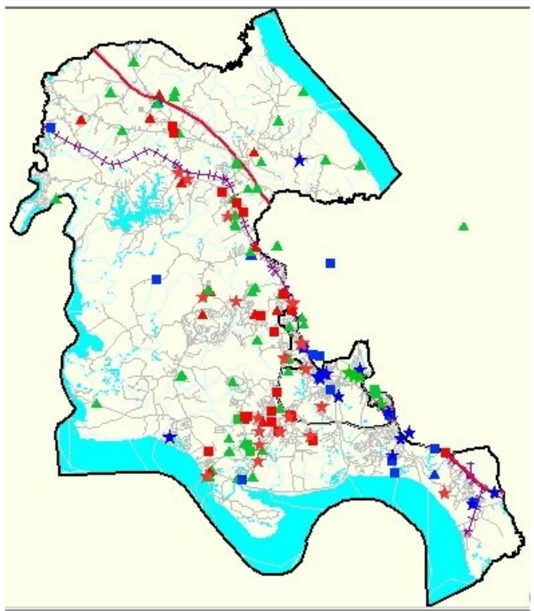
Report on
The Mid-Atlantic States' MTBE Pilot Project



**Public Water Supply Sampling,
GIS Plotting of UST & LUST sites and
Public Drinking Water Wells, and
Ranking Tool Development**

U.S. Environmental Protection Agency
Mid–Atlantic Region
Philadelphia, PA 19103

May 2004

Acknowledgments

The United States Environmental Protection Agency, Region III, could not have run the MTBE Pilot Project without the support of the environmental agencies of the Mid-Atlantic States and the District of Columbia. The MTBE Pilot Project Team comprises the District of Columbia Department of Health, the Delaware Department of Natural Resources and Environmental Control, the Maryland Department of the Environment, the Pennsylvania Department of Environmental Protection, the Virginia Department of Environmental Quality and the West Virginia Department of Environmental Protection.

We thank the U.S. Environmental Protection Agency, Office of Underground storage Tanks, which helped to garner financial and other resources for the Pilot.

MTBE Pilot Project Team Members:

Jack Hwang, EPA, Pilot Project Team Leader
David Iacono, EPA
Chris Adkins, VA DOH
Kofi Berko, DC DOH
Mick Butler, MDE
Dave Chance, VA DEQ
Doug Cordelli, PA DEP
Mike Cramer, EPA
Pat Ellis, DE DNREC
Don Evans, EPA
Yvonne Fernandez, Booz Allen, Inc.
Tripp Fisher, DE DNREC
Paul Gebhard, WVDEP
John Graves, EPA
Michelle Hoover, EPA
John Humphries, EPA
Fred Keer, MDE
Dale Long, EPA
Ellen Malenfant, DE DNREC
Don Martin, WVDEP
Wayne Naylor, EPA
Rose Nino, EPA
Maria Parisi Vickers, EPA
Rick Rogers, EPA
Matt Small, EPA Region IX
V. Sreenivas, DC DOH
Herb Ward, VA DEQ
Jim Weaver, EPA ORDAthens, Georgia

Special thanks to Herb Ward, GIS Coordinator for VADEQ, for his significant technical contributions and support for the pilot project, and to the Commonwealth of Virginia’s Department of Environmental Quality and Department of Health for their cooperation.

Special thanks also to Matt Small, EPA Region IX, and Jim Weaver, EPA ORD, for their assistance in developing the risk ranking models used as part of this pilot project.

We could not have completed this project without the considerable technical and professional contributions of the EPA Region III GIS Team, lead by Don Evans, and supported by Lori Veksland, EPA contractor, Carmen Constantine, EPA contractor, and Toby Wolf, EPA contractor.

Report on the Mid-Atlantic States' MTBE Pilot Project

Table of Contents

Table of Figures

List of Appendices

1. Introduction

In the year 2000, MTBE (methyl tertiary butyl ether) became a more publicized potential national environmental concern following the airing of a "60-Minutes" television program which identified the MTBE contamination problems occurring in California and in other locations across the country. Since most states did not require the collection of monitoring data for MTBE, it was important for EPA to begin a pilot to collect data concerning the extent of MTBE contamination and any impacts it may be having on human health and the environment. To begin this process, EPA Region III proposed to EPA's Office of Underground Storage Tanks (OUST) a pilot project to assess this issue by sampling public water supplies in many locations within two counties in Virginia to determine if, and to what extent, MTBE contamination existed.

1.1 Executive Summary

EPA Region III formed a workgroup of Agency and state personnel to investigate the impact of MTBE within the Mid-Atlantic region. As a pilot effort, the workgroup decided to sample for MTBE public water supply wells in two counties of Virginia and to also review LUST site data for MTBE impact. The related locational information for wells and LUST sites and UST facilities were plotted onto GIS layers to facilitate the creation of a GIS-based tool to help determine relative risk.

The major finding as a result of this pilot project is that MTBE was not found in any of the water samples taken from the 64 public water supplies of the pilot study areas. Based on existing site data, only 10 out of 215 LUST sites in the project areas had MTBE contamination in site ground water; however, not all sites had monitored for MTBE due to the date or nature of the release.

A major outcome of this pilot has been the development of a GIS application and a site ranking software tool that can be used by EPA or the states to consider relative potential risk when prioritizing UST facility inspections or LUST site corrective action oversight. Region III hopes to refine this tool to make it more user-friendly and transportable to other regions or states.

During the span of this pilot, the following two additional efforts were added: (1) to determine if there was any correlation between the "exploding manhole" covers in the District of Columbia and leaking underground storage tanks, and (2) to assist MDE with water sample analysis to determine if MTBE or TBA were present. For the DC project, it was determined that the explosions were caused by the failure of electrical equipment in the underground trench and not due to releases from LUST sites; however, the vapor source was not fully determined. For the Maryland project, revised protocols for sampling and analysis were developed and used for the sampling events to overcome analytical difficulties associated with TBA. The difficulties were resolved and the revised protocol was included in the EPA Fact Sheet on Analytical Methodologies for Fuel Oxygenates.

1.2 Background and Pilot Project Objectives

MTBE has become an important issue for several reasons. When compared to benzene, MTBE is much more soluble, mobile and persistent in ground water. Therefore, a quick response to an MTBE release by State regulatory agencies greatly increases their ability to reduce the spread of MTBE and allows for quicker and more effective remediation of the MTBE contamination.

To begin addressing this issue, an EPA/State MTBE workgroup was formed which consisted of representatives from the Region III states, Region III Waste and Chemicals Management Division (WCMD); Water Protection Division (WPD); Information Systems Branch (ISB), and Office of Environmental Data. Region III also worked closely with the EPA Headquarters' Office of Underground Storage Tanks (OUST), EPA Region IX, and EPA Office of Research and Development (ORD NERL).

The workgroup was charged with collecting ground water data in the pilot counties and developing Geographic Information System (GIS) tools for use by the Region III states to: (1) depict the extent of MTBE contamination in ground water, and (2) correlate this information with the location of nearby USTs and drinking water wells connected to of public water systems (PWS). Ultimately, these tools are intended to assist the states in establishing inspection and corrective action priorities, as well as enforcement strategies.

In August 2000, initial funding for the EPA Region III MTBE Pilot Project was secured. EPA hired Booz Allen Hamilton (BAH) to assist in the development of this project and to conduct the field work under Contract 68-W-99-021, Work Assignment R03108.

Two additional tasks were added later to this pilot project:

(1) In September 2001, a GIS Support Decision Tool was created for the Underground Storage Tank Division of the District of Columbia (D.C.), Department of Health. The D.C. Geographic Information System (GIS) also includes a special application for assisting the investigation of the "exploding manholes" which were occurring in D.C.

(2) In response to a request for assistance from the Maryland Department of Environment (MDE), a new task was added to the Work Assignment for BAH on February 11, 2002. This new task, which involved analyzing water samples collected from Maryland, was completed on April 15, 2002. MDE personnel collected the water samples and BAH was charged with analyzing the samples for MTBE and TBA (tertiary-butyl alcohol) using revised protocols (EPA Fact Sheet EPA 510-F-03-001, April 2003) for sampling and analysis.

Appendix A provides Questions and Answers that address this pilot project.

1.3 Region III MTBE Work Group

The MTBE work group, which met for the first time in EPA's office on September 25 and 26, 2000, discussed the proposed work plan and determined that the pilot project would initially focus on two counties in Virginia. However, the methodology developed for the pilot would be designed to be transportable to other states.

The MTBE work group reconvened on March 27 and 28, 2001. At that point, much of the sampling had been completed and the collected data had been entered into GIS and was available for analysis using various queries. The work group reviewed the prototype GIS application and agreed to use "SiteRank" and the "California Prioritization Scheme" for the next phase of the pilot project. See description of "Site Rank" in Section 3.3 below. The principle author of the "SiteRank" model, Matthew Small of EPA Region IX, assisted the work group in testing the model with actual site data. Mr. Small also assisted the workgroup with the conversion of the software language so it could be used within a web-based GIS application.

1.4 Pilot Areas

Resource and time constraints required that the project data requirements be minimized to the extent possible. Also, rather than taking the time and effort to collect new data, the project was designed to use existing data as much as possible. In addition, it was decided to choose geologic settings that differed from each to determine if the impact of MTBE changed as a result. For these reasons, Rockingham and James City Counties in Virginia were chosen as the pilot project areas. Rockingham County is situated in karst terrain and James City County lies in coastal plain alluvial sediments; therefore, the pilot areas represent a variety of geologic settings.

Rockingham County lies within two ground water regions: the non-glaciated Central Region and the Piedmont and Blue Ridge Region. Karst limestone and dolomite aquifers in the Shenandoah Valley area are the major water-bearing formations, and wells in this area are capable of producing several hundred to several thousand gallons per minute. Water levels frequently are greater than 50 to 100 feet below ground surface. The central valley portion of the county is underlain by alternating sandstone/limestone/shale aquifers where water depths tend to be shallower and the aquifers produce moderate quantities of water.

James City County is within the multi-layer aquifer system of the Northern Atlantic Coastal Plain Province. The geology is characterized by a series of southeastward dipping beds of marine and nonmarine sand, silt, clay and gravel. Typically, the upper surface of the water table ranges from several feet to as much as 30 feet or more below land surface. The aquifer thickness ranges from 10 to 70 feet and with an average of 50 feet. Individual well yields ranges from a few gallons per minutes to 30 gallons per minute. The boundaries of the pilot areas are shown on the Virginia Groundwater Map in Figure 1 (figures are located at the end of this document).

2. Details of the Scope of Work

The Pilot Project consisted of three phases plus two additional tasks:

Phase 1A - Data collection

- **Field measurements of latitude/longitude at operating UST facilities using Global Positioning System (GPS).**
  While on site to take GPS readings, the GPS team would ask the tank owner the current basic facility information such as facility name, street address, point of contact, sketch of facility plan, etc. There were 41 UST facilities in James City County and 58 in Rockingham County. GPS Data Entry Sheets are provided in Appendix B.

- **Creation of information sheets for each LUST site based on file review at VADEQ Valley Regional Office and Tidewater Regional Office**.
  The file review summary sheet contains entries such as general site information, release history, area map, site map, soil and ground water characterization, soil and/or ground water contamination, corrective action milestones and the no further action (NFA) letter. There were 51 LUST sites in James City County and 161 in Rockingham County.

- **Sampling and laboratory analysis of ground water from PWS wells for BTEX, MTBE and TBA.** There were a total of 95 PWS wells in James City County and 55 in Rockingham. However, due to resource constraints, only 29 wells in James City and 35 in Rockingham were sampled. At least one well from each PWS was selected for water sampling. Sampling results are provided in Appendix C.

- **Creation of a file review summary sheet for each individual PWS based on the results of file review in the field offices of Virginia Department of Health**.
  The summary sheet contains entries such as general information of the provider, population served, pump rate, pump duration, pump frequency and some details of well construction.

Phase 1B - Mapping UST and LUST sites and PWS wells

- **Reconciliation of multiple database sets through collaborations among several agencies**. These agencies include: Department of Environmental Quality (DEQ) Main Office in Richmond, DEQ Valley Regional Office in Harrisonburg, DEQ Tidewater Regional Office in Virginia Beach, Virginia Health Department in Richmond and its field offices in Lexington, Harrisonburg and Norfolk and, WCMD, WPD and ISB of EPA Region III.

- **Source of Locational data for LUST sites in two pilot counties.**
  The data was downloaded from an existing Virginia state-wide VA LUST GIS. The data set was modified based on the results of site file review.

- **Role of DEQ Regional Offices**
  DEQ Regional offices provided UST information in spreadsheets. These spreadsheets were then modified by inclusion of field determined locational data (GPS) and updated site status information.

- **SDWIS - Safe Drinking Water Information System**
  This system is a national warehouse for storing the PWS information in digital forms. SDWIS provides an initial database for public drinking wells in these two counties. The data sets were verified and modified based on the results of file review at local Virginia DOH field offices.

- **Creation of a GIS map to display the locations of UST and LUST sites, and PWS wells**.
  All data were then incorporated into a GIS map.

Phase 2 - Creation of web-based GIS for the pilot areas which allows the users to retrieve site information, to analyze data relationships and to generate environmental data maps.

- The EPA Region III GIS Team developed the system.
- EPA demonstrated the system at the UST/LUST National Conference and at the Region III All-States meeting.

Phase 3 - Development of a Priority Ranking Tool

The ranking tool allows users to determine a priority ranking of UST facilities for state inspection planning and a priority ranking of LUST sites for corrective action oversight.

- The tool also allows users to assess the vulnerability of PWS wells to contamination from UST/LUST facilities.

Additional Task 1 - Creation of a GIS Decision Support Tool for D.C. DOH to explore sources of exploding manholes.

Additional Task 2 - Characterization of ground water samples collected from Maryland for MTBE, TBA contamination with validated EPA methods.

3. Pilot Project Accomplishments

3.1. Databases were created to uniformly store the data needed for each pilot project area and GIS map.

Multiple sets of the Rockingham County database were populated with information of LUST sites, operating UST sites and drinking water wells in the Public Water System. The various database file names and their descriptions are as follows:

LUST_ROCK_EQ contains the facility ID, Virginia Pollution Complaint number, site name and street address, latitude and longitude, corrective action status, release date, close date, aquifer designation, contaminants, image files of LUST reports summary, Maximum TPH, maximum MTBE concentration.

UST_ROCK_EQ contains UST facility ID, facility name and street address, latitude and longitude, aquifer designation.

SDWIS_ROCK_EQ contains Public Water System ID, name of the provider, population it serves, aquifer designation, well screen length, pumping rate.

The respective databases for James City County are LUST_JC_EQ, UST_JC_EQ, and SDWIS_JC_EQ. Hard copies of the complete database files along with a table of variable definitions are presented in Appendix D.

3.2 An internet geographical information system called ROCK GIS (Rockingham County) allows users to retrieve site information, analyze data relationships and generate maps of environmental data from multiple data sources. A similar tool called JC GIS has also been developed for James City County.

This pilot project uses ArcIMS 4, Visual Basic 6.0 and a Cold Fusion server to perform the analyses and display of results. The internet capabilities are demonstrated by a set of online queries that allows users to query data from separate databases of the pilot areas.

A default view of ROCK GIS is shown in Figure 2. The right of the screen shows a list of layers that are imbedded in the system. On the left, the Toolbar is provided for map manipulation. In the center is the view of the Rockingham County with selected visible layers. Figures 3 and 4 demonstrate steps of online query for a specific LUST site and for a specific well, respectively. By pressing the “BUFFER” button in the Toolbar, ROCK GIS can display drinking water wells within a specified distance of a LUST site and vice versa. ROCK GIS can generate summary reports for a LUST site as shown in Figure 5. It is noted that the “Lightening Bolt” on the Toolbar provides a useful compliance tool (Figure 6). For example, it creates a hyperlink to a specific state database and allows the user to search for data related to the same facility ID.

ROCK GIS allows regulatory personnel efficient access to the same data and the choice of a common set of tools resulting in less duplication of effort and improved communication. A similar compliance tool, JC GIS was also developed for James City County.

3.3 An application in Visual Basic 6.0 was created for SiteRank model and was successfully incorporated into the existing online GIS.

SiteRank is a screening tool for ranking both sources of contamination and vulnerability of water supply wells. In general, sources with higher concentrations of toxic, recalcitrant compounds will be ranked higher and wells with greater numbers of higher ranking sources in close proximity will be ranked as more vulnerable. SiteRank overcomes some of the limitations of existing ranking models by combining simplified contaminant fate and transport modeling concepts with information about source proximity to the well within a mathematically consistent framework.

The SiteRank model uses information about the aquifer, chemicals of concern, contaminant sources, and pumping wells to calculate ranking values for sources and wells. This approach, developed by Matthew Small of EPA Region 9 and Jim Weaver of EPA Research Laboratory in Athens, Georgia, allows the users to rank contaminated sites and compare well vulnerabilities using relatively limited data. A detailed description of the SiteRank model can be found in Appendix E. This appendix includes model assumptions, required parameters, model formulations, normalized release volume, hazard ranking and the interpretation of ranking results. The source codes in Visual Basic 6.0 for the SiteRank model are also provided in Appendix F.

Additional database fields were created and calculated to provide the parameters needed for SiteRank calculations. The database was created with a “one-to-many relationship” for “chemicals to sources,” “sources to wells,” and “wells to aquifers.” An aquifer number, based on stratigraphy, was assigned to both wells and sources to allow calculation of the relative vertical migration factors (see e.g. ROCK_UST_EQ, ROCK_LUST_EQ, ROCK_SDWIS_EQ). Another database, AQUIFER_ROCK, which contains generalized physical properties of the aquifer such as aquifer number, aquifer name, porosity, fraction of organic carbon, bulk density, etc., was also created for calculation of nondimensional travel time. Chemical properties for MTBE, benzene, ethylbenzene, toluene and xylene are provided in CHEMICALS and, the parameter values for calculating the cancer risk or hazard index are provided in HAZARD. These additional databases are tabulated in Appendix G.

The calculated fixed radius flow model was chosen due to the limited availability of well data in both counties and as a simplified representation of the potentially complex karst flow system in Rockingham county.

3.4 The model was used to rank and plot USTs, LUSTs, and drinking water wells within pilot areas. Virginia DEQ can use this tool to prioritize individual UST facilities for compliance inspections. Virginia DOH can use this tool to evaluate drinking water well vulnerabilities from LUSTs.

Figure 7 demonstrates steps of online query for calculations and displays vulnerability ranking for drinking water wells impacted by UST facilities and LUST sites. Figure 8 demonstrates the steps for calculations and a display of UST facilities. The results of SiteRank for UST inspection priority and drinking water vulnerability are displayed in Figure 9 for Rockingham and in Figure 10 for James City County.

Rankings were multiplied by 100,000 within the GIS system to avoid scientific notation, and categories were assigned a low priority if they had a numerical score between 0 and 20, a medium priority for scores between 20 and 50, and a high priority for sites with scores over 50.

The results of this site ranking analysis will help the Virginia DEQ prioritize individual UST sites for compliance inspections. This will allow limited inspection resources to be focused on the sites predicted to pose the greatest potential threat to drinking water resources in the event of a leak. The Virginia Department of Health Services may also use the well ranking results to evaluate drinking water well vulnerability to LUSTs. This information may aid in strategic use of limited cleanup funds or to prioritize sites for additional regulatory oversight.

Interpretation and application of site ranking data or well vulnerability ranking data is a subjective process. For some applications, the process of simply ranking sources will provide the information required to make decisions and determine appropriate actions. However, other situations may require that the ranking numbers be further classified in some way such as high, medium, and low. The breakpoints for these ranges could be based upon available resources or program goals. For example, the high priority sites might be designated as the top 10% of all sites ranked. Another approach might be to perform more detailed contaminant fate and transport modeling on a subset of sites to more accurately correlate the ranking values with predicted actual impacts to wells. These are policy decisions that must be made by the user and other stakeholders in the process, based upon the goals and the needs of each study.

There are a number of potential actions that could result from a ranking study. Some actions might be reactive once a release has occurred or a facility has already been sited within a sensitive ground water area. Other actions might be more proactive, using the results of a ranking analysis to try to prevent ground water contamination or drinking water well impacts.

Reactive:

- Increased facility inspection frequency in vulnerable areas.
- More stringent cleanup requirements.
- Increased source water sampling.
- Target specific chemicals for analysis.
- Additional and/or refined data collection for vulnerability re-evaluation.
- Investment in well-head treatment.
- Long-term management plans for residual contamination.

Proactive:

- More stringent facility construction standards in sensitive areas.
- Management plans for potential sources of recalcitrant toxic chemicals.
- Ground water sensitivity analysis independent of sources.
- Land use and/or permit restrictions in sensitive or vulnerable areas.
- Well head and recharge zone protection plans.

However, it is important to keep in mind that "SiteRank" does not consider the following factors: the number of people using a well; non-point sources; time of release; dispersion; or general aquifer vulnerability/sensitivity. Therefore, the model is most well-suited to screening level vulnerability ranking and results should only be used in prioritizing further site investigations. Unverified results from "SiteRank" should not be used alone to support enforcement effort or to eliminate sites from further investigation or release them from regulatory programs.

3.5 An application in JavaScript was created for a prioritization scheme (based on the criteria of response time to a release) to assign investigation priority classification for corrective action investigations. As an illustration, the model was applied successfully to the existing ROCK and JC GIS systems using California ranking criteria.

Unlike traditional petroleum constituents such as benzene, toluene, ethylbenzene and xylene (BTEX), MTBE moves quickly to pollute water and is slow to degrade in subsurface environment. Therefore, response time to a petroleum release is critical for MTBE.

The California Priority Scheme, Figure 11, is based on: (i) vulnerability, (ii) distance to the nearest receptor, and (iii) maximum MTBE concentration in the ground water to assign investigation priority classification. For example, Class A requires immediate response and class D has the lowest priority and the response time can be as long as permissible. This priority scheme requires the knowledge of the distance between the site and the nearest receptor which can be estimated quickly using real time data since all the UST/LUST sites and public wells are already entered in the GIS.

Class	Vulnerable	Distance/MTBE conc.	Response Time
A	Yes	Zone A in Figure 11	Immediate or ASAP
B	Yes	Zone B in Figure 11	
C	Yes	Zone C in Figure 11	
D	No	Any other areas in Figure 11	Longest permissible

For the California classification scheme, a site is in a vulnerable area if it has one or more of the following characteristics:

1) Located in an area designated by the state as having a high degree of hydrogeologic susceptibility to contamination,
2) Located on near-surface fractured bedrock geology that is a source of water supply for a community,
3) Located above an aquifer that is a source of water supply for a community,
4) Located within a 1,000 feet radius of a drinking water well or surface water body used as a source of drinking water.

The mathematical algorithm and the computer codes using California ranking criteria are provided in Appendix H.

Figure 12 demonstrates the steps to take for online query of priority classification for a given LUST site. Most of the LUST sites in both Rockingham County and James City County are classified as low priority based on California ranking criteria. It is consistent with the review of LUST corrective action files that not many monitoring wells had reported high concentrations of MTBE. Those sites with recorded high concentrations of MTBE are not close to a drinking water well. The file review also indicated that Virginia DEQ has a short response time in addressing LUSTs and that DEQ responded to Pollution Complaints almost immediately.

3.6 A GIS project was completed for the Underground Storage Tank Division, D.C. Department of Health to assist with the investigation of exploding manholes.

In the May 16th 2001Washington Post, Metro Section, there was an article on manhole explosions in DC. Apparently, there had been 32 such explosions through May 2001 and the frequency had been increasing. The article described "...water troughs in the sewers that are made of 100-year-old wood.... every time a cable or transformer sparks, it ignites the rest of the systems, promoting explosions and failures."

Potomac Electric Power Company (PEPCO), which is responsible to address the explosion events, reported that failures of Paper-Insulated Lead Covered (PILC) cable might have caused the sparks. It was reported that Pepco was committed to develop a long term strategy for the continued use and ultimate replacement of PILC cable. Also, PEPCO would replace the 1,800 existing solid manhole covers with slotted covers. This design allows for the safe venting of gases beneath the manhole covers.

Underground sewer line trenches are preferential pathways for contaminated ground water and vapor migration from a petroleum release site. Off gas from the dissolved phase may contribute to explosive levels of VOCs (volatile organic chemicals). A GIS application, Figure 13, was quickly developed to graphically display the operating UST facilities, open/closed LUSTs within a quarter mile of exploding manholes. With integration of sewer line distribution the GIS allows the D.C. Department of Health (DCDOH) to analyze data relations and determine if there was a need for UST/LUST inspections as a precautionary measure.

Upon the request of DCDOH, the EPA Region III GIS Team completed a GIS plotting project for the D.C. UST Division, Figure 14, within a relatively short time frame using a Geocoding software program. Geocoding finds latitude and longitude of street addresses using electronic databases of streets and returns a classification code describing the quality of the position. A high percentage (about 80%) of UST/LUST sites in D.C. can be geocoded with good accuracy. For those geocoded results with less accuracy, the GIS Team was able to use references from the US Postal Service website and aerial photos to improve the accuracy. Upon completion of this effort, only a handful of sites out of a total of 665 sites required physical measurements using a GPS apparatus on site. EPA delivered the complete GIS Tool to the DCDOH UST Division and trained its personnel on how to use the system on June 14, 2001.

The GIS Tool generated a number of maps indicating the closeness and density of the nearby gasoline stations surrounding the exploding manholes. It was determined later that the explosions were caused by the failure of electrical equipment in the underground trench. However, the vapor source was not determined. The GIS Tool will be valuable to investigations of the similar events in the future.

3.7 Sixty-nine ground water samples collected from Maryland were analyzed for MTBE and TBA contamination, using validated EPA methods and revised protocols for sampling and analysis.

One element of the MDE’s Closed Sites Assessment Project is to collect and analyze water samples from designated drinking water wells and from monitoring wells at closed LUST sites. However, MDE experienced analytical problems with MTBE and TBA . With EPA Method 524.2, the laboratory had difficulties maintaining a consistently low detection level for TBA. In some instances, the concentration of TBA in a sample is very high compared to that for MTBE. TBA is a degradation product of MTBE. In some places, TBA has been used as an oxygenate. Therefore, a reliable analytical method is important, particularly for analysis of water in the filters at private homes. Members of the workgroup worked with EPA OUST, ORD and the

Maryland Department of Health Analytical Laboratory on these problems. As a result, revised protocols for sampling and analysis were developed and used in this pilot project. The revised protocol was included in the EPA Fact Sheet on Analytical Methodologies for Fuel Oxygenates (EPA 510-F-03-001, April 2003).

It is important to note that heating the sample during the preparative phase can increase the sensitivity of the analytical method and lower the method detection limit. Heating is particularly important for preparing samples to be analyzed for alcohols such as TBA. However, heating is not necessary for the analysis of ethers such as MTBE. If one desires to analyze both TBA and MTBE , heating samples to 80^{o}C for 30 minutes could consistently result in a detection limit of 5 ppb or lower for both MTBE and TBA. However, heating acidified samples will cause hydrolysis of ether to alcohol (MTBE to TBA) and, therefore, the chemical preservation method must be changed. EPA recommends use of Trisodium Phosphate Dodecahyrate (TSP) to replace acid to prevent biodegradation in the sample. Hence the revised protocols require both a chemical preservative (TSP) and refrigeration (preferably 4^{o}C). In addition, samples must be analyzed within prescribed holding times (generally 14 days or less).

The abovementioned protocol revisions are included in the EPA Fact Sheet on Analytical Methodologies for Fuel Oxygenates (EPA 510-F-03-001, April 2003). In addition, the report of the analytical results of water samples collected in Maryland, and the Fact Sheet are provided in Appendix I.

4. Pilot Project Findings

Finding 1. MTBE contamination in public drinking water is infrequent in the pilot areas. However, even though MTBE was not detected frequently, the tool was still able to be evaluated.

Only 10 out of 161 LUST sites in Rockingham County have reported MTBE contamination in ground water monitoring wells with concentrations ranging from 15 to 6,000 ppb. None of the 54 LUST sites in James City County have reported MTBE contamination. Furthermore, none of the water samples from 64 PWS wells has any detection of BTEX, MTBE or TBA.

The Commonwealth's LUST program, in general, did not require monitoring of MTBE until recent years. Among the ten MTBE contaminated sites in Rockingham County, one was reported in 1991, two in 1995, one in 1996, and two each in 1997, 1998 and 2000. Also, 107 out of 161 LUST sites were characterized as soil contamination only, meaning the decision was made that, after the removal of contaminated soil, no comprehensive ground water investigation was necessary. DEQ Regional personnel generally respond to a Pollution Complaint by visiting the site in the same day or within a day or two. All the above factors may explain why the reported MTBE contamination in ground water is infrequent in the pilot areas. Although MTBE was not detected frequently, the tool could still be evaluated**.**

Finding 2. Current locational data for UST facilities and for public drinking water wells are inadequate for use by state regulators. The LUST database does not indicate if the site is also an operating UST facility. Locations of LUST sites and operating UST facilities can be determined with moderate accuracy based on commercial site address.

There were 75 operating UST facilities for James City County and 111 for Rockingham County on the original lists provided by DEQ. At the end of the GPS survey, only 41 in James City County and 54 in Rockingham County were verified. The reason for such reduction could be one of the following: (1) tanks had been removed; (2) tanks had been converted to aboveground tanks; (3) wrong or not current address; (4) no street address (only has postal mailbox number); or (5) gasoline business closed.

DEQ Headquarters Office developed the Virginia statewide VA LUST GIS. It had actually measured the latitude and longitude at most of the closed and/or open LUST sites. Some reconciliation may be needed because a number of LUST sites appear on the VA LUST GIS, but the hard copy case files cannot be located. Also, there is no entry in the VA LUST GIS which gives indication of whether the closed site is closed for business or closed out because the cleanup was completed. This would be useful information for the preventive/enforcement side of the tank programs. There are different groups of people working in UST side and in LUST side of the VADEQ state program.

The Safe Drinking Water Information System (SDWIS) is a huge national database which has been designed to contain an enormous amount of valuable data for public water supply systems. However, the database, in its current form, is sporadically populated with data. EPA Region III and the Health Department of Virginia were able to retrieve information from SDWIS for this MTBE pilot project. We found that the locational data do not correspond to the actual well locations. The addresses for the water supply system providers are often different from those for the well fields. In one single well field there could be several wells pumping water.

A relatively high percentage of UST facilities with street addresses can be geocoded to establish latitude and longitude data. The Geocoding computer software program finds latitude and longitude of street addresses using an electronic database of streets and returns a classification code describing the quality of the position. The table below shows that about 53% of the UST facilities in the state database can be readily positioned using a computer program with varying degree of confidence.

Matching category based on Geocoding confidence level	Rockingham County	James City County	Overall Number	Overall Percentage
100%	43	20	63	34%
80 - 99%	2	14	16	9%
76 - 79%	12	7	19	10%
No match	54	34	88	47%
Total	111	75	186	100%

The Project Work Group had an even better experience with Geocoding when preparing the locational data for the D.C. GIS application. A high percentage (about 80%) of UST/LUST sites in D.C. were geocoded with good accuracy (75% or better). For those geocoded results with less accuracy, the GIS Team was able to use references from US Postal Service website and aerial photos to improve the accuracy.

Finding 3. EPA was able to develop a web-based GIS application for the two counties in Virginia UST program. However, remote access and security issues need to be addressed.

GeoTracker is a California GIS that provides online access to environmental data related to underground storage tanks and public drinking water supplies. Regulatory personnel, responsible parties and all stakeholders can efficiently access the same data and an identical set of analysis tools. GeoTracker allows the responsible parties to register their tanks online and it can also quickly identify and display the number of LUST sites with various distances to water supply wells for vulnerability analysis.

The EPA Region III GIS team developed a web-based GIS application, similar to GeoTracker, using the commercially available software, ArcIMS 4. In fact, the Region III GIS applications developed in this pilot project such as ROCK GIS and JC GIS can do what GeoTracker can and more. For example, the Region III GIS application can also provide a census data overlay, and site ranking, etc.

In order for a state to obtain remote access of the web-based GIS application and run the application locally, two issues need to be addressed. Firstly, the host (EPA) and the user (VADEQ) need to have the same system setup. For this case, EPA used ArcIMS and a Cold Fusion server. Virginia used ArcIMS, but did not have Cold Fusion. The second issue regards firewall security. For this pilot project, EPA Region III had discussions with EPA RTP (Research Triangle Park) in North Carolina. One proposal is to request RTP to grant temporary access to one or two DEQ personnel. For a short period of time, DEQ could test the application and make revisions to the GIS application as necessary.

Finding 4. The SiteRank and California Prioritization Scheme have been successfully incorporated into the online geographic information system for pilot prioritization of UST inspections and evaluation of potential MTBE impacts in the pilot areas. The system can also estimate the vulnerability of UST/LUST sites to a specific public drinking water well and shows the potential to expand to private wells, monitoring wells or any sensitive receptor.

Examples of the graphic presentation of the ranking results are shown in Figures 9 and 10. The system can estimate the vulnerability of UST/LUST sites to a specific public drinking well and shows the potential to expand to private wells or monitoring wells or any sensitive receptor. With an adequate amount of available information, there is a potential to expand the tool to identify the potential source of contamination to a drinking water well and to rank the closed LUST sites which will require priority-based state oversight.

Finding 5. Web-based GIS for State UST programs will require establishment of a state centralized data depository. An online readily accessible data repository should result in less duplication of effort and improved communications.

There are already many standardized electronic formats for data collections and management which include a uniform descriptive dictionary of terms. In developing a web-based state UST GIS, these pre-established formats may provide the State with opportunities to review and reorganize their existing data files and design improved data input forms.

With the ability to access the state GIS, EPA can perform GIS-type analysis/assessment without overloading the limited state resources. For example, one can perform such an analysis to “quantify” the potential beneficial effect to the environment and the public health due to the cleanup of a LUST site. This can be done through association of the ground water drinking well and the population it serves and the number of LUST sites within a certain radius from that drinking well.

5. Conclusions and Recommendations

Conclusions

(1) Reported MTBE contamination in ground water was determined to be infrequent in the pilot areas.

(2) This pilot project has demonstrated that GIS is a good tool to graphically display and analyze the potential impact of MTBE releases to known environmental receptors.

(3) The pilot project has demonstrated the need and potential process for establishing a statewide and possibly a region-wide system for the benefit of managing LUST sites and planning

enforcement strategies. The GIS decision tools can effectively link multisets of databases and enable the users to store, collect, retrieve, analyze and display environmental geographic data with relative ease. However, it should be noted that a large scale implementation of this pilot would require a considerable financial investment.

(4) Data can be shared among state and EPA staff over the internet if safeguards are in place.

(5) Current locational data for UST facilities and for public drinking water wells are inadequate for use by state regulators.

(6) Once facility location data have been collected, it is not an unreasonable level of effort for EPA to assist the states in the development of a web-based GIS application for their UST programs. VADEQ, for example, possesses major elements of databases needed for web-based GIS applications.

(7) The pilot project demonstrated that the SiteRank software tool and a state-specific Prioritization Scheme can be successfully incorporated into the online geographic information system for prioritization of UST inspections and evaluation of potential MTBE impact in the pilot areas. The system can also estimate the vulnerability of UST/LUST sites to a specific public drinking water well.

(8) EPA, with contractor support, was able to quickly use the existing UST/LUST database and complete the GIS Arcview project/application for DC UST/LUST Division within two to three weeks time. The GIS application helped the regulatory agencies to decide if precautionary measures would be necessary in response to the “exploding manhole” incidents.

(9) In processing the request from Maryland for characterization of ground water samples, it became evident that revised protocols for sampling and analysis for MTBE and TBA were needed. The collaboration among the workgroup and EPA HQs resulted in establishment of protocol revisions which are included in the EPA Fact Sheet on Analytical Methodologies for Fuel Oxygenates (EPA 510-F-03-001, April 2003).

Recommendations

(1) <u>Continued National Focus on MTBE</u>

Although MTBE was infrequently found in this pilot project, EPA continues to encourage states to monitor for MTBE, TBA and other oxygenates. Given the limited nature of this pilot and EPA’s experience with MTBE outside of the pilot areas, oxygenates in the broader perspective remain a significant threat to ground water quality.

(2) Continued State Collection of Locational Data

Region III recommends that OUST continues to encourage the states to collect locational data for UST facilities and LUST sites so that states may take advantage of the GIS application and tools developed by this pilot project.

(3) Distribution by OUST of the GIS Application and Priority Ranking Tool

The GIS application and priority ranking tools developed in this pilot project are planned to be enhanced by Region III to make them more user friendly and transportable. EPA Region III will then provide the enhanced software package to OUST. It is recommended that OUST distribute the package to interested states. The participating states could use these tools to assist them in increasing efficiency/effectiveness in the implementation of UST/LUST programs.

Figures

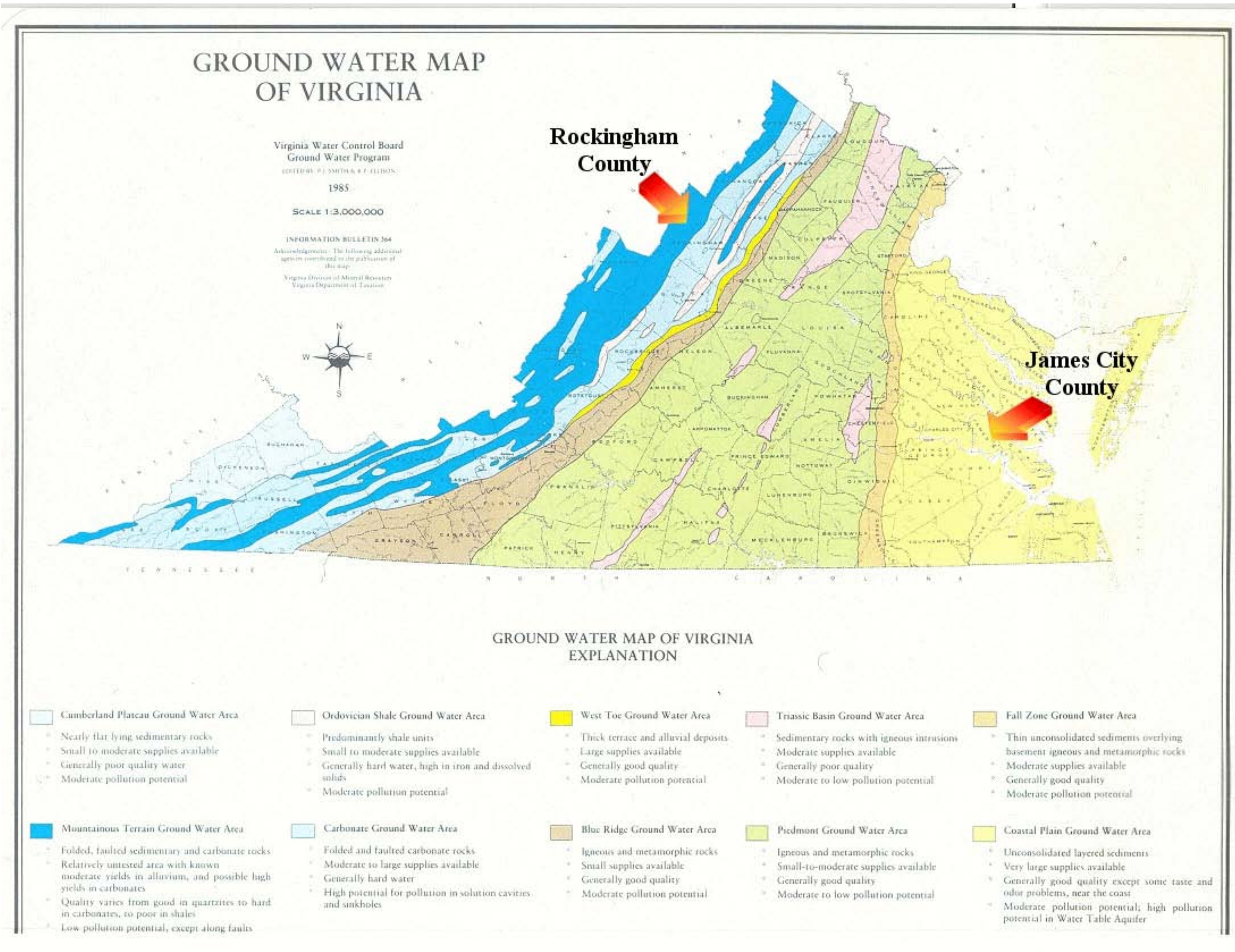


Figure 1: Rockingham and James City Counties are shown on the groundwater map of Virginia.

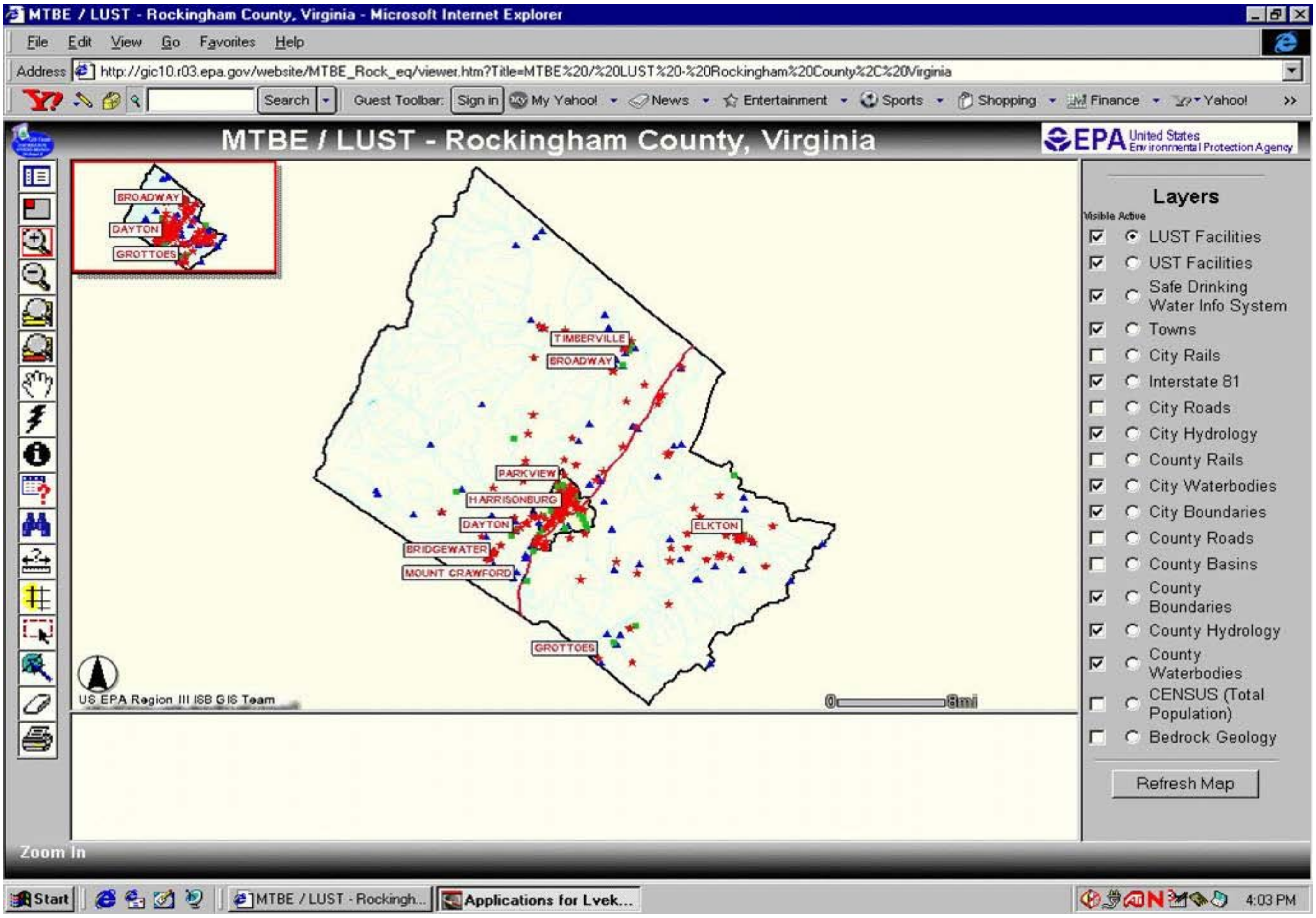


Figure 2: A default view of Rockingham County ArcIMS Application with all Layers(right) and Toolbar with tools for Map manipulation(left).

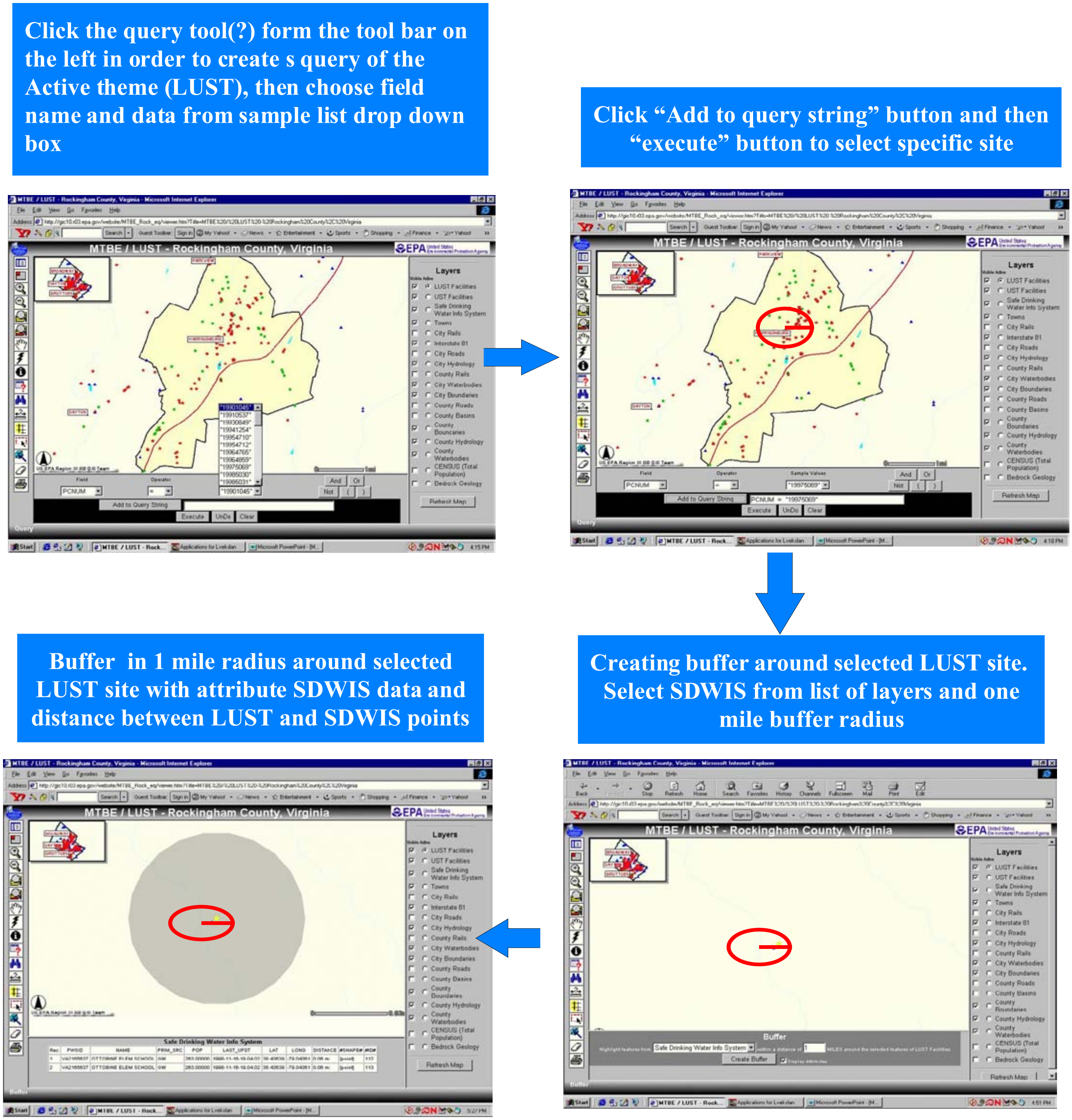


Figure 3: Steps of an online query for a specific LUST Site.

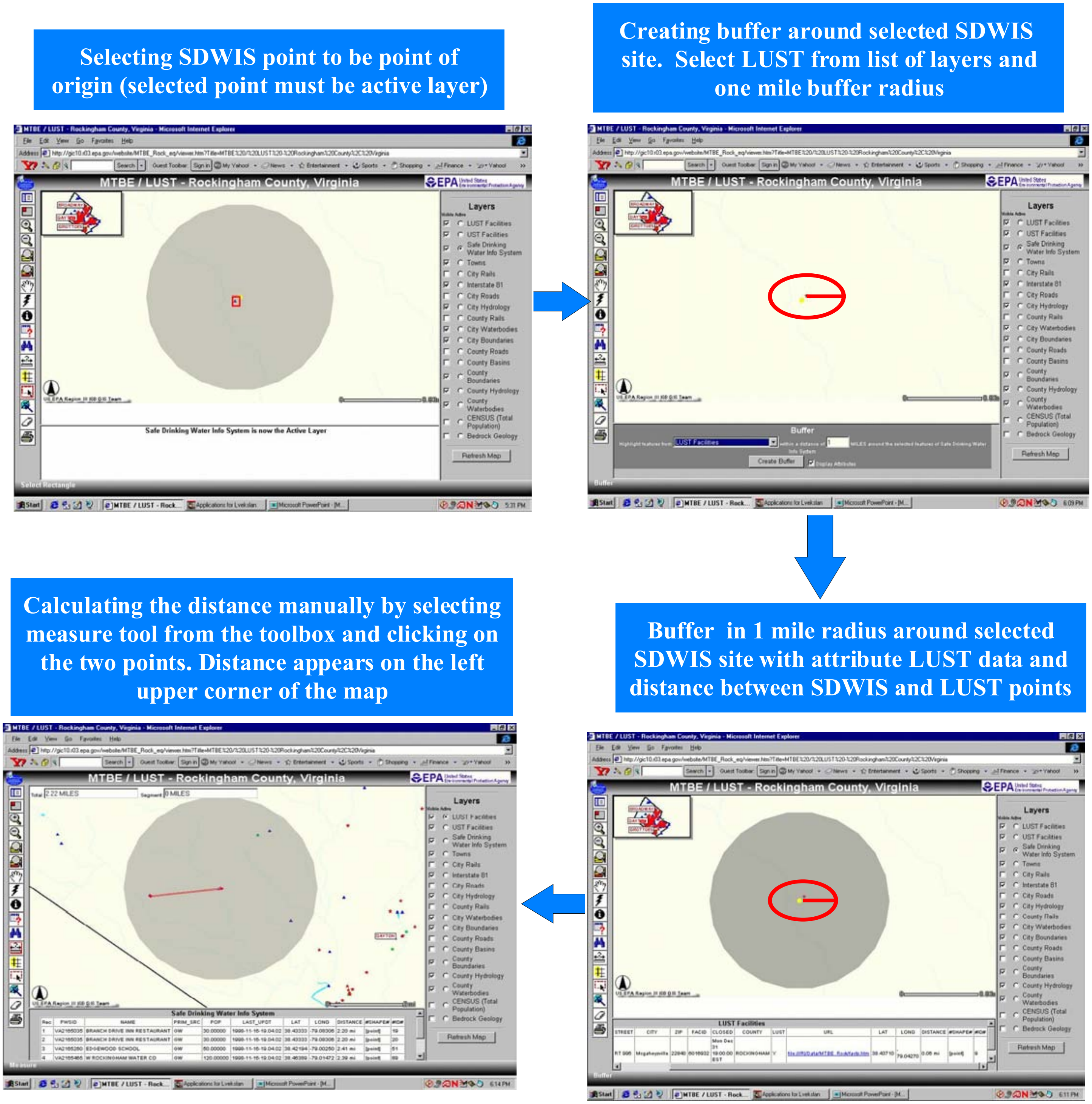


Figure 4: Steps of an online query for a specific well site.

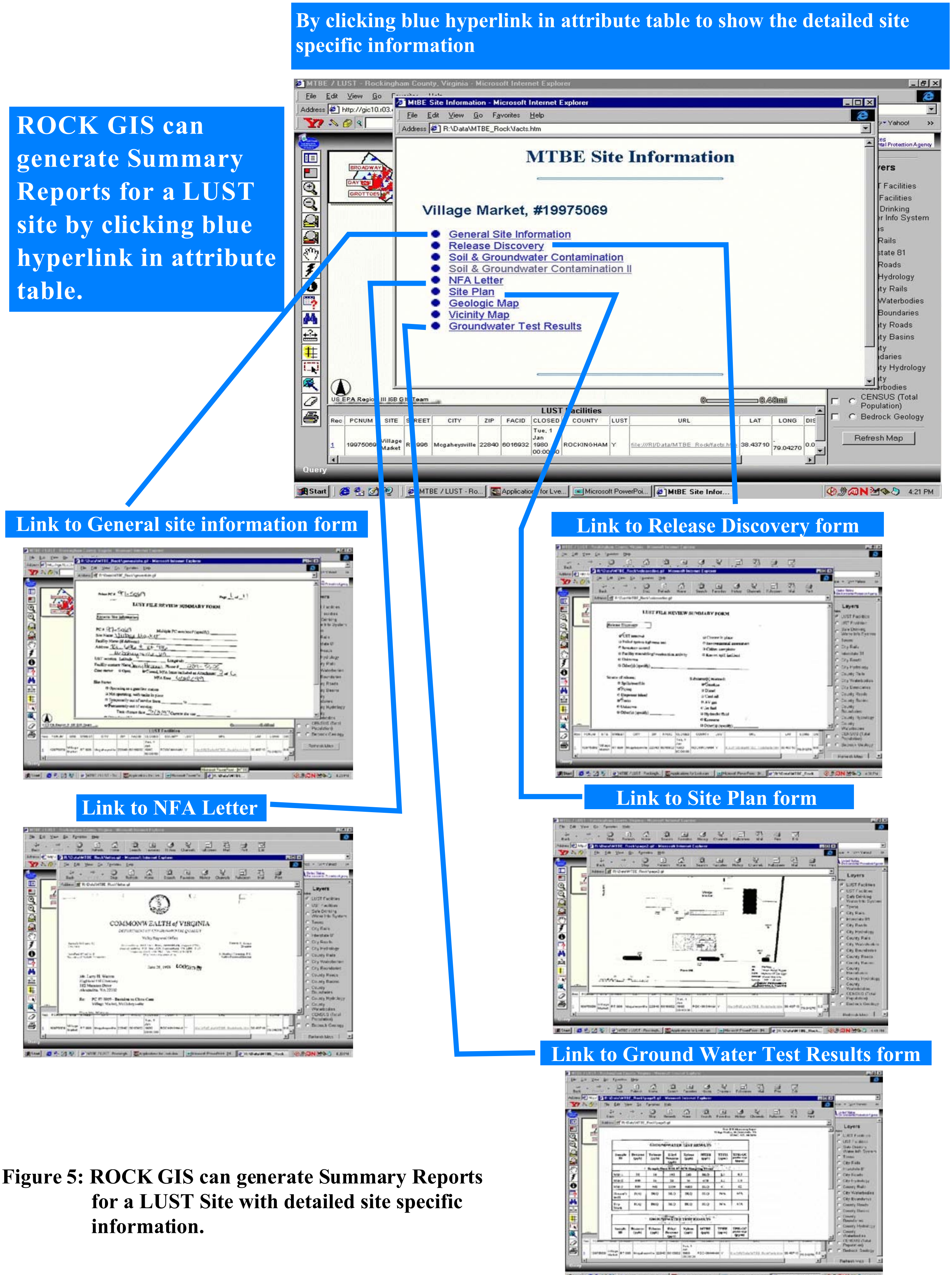


Figure 5: ROCK GIS can generate Summary Reports for a LUST Site with detailed site specific information.

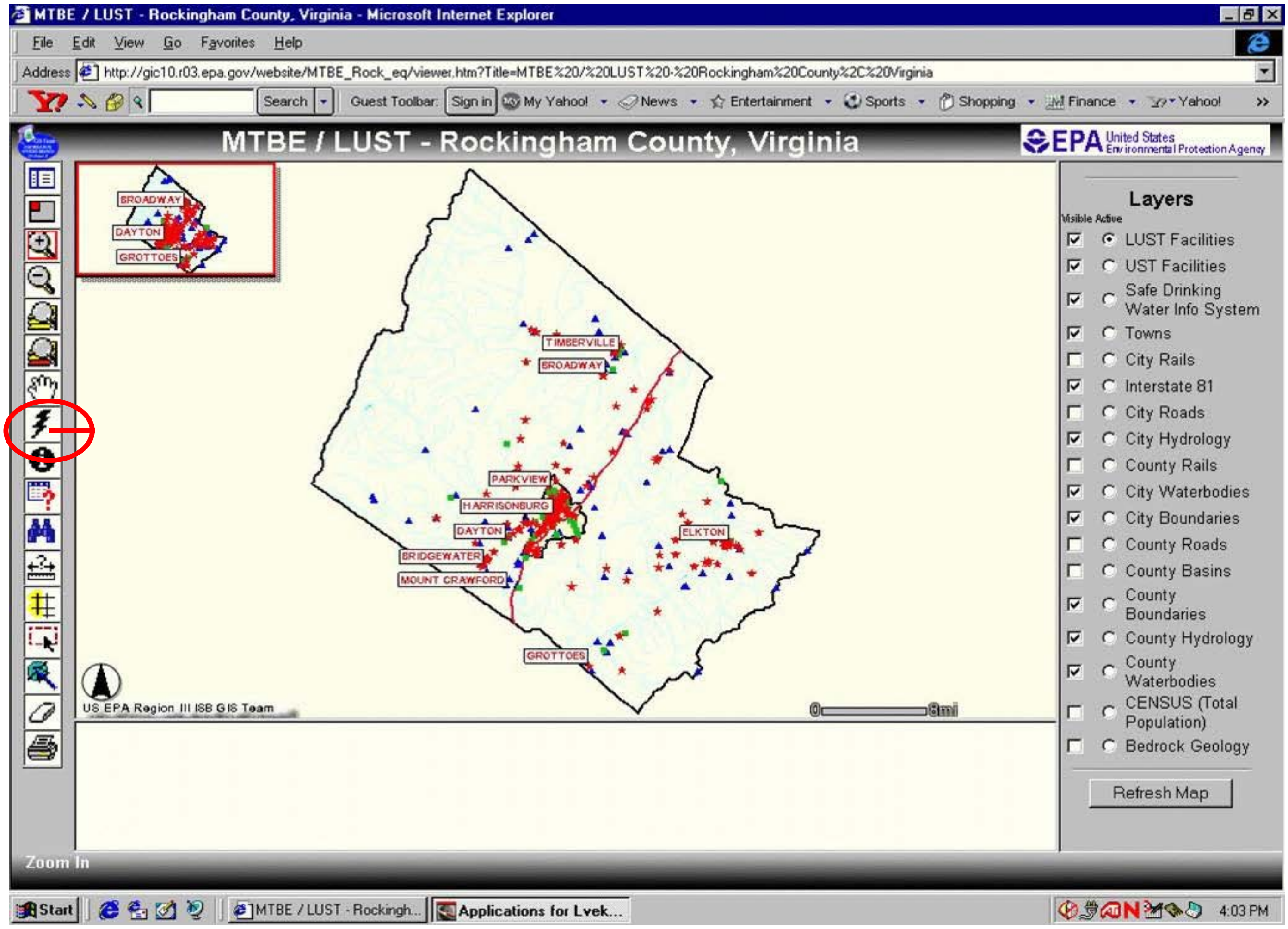
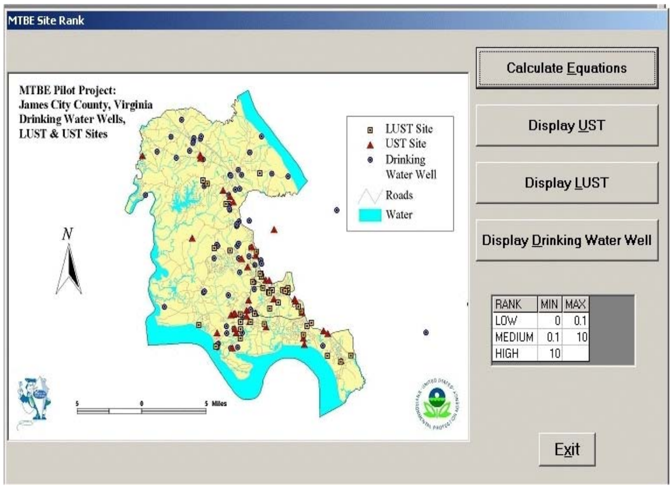


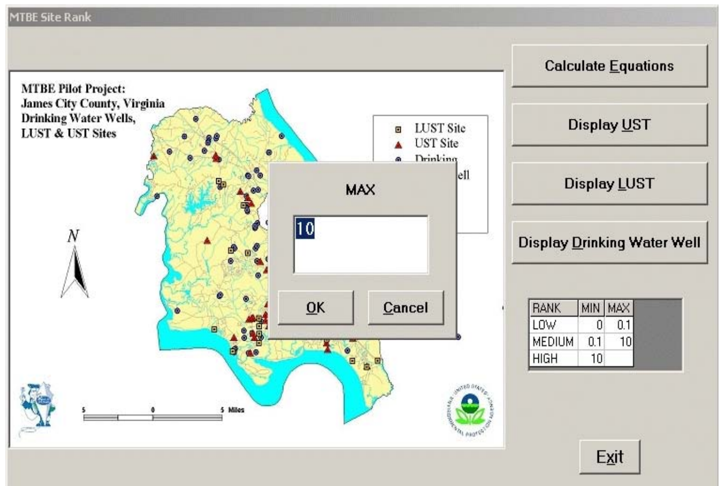
Figure 6: The "Lightning Bolt" icon on the Toolbar provides a useful Enforcement Tool. It creates a Hyperlink to specific State Databases and search for data related to the same Facility ID.

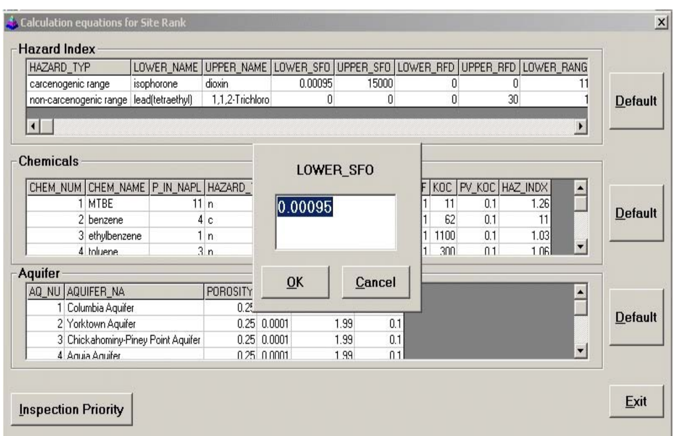
SiteRank Initial Screen



SiteRank - a Vulnerability Ranking Model for Water Wells impacted by MTBE. SiteRank Model overcomes some of the limitations of existing ranking models by combining simplified contaminant fate and transport modeling concepts with information about source proximity to the well within a mathematically consistent framework.

Ability to change Low, Medium, and High Ranking





Ability to change Hazard Index, Chemicals, or Aquifer data

Default Values For Hazard Index, Chemicals, and Aquifer Data

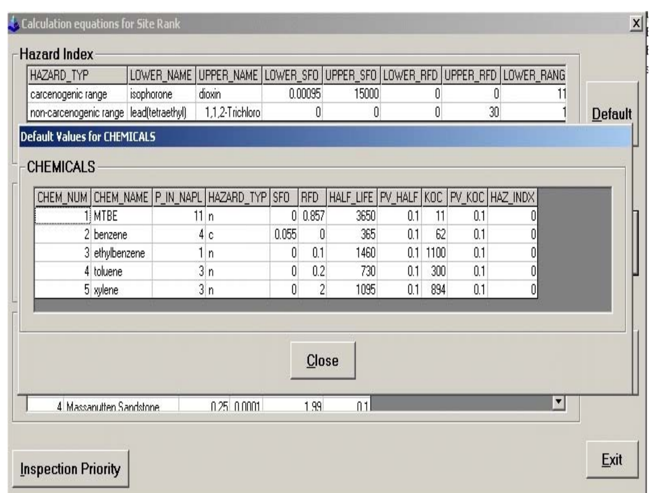
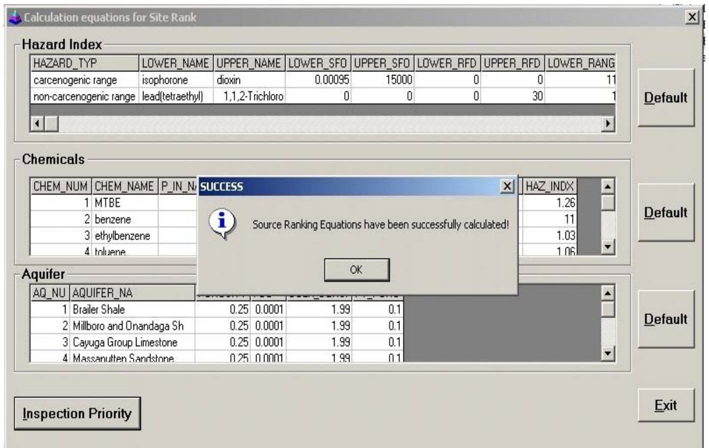
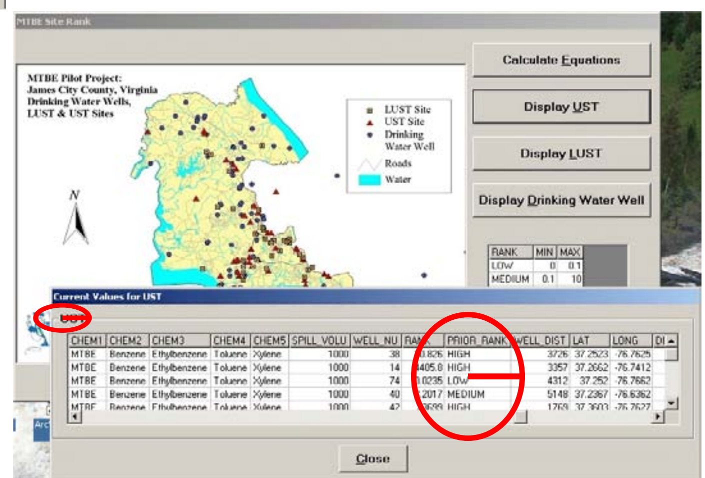


Figure 7: SiteRank -Vulnerability Ranking for Water Wells Impacted by releases from USTs and LUSTs.

Calculating Source Ranking Equations



UST Site Priority Ranking



Well Site Priority Ranking

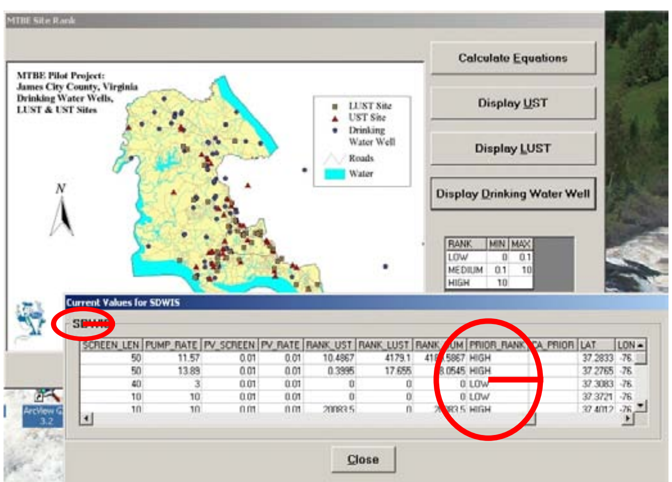


Figure 8: SiteRank - Reports of priority ranking.

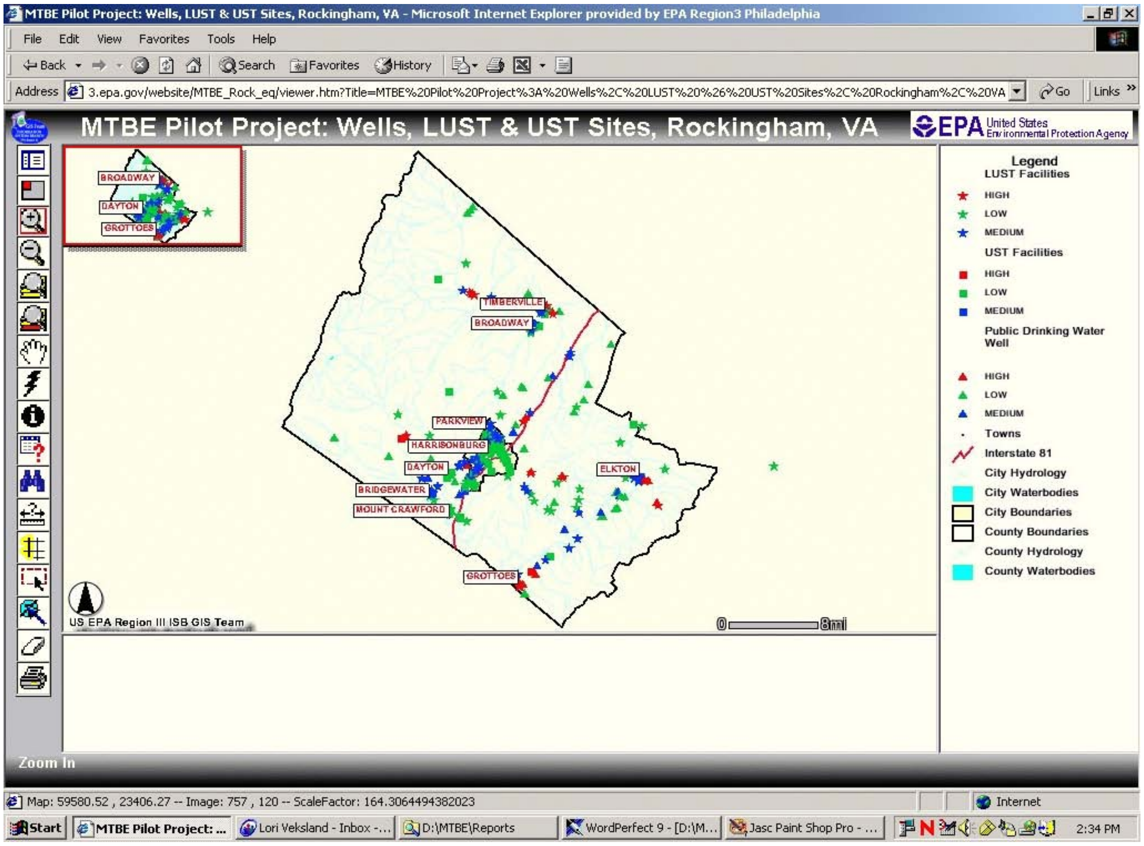


Figure 9: The results SiteRank for UST inspection priority and Drinking well vulnerability for Rockingham County.

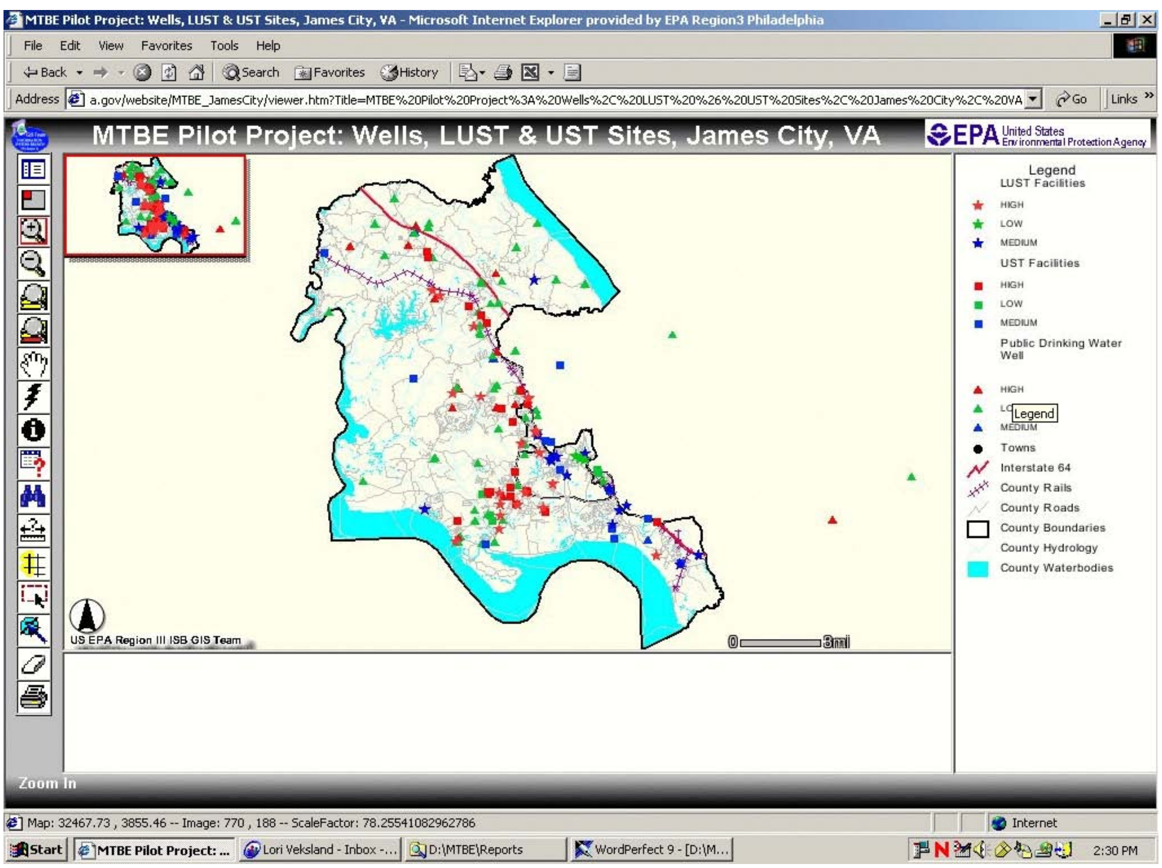


Figure 10: The results SiteRank for UST inspection priority and Drinking well vulnerability for James City County.

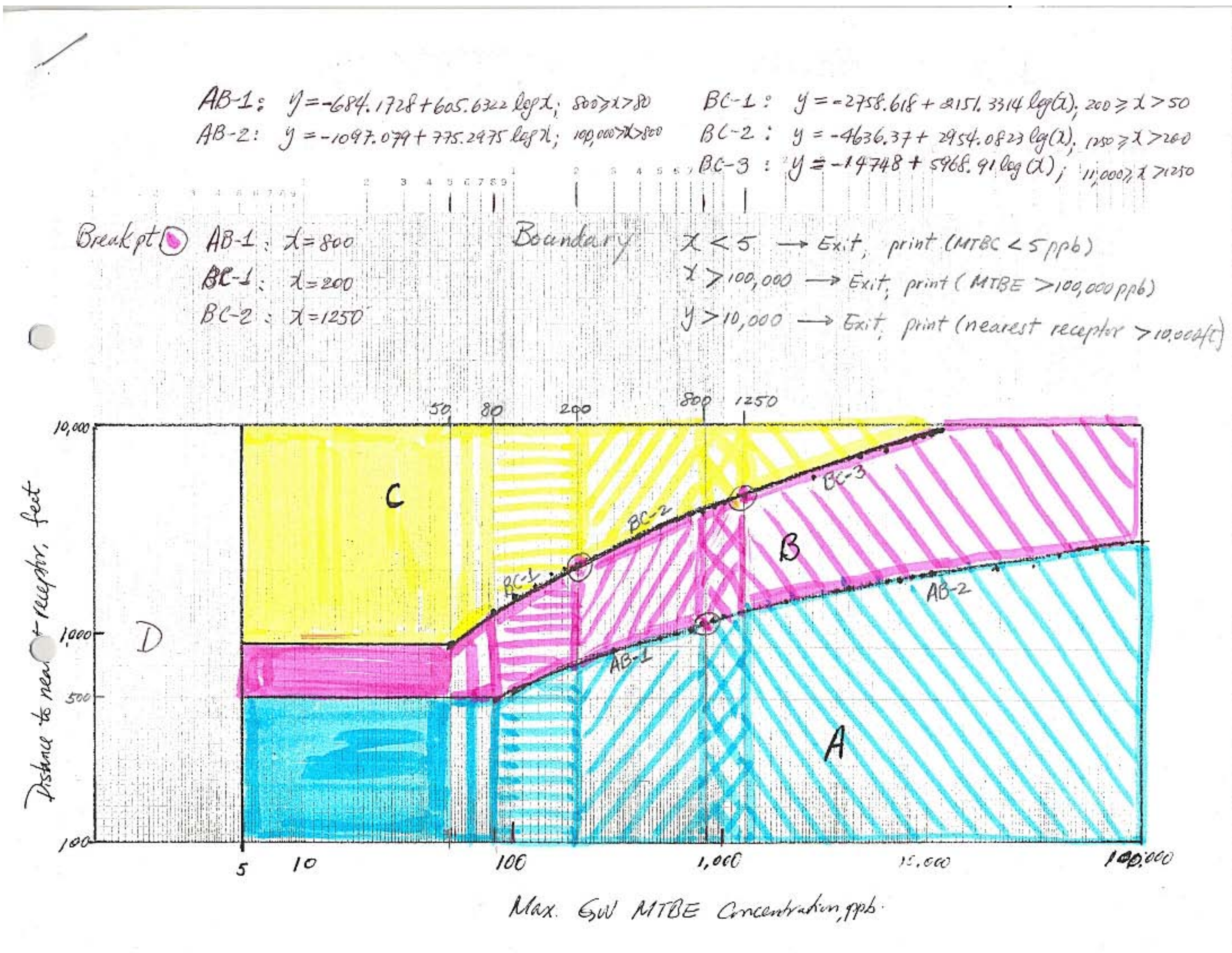
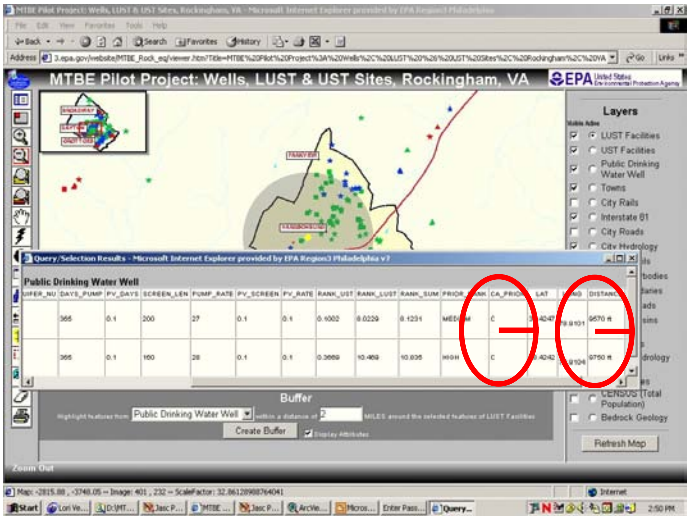


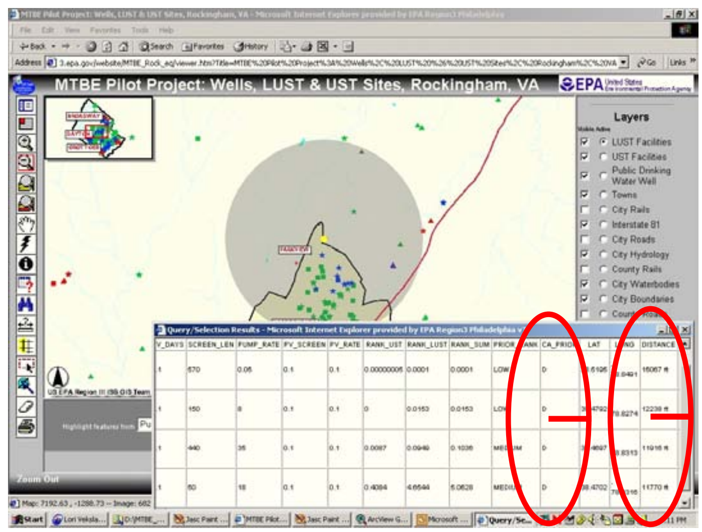
Figure 11: California Priority Scheme.

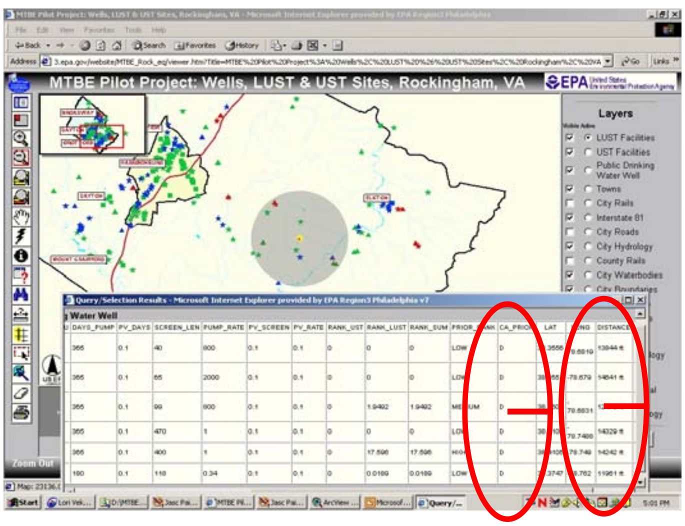


Programming in JavaScript allowed ArcIMS ROCK GIS to:

1. Calculate distance "on-the-fly" inside of specified buffer between LUST Site and Drinking Water Well Facilities.

2. Calculate priority classification for Corrective Action Investigations. Corrective Action Priorities results were incorporated into the Safe Drinking Water Well Attribute Table.





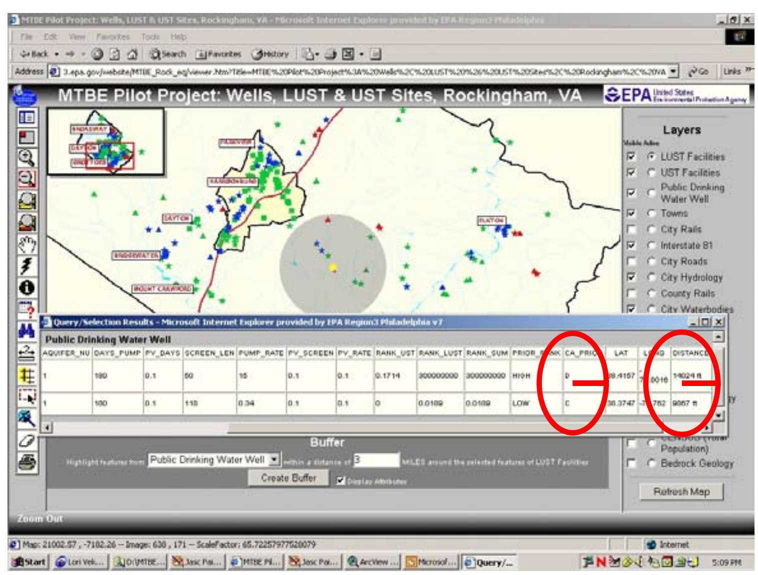


Figure 12: Assigning priority classes for corrective action investigation.

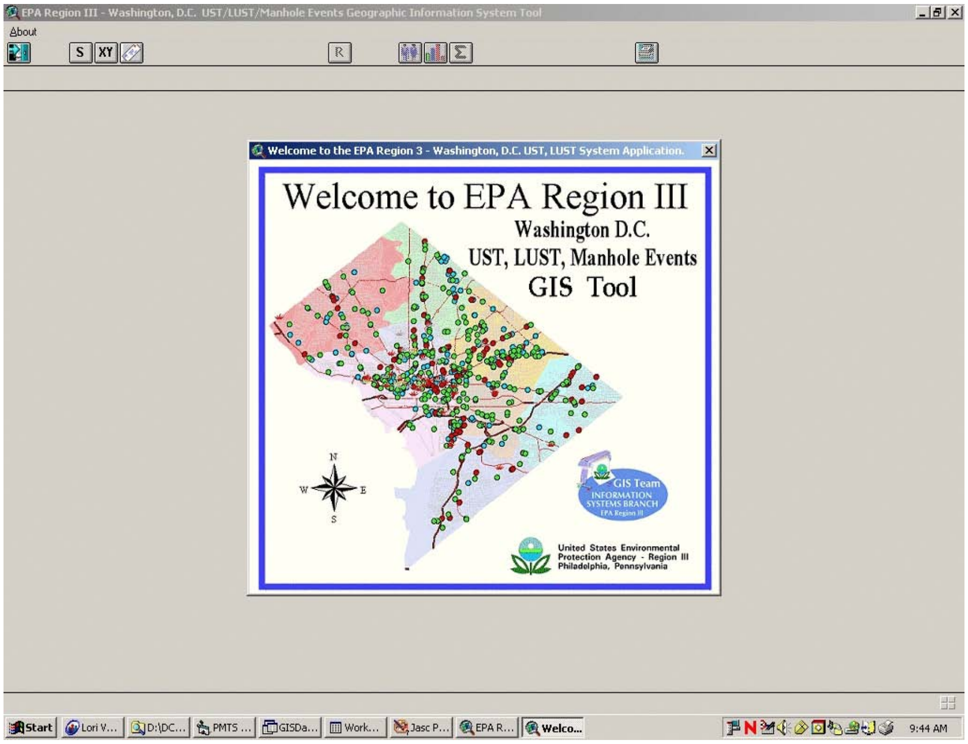


Figure 13: D.C. GIS Application

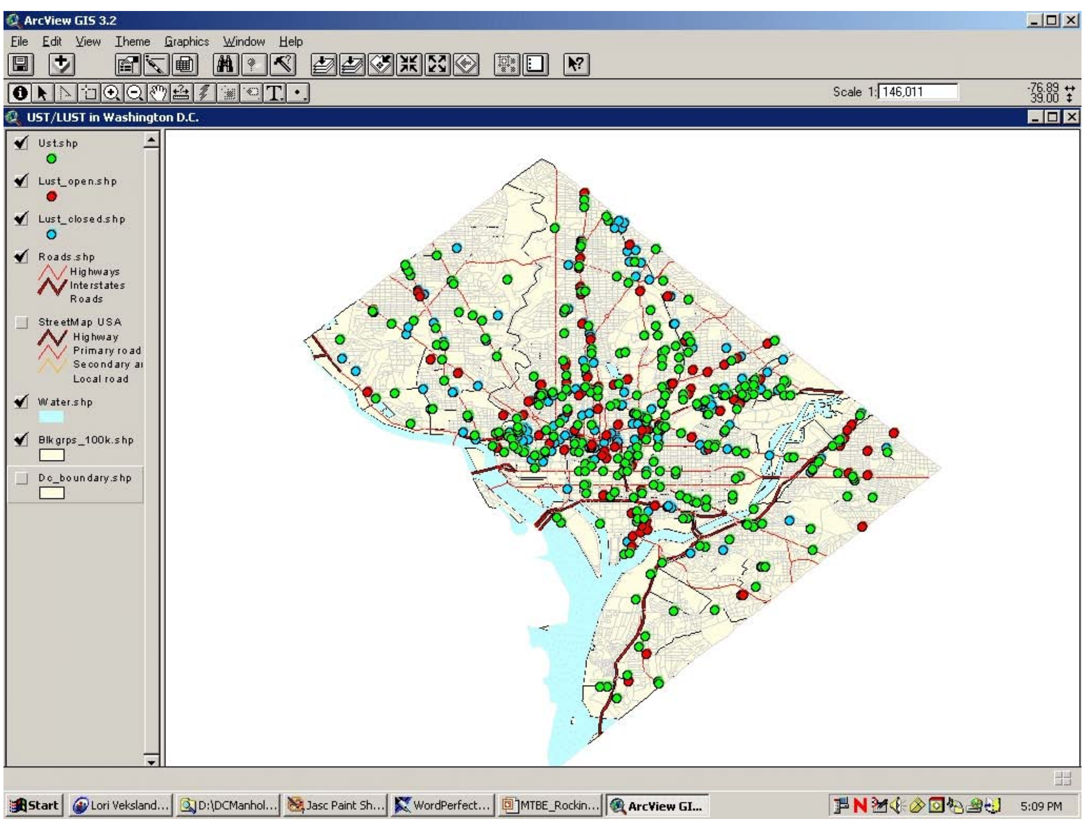


Figure 14: D.C. GIS Project for UST/LUST.

Report on the Mid-Atlantic States' MTBE Pilot Project

Questions and Answers

Q1: Why did Region III undertake this pilot?

A: Because of concerns in California and in other locations across the country with MTBE contamination of water supplies, Region III thought it important to conduct a pilot project to determine the possible extent of contamination in the Mid-Atlantic.

Q2: What did the Region do to check for MTBE contamination?

A: The Region decided to conduct an MTBE pilot study for two counties in Virginia. A sample from at least one well from each of the public water systems (PWS) in the two counties were tested for MTBE, TBA and BTEX. Also, all of the existing LUST site files for these two counties were reviewed to determine if MTBE was present.

Q3: What were the results of the sampling and file review events?

A: The major finding as a result of this pilot project is that MTBE was not found in any of the water samples taken from the 64 public water supplies of the pilot study areas. Based on existing site data, only 10 out of 215 LUST sites in the project areas had MTBE contamination in site ground water; however, not all sites had monitored for MTBE due to the date or nature of the release.

Q4: How were the data organized and used?

A: For LUST sites, UST facilities and PWS wells, locational (latitude/longitude), chemical and hydrogeologic data were organized and incorporated into a GIS application for the purpose of being processed by a risk-ranking tool.

Q5: How does the GIS-based ranking tool ascertain relative risk?

A: The ranking tool was designed to use information about the local aquifer, chemicals of concern, contaminant sources, and PWS pumping rates to calculate risk-ranking values. Chemical properties for MTBE and BTEX, and the parameter values for calculating the cancer risk or hazard index are provided within the application. For LUST cases, sites with higher concentrations of toxic, recalcitrant compounds will be ranked higher and wells with greater numbers of higher ranking sources in close proximity will be ranked as more vulnerable. For UST sites, the tool assumes a fixed release volume which is used to similarly quantify relative risk.

Q6: Can others use the GIS application or risk-ranking tool?

A: While Region III was able to use the application and tool, in its present form, others would need much support to perform similar functions using the existing software package. Region III plans to enhance the application and tool to make them more user friendly and transportable and subsequently provide the enhanced package to OUST for distribution to interested states. The participating states could use these tools to assist them in increasing efficiency/effectiveness in the implementation of UST/LUST programs.

Q7: What other benefits could be derived from this application?

A: While the stated benefits of this GIS application and tool regard risk-ranking, other benefits could be obtained from managing LUST and PWS data in GIS. For example, regulatory agencies could more easily address public requests (FOIAs) for local impacts by pulling information from the GIS application.

Q8: What is schedule to enhance the tool and make the application more user-friendly? What support is needed by Region III for this purpose.

A: Region III plans to address these refinements by the end of FY04 and subsequently forward the enhanced tools to the EPA Office of Underground Storage Tanks for potential distribution. Region III expects that it will be able to perform the general refinements in-house; however, user-interface improvements may require support from outside specialists.

Q9: What support does Region III plan to offer to other states or regions that are interested in developing a similar application?

A: Dependent on resource constraints at the time of a request for assistance, Region III would be willing to help a state/region initiate the development of a similar system