Limited Phase II Investigation Report

Scott's Ivy Exxon Site
Charlottesville, Virginia

ANALYTICAL SERVICES, INC.

Limited Phase II Investigation Report

Scott's Ivy Exxon Site – 4260 Ivy Road
Charlottesville, Virginia

Prepared for:

Mr. Scott Ramm
Scott's Ivy Exxon
4260 Ivy Road
Charlottesville, Virginia 22903

Prepared by:

Analytical Services, Incorporated
402 N. West Street
Culpeper, Virginia 22701

Date: April 12, 2013

Limited Phase II Investigation Report

Scott's Ivy Exxon Site – 4260 Ivy Road
Charlottesville, Virginia

Prepared for:

Mr. Scott Ramm
Scott's Ivy Exxon
4260 Ivy Road
Charlottesville, Virginia 22903

Prepared by:

Analytical Services, Incorporated
402 N. West Street
Culpeper, Virginia 22701

Michael L. Maloy, CPG
Senior Geologist, Principal

Thomas P. Nelson, PG
Hydrogeologist

Date: April 12, 2013

Table of Contents

<u>List of Figures</u>

<u>List of Tables</u>

<u>List of Appendices</u>

1.0 Introduction

Analytical Services, Inc. (ASI) is pleased to provide the following report documenting our findings during a limited investigation performed at the Scott's Ivy Exxon site located at 4260 Ivy Road in Charlottesville, Virginia. The investigation was performed at the request of our client, Mr. Scott Ramm, as part of the due diligence process for a future real estate transaction. The investigation consisted of a subsurface investigation at the site and a review of documents from an open leaking underground storage tank (LUST) site located within 100 feet of the Scott's Ivy Exxon site.

The Scott's Ivy Exxon site is currently being operated as a gasoline and diesel fueling station and as an automotive repair shop. Two buildings are present at the site; the southern building is used as an automotive repair shop (service building) and the northern building is residential (residential building). Gasoline and diesel fueling dispensers are present to the south of the service building. The gasoline fueling island is supplied by two active underground storage tanks (USTs). According to the Virginia UST database, these tanks have capacities of 8,000 gallons and 12,000 gallons, and were installed in 1998. The diesel fueling dispenser is supplied by a 500-gallon aboveground storage tank (AST). The residential building is supplied by a heating oil UST of unknown capacity. A railroad runs along the northern boundary of the site.

The subsurface investigation focused on the gasoline UST basin, an oil change pit, a diesel AST, an out-of-service hydraulic lift and the reported location of a used oil UST and kerosene UST near the northern side of the service building that may, or may not, have been previously removed (see Section 1.1). Your Locator, a private utility locating service, was used to supplement Miss Utility's clearance and line marking at the site. The private utility locator was also used to search the northern side of the service building for indications of the presence of potential USTs where the used oil UST and kerosene UST were reported to have previously existed. Additionally, the investigation addressed the existing residential structure which may have been used as a gasoline station prior to the 1950s. Investigation conducted at the residential structure included utilizing metal locating equipment to screen the yard area for the presence of metallic anomalies, conducting soil borings and sampling, and assessing the subsurface near an existing heating oil UST. In addition shallow soils were sampled near the railroad that lies along the site's northern boundary.

A Geoprobe® direct push drill rig, operated by Bedford Well Drilling, was utilized to collect soil cores and samples from near the UST basin, near the diesel AST, near the reported used oil tank and kerosene tank, and near the residential building. The subsurface investigation consisted of soil characterization, field screening of soil using a photoionization detector (PID), soil sampling, and laboratory analysis of the soil samples to provide a screening-level assessment of overburden soils for the presence of potential contaminants. A grab sample of groundwater was also collected from one boring located near the UST basin. A site location map has been provided as Figure 1 and site layout maps showing site features and sampling locations have been provided as Figures 2a and 2b.

1.1 Summary of Phase I Environmental Site Assessment

ASI completed a Phase I Environmental Site Assessment (ESA) of the Scott's Ivy Exxon site on February 28, 2013 (Analytical Services Inc. 2013). The ESA revealed that the site has been used as a gasoline station since at least the 1950s, and possibly longer. There have been two documented past releases from USTs at the site. The first release was reported in February 1997 (PC#1997-5102) and the second release was reported in November 1998 (PC#1999-5133) following the removal of three 6,000-gallon gasoline USTs. A soil concentration of 85 milligrams per kilogram (mg/Kg) was documented in the vicinity of the UST basin during the investigation of PC#1997-5102 and a soil concentration of 143.2 mg/Kg was documented in the vicinity of the UST basin during the investigation of PC#1999-5133. Both releases have since been closed.

The investigation also identified that four USTs have been removed from the ground in the past. These tanks include three 6,000-gallon gasoline USTs and one 500-gallon kerosene UST according to Virginia UST database records. All three of the 6,000-gallon gasoline USTs were removed in October 1998 and the 500-gallon kerosene UST was reported to have been removed at an unknown date.

The Phase I ESA revealed a correspondence dated March 7, 1997 between the Virginia Department of Environmental Quality (DEQ) and a former owner of the Scott's Ivy Exxon site, Mr. Roy Bailey, Jr. In the letter, the Virginia DEQ recommends the proper closure of two inactive USTs, a 250-gallon used oil tank and a 250-gallon kerosene tank. Although Mr. Roger Gibson, the current property owner, believes that these USTs were removed by Mr. Bailey, closure documentation within the Virginia DEQ's records was not found.

ASI recommended that a Phase II ESA be completed to investigate potential impacts associated with:

-historical use of petroleum storage tanks, oil change pit and hydraulic lift cylinder;
-potentially existing waste oil and/or kerosene UST;
-offsite release at Toddsbury of Ivy property
-residence, heating oil UST and potential use as a former gasoline station
-railroad

In addition, ASI also recommended an inventory of ASTs at the Scotts Ivy Exxon site along with an estimate of aggregate AST storage volume.

2.0 Subsurface Investigation

2.1 Service Building

On March 21, 2013, ASI personnel supervised the completion of five soil borings to a depth of 8–16 feet below ground surface (bgs) in the area of the service building. The borings were completed with a direct push Geoprobe® drill rig and were identified as

Boring 1, 2, 3, 4, and 5 (Figure 2b). Additionally, ASI personnel used a hand-auger to bore to a depth of 5.3 feet bgs near the used oil UST. The hand-augered sample collected near the service building is identified as Service Building: Auger (Figure 2b). A soil sample was also collected in the service building, beneath the concrete building foundation in an oil-changing bay, and is identified as Sub-Slab (Figure 2b).

Utility clearance was requested from Miss Utility and a private utility locator was also used to further screen the work area for underground utilities prior to drilling. Continuous sampling cores (48 inches in length) were extracted during drilling. The soil cores were visually inspected and logged by an ASI geologist. Soil samples were then collected at appropriate intervals, as determined by ASI personnel based on field observations, and placed in a sealable plastic bag. Each bagged sample was field-screened for the presence of volatile organic compound (VOC) vapors via a PID. Recorded PID readings that exceeded two parts per million (ppm) have been summarized in Table 1.

Soil samples collected from selected borings were submitted for laboratory analysis. ASI personnel determined which samples to submit for laboratory analysis based on PID readings and boring proximity to site features of interest. The following samples collected from borings near the service building were submitted for laboratory analysis: **(1)** soil samples identified as Boring 1 and Boring 2 were submitted for analysis of total petroleum hydrocarbons- (TPH) gasoline range organics (GRO) via method 8015B. The sample collected from Boring 1 was a composite sample from depth intervals 8.0–10.0 feet bgs, 10.8–11.8 feet bgs, and 13.5–14.5 feet bgs, with the majority of the sample being collected from the 10.8–11.8 feet bgs interval. The Boring 2 sample was collected from the 7.0–8.0 feet bgs interval. **(2)** Soil sample identified as Boring 3 was submitted for analysis of TPH-GRO and TPH-diesel range organics (DRO) via method 8015B. This sample was collected from depth intervals 8.5–10.0 feet bgs and 10.5–12.0 feet bgs. **(3)** Soil sample identified as Boring 5 was submitted for analysis of oil and grease (O&G) via method 1664. This sample was collected from depth interval 4.0–8.0 feet bgs. **(4)** Soil sample identified as Sub-Slab was submitted for laboratory analysis of O&G via method 1664. This sample was collected from a depth of less than one foot below the bottom of the concrete building foundation.

In addition to the soil samples, a disposable bailer was used to collect a groundwater sample from Boring 1. The groundwater sample, identified as Boring 1, was collected from an open borehole and submitted for analysis of benzene, toluene, ethylbenzene, and xylene (BTEX) via method 8021. While no measurable free product was observed in Boring 1, the water did possess a petroleum odor.

Table 2 summarizes the results of the TPH-GRO, TPH-DRO, and oil and grease constituents detected in soil samples that were submitted for laboratory analysis, and Table 3 summarizes the results of the BTEX constituents detected in the Boring 1 groundwater sample that was submitted for laboratory analysis. The tables include Virginia DEQ/Voluntary Remediation Program (VRP) screening levels for comparison purposes. A copy of the laboratory report and chain-of-custody documentation provided by Phase Separation Science, Inc. has been included in Appendix A.

2.2 Residential Building and Adjoining Railroad

Two soil borings were completed to depths of six and 12 feet bgs in the reported vicinity of the residential building at the site. The borings were identified as Borings 6 and 7 (Figure 2b). Additionally, one hand-augered boring was completed to a depth of 4.6 feet bgs in the vicinity of the residential building's heating oil tank and a second hand-augered boring was completed to a depth of less than one foot bgs within 10 feet of the railroad. The hand-augered borings were identified H.O. Tank: Auger and Railroad: Auger, respectively (Figure 2b). None of the soil samples from Boring 6, Boring 7, H.O. Tank: Auger, nor Railroad: Auger exceeded two ppm.

Soil samples collected from selected borings were submitted for laboratory analysis. ASI personnel determined which samples to submit for laboratory analysis based on PID readings and boring proximity to site features of interest. The following samples collected from borings near the residential building were submitted for laboratory analysis: **(1)** soil sample identified as Boring 6 was submitted for analysis of TPH-GRO via method 8015B. This sample was collected from depth interval 4.0–6.0 feet bgs. **(2)** Soil sample identified as H.O. Tank was submitted for analysis of TPH-DRO via method 8015B. This sample was a composite of material collected from the ground surface to a depth of 4.6 feet bgs. **(3)** Soil sample identified as Railroad was submitted for analysis of polychlorinated biphenyls (PCBs) via method 8082A. This sample was a composite of material collected from directly beneath the concrete building foundation to a depth of less than one foot beneath the bottom of the foundation. Table 2 summarizes the results of the TPH-GRO, TPH-DRO, and PCB constituents detected in these soil samples.

Table 1
Summary of Soil Sample PID Readings Greater than 2 Parts Per Million

Soil Boring Identification	Total Boring Depth (feet)	PID[a] Readings (ppm[b]) (sample interval in feet below ground surface)					
		6.5-8.0 feet	7.0-8.0 feet	8.0-10.0 feet	10.8-11.8 feet	13.5-14.5 feet	14.5-16.0 feet
Boring 1	16	32.3	NS[c]	326	1,875	348	106
Boring 2	12	NS	22.3	NS	NS	NS	NS
Boring 3	12	No readings greater than 2 ppm in boring					
Boring 4	12	No readings greater than 2 ppm in boring					
Boring 5	8	No readings greater than 2 ppm in boring					
Boring 6	6	No readings greater than 2 ppm in boring					
Boring 7	12	No readings greater than 2 ppm in boring					
Service	5.3	No readings greater than 2 ppm in boring					

Building: Auger		
H.O. Tank: Auger	4.6	No readings greater than 2 ppm in boring
Railroad: Auger	<1	No readings greater than 2 ppm in boring
Sub-Slab	<1	No readings greater than 2 ppm in boring

[a]PID = photoionization detector
[b]ppm = parts per million
[c]NS = sample not collected from this depth interval

Table 2
Soil Sampling Results
(Sampled March 21, 2013)

Boring Identification	**TPH-GRO[a] (mg/Kg[b])**	**TPH-DRO[c] (mg/Kg)**	**Oil and Grease (mg/Kg)**	**PCB[d] (mg/Kg)**
Boring 1	1,300	NA[e]	NA	NA
Boring 2	0.240	NA	NA	NA
Boring 3	NA	<5.3	NA	NA
Boring 5	NA	NA	<62	NA
Boring 6	<0.130	NA	NA	NA
H.O. Tank	NA	<4.8	NA	NA
Railroad	NA	NA	NA	<0.14 for all analyzed PCB constituents
Sub-Slab	NA	NA	<150	NA
VDEQ[f] Limit (mg/Kg)	100	None Provided	None Provided	None Provided
VVRP[g] Tier III Screening Concentration: Soil Restricted Commercial /Industrial (mg/Kg)	None Provided	None Provided	None Provided	0.74 mg/Kg for Total PCBs

Red indicates exceedance in screening concentration value
[a]TPH-GRO = total petroleum hydrocarbons-gasoline range organics
[b]mg/Kg = milligrams per kilogram
[c]TPH-DRO = total petroleum hydrocarbons-diesel range organics
[d]PCB = polychlorinated biphenyls
[e]NA = sample not analyzed for this constituent
[f]VDEQ = Virginia Department of Environmental Quality
[g]VVRP = Virginia Voluntary Remediation Program

Table 3
Groundwater Sampling Results
(Sampled March 21, 2013)

Benzene, Toluene, Ethylbenzene, and Xylene via Method 8021B		
Constituent	**Boring 1 Concentration (µg/L[a])**	**VVRP[b] Tier III Commercial Groundwater Screening Level (µg/L)**
Benzene	210	43.9
Toluene	180	8,050
Ethylbenzene	4,200	27.6
m,p-Xylenes	12,000	None Provided
o-Xylene	470	206
Xylenes total	12,470	206

Red indicates exceedance in screening concentration value
[a] µg/L = micrograms per liter
[b] VVRP = Virginia Voluntary Remediation Program

3.0 Document Review of Adjoining Leaking Underground Storage Tank Site

Analytical Services, Inc. reviewed documents from the Toddsbury of Ivy LUST site (PC#01-6134), which is located less than 100 feet southwest of the Scott's Ivy Exxon site, at the intersection of Highway 250 and Ivy Depot Road, in Charlottesville, Virginia. The documents were obtained from the DEQ via a freedom of information request. Based on the document review, the Toddsbury of Ivy site had been operating as a gasoline station since at least the early 1950's and contained three 3,000-gallon USTs at the time of initial investigation. A Site Characterization Report (SCR) was completed by Jeffrey A. Sitler Environmental Service, Inc. (JAS), from Charlottesville, Virginia, in January 2002 (JAS 2002a) and an addendum to the SCR was completed in April 2002 (JAS 2002b) in response to an inconclusive pressure test to the piping lines at the site. Both of these reports are included in Appendix B.

The SCR included the installation and sampling of four monitoring wells in the shallow groundwater system between November 2001 and February 2002. Groundwater levels were measured and groundwater samples were collected from these wells to determine groundwater flow direction, gradient, and contamination levels. It was determined that groundwater from the shallow aquifer flows in an east-southeast direction toward Little Ivy Creek, under a gradient of 0.01–0.03, and discharges into the creek. Laboratory analysis of the samples for TPH-GRO, BTEX, and methyl tert-butyl ether (MTBE) indicated elevated levels of benzene and highly elevated levels of MTBE in the immediate vicinity of the site's UST basin. Laboratory analysis also indicated elevated levels of MTBE in a monitoring well located 75 feet downgradient from the UST basin, although levels were two orders of magnitude less than the concentration measured in the immediate vicinity of the UST basin. Overall, the investigation showed that a release had occurred at an unknown time from the site's USTs, and that although elevated levels of benzene and MTBE were present in the groundwater near the USTs, the lateral extent of the plumes was minimal.

TPH-GRO, BTEX, and MTBE were monitored in the site's wells from February 2002 to March 2004. During this monitoring period, contaminants in the source area did not diminish appreciably and concentrations increased in the downgradient monitoring well. Also during this monitoring period, it was determined that the groundwater contamination plume had approximate dimensions of 75 feet in width by 125 feet in length. A request for a Corrective Action Plan (CAP) was then issued by the Virginia DEQ in March 2004, which was developed by JAS (JAS 2004) and is included in Appendix B.

The final CAP consisted of conducting the following actions: (1) Removal of two of the site's three USTs and inactivate the third UST that is located beneath a building; (2) excavate contaminated soil in the vicinity of the UST basin; (3) install a groundwater pumping system to remove dissolved-phase contaminants from the shallow groundwater system, including the installation of a recovery well completed to a depth of 80 feet bgs into the fractured bedrock; (4) install a soil-vapor extraction (SVE) system in the vicinity of the source area to removed adsorbed-phase contaminants in the vadose zone and free-phase gasoline on the surface of the water table; and (5) quarterly monitoring of the site.

As of the most recent CAP monitoring report, dated February 28, 2013, TPH-GRO and BTEX levels were below laboratory detection limits in all of the monitoring wells. Additionally, MTBE levels were below laboratory detection limits in all of the site's wells except the 80-feet deep recovery well and the furthest downgradient monitoring well. Concentrations of MTBE in these wells were 4.9 micrograms per liter (µg/L) and 2.0 µg/L, respectively (JAS 2013). A copy of this report is included in Appendix B.

4.0 Above Ground Storage Tank Inventory

ASI performed an inventory of ASTs at the site in an attempt to determine if AST aggregate storage volume triggers Spill Prevention, Control, and Countermeasures Plan (SPCC) requirements for the site. The following ASTs were identified at the site:

Exterior Tanks	
Diesel AST -	500 gallons
Waste Oil AST (rectangular)-	300 gallons
Motor Oil 1 -	275 gallons
Motor Oil 2 -	275 gallons
Green Heating Oil AST -	275 gallons
Red Heating Oil* -	275 gallons
Subtotal	1,900 gallons

Interior Tanks	
Pit Waste Oil 1 -	275 gallons
Pit Waste Oil 2 -	275 gallons
Subtotal	550 gallons
Total	2,450 gallons

* reported to be out of service

The existing aggregate volume for the site is deemed to be 2,450 gallons plus any existing 55-gallon drums that are onsite which contain oil. According to EPA personnel heating ASTs used for heating oil at commercial business locations are to be included within the sites aggregate AST storage. The aggregate AST volume was found to exceed the 1,320 gallon aggregate storage threshold for SPCC Plan requirements.

5.0 Discussion of Findings

5.1 Soil Characterization

Similar geologic conditions were encountered in Borings 1 and 2, which were installed in close proximity to each other on the eastern portion of the site. A dark red colored, silty-clay layer was encountered in both borings from beneath the surface fill to a depth of approximately seven feet bgs. Beneath this layer was a light brown colored, silty-clay layer with a higher percentage of silt than in the overlying layer, and was present to a depth of 11 feet bgs. A fine- to coarse-grained, poorly sorted, angular, saturated sand layer was encountered at a depth of 11 feet in both borings, and was approximately one foot thick. Finally, interbedded sand and silty-clay layers were encountered from 12–16 feet bgs in Boring 1. The sand at this interval was fine- to coarse-grained, poorly sorted, angular, saturated, and contained gravels with a diameter of greater than one inch, and the silty-clay at this interval was light brown colored and soft, with moderate plasticity. The most prominent sand layer at the 12–16 feet bgs interval was encountered at 14.1–15.5 feet bgs, and the most prominent silty-clay layer was encountered at 12.0–13.5 feet bgs. It is likely that the geologic material observed in these borings from 7–16 feet bgs are fluvial deposits from a stream located approximately 150 feet east of the borings.

Similar geologic conditions were encountered in Borings 3, 4, 5, 6, and 7. Dark red colored, silty-clay with some sand and gravel was encountered in Borings 3, 4, and 5 to a depth of 4–7 feet bsg. Highly weathered saprolite was encountered beneath this layer to the total depth of these borings. Borings 6 and 7 encountered the same saprolite directly beneath the surface-fill material.

The hand-augered borings showed similar geologic conditions as well. Dark red colored, silty-clay was encountered from beneath the surface-fill material to total augering depth in all of the augered borings.

Soil collected from the Geoprobe® and hand-augered borings provided insight into geologic conditions at the subject property. The borings indicate that unconsolidated overburden sediment is thickest in the vicinity of Borings 1 and 2, as evidenced by these borings not encountering the saprolite that was observed in all of the other Geoprobe® borings. The investigation also revealed that saprolite is within four feet of the surface throughout much of the subject property, as evidenced by the soil cores collected from Borings 3 through 7. The investigation revealed that the brown, silty-clay layers and sand layers observed in Borings 1 and 2, which appear to be of fluvial origin, pinch out before extending westward to the other borings. It is likely that these sand layers have the ability to transmit groundwater at a relatively fast flow rate.

5.2 Soil and Groundwater Sampling

Existing UST Basin Area

Groundwater analytical results of a sample collected from Boring 1 indicate that concentrations of benzene, ethylbenzene, o-xylene, and total xylenes exceed Virginia VRP Tier III screening levels (Table 2). Additionally, soil analytical results of a sample collected from Boring 1 indicate that the concentration of TPH-GRO exceeds the Virginia DEQ UST reporting level for TPH (Table 3). None of concentrations of other analyzed constituents in the soil and groundwater samples collected from the site exceeded Virginia VRP or DEQ screening levels.

Based on soil and groundwater sampling and analytical results generated from this limited Phase II Subsurface Investigation, the area in the vicinity of the UST basin has been impacted by a release of petroleum hydrocarbons. An elevated TPH concentration, found to be above the Virginia DEQ action level, was detected in soil at the site within the gasoline range (TPH-GRO). Additionally, concentrations of BTEX constituents were measured in groundwater from Boring 1 that exceeded Virginia VRP Tier III screening levels. It is likely that the source of this release is associated with either historical or current gasoline USTs used at the site. The existing UST tank pit is located in an apparent upgradient location and in close proximity to Boring 1. Further evidence toward the gasoline UST(s)/pit being the source of the release is that the TPH-GRO concentration measured in the Boring 2 soil sample, which is located in an apparent upgradient direction from the UST basin and Boring 1, contained a relatively low TPH-GRO concentration.

The Virginia DEQ requires that a release of petroleum resulting in soil samples exhibiting TPH concentrations of greater than 100 mg/Kg be reported. Given that the TPH-GRO concentrations noted in soil sample Boring 1 is above 100 mg/Kg, a copy of this report should be submitted to the Virginia DEQ.

Potential Used Oil UST and Kerosene UST

During investigation of the area where both a used oil and kerosene tank had reportedly existed, no direct evidence of an existing buried tank was identified and no evidence of petroleum impact to soils within the areas investigated were found. A metal line does exist from the oil change pit to the area north of the station, however, it abruptly appears to stop based on utility locating equipment readings.

Diesel AST and Hydraulic Lift

A single boring and soil sampling completed in close proximity to the diesel AST and the western most service bay did not yield any evidence of petroleum impacted soil. The out-of-service hydraulic lift should be accessed and any remaining hydraulic oil removed. Removal of the lift is recommended and at such time a better assessment of the soil conditions beneath the lift could be made.

Residence and Railroad

It remains unclear whether the existing building was used as a gasoline station. The existing porch on the structure has been built over deteriorating concrete steps that suggest the building has been in its current location for an extended period of time. The owner of the property had indicated that the building may have been moved to its present location and that the building may have once been closer to the road (Rt. 250). Two relatively small metallic anomalies were identified in the front (southern side) of the residential structure with utility locating equipment. A soil boring was completed near each area and no direct evidence of a tank or petroleum impact was identified. A soil boring was also completed adjacent to a heating oil UST that lies along the northern side of the residence. Again, no evidence of petroleum impact to soils was noted.

A shallow boring was completed near the railroad track and screened with a PID. No elevated PID readings were observed. The sample was submitted for analysis of PCBs and no detection was identified.

5.3 Adjoining Leaking Underground Storage Tank Site

ASI reviewed documents provided by the Virginia DEQ related to the Toddsbury of Ivy LUST site, located on the southwestern adjoining property. The documents showed that a release had occurred from the site's gasoline USTs sometime prior to November 2001, resulting in a benzene and MTBE groundwater contamination plume. A CAP was implemented at the site in 2004 that consisted of UST removal/closure, contaminated soil excavation, installation of a groundwater pumping system and SVE system, and quarterly monitoring.

The CAP actions have reduced concentrations of all contaminants of concern with the exception of MTBE to below laboratory detection limits. Concentrations of MTBE were detected at levels exceeding laboratory detection limits in two of the site's wells during the most recent sampling event, although both wells' concentrations were less than 5 µg/L. Additionally, site data from back to 2001 indicates that the site's groundwater contamination plume has a minimal lateral extent, and discharges to Little Ivy Creek.

It is unlikely that contaminated groundwater from the Toddsbury of Ivy site has impacted groundwater at the Scott's Ivy Exxon site. Shallow groundwater at the Toddsbury of Ivy site has been documented to flow in an east-southeast direction, toward Little Ivy Creek.

Based on this information, it is likely that Scott's Ivy Exxon is located hydraulically cross-gradient from the Toddsbury of Ivy site. Additionally, the maximum lateral extent of the Toddsbury of Ivy site's groundwater contaminant plume has been defined, as determined during site monitoring, and does not extend beneath the Scott's Ivy Exxon site.

5.4 AST Inventory

Based on identified inventory of above ground storage tanks (ASTs) used at the site, and the apparent aggregate storage volume of the existing ASTs, the site does require a Tier 1 Spill Prevention, Control, and Countermeasures Plan (SPCC).

6.0 Conclusions

ASI has performed a limited Phase II Subsurface Investigation to provide a screening level assessment of overburden soils and groundwater for the presence of potential contaminants that may be present at the Scott's Ivy Exxon site. The subsurface investigation focused on concerns identified within a Phase I ESA previously prepared for the site (ASI 2013).

Based on soil and groundwater sampling and analytical results generated from this limited Phase II Subsurface Investigation, the area in the vicinity of the gasoline UST basin has been impacted by a release of petroleum hydrocarbons. An elevated concentration of TPH-GRO was measured in a soil sample collected from a boring located hydraulically downgradient from the UST basin, and elevated concentrations of BTEX constituents were measured in a groundwater sample collected from the same boring. The TPH-GRO concentration measured in the soil sample exceeded the Virginia DEQ UST reporting levels for TPH-GRO. Additionally, benzene, ethylbenzene, o-xylene, and total xylenes concentrations measured in the groundwater sample exceeded Virginia VRP Tier III screening levels. As such, a copy of this report should be submitted to the Virginia DEQ.

The results from this limited Phase II Subsurface Investigation are considered useful for screening purposes. However, additional subsurface investigation is recommended to characterize the nature and extent of the petroleum contaminant plume that exists in the area of the existing UST basin.

Based on identified inventory of above ground storage tanks used at the site, and the apparent aggregate storage volume of the existing ASTs, the site does require a Tier 1 Spill Prevention, Control, and Countermeasures Plan (SPCC).

Limited subsurface investigation and sampling conducted at other areas of concern did not yield evidence of environmental impact at the time of this investigation and at the locations investigated.

7.0 Limitations

The work performed in conjunction with this project, and the data developed, are intended as a description of available information at the sample locations indicated and the dates specified. Generally accepted industry standards were used in the preparation of this report. Laboratory data are intended to approximate actual conditions at the time of sampling. Results from future sampling and testing may vary significantly as a result of natural conditions, a changing environment, or the limits of analytical capabilities. This report does not warrant against future operations or conditions, nor does it warrant against operations or conditions present of a type or at a specific location not investigated. The limited sampling conducted was intended to approximate subsurface conditions by extrapolation between data points. Actual subsurface conditions may vary.

ASI has based its recommendations on observable conditions and analytical results from an independent analytical laboratory, which is solely responsible for the accuracy of its methods and results.

8.0 References

[ASI] Analytical Services, Inc. 2013. Phase I Environmental Site Assessment for the Scott's Ivy Exxon site, Charlottesville, Virginia. Report dated 2/28/2013.

[JAS] Jeffrey A. Sitler Environmental Service, Inc. 2002a. Site Characterization Report for Toddsbury of Ivy site (PC#01-6134). Submitted to Virginia Department of Environmental Quality, 01/03/2002.

[JAS] Jeffrey A. Sitler Environmental Service, Inc. 2002b. Site Characterization Report Addendum for Toddsbury of Ivy site (PC#01-6134). Submitted to Virginia Department of Environmental Quality, 04/18/2002.

[JAS] Jeffrey A. Sitler Environmental Service, Inc. 2004. Corrective Action Plan for Toddsbury of Ivy site (PC#01-6134). Submitted to Virginia Department of Environmental Quality, 06/08/2004.

[JAS] Jeffrey A. Sitler Environmental Service, Inc. 2013. CAPI Monitoring Report CAPI Subphase No. 24 for Toddsbury of Ivy site (PC#01-6134). Submitted to Virginia Department of Environmental Quality, 02/28/2013.

Figures

Appendix A

Laboratory Analytical Results

Analytical Report for

Analytical Services, Inc.(VA)

Certificate of Analysis No.: 13032603

Project Manager: Mike Maloy
Project Name : Scott's Ivy Exxon
Project Location: Ivy, VA
Project ID : 3351

April 2, 2013
Phase Separation Science, Inc.
6630 Baltimore National Pike
Baltimore, MD 21228
Phone: (410) 747-8770
Fax: (410) 788-8723

OFFICES:
6630 BALTIMORE NATIONAL PIKE
ROUTE 40 WEST
BALTIMORE, MD 21228
410-747-8770
800-932-9047
FAX 410-788-8723

**PHASE
SEPARATION
SCIENCE,
INC.**

April 2, 2013

Mike Maloy
Analytical Services, Inc.(VA)
402 N West Street
Culpepper, VA 22701

Reference: PSS Work Order(s) No: **13032603**
Project Name: Scott's Ivy Exxon
Project Location: Ivy, VA
Project ID.: 3351

Dear Mike Maloy :

This report includes the analytical results from the analyses performed on the samples received under the project name referenced above and identified with the Phase Separation Science (PSS) Work Order(s) numbered **13032603**.

All work reported herein has been performed in accordance with current NELAP standards, referenced methodologies, PSS Standard Operating Procedures and the PSS Quality Assurance Manual unless otherwise noted in the Case Narrative Summary. PSS is limited in liability to the actual cost of the sample analysis done.

PSS reserves the right to return any unused samples, extracts or related solutions. Otherwise, the samples are scheduled for disposal, without any further notice, on April 30, 2013. This includes any samples that were received with a request to be held but lacked a specific hold period. It is your responsibility to provide a written request defining a specific disposal date if additional storage is required. Upon receipt , the request will be acknowledged by PSS, thus extending the storage period.

This report shall not be reproduced except in full, without the written approval of an authorized PSS representative. A copy of this report will be retained by PSS for at least 5 years, after which time it will be disposed of without further notice, unless prior arrangements have been made.

We thank you for selecting Phase Separation Science, Inc. to serve your analytical needs. If you have any questions concerning this report, do not hesitate to contact us at 410-747-8770 or info@phaseonline.com.

Sincerely,

Dan Prucnal

Dan Prucnal
Laboratory Manager

Sample Summary

Client Name: Analytical Services, Inc.(VA)

Project Name: Scott's Ivy Exxon

Work Order Number(s): **13032603**

Project ID: 3351

The following samples were received under chain of custody by Phase Separation Science (PSS) on 03/26/2013 at 10:30 am

Lab Sample Id	Sample Id	Matrix	Date/Time Collected
13032603-001	Boring 1	GROUND WATER	03/21/13 12:00
13032603-002	Boring 1	SOIL	03/21/13 12:00
13032603-003	Boring 3	SOIL	03/21/13 12:00
13032603-004	Boring 5	SOIL	03/21/13 12:00
13032603-005	Boring 6	SOIL	03/21/13 12:00
13032603-006	Boring 2	SOIL	03/21/13 12:00
13032603-007	H.O. Tank	SOIL	03/21/13 12:00
13032603-008	Railroad	SOIL	03/21/13 12:00
13032603-009	Sub-slab	SOIL	03/21/13 12:00

Please reference the Chain of Custody and Sample Receipt Checklist for specific container counts and preservatives. Any sample conditions not in compliance with sample acceptance criteria are described in Case Narrative Summary.

Notes:

1. The presence of a common laboratory contaminant such as methylene chloride may be considered a possible laboratory artifact. Where observed, appropriate consideration of data should be taken.
2. The following analytical results are never reported on a dry weight basis: pH, flashpoint, moisture and paint filter test.
3. Drinking water samples collected for the purpose of compliance with SDWA may not be suitable for their intended use unless collected by a certified sampler [COMAR 26.08.05.07.C.2].
4. The analyses of 1,2-dibromo-3-chloropropane (DBCP) and 1,2-dibromoethane (EDB) by EPA 524.2 and calcium, magnesium, sodium and iron by EPA 200.8 are not currently promulgated for use in testing to meet the Safe Drinking Water Act and as such cannot be used for compliance purposes. The listings of the current promulgated methods for testing in compliance with the Safe Drinking Water Act can be found in the 40 CFR part 141.1, for the primary drinking water contaminates, and part 141.3, for the secondary drinking water contaminates.
5. The analyses of chlorine, pH, dissolved oxygen, temperature and sulfite for non-potable water samples tested for compliance for Virginia Pollution Discharge Elimination System (VDPES) permits and Virginia Pollutant Abatement (VPA) permits, have a maximum holding time of 15 minutes established by 40CFR136.3.

Standard Flags/Abbreviations:

B	A target analyte or common laboratory contaminant was identified in the method blank. Its presence indicates possible field or laboratory contamination.
C	Results Pending Final Confirmation.
E	The data exceeds the upper calibration limit; therefore, the concentration is reported as estimated.
Fail	The result exceeds the regulatory level for Toxicity Characteristic (TCLP) as cited in 40 CFR 261.24 Table 1.
J	The target analyte was positively identified below the reporting limit but greater than the LOD.
LOD	Limit of Detection. An estimate of the minimum amount of a substance that an analytical process can reliably detect. An LOD is analyte and matrix specific.
ND	Not Detected at or above the reporting limit.
RL	PSS Reporting Limit.
U	Not detected.

Case Narrative Summary

Client Name: Analytical Services, Inc.(VA)

Project Name: Scott's Ivy Exxon

Work Order Number(s): 13032603
Project ID: 3351

Any holding time exceedances, deviations from the method specifications, regulatory requirements or variations to the procedures outlined in the PSS Quality Assurance Manual are outlined below.

Sample Receipt:

All sample receipt conditions were acceptable.

General Comments:

Results reported on an as received basis for sample 'Sub-Slab'.

NELAP accreditation was held for all analyses performed unless noted below. See www.phaseonline.com for complete PSS scope of accreditation.

OFFICES:
6630 BALTIMORE NATIONAL PIKE
ROUTE 40 WEST
BALTIMORE, MD 21228
410-747-8770
800-932-9047
FAX 410-788-8723

PHASE SEPARATION SCIENCE, INC.

CERTIFICATE OF ANALYSIS

No: 13032603
Analytical Services, Inc.(VA), Culpepper, VA
April 2, 2013

Project Name: Scott's Ivy Exxon
Project Location: Ivy, VA
Project ID: 3351

Sample ID: Boring 1 **Date/Time Sampled: 03/21/2013 12:00** **PSS Sample ID: 13032603-001**
Matrix: GROUND WATER **Date/Time Received: 03/26/2013 10:30**

BTEX Analytical Method: SW-846 8021B Preparation Method: 5030B

USEPA methods recommend that the appearance of detectable levels of the 8021B compounds below be confirmed when unfamiliar samples are analyzed.

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Benzene	**210**	ug/L	25		25	03/27/13	03/27/13 13:51	1035
Toluene	**180**	ug/L	25		25	03/27/13	03/27/13 13:51	1035
Ethylbenzene	**4,200**	ug/L	25		25	03/27/13	03/27/13 13:51	1035
m,p-Xylenes	**12,000**	ug/L	50		25	03/27/13	03/27/13 13:51	1035
o-Xylene	**470**	ug/L	25		25	03/27/13	03/27/13 13:51	1035

Sample ID: Boring 1 **Date/Time Sampled: 03/21/2013 12:00** **PSS Sample ID: 13032603-002**
Matrix: SOIL **Date/Time Received: 03/26/2013 10:30** **% Solids: 82**

Total Petroleum Hydrocarbons-GRO Analytical Method: SW-846 8015C Preparation Method: 5030

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
TPH-GRO (Gasoline Range Organics)	**1,300,000**	ug/kg	12,000		100	03/27/13	03/27/13 20:30	1035

Sample ID: Boring 3 **Date/Time Sampled: 03/21/2013 12:00** **PSS Sample ID: 13032603-003**
Matrix: SOIL **Date/Time Received: 03/26/2013 10:30** **% Solids: 73**

Total Petroleum Hydrocarbons - DRO Analytical Method: SW-846 8015 C Preparation Method: 3550

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
TPH-DRO (Diesel Range Organics)	ND	mg/kg	5.3		1	03/26/13	03/26/13 21:20	1040

Total Petroleum Hydrocarbons-GRO Analytical Method: SW-846 8015C Preparation Method: 5030

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
TPH-GRO (Gasoline Range Organics)	ND	ug/kg	130		1	03/27/13	03/27/13 17:46	1035

Sample ID: Boring 5 **Date/Time Sampled: 03/21/2013 12:00** **PSS Sample ID: 13032603-004**
Matrix: SOIL **Date/Time Received: 03/26/2013 10:30** **% Solids: 80**

Oil and Grease Analytical Method: EPA 1664 A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Oil & Grease, Total Recovered	ND	mg/kg	62		1	04/01/13	04/01/13 09:50	1028

CERTIFICATE OF ANALYSIS

No: 13032603
Analytical Services, Inc.(VA), Culpepper, VA
April 2, 2013

Project Name: Scott's Ivy Exxon
Project Location: Ivy, VA
Project ID: 3351

Sample ID: Boring 6 — **Date/Time Sampled: 03/21/2013 12:00** — **PSS Sample ID: 13032603-005**
Matrix: SOIL — **Date/Time Received: 03/26/2013 10:30** — **% Solids: 77**

Total Petroleum Hydrocarbons-GRO — Analytical Method: SW-846 8015C — Preparation Method: 5030

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
TPH-GRO (Gasoline Range Organics)	ND	ug/kg	130		1	03/27/13	03/27/13 18:13	1035

Sample ID: Boring 2 — **Date/Time Sampled: 03/21/2013 12:00** — **PSS Sample ID: 13032603-006**
Matrix: SOIL — **Date/Time Received: 03/26/2013 10:30** — **% Solids: 75**

Total Petroleum Hydrocarbons-GRO — Analytical Method: SW-846 8015C — Preparation Method: 5030

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
TPH-GRO (Gasoline Range Organics)	**240**	ug/kg	130		1	03/27/13	03/27/13 18:41	1035

Sample ID: H.O. Tank — **Date/Time Sampled: 03/21/2013 12:00** — **PSS Sample ID: 13032603-007**
Matrix: SOIL — **Date/Time Received: 03/26/2013 10:30** — **% Solids: 82**

Total Petroleum Hydrocarbons - DRO — Analytical Method: SW-846 8015 C — Preparation Method: 3550

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
TPH-DRO (Diesel Range Organics)	ND	mg/kg	4.8		1	03/26/13	03/27/13 09:55	1040

Sample ID: Railroad — **Date/Time Sampled: 03/21/2013 12:00** — **PSS Sample ID: 13032603-008**
Matrix: SOIL — **Date/Time Received: 03/26/2013 10:30** — **% Solids: 77**

Polychlorinated Biphenyls — Analytical Method: SW-846 8082 A — Preparation Method: 3550
Clean up Method: SW846 3665A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
PCB-1016	ND	mg/kg	0.14		1	03/27/13	03/27/13 17:20	1029
PCB-1221	ND	mg/kg	0.14		1	03/27/13	03/27/13 17:20	1029
PCB-1232	ND	mg/kg	0.14		1	03/27/13	03/27/13 17:20	1029
PCB-1242	ND	mg/kg	0.14		1	03/27/13	03/27/13 17:20	1029
PCB-1248	ND	mg/kg	0.14		1	03/27/13	03/27/13 17:20	1029
PCB-1254	ND	mg/kg	0.14		1	03/27/13	03/27/13 17:20	1029
PCB-1260	ND	mg/kg	0.14		1	03/27/13	03/27/13 17:20	1029

Sample ID: Sub-slab — **Date/Time Sampled: 03/21/2013 12:00** — **PSS Sample ID: 13032603-009**
Matrix: SOIL — **Date/Time Received: 03/26/2013 10:30**

Oil and Grease — Analytical Method: EPA 1664 A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Oil & Grease, Total Recovered	ND	mg/kg	150		1	04/01/13	04/01/13 09:50	1028

SAMPLE CHAIN OF CUSTODY/AGREEMENT FORM

PHASE SEPARATION SCIENCE, INC.

ANALYTICAL CHEMISTRY • ENVIRONMENTAL SCIENCE

www.phaseonline.com
email: info@phaseonline.com

①
*CLIENT: Analytical Services, Inc. *OFFICE LOC. Culpeper, VA
*PROJECT MGR: Mike Maloy *PHONE NO.: (540) 829-5640
EMAIL: Maloyasi@aol.com FAX NO.: ( )
*PROJECT NAME: Scott's Ivy Exxon PROJECT NO.: 3351
SITE LOCATION: Ivy, VA P.O. NO.:
SAMPLER(S): TPN, MLM DW CERT NO.:

PSS Work Order # 13032603 PAGE 1 OF 1

Matrix Codes:
SW=Surface Wtr DW=Drinking Wtr GW=Ground Wtr WW=Waste Wtr O=Oil S=Soil L=Liquid SOL=Solid A=Air WI=Wipe

② ③

LAB NO.	*SAMPLE IDENTIFICATION	*DATE (SAMPLED)	*TIME (SAMPLED)	MATRIX (See Codes)	No. CONTAINERS	SAMPLE TYPE C = COMP G = GRAB	*Analysis/Method Required: Method 1664; O&G	TPH-GRO	TPH-DRO	PCBs	Method 8021-BTEX									REMARKS
Preservatives Used																				
1	Boring 1	3/21/13	12:00	GW	2	G					X									
2	Boring 1	↓	↓	S	2	G		X												
3	Boring 3	↓	↓	S	1	G		X	X											
4	Boring 5	↓	↓	S	1	G	X													
5	Boring 6	↓	↓	S	1	G		X												
6	Boring 2	↓	↓	S	1	G		X												
7	~~House Auger~~ H.O. Tank	↓	↓	S	1	G			X											
8	Railroad	↓	↓	S	1	G				X										
9	Sub-Slab	↓	↓	S	1	G	X													

⑤

Relinquished By:	Date	Time	Received By:
(1)	3/25/13	4:00pm	UPS
(2) UPS 1ZX097V30395424104	3/26/13	1030A	
(3)			
(4)			

④
*Requested TAT (One TAT per COC)
☐ 5-Day ☐ 3-Day ☐ 2-Day
☐ Next Day ☐ Emergency ☐ Other

Data Deliverables Required:
COA ☐ QC SUMM ☐ CLP LIKE ☐ OTHER ______

# of Coolers: 1
Custody Seal: INTACT-COOLER
Ice Present: PRES Temp: 2°c
Shipping Carrier: UPS-G

Special Instructions:

DW COMPLIANCE? YES ☐
EDD FORMAT TYPE ______
STATE RESULTS REPORTED TO: MD ☐ DE ☐ PA ☐ VA ☐ WV ☐ OTHER ______

6630 Baltimore National Pike • Route 40 West • Baltimore, Maryland 21228 • (410) 747-8770 • (800) 932-9047 • Fax (410) 788-8723

The client (Client Name), by signing, or having client's agent sign, this "Sample Chain of Custody/Agreement Form", agrees to pay for the above requested services per the latest version of the Service Brochure or PSS-provided quotation including any and all attorney's or other reasonable fees if collection becomes necessary. * = REQUIRED

Phase Separation Science, Inc

Sample Receipt Checklist

Work Order #	13032603	**Received By**	Rachel Davis
Client Name	Analytical Services, Inc.(VA)	**Date Received**	03/26/2013 10:30:00 AM
Project Name	Scott's Ivy Exxon	**Delivered By**	UPS
Project Number	3351	**Tracking No**	1zx097v30395424104
Disposal Date	04/30/2013	**Logged In By**	Rachel Davis

Shipping Container(s)

No. of Coolers	1	Ice	Present
		Temp (deg C)	2
Custody Seal(s) Intact?	Yes	Temp Blank Present	No
Seal(s) Signed / Dated?	Yes		

Documentation

		Sampler Name	TPN, MLM
COC agrees with sample labels?	Yes	MD DW Cert. No.	N/A
Chain of Custody	Yes		

Sample Container

Appropriate for Specified Analysis?	Yes	Custody Seal(s) Intact?	Not Applicable
Intact?	Yes	Seal(s) Signed / Dated	Not Applicable
Labeled and Labels Legible?	Yes		

Total No. of Samples Received 9

Total No. of Containers Received 11

Preservation

Metals	(pH<2)	N/A
Cyanides	(pH>12)	N/A
Sulfide	(pH>9)	N/A
TOC, COD, Phenols	(ph<2)	N/A
TOX, TKN, NH3, Total Phos	(pH<2)	N/A
VOC, BTEX (VOA Vials Rcvd Preserved)	(pH<2)	Yes
Do VOA vials have zero headspace?		Yes

Comments: (Any "No" response must be detailed in the comments section below.)

For any improper preservation conditions, list sample ID, preservative added (reagent ID number) below as well as documentation of any client notification as well as client instructions. Samples for pH, chlorine and dissolved oxygen should be analyzed as soon as possible, preferably in the field at the time of sampling. Samples which require thermal preservation shall be considered acceptable when received at a temperature above freezing to 6°C. Samples that are hand delivered on the day that they are collected may not meet these criteria but shall be considered acceptable if there is evidence that the chilling process has begun such as arrival on ice.

Samples Inspected/Checklist Completed By: Rachel Davis
Rachel Davis
Date: 03/26/2013

PM Review and Approval: Amy Friedlander
Amy Friedlander
Date: 03/26/2013

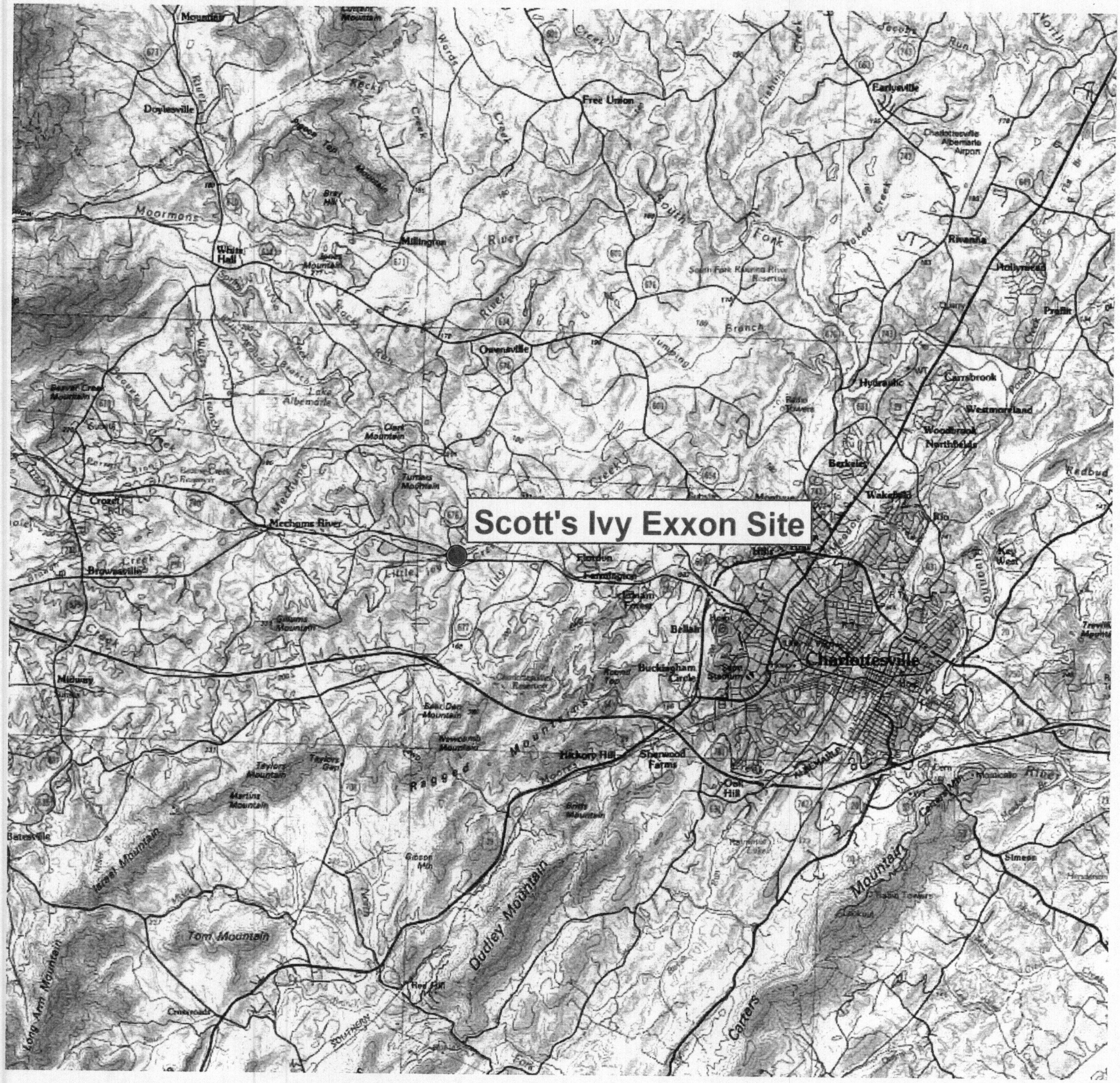


FIGURE 1: SITE LOCATION MAP

Scott's Ivy Exxon
4260 Ivy Road
Charlottesville, VA

Legend

● Scott's Ivy Exxon Site

0 1.5 3 6
Miles

N

ANALYTICAL SERVICES, INC.

ASI Project # 3351

FIGURE 2a: SITE LAYOUT MAP

Legend

▭ Property Boundary
— Ivy Creek
☐ UST Basin
● Domestic Well

Scott's Ivy Exxon
4260 Ivy Road
Charlottesville, VA

N

0 75 150 300
Feet

ANALYTICAL SERVICES, INC.

ASI Project # 3351

FIGURE 2b: BORING LOCATIONS MAP

Scott's Ivy Exxon
4260 Ivy Road
Charlottesville, VA

Legend

▭ Property Boundary

● Boring

0 75 150 300 Feet

N

ANALYTICAL SERVICES, INC.

ASI Project # 3351

Appendix B

Toddsbury of Ivy Virginia Department of Environmental Quality Documents

SITE CHARACTERIZATION REPORT ADDENDUM

TODDSBURY OF IVY
Albemarle County

PC # 01-6134
FAC ID # __________ *(for DEQ use)*

DEQ-VALLEY
JAN 28 2002
TO: __________
FILE: __________

Submitted to:

Joel P. Maynard
Valley Regional Office
Department of Environmental Quality
PO Box 3000
Harrisonburg, VA 22801-3000
(540)574-7800

Prepared for:

Charlottesville Oil Company
PO Box 6340
Charlottesville, Virginia 22906
(804)293-9107

Prepared by:

Jeffrey A. Sitler Environmental Service, Inc.
PO Box 6038
Charlottesville, Virginia 22906
(804)974-7080 fax (804)974-1657

January 3, 2002

SITE SUMMARY

<u>YES</u> Site currently developed

<u>NO</u> Offsite drinking water wells potentially threatened

<u>YES</u> Onsite drinking water well potentially threatened

<u>NO</u> Surface water affected

<u>NO</u> Surface water potentially threatened

<u>NO</u> Liquid phase hydrocarbons on groundwater

<u>YES</u> Dissolved phase present in groundwater above water quality standards

<u>NO</u> Sump, basement, or utility affected

<u>NO</u> Sump, basement, or utility potentially threatened

<u>NO</u> Residual phase present that may leach into groundwater at concentrations of concern

<u>NO</u> Residual phase levels in backfilled soils that merit abatement

Site recommended for: **One additional monitoring well and Post-SCR Monitoring.**

TABLE OF CONTENTS

FIGURES

TABLES

LIST OF APPENDICES

1.0 INTRODUCTION

Jeffrey A. Sitler Environmental Services, Inc., (JAS) was contracted by Charlottesville Oil Company, Rt. 250 West, Charlottesville, Virginia to prepare this Site Characterization Report (SCR) for the property known as Toddsbury of Ivy Market located on US Route 250 in Ivy, Virginia, in Albemarle County, (the "Site" shown in Figure 1).

The objectives of this SCR are to characterize the Site, determine environmental conditions at the Site, investigate the geology and hydrogeology in the vicinity of the Site, evaluate the risks associated with the contamination, and present remedial alternatives to mitigate the contamination at the Site if necessary. This SCR has been prepared following Department of Environmental Quality (DEQ) guidance.

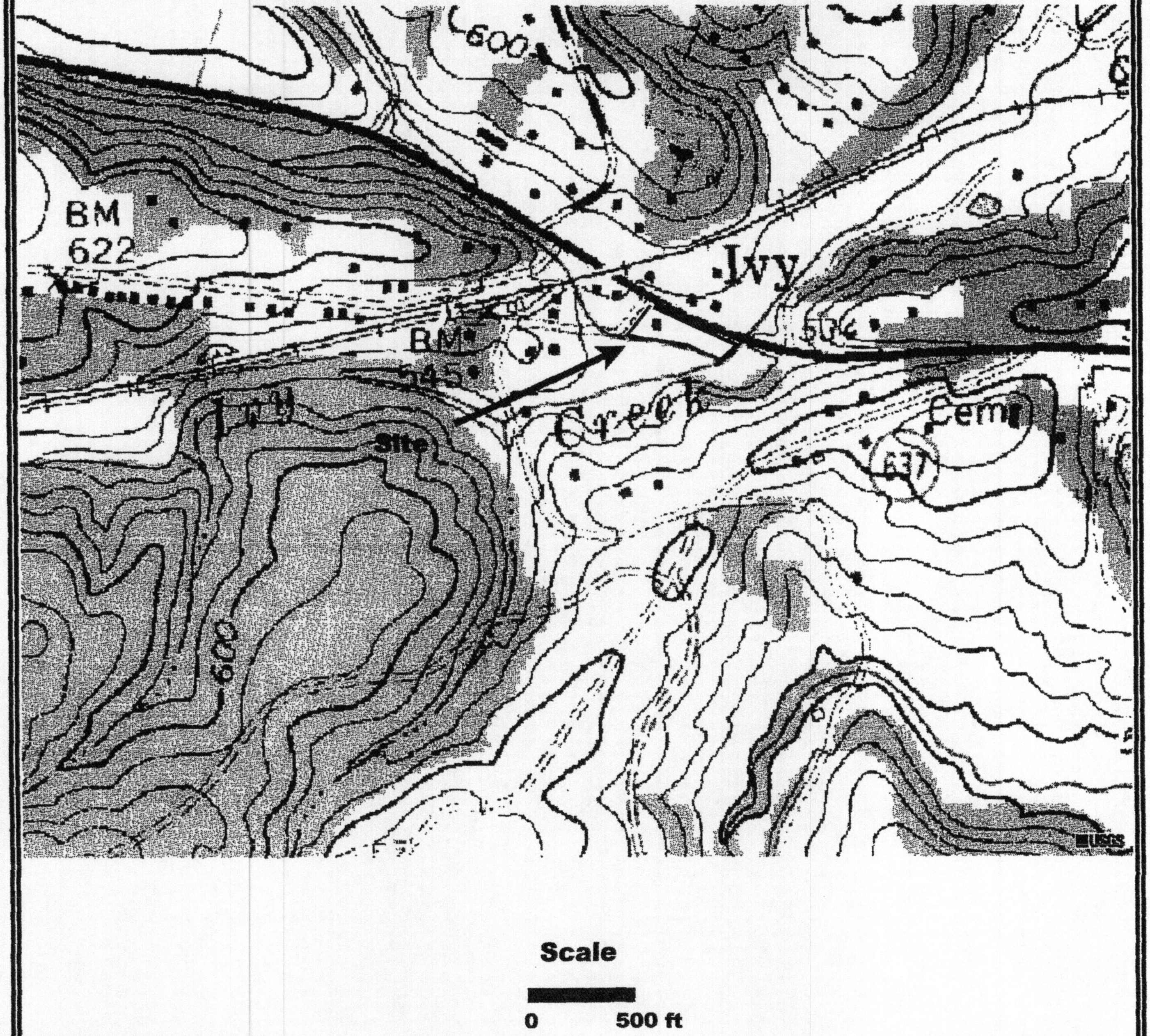
1.1 SITE HISTORY

The Site has been operated as a gas station since at least the early 1950's. Charlottesville Oil Company owns the three gasoline underground storage tanks (USTs) that are currently in service as shown in the site plan in Figure 2. There also is one unused kerosene (?) UST located at the northwest corner of the market building. Figure 3 shows the 1994 USGS aerial photograph for the area of the Site, and Figure 4 shows a ground-view photograph of the front of the Site looking southwest from Route 250.

As a result of an inconclusive pressure test on the lines, on March 27, 2001, JAS completed four hand borings to a depth of four feet below the surface along the supply lines and pump island. Each soil sample was analyzed for total petroleum hydrocarbons-gasoline range organics (TPH-GRO, aka volatile TPH) by EPA Method 8015. The soil analysis indicates the following.

Sample	TPH-GRO
S-1	34.6 mg/kg
S-2	BDL
S-3	BDL
S-4	68.6 mg/kg

The soil samples from each hole did not have any strong gasoline fuel odors. These results indicated that significant leakage had not occurred from the piping at the Site.



Jeffrey A. Sitler - Environmental Services, Inc.
PO Box 6038
Charlottesville, VA 22906
(804)974-7080 - (804)974-1657 (FAX)

Date:	Revised:
Drawn by: LRS	Checked by:
File:	Scale:

Figure 1 - Site Location
Topographic Map
Toddsbury of Ivy

Jeffrey A. Sitler - Environmental Services, Inc.
PO Box 6038
Charlottesville, VA 22906
(804)974-7080 - (804)974-1657 (FAX)

Date:
Drawn by: LRS
File:
Revised:
Checked by:
Scale:

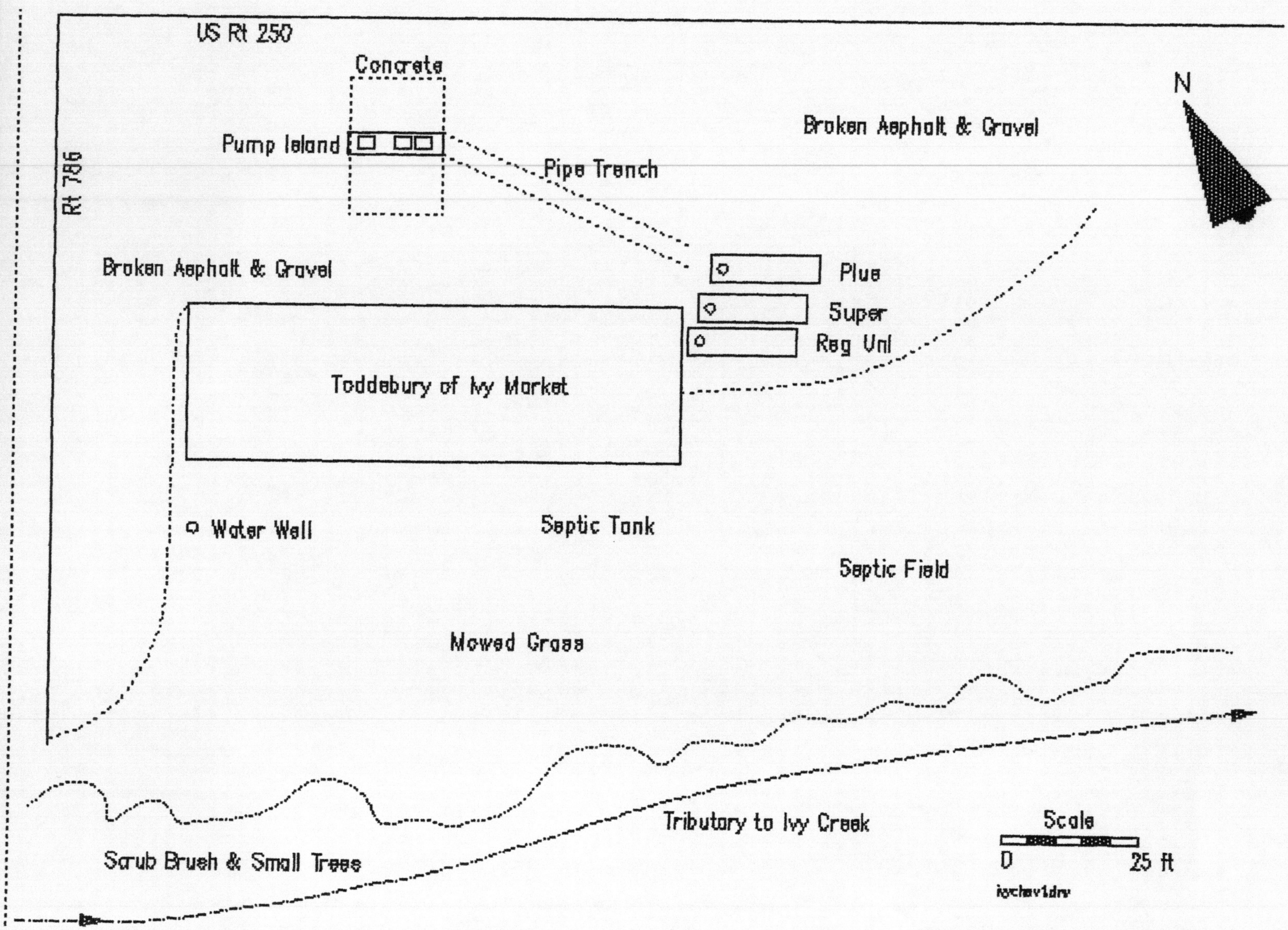
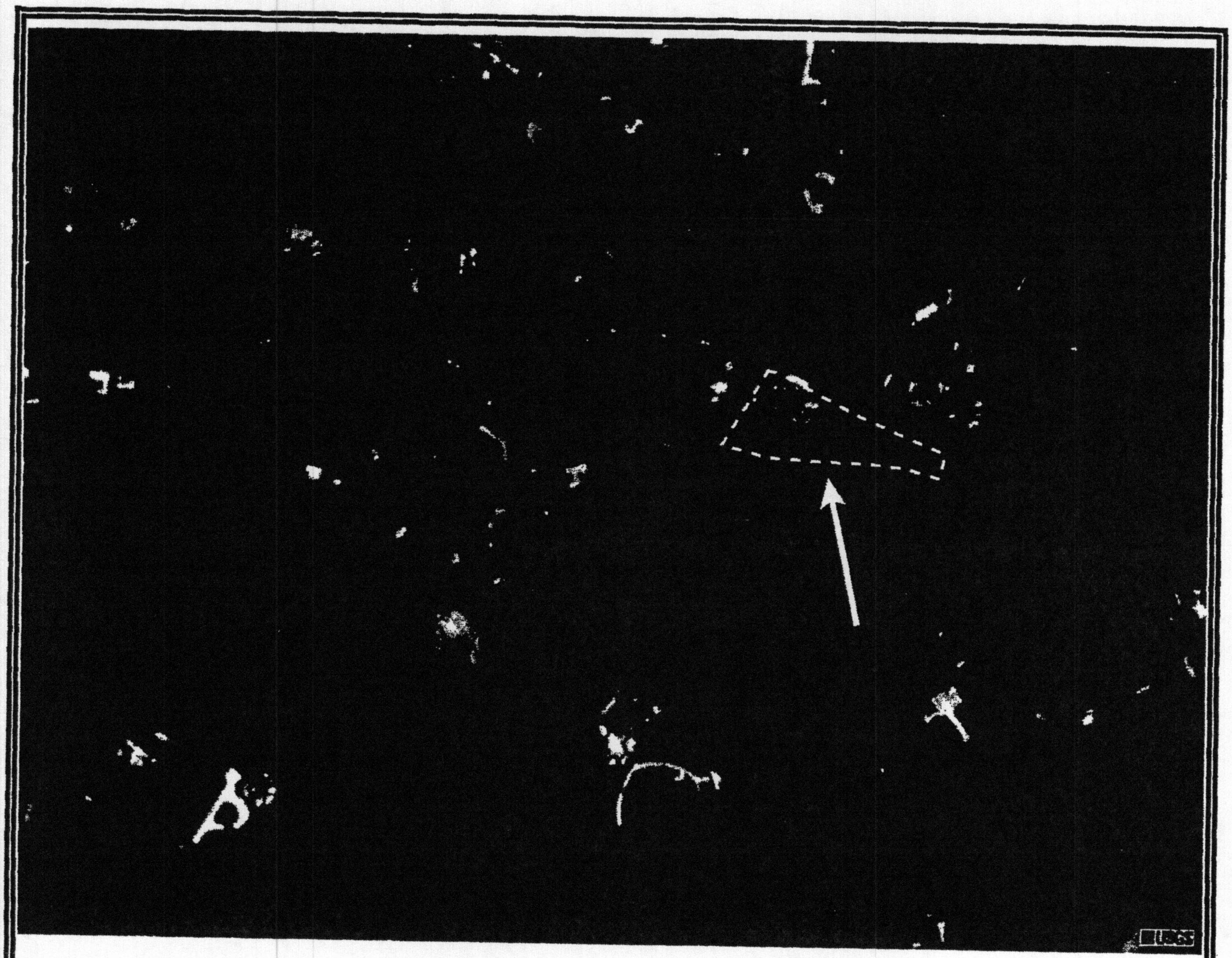


Figure 2 - Site Plan
Toddsbury of Ivy



Scale

0 200 ft

Jeffrey A. Sitler -
Environmental Services, Inc.
PO Box 6038
Charlottesville, VA 22906
(804)974-7080 - (804)974-1657 (FAX)

Date:
Revised:
Drawn by: LRS
Checked by:
File:
Scale:

Figure 3 - 1994 USGS Aerial Photograph
Toddsbury of Ivy

Jeffrey A. Sitler - Environmental Services, Inc.

PO Box 6038
Charlottesville, VA 22906
(804)974-7080 - (804)974-1657 (FAX)

Date:	Revised:
Drawn by: LRS	Checked by:
File:	Scale:

Figure 4 - Photograph of Toddsbury of Ivy

Table 1. UST Information

UST No.	Regulated	Contents	Type	UST/AST	Size Gallons	Est. Age Years	Status
1	Yes	Super Unleaded Gasoline	Steel	UST	3,000	Unknown	In Service
2	Yes	Plus Unleaded Gasoline	Steel	UST	3,000	Unknown	In Service
3	Yes	Regular Unleaded Gasoline	Steel	UST	3,000	Unknown	In Service
4	No	Kerosene	Steel	UST	550?	Unknown	Out of Service prior to 1986

Mike Jones of Charlottesville Oil Company has hypothesized that the line test was affected by faulty foot valves at the end of the lines in the tanks. Subsequent to the soil sampling results, the Department of Environmental Quality (DEQ) issued a directive to complete a Site Characterization Report (SCR) for the Site. An extension to January 18, 2002 for the SCR deadline was granted by Todd Pitsenberger on January 2, 2002.

1.2 SITE DESCRIPTION

The Site is known as Toddsbury of Ivy and is located on the southeast corner of the intersection of State Route 786 and US Route 250 in the village of Ivy, Albemarle County, Virginia. The approximately rectangular Site has an area of about one-half acre with 200 feet fronting Route 250 and a 100-foot depth from Route 250 on the north side to a small stream on the south side. The Site contains a building that houses a small deli/grocery and storage rooms as shown in the photograph in Figure 4. The structure is a mixture of slab-on-grade and crawl space. The three in-service gasoline USTs are located at the east end of the building.

2.0 SITE ASSESSMENT

2.1 SITE LOCATION AND DESCRIPTION

The Site is located in the central portion of Albemarle County. Topographically, the Site is at an elevation of about 535 feet above mean sea level with the ground surface on the Site being relatively flat (Figure 1). The ground slopes imperceptibly to the south where runoff enters a small unnamed perennial tributary to Little Ivy Creek that flows along the southern boundary of the Site. The Site has its own private drinking water supply well located in the rear of the market near the southwest corner of the building. A private septic system is located in the rear on the east end of the property. Electric service is provided by Virginia Power via overhead cables, and telephone service is provided by Sprint via underground cables.

2.2 RECEPTOR SURVEY

A preliminary receptor survey was performed for the Site to identify public and private water supply sources, i.e., wells, springs, and surface water intakes, within the immediate vicinity of the Site. In summary, there are no public water supply wells or public surface water intakes within more than one-half mile of the Site. However, there are private drinking water wells on adjoining properties.

Surface Water

The local surface water drainage system is within the Rivanna River Basin. At the local scale, the runoff from the Site drains south into the small unnamed perennial tributary to Little Ivy Creek located along the southern boundary of the Site as shown in Figure 1. This tributary enters Little Ivy Creek within 100 feet of the Site. The Site is probably within both the 100- and 500-year flood plains. It is not believed that there are statutory wetlands on the Site.

Water Supplies

The residents and businesses in the area of the Site obtain drinking water from private water supply wells. There are no public water supplies in the area of the Site. The following lists the private water supply wells immediately adjacent to the Site.

> Toddsbury of Ivy, drilled well located about 100 feet southwest of the UST basin, unknown depth, sampled November 29, 2001 for the SCR.
>
> Ivy Nursery and US Post Office, located about 200 feet southwest of the UST basin, not sampled.

Exxon Service Station, located on the opposite side of Route 250 about 200 feet northeast of the UST basin, not sampled.

There are numerous businesses and residential water wells further from the Site that have not been listed.

2.3 HISTORICAL RELEASES

Charlottesville Oil Company does not have any specific knowledge concerning historical releases at the Site. However, Mike Jones stated that since the USTs are 3,000 gallon capacities, there may have been times when a delivery caused overflow of product onto the ground.

2.4 REGIONAL GEOLOGY

The Site is within the Blue Ridge Physiographic Province which was developed on metamorphic rocks of primarily gneiss and schist and covers the Commonwealth of Virginia from along Route 29 to the base of the Blue Ridge. The bedrock in the vicinity of the Site consists of the Middle Proterozoic-age porphyroblastic biotite-plagioclase augen gneiss, believed to be a metamorphosed igneous intrusion. The gneiss has been radiometrically dated at slightly more than one billion years old (Virginia Geologic Map-Expanded Explanation, Virginia Department of Mines, Minerals, and Energy, 1993). Overlying the bedrock is saprolite, or weathered bedrock, that grades from nearly unweathered bedrock at depth up to completely weathered soil consisting of clay and silt at the surface. Typically, the thickness of the saprolite is thin to nonexistent in stream valleys to more than 50 feet thick in upland areas. At the Site the unconsolidated soil was found to be 12 to15 feet thick where the auger drill met refusal on the bedrock surface.

2.5 REGIONAL HYDROGEOLOGY

Groundwater occurs in both the unconsolidated soil and the underlying bedrock under unconfined conditions. Most of the rocks of the Blue Ridge province are not known as good aquifers. Drilled wells in the area generally have yields that range from two gallons per minute (gpm) to 20 gpm, with the average closer to three to five gpm with well depth ranging from 75 feet to 400 feet. In some cases, bored or hand dug wells have been utilized. These shallow wells rely on groundwater produced from the highly weathered bedrock at the bedrock-saprolite gradational interface. For the most part, the bedrock does not have appreciable primary porosity or permeability, but produces water from fractures, joints, and fault zones. Therefore, in order for a bedrock well to be successful, the well must intersect fractures and joints that are capable of yielding groundwater at rates and volumes required by the end user. The typical low yield produced by wells in the Blue Ridge has resulted in the development of public water supplies for larger towns and cities that are almost always developed from surface-water sources, such as the Rivanna Water and Sewer Authority for Charlottesville.

Recharge to the groundwater in the Blue Ridge occurs over broad areas as a result of the infiltration of precipitation into the saprolite. The Virginia Department of Mines, Minerals, and Energy estimates that 15% of all precipitation infiltrates as recharge to groundwater. With an average rainfall of 47 inches (Charlottesville, 1961-1990), 7.0 inches of rainfall is recharged to the aquifer in an average year.

The water table in the Blue Ridge generally mimics the topographic surface with the water table being closer to the surface in valleys than in uplands. The resulting groundwater flow is from the upland areas to streams and rivers, providing base flow when no stormwater runoff occurs. Based on the topography in the area of the Site, groundwater would be expected to flow to the south and east, ultimately discharging into either the small tributary on the south side of the Site or into Little Ivy Creek within 200 feet of the USTs to the east.

2.6 RELEASE ASSESSMENT

2.6.1 Release Confirmation

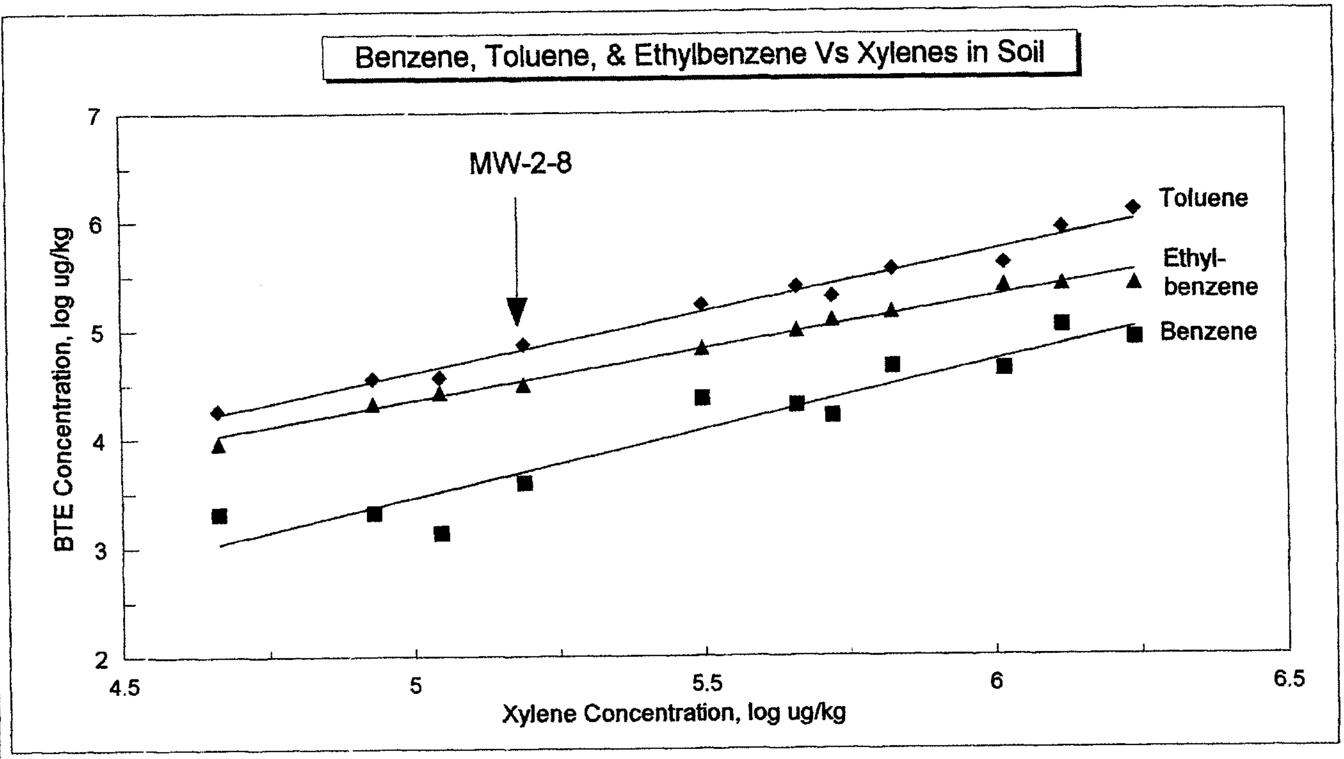
One soil sample was collected from the south edge of the UST basin in MW-2 at a depth of eight feet. No soil samples were collected from the other two monitoring wells due to the absence of any gasoline odors. The laboratory report is provided in Appendix C and summarized in Table 2. The analysis of soil sample MW-2-8 had a TPH-GRO concentration of 1,060 mg/kg and benzene of 3,920 μg/kg.

Figure 5 shows a comparison of the log benzene, log toluene, and log ethylbenzene plotted as dependent variables on the y-axis versus log xylenes on the x-axis. The data represents 12 soil analyses from nine sites around Charlottesville including the one sample from the Site

Table 2. Soil Sampling Analytical Results

Well	Sample ID/Depth	Volatile TPH-GRO mg/kg	Benzene μg/kg	Toluene μg/kg	Ethyl-Benzene μg/kg	Xylenes μg/kg	MTBE μg/kg
MW-2	MW-2-8	1,060	3,920	73,000	31,300	155,000	BDL

Notes: BDL - Below Detection Limit
mg/kg - Milligrams Per Kilogram
ug/kg - Micrograms Per Kilogram



Linear Regression Data

Benzene vs Xylenes	B = 1.25 log {Xylene}-2.80	r = 0.95
Toluene vs Xylenes	T = 1.12 log {Xylene}-1.01	r = 0.99
Ethylbenzene vs Xylenes	E = 0.96 log {Xylene}-0.42	r = 0.99

Jeffrey A. Sitler - Environmental Services, Inc.
PO Box 6038
Charlottesville, VA 22906
(804)974-7080 - (804)974-1657 (FAX)

Date:	Revised:
Drawn by: LRS	Checked by:
File:	Scale:

Figure 5 - Comparison of Ratios of BTE to Xylenes in Soil

(MW-2-8). The straight lines in Figure 5 are the regression lines. The regression analyses indicated correlation coefficients of from 0.95 for benzene versus xylenes to 0.99 for the other two relationships. The eight other sites included in Figure 5 had leaking USTs with either free product present or very high concentrations. The ratios of benzene, toluene, and ethylbenzene to xylene in MW-2-8 relative to the other data indicate that the tank basin is the source of contamination similar to the other sites included in the data base.

2.6.2 Investigative Methods

2.6.2.1 Soil Borings/Monitoring Wells

For the SCR, three soil borings/monitoring wells were installed at the Site in locations recommended by the DEQ and modified in the field due to utility and other restrictions. JAS and Certified Environmental Drilling, of Earlysville, Virginia, mobilized onsite on November 28, 2001 and installed the borings/monitoring wells by hollow-stem auger drill rig. All drilling was supervised by Lyle R. Silka, Virginia certified professional geologist, and was in accordance with standard health and safety practices. The total boring depths were 15 feet for MW-1 and MW-2, and 12 feet for MW-3. The borings were shallow due to refusal of the auger on the top of bedrock. Geologic samples were inspected at five-foot intervals for characterization of the geology and assessing the presence of hydrocarbon contamination. Decontaminated drill stems were used for the borings.

Each soil sample was logged for lithology, inspected for petroleum odors, examined for visual petroleum staining, and tested for total volatile hydrocarbon vapors. Boring logs are presented in Appendix A. One soil sample was collected from MW-2 at a depth of 8 feet where strong gasoline odor and staining were found. Since there was no odor or staining in either of the other two borings, no soil samples were collected from them. The soil sample was collected in a one laboratory-supplied four-ounce glass jar with Teflon septum. The container was labeled and stored on ice and delivered by overnight Federal Express to Maryland Spectral Services, Inc. in Baltimore, Maryland, for analysis of total petroleum hydrocarbons gasoline range organics (TPH-GRO) by EPA Method 5035/8015, and benzene, toluene, ethylbenzene, total xylenes (BTEX) and methyl-tertiary-butyl-ether (MTBE) by EPA Method 5035/8021. Section 2.7 presents a review of the analytical results. All samples collected for laboratory analysis were handled in accordance with standard chain-of-custody and quality assurance controls.

The soil borings were converted to monitoring wells using flush-threaded, two-inch diameter, schedule 40 PVC casing and 0.01-inch factory-slotted PVC screen with a threaded end cap. The wells were installed by assembling and lowering the PVC screen and blank casing into the open borehole to the total depth of the boring. A #2 filter sand was placed around the screen to a height of two feet above the screen, followed by a two-foot bentonite-chip seal that was hydrated in place. From the top of the bentonite seal to the surface, a cement grout mix was placed in the annulus around the casing. Each well was completed with a flush-mount, bolt-down, metal well protector set in concrete at the surface. A locking well cap and padlock were placed on each well casing. Monitoring well depths and screened intervals were selected in the field based on the depth at which groundwater was encountered in order to provide ample open screen above the water table to allow for seasonal fluctuations and allow sufficient screen below the water table to allow for groundwater sampling. The geologic logs of the borings/monitoring wells are presented in Appendix A.

2.6.2.2 Well Development and Elevation Survey

Each monitoring well was purged of approximately three well volumes of water to develop the well and bring in fresh groundwater from the surrounding aquifer. The well purging was accomplished using a pre-cleaned plastic bailer. The relative elevation of the top of casing (TOC) for each monitoring well and the stream at the downstream sampling location was determined by surveying with a rod and transit. A local elevation datum was established for the TOC for MW-1 at 535 feet based on the 7.5 minute USGS topographic map. The horizontal position of the wells on the Site was determined relative to the building using a 200-foot fiberglass tape measure. Appendix A provides the elevation survey results.

2.6.2.3 Aquifer Test

An aquifer test was not completed at the Site. The typical test consists of a single-well slug or recovery method that produces hydraulic conductivity estimates that are usually a factor of 10 too low because the single-well test is isolated to a small aquifer volume. Since there is a perennial stream next to the Site, the water table configuration was used to match predicted water table elevations produced by a drain-field analysis presented by Jacob Bear.[1]

---

[1] Jacob Bear, 1979, Groundwater Hydraulics, McGraw-Hill, NY, page 180.

2.6.3 Groundwater Monitoring

Data on the depth to the water table and thickness of LPH in each monitoring well were collected on the undisturbed water column in each monitoring well prior to purging and sampling the well. An electronic oil/water interface probe capable of detecting both LPH and water to an accuracy of 0.01 feet was used. Also, the presence of LPH was checked by lowering a transparent plastic bailer into the water table to collect any LPH on the water table.

2.6.4 Groundwater Sampling and Analysis

Groundwater samples were obtained from monitoring wells MW-1, -2, and -3, from the onsite water supply well, and from upstream and downstream locations on November 29, 2001. Each monitoring well was purged of approximately three well volumes of water using a separate pre-cleaned plastic bailer. The water supply well sample was collected from outside spigot in front of the market after letting the water run for about 15 minutes. The stream samples were obtained by collecting a sample directly from the flowing stream. Each water sample was placed into two laboratory-supplied 40-milliliter glass vials with Teflon septa in a manner to exclude all air from the vials. All sample bottles were labeled, placed on ice, and delivered via overnight Federal Express under standard chain-of-custody procedures to MSS. Water samples were analyzed for TPH-GRO, BTEX, and MTBE, except for the water supply sample that was analyzed for volatile organics by EPA Method 8260. The laboratory analytical results are discussed in Section 2.7.2.

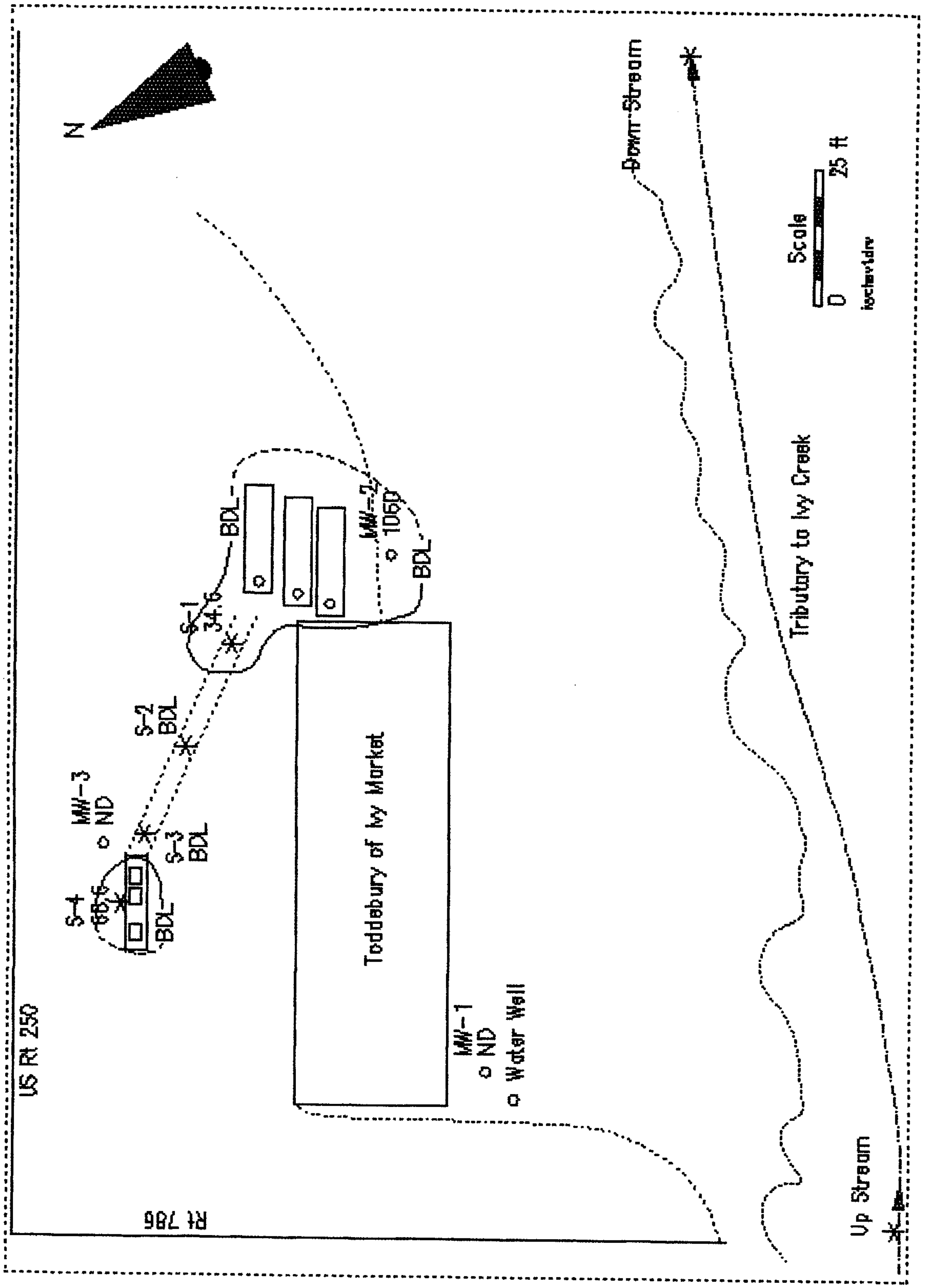
2.7 LABORATORY ANALYTICAL RESULTS

2.7.1 Soil Analytical Results

Table 2, above, presented the results of TPH-GRO, BTEX, and MTBE analyses of the soil sample collected from MW-2. The full laboratory report is presented in Appendix B. Figure 6 shows the estimated extent of residual-phase contamination as TPH-GRO and includes the analytical results from both the SCR and the line sampling study.

2.7.2 Groundwater Analytical Results

The results of the groundwater analyses are summarized in Table 3 and reported in Appendix B. Figures 7 and 8 show the extent of dissolved benzene and MTBE, respectively. The full laboratory report is presented in Appendix B.



Jeffrey A. Sitler - Environmental Services, Inc.
PO Box 6038
Charlottesville, VA 22906
(804)974-7080 - (804)974-1657 (FAX)

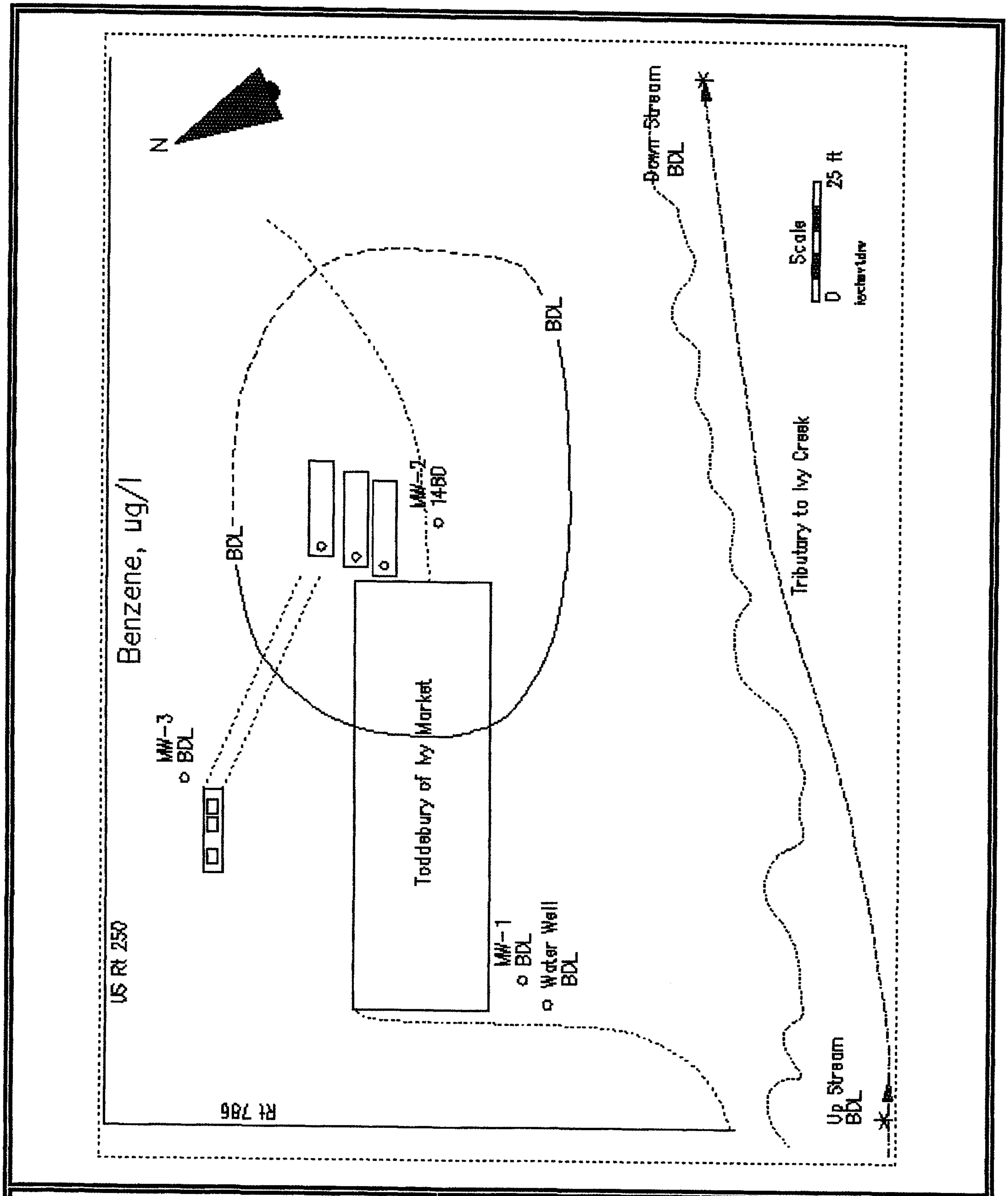
Date:	Revised:
Drawn by: LRS	Checked by:
File:	Scale:

Figure 6 - Extent of Residual Soil Contamination as TPH-GRO
Toddsbury of Ivy
Ivy, Virginia

Table 3. Groundwater Analytical Results

Well No.	Date Sampled	Water Depth feet	LPH in	TPH-GRO μg/l	Benzene μg/l	Toluene μg/l	Ethyl-Benzene μg/l	Xylenes μg/l	MTBE μg/l
MW-1	11/29/01	6.59	0	BDL	BDL	BDL	BDL	BDL	18
MW-2	11/29/01	8.52	0	BDL	1480	1420	BDL	900	56400
MW-3	11/29/01	7.70	0	BDL	BDL	BDL	BDL	BDL	BDL
Onsite Water Well	11/29/01		0	BDL	BDL	BDL	BDL	BDL	3.3j
Up Stream	11/29/01			BDL	BDL	BDL	BDL	BDL	BDL
Down Stream	11/29/01	12.66		BDL	BDL	BDL	BDL	BDL	BDL

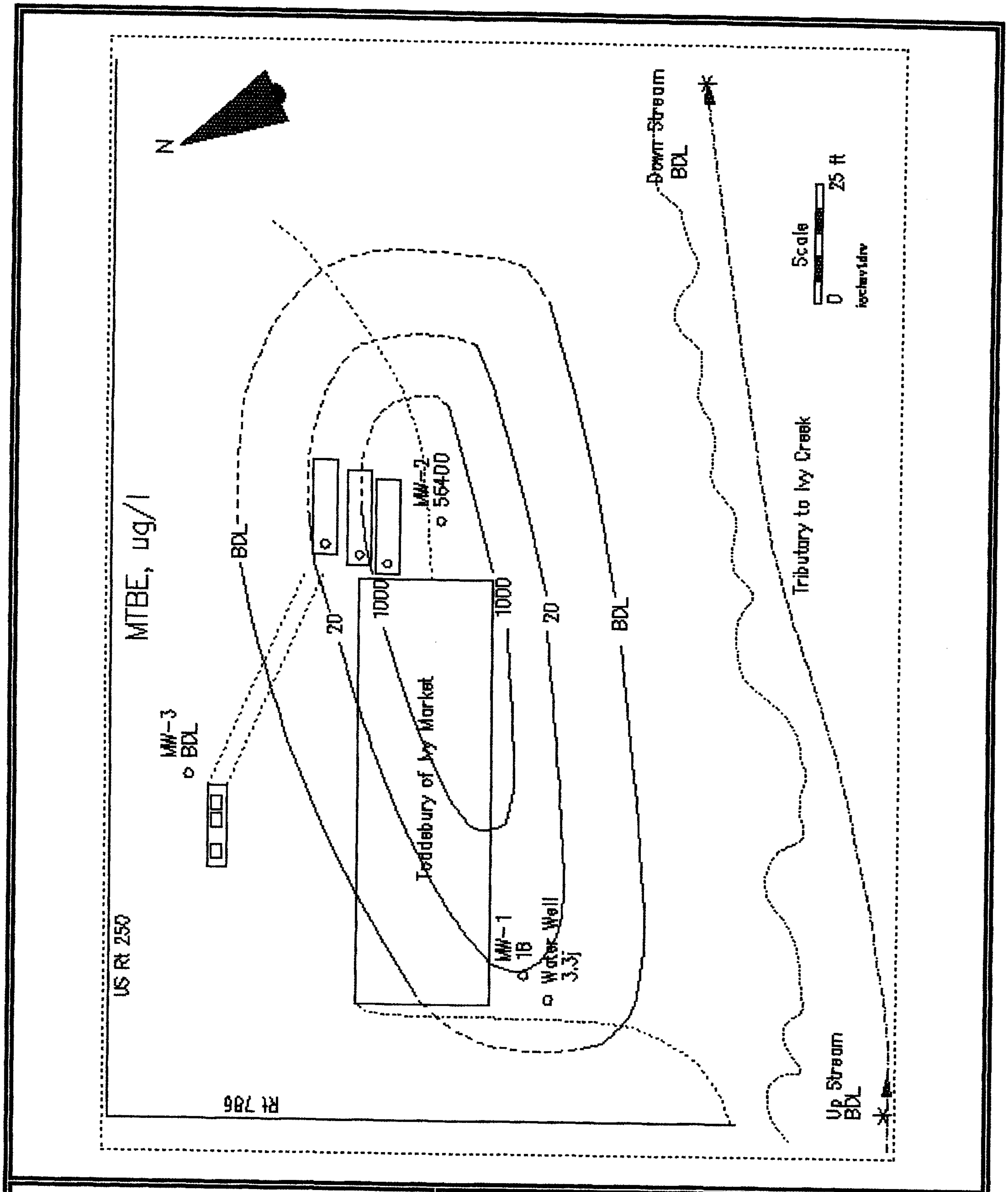
Notes: ND - Not Determined
μg/kg - Micrograms Per Kilogram
BDL - Below Detection Limit
LPH - Liquid Petroleum Hydrocarbon
j - Estimated value
NA - Not applicable



Jeffrey A. Sitler -
Environmental Services, Inc.
PO Box 6038
Charlottesville, VA 22906
(804)974-7080 - (804)974-1657 (FAX)

Date:	Revised:
Drawn by: LRS	Checked by:
File:	Scale:

Figure 7 - Dissolved Benzene in Groundwater, μg/l, 11/29/01
Toddsbury of Ivy
Ivy, Virginia



Jeffrey A. Sitler - Environmental Services, Inc.
PO Box 6038
Charlottesville, VA 22906
(804)974-7080 - (804)974-1657 (FAX)

Date:	Revised:
Drawn by: LRS	Checked by:
File:	Scale:

Figure 8 - Dissolved MTBE in groundwater, µg/l, 11/29/01
Toddsbury of Ivy
Ivy, Virginia

Based on Figure 7 and 8, the dissolved contamination at the Site is primarily limited to the vicinity of the gasoline UST basin. Dissolved benzene was found at 1,480 μg/l and MTBE was at 56,400 μg/l in MW-2. However, MTBE was reported at 18 μg/l in MW-1 and at an estimated 3.3 μg/l in the water supply well.

2.8 SITE GEOLOGY AND HYDROGEOLOGY

The Site is underlain by 12 to 15 feet of red-brown clayey silt to silt soil with cobbles in the lower depths. It is not known whether the soil represents a saprolite or a reworked floodplain sediment. Underlying the soil is the well-indurated bedrock. The depth to the water table ranged from 6.5 to 8.5 feet below the surface. Thus, the shallow aquifer is from 5.5 to 6.5 feet thick in the vicinity of the monitoring wells.

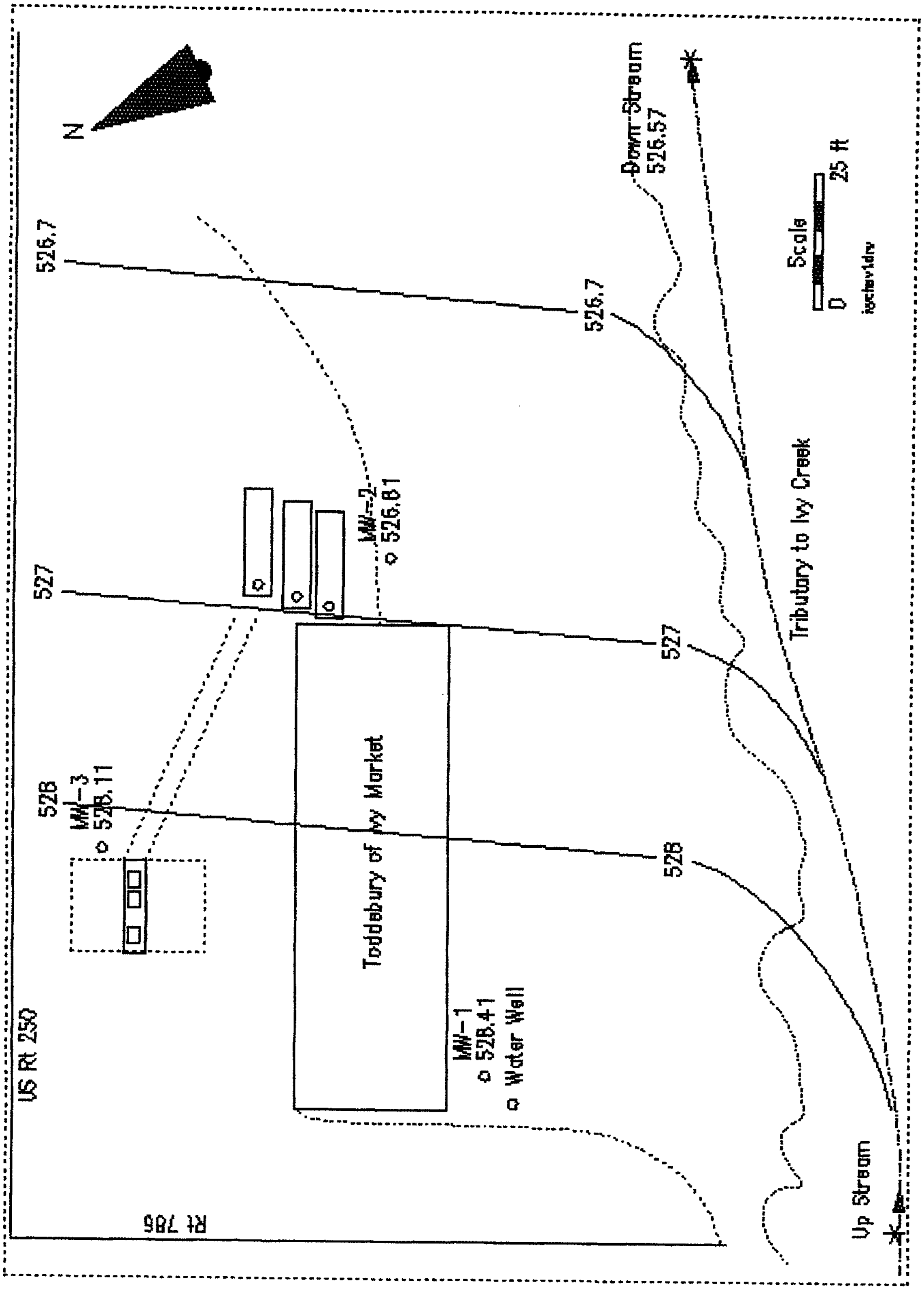
A water-table contour map is presented in Figure 9 that indicates the principal groundwater flow direction is to the southeast toward Little Ivy Creek. Since the small stream along the south side of the Site has continued to flow throughout the recent drought, the water table contours have been curved around to indicate that some groundwater flows into the small tributary. On the sampling date, the flow in the small tributary was low, estimated to be less than one gallon per minute. From Figure 9, the gradient toward Little Ivy Creek is about 0.03 under the market, but flattens out east of the store to an estimated 0.01. The change in gradient may be due to heterogeneities in aquifer permeability.

2.8.1 Hydraulic Conductivity and Groundwater Flow Velocity

The hydraulic conductivity for the shallow aquifer was estimated by comparing the water table elevations in the stream and the monitoring wells to the predicted elevations based on the model presented by Jacob Bear.[2] The Bear model estimates the seepage to parallel drains given uniform recharge and hydraulic conductivity. The uniform recharge was set at 0.0016 feet per day (7.0 inches per year). While the two-drain model assumption is not strictly adhered to in this situation with the tributary on the south flowing eastward into Little Ivy Creek on the east and uplands to the west and north, the extrapolated flow lines are relatively parallel through MW-1, MW-3, and

---

[2] Jacob Bear, 1979, Groundwater Hydraulics, McGraw-Hill, NY, page 180.



Jeffrey A. Sitler - Environmental Services, Inc.
PO Box 6038
Charlottesville, VA 22906
(804)974-7080 - (804)974-1657 (FAX)

Date:	Revised:
Drawn by: LRS	Checked by:
File:	Scale:

Figure 9 - Water Table Elevation as of 11/29/01
Toddsbury of Ivy
Ivy, Virginia

MW-2. If they are parallel, than, along that line, the water table should not be significantly different from the modeled case. Two analyses are reported here: A predicted water table elevation that matches the observed water tables with a drain spacing of 400 feet and 800 feet. The results are presented in Figure 10. The estimated average hydraulic conductivity for the shallow aquifer is between 14 and 32 feet per day. Since the shallow aquifer is primarily within a silty soil, the effective porosity is estimated to be on the order of 0.2. With these parameter estimates, the groundwater velocity is estimated to be on the order of 1.6 to 2.1 feet per day, using the following equation:

x 5.5 → 6.5 [illegible]
= A

$v = K \frac{dh}{dl}$ 0.7 → 2.1
?
$v = ki$

$$v = Ki/n_e \qquad \textbf{Equation (1)}$$

where v is the groundwater seepage velocity, (feet per day),
K is the hydraulic conductivity (14 - 32 feet per day),
i is the hydraulic gradient (0.01 - 0.03 feet per foot), and
n_e is the effective porosity (0.2, dimensionless).

V ~ 14 ft, 0.01 ft [illegible] = 0.1[illegible]
14 [illegible] = 2.1 ft

[illegible]

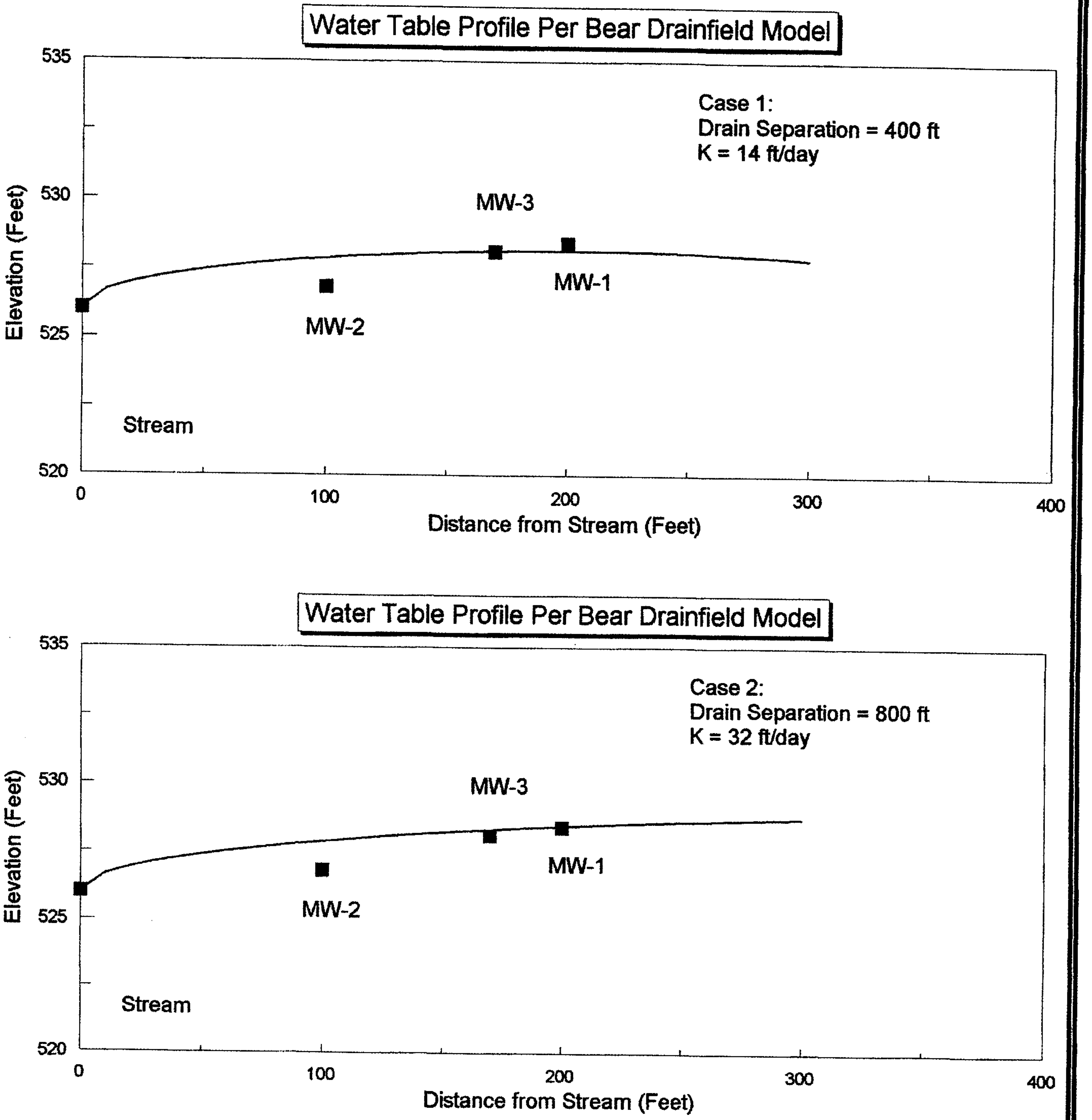
smaller V would yield less [illegible] & greater [illegible] transport [illegible] stream ?

2.9 MATERIAL RELEASED

Gasoline-range hydrocarbons have been confirmed in soil and groundwater samples from the Site. There is no information available concerning the amount of the release or the timing of the release. Since MTBE is present, the release occurred after 1978 when MTBE was first added to gasoline. Inspection of the GC chromatograms indicates that there are no late-eluting compounds that would be suggestive of kerosene or diesel contamination in the samples. Thus, based on these analyses, it appears that the contamination is limited to gasoline.

2.10 CAUSE OF RELEASE

Field observations, including petroleum odors, and laboratory analysis of soil, revealed signs of gasoline contamination associated with the UST basin. Recent pressure testing indicated that the tanks were not leaking, and shallow soil samples did not indicate significant leakage from the supply lines. There may have been older tanks that leaked prior to the current tanks being installed, or overfilling of the tanks that resulted in the contamination.



Jeffrey A. Sitler -
Environmental Services, Inc.
PO Box 6038
Charlottesville, VA 22906
(804)974-7080 - (804)974-1657 (FAX)

Date:	Revised:
Drawn by: LRS	Checked by:
File:	Scale:

Figure 10 - Comparison of Bear Water Table to Observed Water Table

2.11 NUMBER AND SIZE OF TANKS

The Site contained three regulated gasoline USTs and one unregulated abandoned kerosene UST with the characteristics shown in Table 1. The ages of the USTs are unknown. The kerosene UST appears to have a dispenser that is pre-1950's vintage.

2.12 EXTENT OF HYDROCARBON CONTAMINATION

2.12.1 Liquid Phase Hydrocarbons (LPH)

No LPH has been found at the Site in the monitoring wells or soil samples. Typically, where LPH is present, the individual dissolved gasoline components have been found at concentrations greater than 5,000 μg/l, although this is not a consistent indicator. Since the different gasoline components undergo varying rates of biodegradation and loss, samples can produce inconsistent results as to the indication of LPH. Thus, at the Site the BTEX components in MW-2 are well below 2,000 μg/l, but the MTBE component is at 56,400 μg/l. Based on the BTEX, LPH is not expected, but based on the MTBE in groundwater, at least some LPH should be expected, or was present at an earlier time and has since dissipated.

2.12.2 Absorbed or Residual-Phase Contamination

Figure 6 above shows that the adsorbed-phase contamination as TPH-GRO appears to be highest in the vicinity of the gasoline tank basin. However, since the water table is at a depth of 8.5 feet in MW-2, the water table is above the base of the tank basin. Therefore, there is no adsorbed soil contamination per se, since this phase of contamination typically is defined as residing above the water table. The contaminated soil in MW-2 is believed to have undergone anaerobic degradation. The soil had some gray coloring and a strong septic, or anaerobic odor. This fits with the high water table and high contamination levels that caused the low oxygen levels.

2.12.3 Dissolved-Phase Contamination

Dissolved-phase contamination by gasoline components has been identified in MW-2, MW-1, and the water supply well. MW-2, adjacent to the UST tank basin, has the highest contamination levels in groundwater with:

Benzene at 1,480 μg/l
Toluene at 1,420 μg/l
Ethylbenzene at BDL
Total xylenes at 900 μg/l

MTBE at 56,400 μg/l
TPH-GRO at BDL

MW-1 only had 18 μg/l of MTBE detected, and the water well only had 3.3 μg/l of MTBE estimated.

The extent of groundwater contamination is not clearly defined with the current data. The water table contour map in Figure 9 shows that the groundwater flow is toward the southeast, and the concentration contours in Figures 7 and 8 are dashed as uncertain to the southeast of MW-2. Since MW-1 and the water well had MTBE detected, there is a component of groundwater flow toward the water supply well.

2.12.4 Vapor Phase

Some vapor-phase contamination was observed in the soil from MW-2 adjacent to the tank basin. However, the onsite building does not have any reported gasoline vapors and has no basement. There are no buried utilities onsite near the tank basin or dispenser island that could act as conduits for vapor migration.

3.0 RISK ASSESSMENT

The risk assessment evaluates risks to human and environmental receptors posed by the release. In the risk assessment, where appropriate, potential and impacted receptors, including sensitive receptors, are identified; migration rates for the contaminants are estimated; and risks to individual receptors are determined. All potential pathways of exposure are evaluated, including ingestion, inhalation, and dermal contact. If there is determined to be a significant risk posed by the Site, remediation endpoints based upon site-specific risks are proposed. The overall goal of the risk assessment is to determine risks to receptors so that endpoints for corrective action may be defined on a scientific and defensible basis.

3.1 SITE DESCRIPTION

3.1.1 Area Characteristics

Site geology consists of a thin soil less than 15 feet thick of predominantly silt with some clay in the upper region and some cobbles deeper that overlies a gneiss bedrock. The top of the well-indurated bedrock occurs at between 12 and 15 feet of depth across the Site with the water table at a depth of from 6.5 to 8.5 feet below ground surface. Surface-water runoff and groundwater flow are toward the southeast and south.

The Site has been a market and gasoline station for at least 50 years. Currently, there are three, 3,000-gallon gasoline USTs on the east end of the building and an abandoned kerosene (?) UST that may be 550 gallons on the west end. The market building is a mix of slab-on-grade and crawl space. The immediate area surrounding the Site is sparsely developed as commercial and residential land use interspersed with woodlands. Near the Site, the land use is commercial along Route 250. The residential homes are removed from the Site by several hundred feet and are either in the uplands or across the streams to the south and east.

3.1.2 Nature and Extent of Contamination

The nature and extent of contamination due to the gasoline release at the Site is discussed in Section 2.12 and summarized as follows:

- Soil in the tank basin contains TPH-GRO at a concentration of at least 1,060 mg/kg as determined in MW-2-8.
- Since the water table is shallow and extends into the tank basin, the residual soil contamination appears to be limited to a thin zone between about five and eight feet.
- Groundwater contamination was detected in the onsite water supply well with benzene at 1,480 μg/l and MTBE at 56,400 μg/l in MW-1.
- LPH has not been observed in the borings or in the monitoring wells or the onsite water supply well.

3.1.3 Identifying Contaminants of Concern (COC)

The Site has a gasoline release. Therefore, gasoline range organics are considered the only potential COCs. Of the more than 100 gasoline components, the BTEX compounds are generally of most concern due to their greater health threat, solubility and mobility. Benzene is a known human carcinogen, and the EPA has established a maximum contaminant level (MCL) for benzene of 5.0 μg/l (0.005 mg/l) for drinking water. Table 4 lists the highest concentrations of contaminants found in soil and compares the highest observed groundwater concentrations to drinking water MCLs and cancer rating. At the Site, only benzene exceeds an MCL, and MTBE exceeds an EPA health advisory. Therefore, risks associated with benzene, toluene, and MTBE will be addressed in this risk assessment.

Table 4. Maximum Contaminant Levels and Cancer Potential for Contaminants Observed in Soil and Groundwater at the Site.

Adsorbed/Dissolved Constituent	Highest Observed Residual Concentration (ug/kg)	Highest Observed Concentration in Groundwater (ug/l)	EPA Drinking Water MCL (ug/l)	Reason for MCL
Benzene	3,920	1,480	5	A
Toluene	73,000	1,420	1,000	D
Ethylbenzene	31,300	BDL	700	D
Xylenes, Total	155,000	900	10,000	D
MTBE	BDL	56,400	40	H
TPH	1,060,000	BDL	NA	NA

NA = Not Analyzed or Not Applicable
BDL = Below Detection Limit
A = Classified as a human carcinogen, sufficient evidence in epidemiologic studies to support causal association between exposure and cancer.
D = Cancer group not classifiable, inadequate or no human and animal evidence of carcinogenicity.
H = EPA health advisory level for odor aesthetics, not cancer.

3.2 ENVIRONMENTAL FATE AND TRANSPORT OF GASOLINE

Degradation. The BTEX compounds have both chemical and biological degradation pathways. The chemical degradation of aromatics by hydrolysis is the reaction of the aromatic molecule with water. Biological degradation involves the active breakdown of the compounds by enzymes excreted by microbes in the subsurface. In the course of normal life processes, bacteria accidentally cause the enzymatic breakdown of the BTEX compounds, reabsorb the broken molecules, and ultimately metabolize the organic carbon chains into the end products of carbon dioxide and water. Organic contaminants biodegrade on the order of 1,000 times faster in the presence of aerobic bacteria, i.e., dissolved oxygen must be present in the groundwater. For example, under aerobic conditions, the half life for benzene may be as short as 60 days.

Volatility. With a vapor pressure of 5 to 15 millimeters of mercury, gasoline components readily volatilize, and transport in the vapor phase is potentially important. Gasoline vapors have a density that is greater than that of air and will tend to collect and diffuse into low areas, such as basements, sewers, and utility trenches. However, the Site does not have any basements or utility trenches that could act as vapor migration pathways.

Attenuation. Gasoline components, having a lighter molecular weight and slight polarity, can be transported in the dissolved state fairly readily. Indicators of the compound's mobility are its theoretical solubility in water, organic carbon partition coefficient (Koc) and oil/water partition coefficient (Kow). Koc is the ratio of the mass of a compound found adsorbed to the soil versus the mass dissolved in water at equilibrium. A high Koc means that the compound preferentially adheres to the soil solids. Kow is the ratio of the concentration of a compound in oil versus the concentration dissolved in water at equilibrium. A high Kow means that the compound preferentially dissolves into the oil more than the water. Thus, a compound with a high Koc and Kow has a low solubility in water, and as a consequence, is not very mobile in the water environment.

If it is assumed that the adsorbed concentrations in MW-2-8 are at equilibrium with the dissolved concentrations in the MW-2 groundwater sample, then the partition coefficient K_{oc} can be estimated by:

$$K_{oc} = C_s / C_{gw}$$ **Equation (2)**

where K_{oc} is the organic carbon partition coefficient,

C_s is the concentration adsorbed to solids,

C_{gw} is the concentration dissolved in groundwater.

With the K_{oc} estimated, the retardation coefficient, R_f can be estimated by:

$$R_f = 1 + K_{oc} f_{oc} \rho_s / \eta_w$$ **Equation (3)**

where R_f is the retardation coefficient, dimensionless,

K_{oc} is the organic carbon partition coefficient, l/kg,

f_{oc} is the fraction organic carbon, dimensionless,

ρ_s is the bulk aquifer density, mg/kg, and

η_w is the water filled porosity.

R_f also is defined as:

$$R_f = v_w / v_c$$ **Equation (4)**

where v_w is the velocity of groundwater, and

v_c is the velocity of the dissolved contaminant.

Table 5 shows the results of these calculations for the data from MW-2. The R_f values in the last column indicate the velocity of the compound through the aquifer relative to the velocity of groundwater (from Equation 3). Thus, from Equation 4, MTBE moves at the same velocity as groundwater, benzene is indicated to move at 80% the velocity of groundwater, and xylene is estimated to move at just 6% that of groundwater.

Table 5. Environmental Data for Petroleum Compounds at 20C.

Compound	Residual Concentration in MW-2 (ug/kg)	Dissolved Concentration in MW-2 (ug/l)	Calculated Organic Carbon Partition Coef. Koc l/kg	Fuel/Water Partition Coef. Kow	Calculated Retardation Factor f_{oc} = 1%
Benzene	3,920	1,480	2.6	350	1.2
Toluene	73,000	1,420	51	1,250	5.5
Ethyl-benzene	31,300	400	78	4,500	7.8
Xylenes	155,000	900	172	4,110	16
MTBE	500	56,400	0	16	1.0

For example, the travel time for groundwater and MTBE from the tank basin to Little Ivy Creek is estimated to be 200 feet divided by 2.1 feet per day, or 95 days. For benzene, with a retardation factor of 1.2, the travel time is estimated to be 114 days, and toluene, with a retardation factor of 5.5, the travel time would be 523 days.

3.3 EXPOSURE ASSESSMENT

The exposure assessment uses information from the characterization of the site characterization and environmental fate and transport analysis to identify significant completed exposure pathways and to estimate actual or potential exposure point concentrations of identified COC. The results of the exposure assessment are used to determine the potential human health and environmental risks associated with the Site.

3.3.1 Potentially Exposed Human and Environmental Populations

Both onsite and offsite residents can be considered potential receptors of the COCs released at the Site if there is a completed exposure pathway via ingestion of contaminated drinking water, contact with contaminated water or soil, or inhalation of vapors or contaminated dust. The potential exposure of environmental populations, i.e., biota, is via contamination of surface water.

3.3.1.1 Potentially Exposed Human Populations

Both onsite workers and offsite workers and residents can be considered potential receptors of the COC released at the Site if there is a completed exposure pathway via ingestion of contaminated drinking water, contact with contaminated water or soil, or inhalation of vapors or contaminated dust. The results of the site investigation indicate that the groundwater flow direction is toward the southeast and south (see Section 2.8). All workers and residents within one-fourth mile radius are served by private water supply wells. There are no water supply wells in the natural down-gradient direction from the contamination. However, the onsite water well and neighboring monitoring well contain MTBE. There are several up- and side-gradient water supply wells within 500 feet of the Site. Thus, potential exposure to human populations will be evaluated further.

3.3.1.2 Potentially Exposed Environmental Populations

Potential for exposure of environmental populations, i.e., biota, is via contamination of surface water. The nearest perennial stream that would contain biota is either the tributary on the south side of the Site or Little Ivy Creek at the southeast side of the Site. Thus, potential exposure to environmental populations will be evaluated further.

3.3.2 Exposure Pathways and Exposure Point Concentrations

For exposure to occur to a receptor, the contaminant must be able to reach a point where exposure may occur. If the exposure pathway is incomplete, no exposure and no health hazard can take place, and that pathway may be eliminated from further evaluation. The following evaluation considers each of the common exposure pathways typically occurring as a result of a release of petroleum hydrocarbons from a UST.

3.3.2.1 Water Consumption Pathway

Based on available evidence, the onsite water supply well is up gradient of the source under natural conditions (see the water table contours in Figure 9). However, analysis of tap water from the onsite well found an estimated 3.3 μg/l of MTBE. Therefore, it appears that the water well is able to reverse groundwater flow. This completed pathway is retained for further evaluation.

The estimation of the exposure point concentration at the onsite water well is computed by using an analytical equation presented by Jacob Bear[3]. The application of his analytical solution was first applied to modeling contaminant concentrations in a pumping well at a Superfund site.[4] The Lotus 1-2-3 spreadsheet showing the results of the calculation of the Bear model is presented in Appendix C. The Bear model assumes that a circular plume with radius, r, and thickness, h, having an average concentration, c, is drawn into a pumping well. As the contaminated plume is drawn in, it combines with fresh water from the other directions of radial flow to the well. The greatest concentration in the pumped water occurs when the center of mass of the circular plume reaches the well.

For benzene, a plume radius of 25 feet is used based on Figure 7. For MTBE, a plume radius of 50 feet is assumed based on Figure 8. The thickness of each plume is 7.0 feet, and the distance from the center of the plume to the water well is 100 feet. The specific yield of the shallow

---

[3] Bear, Jacob, 1979, Groundwater Hydraulics, McGraw-Hill, New York, pp. 290-292)

[4] Silka, Lyle R., 1987, Predicting Plume Characteristics from Pumping Well Concentrations Using a One-Dimensional Analytical Solution, Proc. of the Conference on Northwestern Ground Water Issues, National Ground Water Association, Dublin, OH, pp. 329-347.

aquifer is 0.2, and the average pumping rate is estimated to be 1.0 gpm (1,440 gallons per day). The average concentration in the benzene plume is estimated as the log average of the highest concentration to the lowest, i.e., $10^{\{\log(1{,}480\ \mu g/l) + \log(2.0\ \mu g/l)\}/2}$ for benzene, or 55 μg/l. The 2.0 μg/l concentration replaces BDL and is the reported detection limit. For toluene, the log average plume concentration is $10^{\{\log(1{,}420\ \mu g/l) + \log(2.0\ \mu g/l)\}/2}$, or 53 μg/l. For MTBE, the log average plume concentration is $10^{\{\log(56{,}400\ \mu g/l) + \log(4.0\ \mu g/l)\}/2}$, or 475 μg/l.

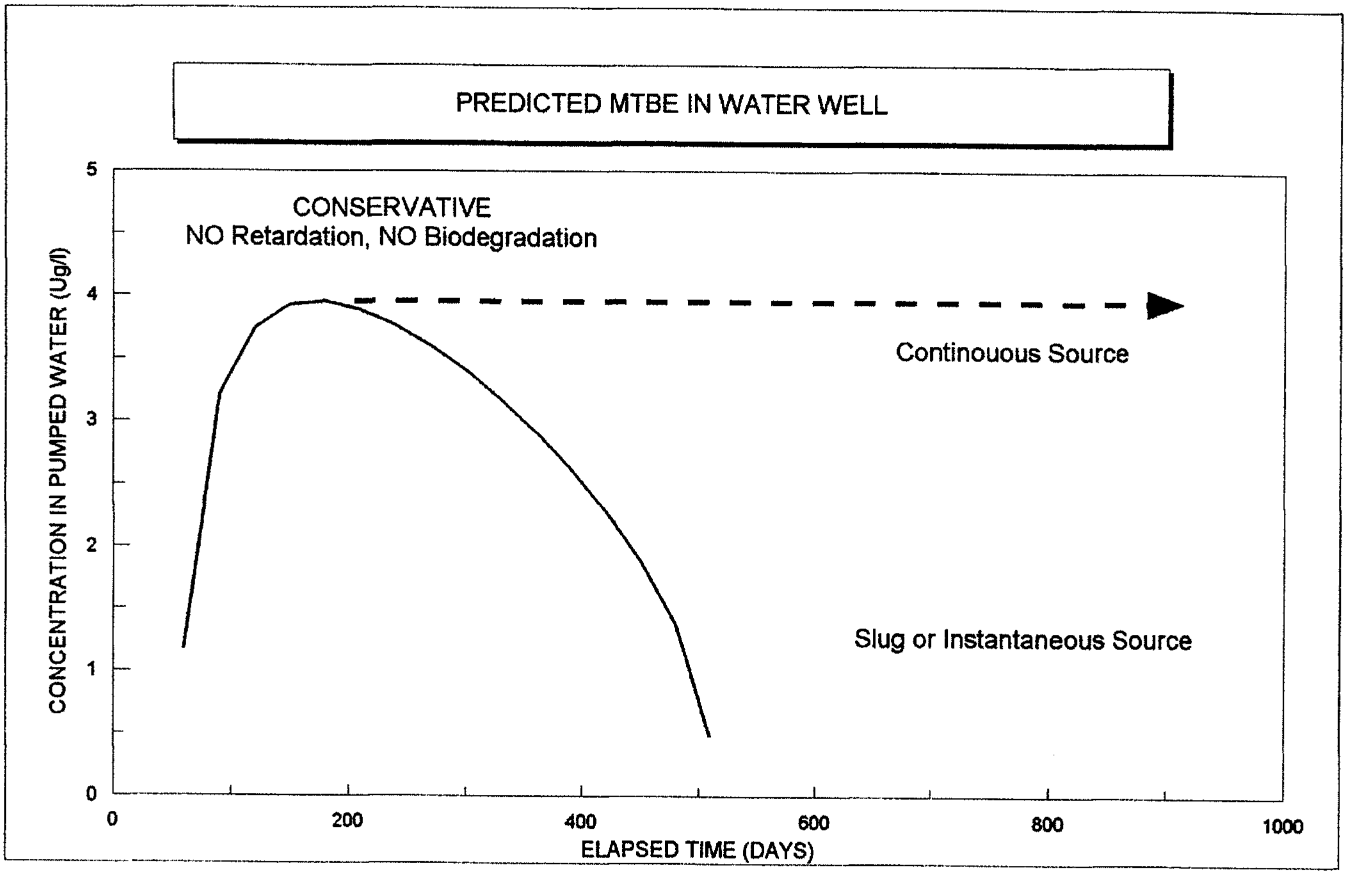
The results of the Bear pumping well model are presented in Figure 10 for MTBE. The figure shows the solid curve with a peak of 4.0 μg/l at a time of 200 days that represents the approximation of a slug, or instantaneous source. The dashed line represents the case if the source were constant and continuing. The horizontal dashed line implies that a steady state condition exists. Since the predicted peak is reached within less than one year, and the field evidence indicates that the contamination probably was in the subsurface for much longer than one year, than the MTBE concentration in the water well may be at an approximate steady state level. In order to match the observed 3.3 μg/l in the water well, the average concentration in the cylindrical plume had to be reduced from 475 μg/l to 24 μg/l. This reduction in the average plume concentration is equivalent to diluting the plume by a factor of 20 in the water well. This corresponds to the well drawing from a saturated thickness that is 20 times thicker than the 7.0-foot thickness of the shallow aquifer used in the model, i.e., 140 feet.

- heterogeneous flow

- fracture flow?

The model for benzene predicts that, based on dilution alone, benzene will not be detectable in the water well. Since the benzene model has a null result, there is no corresponding figure. Since toluene is at a slightly lower concentration than benzene, it also is predicted to remain undetectable in the water well. A spreadsheet for both the MTBE and benzene models are presented in Appendix C.

As for neighboring water wells, the radial distance to these wells is greater than 100 feet. Therefore, adjustment of the above analysis would result in the prediction of no detectable contaminants in these more distant water supply wells also.



Jeffrey A. Sitler - Environmental Services, Inc.
PO Box 6038
Charlottesville, VA 22906
(804)974-7080 - (804)974-1657 (FAX)

Date:	Revised:
Drawn by: LRS	Checked by:
File:	Scale:

Figure 11 - Predicted MTBE in Onsite Water Well
Toddsbury of Ivy
Ivy, Virginia

3.3.2.2 Direct Contact Pathway

Direct contact of humans with contaminated water may be via exposure to contaminated surface water such as during swimming or via contact with contaminated groundwater such as during showering. The closest point at which groundwater emerges, i.e., at a perennial stream, is either in the small tributary about 75 feet south of the UST basin or Little Ivy Creek about 200 feet east of the UST basin. A conservative dilution rate for groundwater from the Site entering either the tributary or Little Ivy Creek can be estimated by the ratio of the area of contamination to the area of the upstream drainage basin. The contaminated area of the Site for benzene is estimated to be 0.04 acres (the area within the BDL contour in Figure 7). For MTBE, the contaminated area is estimated to be 0.08 acres (the area within the BDL contour in Figure 8). The upstream area for the tributary is 430 acres, and the area for Little Ivy Creek is 760 acres. Thus, the dilution rate for the tributary is 430 acres divided by 0.04 acres, or 10,700. For Little Ivy Creek, the dilution rate is 760 acres divided by 0.08 acres, or 9,500.

Without considering degradation and assuming that all contamination went to the tributary, the concentration for benzene in the tributary would be the 55 μg/l log average concentration developed in section 3.3.2.1 divided by 10,700, or BDL, and toluene would be diluted to 53 μg/l divided by 9,500, or BDL. For MTBE, the concentration in the tributary would be the 475 μg/l divided by 10,700, or BDL. For Little Ivy Creek, benzene would be diluted to 55 μg/l divided by 9,500, or BDL, toluene would be diluted to 53 μg/l divided by 9,500, or BDL, while MTBE would be diluted to 475 μg/l divided by 9,500, or BDL. Thus, both streams appear to have sufficient dilution to prevent contamination from becoming detectable even without accounting for degradation.

As for direct contact via a water well, in the preceding section, it was shown that benzene is unlikely to be detected in the onsite well. In addition, it is believed that MTBE is at an approximate steady-state value of about 3.3 μg/l that is well below the 20 μg/l advisory level established for odor. Given these results, the direct contact pathway via contact with surface water or groundwater is insignificant and no potential exposure or health hazard is expected. Therefore, the potential exposure via direct contact with surface- or groundwater is not retained for further evaluation.

— DEQ no impact policy.

3.3.2.3 Soil Ingestion Pathway

The soil ingestion pathway is based on the direct ingestion, or exposure to fugitive dust, from contaminated surface soil. Since the contaminated soil is under the surface, potential exposure via direct ingestion of contaminated soil or fugitive dust by onsite workers is considered insignificant. The soil ingestion pathway is incomplete and no exposure or health hazard can occur. Therefore, this potential pathway is eliminated from further evaluation.

3.3.2.4 Inhalation Pathway

The inhalation pathway can occur from exposure to fugitive dusts and from inhalation of volatile COC. Since the contaminated soil is under the surface, potential exposure via inhalation of contaminated soil or fugitive dust by onsite workers is considered insignificant. The inhalation pathway is incomplete for fugitive dust and no exposure or health hazard can occur. The potential inhalation pathway via vapor entering buildings is minimized by the lack of vapor migration pathways. Therefore, the potential inhalation pathway via fugitive dust and vapor is eliminated from further evaluation.

3.3.2.5 Environmental Receptor Pathway

The environmental receptor pathway is via exposure of aquatic biota to contaminated surface water. The environmental receptor pathway is considered potentially complete, but insignificant since the predicted dilution rates in the tributary and Little Ivy Creek would reduce contamination to undetectable concentrations according to the foregoing calculations (section 3.3.2.2). Therefore, based on only dilution, this potential pathway is eliminated from further evaluation.

3.3.2.6 Summary of Potentially Completed Exposure Pathways and Exposure Point Concentrations

The potentially completed exposure pathway and exposure point concentrations are as follows:

> <u>Ingestion of drinking water from the onsite water supply</u>. The **benzene** exposure point concentration at the water well is currently undetectable and is predicted to remain undetectable on the basis of dilution alone. The **MTBE** exposure point concentration is currently estimated at 3.3 μg/l and is predicted to remain at that level based on the assumption that it is at steady state. This MTBE level is well below the 20 μg/l advisory level for aesthetics (odor).

3.4 RISK CHARACTERIZATION

The primary objective of characterizing risk is to integrate information into a complete evaluation of current and future human health risks and nonhuman impacts associated with contaminants detected at the Site. The risk assessment evaluates the nature and degree of risk to potential receptor populations. The following characterize the potential risks identified for the Site.

- No LPH has been observed at the Site, although MTBE has been detected at 56,400 μg/l, a level usually associated with the presence of LPH.
- The residual soil contamination is minor, since the water table is so shallow.
- There is no significant risk of petroleum vapors migrating to the building.
- Dissolved benzene, toluene, and MTBE are the contaminants of concern present in the groundwater with the highest concentrations observed in MW-2 at 1,480, 1,420, and 56,400 μg/l, respectively.
- The onsite water supply well is contaminated with MTBE at an estimated 3.3 μg/l and is free of all other potential contaminants.
- While dissolved contaminants could migrate to the streams, predicted average dilution rates would render them undetectable.
- MTBE at 3.3 μg/l in the water well is believed to represent an approximate steady-state concentration and is not predicted to increase in the near future.
- No other dissolved contaminants are believed to present any potential threat to the onsite water well.
- There are no risks posed by inhalation, direct contact, or exposure of environmental receptors.
- There are no risks posed to offsite water wells.

4.0 REMEDIATION ASSESSMENT

An assessment of remediation alternatives is conducted if the risk assessment concludes that significant risks are presented by the contamination at the Site. Only MTBE has been detected in the onsite water well, and only MTBE is predicted to be detectable in the well into the future and even then at a similarly low concentration. MTBE does not have an MCL. EPA has established an advisory level for MTBE based solely on odor threshold of 20 to 40 μg/l. Therefore, it is recommended that a remediation assessment not be completed at this time.

If the source characteristics remain constant, the MTBE concentration is predicted to remain at the current level. When the source diminishes or is removed, MTBE is predicted to require less than two years to purge out of the system. If the source increases its intensity, than the MTBE may begin to increase in the water well within 100 days. However, based on the observed concentration of MTBE of 56,400 μg/l, the current source intensity level is quite high.

5.0 CONCLUSIONS AND RECOMMENDATIONS

The Site had a release of gasoline from the UST system that resulted in groundwater contamination with benzene, toluene, and MTBE. No LPH has been observed at the Site, even though the MTBE level is quite high. Groundwater flow is toward the southeast with discharge into Little Ivy Creek. Some groundwater from the Site also discharges into the small tributary on the south boundary of the Site. However, predicted dilution rates in the surface water would render contaminants undetectable. The potential exposure pathway is via the onsite water supply well. The well currently has 3.3 μg/l MTBE but no other contaminants. The MTBE is predicted not to present any concern in the well into the future unless there is an intensification of the source. The other gasoline contaminants also are predicted not to present any concern for the water well at this time. The neighboring offsite water supply wells have remained uncontaminated and are predicted to remain so in the future.

Since the water table contours indicate that the natural groundwater flow is toward the southeast, there is no down-gradient monitoring well. MW-2 represents a monitoring point for the immediate source area. MW-1 is near the water supply well up gradient of the source. MW-3 also is up gradient of the source and also provides confirmation that the pump island is not a source.

It is recommended that one down-gradient monitoring well (MW-4) be installed to the southeast of MW-2 between MW-2 and Little Ivy Creek and that quarterly monitoring of the water supply well, MW-2, and the new MW-4 be conducted to provide confirmation for the predictive modeling.

APPENDIX A

WELL DATA SPREADSHEET
AND
BORING/WELL LOGS

Toddsbury of Ivy
Monitoring Well Data

01/03/02

	MW-1	MW-2	MW-3	Stream
Installation Date	11/28/01	11/28/01	11/28/01	
Heigth of Scope above TOC, ft				
Height of Scope at Rod, ft	4.23	3.90	3.42	12.66
Total depth of well, ft	15.00	15.00	12.00	
Elevation of TOC Relative Local Datum, ft	535.00	535.33	535.81	526.57
Water Table Depth below TOC, 3/3/00, ft	6.59	8.52	7.70	12.66
Elevation of Water Table, ft	528.41	526.81	528.11	513.91

Boring/Well Log

Project: Toddsbury of Ivy

Log of Boring: MW-1	Location: Ivy, VA
Date Drilled: 11/28/01	Ground Surface Elevation: 735 ft
Drilling Method: Hollow Stem Auger	Total Depth: 15 ft
Drilling Company: Certified Environmental Drilling	Geologist: Lyle R. Silka, CPG
VA DEQ PC 01-6134	Weather: Cool, Partly Sunny

Depth (ft)	Sample Number			Geologic Description
0-5				red-brown clayey silt, moist to dry, no gas odor
5-10				same, cobble layer, moist, no gas odor
10-15				same, moist to wet, no gas odor
15				total depth
				2" casing set from 0 to 5 feet.
				2" screen set from 5 to 15 feet.

Boring/Well Log

Project: Toddsbury of Ivy	
Log of Boring: MW-2	Location: Ivy, VA
Date Drilled: 11/28/01	Ground Surface Elevation: 735 ft
Drilling Method: Hollow Stem Auger	Total Depth: 15 ft
Drilling Company: Certified Environmental Drilling	Geologist: Lyle R. Silka, CPG
VA DEQ PC 01-6134	Weather: Cool, Partly Sunny

Depth (ft)	Sample Number			Geologic Description
0-5				red-brown clayey silt, moist to dry, no gas odor
5-10	MW-2-8			same, cobble layer, moist to wet, no gas odor
10-15				same, wet, no gas odor
15				total depth
				2" casing set from 0 to 5 feet.
				2" screen set from 2 to 15 feet.

Boring/Well Log

Project: Toddsbury of Ivy

Log of Boring: MW-3	Location: Ivy, VA
Date Drilled: 11/28/01	Ground Surface Elevation: 735 ft
Drilling Method: Hollow Stem Auger	Total Depth: 12 ft
Drilling Company: Certified Environmental Drilling	Geologist: Lyle R. Silka, CPG
VA DEQ PC 01-6134	Weather: Cool, Partly Sunny

Depth (ft)	Sample Number			Geologic Description
0-5				red-brown clayey silt, moist to dry, no gas odor
5-10				same, cobble layer, moist to wet, no gas odor
10-12				same, refusal at 12', wet, no gas odor
12				total depth
				2" casing set from 0 to 2 feet.
				2" screen set from 2 to 12 feet.

APPENDIX B

LABORATORY ANALYTICAL REPORTS

VOLATILE AROMATICS BY EPA METHODS 5030/8021
VOLATILE TPH BY EPA METHODS 5030/8015

CLIENT SAMPLE ID:	MW-2-8 TODDBURY-IVY	BBLK1205E1
LAB SAMPLE ID:	01120402	METHOD BLANK
SAMPLE DATE:	11/28/01	
RECEIVED DATE:	12/04/01	
ANALYSIS DATE:	12/05/01	12/05/01
FILE NAME:	120402D	1205BBLKE1
INSTRUMENT ID:	GC-E	GC-E
% MOISTURE:	24	N/A
MATRIX:	SOIL	SOIL
UNITS:	UG/KG	UG/KG
DILUTION FACTOR:	2.0	1.0

VOLATILE COMPOUNDS	(Results reported on a dry-weight basis.)			
Benzene	3920		250	U
Toluene	73000		250	U
Ethylbenzene	31300		250	U
Xylenes (total)	155000		500	U
Methyl-t-Butyl Ether	1320	U	500	U
Volatile TPH	1060000		12500	U

B - Detected in lab blank. U - Below reported quantitation level. J - Estimated value.
UG/KG = Microgram per kilogram.

MARYLAND SPECTRAL SERVICES, INC.
1500 Caton Center Drive Baltimore, MD 21227

VOLATILE AROMATICS BY EPA METHODS 5030/8021
VOLATILE TPH BY EPA METHODS 5030/8015

CLIENT SAMPLE ID:	STREAM-UP TODDBURY-IVY	STREAM-DOWN TODDBURY-IVY	MW-1 TODDBURY-IVY	MW-2 TODDBURY-IVY	MW-3 TODDBURY-IVY	BBLK1204E1
LAB SAMPLE ID:	01120403	01120404	01120405	01120406	01120407	METHOD BLANK
SAMPLE DATE:	11/29/01	11/29/01	11/29/01	11/29/01	11/29/01	
RECEIVED DATE:	12/04/01	12/04/01	12/04/01	12/04/01	12/04/01	
ANALYSIS DATE:	12/04/01	12/04/01	12/04/01	12/04/01	12/04/01	12/04/01
FILE NAME:	120403	120404	120405	120406D	120407	1204BBLKE1
INSTRUMENT ID:	GC-E	GC-E	GC-E	GC-E	GC-E	GC-E
MATRIX:	WATER	WATER	WATER	WATER	WATER	WATER
UNITS:	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
DILUTION FACTOR:	1.0	1.0	1.0	200	1.0	1.0
VOLATILE COMPOUNDS						
Benzene	2.0 U	2.0 U	2.0 U	1480	2.0 U	2.0 U
Toluene	2.0 U	2.0 U	2.0 U	1420	2.0 U	2.0 U
Ethylbenzene	2.0 U	2.0 U	2.0 U	400 U	2.0 U	2.0 U
Xylenes (total)	4.0 U	4.0 U	4.0 U	900	4.0 U	4.0 U
Methyl-t-Butyl Ether	4.0 U	4.0 U	18	56400	4.0 U	4.0 U
Volatile TPH	100 U	100 U	100 U	20000 U	100 U	100 U

B - Detected in lab blank. U - Below reported quantitation level. J - Estimated value.
UG/L = Microgram per liter.

MARYLAND SPECTRAL SERVICES, INC.
1500 Caton Center Drive Baltimore, MD 21227

VOLATILE ORGANICS BY EPA GC/MS METHOD 8260

PAGE 1 OF 2

CLIENT SAMPLE ID:	WS TODDBURY-IVY	VBLK1205A1
LAB SAMPLE ID:	01120408	METHOD BLANK
SAMPLE DATE:	11/29/01	
RECEIVED DATE:	12/04/01	
ANALYSIS DATE:	12/05/01	12/05/01
FILE NAME:	120408	1205VBLKA1
INSTRUMENT ID:	MSA	MSA
MATRIX:	WATER	WATER
UNITS:	UG/L	UG/L
DILUTION FACTOR:	1.0	1.0

VOLATILE COMPOUNDS		
Acetone	10 U	10 U
t-Amyl Methyl Ether (TAME)	5.0 U	5.0 U
Benzene	5.0 U	5.0 U
Bromobenzene	5.0 U	5.0 U
Bromochloromethane	5.0 U	5.0 U
Bromodichloromethane	5.0 U	5.0 U
Bromoform	5.0 U	5.0 U
Bromomethane	10 U	10 U
tert-Butanol (TBA)	25 U	25 U
2-Butanone	10 U	10 U
tert-Butylbenzene	5.0 U	5.0 U
sec-Butylbenzene	5.0 U	5.0 U
n-Butylbenzene	5.0 U	5.0 U
Carbon Disulfide	5.0 U	5.0 U
Carbon Tetrachloride	5.0 U	5.0 U
Chlorobenzene	5.0 U	5.0 U
Chloroethane	10 U	10 U
Chloroform	5.0 U	5.0 U
Chloromethane	10 U	10 U
2-Chlorotoluene	5.0 U	5.0 U
4-Chlorotoluene	5.0 U	5.0 U
1,2-Dibromo-3-chloropropane	5.0 U	5.0 U
Dibromochloromethane	5.0 U	5.0 U
1,2-Dibromoethane (EDB)	5.0 U	5.0 U
Dibromomethane	5.0 U	5.0 U
1,3-Dichlorobenzene	5.0 U	5.0 U
1,4-Dichlorobenzene	5.0 U	5.0 U
1,2-Dichlorobenzene	5.0 U	5.0 U
Dichlorodifluoromethane	5.0 U	5.0 U
1,2-Dichloroethane	5.0 U	5.0 U
1,1-Dichloroethane	5.0 U	5.0 U
trans-1,2-Dichloroethene	5.0 U	5.0 U
cis-1,2-Dichloroethene	5.0 U	5.0 U
1,1-Dichloroethene	5.0 U	5.0 U
1,3-Dichloropropane	5.0 U	5.0 U
2,2-Dichloropropane	5.0 U	5.0 U

MARYLAND SPECTRAL SERVICES, INC.

1500 Caton Center Drive Baltimore, MD 21227

VOLATILE ORGANICS BY EPA GC/MS METHOD 8260

PAGE 2 OF 2

CLIENT SAMPLE ID:	WS TODDBURY-IVY	VBLK1205A1
LAB SAMPLE ID:	01120408	METHOD BLANK
SAMPLE DATE:	11/29/01	
RECEIVED DATE:	12/04/01	
ANALYSIS DATE:	12/05/01	12/05/01
FILE NAME:	120408	1205VBLKA1
INSTRUMENT ID:	MSA	MSA
MATRIX:	WATER	WATER
UNITS:	UG/L	UG/L
DILUTION FACTOR:	1.0	1.0
VOLATILE COMPOUNDS		
1,2-Dichloropropane	5.0 U	5.0 U
trans-1,3-Dichloropropene	5.0 U	5.0 U
cis-1,3-Dichloropropene	5.0 U	5.0 U
1,1-Dichloropropene	5.0 U	5.0 U
Ethyl-t-Butyl Ether (ETBE)	5.0 U	5.0 U
Ethylbenzene	5.0 U	5.0 U
Hexachlorobutadiene	5.0 U	5.0 U
2-Hexanone	10 U	10 U
Isopropyl Ether (DIPE)	5.0 U	5.0 U
p-Isopropyl toluene	5.0 U	5.0 U
Isopropylbenzene (Cumene)	5.0 U	5.0 U
4-Methyl-2-Pentanone	10 U	10 U
Methyl-t-Butyl Ether (MTBE)	3.3 J	5.0 U
Methylene Chloride	5.0 U	5.0 U
Naphthalene	5.0 U	5.0 U
n-Propylbenzene	5.0 U	5.0 U
Styrene	5.0 U	5.0 U
1,1,2,2-Tetrachloroethane	5.0 U	5.0 U
1,1,1,2-Tetrachloroethane	5.0 U	5.0 U
Tetrachloroethene	5.0 U	5.0 U
Toluene	5.0 U	5.0 U
1,2,3-Trichlorobenzene	5.0 U	5.0 U
1,2,4-Trichlorobenzene	5.0 U	5.0 U
1,1,2-Trichloroethane	5.0 U	5.0 U
1,1,1-Trichloroethane	5.0 U	5.0 U
Trichloroethene	5.0 U	5.0 U
Trichlorofluoromethane	5.0 U	5.0 U
1,2,3-Trichloropropane	5.0 U	5.0 U
1,2,4-Trimethylbenzene	5.0 U	5.0 U
1,3,5-Trimethylbenzene	5.0 U	5.0 U
Vinyl Chloride	10 U	10 U
o-Xylene	5.0 U	5.0 U
m+p-Xylenes	5.0 U	5.0 U

B - Detected in Lab Blank. U - Below Reported Quantitation Level. J - Estimated Value.
UG/L = Microgram per liter.

CHAIN-OF CUSTODY RECORD

Company Name:
JAS Environmental Services, Inc.
PO Box 6038
Charlottesville, VA 22906

Project Manager:
Jeff Sitler
tel (804)974-7080
fax (804)974-1657

Project Name: Toddbury of Ivy

Project Number:

Sampler(s): **LRS**

Task Number:

Laboratory:
Maryland Spectral Services, Inc.
1500 Caton Center Drive, Suite G
Baltimore, Maryland 21227
(410) 247-7600

	Date	Time	Matrix	no. of container	TPH GRO EPA-5035-8015	TPH DRO EPA-8015	MBTEX EPA-5035-8021	PAH EPA-8270	MBTEXN EPA-5035-8021			MSS#
MW-2-8	11/28/01	1530	S	1	X		X				ICC	01-1204-02
Stream Up	11/29/01	1630	W	2	↓		↓				↓	03
Stream Down	↓	1640	↓	↓	↓		↓				↓	04
MW-1	↓	1530	↓	↓	↓		↓				↓	05
MW-2	↓	1640	↓	↓	↓		↓				↓	06
MW-3	↓	1550	↓	↓	↓		↓				↓	07
WS	↓	1650	↓	↓			8260				this sample only	08

(printed) Lyle R. Silka	12/03/01 1000	Federal Express (printed)	Send report to: Lyle Silka 5709 Cedar Walk #402 Centreville, VA 20121 Fax summary of results to Lyle Silka at (703)631-0726
Relinquished by: (signature) (printed)	Date/Time 12/4/01 1020	~~Received by:~~ (signature) (printed)	Bill: JAS

APPENDIX C

DATA FOR ANALYSIS OF BTEX CONCENTRATIONS IN SOIL
SPREADSHEETS FOR DRAIN FIELD ANALYSIS
SPREADSHEETS FOR PUMPED CONCENTRATION IN WATER WELL

DATA FOR ANALYSIS OF BTEX CONCENTRATIONS IN SOIL

BTEX Concentrations in Soil

PC #	Sample		Benzene ug/kg	Toluene ug/kg	Ethyl-benzene ug/kg	Xylenes ug/kg	MTBE ug/kg
99-5067	Equine	MW-1-10	107,000	841,000	260,000	1,310,000	116,000
99-5192	Ashley's	MW-1-15	81,600	1,220,000	261,000	1,740,000	104,000
99-5158	Beaver Dam	Gas-1	15,900	199,000	123,000	527,000	BDL
99-5158	Beaver Dam	Gas-2	42,400	403,000	253,000	1,040,000	17,200
99-5158	Beaver Dam	MW-1-15	45,100	355,000	146,000	668,000	BDL
99-5159	Crozet	MW-1-10	20,200	246,000	99,400	457,000	NA
00-6036	Jones	SB-2-20	23,100	170,000	67,200	314,000	BDL
99-5195	LJ's	SB-1-10	1,370	36,600	26,800	111,000	1,210
99-5030	Midtown	Pump-1	2,080	35,700	21,200	85,100	NA
99-5060	Stackhouse	MW-4-10	2,070	18,300	9,180	46,100	BDL
01-6134	Toddsbury	MW-2-8	3,920	73,000	31,300	155,000	BDL
N			11	11	11	11	4
Average			31,340	327,055	118,007	586,655	59,603
Std			33,515	362,416	95,165	532,286	50,891

Log BTEX Concentrations in Soil to Xylene

PC #	Sample		Est. Age yr	Benzene ug/kg	Toluene ug/kg	Ethyl-benzene ug/kg	Xylenes ug/kg	MTBE ug/kg
99-5067	Equine	MW-1-10	0	5.03	5.92	5.41	6.12	5.06
99-5192	Ashley's	MW-1-15	0	4.91	6.09	5.42	6.24	5.02
99-5158	Beaver Dam	Gas-1	0	4.20	5.30	5.09	5.72	BDL
99-5158	Beaver Dam	Gas-2	0	4.63	5.61	5.40	6.02	4.24
99-5158	Beaver Dam	MW-1-15	0	4.65	5.55	5.16	5.82	BDL
99-5159	Crozet	MW-1-10	0	4.31	5.39	5.00	5.66	NA
00-6036	Jones	SB-2-20	0	4.36	5.23	4.83	5.50	BDL
99-5195	LJ's	SB-1-10	0	3.14	4.56	4.43	5.05	3.08
99-5030	Midtown	Pump-1	0	3.32	4.55	4.33	4.93	NA
99-5060	Stackhouse	MW-4-10	0	3.32	4.26	3.96	4.66	BDL
01-6134	Toddsbury	MW-2-8	0	3.59	4.86	4.50	5.19	BDL
N				11	11	11	11	4
N				4.13	5.21	4.87	5.54	4.35
Average				0.65	0.56	0.48	0.49	0.80

DRAIN FIELD ANALYSIS

AFTER BEAR (1979, P. 180)

MODELER: LRS

01/04/01

INPUT		INPUT	UNITS
RECHARGE (R)	ON LEFT SIDE OF DRAIN	0.0016	FT/DAY
	ON RIGHT SIDE OF DRAIN	0.0016	FT/DAY
DISTANCE BETWEEN DRAINS (L)		400	FEET
HEIGHT OF DRAIN "0" (H0)		0	FEET
HEIGHT OF DRAIN "1" (H1)		0	FEET
HYDRAULIC CONDUCTIVITY (K)		14	FT/DAY

OUTPUT	OUTPUT	
FLOW RATE TO DRAIN "0"	-0.320	CFD/LINEAL FT
FLOW RATE TO DRAIN "1"	0.320	CFD/LINEAL FT
DISTANCE TO MAXIMUM HEIGHT OF WATER TABLE (HMAX)	200	FEET

	DISTANCE (FT) 10	HEIGHT OF WATER TABLE (FT)	HYDRAULIC GRADIENT	ELEVATION OF WATER TABLE 526	COMMENTS
0	0	0		526.0	526
10	10	1	0.0667	526.7	
20	20	1	0.0264	526.9	
30	30	1	0.0194	527.1	
40	40	1	0.0156	527.3	
50	50	1	0.0131	527.4	
60	60	2	0.0113	527.5	
70	70	2	0.0098	527.6	
80	80	2	0.0086	527.7	
90	90	2	0.0075	527.8	
100	100	2	0.0066	527.9	MW-2 526.8 ~~MW-3~~
110	110	2	0.0058	527.9	
120	120	2	0.0050	528.0	
130	130	2	0.0043	528.0	
140	140	2	0.0037	528.0	
150	150	2	0.0031	528.1	
160	160	2	0.0025	528.1	
170	170	2	0.0019	528.1	528.1 MW-3
180	180	2	0.0013	528.1	
190	190	2	0.0008	528.1	
200	200	2	0.0003	528.1	528.4 MW-1
210	210	2	-0.0003	528.1	
220	220	2	-0.0008	528.1	
230	230	2	-0.0013	528.1	
240	240	2	-0.0019	528.1	
250	250	2	-0.0025	528.1	
260	260	2	-0.0031	528.0	
270	270	2	-0.0037	528.0	
280	280	2	-0.0043	528.0	
290	290	2	-0.0050	527.9	
300	300	2	-0.0058	527.9	

DRAIN FIELD ANALYSIS

AFTER BEAR (1979, P. 180)

INPUT		INPUT	UNITS	MODELER: LRS
RECHARGE (R)	ON LEFT SIDE OF DRAIN	0.0016	FT/DAY	01/04/01
	ON RIGHT SIDE OF DRAIN	0.0016	FT/DAY	
DISTANCE BETWEEN DRAINS (L)		800	FEET	
HEIGHT OF DRAIN "0" (H0)		0	FEET	
HEIGHT OF DRAIN "1" (H1)		0	FEET	
HYDRAULIC CONDUCTIVITY (K)		32	FT/DAY	
OUTPUT		OUTPUT		
FLOW RATE TO DRAIN "0"		-0.639	CFD/LINEAL FT	
FLOW RATE TO DRAIN "1"		0.639	CFD/LINEAL FT	
DISTANCE TO MAXIMUM HEIGHT OF WATER TABLE (HMAX)		400	FEET	

	DISTANCE (FT) 10	HEIGHT OF WATER TABLE (FT)	HYDRAULIC GRADIENT	ELEVATION OF WATER TABLE 526	COMMENTS
0	0	0		526.0	526
10	10	1	0.0628	526.6	
20	20	1	0.0255	526.9	
30	30	1	0.0191	527.1	
40	40	1	0.0158	527.2	
50	50	1	0.0136	527.4	
60	60	1	0.0121	527.5	
70	70	2	0.0108	527.6	
80	80	2	0.0099	527.7	
90	90	2	0.0090	527.8	
100	100	2	0.0083	527.9	526.8 MW-3
110	110	2	0.0077	527.9	
120	120	2	0.0072	528.0	
130	130	2	0.0067	528.1	
140	140	2	0.0063	528.1	
150	150	2	0.0058	528.2	
160	160	2	0.0055	528.3	
170	170	2	0.0051	528.3	528.1 MW-3
180	180	2	0.0048	528.4	
190	190	2	0.0045	528.4	
200	200	2	0.0042	528.4	528.4 MW-1
210	210	2	0.0039	528.5	
220	220	3	0.0037	528.5	
230	230	3	0.0034	528.6	
240	240	3	0.0032	528.6	
250	250	3	0.0030	528.6	
260	260	3	0.0027	528.6	
270	270	3	0.0025	528.7	
280	280	3	0.0023	528.7	
290	290	3	0.0021	528.7	
300	300	3	0.0019	528.7	

CONCENTRATION AT PUMPING WELL (FROM BEAR, 1979, pp. 290-292)

Benzene L.R. SILKA

INPUT DATA:

PLUME RADIUS	25 FEET		
DISTANCE, WELL TO PLUME CENTER	100 FEET	SOURCE CONC.	3 ug/l
AQUIFER THICKNESS	7 FEET	AREA =	1963 SQUARE FEET
SPECIFIC YIELD	0.200	Uo =	43982 CUBIC FEET
AVERAGE PUMPING RATE (gpm)	1.00 GPM	BIODEG HALFLIFE	10000 DAYS
RETARDATION FACTOR	1	BIODEG RATE	0.0001 PER DAY

TIME DAYS	CUMMULATIVE VOLUME PUMPED CF	PARAMETERS FOR BEAR'S EQUATION			CONSERVATIVE PUMPED CONC. ug/l	Observed Concentration	PUMPED CONC. WITH BIODEGRADATION ug/l
		Up/Uo	Ui/Uo	є (Relative Conc.)			
0.00E+00	0.00E+00						
3.00E+01	5.78E+03	1.31E-01	6.25E-02	ERR	ERR		ERR
6.00E+01	1.16E+04	2.63E-01	6.25E-02	ERR	ERR		ERR
9.00E+01	1.73E+04	3.94E-01	6.25E-02	ERR	ERR		ERR
1.20E+02	2.31E+04	5.25E-01	6.25E-02	ERR	ERR		ERR
1.50E+02	2.89E+04	6.57E-01	6.25E-02	5.76E-02	0		0
1.80E+02	3.47E+04	7.88E-01	6.25E-02	7.56E-02	0		0
2.10E+02	4.04E+04	9.19E-01	6.25E-02	8.03E-02	0		0
2.40E+02	4.62E+04	1.05E+00	6.25E-02	7.84E-02	0		0
2.70E+02	5.20E+04	1.18E+00	6.25E-02	7.17E-02	0		0
3.00E+02	5.78E+04	1.31E+00	6.25E-02	6.04E-02	0		0
3.30E+02	6.35E+04	1.44E+00	6.25E-02	4.28E-02	0		0
3.60E+02	6.93E+04	1.58E+00	6.25E-02	ERR	ERR		0
3.90E+02	7.51E+04	1.71E+00	6.25E-02	ERR	ERR		ERR
4.20E+02	8.09E+04	1.84E+00	6.25E-02	ERR	ERR		ERR
4.50E+02	8.66E+04	1.97E+00	6.25E-02	ERR	ERR		ERR
4.80E+02	9.24E+04	2.10E+00	6.25E-02	ERR	ERR		ERR
5.10E+02	9.82E+04	2.23E+00	6.25E-02	ERR	ERR		ERR
5.40E+02	1.04E+05	2.36E+00	6.25E-02	ERR	ERR		ERR
5.70E+02	1.10E+05	2.49E+00	6.25E-02	ERR	ERR		ERR
6.00E+02	1.16E+05	2.63E+00	6.25E-02	ERR	ERR		ERR
6.30E+02	1.21E+05	2.76E+00	6.25E-02	ERR	ERR		ERR
6.60E+02	1.27E+05	2.89E+00	6.25E-02	ERR	ERR		ERR
6.90E+02	1.33E+05	3.02E+00	6.25E-02	ERR	ERR		ERR
7.20E+02	1.39E+05	3.15E+00	6.25E-02	ERR	ERR		ERR
7.50E+02	1.44E+05	3.28E+00	6.25E-02	ERR	ERR		ERR
7.80E+02	1.50E+05	3.41E+00	6.25E-02	ERR	ERR		ERR
8.10E+02	1.56E+05	3.55E+00	6.25E-02	ERR	ERR		ERR
8.40E+02	1.62E+05	3.68E+00	6.25E-02	ERR	ERR		ERR
8.70E+02	1.67E+05	3.81E+00	6.25E-02	ERR	ERR		ERR

CONCENTRATION AT PUMPING WELL (FROM BEAR, 1979, pp. 290-292)

MTBE L.R. SILKA

INPUT DATA:

PLUME RADIUS	50	FEET			
DISTANCE, WELL TO PLUME CENTER	100	FEET	SOURCE CONC.	24	ug/l
AQUIFER THICKNESS	7	FEET	AREA =	7850	SQUARE FEET
SPECIFIC YIELD	0.200		Uo =	43982	CUBIC FEET
AVERAGE PUMPING RATE (gpm)	1.00	GPM	BIODEG HALFLIFE	10000	DAYS
RETARDATION FACTOR	1		BIODEG RATE	0.0001	PER DAY

TIME DAYS	CUMMULATIVE VOLUME PUMPED CF	PARAMETERS FOR BEAR'S EQUATION			CONSERVATIVE PUMPED CONC. ug/l	Observed Concentration	PUMPED CONC. WITH BIODEGRADATION ug/l
		Up/Uo	Ui/Uo	є (Relative Conc.)			
0.00E+00	0.00E+00						
3.00E+01	5.78E+03	1.31E-01	2.50E-01	ERR	ERR		ERR
6.00E+01	1.16E+04	2.63E-01	2.50E-01	4.91E-02	1		1
9.00E+01	1.73E+04	3.94E-01	2.50E-01	1.35E-01	3		3
1.20E+02	2.31E+04	5.25E-01	2.50E-01	1.58E-01	4		4
1.50E+02	2.89E+04	6.57E-01	2.50E-01	1.65E-01	4		4
1.80E+02	3.47E+04	7.88E-01	2.50E-01	1.66E-01	4		4
2.10E+02	4.04E+04	9.19E-01	2.50E-01	1.64E-01	4		4
2.40E+02	4.62E+04	1.05E+00	2.50E-01	1.59E-01	4		4
2.70E+02	5.20E+04	1.18E+00	2.50E-01	1.52E-01	4		4
3.00E+02	5.78E+04	1.31E+00	2.50E-01	1.43E-01	3		3
3.30E+02	6.35E+04	1.44E+00	2.50E-01	1.34E-01	3		3
3.60E+02	6.93E+04	1.58E+00	2.50E-01	1.23E-01	3		3
3.90E+02	7.51E+04	1.71E+00	2.50E-01	1.11E-01	3		3
4.20E+02	8.09E+04	1.84E+00	2.50E-01	9.63E-02	2		2
4.50E+02	8.66E+04	1.97E+00	2.50E-01	7.95E-02	2		2
4.80E+02	9.24E+04	2.10E+00	2.50E-01	5.79E-02	1		1
5.10E+02	9.82E+04	2.23E+00	2.50E-01	1.98E-02	0		0
5.40E+02	1.04E+05	2.36E+00	2.50E-01	ERR	ERR		ERR
5.70E+02	1.10E+05	2.49E+00	2.50E-01	ERR	ERR		ERR
6.00E+02	1.16E+05	2.63E+00	2.50E-01	ERR	ERR		ERR
6.30E+02	1.21E+05	2.76E+00	2.50E-01	ERR	ERR		ERR
6.60E+02	1.27E+05	2.89E+00	2.50E-01	ERR	ERR		ERR
6.90E+02	1.33E+05	3.02E+00	2.50E-01	ERR	ERR		ERR
7.20E+02	1.39E+05	3.15E+00	2.50E-01	ERR	ERR		ERR
7.50E+02	1.44E+05	3.28E+00	2.50E-01	ERR	ERR		ERR
7.80E+02	1.50E+05	3.41E+00	2.50E-01	ERR	ERR		ERR
8.10E+02	1.56E+05	3.55E+00	2.50E-01	ERR	ERR		ERR
8.40E+02	1.62E+05	3.68E+00	2.50E-01	ERR	ERR		ERR
8.70E+02	1.67E+05	3.81E+00	2.50E-01	ERR	ERR		ERR

DEQ-VALLEY

APR 22 2002

TO:_______________

FILE:______________

SITE CHARACTERIZATION REPORT ADDENDUM

TODDSBURY OF IVY
Albemarle County

REVIEWED
VRO Petroleum Program
Date: 5/9/02
By:

PC # 01-6134
FAC ID # __________ *(for DEQ use)*

Submitted to:

Joel P. Maynard
Valley Regional Office
Department of Environmental Quality
PO Box 3000
Harrisonburg, VA 22801-3000
(540)574-7800

Prepared for:

Charlottesville Oil Company
PO Box 6340
Charlottesville, Virginia 22906
(804)293-9107

Prepared by:

Jeffrey A. Sitler Environmental Service, Inc.
PO Box 6038
Charlottesville, Virginia 22906
(804)974-7080 fax (804)974-1657

April 18, 2002

TABLE OF CONTENTS

FIGURES

TABLES

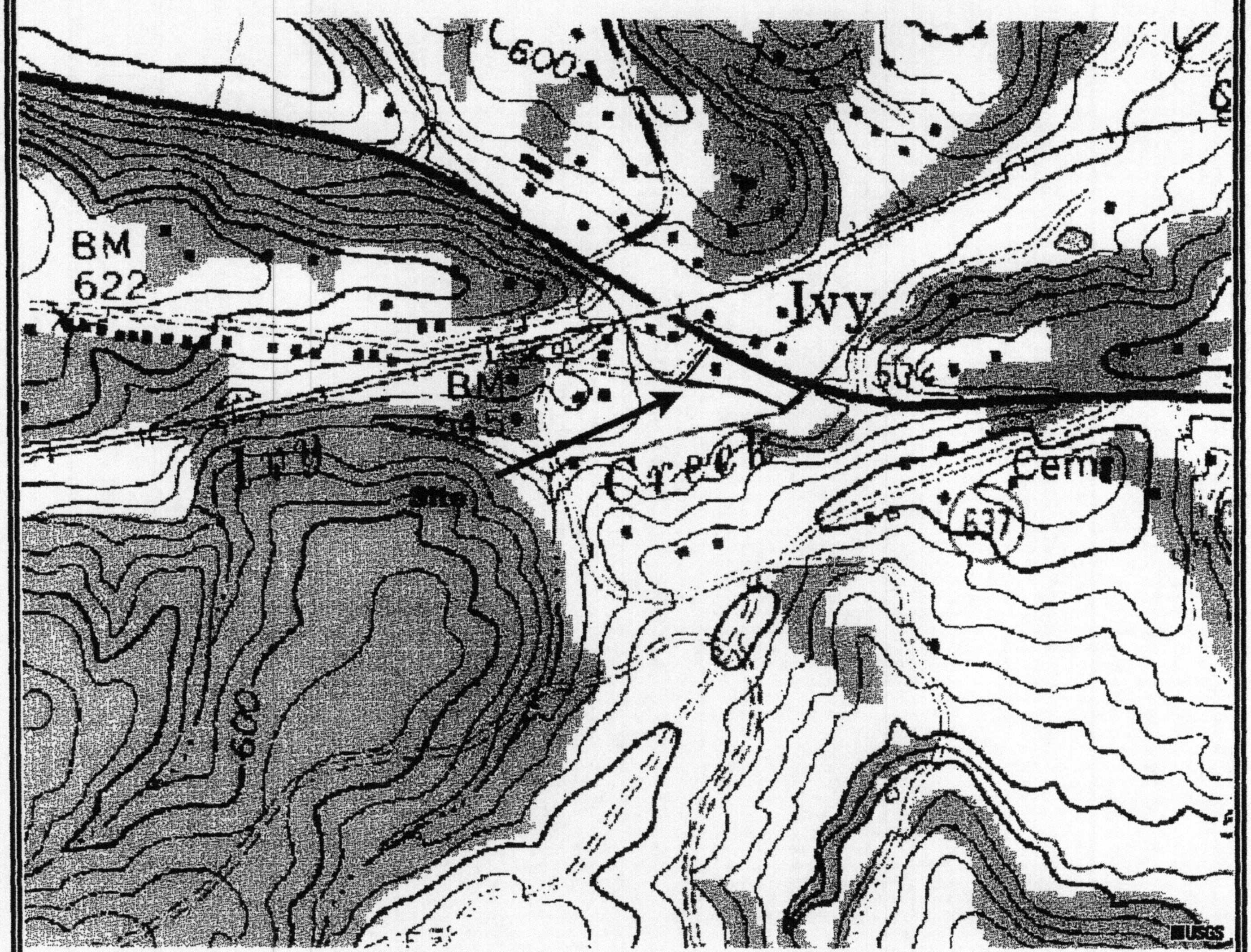
LIST OF APPENDICES

1.0 INTRODUCTION

Jeffrey A. Sitler Environmental Services, Inc., (JAS) was contracted by Charlottesville Oil Company, Rt. 250 West, Charlottesville, Virginia to prepare this Site Characterization Report Addendum (SCRA) for the property known as Toddsbury of Ivy Market located on US Route 250 in Ivy, Virginia, in Albemarle County, (the " Site" shown in Figure 1). The objectives of this SCRA were to install a fourth monitoring well to the east of the tank basin in the down-gradient direction, sample the stream in the down-gradient direction under the Rt 250 bridge over Ivy Creek, and reevaluate the extent of contamination per a letter from Joel P. Maynard of the DEQ dated January 28, 2002.

The Site has been operated as a gas station since at least the early 1950's. Charlottesville Oil Company owns the three gasoline underground storage tanks (USTs) that are currently in service as shown in the site plan in Figure 2. As a result of an inconclusive pressure test on the lines, soil sampling along the supply lines indicated potential petroleum releases. The DEQ-required Site Characterization Report (SCR) was submitted January 3, 2002. The SCR found the following:

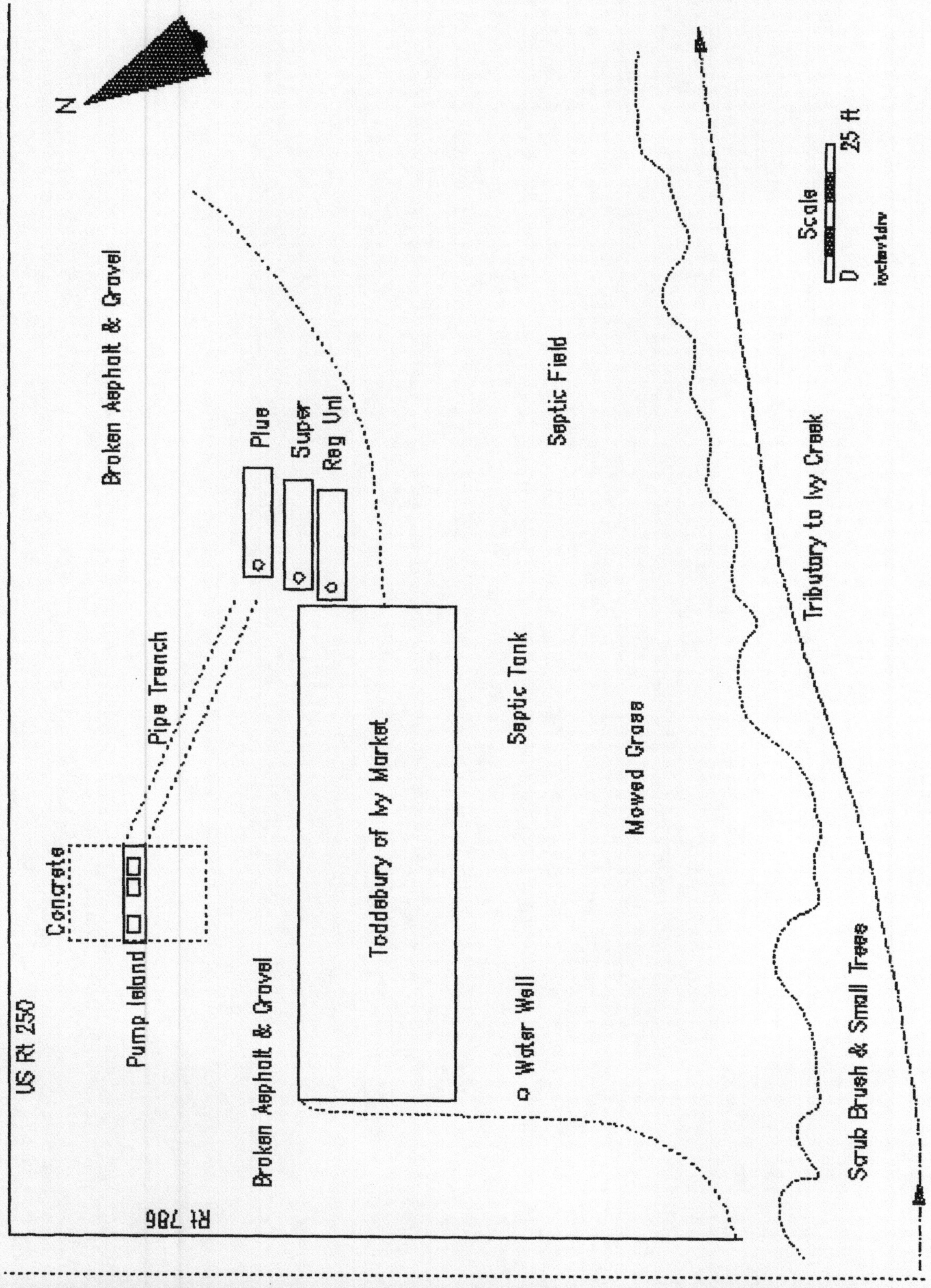
1. No LPH has been observed at the Site, although MTBE has been detected at 56,400 μg/l, a level usually associated with the presence of LPH.
2. The residual soil contamination is minor, since the water table is so shallow.
3. There is no significant risk of petroleum vapors migrating to the building.
4. Dissolved benzene, toluene, and MTBE are the contaminants of concern present in the groundwater with the highest concentrations observed in MW-2 at 1,480, 1,420, and 56,400 μg/l, respectively.
5. The onsite water supply well is contaminated with MTBE at an estimated 3.3 μg/l and is free of all other potential contaminants.
6. While dissolved contaminants could migrate to the streams, predicted average dilution rates would render them undetectable.
7. MTBE at 3.3 μg/l in the water well is believed to represent an approximate steady-state concentration and is not predicted to increase in the near future.



Scale

0 500 ft

Jeffrey A. Sitler - Environmental Services, Inc. PO Box 6038 Charlottesville, VA 22906 (804)974-7080 - (804)974-1657 (FAX)	Date:	Revised:	Figure 1 - Site Location Topographic Map Toddsbury of Ivy
	Drawn by: LRS	Checked by:	
	File:	Scale:	



Jeffrey A. Sitler - Environmental Services, Inc.

PO Box 6038
Charlottesville, VA 22906
(804)974-7080 - (804)974-1657 (FAX)

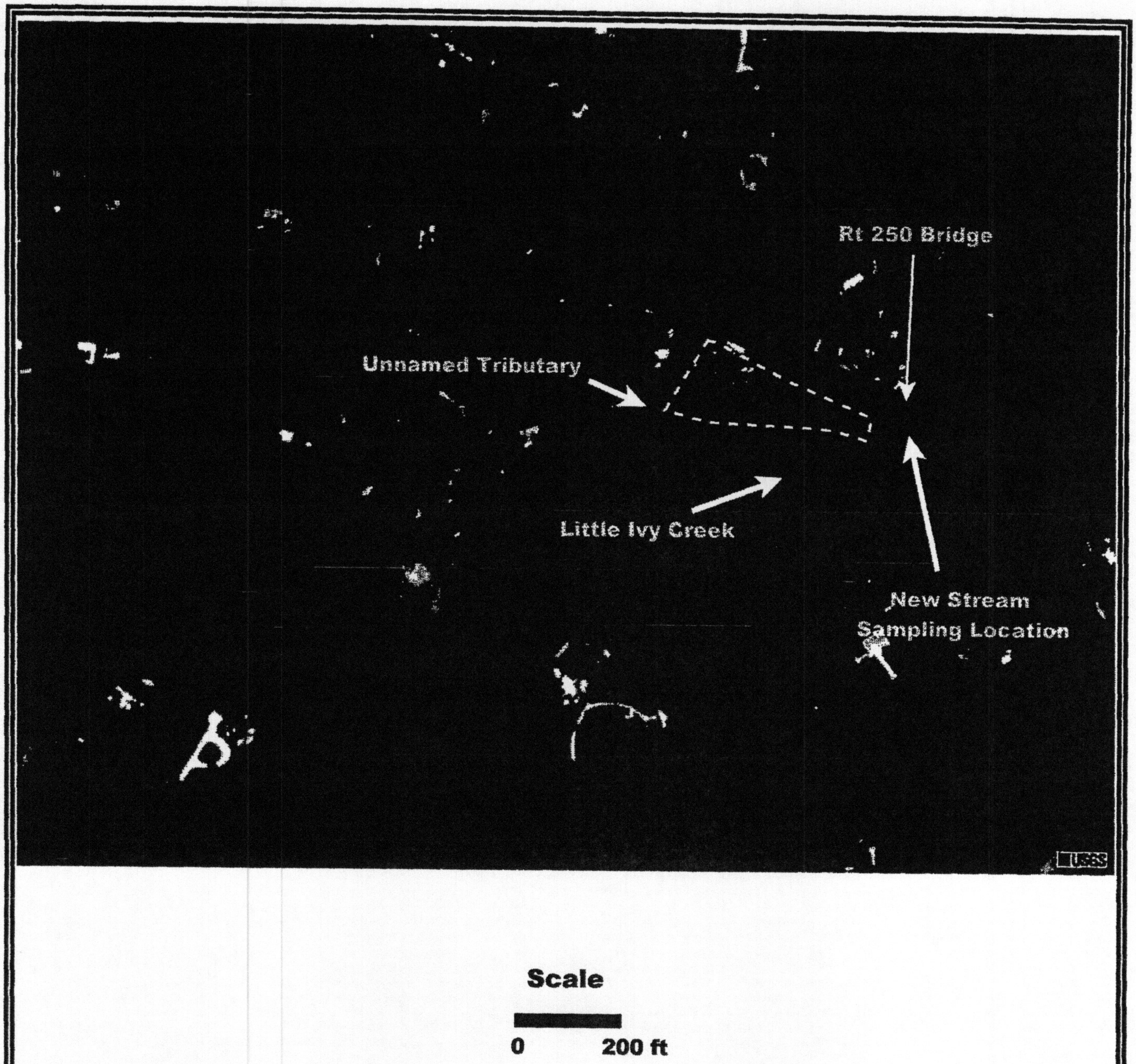
Date:	Revised:
Drawn by: LRS	Checked by:
File:	Scale:

Figure 2 - Site Plan
Toddsbury of Ivy

8. No other dissolved contaminants are believed to present any potential threat to the onsite water well.
9. There are no risks posed by inhalation, direct contact, or exposure of environmental receptors.
10. There are no risks posed to offsite water wells.

Since the submission of the SCR, it was determined that the onsite water well was not used for drinking water.

The SCR determined that the water table gradient sloped to the east southeast, parallel with Rt 250, while the three monitoring wells were installed assuming the groundwater flow would be to the south. Therefore, as part of this SCRA, a fourth well was installed to the east southeast of the tank basin. In addition, the surface water sample was collected from the small unnamed tributary that flows along the southern boundary of the Site near the down-gradient end of the Site. However, the east southeast groundwater flow indicated that Little Ivy Creek may be the recipient of contaminated groundwater leaving the Site. Therefore, as part of this SCRA, a surface water sample was collected from under the Rt 250 bridge. These relationships are shown on Figure 3.



Jeffrey A. Sitler - Environmental Services, Inc.
PO Box 6038
Charlottesville, VA 22906
(804)974-7080 - (804)974-1657 (FAX)

Date:	Revised:
Drawn by: LRS	Checked by:
File:	Scale:

Figure 3 - 1994 USGS Aerial Photograph Showing Streams and Rt 250 Bridge
Toddsbury of Ivy

2.0 MONITORING WELL INSTALLATION

For the SCRA, one monitoring well was installed at the Site in a location that would be down gradient of the tank basin per the water table contours developed in the SCR. JAS and Certified Environmental Drilling, of Earlysville, Virginia, mobilized onsite on February 12, 2002 and installed monitoring well MW-4 by hollow-stem auger drill rig. The drilling was supervised by Lyle R. Silka, Virginia certified professional geologist, and was in accordance with standard health and safety practices. The total boring depth was 20 feet. Geologic samples were inspected at five-foot intervals for characterization of the geology and assessing the presence of hydrocarbon contamination. Decontaminated drill stems were used for the boring.

Each soil sample was logged for lithology, inspected for petroleum odors, examined for visual petroleum staining, and tested for total volatile hydrocarbon vapors. The boring log is presented in Appendix A. Since MW-4 was about 75 feet from the tank basin, no soil sample was collected. In addition, there was no odor or staining in the soil samples until the water table was reached at which depth a slight gasoline odor was encountered.

The soil boring was converted to a monitoring well using flush-threaded, two-inch diameter, schedule 40 PVC casing and 0.01-inch factory-slotted PVC screen with a threaded end cap. The well was installed by assembling and lowering the PVC screen and blank casing into the open borehole to the total depth of the boring. A #2 filter sand was placed around the screen to a height of two feet above the screen, followed by a two-foot bentonite-chip seal that was hydrated in place. From the top of the bentonite seal to the surface, a cement grout mix was placed in the annulus around the casing. The well was completed with a flush-mount, bolt-down, metal well protector set in concrete at the surface. A locking well cap and padlock were placed on each well casing. Monitoring well depths and screened intervals were selected in the field based on the depth at which groundwater was encountered in order to provide ample open screen above the water table to allow for seasonal fluctuations and allow sufficient screen below the water table to allow for groundwater sampling.

The monitoring well was purged of approximately three well volumes of water to develop the well and bring in fresh groundwater from the surrounding aquifer. The well purging was accomplished using a pre-cleaned plastic bailer. The relative elevation of the top of casing

(TOC) for MW-4 was determined by surveying with a rod and transit relative to MW-2. The horizontal position of the wells on the Site was determined relative to the building using a 200-foot fiberglass tape measure. Appendix A provides the elevation survey results.

3.0 GROUNDWATER SAMPLING AND ANALYSIS

Groundwater samples were obtained from monitoring well MW-4 and Little Ivy Creek under the Rt 250 bridge on March 15, 2002. All four monitoring wells were checked for free product and depth to water with an electronic oil-water interface probe. Monitoring well MW-4 was purged of approximately three well volumes of water using a pre-cleaned plastic bailer. The stream sample was obtained by collecting a sample directly from the flowing stream along the west bank. Each water sample was placed into two laboratory-supplied 40-milliliter glass vials with Teflon septa in a manner to exclude all air from the vials. All sample bottles were labeled, placed on ice, and delivered via overnight Federal Express under standard chain-of-custody procedures to MSS. Water samples were analyzed for TPH-GRO, BTEX, and MTBE.

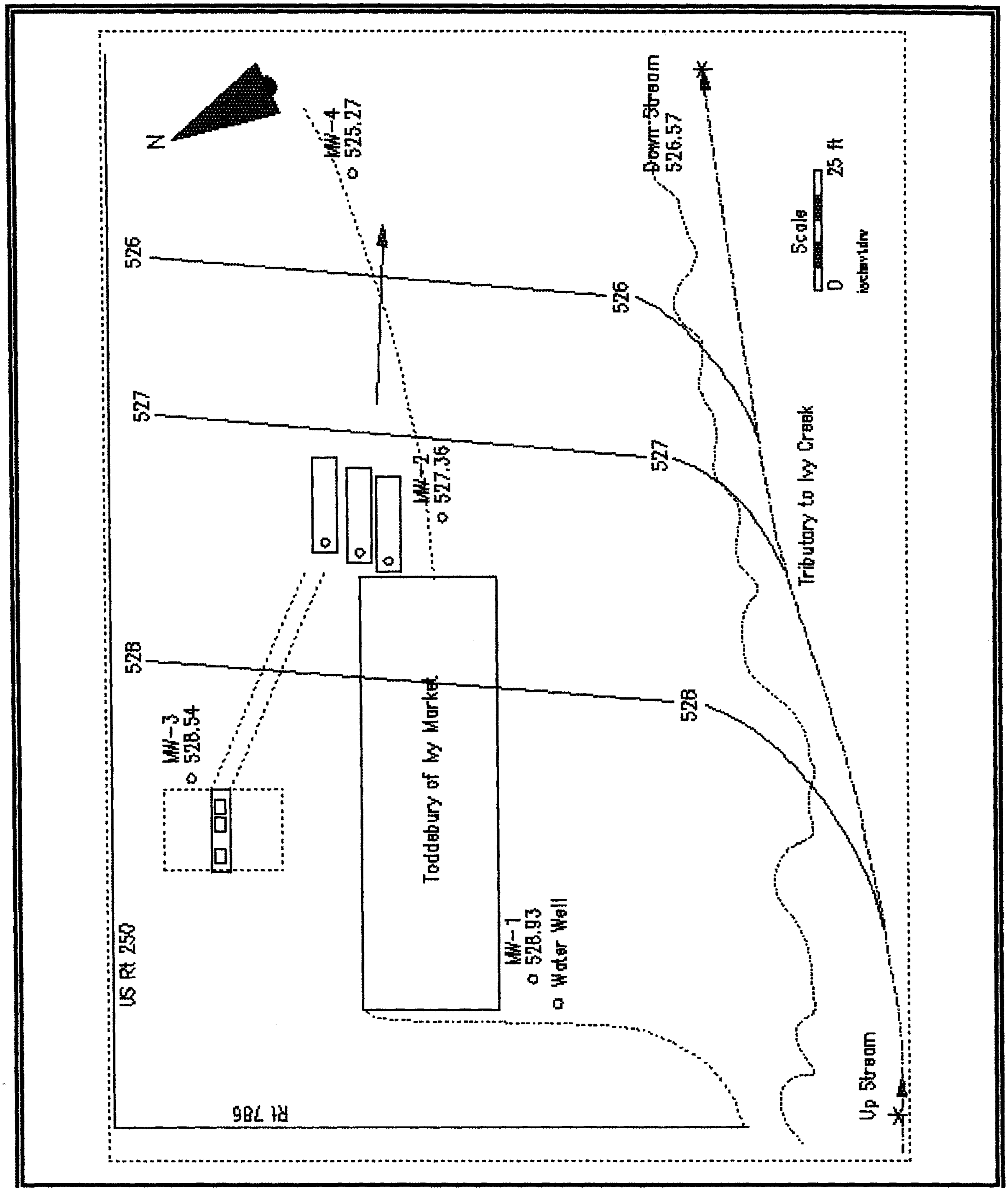
The letter from Joel P. Maynard dated January 28, 2002 called for sampling and analysis of all four monitoring wells and the onsite water supply well. A mistake during field collection erroneously omitted the sampling of MW-1, MW-2, MW-3, and the onsite water well. This SCRA thus combines the data for MW-4 and Little Ivy Creek with the data collected on November 29, 2001.

4.0 GROUNDWATER FLOW DIRECTION

The results of the water table measurements are presented in Figure 4. The data for March 15, 2002 confirm the finding in the SCR that the groundwater flow is toward the east southeast at about the same gradient.

5.0 LABORATORY ANALYTICAL RESULTS

The results of the groundwater analyses are summarized in Table 1 and reported in Appendix B. Figures 5 and 6 show the extent of dissolved benzene and MTBE, respectively. The full laboratory report is presented in Appendix B.



Jeffrey A. Sitler - Environmental Services, Inc.
PO Box 6038
Charlottesville, VA 22906
(804)974-7080 - (804)974-1657 (FAX)

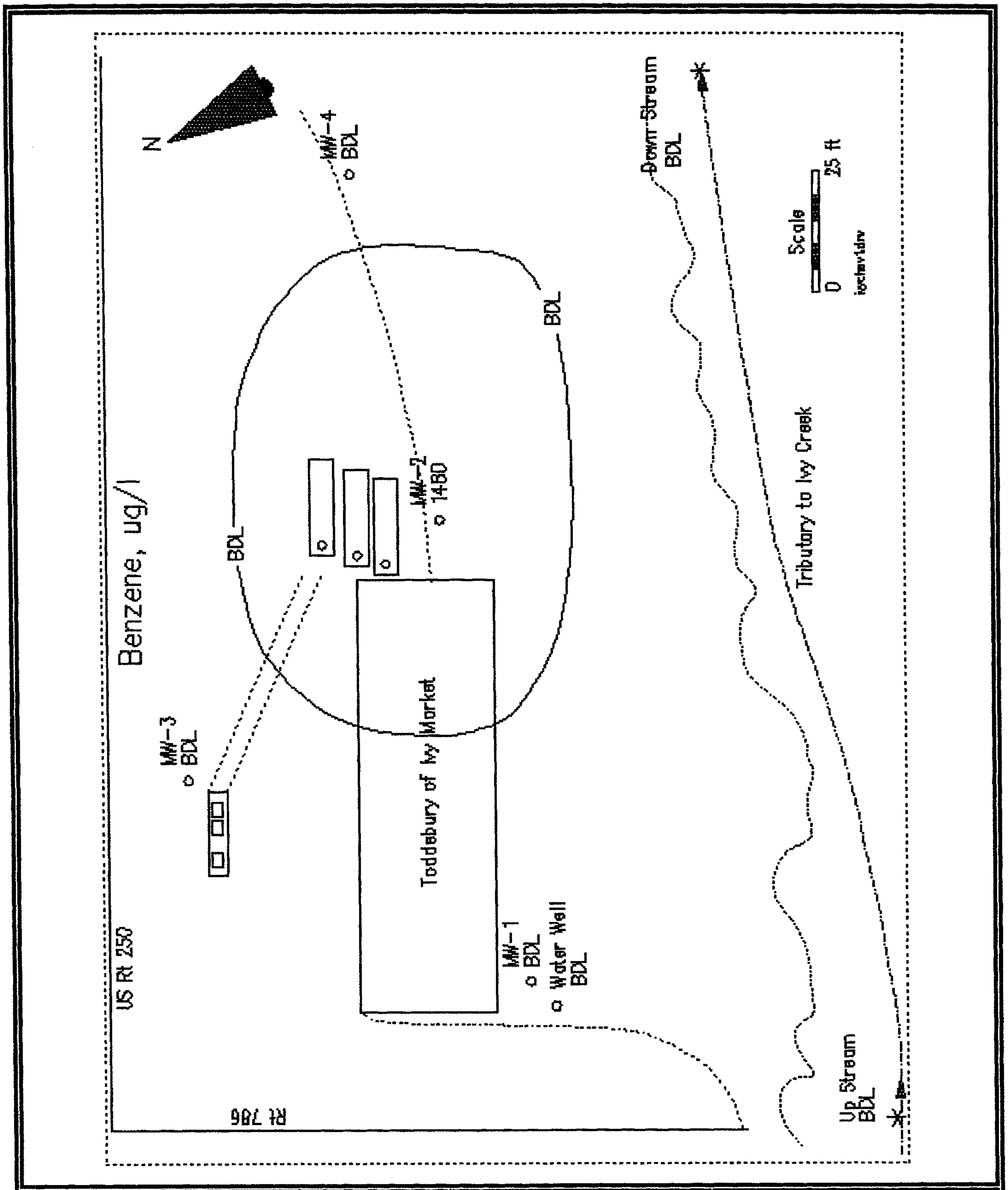
Date:	Revised:
Drawn by: LRS	Checked by:
File:	Scale:

Figure 4 - Water Table Elevation as of 03/14/02
Toddsbury of Ivy
Ivy, Virginia

Table 1. Groundwater Analytical Results

Well No.	Date Sampled	LPH in	TPH-GRO μg/l	Benzene μg/l	Toluene μg/l	Ethyl-Benzene μg/l	Xylenes μg/l	MTBE μg/l
MW-1	11/29/01	0	BDL	BDL	BDL	BDL	BDL	18
MW-2	11/29/01	0	BDL	1480	1420	BDL	900	56400
MW-3	11/29/01	0	BDL	BDL	BDL	BDL	BDL	BDL
MW-4	03/14/02	0	BDL	BDL	BDL	BDL	BDL	662
Onsite Water Well	11/29/01	0	BDL	BDL	BDL	BDL	BDL	3.3j
Up Stream	11/29/01		BDL	BDL	BDL	BDL	BDL	BDL
Down Stream	11/29/01		BDL	BDL	BDL	BDL	BDL	BDL
Rt 250 Bridge	03/14/02		BDL	BDL	BDL	BDL	BDL	BDL

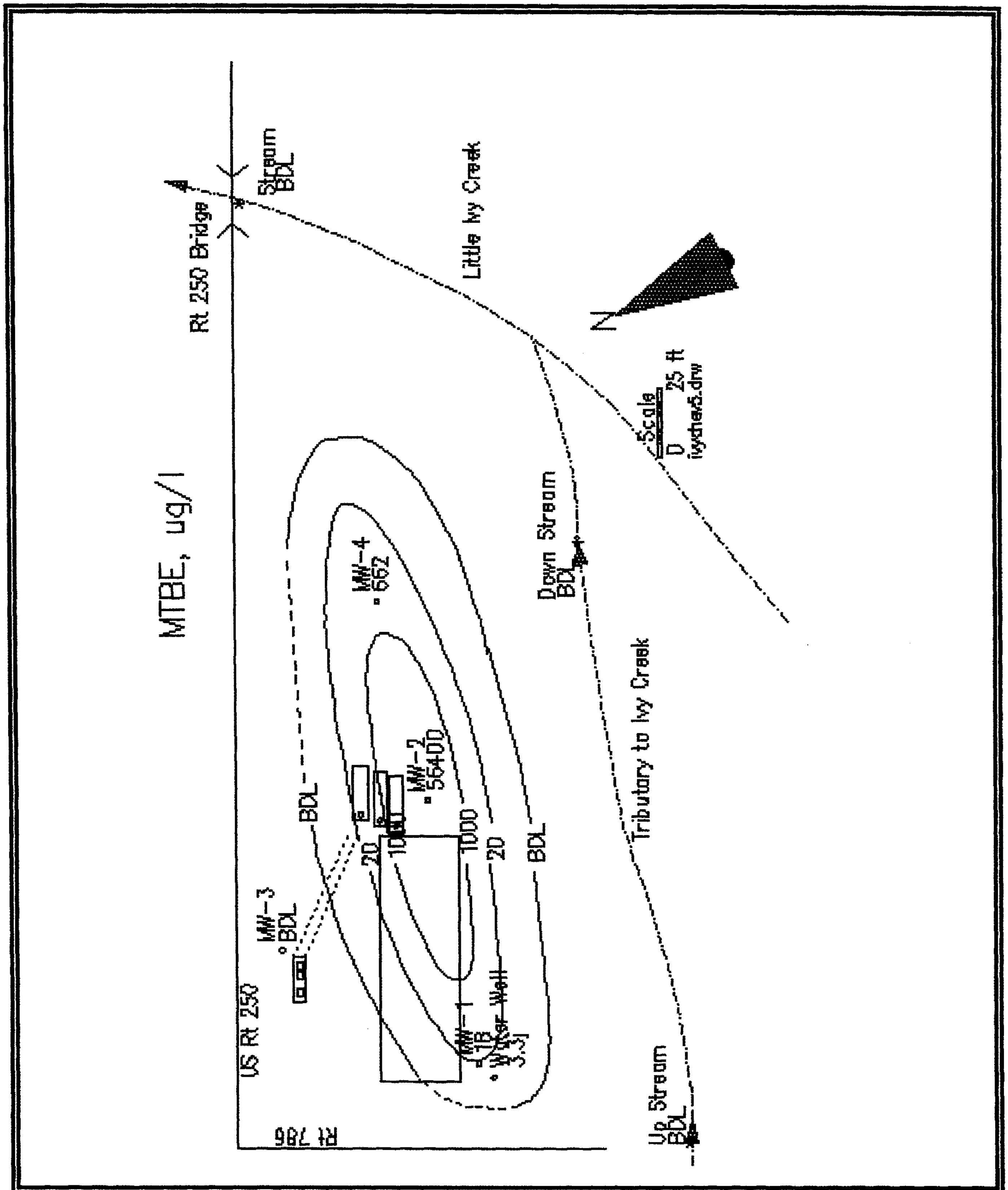
Notes:
ND - Not Determined
μg/kg - Micrograms Per Kilogram
BDL - Below Detection Limit
LPH - Liquid Petroleum Hydrocarbon
j - Estimated value
NA - Not applicable



Jeffrey A. Sitler - Environmental Services, Inc.
PO Box 6038
Charlottesville, VA 22906
(804)974-7080 - (804)974-1657 (FAX)

Date:	Revised:
Drawn by: LRS	Checked by:
File:	Scale:

Figure 5 - Benzene in Groundwater, $\mu g/l$, 11/29/01 & 03/14/02 Toddsbury of Ivy



Jeffrey A. Sitler - Environmental Services, Inc.
PO Box 6038
Charlottesville, VA 22906
(804)974-7080 - (804)974-1657 (FAX)

Date:	Revised:
Drawn by: LRS	Checked by:
File:	Scale:

Figure 6 - MTBE in Groundwater, μg/l, 11/29/01 & 03/14/02 Toddsbury of Ivy

Based on Figures 5 and 6, the major dissolved contamination at the Site is limited to the vicinity of the gasoline UST basin. Dissolved benzene was found at 1,480 μg/l and MTBE was at 56,400 μg/l in MW-2. By the time the contamination reaches MW-1 and the onsite water well, benzene becomes undetectable, and MTBE dropped to 18 μg/l and an estimated 3.3 μg/l, respectively.

Toward the east, benzene was not detected in MW-4, although MTBE was detected at 662 μg/l. However, none of the stream samples have any detectable contamination. These new data provide fairly conclusive data concerning the extent of groundwater contamination as depicted in Figures 5 and 6.

5.0 CONCLUSIONS AND RECOMMENDATIONS

The conclusions from the SCR remain unchanged in the SCRA. The Site had a release of gasoline from the UST system that resulted in groundwater contamination with benzene, toluene, and MTBE. No LPH has been observed at the Site, even though the MTBE level is quite high in MW-2. Groundwater flow is toward the southeast with discharge into Little Ivy Creek. Some groundwater from the Site also discharges into the small tributary on the south boundary of the Site. However, as confirmed by the results of sampling, predicted dilution rates in the surface water would render contaminants undetectable. The potential exposure pathway is via the onsite water supply well. However, it has been determined that the well is not used for drinking water. The MTBE is predicted not to present any concern in the well into the future unless there is an intensification of the source. The other gasoline contaminants also are predicted not to present any concern for the water well at this time.

It is recommended that quarterly monitoring be conducted for the four monitoring wells, the onsite water well, and the stream at the Rt 250 bridge to monitor the benzene and MTBE plumes.

APPENDIX A

WELL DATA SPREADSHEET
AND
BORING/WELL LOG FOR MW-4

Toddsbury of Ivy
Monitoring Well Data

03/17/02

	MW-1	MW-2	MW-3	Stream	MW-4
Installation Date	11/28/01	11/28/01	11/28/01		02/12/02
Heigth of Scope above TOC, ft					5.00
Height of Scope at Rod, ft	4.23	3.90	3.42	12.68	5.57
Total depth of well, ft	*15.00*	*15.00*	*12.00*		*20.00*
Elevation of TOC Relative Local Datum, ft	535.00	535.33	535.81	526.57	534.76
Water Table Depth below TOC, 11/29/01, ft	6.59	8.52	7.70	0.00	
Elevation of Water Table, ft	528.41	526.81	528.11	526.57	
Water Table Depth below TOC, 3/14/00, ft	6.07	7.97	7.27		9.49
Elevation of Water Table, ft	528.93	527.36	528.54	526.57	525.27

Boring/Well Log

Project: Toddsbury of Ivy

Log of Boring: MW-4

Location: Ivy, VA

Date Drilled: 02/12/02

Ground Surface Elevation: 535 ft

Drilling Method: Hollow Stem Auger

Total Depth: 20 ft

Drilling Company: Certified Environmental Drilling

Geologist: Lyle R. Silka, CPG

VA DEQ PC 01-6134

Weather: Warm and Sunny

Depth (ft)	Sample Number			Geologic Description
0-5				red-brown clayey silt, moist to dry, no gas odor
5-10				same, cobble layer, moist, no gas odor
10-15				same, moist to wet, slight gas odor
15-20				same, moist to wet, slight gas odor
20				total depth
				2" casing set from 0 to 5 feet.
				2" screen set from 5 to 15 feet.

APPENDIX B

LABORATORY REPORT

MARYLAND SPECTRAL SERVICES, INC.
1500 Caton Center Drive Baltimore, MD 21227

VOLATILE AROMATICS BY EPA METHODS 5030/8021
VOLATILE TPH BY EPA METHODS 5030/8015

CLIENT SAMPLE ID:	MW-4 TODDSBURY-IVY	STREAM TODDSBURY-IVY	BBLK032102
LAB SAMPLE ID:	02032012	02032013	METHOD BLANK
SAMPLE DATE:	03/14/02	03/14/02	
RECEIVED DATE:	03/20/02	03/20/02	
ANALYSIS DATE:	03/21/02	03/21/02	03/21/02
FILE NAME:	032012D	032013	0321BBLKD2
INSTRUMENT ID:	GC-D	GC-D	GC-D
MATRIX:	WATER	WATER	WATER
UNITS:	UG/L	UG/L	UG/L
DILUTION FACTOR:	2.0	1.0	1.0
VOLATILE COMPOUNDS			
Benzene	4.0 U	2.0 U	2.0 U
Toluene	4.0 U	2.0 U	2.0 U
Ethylbenzene	4.0 U	2.0 U	2.0 U
Xylenes (total)	8.0 U	4.0 U	4.0 U
Methyl-t-Butyl Ether	662	4.0 U	4.0 U
Volatile TPH	200 U	100 U	100 U

CHAIN-OF CUSTODY RECORD

Company Name:
JAS Environmental Services, Inc.
PO Box 6038
Charlottesville, VA 22906

Project Manager:
Jeff Sitler
tel (804)974-7080
fax (804)974-1657

Project Name:
Toddsbury of Ivy

Project Number:

Sampler(s):
LRS

Task Number:

Laboratory:
Maryland Spectral Services, Inc.
1500 Caton Center Drive, Suite G
Baltimore, Maryland 21227
(410) 247-7600

	Date	Time	Matrix	no. of container	TPH GRO EPA-5035-8015	TPH DRO EPA-8015	MBTEX EPA-5035-8021	PAH EPA-8270	MBTEXN EPA-5035-8021			MSS #
MW-4	3/14/02	1045	W	2	X		X					020320-12
Stream at Bridge	3/14/02	1100	W	2	X		X					13

Lyle R Silka
(printed) **Lyle R. Silka**
3/17/02
1200

Federal Express
(printed)

Send report to: Lyle Silka
PO Box 1283
Haymarket, VA 20168
Fax summary of results to Lyle Silka at (703)

Relinquished by: (signature)
(printed)

Date/Time
3/20/02
1100

Received by: (signature)
(printed)

Bill:
JAS

[illegible]
Date: 8/3/04
By:

CORRECTIVE ACTION PLAN
TODDSBURY OF IVY
Albemarle County

PC # 01-6134
FAC ID # __________ *(for VDEQ Use)*

Submitted to:

Joel P. Maynard
Valley Regional Office
Department of Environmental Quality
PO Box 3000
Harrisonburg, VA 22801-1129
(540)574-7800

Prepared for:

Charlottesville Oil Company
PO Box 6340
Charlottesville, Virginia 22901
(434)293-9107

Prepared by:

Jeffrey A. Sitler Environmental Service, Inc.
PO Box 6038
Charlottesville, Virginia 22906
(434)974-7080 fax (434)974-1657

June 8, 2004

DEQ-VALLEY
[illegible] 14 2004
BY:

TABLE OF CONTENTS

Section Page

List of Figures

List of Tables

List of Appendices

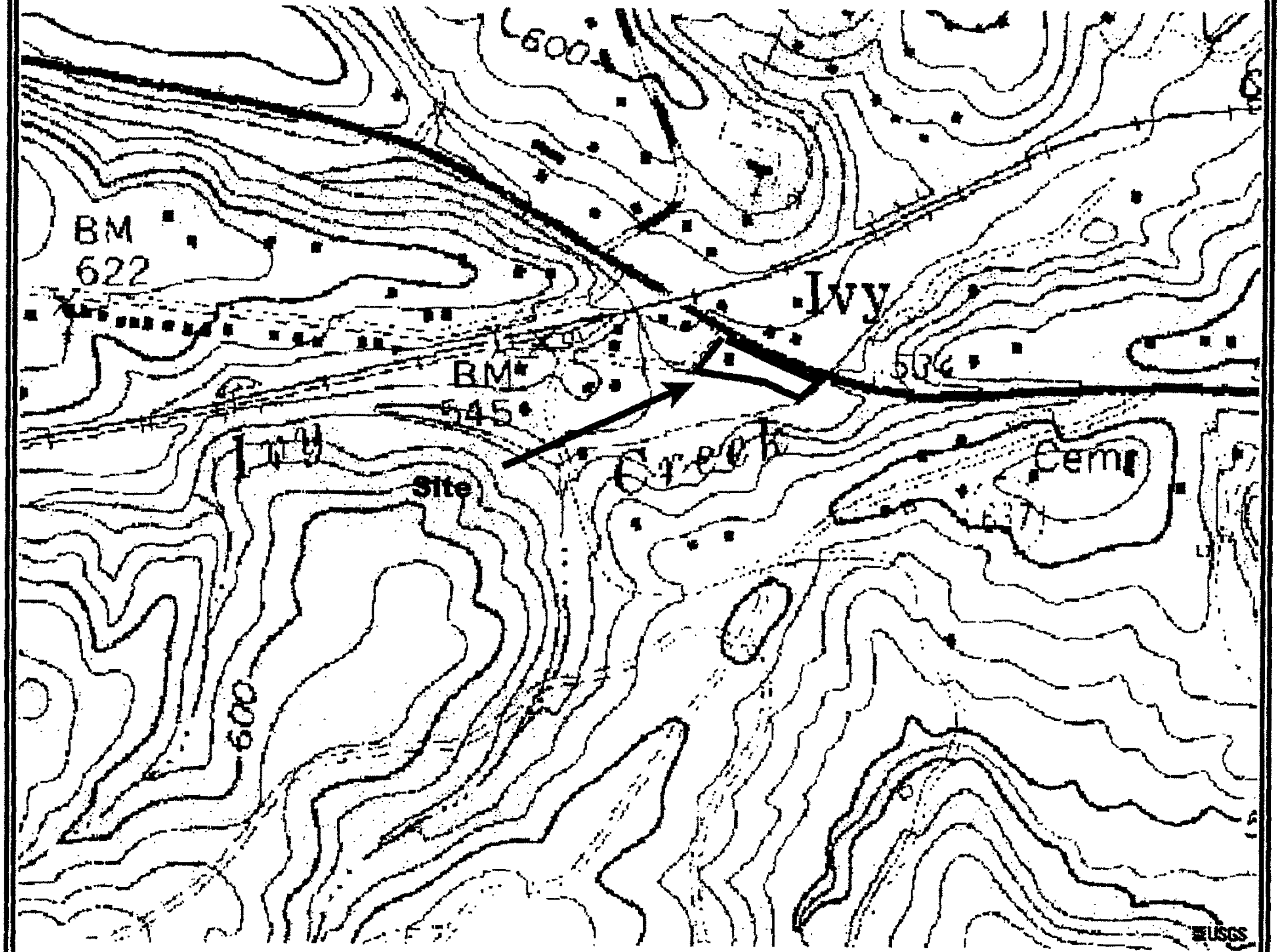
1.0 INTRODUCTION

Jeffrey A. Sitler Environmental Services, Inc., (JAS) was contracted by Charlottesville Oil Company, to prepare a Corrective Action Plan (CAP) for the property known as Toddsbury of Ivy Market located on US Route 250 in Ivy, Virginia, in Albemarle County as shown in Figure 1. Figure 2 is an enlargement of the 1996 USGS aerial photograph for the vicinity of the Site. This CAP has been prepared based on information provided in the Site Characterization Report (SCR) dated January 3, 2002, SCR Addendum (SCRA) dated April 18, 2002, and seven post-SCR monitoring reports. This CAP is designed to address the issues identified in the March 10, 2004 letter addressed to Mr. Mike Jones of Charlottesville Oil Company from Joel P. Maynard, Senior Geologist with the Virginia Department of Environmental Quality's (DEQ) Valley Regional Office in Harrisonburg, Virginia.

1.1 Previous Investigations

The following is a summary of the findings for the Site:

1. High concentrations of MBTEX are present in the shallow groundwater, emanating from the region of the gasoline tank basin and migrating eastward and discharging into Little Ivy Creek. For the latest monitoring event, benzene was 4,400 μg/l, and MTBE was 3,980 μg/l.
2. Free product has been observed near the source in the form of sheen and drops in MW-2. Based on those observations and the high dissolved concentrations, it is hypothesized that there is a lens of free product located near the tank basin or just down gradient.
3. The onsite water supply well has remained contaminated with a low concentration of MTBE that has hovered around 4.0 μg/l.
4. In 3.5 years of monitoring, the dissolved concentrations in the source area have not diminished appreciably and concentrations have increased down gradient.



Jeffrey A. Sitler - Environmental Services, Inc.
PO Box 6038
Charlottesville, VA 22906
(804)974-7080 - (804)974-1657 (FAX)

Date:	Revised:
Drawn by: LRS	Checked by:
File:	Scale:

Figure 1 - Site location on topographic map Toddsbury of Ivy

Maryland
spectral
Services

Analytical Chemistry Services

1500 Caton Center Dr Suite G
Baltimore MD 21227
410-247-7600
www.mdspectral.com
VELAP ID 460040

Analytical Results

Project: **Toddsbury of Ivy**

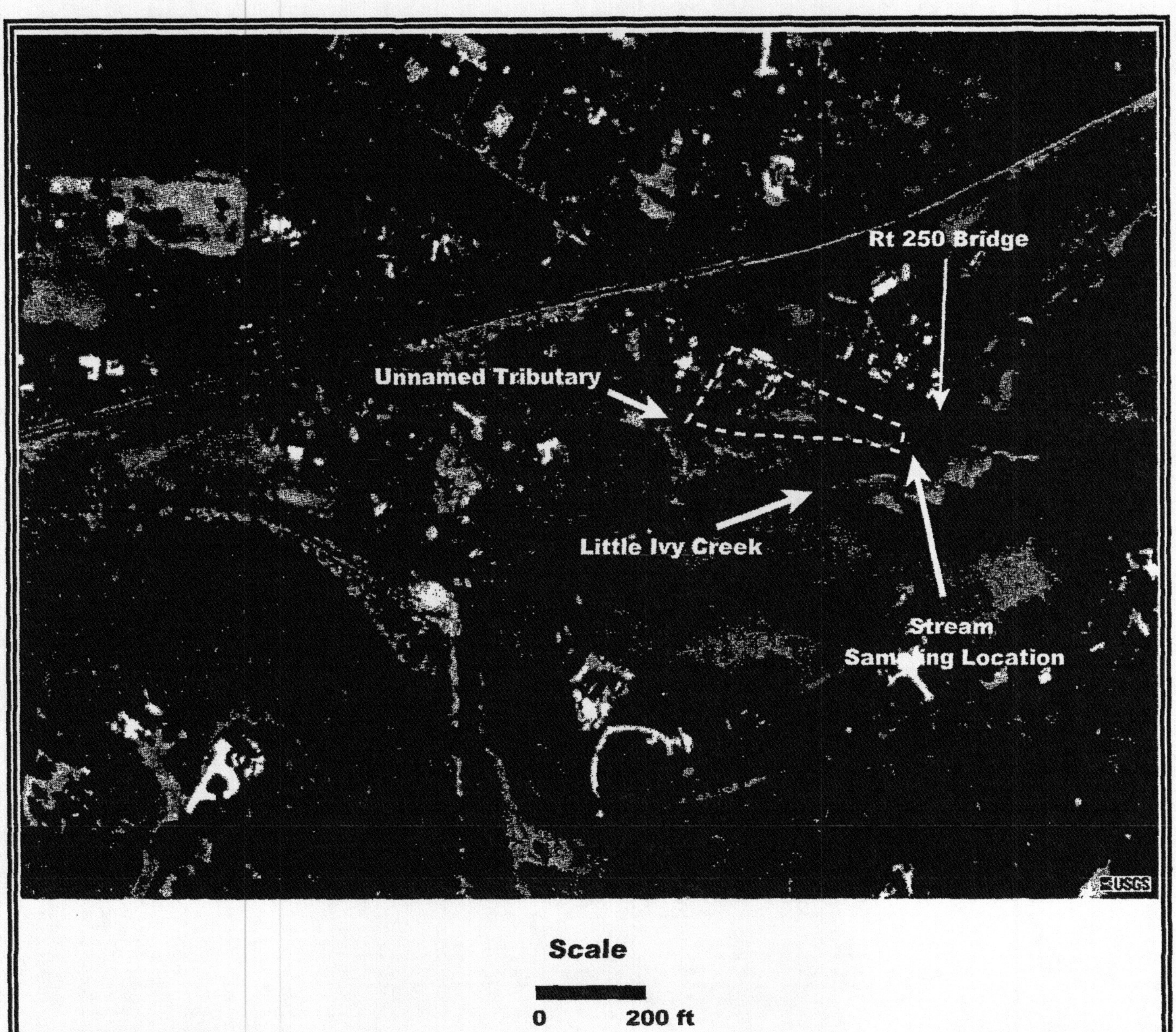
Project Number: N/A

Project Manager: Jeff Sitler

Report Issued: 02/26/13 18:11

JAS Environmental Services
P.O. Box 6038
Charlottesville VA, 22906

CLIENT SAMPLE ID:		MW-2	MW-4	MW-6	WW
LAB SAMPLE ID:		3022102-01	3022102-02	3022102-03	3022102-04
SAMPLE DATE:		02/19/13	02/19/13	02/19/13	02/19/13
RECEIVED DATE:		02/21/13	02/21/13	02/21/13	02/21/13
MATRIX	Units	Nonpotable Water	Nonpotable Water	Nonpotable Water	Potable Water
VOLATILE ORGANICS BY EPA METHOD 8021B (Water)					
Benzene	ug/L	<2.0	<2.0	<2.0	
Toluene	ug/L	<2.0	<2.0	<2.0	
Ethylbenzene	ug/L	<2.0	<2.0	<2.0	
Xylenes, Total	ug/L	<4.0	<4.0	<4.0	
Methyl tert-butyl ether (MTBE)	ug/L	<2.0	**2.0**	**4.9**	



Jeffrey A. Sitler - ***Environmental Services, Inc.*** PO Box 6038 Charlottesville, VA 22906 (804)974-7080 - (804)974-1657 (FAX)	Date:	Revised:	Figure 2 - 1994 USGS Aerial Photograph Showing Streams and Rt 250 Bridge Toddsbury of Ivy
	Drawn by: LRS	Checked by:	
	File:	Scale:	

1.2 Estimated Quantities of Contaminant in Each Phase

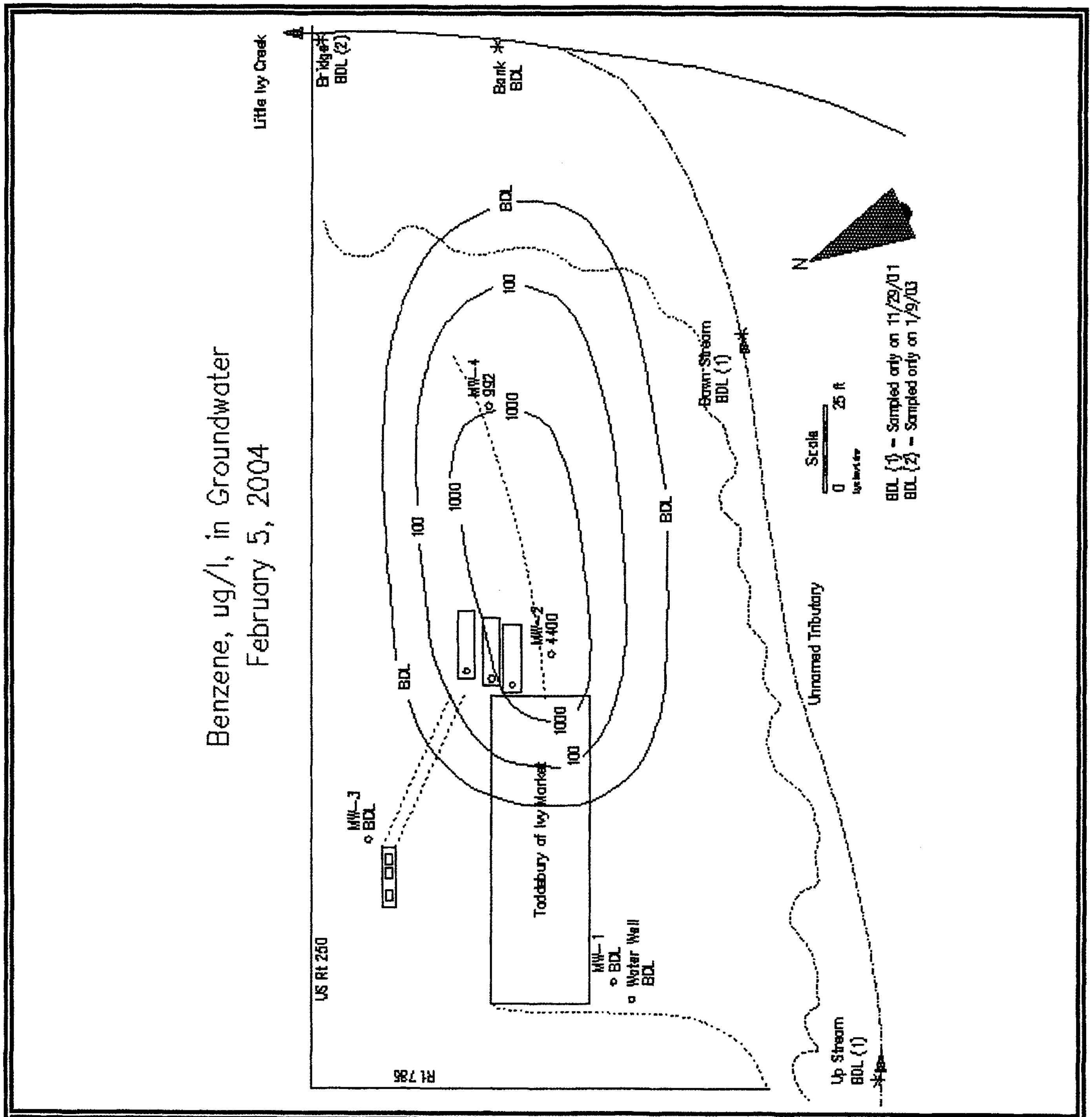
Liquid Phase. There is a hypothesized layer of liquid, or free-phase gasoline floating on the water table. The layer of gasoline may be less than one-fourth inch thick, but probably is thicker than a sheen. The area with free-phase gasoline probably is less than 20 to 30 feet across. In order to create the observed plume of dissolved gasoline, it is estimated that the liquid phase originally contained on the order of 50 gallons of gasoline. This estimate is based on the fact that the release has been losing an estimated 2.0 gallons of gasoline per year (see "Dissolved Phase" section below). Thus, if the release is 20 years old, the source would have involved at least 40 gallons. In the SCR, it was concluded that if the source disappeared, it would take two years for MTBE to flush out of the shallow aquifer. The SCR was published more than two years ago and MTBE is still at a relatively high concentration. However, with the continuous flushing of contamination out of the aquifer, the current liquid phase probably contains on the order of five or ten gallons of gasoline.

← or [illegible] ?

Adsorbed Phase. There is a thin unsaturated zone that is about seven feet thick that may have gasoline adsorbed and suspended within the pore space. This adsorbed contamination is limited to the immediate vicinity of the tank basin and to the area of the liquid-phase gasoline. It is estimated that the adsorbed phase contains on the order of five gallons of gasoline.

← [illegible] MW5 [illegible]

Dissolved Phase. There is a plume of contaminated groundwater with an approximate width of 75 feet and a length of 125 feet. The highest TPH-GRO concentration was reported in April of 2003 at 64.2 mg/l (64,200 μg/l). Figure 3 shows the extent of the dissolved plume in the groundwater as dissolved benzene concentration contours. Figure 4 shows the worksheet used to estimate the log average concentration, volume of the plume, and volume of gasoline dissolved in the plume. The gasoline dissolved in the plume is estimated to be 1.3 gallons. An estimate of the volume of gasoline moving through the groundwater each year is estimated using the Darcy groundwater flow equation (q=KAi), where K is the average hydraulic conductivity of 23 feet per day, A is the aquifer cross-sectional area to groundwater flow in the plume of 75 feet wide by 10 feet thick, and i is the average hydraulic gradient of 0.2.



Jeffrey A. Sitler - Environmental Services, Inc.
PO Box 6038
Charlottesville, VA 22906
(804)974-7080 - (804)974-1657 (FAX)

Date:	Revised:
Drawn by: LRS	Checked by:
File:	Scale:

Figure 3 - Benzene in groundwater Toddsbury of Ivy

Estimation of the Volume of Dissolved Fuel in Plume

Parameter		Value	Unit
Maximum Concentration	TPH-GRO	64.2	mg/l
Log Max Conc		1.81	
Minimum Concentration		0.1	mg/l
Log Min Conc		-1.00	
Log Average Conc		2.5	mg/l
Area of Plume		9375	feet
Thickness of Plume		30	feet
Volume of Aquifer		281,250	cubic feet
Porosity		0.25	
Volume of Plume		525,938	gallon
Volume of Contaminant in Plume		1.33	gallon

Area of Plume	9,375	square feet
Recharge	0.58	feet per year
Volume of Recharge	5,469	cubic feet
	40,906	gallons
Contaminated Water to Recharge	13	
hydraulic gradient	0.02	
hydraulic conductivity	23	feet per day
vertical cross section to flow	750	sq feet
groundwater flow volume	345	cfd
	125,925	cfy
	941,919	gallons
gas removed by groundwater flow	2	gallons per year

Jeffrey A. Sitler - Environmental Services, Inc.
PO Box 6038
Charlottesville, VA 22906
(804)974-7080 - (804)974-1657 (FAX)

Date	Revised:
Drawn by: LRS	Checked by:
File:	Scale:

Figure 4 - Estimation of Gasoline in Groundwater

At the bottom of Figure 4, these values produce an estimate of two gallons of gasoline moving through the shallow aquifer each year. Thus, there is a source of gasoline that adds two gallons of gasoline per year to the shallow aquifer.

The gasoline contamination has been estimated to be distributed amongst the three phases as summarized in the following table. Based on this analysis, it is apparent that the primary source of contamination has been the free-phase gasoline.

Table 1. Distribution of Gasoline Amongst Three Phases.

Phase	Original Volume in Gallons	Current Volume in Gallons	Original Percent of Total
Free Phase	50	5	81
Adsorbed Phase	10	5	16
Dissolved Phase	2	2	3
Total	62	12	100

1.3 Previous Remedial Efforts

No remediation activities have been conducted at the Site.

1.4 CAP Objectives

This CAP is designed to address the dissolved-phase plume, any free-phase gasoline floating on the water table, and, as a spinoff, the adsorbed-phase gasoline associated with the free-phase gasoline. The following objectives are proposed for the CAP.

1. Develop a zone of capture that will encompass contaminated groundwater in the area of MW-2 and MW-4 to accelerate the removal of free-phase gasoline.

2. Reduce the concentration of MTBE in the onsite water well to below the detection limit.

The CAP has been prepared in accordance with VR680-13-02 and guidance documents published by the DEQ. Section 2.0 discusses the hydrogeology and remedial design. Section 3.0 details the selected remedial design for the Site. Schedules for operations and monitoring, numerical end points, waste disposal, and reporting requirements are described in Section 4.0. The CAP Summary Worksheet is presented in Appendix A, and a copy of the Public Notice is included in Appendix B.

2.0 REMEDIAL DESIGN

The remedial design is for a total fluids pumping system installed in MW-2 and MW-4 that pumps 120 gallons per day.

2.1 Aquifer Characteristics

The Site is underlain by 12 to 15 feet of red-brown clayey silt to silt soil with cobbles in the lower depths. It is not known whether the soil represents a saprolite or a reworked floodplain sediment. Underlying the soil is indurated bedrock. At MW-2, the depth to the water table has remained close to 7.0 feet below the surface. During drilling of MW-2, hard bedrock was encountered at 15 feet. Thus, the shallow aquifer is eight feet thick in the vicinity of MW-2. The SCR estimate for hydraulic conductivity was between 14 and 32 feet per day. The result of the pumping test on MW-2 indicated a hydraulic conductivity of 1.0 feet per day. Pumping of MW-2 was able to achieve 60 gallons per day.

The natural groundwater flow direction is eastward with discharge in Little Ivy Creek. Under natural conditions, the contamination remains in the shallow groundwater, since the area is in the discharge zone with upward flowing groundwater. However, the onsite water well that is completed in the fractured bedrock creates downward flow lines when it is pumping. Even so, there is relatively little contamination in the fractured bedrock due to the fact that the bedrock contains so little pore space, on the order of a few percent. Since the free-phase gasoline floats on the water table, no free-phase gasoline will occur in the deeper fractured aquifer.

2.2 Zone of Capture

The zone of capture for pumping the two-inch diameter monitoring wells will have the estimated values over time shown in Table 2. These estimates use an aquifer porosity of 20% and a pumping rate of 60 gallons per day.

Table 2. Estimated Radius of Capture per Two-Inch Well

Time, days	Radius, feet	Volume pumped, gallons
60	10	3600
180	18	10800
365	26	21900
730	36	43800

2.3 Water Quality Characteristics for Recovered Groundwater

Since there is a significant plume of dissolved gasoline near MW-2, it is predicted that MW-2 will produce water having maximum dissolved concentrations that approach those shown in Table 2. These concentrations were observed during the pump test on MW-2 completed in mid-2003. MW-4 produces groundwater with somewhat less concentration than MW-2 as shown in Table 2.

Table 3. Highest Observed Concentrations at Proposed Recovery Wells and Predicted Discharge and Treated Discharge Concentrations

Well No.	TPH-GRO µg/l	Benzene µg/l	Toluene µg/l	Ethyl-Benzene µg/l	Xylenes µg/l	MTBE µg/l
MW-2	95,300	4,500	1,950	470	2,780	89,500
MW-4	3,120	992	42	275	552	6,700

The estimation of concentrations in the discharge from the groundwater recovery system has been evaluated by using an analytical solution developed by Jacob Bear.[1] [2] The Bear model, as modified by Silka, assumes that the well is pumping from an isotropic homogeneous aquifer and draws in a cylindrical plume of a specified radius and thickness with its center initially at a certain distance from the pumping well. The Bear model also assumes that the source is not continuous. The cylindrical plume can be assigned a thickness of uniform concentration, and the well can draw groundwater from a different aquifer thickness. The Lotus 1-2-3 spreadsheet showing the results of the calculation of the Bear model is presented in the appendix. The input parameters for the Bear model are:

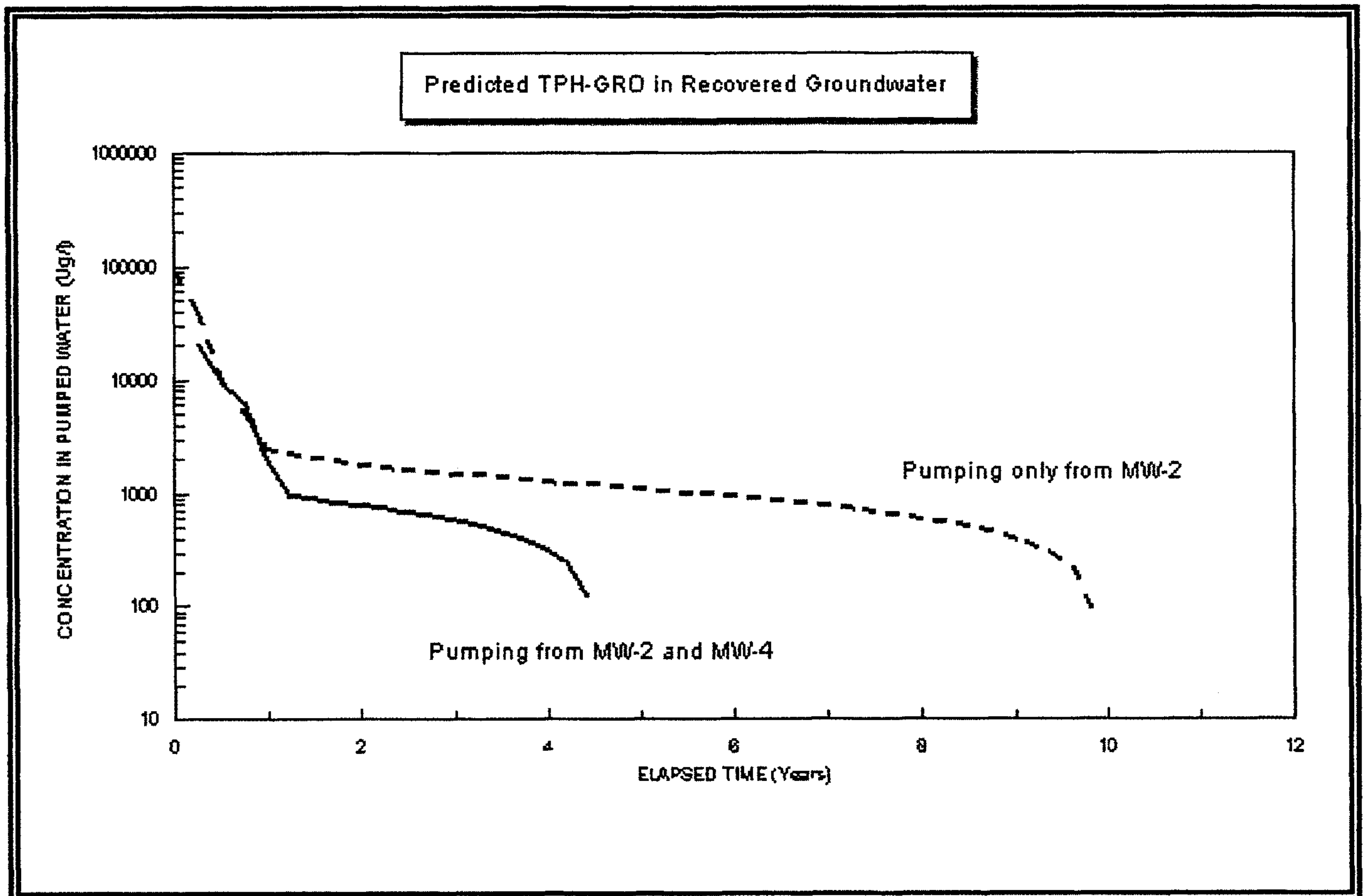
1. Plume uniform concentration of each constituent is estimated as the following log average: $10^{[\{\log(\text{highest concentration})+\log(\text{detection limit})\}/2]}$
   The highest concentration of TPH-GRO in MW-2 is 90,000 μg/l. The lowest concentration is the detection limit of 100 μg/l for TPH-GRO.
2. Plume radius is 50 feet when only MW-2 is pumping and 25 feet when both MW-2 and MW-4 are pumping.
3. Plume thickness is 7.0 feet.
4. Distance from the center of the plume to the onsite well is 25 feet.
5. Aquifer thickness (the saturated length of the water well) is assumed to be 7.0 feet.
6. Specific yield is 0.2.
7. Average pumping rate is 60 gpd per well.
5. Retardation factor is 1.2. This is conservative since 90% of the TPH-GRO is attributable to MTBE and the weighted average retardation factor is 1.1.
6. No biodegradation.

---

[1] Bear, Jacob, 1979, Groundwater Hydraulics, McGraw-Hill, New York, pp. 290-292)

[2] Silka, Lyle R., 1987, Predicting Plume Characteristics from Pumping Well Concentrations Using a One-Dimensional Analytical Solution, Proc. of the Conference on Northwestern Groundwater Issues, National Ground Water Association, Dublin, OH, pp. 329-347.

Figure 5 shows the results of the model prediction for the concentrations in MW-2 when either MW-2 is the only pumped well or when both MW-2 and MW-4 are pumped together. It is predicted that pumping from both wells accelerates the cleanup of the aquifer by more than a factor of two. This figure assumes that the free-phase gasoline ceases to be a source quickly.



Jeffrey A. Sitler - Environmental Services, Inc.
PO Box 6038
Charlottesville, VA 22906
(804)974-7080 - (804)974-1657 (FAX)

Date:	Revised:
Drawn by: LRS	Checked by:
File:	Scale:

Figure 5 - Estimated TPH-GRO Concentration in MW-2 Discharge for Two Cases

3.0 REMEDIATION SYSTEM DESIGN

3.1 Remediation System Design

The remediation system has the following objectives.

I. Recover free-phase gasoline from the water table.

II. Prevent further migration of contaminated groundwater.

III. Recover dissolved-phase gasoline from groundwater.

IV. Reduce dissolved contamination in the onsite water well to below detection limits.

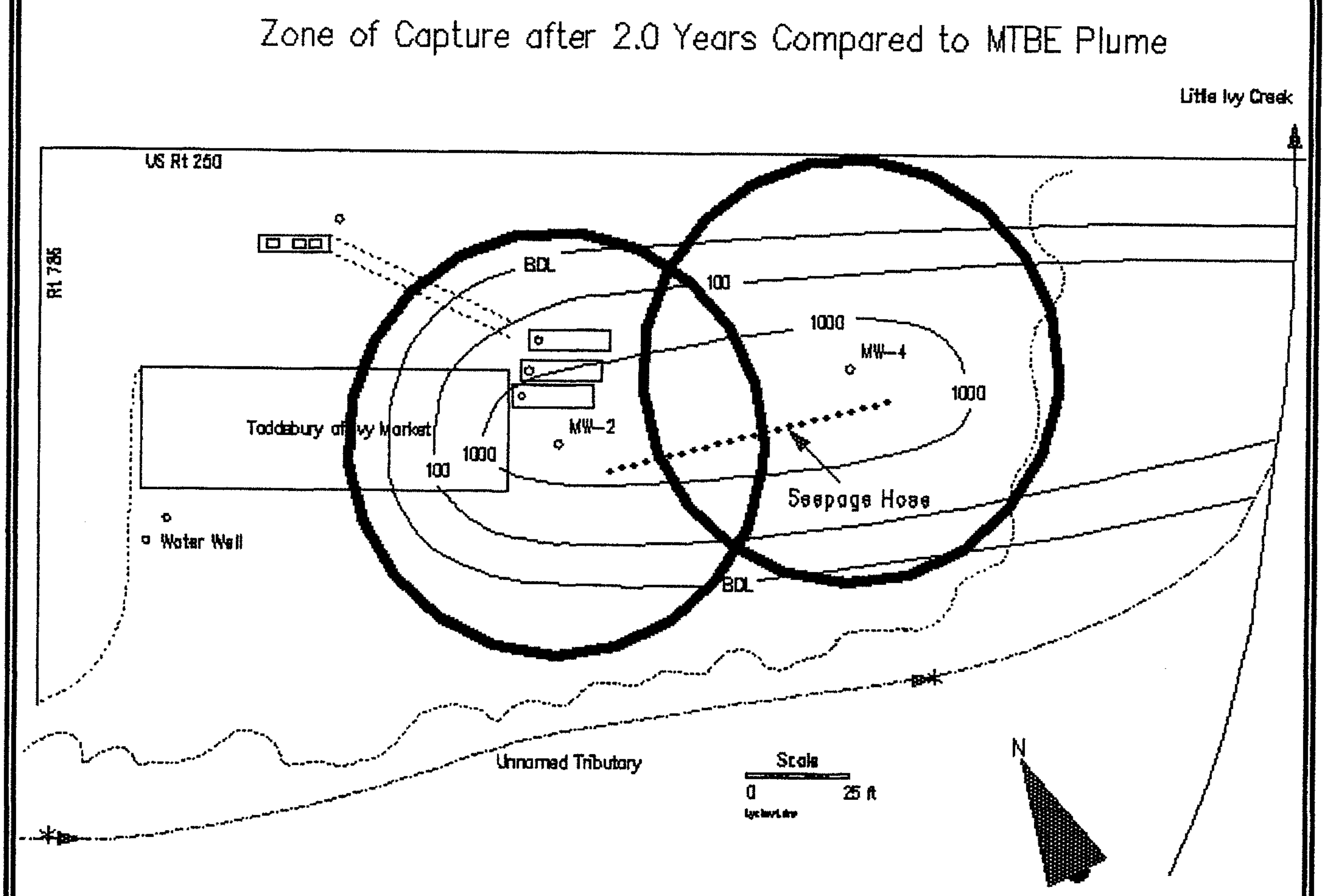
3.2 Water Treatment System

Discharge from the recovery system will be pumped to a 300-gallon polytank. The tank will be fitted with a 110-volt aerator that puts out about 7.0 cfm through a large air diffuser. With a pumping rate of 120 gallons per day, the residence time in the holding tank will be approximately 24 hours. This system has been found to attain up to 90% removal of volatile organics.

The tank will be fitted with a passive drain that will allow water from the bottom of the tank to drain out to a seepage hose. The drain will have an anti-syphon device. As water is pumped into the tank, when the water level in the tank reaches the outflow level of the drain, the water from the bottom of the tank will flow out the tank. In this manner, any free-phase gasoline that is collected in the tank will be trapped within the tank and cannot be discharged. The discharge of the water on the ground will allow natural biodegradation and evaporation to further treat the water. The seepage hose will be moved around to prevent water logging and also to prevent the infiltration of the water to reduce the effective growth of the zone of capture.

3.3 Treated Groundwater Discharge

Groundwater from the aerated holding tank will be passively drained to an infiltration hose that will overly the plume of contaminated groundwater. The discharge will be through a 50-foot-long, three-fourth-inch diameter seepage hose. Figure 6 shows the location of the seepage hose along the fence line next to MW-2 and MW-4.



**Jeffrey A. Sitler -
Environmental Services, Inc.**
PO Box 6038
Charlottesville, VA 22906
(804)974-7080 - (804)974-1657 (FAX)

Date:	Revised:
Drawn by: LRS	Checked by:
File:	Scale:

Figure 6 - Zone of Capture after Two Years and Seepage Hose Location.

3.4 Pumping Equipment

The monitoring wells will be pumped using Weldon air-diaphragm pumps capable of pumping between 1.0 and 10 gpm. The air-diaphragm pumps are driven by compressed air from a small electric air compressor. The air-diaphragm pumps are equipped with Viton diaphragms designed for pumping gasoline. The holding tank, pumps, and air compressor will be mounted on a small trailer behind the fence next to the MW-2 and MW-4. The pumps will have an intake hose run out to each well where a fitting will attach the hose to the two-inch PVC well casing. A riser will be inserted into each well to pump in groundwater from near the bottom of each well to maximize drawdown. The two pumps will be installed inside a weatherproof box on the trailer. Electrical service will be obtained from the existing service in the market by running a contractor-grade 12-AWG UL extension cord from the market to the trailer.

4.0 SYSTEM OPERATION AND MONITORING

4.1 Operation Schedule

The operation schedule has been developed to ensure continuous system operation, verify compliance with applicable discharge requirements, and track system efficiency and effectiveness. Table 4 summarizes the operation schedule for the system components to be implemented at the Site.

Table 4. Operation Schedule

Component	Estimated Operation	Comments
Free-phase gasoline and groundwater recovery	4.5 years	Monitor production for significant decline and determine necessary operation change.
Groundwater Treatment	4.5 years	Monitor operation, replace air compressors as needed.

The monitoring schedule is shown in Table 5. Routine monitoring of system performance and compliance with requirements will ensure that the system is operating at optimum effectiveness.

Table 5. Monitoring Schedule

Component	Estimated Operation	Comments
Free-phase gasoline recovery	Semi-monthly check	Record accumulated volume
Groundwater recovery	Semi-monthly check	Confirm flow rates, record total volume pumped
	Quarterly sampling of effluent.	Effluent water analysis to include BTEX + MTBE (8020) and TPH-GRO (8015).
Groundwater Treatment	Semi-monthly check	Check aeration tank for iron or biofouling. Clean out sediment as needed. Check anti-syphon passive drain for proper functioning
	Quarterly sampling of monitoring wells and water supply wells	Water analysis to include BTEX + MTBE (8020) and TPH-GRO (8015).

4.2 Numerical Remedial End Points

The groundwater remediation program is designed to remediate the Site and decrease contaminant concentrations over time. The longer the remediation is conducted, the greater the decrease of contaminants in groundwater. While the MCL for benzene is 5.0 ug/l, the Commonwealth of Virginia has a zero-tolerance policy for gasoline contaminants, especially benzene, in drinking water. However, it is questionable whether zero concentration is achievable within a reasonable time frame and cost. In addition, it is often the case that a remediation system will reach a point of diminishing return when the concentrations will reach a plateau where there are no further decreases in concentration (asymptotic concentration). This plateau occurs when the amount of contaminants being added to the groundwater equals the amount of contaminants being removed by the recovery wells. The sources of the contaminants being added to the groundwater include contaminants adsorbed to the soil particles that are gradually released to the groundwater, and contaminated groundwater caught in less permeable soil or aquifer zones that slowly is released to the groundwater flowing through the higher permeability fractures (this is referred to as "dual porosity"). In addition, concentrations in pumped water may approach asymptotes, but upon resting, the concentrations may recover again. Thus, the achievable end point for the remediation system is difficult to determine in advance. However, the goal of the remediation system is to achieve the MCLs.

4.3 Groundwater Discharge

A total of 120 gpd of treated groundwater will be discharged from the system. The discharge of treated groundwater will be made to the seepage hose located over the groundwater plume. Therefore, no direct discharge to surface water will occur from the treatment system, and no discharge permit is required.

4.4 Schedule -Post-Operational

After the proposed numerical end points have been achieved for six consecutive months, the remediation system will be shut down and taken off-line. Groundwater monitoring will be continued on a quarterly basis for one year following the remediation system shut-down. Groundwater samples from all monitoring wells and previously contaminated water supply wells will be analyzed for BTEX plus MTBE. The remediation system will be reactivated if the numerical end points are exceeded at any time during the post-operational phase. The remediation system will be dismantled after the numerical end points have been achieved for four consecutive quarters.

4.5 Implementation Schedule

The main elements of CAP implementation are: mobilization of the system to the site, system start-up and break-in period, monitoring and maintenance, and post-operational monitoring. It is expected that the remediation system can be in operation within 90 days of DEQ authorization. The break-in period is expected to last approximately four weeks. The remediation system is expected to operate for up to 4.5 years.

4.6 Reporting Requirements

Quarterly monitoring reports will be submitted to the DEQ that will include treatment system sampling analysis results, system flow rates and efficiency, and cumulative recovery data for free-phase gasoline and total groundwater pumped.

The fourth quarterly report of each year will also be the annual report that will include an evaluation of CAP effectiveness and its progress in achieving the numerical end points.

4.7 Waste Disposal

No wastes are anticipated to be developed during CAP construction. During operation, if free-phase gasoline is collected, the RECO Biotechnology vacuum truck will be scheduled as required to remove the gasoline for recycling.

4.8 Public Notification

The adjacent landowners will be made aware of the CAP by being provided with a public notice statement. The public notice will not be published in the local paper. A copy of the statement is included in Appendix B.

4.9 Contingency Plan

In the event that proposed numerical end points cannot be achieved using the chosen technology, a contingency plan will be activated. The plan will be based on site-specific conditions and may include actions such as installing additional recovery points or changing recovery rates through flow and pumping schedule adjustments. The remediation system components including pump and air stripping system have been oversized to provide at least a 100 percent increase in designed flow requirements. This expansion capability should enable the system to comply with the contingency requirements.

APPENDIX A

CAP Summary Worksheet

CAP Summary Worksheet

Phase of Contamination	Proposed Cleanup Endpoints	Proposed Monitoring to Achieve Endpoints					System Shutdown	Proposed Post Oper. Monitoring		Close Site or Reactivate System
		Sampling Location	Sampling Frequency & Type	Method of Analysis	Schedule to Achieve Endpoints	Schedule to Maintain Endpoints		Sampling Frequency & Type	Post Oper. Monitoring Schedule	
Free Product - Gasoline	0.01 ft for 6 months if encountered	MW-2 MW-4	Quarterly, probe and bailer	NA	NA	NA		Quarterly, grab	12 months	
Dissolved Product in GW - BTEX & MTBE TPH-GRO	Asymptotic Endpoints	MW-1 MW-2 MW-3 MW-4 Stream WS	Quarterly, grab	BTEX/MTBE by EPA 8020 TPH-GRO by EPA 8015	4.5 years	6 months		Quarterly, grab	12 months	

For VDEQ Use: Comments:

Reviewed by: Date:

APPENDIX B

Public Notice

PUBLIC NOTICE

PROPOSAL TO CLEANUP
AN UNDERGROUND STORAGE TANK (UST) SITE

Released June 10, 2004

There has been a release of petroleum from an underground storage tank system at:

Toddsbury of Ivy Market
Rt 250 West
Ivy, VA
Albemarle County

The Department of Environmental Quality (DEQ) is requiring Charlottesville Oil Company, the owner of the underground storage tanks that were involved in the release, to develop a Corrective Action Plan to address cleanup of gasoline contamination at the Site. The corrective action will consist of the pumping and treatment of contaminated groundwater. If you have any questions regarding the cleanup, please contact:

Lyle R. Silka
Jeffrey A. Sitler Environmental Services Inc.
PO Box 6038
Charlottesville, VA 22906
(703)216-2490

The Corrective Action Plan was submitted to the Valley Regional Office of the DEQ on June 10, 2004. If you would like to review or discuss the proposed Corrective Action Plan with the staff of the DEQ, please feel free to contact Mr. Joel P. Maynard (540)574-7800.

The DEQ Valley Regional Office will consider written comments regarding the proposed Corrective Action Plan until **July 31, 2004** and may decide to hold a public meeting if there is significant public interest. Written comments should be sent to the DEQ at the address listed below. The DEQ requests that all written comments reference the tracking number for this case; PC# 01-6134.

Joel P. Maynard
Storage Tank Program
Department of Environmental Quality
PO Box 3000
Harrisonburg, VA 22801

CAPI Monitoring Report CAPI Subphase No. 24
Toddsbury of Ivy
4297 Ivy Road
Ivy, Virginia 22945
Albemarle County

PC 2001-6134
FAC ID # _________ *(for DEQ use)*

Submitted to:

David A. Fitt
Valley Regional Office
Department of Environmental Quality
PO Box 3000
Harrisonburg, VA 22801
(540)574-7800

Prepared for:

Charlottesville Oil Company
PO Box 6340
Charlottesville, Virginia 22906
(434)293-9107

Prepared by:

Jeffrey A. Sitler Environmental Service, Inc.
PO Box 6038
Charlottesville, Virginia 22906
(434)974-7080 fax (434)974-1657

February 28, 2013

Jeffrey A. Sitler - Environmental Services, Inc.
PO Box 6038
Charlottesville, VA 22906
(434)974-7080
Fax (434)974-1657

February 28, 2013

David A. Fitt
Department of Environmental Quality
PO Box 3000
Harrisonburg, VA 22801

RE: Toddsbury of Ivy CAPI Subphase No. 24
Quarterly Groundwater Monitoring Report
PC 01-6134

Dear David:

This report is for the latest quarterly monitoring event completed at the subject Site and covers the O&M period from December 16, 2012 to February 28, 2013. Figure 1 shows the topographic map with the Site location indicated.

Groundwater Monitoring. On February 19, 2013, Brian Silka went to the Site to complete quarterly sampling. Monitoring wells MW-1 through MW-4 were opened and the depth to water measured. The water-table elevation worksheet is included in Appendix A. For this event, only MW-2, 4, 6 were sampled. The groundwater samples were analyzed for benzene, toluene, ethylbenzene, xylenes, naphthalene, and MTBE by EPA Method 8021B. Usually, the analysis has been limited to MBTEX, but naphthalene was inadvertently left on the chain of custody form. The water well was sampled and analyzed for volatile organics by EPA Method 8260B.

Table 1, at the end of this report, presents a summary of all groundwater analyses to date. The lab report for this quarterly sampling event is presented in Appendix B.

Figure 2 shows the water-table contours for this event. Overall, the interpreted groundwater flow direction has not changed significantly since the beginning of investigations at the Site in 2001.

Last fall, only the recovery well MW-6 had any MBTEX contamination with BEXM. For this quarter, MW-6 had only MTBE at 4.9 µg/l. For this quarter, MW-4 had 2.0 µg/l MTBE. MW-2 was free of detectable MBTEX. Only a figure for the extent of dissolved MTBE is presented (Figure 3).

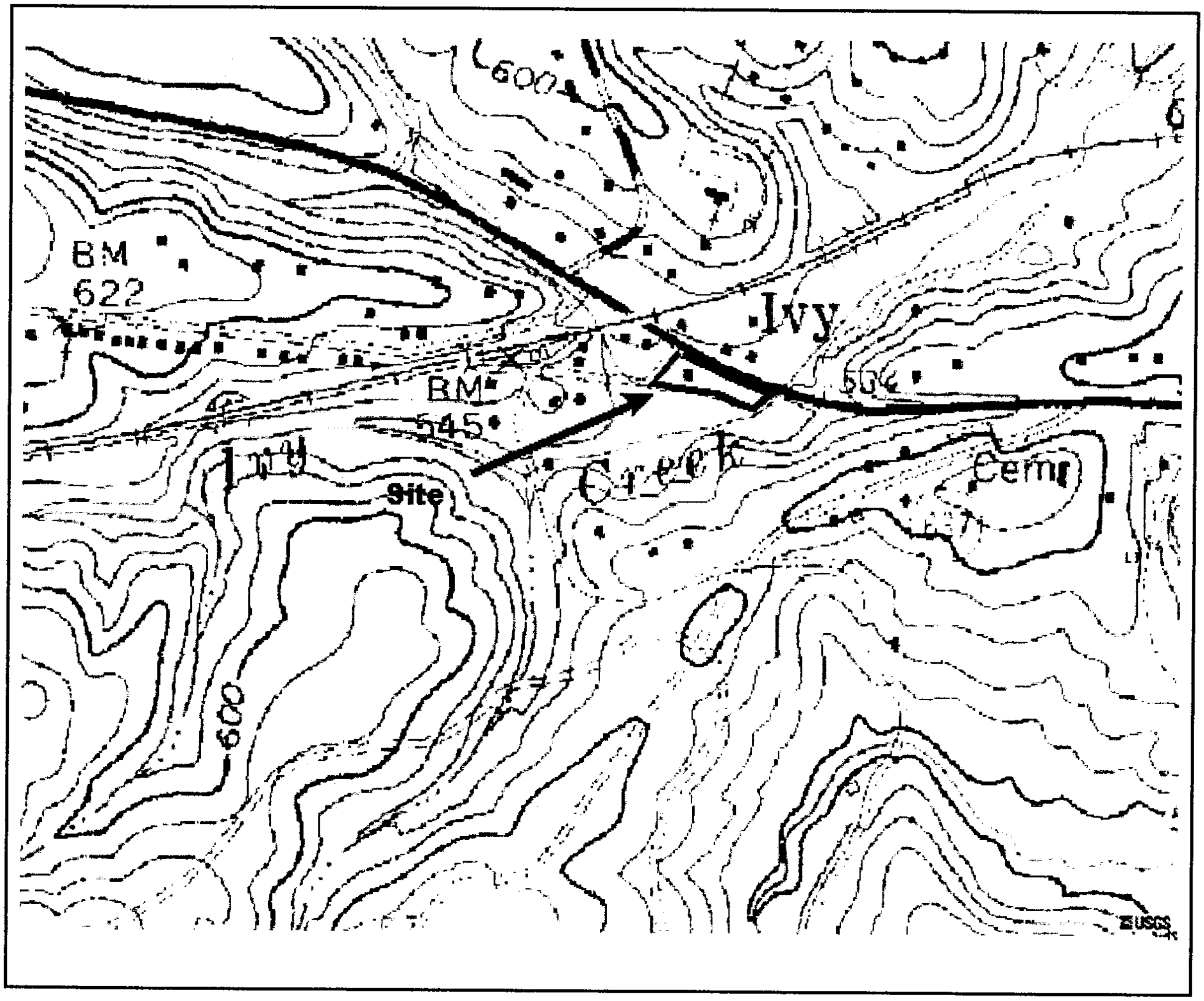


Figure 1. Site location on topographic map, Toddsbury of Ivy.

Source Area Recovery

The four-inch diameter MW-6 is an 80-foot deep recovery well located about 10 feet east of MW-2. MW-6 pumps from the depth interval 10 to 80 feet. Thus, it pumps from both the shallow zone above the bedrock surface (at 13 feet of depth at MW-6) and the deeper fractured bedrock zone. MW-6 began pumping on June 1, 2009.

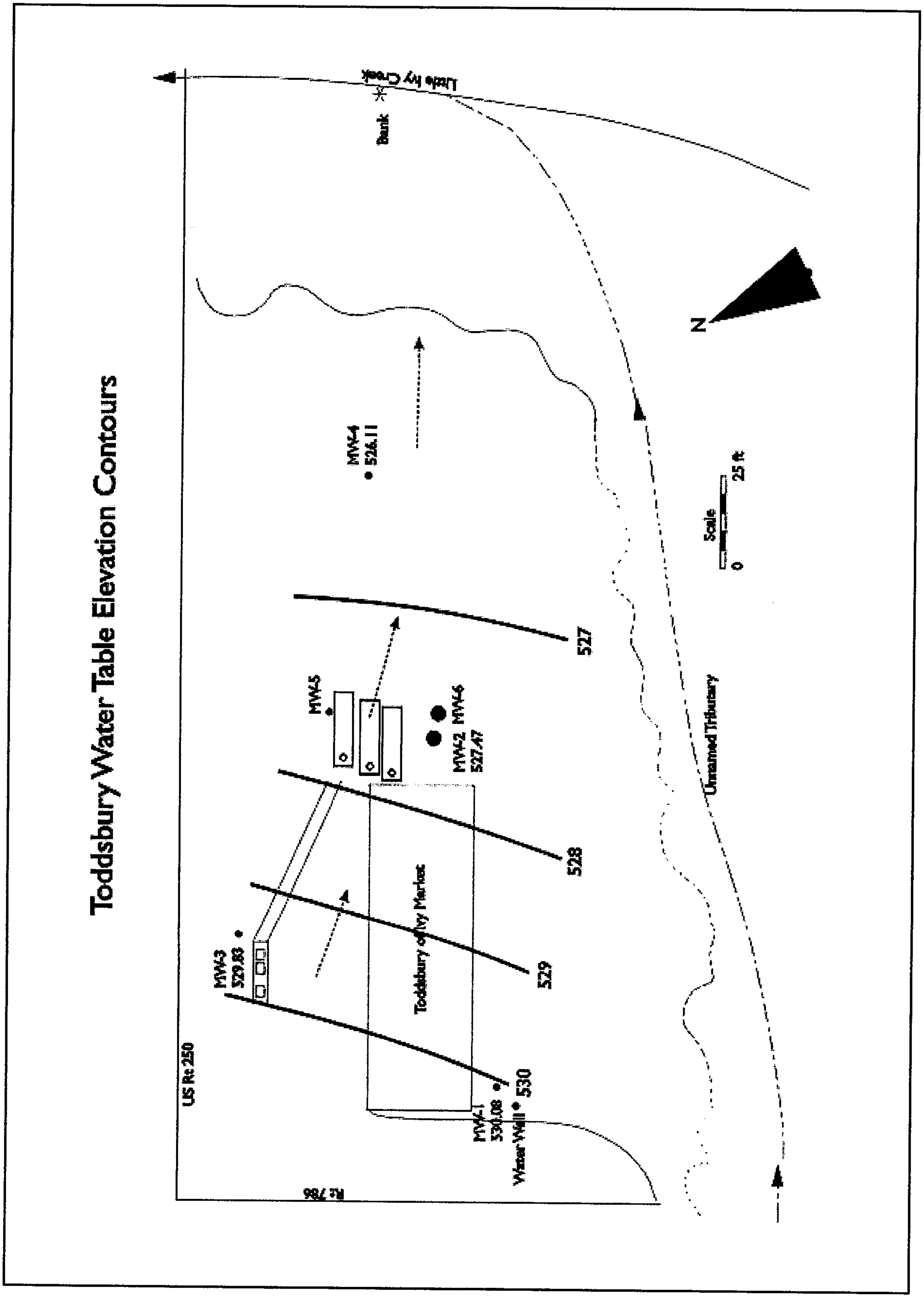


Figure 2. Water-table elevations for this event at Toddsbury of Ivy.

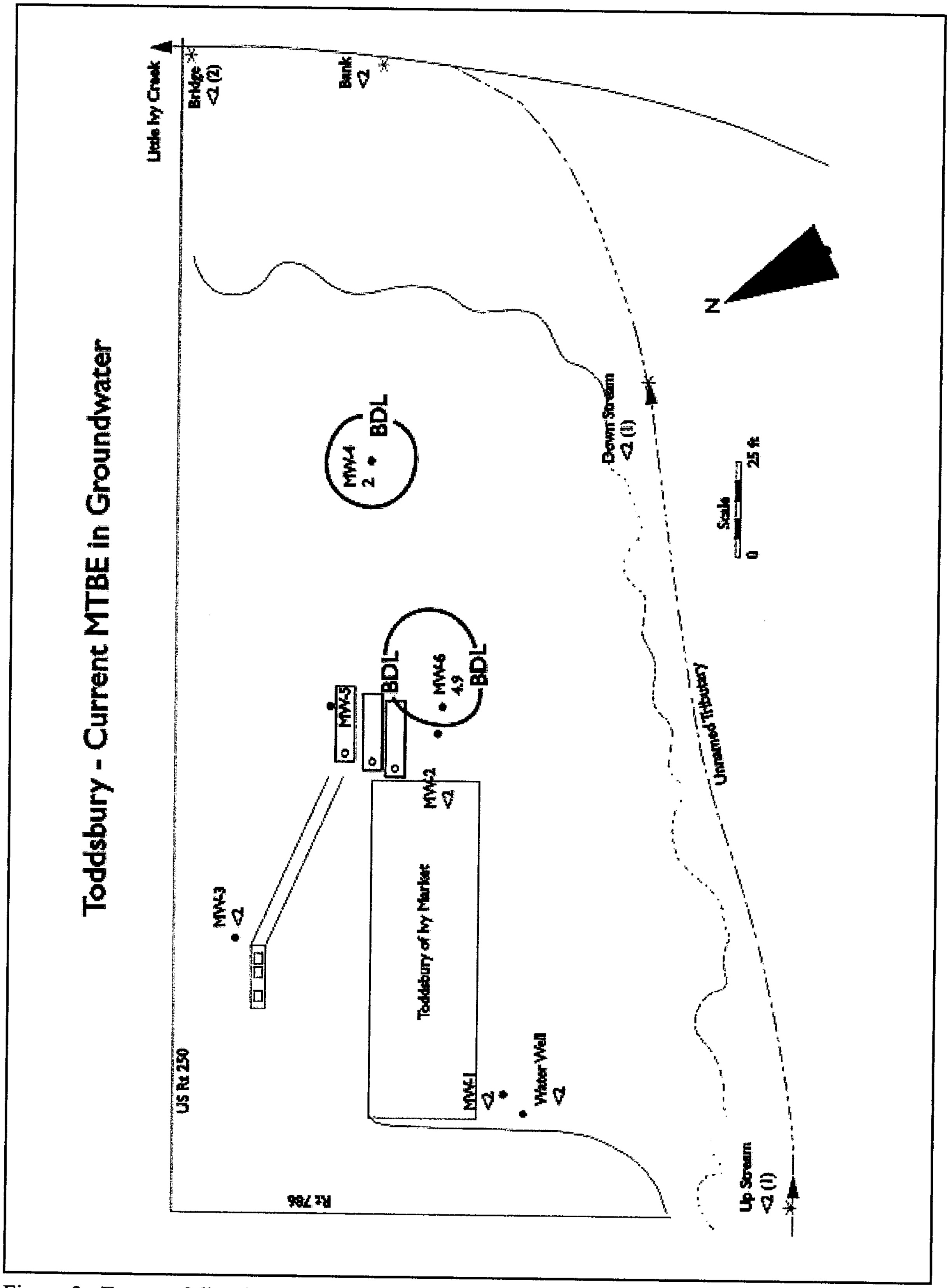


Figure 3. Extent of dissolved MTBE in the groundwater for this event.

Concentration Trends

MW-2/MW-5. The shallow groundwater from MW-2 had the highest concentrations historically, with MTBE at 56,400 µg/l and benzene at 11,500 µg/l in 2001 and 2002. Even with the historically high concentrations in MW-2, measurable free product has not been observed, and a sheen was seen only once in 2005. After a period of two years with MTBE at between 10 and 20 µg/l, MTBE has not been detected for the last two quarters.

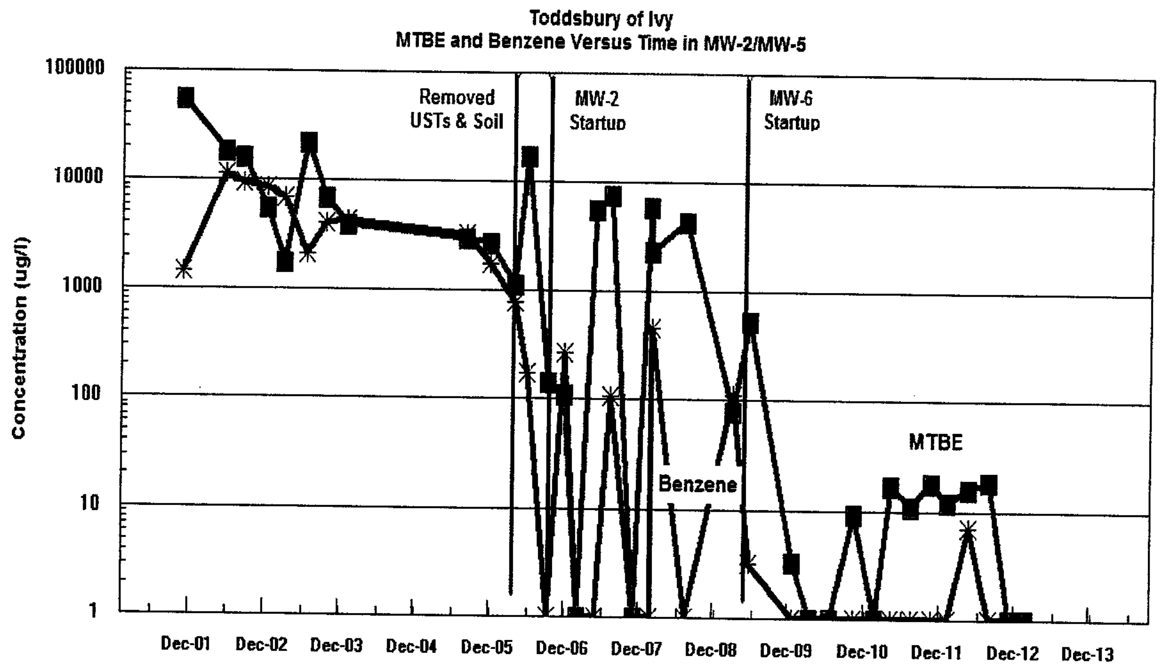


Figure 4. MTBE and benzene concentrations versus time in MW-2/MW-5.

Down gradient (MW-4). Down gradient of the source area at MW-4, MTBE has been following an overall decreasing trend since 2003, even before remediation began, as shown in the graph in Figure 5. This may be related to groundwater migrating eastward through MW-4. However, since MW-6 began pumping, MTBE in MW-4 increased for a short period, then began a steep downward trend. MTBE was not detected for the summer and fall events, but was 2.0 µg/l for this event. The BTEX compounds have been virtually absent from MW-4 since early 2010.

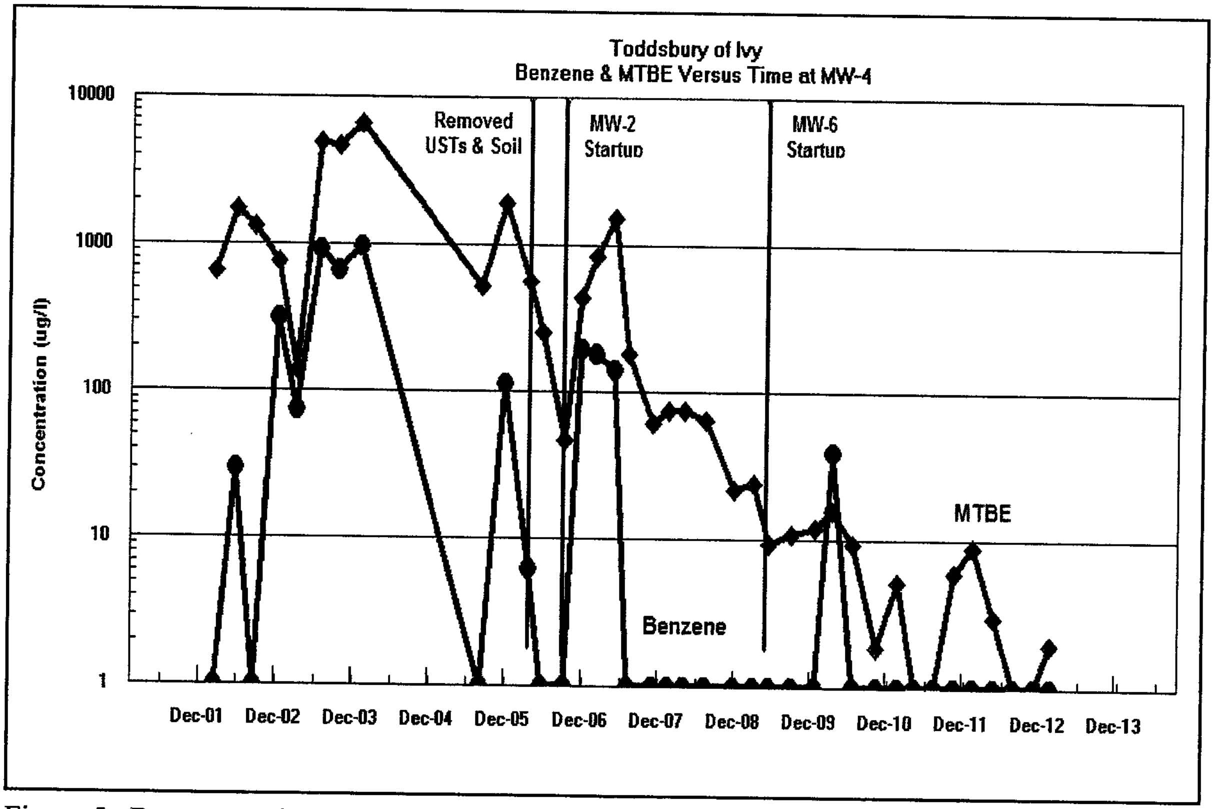


Figure 5. Benzene and MTBE versus time at MW-4.

Stream Bank. The groundwater quality at the stream bank was below detection from August 2008 through November of 2010 (the last sample analyzed). Figure 6 shows the change in MTBE concentration in the stream bank sample over time. The stream bank groundwater, and, by association, the stream, are no longer at risk from contaminated groundwater.

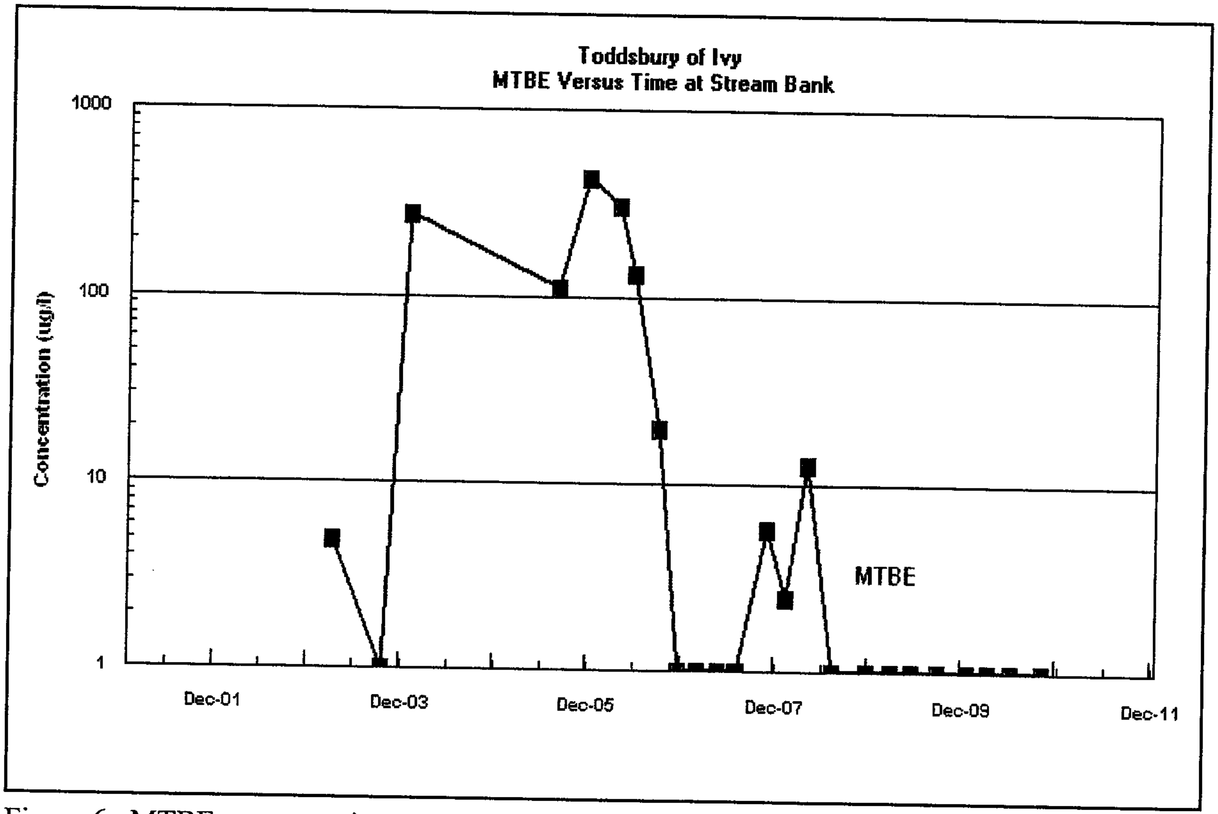


Figure 6. MTBE concentration versus time at the Stream Bank.

<u>MW-6</u>. The trends for MTBE and benzene in the recovery well, MW-6, are shown in Figure 7. MTBE showed a relatively consistent decrease over time from the startup of MW-6.

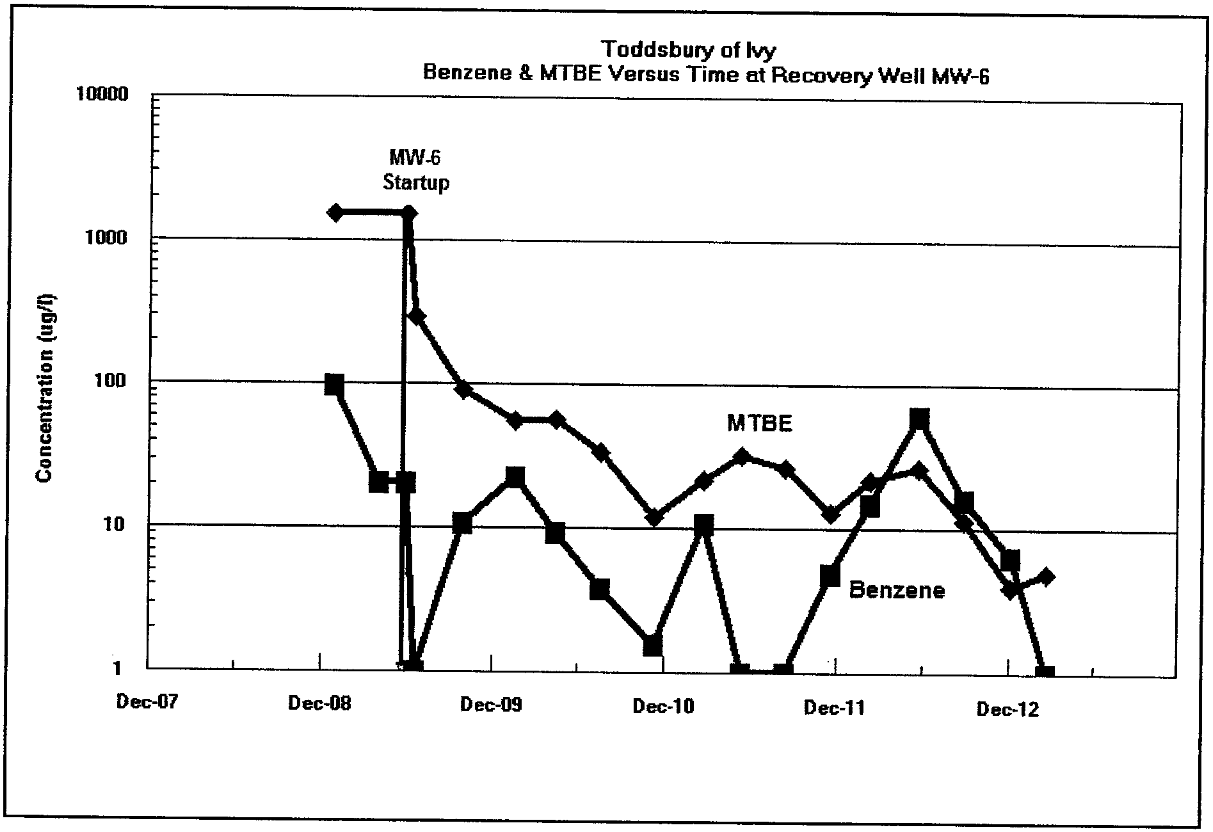


Figure 7. Benzene and MTBE versus time at MW-6.

MTBE and benzene have had three peaks since startup of MW-6 pumping. All three peaks have occurred in the January 2010, February 2011, and May 2012 for benzene, while the peaks for MTBE have been in April 2010, and May of 2011 and 2012. These peaks coincide with the normal groundwater recharge season. Since one of the gasoline USTs was left in the ground, because it was under the building, the annual recharge events may be causing residual gasoline from in and around that remaining gasoline UST to be flushed into the groundwater.

Onsite Water Well. The well water samples had been less than 2.0 µg/l from November of 2009, and less than 1.0 µg/l for eight out of the nine quarters and the last six straight leading to May of 2012. As with the spikes in MTBE witnessed in MW-2, 4 and 6, the well water had a small spike in August of 3.7 µg/l. MTBE was not detected in the water well for the last two events.

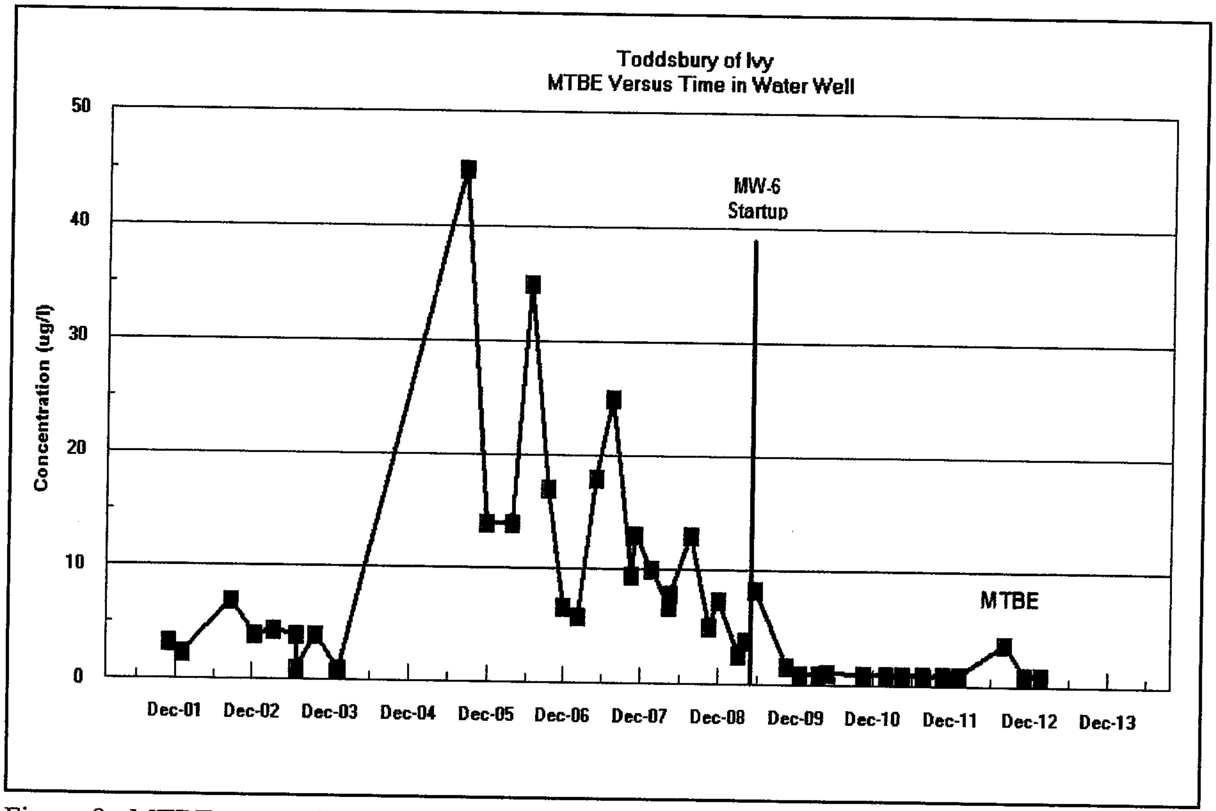


Figure 8. MTBE versus time in the onsite water well. MTBE cleanup is predicted to be much quicker after MW-6 startup than before.

CAPI Performance. The well water was virtually clean from January of 2010 through February of 2012. Now that the spike of 2012 appears to have passed through, the well water is expected to remain clean. .

Figure 9 shows the comparison of the current plume interpretation to the historical "highest" MTBE plume. With MTBE detected only in MW-6, the MTBE plume is reduced to the immediate area around MW-6.

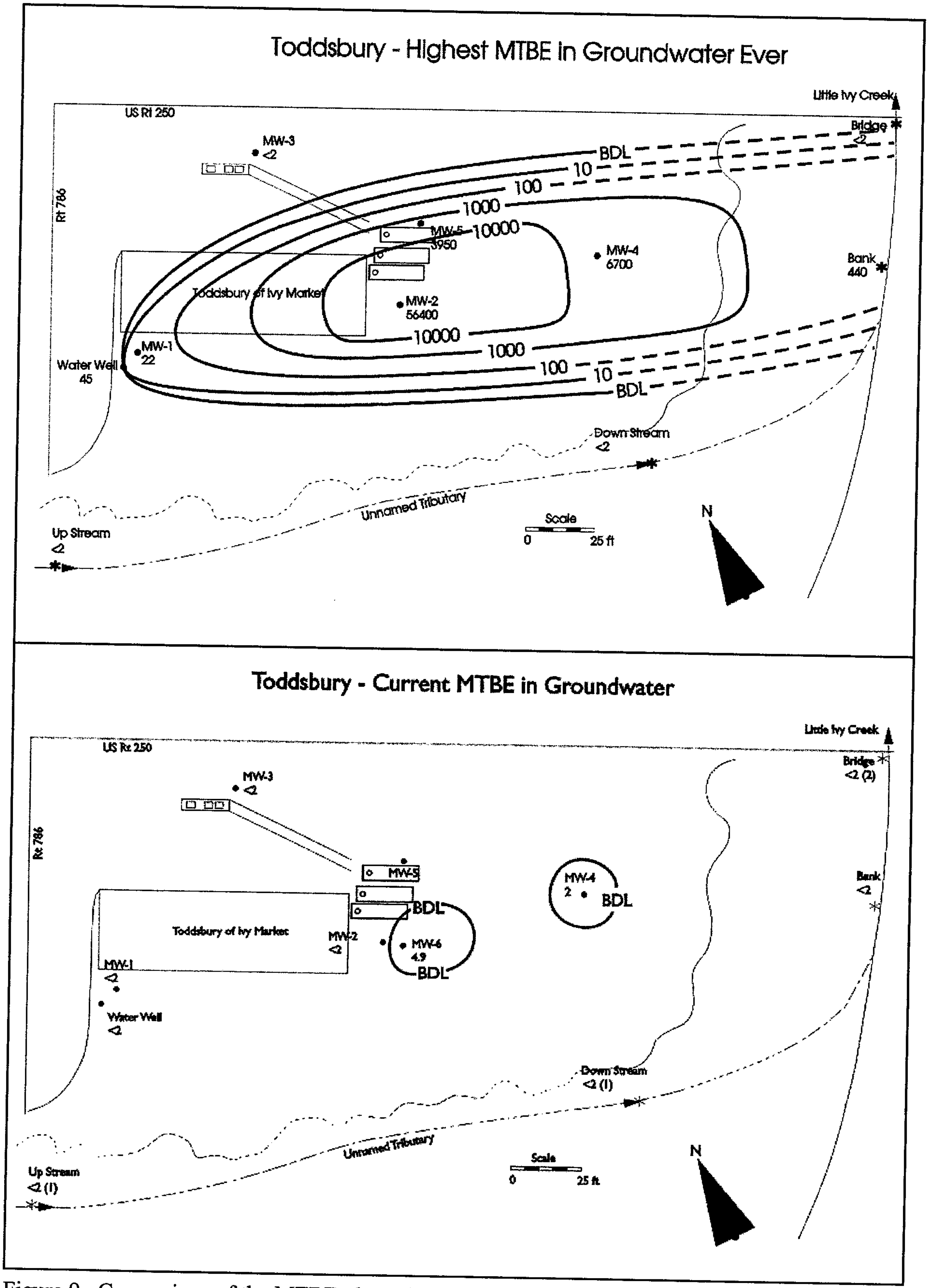
Conclusions and Recommendations. The pumping of MW-6 has reduced the MTBE to a low concentration and may have reduced BTEX to undetectable levels. The next sampling event in May may confirm whether another spike in MTBE or other contaminant occurs as a result of the seasonal groundwater recharge.

Please do not hesitate to contact me if I can be of further service in this matter.

Sincerely,

Lyle R. Silka, CPG

enclosures



Toddsbury - Highest MTBE in Groundwater Ever

Toddsbury - Current MTBE in Groundwater

Figure 9. Comparison of the MTBE plume based on the highest concentrations ever observed (top) to the current MTBE plume (bottom).

APPENDIX A
WATER TABLE DATA WORKSHEET
LABORATORY REPORT

WATER TABLE DATA WORKSHEET

Toddsbury of Ivy - Monitoring Well Data

	MW-1	MW-2	MW-3	Stream	MW-4	MW-5	MW-6
Installation Date	11/28/2001	11/28/2001	11/28/2001		02/12/2002	09/06/2005	12/29/2008
Heigth of Scope above TOC, ft					5.00		
Height of Scope at Rod, ft	4.23	3.90	3.42	12.66	5.57		
Total depth of well, ft	15.00	15.00	12.00		20.00	16.00	80.00
Elevation of TOC Relative Local Datum, ft	535.00	535.33	535.81	526.57	534.76		
Elevation of Water Table, ft	531.04	528.42	531.41	526.57	527.77		
Water Table Depth below TOC, 11/11/10, ft	5.83	6.10	6.97		9.52		8.21
Elevation of Water Table, ft	529.17	528.62	528.84	526.57	525.24		
Water Table Depth below TOC, 2/24/11, ft	5.68	6.33	6.82		9.17		Pumping
Elevation of Water Table, ft	529.32	528.39	528.99	526.57	525.59		
Water Table Depth below TOC, 5/16/11, ft	4.44	7.81	5.49		7.98		Pumping
Elevation of Water Table, ft	530.56	526.91	530.32	526.57	526.78		
Water Table Depth below TOC, 8/17/11, ft	4.01	5.96	5.20		9.68		Pumping
Elevation of Water Table, ft	530.99	528.76	530.61	526.57	525.08		
Water Table Depth below TOC, 11/21/11, ft	4.11	5.66	5.00		9.41		Pumping
Elevation of Water Table, ft	530.89	529.06	530.81	526.57	525.35		
Water Table Depth below TOC, 2/13/12, ft	4.78	5.22	5.79		8.12		Pumping
Elevation of Water Table, ft	530.22	529.50	530.02	526.57	526.64		
Water Table Depth below TOC, 5/23/12, ft	5.53	8.20	6.56		8.93		Pumping
Elevation of Water Table, ft	529.47	526.52	529.25	526.57	525.83		
Water Table Depth below TOC, 8/27/12, ft	6.25	8.90	7.21		9.59		Pumping
Elevation of Water Table, ft	528.75	525.82	528.60	526.57	525.17		
Water Table Depth below TOC, 12/4/12, ft	5.83	8.49	6.85		9.14		Pumping
Elevation of Water Table, ft	529.17	526.23	528.96	526.57	525.62		
Water Table Depth below TOC, 2/19/13, ft	4.92	7.25	5.98		8.65		Pumping
Elevation of Water Table, ft	530.08	527.47	529.83	526.57	526.11		

Maryland
spectral
Services

Analytical Chemistry Services

1500 Caton Center Dr Suite G
Baltimore MD 21227
410-247-7600
www.mdspectral.com
VELAP ID 460040

Analytical Results

Project: Todsbury of Ivy
Project Number: N/A
Project Manager: Jeff Sitler
Report Issued: 02/26/13 18:11

JAS Environmental Services
P.O. Box 6038
Charlottesville VA, 22906

CLIENT SAMPLE ID:		MW-2	MW-4	MW-6	VW
LAB SAMPLE ID:		3022102-01	3022102-02	3022102-03	3022102-04
SAMPLE DATE:		02/19/13	02/19/13	02/19/13	02/19/13
RECEIVED DATE:		02/21/13	02/21/13	02/21/13	02/21/13
MATRIX	Units	Nonpotable Water	Nonpotable Water	Nonpotable Water	Potable Water

VOLATILE ORGANICS BY EPA METHOD 8260B (GC/MS) (Water)

Acetone	ug/L				<10.0
tert-Amyl alcohol (TAA)	ug/L				<20.0
tert-Amyl methyl ether (TAME)	ug/L				<5.0
Benzene	ug/L				<5.0
Bromobenzene	ug/L				<5.0
Bromochloromethane	ug/L				<5.0
Bromodichloromethane	ug/L				<5.0
Bromoform	ug/L				<5.0
Bromomethane	ug/L				<5.0
tert-Butanol (TBA)	ug/L				<15.0
2-Butanone (MEK)	ug/L				<10.0
n-Butylbenzene	ug/L				<5.0
sec-Butylbenzene	ug/L				<5.0
tert-Butylbenzene	ug/L				<5.0
Carbon disulfide	ug/L				<5.0
Carbon tetrachloride	ug/L				<5.0
Chlorobenzene	ug/L				<5.0
Chloroethane	ug/L				<5.0
Chloroform	ug/L				<5.0
Chloromethane	ug/L				<5.0
2-Chlorotoluene	ug/L				<5.0
4-Chlorotoluene	ug/L				<5.0
Dibromochloromethane	ug/L				<5.0
1,2-Dibromo-3-chloropropane	ug/L				<5.0
1,2-Dibromoethane (EDB)	ug/L				<5.0
Dibromomethane	ug/L				<5.0
1,2-Dichlorobenzene	ug/L				<5.0
1,3-Dichlorobenzene	ug/L				<5.0
1,4-Dichlorobenzene	ug/L				<5.0
Dichlorodifluoromethane	ug/L				<5.0
1,1-Dichloroethane	ug/L				<5.0
1,2-Dichloroethane	ug/L				<5.0
1,1-Dichloroethene	ug/L				<5.0
cis-1,2-Dichloroethene	ug/L				<5.0
trans-1,2-Dichloroethene	ug/L				<5.0
Dichlorofluoromethane	ug/L				<5.0

Maryland spectral Services

Analytical Chemistry Services

1500 Caton Center Dr Suite G
Baltimore MD 21227
410-247-7600
www.mdspectral.com
VELAP ID 460040

Analytical Results

Project: **Toddsbury of Ivy**
Project Number: N/A
Project Manager: Jeff Sitler
Report Issued: 02/26/13 18:11

JAS Environmental Services
P.O. Box 6038
Charlottesville VA. 22906

CLIENT SAMPLE ID:		MW-2	MW-4	MW-6	WW
LAB SAMPLE ID:		3022102-01	3022102-02	3022102-03	3022102-04
SAMPLE DATE:		02/19/13	02/19/13	02/19/13	02/19/13
RECEIVED DATE:		02/21/13	02/21/13	02/21/13	02/21/13
MATRIX	Units	Nonpotable Water	Nonpotable Water	Nonpotable Water	Potable Water
VOLATILE ORGANICS BY EPA METHOD 8260B (GC/MS) (continued)					
1,2-Dichloropropane	ug/L				<5.0
1,3-Dichloropropane	ug/L				<5.0
2,2-Dichloropropane	ug/L				<5.0
1,1-Dichloropropene	ug/L				<5.0
cis-1,3-Dichloropropene	ug/L				<5.0
trans-1,3-Dichloropropene	ug/L				<5.0
Diisopropyl ether (DIPE)	ug/L				<5.0
Ethyl tert-butyl ether (ETBE)	ug/L				<5.0
Ethylbenzene	ug/L				<5.0
Hexachlorobutadiene	ug/L				<5.0
2-Hexanone	ug/L				<10.0
Isopropylbenzene (Cumene)	ug/L				<5.0
4-Isopropyltoluene	ug/L				<5.0
Methyl tert-butyl ether (MTBE)	ug/L				<5.0
4-Methyl-2-pentanone	ug/L				<10.0
Methylene chloride	ug/L				<10.0
Naphthalene	ug/L				<5.0
n-Propylbenzene	ug/L				<5.0
Styrene	ug/L				<5.0
1,1,1,2-Tetrachloroethane	ug/L				<5.0
1,1,2,2-Tetrachloroethane	ug/L				<5.0
Tetrachloroethene	ug/L				<5.0
Toluene	ug/L				<5.0
1,2,3-Trichlorobenzene	ug/L				<5.0
1,2,4-Trichlorobenzene	ug/L				<5.0
1,1,1-Trichloroethane	ug/L				<5.0
1,1,2-Trichloroethane	ug/L				<5.0
Trichloroethene	ug/L				<5.0
Trichlorofluoromethane (Freon 11)	ug/L				<5.0
1,2,3-Trichloropropane	ug/L				<5.0
1,2,4-Trimethylbenzene	ug/L				<5.0
1,3,5-Trimethylbenzene	ug/L				<5.0
Vinyl chloride	ug/L				<5.0
o-Xylene	ug/L				<5.0
m- & p-Xylenes	ug/L				<5.0

CHAIN-OF CUSTODY RECORD

Company Name:
JAS Environmental Services, Inc.
PO Box 6038
Charlottesville, VA 22906

Project Name:
Toddsbury of Ivy

Sampler(s):
LRS / BNS

Project Manager:
Jeff Sitler
tel (434)974-7080
fax (434)974-1657

Location:
Ivy, VA

Task Number:

Laboratory:
Maryland Spectral Services, Inc.
1500 Caton Center Drive, Suite G
Baltimore, Maryland 21227
(410) 247-7600
(410) 247-7602 fax
FX 1353-7342-7
UPS 3X6699 for MSS

	Date	Time	Matrix	No. Container	TPH GRO EPA-8015	TPH DRO EPA-8015	MBTEX EPA-8021	VOA EPA-8260	PAH EPA-8270		
										Ice	
MW-2	02/19/2013	1230	W	2			X			Ice	3022102-01
MW-4	02/19/2013	100	W	2			X			Ice	-02
MW-6	02/19/2013	130	W	2			X			Ice	-03
WW	02/19/2013	1200	W	2				X		Ice	-04
										Ice	
										Ice	
										Ice	
										Ice	
										Ice	
										Ice	
										Ice	
										Ice	
										Ice	
										Ice	
										Ice	
										Ice	
										Ice	
										Ice	
										Ice	
										Ice	
										Ice	
										Ice	

Shipped by: (signature) LR Silka	Date/Time 02/19/2013 1500	UPS	Date/Time	Email report to lsilka@crols.com
(printed) Lyle R. Silka		(printed)		
Relinquished by: (signature)	Date/Time 2/21/13 9:40	Received by: (signature)	Date/Time	Bill:
(printed)		(printed) Ron Michael		JAS

14.6°C

APPENDIX B
ANALYTICAL DATA SUMMARY

Groundwater Analytical Results							
Well No.	Date Sampled	TPH-GRO µg/l	Benzene µg/l	Toluene µg/l	Ethyl-Benzene µg/l	Xylenes µg/l	MTBE µg/l
MW-1	11/29/01	BDL	BDL	BDL	BDL	BDL	18
	06/26/02	BDL	BDL	BDL	BDL	BDL	BDL
	09/19/02	BDL	BDL	BDL	BDL	BDL	22
	01/09/03	BDL	BDL	BDL	BDL	BDL	BDL
	04/09/03	BDL	BDL	BDL	BDL	BDL	BDL
	07/24/03	BDL	BDL	BDL	BDL	BDL	BDL
	10/23/03	BDL	BDL	BDL	BDL	BDL	BDL
	02/05/04	BDL	BDL	BDL	BDL	BDL	BDL
	09/06/05	BDL	BDL	BDL	BDL	BDL	BDL
	12/27/05	BDL	BDL	BDL	BDL	BDL	BDL
	04/26/06	BDL	BDL	BDL	BDL	BDL	BDL
	06/27/06	BDL	BDL	BDL	BDL	BDL	BDL
	10/09/06	ND	BDL	BDL	BDL	BDL	BDL
	12/27/06	ND	BDL	BDL	BDL	BDL	BDL
	03/07/07	ND	BDL	BDL	BDL	BDL	BDL
	05/29/07	ND	BDL	BDL	BDL	BDL	BDL
	08/09/07	ND	BDL	BDL	BDL	BDL	BDL
	12/04/07	ND	BDL	BDL	BDL	BDL	BDL
	02/18/08	ND	BDL	BDL	BDL	BDL	BDL
	05/07/08	ND	BDL	BDL	BDL	BDL	BDL
	08/15/08	ND	BDL	BDL	BDL	BDL	BDL
	12/29/08	ND	BDL	BDL	BDL	BDL	BDL
	04/04/09	ND	BDL	BDL	BDL	BDL	BDL
	06/19/09	ND	BDL	BDL	BDL	BDL	BDL
	09/29/09	ND	BDL	BDL	BDL	BDL	BDL
	01/20/10	ND	BDL	BDL	BDL	BDL	BDL
	04/15/10	ND	BDL	BDL	BDL	BDL	BDL
	07/21/10	ND	BDL	BDL	BDL	BDL	BDL
	11/11/10	ND	BDL	BDL	BDL	BDL	BDL

Well No.	Date Sampled	TPH-GRO µg/l	Benzene µg/l	Toluene µg/l	Ethyl-Benzene µg/l	Xylenes µg/l	MTBE µg/l
MW-2	11/29/01	BDL	1,480	1,420	BDL	900	56,400
	06/26/02	57,100	11,500	18,200	2,580	10,700	18,900
	09/19/02	38,500	9,600	8,000	2,130	9,120	16,600
	01/09/03	56,500	8,800	17,000	3,040	14,000	5,600
	04/09/03	64,200	7,140	19,000	3,070	15,300	1,790
	07/16/03	9,950	2,170	1,950	470	1,750	22,400
	10/23/03	32,300	4,080	11,200	1,660	7,480	7,000
	02/05/04	31,600	4,400	8,560	2,020	7,560	3,980
	09/06/05	40,200	3,300	5,280	3,210	14,600	723
	12/27/05	16,800	1,770	1,710	1,250	5,430	497
	04/26/06	5,750	775	850	415	2,060	305
	06/27/06	ND	175	BDL	BDL	BDL	17,800
	10/09/06	ND	BDL	BDL	BDL	BDL	144
	12/27/06	ND	267	508	288	1,090	112
	03/07/07	ND	BDL	BDL	BDL	BDL	BDL
	05/29/07	ND	BDL	BDL	BDL	BDL	5,630
	08/09/07	ND	110	BDL	60	168	7,760
	12/04/07	ND	BDL	BDL	BDL	BDL	BDL
	02/18/08	ND	BDL	BDL	BDL	BDL	5,980
	02/24/08	ND	458	118	261	725	2,320
	05/07/08	ND	ND	ND	ND	ND	ND
	08/15/08	ND	BDL	BDL	BDL	BDL	4,470
	04/04/09	ND	112	26	90	222	79
	06/19/09	ND	3.2	7.2	5.2	26	543
	01/20/10	ND	BDL	BDL	BDL	BDL	3.3
	04/15/10	ND	BDL	3.8	3.6	14	BDL
	07/21/10	ND	BDL	BDL	BDL	BDL	BDL
	11/11/10	ND	BDL	BDL	BDL	BDL	9.3
	02/24/11	ND	BDL	BDL	BDL	BDL	BDL
	05/16/11	ND	BDL	BDL	BDL	BDL	17
	08/17/11	ND	BDL	BDL	BDL	BDL	11
	11/21/11	ND	BDL	BDL	BDL	BDL	18
	02/13/12	ND	BDL	BDL	BDL	BDL	12
	05/23/12	ND	6.7	7.9	BDL	5.7	16.4
	08/27/12	ND	BDL	BDL	10	BDL	18.5
	12/04/12	ND	BDL	BDL	BDL	BDL	BDL
	02/19/13	ND	BDL	BDL	BDL	BDL	BDL

Well No.	Date Sampled	TPH-GRO µg/l	Benzene µg/l	Toluene µg/l	Ethyl-Benzene µg/l	Xylenes µg/l	MTBE µg/l
MW-3	11/29/01	BDL	BDL	BDL	BDL	BDL	18
	06/26/02	BDL	BDL	BDL	BDL	BDL	BDL
	09/19/02	BDL	BDL	BDL	BDL	BDL	BDL
	01/09/03	BDL	BDL	BDL	BDL	BDL	BDL
	04/09/03	BDL	BDL	BDL	BDL	BDL	BDL
	07/24/03	103	BDL	BDL	BDL	6.3	BDL
	10/23/03	BDL	BDL	BDL	BDL	BDL	BDL
	02/05/04	BDL	BDL	BDL	BDL	BDL	BDL
	09/06/05	BDL	BDL	BDL	BDL	BDL	BDL
	12/27/05	BDL	BDL	BDL	BDL	BDL	BDL
	04/26/06	BDL	BDL	BDL	BDL	BDL	BDL
	06/27/06	ND	BDL	BDL	BDL	BDL	BDL
	10/09/06	ND	BDL	BDL	BDL	BDL	BDL
	12/27/06	ND	BDL	BDL	BDL	4.4	BDL
	03/07/07	ND	BDL	BDL	BDL	BDL	BDL
	05/29/07	ND	BDL	BDL	BDL	BDL	BDL
	08/09/07	ND	BDL	BDL	BDL	BDL	BDL
	12/04/07	ND	BDL	BDL	BDL	BDL	BDL
	02/18/08	ND	BDL	BDL	BDL	BDL	BDL
	05/07/08	ND	BDL	BDL	BDL	BDL	BDL
	08/15/08	ND	BDL	BDL	BDL	BDL	BDL
	12/29/08	ND	BDL	BDL	BDL	BDL	BDL
	04/04/09	ND	BDL	BDL	BDL	BDL	BDL
	06/19/09	ND	BDL	BDL	BDL	BDL	BDL
	09/29/09	ND	BDL	BDL	BDL	BDL	BDL
	01/20/10	ND	BDL	BDL	BDL	BDL	BDL
	04/15/10	ND	BDL	BDL	BDL	BDL	BDL
	07/21/10	ND	BDL	BDL	BDL	BDL	BDL
	11/11/10	ND	BDL	BDL	BDL	BDL	BDL

Well No.	Date Sampled	TPH-GRO µg/l	Benzene µg/l	Toluene µg/l	Ethyl-Benzene µg/l	Xylenes µg/l	MTBE µg/l
MW-4	03/14/02	BDL	BDL	BDL	BDL	BDL	662
	06/26/02	BDL	30	BDL	BDL	BDL	1,730
	09/19/02	BDL	BDL	BDL	BDL	BDL	1,330
	01/09/03	1,120	320	20	42	98	758
	04/09/03	2,280	76	6.2	7.6	21	142
	07/24/03	3,120	929	42	275	552	4,950
	10/23/03	BDL	675	BDL	167	122	4,670
	02/05/04	2,200	992	BDL	124	BDL	6,700
	09/06/05	282	BDL	BDL	BDL	BDL	534
	12/27/05	2,110	116	46	41	315	1,940
	04/26/06	466	6.4	4	4	21	562
	06/27/06	ND	BDL	BDL	BDL	BDL	260
	10/09/06	ND	BDL	BDL	BDL	BDL	47
	12/27/06	ND	199	313	139	449	439
	03/07/07	ND	187	34	81	336	848
	05/29/07	ND	146	BDL	BDL	55	1,520
	08/09/07	ND	BDL	BDL	2.9	BDL	185
	12/04/07	ND	BDL	BDL	BDL	14	63
	02/18/08	ND	BDL	BDL	BDL	BDL	76
	05/07/08	ND	BDL	BDL	BDL	BDL	77
	08/15/08	ND	BDL	BDL	BDL	BDL	66
	12/29/08	ND	BDL	BDL	2.6	BDL	22
	04/04/09	ND	BDL	BDL	2.5	BDL	24
	06/19/09	ND	BDL	BDL	BDL	BDL	9.4
	09/29/09	ND	BDL	BDL	BDL	BDL	11
	01/20/10	ND	1.0	BDL	BDL	5.7	12
	04/15/10	ND	40	26	229	337	16
	07/21/10	ND	BDL	BDL	BDL	BDL	9.5
	11/11/10	ND	BDL	BDL	BDL	BDL	1.9
	02/24/11	ND	BDL	BDL	BDL	BDL	5.2
	05/16/11	ND	BDL	BDL	BDL	BDL	BDL
	08/17/11	ND	BDL	BDL	BDL	BDL	BDL
	11/21/11	ND	BDL	BDL	BDL	BDL	6
	02/13/12	ND	BDL	BDL	15	6	9
	05/23/12	ND	BDL	BDL	BDL	BDL	3.4
	08/27/12	ND	BDL	BDL	BDL	BDL	BDL
	12/04/12	ND	BDL	BDL	BDL	BDL	BDL
	02/19/13	ND	BDL	BDL	BDL	BDL	2.0

Well No.	Date Sampled	TPH-GRO µg/l	Benzene µg/l	Toluene µg/l	Ethyl-Benzene µg/l	Xylenes µg/l	MTBE µg/l
MW-5	09/06/05	32,800	1,150	8,680	1,610	11,600	2,990
	12/27/05	24,700	1,470	8,520	1,180	6,870	2,730
	04/26/06	6,560	366	1,770	362	2,250	1,130
	02/18/08	BDL	BDL	BDL	BDL	BDL	3,950
MW-6	12/29/08	ND	99	1,420	1,880	6,080	1,530
	04/04/09	ND	21	356	723	2,410	BDL
	06/19/09	ND	BDL	14	5.4	82	298
	09/29/09	ND	11	26	79	189	92
	01/20/10	ND	23	27	73	206	56
	04/15/10	ND	9.4	9.1	44	101	58
	07/21/10	ND	3.9	4.6	55	91	34
	11/11/10	ND	1.6	2.2	24	36	12
	02/24/11	ND	11	4	20	37	22
	05/16/11	ND	BDL	BDL	BDL	18	33
	08/17/11	ND	11	BDL	19	24	27
	11/21/11	ND	5	BDL	13	32	13
	02/13/12	ND	15	BDL	17	23	22
	05/23/12	ND	63	7.3	74	89	27
	08/27/12	ND	16.3	BDL	31.3	30.5	11.4
	12/04/12	ND	4	BDL	BDL	BDL	6.5
	02/19/13	ND	BDL	BDL	BDL	BDL	4.9
Discharge to Trench	06/19/09	ND	BDL	3.1	BDL	5.4	3.2
	09/29/09	ND	BDL	BDL	BDL	BDL	12
	01/20/10	ND	3.4	2.9	BDL	15	18
	04/15/10	ND	BDL	BDL	2.1	5.1	15
	07/21/10	ND	BDL	BDL	BDL	BDL	7.8
	11/11/10	ND	1.2	BDL	11	29	15

Well No.	Date Sampled	TPH-(µg	Benzene µg/l	Toluene µg/l	Ethyl-Benzene µg/l	Xylenes µg/l	MTBE µg/l
Onsite Water Well	11/29/01		BDL	BDL	BDL	BDL	3.3j
	01/31/02		BDL	BDL	BDL	BDL	2.3j
	09/20/02		BDL	BDL	BDL	BDL	6.9
	01/09/03		BDL	BDL	BDL	BDL	4.0
	04/09/03		BDL	BDL	BDL	BDL	4.4
	07/24/03c		BDL	BDL	BDL	BDL	4.0
	10/23/03		BDL	BDL	BDL	BDL	4.0
	02/05/04		BDL	BDL	BDL	BDL	BDL
	09/06/05		BDL	BDL	BDL	BDL	45.0
	12/27/05		BDL	BDL	BDL	BDL	14.0
	04/26/06		BDL	BDL	BDL	BDL	14.0
	06/27/06		BDL	BDL	BDL	BDL	35
	10/09/06		BDL	BDL	BDL	BDL	17.0
	12/27/06		BDL	BDL	BDL	BDL	6.7
	03/07/07		BDL	BDL	BDL	BDL	5.9
	05/29/07		BDL	BDL	BDL	BDL	18.0
	08/09/07		BDL	BDL	BDL	BDL	25.0
	11/15/07c		BDL	BDL	BDL	BDL	9.5
	12/04/07		BDL	BDL	BDL	BDL	13
	02/18/08		BDL	BDL	BDL	BDL	10
	05/07/08		BDL	BDL	BDL	BDL	6.8
	05/15/08c		BDL	BDL	BDL	BDL	7.9
	08/15/08		BDL	BDL	BDL	BDL	13
	11/15/08		BDL	BDL	BDL	BDL	5.0
	12/29/08		BDL	BDL	BDL	BDL	7.3
	04/04/09		BDL	BDL	5	16	2.6
	05/04/09c		BDL	BDL	BDL	BDL	3.9
	06/19/09		BDL	BDL	BDL	BDL	8.3
	11/18/09c		BDL	BDL	BDL	BDL	1.7
	01/20/10		BDL	BDL	BDL	BDL	BDL
	04/15/10		BDL	BDL	BDL	BDL	BDL
	05/25/10c		BDL	BDL	BDL	BDL	1.2
	11/11/10		BDL	BDL	BDL	BDL	BDL
	02/24/11		BDL	BDL	BDL	BDL	BDL
	05/16/11		BDL	BDL	BDL	BDL	BDL
	05/24/11		BDL	BDL	BDL	BDL	BDL
	08/17/11		BDL	BDL	BDL	BDL	BDL
	08/23/11		BDL	BDL	BDL	BDL	0.9
	11/21/11		BDL	BDL	BDL	BDL	BDL
	02/03/12		BDL	BDL	BDL	BDL	BDL
	08/27/12		4.9	BDL	1.7	BDL	3.4
	08/27/12		3.3	BDL	1.0	BDL	3.7
	12/04/12		BDL	BDL	BDL	BDL	BDL
	02/19/13		BDL	BDL	BDL	BDL	BDL

Well No.	Date Sampled	TPH-GRO µg/l	Benzene µg/l	Toluene µg/l	Ethyl-Benzene µg/l	Xylenes µg/l	MTBE µg/l
Up Stream	11/29/01	BDL	BDL	BDL	BDL	BDL	BDL
Down Stream	11/29/01	BDL	BDL	BDL	BDL	BDL	BDL
Bank	04/09/03	BDL	BDL	BDL	BDL	BDL	5.0
	10/23/03	BDL	BDL	BDL	BDL	BDL	BDL
	02/05/04	BDL	BDL	BDL	BDL	BDL	278
	09/06/05	100	BDL	BDL	BDL	BDL	112
	12/27/05	BDL	BDL	BDL	BDL	BDL	440
	04/26/06	BDL	BDL	BDL	BDL	BDL	313
	06/27/06	ND	BDL	BDL	BDL	BDL	134
	10/09/06	ND	BDL	BDL	BDL	BDL	20
	12/27/06	ND	BDL	BDL	BDL	BDL	BDL
	03/07/07	ND	BDL	BDL	BDL	BDL	BDL
	05/29/07	ND	BDL	BDL	BDL	BDL	BDL
	08/09/07	ND	BDL	BDL	BDL	BDL	BDL
	12/04/07	ND	BDL	BDL	BDL	BDL	5.8
	02/18/08	ND	BDL	BDL	BDL	5.8	2.5
	05/07/08	ND	BDL	BDL	BDL	BDL	13
	08/15/08	ND	BDL	BDL	BDL	BDL	BDL
	12/29/08	ND	BDL	BDL	BDL	BDL	BDL
	04/04/09	ND	BDL	BDL	BDL	BDL	BDL
	06/19/09	ND	BDL	BDL	BDL	BDL	BDL
	09/29/09	ND	BDL	BDL	BDL	BDL	BDL
	01/20/10	ND	BDL	BDL	BDL	BDL	BDL
	04/15/10	ND	BDL	BDL	BDL	BDL	BDL
	07/21/10	ND	BDL	BDL	BDL	BDL	BDL
	11/11/10	ND	BDL	BDL	BDL	BDL	BDL
Rt 250 Bridge	03/14/02	BDL	BDL	BDL	BDL	BDL	BDL
	06/26/02	BDL	BDL	BDL	BDL	BDL	BDL
	09/19/02	BDL	BDL	BDL	BDL	BDL	BDL
	01/09/03	BDL	BDL	BDL	BDL	BDL	BDL

Notes: ND- Not Determined
BDL- Below Detection Limit
j- Estimated value
µg/l- Micrograms per liter
LPH- Liquid Petroleum Hydrocarbon
NA- Not applicable
c- Culligan raw, untreated drinking water