Daily flow data begin date:	Not Reported
Daily flow data end date:	Not Reported	Daily flow data count:	Not Reported
Peak flow data begin date:	Not Reported	Peak flow data end date:	Not Reported
Peak flow data count:	Not Reported	Water quality data begin date:	Not Reported
Water quality data end date:	Not Reported	Water quality data count:	Not Reported
Ground water data begin date:	Not Reported	Ground water data end date:	Not Reported
Ground water data count:	Not Reported		

Ground-water levels, Number of Measurements: 0

G19
East
1/2 - 1 Mile
Lower

FED USGS **USGS2261192**

Agency cd:	USGS	Site no:	375808080460002
Site name:	Grb-0021		
Latitude:	375807		
Longitude:	0804553	Dec lat:	37.96872792
Dec lon:	-80.76453418	Coor meth:	M
Coor accr:	S	Latlong datum:	NAD27
Dec latlong datum:	NAD83	District:	54
State:	54	County:	025
Country:	US	Land net:	Not Reported
Location map:	RAINELLE	Map scale:	24000
Altitude:	2400		
Altitude method:	Interpolated from topographic map		
Altitude accuracy:	20		
Altitude datum:	National Geodetic Vertical Datum of 1929		
Hydrologic:	Gauley. West Virginia. Area = 1420 sq.mi.		
Topographic:	Hillside (slope)		
Site type:	Ground-water other than Spring	Date construction:	19280101
Date inventoried:	19610106	Mean greenwich time offset:	EST
Local standard time flag:	Y		
Type of ground water site:	Single well, other than collector or Ranney type		
Aquifer Type:	Not Reported		
Aquifer:	MAUCH CHUNK FORMATION		
Well depth:	120	Hole depth:	120
Source of depth data:	memory		
Project number:	Not Reported		
Real time data flag:	0	Daily flow data begin date:	0000-00-00
Daily flow data end date:	0000-00-00	Daily flow data count:	0
Peak flow data begin date:	0000-00-00	Peak flow data end date:	0000-00-00
Peak flow data count:	0	Water quality data begin date:	0000-00-00
Water quality data end date:	0000-00-00	Water quality data count:	0
Ground water data begin date:	0000-00-00	Ground water data end date:	0000-00-00
Ground water data count:	0		

Ground-water levels, Number of Measurements: 0

Map ID Direction Distance Elevation	Database	EDR ID Number
G20 **East** **1/2 - 1 Mile** **Lower**	**FED USGS**	**USGS2261191**

Agency cd:	USGS	Site no:	375808080460001
Site name:	Grb-0020		
Latitude:	375807		
Longitude:	0804553	Dec lat:	37.96872792
Dec lon:	-80.76453418	Coor meth:	M
Coor accr:	S	Latlong datum:	NAD27
Dec latlong datum:	NAD83	District:	54
State:	54	County:	025
Country:	US	Land net:	Not Reported
Location map:	RAINELLE	Map scale:	24000
Altitude:	2400		
Altitude method:	Interpolated from topographic map		
Altitude accuracy:	20		
Altitude datum:	National Geodetic Vertical Datum of 1929		
Hydrologic:	Gauley. West Virginia. Area = 1420 sq.mi.		
Topographic:	Valley flat		
Site type:	Ground-water other than Spring	Date construction:	19450101
Date inventoried:	19650106	Mean greenwich time offset:	EST
Local standard time flag:	Y		
Type of ground water site:	Single well, other than collector or Ranney type		
Aquifer Type:	Not Reported		
Aquifer:	MAUCH CHUNK FORMATION		
Well depth:	116	Hole depth:	116
Source of depth data:	memory		
Project number:	Not Reported		
Real time data flag:	0	Daily flow data begin date:	0000-00-00
Daily flow data end date:	0000-00-00	Daily flow data count:	0
Peak flow data begin date:	0000-00-00	Peak flow data end date:	0000-00-00
Peak flow data count:	0	Water quality data begin date:	0000-00-00
Water quality data end date:	0000-00-00	Water quality data count:	0
Ground water data begin date:	0000-00-00	Ground water data end date:	0000-00-00
Ground water data count:	0		

Ground-water levels, Number of Measurements: 0

GEOCHECK® - PHYSICAL SETTING SOURCE MAP FINDINGS
RADON

AREA RADON INFORMATION

EPA Region 3 Statistical Summary Readings for Zip Code: 25962

Number of sites tested: 29.

Maximum Radon Level: 7.3 pCi/L.
Minimum Radon Level: 0.1 pCi/L.

pCi/L <4	pCi/L 4-10	pCi/L 10-20	pCi/L 20-50	pCi/L 50-100	pCi/L >100
28 (96.55%)	1 (3.45%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)

PHYSICAL SETTING SOURCE RECORDS SEARCHED

TOPOGRAPHIC INFORMATION

USGS 7.5' Digital Elevation Model (DEM)
Source: United States Geologic Survey
EDR acquired the USGS 7.5' Digital Elevation Model in 2002 and updated it in 2006. The 7.5 minute DEM corresponds to the USGS 1:24,000- and 1:25,000-scale topographic quadrangle maps. The DEM provides elevation data with consistent elevation units and projection.

Scanned Digital USGS 7.5' Topographic Map (DRG)
Source: United States Geologic Survey
A digital raster graphic (DRG) is a scanned image of a U.S. Geological Survey topographic map. The map images are made by scanning published paper maps on high-resolution scanners. The raster image is georeferenced and fit to the Universal Transverse Mercator (UTM) projection.

HYDROLOGIC INFORMATION

Flood Zone Data: This data, available in select counties across the country, was obtained by EDR in 1999 from the Federal Emergency Management Agency (FEMA). Data depicts 100-year and 500-year flood zones as defined by FEMA.

NWI: National Wetlands Inventory. This data, available in select counties across the country, was obtained by EDR in 2002 and 2005 from the U.S. Fish and Wildlife Service.

HYDROGEOLOGIC INFORMATION

AQUIFLOW[R] Information System
Source: EDR proprietary database of groundwater flow information
EDR has developed the AQUIFLOW Information System (AIS) to provide data on the general direction of groundwater flow at specific points. EDR has reviewed reports submitted to regulatory authorities at select sites and has extracted the date of the report, hydrogeologically determined groundwater flow direction and depth to water table information.

GEOLOGIC INFORMATION

Geologic Age and Rock Stratigraphic Unit
Source: P.G. Schruben, R.E. Arndt and W.J. Bawiec, Geology of the Conterminous U.S. at 1:2,500,000 Scale - A digital representation of the 1974 P.B. King and H.M. Beikman Map, USGS Digital Data Series DDS - 11 (1994).

STATSGO: State Soil Geographic Database
Source: Department of Agriculture, Natural Resources Conservation Services
The U.S. Department of Agriculture's (USDA) Natural Resources Conservation Service (NRCS) leads the national Conservation Soil Survey (NCSS) and is responsible for collecting, storing, maintaining and distributing soil survey information for privately owned lands in the United States. A soil map in a soil survey is a representation of soil patterns in a landscape. Soil maps for STATSGO are compiled by generalizing more detailed (SSURGO) soil survey maps.

SSURGO: Soil Survey Geographic Database
Source: Department of Agriculture, Natural Resources Conservation Services (NRCS)
Telephone: 800-672-5559
SSURGO is the most detailed level of mapping done by the Natural Resources Conservation Services, mapping scales generally range from 1:12,000 to 1:63,360. Field mapping methods using national standards are used to construct the soil maps in the Soil Survey Geographic (SSURGO) database. SSURGO digitizing duplicates the original soil survey maps. This level of mapping is designed for use by landowners, townships and county natural resource planning and management.

PHYSICAL SETTING SOURCE RECORDS SEARCHED

LOCAL / REGIONAL WATER AGENCY RECORDS

FEDERAL WATER WELLS

PWS: Public Water Systems
Source: EPA/Office of Drinking Water
Telephone: 202-564-3750
Public Water System data from the Federal Reporting Data System. A PWS is any water system which provides water to at least 25 people for at least 60 days annually. PWSs provide water from wells, rivers and other sources.

PWS ENF: Public Water Systems Violation and Enforcement Data
Source: EPA/Office of Drinking Water
Telephone: 202-564-3750
Violation and Enforcement data for Public Water Systems from the Safe Drinking Water Information System (SDWIS) after August 1995. Prior to August 1995, the data came from the Federal Reporting Data System (FRDS).

USGS Water Wells: USGS National Water Inventory System (NWIS)
This database contains descriptive information on sites where the USGS collects or has collected data on surface water and/or groundwater. The groundwater data includes information on wells, springs, and other sources of groundwater.

STATE RECORDS

West Virginia Water Well Information
Source: Bureau of Public Health
Telephone: 304-558-6765

OTHER STATE DATABASE INFORMATION

West Virginia Oil and Gas Well Database
Source: Department of Environmental Protection
Telephone: 304-926-0450
Oil and Gas well locations in the state.

RADON

Area Radon Information
Source: USGS
Telephone: 703-356-4020
The National Radon Database has been developed by the U.S. Environmental Protection Agency (USEPA) and is a compilation of the EPA/State Residential Radon Survey and the National Residential Radon Survey. The study covers the years 1986 - 1992. Where necessary data has been supplemented by information collected at private sources such as universities and research institutions.

EPA Radon Zones
Source: EPA
Telephone: 703-356-4020
Sections 307 & 309 of IRAA directed EPA to list and identify areas of U.S. with the potential for elevated indoor radon levels.

EPA Region 3 Statistical Summary Readings
Source: Region 3 EPA
Telephone: 215-814-2082
Radon readings for Delaware, D.C., Maryland, Pennsylvania, Virginia and West Virginia.

OTHER

Airport Landing Facilities: Private and public use landing facilities
Source: Federal Aviation Administration, 800-457-6656

Epicenters: World earthquake epicenters, Richter 5 or greater
Source: Department of Commerce, National Oceanic and Atmospheric Administration

PHYSICAL SETTING SOURCE RECORDS SEARCHED

STREET AND ADDRESS INFORMATION

Attachment 4

BIOSCREEN

Table 1
Summary of BIOSCREEN Model Input Parameters
Risk Assessment Report
Former 7-Eleven Facility #135 - 44 Main Street
Rainelle, West Virginia

Parameter	Parameter Description	Units	Notes	Actual Input Value	Sensitivity Analysis [1] Input Value Minimum (Least Conservative)	Sensitivity Analysis [1] Input Value Maximum (Most Conservative)	Default or Site-Specific or Calculated	Actual Input Value Rationale	Sensitivity Analysis Input Value Rationale
BIOSCREEN Model Version 1.4									
				MTBE	**MTBE**	**MTBE**			
Hydrogeology									
Vs Velocity	Seepage Velocity	ft/yr	Either enter Vs **OR** enter k, i, and n to calculate Vs	9.05E+02	1.19E-02	7.54E+04	Calculated	Calculated in the BIOSCREEN model	Calculated in the BIOSCREEN model
K Hydraulic Conductivity	Soil permeability	cm/sec		1.0E-02	1.0E-08	1.0E+00	Default	Within the range of "clean sand" values presented in the BIOSCREEN guidance (USEPA 1996). Value adjusted for model calibration.	The K value is within the acceptable value for a "clay" (<1.0E-06) and a "sand" and "gravel" (1) in EPA's June 1996 BIOSCREEN User Manual
i Hydraulic Gradient	Slope of water table	ft/foot		0.0175	0.0115	0.0255	Site-Specific	Average of six quarters of gauging at site. Gradient was calculated between groundwater monitoring wells MW-3 and MW-6.	Min and Max derived from six quarters of gauging at the site.
n Porosity	Effective porosity	unitless		0.20	0.01	0.35	Default	Within the range of "coarse sand" values presented in the BIOSCREEN guidance (USEPA 1996). Value adjusted for model calibration.	Based on EPA's June 1996 BIOSCREEN User Manual for clay and sand/gravel
Dispersion									
x Alpha x	Longitudinal Dispersivity	ft	Either enter x, y, and z **OR** enter Lp to calculate x, y, and z	10.4	4.4	47.3	Calculated	Calculated in the BIOSCREEN model	Calculated in the BIOSCREEN model
y Alpha y	Transverse Dispersivity	ft		1.0	0.4	4.7	Calculated	Calculated in the BIOSCREEN model	Calculated in the BIOSCREEN model
z Alpha z	Vertical Dispersivity	ft		1.0E-99	0.2	1.0E-99	Default	Conservative default recommended value from the BIOSCREEN guidance (USEPA 1996)	Values as per EPA's June 1996 BIOSCREEN User Manual for most conservative (1.0E-99) to least conservative (0.05 * Alpha X)
Lp Estimated Plume Length	Plume Length	ft		180	55	6,020	Site-Specific	Estimated plume length based on a series of model iterations where the centerline of the plume reaches the de minimis standard for MTBE of 14 µg/L.	Dimension from the source area (MW-3R) to the distance at which MTBE attenuates to the WVDEP groundwater de minimis standard of 14 ug/L (55ft and 6,020 ft).
Absorption									
R Retardation	Factor for each constituent based on the soil to water partition coefficient (Koc * Foc)	unitless	Either enter retardation factor **OR** enter rho, Koc, and foc to calculate R	2.9	72	1.0	Calculated	Calculated in the BIOSCREEN model	Calculated in the BIOSCREEN model
rho Soil Bulk Density	Dry weight of soil/volume	kg/L		1.58	1.7	1.58	Site-Specific	Based on geotechnical analytical results and observations made during site assessment activities	Based on EPA's June 1996 BIOSCREEN Manual and based on site derived value
Koc Partition Coefficient	Organic Carbon Partition Coefficient	L/kg		11.6	11.6	11.6	Default	Based on WVDEP Chemical Properties Database, last updated June 5, 2014	Based on WVDEP Chemical Properties Database, last updated June 5, 2014
Foc Fraction Organic Carbon	Soil Organic Carbon Fraction	unitless		0.036	0.036	0.0002	Site-Specific	Based on geotechnical analytical results	Most conservative value based on EPA's June 1996 BIOSCREEN User Manual vs. site derived value (least conservative)
Biodegradation									
Lambda 1st Order Decay Coefficient	First Order Decay Coefficient	yr-1	Enter lambda **OR** enter in t-half to calculate lambda	4.6E+00	4.6E+00	6.9E-01	Calculated	Calculated in the BIOSCREEN model	Calculated in the BIOSCREEN model
t-half Solute Half-Life	Dissolved Plume Concentrations to decay by one half	year		0.15	0.15	1	Default	Within range of half life values for MTBE presented in Howard et. al. 1991. Value adjusted for model calibration.	Based on range of half life values for MTBE presented in Howard et. al. 1991
General									
Modeled Area Length	Length to view plume	ft	---	550	550	6,020	Site-Specific	The dimension from the source area (MW-3R) to the closest active downgradient potable water supply identified as cluster "E" in the EDR map (550 ft).	The dimension from the source area (MW-3R) to the closest active downgradient potable water supply identified as cluster "E" in the EDR map (550 ft), and the dimension from the source area (MW-3R) to the distance at which MTBE attenuates to the WVDEP groundwater de minimis standard of 14 ug/L (6,020 ft).
Modeled Area Width	Width to view plume	ft		180	180	180	Site-Specific	The dimension perpendicular to the direction of groundwater flow estimated to depict modeled plume dispersion.	Site derived value
Simulation Time	Time of model output	years		1000	1	1000	Default	Default recommended value from the BIOSCREEN guidance (USEPA 1996)	Typical values recommended in EPA's June 1996 BIOSCREEN User Manual
Source Data									
Source Thickness	Sum of thickness of saturated zone impacts and water level fluctuations within source area	ft	---	10	10	10	Site-Specific	Determined through the smear-zone and water column height in each well	Site derived value
Source Width	Width of source concentration area	ft		60	60	60	Site-Specific	The dimension perpendicular to the direction of groundwater flow based on an MTBE isopleth generated for the site.	Site derived value
Source Zone Concentration	Source area monitoring well data	mg/L		0.1533	0.1533	0.1533	Site-Specific	A UCL of the dissolved-phase MTBE concentrations from the 8 most recent post-remediation sampling events collected between March 2011 and August 2016 from MW-3/3R (i.e. source area well) was used.	A UCL of the dissolved-phase MTBE concentrations from the 8 most recent post-remediation sampling events collected between March 2011 and August 2016 from MW-3/3R (i.e. source area well) was used.

Notes:
Howard et. al. 1991, Handbook of Environmental Degradation Rates, CRC Press, LLC, Lewis Publishers, 1991.
USEPA 1996, BIOSCREEN Natural Attenuation Decision Support System User's Manual, Version 1.3, United States Environmental Protection Agency, EPA/600/R-96/087, August 1996.
[1] The sensitivity analysis minimum scenario is the least conservative scenario and the sensitivity analysis maximum scenario is the most conservative analysis.

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

7-Eleven Rainelle
MTBE
Run Name

Data Input Instructions:

115 — 1. Enter value directly....or
or — 2. Calculate by filling in grey cells below. (To restore formulas, hit button below).
0.02

Variable* — Data used directly in model.
20 — Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	Vs	9.05E+02	(ft/yr)
or			
Hydraulic Conductivity	K	1.0E-02	(cm/sec)
Hydraulic Gradient	i	0.0175	(ft/ft)
Porosity	n	0.20	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	10.4	(ft)
Transverse Dispersivity*	alpha y	1.0	(ft)
Vertical Dispersivity*	alpha z	1.0E-99	(ft)
or			
Estimated Plume Length	Lp	180	(ft)

3. ADSORPTION

Retardation Factor*	R	2.9	(-)
or			
Soil Bulk Density	rho	1.58	(kg/l)
Partition Coefficient	Koc	11.6	(L/kg)
FractionOrganicCarbon	foc	3.6E-2	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	4.6E+0	(per yr)
or			
Solute Half-Life	t-half	0.15	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	550	(ft)
Modeled Area Width*	180	(ft)
Simulation Time*	1000	(yr)

L, W

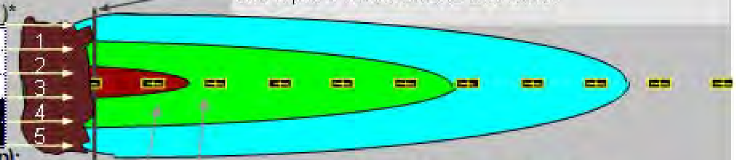
6. SOURCE DATA

Source Thickness in Sat.Zone* 10 (ft)

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths

Source Zones:

Zone	Width* (ft)	Conc. (mg/L)*
1		
2		
3	60	0.1533
4	0	0
5	0	0



View of Plume Looking Down

Source Halflife (see Help):

Infinite	Infinite	(yr)
Inst. React.	1st Order	

Soluble Mass Infinite (Kg)
In Source NAPL, Soil

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)	.153		.023								
Dist. from Source (ft)	0	55	110	165	220	275	330	385	440	495	550

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN — View Output

RUN ARRAY — View Output

Help — Recalculate

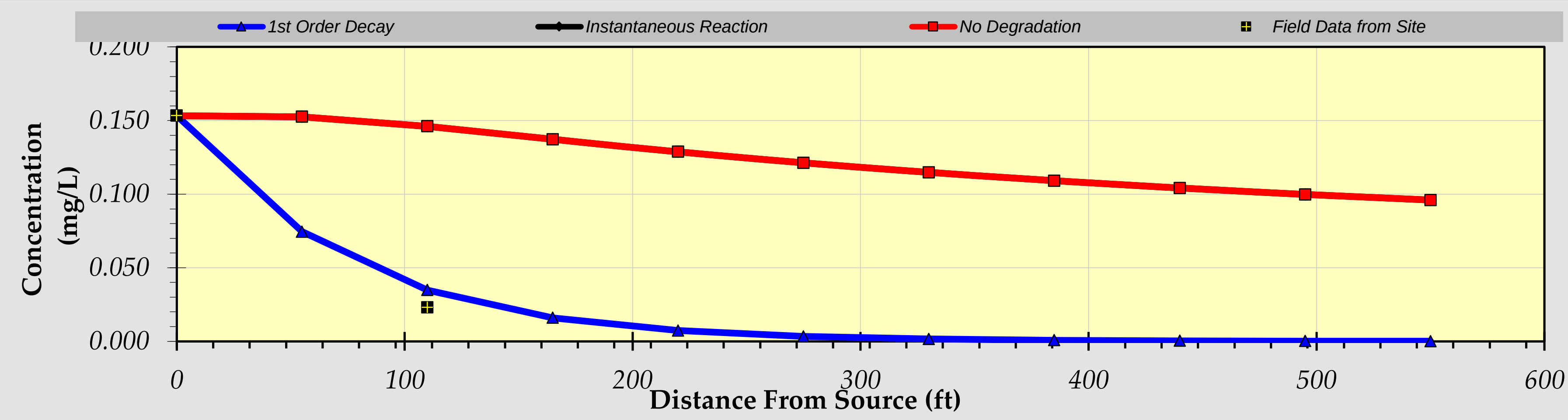
Paste Example Dataset

Restore Formulas for Vs,

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	55	110	165	220	275	330	385	440	495	550
No Degradation	0.153	0.153	0.146	0.137	0.129	0.121	0.115	0.109	0.104	0.100	0.096
1st Order Decay	0.153	0.074	0.035	0.016	0.007	0.003	0.002	0.001	0.000	0.000	0.000
Inst. Reaction	0.153	0.153	0.146	0.137	0.129	0.121	0.115	0.109	0.104	0.100	0.096
Field Data from Site	0.153		0.023								



Calculate Animation

Time:

1,000 Years

Return to

Recalculate This

DISSOLVED HYDROCARBON CONCENTRATIONS IN PLUME (mg/L at Z=0)

Transverse Distance (ft) / *Distance from Source (ft)*

	0	55	110	165	220	275	330	385	440	495	550
90	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00
45	0.000	0.006	0.006	0.004	0.002	0.001	0.001	0.000	0.000	0.000	0.000
0	0.153	0.074	0.035	0.016	0.007	0.003	0.002	0.001	0.000	0.000	0.00
-45	0.000	0.006	0.006	0.004	0.002	0.001	0.001	0.000	0.000	0.000	0.00
-90	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
MASS FLUX (mg/day)	-	-	-	-	-	-	-	-	-	-	-

Can't calculate mass flux when vertical dispersivity not equal to 0

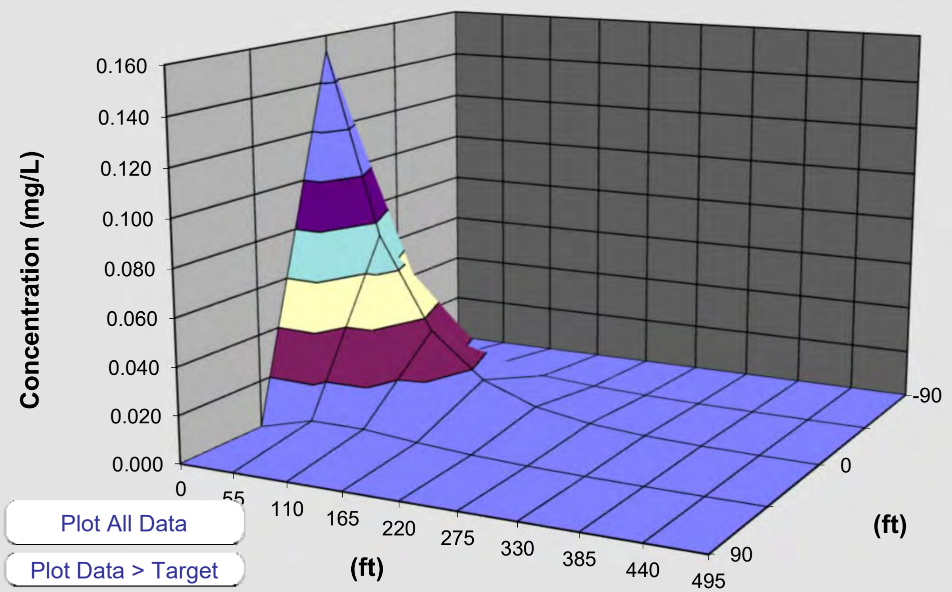
Model to Display:

No Degradation

1st Order Decay Model

Instantaneous

Time: **1000 Years** Target Level: **0.014** mg/L Displayed Model: **1st Order Decay**



Plot All Data

Plot Data > Target

Plume and Source Masses (Order-of-Magnitude Accuracy)

Plume Mass if No Biodegradation Can't Calc. *(Kg)*

- Actual Plume Mass Can't Calc. *(Kg)*

= Plume Mass Removed by Biodeg - *(Kg)*

Change in Electron Acceptor/Byproduct Masses:

Oxygen	*Nitrate*	*Iron II*	*Sulfate*	*Methane*	
na	na	na	na	na	*(Kg)*

Contam. Mass in Source (t=0 Years) Infinite *(Kg)*

Contam. Mass in Source Now (t=1000Years) Infinite *(Kg)*

Current Volume of Groundwater in Plume Can't Calc. *(ac-ft)*

Flowrate of Water Through Source Zone Can't Calc. *(ac-ft/yr)*

Mass HELP

Recalculate

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence — *Version 1.4*

7-Eleven Rainelle
MTBE
Run Name

Data Input Instructions:

115 — 1. Enter value directly....or
or — 2. Calculate by filling in grey cells below. (To restore formulas, hit button below).
0.02

Variable* — Data used directly in model.
20 — Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	Vs	7.54E+04	(ft/yr)
or			
Hydraulic Conductivity	K	1.0E+00	(cm/sec)
Hydraulic Gradient	i	0.0255	(ft/ft)
Porosity	n	0.35	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	47.3	(ft)
Transverse Dispersivity*	alpha y	4.7	(ft)
Vertical Dispersivity*	alpha z	1.0E-99	(ft)
or			
Estimated Plume Length	Lp	6020	(ft)

3. ADSORPTION

Retardation Factor*	R	1.0	(-)
or			
Soil Bulk Density	rho	1.58	(kg/l)
Partition Coefficient	Koc	11.6	(L/kg)
FractionOrganicCarbon	foc	2.0E-4	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	6.9E-1	(per yr)
or			
Solute Half-Life	t-half	1.00	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	6020	(ft)
Modeled Area Width*	180	(ft)
Simulation Time*	1000	(yr)

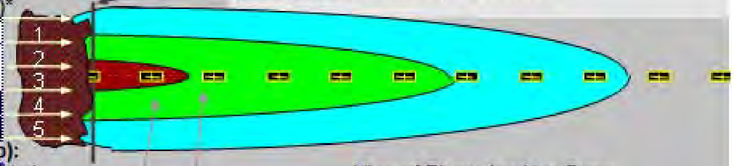
6. SOURCE DATA

Source Thickness in Sat.Zone* 10 (ft)

Source Zones:

Zone	Width* (ft)	Conc. (mg/L)*
1		
2		
3	60	0.1533
4	0	0
5	0	0

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths



View of Plume Looking Down

Source Halflife (see Help):

Inst. React.	1st Order	
Infinite	Infinite	(yr)

Soluble Mass In Source NAPL, Soil: Infinite (Kg)

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)											
Dist. from Source (ft)	0	602	1204	1806	2408	3010	3612	4214	4816	5418	6020

8. CHOOSE TYPE OF OUTPUT TO SEE:

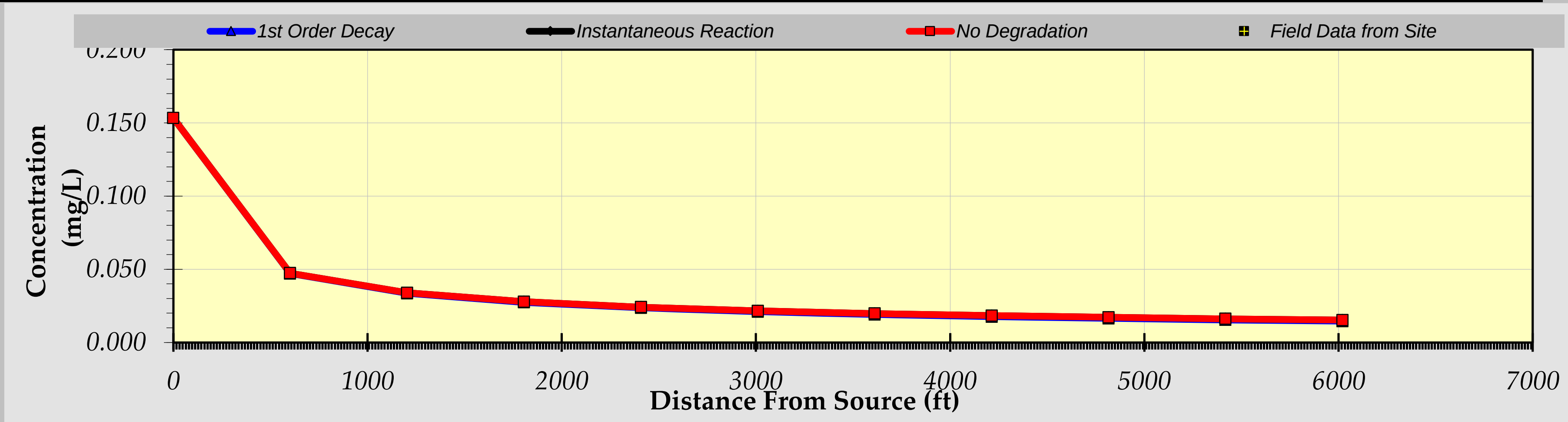
RUN | RUN ARRAY | Help | Recalculate

View Output | View Output | Paste Example Dataset | Restore Formulas for Vs,

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	602	1204	1806	2408	3010	3612	4214	4816	5418	6020
No Degradation	0.153	0.047	0.034	0.028	0.024	0.022	0.020	0.018	0.017	0.016	0.015
1st Order Decay	0.153	0.047	0.034	0.027	0.024	0.021	0.019	0.018	0.016	0.015	0.014
Inst. Reaction	0.153	0.047	0.034	0.028	0.024	0.022	0.020	0.018	0.017	0.016	0.015
Field Data from Site											



Calculate Animation

Time:

1,000 Years

Return to

Recalculate This

DISSOLVED HYDROCARBON CONCENTRATIONS IN PLUME (mg/L at Z=0)

Transverse Distance (ft)	Distance from Source (ft): 0	602	1204	1806	2408	3010	3612	4214	4816	5418	6020
90	0.000	0.024	0.024	0.022	0.020	0.018	0.017	0.016	0.015	0.014	0.014
45	0.000	0.040	0.031	0.026	0.023	0.020	0.019	0.017	0.016	0.015	0.014
0	0.153	0.047	0.034	0.027	0.024	0.021	0.019	0.018	0.016	0.015	0.014
-45	0.000	0.040	0.031	0.026	0.023	0.020	0.019	0.017	0.016	0.015	0.014
-90	0.000	0.024	0.024	0.022	0.020	0.018	0.017	0.016	0.015	0.014	0.014
MASS FLUX (mg/day)	-	-	-	-	-	-	-	-	-	-	-

Can't calculate mass flux when vertical dispersivity not equal to 0

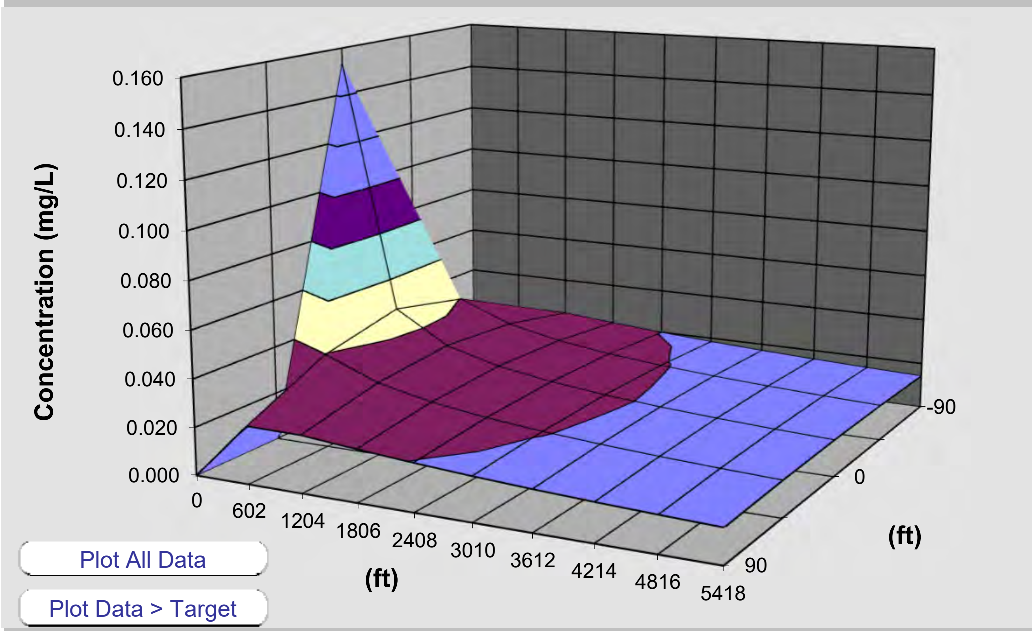
Time: **1000 Years** Target Level: **0.014** mg/L Displayed Model: **1st Order Decay**

Model to Display:

No Degradation

1st Order Decay

Instantaneous



Plot All Data

Plot Data > Target

Plume and Source Masses (Order-of-Magnitude Accuracy)

Plume Mass if No Biodegradation	Can't Calc.	*(Kg)*
- Actual Plume Mass	Can't Calc.	*(Kg)*
= Plume Mass Removed by Biodeg	-	*(Kg)*

Change in Electron Acceptor/Byproduct Masses:

Oxygen	*Nitrate*	*Iron II*	*Sulfate*	*Methane*	
na	na	na	na	na	*(Kg)*

Contam. Mass in Source (t=0 Years)	Infinite	*(Kg)*
Contam. Mass in Source Now (t=1000Years)	Infinite	*(Kg)*
Current Volume of Groundwater in Plume	Can't Calc.	*(ac-ft)*
Flowrate of Water Through Source Zone	Can't Calc.	*(ac-ft/yr)*

Mass HELP

Recalculate

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

7-Eleven Rainelle
MTBE
Run Name

Data Input Instructions:

115	1. Enter value directly....or
↑ or	2. Calculate by filling in grey
0.02	cells below. (To restore formulas, hit button below).
Variable*	Data used directly in model.
20	Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	*Vs*	1.19E-02	(ft/yr)
or		↑ or	
Hydraulic Conductivity	*K*	1.0E-08	(cm/sec)
Hydraulic Gradient	*i*	0.0115	(ft/ft)
Porosity	*n*	0.01	(-)

2. DISPERSION

Longitudinal Dispersivity*	*alpha x*	4.4	(ft)
Transverse Dispersivity*	*alpha y*	0.4	(ft)
Vertical Dispersivity*	*alpha z*	2.0E-01	(ft)
or		↑ or	
Estimated Plume Length	*Lp*	55	(ft)

3. ADSORPTION

Retardation Factor*	*R*	72.0	(-)
or		↑ or	
Soil Bulk Density	*rho*	1.7	(kg/l)
Partition Coefficient	*Koc*	11.6	(L/kg)
FractionOrganicCarbon	*foc*	3.6E-2	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	*lambda*	4.6E+0	(per yr)
or		↑ or	
Solute Half-Life	*t-half*	0.15	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	*DO*		(mg/L)
Delta Nitrate*	*NO3*		(mg/L)
Observed Ferrous Iron*	*Fe2+*		(mg/L)
Delta Sulfate*	*SO4*		(mg/L)
Observed Methane*	*CH4*		(mg/L)

5. GENERAL

Modeled Area Length*	550	(ft)
Modeled Area Width*	180	(ft)
Simulation Time*	1	(yr)

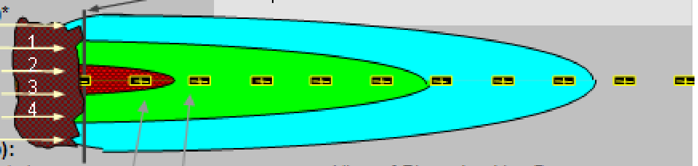
6. SOURCE DATA

Source Thickness in Sat.Zone* 10 (ft)

Source Zones:

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths

Width* (ft)	Conc. (mg/L)*
60	0.1533
0	0
0	0



View of Plume Looking Down

Source Halflife (see Help):

Infinite	Infinite	(yr)
Inst. React.	1st Order	
Soluble Mass	Infinite	(Kg)
In Source NAPL, Soil		

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)											
Dist. from Source (ft)	0	55	110	165	220	275	330	385	440	495	550

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLIN | View Output

RUN ARRAY | View Output

Help | Recalculate

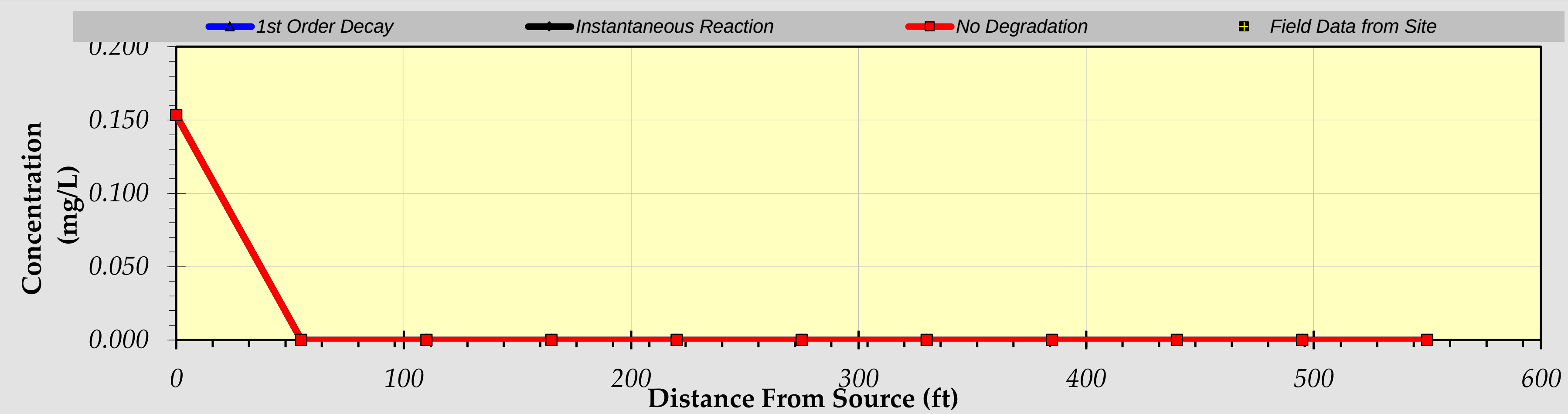
Paste Example Dataset

Restore Formulas for Vs,

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	55	110	165	220	275	330	385	440	495	550
No Degradation	0.153	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1st Order Decay	0.153	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	0.153	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site											



Calculate Animation

Time:

1 Years

Return to

Recalculate This

DISSOLVED HYDROCARBON CONCENTRATIONS IN PLUME (mg/L at Z=0)

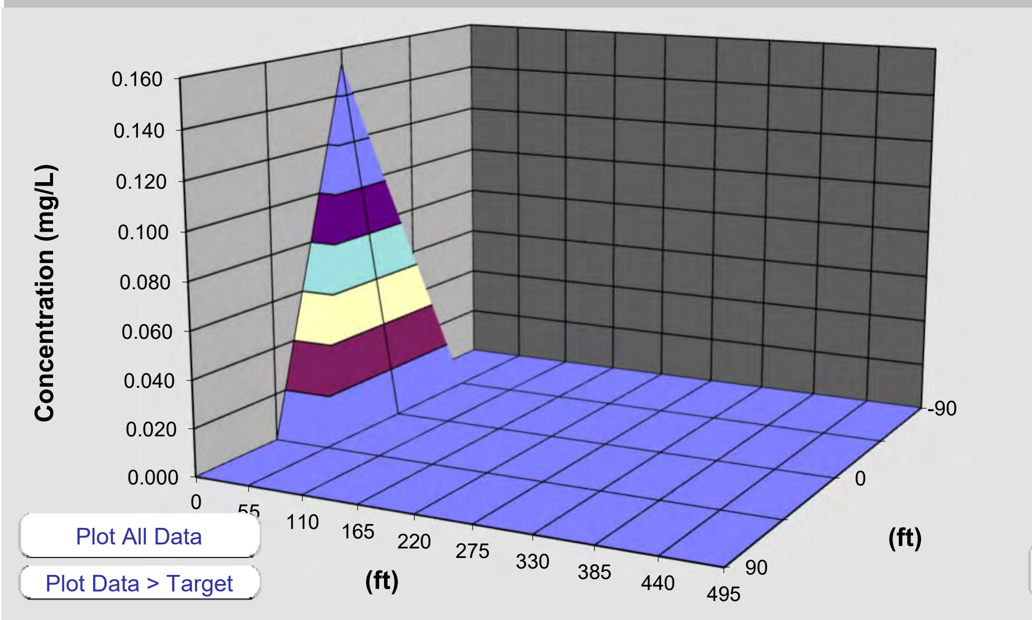
Transverse Distance (ft) / *Distance from Source (ft)*

	0	55	110	165	220	275	330	385	440	495	550
90	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
45	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0	0.153	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-45	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-90	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
MASS FLUX (mg/day)	-	-	-	-	-	-	-	-	-	-	-

Can't calculate mass flux when vertical dispersivity not equal to 0

Time: **1 Years** Target Level: **0.014** mg/L Displayed Model: **1st Order Decay**

Model to Display: *No Degradation* | *1st Order Decay Model* | *Instantaneous*



Plot All Data
Plot Data > Target

Plume and Source Masses (Order-of-Magnitude Accuracy)

Plume Mass if No Biodegradation	Can't Calc.	*(Kg)*
- Actual Plume Mass	Can't Calc.	*(Kg)*
= Plume Mass Removed by Biodeg	-	*(Kg)*

Change in Electron Acceptor/Byproduct Masses:

Oxygen	*Nitrate*	*Iron II*	*Sulfate*	*Methane*	
na	na	na	na	na	*(Kg)*

Contam. Mass in Source (t=0 Years)	Infinite	*(Kg)*
Contam. Mass in Source Now (t=1Years)	Infinite	*(Kg)*
Current Volume of Groundwater in Plume	Can't Calc.	*(ac-ft)*
Flowrate of Water Through Source Zone	Can't Calc.	*(ac-ft/yr)*

Mass HELP
Recalculate

Groundwater Goodness of Fit Test - MW-3
Former 7-Eleven Facility #135 - 44 Main Street
Rainelle, West Virginia

	Goodness-of-Fit Test Statistics for Data Sets with Non-Detects					
User Selected Options						
Date/Time of Computation	ProUCL 5.12/8/2019 8:34:41 AM					
From File	WorkSheet.xls					
Full Precision	OFF					
Confidence Coefficient	0.95					

MTBE (ug/L)

	Num Obs	Num Miss	Num Valid	Detects	NDs	% NDs
Raw Statistics	7	0	7	6	1	14.29%

	Number	Minimum	Maximum	Mean	Median	SD
Statistics (Non-Detects Only)	1	2	2	2	2	N/A
Statistics (Non-Detects Only)	6	17.6	194	118.8	127	57.71
Statistics (All: NDs treated as DL value)	7	2	194	102.1	120	68.73
Statistics (All: NDs treated as DL/2 value)	7	1	194	101.9	120	68.97
Statistics (Normal ROS Imputed Data)	7	-17.72	194	99.27	120	73.73
Statistics (Gamma ROS Imputed Data)	7	17.6	194	105.4	120	63.4
Statistics (Lognormal ROS Imputed Data)	7	16.94	194	104.2	120	65.24

	K hat	K Star	Theta hat	Log Mean	Log Stdv	Log CV
Statistics (Non-Detects Only)	2.603	1.413	45.63	4.573	0.858	0.188
Statistics (NDs = DL)	0.956	0.641	106.8	4.019	1.663	0.414
Statistics (NDs = DL/2)	0.837	0.574	121.8	3.92	1.898	0.484
Statistics (Gamma ROS Estimates)	1.961	1.216	53.76	4.382	0.932	0.213
Statistics (Lognormal ROS Estimates)	--	--	--	4.324	1.024	0.237

Normal GOF Test Results

	No NDs	NDs = DL	NDs = DL/2	Normal ROS
Correlation Coefficient R	0.942	0.953	0.953	0.954

	Test value	Crit. (0.05)	Conclusion with Alpha(0.05)
Shapiro-Wilk (Detects Only)	0.914	0.788	Data Appear Normal
Shapiro-Wilk (NDs = DL)	0.905	0.803	Data Appear Normal
Shapiro-Wilk (NDs = DL/2)	0.905	0.803	Data Appear Normal
Shapiro-Wilk (Normal ROS Estimates)	0.911	0.803	Data Appear Normal
Lilliefors (Detects Only)	0.259	0.325	Data Appear Normal
Lilliefors (NDs = DL)	0.249	0.304	Data Appear Normal
Lilliefors (NDs = DL/2)	0.249	0.304	Data Appear Normal
Lilliefors (Normal ROS Estimates)	0.261	0.304	Data Appear Normal

Gamma GOF Test Results

	No NDs	NDs = DL	NDs = DL/2	Gamma ROS
Correlation Coefficient R	0.872	0.83	0.818	0.894

	Test value	Crit. (0.05)	Conclusion with Alpha(0.05)
Anderson-Darling (Detects Only)	0.763	0.702	
Kolmogorov-Smirnov (Detects Only)	0.357	0.335	Data Not Gamma Distributed
Anderson-Darling (NDs = DL)	0.82	0.729	
Kolmogorov-Smirnov (NDs = DL)	0.369	0.32	Data Not Gamma Distributed
Anderson-Darling (NDs = DL/2)	0.864	0.733	
Kolmogorov-Smirnov (NDs = DL/2)	0.377	0.322	Data Not Gamma Distributed
Anderson-Darling (Gamma ROS Estimates)	0.695	0.715	
Kolmogorov-Smirnov (Gamma ROS Est.)	0.322	0.315	Detected Data appear Approximate Gamma Distri

Groundwater Goodness of Fit Test - MW-3
Former 7-Eleven Facility #135 - 44 Main Street
Rainelle, West Virginia

Lognormal GOF Test Results							
	No NDs	NDs = DL	NDs = DL/2	Log ROS			
Correlation Coefficient R	0.829	0.855	0.839	0.876			
	Test value	Crit. (0.05)	Conclusion with Alpha(0.05)				
Shapiro-Wilk (Detects Only)	0.716	0.788	Data Not Lognormal				
Shapiro-Wilk (NDs = DL)	0.742	0.803	Data Not Lognormal				
Shapiro-Wilk (NDs = DL/2)	0.718	0.803	Data Not Lognormal				
Shapiro-Wilk (Lognormal ROS Estimates)	0.753	0.803	Data Not Lognormal				
Lilliefors (Detects Only)	0.384	0.325	Data Not Lognormal				
Lilliefors (NDs = DL)	0.369	0.304	Data Not Lognormal				
Lilliefors (NDs = DL/2)	0.37	0.304	Data Not Lognormal				
Lilliefors (Lognormal ROS Estimates)	0.351	0.304	Data Not Lognormal				
Note: Substitution methods such as DL or DL/2 are not recommended.							

Groundwater Stats Database - MW-3

Former 7-Eleven # 135 - 44 Main Street

Rainelle, West Virginia

Sampling Location	Sampling Date	MTBE (ug/L)	d_MTBE (ug/L)	NROS_MTBE (ug/L)	GROS_MTBE (ug/L)	LnROS_MTBE (ug/L)
MW-3R	08/16/16	17.6	1	17.6	17.6	17.6
MW-3	04/03/12	108	1	108	108	108
	01/17/12	134	1	134	134	134
	10/31/11	120	1	120	120	120
	08/18/11	194	1	194	194	194
	06/20/11	139	1	139	139	139
	03/28/11	2	0	-17.71814609	25.4416071	16.94442952

Groundwater UCL - MW-3
Former 7-Eleven Facility #135 - 44 Main Street
Rainelle, West Virginia

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.12/8/2019 8:34:51 AM
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

MTBE (ug/L)

General Statistics

Total Number of Observations	7	Number of Distinct Observations	7
Number of Detects	6	Number of Non-Detects	1
Number of Distinct Detects	6	Number of Distinct Non-Detects	1
Minimum Detect	17.6	Minimum Non-Detect	2
Maximum Detect	194	Maximum Non-Detect	2
Variance Detects	3331	Percent Non-Detects	14.29%
Mean Detects	118.8	SD Detects	57.71
Median Detects	127	CV Detects	0.486
Skewness Detects	-0.935	Kurtosis Detects	2.396
Mean of Logged Detects	4.573	SD of Logged Detects	0.858

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.914	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.788	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.259	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.325	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	102.1	KM Standard Error of Mean	26.34
KM SD	63.63	95% KM (BCA) UCL	139.8
95% KM (t) UCL	153.3	95% KM (Percentile Bootstrap) UCL	141.4
95% KM (z) UCL	145.4	95% KM Bootstrap t UCL	145
90% KM Chebyshev UCL	181.1	95% KM Chebyshev UCL	216.9
97.5% KM Chebyshev UCL	266.6	99% KM Chebyshev UCL	364.2

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.763	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.702	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.357	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.335	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only			
k hat (MLE)	2.603	k star (bias corrected MLE)	1.413
Theta hat (MLE)	45.63	Theta star (bias corrected MLE)	84.07
nu hat (MLE)	31.24	nu star (bias corrected)	16.95
Mean (detects)	118.8		
Gamma ROS Statistics using Imputed Non-Detects			
GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs			
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)			
For such situations, GROS method may yield incorrect values of UCLs and BTVs			
This is especially true when the sample size is small.			
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates			
Minimum	17.6	Mean	105.4
Maximum	194	Median	120
SD	63.4	CV	0.601
k hat (MLE)	1.961	k star (bias corrected MLE)	1.216
Theta hat (MLE)	53.76	Theta star (bias corrected MLE)	86.7
nu hat (MLE)	27.46	nu star (bias corrected)	17.02
Adjusted Level of Significance (β)	0.0158		
Approximate Chi Square Value (17.02, α)	8.69	Adjusted Chi Square Value (17.02, β)	6.969
95% Gamma Approximate UCL (use when n>=50)	206.6	95% Gamma Adjusted UCL (use when n<50)	257.6
Estimates of Gamma Parameters using KM Estimates			
Mean (KM)	102.1	SD (KM)	63.63
Variance (KM)	4049	SE of Mean (KM)	26.34
k hat (KM)	2.574	k star (KM)	1.566
nu hat (KM)	36.04	nu star (KM)	21.93
theta hat (KM)	39.66	theta star (KM)	65.18
80% gamma percentile (KM)	157.2	90% gamma percentile (KM)	210.5
95% gamma percentile (KM)	262.1	99% gamma percentile (KM)	378.4
Gamma Kaplan-Meier (KM) Statistics			
Approximate Chi Square Value (21.93, α)	12.28	Adjusted Chi Square Value (21.93, β)	10.17
95% Gamma Approximate KM-UCL (use when n>=50)	182.2	95% Gamma Adjusted KM-UCL (use when n<50)	220
Lognormal GOF Test on Detected Observations Only			
Shapiro Wilk Test Statistic	0.716	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.788	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.384	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.325	Detected Data Not Lognormal at 5% Significance Level	
Detected Data Not Lognormal at 5% Significance Level			
Lognormal ROS Statistics Using Imputed Non-Detects			
Mean in Original Scale	104.2	Mean in Log Scale	4.324
SD in Original Scale	65.24	SD in Log Scale	1.024
95% t UCL (assumes normality of ROS data)	152.1	95% Percentile Bootstrap UCL	141.7
95% BCA Bootstrap UCL	140.1	95% Bootstrap t UCL	145
95% H-UCL (Log ROS)	615		
Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution			
KM Mean (logged)	4.019	KM Geo Mean	55.63
KM SD (logged)	1.539	95% Critical H Value (KM-Log)	5.305
KM Standard Error of Mean (logged)	0.637	95% H-UCL (KM -Log)	5101
KM SD (logged)	1.539	95% Critical H Value (KM-Log)	5.305
KM Standard Error of Mean (logged)	0.637		

Groundwater UCL - MW-3
Former 7-Eleven Facility #135 - 44 Main Street
Rainelle, West Virginia

DL/2 Statistics			
DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	101.9	Mean in Log Scale	3.92
SD in Original Scale	68.97	SD in Log Scale	1.898
95% t UCL (Assumes normality)	152.6	95% H-Stat UCL	44234
DL/2 is not a recommended method, provided for comparisons and historical reasons			
Nonparametric Distribution Free UCL Statistics			
Detected Data appear Normal Distributed at 5% Significance Level			
Suggested UCL to Use			
95% KM (t) UCL	153.3		
Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
Recommendations are based upon data size, data distribution, and skewness.			
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			

Groundwater Goodness of Fit Test for MW-6

Risk Assessment Report
Former 7-Eleven Facility #135 - 44 Main Street
Rainelle, West Virginia

	Goodness-of-Fit Test Statistics for Data Sets with Non-Detects
User Selected Options	
Date/Time of Computation	ProUCL 5.12/1/2019 1:36:51 PM
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	0.95

MTBE (ug/L)

	Num Obs	Num Miss	Num Valid	Detects	NDs	% NDs
Raw Statistics	8	0	8	6	2	25.00%

	Number	Minimum	Maximum	Mean	Median	SD
Statistics (Non-Detects Only)	2	2	2	2	2	0
Statistics (Non-Detects Only)	6	18.6	24.7	21.8	21.75	2.249
Statistics (All: NDs treated as DL value)	8	2	24.7	16.85	20.65	9.361
Statistics (All: NDs treated as DL/2 value)	8	1	24.7	16.6	20.65	9.814
Statistics (Normal ROS Imputed Data)	8	15.2	24.7	20.35	20.65	3.322
Statistics (Gamma ROS Imputed Data)	8	15.57	24.7	20.42	20.65	3.211
Statistics (Lognormal ROS Imputed Data)	8	16.01	24.7	20.5	20.65	3.08

	K hat	K Star	Theta hat	Log Mean	Log Stdv	Log CV
Statistics (Non-Detects Only)	111.2	55.72	0.196	3.077	0.104	0.0339
Statistics (NDs = DL)	1.604	1.086	10.5	2.481	1.107	0.446
Statistics (NDs = DL/2)	1.135	0.793	14.63	2.308	1.427	0.618
Statistics (Gamma ROS Estimates)	44.63	27.98	0.457	3.005	0.162	0.0539
Statistics (Lognormal ROS Estimates)	--	--	--	3.01	0.153	0.051

Normal GOF Test Results

	No NDs	NDs = DL	NDs = DL/2	Normal ROS
Correlation Coefficient R	0.992	0.868	0.864	0.99

	Test value	Crit. (0.05)	Conclusion with Alpha(0.05)
Shapiro-Wilk (Detects Only)	0.976	0.788	Data Appear Normal
Shapiro-Wilk (NDs = DL)	0.74	0.818	Data Not Normal
Shapiro-Wilk (NDs = DL/2)	0.732	0.818	Data Not Normal
Shapiro-Wilk (Normal ROS Estimates)	0.965	0.818	Data Appear Normal
Lilliefors (Detects Only)	0.155	0.325	Data Appear Normal
Lilliefors (NDs = DL)	0.324	0.283	Data Not Normal
Lilliefors (NDs = DL/2)	0.331	0.283	Data Not Normal
Lilliefors (Normal ROS Estimates)	0.131	0.283	Data Appear Normal

Groundwater Goodness of Fit Test for MW-6

Risk Assessment Report
Former 7-Eleven Facility #135 - 44 Main Street
Rainelle, West Virginia

Gamma GOF Test Results							
	No NDs	NDs = DL	NDs = DL/2	Gamma ROS			
Correlation Coefficient R	0.989	0.714	0.673	0.983			
	Test value	Crit. (0.05)	Conclusion with Alpha(0.05)				
Anderson-Darling (Detects Only)	0.2	0.696					
Kolmogorov-Smirnov (Detects Only)	0.161	0.332	Detected Data Appear Gamma Distributed				
Anderson-Darling (NDs = DL)	1.454	0.727					
Kolmogorov-Smirnov (NDs = DL)	0.402	0.299	Data Not Gamma Distributed				
Anderson-Darling (NDs = DL/2)	1.554	0.734					
Kolmogorov-Smirnov (NDs = DL/2)	0.419	0.301	Data Not Gamma Distributed				
Anderson-Darling (Gamma ROS Estimates)	0.213	0.715					
Kolmogorov-Smirnov (Gamma ROS Est.)	0.145	0.293	Data Appear Gamma Distributed				
Lognormal GOF Test Results							
	No NDs	NDs = DL	NDs = DL/2	Log ROS			
Correlation Coefficient R	0.99	0.805	0.795	0.987			
	Test value	Crit. (0.05)	Conclusion with Alpha(0.05)				
Shapiro-Wilk (Detects Only)	0.973	0.788	Data Appear Lognormal				
Shapiro-Wilk (NDs = DL)	0.637	0.818	Data Not Lognormal				
Shapiro-Wilk (NDs = DL/2)	0.621	0.818	Data Not Lognormal				
Shapiro-Wilk (Lognormal ROS Estimates)	0.959	0.818	Data Appear Lognormal				
Lilliefors (Detects Only)	0.151	0.325	Data Appear Lognormal				
Lilliefors (NDs = DL)	0.405	0.283	Data Not Lognormal				
Lilliefors (NDs = DL/2)	0.417	0.283	Data Not Lognormal				
Lilliefors (Lognormal ROS Estimates)	0.138	0.283	Data Appear Lognormal				
Note: Substitution methods such as DL or DL/2 are not recommended.							

Groundwater Stats Database for MW-6

Risk Assessment Report
Former 7-Eleven Facility #135 - 44 Main Street
Rainelle, West Virginia

Sample Location	Sample Date	MTBE (ug/L)	d_MTBE (ug/L)	NROS_MTBE (ug/L)	GROS_MTBE (ug/L)	LnROS_MTBE (ug/L)
MW-6	08/16/16	20.9	1	20.9	20.9	20.9
MW-6	04/03/12	22.6	1	22.6	22.6	22.6
MW-6	01/17/12	18.6	1	18.6	18.6	18.6
MW-6	10/31/11	20.4	1	20.4	20.4	20.4
MW-6	08/18/11	2	0	15.20250517	15.56534314	16.01146551
MW-6	06/20/11	24.7	1	24.7	24.7	24.7
MW-6	03/28/11	2	0	16.76631698	16.97190215	17.20821407
MW-6	12/29/10	23.6	1	23.6	23.6	23.6

Groundwater UCL for MW-6
Risk Assessment Report
Former 7-Eleven Facility #135 - 44 Main Street
Rainelle, West Virginia

UCL Statistics for Data Sets with Non-Detects			
User Selected Options			
Date/Time of Computation	ProUCL 5.12/1/2019 1:37:03 PM		
From File	WorkSheet.xls		
Full Precision	OFF		
Confidence Coefficient	95%		
Number of Bootstrap Operations	2000		
MTBE (ug/L)			
General Statistics			
Total Number of Observations	8	Number of Distinct Observations	7
Number of Detects	6	Number of Non-Detects	2
Number of Distinct Detects	6	Number of Distinct Non-Detects	1
Minimum Detect	18.6	Minimum Non-Detect	2
Maximum Detect	24.7	Maximum Non-Detect	2
Variance Detects	5.06	Percent Non-Detects	25%
Mean Detects	21.8	SD Detects	2.249
Median Detects	21.75	CV Detects	0.103
Skewness Detects	-0.145	Kurtosis Detects	-1.028
Mean of Logged Detects	3.077	SD of Logged Detects	0.104
Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use			
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.			
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).			
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1			
Normal GOF Test on Detects Only			
Shapiro Wilk Test Statistic	0.976	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.788	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.155	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.325	Detected Data appear Normal at 5% Significance Level	
Detected Data appear Normal at 5% Significance Level			
Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs			
KM Mean	16.85	KM Standard Error of Mean	3.391
KM SD	8.756	95% KM (BCA) UCL	21.76
95% KM (t) UCL	23.27	95% KM (Percentile Bootstrap) UCL	21.8
95% KM (z) UCL	22.43	95% KM Bootstrap t UCL	20.93
90% KM Chebyshev UCL	27.02	95% KM Chebyshev UCL	31.63
97.5% KM Chebyshev UCL	38.03	99% KM Chebyshev UCL	50.59
Gamma GOF Tests on Detected Observations Only			
A-D Test Statistic	0.2	Anderson-Darling GOF Test	
5% A-D Critical Value	0.696	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.161	Kolmogorov-Smirnov GOF	
5% K-S Critical Value	0.332	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			

Groundwater UCL for MW-6

Risk Assessment Report
Former 7-Eleven Facility #135 - 44 Main Street
Rainelle, West Virginia

Gamma Statistics on Detected Data Only			
k hat (MLE)	111.2	k star (bias corrected MLE)	55.72
Theta hat (MLE)	0.196	Theta star (bias corrected MLE)	0.391
nu hat (MLE)	1335	nu star (bias corrected)	668.6
Mean (detects)	21.8		
Gamma ROS Statistics using Imputed Non-Detects			
GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs			
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)			
For such situations, GROS method may yield incorrect values of UCLs and BTVs			
This is especially true when the sample size is small.			
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates			
Minimum	15.57	Mean	20.42
Maximum	24.7	Median	20.65
SD	3.211	CV	0.157
k hat (MLE)	44.63	k star (bias corrected MLE)	27.98
Theta hat (MLE)	0.457	Theta star (bias corrected MLE)	0.73
nu hat (MLE)	714.1	nu star (bias corrected)	447.7
Adjusted Level of Significance (β)	0.0195		
Approximate Chi Square Value (447.67, α)	399.6	Adjusted Chi Square Value (447.67, β)	388.1
95% Gamma Approximate UCL (use when n>=50)	22.87	95% Gamma Adjusted UCL (use when n<50)	23.55
Estimates of Gamma Parameters using KM Estimates			
Mean (KM)	16.85	SD (KM)	8.756
Variance (KM)	76.67	SE of Mean (KM)	3.391
k hat (KM)	3.703	k star (KM)	2.398
nu hat (KM)	59.25	nu star (KM)	38.37
theta hat (KM)	4.55	theta star (KM)	7.027
80% gamma percentile (KM)	24.69	90% gamma percentile (KM)	31.42
95% gamma percentile (KM)	37.78	99% gamma percentile (KM)	51.74
Gamma Kaplan-Meier (KM) Statistics			
Approximate Chi Square Value (38.37, α)	25.18	Adjusted Chi Square Value (38.37, β)	22.51
95% Gamma Approximate KM-UCL (use when n>=50)	25.67	95% Gamma Adjusted KM-UCL (use when n<50)	28.71
Lognormal GOF Test on Detected Observations Only			
Shapiro Wilk Test Statistic	0.973	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.788	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.151	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.325	Detected Data appear Lognormal at 5% Significance Level	
Detected Data appear Lognormal at 5% Significance Level			
Lognormal ROS Statistics Using Imputed Non-Detects			
Mean in Original Scale	20.5	Mean in Log Scale	3.01
SD in Original Scale	3.08	SD in Log Scale	0.153
95% t UCL (assumes normality of ROS data)	22.57	95% Percentile Bootstrap UCL	22.23
95% BCA Bootstrap UCL	22.25	95% Bootstrap t UCL	22.47
95% H-UCL (Log ROS)	22.92		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution			
KM Mean (logged)	2.481	KM Geo Mean	11.96
KM SD (logged)	1.036	95% Critical H Value (KM-Log)	3.514
KM Standard Error of Mean (logged)	0.401	95% H-UCL (KM -Log)	80.92
KM SD (logged)	1.036	95% Critical H Value (KM-Log)	3.514
KM Standard Error of Mean (logged)	0.401		
DL/2 Statistics			
DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	16.6	Mean in Log Scale	2.308
SD in Original Scale	9.814	SD in Log Scale	1.427
95% t UCL (Assumes normality)	23.17	95% H-Stat UCL	322.8
DL/2 is not a recommended method, provided for comparisons and historical reasons			
Nonparametric Distribution Free UCL Statistics			
Detected Data appear Normal Distributed at 5% Significance Level			
Suggested UCL to Use			
95% KM (t) UCL	23.27		
Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
Recommendations are based upon data size, data distribution, and skewness.			
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			

Attachment 5

Ecological Checklist

ATTACHMENT 5

Checklist to Determine Applicable Remediation Standards

Part 1: Ecological Standards

STEP 1: Determine Whether a De Minimis Ecological Screening Evaluation is Appropriate for the Site		
1.1	Are there any undeveloped terrestrial areas on or adjacent to the site (e.g., areas that are not under intensive landscape or agricultural control)?	☐ Yes ☑ No
1.2	Are there any potential wetlands (including vernal pools) on or adjacent to the site?	☐ Yes ☑ No
1.3	Are there any surface water bodies (i.e., lotic or lentic habitat) on or adjacent to the site?	☐ Yes ☑ No
1.4	Are there any terrestrial, wetland, or aquatic habitats off-site, but situated downstream, downwind, or downgradient from the site that may be affected by site-related stressors?	☐ Yes ☑ No
1.5	Are there any projected land uses for the site that would result in undeveloped areas, wetland habitat, lotic habitat, or lentic habitat?	☐ Yes ☑ No
If "Yes" to any: A complete exposure pathway may exist for potential ecological receptors of concern. Proceed to Step 2. *If "No" to all: No further ecological evaluation is required. File this completed form with the Risk Assessment Report.*		

ATTACHMENT 5

STEP 2: Identify any Readily Apparent Harm or Exceedances of Surface Water Quality Standards		
2.1	Have there been any incidents where harm to wildlife attributable to contaminants originating from the site has been readily apparent?	☐ Yes ☐ No
	If "Yes": Proceed to Question 2.2. *If "No": Skip to Question 2.3.*	
2.2	Has the cause of such harm been eliminated?	☐ Yes ☐ No
	If "Yes": Briefly describe the action taken and complete the rest of the checklist. *If "No": Proceed directly to the remedy evaluation or, alternately, proceed with a determination of a Uniform or Site-Specific Ecological Standard, as described in the VRP Guidance Manual, prior to implementation of the remedy. File this form with the Risk Assessment Report.*	
	Action Taken:	
2.3	Is the site contributing to exceedances of surface water quality standards established for the protection of aquatic life (see W. Va. Legislative Rule 47CSR2)?	☐ Yes ☐ No
	If "Yes": Proceed directly to the remedy evaluation or, alternately, proceed with a determination of a Uniform or Site-Specific Ecological Standard, as described in the VRP Guidance Manual, prior to implementation of the remedy. *If "No": Proceed to Step 3.*	

ATTACHMENT 5

STEP 3: Identify Contamination Associated with Ecological Habitats		
3.1	Have the environmental media (e.g., soil, surface water, sediment, biota) associated with the ecological habitat(s) identified in Questions 1.2 through 1.5 been sampled and analyzed with regard to potential site-related contaminants of concern?	☐ Yes ☐ No
	If "Yes": Proceed to Question 3.2. *If "No": Skip to Step 4.*	
3.2	Have any site-related contaminants been detected above natural background concentrations in environmental media collected from terrestrial habitat?	☐ Yes ☐ No ☐ Unknown ☐ n/a
3.3	Have any site-related contaminants been detected above natural background concentrations in environmental media collected from wetland or aquatic habitats (lotic or lentic habitats)?	☐ Yes ☐ No ☐ Unknown ☐ n/a
	If "Yes" or "Unknown" to 3.2 and/or 3.3: Proceed to Question 3.4. *If "No" or "n/a" to both 3.2 and 3.3: Skip to Question 3.6.*	
3.4	Are site-related contaminants presenting an ecological risk over and above "local" condition?	☐ Yes ☐ No ☐ Unknown
	If "Yes": Skip to Step 4. *If "No" or "Unknown": Proceed to Question 3.5.*	
3.5	Have site-related releases of contaminants been stopped?	☐ Yes ☐ No
	If "Yes": Proceed to Question 3.6. *If "No": Skip to Part 4.*	
3.6	Are site-related contaminants currently or likely to be migrating to aquatic habitat (e.g., lotic, lentic, or wetland habitat)?	☐ Yes ☐ No ☐ n/a
	If "Yes": Proceed to Step 4. *If "No" or "n/a": No further ecological evaluation is required. File this completed form with the Risk Assessment Report.*	

ATTACHMENT 5

STEP 4: Characterize the Potential Ecological Habitat		
4.1	Describe the general land use in the immediate vicinity of the site.	
	☐ Commercial/Industrial ☐ Residential ☐ Rural/Agricultural ☐ Rural/Undeveloped ☐ Urban ☐ Other:	
4.2	For all affected areas that fulfill the descriptions in Step 1, answer the following and attach a site map identifying the potential ecological habitat.	
	4.2.1 Outline characteristics for potential terrestrial habitats.	
	Location:	
	Contiguous Area:	
	General Topography:	
	Primary Soil Type:	
	Predominant Vegetation Species:	
	4.2.2 Outline characteristics for potential wetland habitats (e.g., vernal pools, marshes, etc.).	
	Location:	
	Contiguous Area:	
	General Topography:	
	Primary Soil Type:	
	Predominant Vegetation Species:	
	4.2.3 Outline characteristics for potential lotic habitats (e.g., flowing water habitat such as rivers and streams).	
	Location:	
	Typical Width and Depth:	
	Typical Flow Rate:	
	Typical Gradient (m/km):	
	Type of River/Creek Bottom:	
	Types of Aquatic Vegetation Present:	
	Topography of the Riparian Zone:	
	Predominant Riparian Vegetation:	
	Human Utilization of Lotic Habitat:	
	Local Conditions:	
	4.2.4 Outline characteristics for potential lentic habitats (e.g., standing water habitats such as lakes and ponds).	
	Location:	
	Is the lentic habitat…?	☐ Natural ☐ Man-made
	Area of Lentic Habitat	
	Typical and Maximum Depth:	
	Description of Sources & Drainage:	
	Predominant Aquatic Vegetation:	
	Topography of Littoral Zone:	
	Predominant Littoral Zone Vegetation:	
	Human Utilization of Lentic Habitat:	

	Local Conditions:	
4.3	Indicate if the site contains or is adjacent to any of the following types of valued terrestrial habitats:	
	☐ Climax Community (e.g., old growth forest) ☐ Federal Wilderness Area (designated or administratively proposed) ☐ National or State Forest ☐ National or State Park ☐ National or State Wildlife Refuge ☐ National Preserve Area ☐ State designated natural area ☐ Federal land designated for protection of natural ecosystems ☐ Federal or State land designated for wildlife or game management ☐ Area utilized for breeding by large or dense aggregations of wildlife ☐ Feeding, breeding, nesting, cover, or wintering habitat for migratory birds ☐ Area important to the maintenance of unique biotic communities (e.g., high proportion of endemic species) *Threatened or Endangered Species* ☐ Critical habitat for federally designated threatened or endangered species ☐ Habitat known to be used or potentially used by Federal or State designated threatened or endangered species, or species in the State Wildlife Action Plan	
4.4	Indicate if the site contains or is adjacent to any of the following types of valued wetlands:	
	☐ Area important to the maintenance of unique biotic communities (e.g., high proportion of endemic species) ☐ Area utilized for breeding by large or dense aggregations of wildlife ☐ Spawning or nursery areas critical to the maintenance of fish/shellfish species ☐ Feeding, breeding, nesting, cover, or wintering habitat for migratory waterfowl or other aquatic birds ☐ Area important to the maintenance of unique biotic communities (e.g., high proportion of endemic species) *Threatened or Endangered Species* ☐ Critical habitat for federally designated threatened or endangered species ☐ Habitat known to be used or potentially used by Federal or State designated threatened or endangered species, or species in the State Wildlife Action Plan	
4.5	Indicate if the site is within or adjacent to any of the following valued aquatic habitats:	
	☐ Federal or State Fish Hatchery ☐ Federal or State designated Scenic or Wild River ☐ National River Reach designated as recreational ☐ Critical areas identified under the Clean Lakes Program ☐ Trout-stocked streams or wild trout streams with verified trout production ☐ Spawning or nursery areas critical the maintenance of fish/shellfish species ☐ Feeding, breeding, nesting, cover, or wintering habitat for migratory waterfowl or other aquatic birds ☐ Area important to the maintenance of unique biotic communities (e.g., high proportion of endemic species) *Threatened or Endangered Species* ☐ Critical habitat for federally designated threatened or endangered species ☐ Habitat known to be used or potentially used by Federal or State designated threatened or endangered species, or species in the State Wildlife Action Plan	
4.6	Have valued terrestrial, wetland, or aquatic habitats been identified within or adjacent to this site? *(A list of agencies that can provide information that should assist in determining whether the site is located within or adjacent to the areas listed in 4.3, 4.4, and 4.5 is provided at the end of this checklist.)*	☐ Yes ☐ No

ATTACHMENT 5

STEP 5: Identify Any Potential Ecological Receptors of Concern		
5.1	Threatened and Endangered Species Were any potential habitats within or adjacent to the site identified as critical habitat for federally designated threatened or endangered species listed in 50CFS17.95 or 17.96, or areas known to be used by federal or state designated threatened or endangered species?	☐ Yes ☐ No
	If "Yes", indicate which species*: *Amphibians* ☐ Cheat Mountain salamander (Plethodon nettingi) *Birds* ☐ Bald eagle (Haliaeetus leucocephalus) *Clams* ☐ Clubshell (Pleurobema clava) ☐ Fanshell (Cyprogenia stegaria) ☐ James spinymussel (Pleurobeam collina) ☐ Northern riffleshell (Epioblasma torulosa rangiana) ☐ Pink mucket pearlymussel (Lampsilis abrupta) ☐ Tubercled blossom pearlymussel (Epioblasma torulosa torulosa) *Flowering Plants* ☐ Harperella (Ptilimnium nodosum) ☐ Northeastern bulrush (Scirpus ancistrochaetus) ☐ Running buffalo cover (Trifolium stoloniferum) ☐ Shale barren rock cress (Arabis perstellata) ☐ Small whorled pogonia (Isotria medeoloides) ☐ Virginia spiraea (Spiraea virginiana) *Mammals* ☐ Eastern cougar (Felis concolor couguar) ☐ Gray bat (Myotis grisescens) ☐ Indiana bat (Myotis sodalis) ☐ Virginia big-eared bat (Corynorhinus towsendii virgniaus) ☐ Virginia northern flying squirrel (Glaucomys sabrinus fuscus) *Snails* ☐ Flat-spired three-toothed land snail (Triodopsis platysayoides)	
5.2	Local Populations Providing Important Natural or Economic Resources, Functions, and Values Were any valued terrestrial, wetland, or aquatic habitats listed in 4.3, 4.4, or 4.5 identified within or adjacent to the site?	☐ Yes ☐ No
If "Yes" to 5.1 and/or 5.2 and/or surface water bodies are not in compliance with applicable water quality standards: The site does not pass the De Minimis ecological risk screening, since a complete exposure pathway may exist for potential ecological receptors of concern. Further evaluation of the site is required using either the Uniform Ecological Standard or the Site-Specific Ecological Standard. *If "No" to 5.1 and 5.2 and surface water bodes are in compliance with applicable water quality standards: No further ecological evaluation is required. File this completed form with the Risk Assessment Report.*		

*The list contains those federally designated threatened and endangered species that are indigenous to WV. WVDNR, Wildlife Resources Section should be consulted to ensure the list is correct. WV has not established a list of state designated threatened or endangered species; however, the WVDNR has developed a "Species of Greatest Conservation Need" list in the State Wildlife Action Plan. Species listed in the in the State Wildlife Action Plan should also be considered in any Ecological Risk Assessment.

Attachment 6

Supporting Documentation for Derivation of Source Concentrations

Groundwater Stats Database - Entire Site
Former 7-Eleven #135 - 44 Main Street
Rainelle, West Virginia

Sampling Location	Sampling Date	Benzene (ug/L)	d_Benzene (ug/L)	NROS_Benzene (ug/L)	GROS_Benzene (ug/L)	LnROS_Benzene (ug/L)	MTBE (ug/L)	d_MTBE (ug/L)	NROS_MTBE (ug/L)	GROS_MTBE (ug/L)	LnROS_MTBE (ug/L)
MW-3R	08/16/16	91.2	1	91.2	91.2	91.2	17.6	1	17.6	17.6	17.6
MW-3	04/03/12	54.8	1	54.8	54.8	54.8	108	1	108	108	108
	01/17/12	80.2	1	80.2	80.2	80.2	134	1	134	134	134
	10/31/11	75	1	75	75	75	120	1	120	120	120
	08/18/11	107	1	107	107	107	194	1	194	194	194
	06/20/11	74.5	1	74.5	74.5	74.5	139	1	139	139	139
	03/28/11	44.4	1	44.4	44.4	44.4	2	0	-167.7677337	0.01	0.062975898
MW-2	08/16/16	1	0	-67.14473605	0.01	10.39393873	2	0	-133.5562552	0.01	0.153265107
	04/03/12	1	0	-49.71102917	0.01	13.18567746	2	0	-110.6733757	0.01	0.277846718
	01/17/12	1	0	-38.09041126	0.01	15.45158354	2	0	-92.63881044	0.01	0.444044768
	10/31/11	1	0	-28.96188715	0.01	17.5014464	2	0	-77.30114992	0.01	0.661604587
	08/18/11	1	0	-21.22438422	0.01	19.45050532	2	0	-63.65624375	0.01	0.943317749
	06/20/11	1	0	-14.36513927	0.01	21.35909105	2	0	-51.14248356	0.01	1.306008974
	03/28/11	1	0	-8.098516191	3.573674143	23.26603748	2	0	-39.40549205	0.01	1.772001615
	12/29/10	1	0	-2.245523752	7.902707651	25.2005874	2	0	-28.19972361	0.01	2.371287577
MW-1	08/16/16	1	0	3.316443503	12.10655318	27.18780332	13.2	1	13.2	13.2	13.2
	04/03/12	1	0	8.677951829	16.24265701	29.25159413	2	0	-17.34049585	0.01	3.144790207
	01/17/12	1	0	13.91077653	20.35940387	31.41682582	0.9	1	0.9	0.9	0.9
	10/31/11	1	0	19.07593057	24.50091029	33.7111846	2	0	-6.677476741	0.01	4.149385766
	08/18/11	1	0	24.22915425	28.71062766	36.16721077	19.4	1	19.4	19.4	19.4
	06/20/11	1	0	29.42528517	33.03460777	38.82489713	2	0	3.921964625	2.128314869	5.465855105
	03/28/11	1	0	34.7224449	37.52510375	41.7353794	13.7	1	13.7	13.7	13.7
	12/29/10	1	0	40.18690429	42.24524664	44.96658779	7.5	1	7.5	7.5	7.5

Groundwater Goodness of Fit Test - Entire Site

Former 7-Eleven Facility #135 - 44 Main Street

Rainelle, West Virginia

	Goodness-of-Fit Test Statistics for Data Sets with Non-Detects
User Selected Options	
Date/Time of Computation	ProUCL 5.13/20/2020 10:32:30 AM
From File	GW Stats Database_On-Site_032020.xls
Full Precision	OFF
Confidence Coefficient	0.95

Benzene (ug/L)

	Num Obs	Num Miss	Num Valid	Detects	NDs	% NDs
Raw Statistics	23	0	23	7	16	69.57%

	Number	Minimum	Maximum	Mean	Median	SD
Statistics (Non-Detects Only)	16	1	1	1	1	0
Statistics (Non-Detects Only)	7	44.4	107	75.3	75	21.05
Statistics (All: NDs treated as DL value)	23	1	107	23.61	1	36.64
Statistics (All: NDs treated as DL/2 value)	23	0.5	107	23.27	0.5	36.87
Statistics (Normal ROS Imputed Data)	23	-67.14	107	20.47	19.08	46.53
Statistics (Gamma ROS Imputed Data)	23	0.01	107	32.75	24.5	33.22
Statistics (Lognormal ROS Imputed Data)	23	10.39	107	41.57	33.71	26.74

	K hat	K Star	Theta hat	Log Mean	Log Stdv	Log CV
Statistics (Non-Detects Only)	13.9	8.041	5.416	4.285	0.299	0.0697
Statistics (NDs = DL)	0.36	0.342	65.54	1.304	2.022	1.55
Statistics (NDs = DL/2)	0.297	0.287	78.32	0.822	2.347	2.856
Statistics (Gamma ROS Estimates)	0.321	0.308	102	1.366	3.713	2.718
Statistics (Lognormal ROS Estimates)	--	--	--	3.537	0.636	0.18

Normal GOF Test Results

	No NDs	NDs = DL	NDs = DL/2	Normal ROS
Correlation Coefficient R	0.986	0.812	0.812	0.997

	Test value	Crit. (0.05)	Conclusion with Alpha(0.05)
Shapiro-Wilk (Detects Only)	0.973	0.803	Data Appear Normal
Shapiro-Wilk (NDs = DL)	0.652	0.914	Data Not Normal
Shapiro-Wilk (NDs = DL/2)	0.652	0.914	Data Not Normal
Shapiro-Wilk (Normal ROS Estimates)	0.986	0.914	Data Appear Normal
Lilliefors (Detects Only)	0.199	0.304	Data Appear Normal
Lilliefors (NDs = DL)	0.427	0.18	Data Not Normal
Lilliefors (NDs = DL/2)	0.427	0.18	Data Not Normal
Lilliefors (Normal ROS Estimates)	0.0946	0.18	Data Appear Normal

Groundwater Goodness of Fit Test - Entire Site
Former 7-Eleven Facility #135 - 44 Main Street
Rainelle, West Virginia

Gamma GOF Test Results				
	No NDs	NDs = DL	NDs = DL/2	Gamma ROS
Correlation Coefficient R	0.98	0.901	0.888	0.89

	Test value	Crit. (0.05)	Conclusion with Alpha(0.05)
Anderson-Darling (Detects Only)	0.258	0.708	
Kolmogorov-Smirnov (Detects Only)	0.234	0.312	Detected Data Appear Gamma Distributed
Anderson-Darling (NDs = DL)	4.329	0.836	
Kolmogorov-Smirnov (NDs = DL)	0.448	0.195	Data Not Gamma Distributed
Anderson-Darling (NDs = DL/2)	4.334	0.85	
Kolmogorov-Smirnov (NDs = DL/2)	0.448	0.197	Data Not Gamma Distributed
Anderson-Darling (Gamma ROS Estimates)	1.918	0.844	
Kolmogorov-Smirnov (Gamma ROS Est.)	0.205	0.196	Data Not Gamma Distributed

Lognormal GOF Test Results				
	No NDs	NDs = DL	NDs = DL/2	Log ROS
Correlation Coefficient R	0.974	0.789	0.788	0.994

	Test value	Crit. (0.05)	Conclusion with Alpha(0.05)
Shapiro-Wilk (Detects Only)	0.95	0.803	Data Appear Lognormal
Shapiro-Wilk (NDs = DL)	0.609	0.914	Data Not Lognormal
Shapiro-Wilk (NDs = DL/2)	0.605	0.914	Data Not Lognormal
Shapiro-Wilk (Lognormal ROS Estimates)	0.98	0.914	Data Appear Lognormal
Lilliefors (Detects Only)	0.249	0.304	Data Appear Lognormal
Lilliefors (NDs = DL)	0.436	0.18	Data Not Lognormal
Lilliefors (NDs = DL/2)	0.436	0.18	Data Not Lognormal
Lilliefors (Lognormal ROS Estimates)	0.105	0.18	Data Appear Lognormal

Note: Substitution methods such as DL or DL/2 are not recommended.

Groundwater Goodness of Fit Test - Entire Site

Former 7-Eleven Facility #135 - 44 Main Street

Rainelle, West Virginia

MTBE (ug/L)								
	Num Obs	Num Miss	Num Valid	Detects	NDs	% NDs		
Raw Statistics	23	0	23	11	12	52.17%		
	Number	Minimum	Maximum	Mean	Median	SD		
Statistics (Non-Detects Only)	12	2	2	2	2	0		
Statistics (Non-Detects Only)	11	0.9	194	69.75	19.4	69.68		
Statistics (All: NDs treated as DL value)	23	0.9	194	34.4	2	58.35		
Statistics (All: NDs treated as DL/2 value)	23	0.9	194	33.88	1	58.66		
Statistics (Normal ROS Imputed Data)	23	-167.8	194	-0.745	0.9	91.51		
Statistics (Gamma ROS Imputed Data)	23	0.01	194	33.46	0.9	58.91		
Statistics (Lognormal ROS Imputed Data)	23	0.063	194	34.26	4.149	58.45		
	K hat	K Star	Theta hat	Log Mean	Log Stdv	Log CV		
Statistics (Non-Detects Only)	0.721	0.585	96.77	3.41	1.662	0.487		
Statistics (NDs = DL)	0.422	0.396	81.51	1.993	1.784	0.895		
Statistics (NDs = DL/2)	0.355	0.337	95.54	1.631	2.071	1.27		
Statistics (Gamma ROS Estimates)	0.184	0.189	181.7	-0.539	4.171	-7.742		
Statistics (Lognormal ROS Estimates)	--	--	--	1.577	2.329	1.477		
Normal GOF Test Results								
	No NDs	NDs = DL	NDs = DL/2	Normal ROS				
Correlation Coefficient R	0.919	0.785	0.787	0.981				
	Test value	Crit. (0.05)	Conclusion with Alpha(0.05)					
Shapiro-Wilk (Detects Only)	0.828	0.85	Data Not Normal					
Shapiro-Wilk (NDs = DL)	0.618	0.914	Data Not Normal					
Shapiro-Wilk (NDs = DL/2)	0.62	0.914	Data Not Normal					
Shapiro-Wilk (Normal ROS Estimates)	0.96	0.914	Data Appear Normal					
Lilliefors (Detects Only)	0.31	0.251	Data Not Normal					
Lilliefors (NDs = DL)	0.384	0.18	Data Not Normal					
Lilliefors (NDs = DL/2)	0.38	0.18	Data Not Normal					
Lilliefors (Normal ROS Estimates)	0.195	0.18	Data Not Normal					
Gamma GOF Test Results								
	No NDs	NDs = DL	NDs = DL/2	Gamma ROS				
Correlation Coefficient R	0.907	0.943	0.94	0.909				

Groundwater Goodness of Fit Test - Entire Site

Former 7-Eleven Facility #135 - 44 Main Street

Rainelle, West Virginia

	Test value	Crit. (0.05)	Conclusion with Alpha(0.05)			
Anderson-Darling (Detects Only)	0.641	0.765				
Kolmogorov-Smirnov (Detects Only)	0.238	0.265	Detected Data Appear Gamma Distributed			
Anderson-Darling (NDs = DL)	2.786	0.822				
Kolmogorov-Smirnov (NDs = DL)	0.331	0.194	Data Not Gamma Distributed			
Anderson-Darling (NDs = DL/2)	2.762	0.837				
Kolmogorov-Smirnov (NDs = DL/2)	0.343	0.195	Data Not Gamma Distributed			
Anderson-Darling (Gamma ROS Estimates)	1.827	0.912				
Kolmogorov-Smirnov (Gamma ROS Est.)	0.3	0.202	Data Not Gamma Distributed			
Lognormal GOF Test Results						
	No NDs	NDs = DL	NDs = DL/2	Log ROS		
Correlation Coefficient R	0.94	0.892	0.875	0.986		
	Test value	Crit. (0.05)	Conclusion with Alpha(0.05)			
Shapiro-Wilk (Detects Only)	0.883	0.85	Data Appear Lognormal			
Shapiro-Wilk (NDs = DL)	0.783	0.914	Data Not Lognormal			
Shapiro-Wilk (NDs = DL/2)	0.748	0.914	Data Not Lognormal			
Shapiro-Wilk (Lognormal ROS Estimates)	0.96	0.914	Data Appear Lognormal			
Lilliefors (Detects Only)	0.233	0.251	Data Appear Lognormal			
Lilliefors (NDs = DL)	0.332	0.18	Data Not Lognormal			
Lilliefors (NDs = DL/2)	0.35	0.18	Data Not Lognormal			
Lilliefors (Lognormal ROS Estimates)	0.126	0.18	Data Appear Lognormal			
Note: Substitution methods such as DL or DL/2 are not recommended.						

Groundwater UCL - Entire Site
Former 7-Eleven # 135 - 44 Main Street
Rainelle, West Virginia

UCL Statistics for Data Sets with Non-Detects	
User Selected Options	
Date/Time of Computation	ProUCL 5.13/20/2020 10:00:45 AM
From File	GW Stats Database_On-Site_032020.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Benzene (ug/L)

General Statistics			
Total Number of Observations	23	Number of Distinct Observations	8
Number of Detects	7	Number of Non-Detects	16
Number of Distinct Detects	7	Number of Distinct Non-Detects	1
Minimum Detect	44.4	Minimum Non-Detect	1
Maximum Detect	107	Maximum Non-Detect	1
Variance Detects	442.9	Percent Non-Detects	69.57%
Mean Detects	75.3	SD Detects	21.05
Median Detects	75	CV Detects	0.279
Skewness Detects	-0.0532	Kurtosis Detects	-0.256
Mean of Logged Detects	4.285	SD of Logged Detects	0.299

Normal GOF Test on Detects Only		
Shapiro Wilk Test Statistic	0.973	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.803	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.199	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.304	Detected Data appear Normal at 5% Significance Level
Detected Data appear Normal at 5% Significance Level		

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs			
KM Mean	23.61	KM Standard Error of Mean	8.071
KM SD	35.84	95% KM (BCA) UCL	36.18
95% KM (t) UCL	37.47	95% KM (Percentile Bootstrap) UCL	36.03
95% KM (z) UCL	36.89	95% KM Bootstrap t UCL	36.02
90% KM Chebyshev UCL	47.83	95% KM Chebyshev UCL	58.8
97.5% KM Chebyshev UCL	74.02	99% KM Chebyshev UCL	103.9

Gamma GOF Tests on Detected Observations Only		
A-D Test Statistic	0.258	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.708	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.234	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.312	Detected data appear Gamma Distributed at 5% Significance Level
Detected data appear Gamma Distributed at 5% Significance Level		

Gamma Statistics on Detected Data Only			
k hat (MLE)	13.9	k star (bias corrected MLE)	8.041
Theta hat (MLE)	5.416	Theta star (bias corrected MLE)	9.365
nu hat (MLE)	194.7	nu star (bias corrected)	112.6
Mean (detects)	75.3		
Gamma ROS Statistics using Imputed Non-Detects			
GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs			
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)			
For such situations, GROS method may yield incorrect values of UCLs and BTVs			
This is especially true when the sample size is small.			
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates			
Minimum	0.01	Mean	32.75
Maximum	107	Median	24.5
SD	33.22	CV	1.014
k hat (MLE)	0.321	k star (bias corrected MLE)	0.308
Theta hat (MLE)	102	Theta star (bias corrected MLE)	106.2
nu hat (MLE)	14.78	nu star (bias corrected)	14.18
Adjusted Level of Significance (β)	0.0389		
Approximate Chi Square Value (14.18, α)	6.696	Adjusted Chi Square Value (14.18, β)	6.325
95% Gamma Approximate UCL (use when n>=50)	69.37	95% Gamma Adjusted UCL (use when n<50)	73.44
Estimates of Gamma Parameters using KM Estimates			
Mean (KM)	23.61	SD (KM)	35.84
Variance (KM)	1284	SE of Mean (KM)	8.071
k hat (KM)	0.434	k star (KM)	0.406
nu hat (KM)	19.97	nu star (KM)	18.7
theta hat (KM)	54.39	theta star (KM)	58.09
80% gamma percentile (KM)	38.18	90% gamma percentile (KM)	66.51
95% gamma percentile (KM)	97.56	99% gamma percentile (KM)	175.5
Gamma Kaplan-Meier (KM) Statistics			
Approximate Chi Square Value (18.70, α)	9.898	Adjusted Chi Square Value (18.70, β)	9.435
95% Gamma Approximate KM-UCL (use when n>=50)	44.61	95% Gamma Adjusted KM-UCL (use when n<50)	46.8
Lognormal GOF Test on Detected Observations Only			
Shapiro Wilk Test Statistic	0.95	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.803	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.249	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.304	Detected Data appear Lognormal at 5% Significance Level	
Detected Data appear Lognormal at 5% Significance Level			

Lognormal ROS Statistics Using Imputed Non-Detects			
Mean in Original Scale	41.57	Mean in Log Scale	3.537
SD in Original Scale	26.74	SD in Log Scale	0.636
95% t UCL (assumes normality of ROS data)	51.15	95% Percentile Bootstrap UCL	50.49
95% BCA Bootstrap UCL	52.16	95% Bootstrap t UCL	53.1
95% H-UCL (Log ROS)	55.95		
Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution			
KM Mean (logged)	1.304	KM Geo Mean	3.685
KM SD (logged)	1.978	95% Critical H Value (KM-Log)	4.015
KM Standard Error of Mean (logged)	0.445	95% H-UCL (KM -Log)	141.5
KM SD (logged)	1.978	95% Critical H Value (KM-Log)	4.015
KM Standard Error of Mean (logged)	0.445		
DL/2 Statistics			
DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	23.27	Mean in Log Scale	0.822
SD in Original Scale	36.87	SD in Log Scale	2.347
95% t UCL (Assumes normality)	36.47	95% H-Stat UCL	363.9
DL/2 is not a recommended method, provided for comparisons and historical reasons			
Nonparametric Distribution Free UCL Statistics			
Detected Data appear Normal Distributed at 5% Significance Level			
Suggested UCL to Use			
95% KM (t) UCL	37.47		
Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
Recommendations are based upon data size, data distribution, and skewness.			
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			

Groundwater UCL - Entire Site
Former 7-Eleven # 135 - 44 Main Street
Rainelle, West Virginia

MTBE (ug/L)			
General Statistics			
Total Number of Observations	23	Number of Distinct Observations	12
Number of Detects	11	Number of Non-Detects	12
Number of Distinct Detects	11	Number of Distinct Non-Detects	1
Minimum Detect	0.9	Minimum Non-Detect	2
Maximum Detect	194	Maximum Non-Detect	2
Variance Detects	4856	Percent Non-Detects	52.17%
Mean Detects	69.75	SD Detects	69.68
Median Detects	19.4	CV Detects	0.999
Skewness Detects	0.543	Kurtosis Detects	-1.381
Mean of Logged Detects	3.41	SD of Logged Detects	1.662
Normal GOF Test on Detects Only			
Shapiro Wilk Test Statistic	0.828	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.85	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.31	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.251	Detected Data Not Normal at 5% Significance Level	
Detected Data Not Normal at 5% Significance Level			
Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs			
KM Mean	33.83	KM Standard Error of Mean	12.55
KM SD	57.4	95% KM (BCA) UCL	54.9
95% KM (t) UCL	55.38	95% KM (Percentile Bootstrap) UCL	55.56
95% KM (z) UCL	54.48	95% KM Bootstrap t UCL	63.14
90% KM Chebyshev UCL	71.49	95% KM Chebyshev UCL	88.54
97.5% KM Chebyshev UCL	112.2	99% KM Chebyshev UCL	158.7
Gamma GOF Tests on Detected Observations Only			
A-D Test Statistic	0.641	Anderson-Darling GOF Test	
5% A-D Critical Value	0.765	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.238	Kolmogorov-Smirnov GOF	
5% K-S Critical Value	0.265	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics on Detected Data Only			
k hat (MLE)	0.721	k star (bias corrected MLE)	0.585
Theta hat (MLE)	96.77	Theta star (bias corrected MLE)	119.3
nu hat (MLE)	15.86	nu star (bias corrected)	12.87
Mean (detects)	69.75		

Gamma ROS Statistics using Imputed Non-Detects			
GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs			
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)			
For such situations, GROS method may yield incorrect values of UCLs and BTVs			
This is especially true when the sample size is small.			
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates			
Minimum	0.01	Mean	33.46
Maximum	194	Median	0.9
SD	58.91	CV	1.761
k hat (MLE)	0.184	k star (bias corrected MLE)	0.189
Theta hat (MLE)	181.7	Theta star (bias corrected MLE)	177
nu hat (MLE)	8.468	nu star (bias corrected)	8.697
Adjusted Level of Significance (β)	0.0389		
Approximate Chi Square Value (8.70, α)	3.145	Adjusted Chi Square Value (8.70, β)	2.907
95% Gamma Approximate UCL (use when n>=50)	92.52	95% Gamma Adjusted UCL (use when n<50)	100.1
Estimates of Gamma Parameters using KM Estimates			
Mean (KM)	33.83	SD (KM)	57.4
Variance (KM)	3294	SE of Mean (KM)	12.55
k hat (KM)	0.347	k star (KM)	0.331
nu hat (KM)	15.98	nu star (KM)	15.23
theta hat (KM)	97.38	theta star (KM)	102.2
80% gamma percentile (KM)	53.02	90% gamma percentile (KM)	98.5
95% gamma percentile (KM)	149.9	99% gamma percentile (KM)	281.8
Gamma Kaplan-Meier (KM) Statistics			
Approximate Chi Square Value (15.23, α)	7.422	Adjusted Chi Square Value (15.23, β)	7.028
95% Gamma Approximate KM-UCL (use when n>=50)	69.42	95% Gamma Adjusted KM-UCL (use when n<50)	73.31
Lognormal GOF Test on Detected Observations Only			
Shapiro Wilk Test Statistic	0.883	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.85	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.233	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.251	Detected Data appear Lognormal at 5% Significance Level	
Detected Data appear Lognormal at 5% Significance Level			
Lognormal ROS Statistics Using Imputed Non-Detects			
Mean in Original Scale	34.26	Mean in Log Scale	1.577
SD in Original Scale	58.45	SD in Log Scale	2.329
95% t UCL (assumes normality of ROS data)	55.19	95% Percentile Bootstrap UCL	55.01
95% BCA Bootstrap UCL	57.68	95% Bootstrap t UCL	64.3
95% H-UCL (Log ROS)	716.9		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution			
KM Mean (logged)	1.576	KM Geo Mean	4.835
KM SD (logged)	2.07	95% Critical H Value (KM-Log)	4.168
KM Standard Error of Mean (logged)	0.453	95% H-UCL (KM -Log)	259.2
KM SD (logged)	2.07	95% Critical H Value (KM-Log)	4.168
KM Standard Error of Mean (logged)	0.453		
DL/2 Statistics			
DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	33.88	Mean in Log Scale	1.631
SD in Original Scale	58.66	SD in Log Scale	2.071
95% t UCL (Assumes normality)	54.88	95% H-Stat UCL	274.9
DL/2 is not a recommended method, provided for comparisons and historical reasons			
Nonparametric Distribution Free UCL Statistics			
Detected Data appear Gamma Distributed at 5% Significance Level			
Suggested UCL to Use			
Adjusted KM-UCL (use when k<=1 and 15 < n < 50 but k<=1)	73.31		
Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
Recommendations are based upon data size, data distribution, and skewness.			
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			

Groundwater Stats Database - Source Area
Former 7-Eleven # 135 - 44 Main Street
Rainelle, West Virginia

Sampling Location	Sampling Date	Benzene (ug/L)	d_Benzene (ug/L)	MTBE (ug/L)	d_MTBE (ug/L)	NROS_MTBE (ug/L)	GROS_MTBE (ug/L)	LnROS_MTBE (ug/L)
MW-3R	08/16/16	91.2	1	17.6	1	17.6	17.6	17.6
MW-3	04/03/12	54.8	1	108	1	108	108	108
	01/17/12	80.2	1	134	1	134	134	134
	10/31/11	75	1	120	1	120	120	120
	08/18/11	107	1	194	1	194	194	194
	06/20/11	74.5	1	139	1	139	139	139
	03/28/11	44.4	1	2	0	-17.71814609	25.4416071	16.94442952

Groundwater Goodness of Fit Test - Source Area
Former 7-Eleven Facility #135 - 44 Main Street
Rainelle, West Virginia

	Goodness-of-Fit Test Statistics for Data Sets with Non-Detects
User Selected Options	
Date/Time of Computation	ProUCL 5.12/8/2019 8:34:41 AM
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	0.95

Benzene (ug/L)	
Raw Statistics	
Number of Valid Observations	7
Number of Distinct Observations	7
Minimum	44.4
Maximum	107
Mean of Raw Data	75.3
Standard Deviation of Raw Data	21.05
Khat	13.9
Theta hat	5.416
Kstar	8.041
Theta star	9.365
Mean of Log Transformed Data	4.285
Standard Deviation of Log Transformed Data	0.299
Normal GOF Test Results	
Correlation Coefficient R	0.986
Shapiro Wilk Test Statistic	0.973
Shapiro Wilk Critical (0.05) Value	0.803
Approximate Shapiro Wilk P Value	0.915
Lilliefors Test Statistic	0.199
Lilliefors Critical (0.05) Value	0.304
Data appear Normal at (0.05) Significance Level	
Gamma GOF Test Results	
Correlation Coefficient R	0.98
A-D Test Statistic	0.258
A-D Critical (0.05) Value	0.708
K-S Test Statistic	0.234
K-S Critical(0.05) Value	0.312
Data appear Gamma Distributed at (0.05) Significance Level	
Lognormal GOF Test Results	
Correlation Coefficient R	0.974
Shapiro Wilk Test Statistic	0.95
Shapiro Wilk Critical (0.05) Value	0.803
Approximate Shapiro Wilk P Value	0.734
Lilliefors Test Statistic	0.249
Lilliefors Critical (0.05) Value	0.304
Data appear Lognormal at (0.05) Significance Level	

Groundwater Goodness of Fit Test - Source Area
Former 7-Eleven Facility #135 - 44 Main Street
Rainelle, West Virginia

MTBE (ug/L)						
	Num Obs	Num Miss	Num Valid	Detects	NDs	% NDs
Raw Statistics	7	0	7	6	1	14.29%
	Number	Minimum	Maximum	Mean	Median	SD
Statistics (Non-Detects Only)	1	2	2	2	2	N/A
Statistics (Non-Detects Only)	6	17.6	194	118.8	127	57.71
Statistics (All: NDs treated as DL value)	7	2	194	102.1	120	68.73
Statistics (All: NDs treated as DL/2 value)	7	1	194	101.9	120	68.97
Statistics (Normal ROS Imputed Data)	7	-17.72	194	99.27	120	73.73
Statistics (Gamma ROS Imputed Data)	7	17.6	194	105.4	120	63.4
Statistics (Lognormal ROS Imputed Data)	7	16.94	194	104.2	120	65.24
	K hat	K Star	Theta hat	Log Mean	Log Stdv	Log CV
Statistics (Non-Detects Only)	2.603	1.413	45.63	4.573	0.858	0.188
Statistics (NDs = DL)	0.956	0.641	106.8	4.019	1.663	0.414
Statistics (NDs = DL/2)	0.837	0.574	121.8	3.92	1.898	0.484
Statistics (Gamma ROS Estimates)	1.961	1.216	53.76	4.382	0.932	0.213
Statistics (Lognormal ROS Estimates)	--	--	--	4.324	1.024	0.237

Normal GOF Test Results

	No NDs	NDs = DL	NDs = DL/2	Normal ROS
Correlation Coefficient R	0.942	0.953	0.953	0.954

	Test value	Crit. (0.05)	Conclusion with Alpha(0.05)
Shapiro-Wilk (Detects Only)	0.914	0.788	Data Appear Normal
Shapiro-Wilk (NDs = DL)	0.905	0.803	Data Appear Normal
Shapiro-Wilk (NDs = DL/2)	0.905	0.803	Data Appear Normal
Shapiro-Wilk (Normal ROS Estimates)	0.911	0.803	Data Appear Normal
Lilliefors (Detects Only)	0.259	0.325	Data Appear Normal
Lilliefors (NDs = DL)	0.249	0.304	Data Appear Normal
Lilliefors (NDs = DL/2)	0.249	0.304	Data Appear Normal
Lilliefors (Normal ROS Estimates)	0.261	0.304	Data Appear Normal

Gamma GOF Test Results

	No NDs	NDs = DL	NDs = DL/2	Gamma ROS
Correlation Coefficient R	0.872	0.83	0.818	0.894

	Test value	Crit. (0.05)	Conclusion with Alpha(0.05)
Anderson-Darling (Detects Only)	0.763	0.702	
Kolmogorov-Smirnov (Detects Only)	0.357	0.335	Data Not Gamma Distributed
Anderson-Darling (NDs = DL)	0.82	0.729	
Kolmogorov-Smirnov (NDs = DL)	0.369	0.32	Data Not Gamma Distributed
Anderson-Darling (NDs = DL/2)	0.864	0.733	
Kolmogorov-Smirnov (NDs = DL/2)	0.377	0.322	Data Not Gamma Distributed
Anderson-Darling (Gamma ROS Estimates)	0.695	0.715	
Kolmogorov-Smirnov (Gamma ROS Est.)	0.322	0.315	Detected Data appear Approximate Gamma Distri

Groundwater Goodness of Fit Test - Source Area
Former 7-Eleven Facility #135 - 44 Main Street
Rainelle, West Virginia

Lognormal GOF Test Results							
	No NDs	NDs = DL	NDs = DL/2	Log ROS			
Correlation Coefficient R	0.829	0.855	0.839	0.876			
	Test value	Crit. (0.05)	Conclusion with Alpha(0.05)				
Shapiro-Wilk (Detects Only)	0.716	0.788	Data Not Lognormal				
Shapiro-Wilk (NDs = DL)	0.742	0.803	Data Not Lognormal				
Shapiro-Wilk (NDs = DL/2)	0.718	0.803	Data Not Lognormal				
Shapiro-Wilk (Lognormal ROS Estimates)	0.753	0.803	Data Not Lognormal				
Lilliefors (Detects Only)	0.384	0.325	Data Not Lognormal				
Lilliefors (NDs = DL)	0.369	0.304	Data Not Lognormal				
Lilliefors (NDs = DL/2)	0.37	0.304	Data Not Lognormal				
Lilliefors (Lognormal ROS Estimates)	0.351	0.304	Data Not Lognormal				
Note: Substitution methods such as DL or DL/2 are not recommended.							

Groundwater UCL - Source Area
Former 7-Eleven Facility #135 - 44 Main Street
Rainelle, West Virginia

UCL Statistics for Data Sets with Non-Detects			
User Selected Options			
Date/Time of Computation	ProUCL 5.12/8/2019 8:34:51 AM		
From File	WorkSheet.xls		
Full Precision	OFF		
Confidence Coefficient	95%		
Number of Bootstrap Operations	2000		

Benzene (ug/L)

General Statistics			
Total Number of Observations	7	Number of Distinct Observations	7
		Number of Missing Observations	0
Minimum	44.4	Mean	75.3
Maximum	107	Median	75
SD	21.05	Std. Error of Mean	7.954
Coefficient of Variation	0.279	Skewness	-0.0532

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test			
Shapiro Wilk Test Statistic	0.973	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.803	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.199	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.304	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			

Assuming Normal Distribution			
95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	90.76	95% Adjusted-CLT UCL (Chen-1995)	88.21
		95% Modified-t UCL (Johnson-1978)	90.73

Gamma GOF Test		
A-D Test Statistic	0.258	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.708	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.234	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.312	Detected data appear Gamma Distributed at 5% Significance Level
Detected data appear Gamma Distributed at 5% Significance Level		

Gamma Statistics			
k hat (MLE)	13.9	k star (bias corrected MLE)	8.041
Theta hat (MLE)	5.416	Theta star (bias corrected MLE)	9.365
nu hat (MLE)	194.7	nu star (bias corrected)	112.6
MLE Mean (bias corrected)	75.3	MLE Sd (bias corrected)	26.56
		Approximate Chi Square Value (0.05)	89.08
Adjusted Level of Significance	0.0158	Adjusted Chi Square Value	82.78
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	95.16	95% Adjusted Gamma UCL (use when n<50)	102.4
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.95	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.803	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.249	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.304	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	3.793	Mean of logged Data	4.285
Maximum of Logged Data	4.673	SD of logged Data	0.299
Assuming Lognormal Distribution			
95% H-UCL	99.41	90% Chebyshev (MVUE) UCL	101
95% Chebyshev (MVUE) UCL	112.6	97.5% Chebyshev (MVUE) UCL	128.7
99% Chebyshev (MVUE) UCL	160.3		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	88.38	95% Jackknife UCL	90.76
95% Standard Bootstrap UCL	87.32	95% Bootstrap-t UCL	90.6
95% Hall's Bootstrap UCL	91.65	95% Percentile Bootstrap UCL	87.24
95% BCA Bootstrap UCL	87.31		
90% Chebyshev(Mean, Sd) UCL	99.16	95% Chebyshev(Mean, Sd) UCL	110
97.5% Chebyshev(Mean, Sd) UCL	125	99% Chebyshev(Mean, Sd) UCL	154.4
Suggested UCL to Use			
95% Student's-t UCL	90.76		
Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
Recommendations are based upon data size, data distribution, and skewness.			
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be			
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.			

MTBE (ug/L)			
General Statistics			
Total Number of Observations	7	Number of Distinct Observations	7
Number of Detects	6	Number of Non-Detects	1
Number of Distinct Detects	6	Number of Distinct Non-Detects	1
Minimum Detect	17.6	Minimum Non-Detect	2
Maximum Detect	194	Maximum Non-Detect	2
Variance Detects	3331	Percent Non-Detects	14.29%
Mean Detects	118.8	SD Detects	57.71
Median Detects	127	CV Detects	0.486
Skewness Detects	-0.935	Kurtosis Detects	2.396
Mean of Logged Detects	4.573	SD of Logged Detects	0.858
Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use			
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.			
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).			
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1			
Normal GOF Test on Detects Only			
Shapiro Wilk Test Statistic	0.914	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.788	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.259	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.325	Detected Data appear Normal at 5% Significance Level	
Detected Data appear Normal at 5% Significance Level			
Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs			
KM Mean	102.1	KM Standard Error of Mean	26.34
KM SD	63.63	95% KM (BCA) UCL	139.8
95% KM (t) UCL	153.3	95% KM (Percentile Bootstrap) UCL	141.4
95% KM (z) UCL	145.4	95% KM Bootstrap t UCL	145
90% KM Chebyshev UCL	181.1	95% KM Chebyshev UCL	216.9
97.5% KM Chebyshev UCL	266.6	99% KM Chebyshev UCL	364.2
Gamma GOF Tests on Detected Observations Only			
A-D Test Statistic	0.763	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.702	Detected Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.357	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.335	Detected Data Not Gamma Distributed at 5% Significance Level	
Detected Data Not Gamma Distributed at 5% Significance Level			
Gamma Statistics on Detected Data Only			
k hat (MLE)	2.603	k star (bias corrected MLE)	1.413
Theta hat (MLE)	45.63	Theta star (bias corrected MLE)	84.07
nu hat (MLE)	31.24	nu star (bias corrected)	16.95
Mean (detects)	118.8		

Gamma ROS Statistics using Imputed Non-Detects			
GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs			
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)			
For such situations, GROS method may yield incorrect values of UCLs and BTVs			
This is especially true when the sample size is small.			
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates			
Minimum	17.6	Mean	105.4
Maximum	194	Median	120
SD	63.4	CV	0.601
k hat (MLE)	1.961	k star (bias corrected MLE)	1.216
Theta hat (MLE)	53.76	Theta star (bias corrected MLE)	86.7
nu hat (MLE)	27.46	nu star (bias corrected)	17.02
Adjusted Level of Significance (β)	0.0158		
Approximate Chi Square Value (17.02, α)	8.69	Adjusted Chi Square Value (17.02, β)	6.969
95% Gamma Approximate UCL (use when n>=50)	206.6	95% Gamma Adjusted UCL (use when n<50)	257.6
Estimates of Gamma Parameters using KM Estimates			
Mean (KM)	102.1	SD (KM)	63.63
Variance (KM)	4049	SE of Mean (KM)	26.34
k hat (KM)	2.574	k star (KM)	1.566
nu hat (KM)	36.04	nu star (KM)	21.93
theta hat (KM)	39.66	theta star (KM)	65.18
80% gamma percentile (KM)	157.2	90% gamma percentile (KM)	210.5
95% gamma percentile (KM)	262.1	99% gamma percentile (KM)	378.4
Gamma Kaplan-Meier (KM) Statistics			
Approximate Chi Square Value (21.93, α)	12.28	Adjusted Chi Square Value (21.93, β)	10.17
95% Gamma Approximate KM-UCL (use when n>=50)	182.2	95% Gamma Adjusted KM-UCL (use when n<50)	220
Lognormal GOF Test on Detected Observations Only			
Shapiro Wilk Test Statistic	0.716	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.788	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.384	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.325	Detected Data Not Lognormal at 5% Significance Level	
Detected Data Not Lognormal at 5% Significance Level			
Lognormal ROS Statistics Using Imputed Non-Detects			
Mean in Original Scale	104.2	Mean in Log Scale	4.324
SD in Original Scale	65.24	SD in Log Scale	1.024
95% t UCL (assumes normality of ROS data)	152.1	95% Percentile Bootstrap UCL	141.7
95% BCA Bootstrap UCL	140.1	95% Bootstrap t UCL	145
95% H-UCL (Log ROS)	615		
Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution			
KM Mean (logged)	4.019	KM Geo Mean	55.63
KM SD (logged)	1.539	95% Critical H Value (KM-Log)	5.305
KM Standard Error of Mean (logged)	0.637	95% H-UCL (KM -Log)	5101
KM SD (logged)	1.539	95% Critical H Value (KM-Log)	5.305
KM Standard Error of Mean (logged)	0.637		

DL/2 Statistics			
DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	101.9	Mean in Log Scale	3.92
SD in Original Scale	68.97	SD in Log Scale	1.898
95% t UCL (Assumes normality)	152.6	95% H-Stat UCL	44234
DL/2 is not a recommended method, provided for comparisons and historical reasons			
Nonparametric Distribution Free UCL Statistics			
Detected Data appear Normal Distributed at 5% Significance Level			
Suggested UCL to Use			
95% KM (t) UCL	153.3		
Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
Recommendations are based upon data size, data distribution, and skewness.			
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			

Attachment 7

Constituent Volatilization Transfer Factor Calculations

TABLE OF CONTENTS

LIST OF TABLES

1 Introduction

This attachment presents the mathematical models used in the quantitative risk assessment to estimate the concentrations of constituents in:

- ambient (outdoor) air due to volatilization from exposed groundwater (during intrusive activities) into a trench for the on-site construction worker and on-site utility worker; and,

- ambient (outdoor) air due to volatilization from unexposed groundwater (without intrusive activities) for the on-site maintenance worker.

In order to estimate concentrations of constituents in ambient air due to volatilization from unexposed groundwater (without intrusive activities), the ASTM Standard Guidance [ASTM 2015] was used. For the excavation workers, models presented in the Virginia Department of Environmental Quality (VA DEQ) Voluntary Remediation Program [VA DEQ 2019] were used to estimate concentrations of constituents in trench air due to volatilization from groundwater into a trench during intrusive activities. Two different methods may be used to estimate volatilization into a trench. The selected method depends on whether groundwater is exposed in the trench or unexposed beneath the trench.

The ASTM approach is based on linear partitioning between dissolved chemicals in groundwater and chemical vapors at the groundwater table, steady-state vapor-phase and liquid-phase diffusion through the capillary fringe and vadose zones to ground surface, and steady well-mixed atmospheric dispersion of emanating vapors within the breathing zone as modeled by a box model for air dispersion.

The VA DEQ approach is based on a combination of a vadose zone model to estimate volatilization of gases from groundwater into a trench and a box model to estimate dispersion of the constituents from air inside the trench into the above-ground atmosphere in order to estimate the exposure point concentration (EPC) for air in a construction/utility trench.

2 Estimating Ambient (Outdoor) Air Concentrations from Volatile Emissions from Groundwater

2.1 Exposed Groundwater Equations During Intrusive Activities

For this evaluation, the VA DEQ model assumes that the worker would encounter groundwater when digging an excavation or a trench. The worker would then have direct exposure to the groundwater. The worker would be exposed to constituents in the air inside the trench that would result from volatilization from the groundwater pooling at the bottom of the trench. This evaluation was conducted for the on-site construction worker and on-site utility worker.

Ambient concentrations of constituents of interest in air resulting from volatile emissions from groundwater may be estimated as follows:

$$C_{trench} = VF * C_{gw}$$

where:

C_{trench}	=	concentration of constituent in trench (ug/m^3)
VF	=	volatilization factor (L/m^3)
C_{gw}	=	concentration of constituent in groundwater (ug/L)

For shallow groundwater depths that result in exposed groundwater within the trench, the volatilization factor (L/m^3) is given by the following equation:

$$VF = \frac{K_i * A * F * CF1 * CF2 * CF3}{ACH * V}$$

where:

K_i	=	overall mass transfer coefficient of constituent (cm/sec)
A	=	area of the trench (m^2)
F	=	fraction of floor through which constituent can enter (unitless)

ACH	=	air changes per hour (1/hr)
V	=	volume of the trench (m^3)
CF1	=	conversion factor ($1x10^{-3}$ L/cm^3)
CF2	=	conversion factor ($1x10^4$ cm^2/m^2)
CF3	=	conversion factor (3600 sec/hr)

Studies of urban canyons suggest that if the ratio of trench width, relative to wind direction, to trench depth is less than or equal to one, a circulation cell or cells will be set up within the trench that limits the degree of gas exchange with the atmosphere. The *ACH* in this case is assumed to be 2/hr [VA DEQ 2019]. If the ratio of trench width to trench depth is greater than one, air exchange between the trench and above-ground atmosphere is not restricted. The *ACH* in this case is assumed to be 360/hr [VA DEQ 2019].

The assumption that there is almost no air exchange between the open trench and above-ground atmosphere may be overly conservative. Based on a study conducted by the USEPA Region 8, the number of air exchanges in a trench for commercial buildings depends on the wind speed and the dimension of the trench parallel to the wind direction [USEPA 1999]. To estimate the air exchange rate in a worst case scenario, the USEPA Region 8 assumes that 1) a trench has a length up to 30 meters, 2) the wind direction is parallel to the long axis of trench (e.g., trench length), and 3) the wind is calm with a wind speed of 1 mile per hour (or 0.45 meters per second). This results in an air exchange rate of 0.015 per second or 54 exchanges per hour [USEPA 1999]. Since uniform mixing in the trench is not expected, a mixing factor of 0.5 is applied to account for deviation from complete mixing in an open trench. The resulting air exchange rate is 0.0075 per second or 27 exchanges per hour.

Despite the overly conservative nature of VA DEQ's default *ACH*, the VADEQ default *ACH* of 2 hr^{-1} was conservatively utilized in this risk assessment for those receptors that have a trench with a width to depth ratio less than or equal to one as requested by WVDEP [Personal correspondence 2020]. Default trench dimensions provided by VA

DEQ were also conservatively utilized in this risk assessment (trench length of 8 feet, trench width of 3 feet, and trench depth of 8 feet). Note that in actuality the trench width is likely to be wider after the installation of adequate protective systems (e.g., sloping, benching or trench shielding) for an excavation of 5 feet or deeper as required by Occupational Safety and Health Administration (OSHA) regulation (29 Code of Federal Regulation [CFR] 1926 652[a]). In addition, although this risk assessment assumed a maximum excavation depth of 6 feet for the on-site construction and utility workers, the default VA DEQ trench depth was utilized as requested by WVDEP [Personal correspondence 2020]. Based on the dimensions of the trench, the trench width to depth ratio (3:8) is less to one. Therefore, an *ACH* of 2 hr^{-1} was utilized for the on-site construction worker and on-site utility worker.

The overall mass transfer coefficient of a constituent is given by the following equation:

$$K_i = \frac{1}{\frac{1}{k_{iL}} + \frac{R * T}{H_i * k_{iG}}}$$

where:

k_{iL}	=	liquid-phase mass transfer coefficient of constituent *i* (cm/sec)
R	=	ideal gas constant (atm-m^3/mol-°K)
T	=	average system absolute temperature (°K)
H_i	=	Henry's Law constant of constituent *i* (atm-m^3/mol)
k_{iG}	=	gas-phase mass transfer coefficient of constituent *i* (cm/sec)

The liquid-phase mass transfer coefficient is given by the following equation:

$$k_{iL} = \left(\frac{MW_{O2}}{MW_i}\right)^{0.5} * \frac{T}{298} * k_{L,O2}$$

where:

MW_{O2}	=	molecular weight of oxygen (g/mol)
MW_i	=	molecular weight of constituent *i* (g/mol)
$k_{L,O2}$	=	liquid-phase mass transfer coefficient of oxygen at 25ºC (0.002 cm/sec)

The gas-phase mass transfer coefficient is given by the following equation:

$$k_{iG} = \left(\frac{MW_{H2O}}{MW_i} \right)^{0.335} * \left(\frac{T}{298} \right)^{1.005} * k_{G,H2O}$$

where:

MW_{H2O}	=	molecular weight of water (g/mol)
$k_{G,H2O}$	=	gas-phase mass transfer coefficient of water vapor at 25ºC (0.833 cm/sec)

The results of the calculation of the volatilization transfer factors to predict air concentrations as a result of volatilization from exposed groundwater during intrusive activities for the on-site construction worker and on-site utility worker are presented in Tables 1 and 2, respectively. Individual constants used in the equations are presented and referenced in Tables 1 and 2.

2.2 Unexposed Groundwater Equations Without Intrusive Activities

ASTM Model

For this evaluation, the ASTM model assumes that groundwater will not be exposed. The receptor would then have exposure to volatile constituents emitted from unexposed groundwater to ambient air without intrusive activities. This evaluation was conducted for the on-site maintenance worker.

Ambient concentrations of constituents of interest in air resulting from volatile emissions from groundwater may be estimated as follows:

$$C_A = VF_{wamb} * C_{gw}$$

where:

C_A	=	concentration of constituent in ambient air (ug/m^3)
VF_{wamb}	=	volatilization factor - groundwater to ambient air (L/m^3)
C_{gw}	=	concentration of constituent in groundwater (ug/L)

The volatilization factor (L/m^3) is given by the following equation:

$$VF_{wamb} = \frac{H'}{1 + \left[\frac{DF_{amb} * L_{GW}}{D_{eff-ws}}\right]} * CF$$

where:

H'	=	dimensionless Henry's Law Constant {if calculated from H, equal to 41 * H}
H	=	Henry's Law Constant (atm-m^3-H_2O/mol)
DF_{amb}	=	dispersion factor for ambient air (cm/s)
L_{GW}	=	depth to groundwater (cm)
D_{eff-ws}	=	effective diffusion coefficient between groundwater and soil surface (cm^2/s)
CF	=	conversion factor (1x10^3 L/m^3)

The dispersion factor for ambient air is given by the following equation:

$$DF_{amb} = \frac{U_{air} * W * \delta_{air}}{A}$$

where:

U_{air}	=	wind speed above ground surface in ambient air mixing zone (cm/s)

W	=	width of source area parallel to wind, or groundwater flow direction (cm)
δ_{air}	=	ambient air mixing zone height (cm)
A	=	source-zone area (cm^2)

The effective diffusion coefficient between groundwater and soil surface is given by the following equation:

$$D_{eff-ws} = (h_{cap} + h_v) * \left[\frac{h_{cap}}{D_{eff-cap}} + \frac{h_v}{D_{eff-s}} \right]^{-1}$$

where:

h_{cap}	=	thickness of capillary fringe (cm)
h_v	=	thickness of vadose zone (cm)
$D_{eff\text{-}cap}$	=	effective diffusion coefficient through capillary fringe (cm^2/s)
$D_{eff\text{-}s}$	=	effective diffusion coefficient in soil (cm^2/s)

The effective diffusion coefficient through the capillary fringe is given by the following equation:

$$D_{eff-cap} = D_{air} * \frac{\theta_{acap}^{3.33}}{\theta_T^2} + D_{wat} * \frac{1}{H'} * \frac{\theta_{wcap}^{3.33}}{\theta_T^2}$$

where:

D_{air}	=	diffusion coefficient in air (cm^2/s)
D_{wat}	=	diffusion coefficient in water (cm^2/s)
Θ_{acap}	=	volumetric air content in capillary fringe soils (cm^3-air/cm^3-soil)
Θ_{wcap}	=	volumetric water content in capillary fringe soils (cm^3-water/cm^3-soil)

Θ_T = total soil porosity (cm^3/cm^3-soil)

H' = dimensionless Henry's Law Constant {if calculated from H, equal to 41 * H}

The effective diffusion coefficient in soil is given by the following equation:

$$D_{eff-s} = D_{air} * \frac{\theta_{as}^{3.33}}{\theta_T^2} + D_{wat} * \frac{1}{H'} * \frac{\theta_{ws}^{3.33}}{\theta_T^2}$$

where:

D_{air} = diffusion coefficient in air (cm^2/s)

D_{wat} = diffusion coefficient in water (cm^2/s)

Θ_{as} = volumetric air content in vadose zone soils (cm^3-air/cm^3-soil)

Θ_{ws} = volumetric water content in vadose zone soils (cm^3-water/cm^3-soil)

Θ_T = total soil porosity (cm^3/cm^3-soil)

H' = dimensionless Henry's Law Constant {if calculated from H, equal to 41 * H}

The results of the calculation of the volatilization transfer factors to predict air concentrations as a result of volatilization from unexposed groundwater (without intrusive activities) for the on-site maintenance worker are presented in Table 3. Individual constants used in the equations are presented and referenced in Table 3.

3 References

ASTM 2015. Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites. American Society for Testing and Materials, Designation E1739-95, Reapproved 2015.

Code of Federal Regulations, Title 29: Labor, Chapter XVII: Occupational Safety and Health Administration, Part 1926: Safety and Health Regulations for Construction.

Personal Correspondence 2020. Email correspondence between The Mahfood Group LLC (Adrienne Remo) and WVDEP (Ross Brittain). March 19, 2020.

USEPA 1999. *Derivation of a volatilization factor to estimate upper bound exposure point concentration for workers in trenches flooded with ground water off-gassing volatile organic chemicals*. U.S. Environmental Protection Agency, Region 8, 8EPR-PS, Denver, Colorado, July 1999.

VA DEQ 2019. Virginia Unified Risk Assessment Model – VURAM's Users Guide For Risk Assessors. Virginia Department of Environmental Quality, 2019.

Tables

Table 1
Calculation of Exposed Groundwater Volatilization Transfer Factors for an On-Site Construction Worker
Risk Assessment Report
Former 7-Eleven Facility #135 - 44 Main Street
Rainelle, West Virginia

System Parameters **Exposed Groundwater - During Intrusive Activities**

Variable	Value	Units	Description
Mass Transfer Coefficient Parameters			
$k_{G,H2O}$	0.833	cm/sec	gas-phase mass transfer coefficient of water vapor at 25 ^{o}C
MW_{H2O}	18	g/mol	molecular weight of water
$k_{L,O2}$	0.002	cm/sec	liquid-phase mass transfer coefficient of oxygen at 25^{o}C
MW_{O2}	32	g/mol	molecular weight of oxygen
T	77	^{o}F	average system absolute temperature
	298	^{o}K	
R	8.21E-05	atm-m^{3}/mol-^{o}K	gas constant
Emission Flux and Concentration in Trench Parameters			
F	1	unitless	fraction of floor through which contaminant can enter
ACH	2	1/hr	air changes per hour; default assumption (VADEQ 2019)
CF1	1.0E-03	L/cm^{3}	converson factor
CF2	1.0E+04	cm^{2}/m^{2}	converson factor
CF3	3600	sec/hr	converson factor
Trench Dimensions			
L	8	ft	length; default assumption (VADEQ 2019)
	2.44	m	
W	3	ft	width; default assumption (VADEQ 2019)
	0.91	m	
D	8	ft	depth; default assumption (VADEQ 2019)
	2.44	m	
A	2.23	m^{2}	area
V	5.44	m^{3}	volume
W/D	0.38	unitless	
Volatilization Control	1	0 indicates no limits on volatilization	
		1 indicates volatile if Hen law const. ≥ limit or if vapor pressure ≥ limit	
		2 indicates volatile if boiling point < limit	
Henry's law limit	1.0E-05	atm-m³/mol	
vapor pressure limit	1	mm Hg	
boiling point limit	200	deg C	

Note: VADEQ groundwater volatilization model [VADEQ 2019]

Table 1
Calculation of Exposed Groundwater Volatilization Transfer Factors for an On-Site Construction Worker
Risk Assessment Report
Former 7-Eleven Facility #135 - 44 Main Street
Rainelle, West Virginia

Chemical-Specific Variables

	Chemical Properties				Calculated Parameters				
Chemical	**Vapor Pressure VP (mm Hg)**	**Molecular Weight MW_i (g/mol)**	**Boiling Point BP_i (°C)**	**Henry's Law Constant H_i (atm-m³/mol)**	**Gas-Phase Mass Transfer Coefficient k_{iG} (cm/sec)**	**Liquid-Phase Mass Transfer Coefficient k_{iL} (cm/sec)**	**Overall Mass Transfer Coefficient K_i (cm/sec)**	**Volatilization Control**	**Volatilization Factor VF (L/m³)**
Volatile Organic Compounds									
Benzene	9.5E+01	78	80	5.6E-03	5.10E-01	1.28E-03	1.27E-03	1	9.35E+00
Methyl tert-butyl ether (MTBE)	2.5E+02	88	55	5.9E-04	4.90E-01	1.21E-03	1.09E-03	1	8.07E+00

Note: For the volatilization control column: "1" means the constituent is a volatile and a "0" means the constituent is not a volatile based on the selected definition of a volatile on page 1 of this table.

Table 2

Calculation of Exposed Groundwater Volatilization Transfer Factors for an On-Site Utility Worker

Risk Assessment Report
Former 7-Eleven - 44 Main Street
Rainelle West Virginia

System Parameters

Variable	Value	Units	Description
Mass Transfer Coefficient Parameters			
$k_{G,H2O}$	0.833	cm/sec	gas-phase mass transfer coefficient of water vapor at 25 ^oC
MW_{H2O}	18	g/mol	molecular weight of water
$k_{L,O2}$	0.002	cm/sec	liquid-phase mass transfer coefficient of oxygen at 25^oC
MW_{O2}	32	g/mol	molecular weight of oxygen
T	77	^oF	average system absolute temperature
	298	^oK	
R	8.21E-05	atm-m^3/mol-^oK	gas constant
Emission Flux and Concentration in Trench Parameters			
F	1	unitless	fraction of floor through which contaminant can enter
ACH	2	1/hr	air changes per hour; default assumption (VADEQ 2019)
CF1	1.0E-03	L/cm^3	conversion factor
CF2	1.0E+04	cm^2/m^2	conversion factor
CF3	3600	sec/hr	conversion factor
Trench Dimensions			
L	8	ft	length; default assumption (VADEQ 2019)
	2.44	m	
W	3	ft	width; default assumption (VADEQ 2019)
	0.91	m	
D	8	ft	depth; default assumption (VADEQ 2019)
	2.44	m	
A	2.23	m^2	area
V	5.44	m^3	volume
W/D	0.38	unitless	
Volatilization Control	1	0 indicates no limits on volatilization	
		1 indicates volatile if Hen law const. ≥ limit or if vapor pressure ≥ limit	
		2 indicates volatile if boiling point < limit	
Henry's law limit	1.0E-05	atm-m³/mol	
vapor pressure limit	1	mm Hg	
boiling point limit	200	deg C	

Note: VADEQ groundwater volatilization model [VADEQ 2019]

Table 2
Calculation of Exposed Groundwater Volatilization Transfer Factors for an On-Site Utility Worker
Risk Assessment Report
Former 7-Eleven - 44 Main Street
Rainelle West Virginia

Chemical-Specific Variables

	Chemical Properties				Calculated Parameters				
Chemical	**Vapor Pressure VP (mm Hg)**	**Molecular Weight MW_i (g/mol)**	**Boiling Point BP_i (°C)**	**Henry's Law Constant H_i (atm-m³/mol)**	**Gas-Phase Mass Transfer Coefficient k_{iG} (cm/sec)**	**Liquid-Phase Mass Transfer Coefficient k_{iL} (cm/sec)**	**Overall Mass Transfer Coefficient K_i (cm/sec)**	**Volatilization Control**	**Volatilization Factor VF (L/m³)**
Volatile Organic Compounds									
Benzene	9.5E+01	78	80	5.6E-03	5.10E-01	1.28E-03	1.27E-03	1	9.35E+00
Methyl tert-butyl ether (MTBE)	2.5E+02	88	55	5.9E-04	4.90E-01	1.21E-03	1.09E-03	1	8.07E+00

Note: For the volatilization control column: "1" means the constituent is a volatile and a "0" means the constituent is not a volatile based on the selected definition of a volatile on page 1 of this table.

Table 3
Calculation of Unexposed Groundwater Volatilization Transfer Factors for an On-Site Maintenance Worker
Risk Assessment Report
Former 7-Eleven Facility #135 - 44 Main Street
Rainelle, West Virginia

System Parameters **Unexposed Groundwater - Without Intrusive Activities**

Variable Name	Value	Units	Description
θ_{as}	0.26	cm³-air/cm³-soil	ASTM default volumetric air content in vadose zone soils
θ_{ws}	0.12	cm³-H2O/cm³-soil	ASTM default volumetric water content in vadose zone soils
θ_{acap}	0.038	cm³-air/cm³-soil	ASTM default volumetric air content in capillary fringe soils
θ_{wcap}	0.342	cm³-H2O/cm³-soil	ASTM default volumetric water content in capillary fringe soils
θ_T	0.43	cm³-pore/cm³-soil	total soil porosity; default value from SSG (USEPA, 2002)
A	1.82E+07	cm²	Estimated acreage of site (approximately 0.45 acres)
L_{GW}	5.5	ft	approximate depth to groundwater; the average depth to groundwater from all on-site monitoring wells based on groundwater elevation data collected between December 2010 to August 2016.
	167.6	cm	
h_v	5.336	ft	thickness of vadose zone (calculated as L_{GW} - h_{cap})
	162.6	cm	
h_{cap}	0.164	ft	thickness of capillary fringe (ASTM default value)
	5.0	cm	
U_{air}	7.1	mph	wind speed above ground surface (7.1 mph; Beckley, WV annual average; NOAA 2018)
	317.4	cm/sec	
δ_{air}	200	cm	ambient air mixing zone height (ASTM default value)
W	50	ft	ASTM default width of source area parallel to wind or groundwater flow direction
	1524	cm	
CF1	1.0E+03	L/m³	conversion factor
Volatilization Control	1	0 indicates no limits on volatilization	
		1 indicates volatile if Hen law const. ≥ limit or if vapor pressure ≥ limit	
		2 indicates volatile if boiling point < limit	
Henry's law limit	1.0E-05	atm-m³/mol	
vapor pressure limit	1	mm Hg	
boiling point limit	200	deg C	

Note: ASTM groundwater volatilization model [ASTM 2015]

Table 3
Calculation of Unexposed Groundwater Volatilization Transfer Factors for an On-Site Maintenance Worker
Risk Assessment Report
Former 7-Eleven Facility #135 - 44 Main Street
Rainelle, West Virginia

Chemical-Specific Variables

	Chemical Properties						
Chemical	**Vapor Pressure** **VP** **(mm Hg)**	**Molecular Weight** **MW_i** **(g/mol)**	**Boiling Point** **BP** **(°C)**	**Henry's Law Constant** **H** **(atm-m³/mol)**	**Dim. Henry's Law Constant** **H'** **(unitless)**	**Vapor Phase Diffusivity** **D_a** **(cm²/s)**	**Water Phase Diffusivity** **D_w** **(cm²/s)**
Volatile Organic Compounds							
Benzene	9.5E+01	78.1	81	5.6E-03	2.3E-01	9.0E-02	1.0E-05
Methyl tert-butyl ether (MTBE)	2.5E+02	88	55	5.9E-04	2.4E-02	7.5E-02	8.6E-06

Table 3
Calculation of Unexposed Groundwater Volatilization Transfer Factors for an On-Site Maintenance Worker
Risk Assessment Report
Former 7-Eleven Facility #135 - 44 Main Street
Rainelle, West Virginia

Chemical-Specific Variables

	Calculated Parameters					
Chemical	**Dispersion Factor for Ambient Air** DF_{amb} **(cm/s)**	**Effective Diffusion Coefficient in Soil** D_{eff-s} **(cm²/s)**	**Effective Diffusion Coefficient Cap. Fringe** $D_{eff-cap}$ **(cm²/s)**	**Effective Diff. Coeff. between GW and Soil Surface** D_{eff-ws} **(cm²/s)**	**Volatilization Control [1] (unitless)**	**GW to Outdoor Air Volatilization Factor** VF_{wamb} **(L/m³)**
Volatile Organic Compounds						
Benzene	5.3E+00	5.5E-03	1.6E-05	4.9E-04	1	1.2E-04
Methyl tert-butyl ether (MTBE)	5.3E+00	4.6E-03	6.2E-05	1.4E-03	1	3.9E-05

Notes:

[1] For the volatilization control column: "1" means the constituent is a volatile and a "0" means the constituent is not a volatile based on the selected definition of a volatile on page 1 of this table.

March 24, 2020

COMMENTS FOR FEBRUARY 2020 HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENT

FORMER PARK AVENUE EXXON

HINTON, SUMMERS COUNTY, WEST VIRGINIA

WVDEP ID # 4-505384

LEAK ID # 97-136

A review of the November 2018 Human Health and Ecological Risk Assessment report (HHERA) was originally completed in January 2019 and WVDEP comments were provided to CORE Environmental Services, Inc. (CORE). CORE prepared and submitted a response to comments letter (dated February 17, 2020) and a revised HHERA report dated February 2020.

As defined in the Work Directive No. DEP19*021-EE106, the scope of work was to perform a complete review of the February 2020 HHERA for the Former Park Avenue Exxon site located in Hinton, Summers County, West Virginia. The response to comments and revised February 2020 RAR satisfy WVDEP's comments with the exception of the following listed below. Part A are follow-up comments on the February 2020 response to comments. Part B are additional comments on the February 2020 HHERA.

Please note that the September 2019 WVDEP VRP Guidance Manual was released several months ago. This latest guidance contains updated risk assessment procedures and sources. Some of these updated risk assessment elements include but are not limited to default exposure parameters, the new "Checklist to Determine Applicable Remediation Standard" in the risk assessment report (which includes the ecological and human health checklist), etc. Given it has been several months since the publication of this guidance document, it is prudent that the next revision to this risk assessment incorporates the necessary elements of the latest WVDEP guidance.

Part A (Original January 2019 Comments):

1. **Original WVDEP-TCAU Comment No. 6 – Section 2.5.1** (Soils) on page 14 states "Since groundwater is evaluated through direct sampling of groundwater, constituents exceeding the WVDEP De Minimis standard for migration to groundwater will not be retained for further quantitative assessment." A similar statement is also made in the executive summary. It is acknowledged that groundwater was evaluated in this RAR and therefore, constituents that only exceeded the migration to groundwater De Minimis screening value would not be retained as a COC and will be evaluated through

groundwater data. However, it is recommended to include the migration to groundwater screening in Tables 2A and 2B (Soil Analytical Results) to show which constituents exceeded a migration to groundwater screening value.

CORE Response (Feb 2020): *The WVDEP de minimis values for migration to groundwater were added to the soil sample results tables (2A and 2B) and exceedances were highlighted.*

WVDEP-TCAU Follow-up Comment (March 2020): The migration to groundwater de minimis values are listed in µg/kg in Tables 2A and 2B (with the exception of TBA screening, which is in mg/kg). To match the analytical results and the units of the residential and industrial de minimis standards, please revise the screening to be in mg/kg and highlight exceedances accordingly.

2. **Original WVDEP-TCAU Comment No. 15.h – Figure 8** (Conceptual Site Model): Benzene and naphthalene were retained as COC in groundwater for the on-site and off-site construction worker. There is also the potential for volatile COC in groundwater to migrate from unexposed groundwater to outdoor air without intrusive activities. Therefore, the inhalation of volatiles from groundwater to outdoor air may be a potentially complete exposure pathway for receptors that do not perform intrusion activities (e.g. off-site resident). We recognize that this is a de minimis exposure pathway; however, it is recommended to include a discussion in the risk assessment report stating why this potential exposure pathway was not quantified.

   CORE Response (Feb 2020): *The Conceptual Site Exposure Model (CSEM) and supporting text (Section 3.2) have been revised in their entirety to address the above comments.*

WVDEP-TCAU Follow-Up Comment (March 2020): A discussion of the potential exposure for the off-site resident to be exposed to volatiles in groundwater via the inhalation of outdoor air is still missing from the revised HHERA. Section 3.2.1.2 lists all of the potentially complete exposure pathways for the resident but does not discuss the inhalation of volatiles in outdoor air from groundwater. Section 3.2.2.2 (Groundwater) refers to Section 3.2.2.3 (Air) for a discussion of the indoor/outdoor air exposure pathway. However, this section only discusses the air samples in relation to vapor intrusion and trench air for the utility worker. Please add a discussion of the inhalation of volatiles from groundwater to outdoor air exposure pathway for the off-site resident and why this potential exposure pathway was not quantified given there were COC retained in groundwater.

3. **Original WVDEP-TCAU Comment No. 22** – The following are comments on **Appendix G** (Toxicity Data):

a. It is recognized the WVDEP provides a toxicity database online; however, this database is outdated. It is recommended to follow the toxicity hierarchy to select toxicity values as specified in the Rule Title 60, Series 3, §60-3-8.1.c. For example, IRIS has updated the cancer slope factor (CSF) and inhalation unit risk (IUR) presented for benzo(a)pyrene to 1 $(mg/kg\text{-}day)^{-1}$ and 6E-4 $(ug/m^3)^{-1}$, respectively. In addition, IRIS provides an oral reference dose and inhalation reference concentration for benzo(a)pyrene. Please be sure the most recent toxicity values and source references are used.

CORE Response (Feb 2020): *The most recent toxicity data have been used for the COCs selected in the risk assessment. Also, the source used for tau, and t* are referenced in the Appendix G table and in the References Section of the text.*

WVDEP-TCAU Follow-Up Comment (March 2020): Appendix G still references "WVDEP Chemical Specific Data – June 2012" as the source of toxicity information. However, the appropriate revisions were made in Section 3.4.4 of the text. Please remove the reference to the outdated WVDEP source in Appendix G.

In addition, text was added to Section 3.4.4 discussing the toxicity values for various exposure durations (i.e., acute, short-term and subchronic). However, it does not appear that the HHERA selected the appropriate toxicity value based on the exposure duration ranges presented in this section. For example, the utility worker exposure falls under the short-term category based on an exposure frequency of 10 days/year; however, the HHERA utilized chronic toxicity values. Please ensure that the quantitative assessment utilizes the appropriate toxicity values based on exposure duration as described in the text, when toxicity criteria are available for the exposure duration. If a toxicity value is not available for that exposure duration, please select the next conservative toxicity value for the calculation.

4. **Original WVDEP-TCAU Comment No. 29** – In **Section 3.5.2** (Carcinogenic Risk Characterization), it states "The calculated indoor air VI carcinogenic risk for an off-property resident based on sub-slab vapor data retained for analysis in 2013 is above the USEPA and WVDEP established risk ranges with a potential cumulative cancer risk of 3.63×10^{-6}. However, current and future risk is adequately characterized by the soil vapor, indoor air, and outdoor air sampling that was completed in 2017. Soil vapor, indoor air, and outdoor air analytical results obtained from samples retained for analysis in 2017 were not detected above the VISL target concentrations." Although soil vapor samples collected in 2017 from SV-5 and SV-6 do not exceed vapor intrusion screening criteria, this does not negate the naphthalene exceedances in the sub-slab soil vapor samples. In addition, all off-site indoor air samples had one or more non-detected

reporting limits that exceed the indoor air VISL. Therefore, the vapor intrusion pathway needs to be further addressed for the off-site residences.

CORE Response (Feb 2020): *Naphthalene has never been detected in the indoor air in the off-Site residences. Due to the fact that the target indoor air naphthalene concentration from the VISL Calculator is in excess of one order of magnitude below the TO-15 method detection limit (emphasis added – the reporting limit is even higher), screening any detected or non-detected value will always result in naphthalene (and other compounds) being selected as COCs. The subsequent quantitative risk assessment will also necessarily calculate unacceptable risks/His, even if ½ of the detection limit is used as the EPC. In addition, naphthalene is present in many common household products and separating naphthalene originating in an UST from that of other anthropogenic sources is very unlikely. This leads to several issues from a remedial perspective:*

1. *Naphthalene remediation will always be required at an UST release site, assuming a plausible exposure pathway to a resident exists; and*
2. *Demonstrating compliance with risk-based cleanup values cannot be achieved.*

As such, the risk assessment acknowledges the sub-slab detections of naphthalene, but eliminated naphthalene as a COC due to the fact that it was never detected in the residences.

WVDEP-TCAU Follow-Up Comment (March 2020): Each residential property needs to be evaluated separately for vapor intrusion. Given the number of samples in various media across 2013 and 2017, the current vapor intrusion analysis is very difficult to follow. The vapor intrusion analysis should discuss the construction of each structure (e.g., presence of basement, significant foundation openings or preferential pathways), outline which samples are used to evaluate each structure, and follow a multiple lines of evidence approach. In the multiple lines of evidence approach, media is discussed on a tiered-basis in order of preference where the media sampled closest to the point of exposure is preferred (i.e., indoor air, sub-slab soil gas, exterior soil gas, then groundwater). However, given the method detection limits exceed the applicable VISL criteria for some constituents in indoor air, second-tier media (i.e., sub-slab soil gas) should be used to evaluate these constituents. Based on this tiered analysis of screening available media against applicable criteria, appropriate quantitative analyses can then be completed. It is recommended to refer to the address number when discussing vapor intrusion for each structure.

5. **Original WVDEP-TCAU Comment No. 53 –** Please cross-check references presented in the text, tables, and appendices to make sure they match. For example, in Section 3.4.6.3 (Incidental Ingestion of Groundwater), the text states that the ingestion rate of one liter per day was used based on USEPA's recommendation for construction workers (USEPA, 2002). However, Table 21C (Exposure Dose Formulas and Parameters Construction/Utility Worker) references EPA, March 2001 for the water ingestion rate of 1 liter per day. In addition, please make sure all references are up-to-date.

   CORE Response (Feb 2020): *The references to tables, figures, and appendices have been cross-checked.*

WVDEP-TCAU Follow-Up Comment (March 2020): Several exposure parameter references in Table 20 still do not match the text (e.g., averaging time). Additionally, several references in Section 7.0 and throughout the text are outdated. Please update the following references throughout the HHERA:

a. ASTM 2002 – the most recent version is 2015.
b. USEPA March 2001 – this is a peer-reviewed draft of the final Supplemental Guidance published in December 2002.
c. USEPA 2017a / USEPA 2017b / USEPA 2018 – these documents were updated in November 2019. They are updated bi-annually.
d. WVDEP 2001 – this document was replaced with the September 2019 VRP Guidance Manual.
e. WVDEP 2017a – The Rule was updated in March 2018, effective April 2018.

Note that the dates listed above are the most recent versions as of the date of this letter. However, the remediator is obligated to check the last versions of each reference prior to submitting a report.

Part B (Additional WVDEP Comments):

1. Starting in Section 2.1, it appears that the term "constituent of potential concern" ("COPC") is misused in the text and in Tables 11 through 14. According to the WVDEP VRP Guidance Manual, a COPC is a chemical detected in at least one sample in a given medium at the site and should be carried through the screening assessment or risk assessment unless there is specific, justifiable rationale for dropping the contaminant from the risk characterization. Constituents of concern (COCs) are the final list of chemicals that are carried through the risk assessment after the screening process (e.g. screening against de minimis standards). Please correct the language in the applicable places in the text and tables.

2. **Section 2.4.1.2 (Constituents Detected) –** The first paragraph of this section is unclear. Based on information provided in the HHERA, the soil samples were compared to both residential and industrial soil de minimis standards. There were no exceedances of the industrial soil de minimis standards; however, there were exceedances of the residential de minimis standards. The residential screening and associated exceedances support the application of an LUC on-site for a future residential scenario. Please revise this text for clarity.
3. **Section 2.4.3 (Surface Water and Sediment)** – Please provide additional analysis of the potential for the drainage ditch located north of the site to act as a conduit for site-related constituents. For example, is the drainage ditch only flowing intermittently? Is it connected to the storm sewer system present in Park Avenue (identified in Section 3.1 of text)? What is the source of water to this drainage ditch – surface water runoff or groundwater? Please confirm the construction of the drainage ditch (e.g., brick-lined as identified in the HHERA figures) and add a discussion in text.
4. **Section 2.5 (Summary of Constituents of Concern) –** Please check the number of samples listed in the various subsections of this section of the HHERA. For example, in Section 2.5.2, it states that "Eight groundwater samples, including one field duplicate, were collected from monitoring wells in the vicinity of the site." However, based on the samples collected in 2017, there are actually nine samples (which includes two field duplicates). In addition, Section 2.5.1.2 states that the off-site soil samples range in depth from zero to 13 ft-bgs; however, the range should actually be 0-8 ft-bgs based on depths provided in the soil data tables.
5. **Section 2.5.1.2 (Off-Site Surface/Subsurface Soil)** – Please provide additional justification for not retaining benzo(a)pyrene and dibenz(a,h)anthracene as COCs in off-site surface soil. It is necessary to fully evaluate all migration routes, such as preferential migration through a storm sewer, for example. If the PAHs are not related to the UST release, please provide another plausible source. Although not required, it is recommended to notify the property owner of the presence of constituents above applicable criteria on their property.

   Alternatively, please consider quantitatively evaluating potential risk associated with these constituents. Note that the current de minimis standards are based on outdated toxicity criteria. Utilizing the more recent toxicity criteria for benzo(a)pyrene provided by IRIS and the associated Relative Potency Factors (RPF) for other related PAHs may result in risk calculations below benchmark criteria.
6. **Section 3.1 (Conceptual Site Model)** – According to the Site Assessment Report (CORE, 2017), "The source of municipal water supply is the New River, which is located approximately 375 feet due west of the Site." Given that the point of discharge for the

site is the believed to be the New River, it is necessary to provide further discussion on the potential for constituents at the site to impact the public water supply. For example, where is the intake for the City of Hinton potable water supply? Is it upstream or downstream and how far from the site?

In addition, as requested in the March 13, 2018 SSAR approval letter from WVDEP, please include fate and transport modeling to evaluate off-site groundwater migration.

7. **Section 3.2.1.2 (Off-Site)** – WVDEP acknowledges that the use of groundwater will be restricted on the adjacent residential properties. However, the exposure pathways associated with potable use of groundwater should be acknowledged in this section for completeness and to support the application of an LUC restricting potable use of groundwater based on exceedances of the de minimis standards in groundwater at the site property boundary.

8. **Section 4 (Risk Characterization)** – The first sentence of this section discusses risk calculations for an *on-site* utility worker. Based on the description of this receptor throughout the HHERA, the utility worker evaluated has equal potential to perform excavation activities both on-site and on the neighboring properties. In addition, the executive summary indicates that the risk and HI were calculated for potential future on-site and off-site utility workers. Please clarify and revise the text as appropriate.

9. **Table 20 (Exposure Dose Formulas and Parameters) and Appendix G** – Currently, Equation 3.3 from RAGS-E is presented as the DAevent equation for estimating Dermal Contact (Absorbed Dose per Event). Based on the event duration (t_{event}) value provided in Table 20 of 8 hrs/event and the comparison to the t* values presented in Appendix G, t_{event} is greater than t* for all retained COC. Thus, Equation 3.2 from RAGS-E should be utilized to calculate DAevent instead of Equation 3.3 (in which $t_{event} \leq t^*$). In addition, the comparison of t_{event} to t* should be made under the Absorbed Dose per Event equation, rather than the Dermally Absorbed Dose equation. Note that Equation 3.3 from RAGS-E requires additional dermal parameters (e.g., B), which should be added to Appendix G. Please ensure that the calculated DAevent in Appendix G is revised based on the updated equation. Also, please show only the applicable exposure factors in Table 20 for the dermal contact equations.

10. **Tables 11 through 13 –** Please correct the following errors:

    a. The residential soil de minimis value for fluorene and the industrial soil de minimis value for benzo(a)anthracene are incorrect in these tables. Please revise.

    b. Please correct the COPC rationale columns in Tables 12 and 13, as there are several errors. For example, in Table 12, several VOCs are listed as not detected when there were actually detections. In addition, the rationale for not retaining benzo(a)anthracene and dibenz(a,h)anthracene as COCs is not accurate (i.e., not detected or less than screening value). Please revise the rationales where appropriate.

c. Table 12 – The maximum detection for ethylbenzene should be 46 µg/kg instead of 37.6 µg/kg. This maximum concentration comes from SB-13, not SB-14.

11. **Table 14 –** Benzo(k)fluoranthene is missing as a COPC in this table. In addition, the de minimis values for chrysene and dibenz(a,h)anthracene are not correct. Lastly, please revise the COPC rationale for MTBE and anthracene as the rationale is not accurate.

12. **Table 16 –** The maximum detected concentrations for xylenes (m&p) and xylenes (o) are incorrect. In addition, please list the minimum detected concentration for naphthalene.

13. From Section 3.2.2.3 onwards, the table numbers are incorrect. For example, the reference to risk calculation results is Table 25; however, this table does not exist in the revised HHERA. Please check all table references.