West Virginia Department of Environmental Protection
Office of Environmental Remediation
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VRP NO.	04506
SITE NAME	PQS #5117-Etowah
LOCATION	Barlow Road-Charleston

Baseline/Residual Human Health and Ecological Risk Assessment

November 2004
(Revised)

Shaw Environmental, Inc.

Project No. 845335
PQS dba SOPUS Products Tax ID No. 76-0200625

BASELINE/RESIDUAL HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENT FOR PENNZOIL-QUAKER STATE dba SOPUS PRODUCTS FORMER ETOWAH TERMINAL 1015 BARLOW DRIVE CHARLESTON, WEST VIRGINIA VCP No. 04506

Prepared for:

Pennzoil-Quaker State dba SOPUS Products
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November 2004 (Revised)

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EXECUTIVE SUMMARY

Shaw Environmental, Inc. (Shaw Environmental) has completed the following risk assessment for the former Pennzoil-Quaker State (PQS) Etowah Terminal in Charleston, West Virginia. During 1938, the site began operations as a bulk distribution facility for petroleum products. On November 30, 2001, PQS sold the subject property to Etowah River Terminal, LLC. The Etowah River Terminal, LLC currently operates the site as bulk storage terminal for freeze conditioning agents including ethylene glycol and calcium chloride solutions. On September 3, 2003, PQS (now PQS dba SOPUS Products) entered the site into a Voluntary Remediation and Redevelopment Agreement within the West Virginia Voluntary Remediation and Redevelopment Rule (The Rule).

Environmental investigations completed between November 2000 and June 2004 documented that soil and groundwater at the Site have been impacted by Site operations. Constituents detected in soil include benzene, toluene, ethylbenzene and xylenes (BTEX), methyl tertiary butyl ether (MTBE), total petroleum hydrocarbons (TPH) gasoline range organics (GRO), diesel range organics (DRO), and oil range organics (ORO), chromium (both trivalent and hexavalent), lead, 18 polynuclear aromatic hydrocarbons (PAHs), acetone, 2-butanone, carbon disulfide, and methylene chloride. Constituents detected in groundwater include BTEX, MTBE, TPH (including GRO, DRO, and ORO), 18 PAHs, and dissolved lead. Constituents detected in surface water include TPH (DRO and ORO, only); lead, both total and dissolved; and 11 PAHs. Constituents detected in near shore sediment include TPH (ORO, only) and lead.

Chemicals of Potential Human Concern (COPHCs) were determined by screening maximum concentrations in soil and groundwater against conservative benchmarks developed to be protective of human health for direct contact exposure, potential migration to groundwater, and potential migration to indoor air. Constituents exceeding the screening criteria were designated as COPHCs to be evaluated in the risk assessment. Based on analytical data, COPHC in soil include benzene, ethylbenzene, toluene, xylenes (total), MTBE, acetone, carbon disulfide, and methylene chloride. COPHCs for groundwater include benzene, MTBE, TPH-GRO, TPH-DRO, TPH-ORO, dissolved lead, 1-methylnaphthalene, 2-methylnaphthalene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene. Based on analytical data COPHCs do not exist for surface water and sediment; however, these media were evaluated further for potential impacts to ecological receptors.

A groundwater model was constructed to assess the potential for soil to groundwater migration and to assess the fate and transport of COPHCs in groundwater. Using the surface water data and the model results, a screening level assessment for both current and future exposure scenarios was completed to assess the potential of surface water concentrations to pose health concerns for human receptors. Since the referenced potential groundwater concentrations were below the referenced screening levels, COPHCs do not exist for surface water.

A conceptual site model was developed for the Site. Potential human receptors evaluated in the risk assessment included on-site commercial workers and on-site construction workers. On-site commercial workers are assessed for exposure to COPHCs in groundwater via inhalation of indoor air. On-site construction workers are assessed for exposure to COPHCs in groundwater via dermal contact and inhalation of indoor air. Estimated cancer risks for all receptors were within both West Virginia's and

USEPA's target risk range of 1 x 10^{-6} to 1 x 10^{-4}. The West Virginia Department of Environmental Protection (WVDEP) and United States Environmental Protection Agency (USEPA) consider noncarcinogenic hazard indices that are less than one (1.0) to be acceptable. Hazard indices for the evaluated receptors are below 1.0.

1.0 SITE DESCRIPTION AND HISTORY

In November 2001, PQS submitted an application for the former Etowah Terminal in Charleston, West Virginia to the WVDEP Office of Environmental Remediation (OER), and on September 3, 2003 the Site entered into a Voluntary Remediation and Redevelopment Agreement within the Rule. By submitting this application, PQS agreed to remediate the Site according to the standards, terms and conditions set forth under the West Virginia Voluntary Remediation and Redevelopment Rule (The Rule), Title 60 Code of State Regulations, Series 3, as established in the Voluntary Remediation and Redevelopment Act (VRRA) West Virginia Code §22-22-1 (Shaw, 2003). The following risk assessment was conducted in accordance with the Rule for the purpose of evaluating potential risks to human health and the environment posed by this Site, and directing remediation efforts to reduce those risks, if necessary, to acceptable levels.

Section summarizes information from the Additional Site Characterization Report (ASCR) for the Former PQS Etowah Terminal (Shaw Environmental, 2003).

1.1 Physical Description of Site

The former PQS Etowah Terminal is located in Kanawha County at 1015 Barlow Road in Charleston, West Virginia **(Figure 1)**. The property (hereafter referred to as the Site) is bordered to the north by woodlands. An Allegheny Power natural gas pipeline crosses the northern end of the Site. A former Columbia Gas Transmission (CGT) pipeline station facility is located approximately 0.5 mile north of the Site. The Site is bordered to the east by a railroad corridor and Barlow Road beyond. A steep, wooded slope is located beyond Barlow Road, east of the Site. Residences are located immediately to the south and the Elk River is located along the western border of the Site.

1.2 General History and Land Use

1.2.1 Historical Land Use

Prior to the construction of the Site, the property was used for agricultural purposes. On December 28, 1938, Elk Refining Company purchased a 1.56-acre tract of land (identified as Plot 32 on Elk District Map 44L) from Edith Bowers Bailey and Homer Bailey. The first above ground storage tanks (ASTs) were constructed on-site during 1938 and additional ASTs were added as the petroleum bulk storage terminal expanded. On August 30, 1941, Elk Refining Company purchased a 1.3-acre tract of land (identified as Plot 31 on Elk District Map 44L) from Delia Bowers and James C. Bowers. On July 30, 1947, Elk Refining Company purchased a 1.0-acre tract of land (identified as Plot 30 on Elk District Map 44L) from Ambrose C. Smith and his wife. On January 9, 1948, Elk Refining Company purchased a 1.01 tract of land including the former one-story "Bower's School" building (identified as Plot 33 on Elk District Map 44L) from the Board of Education of the County of Kanawha. The warehouse/office and garage/storage buildings were constructed during 1950.

On January 1, 1970, Elk Refining Company was merged with Pennzoil United, Inc. (now PQS). On November 30, 2001, PQS sold the subject property to Etowah River Terminal, LLC.
The Site consists of a two-story warehouse/office building, a garage/storage building, asphalt parking lots, a grave yard, a fire (pump) house, a flair, a fuel loading rack, an oil loading rack, an oil/water separator, a dock, two former fire houses, a former pump house, a former loading rack, and 19 aboveground storage tanks (ASTs) and associated aboveground product piping **(Figure 2)**. The 14 main ASTs (numbered ASTs) are located inside of the diked areas. The four non-numbered ASTs include the following:

- A 275-gallon diesel additive AST installed during 1999 inside the diked area adjacent to the fuel loading rack;
- A 275-gallon drip oil AST installed during 1999 inside the diked area adjacent to the oil loading rack;
- A 320-gallon kerosene heating oil AST located on a concrete floor inside the garage/storage building; and
- A 30-gallon hydraulic oil AST located on a concrete floor in the garage/storage building.

The fuel loading rack is constructed on bermed concrete near the center of the site. The inactive oil loading rack is constructed on gravel near the north end of the site.

Stormwater drains located in the diked area and on the asphalt parking lot on the northern end of the site flow into an oil/water separator located on the eastern side of the site **(Figure 2)**. Treated stormwater from the oil/water separator discharges into the Elk River in accordance with National Pollution Discharge Elimination System (NPDES) Permit No. WV0045225. Stormwater that falls on the asphalt parking lot located on the southern end of the site flows into catch basins along the western edge of the facility and is discharged into the Elk River.

1.2.2 Current Land Use

Currently the Etowah River Terminal LLC operates the Site as a bulk storage terminal for freeze conditioning agents including ethylene glycol and calcium chloride solutions. Calcium chloride is stored in ASTs 403, 404 and 405. Ethylene glycol mixtures are stored in ASTs 393 and 398 through 402. The Site is zoned for industrial use. Current land surface features are shown on **Figure 2**.

Drinking water wells do not exist within 2,000 feet of the facility (Shaw, 2003). The closest water supply wells are located west of the Site on the opposite side of the Elk River. No groundwater irrigation activity is known in the vicinity of the Site. Groundwater is not used as a local drinking water supply and depth to the unconfined groundwater aquifer ranges from approximately 14 to 40 feet below ground surface (b.g.s). Drinking water in the area is supplied by the West Virginia American Water Company, which obtains potable water from an intake along the Elk River located approximately 1.3 miles southwest (downstream) of the Site.

Basements are reported in residential buildings located approximately 200 feet south of the Site. The office/warehouse and garage/storage buildings at the Site are constructed on concrete slabs and foundations. This bottom floor of the Office/Warehouse is approximately 50% below grade.

1.2.3 Anticipated Future Land Use

The current operations are expected to continue at the Site. The future land use is assumed to remain non-residential for this evaluation.

1.2.4 Land Use of Adjacent Properties

Residences are located to the south of the Site and are anticipated to remain for at least 30 years into the future. The hillside across Barlow Road is wooded and relatively steep and is unlikely to be developed. Based on this, land use of adjacent properties is not expected to change.

1.3 Geologic Conditions of Site

The Site is located in Charleston, West Virginia on a steep sided fluvial terrace adjacent to the Elk River (**Figure 1**). The Elk River is a southwest flowing tributary of the Kanawha River. The unconfined groundwater table ranges from approximately 15 to 38 feet b.g.s. The area lies within the unglaciated portion of the Appalachian Plateau physiographic province, which is generally characterized by relatively flat lying gently folded Upper Paleozoic sedimentary rocks. Quaternary fluvial and colluvial deposits greater than approximately 40 feet thick underlie the site. Udorthents Smoothed-Urban Land complex soils are developed at the surface of the Site (Van Houten, et. al., 1981). The Udorthents Smoothed-Urban Land complex typically consists of areas of heterogeneous fill material that has been leveled by cutting the higher parts and filling the lower parts. Based on boring logs, fill materials at the Site range from approximately 4 to 12 feet thick. The fill appears to be underlain by a fining upward sequence of Quaternary alluvial deposits generally comprised of silty sand with occasional gravel overlain by clayey silt and silty clay. The Quaternary alluvium is disconformably underlain by the Pennsylvanian Allegheny Formation, which is generally comprised of cyclic sequences of sandstone, siltstone and shale with occasional thin limestone and coal strata (Cardwell, et. al., 1986).

1.4 Hydrogeologic Conditions of Site

The Elk River is adjacent to the Site. The normal pool elevation of the Elk River is approximately 566 feet above mean sea level (MSL). The unconfined groundwater table ranges from approximately 14 feet to 40 b.g.s. (estimated to be approximately 572 - 587 feet MSL). Based on boring logs, the unconfined aquifer appears to be characterized by gray to orangish brown sandy clay, sandy silt and fine to coarse sand. Based on historical gauging data, groundwater in the unconfined aquifer appears to flow westward toward the Elk River with an average hydraulic gradient of approximately 0.07 feet/foot (Shaw Environmental, November, 2004 and previous Quarterly Monitoring Reports, June 2001 - November 2004, and Shaw Environmental, November 2003. The unconfined aquifer appears to be in hydraulic communication with the Elk River, (Shaw, 2003).

2.0 SITE INVESTIGATION AND IDENTIFICATION OF COPHCs

This section summarizes the scope and findings of prior field investigations conducted at the Site. Additional information on the individual Site investigations can be found in the Former PQS Etowah Terminal No. 5117, Charleston, West Virginia - Application to Participate in Voluntary Remediation Program (Shaw Environmental, 2001) and in the ASCR (Shaw Environmental, 2003).

2.1 Summary of Previous Site Investigations and Site Remediation

The following investigations have been conducted at the Site to assess and characterize environmental conditions:

- January 2001 – Phase II Environmental Investigation performed by IT Corporation (now Shaw Environmental). This investigation was conducted to assess Site conditions. Activities included: collection of 5 hand auger soil samples (HA-1 through HA-5), collection of 3 composite soil samples for lead analysis (C-1 through C-3), collection of 5 discrete soil samples for lead analysis (C2-A through C2-E), installation of 10 Geoprobe® soil borings (GP-1 through GP-10), and installation of groundwater monitoring wells MW-1 through MW-6.

- September 2001 – Etowah River Terminal, LLC Due Diligence Investigation. This investigation included the installation of monitoring well MW-7 and collection of soil samples from the soil boring. Groundwater samples were collected from wells MW-1 through MW-5 and MW-7.

- July 2003 – Additional Site Characterization (Shaw Environmental). This investigation was conducted to further delineate dissolved-phase hydrocarbons. Activities included installing 26 additional Geoprobe soil borings, of which 14 were completed as temporary monitoring wells so that groundwater samples could also be collected.

- September 2003 – Surface Water and Sediment Sampling of Elk River (Shaw Environmental). Activities included collection of 5 near shore sediment samples (NS-1 through NS-5) and 5 collocated near shore surface water samples (also NS-1 through NS-5) to characterize sediment and surface water in the Elk River. Additionally, 15 surface water samples (E-1 through E-15) were collected from the Elk River at locations farther away from the shore.

- June 2004 – Additional Surface Water Sampling in Elk River (Shaw Environmental). Activities were limited to collecting 4 surface water samples (ES-2, ES-2 DUP, ES-5, and ES-7) to further assess PAH concentrations in the Elk River.

- June 2001 through May 2004 - Quarterly Groundwater Sampling (IT Corporation and Shaw Environmental). Quarterly sampling events were conducted to assess groundwater at the Site (Shaw Environmental, November, 2004 and previous Quarterly Monitoring Reports, June 2001 - November 2004).

Additional information on the above investigations is available in the ASCR (Shaw Environmental, 2003).

2.2 Data Segregation and Selection of Chemicals of Potential Concern

The previously discussed site investigations provide the analytical data that are available to assess potential human and ecological risks at the Site. Analytical data are available for soil, groundwater, surface water and sediment.

Level III data validation was performed in accordance with the Region III Modifications to National Functional Guidelines (Organics - 9/94, and Inorganics - 4/93), as applied to SW-846 methodology for at least 10 percent of the soil and groundwater samples collected during the Additional Site Characterization. A summary of Level III data validation is included in Section 3.2 of the referenced Additional Site Characterization (Shaw Environmental, 2003). A full report of Level III data validation is included in Appendix F of the referenced Additional Site Characterization (Shaw Environmental, 2003).

As part of the Quality Assurance/Quality Control (QA/QC) program during the site characterization, the precision, accuracy, representativeness, comparability and completeness of field sampling procedures was evaluated by analyzing the results of trip blanks, rinsate blanks, split soil samples and duplicate groundwater and surface water samples (Section 3.0 of Shaw Environmental, November, 2003). In accordance with EPA approved protocol for risk assessment, duplicate results for soil and groundwater media are treated as one sample and not individually. However, since the WVDEP Division of Water Resources requires that surface water samples be reported individually, surface water duplicates results were not averaged. Duplicate groundwater and surface water samples were within typical and analytical precision expectations (Sections 3.1, 3.2 and Appendix F, Table D of Shaw Environmental, 2003).

2.2.1 Soil

A total of 103 soil samples (including 3 duplicate soil samples) from previous investigations were available for use in the risk assessment. Of the 103 soil samples, 29 were surface soil samples and 74 were subsurface soil samples. The 3 duplicate samples (SB-6, TMW/SB-16 and SB-21) were averaged with the corresponding sample and treated as one discrete sample. **Table 2-1** presents a list of the soil samples collected in the previous investigations and the analyses conducted on each sample. Analytical results from the soil samples listed in **Table 2.1** were used in the risk assessment. Background soil samples are also presented in the table; however, it should be noted that these samples were not used to quantify exposures in the risk assessment. A summary of all soil analytical sample results collected at the Site is provided in **Appendix A Tables 2, 8, 9, 11 and 11**.

2.2.1.1 Chemicals Analyzed

Table 2-1 provides a list of the samples and the corresponding analyses for each sample. Soil samples collected in November 2000 and June 2001 were generally analyzed for benzene, total BTEX, TPH (GRO, DRO, and ORO), and lead. Samples collected during the ASCR field activities (July 2003) were analyzed for BTEX, MTBE, and TPH-GRO, PAHs, cadmium, chromium, and lead as summarized in **Table 2-1**. Additionally, 5 samples collected in May 2001 were analyzed only for lead.

2.2.1.2 Chemicals Detected

Tables 2-2 and 2-3 provide a statistical summary of the analytical results of the constituents detected in soil samples, regardless of depth. In order to evaluate the potential for migration of COPHCs in soil to groundwater, the total soil column was utilized. Therefore, **Table 2-2** summarizes data for the total soil column to facilitate the evaluation of the potential migration of COPHCs from soil to groundwater. Detected constituents in soil included BTEX, MTBE, TPH (GRO, DRO, and ORO), chromium (both trivalent and hexavalent), lead, 18 PAHs, acetone, 2-butanone, carbon disulfide, and methylene chloride.

2.2.1.3 Selection of Chemicals of Potential Human Concern

Table 2-2 also provides a conservative comparison of the maximum detected concentration (MDC) for each constituent detected in soil with its respective West Virginia *De Minimis* Level for direct contact (industrial soil) and migration to groundwater. Only the maximum concentration for lead exceeds the *De Minimis* levels for direct contact. However, benzene, MTBE, TPH-GRO, TPH-DRO, 1-methylnaphthalene, 2-methylnaphthalene, and naphthalene maximum soil concentrations exceed their respective *De Minimis* levels for migration to groundwater.

Volatile Organic COPHCs include benzene, ethylbenzene, toluene, xylenes, MTBE, and naphthalene. **Table 2-3** presents the volatile organic compounds (VOCs) in total soil column at the Site that potentially pose a concern for the indoor air pathway.

2.2.2 Groundwater

The first groundwater samples were collected at the Site on June 20, 2001. Analytical results for groundwater samples collected from monitoring wells from June 2001 through August 2004, were used. During this time, 128 groundwater samples (including 3 duplicate samples) have been collected from the Site. The duplicate samples for MW-8 (08/31/04), SB-2/MW-5, and TMW/SB-22 were averaged with the corresponding sample and the results treated as one discrete sample. **Appendix A Tables 3 and 12** provides a complete summary of the groundwater analytical results obtained from the Site monitoring wells.

2.2.2.1 Chemicals Analyzed

Groundwater samples were generally analyzed for BTEX, MTBE, and TPH (GRO, DRO, and ORO). The groundwater samples collected during the October/November 2003 ACSR sampling event were analyzed for cadmium, lead, chromium (both hexavalent and trivalent), BTEX, MTBE, TPH (including GRO, DRO, and ORO), ethylene glycol, PAHs, and VOC and semi volatile organic compounds (SVOC) in accordance with the WVDEP approved SAP. A list of the groundwater samples used in the risk assessment and the corresponding analyses are provided in **Table 2-1.**

2.2.2.2 Chemicals Detected

Tables 2-4 and 2-5 provide a statistical summary of the constituents detected in the above-referenced groundwater samples. Constituents detected in groundwater included BTEX, MTBE, TPH (including GRO, DRO, and ORO), 18 PAHs, and dissolved lead.

Based on the analysis of groundwater samples collected from monitoring wells at the Site on a quarterly basis during June 20, 2001 through August 31, 2004 BTEX, MTBE and TPH-GRO were not detected above Table 60-3B Groundwater De Minimis levels (Shaw Environmental, November, 2004 and previous Quarterly Monitoring Reports, June 2000 - November 2004). Based on quarterly data, TPH-DRO concentrations detected in MW-3 and MW-7 and TPH-ORO concentrations detected in MW-7 appear to be declining. Based on quarterly data, PAH concentrations appear to be stable at concentrations close to the method detection limits. These data are referenced in **Table 2-1** and are included in **Appendix A Tables 2 and 2a**.

2.2.2.3 Selection of Chemicals of Potential Human Concern

Table 2-4 also provides a comparison of the MCD for each constituent detected in groundwater with its respective *De Minimis* Level for direct contact with groundwater. There were 10 constituents with MDCs that exceeded their respective *De Minimis* direct contact levels for groundwater (benzene, MTBE, TPH-GRO, TPH-DRO, TPH-ORO, dissolved lead, 1-methylnaphthalene, 2-methylnaphthalene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene).

A screening assessment was conducted to evaluate the potential for volatile organic constituents to volatilize and migrate from groundwater to indoor air and pose health risks to human receptors. Since the West Virginia VRRP has no screening values available to assess volatilization from groundwater to indoor air, default screening concentrations were utilized from the USEPA (USEPA, 2002). The values presented in Table 2b of USEPA, 2002 represent values for residential exposure at a target cancer risk of 1E-05 and a hazard of 1.0. These values were adjusted by a factor of 7.0 to reflect the more limited exposure of an on-site worker as compared to that of a resident. Exposure factors adjusted included the exposure frequency (1.4 times), the building air exchange rate (1.6 times), and the exposure time (3 times). The default nonresidential volatilization to indoor air screen for constituents in groundwater was used to focus the risk assessment of indoor air vapors on those constituents most likely to pose health risks. **Table 2-5** presents the screening of the detected VOCs at the Site. Only benzene exceeds the screening value. Therefore, benzene in groundwater was evaluated further as a COPHC for all complete air pathways (Section 3.0).

2.2.3 Surface Water

Twenty-five surface water samples (including 2 duplicate samples) were collected from the Elk River. **Appendix A Tables 12 and 16** provides a complete summary of the surface water analytical results obtained from the Elk River. The results from the surface water samples are used to evaluate the potential for current exposure to constituents in surface water.

2.2.3.1 Chemicals Analyzed

Twenty-one surface water samples collected from the Elk River in September 2003, were analyzed for BTEX, MTBE, TPH (GRO, DRO, and ORO), and lead (both total and dissolved). Additionally, 4 surface samples collected in June 2004 were analyzed for PAHs in accordance with the WVDEP approved SAP. A list of the surface water samples used in the risk assessment and the corresponding analyses are provided in **Table 2-1**.

2.2.3.2 Chemicals Detected

Table 2-6 provides a statistical summary of the constituents detected in the surface water samples collected from the Elk River. Constituents detected in surface water included TPH (DRO and ORO, only), lead, both total and dissolved, and 11 PAHs.

2.2.3.3 Selection of Chemicals of Potential Human Concern

Table 2-6 also provides a comparison of the maximum concentration for each detected constituent in surface water with the appropriate WVDEP Surface Water Quality Standards (46 CSR, Appendix E Table 1). The data summarized in **Table 2-6** provides a comparison of available surface water data for the current exposure scenarios.

Maximum TPH concentrations exceeded the groundwater De Minimis levels, however, surface water quality standards do not exist for TPH. In accordance with the WVDEP, TPH was addressed by assessing the PAH constituents of TPH. Fluoranthene concentrations were not detected above the Surface Water Quality Standard. Total carcinogenic PAH were calculated by adding the respective PAH concentrations. Non-detect concentrations were added at half of the laboratory method detection limit. The laboratory method detection limit was the lowest achievable limit available from an analytical laboratory. The Surface Water Quality Standard for total carcinogenic PAHs (0.000031 mg/L) is close to the laboratory method detection limits for PAHs (0.0000017 - 0.0000046). **Appendix A Table 16** shows that total carcinogenic PAH concentrations did not differ from background concentrations and that the Site is not contributing PAHs to the Elk River. Additionally, there were no "clear" PAH detections. All concentrations were estimated values below the laboratory reporting limit and were flagged as J values. Based on background or upgradient surface water analytical data, PAH and TPH were eliminated as COPHCs.

No COPHs were selected for surface water based on actual surface water analytical results.

In order to address potential future exposures to surface water constituents at the site, groundwater modeling was conducted for the site to estimate potential future groundwater concentrations that might discharge to the Elk River **(Appendix B)**. Benzene, TPH-GRO, TPH-DRO, TPH-ORO, dibenz(a,h)anthracene, and lead concentrations in groundwater exceeded the groundwater *De Minimis* levels and were modeled to analyze their fate and transport in groundwater at the Site. Estimated surface water concentrations were developed by application of an alternate default dilution factor of 10-fold as recommended by WVDEP (WVDEP, November 29, 2004). The maximum modeled groundwater constituent concentrations at the discharge point to the Elk River were divided by this dilution factor to account for dilution of the constituent concentrations once the plumes mix with surface water in the Elk River. These resultant concentrations were then compared to the WVDEP Surface Water Quality Standards (46 CSR, Appendix E Table 1). Constituents that exceeded the Surface Water Quality Standards are designated as COPHCs for surface water for future exposure scenarios. **Table 2-7** provides the comparison of the potential future surface water concentrations (based on the fate and transport groundwater model developed for the Site) with the adjusted *De Minimis* Levels. Based on modeling, no constituents were designated as COPHCs for direct contact with surface water.

2.2.3.4 Selection of Chemicals of Potential Ecological Concern

As previously discussed, the results of the groundwater model demonstrated the potential for migration of constituents in groundwater to the Elk River **(Appendix B)**. Therefore, impacts to aquatic biota from the current and future water concentrations were addressed by comparing the water concentrations to applicable surface water quality standards protective of aquatic biota. For this evaluation, data from the West Virginia Water Quality Standards (46 CSR, Appedix E, Table 1), the Ecological Preliminary Remediation Goals from Efroymson et al (1997), and the USEPA Region 5 Ecological Screening Levels for Water (USEPA, 2003), were utilized. **Table 2-8** provides the ecological comparison for surface water. Lead and benzo(a)pyrene were selected as COPECs in surface water and further discussed in Section 4.0.

2.2.4 Sediment

Six nearshore sediment samples (including 1 duplicate sample) were collected from the Elk River. The duplicate sample, NS-2 DUP (09/11/03), was averaged with its respective corresponding sample and the result was treated as one discrete sample. **Appendix A Table 8** provides a complete summary of the nearshore sediment analytical results obtained from the Elk River.

2.2.4.1 Chemicals Analyzed

Near shore sediment samples were analyzed for BTEX, MTBE, TPH (GRO, DRO, and ORO), and lead in accordance with the WVDEP approved SAP. A list of the sediment samples used in the risk assessment and the corresponding analyses are provided in **Table 2-1**.

2.2.4.2 Chemicals Detected

Table 2-8 provides a statistical summary of the constituents detected in the sediment samples collected from the Elk River. Constituents detected in sediment included TPH (ORO, only) and lead.

2.2.4.3 Selection of Chemicals of Potential Human Concern

Table 2-8 also provides a comparison of the MDC for each detected constituent in nearshore sediment with an appropriate *De Minimis* screening level for direct contact with sediment. Since West Virginia has no approved screening criteria for sediment, the residential soil *De Minimis* levels were conservatively used to screen detected constituents in sediment. The MDCs for nearshore sediment constituents were below the conservative screening concentrations.

2.2.4.4 Selection of Chemicals of Potential Ecological Concern

Since the MDCs for nearshore sediment constituents were below the conservative screening concentrations, there are no constituents of potential ecological concern (COPECs).

2.3 Summary of Chemicals of Potential Concern

2.3.1 Soil

Lead is the only detected constituent that exceeds the *De Minimis* levels for direct contact with soil. However, removal of the soil with elevated lead was completed on October 12, 2004 in accordance with the WVDEP approved Remedial Action Plan For Removal of Lead Impacted Soil (Shaw Environmental, August 2004). Therefore, lead is not designated as a COPHC for further consideration in soil for the risk assessment.

Seven constituents (benzene, MTBE, TPH-GRO, TPH-DRO, 1-methylnaphthalene, 2-methylnaphthalene, and naphthalene) in soil have a MDC that exceeds the *De Minimis* levels for migration to groundwater. Thus, the soil to groundwater COPHCs designated are benzene, MTBE, TPH-GRO, TPH-DRO, 1-methylnaphthalene, 2-methylnaphthalene, and naphthalene. These seven COPHCs were further evaluated for the potential to leach to groundwater by a conducting a modeling study.

For the soil to indoor air pathway, all detected VOC constituents and napthtalene were evaluated further in the risk assessment.

2.3.2 Groundwater

Based on comparison of the groundwater MDCs with *De Minimis* levels for direct contact with groundwater, the following ten constituents were designated as COPHCs in groundwater:

- Benzene
- MTBE
- TPH-GRO
- TPH-DRO
- TPH-ORO
- Lead
- 1-Methylnaphthalene
- 2-Methylnaphthalene
- Dienz(a,h)anthracene, and
- Indeno(1,2,3-cd)pyrene.

Based on the results of screening for potential volatilization to indoor air **(Table 2-5)**, benzene is the only COPHC retained for the groundwater to air pathway.

2.3.3 Surface Water

Based on the screening assessment for surface water, no COPHCs were designated for either the potential current or future exposure scenarios for surface water. COPECs were limited to lead and benzo(a)pyrene.

2.3.4 Sediment

Based on the screening assessment for sediment, no COPHCs were designated for exposure to sediment. No COPECs were selected for sediment at the site.

3.0 HUMAN HEALTH EXPOSURE AND RISK ASSESSMENT

3.1 Site Conceptual Model for Potential Human Exposure

A conceptual site model was developed for this Site and is presented in **Figure 3**.

3.1.1 Soil

Based on analytical data, COPHCs were not detected at or above screening values. Thus, COPHCs were not designated for either direct contact with constituents in soil. Since VOCs were detected in soil, the potential for volatilization of COPHCs in soil to indoor or ambient air was further assessed.

Soil-to-groundwater COPHCs were identified and were assessed for potential migration to groundwater using VLEACH as part of the groundwater model **(Appendix B)**. Based on screening results, all detected VOCs were eliminated.

3.1.2 Groundwater

On-site receptors that may be exposed to constituents in groundwater at the Site include both commercial workers and future construction workers. Commercial workers at the Site may be exposed to volatile organic constituents in soil and groundwater through volatilization and subsequent migration of vapors into indoor breathing air. It is assumed that on-site workers will not have direct contact exposure to groundwater since the Site receives publicly-supplied water. A future construction worker may install or repair underground utility lines as part of routine site maintenance. Therefore, future exposure to constituents in groundwater via direct contact (dermal contact only) with groundwater is plausible for future construction workers. The construction worker may also inhale VOC vapors that have volatilized and migrated from soil and groundwater to outdoor air. These potential exposures were evaluated for construction workers at the Site.

Groundwater COPHCs with MDCs at or above De Minimis levels were identified and were assessed for potential off-site migration (toward the Elk River) by the groundwater model for the Site **(Appendix B)**.

3.1.3 Surface Water

The nearest surface water body is the Elk River, located adjacent to the property. Based on the analytical results of surface water samples collected from the Elk River, and the site-specific groundwater models estimated concentrations, potential groundwater COPHC concentrations were estimated for the Elk River **(Appendix B)**. Using the available surface water data and the model results, a screening level assessment for both current and future exposure scenarios was completed to assess the potential of surface water concentrations to pose health concerns for human receptors **(Tables 2-6 and 2-7)**. Since the modeled potential groundwater concentrations were below the referenced conservative screening levels, neither COPHCs nor COPECs exist for surface water.

3.1.4 Sediment

Based on analytical data from near shore sediments; no COPHCs or COPECs were designated in sediment.

3.2 Incomplete Exposure Pathways

3.2.1 Commercial Worker

For on-site commercial workers, all exposure pathways associated with potential contact with soil (incidental ingestion and dermal contact) are considered incomplete, since no direct contact COPHCs were designated in soil. Additionally, no contact with surface water or sediment is anticipated for on-site commercial workers. Since the Site has publicly-supplied drinking water, incidental ingestion of and dermal contact with COPHCs in groundwater are considered to be incomplete pathways.

3.2.2 Construction Worker

For on-site construction workers, all exposure pathways associated with potential direct contact with soil (incidental ingestion and dermal contact) are considered incomplete, since no direct contact COPHCs are designated in soil. Additionally, no contact with surface water or sediment is anticipated for construction workers.

3.2.3 Residents

The Site is assumed to remain in use as a commercial establishment for at least 30 years into the future; therefore, all on-site residential exposure pathways to soil and groundwater are considered incomplete. A land use covenant (LUC) will be required. The site receives publicly-supplied water to support the designation of groundwater pathways as incomplete.

Off-site residential exposure pathways to soil is considered to be incomplete. Although there are residents located near the Site boundaries, no documented spills are known to have occurred at the Site which would be potentially responsible for off-site soil contamination. Since there are no documented off-site spills from the Site, potential exposures to soil for nearby residents are considered incomplete exposure pathways.

In a similar manner, off-site residential exposures to constituents in groundwater are also considered incomplete. Known constituent plumes in groundwater are estimated to migrate off-site in a general westward direction toward the Elk River, not toward the nearby homes. The area has publicly-supplied water and no known wells have been documented within 2,000 feet of the Site (Shaw, 2004). Based on the direction of contaminant migration at the Site and that water usage in the immediate area of the Site is not supplied from the local groundwater aquifer, off-site residential exposure pathways associated with groundwater at the Site are considered incomplete.

3.2.4 Recreational Youth

The Site is not used for recreational purposes; therefore, on-site recreation exposure pathways are considered to be incomplete. As discussed in Section 3.1.3, surface water and groundwater model results were screened for current and future exposure scenarios and modeled results were below the conservative screening levels. Thus, COPHCs do not exist for surface water. Soil exposure pathways are considered incomplete for the off-site recreational user since off-site surface spills have not been documented. Exposure pathways associated with sediment are considered to be incomplete because no COPHCs are designated in sediment.

Using the available surface water data and the model results, a screening level assessment for both current and future exposure scenarios was completed to assess the potential of surface water concentrations to pose health concerns for human receptors **(Tables 2-6 and 2-7)**. Since the modeled potential groundwater concentrations were below the referenced conservative screening levels, COPHCs do not exist for surface water.

3.3 Complete Exposure Pathways

Commercial Worker

Complete exposure pathways for commercial workers on-site include the following:

- Inhalation from COPHCs in soil and groundwater that may migrate to ambient air, and
- Inhalation from COPHCs in soil and groundwater that may migrate to indoor air

It is assumed that commercial workers spend the entire duration of their work shifts exposed to indoor air. This is a conservative assumption, since commercial workers may spend portions of their work shift exposed to outdoor ambient air where concentrations of vapors are expected to be significantly lower as compared to indoor air. Based on this, the ambient air pathways from groundwater are qualitatively assessed by the assumption if risks and hazards are acceptable for indoor air, they are also acceptable for ambient air.

Construction Worker

Complete exposure pathways for construction workers include the following:

- Dermal contact with COPHCs in groundwater, and
- Inhalation from COPHCs in soil and groundwater that may migrate to ambient air.

Construction workers exposed to COPHCs in ambient air are assessed qualitatively in this risk assessment by the assumption if risks and hazards are acceptable for indoor air, they are also acceptable for ambient air.

Figure 3 presents the conceptual site model for this assessment.

3.3.1 Exposure Point Concentrations

Exposure point concentrations (EPCs) were developed for use in estimating potential risks and hazards for potentially exposed receptor populations at the Site. Determination of EPCs typically relies on the use of various approved statistical methodologies aimed at calculating the 95% upper confidence level (UCL) on the mean. The procedures employed to estimate the 95% UCL for COPHCs are discussed below.

Appendix H in the West Virginia Voluntary Remediation and Redevelopment Act Guidance Manual, Version 2.1 (WVDEP, 2002) indicates that the UCL on the mean depends on whether the data follow a normal distribution or a lognormal distribution. The WV guidance also recommends using USEPA guidance (USEPA, 1992a) when calculating the 95% UCL on the mean for both distributions. Accordingly, COPHCs in groundwater were tested for normality and lognormality with the Shapiro-Wilk test (USEPA, 1992b).

Since the USEPA guidance (USEPA, 1992a) was issued, the USEPA's Office of Research and Development issued a publication titled: *The Lognormal Distribution in Environmental Applications* (USEPA, 1997a). This publication states the following conclusion:

"It is seen from the simulated examples that, even when the underlying distribution is lognormal, the performance of the jackknife, bootstrap, and CLP procedures is more accurate than that of the H-UCL".

Based on this analysis of the accuracy of the H-statistic (H-UCL), EPCs for the data sets that were determined to have lognormal distributions were calculated using the bootstrap method. The bootstrap method was selected for constituents with lognormal distributions because it randomly samples the entire data set, including non-detect values. In the bootstrap procedure, repeated samples of size *n* are drawn with replacement from a given set of observations. The procedure is repeated a large number of times (5,000 times for the current application), and each time an estimate of the mean is computed. The estimates thus obtained are used to compute the standard error of the mean. The "bootstrap t" approach by Efron (1982) was used in the current assessment and is discussed in USEPA (1997a).

For the constituents with undefined distributions, as determined using the Shapiro-Wilk test, the bootstrap statistic was also selected as the technique to estimate the EPC. It should be noted that no COPHCs in any site media were found to have a normal data distribution.

3.3.1.1 Soil EPCs

Soil EPCs were not calculated for direct contact for this risk assessment since no soil direct contact COPHCs were designated.

For evaluating the soil to indoor air pathway, EPCs for VOC constituents were determined based on the maximum soil analytical results from areas where either current buildings are located or where it is plausible for buildings to be located at the Site in the future. Since it is nearly impossible to construct a building on the steep sloped bank of Elk River due to the proximity of the river and the steep nature of the slope at the Site, soil data obtained from the escarpent area below the Site were eliminated from consideration in determining EPC. Also, the developed portion of the Site is fairly narrow on the northern end (only approximately 30 feet wide); therefore, this area is unlikely to be developed in the future. Based on this, the soil EPCs were determined using data from the soil samples collected around the current existing buildings at the site. Soil samples from soil borings SB-4, SB-5, SB-6, SB-8, TMW/SB-7, and TMW/SB-3 were used to represent concentrations of VOCs in soil that could potentially migrate to indoor air. In the case of all VOCs, maximum soil concentrations were utilized as the EPC. Soil to Indoor Air EPCs used in the evaluation are summarized below.

Soil EPCs Used to Evaluate the Indoor Air Pathway

COPHC	EPC (ug/L)	Sample Location
Benzene	375	TMW/SB-3
Ethylbenzene	16.6	TMW/SB-3
Toluene	8.1	TMW/SB-3
Xylenes (total)	353	TMW/SB-7
MTBE	625	TMW/SB-7
Acetone	81.3	SB-6
Carbon disulfide	4.83	SB-5
Methylene chloride	4.6	SB-6

3.3.1.2 On-Site Groundwater EPCs

On-site groundwater EPCs were calculated from the on-site groundwater data and are presented in **Table 3-1.** EPCs were calculated from the groundwater data set as discussed in Section 3.3.1. As shown in **Table 3-1**, the total number of on-site sample results used to calculate EPCs for groundwater ranged from 9 to 125. The calculated EPCs were used in this analysis to quantitatively evaluate the exposure via inhalation and dermal contact with COPHCs in groundwater.

3.3.1.3 Surface Water EPCs

The derivation of EPCs for surface water was discussed in Section 2.2.3. Since surface water concentrations were estimated based on results of the groundwater fate and transport model, 95% UCLs were not calculated for surface water. EPCs for surface water were based on the maximum modeled groundwater concentration estimated at the

Elk River adjusted by a dilution factor of 10. **Table 2-6 and 2-7** provide the surface water EPCs used in this assessment.

3.3.1.4 Sediment EPCs

EPCs for sediment were not statistically calculated because only five sediment samples were collected from Elk River. Therefore, EPCs for sediment are the maximum detected constituent concentrations summarized in **Table 2-9**.

3.3.2 Exposure Models and Corresponding Parameter Values

Spreadsheets have been developed to calculate risks and hazards for each receptor. **Appendix C** includes these spreadsheets with the input values used to estimate the indoor air concentrations using the fate and transport model discussed in the following section.

3.3.2.1 Inhalation of COPHCs in Indoor Air

Potential indoor air exposures were estimated by determining representative EPCs in each media. Soil EPCs were based on maximum VOC concentrations in soil as discussed in Section 3.3.1.1 and groundwater EPC concentrations were based on 95% UCL concentration for benzene.

The Johnson and Ettinger (2003) screening-level model was used to estimate indoor air concentrations at the Site for COPHCs in both soil and groundwater. This model incorporates both convective and diffusive mechanisms for estimating the transport of contaminant vapors emanating from either subsurface soils or groundwater into indoor spaces located directly above the source of contamination. The Johnson and Ettinger model is a one-dimensional analytical solution for vapor transport into indoor spaces and provides an estimated attenuation coefficient that relates the vapor concentration in the indoor space to the vapor concentration at the source of contamination. The model is constructed as both a steady state solution to vapor transport (infinite or nondiminishing source) and as a quasi-steady state solution (finite or diminishing source). Inputs to the model include chemical properties of the contaminant, saturated and unsaturated zone soil properties, and structural properties of the building. The model inputs and resultant risks and hazards are provided in **Appendix C**. Chemical-specific input parameters are also used by the model.

3.3.3 Estimated Chemical Intake Values for Individual Pathways

The chemical-specific and pathway-specific values used to estimate the body dose for each of the exposure pathways quantitatively evaluated are provided in **Appendix C**. **Table 3-2** provides a summary of the intake parameters used in the risk assessment.

The "Average Daily Dose" (ADD) and "Lifetime Average Daily Dose" (LADD) are the general parameters used to quantify exposure doses in human health risk assessments. The ADD is used as a standard measure for characterizing long-term non-carcinogenic effects. The LADD addresses exposures that may occur over varying durations from a single event to an average 70-year human lifetime and are used to estimate potential carcinogenic risks. These equations, and the factors used in each, apply to all COPHCs. The following subsections present the equations for calculating ADD and LADD.

It should be noted that the Johnson & Ettinger indoor air model does not calculate a dose, but simply estimates risks and hazards using COPHC unit risks $(\mu g/m^3)^{-1}$ and reference concentrations (mg/m^3) that assume 24 hour per day exposure.

3.3.3.1 Dermal Contact with COPHCs in Groundwater

The type of dose calculated for dermal contact with water is described by the following equation:

$$ADD\ or\ LADD = \frac{CW \times SA \times K_p \times EF \times ED \times ET \times CF}{BW \times AT}$$

where:

CW	=	constituent concentration in water (mg/l)
SA	=	skin surface area exposed (cm^2/event)
K_p	=	permeability constant (cm/hr)
EF	=	exposure frequency (events/year)
ED	=	exposure duration (years)
ET	=	exposure time (hr)
CF	=	conversion factor (10^{-3} L/cm^3)
BW	=	body weight (kg)
AT	=	averaging time (days) for carcinogenic effects: 70 years x 365 days; for non-carcinogenic effects: ED x 365 days

For this assessment, values for skin area for the construction worker were based on average values for hands and forearms as provided in the Exposure Factors Handbook (USEPA, 1997b). Permeability constants are from RAGS Part E (USEPA, 2001).

3.3.4 Toxicity Values for Noncarcinogens

USEPA-derived toxicity values used in evaluating noncarcinogenic health hazards are called reference doses (RfDs). RfDs are expressed in units of dose (USEPA, 1989) (mg/kg-day) and incorporate uncertainty factors to account for limitations in the quality or quantity of available data. Chronic oral RfDs were used in this assessment to evaluate noncarcinogenic effects from both oral and dermal exposure to COPHCs at the site. The RfDs utilized in this assessment and their sources are as follows:

- Benzene – 0.004 mg/kg-day, IRIS (USEPA, 2004),
- MTBE – 0.86 mg/kg-day, (USEPA Region 9 PRG Table, 2002),
- TPH-GRO – 0.2 mg/kg-day (WV Draft Supplemental Guidance for TPH, GRO assumed to be aromatic),

- TPH-DRO – 0.04 mg/kg-day (WV Draft Supplemental Guidance for TPH-DRO),
- TPH-ORO – 0.03 mg/kg-day (WV Draft Supplemental Guidance for TPH-ORO),
- Lead – No RfDs are available,
- 1-Methylnaphthalene – 0.004 mg/kg-day, IRIS (USEPA, 2004),
- 2-Methylnaphthalene – 0.004 mg/kg-day, IRIS (USEPA, 2004),
- Dibenz(a,h)anthracene - No RfDs are available,
- Indeno(1,2,3-cd)pyrene - No RfDs are available.

The Johnson & Ettinger Model uses reference concentrations (RfC) (Section 3.3.3) to estimate non carcinogenic hazards associated with inhalation of COPHCs in indoor air. RfC values utilized in this assessment include:

- Benzene – 0.03 mg/m^3, IRIS (USEPA, 2004),
- Ethylbenzene – 1.0 mg/m^3, IRIS (USEPA, 2004),
- Toluene - 0.4 mg/m^3, IRIS (USEPA, 2004),
- Xylenes (total) - 0.1 mg/m^3, IRIS (USEPA, 2004),
- MTBE - 3.0 mg/m^3, IRIS (USEPA, 2004),
- Acetone - 3.3 mg/m^3, USEPA Region 9, 2004 (based on Route to route extrapolation,
- Carbon disulfide - 0.7 mg/m^3, IRIS (USEPA, 2004),
- Methylene chloride - 3.0 mg/m^3, (USEPA Region 3, 2004, from HEAST),

3.3.5 Carcinogenic Slope factors

The slope factor is used to estimate an upperbound lifetime probability of an individual developing cancer as a result of exposure to a particular level of a potential carcinogen. To derive the carcinogenic slope factors (CSF), data from animal studies (or occasionally from human epidemiological studies) are fit to the linearized multistage model, and the upper 95th percent confidence limit on the slope of the resulting dose-response curve is calculated. Therefore, this slope factor reflects an upperbound estimate of the probability of carcinogenic response per unit dose of a chemical. The CSF is expressed in units of reciprocal dose (mg/kg-day)$^{-1}$. CSFs are derived separately for oral and inhalation exposure, as appropriate.

Oral CSFs were used in this assessment to evaluate carcinogenic effects from dermal exposure to COPHCs at the Site (see Section 3.3.5 for discussion of dermal toxicity criteria). The oral CSFs utilized in this assessment and their sources are as follows:

- Benzene – 0.055 (mg/kg-day)$^{-1}$, IRIS (USEPA, 2004),
- MTBE – 0.004 (mg/kg-day)$^{-1}$, (USEPA Region 3 RBC Table, April 2004),
- THP-GRO – No oral CSF is available,
- THP-DRO – No oral CSF is available,
- THP-ORO – No oral CSF is available,
- Lead - No oral CSF is available,
- 1-Methylnaphthalene – No oral CSF is available,

- 2-Methylnaphthalene – No oral CSF is available,
- Dibenz(a,h)anthracene – 7.3 $(mg/kg\text{-}day)^{-1}$, NCEA Provisional Value, (USEPA Region 3 RBC Table, April 2004),
- Indeno(1,2,3-cd)pyrene – 0.73 $(mg/kg\text{-}day)^{-1}$, IRIS (USEPA, 2004).

The Johnson & Ettinger Model uses unit risk factors (URFs) (Section 3.3.3) to estimate carcinogenic risks associated with inhalation of COPHCs in indoor air. URFs utilized in this assessment include:

- Benzene – 7.8×10^{-6} $(\mu g/m^3)^{-1}$, IRIS (USEPA, 2004),
- Ethylbenzene – No inhalation CSF is available,
- Toluene – No inhalation CSF is available,
- Xylenes (total) – No inhalation CSF is available,
- MTBE – No inhalation CSF is available,
- Acetone – No inhalation CSF is available,
- Carbon disulfide – No inhalation CSF is available,
- Methylene chloride – 4.7×10^{-7} $(\mu g/m^3)^{-1}$, IRIS (USEPA, 2004),

3.3.6 Dermal Toxicity Criteria

USEPA has developed CSFs and RfDs only for ingestion and inhalation exposures (USEPA, 1989). There are no available toxicity criteria for evaluating dermal exposures. In the absence of dermal criteria, oral CSFs and RfDs, which are based on administered dose, are generally used. However, the dermal exposure doses estimated in the Section 3.3.3 are absorbed doses, as the exposure algorithms consider the amount of the COPHC that crosses the stratum corneum of the skin into the systemic distribution. In order to make analogous comparisons to these doses, oral toxicity criteria based on administered doses would need to be adjusted to absorbed (internal) doses. To calculate an absorbed oral CSF or RfD for a chemical, the oral absorption efficiency of the chemical in the toxicity test vehicle (e.g., water, oil, food) needs to be known. Gastrointestinal absorption factors of 1.0 were applied for all COPHCs in this assessment based on guidance provided by RAGS Part E (USEPA, 2001).

Adjustments to administered dose-based toxicity criteria are made as follows:

$$RfD_{dermal} = RfD_{oral} \times ABS_{oral}$$

$$CSF_{dermal} = \frac{CSF_{oral}}{ABS_{oral}}$$

where:

ABS_{oral} = oral absorption factor for the constituent.

3.4 Risk Characterization

Risk characterization is the final step of the health risk assessment process. It includes a description of the nature and magnitude of the potential for occurrence of adverse health effects under a specific set of conditions. In this step, the site-specific exposure assessment and the dose-response assessment are integrated into quantitative estimates of potential health risks to Site receptors. The calculated carcinogenic and noncarcinogenic risks are summarized in **Table 3-3**.

3.4.1 Carcinogenic Risks

The potential carcinogenic risk to current and future on-site commercial workers at the Site is 1×10^{-5}. The total potential carcinogenic risk to future on-site construction workers at the Site is less than 1×10^{-5}. Exposure pathways evaluated for each receptor are summarized in **Table 3-3**. The carcinogenic risk estimates to each of these potential receptors are within West Virginia's and USEPA's target cancer risk range of 1.0×10^{-6} to 1.0×10^{-4}.

3.4.2 Noncarcinogenic Hazard Indices

The potential noncarcinogenic hazard index for current and future on-site commercial workers at the Site is 0.1. The total potential noncarcinogenic hazard index for future on-site construction workers at the Site is less than 0.2. Exposure pathways evaluated for each receptor are summarized in Table 3-3.

The WVDEP and USEPA consider noncarcinogenic hazard indices less than one (1.0) to be acceptable. Accordingly, the calculated non-carcinogenic hazard indices for both receptors are considered acceptable.

3.5 Uncertainty Analysis

Uncertainties are inherent in every aspect of a quantitative risk assessment. Often times during the risk assessment process, certain assumptions are made. These assumptions may lead to an overestimation or an underestimation of the actual risks associated with this Site. In general, these assumptions are "conservative", that is, made in such a way as to more likely result in an overestimation of the actual risk. Conservative assumptions made in this risk assessment are described in Section 3.3.3. Generally, these assumptions are related to receptor exposure parameters. The inclusion of site-specific factors can decrease the level of uncertainty, although some uncertainty persists in even the most site-specific and accurate risk assessments. A careful and comprehensive analysis of the critical areas of uncertainty in a risk assessment is an important part of the risk assessment process. The uncertainty analysis provides a context for better understanding the assessment conclusions by identifying the uncertainties that have most significantly affected the assessment results. **Table 3-4** provides a brief summary of the key uncertainties in this assessment and qualifies the level of effect each uncertainty has on the assessment. For this assessment, the exposure frequency for the construction worker was conservatively assumed to be 20 days per year based on professional judgment. Based on the area of the Site (approximately 4.55 acres), it is likely that this value is biased high and that actual Site construction with intrusive activities in soil would not last for a one-month five day per week period. This assumption for the exposure frequency has likely contributed to the overestimation of risks for the construction worker. Another exposure assumption based on professional judgment is the exposure time. The exposure time utilized for this assessment was 4 hours per day. It is highly unlikely that actual intrusive construction work within the water table at the Site would last for 4 hours each day. This assumption, too, likely has contributed to an overestimation of risk for the construction worker.

Uncertainties associated with toxicity data also contribute to the overall uncertainty associated with estimated risks at this Site. The carcinogenic slope factors utilized for all PAH constituents other than benzo(a)pyrene are provisional values based on guidance from the National Center for Environmental Assessment (NCEA). The assumption used for these provisional values is based on the theory that the carcinogenic PAHs have a cancer potency that can be equated to some fraction of the potency of benzo(a)pyrene. The slope factors are not based on actual toxicological studies of each individual PAH constituent. It is possible that this overestimates potential risks rather than underestimates risks for the PAH constituents, as these slope factors are not presented in the IRIS database (USEPA, 2004).

Similar uncertainties exist with the toxicity of MTBE. Information on the toxicity of MTBE is uncertain; more is known about MTBE's inhalation toxicity than its oral toxicity. Recent evidence suggests that MTBE may be carcinogenic; however, USEPA has not formally designated a carcinogenicity classification. The impacts of the uncertainty of the toxicity data for MTBE are not significant on this assessment, since risks and hazards associated with MTBE were below the West Virginia and USEPA thresholds.

PAH dermal absorption coefficients utilized in this assessment were based on guidance from RAGS Part E (USEPA, 2001). The dermal coefficients for PAHs in this guidance were estimated based on a regression equation determined from various chemical constituents with relatively low (below 3.0) octanol-water partition coefficients (Log K_{ow}). The Log K_{ow}s for potentially carcinogenic PAHs are generally higher than 5.0. Since the large majority of the experimental data set that was used to derive the dermal absorption coefficients in RAGS Part E has Log K_{ow}s equal to 3.0 or below, and only one chemical had a Log K_{ow} above 5.0, a potentially high level of uncertainty exists regarding the use of the regression-based dermal absorption coefficients in RAGS Part E for PAHs with elevated K_{ow}s. PAH dermal absorption coefficients estimated from equations presented in RAGS Part E are expected to be overestimated.

4.0 De MINIMIS ECOLOGICAL SCREENING RISK ASSESSMENT

The Elk River is located along the western border of the Site. There are no suspected impacts to terrestrial wildlife at the Site because of limited habitat. A checklist to determine the applicable ecological standard is included as **Appendix D**.

Tables 2-8 and 2-9 provide the summaries of the environmental assessments for surface water and sediment to determine potential impacts to aquatic biota from Site-related constituents in the Elk River. Benchmarks protective of aquatic biota were used for the comparison of surface water data from the West Virginia Water Quality Criteria, Ecological PRGs (Efroymson et. al (1997), and USEPA Region 5 Ecological Screening Levels for Water (USEPA Region 5, 2003). To assess surface water COPEC concentrations, a site-specific dilution factor was derived utilizing a calculated site-specific flow rate for groundwater discharging to the Elk River and the documented low flow rate of the Elk River. The derivation of the dilution factor is discussed in **Appendix E**. Based on calculations presented in **Appendix E**, a dilution factor of approximately 4,000 was estimated for the site. To conservatively account for the fact that mixing may not be instantaneous, the dilution factor of 4,000 was reduced to a site-specific dilution factor of 400 for use in risk assessment. However, the WVDEP suggested the use of an alternate (more conservative) default dilution factor of 10 (WVDEP, November 29, 2004). Therefore, the 10-fold dilution factor was applied to the modeled results to estimate potential future COPEC concentrations in the Elk River.

For surface water, lead and benzo(a)pyrene concentrations exceed ecological standards **(Table 2-8)**. The surface water assessment (Shaw Environmental, 2004) included the collection of upgradient background surface water samples for PAHs. As discussed in Section 2.2.3.3, it was determined that site-associated sample results were not different from the upgradient surface water samples. Therefore, concentrations of benzo(a)pyrene in surface water are not attributable to site-related activities. Lead concentrations were detected in only 2 out of a total of 21 surface water samples collected at the Site. The two concentrations were not detected in samples collected adjacent to the Site. Concentrations were not detected above ecological standards in near-shore surface water samples that were collected within two feet of the shoreline. The samples with lead detections were collected in the river channel at distances ranging from 50 to 75 feet away from the shore line. These distances indicate that lead concentrations in surface water from actual samples are not attributable to site-related activities. Additionally, both of the lead concentrations (0.0030 mg/L and 0.0040 mg/L) were low estimated (flagged J) concentrations that were below the laboratory reporting limits. For future surface water conditions based on modeled groundwater concentrations, the concentrations of lead are predicted to be similar to actual surface water sample results from the Elk River (4.10×10^{-3} after application of the 10-fold dilution factor—refer to Table 2-8). The modeled concentrations were based on groundwater data obtained prior to the remediation of lead impacted soil at the Site. Since the soil containing the elevated lead concentrations has been removed from the Site, the potential for leaching of lead from Site soil to the Elk River has been mitigated. Additionally, model-predicted lead concentrations in surface water were based on pre-remedial groundwater sample data and are numerically similar to the ecological standards for lead (0.0032 mg/L). Further, based on the known low flow rates for the Elk River, it is likely that the conservative 10-fold dilution factor applied to the modeled groundwater results underestimates the amount of dilution for the Site. Therefore, lead concentrations in surface water are not considered to be a concern for ecological receptors, and further clean-up of Site related media to address elevated lead concentrations above the ecological thresholds is not warranted.

For near shore sediment, only two constituents, TPH-ORO (maximum of 87.2 mg/kg) and lead (maximum of 30.5 mg/kg) were detected. No ecological screening values protective of aquatic biota could be located for THP-ORO. Values of 110 mg/kg and 31 mg/kg for lead are available from the Ecological PRGs (Efroymson et al., (1997), and USEPA Region 5, respectively. Since the Site MDC for lead in near shore sediment is below both of these criteria, potential impacts from lead in sediment on aquatic biota are not predicted.

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary

Environmental investigations completed at the Site between November 2000 and June 2004 documented that both soil and groundwater at the Site were impacted by Site operations. Samples were also collected to determine if surface water and sediment in the Elk River had been impacted by Site operations. Constituents detected in soil include BTEX, MTBE, TPH (GRO, DRO, and ORO), chromium (both trivalent and hexavalent), lead, 18 PAHs, acetone, 2-butanone, carbon disulfide, and methylene chloride. Constituents detected in groundwater include BTEX, MTBE, TPH (including GRO, DRO, and ORO), 18 PAHs, and dissolved lead. Constituents detected in surface water include TPH (DRO and ORO, only); lead, both total and dissolved; and 11 PAHs. Constituents detected in sediment include TPH (ORO, only), and lead.

COPHCs were determined by screening MDCs in soil and groundwater against conservative benchmarks developed to be protective of human health for direct contact exposure, potential migration to groundwater, and potential migration to indoor air. For VOCs in soil, no appropriate screening criteria were available so all detected VOCs in soil were analyzed for migration to indoor air. Constituents exceeding the screening criteria were designated as COPHCs, and evaluated further in the risk assessment. Based on analytical data, COPHC in soil include benzene, ethylbenzene, toluene, xylenes (total), MTBE, acetone, carbon disulfide, and methylene chloride. COPHCs in groundwater included benzene, MTBE, TPH-GRO, TPH-DRO, TPH-ORO, dissolved lead, 1-methylnaphthalene, 2-methylnaphthalene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene. Based on analytical data, COPHCs do not exist for surface water and sediment; however, these media were evaluated further for potential impacts to ecological receptors.

A groundwater model was executed to assess the potential for COPHC concentrations in soil to migrate to groundwater and to assess the fate and transport of COPHCs in groundwater. Surface water data and modeled results were screened for both current and future exposure scenarios to assess the potential of surface water concentrations to pose health concerns for human receptors. Since the predicted groundwater concentrations were below the referenced screening levels, COPHCs do not exist for surface water.

A conceptual site model was developed for the Site. Potential human receptors evaluated in the risk assessment included on-site commercial workers and on-site construction workers. On-site commercial workers were assessed for exposure to COPHCs in groundwater via inhalation of indoor air. On-site construction workers were assessed for exposure to COPHCs in groundwater via dermal contact and qualitatively for inhalation of ambient air. Estimated cancer risks for receptors were significantly below both West Virginia's and USEPA's target risk range of 1×10^{-6} to 1×10^{-4}. Hazard indices for the evaluated receptors are below 1.0. The WVDEP and USEPA consider noncarcinogenic hazard indices less than one (1.0) to be acceptable. Cancer risks and noncarcinogenic health hazards are summarized as follows:

Summary of Cancer Risks and Noncarcinogenic Hazards

Receptor	Estimated Cancer Risk	Estimated Hazard Index
On-site Commercial Worker (Current and Future)	1.0E-05	0.1
On-site Construction Worker (Future)	Less than 1.0E-05	Less than 0.2

An evaluation of ecological risks associated with potential surface water and sediment COPECs was conducted for the Elk River. Based on the evaluation of surface water and sediment COPECs, potential impacts to aquatic biota are not predicted.

5.2 Conclusion and Recommendation

Based on analytical and field data collected during the environmental site assessments and the results of this risk assessment, the Site does not pose a risk to potential human or ecological receptors. Thus, a final report should be prepared and application for a certificate of completion should be filed in accordance with standards and terms set forth by The Voluntary Remediation and Redevelopment Rule and the Voluntary Remediation and Redevelopment Act. Additionally, based on the analytical results from quarterly groundwater samples referenced in Section 2.2.2 and the results of this risk assessment, no further remedial or monitoring action is needed.

A deed restriction should be filed with the Clerk of Kanawha County Commission in the form of a LUC to restrict Site usage to non-residential and restrict groundwater from portable usage as defined by Title 60 CSR Series 3, Voluntary Remediation and Redevelopment Rule. The LUC and certain engineering controls concerning facility maintenance should be outlined in the Final Report.

6.0 REFERENCES

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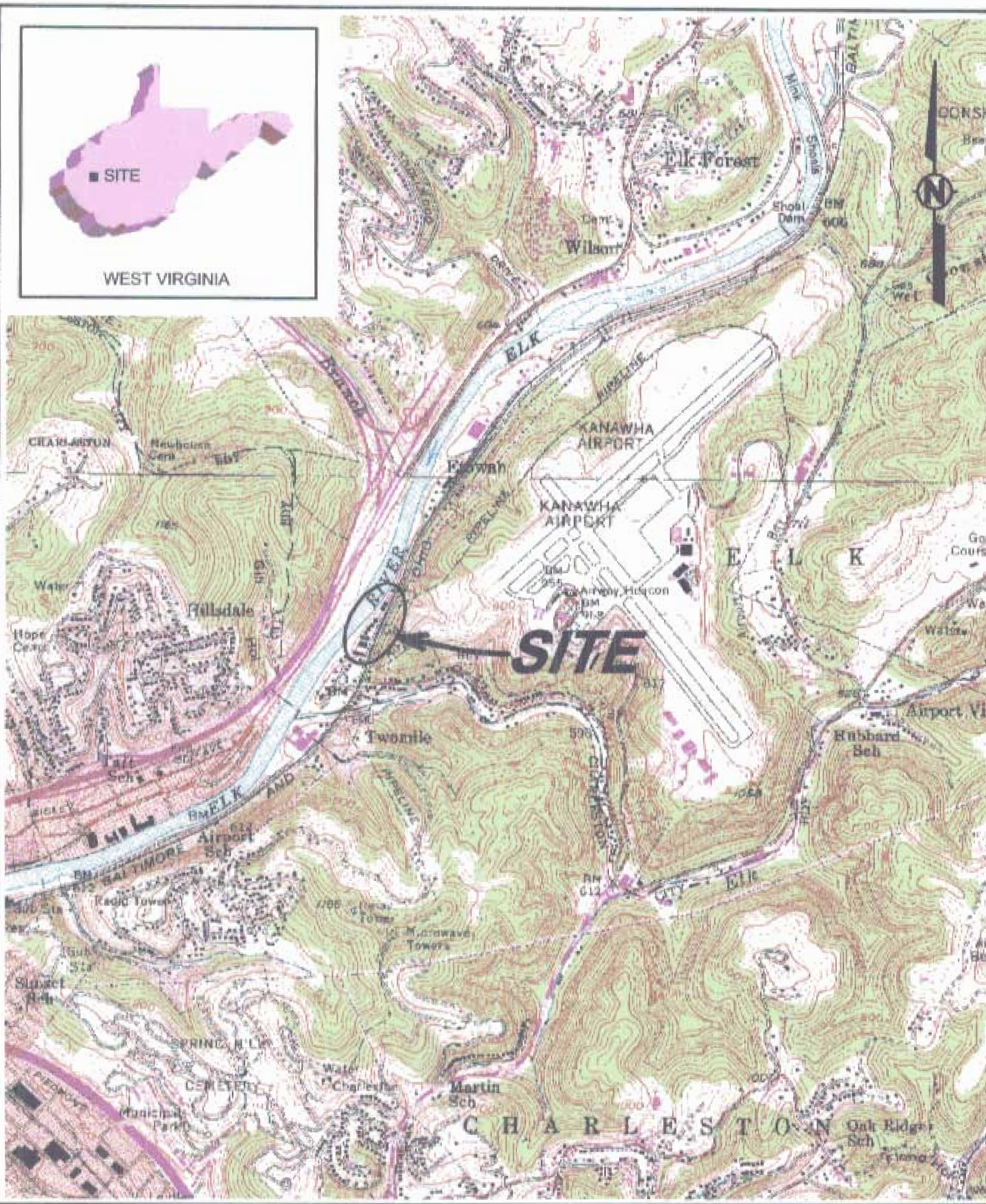
FIGURES

Large map
not scanned

DRAWN BY	MSN	7/31/02
CHECKED BY	GAR	11/7/03
APPROVED BY	DAC	11/7/03
DRAWING NUMBER	2002 57-01.DWG	



SCALE: 1"=2000'

0 500 1000 1500 2000 4000 FEET

REFERENCE:

U.S.G.S. 7.5 MIN. TOPOGRAPHIC MAP OF CHARLESTON EAST WEST VIRGINIA, DATED 1958, PHOTOREVISED 1968; SCALE: 1"=2000'

Shaw Environmental, Inc.

SHELL OIL PRODUCTS, U.S.

FIGURE 1
SITE LOCATION MAP

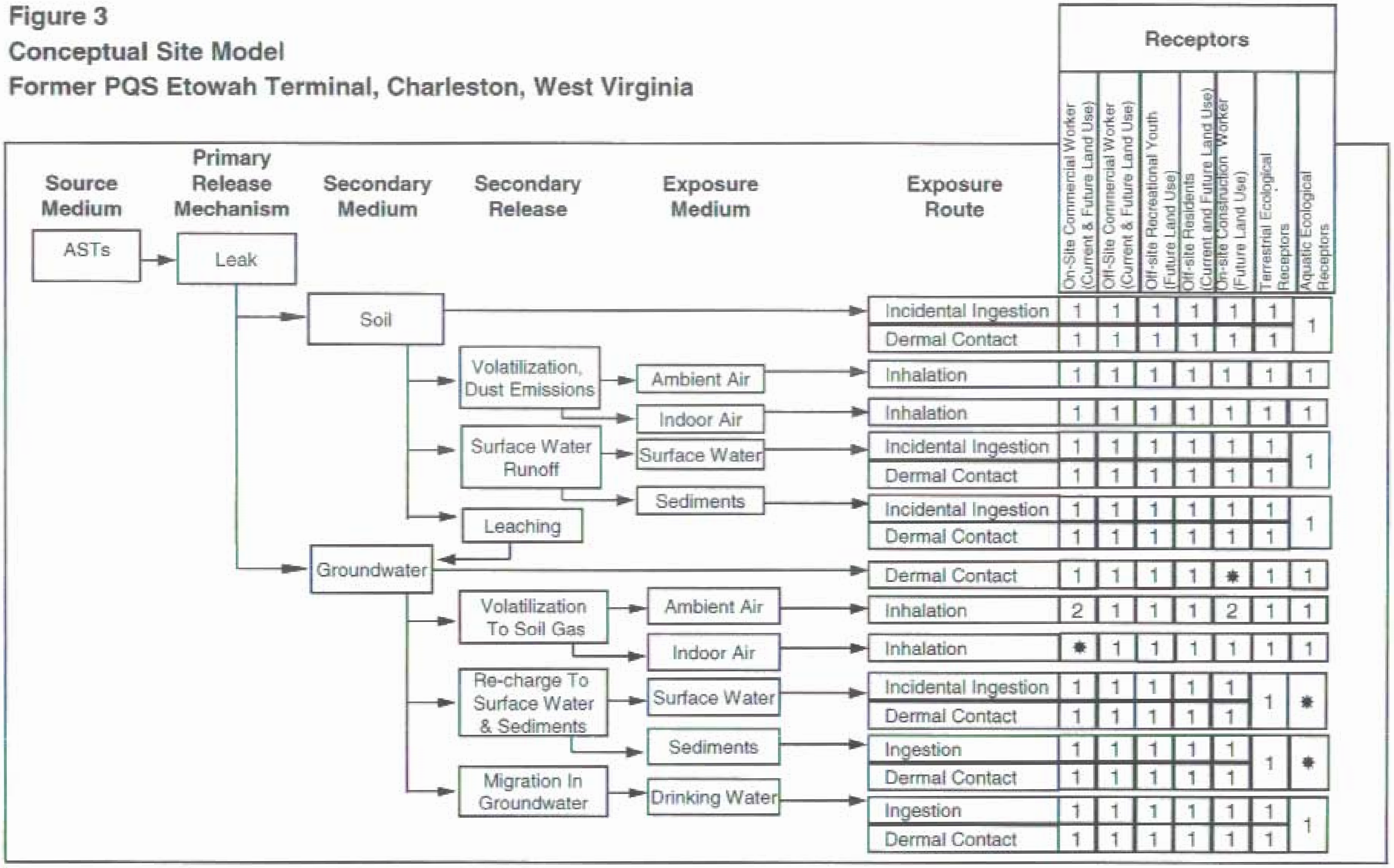
FORMER PQS ETOWAH TERMINAL
1015 BARLOW DRIVE
CHARLESTON, WEST VIRGINIA

M. Najar - D:\Acad 2002\2002 57\2002 57-01.dwg - Thu, 30 Sep 2004 - 15:22

Figure 3

Conceptual Site Model

Former PQS Etowah Terminal, Charleston, West Virginia



✱ = Complete exposure pathway quantitatively evaluated.

1 = Incomplete exposure pathway.

2 = Complete exposure pathway qualitatively evaluated.

N:Projects/PQS/Etowah/Reports/RA Rpt/Figure 3

TABLES

Table 1
Aboveground Storage Tank Information
Former PQS Etowah Terminal
Charleston, West Virginia

STORAGE TANK NUMBER OR NAME	TYPE	YEAR INSTALLED	CAPACITY	CONTENTS*
Aboveground Storage Tank No. 392	Aboveground Storage Tank	1991	8,000	Additive
Aboveground Storage Tank No. 393	Aboveground Storage Tank	1951	420,000	Kerosene
Aboveground Storage Tank No. 394	Aboveground Storage Tank	1951	420,000	Kerosene
Aboveground Storage Tank No. 395	Aboveground Storage Tank	1938	18,700	Bulk Oil
Aboveground Storage Tank No. 396	Aboveground Storage Tank	1938	18,700	Bulk Oil
Aboveground Storage Tank No. 397	Aboveground Storage Tank	1938	420,000	Bulk Oil
Aboveground Storage Tank No. 398	Aboveground Storage Tank	1945	420,000	Gasoline
Aboveground Storage Tank No. 399	Aboveground Storage Tank	1940	420,000	Gasoline
Aboveground Storage Tank No. 400	Aboveground Storage Tank	1940	420,000	Gasoline
Aboveground Storage Tank No. 401	Aboveground Storage Tank	1940	420,000	Gasoline
Aboveground Storage Tank No. 402	Aboveground Storage Tank	1940	420,000	Gasoline
Aboveground Storage Tank No. 403	Aboveground Storage Tank	1950	420,000	Diesel
Aboveground Storage Tank No. 404	Aboveground Storage Tank	1950	420,000	Diesel
Aboveground Storage Tank No. 405	Aboveground Storage Tank	1951	420,000	Diesel

Table 2-1
Samples Used
In The Risk Assessment
Former PQS Etowah Terminal
Charleston, West Virginia

Shaw Environmental, Inc.
PQS dba SOPUS Products
Tax ID No. 76-0200625

Sample ID	Date Sampled	Sample Depth (ft bgs)	Analysis
Soil Samples			
C-1	11/3/2000	(0 – 0.5)	Benzene, Total BTEX, Pb
C-2	11/3/2000	(0 – 0.0)	Benzene, Total BTEX, Pb
C-3	11/3/2000	(0 – 0.5)	Benzene, Total BTEX, Pb
HA-1	11/3/2000	(0 –1.5)	Benzene, Total BTEX, Pb, TPH
HA-2	11/3/2000	(3 – 3.5)	Benzene, Total BTEX, Pb, TPH
HA-3	11/3/2000	(0 – 1.0)	Benzene, Total BTEX, Pb, TPH
HA-4	11/3/2000	(2 – 3)	Benzene, Total BTEX, Pb, TPH
HA-5	11/3/2000	(2 – 3)	Benzene, Total BTEX, Pb, TPH
GP-1	11/16/2000	(4 – 8)	Benzene, Total BTEX, Pb, TPH
	11/16/2000	(12 – 16)	Benzene, Total BTEX, Pb, TPH
GP-2	11/16/2000	(4 – 8)	Benzene, Total BTEX, Pb, TPH
	11/16/2000	(12 – 16)	Benzene, Total BTEX, Pb, TPH
GP-3	11/16/2000	(8 – 12)	Benzene, Total BTEX, Pb, TPH
	11/16/2000	(12 – 16)	Benzene, Total BTEX, Pb, TPH
GP-4	11/16/2000	(8 – 12)	Benzene, Total BTEX, Pb, TPH
	11/16/2000	(12 – 16)	Benzene, Total BTEX, Pb, TPH
GP-5	11/16/2000	(8 – 12)	Benzene, Total BTEX, Pb, TPH
	11/16/2000	(12 – 16)	Benzene, Total BTEX, Pb, TPH
GP-6	11/16/2000	(4 – 8)	Benzene, Total BTEX, Pb, TPH
	11/16/2000	(16 – 20)	Benzene, Total BTEX, Pb, TPH
	11/16/2000	(36 - 40)	Benzene, Total BTEX, Pb, TPH
GP-7	11/16/2000	(8 – 12)	Benzene, Total BTEX, Pb, TPH
	11/16/2000	(40 – 43)	Benzene, Total BTEX, Pb, TPH
GP-8	11/17/2000	(12 – 16)	Benzene, Total BTEX, Pb, TPH
	11/17/2000	(24 – 28)	Benzene, Total BTEX, Pb, TPH
GP-9	11/17/2000	(16 – 20)	Benzene, Total BTEX, Pb, TPH
	11/17/2000	(28 – 32)	Benzene, Total BTEX, Pb, TPH
GP-10	11/17/2000	(12 – 16)	Benzene, Total BTEX, Pb, TPH
	11/17/2000	(20 – 24)	Benzene, Total BTEX, Pb, TPH
MW-1	6/14/2001	(8 - 10)	Benzene, Total BTEX, MTBE, TPH
	6/14/2001	(10 - 12)	Benzene, Total BTEX, MTBE, TPH
MW-2	6/13/2001	(0 - 2)	Benzene, Total BTEX, MTBE, TPH
	6/13/2001	(10 - 12)	Benzene, Total BTEX, MTBE, TPH
MW-3	6/14/2001	(4 - 6)	Benzene, Total BTEX, MTBE, TPH
	6/14/2001	(12 - 14)	Benzene, Total BTEX, MTBE, TPH
MW-4	6/4/2001	(22 - 24)	Benzene, Total BTEX, MTBE, TPH
MW-5	6/4/2001	(18 - 20)	Benzene, Total BTEX, MTBE, TPH
	6/4/2001	(20 - 22)	Benzene, Total BTEX, MTBE, TPH
MW-6	6/4/2001	(2 - 4)	Benzene, Total BTEX, MTBE, TPH
	6/5/2001	(12 - 14)	Benzene, Total BTEX, MTBE, TPH
MW-7	9/27/2001	(14 - 16)	Benzene, Total BTEX, GRO, DRO
C2-A	5/30/2001	(0 - 0.5)	Pb
C2-B	5/30/2001	(0 - 0.5)	Pb
C2-C	5/30/2001	(0 - 0.5)	Pb
C2-D	5/30/2001	(0 - 0.5)	Pb
C2-E	5/30/2001	(0 - 0.5)	Pb
SB-1	7/17/2003	(0 - 2)	BTEX, MTBE, Pb, TPH, PAHs
	7/17/2003	(2 - 8)	BTEX, MTBE, Pb, TPH, PAHs
SB-1	7/17/2003	(18 - 20)	BTEX, MTBE, Pb, TPH, PAHs

Table 2-1 (Continued)
Samples Used
In The Risk Assessment
Former PQS Etowah Terminal
Charleston, West Virginia

Sample ID	Date Sampled	Sample Depth (ft bgs)	Analysis
	7/16/2003	(0 - 2)	BTEX, MTBE, Pb, TPH, PAHs
TMW/SB-2S	7/16/2003	(2 - 4)	BTEX, MTBE, Pb, TPH, PAHs
	7/16/2003	(0 - 2)	BTEX, MTBE, Pb, TPH, PAHs
	7/16/2003	(2 - 7.5)	BTEX, MTBE, Pb, TPH, PAHs
TMW/SB-3 S & D	7/17/2003	(26 - 28)	BTEX, MTBE, Pb, TPH, PAHs
	7/16/2003	(0 - 2)	BTEX, MTBE, Pb, TPH, PAHs
	7/16/2003	(2 - 8)	BTEX, MTBE, Pb, TPH, PAHs
SB-4	7/16/2003	(22 - 24)	BTEX, MTBE, Pb, TPH, PAHs
	7/15/2003	(0 - 2)	BTEX, MTBE, TPH, VOCs, Cd, Pb, Cr
SB-5	7/15/2003	(2 - 8)	BTEX, MTBE, TPH, VOCs, Cd, Pb, Cr
	7/15/2003	(0 - 2)	BTEX, MTBE, TPH, VOCs, PAHs, Cd, Pb, Cr
SB-6	7/15/2003	(2 - 8)	BTEX, MTBE, TPH, VOCs, Cd, Pb, Cr
SB-6 FS	7/15/2003	(2 - 8)	BTEX, MTBE, TPH, VOCs, Cd, Pb, Cr
	7/15/2003	(0 - 2)	BTEX, MTBE, TPH, VOCs, PAHs, Cd, Pb, Cr
	7/15/2003	(2 - 4)	BTEX, MTBE, TPH, VOCs, PAHs, Cd, Pb, Cr
TMW/SB-7 S & D	7/23/2003	(34 - 36)	BTEX, MTBE, TPH, VOCs, PAHs, Cd, Pb, Cr
	7/16/2003	(0 - 2)	BTEX, MTBE, Pb, TPH, PAHs
SB-8	7/16/2003	(2 - 8)	BTEX, MTBE, Pb, TPH, PAHs
	7/17/2003	(0 - 2)	BTEX, MTBE, Pb, TPH, PAHs
SB-9	7/17/2003	(2 - 4)	BTEX, MTBE, Pb, TPH, PAHs
	7/14/2003	(0 - 2)	BTEX, MTBE, Pb, TPH
	7/14/2003	(2 - 8)	BTEX, MTBE, Pb, TPH
SB-10	7/14/2003	(10 - 12)	BTEX, MTBE, Pb, TPH
TMW/SB-11	7/14/2003	(2 - 4)	BTEX, MTBE, Pb, TPH
TMW/SB-12	7/14/2003	(2 - 4)	BTEX, MTBE, Pb, TPH
TMW/SB-13	7/15/2003	(10 - 12)	BTEX, MTBE, Pb, TPH
TMW/SB-14	7/15/2003	(8 - 10)	BTEX, MTBE, Pb, TPH
	7/15/2003	(0 - 2)	BTEX, MTBE, Pb, TPH, PAHs
	7/15/2003	(2 - 8)	BTEX, MTBE, Pb, TPH, PAHs
SB-15	7/15/2003	(10 - 12)	BTEX, MTBE, Pb, TPH, PAHs
TMW/SB-16	7/15/2003	(14 - 16)	BTEX, MTBE, Pb, TPH, PAHs
TMW/SB-16 FS	7/15/2003	(14 - 16)	BTEX, MTBE, Pb, TPH, PAHs
TMW/SB-17	7/14/2003	(10 - 12)	BTEX, MTBE, Pb, TPH
TMW/SB-18	7/14/2003	(6 - 8)	BTEX, MTBE, Pb, TPH
	7/14/2003	(0 - 2)	BTEX, MTBE, Pb, TPH
SB-19	7/14/2003	(2 - 6)	BTEX, MTBE, Pb, TPH
TMW/SB-20	7/21/2003	(14 - 16)	BTEX, MTBE, Pb, TPH, PAHs
	7/22/2003	(0 - 2)	BTEX, MTBE, Pb, TPH, PAHs
SB-21	7/22/2003	(2 - 8)	BTEX, MTBE, Pb, TPH, PAHs
SB-21 FS	7/22/2003	(2 - 8)	BTEX, MTBE, Pb, TPH, PAHs
	7/21/2003	(0 - 2)	BTEX, MTBE, Pb, TPH, PAHs
	7/21/2003	(2 - 8)	BTEX, MTBE, Pb, TPH, PAHs
TMW/SB-22	7/22/2003	(20 - 22)	BTEX, MTBE, Pb, TPH, PAHs
	7/22/2003	(0 - 2)	BTEX, MTBE, Pb, TPH, PAHs
	7/22/2003	(2 - 8)	BTEX, MTBE, Pb, TPH, PAHs
TMW/SB-23	7/22/2003	(22 - 23.5)	BTEX, MTBE, Pb, TPH, PAHs
	7/21/2003	(0 - 2)	BTEX, MTBE, Pb, TPH, PAHs
SB-24	7/21/2003	(2 - 8)	BTEX, MTBE, Pb, TPH, PAHs
SB-24	7/21/2003	(10 - 12)	BTEX, MTBE, Pb, TPH, PAHs
SB-25	7/21/2003	(0 - 2)	BTEX, MTBE, Pb, TPH, PAHs

Table 2-1 (Continued)
Samples Used
In The Risk Assessment
Former PQS Etowah Terminal
Charleston, West Virginia

Sample ID	Date Sampled	Sample Depth (ft bgs)	Analysis
SB-25	7/21/2003	(2 - 8)	BTEX, MTBE, Pb, TPH, PAHs
	7/17/2003	(0 - 2)	BTEX, MTBE, Pb, TPH, PAHs
	7/17/2003	(2 - 8)	BTEX, MTBE, Pb, TPH, PAHs
TMW/SB-26	7/23/2003	(20 - 22)	BTEX, MTBE, Pb, TPH
Background Soil Samples			
	7/16/2003	(0 - 2)	BTEX, MTBE, Pb, TPH, PAHs
	7/16/2003	(2 - 8)	BTEX, MTBE, Pb, TPH, PAHs
TMW/BG-1	7/16/2003	(10 - 12)	BTEX, MTBE, Pb, TPH, PAHs
	7/16/2003	(0 - 2)	BTEX, MTBE, Pb, TPH, PAHs
	7/16/2003	(2 - 8)	BTEX, MTBE, Pb, TPH, PAHs
TMW/BG-2	7/16/2003	(14 - 16)	BTEX, MTBE, Pb, TPH, PAHs
Groundwater Samples			
MW-1	8/31/2004	NA	BTEX, MTBE, and TPH
	5/17/2004	NA	BTEX, MTBE, and TPH
	3/1/2004	NA	BTEX, MTBE, and TPH
	12/2/2003	NA	BTEX, MTBE, and TPH
	8/15/2003	NA	BTEX, MTBE, and TPH
	6/4/2003	NA	BTEX, MTBE, and TPH
	3/13/2003	NA	BTEX, MTBE, and TPH
	12/9/2002	NA	BTEX, MTBE, and TPH
	9/23/2002	NA	BTEX, MTBE, and TPH
	6/25/2002	NA	BTEX, MTBE, and TPH
	3/18/2002	NA	BTEX, MTBE, and TPH
	12/12/2001	NA	BTEX, MTBE, and TPH
	10/2/2001	NA	BTEX, MTBE, and TPH
	9/11/2001	NA	BTEX, MTBE, and TPH
	6/20/2001	NA	BTEX, MTBE, and TPH
MW-2	8/31/2004	NA	BTEX, MTBE, and TPH
	5/17/2004	NA	BTEX, MTBE, and TPH
	3/1/2004	NA	BTEX, MTBE, and TPH
	12/2/2003	NA	BTEX, MTBE, and TPH
	8/15/2003	NA	BTEX, MTBE, and TPH
	6/4/2003	NA	BTEX, MTBE, and TPH
	3/13/2003	NA	BTEX, MTBE, and TPH
	12/9/2002	NA	BTEX, MTBE, and TPH
	9/23/2002	NA	BTEX, MTBE, and TPH
	6/25/2002	NA	BTEX, MTBE, and TPH
	3/18/2002	NA	BTEX, MTBE, and TPH
	12/12/2001	NA	BTEX, MTBE, and TPH
	10/2/2001	NA	BTEX, MTBE, and TPH
	9/11/2001	NA	BTEX, MTBE, and TPH
	6/20/2001	NA	BTEX, MTBE, and TPH
MW-3	8/31/2004	NA	BTEX, MTBE, PAHs, and TPH
	5/17/2004	NA	BTEX, MTBE, PAHs, and TPH
	3/1/2004	NA	BTEX, MTBE, PAHs, and TPH
	12/2/2003	NA	BTEX, MTBE, and TPH
	8/15/2003	NA	BTEX, MTBE, PAHs, and TPH
	6/4/2003	NA	BTEX, MTBE, and TPH
	3/13/2003	NA	BTEX, MTBE, and TPH
	12/9/2002	NA	BTEX, MTBE, and TPH

Table 2-1 (Continued)
Samples Used
In The Risk Assessment
Former PQS Etowah Terminal
Charleston, West Virginia

Sample ID	Date Sampled	Sample Depth (ft bgs)	Analysis
MW-3	9/23/2002	NA	BTEX, MTBE, and TPH
	6/25/2002	NA	BTEX, MTBE, and TPH
	3/18/2002	NA	BTEX, MTBE, and TPH
	12/12/2001	NA	BTEX, MTBE, and TPH
	10/2/2001	NA	BTEX, MTBE, and TPH
	9/11/2001	NA	BTEX, MTBE, and TPH
	6/20/2001	NA	BTEX, MTBE, and TPH
MW-4	8/31/2004	NA	BTEX, MTBE, and TPH
	5/17/2004	NA	BTEX, MTBE, and TPH
	3/1/2004	NA	BTEX, MTBE, and TPH
	12/2/2003	NA	BTEX, MTBE, and TPH
	8/15/2003	NA	BTEX, MTBE, and TPH
	6/4/2003	NA	BTEX, MTBE, and TPH
	3/13/2003	NA	BTEX, MTBE, and TPH
	12/9/2002	NA	BTEX, MTBE, and TPH
	9/23/2002	NA	BTEX, MTBE, and TPH
	6/25/2002	NA	BTEX, MTBE, and TPH
	3/18/2002	NA	BTEX, MTBE, and TPH
	12/12/2001	NA	BTEX, MTBE, and TPH
	10/2/2001	NA	BTEX, MTBE, and TPH
	9/11/2001	NA	BTEX, MTBE, and TPH
	6/20/2001	NA	BTEX, MTBE, and TPH
MW-5	8/31/2004	NA	BTEX, MTBE, and TPH
	5/17/2004	NA	BTEX, MTBE, and TPH
	3/1/2004	NA	BTEX, MTBE, and TPH
	12/2/2003	NA	BTEX, MTBE, and TPH
	8/15/2003	NA	BTEX, MTBE, and TPH
	6/4/2003	NA	BTEX, MTBE, and TPH
	3/13/2003	NA	BTEX, MTBE, and TPH
	12/9/2002	NA	BTEX, MTBE, and TPH
	9/23/2002	NA	BTEX, MTBE, and TPH
	6/25/2002	NA	BTEX, MTBE, and TPH
	3/18/2002	NA	BTEX, MTBE, and TPH
	12/12/2001	NA	BTEX, MTBE, and TPH
	10/2/2001	NA	BTEX, MTBE, and TPH
	9/11/2001	NA	BTEX, MTBE, and TPH
	6/20/2001	NA	BTEX, MTBE, and TPH
MW-6	8/31/2004	NA	BTEX, MTBE, and TPH
	5/17/2004	NA	BTEX, MTBE, and TPH
	3/1/2004	NA	BTEX, MTBE, and TPH
	12/2/2003	NA	BTEX, MTBE, and TPH
	8/15/2003	NA	BTEX, MTBE, and TPH
	6/4/2003	NA	BTEX, MTBE, and TPH
	3/13/2003	NA	BTEX, MTBE, and TPH
	12/9/2002	NA	BTEX, MTBE, and TPH
	9/23/2002	NA	BTEX, MTBE, and TPH
	6/25/2002	NA	BTEX, MTBE, and TPH
	3/18/2002	NA	BTEX, MTBE, and TPH
	12/12/2001	NA	BTEX, MTBE, and TPH
	9/11/2001	NA	BTEX, MTBE, and TPH

Table 2-1 (Continued)
Samples Used
In The Risk Assessment
Former PQS Etowah Terminal
Charleston, West Virginia

Shaw Environmental, Inc.
PQS dba SOPUS Products
Tax ID No. 76-0200625

Sample ID	Date Sampled	Sample Depth (ft bgs)	Analysis
MW-6	6/20/2001	NA	BTEX, MTBE, and TPH
MW-7	8/31/2004	NA	BTEX, MTBE, PAHs, and TPH
	5/17/2004	NA	BTEX, MTBE, PAHs, and TPH
	3/1/2004	NA	BTEX, MTBE, PAHs, and TPH
	12/2/2003	NA	BTEX, MTBE, and TPH
	8/15/2003	NA	BTEX, MTBE, PAHs, TPH, and Dissolved Pb
	6/4/2003	NA	BTEX, MTBE, and TPH
	3/13/2003	NA	BTEX, MTBE, and TPH
	12/9/2002	NA	BTEX, MTBE, and TPH
	9/23/2002	NA	BTEX, MTBE, and TPH
	6/25/2002	NA	BTEX, MTBE, and TPH
	3/18/2002	NA	BTEX, MTBE, and TPH
	12/12/2001	NA	BTEX, MTBE, and TPH
	10/2/2001	NA	BTEX, MTBE, and TPH
MW-8	8/31/2004	NA	BTEX, MTBE, PAHs, and TPH
	5/17/2004	NA	BTEX, MTBE, PAHs, and TPH
	3/1/2004	NA	BTEX, MTBE, PAHs, and TPH
	12/2/2003	NA	BTEX, MTBE, and TPH
SB-1/MW-6	8/15/2003	NA	BTEX, MTBE, TPH, and Dissolved Pb
TMW/SB-2S	8/15/2003	NA	BTEX, MTBE, TPH, and PAHs
SB-2/MW-5	8/15/2003	NA	BTEX, MTBE, TPH, and Dissolved Pb
SB-2/MW-5 DUP	8/15/2003	NA	BTEX, MTBE, TPH, and Dissolved Pb
TMW/SB-3S	8/15/2003	NA	BTEX and MTBE
TMW/SB-3D	8/15/2003	NA	BTEX, MTBE, and TPH
SB-4/MW-4	8/15/2003	NA	BTEX, MTBE, TPH, and Dissolved Pb
TMW/SB-7S	8/15/2003	NA	BTEX, MTBE, and TPH
SB-10/MW-1	8/15/2003	NA	BTEX, MTBE, TPH, and Dissolved Pb
TMW/SB-11	8/15/2003	NA	BTEX, MTBE, GRO
TMW/SB-12	8/15/2003	NA	BTEX, MTBE, TPH, Dissolved Pb, and PAHs
TMW/SB-13	8/15/2003	NA	BTEX, MTBE, TPH, Dissolved Pb, and PAHs
TMW/SB-14	8/15/2003	NA	BTEX, MTBE, TPH, Dissolved Pb, and PAHs
SB-15/MW-2	8/15/2003	NA	BTEX, MTBE, TPH, and Dissolved Pb
TMW/SB-16	8/15/2003	NA	BTEX, MTBE, TPH, Dissolved Pb, and PAHs
TMW/SB-17	8/15/2003	NA	BTEX, MTBE, TPH, Dissolved Pb, and PAHs
SB-19/MW-3	8/15/2003	NA	BTEX, MTBE, TPH, Dissolved Pb, and PAHs
TMW/SB-20	8/15/2003	NA	BTEX, MTBE, TPH, Dissolved Pb, and PAHs
TMW/SB-22	8/15/2003	NA	BTEX, MTBE, TPH, Dissolved Pb, and PAHs
TMW/SB-22 DUP	8/15/2003	NA	BTEX, MTBE, TPH, Dissolved Pb, and PAHs
TMW/SB-23	8/15/2003	NA	BTEX, MTBE, TPH and PAHs
Background Groundwater Samples			
TMW/BG-1	8/15/2003	NA	BTEX, MTBE, and GRO
TMW/BG-2	8/15/2003	NA	BTEX, MTBE, TPH and Dissolved Pb
Sediment			
NS-1 (0 - 0.5)	9/11/2003	(0 - 0.5)	BTEX, MTBE, Pb, TPH
NS-2 (0 - 0.5)	9/11/2003	(0 - 0.5)	BTEX, MTBE, Pb, TPH
NS-3 (0 - 0.5)	9/11/2003	(0 - 0.5)	BTEX, MTBE, Pb, TPH
NS-4 (0 - 0.5)	9/11/2003	(0 - 0.5)	BTEX, MTBE, Pb, TPH
NS-5 (0 - 0.5)	9/11/2003	(0 - 0.5)	BTEX, MTBE, Pb, TPH
NS-2 FS (0 - 0.5)	9/11/2003	(0 - 0.5)	BTEX, MTBE, Pb, TPH
Surface Water			

**Table 2-1 (Continued)
Samples Used
In The Risk Assessment
Former PQS Etowah Terminal
Charleston, West Virginia**

Sample ID	Date Sampled	Sample Depth (ft bgs)	Analysis
NS-1	9/11/2003	NA	BTEX, MTBE, Pb (total and dissolved), and TPH
NS-2	9/11/2003	NA	BTEX, MTBE, Pb (total and dissolved), and TPH
NS-3	9/11/2003	NA	BTEX, MTBE, Pb (total and dissolved), and TPH
NS-4	9/11/2003	NA	BTEX, MTBE, Pb (total and dissolved), and TPH
NS-4 DUP	9/11/2003	NA	BTEX, MTBE, Pb (total and dissolved), and TPH
NS-5	9/11/2003	NA	BTEX, MTBE, Pb (total and dissolved), and TPH
E-1	9/11/2003	NA	BTEX, MTBE, Pb (total and dissolved), and TPH
E-2	9/11/2003	NA	BTEX, MTBE, Pb (total and dissolved), and TPH
E-2	6/15/2004	NA	PAHs
E-2 DUP	6/15/2004	NA	PAHs
E-3	9/11/2003	NA	BTEX, MTBE, Pb (total and dissolved), and TPH
E-4	9/11/2003	NA	BTEX, MTBE, Pb (total and dissolved), and TPH
E-5	9/11/2003	NA	BTEX, MTBE, Pb (total and dissolved), and TPH
E-5	6/15/2004	NA	PAHs
E-6	9/11/2003	NA	BTEX, MTBE, Pb (total and dissolved), and TPH
E-7	9/11/2003	NA	BTEX, MTBE, Pb (total and dissolved), and TPH
E-7	6/15/2004	NA	PAHs
E-8	9/11/2003	NA	BTEX, MTBE, Pb (total and dissolved), and TPH
E-9	9/11/2003	NA	BTEX, MTBE, Pb (total and dissolved), and TPH
E-10	9/11/2003	NA	BTEX, MTBE, Pb (total and dissolved), and TPH
E-11	9/11/2003	NA	BTEX, MTBE, Pb (total and dissolved), and TPH
E-12	9/11/2003	NA	BTEX, MTBE, Pb (total and dissolved), and TPH
E-13	9/11/2003	NA	BTEX, MTBE, Pb (total and dissolved), and TPH
E-14	9/11/2003	NA	BTEX, MTBE, Pb (total and dissolved), and TPH
E-15	9/11/2003	NA	BTEX, MTBE, Pb (total and dissolved), and TPH

BTEX = benzene, toluene, ethylbenzene, and xylenes
MTBE = methyl-t-butyl ether
TPH = total petroleum hydrocarbons (gasoline, diesel and oil range organics)
GRO = gasoline range organics
DRO = diesel range organics
Cd = cadmium
Pb = lead
Cr = chromium (both trivalent and hexavalent)
PAHs = polynuclear aromatic hydrocarbons
VOCs = volatile organic compounds (solvents)

Table 2-2
Identification of COPCs For Direct Contact Soil to Groundwater Migration
Former PQS Etowah Terminal
Charleston, West Virginia

Constituent	CAS Number	Units	Frequency of Detection	Range of Detections	Sample of Maximum Detection	Range of Detection Limits	West Virginia DeMinimis Levels[a] Direct Contact (Industrial)	West Virginia DeMinimis Levels[a] Soil-to-Groundwater	Maximum Detection Exceeds DeMinimis Levels?
BTEX									
Benzene	71-43-2	mg/kg	46 / 95	7.00E-04 J - 5.30E-01	GP-1 (4 – 8)	1.00E-03 - 1.20E-01	1.50E+01	3.40E-02	No/Yes
Ethylbenzene	100-41-4	mg/kg	19 / 54	9.00E-04 J - 1.96E+00	TMW/SB-14 (8 -10)	1.50E-03 - 2.30E-03	6.00E+03	1.70E+01	No/No
Toluene	108-88-3	mg/kg	36 / 54	8.00E-04 J - 6.28E-02	TMW/SB-14 (8 -10)	1.50E-03 - 2.10E-03	2.00E+03	1.00E+01	No/No
Xylenes (total)	1330-20-7	mg/kg	22 / 54	1.00E-03 J - 1.48E+00	TMW/SB-14 (8 -10)	1.50E-03 - 2.10E-03	4.50E+03	1.20E+02	No/No
MTBE	1634-04-4	mg/kg	16 / 65	1.10E-03 J - 6.25E-01	TMW/SB-7 (2 - 4)	1.50E-03 - 1.00E-02	8.00E+02	9.50E-02	No/Yes
Total Petroleum Hydrocarbons									
GRO	N/A	mg/kg	34 / 92	1.30E-01 - 6.30E+03	HA-2 (3 – 3.5)	1.00E-01 - 1.00E+02	6.60E+03	8.30E+01	No/Yes
DRO	N/A	mg/kg	70 / 92	3.70E+00 - 4.50E+03	GP-1 (4 – 8)	3.70E+00 - 6.65E+00	8.30E+03	6.80E+01	No/Yes
ORO	N/A	mg/kg	47 / 91	4.10E+00 - 1.80E+03	GP-1 (4 – 8)	3.70E+00 - 6.39E+02	9.00E+03	5.40E+03	No/No
Metals									
Chromium (III)	16065-83-1	mg/kg	7 / 7	7.34E+00 - 4.56E+01	SB-5 (2 - 8)	N/A	1.00E+06	2.00E+09	No/No
Chromium (VI)	18540-29-9	mg/kg	1 / 7	3.14E+00 - 3.14E+00	TMW/SB-7 (34 - 36)	2.24E+00 - 2.66E+00	6.60E+02	4.20E+01	No/No
Lead	7439-92-1	mg/kg	97 / 97	2.13E+00 - 3.05E+03	C2-C (0 - 0.5)	N/A	1.00E+03	N/A	Yes/ N/A
PAHs									
1-Methylnaphthalene	90-12-0	mg/kg	22 / 38	2.05E-03 J - 2.18E+00	TMW/SB-16 (14 - 16)	3.87E-03 - 4.29E-03	4.10E+03[b]	2.20E-01[b]	No/Yes
2-Methylnaphthalene	91-57-6	mg/kg	14 / 38	5.30E-03 - 3.22E+00	SB-15 (10 - 12)	3.71E-03 - 4.29E-03	4.10E+03[b]	2.20E-01[b]	No/Yes
Acenaphthene	83-32-9	mg/kg	7 / 38	2.34E-03 J - 1.34E-01	TMW/SB-20 (14 - 16)	3.69E-03 - 4.38E-03	3.80E+04	7.30E+01	No/No
Acenaphthylene	208-96-8	mg/kg	7 / 38	3.87E-03 - 5.41E-02	TMW/SB-20 (14 - 16)	3.69E-03 - 5.10E-03	3.80E+04	7.30E+01	No/No
Anthracene	120-12-7	mg/kg	18 / 38	4.84E-03 - 9.39E-02	TMW/SB-7 (0 - 2)	3.91E-03 - 4.38E-03	3.90E+05	1.70E+03	No/No
Benzo(a)anthracene	56-55-3	mg/kg	11 / 38	4.64E-03 - 2.20E-01	TMW/SB-7 (0 - 2)	3.71E-03 - 4.38E-03	2.90E+01	1.40E+00	No/No
Benzo(a)pyrene	50-32-8	mg/kg	9 / 38	1.03E-02 - 8.63E-02	SB-4 (0 - 2)	3.71E-03 - 4.38E-03	2.90E+00	8.20E+00	No/No
Benzo(b)fluoranthene	205-99-2	mg/kg	11 / 38	5.49E-03 - 1.65E-01	TMW/SB-7 (0 - 2)	3.71E-03 - 4.29E-03	2.90E+01	4.50E+00	No/No
Benzo(g,h,i)perylene	191-24-2	mg/kg	12 / 38	7.60E-03 - 1.37E-01	TMW/SB-7 (0 - 2)	3.71E-03 - 4.29E-03	5.40E+04	5.00E+02	No/No
Benzo(k)fluoranthene	207-08-9	mg/kg	10 / 38	4.22E-03 - 1.55E-01	TMW/SB-7 (0 - 2)	3.71E-03 - 4.38E-03	2.90E+02	4.50E+01	No/No
Chrysene	218-01-9	mg/kg	12 / 38	2.99E-03 J - 2.03E-01	TMW/SB-7 (0 - 2)	3.78E-03 - 4.38E-03	2.90E+03	1.40E+02	No/No
Dibenz(a,h)anthracene	53-07-3	mg/kg	7 / 38	1.20E-02 - 4.91E-02	TMW/SB-7 (0 - 2)	3.71E-03 - 4.38E-03	2.90E+00	1.40E+00	No/No
Fluoranthene	206-44-0	mg/kg	10 / 38	3.54E-03 J - 5.64E-01	TMW/SB-7 (0 - 2)	3.71E-03 - 4.29E-03	3.00E+04	6.30E+03	No/No
Fluorene	86-73-7	mg/kg	16 / 38	5.95E-03 - 4.91E-01	TMW/SB-7 (0 - 2)	3.87E-03 - 4.38E-03	3.30E+04	7.80E+01	No/No
Indeno(1,2,3-cd)pyrene	193-39-5	mg/kg	13 / 38	8.99E-03 - 1.17E-01	TMW/SB-7 (0 - 2)	3.71E-03 - 4.29E-03	2.90E+01	1.30E+01	No/No
Naphthalene	91-20-3	mg/kg	18 / 38	4.09E-03 - 7.61E-01	SB-15 (10 - 12)	3.71E-03 - 4.29E-03	1.90E+02	3.20E-01	No/Yes
Phenanthrene	85-01-8	mg/kg	24 / 38	2.46E-03 J - 3.53E-01	TMW/SB-7 (0 - 2)	3.91E-03 - 4.29E-03	3.90E+05	1.70E+03	No/No
Pyrene	129-00-0	mg/kg	14 / 38	4.08E-03 - 3.72E-01	TMW/SB-7 (0 - 2)	3.84E-03 - 4.38E-03	5.40E+04	5.00E+02	No/No
Solvents									
Acetone	67-64-1	mg/kg	7 / 7	2.19E-02 J - 2.15E-01	TMW/SB-7 (0 - 2)	N/A	6.20E+03	2.40E+00	No/No
2-Butanone	78-93-3	mg/kg	2 / 7	2.11E-02 J - 4.06E-02 J	TMW/SB-7 (0 - 2)	4.04E-02 - 5.06E-02	2.80E+04	8.00E+00	No/No
Carbon Disulfide	75-15-0	mg/kg	5 / 7	3.93E-03 - 6.48E-03	TMW/SB-7 (2 - 4)	1.90E-03 - 2.02E-03	1.20E+03	8.30E+00	No/No
Methylene chloride	75-09-2	mg/kg	5 / 7	2.40E-03 J - 4.35E-03 J	SB-6 (2 - 8)	4.70E-03 - 4.80E-03	2.10E+02	2.30E-02	No/No

Total Soil = On-site and Off-site Soil data combined.
N/A = Not Available or Not Applicable
[a] Unless otherwise specifed, the values presented are from the West Virginia VRRP; De Minimis Levels (Table 60-3B, revised January 2002). According to the Supplemental Guidance for PAH DeMinimis standards, the DeMinimis level for acenapthene was used as a surrogate for acenaphtylene and anthracene was used as a surrogate for phenanthrene.

[b] Values for 1- and 2-methylnaphthalene are based on the value for 2-methylnaphthalene presented in the U.S. EPA Region 3 RBC Table (dated 4/14/2004), since no De Minimis Levels are available.
COPCs - chemicals of potential concern

Table 2-3
Identification of COPHCs For The Soil To Air Pathway
Former PQS Etowah Terminal
Charleston, West Virginia

Constituent	CAS Number	Units	Frequency of Detection	Range of Detections	Sample of Maximum Detection	Range of Detection Limits	Volatile or Non-Volatile	Selected as a COPC for the Soil-to-Air Pathway
BTEX								
Benzene	71-43-2	mg/kg	46 / 95	7.00E-04 J - 5.30E-01	GP-1 (4 – 8)	1.00E-03 - 1.20E-01	Volatile	Yes
Ethylbenzene	100-41-4	mg/kg	19 / 54	9.00E-04 J - 1.96E+00	TMW/SB-14 (8 -10)	1.50E-03 - 2.30E-03	Volatile	Yes
Toluene	108-88-3	mg/kg	36 / 54	8.00E-04 J - 6.28E-02	TMW/SB-14 (8 -10)	1.50E-03 - 2.10E-03	Volatile	Yes
Xylenes (total)	1330-20-7	mg/kg	22 / 54	1.00E-03 J - 1.48E+00	TMW/SB-14 (8 -10)	1.50E-03 - 2.10E-03	Volatile	Yes
MTBE	1634-04-4	mg/kg	16 / 65	1.10E-03 J - 6.25E-01	TMW/SB-7 (2 - 4)	1.50E-03 - 1.00E-02	Volatile	Yes
Total Petroleum Hydrocarbons								
GRO	N/A	mg/kg	34 / 92	1.30E-01 - 6.30E+03	HA-2 (3 – 3.5)	1.00E-01 - 1.00E+02	N/A	No
DRO	N/A	mg/kg	70 / 92	3.70E+00 - 4.50E+03	GP-1 (4 – 8)	3.70E+00 - 6.65E+00	N/A	No
ORO	N/A	mg/kg	47 / 91	4.10E+00 - 1.80E+03	GP-1 (4 – 8)	3.70E+00 - 6.39E+02	N/A	No
Metals								
Chromium (III)	16065-83-1	mg/kg	7 / 7	7.34E+00 - 4.56E+01	SB-5 (2 - 8)	N/A	Not Volatile	No
Chromium (VI)	18540-29-9	mg/kg	1 / 7	3.14E+00 - 3.14E+00	TMW/SB-7 (34 - 36)	2.24E+00 - 2.66E+00	Not Volatile	No
Lead	7439-92-1	mg/kg	97 / 97	2.13E+00 - 3.05E+03	C2-C (0 - 0.5)	N/A	Not Volatile	No
PAHs								
1-Methylnaphthalene	90-12-0	mg/kg	22 / 38	2.05E-03 J - 2.18E+00	TMW/SB-16 (14 - 16)	3.87E-03 - 4.29E-03	Not Volatile	No
2-Methylnaphthalene	91-57-6	mg/kg	14 / 38	5.30E-03 - 3.22E+00	SB-15 (10 - 12)	3.71E-03 - 4.29E-03	Not Volatile	No
Acenaphthene	83-32-9	mg/kg	7 / 38	2.34E-03 J - 1.34E-01	TMW/SB-20 (14 - 16)	3.69E-03 - 4.38E-03	Not Volatile	No
Acenaphthylene	208-96-8	mg/kg	7 / 38	3.87E-03 - 5.41E-02	TMW/SB-20 (14 - 16)	3.69E-03 - 5.10E-03	Not Volatile	No
Anthracene	120-12-7	mg/kg	18 / 38	4.84E-03 - 9.39E-02	TMW/SB-7 (0 - 2)	3.91E-03 - 4.38E-03	Not Volatile	No
Benzo(a)anthracene	56-55-3	mg/kg	11 / 38	4.64E-03 - 2.20E-01	TMW/SB-7 (0 - 2)	3.71E-03 - 4.38E-03	Not Volatile	No
Benzo(a)pyrene	50-32-8	mg/kg	9 / 38	1.03E-02 - 8.63E-02	SB-4 (0 - 2)	3.71E-03 - 4.38E-03	Not Volatile	No
Benzo(b)fluoranthene	205-99-2	mg/kg	11 / 38	5.49E-03 - 1.65E-01	TMW/SB-7 (0 - 2)	3.71E-03 - 4.29E-03	Not Volatile	No
Benzo(g,h,i)perylene	191-24-2	mg/kg	12 / 38	7.60E-03 - 1.37E-01	TMW/SB-7 (0 - 2)	3.71E-03 - 4.29E-03	Not Volatile	No
Benzo(k)fluoranthene	207-08-9	mg/kg	10 / 38	4.22E-03 - 1.55E-01	TMW/SB-7 (0 - 2)	3.71E-03 - 4.38E-03	Not Volatile	No
Chrysene	218-01-9	mg/kg	12 / 38	2.99E-03 J - 2.03E-01	TMW/SB-7 (0 - 2)	3.78E-03 - 4.38E-03	Not Volatile	No
Dibenz(a,h)anthracene	53-07-3	mg/kg	7 / 38	1.20E-02 - 4.91E-02	TMW/SB-7 (0 - 2)	3.71E-03 - 4.38E-03	Not Volatile	No
Fluoranthene	206-44-0	mg/kg	10 / 38	3.54E-03 J - 5.64E-01	TMW/SB-7 (0 - 2)	3.71E-03 - 4.29E-03	Not Volatile	No
Fluorene	86-73-7	mg/kg	16 / 38	5.95E-03 - 4.91E-01	TMW/SB-7 (0 - 2)	3.87E-03 - 4.38E-03	Not Volatile	No
Indeno(1,2,3-cd)pyrene	193-39-5	mg/kg	13 / 38	8.99E-03 - 1.17E-01	TMW/SB-7 (0 - 2)	3.71E-03 - 4.29E-03	Not Volatile	No
Naphthalene	91-20-3	mg/kg	18 / 38	4.09E-03 - 7.61E-01	SB-15 (10 - 12)	3.71E-03 - 4.29E-03	Volatile	Yes
Phenanthrene	85-01-8	mg/kg	24 / 38	2.46E-03 J - 3.53E-01	TMW/SB-7 (0 - 2)	3.91E-03 - 4.29E-03	Not Volatile	No
Pyrene	129-00-0	mg/kg	14 / 38	4.08E-03 - 3.72E-01	TMW/SB-7 (0 - 2)	3.84E-03 - 4.38E-03	Not Volatile	No
Solvents								
Acetone	67-64-1	mg/kg	7 / 7	2.19E-02 J - 2.15E-01	TMW/SB-7 (0 - 2)	N/A	Volatile	No
2-Butanone	78-93-3	mg/kg	2 / 7	2.11E-02 J - 4.06E-02 J	TMW/SB-7 (0 - 2)	4.04E-02 - 5.06E-02	Volatile	No
Carbon Disulfide	75-15-0	mg/kg	5 / 7	3.93E-03 - 6.48E-03	TMW/SB-7 (2 - 4)	1.90E-03 - 2.02E-03	Volatile	No
Methylene chloride	75-09-2	mg/kg	5 / 7	2.40E-03 J - 4.35E-03 J	SB-6 (2 - 8)	4.70E-03 - 4.80E-03	Volatile	No

N/A = Not Available or Not Applicable
COPHCs - chemicals of potential human concern

Table 2-4
Identification of COPCs in Groundwater for Direct Contact
Former PQS Etowah Terminal
Charleston, West Virginia

Constituent	CAS Number	Units	Frequency of Detection	Range of Detections	Sample of Maximum Detection	Range of Detection Limits	West Virginia DeMinimis Levels[a] Groundwater	Maximum Detection Exceeds DeMinimis Levels?
BTEX & MTBE								
Benzene	71-43-2	mg/L	11 / 125	1.00E-03 - 3.22E-01	TMW/SB-3S (8/15/03)	3.40E-04 - 5.00E-03	0.005	Yes
Ethylbenzene	100-41-4	mg/L	7 / 125	1.00E-03 - 1.50E-01	TMW/SB-3S (8/15/03)	3.60E-04 - 5.00E-03	1.3	No
Toluene	108-88-3	mg/L	11 / 125	1.00E-03 - 8.00E-03	TMW/SB-7S (8/15/03)	4.60E-04 - 5.00E-03	1.0	No
Xylenes (total)	1330-20-7	mg/L	15 / 125	1.40E-03 - 2.82E-01	TMW/SB-3S (8/15/03)	2.60E-04 - 1.00E-02	10	No
MTBE	1634-04-4	mg/L	15 / 125	1.00E-03 - 1.23E+00	TMW/SB-7S (8/15/03)	4.70E-04 - 1.00E-02	0.02	Yes
Total Petroleum Hydrocarbons								
GRO	N/A	mg/L	27 / 124	1.50E-02 - 2.83E+00	TMW/SB-23 (8/15/03)	1.20E-02 - 5.00E-01	1.5	Yes
DRO	N/A	mg/L	73 / 123	7.20E-02 - 3.00E+01	TMW/SB-23 (8/15/03)	9.70E-03 - 2.00E-01	0.33	Yes
ORO	N/A	mg/L	66 / 117	8.55E-02 - 1.08E+01	TMW/SB-12 (8/15/03)	1.00E-01 - 1.00E+02	0.6	Yes
Metals								
Lead (Dissolved)	7439-92-1	mg/L	2 / 13	4.00E-02 - 5.00E-02	TMW/SB-16 (8/15/03)	5.00E-03 - 5.00E-03	0.015	Yes
PAHs								
1-Methylnaphthalene	90-12-0	mg/L	7 / 9	2.50E-04 - 4.10E-02	TMW/SB-17 (8/15/03)	1.00E-04 - 1.00E-04	2.40E-02[b]	Yes
2-Methylnaphthalene	91-57-6	mg/L	1 / 9	4.21E-02 - 4.21E-02	TMW/SB-2S (8/15/03)	1.00E-04 - 1.00E-04	2.40E-02[b]	Yes
Acenaphthene	83-32-9	mg/L	9 / 20	3.50E-06 - 1.10E-03	TMW/SB-12 (8/15/03)	5.00E-05 - 1.00E-04	3.70E-01	No
Acenaphthylene	208-96-8	mg/L	4 / 14	2.70E-04 - 6.70E-04	TMW/SB-17 (8/15/03)	5.00E-05 - 1.00E-04	3.70E-01	No
Anthracene	120-12-7	mg/L	3 / 20	2.50E-04 - 3.20E-04	TMW/SB-2S (8/15/03)	2.00E-06 - 1.00E-04	1.80E+00	No
Benzo(a)anthracene	56-55-3	mg/L	3 / 20	1.20E-05 - 1.80E-05	MW-8 (03/01/04)	2.70E-06 - 1.00E-04	9.10E-05	No
Benzo(a)pyrene	50-32-8	mg/L	1 / 20	2.60E-05 - 2.60E-05	MW-3 (03/01/04)	1.00E-06 - 1.00E-04	2.00E-04	No
Benzo(b)fluoranthene	205-99-2	mg/L	2 / 11	1.90E-05 - 7.00E-05	MW-3 (05/17/04)	1.70E-06 - 1.00E-04	9.10E-05	No
Benzo(g,h,i)perylene	191-24-2	mg/L	2 / 14	6.90E-05 - 2.10E-04	TMW/SB-12 (8/15/03)	5.00E-05 - 1.00E-04	1.80E-01	No
Benzo(k)fluoranthene	207-08-9	mg/L	1 / 20	6.40E-05 - 6.40E-05	MW-7 (05/17/04)	2.00E-06 - 1.00E-04	9.10E-04	No
Chrysene	218-01-9	mg/L	3 / 20	1.40E-05 - 2.70E-04	TMW/SB-12 (8/15/03)	3.00E-06 - 1.00E-04	9.10E-03	No
Dibenz(a,h)anthracene	53-07-3	mg/L	3 / 20	7.10E-05 - 1.30E-04	MW-8 (05/17/04)	1.60E-06 - 1.00E-04	9.10E-06	Yes
Fluoranthene	206-44-0	mg/L	3 / 20	2.30E-05 - 2.50E-05	MW-3 (03/01/04)	3.70E-06 - 1.00E-04	1.50E+00	No
Fluorene	86-73-7	mg/L	11 / 20	1.80E-05 - 1.80E-03	TMW/SB-17 (8/15/03)	1.80E-05 - 1.00E-04	2.40E-01	No
Indeno(1,2,3-cd)pyrene	193-39-5	mg/L	1 / 20	2.10E-04 - 2.10E-04	TMW/SB-12 (8/15/03)	4.00E-06 - 1.00E-04	9.10E-05	Yes
Naphthalene	91-20-3	mg/L	8 / 20	1.70E-05 - 3.48E-03	TMW/SB-2S (8/15/03)	5.00E-05 - 1.00E-04	6.20E-03	No
Phenanthrene	85-01-8	mg/L	3 / 14	3.30E-04 - 1.86E-03	TMW/SB-2S (8/15/03)	5.00E-05 - 1.00E-04	1.80E+00	No
Pyrene	129-00-0	mg/L	6 / 20	1.50E-05 - 1.19E-03	TMW/SB-12 (8/15/03)	3.80E-06 - 1.00E-04	1.80E-01	No

N/A = Not Available or Not Applicable
[a] Unless otherwise specifed, the values presented are from the West Virginia VRRP; De Minimis Levels (Table 60-3B, revised January 2002).

[b] Values for 1- and 2-methylnaphthalene are based on the value for 2-methylnaphthalene presented in the U.S. EPA Region 3 RBC Table (dated 4/14/2004), since no De Minimis Levels are available.
COPCs - chemicals of potential concern

Table 2-5
Identification of COPCs in Groundwater For The Groundwater To Air Pathway
Former PQS Etowah Terminal
Charleston, West Virginia

Constituent	CAS Number	Units	Frequency of Detection	Range of Detections	Sample of Maximum Detection	Range of Detection Limits	West Virginia DeMinimis Levels[a] Groundwater	Maximum Detection Exceeds DeMinimis Levels?
BTEX & MTBE								
Benzene	71-43-2	mg/L	11 / 125	1.00E-03 - 3.22E-01	TMW/SB-3S (8/15/03)	3.40E-04 - 5.00E-03	0.098	Yes
Ethylbenzene	100-41-4	mg/L	7 / 125	1.00E-03 - 1.50E-01	TMW/SB-3S (8/15/03)	3.60E-04 - 5.00E-03	4.9	No
Toluene	108-88-3	mg/L	11 / 125	1.00E-03 - 8.00E-03	TMW/SB-7S (8/15/03)	4.60E-04 - 5.00E-03	1.26	No
Xylenes (total)	1330-20-7	mg/L	15 / 125	1.40E-03 - 2.82E-01	TMW/SB-3S (8/15/03)	2.60E-04 - 1.00E-02	154	No
MTBE	1634-04-4	mg/L	15 / 125	1.00E-03 - 1.23E+00	TMW/SB-7S (8/15/03)	4.70E-04 - 1.00E-02	840	No
Total Petroleum Hydrocarbons								
GRO	N/A	mg/L	27 / 124	1.50E-02 - 2.83E+00	TMW/SB-23 (8/15/03)	1.20E-02 - 5.00E-01	N/A	No
DRO	N/A	mg/L	73 / 123	7.20E-02 - 3.00E+01	TMW/SB-23 (8/15/03)	9.70E-03 - 2.00E-01	N/A	No
ORO	N/A	mg/L	66 / 117	8.55E-02 - 1.08E+01	TMW/SB-12 (8/15/03)	1.00E-01 - 1.00E+02	N/A	No
Metals								
Lead (Dissolved)	7439-92-1	mg/L	2 / 13	4.00E-02 - 5.00E-02	TMW/SB-16 (8/15/03)	5.00E-03 - 5.00E-03	N/A	No
PAHs								
1-Methylnaphthalene	90-12-0	mg/L	7 / 9	2.50E-04 - 4.10E-02	TMW/SB-17 (8/15/03)	1.00E-04 - 1.00E-04	23.1	No
2-Methylnaphthalene	91-57-6	mg/L	1 / 9	4.21E-02 - 4.21E-02	TMW/SB-2S (8/15/03)	1.00E-04 - 1.00E-04	23.1	No
Acenaphthene	83-32-9	mg/L	9 / 20	3.50E-06 - 1.10E-03	TMW/SB-12 (8/15/03)	5.00E-05 - 1.00E-04	N/A	No
Acenaphthylene	208-96-8	mg/L	4 / 14	2.70E-04 - 6.70E-04	TMW/SB-17 (8/15/03)	5.00E-05 - 1.00E-04	N/A	No
Anthracene	120-12-7	mg/L	3 / 20	2.50E-04 - 3.20E-04	TMW/SB-2S (8/15/03)	2.00E-06 - 1.00E-04	N/A	No
Benzo(a)anthracene	56-55-3	mg/L	3 / 20	1.20E-05 - 1.80E-05	MW-8 (03/01/04)	2.70E-06 - 1.00E-04	Non Volatile	No
Benzo(a)pyrene	50-32-8	mg/L	1 / 20	2.60E-05 - 2.60E-05	MW-3 (03/01/04)	1.00E-06 - 1.00E-04	N/A	No
Benzo(b)fluoranthene	205-99-2	mg/L	2 / 11	1.90E-05 - 7.00E-05	MW-3 (05/17/04)	1.70E-06 - 1.00E-04	N/A	No
Benzo(g,h,i)perylene	191-24-2	mg/L	2 / 14	6.90E-05 - 2.10E-04	TMW/SB-12 (8/15/03)	5.00E-05 - 1.00E-04	N/A	No
Benzo(k)fluoranthene	207-08-9	mg/L	1 / 20	6.40E-05 - 6.40E-05	MW-7 (05/17/04)	2.00E-06 - 1.00E-04	N/A	No
Chrysene	218-01-9	mg/L	3 / 20	1.40E-05 - 2.70E-04	TMW/SB-12 (8/15/03)	3.00E-06 - 1.00E-04	Non Volatile	No
Dibenz(a,h)anthracene	53-07-3	mg/L	3 / 20	7.10E-05 - 1.30E-04	MW-8 (05/17/04)	1.60E-06 - 1.00E-04	N/A	No
Fluoranthene	206-44-0	mg/L	3 / 20	2.30E-05 - 2.50E-05	MW-3 (03/01/04)	3.70E-06 - 1.00E-04	N/A	No
Fluorene	86-73-7	mg/L	11 / 20	1.80E-05 - 1.80E-03	TMW/SB-17 (8/15/03)	1.80E-05 - 1.00E-04	N/A	No
Indeno(1,2,3-cd)pyrene	193-39-5	mg/L	1 / 20	2.10E-04 - 2.10E-04	TMW/SB-12 (8/15/03)	4.00E-06 - 1.00E-04	N/A	No
Naphthalene	91-20-3	mg/L	8 / 20	1.70E-05 - 3.48E-03	TMW/SB-2S (8/15/03)	5.00E-05 - 1.00E-04	1.05	No
Phenanthrene	85-01-8	mg/L	3 / 14	3.30E-04 - 1.86E-03	TMW/SB-2S (8/15/03)	5.00E-05 - 1.00E-04	Non Volatile	No
Pyrene	129-00-0	mg/L	6 / 20	1.50E-05 - 1.19E-03	TMW/SB-12 (8/15/03)	3.80E-06 - 1.00E-04	Non Volatile	No

N/A = Not Available or Not Applicable

[a] Values are from USEPA (2002), Evaluating the Vapor Intrusion into Indoor Air, EPA 530-F-02-052. Target risk of 1E-05 used for carcinogens for residential exposure. Uncertainty factors have been applied to adjust the groundwater screening value to values more appropriate for non-residential exposure using an adjustment factor of 7.

[b] Values for 1- and 2-methylnaphthalene are based on the value for 2-methylnaphthalene presented in the U.S. EPA Region 3 RBC Table (dated 10/15/2003), since no De Minimis Levels are available.

COPCs - chemicals of potential concern

Table 2-6
Identification of COPHCs in Surface Water (Current Scenario)
Former PQS Etowah Terminal
Charleston, West Virginia

Constituent	CAS Number	Units	Frequency of Detection	Range of Detections	Sample of Maximum Detection	Range of Detection Limits	West Virginia Surface Water Quality Standards (A Criteria)	Background Data	Selected as a COPHC ?
Total Petroleum Hydrocarbons									
DRO	N/A	mg/L	2 / 21	1.18E-01 - 7.85E-01	E-5 (9/11/03)	1.00E-01 - 1.00E-01	NVA	N/A	No
ORO	N/A	mg/L	4 / 21	1.18E-01 - 1.40E+00	E-5 (9/11/03)	1.00E-01 - 1.00E-01	NVA	N/A	No
Metals									
Lead (Total)	7439-92-1	mg/L	1 / 21	3.20E-03 J - 3.20E-03 J	E-14 (6/15/04)	5.00E-03 - 5.00E-03	5.00E-02	N/A	No
Lead (Dissolved)	7439-92-1	mg/L	2 / 21	3.00E-03 J - 4.00E-03 J	E-11 (6/15/04)	5.00E-03 - 5.00E-03	5.00E-02	N/A	No
PAHs									
Acenaphthene	83-32-9	mg/L	2 / 4	5.18E-06 J - 8.60E-06 J	E-5 (6/15/04)	3.50E-06 - 3.50E-06	NVA	Not Attributed to Site	No[b]
Benzo(a)anthracene	56-55-3	mg/L	4 / 4	1.85E-05 JB - 1.90E-05 JB	E-5 (6/15/04)	N/A	NVA	Not Attributed to Site	No[b]
Benzo(a)pyrene	50-32-8	mg/L	1 / 4	2.50E-05 J - 2.50E-05 J	E-7 (6/15/04)	3.00E-06 - 3.00E-06	NVA	Not Attributed to Site	No[b]
Benzo(b)fluoranthene	205-99-2	mg/L	3 / 4	1.39E-05 J - 2.80E-05 J	E-7 (6/15/04)	N/A	NVA	Not Attributed to Site	No[b]
Benzo(k)fluoranthene	207-08-9	mg/L	3 / 4	1.42E-05 J - 2.90E-05 J	E-7 (6/15/04)	N/A	NVA	Not Attributed to Site	No[b]
Chrysene	218-01-9	mg/L	4 / 4	2.00E-05 J - 2.20E-05 J	E-7 (6/15/04)	N/A	NVA	Not Attributed to Site	No[b]
Dibenz(a,h)anthracene	53-70-3	mg/L	3 / 4	2.04E-05 J - 4.30E-05 J	E-7 (6/15/04)	N/A	NVA	Not Attributed to Site	No[b]
Fluoranthene	206-44-0	mg/L	3 / 4	1.44E-05 J - 2.70E-05 J	E-5 (6/15/04)	N/A	3.00E-01	Not Attributed to Site	No
Indeno(1,2,3-cd)pyrene	193-39-5	mg/L	2 / 4	3.17E-05 J - 6.20E-05 J	E-5 (6/15/04)	4.60E-06 - 4.60E-06	NVA	Not Attributed to Site	No[b]
Naphthalene	91-20-3	mg/L	4 / 4	1.70E-05 JB - 2.15E-05 JB	E-2 (6/15/04)	N/A	NVA	Not Attributed to Site	No[b]
Pyrene	129-00-0	mg/L	4 / 4	2.10E-05 J - 2.20E-05 J	E-2 (6/15/04)	N/A	NVA	Not Attributed to Site	No[b]
Total Carcenogenic PAH[c]	N/A	mg/L	4 / 4	4.78E-05 J - 1.97E-04 J	E-5 (6/15/04)	N/A	2.80E-06	Not Attributed to Site	No[d]

PAH = Polynuclear aromatic hydrocarbons
N/A = Not Available or Not Applicable
[a] The values presented are the West Virginia Water Quality Standard for protection of human health (46 CSR 1, Appendix E Table 1). The A criteria was assumed.
[b] Individual PAH constituents are analyzed by evaluating the total carcinogenic PAHs.
[c] Total PAHs are the summation of the individual carcinogenic PAH data for each sample, with non-detects evaluated at 1/2 the detection limit.
[d] While the maximum detected Total PAH exceeds the WV Surface Water Quliaty Criteria, PAHs in surface water were determined to not be attributed to site operations.

Table 2-7
Identification of COPHCs in Surface Water
(Future Scenario)
Former PQS Etowah Terminal
Charleston, West Virginia

Based on Modeled Groundwater Concentrations

Constituent	Maximum Modeled Surface Water Concentration in the Elk River (mg/L)	Surface Water Concentration after Applying 10X Dilution Factor[a] (mg/L)	West Virginia Surface Water Quality Standards[b] (A Criteria)	Maximum Detection Exceeds DeMinimis Levels?
BTEX & MTBE				
Benzene	2.00E-03	2.00E-04	6.60E-04	No
Total Petroleum Hydrocarbons				
GRO	9.00E-02	9.00E-03	N/A	No
DRO	1.23E+01	1.23E+00	N/A	No
ORO	4.70E+00	4.70E-01	N/A	No
Metals				
Lead	4.10E-02	4.10E-03	5.00E-02	No
PAHs				
Dibenz(a,h)anthracene	Modeled, will not reach Elk River	N/A	N/A	No

N/A = Not Available or Not Applicable
[a]WVDEP approved alternate dilution factor.
[b]The values presented are the West Virginia Water Quality Standard for protection of human health (46 CSR 1, Appendix E Table 1). The A criteria was assumed.

COPHCs - chemicals of potential human concern

Table 2-8
Identification of COPECs in Surface Water
Former PQS Etowah Terminal
Charleston, West Virginia

Constituent	Maximum Detected Surface Water Concentration in the Elk River (from Table 2-6) (mg/L)	Maximum Modeled Groundwater Concentration at the Elk River (mg/L)	Elk Creek Water Concentration after Applying 10X Dilution[a] Factor (mg/L)	West Virginia Aquatic Life Water Quality Criteria[b] (mg/L)	Ecological PRGs[c] (mg/L)	USEPA Region 5 Ecological Screening Levels for Water[d] (mg/L)	Maximum Detected Water Concentration Exceeds Screening Criteria?	Modeled Groundwater Concentration with 10-fold Dilution Exceeds Screening Criteria?
BTEX & MTBE								
Benzene	Analyzed, not detected	2.00E-03	2.00E-04	N/A	1.30E-01	1.42E-01	N/A	No
Total Petroleum Hydrocarbons								
GRO	Analyzed, not detected	9.00E-02	9.00E-03	N/A	N/A	N/A	N/A	No
DRO	7.85E-01	1.23E+01	1.23E+00	N/A	N/A	N/A	No	No
ORO	1.40E+00	4.70E+00	4.70E-01	N/A	N/A	N/A	No	No
Metals								
Lead	4.00E-03	4.10E-02	4.10E-03	3.20E-03	3.20E-03	1.17E-03	Yes (3/3)	Yes (3/3)
PAHs								
Acenaphthene	8.60E-06 J	Not modeled	N/A	N/A	2.30E-02	3.80E-02	No	No
Benzo(a)anthracene	1.90E-05 JB	Not modeled	N/A	N/A	2.70E-05	2.50E-05	No	No
Benzo(a)pyrene	2.50E-05 J	Not modeled	N/A	N/A	1.40E-05	1.40E-05	Yes (2/2)	No
Benzo(b)fluoranthene	2.80E-05 J	Not modeled	N/A	N/A	N/A	9.07E-03	No	No
Benzo(k)fluoranthene	2.90E-05 J	Not modeled	N/A	N/A	N/A	N/A	No	No
Chrysene	2.20E-05 J	Not modeled	N/A	N/A	N/A	N/A	No	No
Dibenz(a,h)anthracene	4.30E-05 J	Modeled, will not reach Elk River	N/A	N/A	N/A	N/A	No	No
Fluoranthene	2.70E-05 J	Not modeled	N/A	N/A	6.20E-03	1.90E-03	No	No
Indeno(1,2,3-cd)pyrene	6.20E-05 J	Not modeled	N/A	N/A	N/A	4.31E-03	No	No
Naphthalene	2.15E-05 JB	Not modeled	N/A	N/A	1.20E-02	1.30E-02	No	No
Pyrene	2.20E-05 J	Not modeled	N/A	N/A	N/A	3.00E-04	No	No
Total Carcinogenic PAH	1.97E-04 J	Not modeled	N/A	2.80E-06	N/A	N/A	Yes	No

N/A = Not Available or Not Applicable

[a]The derivation of the dilution factor is discussed in Appendix E.

[b] West Virginia Surface Water Quality Standard from 46 CSR 1, Appendix E, Table 1. Values for aquatic life used. Note: value for lead is based on a default hardness of 100 mg/L.

[c] Ecological PRGs are from Preliminary Remediation Goals for Ecological Endpoints, Efroymson et. al., 1997. ES/ER/TM-162/R2.

[d] Ecological Screening Values are from USEPA Region 5, August 2003.

COPECs - chemicals of potential ecological concern

Table 2-9
Identification of COPCs in Sediment
Former PQS Etowah Terminal
Charleston, West Virginia

Constituent	CAS Number	Units	Frequency of Detection	Range of Detections	Sample of Maximum Detection	Range of Detection Limits	West Virginia DeMinimis Levels[a] Residential Soil	Maximum Detection Exceeds DeMinimis Levels?
Total Petroleum Hydrocarbons								
ORO	N/A	mg/kg	5 / 5	2.61E+01 - 8.72E+01	NS-1 (0 - 0.5)	N/A	6.10E+03	No
Metals								
Lead	7439-92-1	mg/kg	5 / 5	2.10E+01 - 3.05E+01	NS-3 (0 - 0.5)	N/A	4.00E+02	No

N/A = Not Available or Not Applicable
[a] The values presented are from the West Virginia VRRP; De Minimis Levels (Table 60-3B, revised January 2002) for residential soil.
COPCs - chemicals of potential concern

Table 3-1
Determination of Exposure Point Concentrations for COPCs in Groundwater
Former PQS Etowah Terminal
Charleston, West Virginia

Constituent	CAS Number	Units	Frequency of Detection	Range of Detections	Distribution Type	95 % Upper Confidence Limit (95% UCL)	Exposure Point Concentration (EPC)	EPC Basis
On-Site Groundwater								
Benzene	71-43-2	mg/L	11 / 125	1.00E-03 - 3.22E-01	Undefined	6.86E-03	6.86E-03	95% UCL - Bootstrap
MTBE	1634-04-4	mg/L	15 / 125	1.00E-03 - 1.23E+00	Undefined	2.15E-02	2.15E-02	95% UCL - Bootstrap
TPH-GRO	N/A	mg/L	27 / 124	1.50E-02 - 2.83E+00	Undefined	1.66E-01	1.66E-01	95% UCL - Bootstrap
TPH-DRO	N/A	mg/L	73 / 123	7.20E-02 - 3.00E+01	Undefined	1.58E+00	1.58E+00	95% UCL - Bootstrap
TPH-ORO	N/A	mg/L	66 / 117	8.55E-02 - 1.08E+01	Undefined	1.32E+00	1.32E+00	95% UCL - Bootstrap
Lead	7439-92-1	mg/L	2 / 13	4.00E-02 - 5.00E-02	Undefined	1.45E-02	1.45E-02	95% UCL - Bootstrap
1-Methylnaphthalene	90-12-0	mg/L	7 / 9	2.50E-04 - 4.10E-02	Lognormal	1.77E-02	1.77E-02	95% UCL - Bootstrap
2-Methynaphthalene	91-57-6	mg/L	1 / 9	4.21E-02 - 4.21E-02	Undefined	5.50E-05	5.50E-05	95% UCL - Bootstrap
Dibenz(a,h)anthracene	53-70-3	mg/L	3 / 20	7.10E-05 - 1.30E-04	Undefined	5.48E-05	5.48E-05	95% UCL - Bootstrap
Indeno(1,2,3-cd)pyrene	193-39-5	mg/L	1 / 20	2.10E-04 - 2.10E-04	Undefined	5.25E-05	5.25E-05	95% UCL - Bootstrap

N/A = Not Available or Not Applicable
COPCs - chemical of potential concern

Table 3-2
Exposure Parameters for the Com. Worker, Constr. Worker Recreational Youth
Former PQS Etowah Terminal
Charleston, West Virginia

Parameter	Commercial Worker[a]		Construction Worker[b]	
	Value	Units	Value	Units
ALL PATHWAYS				
Body Weight	70	kg	70	kg
Exposure Duration	25	yr	1	yr
Averaging Time-NC	9,125	days	365	days
Averaging Time-CA	25,550	days	25,550	days
DERMAL CONTACT WITH GROUNDWATER				
Surface Area	NA		1,900	cm^2
Exposure Time	NA		4	hr/day
Exposure Frequency	NA		20	days/yr
INHALATION OF VOLATILES				
Inhalation Rate (indoor air) (J& E Model)	20	m^3/day	NA	
Exposure Frequency	250	days/yr	NA	

Note: Exposure parameters are from Table 6-2 of the User Guide for Risk Assessment of Petroleum Releases, Version 1.0, West Virginia Division of Environmental Protection, November 1999, unless otherwise noted.

[a] For the Commercial Worker, the inhalation rate is from the default exposure factors, U.S. EPA, 1991, OSWER Directive Supplement to RAGS Part A.

[b] For the construction worker, the basis for exposure parameters is as follows:

Exposure Frequency - 5 days per week for 4 weeks: professional judgment.

Exposure Time - is assumed to not exceed more than 4 hours each work day: professional judgment

Exposure Duration - is assumed to be 1 year since the exposure frequency is 4 weeks.

Skin Surface Area - from the Exposure Factors Handbook (USEPA, 1997), based on hands and forearms.

NA = not applicable.

Com - Commercial

Constr - Construction

Table 3-3
Summary of Carcinogenic Risks and Noncarcinogenic Hazards
Former PQS Etowah Terminal
Charleston, West Virginia

Receptor/Scenario/Exposure Route/Medium	Cancer Risk	Percent of Total	Contributor	Hazard Index	Percent of Total	Contributor
On-site Commercial Worker (current)						
Inhalation of Vapors from Groundwater (indoor air)	1.8E-08	100%	Benzene	0.000220	100%	Benzene
	1.8E-08			**0.000220**		
Inhalation of Vapors from Soil (indoor air)						
	1.0E-05	100%	Benzene	0.12	99%	Benzene
	N/A	N/A	Ethylbenzene	0.000062	0%	Ethylbenzene
	N/A	N/A	Toluene	0.00012	0%	Toluene
	N/A	N/A	Xylenes	0.00012	0%	Xylenes
	N/A	N/A	MTBE	0.00041	0%	MTBE
	N/A	N/A	Acetone	0.000032	0%	Acetone
	N/A	N/A	Carbon disulfide	0.00031	0%	Carbon disulfide
	5.0E-09	0%	Methylene chloride	0.00001	0%	Methylene chloride
	1.0E-05			**0.12**		
TOTAL	**1E-05**			**0.1**		
On-site Construction Worker (future)						
Inhalation of vapors from Groundwater (outdoor air)	<6.0E-09	N/A	N/A	<0.00007	N/A	N/A
(Qualitatively Assessed based on commercial worker)	**<6.0E-09**			**<0.00007**		
Inhalation of vapors from Soil (outdoor air)	<1.0E-05	N/A	N/A	<0.12	N/A	N/A
(Qualitatively Assessed based on commercial worker)	**<1.0E-05**			**<0.1**		
Dermal Contact with Groundwater	4.8E-10	0.8%	Benzene	0.00015	0.1%	Benzene
	3.3E-09	5.7%	MTBE	0.00007	0.1%	MTBE
	N/A	N/A	TPH-GRO	0.00015	0.1%	TPH-GRO
	N/A	N/A	TPH-DRO	0.01100	9.6%	TPH-DRO
	N/A	N/A	TPH-ORO	0.03660	31.9%	TPH-ORO
	N/A	N/A	Lead	N/A	N/A	Lead
	N/A	N/A	1-Methylnaphthalene	0.04370	38.0%	1-Methylnaphthalene
	N/A	N/A	2-Methylnaphthalene	0.02320	20.2%	2-Methylnaphthalene
	5.1E-08	87.9%	Dibenz(a,h)anthracene	N/A	N/A	Dibenz(a,h)anthracene
	3.3E-09	5.6%	Indeno(1,2,3-cd)pyrene	N/A	N/A	Indeno(1,2,3-cd)pyrene
	5.8E-08			**0.11**		
TOTAL	**<1E-05**			**<0.2**		

Notes:
N/A = Not applicable

Table 3-4
Key Uncertainties Associated with the Risk Assessment
Former PQS Etowah Terminal
Charleston, West Virginia

Source of Uncertainty	Effect on Risk/Hazard Estimates	Potential Magnitude	Rationale for Assumptions
Biased Sampling; Collecting Soil Samples at locations where concentrations are likely to be highest	Overestimate	Moderate	Samples were not collected on a random sample grid pattern.
Exposure Assumptions	Over- or Underestimate	Moderate	Exposure assumptions such as the exposure frequency and exposure duration were selected based on best professional judgment, based on current and future site use.
Use of chronic RfDs to evaluate 20-day exposure for some COPCs	Overestimate	Moderate	Chronic exposures by definition last for at least 7 years. Application of chronic toxicity values to a subchronic exposure may overestimate risks by an order of magnitude.
PAH and MTBE Toxicity Data	Over- or Underestimate (likely overestimate)	Slight to Moderate	Some toxicity data, mainly for PAHs and MTBE, are based on provisional guidance from USEPA. Every effort has been made to make sure the most current and accurate toxicity data were used in this assessment.
TPH Toxicity Data	Over- or Underestimate	Slight to Moderate	Toxicity data used in evaluating TPH constituents basically assumes surrogate toxicity values, since no specific toxicological data are available for TPH constituents. While this approach provides a method to analyze potential risks and hazards associated with TPH, risks and hazards may be over- or underestimated.
PAH Dermal Absorption Coefficients	Overestimate	Moderate to High	RAGS Part E provides Dermal Absorption Factors for use in assessing PAH exposure. However, further evaluation suggests that these absorption factors may be unrealistically high.

APPENDIX A

ANALYTICAL DATA TABLES

Table 1
Aboveground Storage Tank Information
Former PQS Etowah Terminal
1015 Barlow Drive
Charleston, West Virginia

STORAGE TANK NUMBER OR NAME	TYPE	YEAR INSTALLED	CAPACITY	CONTENTS*
Aboveground Storage Tank No. 392	Aboveground Storage Tank	1991	8,000	Additive
Aboveground Storage Tank No. 393	Aboveground Storage Tank	1951	420,000	Kerosene
Aboveground Storage Tank No. 394	Aboveground Storage Tank	1951	420,000	Kerosene
Aboveground Storage Tank No. 395	Aboveground Storage Tank	1938	18,700	Bulk Oil
Aboveground Storage Tank No. 396	Aboveground Storage Tank	1938	18,700	Bulk Oil
Aboveground Storage Tank No. 397	Aboveground Storage Tank	1938	420,000	Bulk Oil
Aboveground Storage Tank No. 398	Aboveground Storage Tank	1945	420,000	Gasoline
Aboveground Storage Tank No. 399	Aboveground Storage Tank	1940	420,000	Gasoline
Aboveground Storage Tank No. 400	Aboveground Storage Tank	1940	420,000	Gasoline
Aboveground Storage Tank No. 401	Aboveground Storage Tank	1940	420,000	Gasoline
Aboveground Storage Tank No. 402	Aboveground Storage Tank	1940	420,000	Gasoline
Aboveground Storage Tank No. 403	Aboveground Storage Tank	1950	420,000	Diesel
Aboveground Storage Tank No. 404	Aboveground Storage Tank	1950	420,000	Diesel
Aboveground Storage Tank No. 405	Aboveground Storage Tank	1951	420,000	Diesel

Table 2
Historical Soil Analytical Data
Former PQS Etowah Terminal
1015 Barlow Drive
Charleston, West Virginia

Location	Date	Depth (Feet)	Benzene (mg/kg)	Total BTEX (mg/kg)	MTBE (mg/kg)	Lead Total (mg/L)	Lead TCLP (mg/L)	TPH GRO (mg/kg)	TPH DRO (mg/kg)	TPH ORO (mg/kg)
C-1	11/3/00	0 – 0.5	0.0031	0.0244	NS	2.13	0.07	NS	NS	NS
C-2	11/3/00	0 – 0.0	<0.0011	<0.0011	NS	2220	8.2	NS	NS	NS
C-3	11/3/00	0 – 0.5	<0.0012	<0.0012	NS	545	1.2	NS	NS	NS
HA-1	11/3/00	0 –1.5	<0.0012	<0.0012	NS	245	0.15	0.98	1700	1600
HA-2	11/3/00	3 – 3.5	<0.120	746	NS	23.2	0.13	6300	1200	190
HA-3	11/3/00	0 – 1.0	<0.0012	<0.0012	NS	139	<0.04	<0.12	170	230
HA-4	11/3/00	2 – 3	0.0036	0.0149	NS	23.8	<0.04	5.1	25	37
HA-5	11/3/00	2 – 3	0.0160	0.0160	NS	53.3	0.06	0.74	240	260
GP-1	11/16/00	4 – 8	0.5300	3.5900	NS	59.6	NS	190	4,500	1,800
GP-1	11/16/00	12 – 16	<0.0012	<0.0012	NS	6.8	NS	<0.12	38	25
GP-2	11/16/00	4 – 8	<0.0013	<0.0013	NS	13.9	NS	<0.13	13	19
GP-2	11/16/00	12 – 16	<0.0011	<0.0011	NS	5.6	NS	<0.11	3.7	4.4
GP-3	11/16/00	8 – 12	0.2500	8.3500	NS	17.9	NS	900	150	13
GP-3	11/16/00	12 – 16	<0.0012	<0.0012	NS	5.7	NS	<0.12	7.4	7.1
GP-4	11/16/00	8 – 12	<0.0014	<0.0014	NS	12	NS	<0.14	4.8	9.2
GP-4	11/16/00	12 – 16	0.0660	0.6160	NS	8.4	NS	6.3	30	6.4
GP-5	11/16/00	8 – 12	<0.0011	<0.0011	NS	6.7	NS	0.17	200	450
GP-5	11/16/00	12 – 16	<0.0012	<0.0012	NS	8.5	NS	<0.12	<3.7	4.5
GP-6	11/16/00	4 – 8	0.5000	5.9500	NS	14.6	NS	80	1,000	320
GP-6	11/16/00	16 – 20	0.0470	0.5410	NS	14.1	NS	33	4.2	7
GP-6	11/16/00	36 - 40	<0.0012	<0.0012	NS	5.8	NS	<0.12	<3.9	<3.9
GP-7	11/16/00	8 – 12	<0.0012	<0.0012	NS	11.2	NS	0.15	5.1	5.5
GP-7	11/16/00	40 – 43	<0.0012	<0.0012	NS	15	NS	<0.12	<3.8	<3.8
GP-8	11/17/00	12 – 16	0.3000	1.0200	NS	12.8	NS	37	310	40
GP-8	11/17/00	24 – 28	0.0200	0.0200	NS	10.4	NS	0.13	4.6	8.2
GP-9	11/17/00	16 – 20	0.3700	1.9500	NS	10.2	NS	100	300	68
GP-9	11/17/00	28 – 32	<0.0011	<0.0011	NS	5.7	NS	<0.11	<3.7	4.1
GP-10	11/17/00	12 – 16	0.0130	0.2456	NS	10.2	NS	150	5.4	<4.0
GP-10	11/17/00	20 – 24	<0.0012	<0.0012	NS	8.1	NS	<0.12	<4.1	5.6
C2-A	5/30/01	0 - 0.5	NS	NS	NS	1,590	3	NS	NS	NS
C2-B	5/30/01	0 - 0.5	NS	NS	NS	658	3.2	NS	NS	NS
C2-C	5/30/01	0 - 0.5	NS	NS	NS	3,050	75.2	NS	NS	NS
C2-D	5/30/01	0 - 0.5	NS	NS	NS	949	6.49	NS	NS	NS
C2-E	5/30/01	0 - 0.5	NS	NS	NS	151	0.228	NS	NS	NS
MW-1	6/14/01	8 - 10	<0.0012	<0.0012	<0.0098	NS	NS	<4.0	6.1	6
MW-1	6/14/01	10 - 12	<0.0011	<0.0011	<0.0091	NS	NS	<0.11	9.5	12
MW-2	6/13/01	0 - 2	<0.0012	<0.0012	<0.0099	NS	NS	<0.12	53	43
MW-2	6/13/01	10 - 12	<0.0012	<0.0012	<0.0092	NS	NS	<0.12	7.1	11
MW-3	6/14/01	4 - 6	<0.0013	<0.0013	<0.010	NS	NS	5.6	160	80
MW-3	6/14/01	12 - 14	<0.0011	<0.0011	<0.0088	NS	NS	<0.11	8.3	11

**Table 2 (Continued)
Historical Soil Analytical Data
Former PQS Etowah Terminal
1015 Barlow Road
Charleston, West Virginia**

Location	Date	Depth (Feet)	Benzene (mg/kg)	Total BTEX (mg/kg)	MTBE (mg/kg)	Lead Total (mg/L)	Lead TCLP (mg/L)	TPH GRO (mg/kg)	TPH DRO (mg/kg)	TPH ORO (mg/kg)
MW-4	6/4/01	22 - 24	<0.001	<0.001	<0.008	NS	NS	<0.1	<3.7	<3.7
MW-5	6/4/01	18 - 20	0.1800	10.9100	0.1500	NS	NS	<100	130	43
MW-5	6/4/01	20 - 22	<0.001	<0.001	<0.008	NS	NS	<0.100	19	4.8
MW-6	6/4/01	2 - 4	<0.001	<0.001	<0.008	NS	NS	<0.100	4.9	6.6
MW-6	6/5/01	12 - 14	<0.001	<0.001	<0.008	NS	NS	0.17	<4.0	<4.0
MW-7	9/27/01	14 - 16	<0.005	0.2490	NS	NS	NS	21	1,210	NS

mg/kg - milligrams per kilogram
BTEX - benzene, toluene, ethylbenzene and xylenes
MTBE - methyl tertiary butyl ether
TCLP - toxicity characteristic leaching procedure
TPH - total petroleum hydrocarbons
GRO - gasoline range organics (C_6 - C_{10})
DRO - diesel range organics (C_{10} - C_{28})
ORO - oil range organics (C_{28} - C_{35})
WVDEP- West Virginia Department of Environmental Protection

NE - not established
NS - not sampled
< - not detected at the following method detection limit
mg/L - milligrams per liter

Table 3
Historical Groundwater Analytical Data
Former PQS Etowah Terminal
1015 Barlow Drive
Charleston, West Virginia

Location	Date	Benzene (ug/L)	Toluene (ug/L)	Ethyl-benzene (ug/L)	Total Xylenes (ug/L)	MTBE (ug/L)	TPH GRO (ug/L)	TPH DRO (mg/L)	TPH ORO (mg/L)
WVGS	NA	5	1,000	700	10,000	NE	NE	NE	NE
MW-1	8/31/04	<0.34	<0.46	<0.36	<0.26	<0.47	<30	0.180	<0.150
	5/17/04	<5	<5	<5	<10	<5	<100	<0.200	0.250
	3/1/04	<0.34	<0.46	<0.36	<0.26	<0.47	23	<0.150	<0.150
	12/2/03	<1	<1	<1	<1	<1	<100	0.147	0.282
	08/15/03	<1	<1	<1	<1	<1	<100	0.129	0.387
	06/4/03	<1	<1	<1	<1	<1	<100	0.562	0.566
	03/13/03	<1	<1	<1	<1	<1	<100	0.149	<0.100
	12/9/02	<1	<1	<1	<1	<1	<100	0.197	0.342
	9/23/02	<1	<1	<1	<1	<1	<100	0.204	0.293
	6/25/02	<1	<1	<1	<1	<1	<100	0.181	0.323
	3/18/02	<1	<1	<1	<1	<1	<100	0.179	0.24
	12/12/01	<1	<1	<1	<1	<8	<100	<0.10	0.11
	10/2/01	<1	<1	<1	<1	<1	<100	0.136	NS
	9/11/01	<1	<1	<1	<2	<10	<500	<0.15	<0.40
	6/20/01	<1	<1	<1	<2	<8	<100	<0.10	<0.10
MW-2	8/31/04	<0.34	<0.46	<0.36	<0.26	<0.47	<30	0.078	<0.15
	5/17/04	<5	<5	<5	<10	<5	<100	<0.20	0.25
	3/1/04	<0.34	<0.46	<0.36	<0.26	4	16	0.16	<0.15
	12/2/03	<1	<1	<1	<1	<1	<100	<0.10	0.145
	08/15/03	<1	<1	<1	<1	1.2	<100	<0.10	0.143
	06/4/03	<1	<1	<1	<1	<1	<100	0.104	0.130
	03/13/03	1.6	<1	<1	<1	<1	<100	<0.10	<0.10
	12/9/02	<1	<1	<1	<1	<1	<100	<0.10	0.106
	9/23/02	<1	<1	<1	<1	<1	<100	<0.10	<0.10
	6/25/02	<1	<1	<1	<1	<1	<100	<0.10	<0.10
	3/18/02	<1	<1	<1	<1	<1	<100	<0.10	0.11
	12/12/01	<1	1	<1	<1	<8	<100	<0.10	0.12
	10/2/01	<1	<1	<1	<1	<1	<100	0.128	NS
	9/11/01	<1	<1	<1	<2	<10	<500	<0.12	<0.30
	6/20/01	<1	<1	<1	<2	<8	<100	<0.10	<0.10
MW-3	8/31/04	<0.34	<0.46	<0.36	<0.26	<0.47	52	0.86	<0.15
	5/17/04	<5	<5	<5	<10	<5	<100	0.27	0.43
	3/1/04	<0.34	<0.46	<0.36	<0.26	<0.47	16	<0.0097	<0.15
	12/2/03	<1	<1	<1	<1	<1	<100	0.273	0.209
	08/15/03	<1	<1	<1	<1	<1	<100	1.540	0.248
	06/4/03	<1	<1	<1	1.9	<1	<100	0.546	0.140
	03/13/03	<1	<1	<1	<1	<1	<100	0.204	0.140
	12/9/02	<1	<1	<1	<1	<1	<100	1.350	<100
	9/23/02	<1	<1	1	5.8	<1	108	1.44	<0.10
	6/25/02	<1	<1	<1	4.9	<1	179	1.15	<0.10
	3/18/02	<1	1.1	1.2	9.4	1.3	244	1.03	0.47
	12/12/01	2.7	1.1	<1	2.4	<8	300	0.37	0.23
	10/2/01	<1	1.4	1.9	8.5	<1	346	0.642	NS
	9/11/01	<1	<1	<1	<2	<10	<500	0.83	<0.30

Table 3 (Continued)
Historical Groundwater Analytical Data
Former PQS Etowah Terminal
1015 Barlow Road
Charleston, West Virginia

Location	Date	Benzene (ug/L)	Toluene (ug/L)	Ethyl-benzene (ug/L)	Total Xylenes (ug/L)	MTBE (ug/L)	TPH GRO (ug/L)	TPH DRO (mg/L)	TPH ORO (mg/L)
WVGS	NA	5	1,000	700	10,000	NE	NE	NE	NE
MW-3	6/20/01	<1	<1	<1	<2	<8	190	0.63	0.15
MW-4	8/31/04	<0.34	<0.46	<0.36	<0.26	<0.47	<30	0.09	<0.15
	5/17/04	<5	<5	<5	<10	<5	<100	<0.20	0.34
	3/1/04	<0.34	<0.46	<0.36	<0.26	<0.47	35	0.12	<0.15
	12/2/03	<1	<1	<1	<1	<1	<100	<0.10	0.139
	08/15/03	<1	<1	<1	<1	<10	<100	<0.10	0.145
	06/4/03	<1	<1	<1	<1	<1	<100	<0.10	0.141
	03/13/03	<1	<1	<1	<1	<1	<100	<0.10	<0.10
	12/9/02	<1	<1	<1	<1	<1	<100	<0.10	<0.10
	9/23/02	<1	<1	<1	<1	<1	<100	<0.10	<0.10
	6/25/02	<1	<1	<1	<1	<1	<100	<0.10	<0.10
	3/18/02	<1	<1	<1	<1	<1	<100	<0.10	<0.10
	12/12/01	<1	<1	<1	<1	<8	<100	<0.10	<0.10
	10/2/01	<1	<1	<1	<1	<1	<100	<0.10	NS
	9/11/01	<1	<1	<1	<2	<10	<500	<0.12	<0.30
	6/20/01	<1	<1	<1	<2	<8	<100	<0.10	<0.10
MW-5	8/31/04	<0.34	<0.46	<0.36	<0.26	<0.47	<30	0.094	<0.15
	5/17/04	<5	<5	<5	<10	<5	<100	<0.20	0.22
	3/1/04	<0.34	<0.46	<0.36	<0.26	<0.47	15	0.10	<0.15
	12/2/03	<1	<1	<1	<1	<1	<100	<0.10	0.113
	08/15/03	<1	<1	<1	<1	<10	<100	<0.10	0.121
	06/4/03	<1	<1	<1	<1	<1	<100	0.117	0.182
	03/13/03	<1	<1	<1	<1	<1	<100	<0.10	0.120
	12/9/02	<1	<1	<1	<1	<1	<100	0.490	1.290
	9/23/02	<1	<1	<1	<1	<1	<100	<0.10	<0.10
	6/25/02	<1	<1	<1	<1	<1	<100	<0.10	<0.10
	3/18/02	<1	<1	<1	<1	<1	<100	<0.10	<0.10
	12/12/01	<1	<1	<1	<1	<8	<100	<0.10	<0.10
	10/2/01	<1	<1	<1	<1	<1	<100	<0.10	NS
	9/11/01	<1	<1	<1	<2	<10	<500	<0.13	<0.30
	6/20/01	<1	<1	<1	<2	<8	<100	<0.11	<0.11

Table 3 (Continued)
Historical Groundwater Analytical Data
Former PQS Etowah Terminal
1015 Barlow Road
Charleston, West Virginia

Location	Date	Benzene (ug/L)	Toluene (ug/L)	Ethyl-benzene (ug/L)	Total Xylenes (ug/L)	MTBE (ug/L)	TPH GRO (ug/L)	TPH DRO (mg/L)	TPH ORO (mg/L)
WVGS	NA	5	1,000	700	10,000	NE	NE	NE	NE
MW-6	8/31/04	<0.34	<0.46	<0.36	<0.26	<0.47	<30	0.091	<0.15
	5/17/04	<5	<5	<5	<10	<5	<100	<0.20	0.22
	3/1/04	<0.34	<0.46	<0.36	<0.26	<0.47	45	0.12	<0.15
	12/2/03	<1	<1	<1	<1	<1	<100	0.103	0.163
	08/15/03	<1	<1	<1	<1	<10	117	0.121	0.106
	06/4/03	<1	<1	<1	<1	<1	<100	0.170	0.176
	03/13/03	1.3	<1	<1	<1	<1	106	0.202	0.115
	12/9/02	1	<1	<1	<1	<1	120	0.290	0.631
	9/23/02	<1	<1	<1	1.4	<1	<100	<0.100	<0.100
	6/25/02	<1	<1	<1	2.4	<1	<100	<0.10	<0.10
	3/18/02	<1	<1	<1	<1	<1	<100	<0.10	<0.10
	12/12/01	4.8	1.4	<1	2.8	<8	200	0.13	0.29
	10/2/01	NS	NS	NS	NS	NS	NS	NS	NS
	9/11/01	<1	2	<1	<2	<10	<500	<0.13	<0.30
	6/20/01	<1	<1	<1	<2	<8	160	0.16	<0.10
MW-7	8/31/04	<0.34	<0.46	<0.36	<0.26	<0.47	<30	0.560	<0.15
	5/17/04	<5	<5	<5	<10	<5	<100	0.490	0.71
	3/1/04	<0.34	<0.46	<0.36	<0.26	<0.47	<12	<0.0097	1.200
	12/2/03	<1	<1	<1	<1	<1	<100	1.400	0.244
	08/15/03	<1	<1	<1	<1	<10	<100	0.705	0.140
	06/4/03	<1	<1	<1	<1	<1	<100	1.47	0.344
	03/13/03	<1	<1	<1	<1	<1	<100	5.51	<0.100
	12/9/02	<1	<1	<1	<1	1.3	<100	1.2	1.16
	9/23/02	<1	<1	<1	<1	1.7	<100	0.775	0.139
	6/25/02	<1	<1	<1	1.9	2.1	<100	0.719	<0.10
	3/18/02	<1	<1	<1	<1	2.5	<100	0.841	0.48
	12/12/01	<1	<1	<1	<1	<8	110	0.39	0.27
	10/2/01	<1	<1	<1	<1	1.3	<100	0.607	NS

TPH - total petroleum hydrocarbons
DRO - diesel range organics
GRO - gasoline range organics
ORO - oil range organics
< - analyte was not detected at the referenced method detection limit
WVGS - West Virginia Groundwater Standard (Title 46 CFR Series 12, Appendix A)

ug/L - micrograms per liter
mg/L - milligrams per liter
MTBE - methyl tertiary butyl ether
NE - not established
NS - not sampled

Table 3a
Historical Groundwater Polynuclear Aromatic Hydrocarbons Analytical Data
Former PQS Etowah Terminal
1015 Barlow Drive
Charleston, West Virginia

WELL ID	DATE	Acenap-hthene (ug/L)	Acenaph-thylene (ug/L)	Anthracene (ug/L)	Benzo(a) anthracene (ug/L)	Benzo(a) pyrene (ug/L)	Benzo(b)flu-oranthene (ug/L)	Benzo(g,h,l) perylene (ug/L)	Benzo(k)flu-oranthene (ug/L)	Chrysene (ug/L)	Dibenz(a,h) anthracene (ug/L)	Fluor-anthene (ug/L)	Fluorene (ug/L)	Indeno(1,2,-3-cd)pyrene (ug/L)	Naphth-alene (ug/L)	Phenan-threne (ug/L)	Pyrene (ug/L)
De Minimis		370	NE	1,800	0.091	0.2	0.091	NE	0.9	9.1	0.0091	1,500	240	0.091	6.2	NE	180
MW-3	8/31/04	0.031	NS	<0.0056	<0.0027	<0.003	<0.0017	NS	<0.0027	<0.0042	<0.0016	<0.0037	0.13	<0.0046	0.017	NS	<0.0038
	5/17/04	<0.05	0.51	<0.05	<0.05	<0.05	0.07	<0.05	<0.05	<0.05	0.071	<0.05	0.17	<0.05	<0.05	<0.05	<0.05
	3/1/04	0.008	NS	<0.002	0.012	0.026	0.019	NS	<0.002	0.014	<0.002	0.025	0.029	<0.004	0.048	NS	0.015
	8/15/03	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
MW-7	8/31/04	0.0091	NS	<0.0056	<0.0027	<0.003	<0.0017	NS	<0.0027	<0.0042	<0.0016	<0.0037	0.018	<0.0046	0.023	NS	<0.0038
	5/17/04	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.069	0.064	<0.05	0.089	<0.05	<0.05	<0.05	<0.05	<0.05	0.13
	3/1/04	0.0086	NS	<0.002	0.013	<0.001	<0.002	NS	<0.002	0.014	<0.002	0.023	0.025	<0.004	0.048	NS	0.015
	8/15/03	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
MW-8	8/31/04	0.0035	NS	<0.0056	<0.0027	<0.003	<0.0017	NS	<0.0027	<0.0042	<0.0016	<0.0037	<0.018	<0.0046	0.018	NS	<0.0038
	8/31/04 d	0.0035	NS	<0.0056	<0.0027	<0.003	<0.0017	NS	<0.0027	<0.0042	<0.0016	<0.0037	<0.018	<0.0046	0.018	NS	<0.0038
	5/17/04	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.13	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
	3/1/04	0.008	NS	<0.002	0.018	<0.001	<0.002	NS	<0.002	<0.003	<0.002	0.024	0.028	<0.004	0.049	NS	0.015

De Minimis = Table 60-3B Groundwater De Minimis Levels
< = Not detected at the following method detection limit.
ug/L = micrograms per liter (parts per billion)
d = Duplicate sample
NS = Parameter not analyzed
NE = Not Established
Concentrations above DeMinimis Levels are highlighted. (Based on historical data and later sample results the concentrations detected on above De Minimis levels on 5/17/04 are believed to be analomous).

Table 4
List of Chemicals of Potential Concern
Former PQS Etowah Terminal
1015 Barlow Drive
Charleston, West Virginia

COPC	Media	CAS Number	Included in Table 60-3B	Use/Occurrence	Decision Notes	To be sampled Yes	To be sampled No	Analysis
benzene	soil/water	71432	yes	constituent of gasoline fuel stored in ASTs	delineate full extent on-site	X		BTEX
cadmium	soil/water	7440439	yes	possible waste oil constituent	investigate near waste oil UST	X		Cadmium
chromium III	soil/water	16065831	yes	possible waste oil constituent	investigate near waste oil UST	X		Chromium III
chromium VI	soil/water	18540299	yes	possible waste oil constituent	investigate near waste oil UST	X		Chromium VI
diesel range organics	soil/water	none	no*	fuel stored in ASTs	delineate full extent on-site	X		DRO
ethylbenzene	soil/water	100-41-4	yes	constituent of gasoline fuel stored in ASTs	delineate full extent on-site	X		BTEX
ethylene glycol	soil/water	107211	yes	possible constituent in waste oil UST	investigate near waste oil UST	X		SVOC
gasoline range organics	soil/water	8006-61-9	no*	fuel stored in ASTs	delineate full extent on-site	X		GRO
lead	soil/water	7439921	yes	possible in paint on ASTs and petroleum product additive	delineate full extent on-site	X		Lead
lead tetraethyl	soil/water	78002	yes	possible gasoline additive for "knocking"	included with lead	X		Lead
methyl tertiary butyl ether	soil/water	none	no*	possible gasoline additive	delineate full extent on-site	X		MTBE
oil range organics	soil/water	none	no*	fuel stored in ASTs	delineate full extent on-site	X		ORO
PAH	soil/water	various	yes	constituents of diesel fuel stored in ASTs	delineate full extent on-site	X		PAH
Solvents	soil/water	various	yes	possible constituents in waste oil UST	investigate near waste oil UST	X		Solvent Screen
toluene	soil/water	108883	yes	constituent of gasoline fuel stored in ASTs	delineate full extent on-site	X		BTEX
xylenes	soil/water	1330207	yes	constituent of gasoline fuel stored in ASTs	delineate full extent on-site	X		BTEX

COPC - chemicals of potential concern
BTEX - benzene, toluene, ethylbenzene and xylenes
MTBE - methyl tertiary butyl ether
* - The WVDEP has established draft de minimis levels for MTBE and TPHs.
TPH - total petroleum hydrocarbons
GRO - gasoline range organics
DRO - diesel range organics
ORO - oil range organics
PAH - polynuclear aromatic hydrocarbons
No. - number
AST - aboveground storage tank
Some overlapping of analytical results is possible between GRO, DRO, KRO and ORO.

Table 5
List of Chemicals of Concern
Former PQS Etowah Terminal
1015 Barlow Drive
Charleston, West Virginia

COC	Media	CAS Number	Included in Table 60-3B	Analytical Method	SW 846 Method
benzene	soil/water	71432	yes	BTEX	8260B
cadmium	soil/water	7440439	yes	Cacmium	6010B
chromium III	soil/water	16065831	yes	Chromium III	6010B
chromium VI	soil/water	18540299	yes	Chromium VI	7196A
diesel range organics	soil/water	none	no*	DRO	8015B
ethylbenzene	soil/water	100-41-4	yes	BTEX	8260B
ethylene glycol	soil/water	107211	yes	Ethylene Glycol	8015B
gasoline range organics	soil/water	8006-61-9	no*	GRO	8260B
lead	soil/water	7439921	yes	Lead	6010B
lead tetraethyl	soil/water	78002	yes	Lead	6010B
methyl tertiary butyl ether	soil/water	none	no*	MTBE	8260B
oil range organics	soil/water	none	no*	ORO	8015B
PAH	soil/water	various	yes	PAH	8270C SIMS
Solvents	soil/water	various	yes	Solvent Screen	8270C
toluene	soil/water	108883	yes	BTEX	8260B
xylenes	soil/water	1330207	yes	BTEX	8260B

COC - chemicals of concern

SW 846 - test Methods for Evaluation of Solid Wastes: Physical/Chemical Methods, Third Edition

* - The West Virginia Department of Environmental Protection has established draft de minimis levels for methyl tertiary butyl ether and TPH.

BTEX - benzene, toluene, ethylbenzene and total xylenes

MTBE - methyl tertiary butyl ether

TPH - total petroleum hydrocarbons

GRO - gasoline range organics

DRO - diesel range organics

ORO - oil range organics

PAH - polynuclear aromatic hydrocarbons

No. - number

AST - aboveground storage tank

Some overlapping of analytical results is possible between GRO, DRO, KRO and ORO.

Table 6
Summary of Soil and Sediment Analytical Program
Former PQS Etowah Terminal
1015 Barlow Drive
Charleston, West Virginia

Matrix	Analysis	SW 846 Method	Parameter	CAS Number	Table 60-3B De Minimis Level (mg/kg)	Maximum Detection Limit (a) (mg/kg)	Sample Container	Preservation	Holding Time
Soil and Sediment	VOCs Solvents	8260B	Benzene	71-43-2	15	8			
			Toluene	108-88-3	2,000	1,000	using Terra Core sampler		
			Ethylbenzene	100-41-4	6,000	3,000	3-40ml glass	Cool to 4 deg. C	14
			Xylenes	1330-20-7	4,500	2,250	VOA viles	(2 viles)$HNaSO_4$	days
			Methyl tertiary butyl ether	none	800 (b)	400	4 oz. Glass	(1 vial) CH_4O	
			Acetone	67641	6,200	3,100	SW-846	(1 Glass) none	
			n-Butanol (1-Butanol)	71-36-3	88,000	44,000			
			Carbon disulfide	75150	1,200	600			
			Carbon tetrachloride	56235	5.3	3		using En Core sampler	
			Chlorobenzene	108907	540	270	3-En Cores	Cool to 4 deg. C	48
			Cyclohexanone	108941	1,000,000	500,000		no headspace	hours
			1,2-Dichlorobenzene	95501	3,300	1,650			
			Isobutanol	78831	77,000	38,500			
			1,1,2-Trichloroethane	79005	19	10			
			Trichloroethene	79016	61	31			
			Methylene chloride	75-92	210	105			
			Methyl ethyl ketone (MEK)	78933	28,000	14,000			
			Methyl isobutyl ketone (MIBK)	108101	2,900	1,450			
			Tetrachloroethene	127184	190	95			
			1,1,1-Trichloroethane (TCA)	71556	3,200	1,600			
			Trichlorofluoromethane	75694	1,300	650			
	SVOCs Solvents and PAH	8270C SIMS	o-Cresol (2-Methylphenol)	95487	44,000	22,000	4 oz. Glass	Cool to 4 deg. C	14 days
			m-cresol (3-Methylphenol)	108394	44,000	22,000			
			p-Cresol (4-Methylphenol)	106445	4,400	2,200			
			Pyridine	110861	880	440			
			Nitrobenzene	98953	110	55			
			Acenaphthene	83-32-9	38,000	19,000			
			Anthracene	120-12-7	390,000	195,000			
			Benzo(a)anthracene	56-55-3	29	15			
			Benzo(a)pyrene	50328	2.9	1			
			Benzo(b)fluoranthene	205992	29	15			
			Benzo(k)fluroanthene	207089	290	145			
			Chrysene	218-01-9	2,900	1,450			
			Dibenzo(ah)anthracene	53703	2.9	1			
			Fluoranthene	206-44-0	30,000	15,000			
			Fluorene	86-73-7	33,000	16,500			
			Indeno(1,2,3-cd)pyrene	193395	29	15			
			Naphthalene	91-20-3	190	95			
			Pyrene	129-00-0	54,000	27,000			
	TPH	8015B	2-Ethoxyethanol	110805	350,000	175,000	4 oz. Glass	Cool to 4 deg. C	14 days
			Ethylene glycol	107211	1,000,000	500,000			
			Methanol	67561	440,000	220,000			
			Diesel range organics C_{10}-C_{28}	none	8,300 (b)	4,150			
			Gasoline range organics C_6-C_{10}	8006-61-9	6,600 (b)	3,300			
			Oil range organics C_{28}-C_{35}	none	9,000 (b)	4,500			

Table 6 (Continued)
Summary of Soil and Sediment Analytical Program
Former PQS Etowah Terminal
1015 Barlow Drive
Charleston, West Virginia

Matrix	Analysis	SW 846 Method	Parameter	CAS Number	Table 60-3B De Minimis Level (mg/kg)	Maximum Detection Limit (a) (mg/kg)	Sample Container	Preservation	Holding Time
	Inorganics	6010B	Cadmium	7440439	811	406	4 oz. Plastic	Cool to 4 deg. C	28 days
		6010B	Chromium III	16065831	1,000,000	500,000			
		7196A	Chromium VI	18540299	660	330			
		6010B	Lead (TCLP lead as per Table 9)	7439-92-1	1,000	500			

VOC - volatile organic compound
SVOC - semi-volatile organic compound
VOA - volatile organic analysis
TPH - total petroleum hydrocarbons
PAH - polynuclear aromatic hydrocarbons
SIMS - single ion monitoring spectrometry
MIBK - methylisobutyl ketone, also 4-methyl-2-pentanone
HNaSO$_4$ - sodium bisulfate
CH$_4$O - methanol
deg. C - degrees celsius
oz - ounce
mg/kg - milligrams per kilogram
NE - not established
MEK - methyl ethyl ketone, also 2-butanone
SW 846 - Test Methods for Evaluation of Solid Wastes: Physical/Chemical Methods, Third Edition
Table 60-3B De Minimis Level - West Virginia de minimis levels for industrial soil (revised January 2002)
(a) - maximum detection limit is half of the above-referenced De Minimis level or the standard laboratory method detection limit, whichever is lower
(b) - West Virginia Table 2, draft De Minimis level for industrial soil (revised January 2002)
For PAH and solvents samples, extract and hold pending results of TPH-DRO (analyze if TPH-DRO is equal to or greater than 100 mg/kg).
Where laboratory method detection limits are above the De Minimis Level, the laboratory will achieve the lowest practical J value (anticipated problem analytes are highlighted).

Table 7
Summary of Groundwater and Surface Water Analytical Program
Former PQS Etowah Terminal
1015 Barlow Drive
Charleston, West Virginia

Matrix	Analysis	SW 846 Method	Parameter	CAS Number	Table 60-3B De Minimis (mg/L)	Detection Limit (a) (mg/L)	Sample Container	Preservation	Holding Time
Water	VOCs	8260B	Benzene	71-43-2	0.005	0.0025	3-40ml glass	Cool to 4 deg. C	14 days
	Solvents	(10mL Purge	Toluene	108-88-3	1	0.5	VOA viles	HCl to pH <2	
		when	Ethylbenzene	100-41-4	1.3	0.65			
		solvents	Xylenes	1330-20-7	10	5			
		are	Methyl tertiary butyl ether	none	0.020 (b)	0.01			
		included)	Acetone	67641	0.61	0.305			
			n-Butanol (1-Butanol)	71-36-3	3.7	1.85			
			Carbon disulfide	75150	1	0.5			
			Carbon tetrachloride	56235	0.005	0.0025			
			Chlorobenzene	108907	0.11	0.055			
			Cyclohexanone	108941	180,000	90000			
			1,2-Dichlorobenzene	95501	0.6	0.3			
			Isobutanol	78831	1.8	0.9			
			1,1,2-Trichloroethane	79005	0.005	0.0025			
			Trichloroethene	79016	0.005	0.0025			
			Methylene chloride	75-92	0.005	0.0025			
			Methyl ethyl ketone (MEK)	78933	1.9	0.95			
			Methyl isobutyl ketone (MIBK)	108101	0.16	0.08			
			Tetrachloroethene	127184	0.005	0.0025			
			1,1,1-Trichloroethane (TCA)	71556	0.54	0.27			
			Trichlorofluoromethane	75694	1.3	0.65			
	VOCs	8270C	o-Cresol (2-Methylphenol)	95487	1.8	0.9	1 L a-glass	Cool to 4 deg. C	14 days
	Solvents	SIMS	m-cresol (3-Methylphenol)	108394	1.8	0.9			
	and PAH		p-Cresol (4-Methylphenol)	106445	0.18	0.09			
			Pyridine	110861	0.037	0.0185			
			Nitrobenzene	98953	0.0034	0.0017			
			Acenaphthene	83-32-9	0.37	0.185			
			Anthracene	120-12-7	1.8	0.9			
			Benzo(a)anthracene	56-55-3	0.000091	0.0000455			
			Benzo(a)pyrene	50328	0.0002	0.0001			
			Benzo(b)fluoranthene	205992	0.000091	0.0000455			
			Benzo(k)fluoranthene	207089	0.00091	0.000455			
			Chrysene	218-01-9	0.0091	0.00455			
			Dibenzo(a,h)anthracene	53703	0.0000091	0.00000455			

Table 7 (Continued)
Summary of Groundwater and Surface Water Analytical Program
Former PQS Etowah Terminal
1015 Barlow Drive
Charleston, West Virginia

Matrix	Analysis	SW 846 Method	Parameter	CAS Number	Table 60-3B De Minimis (mg/L)	Detection Limit (a) (mg/L)	Sample Container	Preservation	Holding Time
	Solvents and PAH (Continued)	8270C SIMS	Fluoranthene	206-44-0	1.5	0.75	(continued)	(continued)	(continued)
			Fluorene	86-73-7	0.24	0.12			
			Indeno(1,2,3-cd)pyrene	193395	0.000091	0.0000455			
			Naphthalene	91-20-3	0.0062	0.0031			
			Pyrene	129-00-0	0.18	0.09			
	TPH	8015B	2-Ethoxyethanol	110805	15	7.5	3-40mL a-glass VOAs	Cool to 4 deg. C	14 days
			Ethylene glycol	107211	73	36.5	3-40mL a-glass VOAs	Cool to 4 deg. C	14 days
			Methanol	67561	18	9	3-40mL a-glass VOAs	Cool to 4 deg. C	14 days
			Diesel range organics C_{10}-C_{28}	none	0.33 (b)	0.16	1 L a-glass	Cool to 4 deg. C, HCl	7 days to extract
			Oil range organics C_{28}-C_{35}	none	0.16 (b)	0.08	1 L a-glass	Cool to 4 deg. C, HCl	7 days to extract
			Gasoline range organics C_6-C_{10}	800-61-9	1.5 (b)	0.75	3-40ml glass VOA viles	Cool to 4 deg. C, HCl	14 days
	Inorganics	6010B	Cadmium	7440439	0.018	0.009	250 ml plastic (filtered)	Cool to 4 deg. C,HNO_3	180 days
		6010B	Chromium III	16065831	55	27.5	250 ml plastic (filtered)	Cool to 4 deg. C,HNO_3	180 days
		6010B	Lead	7439-82-1	0.015	0.0075	250 ml plastic (filtered)	Cool to 4 deg. C,HNO_3	180 days
		7196A	Chromium VI	18540299	0.11	0.055	125 ml plastic (filtered)	Cool to 4 deg. C	24 hour-alert lab

VOC - volatile organic compound
SVOC - Solvents (solvent screen)
VOA - volatile organic analysis
SW 846 - Methods Eval. Solid Wastes: Phys./Chem. Methods, 3rd Ed.
MIBK - methylisobutyl ketone, also 4-methyl-2-pentanone
TPH - total petroleum hydrocarbons
PAH - polynuclear aromatic hydrocarbons
SIMS - single ion monitoring spectrometry
MEK - methyl ethyl ketone, also 2-butanone
HNO_3 - nitric acid
NE - not established
oz - ounce
a - amber
ug/L - micrograms per liter
HCl - hydrochloric acid
deg. C - degrees celsius

Table 60-3B De Minimis Level - West Virginia de minimis levels for groundwater (revised January 2002)

(a) - maximum detection limit is half of the De Minimis level or the standard laboratory method detection limit, whichever is lower (exceptions are explained in footnotes).

(b) - West Virginia Table 2, draft De Minimis level for groundwater (revised January 2002)

For PAH and solvents samples, extract and hold pending results of TPH-DRO (analyze if TPH-DRO is equal to or greater than 330 ug/L).

Where laboratory method detection limits are above De Minimis Level, the laboratory will achieve the lowest practical J value.

TABLE 8
SOIL ANALYTICAL RESULTS FOR VOC, LEAD AND TPH
Former POS Etowah Terminal
1015 Barlow Drive
Charleston, West Virginia

Sample Identification			Volatile Organic Compound Parameters					Lead	Total Petroleum Hydrocarbons		
Sample Location	Depth (Feet)	Date	Benzene (mg/kg)	Ethylbenzene (mg/kg)	Toluene (mg/kg)	Total Xylenes (mg/kg)	Methyl Tertiary Butyl Ether (mg/kg)	Lead (mg/kg)	Gasoline Range Organics (mg/kg)	Diesel Range Organics (mg/kg)	Oil Range Organics (mg/kg)
Table 60-3B - Industrial			15	6,000	2,000	4,500	600 (a)	1,000	6,600 (a)	8,300 (a)	9,000 (a)
SB-1 (adjacent to MW-6)	0 - 2	7/17/03	<0.0017	<0.0017	<0.0017	<0.0017	0.0427	58.3	<5.78	331.0	339.0
	2 - 8	7/17/03	0.0366	0.0077	0.0013 J	0.0386	0.0023	13.1	<6.12	6.46	<6.12
	18 - 20	7/17/03	<0.0018	<0.0018	<0.0018	<0.0018	<0.0018	10.6	<6.10	<6.10	<6.10
TMW/SB-2S (adjacent to MW-5)	0 - 2	7/16/03	<0.0019	<0.0019	0.0014 J	<0.0019	0.0129	15.9	<6.20	<6.20	<6.20
	2 - 4	7/16/03	0.0030	<0.0016	0.0012 J	0.0021	0.0192	15.9	6.40	61.7	<6.17
TMW/SB-3 S & D	0 - 2	7/16/03	0.375	0.0074	0.0081	0.0098	0.0015 J	20.3	<6.15	21.6	20.8
	2 - 7.5	7/16/03	0.102	0.0166	0.0060	0.0105	0.0021	19.6	67.0	188.0	<31.1
	26 - 28	7/17/03	<0.0019	<0.0019	<0.0019	<0.0019	<0.0019	14.2	<6.49	<6.49	27.1
SB-4 (adjacent to MW-4)	0 - 2	7/16/03	0.0012 J	<0.0018	0.0014 J	<0.0018	<0.0018	29.3	<5.86	50.9	100.0
	2 - 8	7/16/03	<0.0017	<0.0017	0.0015 J	<0.0017	<0.0017	15.1	<6.20	<6.20	<6.20
	22 - 24	7/16/03	<0.0018	<0.0018	<0.0018	<0.0018	<0.0018	14.2	<6.39	<6.39	<6.39
SB-5	0 - 2	7/15/03	0.0093	<0.0020	0.0013 J	<0.0020	<0.0020	21.0	<6.53	<6.53	10.8
	2 - 8	7/15/03	0.0020	<0.0017	0.0013 J	<0.0017	<0.0017	19.7	<6.65	<6.65	<6.65
SB-6	0 - 2	7/15/03	0.0020	0.0012 J	0.0018	0.0030	<0.0016	11.7	<5.59	320.0	<112.0
	2 - 8	7/15/03	<0.0021	<0.0021	0.0013 J	<0.0021	<0.0021	17.2	<6.99	<6.99	<6.99
TMW/SB-7 S & D	0 - 2	7/15/03	0.0011 J	<0.0017	0.0011 J	<0.0017	<0.0017	195.0	<5.90	327.0	1060.0
	2 - 4	7/15/03	0.128	0.0139	0.0138	0.353	0.625	26.5	15.9	257.0	634.0
	34 - 36	7/23/03	0.0021	<0.0019	<0.0019	<0.0019	0.0017 J	7.36	<5.61	34.6	55.0
SB-8	0 - 2	7/16/03	0.0027	<0.0015	<0.0015	<0.0015	<0.0015	15.4	<5.86	11.5	22.6
	2 - 8	7/16/03	<0.0016	<0.0016	0.0008 J	<0.0016	<0.0016	17.2	<6.00	<6.00	<6.00
SB-9	0 - 2	7/17/03	0.0007 J	0.0009 J	0.0009 J	0.0040	0.0011 J	15.6	144.0	129.0	<12.4
	2 - 4	7/17/03	<0.0017	<0.0017	0.0010 J	<0.0017	0.0014 J	13.6	<6.19	95.4	<12.4
SB-10 (adjacent to MW-1)	0 - 2	7/14/03	<0.0017	<0.0017	<0.0017	<0.0017	<0.0017	50.8	<5.82	16.6	31.4
	2 - 8	7/14/03	<0.0019	<0.0019	0.0010 J	<0.0019	<0.0019	15.5	<5.41	9.77	17.2
	10 - 12	7/14/03	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	10.9	<6.02	<6.02	<6.02
TMW/SB-11	2 - 4	7/14/03	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	20.2	<5.84	18.7	18.7
TMW/SB-12	2 - 4	7/14/03	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	32.5	<6.02	10.0	16.9
TMW/SB-13	10 - 12	7/15/03	<0.0020	0.0019 J	0.0019 J	<0.002 J	<0.0020	13.2	<6.64	<6.64	<6.64
TMW/SB-14	8 - 10	7/15/03	0.0347	1.96	0.0628	1.48	<0.0021	25.4	2,590	76.3	<13.0
SB-15 (adjacent to MW-2)	0 - 2	7/15/03	0.0011 J	<0.0017	0.0012 J	<0.0017	<0.0017	19.4	<6.05	<6.05	<6.05
	2 - 8	7/15/03	0.0019 J	<0.0023	0.005	0.0061	<0.0023	48.1	24.4	65.8	<12.9
	10 - 12	7/15/03	0.0123	0.442	0.0332	0.294	<0.0023	23.5	531.0	207.0	<66.3
TMW/SB-16	14 - 16	7/15/03	0.0015 J	0.0086	0.0063	0.0384	<0.0020	6.61	673.0	2,310	<564.0
TMW/SB-17	10 - 12	7/14/03	0.0008 J	<0.0018	0.0014 J	<0.001 J	<0.0018	7.02	<5.41	321	<108
TMW/SB-18	6 - 8	7/14/03	<0.0018	<0.0018	<0.0018	<0.0018	<0.0018	20.1	<6.01	<6.01	<6.01
SB-19 (adjacent to MW-3)	0 - 2	7/14/03	<0.0018	<0.0018	<0.0018	<0.0018	<0.0018	28.0	<5.92	8.36	13.7
	2 - 6	7/14/03	<0.0021	<0.0021	<0.0021	<0.0021	<0.0021	15.6	<6.60	<6.60	<6.60
TMW/SB-20	14 - 16	7/21/03	<0.0019	<0.0019	<0.0019	<0.0019	<0.0019	8.02	132	977	<286
SB-21	0 - 2	7/22/03	0.0079	0.0010 J	0.0010 J	0.0099	<0.0018	22.2	<6.11	26.0	<6.01
	2 - 8	7/22/03	0.0043	<0.0018	0.0010 J	0.0015 J	<0.0018	11.9	<6.11	8.07	<6.19
TMW/SB-22	0 - 2	7/21/03	0.0043	<0.0018	0.0058	<0.0018	<0.0018	15.1	729	3610	<639
	2 - 8	7/21/03	0.0020	<0.0019	<0.0019	<0.0019	<0.0019	12.9	26.2	136	<62.7
	20 - 22	7/22/03	0.0040	0.0026	0.0024	0.0104	<0.0018	10.2	21.9	205	<59.6
TMW/SB-23	0 - 2	7/22/03	<0.0019	<0.0019	<0.0019	<0.0019	<0.0019	14.6	<6.33	8.84	<6.28
	2 - 8	7/22/03	<0.0019	<0.0019	<0.0019	<0.0019	<0.0019	15.6	<6.19	328	<125
	22 - 23.5	7/22/03	0.0037	0.0019 J	0.0019 J	0.0067	<0.0021	7.94	51.8	615	<295
SB-24	0 - 2	7/21/03	0.0017	<0.0017	0.0020	<0.0017	<0.0017	16.3	<6.23	117	<12.5
	2 - 8	7/21/03	0.0045	0.0581	0.0025	0.0292	<0.0017	13.4	54.8	59.7	<6.24
	10 - 12	7/21/03	0.0011 J	<0.0016	<0.0016	<0.0016	<0.0016	13.8	<6.18	<6.18	<6.18
SB-25	0 - 2	7/21/03	0.0106	0.0018	0.0031	0.0067	0.0037	52.9	<6.36	20.4	6.41
	2 - 8	7/21/03	0.0037	0.0052	0.0011 J	<0.0016	0.0157	12.1	<6.20	51.7	<6.20
TMW/SB-26	0 - 2	7/17/03	0.228	0.867	0.0095	0.274	0.180	15.9	231.0	961.0	<125.0
	2 - 8	7/17/03	0.133	0.0376	0.0030	0.0392	0.296	15.3	<6.01	62.7	<6.01
	20 - 22	7/23/03	0.0025	0.0090	0.0010 J	0.0195	0.0022	8.92	6.37	28.7	<5.74
TMW/BG-1	0 - 2	7/16/03	0.0219	<0.0017	0.0012 J	0.0042	<0.0017	16.0	<6.15	<6.15	<6.15
	2 - 8	7/16/03	<0.0017	<0.0017	0.0012 J	<0.0017	<0.0017	16.0	<6.14	<6.14	<6.14
	10 - 12	7/16/03	<0.0017	<0.0017	0.0009 J	<0.0017	<0.0017	14.4	<6.09	<6.09	<6.09
TMW/BG-2	0 - 2	7/16/03	0.0016 J	<0.0020	0.0023	<0.0020	<0.0020	33.9	24.7	<6.50	54.9
	2 - 8	7/16/03	<0.0017	<0.0017	0.0009 J	<0.0017	<0.0017	14.6	<6.19	134.0	<30.9
	14 - 16	7/16/03	<0.0017	<0.0017	0.0008 J	<0.0017	<0.0017	11.6	<6.00	12.0	<6.00
NS-1	0 - 0.5	9/11/03	<0.0043	<0.0043	<0.0043	<0.0043	<0.0043	26.0	<10.7	<10.7	87.2
NS-2	0 - 0.5	9/11/03	<0.0031	<0.0031	<0.0031	<0.0031	<0.0031	19.8	<7.66	<7.66	27.1
NS-3	0 - 0.5	9/11/03	<0.005	<0.005	<0.005	<0.005	<0.005	30.5	<9.71	<9.71	58.6
NS-4	0 - 0.5	9/11/03	<0.0023	<0.0023	<0.0023	<0.0023	<0.0023	22.2	<7.16	<7.16	28.7
NS-5	0 - 0.5	9/11/03	<0.0035	<0.0035	<0.0035	<0.0035	<0.0035	26.8	<9.24	<9.24	84.1
NS-2 FS	0 - 0.5	9/11/03	<0.0031	<0.0031	<0.0031	<0.0031	<0.0031	22.1	<7.73	<7.73	26.1
SB-6 FS	2 - 8	7/15/03	<0.0019	<0.0019	0.0013 J	<0.0019	<0.0019	14.3	<6.02	<6.02	<6.02
TMW/SB-16 FS	14 - 16	7/15/03	0.0019 J	0.0145	0.0114	0.0276	<0.0020	6.74	592.0	2,020	<561
SB-21 FS	2 - 8	7/22/03	0.0042	<0.0019	0.0010 J	0.0013 J	<0.0019	15.2	<6.39	9.72	<6.50

NS - analyte was not analyzed
FS - field split
mg/kg - milligrams per kilogram

< - less than the following laboratory method detection limit
J - analyte below practical quantitation limit
Table 60-3B De Minimis - De Minimus Levels from West Virginia De Minimis Levels for Soil and Groundwater (revised January, 2002)
(a) - West Virginia Department of Environmental Protection Draft De Minimis Levels in Soil and Groundwater for TPH

TABLE 9
SOIL ANALYTICAL RESULTS FOR PAH
Former PQS Etowah Terminal
1015 Barlow Drive
Charleston, West Virginia

Sample Identification			PAH Parameters																		
Sample Location	Depth (Feet)	Date	Acenaphthene (mg/kg)	Acenaphthylene (mg/kg)	Anthracene (mg/kg)	Benzo(a) anthracene (mg/kg)	Benzo(a) pyrene (mg/kg)	Benzo(b)fluoranthene (mg/kg)	Benzo(ghi) perylene (mg/kg)	Benzo(k)fluoranthene (mg/kg)	Chrysene (mg/kg)	Dibenz(ah)-anthracene (mg/kg)	Fluoranthene (mg/kg)	Fluorene (mg/kg)	Indeno(123-cd)pyrene (mg/kg)	2-Methylnaphthalene (mg/kg)	Naphthalene (mg/kg)	Phenanthrene (mg/kg)	Pyrene (mg/kg)	1-Methyl naphthalene (mg/kg)
Table 60-3B - Industrial			38,000	NE	390,000	29	2.9	29	NE	290	2,900	2.9	30,000	33,000	29	NE	190	NE	54,000	NE
SB-1 (adjacent to MW-6)	0 - 2	7/17/03	0.01380	0.02750	0.02590	0.04960	0.06290	0.06450	0.08970	0.06450	0.06220	0.02590	0.09690	0.02250	0.05950	0.29400	0.09190	0.06400	0.07930	0.37600
	2 - 8	7/17/03	<0.00404	<0.00404	<0.00404	<0.00404	<0.00404	<0.00404	<0.00404	<0.00404	<0.00404	<0.00404	<0.00404	<0.00404	<0.00404	<0.00404	0.0097	0.00367 J	<0.00404	<0.00404
	18 - 20	7/17/03	<0.00402	<0.00402	<0.00402	<0.00402	<0.00402	<0.00402	<0.00402	<0.00402	<0.00402	<0.00402	<0.00402	<0.00402	<0.00402	<0.00402	<0.00402	<0.00402	<0.00402	<0.00402
SB-2 (adjacent to MW-5)	0 - 2	7/16/03	<0.00409	<0.00409	<0.00409	<0.00409	<0.00409	<0.00409	<0.00409	<0.00409	<0.00409	<0.00409	<0.00409	<0.00409	<0.00409	<0.00409	<0.00409	<0.00409	<0.00409	<0.00409
	2 - 4	7/16/03	<0.00407	<0.00407	<0.00407	<0.00407	<0.00407	<0.00407	<0.00407	<0.00407	<0.00407	<0.00407	<0.00407	<0.00407	<0.00407	0.02640	0.01380	<0.00407	<0.00407	0.02030
TMW/SB-3 S & D	0 - 2	7/16/03	<0.00406	<0.00406	<0.00406	<0.00406	<0.00406	<0.00406	<0.00406	<0.00406	<0.00406	<0.00406	<0.00406	<0.00406	<0.00406	<0.00406	<0.00406	0.00246 J	<0.00406	<0.00406
	2 - 7.5	7/16/03	0.01970	0.00904	0.00740	<0.00411	<0.00411	<0.00411	<0.00411	<0.00411	<0.00411	<0.00411	<0.00411	0.04810	<0.00411	0.81700	0.08060	0.05920	<0.00411	0.55500
	26 - 28	7/17/03	<0.00429	<0.00429	<0.00429	<0.00429	<0.00429	<0.00429	<0.00429	<0.00429	<0.00429	<0.00429	<0.00429	<0.00429	<0.00429	<0.00429	<0.00429	<0.00429	<0.00429	<0.00429
SB-4 (adjacent to MW-4)	0 - 2	7/16/03	0.00234 J	0.01430	0.01400	0.09400	0.08630	0.08160	0.07080	0.07550	0.09940	0.02560	0.15000	0.00658	0.06190	0.02050	0.00928	0.03790	0.13200	0.01970
	2 - 8	7/16/03	<0.00409	<0.00409	<0.00409	<0.00409	<0.00409	<0.00409	<0.00409	<0.00409	<0.00409	<0.00409	<0.00409	<0.00409	<0.00409	<0.00409	<0.00409	<0.00409	<0.00409	<0.00409
	22 - 24	7/16/03	<0.00421	<0.00421	<0.00421	<0.00421	<0.00421	<0.00421	<0.00421	<0.00421	<0.00421	<0.00421	<0.00421	<0.00421	<0.00421	<0.00421	<0.00421	0.00345 J	<0.00421	<0.00421
SB-6	0 - 2	7/15/03	<0.00369	<0.00369	0.0716	0.0801	0.0428	0.0403	0.0324	0.0513	0.0642	0.0192	0.285	0.103	0.0321	0.114	0.0255	0.313	0.178	0.130
TMW/SB-7 S	0 - 2	7/15/03	0.0335	0.0152	0.0939	0.220	0.171	0.165	0.137	0.155	0.203	0.0491	0.564	0.0491	0.117	0.0230	0.0179	0.353	0.372	0.0249
	2 - 4	7/15/03	<0.00403	0.0101	0.0279	0.0291	<0.00403	<0.00403	0.0267	<0.00403	0.0738	<0.00403	0.0775	0.0642	0.0198	0.101	0.0205	0.137	0.0919	0.176
SB-8	0 - 2	7/16/03	<0.00387	0.00387	0.00812	0.00619	0.02470	0.01820	0.02740	0.00928	0.00812	0.01200	0.01120	<0.00387	0.02130	<0.00387	<0.00387	0.00735	0.00851	<0.00387
	2 - 8	7/16/03	<0.00396	<0.00396	<0.00396	<0.00396	<0.00396	<0.00396	<0.00396	<0.00396	<0.00396	<0.00396	<0.00396	<0.00396	<0.00396	<0.00396	<0.00396	<0.00396	<0.00396	<0.00396
SB-9	0 - 2	7/17/03	0.02330	<0.00408	0.01230	<0.00408	<0.00408	<0.00408	<0.00408	<0.00408	<0.00408	<0.00408	<0.00408	0.04280	0.00899	<0.00408	<0.00408	0.07310	0.00899	0.23600
	2 - 4	7/17/03	0.00858	<0.00408	0.00653	<0.00408	<0.00408	<0.00408	<0.00408	<0.00408	<0.00408	<0.00408	<0.00408	0.01510	0.00899	<0.00408	<0.00408	0.02410	0.00408	0.06660
SB-15 (adjacent to MW-2)	0 - 2	7/15/03	<0.00400	<0.00400	0.00999	0.0268	0.0240	0.0280	0.0255	0.0203	0.0308	0.0144	0.0556	<0.00400	0.0220	0.0831	0.0511	0.0516	0.0387	0.0703
	2 - 8	7/15/03	<0.00425	0.00510	0.00638	0.0179	0.0166	0.0251	0.0242	0.0149	0.0285	0.0140	0.0349	0.00595	0.0191	0.398	0.171	0.0745	0.0272	0.531
	10 - 12	7/15/03	<0.00438	<0.00438	<0.00438	<0.00438	<0.00438	0.00700	0.00875	<0.00438	<0.00438	<0.00438	0.00354J	<0.00438	0.0101	3.22	0.761	0.00788	<0.00438	1.80
TMW/SB-16	14 - 16	7/15/03	<0.00372	<0.00372	0.0536	<0.00372	<0.00372	<0.00372	<0.00372	<0.00372	0.0198	<0.00372	<0.00372	0.267	<0.00372	<0.00372	<0.00372	0.274	0.0178	2.18
TMW/SB-20	14 - 16	7/21/03	0.13400	0.05410	0.08660	<0.00378	<0.00378	<0.00378	<0.00378	<0.00378	<0.00378	<0.00378	<0.00378	0.06010	<0.00378	<0.00378	0.01970	0.03630	0.02380	0.04190
SB-21	0 - 2	7/22/03	<0.00403	<0.00403	0.00484	0.01370	0.01610	0.01290	0.01250	0.01330	0.01610	<0.00403	0.03060	<0.00403	0.01330	<0.00403	<0.00403	0.01330	0.02420	<0.00403
	2 - 8	7/22/03	<0.00403	<0.00403	<0.00403	<0.00403	<0.00403	<0.00403	<0.00403	<0.00403	<0.00403	<0.00403	<0.00403	<0.00403	<0.00403	<0.00403	<0.00403	<0.00403	<0.00403	<0.00403
TMW/SB-22	0 - 2	7/21/03	<0.00422	<0.00422	0.01890	0.00464	<0.00422	0.00549	0.00760	0.00422	0.00422	<0.00422	<0.00422	0.19200	<0.00422	<0.00422	<0.00422	0.13700	0.00675	1.38000
	2 - 8	7/21/03	<0.00414	<0.00414	0.00662	<0.00414	<0.00414	<0.00414	<0.00414	<0.00414	<0.00414	<0.00414	<0.00414	0.02990	<0.00414	<0.00414	<0.00414	0.01240	<0.00414	0.28500
	20 - 22	7/22/03	<0.00391	<0.00391	<0.00391	<0.00391	<0.00391	<0.00391	<0.00391	<0.00391	<0.00391	<0.00391	<0.00391	<0.00391	<0.00391	<0.00391	<0.00391	<0.00391	<0.00391	<0.00391
TMW/SB-23	0 - 2	7/22/03	<0.00418	<0.00418	<0.00418	<0.00418	<0.00418	<0.00418	<0.00418	<0.00418	<0.00418	<0.00418	<0.00418	<0.00418	<0.00418	<0.00418	<0.00418	<0.00418	<0.00418	<0.00418
	2 - 8	7/22/03	<0.00408	<0.00408	<0.00408	<0.00408	<0.00408	<0.00408	<0.00408	<0.00408	<0.00408	<0.00408	<0.00408	<0.00408	<0.00408	<0.00408	<0.00408	<0.00408	<0.00408	<0.00408
	22 - 23.5	7/22/03	<0.00384	<0.00384	0.01150	<0.00384	<0.00384	<0.00384	<0.00384	<0.00384	<0.00384	<0.00384	<0.00384	0.07870	<0.00384	<0.00384	0.00730	0.06030	<0.00384	0.59600
SB-24	0 - 2	7/21/03	<0.00411	<0.00411	<0.00411	0.00535	0.01030	0.00617	0.00823	0.00494	0.00299 J	<0.00411	<0.00411	<0.00411	0.00988	<0.00411	<0.00411	<0.00411	<0.00411	<0.00411
	2 - 8	7/21/03	<0.00412	<0.00412	0.00577	<0.00412	<0.00412	<0.00412	<0.00412	<0.00412	<0.00412	<0.00412	<0.00412	0.01490	<0.00412	0.05970	0.03050	0.01070	<0.00412	0.11500
	10 - 12	7/21/03	<0.00408	<0.00408	<0.00408	<0.00408	<0.00408	<0.00408	<0.00408	<0.00408	<0.00408	<0.00408	<0.00408	<0.00408	<0.00408	0.00530	0.03350	<0.00408	<0.00408	0.00205 J
SB-25	0 - 2	7/21/03	<0.00420	<0.00420	<0.00420	<0.00420	<0.00420	<0.00420	<0.00420	<0.00420	<0.00420	<0.00420	<0.00420	<0.00420	<0.00420	<0.00420	<0.00420	<0.00420	<0.00420	<0.00420
	2 - 8	7/21/03	<0.00409	<0.00409	<0.00409	<0.00409	<0.00409	<0.00409	<0.00409	<0.00409	<0.00409	<0.00409	<0.00409	<0.00409	<0.00409	<0.00409	0.00409	<0.00409	<0.00409	0.03680
TMW/SB-26	0 - 2	7/17/03	<0.00414	<0.00414	<0.00414	<0.00414	<0.00414	<0.00414	<0.00414	<0.00414	<0.00414	<0.00414	<0.00414	0.02770	<0.00414	0.20900	0.11200	0.02730	<0.00414	0.25200
	2 - 8	7/17/03	<0.00397	<0.00397	<0.00397	<0.00397	<0.00397	<0.00397	<0.00397	<0.00397	<0.00397	<0.00397	<0.00397	<0.00397	<0.00397	0.05910	0.02860	0.00555	<0.00397	0.04680

TABLE 9 (Continued)
SOIL ANALYTICAL RESULTS FOR PAH
Former PQS Etowah Terminal
1015 Barlow Drive
Charleston, West Virginia

Sample Identification			PAH Parameters																	
Sample Location	Depth (Feet)	Date	Acenaphthene (mg/kg)	Acenaphthylene (mg/kg)	Anthracene (mg/kg)	Benzo(a) anthracene (mg/kg)	Benzo(a) pyrene (mg/kg)	Benzo(b)fluoranthene (mg/kg)	Benzo(ghi) perylene (mg/kg)	Benzo(k)fluoranthene (mg/kg)	Chrysene (mg/kg)	Dibenz(ah)-anthracene (mg/kg)	Fluoranthene (mg/kg)	Fluorene (mg/kg)	Indeno(123-cd)pyrene (mg/kg)	2-Methylnaphthalene (mg/kg)	Naphthalene (mg/kg)	Phenanthrene (mg/kg)	Pyrene (mg/kg)	1-Methyl naphthalene (mg/kg)
Table 60-3B - Industrial			38,000	NE	390,000	29	2.9	29	NE	290	2,900	2.9	30,000	33,000	29	NE	190	NE	54,000	NE
TMW/BG-1	0 - 2	7/16/03	<0.00406	<0.00406	<0.00406	<0.00406	<0.00406	<0.00406	<0.00406	<0.00406	<0.00406	<0.00406	<0.00406	<0.00406	<0.00406	<0.00406	<0.00406	<0.00406	<0.00406	<0.00406
	2 - 8	7/16/03	<0.00405	<0.00405	<0.00405	<0.00405	<0.00405	<0.00405	<0.00405	<0.00405	<0.00405	<0.00405	<0.00405	<0.00405	<0.00405	<0.00405	<0.00405	<0.00405	<0.00405	<0.00405
	10 - 12	7/16/03	<0.00402	<0.00402	<0.00402	<0.00402	<0.00402	<0.00402	<0.00402	<0.00402	<0.00402	<0.00402	<0.00402	<0.00402	<0.00402	<0.00402	<0.00402	<0.00402	<0.00402	<0.00402
TMW/BG-2	0 - 2	7/16/03	<0.00429	<0.00429	<0.00429	<0.00429	<0.00429	<0.00429	<0.00429	<0.00429	<0.00429	<0.00429	<0.00429	<0.00429	<0.00429	<0.00429	<0.00429	<0.00429	<0.00429	<0.00429
	2 - 8	7/16/03	<0.00408	<0.00408	<0.00408	<0.00408	<0.00408	<0.00408	<0.00408	<0.00408	<0.00408	<0.00408	<0.00408	0.01060	<0.00408	<0.00408	<0.00408	<0.00408	<0.00408	<0.00408
	14 - 16	7/16/03	<0.00396	<0.00396	<0.00396	<0.00396	<0.00396	<0.00396	<0.00396	<0.00396	<0.00396	<0.00396	<0.00396	<0.00396	<0.00396	<0.00396	<0.00396	<0.00396	<0.00396	<0.00396
TMW/SB-16 FS	14 - 16	7/15/03	<0.00370	<0.00370	0.0555	<0.00370	<0.00370	<0.00370	<0.00370	<0.00370	0.0193	<0.00370	<0.00370	0.271	<0.00370	<0.00370	<0.00370	0.279	0.0193	2.22
SB-21 FS	2 - 8	7/22/03	<0.00422	<0.00422	<0.00422	<0.00422	<0.00422	<0.00422	<0.00422	<0.00422	<0.00422	<0.00422	<0.00422	<0.00422	<0.00422	<0.00422	<0.00422	<0.00422	<0.00422	<0.00422

VOC - volatile organic compounds
SVOC - semivolatile organic compounds
TPH - total petroleum hydrocarbons
DRO - diesel range organics
GRO - gasoline range organics
ORO - oil range organics
PAH - polynuclear aromatic hydrocarbons

mg/kg - milligrams per kilogram
NE - not established
NS - analyte was not analyzed
FS - field split
J - analyte below practical quantitation limit
< - less than the following laboratory method detection limit.
Table 60-3B De Minimis - De Minimus Levels from West Virginia De Minimis Levels for Soil and Groundwater (revised January, 2002)
(a) - West Virginia Department of Environmental Protection Draft De Minimis Levles in Soil and Groundwater for TPH

TABLE 10
SOIL ANALYTICAL RESULTS FOR SOLVENTS AND METALS
Former PQS Etowah Terminal
1015 Barlow Drive
Charleston, West Virginia

Sample Identification			Metals				Solvents																
					Chromium																		
Sample Location	Depth (Feet)	Date	Cadmium (mg/kg)	Lead (mg/kg)	hexavalent (mg/kg)	trivalent (mg/kg)	Acetone (mg/kg)	2-Butanone (mg/kg)	Carbon disulfide (mg/kg)	Carbon tetrachloride (mg/kg)	Chlorobenzene (mg/kg)	1,2-Dichlorobenzene (mg/kg)	Isobutyl alcohol (mg/kg)	Methylene chloride (mg/kg)	Tetrachloroethene (mg/kg)	1,1,1-Trichloroethane (mg/kg)	1,1,2-Trichloroethane (mg/kg)	Trichloroethene (mg/kg)	Cyclohexanone (mg/kg)	Trichlorofluoromethane (mg/kg)	n-Butanol (mg/kg)	Methanol (mg/kg)	2-Ethoxyethanol (mg/kg)
Table 60-3B - Industrial			810	1,000	660	1,000,000	6,200	28,000.0	1,200.0	5.300	540	3,300	77,000.0	210.0	190.0	3,200	19.00	61.0	1,000,000	1,300	88,000	440,000	350,000
SB-5	0 - 2	7/15/03	<1.25	21.0	<2.61	27.0	0.0356 J	<0.0490	0.00411	<0.0020	<0.0020	<0.0020	<0.0131	0.0027 J	<0.0020	<0.0020	<0.0020	<0.0020	<0.00653	<0.0020	<0.00980	<13.1	<26.1
	2 - 8	7/15/03	<1.30	19.7	<2.66	45.6	0.0219 J	<0.0447	0.00483	<0.0017	<0.0017	<0.0017	<0.0133	0.0036 J	<0.0017	<0.0017	<0.0017	<0.0017	<0.00665	<0.0017	<0.00894	<13.3	<26.6
SB-6	0 - 2	7/15/03	<1.06	11.7	<2.24	18.1	0.04680	<0.0404	0.00460	<0.0016	<0.0016	<0.0016	<0.0112	0.0031 J	<0.0016	<0.0016	<0.0016	<0.0016	<0.00559	<0.0016	<0.00808	<11.2	<22.4
	2 - 8	7/15/03	<1.37	17.2	<2.80	37.2	0.08130	<0.0538	<0.00215	<0.0021	<0.0021	<0.0021	<0.0140	0.0046 J	<0.0021	<0.0021	<0.0021	<0.0021	<0.00699	<0.0021	<0.0108	<14.0	<28.0
TMW/SB-7 S & D	0 - 2	7/15/03	<1.16	195	<2.36	32.6	0.21500	0.0406 J	0.00393	<0.0017	<0.0017	<0.0017	<0.0118	0.0024 J	<0.0017	<0.0017	<0.0017	<0.0017	<0.00590	<0.0017	<0.00855	<11.8	<23.6
	2 - 4	7/15/03	<1.20	26.5	<2.44	34.8	0.10300	0.0211 J	0.00648	<0.0020	<0.0020	<0.0020	<0.0122	<0.0048	<0.0020	<0.0020	<0.0020	<0.0020	<0.00611	<0.0020	<0.00954	<12.2	<24.4
	34 - 36	7/23/03	<1.11	7.36	3.14	7.34	0.0226 J	<0.0476	<0.00190	<0.0019	<0.0019	<0.0019	<0.0112	<0.0047	<0.0019	<0.0019	<0.0019	<0.0019	<0.00561	<0.0019	<0.00951	<11.2	<22.4
SB-6 FS	2 - 8	7/15/03	<1.16	14.3	<2.41	31.8	0.07970	<0.0473	<0.00189	<0.0019	<0.0019	<0.0019	<0.0120	0.0041 J	<0.0019	<0.0019	<0.0019	<0.0019	<0.00602	<0.0019	<0.00946	<12.0	<24.1

mg/kg - milligrams per kilogram

J - analyte below practical quantitation limit

Table 60-3B De Minimis - De Minimus Levels from West Virginia De Minimis Levels for Soil and Groundwater (revised January, 2002)

< - less than the following laboratory method detection limit.

NE - not established

NS - analyte was not analyzed

Dup - Duplicate

S - spike recovery outside accepted recovery limits

* - Resample for broken bottle for TPH DRO and ORO analyses collected on 8/27/02.

TABLE 11
SURFACE SOIL ANALYTICAL RESULTS FOR TCLP LEAD
Former PQS Etowah Terminal
1015 Barlow Drive
Charleston, West Virginia

Sample Identification			TCLP Lead (mg/L)
Sample Location	Depth (Feet)	Date	
SS-1	0 - 0.5	7/18/03	<0.500
SS-2	0 - 0.5	7/18/03	0.570
SS-3	0 - 0.5	7/18/03	<0.500
SS-4	0 - 0.5	7/18/03	3.05
SS-5	0 - 0.5	7/18/03	<0.500
SS-6	0 - 0.5	7/18/03	<0.500
SS-4 Field Split	0 - 0.5	7/18/03	2.94

TCLP - toxicity characteristic leaching procedure.
SS - surface soil sample
mg/kg - milligrams per kilogram

TABLE 12
GROUNDWATER ANALYTICAL RESULTS
Former PQS Etowah Terminal
1015 Barlow Drive
Charleston, West Virginia

Sample Identification		VOC Parameters					Metals		TPH		
Sample Location	Date	Benzene (mg/L)	Ethyl-benzene (mg/L)	Toluene (mg/L)	Total Xylenes (mg/L)	MTBE (mg/L)	Total Lead (mg/L)	Dissolved Lead (mg/L)	GRO (mg/L)	DRO (mg/L)	ORO (mg/L)
Table 60-3B - De Minimis		0.005	1.300	1.000	10.000	0.020 (b)	NE	0.015	1.500 (a)	0.330 (a)	0.610 (a)
SB-UMW-6	8/15/03	<0.001	<0.001	<0.001	<0.001	<0.01	NS	<0.005	0.117	0.121	0.106
TMW/SB-2S	8/15/03	0.0012	<0.001	<0.001	0.0058	0.0137	NS	NS	0.159	1.56	0.260
SB-2/MW-5	8/15/03	<0.001	<0.001	<0.001	<0.001	<0.01	NS	<0.005	<0.100	<0.100	0.121
TMW/SB-3S	8/15/03	0.322	0.150	0.003	0.262	0.014	NS	Due to insufficient recovery within 24 hours following purging, analysis of other parameters (besides VOCs) was not possible.			
TMW/SB-3D	8/15/03	<0.001	<0.001	<0.001	<0.001	<0.001	NS	NS	<0.100	<0.100	0.157
SB-4/MW-4	8/15/03	<0.001	<0.001	<0.001	<0.001	<0.01	NS	<0.005	<0.100	<0.100	0.145
TMW/SB-7S	8/15/03	0.07	0.0051	0.008	0.0496	1.230	NS	NS	1.51	8.90	5.92
TMW/SB-7D	Due to the presence of liquid-phase hydrocarbons, a groundwater sample was not collected.										
SB-10/MW-1	8/15/03	<0.001	<0.001	<0.001	<0.001	<0.001	NS	<0.005	<0.100	0.129	0.367
TMW/SB-11	8/15/03	<0.001	<0.001	<0.001	<0.001	0.0106	NS	NS	0.153	Due to insufficient recovery within 24 hours following purging, analysis of other parameters (besides VOCs and TPH-GRO) was not possible.	
TMW/SB-12	8/15/03	<0.001	<0.001	<0.001	<0.001	<0.001	NS	<0.005	<0.100	21.0	10.8
TMW/SB-13	8/15/03	<0.001	<0.001	<0.001	<0.001	<0.001	NS	<0.005	<0.100	0.647	0.353
TMW/SB-14	8/15/03	<0.001	<0.001	<0.001	<0.001	<0.001	NS	<0.005	<0.100	0.853	0.402
SB-15/MW-2	8/15/03	<0.001	<0.001	<0.001	<0.001	0.0012	NS	<0.005	<0.100	<0.100	0.143
TMW/SB-15	8/15/03	0.001	0.0015	0.0017	0.0043	0.001	NS	0.05	1.38	18.4	5.80
TMW/SB-17	8/15/03	0.0035	<0.001	0.0014	<0.001	<0.001	NS	0.04	1.26	17.7	2.10
TMW/SB-18	Due to insufficient recharge within 24 hours following purging, a groundwater sample was not collected.										
SB-19/MW-3	8/15/03	<0.001	<0.001	<0.001	<0.001	<0.001	NS	<0.005	<0.100	1.54	0.248
TMW/SB-20	8/15/03	<0.001	<0.001	<0.001	<0.001	<0.001	NS	<0.005	<0.100	2.89	<0.500
TMW/SB-22	8/15/03	<0.001	<0.001	<0.001	<0.001	<0.001	NS	<0.005	0.877	2.04	<0.200
TMW/SB-23	8/15/03	0.0688	0.0036	0.0041	0.0044	0.0023	NS	NS	2.83	30.0	<2.50
TMW/SB-26	Due to insufficient recharge within 24 hours following purging, a groundwater sample was not collected.										
MW-T	8/15/03	<0.001	<0.001	<0.001	<0.001	<0.01	NS	<0.005	<0.100	0.705	0.14
TMW/BG-1	8/15/03	<0.001	<0.001	<0.001	<0.001	0.0051	NS	NS	<0.100	Due to insufficient recovery within 24 hours following purging, analysis of other parameters (besides VOCs and TPH-GRO) was not possible.	
TMW/BG-2	8/15/03	<0.001	<0.001	<0.001	<0.001	<0.01	NS	<0.005	<0.100	0.325	0.288
NS-1	9/11/03	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0050	<0.0050	<0.100	<0.100	0.118
NS-2	9/11/03	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0050	<0.0050	<0.100	<0.100	<0.100
NS-3	9/11/03	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0050	<0.0050	<0.100	<0.100	<0.100
NS-4	9/11/03	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0050	<0.0050	<0.100	<0.100	<0.100
NS-5	9/11/03	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0050	<0.0050	<0.100	<0.100	<0.100
E-1	9/11/03	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0050	<0.0050	<0.100	<0.100	<0.100
E-2	9/11/03	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0050	<0.0050	<0.100	<0.100	<0.100
E-3	9/11/03	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0050	<0.0050	<0.100	<0.100	<0.100
E-4	9/11/03	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0050	0.0030 J	<0.100	<0.100	<0.100
E-5	9/11/03	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0050	<0.0050	<0.100	0.785	1.40
E-6	9/11/03	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0050	<0.0050	<0.100	<0.100	<0.100
E-7	9/11/03	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0050	<0.0050	<0.100	0.118	0.235
E-8	9/11/03	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0050	<0.0050	<0.100	<0.100	<0.100
E-8	9/11/03	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0050	<0.0050	<0.100	<0.100	<0.100
E-9	9/11/03	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0050	<0.0050	<0.100	<0.100	<0.100
E-10	9/11/03	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0050	<0.0050	<0.100	<0.100	<0.100
E-11	9/11/03	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0050	0.0040 J	<0.100	<0.100	<0.100
E-12	9/11/03	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0050	<0.0050	<0.100	<0.100	<0.100
E-13	9/11/03	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0050	<0.0050	<0.100	<0.100	<0.100
E-14	9/11/03	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0032 J	<0.0050	<0.100	<0.100	<0.100
E-15	9/11/03	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0050	<0.0050	<0.100	<0.100	<0.100
NS-4 DUP	9/11/03	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0050	<0.0050	<0.100	<0.100	0.206
SB-2/MW-5 DUP	8/15/03	<0.001	<0.001	<0.001	<0.001	<0.001	NS	<0.005	<0.100	0.108	<0.100
TMW/SB-22 DUP	8/15/03	<0.001	<0.001	<0.001	<0.001	<0.01	NS	<0.005	0.822	3.70	<0.500

Sample Location	PAH Parameters																	
	Acenaph-thene (mg/L)	Acenaph-thylene (mg/L)	Anthra-cene (mg/L)	Benzo(a) anthracene (mg/L)	Benzo(a) pyrene (mg/L)	Benzo(b)flu-oranthene (mg/L)	Benzo(ghi) perylene (mg/L)	Benzo(k)flu-oranthene (mg/L)	Chry-sene (mg/L)	Dibenz(ah)-anthracene (mg/L)	Fluoro-anthene (mg/L)	Fluorene (mg/L)	Indeno(123-cd)pyrene (mg/L)	2-Methyl Naphthalene (mg/L)	Naph-thalene (mg/L)	Phenan-threne (mg/L)	Pyrene (mg/L)	1-Methyl Naphthalene (mg/L)
Table 60-3B - De Minimis	0.370	NE	1.800	0.000091	0.0002	0.000091	NE	0.00091	0.0091	0.0000091	1.500	0.240	0.000091	NE	0.0062	NE	0.180	NE
SB-UMW-6	Not analyzed for PAH Parameters																	
TMW/SB-2S	0.00065	0.00027	0.00032	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	0.00132	<0.00010	0.04210	0.00348	0.00186	0.00011	0.03780
SB-2/MW-5	Not analyzed for PAH Parameters																	
TMW/SB-3S																		
TMW/SB-3D	Not analyzed for PAH Parameters																	
SB-4/MW-4	Not analyzed for PAH Parameters																	
TMW/SB-7S	Due to insufficient recharge within 24 hours following purging, analysis for PAH parameters was not possible.																	
TMW/SB-7D																		
SB-10/MW-1	Not analyzed for PAH Parameters																	
TMW/SB-11																		
TMW/SB-12	0.00110	0.00028	0.00025	<0.00010	<0.00010	<0.00010	0.00021	<0.00010	0.00027	<0.00010	<0.00010	0.00123	0.00021	<0.00010	0.00037	0.00033	0.00119	0.00559
TMW/SB-13	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
TMW/SB-14	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
SB-15/MW-2	Not analyzed for PAH Parameters																	
TMW/SB-15	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	0.00071
TMW/SB-17	<0.00010	0.00067	0.00026	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	0.00180	<0.00010	<0.00010	<0.00010	0.00134	<0.00010	0.0410
TMW/SB-18																		
SB-19/MW-3	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	0.00052
TMW/SB-20	0.00045	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	0.00025
TMW/SB-22	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	0.00018	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	0.00066
TMW/SB-23	Due to insufficient recharge within 24 hours following purging, analysis for PAH parameters was not possible.																	
TMW/SB-26																		
MW-T	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
TMW/BG-1																		
TMW/BG-2	Not analyzed for PAH Parameters																	
NS-1	Not analyzed for PAH Parameters																	
NS-2	Not analyzed for PAH Parameters																	
NS-3	Not analyzed for PAH Parameters																	
NS-4	Not analyzed for PAH Parameters																	
NS-5	Not analyzed for PAH Parameters																	
E-1	Not analyzed for PAH Parameters																	
E-2	Not analyzed for PAH Parameters																	
E-3	Not analyzed for PAH Parameters																	
E-4	Not analyzed for PAH Parameters																	
E-5	Not analyzed for PAH Parameters																	
E-6	Not analyzed for PAH Parameters																	
E-7	Not analyzed for PAH Parameters																	
E-8	Not analyzed for PAH Parameters																	
E-8	Not analyzed for PAH Parameters																	
E-9	Not analyzed for PAH Parameters																	
E-10	Not analyzed for PAH Parameters																	
E-11	Not analyzed for PAH Parameters																	
E-12	Not analyzed for PAH Parameters																	
E-13	Not analyzed for PAH Parameters																	
E-14	Not analyzed for PAH Parameters																	
E-15	Not analyzed for PAH Parameters																	
NS-4 DUP	Not analyzed for PAH Parameters																	
SB-2/MW-5 DUP	Not analyzed for PAH Parameters																	
TMW/SB-22 DUP	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	0.00014	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	0.00040

VOC - volatile organic compounds
PAH - polynuclear aromatic hydrocarbons
TPH - total petroleum hydrocarbons
DRO - diesel range organics
GRO - gasoline range organics
ORO - oil range organics
Table 60-3B De Minimis - De Minimus Levels from West Virginia De Minimis Levels for Soil and Groundwater (revised January, 2002)
(a) - West Virginia Department of Environmental Protection Draft De Minimis Levles in Soil and Groundwater for TPH
Analytes detected above the Table 60-3B Groundwater De Minimis levels are shaded.

< - less than the following laboratory method detection limit.
NE - not established
NS - analyte was not analyzed
Dup - Duplicate
mg/L - milligrams per liter
J - analyte below practical quantitation limit
S - spike recovery outside accepted recovery limits
* - Resample for broken bottle for TPH DRO and ORO analyses collected on 8/27/03.

TABLE 12a
GROUNDWATER ANALYTICAL RESULTS FOR TOTAL PAH
Former PQS Etowah Terminal
1015 Barlow Drive
Charleston, West Virginia

Sample Identification		PAH Parameters																			
Sample Location	Date	Acenaph-thene (mg/L)	Acenaph-thylene (mg/L)	Anthra-cene (mg/L)	* **Benzo(a) anthracene (mg/L)**	* **Benzo(a) pyrene (mg/L)**	* **Benzo(b)flu-oranthene (mg/L)**	Benzo(ghi) perylene (mg/L)	* **Benzo(k)flu-oranthene (mg/L)**	* **Chry-sene (mg/L)**	* **Dibenz(ah)-anthracene (mg/L)**	Fluoro-anthene (mg/L)	Fluorene (mg/L)	* **Indeno(123-cd)pyrene (mg/L)**	2-Methyl Naphthalene (mg/L)	Naph-thalene (mg/L)	Phenan-threne (mg/L)	Pyrene (mg/L)	1-Methyl Naphthalene (mg/L)	Total PAH (mg/L)	Total Carcenogenic PAH (mg/L)
Table 60-3B - De Minimis		0.370	NE	1.800	**0.000091**	**0.0002**	**0.000091**	NE	**0.00091**	**0.0091**	**0.0000091**	1.500	0.240	**0.000091**	NE	0.0062	NE	0.180	NE	NE	NE
TMW/SB-2S	8/15/03	0.00085	0.00027	0.00032	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	0.00132	<0.00010	0.04210	0.00348	0.00186	0.00011	0.03780	0.08856	0.00035
TMW/SB-12	8/15/03	0.00110	0.00028	0.00025	<0.00010	<0.00010	<0.00010	0.00021	<0.00010	0.00027	<0.00010	<0.00010	0.00123	0.00021	<0.00010	0.00037	0.00033	0.00119	0.00559	0.01100	0.00051
TMW/SB-13	8/15/03	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	0.00090	0.00035
TMW/SB-14	8/15/03	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	0.00090	0.00035
TMW/SB-16	8/15/03	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	0.00071	0.00156	0.00035
TMW/SB-17	8/15/03	<0.00010	0.00067	0.00026	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	0.00180	<0.00010	<0.00010	<0.00010	0.00134	<0.00010	0.0410	0.04572	0.00035
SB-19/MW-3	8/15/03	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	0.00052	0.00137	0.00035
TMW/SB-20	8/15/03	0.00045	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	0.00025	0.00155	0.00035
TMW/SB-22	8/15/03	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	0.00018	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	0.00066	0.00164	0.00035
MW-7	8/15/03	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	0.00090	0.00035
TMW/SB-22 DUP	8/15/03	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	0.00014	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	0.00040	0.00134	0.00035

< - less than the following laboratory method detection limit.

NE - not established

PAH - polynuclear aromatic hydrocarbons

Dup - Duplicate

mg/L - milligrams per liter

* **Carcenogenic PAH**

Table 60-3B De Minimis - De Minimus Levels from West Virginia De Minimis Levels for Soil and Groundwater (revised January, 2002)

(a) - West Virginia Department of Environmental Protection Draft De Minimis Levies in Soil and Groundwater for TPH

Analytes detected above the Table 60-3B Groundwater De Minimis levels are shaded.

Total concentrations were calculated by summing constituent concentrations. Nondetect concentrations were summed using half of their respective method detection limit.

Table 13
Liquid Level Gauging Data (August 14, 2003)
Former PQS Etowah Terminal
1015 Barlow Drive
Charleston, West Virginia

Location	Casing Diameter (Inches)	TOC Elevation (Feet)	Depth to Product (Feet)	Depth to Water (Feet)	LPH Thickness (Feet)	Corrected Groundwater Elevation (Feet)
MW-1	2	79.27	ND	15.84	<0.01	63.43
MW-2	2	79.84	ND	16.36	<0.01	63.48
MW-3	2	80.93	ND	17.37	<0.01	63.56
MW-4	2	100.16	ND	25.64	<0.01	74.52
MW-5	2	100.89	ND	37.47	<0.01	63.42
MW-6	2	102.14	ND	15.82	<0.01	86.32
MW-7	2	99.40	ND	35.82	<0.01	63.58
TMW/SB-2S	1	103.27	ND	3.03	<1.00	100.24
TMW/SB-3S	1	100.94	ND	11.28	<1.00	89.66
TMW/SB-3D	1	100.86	ND	28.20	<1.00	72.66
TMW/SB-7S	1	102.44	ND	7.54	<1.00	94.90
TMW/SB-7D	1	102.41	39.05	39.74	0.69	62.15
TMW/SB-11	1	78.35	ND	13.91	<1.00	64.44
TMW/SB-12	1	76.90	ND	4.40	<1.00	72.50
TMW/SB-13	1	78.47	ND	15.09	<1.00	63.38
TMW/SB-14	1	77.27	ND	13.86	<1.00	63.41
TMW/SB-16	1	79.84	ND	16.41	<1.00	63.43
TMW/SB-17	1	79.81	ND	16.32	<1.00	63.49
TMW/SB-18	1	80.02	ND	15.00	<1.00	65.02
TMW/SB-20	1	77.67	ND	14.20	<1.00	63.47
TMW/SB-22	1	101.37	ND	20.52	<1.00	80.85
TMW/SB-23	1	105.09	ND	27.05	<1.00	78.04
TMW/SB-26	1	100.38	ND	23.35	<1.00	77.03
TMW/BG-1	1	102.47	ND	15.71	<1.00	86.76
TMW/BG-2	1	104.48	ND	16.38	<1.00	88.10

TOC - top of casing

LPH - liquid-phase hydrocarbons

MW - monitoring well

ND - not detected

NM - not measured

Notes:

1. Elevations are in feet based on an arbitrary on-site datum of 100.00 feet.
2. The elevation of MW-7 has not been surveyed. The total depth of MW-7 is 40.00 feet with 10.00 feet of screen.
3. Unconfined groundwater aquifer data are unshaded and perched groundwater data are shown in blue.
4. Average depth to water below TOC: 18.65 Feet

Table 14
Liquid-Phase Hydrocarbons Recovery
Former PQS Etowah Terminal
1015 Barlow Drive
Charleston, West Virginia

Monitoring Well	Date	Depth to LPH (Feet)	Depth to Water (Feet)	LPH Thickness (Feet)	LPH Recovery (Gallons)
TMW/SB-7D	8/14/03	39.05	39.74	0.69	0.00
	8/29/02	39.72	40.41	0.69	0.02
	9/4/03	39.35	40.41	1.06	0.04
	9/12/03	39.00	40.72	1.72	0.13*
	Abandoned TMW/SB-7D and replaced with 4-inch diameter MW-8 on 10/15/03				
	Total Gallons LPH Recovered From TMW/SB-7D:				0.19
MW-8	10/16/03	NA	39.57	NA	0.00
(Replaced TMW/SB-7D)	10/21/03	NA	39.41	NA	0.00*
	10/31/03	NA	39.37	NA	0.00
	Total Gallons LPH Recovered To Date:				0.00
Total Gallons LPH Recovered Sitewide:					0.19

LPH - Liquid-Phase Hydrocarbons
TMW/SB - temporary monitoring well/soil boring
NA - not applicable (LPH not detected)
LPH was first observed in TMW/SB-7D on 8/14/03.
* Estimated recovery during high vacuum mobile treatment unit event.

TABLE 15
ANALYTICAL RESULTS FOR EQUIPMENT AND TRIP BLANKS
Former PQS Etowah Terminal
1015 Barlow Drive
Charleston, West Virginia

Sample Identification			VOC Parameters					Metals	TPH		
Sample Location	Depth (Feet)	Date	Benzene (mg/L)	Ethyl-benzene (mg/L)	Toluene (mg/L)	Total Xylenes (mg/L)	MTBE (mg/L)	Lead (mg/L)	GRO (mg/L)	DRO (mg/L)	ORO (mg/L)
SB-1 EB	18 - 20	7/17/03	<0.0020	<0.0020	0.0011 J	<0.0020	<0.0020	<0.0030	<0.100	0.117	<0.100
SB-20 EB	14 - 16	7/21/03	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0030	<0.100	0.125	0.108
SB-23 EB	22 - 23.5	7/22/03	<0.001	<0.001	<0.001	<0.001	<0.001	<0.003	<0.100	<0.131	<0.100
SB-26 EB	20 - 22	7/23/03	<0.001	<0.001	<0.001	<0.001	<0.001	<0.003	<0.100	0.118	<0.100
NS-5 EB	0 - 0.5	9/11/03	<0.001	<0.001	0.0007 J	<0.001	<0.001	<0.0050	<0.100	0.210	0.148
TB-1	NA	7/14/03	<0.001	<0.001	0.0009 J	<0.001	<0.001	NS	NS	NS	NS
TB-2	NA	7/15/03	<0.001	<0.001	<0.001	<0.001	<0.001	NS	NS	NS	NS
TB-3	NA	7/16/03	<0.001	<0.001	0.0009 J	<0.001	<0.001	NS	NS	NS	NS
TB-4	NA	7/17/03	<0.001	<0.001	<0.001	<0.001	<0.001	NS	NS	NS	NS
TB-5	NA	7/21/03	<0.002	<0.002	<0.002	<0.002	<0.002	NS	NS	NS	NS
TB-6	NA	7/22/03	<0.001	<0.001	<0.001	<0.001	<0.001	NS	NS	NS	NS
TB-7	NA	7/23/03	<0.001	<0.001	<0.001	<0.001	<0.001	NS	NS	NS	NS
TB-8	NA	8/15/03	<0.001	<0.001	<0.001	<0.001	<0.001	NS	NS	NS	NS

Sample Location	PAH Parameters																			
	Acenaph-thene (mg/L)	Acenaph-thylene (mg/L)	Anthra-cene (mg/L)	Benzo(a) anthracene (mg/L)	Benzo(a) pyrene (mg/L)	Benzo(b)flu-oranthene (mg/L)	Benzo(ghi) perylene (mg/L)	Benzo(k)flu-oranthene (mg/L)	Chry-sene (mg/L)	Dibenz(ah)-anthracene (mg/L)	Fluoro-anthene (mg/L)	Fluorene (mg/L)	Indeno(123-cd)pyrene (mg/L)	2-Methyl-naphthalene (mg/L)	Naph-thalene (mg/L)	Phenan-threne (mg/L)	Pyrene (mg/L)	1-Methyl naphthalene (mg/L)
SB-1 EB	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	0.00026	<0.00010	<0.00010	<0.00010
SB-20 EB	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	0.00025	0.00035	<0.00010	<0.00010	0.00018
SB-23 EB	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
SB-26 EB	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
NS-5 EB	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
TB-1	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
TB-2	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
TB-3	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
TB-4	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
TB-5	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
TB-6	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
TB-7	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
TB-8	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

VOC - volatile organic compounds
PAH - polynuclear aromatic hydrocarbons
TPH - total petroleum hydrocarbons
NE - not established
NS - analyte was not analyzed
FS - field split
NA - not applicable
mg/kg - milligrams per kilogram

GRO - gasoline range organics
DRO - diesel range organics
ORO - oil range organics
MTBE - methyl tertiary butyl ether
mg/kg - milligrams per kilogram
B - detected in method blank
< - analyte was not detected at the referenced method detection limit
Analytes detected at more than one times the method detection limit above the method detection limit are shaded.

TABLE 16
SURFACE WATER ANALYTICAL RESULTS
Former PQS Etowah Terminal
1015 Barlow Drive
Charleston, West Virginia

Sample Identification		PAH Parameters													
Sample Location	Date	Acenaph-thene (mg/L)	Anthra-cene (mg/L)	Benzo(a) anthracene (mg/L)	Benzo(a) pyrene (mg/L)	Benzo(b)flu-oranthene (mg/L)	Benzo(k)flu-oranthene (mg/L)	Chry-sene (mg/L)	Dibenz(ah)-anthracene (mg/L)	Fluoro-anthene (mg/L)	Fluorene (mg/L)	Indeno(123-cd)pyrene (mg/L)	Naph-thalene (mg/L)	Pyrene (mg/L)	Total PAHs (mg/L)
Water Quality Standards		Surface Water Quality Standard for PAH = 0.000031								0.370	Surface Water Quality Standard for PAH = 0.000031				
E-2	6/15/04	<0.0000035	<0.0000056	0.000019 JB	<0.000003	<0.0000017	<0.0000027	0.000022 J	<0.0000016	<0.0000037	<0.000018	<0.0000046	0.000023 JB	0.000023 J	0.0000870
E-2 DUP (ED)	6/15/04	0.0000086 J	<0.0000056	0.000018 JB	<0.000003	0.000027 J	0.000027 J	0.00002 J	0.00004 J	0.000027 J	<0.000018	0.000061 J	0.00002 JB	0.000021 J	0.0002696
E-5	6/15/04	0.0000085 J	<0.0000056	0.000019 JB	<0.000003	0.000027 J	0.000027 J	0.00002 J	0.000041 J	0.000027 J	<0.000018	0.000062 J	0.000021 JB	0.000021 J	0.0002735
E-7	6/15/04	<0.0000035	<0.0000056	0.000019 JB	0.000025 J	0.000028 J	0.000029 J	0.000022 J	0.000043 J	0.000026 J	<0.000018	<0.0000046	0.000017 JB	0.000021 J	0.0002300

PAH - polynuclear aromatic hydrocarbons

< - less than the following laboratory method detection limit.

DUP (ED) - Duplicate

mg/L - milligrams per liter

J - estimated concentration of analyte below practical quantitation limit

B - laboratory blank contamination problem associated with the analysis.

Water Quality Standards - Surface Water Quality Standards from 46 CSR 1, Appendix E Table 1.

Total PAH concentrations above the Surface Water Quality Standard of 0.000031 mg/L are shaded yellow.

APPENDIX B

GROUNDWATER MODELING PARAMETERS AND RESULTS

APPENDIX B

Soil Leaching and Groundwater Fate and Transport Analysis
Former PQS Etowah Terminal
1015 Barlow Drive
Charleston, West Virginia

Introduction

Volatile organic compounds (VOCs), semi- volatile organic compounds (SVOCs), total petroleum hydrocarbon (TPH) fractions and the metal Lead have been detected in the soil and groundwater beneath the Former Pennzoil Quaker State Etowah Terminal exceeding the applicable West Virginia Department of Environmental Protection (WVDEP) De Minimis criteria regulatory standards. The terminal is located on 1015 Barlow Drive in Charleston, West Virginia. Soil leaching and groundwater fate and transport models were prepared to determine the migration of the VOC, SVOC, metal and TPH chemicals of potential concern (COPCs) from soil to groundwater, and delineate the spatial extent and the persistence of dissolved COPCs in groundwater. Model inputs, procedures and results are presented in this report.

Based on the analysis of the soil samples collected in August 2003, one VOC (Benzene), one SVOC (Naphthalene) and a metal constituent (Lead) have been documented in the soil beneath the facility at concentrations that exceed the WVDEP De Minimis levels for soil to groundwater migration. However, the soil impacted with Lead is being proposed for removal action. Therefore, Lead was eliminated as a chemical of potential concern (COPC) for the purposes of soil leaching and groundwater transport analysis.

VOCs Benzene and MTBE were measured in groundwater at concentrations exceeding the WVDEP De Minimis level for groundwater. TPH fractions – GRO (Gasoline Range Organics), DRO (Diesel Range Organics) and ORO (Oil Range Organics) were also detected in groundwater at concentrations exceeding the WVDEP De Minimis levels for groundwater. A dissolved metal – Lead was also measured in site groundwater in exceedance of the De Minimis level. In addition, SVOC Naphthalene was retained for evaluation as a potential candidate for groundwater fate and transport analysis.

MTBE exceedences of WVDEP groundwater De Minimis level in groundwater were documented only at one location at the facility – at TWM/SB-7S. Groundwater at this location was encountered under perched conditions. In September 2003, a recovery action was undertaken at this location. TWM/SB-7S was later abandoned and replaced by monitoring well MW-8. Groundwater sampling at MW-8 indicates that MTBE is no longer present at this location. Therefore MTBE was eliminated as a COPC for the purposes of groundwater fate and transport analysis.

In summary, a total of two COPCs were selected for soil leaching analysis. Six COPCs were selected for groundwater fate and transport analysis. These are listed below:

COPCs for Soil to Groundwater Leaching Evaluation

- Benzene
- Naphthalene

COPCs for Groundwater Fate and Transport Evaluation

- Naphthalene
- TPH – GRO
- TPH – DRO
- TPH – ORO
- Benzene
- Lead

Available Data

Several soil borings and monitoring wells have been installed at the facility. Groundwater elevation data, and soil and groundwater analytical results for the period June 2001 and October 2003 were reported in Additional Site Characterization Report prepared by Shaw Environmental, Inc. (Shaw) in November 2003. The shallow subsurface beneath the facility consists of fill material approximately 4 to 12 feet thick, underlain by silty, clayey fine to medium sand with occasional gravel lenses. Perched groundwater conditions exist in vicinity of TMW/SB-7S&D, SB-9, TMW/SB-2S&D and TMW/SB-3S&D. Based on analytical results from site investigations, it appears that the majority of the soil COPC mass is within the shallow silty, clayey sand units, while the COPCs dissolved in groundwater are primarily in the unconfined aquifer underlying the perched water table.

Prior to preparation of the model, additional data was acquired based on (slug) testing conducted in August 2004. Saturated hydraulic conductivity values were obtained from the slug tests conducted at monitoring wells MW-3, MW-5 and MW-8. The average hydraulic conductivity of the silty clayey sand unit representing the saturated zone was 5.9×10^{-4} cm/sec.

Groundwater elevation data from August 2003 monitoring event was used to determine the site wide hydraulic gradient and the groundwater flow direction. The average site wide hydraulic gradient was 0.12 feet/feet, and groundwater flow was generally directed west towards the Elk River.

Soil Leachate Modeling

A vadose zone leaching model - VLEACH (Varadhan and Johnson, USEPA, 1997) was used to assess the potential groundwater impacts related to COPCs present in the soil. VLEACH is a one-dimensional, finite difference model used for making assessments of the effects on ground water from the leaching of volatile, sorbed contaminants through the vadose zone. The program models four main processes: liquid-phase advection, solid-phase sorption, vapor-phase diffusion, and three-phase equilibration. In an individual run, VLEACH can simulate leaching in a number of distinct polygons, which may differ in terms of soil properties, recharge rates, depth of water, or initial conditions. VLEACH can account for heterogeneities laterally but not vertically. VLEACH modeling results in an overall, area-weighted assessment of ground-water impact.

The site soil analytical data were evaluated to determine the locations where soil leachate may be expected to impact groundwater. As shown in **Table 1**, 5 areas (polygons) were selected for VLEACH modeling of Benzene and one area was selected for Naphthalene. Soil concentrations that were greater than the WVDEP De Minimis levels for soil to groundwater migration were used to define the areas for VLEACH modeling.

The input parameters for VLEACH models for Benzene and Naphthalene are provided in **Tables 2a** through **2b**. Model input parameters were developed using site-specific data or estimated values from the literature. Results of VLEACH modeling are tabulated in **Tables 3a** through **3b**. The highest leachate concentrations for Benzene are predicted to occur over the next 10 to 30 years and range from 5 ug/L at TMW/SB-14 to 48 ug/L at TMW/SB-26. The WVDEP De Minimis level for Benzene in groundwater is 5 ug/L. Naphthalene leachate concentrations are expected to be 5 ug/L or less, which are less than the groundwater De Minimis level of 6.2 ug/L for Naphthalene.

Groundwater Fate and Transport Modeling

Fate and transport analysis of TPH constituents GRO, DRO and ORO were conducted using the highest measured source terms in groundwater. In addition, fate and transport for DRO was also conducted using a high source term in close vicinity of the Elk River.

The soil based source term were added to the highest measured dissolved groundwater concentrations to develop combined source terms for groundwater modeling of Benzene. Naphthalene was not detected in site groundwater, and since the soil leachate source term is less than the WVDEP groundwater De Minimis level, Naphthalene was eliminated from consideration as a groundwater COPC.

The fate and transport of the TPH and Benzene constituents were evaluated using the USEPA model BIOSCREEN, version 1.4. BIOSCREEN is a screening model that simulates the fate and transport of dissolved hydrocarbons at petroleum fuel release sites. The model is based on the Domenico analytical solute transport equations, and has the ability to simulate advection, dispersion, adsorption, and biodegradation.

Input parameters that were used to construct the models and the rationale for selecting parameter values are listed in **Tables 4** through **7**. The BIOSCREEN models were run to predict the future concentrations distributions of the COPCs in groundwater over the next 30 years.

The concentration distributions of the TPH-GRO along the centerline of the plume axis originating from TMW/SB-23 (highest concentration source term – 2830 ug/L) are shown for the next 15 years on **Figures 1** through **3**. TPH-GRO concentrations at TMW/SB-23 are expected to decline rapidly and be less than the WVDEP groundwater De Minimis level of 1500 ug/L within the next 5 years (by 2009). As shown in **Figure 1**, the highest concentration of TPH-GRO is predicted to be 239 ug/L in 2009 (approximately 80 feet down gradient from the current source at TMW/SB-23 and approximately 20 feet upgradient of Elk River). In 2014, the highest concentration of TPH-GRO is predicted to be 2 ug/L, and is expected to be located at the site-Elk river boundary (**Figure 2**). By 2019, the TPH-GRO concentrations are expected to diminish to be non-detect levels in the site groundwater.

The concentration distributions of the TPH-DRO along the centerline of the plume axis originating from highest concentration source term at TMW/SB-23 (30,000 ug/L) are shown for the next 30 years on **Figures 4** through **9**. TPH-DRO concentrations at TMW/SB-23 are expected to decline gradually and persist at levels higher than the WVDEP groundwater De Minimis level of 330 ug/L over the next 30 years (through 2034). As shown in **Figure 4**, the highest concentration of TPH-GRO is predicted to be 27,430 ug/L in 2009, located at the current source (TMW/SB-23) which is approximately 100 feet upgradient of Elk River. The TPH-DRO plume, as defined by TPH-DRO concentrations exceeding the groundwater De Minimis level of 330 ug/L, is predicted to extend in 2009 to a distance of approximately 75 feet down gradient from the current highest source at TMW/SB-23 and approximately 25 feet upgradient of Elk River. By 2014, TPH-DRO plume extends from the TMW/SB-23 source to the Elk River (**Figure 5**). The model predicts that TPH-DRO plume will extend from the TMW/SB-23 source to the Elk River between 2015 and 2034 (Figures **6** through **9**), with the center of plume mass gradually moving towards the Elk River.

The concentration distributions of the TPH-DRO along the centerline of the plume axis originating from high concentration source located near the Elk River (TMW/SB-12 (21,000 ug/L) are shown for the next 30 years on **Figures 10** through **15**. TPH-DRO concentrations at TMW/SB-12 are expected to decline gradually and persist at levels higher than the WVDEP groundwater De Minimis level of 330 ug/L over the next 30 years (through 2034). As shown in **Figure 10** the highest concentration of TPH-GRO is predicted to be 19,311 ug/L in 2009, located at the current source (TMW/SB-12) which is approximately 30 feet upgradient of Elk River. The TPH-DRO plume, as defined by TPH-DRO concentrations exceeding the groundwater De Minimis level of 330 ug/L, is predicted to extend to the Elk River over the next 30 years (**Figures 10** through **15**).

The concentration distributions of the TPH-ORO along the centerline of the plume axis originating from highest concentration source term at TMW/SB-12 (10,800 ug/L) are shown for the next 30 years on **Figures 16** through **21**. TPH-DRO concentrations at TMW/SB-23 are expected to decline gradually and persist at levels higher than the WVDEP groundwater De Minimis level of 610 ug/L over the next 30 years (through 2034). As shown in **Figure 16**, the highest concentration of TPH-GRO is predicted to be 7,032 ug/L in 2009, located at the current source (TMW/SB-12) which is approximately 30 feet upgradient of Elk River. The TPH-ORO plume, as defined by TPH-ORO concentrations exceeding the groundwater De Minimis level of 610 ug/L, is predicted to extend to the Elk River through 2034.

Benzene concentration distributions along the centerline of the plume axis originating from highest concentration source term of 71 ug/L (combined soil leachate and groundwater Benzene concentration in vicinity of TMW/SB-23) are shown for the next 10 years on **Figures 22** and **23**. Benzene concentrations at TMW/SB-23 are expected to decline rapidly and be less than the WVDEP groundwater De Minimis level of 5 ug/L within the next 5 years (by 2009). As shown in **Figure 22**, the highest concentration of Benzene is predicted to be 4 ug/L in 2009. By 2014, Benzene concentrations are expected to diminish to be non-detect levels in the site groundwater (**Figure 23**).

The concentration distributions of the dissolved Lead along the centerline of the plume axis originating from highest concentration source (50 ug/L at TMW/SB-16) are shown for the next 30 years on **Figures 24** through **29**. Lead concentrations at TMW/SB-16 are expected to decline gradually and persist at levels higher than the WVDEP groundwater De Minimis level of 15 ug/L over the next 20 years (through 2024). As shown in **Figure 24** the highest concentration of Lead is predicted to be 41 ug/L in 2009, located at the site boundary along the Elk River. The Lead plume, as defined by Lead concentrations exceeding the groundwater De Minimis level of 15 ug/L, is predicted to extend to the Elk River over the next 29 years. From 2029 and beyond, dissolved lead concentrations in site groundwater are expected to be less than the groundwater lead De Minimis level.

Dibenz(a,h)anthracene concentration distributions along the centerline of the plume axis originating from highest concentration source term of 130 ug/L at MW-8 are shown for the next 30 years on **Figures 30** and **35**. Dibenz(a,h)anthracene concentrations at MW-8 are expected to decline rapidly and be less than the WVDEP groundwater De Minimis level of 9.1 ug/L within the next 15 years (by 2019). However, due to the tendency of Dibenz(a,h)anthracene to adsorb to the soil, it is not expected to migrate beyond 5 ft from the source area.

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APPENDIX B

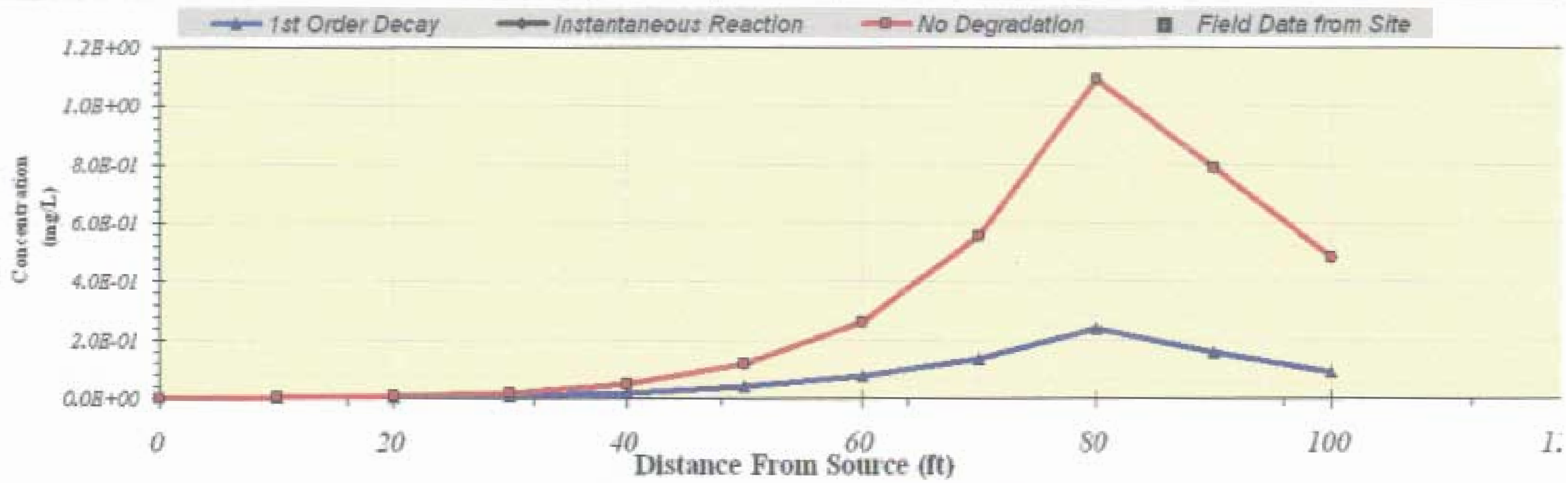
FIGURES

Figure 1
2009 Groundwater GRO Concentration Distribution Prediction
Downgradient of Source (TMW/SB-23)

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	10	20	30	40	50	60	70	80	90	100
No Degradation	0.001	0.003	0.008	0.020	0.049	0.116	0.263	0.557	1.090	0.789	0.482
1st Order Decay	0.001	0.002	0.005	0.010	0.020	0.039	0.075	0.137	0.239	0.158	0.090
Inst. Reaction	0.001	0.003	0.008	0.020	0.049	0.116	0.263	0.557	1.090	0.789	0.482
Field Data from Site											



Replay Animation | Next Timestep | Prev Timestep

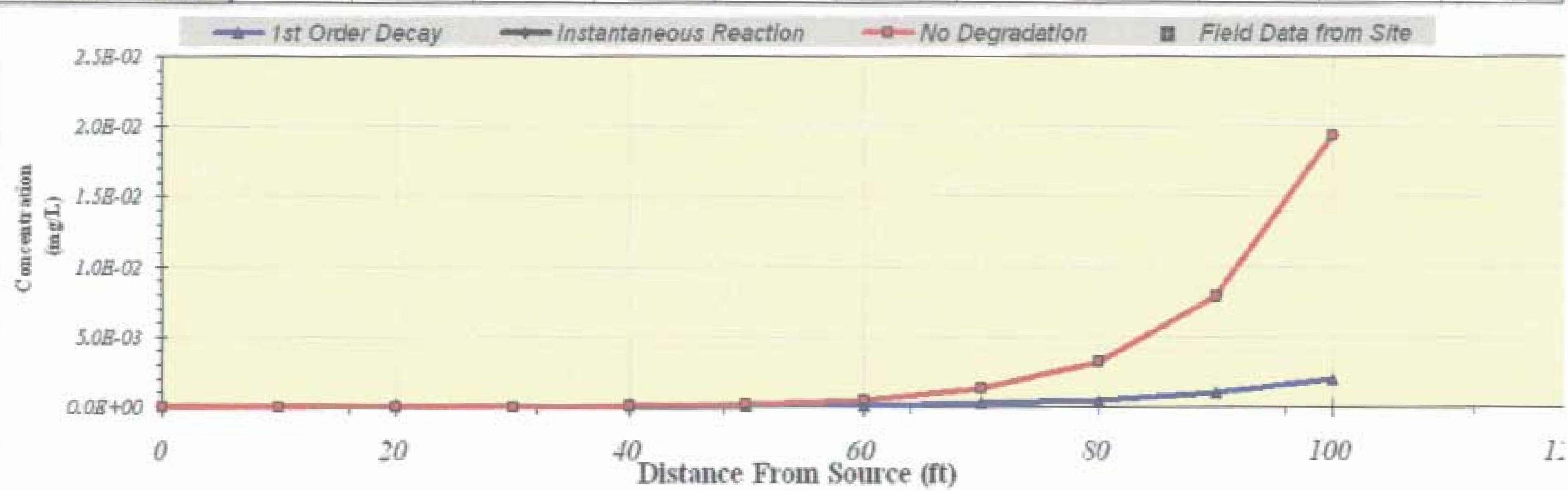
Time: 6.0 Years

Return to Input | Recalculate This Sheet

Figure 2
2014 Groundwater GRO Concentration Distribution Prediction
Downgradient of Source (TMW/SB-23)

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

	Distance from Source (ft)										
TYPE OF MODEL	0	10	20	30	40	50	60	70	80	90	100
No Degradation	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.003	0.008	0.019
1st Order Decay	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.002
Inst. Reaction	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.003	0.008	0.019
Field Data from Site											



Calculate Animation

Time: 11.0 Years

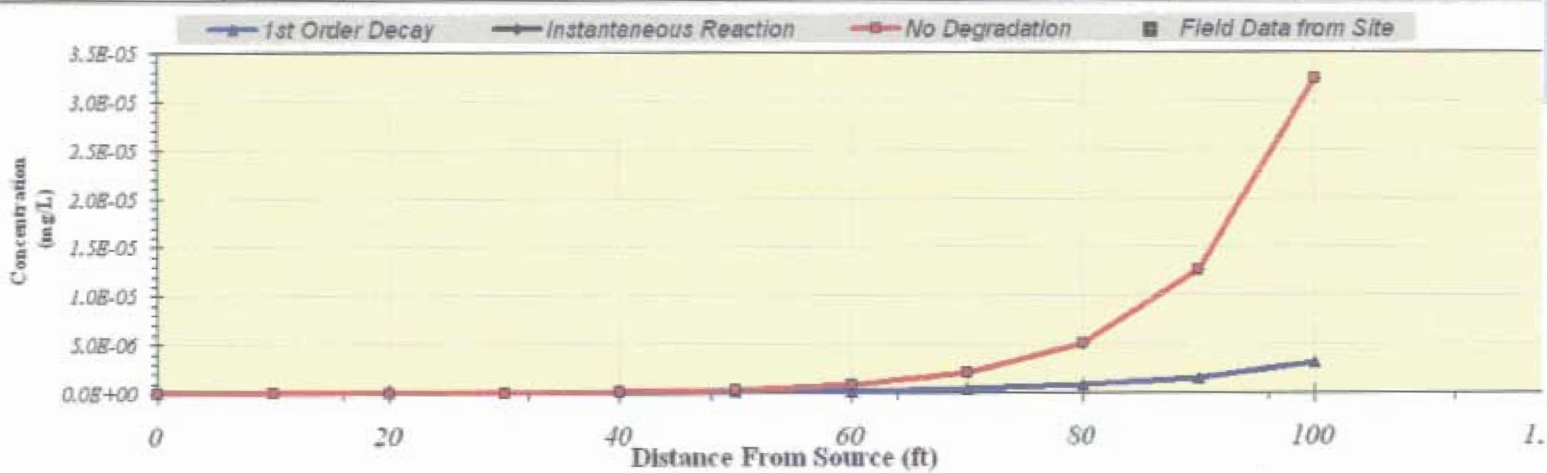
Return to Input

Recalculate This Sheet

Figure 3
2019 Groundwater GRO Concentration Distribution Prediction
Downgradient of Source (TMW/SB-23)

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

A	B	C	D	E	F	G	H	I	J	K	L
	Distance from Source (ft)										
TYPE OF MODEL	0	10	20	30	40	50	60	70	80	90	100
No Degradation	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1st Order Decay	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	0.000	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: 16.0 Years

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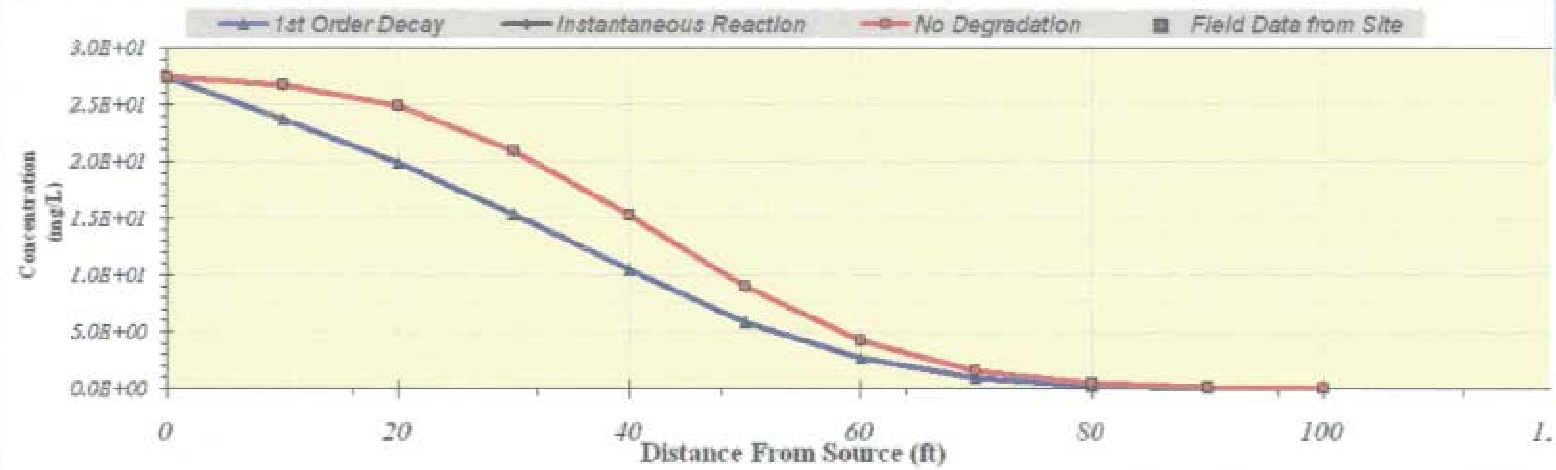
Recalculate This Sheet

Figure 4
2009 Groundwater DRO Concentration Distribution Prediction
Downgradient of Highest Source (TMW/SB-23)

O Bioscreen Model

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

	Distance from Source (ft)										
TYPE OF MODEL	0	10	20	30	40	50	60	70	80	90	100
No Degradation	27.430	26.720	24.915	20.987	15.225	8.933	4.192	1.539	0.436	0.094	0.015
1st Order Decay	27.430	23.738	19.866	15.346	10.432	5.839	2.649	0.950	0.264	0.056	0.009
Inst. Reaction	27.430	26.720	24.915	20.987	15.225	8.933	4.192	1.539	0.436	0.094	0.015
Field Data from Site											



Calculate Animation

Time:
6.0 Years

Return to Input

Recalculate This Sheet

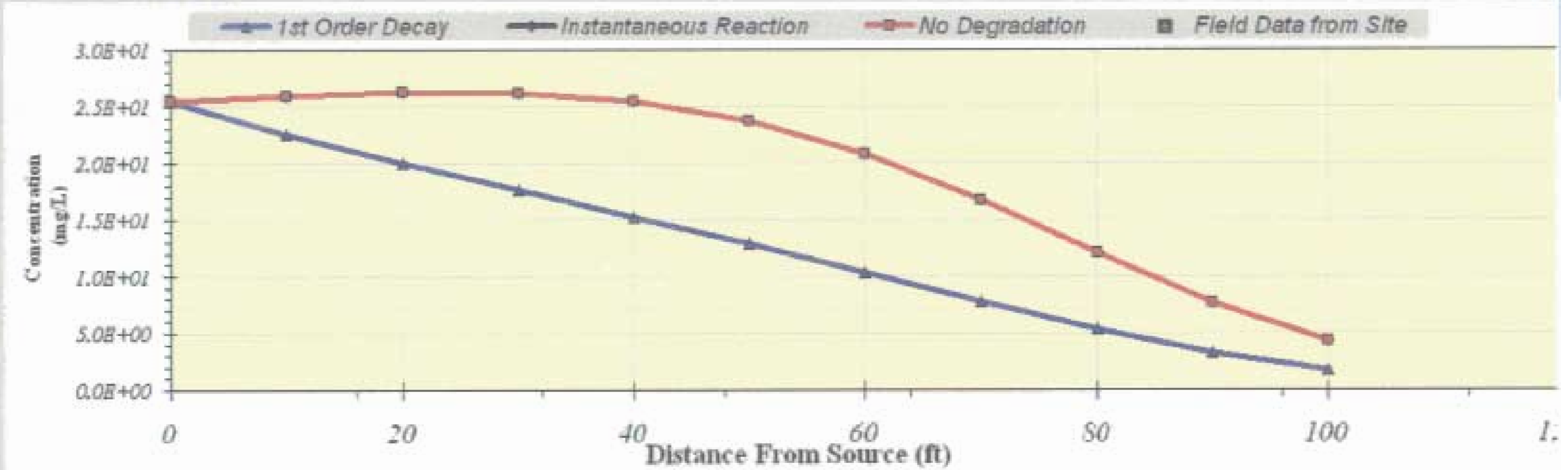
Figure 5
2014 Groundwater DRO Concentration Distribution Prediction
Downgradient of Highest Source (TMW/SB-23)

O Bioscreen Model

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	10	20	30	40	50	60	70	80	90	100
No Degradation	25.458	25.908	26.239	26.209	25.500	23.763	20.805	16.786	12.105	7.726	4.353
1st Order Decay	25.458	22.609	20.031	17.622	15.265	12.849	10.329	7.776	5.308	3.245	1.768
Inst. Reaction	25.458	25.908	26.239	26.209	25.500	23.763	20.805	16.786	12.105	7.726	4.353
Field Data from Site											



Time Chart Area
11.0 Years

Calculate Animation

Return to Input

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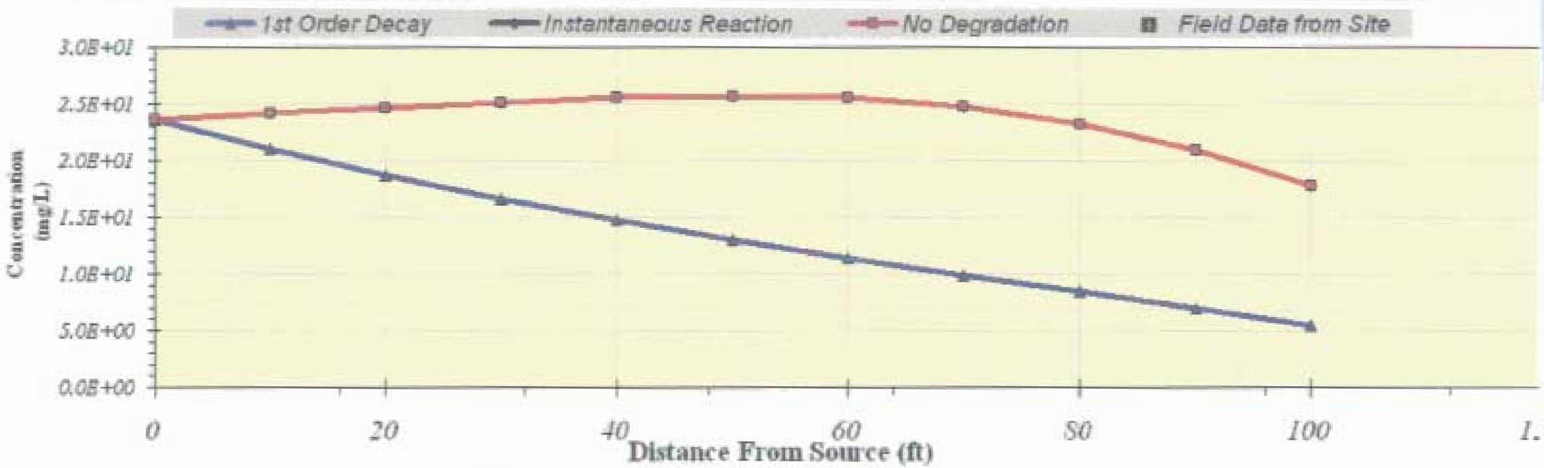
Figure 6
2019 Groundwater DRO Concentration Distribution Prediction
Downgradient of Highest Source (TMW/SB-23)

O Bioscreen Model

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

	Distance from Source (ft)										
TYPE OF MODEL	0	10	20	30	40	50	60	70	80	90	100
No Degradation	23.627	24.145	24.660	25.141	25.528	25.713	25.530	24.775	23.257	20.883	17.741
1st Order Decay	23.627	21.014	18.688	16.609	14.740	13.037	11.450	9.930	8.434	6.946	5.486
Inst. Reaction	23.627	24.145	24.660	25.141	25.528	25.713	25.530	24.775	23.257	20.883	17.741
Field Data from Site											



Calculate Animation

Time: 16.0 Years

Return to Input

Recalculate This Sheet

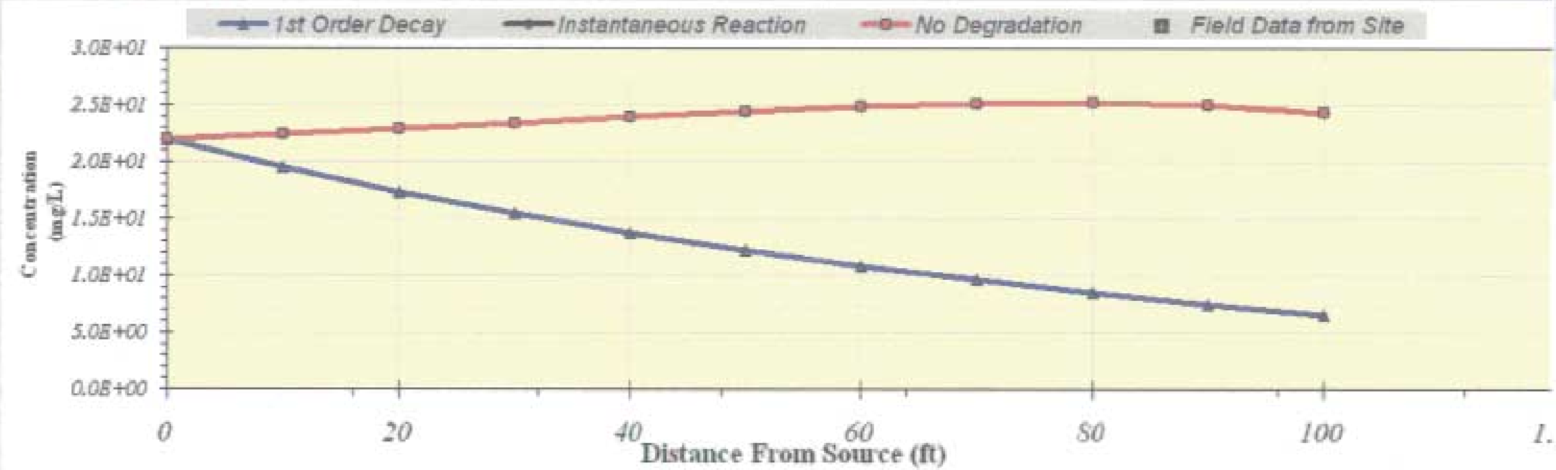
Figure 7
2024 Groundwater DRO Concentration Distribution Prediction
Downgradient of Highest Source (TMW/SB-23)

O Bioscreen Model

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	10	20	30	40	50	60	70	80	90	100
No Degradation	21.928	22.418	22.919	23.425	23.928	24.412	24.840	25.152	25.253	25.016	24.302
1st Order Decay	21.928	19.505	17.350	15.432	13.725	12.202	10.840	9.614	8.497	7.464	6.490
Inst. Reaction	21.928	22.418	22.919	23.425	23.928	24.412	24.840	25.152	25.253	25.016	24.302
Field Data from Site											



Calculate Animation

Time: 21.0 Years

Return to

Recalculate This

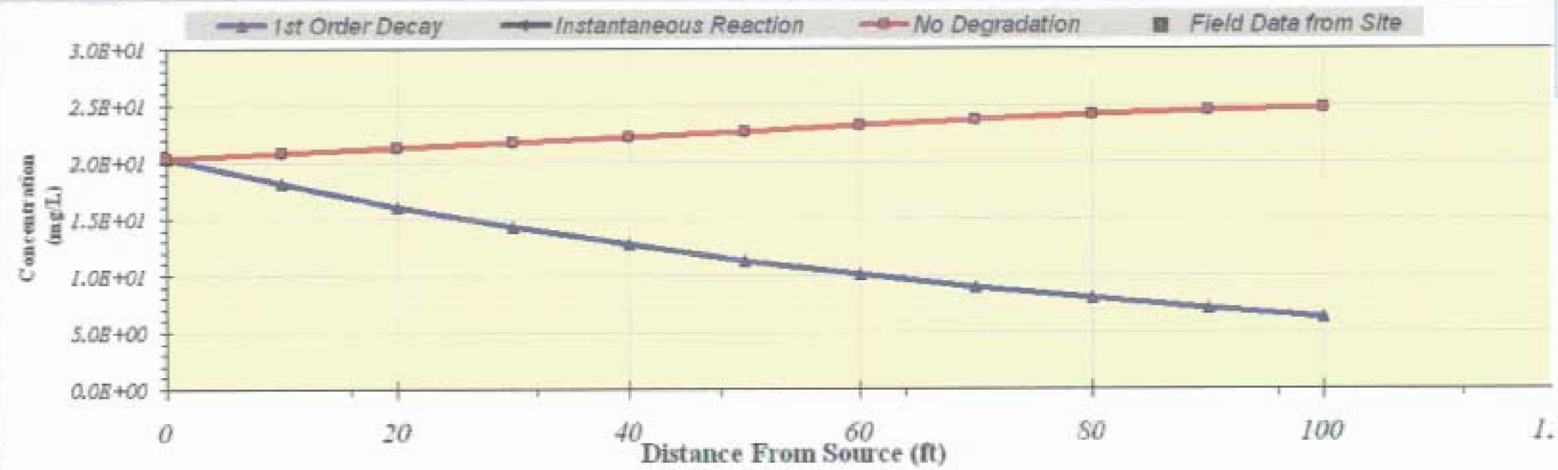
Figure 8
2029 Groundwater DRO Concentration Distribution Prediction
Downgradient of Highest Source (TMW/SB-23)

O Bioscreen Model

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	10	20	30	40	50	60	70	80	90	100
No Degradation	20.351	20.807	21.274	21.750	22.236	22.728	23.221	23.705	24.157	24.542	24.802
1st Order Decay	20.351	18.103	16.103	14.324	12.741	11.333	10.080	8.964	7.968	7.076	6.274
Inst. Reaction	20.351	20.807	21.274	21.750	22.236	22.728	23.221	23.705	24.157	24.542	24.802
Field Data from Site											



Calculate Animation

Time: 26.0 Years

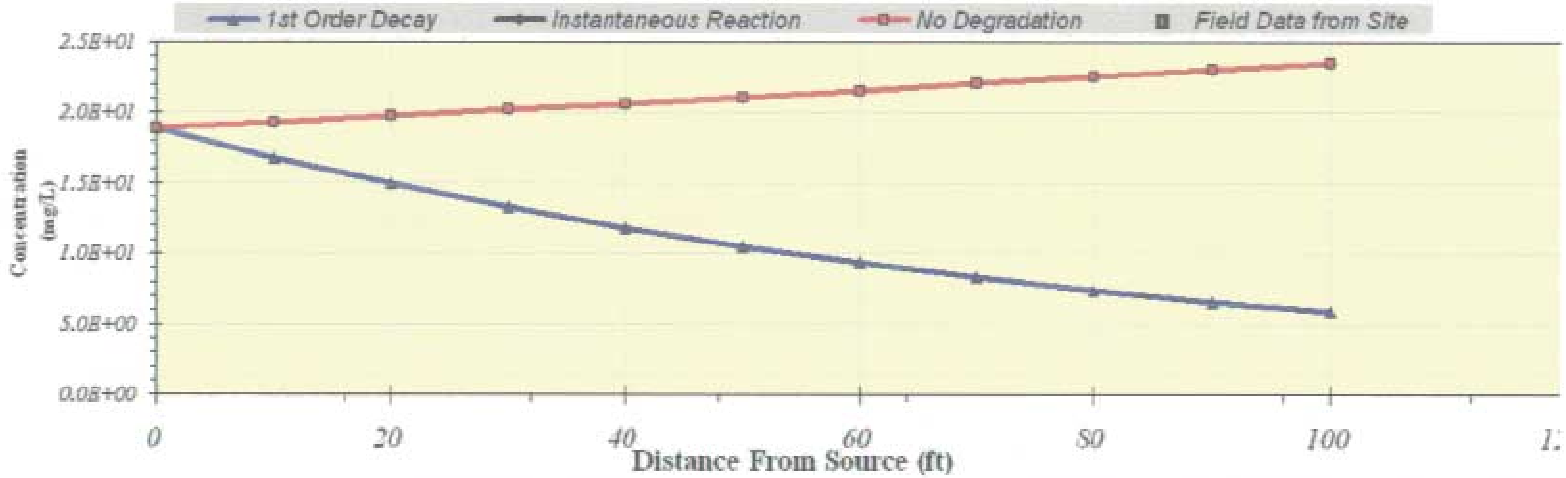
Return to Input

Recalculate This Sheet

Figure 9
2034 Groundwater DRO Concentration Distribution Prediction
Downgradient of Highest Source (TMW/SB-23)

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

	Distance from Source (ft)										
TYPE OF MODEL	0	10	20	30	40	50	60	70	80	90	100
No Degradation	18.887	19.311	19.744	20.187	20.640	21.102	21.574	22.052	22.535	23.015	23.479
1st Order Decay	18.887	16.801	14.945	13.294	11.825	10.519	9.357	8.323	7.403	6.584	5.854
Inst. Reaction	18.887	19.311	19.744	20.187	20.640	21.102	21.574	22.052	22.535	23.015	23.479
Field Data from Site											



Calculate Animation

Time:
31.0 Years

Return to Input

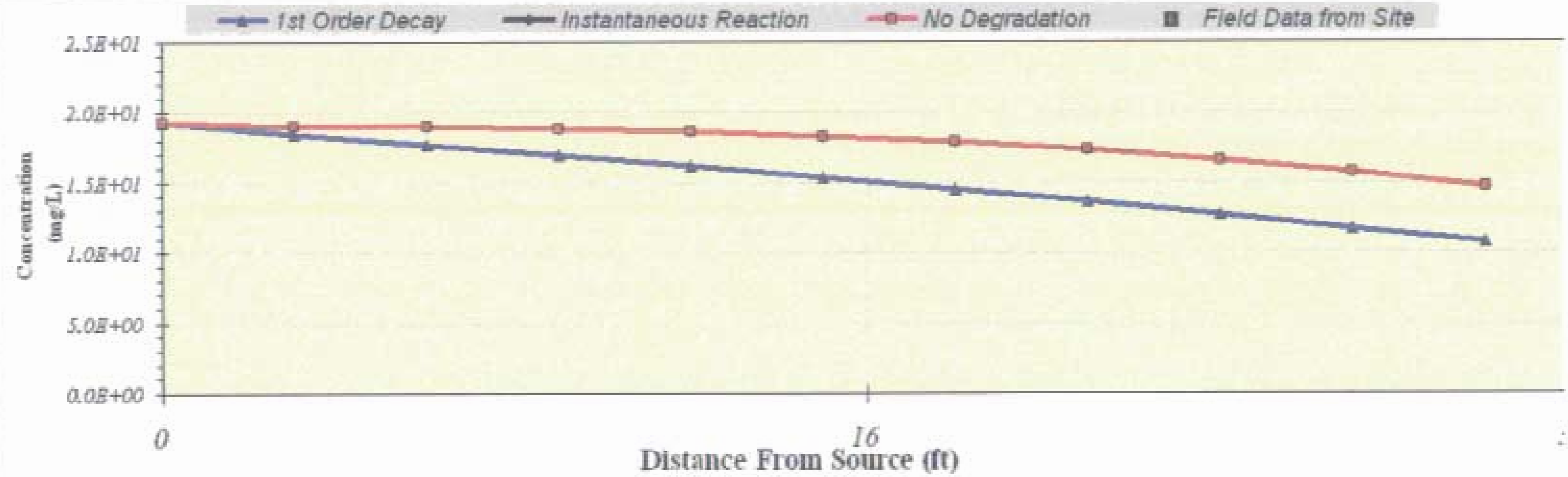
Recalculate This Sheet

Figure 10
2009 Groundwater DRO Concentration Distribution Prediction Downgradient of Source Near River Boundary (TMW/SB-12)

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	3	6	9	12	15	18	21	24	27	30
No Degradation	19.311	19.046	18.982	18.847	18.627	18.303	17.858	17.279	16.556	15.688	14.680
1st Order Decay	19.311	18.442	17.699	16.944	16.169	15.366	14.526	13.645	12.717	11.745	10.734
Inst. Reaction	19.311	19.046	18.982	18.847	18.627	18.303	17.858	17.279	16.556	15.688	14.680
Field Data from Site											



Calculate Animation

Time: 6.0 Years

Return to Input

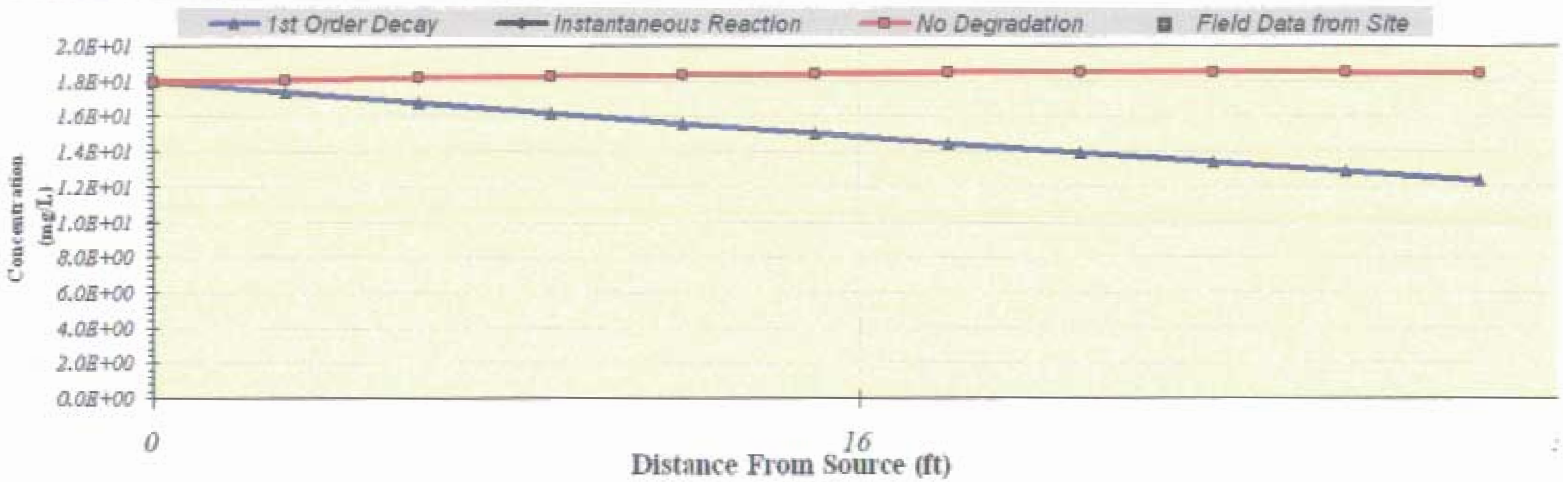
Recalculate This Sheet

Figure 11
2014 Groundwater DRO Concentration Distribution Prediction
Downgradient of Source Near River Boundary (TMW/SB-12)

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	3	6	9	12	15	18	21	24	27	30
No Degradation	18.008	18.085	18.182	18.272	18.354	18.425	18.480	18.513	18.519	18.490	18.420
1st Order Decay	18.008	17.368	16.756	16.164	15.588	15.029	14.484	13.950	13.424	12.903	12.385
Inst. Reaction	18.008	18.085	18.182	18.272	18.354	18.425	18.480	18.513	18.519	18.490	18.420
Field Data from Site											



Calculate Animation

Time: 11.0 Years

Return to Input

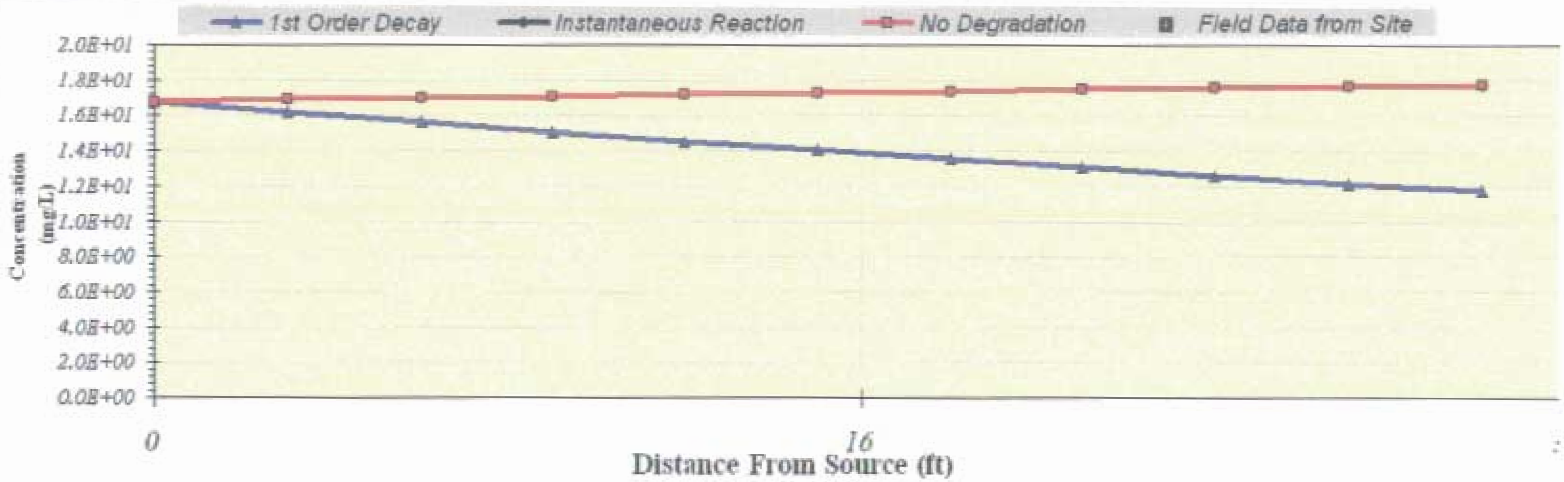
Recalculate This Sheet

Figure 12
2019 Groundwater DRO Concentration Distribution Prediction
Downgradient of Source Near River Boundary (TMW/SB-12)

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	3	6	9	12	15	18	21	24	27	30
No Degradation	16.792	16.894	16.998	17.102	17.205	17.308	17.409	17.506	17.597	17.681	17.754
1st Order Decay	16.792	16.205	15.639	15.093	14.565	14.055	13.562	13.085	12.621	12.169	11.729
Inst. Reaction	16.792	16.894	16.998	17.102	17.205	17.308	17.409	17.506	17.597	17.681	17.754
Field Data from Site											



Calculate Animation

Time: 16.0 Years

Return to Input

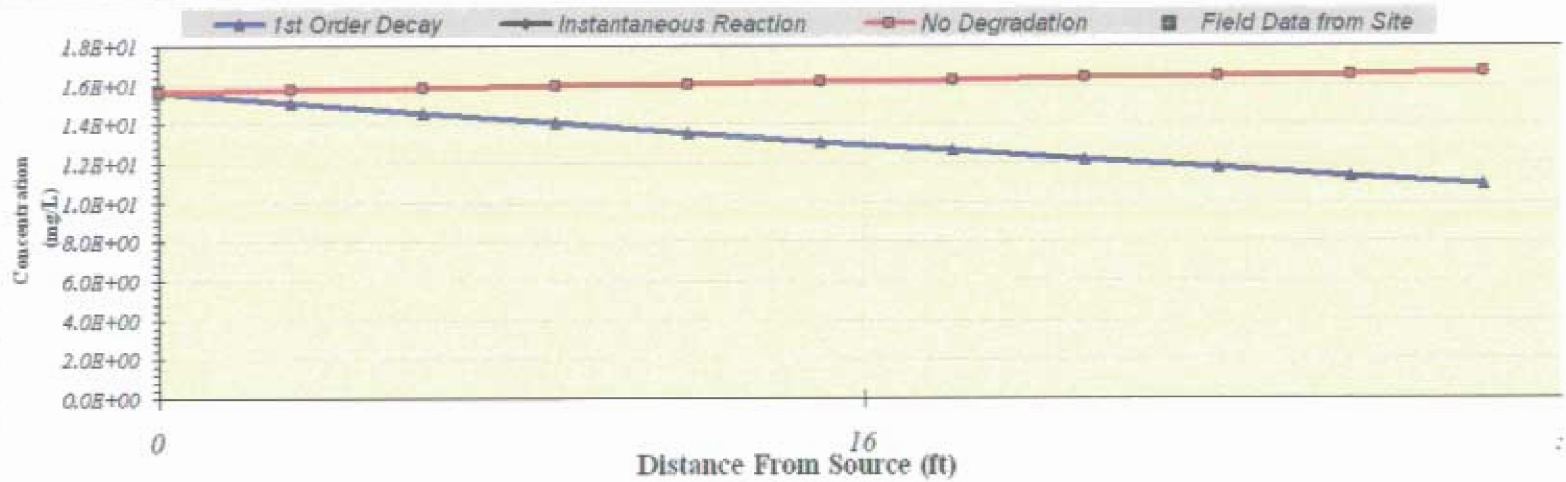
Recalculate This Sheet

Figure 13
2024 Groundwater DRO Concentration Distribution Prediction Downgradient of Source Near River Boundary (TMW/SB-12)

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	3	6	9	12	15	18	21	24	27	30
No Degradation	15.659	15.757	15.855	15.954	16.053	16.153	16.252	16.350	16.445	16.535	16.621
1st Order Decay	15.659	15.112	14.585	14.075	13.584	13.109	12.650	12.206	11.776	11.357	10.950
Inst. Reaction	15.659	15.757	15.855	15.954	16.053	16.153	16.252	16.350	16.445	16.535	16.621
Field Data from Site											



Calculate Animation

Time: 21.0 Years

Return to Input

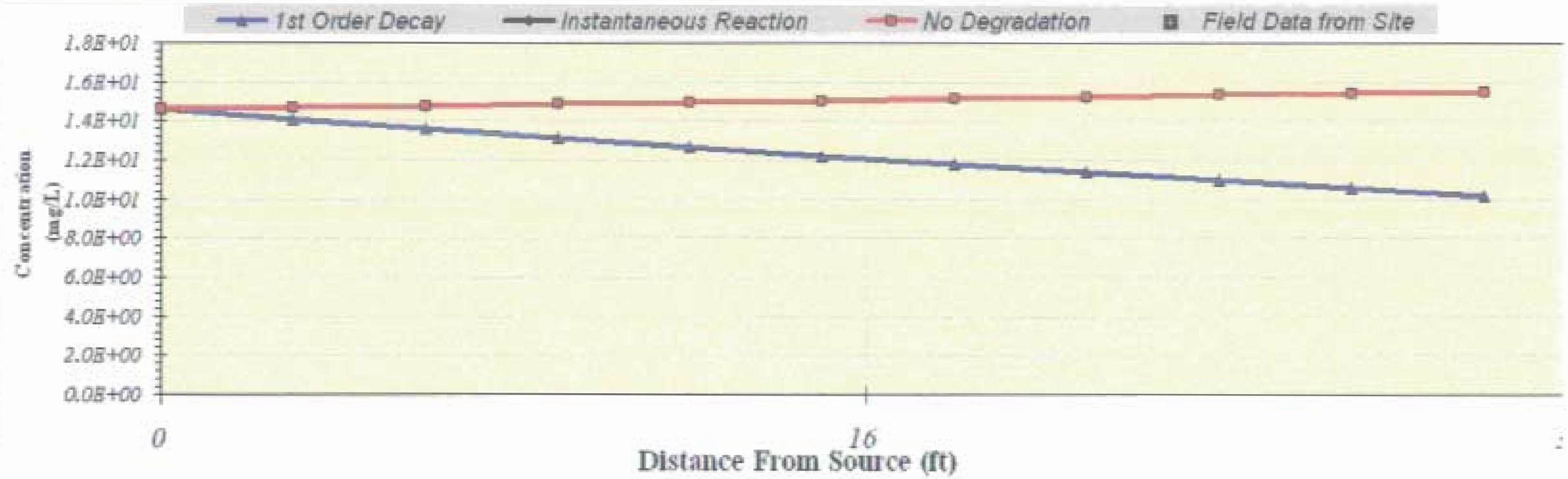
Recalculate This Sheet

Figure 14
2029 Groundwater DRO Concentration Distribution Prediction
Downgradient of Source Near River Boundary (TMW/SB-12)

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	3	6	9	12	15	18	21	24	27	30
No Degradation	14.602	14.694	14.785	14.878	14.971	15.064	15.157	15.249	15.339	15.425	15.506
1st Order Decay	14.602	14.092	13.600	13.125	12.667	12.225	11.797	11.383	10.981	10.591	10.212
Inst. Reaction	14.602	14.694	14.785	14.878	14.971	15.064	15.157	15.249	15.339	15.425	15.506
Field Data from Site											



Calculate Animation

Time: 26.0 Years

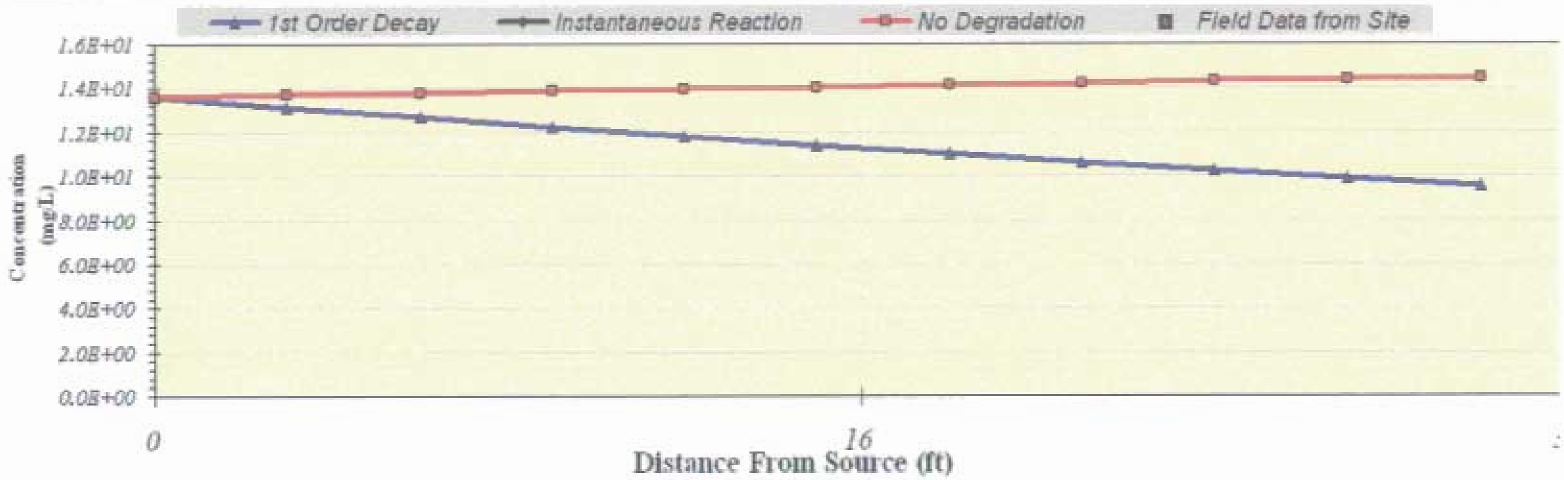
Return to Input

Recalculate This Sheet

Figure 15
2034 Groundwater DRO Concentration Distribution Prediction Downgradient of Source Near River Boundary (TMW/SB-12)

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

TYPE OF MODEL	Distance from Source (ft)										
	0	3	6	9	12	15	18	21	24	27	30
No Degradation	13.617	13.702	13.788	13.874	13.961	14.048	14.135	14.220	14.304	14.384	14.461
1st Order Decay	13.617	13.141	12.683	12.240	11.812	11.400	11.001	10.615	10.240	9.876	9.523
Inst. Reaction	13.617	13.702	13.788	13.874	13.961	14.048	14.135	14.220	14.304	14.384	14.461
Field Data from Site											



Calculate Animation

Time: 31.0 Years

Return to Input

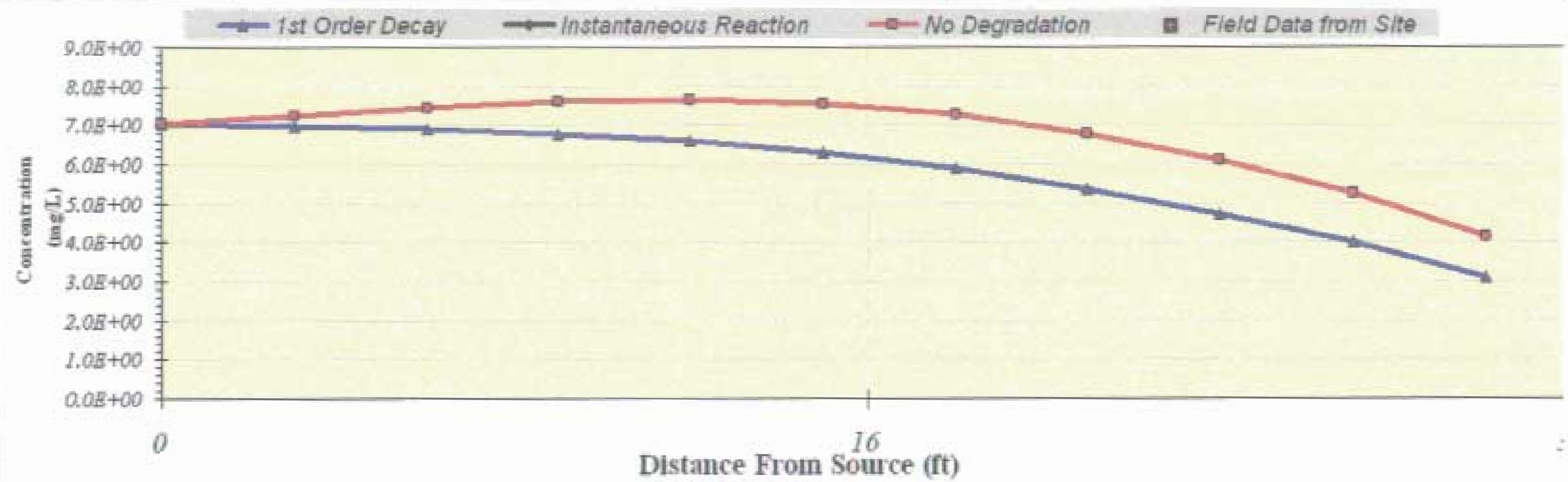
Recalculate This Sheet

Figure 16
2009 Groundwater ORO Concentration Distribution Prediction
Downgradient of Highest Source (TMW/SB-12)

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	3	6	9	12	15	18	21	24	27	30
No Degradation	7.032	7.234	7.465	7.623	7.668	7.562	7.274	6.788	6.116	5.264	4.156
1st Order Decay	7.032	6.964	6.904	6.789	6.596	6.303	5.895	5.368	4.734	4.001	3.109
Inst. Reaction	7.032	7.234	7.465	7.623	7.668	7.562	7.274	6.788	6.116	5.264	4.156
Field Data from Site											



Calculate Animation

Time: 6.0 Years

Return to Input

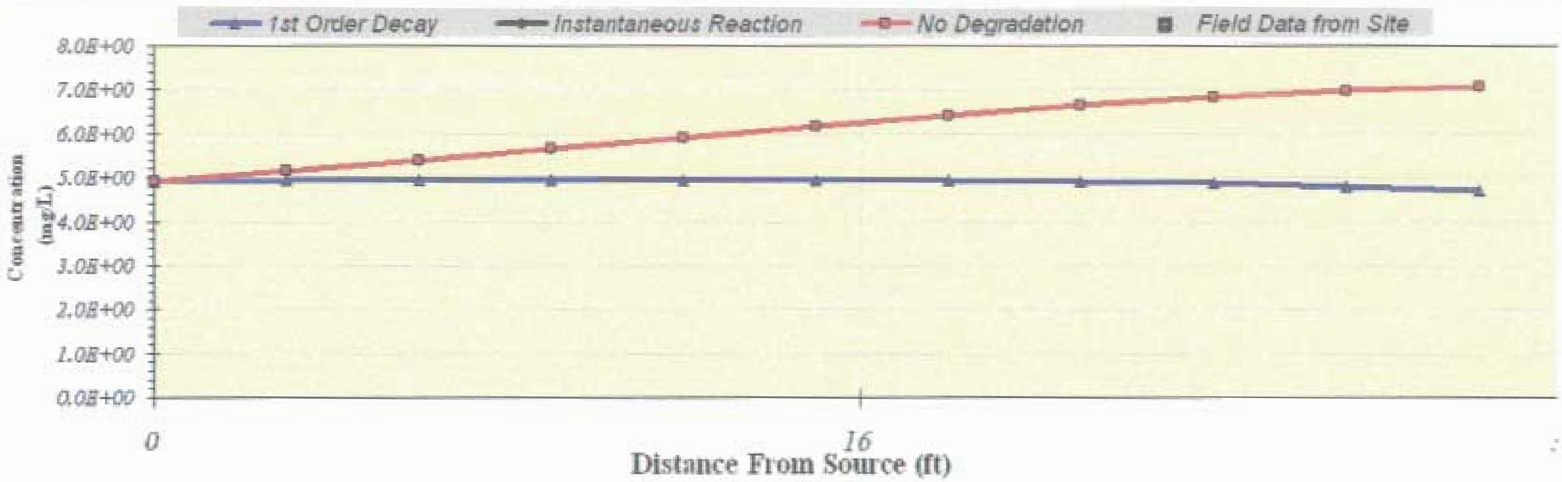
Recalculate This Sheet

Figure 17
2014 Groundwater ORO Concentration Distribution Prediction
Downgradient of Highest Source (TMW/SB-12)

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	3	6	9	12	15	18	21	24	27	30
No Degradation	4.918	5.153	5.401	5.655	5.913	6.169	6.416	6.644	6.840	6.989	7.073
1st Order Decay	4.918	4.930	4.942	4.952	4.958	4.957	4.946	4.920	4.875	4.804	4.700
Inst. Reaction	4.918	5.153	5.401	5.655	5.913	6.169	6.416	6.644	6.840	6.989	7.073
Field Data from Site											



Calculate Animation

Time: 11.0 Years

Return to Input

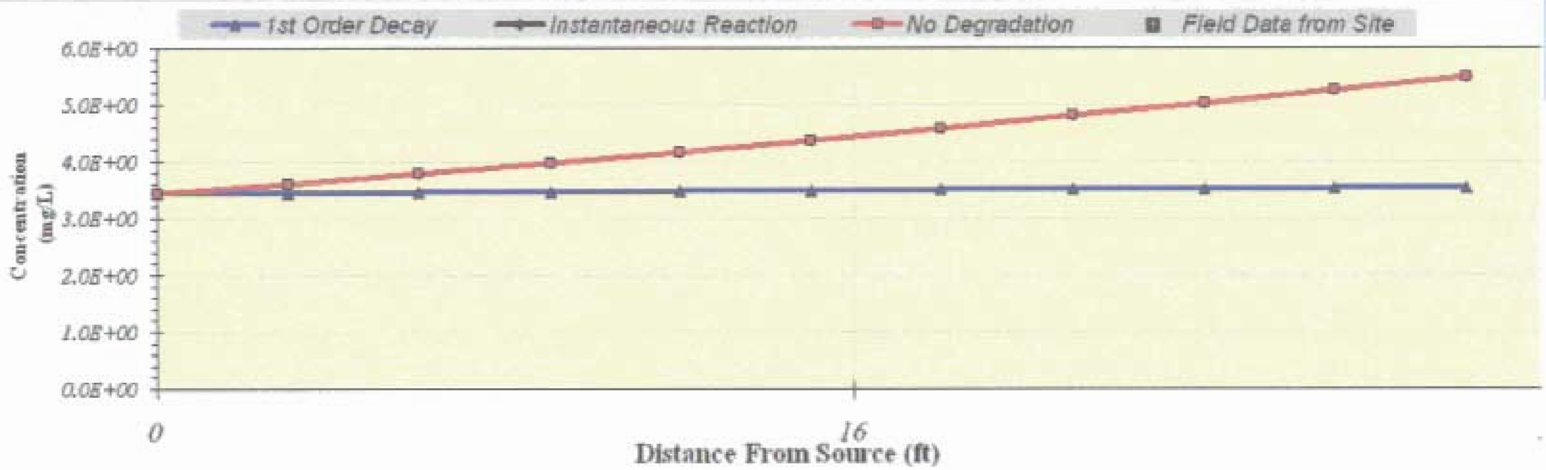
Recalculate This Sheet

Figure 18
2019 Groundwater ORO Concentration Distribution Prediction
Downgradient of Highest Source (TMW/SB-12)

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	3	6	9	12	15	18	21	24	27	30
No Degradation	3.439	3.609	3.787	3.974	4.169	4.373	4.585	4.805	5.032	5.263	5.496
1st Order Decay	3.439	3.450	3.461	3.472	3.482	3.492	3.502	3.511	3.518	3.524	3.526
Inst. Reaction	3.439	3.609	3.787	3.974	4.169	4.373	4.585	4.805	5.032	5.263	5.496
Field Data from Site											



Calculate Animation

Time: 16.0 Years

Return to Input

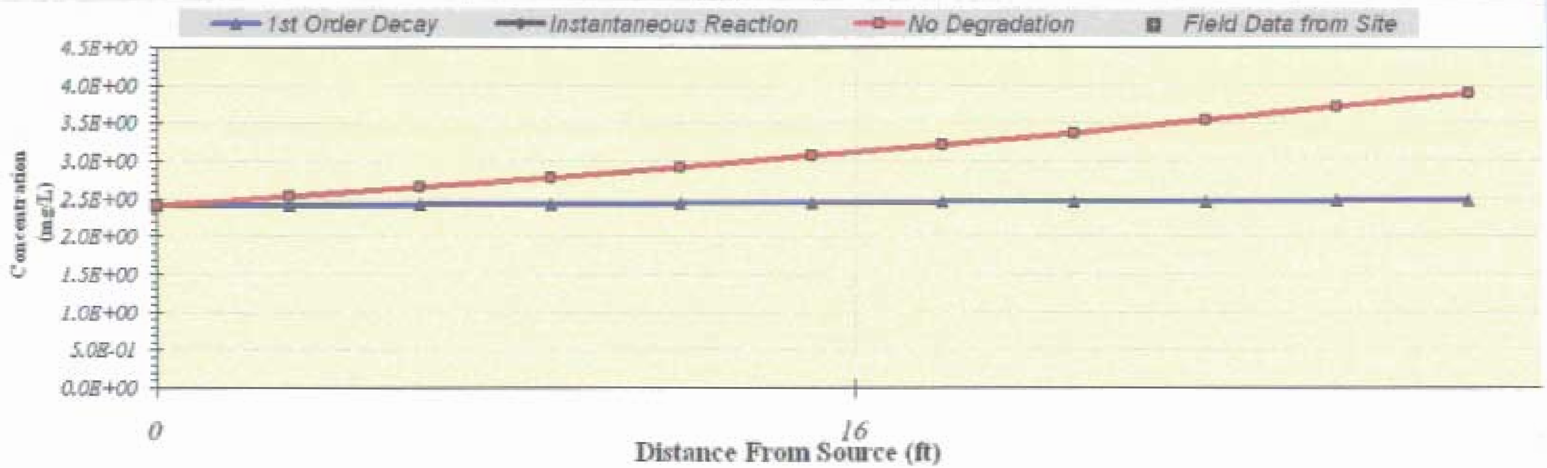
Recalculate This Sheet

Figure 19
2024 Groundwater ORO Concentration Distribution Prediction
Downgradient of Highest Source (TMW/SB-12)

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	3	6	9	12	15	18	21	24	27	30
No Degradation	2.405	2.524	2.649	2.780	2.918	3.062	3.214	3.372	3.538	3.712	3.893
1st Order Decay	2.405	2.413	2.420	2.428	2.436	2.444	2.451	2.459	2.467	2.474	2.481
Inst. Reaction	2.405	2.524	2.649	2.780	2.918	3.062	3.214	3.372	3.538	3.712	3.893
Field Data from Site											



Calculate Animation

Time: 21.0 Years

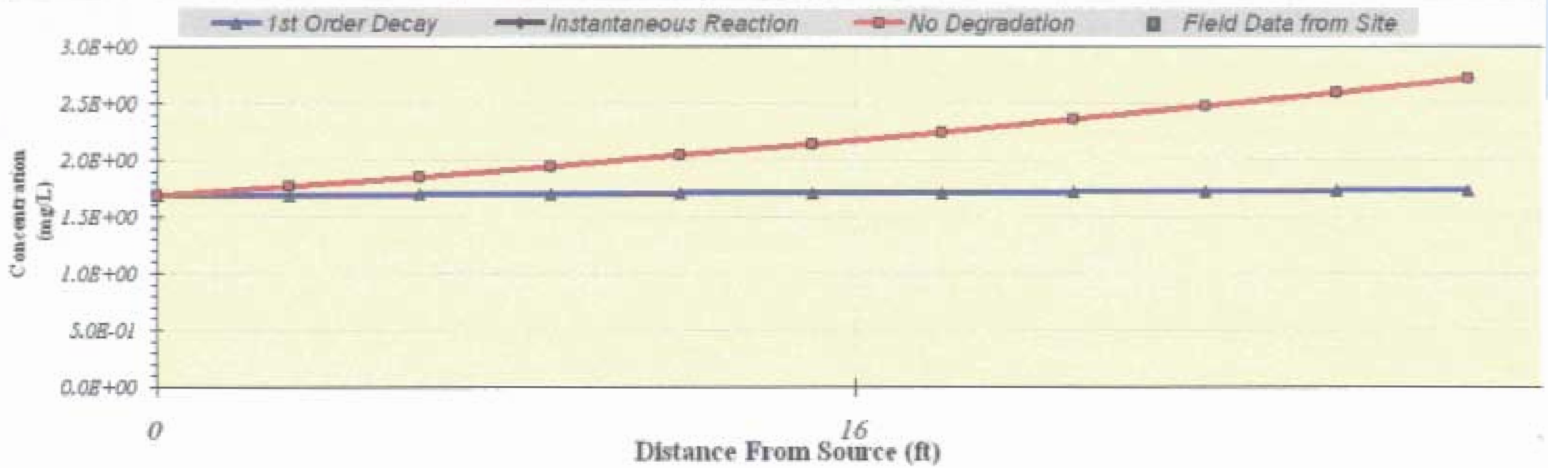
Return to Input

Recalculate This Sheet

Figure 20
2029 Groundwater ORO Concentration Distribution Prediction
Downgradient of Highest Source (TMW/SB-12)

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

A	B	C	D	E	F	G	H	I	J	K	L
	Distance from Source (ft)										
TYPE OF MODEL	0	3	6	9	12	15	18	21	24	27	30
No Degradation	1.682	1.765	1.853	1.944	2.041	2.142	2.248	2.359	2.476	2.598	2.727
1st Order Decay	1.682	1.687	1.693	1.698	1.704	1.709	1.714	1.720	1.725	1.731	1.736
Inst. Reaction	1.682	1.765	1.853	1.944	2.041	2.142	2.248	2.359	2.476	2.598	2.727
Field Data from Site											



Calculate Animation

Time: 26.0 Years

Return to Input

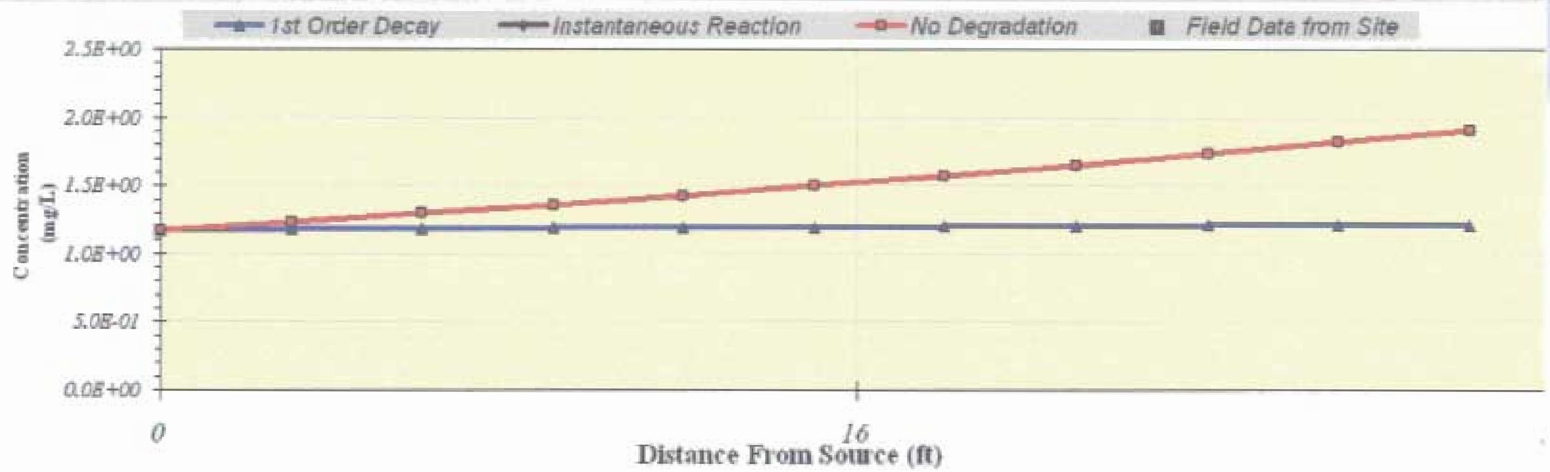
Recalculate This Sheet

Figure 21
2034 Groundwater ORO Concentration Distribution Prediction
Downgradient of Highest Source (TMW/SB-12)

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	3	6	9	12	15	18	21	24	27	30
No Degradation	1.176	1.235	1.296	1.360	1.427	1.498	1.572	1.650	1.732	1.817	1.907
1st Order Decay	1.176	1.180	1.184	1.188	1.191	1.195	1.199	1.203	1.207	1.210	1.214
Inst. Reaction	1.176	1.235	1.296	1.360	1.427	1.498	1.572	1.650	1.732	1.817	1.907
Field Data from Site											



Calculate Animation

Time: 31.0 Years

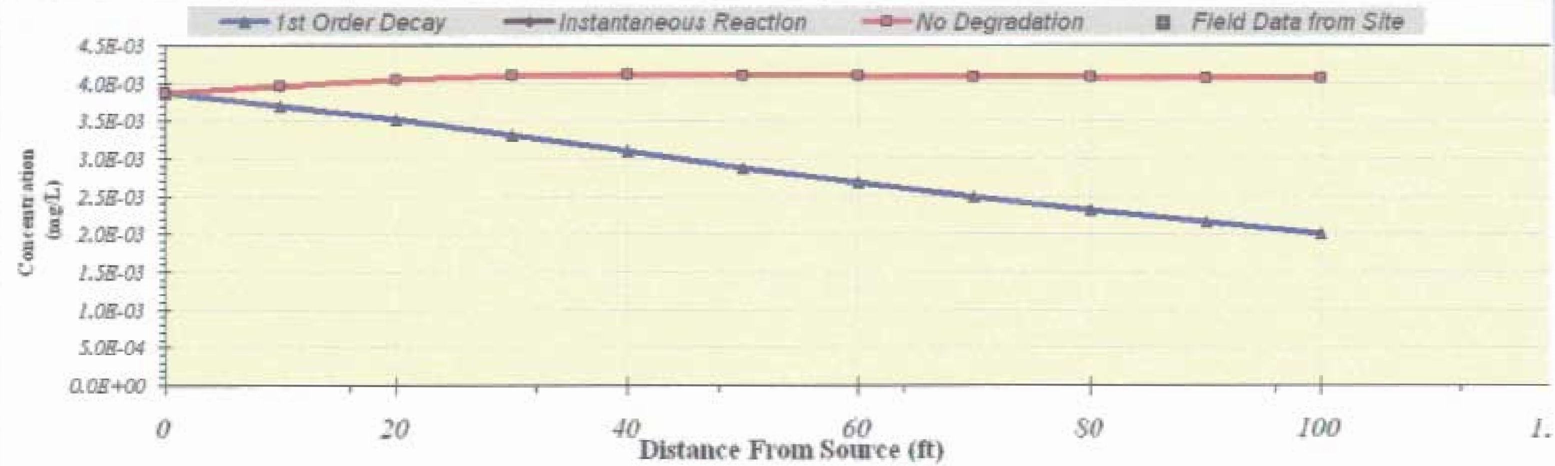
Return to Input

Recalculate This Sheet

Figure 22
2009 Groundwater Benzene Concentration Distribution Prediction
Downgradient of Highest Source (TMW/SB-23)

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

TYPE OF MODEL	Distance from Source (ft)										
	0	10	20	30	40	50	60	70	80	90	100
No Degradation	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004
1st Order Decay	0.004	0.004	0.004	0.003	0.003	0.003	0.003	0.002	0.002	0.002	0.002
Inst. Reaction	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004
Field Data from Site											



Calculate Animation

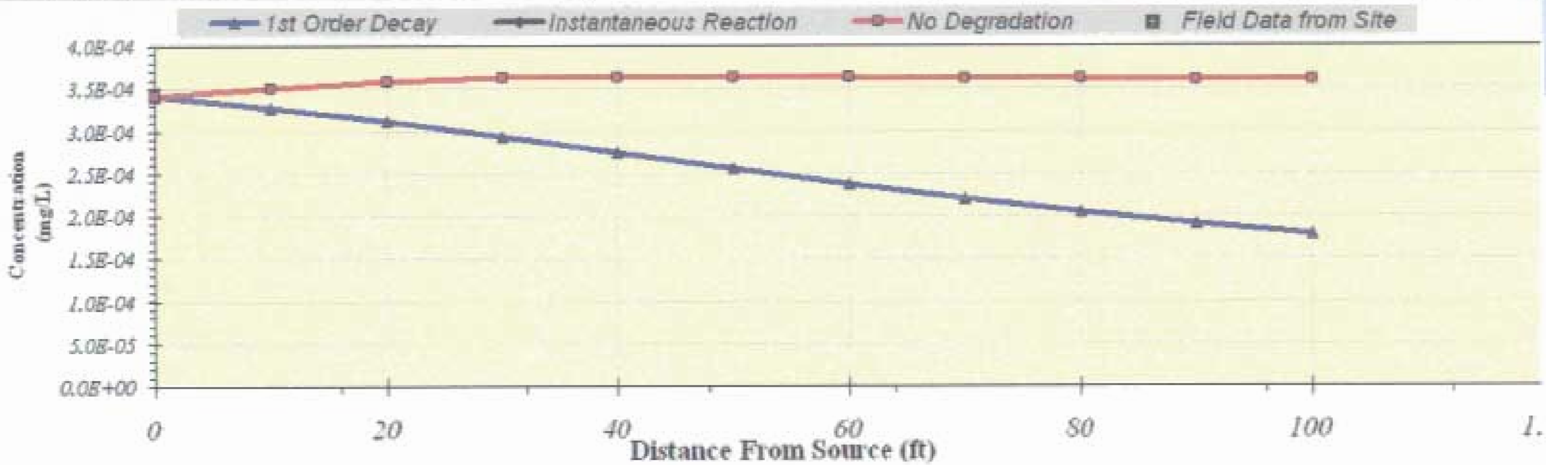
Time: 6.0 Years

Return to Input

Recalculate This Sheet

Figure 23
2014 Groundwater Benzene Concentration Distribution Prediction
Downgradient of Highest Source (TMW/SB-23)

A	B	C	D	E	F	G	H	I	J	K	L
	DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)										
	Distance from Source (ft)										
TYPE OF MODEL	0	10	20	30	40	50	60	70	80	90	100
No Degradation	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1st Order Decay	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	0.000	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: 11.0 Years

Return to Input

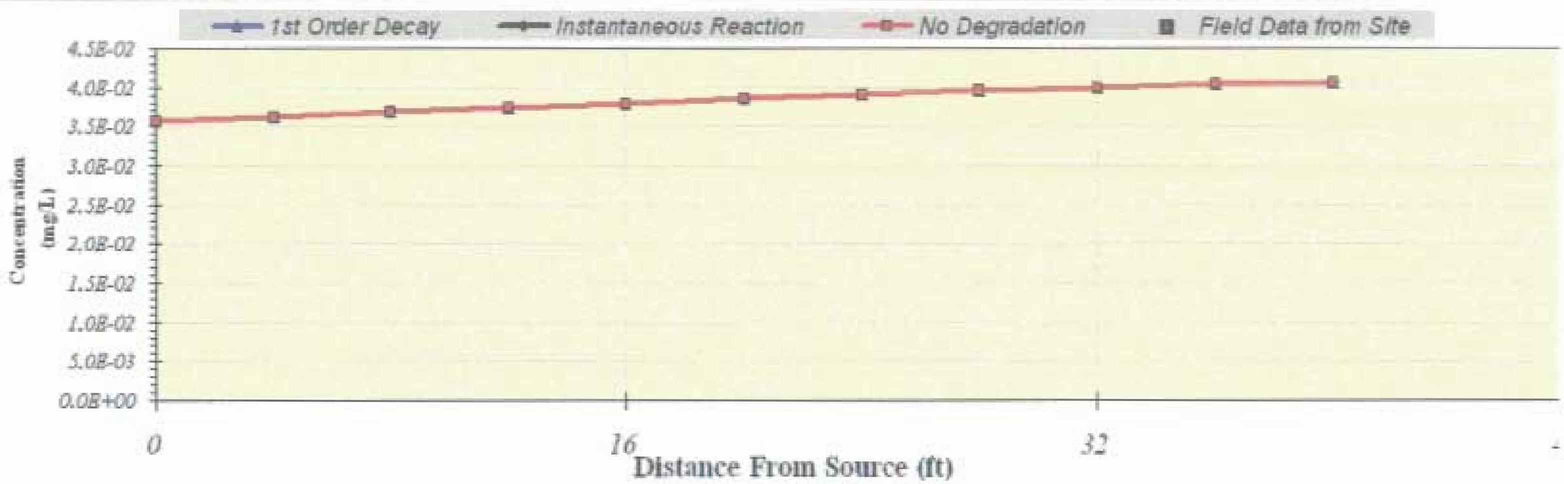
Recalculate This Sheet

Figure 24
2009 Groundwater Lead Concentration Distribution Prediction
Downgradient of Highest Source (TMW/SB-16)

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	4	8	12	16	20	24	28	32	36	40
No Degradation	0.036	0.036	0.037	0.037	0.038	0.039	0.039	0.040	0.040	0.040	0.041
1st Order Decay	0.036	0.036	0.037	0.037	0.038	0.039	0.039	0.040	0.040	0.040	0.041
Inst. Reaction	0.036	0.036	0.037	0.037	0.038	0.039	0.039	0.040	0.040	0.040	0.041
Field Data from Site											



Calculate Animation

Time: 6.0 Years

Return to Input

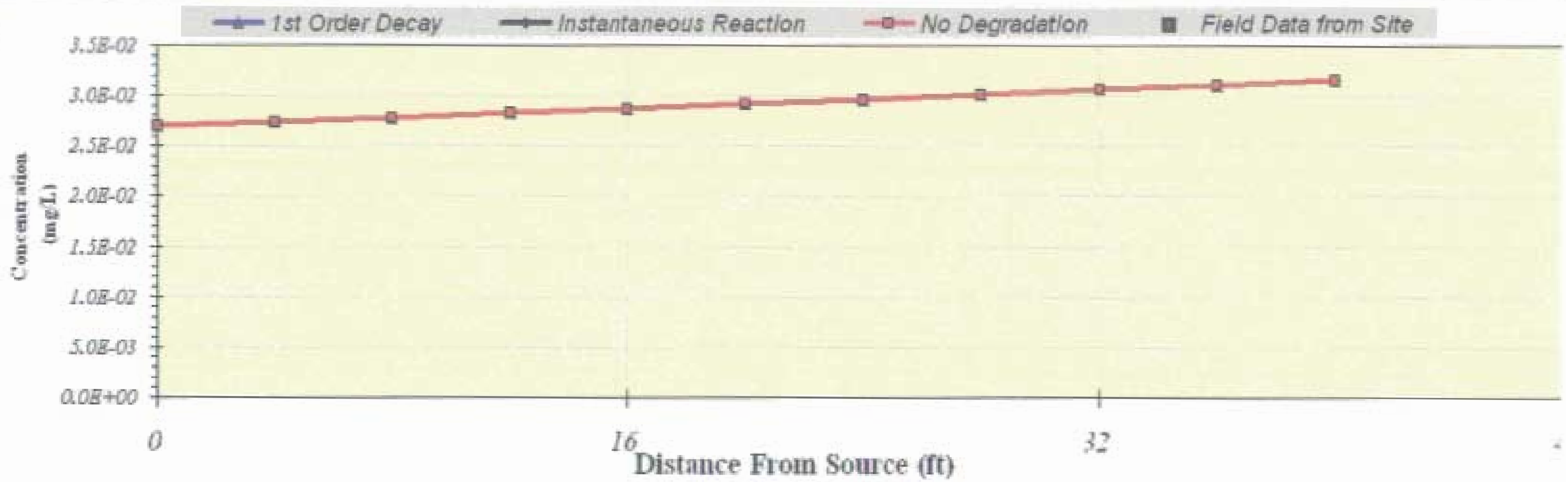
Recalculate This Sheet

Figure 25
2014 Groundwater Lead Concentration Distribution Prediction
Downgradient of Highest Source (TMW/SB-16)

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	4	8	12	16	20	24	28	32	36	40
No Degradation	0.027	0.027	0.028	0.028	0.029	0.029	0.030	0.030	0.031	0.031	0.032
1st Order Decay	0.027	0.027	0.028	0.028	0.029	0.029	0.030	0.030	0.031	0.031	0.032
Inst. Reaction	0.027	0.027	0.028	0.028	0.029	0.029	0.030	0.030	0.031	0.031	0.032
Field Data from Site											



Calculate Animation

Time: 11.0 Years

Return to Input

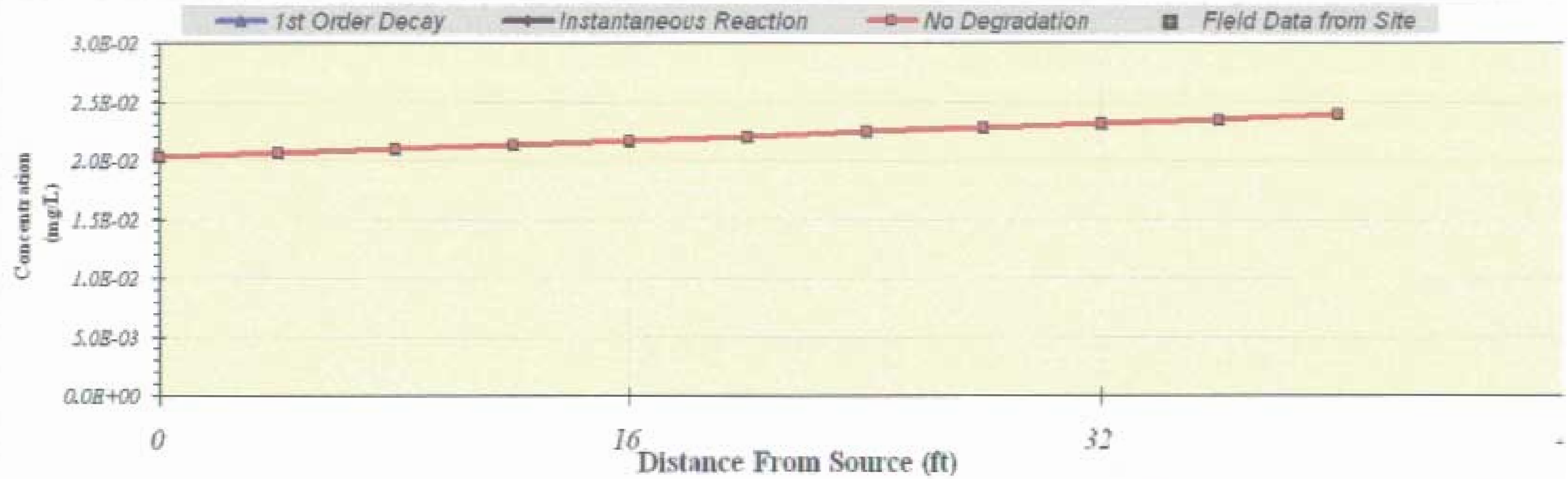
Recalculate This Sheet

Figure 26
2019 Groundwater Lead Concentration Distribution Prediction
Downgradient of Highest Source (TMW/SB-16)

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	4	8	12	16	20	24	28	32	36	40
No Degradation	0.020	0.021	0.021	0.021	0.022	0.022	0.022	0.023	0.023	0.024	0.024
1st Order Decay	0.020	0.021	0.021	0.021	0.022	0.022	0.022	0.023	0.023	0.024	0.024
Inst. Reaction	0.020	0.021	0.021	0.021	0.022	0.022	0.022	0.023	0.023	0.024	0.024
Field Data from Site											



Calculate Animation

Time: 16.0 Years

Return to Input

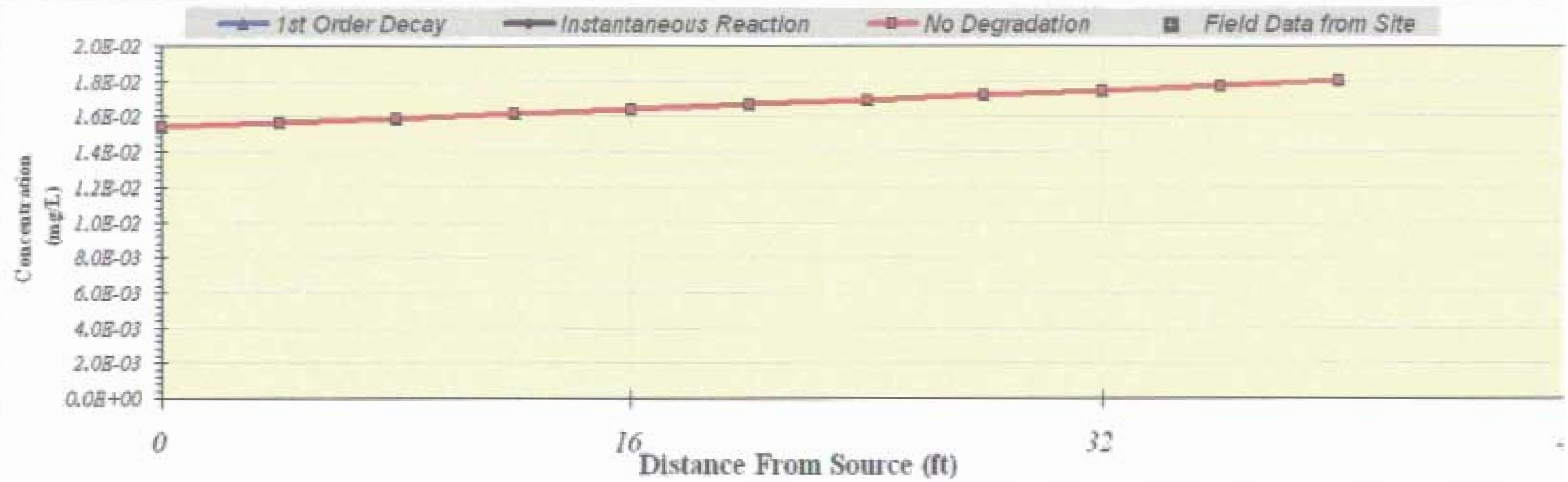
Recalculate This Sheet

Figure 27
2024 Groundwater Lead Concentration Distribution Prediction
Downgradient of Highest Source (TMW/SB-16)

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	4	8	12	16	20	24	28	32	36	40
No Degradation	0.015	0.016	0.016	0.016	0.016	0.017	0.017	0.017	0.017	0.018	0.018
1st Order Decay	0.015	0.016	0.016	0.016	0.016	0.017	0.017	0.017	0.017	0.018	0.018
Inst. Reaction	0.015	0.016	0.016	0.016	0.016	0.017	0.017	0.017	0.017	0.018	0.018
Field Data from Site											



Calculate Animation

Time: 21.0 Years

Return to Input

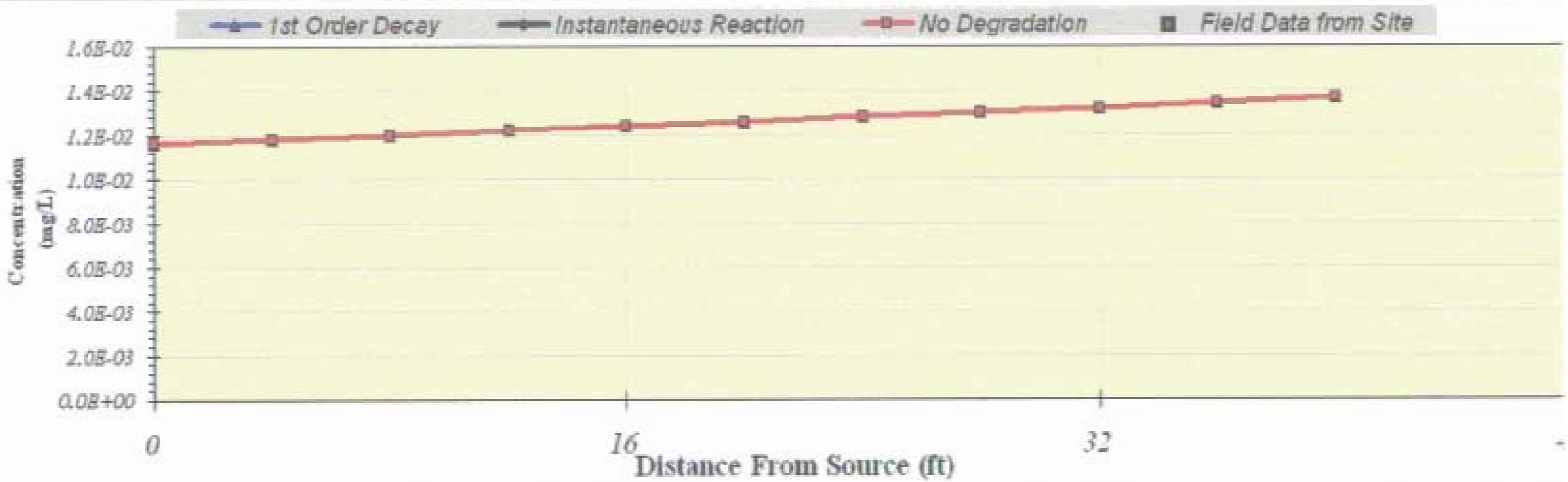
Recalculate This Sheet

Figure 28
2029 Groundwater Lead Concentration Distribution Prediction
Downgradient of Highest Source (TMW/SB-16)

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	4	8	12	16	20	24	28	32	36	40
No Degradation	0.012	0.012	0.012	0.012	0.012	0.013	0.013	0.013	0.013	0.013	0.014
1st Order Decay	0.012	0.012	0.012	0.012	0.012	0.013	0.013	0.013	0.013	0.013	0.014
Inst. Reaction	0.012	0.012	0.012	0.012	0.012	0.013	0.013	0.013	0.013	0.013	0.014
Field Data from Site											



Calculate Animation

Time: 26.0 Years

Return to Input

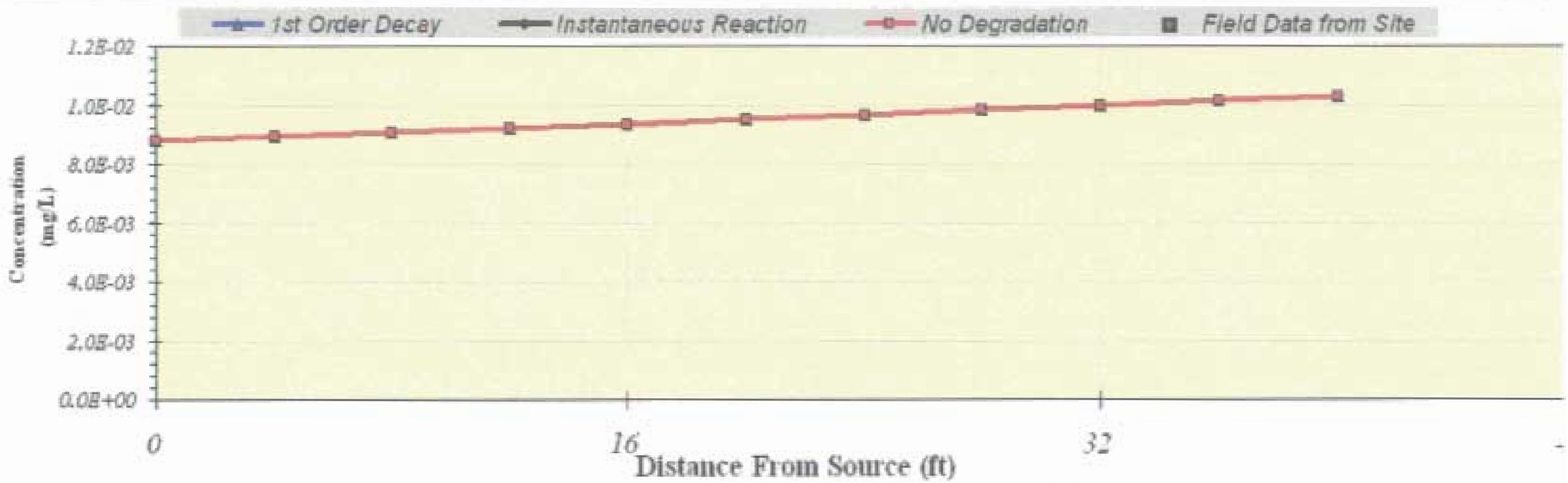
Recalculate This Sheet

Figure 29
2034 Groundwater Lead Concentration Distribution Prediction
Downgradient of Highest Source (TMW/SB-16)

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	4	8	12	16	20	24	28	32	36	40
No Degradation	0.009	0.009	0.009	0.009	0.009	0.010	0.010	0.010	0.010	0.010	0.010
1st Order Decay	0.009	0.009	0.009	0.009	0.009	0.010	0.010	0.010	0.010	0.010	0.010
Inst. Reaction	0.009	0.009	0.009	0.009	0.009	0.010	0.010	0.010	0.010	0.010	0.010
Field Data from Site											



Calculate Animation

Time: 31.0 Years

Chart Area

Return to Input

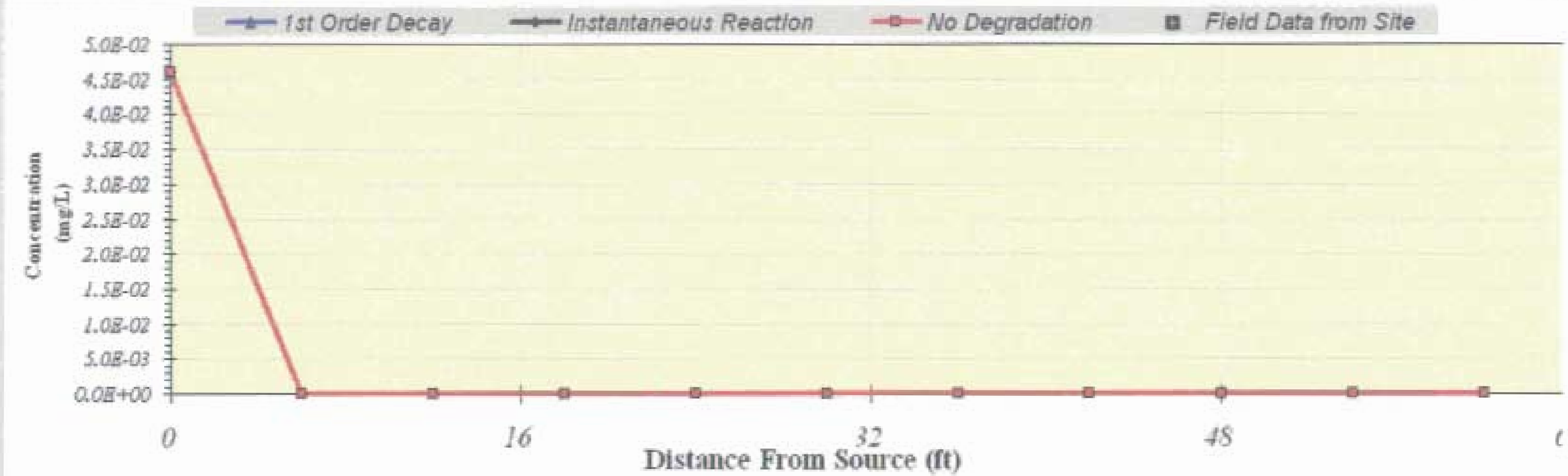
Recalculate This Sheet

Figure 30
2009 Groundwater Dibenz(a,h)anthracene Concentration Distribution Prediction Downgradient of Highest Source (MW-8)

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	6	12	18	24	30	36	42	48	54	60
No Degradation	0.046	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1st Order Decay	0.046	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	0.046	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: 6.0 Years

Return to Input

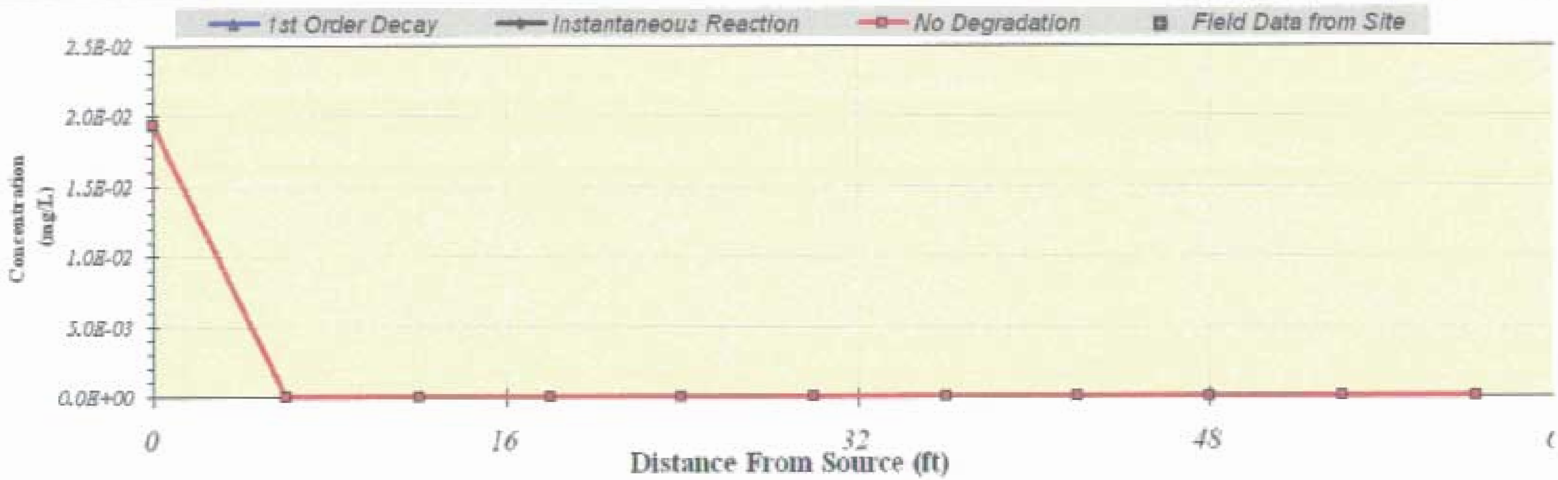
Recalculate This Sheet

Figure 31
2014 Groundwater Dibenz(a,h)anthracene Concentration Distribution Prediction Downgradient of Highest Source (MW-8)

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	6	12	18	24	30	36	42	48	54	60
No Degradation	0.019	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1st Order Decay	0.019	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	0.019	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: 11.0 Years

Return to Input

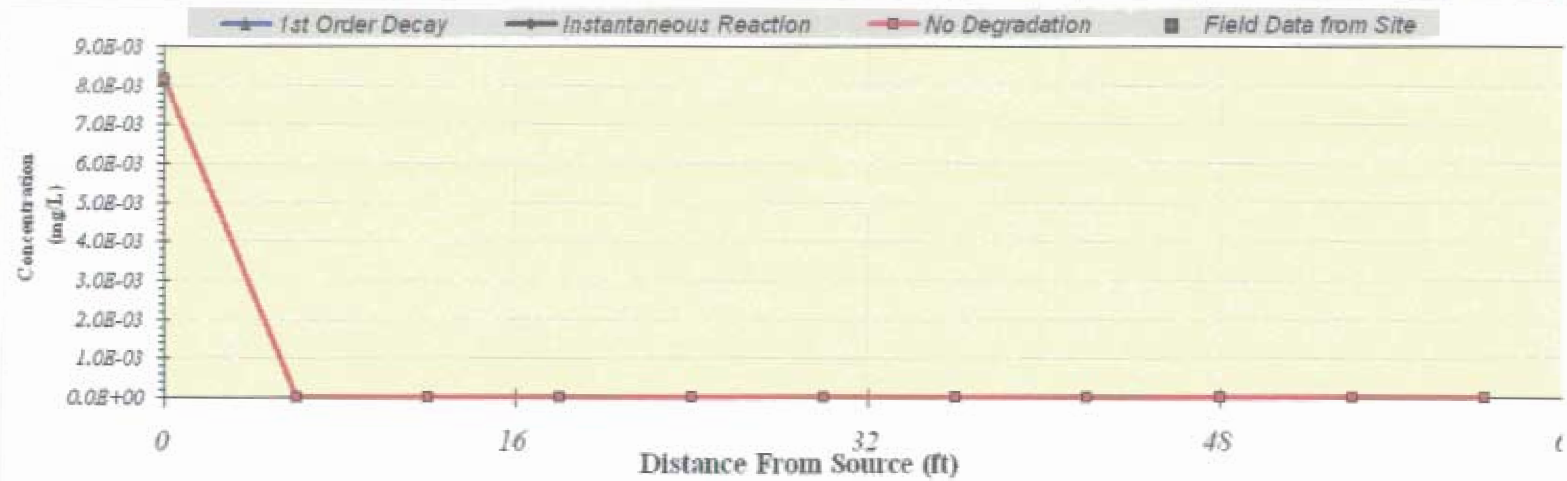
Recalculate This Sheet

Figure 32
2019 Groundwater Dibenz(a,h)anthracene Concentration Distribution Prediction Downgradient of Highest Source (MW-8)

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	6	12	18	24	30	36	42	48	54	60
No Degradation	0.008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1st Order Decay	0.008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	0.008	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: 16.0 Years

Return to Input

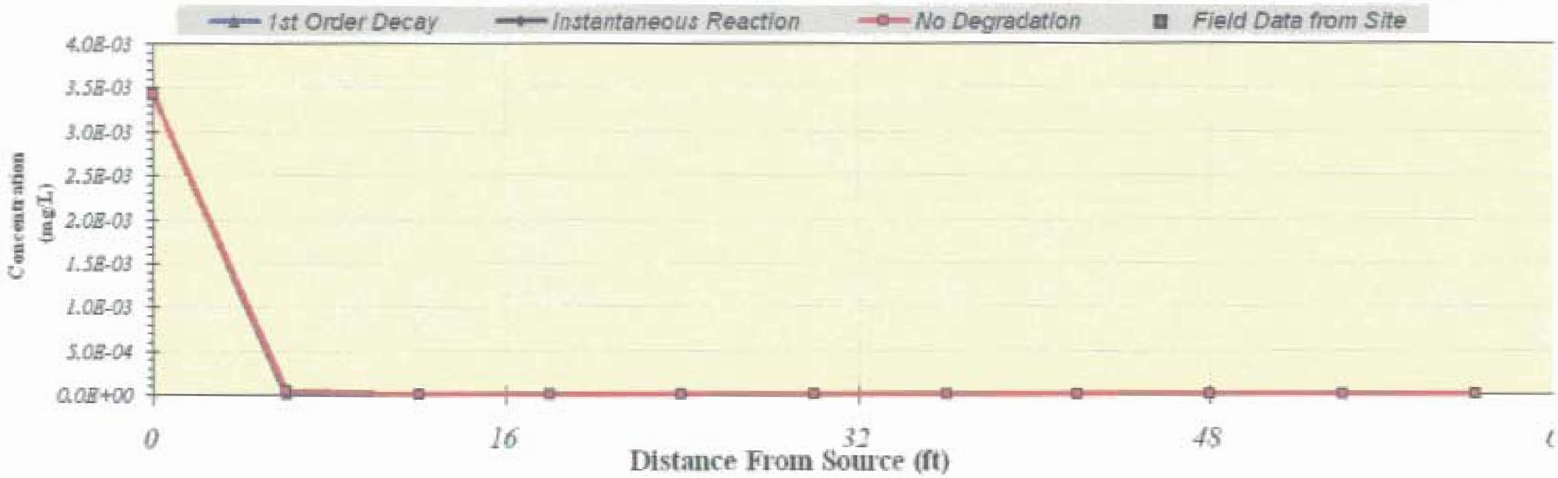
Recalculate This Sheet

Figure 33
2024 Groundwater Dibenz(a,h)anthracene Concentration Distribution Prediction
Downgradient of Highest Source (MW-8)

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	6	12	18	24	30	36	42	48	54	60
No Degradation	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1st Order Decay	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	0.003	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: 21.0 Years

Return to Input

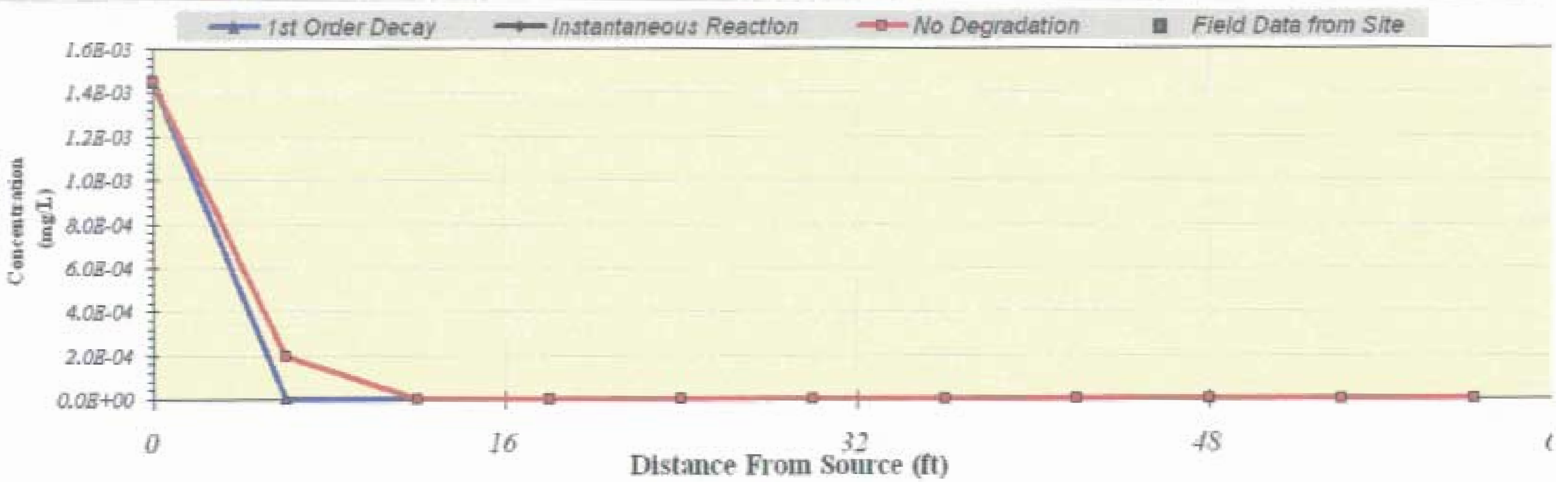
Recalculate This Sheet

Figure 34
2029 Groundwater Dibenz(a,h)anthracene Concentration Distribution Prediction
Downgradient of Highest Source (MW-8)

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	6	12	18	24	30	36	42	48	54	60
No Degradation	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1st Order Decay	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	0.001	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: 26.0 Years

Return to Input

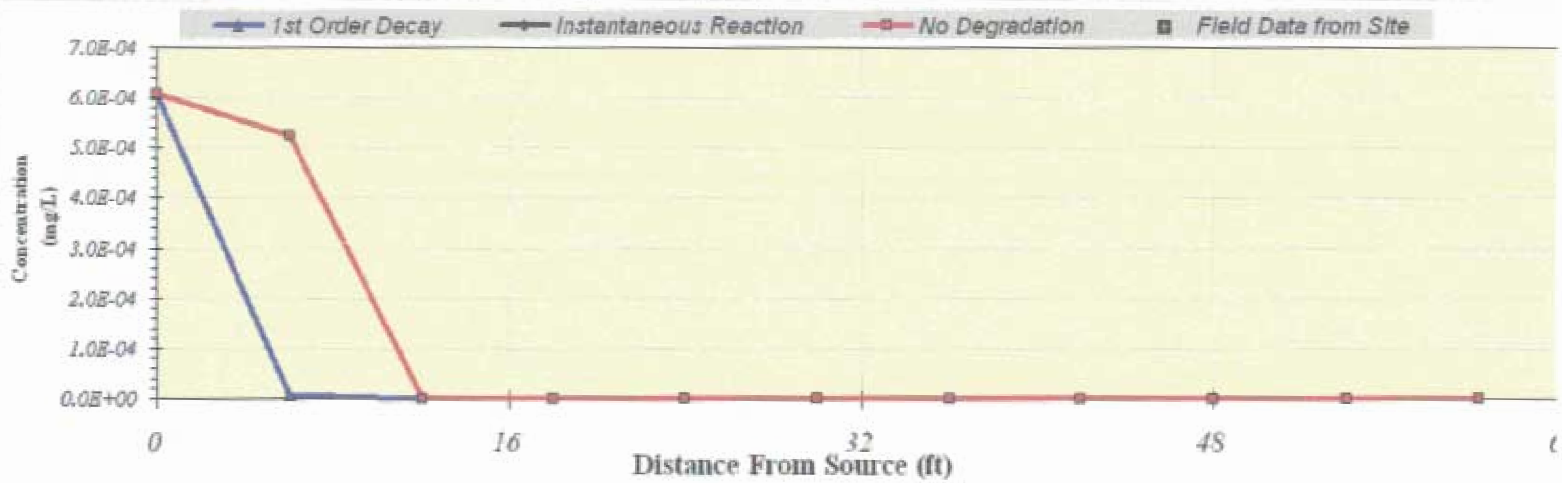
Recalculate This Sheet

Figure 35
2034 Groundwater Dibenz(a,h)anthracene Concentration Distribution Prediction
Downgradient of Highest Source (MW-8)

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	6	12	18	24	30	36	42	48	54	60
No Degradation	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1st Order Decay	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	0.001	0.001	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: 31.0 Years

Return to Input

Recalculate This Sheet

APPENDIX B

TABLES

TABLE 1
SOIL SOURCE TERMS
Former PQS Etowah Terminal
1015 Barlow Drive
Charleston, West Virginia

Benzene (UG/KG)							
Area #	Sample Location	Sample Interval Top, ft bgs	Sample Interval Bottom, ft bgs	Conc, ug/Kg	Depth to water, ft	Depth to water from sample, ft	Highest Conc, ug/Kg
1	SB-1 (adjacent to MW-6)	0 2 18	2 8 20	ND 37 ND	15.82	14.82 10.82 Below water	37
2	TMW/SB-3S&D (adjacent to MW-5)	0 2 26	2 7.5 28	375 102 ND	37.47	36.47 32.72 10.47	375
3	TMW/SB-26	0 2 20	2 8 22	228 133 3	23.35	22.35 18.35 2.35	228
4	TMW/SB-14	8	10	35	13.86	13.86	35
5	TMW/SB-7S&D	0 2 34	2 4 36	1 128 2	39.74	38.74 36.74 4.74	128

Naphthalene (UG/KG)							
Area #	Sample Location	Sample Interval Top, ft bgs	Sample Interval Bottom, ft bgs	Conc, ug/Kg	Depth to water, ft	Depth to water from sample, ft	Highest Conc, ug/Kg
1	SB-15 (adjacent to MW-2)	0 2 10	2 8 12	51 171 761	16.36	15.36 11.36 5.36	761

Notes:

1. Soil concentrations are based on soil samples collected between August 15, 2003 and August 22, 2003.
2. Depth to water was obtained from monitoring wells adjacent to soil boring locations, if available. Groundwater gauging records from August 14, 2003 monitoring event were used.
3. ND = Sample concentration below detection limit

TABLE 2-A
INPUT PARAMETERS FOR BENZENE VLEACH MODEL
Former PQS Etowah Terminal
1015 Barlow Drive
Charleston, West Virginia

Parameter	Value	Unit	Source
Simulation Data			
Number of polygons	5		
Time step	5	years	
Simulation Time	30	years	
Output Time Interval	5	years	
Profile Time Interval	5	years	
Koc	64.57	mL/g	VLEACH reference manual
Henry's Constant	0.221		VLEACH reference manual
Water Solubility	1780	mg/L	VLEACH reference manual
Free Air Diffusion Coefficient	0.80	m^2/day	ASTM E 1739-95
Polygon Data			
Area	100	$feet^2$	
Vertical Cell Dimension	1	feet	Uniform cells
Recharge Rate	1	feet/year	ASTM E 1739-95
Dry Bulk Density	1.62	g/cm^3	VLEACH recommended value for sand / loamy sand (used as approximation to site lithology of silty, clayey fine to medium sand)
Effective Porosity	0.33		VLEACH recommended value for sand / loamy sand; calculated as: *effective porosity = total porosity - irreducible water content*
Volumetric Water Content	0.30		User's Guide for the Johnson and Ettinger (1991) Model For Subsurface Vapor Intrusion Into Buildings, U.S. EPA 1997
Soil Organic Carbon Content	0.007		VLEACH recommended value for sand / loamy sand
Concentration of Recharge Water	0	mg/L	Recharge water derived from precipitation
Upper Boundary Condition	0	mg/L	Atmospheric concentration
Lower Boundary Condition	0	mg/L	groundwater concentration
Total Number of cells			Site specific data
SB-1 area	11		
TMW/SB-3S& D area	36		
TMW/SB-26 area	22		
TMW/SB-14 area	14		
TMW/SB-7S&D area	37		

TABLE 2-B
INPUT PARAMETERS FOR NAPHTHALENE VLEACH MODEL
Former PQS Etowah Terminal
1015 Barlow Drive
Charleston, West Virginia

Parameter	Value	Unit	Source
Simulation Data			
Number of polygons	1		
Time step	5	years	
Simulation Time	30	years	
Output Time Interval	5	years	
Profile Time Interval	5	years	
Koc	1288.25	mL/g	VLEACH reference manual
Henry's Constant	0.0516		VLEACH reference manual
Water Solubility	31	mg/L	VLEACH reference manual
Free Air Diffusion Coefficient	0.62	m^2/day	ASTM E 1739-95
Polygon Data			
Area	100	$feet^2$	
Vertical Cell Dimension	1	feet	Uniform cells
Recharge Rate	1	feet/year	ASTM E 1739-95
Dry Bulk Density	1.62	g/cm^3	VLEACH recommended value for sand / loamy sand (used as approximation to site lithology of silty, clayey fine to medium sand)
Effective Porosity	0.33		VLEACH recommended value for sand / loamy sand; calculated as: *effective porosity = total porosity - irreducible water content*
Volumetric Water Content	0.30		User's Guide for the Johnson and Ettinger (1991) Model For Subsurface Vapor Intrusion Into Buildings, U.S. EPA 1997
Soil Organic Carbon Content	0.007		VLEACH recommended value for sand / loamy sand
Concentration of Recharge Water	0	mg/L	Recharge water derived from precipitation
Upper Boundary Condition	0	mg/L	Atmospheric concentration
Lower Boundary Condition	0	mg/L	groundwater concentration
Total Number of cells SB-15 area	16		Site specific data

TABLE 3
VLEACH MODEL RESULTS
Former PQS Etowah Terminal
1015 Barlow Drive
Charleston, West Virginia

Chemical: Benzene

Time (years)	SB-1 area		TMW/SB-3S& D area		TMW/SB-26 area		TMW/SB-14 area		TMW/SB-7S&D area	
	Conc (g/cu.ft.)	Conc (ug/L)	Conc (g/cu.ft.)	Conc (ug/L)	Conc (g/cu.ft.)	Conc (ug/L)	Conc (g/cu.ft.)	Conc (ug/L)	Conc (g/cu.ft.)	Conc (ug/L)
0	0.0E+00	0	0.0E+00	0	1.3E-04	5	0.0E+00	0	0.0E+00	0
5	1.9E-04	7	7.6E-05	3	4.9E-04	17	1.2E-04	4	7.6E-05	3
10	2.9E-04	10	2.3E-04	8	8.8E-04	31	1.4E-04	5	2.3E-04	8
15	3.1E-04	11	4.3E-04	15	1.2E-03	41	1.2E-04	4	4.3E-04	15
20	2.9E-04	10	6.5E-04	23	1.3E-03	47	9.1E-05	3	6.5E-04	23
25	2.4E-04	9	8.4E-04	30	1.4E-03	48	6.4E-05	2	8.4E-04	30
30	1.9E-04	7	9.8E-04	35	1.3E-03	45	4.3E-05	2	9.8E-04	35

Chemical: Naphthalene

Time (years)	SB-15 area	
	Conc (g/cu.ft.)	Conc (ug/L)
0	0.0E+00	0
5	2.6E-05	1
10	5.0E-05	2
15	7.4E-05	3
20	9.6E-05	3
25	1.2E-04	4
30	1.4E-04	5

TABLE 4
INPUT PARAMETERS FOR BIOSCREEN MODEL
CONSTITUENT OF CONCERN: GRO
Former PQS Etowah Terminal
1015 Barlow Drive
Charleston, West Virginia

PARAMETER	VALUE	UNIT	SOURCE
1. HYDROGEOLOGY			
Seepage Velocity	222.0	ft/yr	Calculated using site data
Hydraulic conductivity	5.9×10^{-4} 612	cm/sec ft/year	Based on rising head slug tests conducted at site wells in 2004
Hydraulic gradient	0.12	ft/ft	Site-specific value (November 2003 Additional Site Characterization Report)
Effective Porosity	0.33	unit less	Based on silty clayey sand lithology (Reference: Domenico & Schwartz, 1990)
2. DISPERSION			
Longitudinal dispersivity	4.1	ft	Calculated by model based on plume length
Transverse dispersivity	0.4	ft	10% of Longitudinal dispersivity
Vertical dispersivity	0.0	ft	Conservative BIOSCREEN recommended value of 1×10^{-99} ft
Estimated plume length	50	ft	Based on 2003 concentration distribution
3. ADSORPTION			
Retardation factor	16.5	unit less	Calculated by Model
Soil bulk density	1.62	kg/L	VLEACH recommended value
Partition coefficient (Koc)	$3.16 \times 10^{+3}$	L/kg	Reference: Guidelines for TPH Fractionation at Leaking Underground Storage Tank Sites, Utah Department of Environmental Quality, Final Draft, July 2001
Fraction of organic carbon	0.001	unit less	BIOSCREEN recommended value
4. BIODEGRADATION			
Half Life	2	years	Reference: Guidelines for assessing and managing petroleum hydrocarbon contaminated sites in New Zealand, Appendix 4E, June 1999
5. GENERAL			
Modeled area length	100	ft	Distance to western site boundary (Elk River) along direction of flow from GRO source in groundwater at TMW/SB-23
Modeled area width	50	ft	Approximately half of modeled area length
6. SOURCE DATA			
Source thickness	10	ft	Approximate value
Source concentration	2.83	mg/L	Site-specific value based on the most recent GRO concentration measured at TMW/SB-23 in August 2003.
Source half-life	<1	years	Model adjusted value
Soluble mass	1	Kg	Model adjusted value

TABLE 5
INPUT PARAMETERS FOR BIOSCREEN MODEL
CONSTITUENT OF CONCERN: DRO – HIGHEST CONCENTRATION
Former PQS Etowah Terminal
1015 Barlow Drive
Charleston, West Virginia

PARAMETER	VALUE	UNIT	SOURCE
1. HYDROGEOLOGY			
Seepage Velocity	222.0	ft/yr	Calculated using site data
Hydraulic conductivity	5.9×10^{-4} 612	cm/sec ft/year	Based on rising head slug tests conducted at site wells in 2004
Hydraulic gradient	0.12	ft/ft	Site-specific value (November 2003 Additional Site Characterization Report)
Effective Porosity	0.33	unit less	Based on silty clayey sand lithology (Reference: Domenico & Schwartz, 1990)
2. DISPERSION			
Longitudinal dispersivity	4.1	ft	Calculated by model based on plume length
Transverse dispersivity	0.4	ft	10% of Longitudinal dispersivity
Vertical dispersivity	0.0	ft	Conservative BIOSCREEN recommended value of 1×10^{-99} ft
Estimated plume length	50	ft	Based on 2003 concentration distribution
3. ADSORPTION			
Retardation factor	33.0	unit less	Two times the retardation factor for GRO
Soil bulk density	1.62	kg/L	VLEACH recommended value
Partition coefficient (Koc)	$5 \times 10^{+6}$	L/kg	Reference: Guidelines for TPH Fractionation at Leaking Underground Storage Tank Sites, Utah Department of Environmental Quality, Final Draft, July 2001
Fraction of organic carbon	0.001	unit less	BIOSCREEN recommended value
4. BIODEGRADATION			
Half Life	7	years	Reference: Guidelines for assessing and managing petroleum hydrocarbon contaminated sites in New Zealand, Appendix 4E, June 1999
5. GENERAL			
Modeled area length	100, 30	ft	Distances to western site boundary (Elk River) along direction of flow measured from highest onsite DRO source in groundwater (TMW/SB-23) and source near river (TMW/SB-12), respectively.
Modeled area width	300	ft	Based on site conditions
6. SOURCE DATA			
Source thickness	10	ft	Approximate value
Source concentration	30.0, 21.0	mg/L	Site-specific values based on the most recent DRO concentration measured at TMW/SB-23 and TMW/SB-12 in August 2003.
Source half-life	50	years	Model adjusted value
Soluble mass	5000, 1000	Kg	Model adjusted values for sources at TMW/SB-23 and TMW/SB-12

TABLE 6
INPUT PARAMETERS FOR BIOSCREEN MODEL
CONSTITUENT OF CONCERN: ORO – HIGHEST CONCENTRATION
Former PQS Etowah Terminal
1015 Barlow Drive
Charleston, West Virginia

PARAMETER	VALUE	UNIT	SOURCE
1. HYDROGEOLOGY			
Seepage Velocity	222.0	ft/yr	Calculated using site data
Hydraulic conductivity	5.9×10^{-4} 612	cm/sec ft/year	Based on rising head slug tests conducted at site wells in 2004
Hydraulic gradient	0.12	ft/ft	Site-specific value (November 2003 Additional Site Characterization Report)
Effective Porosity	0.33	unit less	Based on silty clayey sand lithology (Reference: Domenico & Schwartz, 1990)
2. DISPERSION			
Longitudinal dispersivity	2.5	ft	Calculated by model based on plume length
Transverse dispersivity	0.2	ft	10% of Longitudinal dispersivity
Vertical dispersivity	0.0	ft	Conservative BIOSCREEN recommended value of 1×10^{-99} ft
Estimated plume length	30	ft	Based on 2003 concentration distribution
3. ADSORPTION			
Retardation factor	50.0	unit less	Three times the retardation factor for GRO
Soil bulk density	1.62	kg/L	VLEACH recommended value
Partition coefficient (Koc)	$4 \times 10^{+8}$	L/kg	Reference: Guidelines for TPH Fractionation at Leaking Underground Storage Tank Sites, Utah Department of Environmental Quality, Final Draft, July 2001
Fraction of organic carbon	0.001	unit less	BIOSCREEN recommended value
4. BIODEGRADATION			
Half Life	10	years	Reference: Guidelines for assessing and managing petroleum hydrocarbon contaminated sites in New Zealand, Appendix 4E, June 1999
5. GENERAL			
Modeled area length	30	ft	Distance to western site boundary (Elk River) along direction of flow measured from highest onsite ORO source in groundwater (TMW/SB-12), which is only 30 ft up gradient of the river.
Modeled area width	60	ft	Based on site conditions
6. SOURCE DATA			
Source thickness	10	ft	Approximate value
Source concentration	10.8	mg/L	Site-specific value based on the most recent ORO concentration measured at TMW/SB-12 in August 2003.
Source half-life	10	years	Model adjusted value
Soluble mass	100	Kg	Model adjusted value for source at TMW/SB-12

TABLE 7
INPUT PARAMETERS FOR BIOSCREEN MODEL
CONSTITUENT OF CONCERN: BENZENE – HIGHEST CONCENTRATION
Former PQS Etowah Terminal
1015 Barlow Drive
Charleston, West Virginia

PARAMETER	VALUE	UNIT	SOURCE
1. HYDROGEOLOGY			
Seepage Velocity	222.0	ft/yr	Calculated using site data
Hydraulic conductivity	5.9×10^{-4} 612	cm/sec ft/year	Based on rising head slug tests conducted at site wells in 2004
Hydraulic gradient	0.12	ft/ft	Site-specific value (November 2003 Additional Site Characterization Report)
Effective Porosity	0.33	unit less	Based on silty clayey sand lithology (Reference: Domenico & Schwartz, 1990)
2. DISPERSION			
Longitudinal dispersivity	7.1	ft	Calculated by model based on plume length
Transverse dispersivity	0.7	ft	10% of Longitudinal dispersivity
Vertical dispersivity	0.0	ft	Conservative BIOSCREEN recommended value of 1×10^{-99} ft
Estimated plume length	100	ft	Based on 2003 concentration distribution
3. ADSORPTION			
Retardation factor	1.2	unit less	Model calculated value
Soil bulk density	1.62	kg/L	VLEACH recommended value
Partition coefficient (Koc)	38	L/kg	Reference: ASTM E-1739 1995
Fraction of organic carbon	0.001	unit less	BIOSCREEN recommended value
4. BIODEGRADATION			
Half Life	0.5	Year	BIOSCREEN recommended / model adjusted value
5. GENERAL			
Modeled area length	100	ft	Distance to western site boundary (Elk River) along direction of flow measured from highest onsite benzene source in groundwater (TMW/SB-23), excluding perched groundwater.
Modeled area width	60	ft	Based on site conditions
6. SOURCE DATA			
Source thickness	10	ft	Approximate value
Source concentration	0.071	mg/L	Site-specific value based on the most recent benzene concentration measured at TMW/SB-23 and the maximum contribution from soil leachate at up gradient soil source around SB-1 /MW-6 area
Source half-life	1	years	Model adjusted value
Soluble mass	0.1	Kg	Model adjusted value

TABLE 8
INPUT PARAMETERS FOR BIOSCREEN MODEL
CONSTITUENT OF CONCERN: LEAD – HIGHEST CONCENTRATION
Former PQS Etowah Terminal
1015 Barlow Drive
Charleston, West Virginia

PARAMETER	VALUE	UNIT	SOURCE
1. HYDROGEOLOGY			
Seepage Velocity	222.0	ft/yr	Calculated using site data
Hydraulic conductivity	5.9×10^{-4} 612	cm/sec ft/year	Based on rising head slug tests conducted at site wells in 2004
Hydraulic gradient	0.12	ft/ft	Site-specific value (November 2003 Additional Site Characterization Report)
Effective Porosity	0.33	unit less	Based on silty clayey sand lithology (Reference: Domenico & Schwartz, 1990)
2. DISPERSION			
Longitudinal dispersivity	3.3	ft	Calculated by model based on plume length
Transverse dispersivity	0.3	ft	10% of Longitudinal dispersivity
Vertical dispersivity	0.0	ft	Conservative BIOSCREEN recommended value of 1×10^{-99} ft
Estimated plume length	40	ft	Distance from source to Elk River
3. ADSORPTION			
Retardation factor	15.7	unit less	Model calculated value
Soil bulk density	1.62	kg/L	VLEACH recommended value
Partition coefficient (Koc)	3000	L/kg	Reference: EPA 402-R-99-004B
Fraction of organic carbon	0.001	unit less	BIOSCREEN recommended value
4. BIODEGRADATION			
Half Life	0.0	Year	No biodegradation
5. GENERAL			
Modeled area length	30	ft	Distance to western site boundary (Elk River) along direction of flow measured from highest onsite Lead source in groundwater (TMW/SB-16)
Modeled area width	100	ft	Based on site conditions
6. SOURCE DATA			
Source thickness	10	ft	Approximate value
Source concentration	0.05	mg/L	Site-specific value based on the most recent Lead concentration measured at TMW/SB-16
Source half-life	10	years	Model adjusted value
Soluble mass	1	Kg	Model adjusted value

TABLE 9
INPUT PARAMETERS FOR BIOSCREEN MODEL
CONSTITUENT OF CONCERN: DIBENZ(A,H)ANTHRACENE – HIGHEST CONCENTRATION
Former PQS Etowah Terminal
1015 Barlow Drive
Charleston, West Virginia

PARAMETER	VALUE	UNIT	SOURCE
1. HYDROGEOLOGY			
Seepage Velocity	222.0	ft/yr	Calculated using site data
Hydraulic conductivity	5.9×10^{-4} 612	cm/sec ft/year	Based on rising head slug tests conducted at site wells in 2004
Hydraulic gradient	0.12	ft/ft	Site-specific value (November 2003 Additional Site Characterization Report)
Effective Porosity	0.33	unit less	Based on silty clayey sand lithology (Reference: Domenico & Schwartz, 1990)
2. DISPERSION			
Longitudinal dispersivity	3.3	ft	Calculated by model based on plume length
Transverse dispersivity	0.3	ft	10% of Longitudinal dispersivity
Vertical dispersivity	0.0	ft	Conservative BIOSCREEN recommended value of 1×10^{-99} ft
Estimated plume length	30	ft	Distance from source to Elk River
3. ADSORPTION			
Retardation factor	8788	unit less	Model calculated value
Soil bulk density	1.62	kg/L	VLEACH recommended value
Partition coefficient (Koc)	1.79×10^{6}	L/kg	Reference: Montana Department of Environmental Quality, Remediation Division, 2003. Risk Based Corrective Action Guidance, Appendix D, Table 3, http://www.deq.state.mt.us/rem/hwc/rbca/NewRBCA11-2003/AppD/appdtb3.pdf
Fraction of organic carbon	0.001	unit less	BIOSCREEN recommended value
4. BIODEGRADATION			
Half Life	3.6	Year	Average half life (Reference: Howard et al., 1991)
5. GENERAL			
Modeled area length	60	ft	Distance to western site boundary (Elk River) along direction of flow measured from highest onsite source in groundwater (MW-8)
Modeled area width	60	ft	Based on site conditions
6. SOURCE DATA			
Source thickness	10	ft	Approximate value
Source concentration	0.13	mg/L	Site-specific value based on the most recent Lead concentration measured at MW-8
Source half-life	4	years	Model adjusted value
Soluble mass	0.5	Kg	Model adjusted value

APPENDIX C

AMBIENT AIR MODELING & RISK CALCULATIONS

APPENDIX C

ON-SITE COMMERCIAL WORKER

TABLE C-1
COMMERCIAL WORKER GROUNDWATER TO INDOOR AIR
DATA ENTRY SHEET

GW-SCREEN
Version 3.0, 04/03

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION
(enter "X" in "YES" box and initial groundwater conc. below)

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
71432	6.86E+00	Benzene

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER SCS soil type directly above water table	ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
200	427	SIC	11	

MORE ↓

ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vandose zone soil vapor permeability, k_v (cm²)	ENTER Vadose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^V (g/cm³)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm³/cm³)
SIC			SIC	1.38	0.481	0.216

MORE ↓

ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)
1.0E-06	1	70	25	25	250

Used to calculate risk-based groundwater concentration.

TABLE C-1
COMMERCIAL WORKER GROUNDWATER TO INDOOR AIR
CHEMICAL PROPERTIES SHEET

ABC

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H ($atm\text{-}m^3/mol$)	Henry's law constant reference temperature, T_R (°C)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (°K)	Critical temperature, T_C (°K)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
8.80E-02	9.80E-06	5.54E-03	25	7,342	353.24	562.16	5.89E+01	1.79E+03	7.8E-06	3.0E-02

END

TABLE C-1
COMMERCIAL WORKER GROUNDWATER TO INDOOR AIR
INTERMEDIATE CALCULATIONS SHEET

Source-building separation, L_T (cm)	Vadose zone soil air-filled porosity, θ_a^V (cm^3/cm^3)	Vadose zone effective total fluid saturation, S_{te} (cm^3/cm^3)	Vadose zone soil intrinsic permeability, k_i (cm^2)	Vadose zone soil relative air permeability, k_{rg} (cm^2)	Vadose zone soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
227	0.265	0.284	1.48E-09	0.844	1.25E-09	192.31	0.481	0.057	0.424	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} ($atm\text{-}m^3/mol$)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Vadose zone effective diffusion coefficient, D^{eff}_V (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)
2.54E+04	1.80E+06	2.22E-04	200	8,112	2.82E-03	1.21E-01	1.76E-04	4.57E-03	4.80E-05	5.66E-05

Diffusion path length, L_d (cm)	Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, exp(Pe^f) (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF ($\mu g/m^3$)$^{-1}$	Reference conc., RfC (mg/m^3)
227	200	8.30E+02	0.10	8.64E-01	4.57E-03	4.00E+02	1.13E+02	1.17E-05	9.67E-03	7.8E-06	3.0E-02

TABLE C-1
COMMERCIAL WORKER GROUNDWATER TO INDOOR AIR
RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
NA	NA	NA	1.79E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
1.8E-08	2.2E-04

MESSAGE SUMMARY BELOW:

END

APPENDIX C

ON-SITE CONSTRUCTION WORKER

Shaw Environmental, Inc.
PQS dba SOPUS Products
Tax ID No. 75-0200625

TABLE C-2
CONSTRUCTION WORKER DERMAL CONTACT WITH GROUNDWATER

Print Date: 10/11/04

Site Name: Former PQS Elowah Terminal - Charleston, WV

Scenario: Dermal Contact with Chemical Constituents in Groundwater
Receptor: On-site construction worker

This table calculates estimated body dose, incremental cancer risk, and hazard indices from dermal exposure to chemical constituents in water.
The equations used to calculate body doses, incremental cancer risks, and hazard indices are:

Body Dose = (CW * SA * PC * ET * EF * ED * CFv)/(BW * AT) (mg/kg-day)

Body Dose / ABSo = Adjusted Body Dose

Cancer Risk = Adj. Body Dose (mg/kg-day) * Cancer Slope Factor (mg/kg-day)^-1

Hazard Index = Adj. Body Dose (mg/kg-day) / Reference Dose (mg/kg-day)

WHERE:

CW = CONCENTRATION OF CONSTITUENT IN WATER (mg/l)
SA = SKIN SURFACE AREA (cm^2)
PC = CHEMICAL SPECIFIC DERMAL PERMEABILITY CONSTANT (cm/hour)
ET = EXPOSURE TIME (hours/day)
EF = EXPOSURE FREQUENCY (days/year)
ED = EXPOSURE DURATION (years)
CFv = VOLUMETRIC CONVERSION FACTOR (1 liter/1000 cm^3)
BW = BODY WEIGHT (kg)
AT = AVERAGING TIME (days) = 25,550 for carcinogens
AT = AVERAGING TIME (days) = ED * 365 days/year for noncarcinogens
ABSo = ORAL ABSORPTION FACTOR (unitless)

Constituent	"CW" Concentration (mg/L)	"SA" Skin Area (cm^2)	"ET" Exp. Time (hr/day)	"PC" Perm. Constant (cm/hr)	"EF" Expos. Freq. (days/year)	"BW" Body Weight (kg)	"AT" Averaging Time (days)	"ED" Exp. Duration (years)	Body Dose (mg/kg-day)	Oral Absorp Factor (unitless)	Adjusted Body Dose (mg/kg-day)	CSF (mg/kg-day)-1	Dermal Cancer Risk	Reference Dose (RfD) (mg/kg-day)	"HI" Hazard Index
Carcinogen Effects:															
Benzene	6.86E-03	1,900	4	1.50E-02	20	70	25,550	1	8.75E-09	1	8.75E-09	5.50E-02	4.81E-10		
MTBE	2.15E-02	1,900	4	4.52E-01	20	70	25,550	1	8.26E-07	1	8.26E-07	4.00E-03	3.30E-09		
TPH-GRO	1.66E-01	1,900	4	3.10E-02	20	70	25,550	1	4.37E-07	1	4.37E-07	NA	NA		
TPH-DRO	1.58E+00	1,900	4	4.70E-02	20	70	25,550	1	6.31E-06	1	6.31E-06	NA	NA		
TPH-ORO	1.32E+00	1,900	4	1.40E-01	20	70	25,550	1	1.57E-05	1	1.57E-05	NA	NA		
Lead	1.45E-02	1,900	4	1.00E-04	20	70	25,550	1	1.23E-10	1	1.23E-10	NA	NA		
1-Methylnaphthalene	1.77E-02	1,900	4	1.66E+00	20	70	25,550	1	2.50E-06	1	2.50E-06	NA	NA		
2-Methylnaphthalene	9.40E-03	1,900	4	1.66E+00	20	70	25,550	1	1.33E-06	1	1.33E-06	NA	NA		
Dibenz(a,h)anthracene	5.50E-05	1,900	4	1.50E+00	20	70	25,550	1	7.01E-09	1	7.01E-09	7.30E+00	5.12E-08		
Indeno(1,2,3-cd)pyrene	5.25E-05	1,900	4	1.00E+00	20	70	25,550	1	4.46E-09	1	4.46E-09	7.30E-01	3.26E-09		
Noncarcinogenic Effects:															
Benzene	6.86E-03	1,900	4	1.50E-02	20	70	365	1	6.12E-07	1	6.12E-07	NA	NA	4.00E-03	1.53E-04
MTBE	2.15E-02	1,900	4	4.52E-01	20	70	365	1	5.78E-05	1	5.78E-05	NA	NA	8.60E-01	6.72E-05
TPH-GRO	1.66E-01	1,900	4	3.10E-02	20	70	365	1	3.06E-05	1	3.06E-05	NA	NA	2.00E-01	1.53E-04
TPH-DRO	1.58E+00	1,900	4	4.70E-02	20	70	365	1	4.42E-04	1	4.42E-04	NA	NA	4.00E-02	1.10E-02
TPH-ORO	1.32E+00	1,900	4	1.40E-01	20	70	365	1	1.10E-03	1	1.10E-03	NA	NA	3.00E-02	3.66E-02
Lead	1.45E-02	1,900	4	1.00E-04	20	70	365	1	8.63E-09	1	8.63E-09	NA	NA	NA	NA
1-Methylnaphthalene	1.77E-02	1,900	4	1.66E+00	20	70	365	1	1.75E-04	1	1.75E-04	NA	NA	4.00E-03	4.37E-02
2-Methylnaphthalene	9.40E-03	1,900	4	1.66E+00	20	70	365	1	9.28E-05	1	9.28E-05	NA	NA	4.00E-03	2.32E-02
Dibenz(a,h)anthracene	5.50E-05	1,900	4	1.50E+00	20	70	365	1	4.91E-07	1	4.91E-07	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	5.25E-05	1,900	4	1.00E+00	20	70	365	1	3.12E-07	1	3.12E-07	NA	NA	NA	NA
												SUMMATION:	5.82E-08	SUMMATION:	1.15E-01

SOURCES: Section 7.3.3.3, User Guide for Risk Assessment of Petroleum Releases, West Virginia Voluntary Remediation and Redevelopment Act Guidance Manual, November 1999.
Skin Area is from USEPA, 1997, Exposure Factors Handbook, EPA/600/p-95/002Fa. Mean value for hands and forearms used for construction worker.
Oral Absorption Factors and Permeability Constants are from USEPA, 2001, RAGS, Part E, Supplemental Guidance for Dermal Risk Assessment, EPA/540/R/99/005.
PC values are from RAGS -E (USEPA, 2001), with MTBE estimated as follows:

Log PC = -2.80 + 0.66*log Kow - 0.0056*MW and input data as follows:

Chemical	Log Kow	MW	Reference	Calculated PC
MTBE	1.43	88.15	www.syrres.com	0.452
1-methylnaphthalene	3.72	142.2	www.syrres.com	1.66
2-methylnaphthalene	3.72	142.2	www.syrres.com	1.66

TPH-GRO PC assumed = toluene
TPH-DRO assumed = naphthalene
TPH-ORO assumed = pyrene/phenanthrene (surrogate from WV Draft Supplemental Guidance, TPH, Table 3).

NOTES: Body Dose (absorbed) converted to Adjusted Body Dose (administered) by dividing by oral absorption factor, as recommended in RAGS (USEPA, 1989) Appendix A) to allow use of CSFs and RfDs based on administered doses.
Skin surface area for entire body.

APPENDIX D

CHECKLIST TO DETERMINE THE APPLICABLE ECOLOGICAL STANDARD

APPENDIX C-2: CHECKLIST TO DETERMINE THE APPLICABLE ECOLOGICAL STANDARD

This checklist is cross referenced to 60CSR3, the Voluntary Remediation and Redevelopment Rule (the Rule). This checklist is based on Section 9.5 – Ecological – De Minimis Screening Evaluation (cited as 60-3-9.5). The specific references are to subsections of this section of the Rule.

Step 1. Determine Whether a De Minimis Ecological Screening Evaluation is Appropriate for Your Site

See 60-3.9.5.a.1

Check "yes" or "no" to each of the following questions:

1.1 Has there been a release to the environment at or from the site?

_✓_ yes ___ no ___ unknown

If the answer to 1.1 is "no", then no further ecological evaluation is required. File this completed form with the Final Report for the site. If the answer to 1.1 is "yes" or "unknown", proceed to Step 1.2.

1.2 Has the entire site been developed (e.g., predominantly covered by buildings, pavement, etc.)?

_✓_ yes ___ no

If "yes", go to 1.6. If "no", go to 1.3.

1.3 Are there any undeveloped areas on or adjacent to the site (e.g., areas that are not under intensive landscape or agricultural control)?

___ yes ___ no

If the answer to 1.3 is "no" then no further ecological evaluation of terrestrial habitat is required. Continue with Step 1.4.

1.4 Are there any potential wetlands (including vernal pools) on or adjacent to the site?

___ yes ___ no

If the answer to 1.4 is "no", then no further ecological evaluation of wetland habitats is required. Continue with Step 1.5.

1.5 Are there any surface water bodies (i.e., lotic or lentic habitat) on or adjacent to the site?

___ yes ___ no

If the answer to 1.5 is "no", then no further ecological evaluation of lotic and lentic aquatic habitat is required. Continue with Step. 1.6

1.6 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

1.7 Are there any project land uses for the site that would result in undeveloped areas, wetland habitat, lotic habitat, or lentic habitat?

___ yes _✓_ no

If the answers to 1.3 through 1.7 are "no", then no further ecological evaluation is required. File this completed form with the Final Report of the site. If a question was answered "yes", then go to Step 2 because a complete exposure pathway may exist for potential ecological receptors of concern.

Step 2. Identify any Readily Apparent Harm or Exceedances of Surface Water Quality Standards.

See 60-3-2-2.44 and 60-3-9.5.a.5

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 the answer to 2.1 is "yes", go to 2.2; if "no", go to Step 2.3.

2.2 Has the cause of such harm been eliminated?

___ yes ___ no

If the answer to 2.2 is "yes", briefly describe the action taken and continue with this checklist.

If "no", the applicant can proceed directly to the remedy evaluation or alternately proceed with a determination of a Uniform or Site Specific Ecological Standard, as described in the guidance manual prior to implementation of the remedy.

2.3 Is the site contributing to exceedances of Surface Water Quality Standards established for the protection of aquatic life (see 46 CSR1)?

___ yes ✓ no

If the answer to 2.3 is "yes", the applicant can proceed directly to the remedy evaluation or, alternately, proceed with a determination of a Uniform or Site Specific Ecological Standard, as described in the guidance manual prior to implementation of the remedy.

If "no", go to Step 3.

Step 3. Identification of Contamination Associated with Ecological Habitats

See 60-3-9.5.a.2 and 60-3-9.5.a.3

3.1 Have the environmental media (e.g., soil, surface water, sediment, biota) associated with the ecological habitat(s) identified in 1.3 through 1.6 been sampled and analyzed with regard to potential site-related contaminants of concern?

✓ yes ___ no

If the answer to 3.1 is "yes", proceed to 3.2; if "no", proceed 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 ___ not applicable (no terrestrial)

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 ___not applicable (no wetland/aquatic habitat)

If the answer to 3.3 is "yes", go to 3.4. If the answer is "no", go to 3.6.

3.4 Are site related contaminants presenting an ecological risk over and above "local" condition?

___ yes ___ no

If the answer to 3.4 is "yes", go to Step 4. If the answer is "no", go to 3.5.

3.5 Have site-related releases of contaminants been stopped?

___ yes ___ no

If the answer to 3.5 is "yes", go to 3.6. If the answer is "no", go to Step 4.

3.6 Are site-related contaminants currently migrating to aquatic habitat (e.g., lotic, lentic, or wetland habitat)?

___ yes _✓_ no ___ not applicable (no aquatic habitat)

If the answers to 3.2, 3.3, and 3.6 are "no" or "not applicable", no further ecological evaluation is required. File this completed form with the Final Report for the site. If the answers to 3.2, 3.3, or 3.6 are "yes", proceed to Step 4 because a complete exposure pathway may exist.

Step 4. Characterize the Potential Ecological Habitat

See 60-3-9.5.a.4

4.1 Describe the general land use in the immediate vicinity of the site.

___	Urban	___	Industrial / Commercial
___	Rural / Agricultural	___	Rural / Undeveloped
___	Residential	___	Other (Describe) ______________

4.2 For all affected areas that fulfill the descriptions in Questions 1.3 through 1.6, answer the following and provide a site map identifying the potential ecological habitat.

4.2.1 Outline the following characteristics for potential terrestrial habitats.
Location: ______________________________
Contiguous area: ______________________________
General topography: ______________________________
Predominant vegetation species: ______________________________
Primary soil type: ______________________________

4.2.2 Outline the following characteristics for potential wetland habitats (e.g., vernal pools, marshes, etc.

Location: ______________________________

Contiguous area: ______________________________

General topography: ______________________________

Predominant vegetation species: ______________________________

Primary soil type: ______________________________

4.2.3 Outline the following 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 the river / creek and riparian zone: ______________________________

Local conditions: ______________________________

4.2.4 Outline the following characteristics for potential lentic habitats (e.g., standing water habitats such as lakes and ponds).

Location: ______________________________

Is the pond / lake natural or man-made: ______________________________

Area of the pond / lake: ______________________________

Typical and maximum depth: ______________________________

Brief description of sources and drainage: ______________________________

Predominant aquatic vegetation: ______________________________

Topography of the littoral zone: ______________________________

Predominant vegetation in littoral zone: ______________________________

Human utilization of the pond / lake and shoreline: ______________________________

Local conditions: ______________________________

4.3 Indicate if the site contains or is adjacent to any of the following types of valued terrestrial habitats:

___ Area designated as a National Preserve

___ Federal land designated for protection of natural ecosystems

___ National or State wildlife refuge

___ Designated Federal wilderness area or administratively proposed wilderness area

___ Federal or State land designated for wildlife or game management

___ Nationa l or State park

___ National or State forest

___ State designated natural area

___ Climax community (e.g., old growth forest)

___ Area utilized for breeding by large or dense aggregations of wildlife

___ Area important to the maintenance of unique biotic communities (e.g., area with a high proportion of endemic 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
___ Habitat needed for feeding, breeding, nesting, cover, or wintering habitat for migratory birds

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., area with a high proportion of endemic species)
___ Area utilized for breeding by large or dense aggregations of wildlife
___ Feeding, breeding, nesting, cover, or wintering habitat for migratory waterfowl or other aquatic birds
___ Spawning or nursery areas critical to the maintenance of fish / shellfish species
___ Critical habitat for Federal-designated threatened or endangered species
___ Habitat known to be used or potentially used by Federal or State designated threatened or endangered species.

4.5 Indicate if the site is within or adjacent to any of the following valued aquatic habitats:

___ Area important to the maintenance of unique biotic communities (e.g., area with a high proportion of endemic species
___ Critical areas identified under the Clean Lakes Program
___ National river reach designated as recreational
___ Federal or State designated scenic or wild river
___ Federal or State fish hatchery
___ Trout-stocked streams or wild trout streams with verified trout production
___ Habitat needed for feeding, breeding, nesting, cover, or wintering habitat for migratory waterfowl or other aquatic birds
___ Spawning or nursery areas critical to the maintenance of fish / shellfish species
___ Critical habitat for Federal designated threatened or endangered species
___ Habitat known to be used or potentially used by Federal or State designated threatened or endangered species

4.6 Have valued terrestrial, wetland, or aquatic habitats been identified within or adjacent to the site?

___ yes ___ no

(A list of agencies that can provide information that should assist in making a determination of whether the site is located within or adjacent to the areas listed in 4.3, 4.4, and 4.5 is provided at end of Section C2)

After completing 4.6, proceed to Step 5.

Step 5. Identify any Potential Ecological Receptors of Concern

See 60-3-2.2.14 and 60-3-9.5.a.4

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 50 CFS 17.95 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:

Mammals:

___ Gray bat *(Myotis grisescens)*
___ Indiana bat *(Myotis sodalis)*
___ Virginia big-eared bat *(Corynorhinus towsendii virginianus)*
___ Virginia northern flying squirrel *(Glaucomys sabrinus fuscus)*
___ Eastern cougar *(Felis concolor couguar)*

Birds:

___ Bald eagle *(Haliaeetus leucocephalus)*

Amphibians:

___ Cheat Mountain salamander *(Plethodon nettingi)*

Snails:

___ Flat-spired three-toothed land snail *(Triodopsis platysayoides)*

Clams:

___ Pink mucket pearlymussel *(Lampsilis abrupta)*
___ Tuberculed blossom pearlymussel *(Epioblasma torulosa torulosa)*
___ James spinymussel *(Pleurobema collina)*
___ Fanshell *(Cyprogenia stegaria)*
___ Clubshell *(Pleurobema clava)*
___ Northern riffleshell *(Epioblasma torulosa rangiana)*

Flowering Plants:

___ Shale barren rock cress *(Arabis perstellata)*
___ Harperella *(Ptilimnium nodosum)*
___ Northeastern bulrush *(Scirpus ancistrochaetus)*
___ Virginia spiraea *(Spiraea virginiana)*

___ Running buffalo clover *(Trifolium stoloniferum)*
___ Small whorled pogonia *(Isotria medeoloides)*

(The above list contains those federally designated threatened and endangered species that are indigenous to West Virginia. They will be revised as necessary to reflect changes to a species federal designation (e.g., addition or removal of a species from the list of federally designated species). The West Virginia Division of Natural Resources, Wildlife Resources Section should be consulted to ensure the above list is current. Note that West Virginia has not established a list of State designated threatened or endangered species. If such a list is established, the Federal designated species list will be revised to include State designated threatened and endangered species.)

5.2 Local populations that provide 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

(The valued terrestrial, wetland, and aquatic habitats listed in 4.3, 4.4, and 4.5 may potentially contain local populations that provide important natural or economic resources, functions, and values)

If 5.1 and 5.2 are answered "no" and surface water bodies are shown to be in compliance with Appendix J. the ecological evaluation is complete and the site has passed the De Minimis Ecological Screening Evaluation. File this completed form with the Final Report for the site.

If either 5.1 or 5.2 are answered "yes", 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. See Guidance Manual, Section 4.

West Virginia Division of Natural Resources
Main Office
State Capitol Complex, Building 3
1900 Kanawha Boulevard
Charleston, West Virginia 25305
(304) 558-2754
http://www.dnr.state.wv.us/default.htm

West Virginia Division of Natural Resources
Wildlife Resources Section
PO Box 67
Elkins, West Virginia 26241
(304) 637-0245
http://www.dnr.state.wv.us/wvwildlife/default.htm

West Virginia Division of Forestry
1900 Kanawha Boulevard East
Charleston, West Virginia 25303
(304) 558-2788

US Fish and Wildlife Service
West Virginia Ecological Services Field Office
Elkins Shopping Plaza
PO Box 1278
Elkins, West Virginia 26241
(304) 636-6586
http://northeast.fws.gov/wv.htm

US Department of Agriculture
Natural Resource and Conservation Service
75 Night Street -- Room 301
Morgantown, WV 26505
(304) 291-4153

APPENDIX E

DETERMINATION OF SITE-SPECIFIC DILUTION FACTOR

Appendix E
Determination of Site-Specific Dilution Factor
Former PQS Etowah Terminal

Lead concentrations were detected above the West Virginia groundwater De Minimis levels in groundwater samples collected from TMW/SB-16 (located along the western property boundary downgradient from the diked AST areas) and TMW/SB-17 (along the western property boundary downgradient from the former pump house and ASTs). The two sampling locations are approximately 60 feet apart. Lead concentrations were not documented above the referenced De Minimis levels in any other groundwater samples. Therefore, it is assumed that a 120 feet wide section of the saturated groundwater unit in vicinity of TMW/SB-16 and TMW/SB-17 had groundwater lead concentrations above the referenced De Minimis level. Groundwater flowing through this section discharges to the Elk River where it is diluted with the Elk River flow. The volume of groundwater discharging from this section to the Elk River was calculated as following.

Qgw = K x i x L X b

where:

Qgw = Volume of groundwater with Lead exceedences discharging from the Site to the Elk River;

K = Hydraulic conductivity of the saturated media (1.67 ft/day from slug tests)

i = Hydraulic gradient (0.18 ft/ft in vicinity of TMW/SB-and TMW/SB-17)

L = Width of the aquifer section through which groundwater with lead exceedences discharges

b = saturated thickness (40 ft; approximated from geological cross-section)

Qgw = 1445 cubic ft /day = 7.5 gallons/min = 0.017 cubic feet per second

The dilution factor is then calculated by the following equation:

D = Qsw / Qgw

where:

D = Dilution Factor,

Qsw = Volume of surface water in the Elk River, and

Qgw = Volume of groundwater with Lead exceedences discharging from the Site to the Elk River.

The 7Q10 statistic is calculated for streams and rivers to describe low flow conditions of the water body. However, based on personal communication (USGS, October 12, 2004), 7Q10 data is not available for the Elk River because the surface water flow is regulated by the dam on the Elk River at Sutton Lake in

Sutton, West Virginia. According to the USGS, minimum flow from the dam is 75 cubic feet per second. Since the Former Etowah Terminal is approximately 70 miles downstream from Sutton Lake, the use of this minimum flow rate is considered conservative. Using this flow as the flow for the Elk River the following dilution factor is calculated:

$D = 75 \text{ cfs} / 0.017 \text{ cfs} = 4{,}411 \approx 4{,}000.$

The above dilution factor assumes instantaneous mixing of the lead plume in the Elk River. To account for the potential that mixing of the plume is not instantaneous, one-tenth (or 400) of the dilution factor will be used for risk assessment purposes as a conservative approximation of the site-specific dilution factor.

Image:
SCAN-1

Xref: