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AquAeTer

optimizing resources | water, air, earth

The AquAeTerian

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AquAeTer News

Steve Wampler recently participated on the Quantitative Risk Assessment (QRA) team that presented a summary of the QRA findings on the West Valley Low-Level Radioactive Waste Disposal Site to the Nuclear Waste Technical Review Board in Buffalo, New York.

GSA Contract Holder
Contract GS-10F-0188X

Congratulations to Christy Lewis, Corporate Marketing Director, on the award of our GSA Schedule for Environmental Services. This was a long waiting process for Christy and her team of helpers. A special thanks to the UT Procurement Technical Assistance Center for their guidance during the process.

The President's Corner

"cyclus vitae"
The Cycle of Life

AquAeTer has been fortunate during the last couple of years to have maintained our staff and have been able to assist our many clients in a variety of projects. Paul Marotta in our Tennessee office has added three new employees including Richard Rogers, Geologist, who is featured in this issue for his ARC-GIS expertise; Ms. Ashley Housley, Project Geological Engineer and Hydrogeologist, who presents an article in this newsletter on three dimensional groundwater modeling; and finally Ms. Natalie Buckley, Administrative Assistant, who will also be assisting with our forensic litigation services. Chris Bolin, Operations Manager for our Colorado Office has added Tyler Berry, Geologist, who will be assisting on the Trust work at the former Kerr-McGee/Tronox wood treating sites and on the Waste Management landfill work.

I would like to congratulate Chris Bolin and Steve Smith in our Montana office on their completion of four published articles on their Life Cycle Assessments of wood products which included greenhouse gas sequestration, energy use, water use and environmental impacts. These assessments were completed for the Treated Wood Council (TWC) and gives the treated wood industry a powerful tool for assessing the positive impacts of treated wood on the environment. The published articles have been peer reviewed by both industry and non-industry technical experts which gives them great credibility. Links to these online publications can be found on our website at www.aquaeter.com/news and shared for use by the industry.

We have several employees who have reached milestones in their careers with **AquAeTer** including: Amanda Alvis, Project Biologist, 5 years; Laura Major, CAD Specialist, 10 years; and Paul Marotta, Operations Manager for Brentwood, 10 years. Profiles of our employees can be found on our website at www.aquaeter.com/company-profile/team. We are thankful, as always, for our clients and our dedicated staff.

AquAeTer has just launched a brand new website at www.aquaeter.com. The website now contains a news section, social media, and many other great features.

Michael R. Corn

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INTRODUCTION

Geographic Information Systems (GIS) have many applications in today's electronic age. Environmental Systems Research Institute (ESRI), the leading provider of GIS software, explains that "GIS allows us to view, understand, question, interpret, and visualize data in many ways that reveal relationships, patterns, and trends in the form of maps, globes, reports and charts." This tool is ideal for a scenario where it is important to display the spatial relationships of one's data.

In the summer of 2008, I was working with **AquAeTer** as an intern providing GIS support on several projects. I was asked to provide GIS support for a project in a coal mining region. As in most projects, it was imperative that we display the results of our research in a way that was easily and quickly understood by the viewer. We were interested in displaying physical addresses and their spatial relationships to historical land use data, background sampling locations, parks and recreational areas, and a specific source of a potential constituent. It was determined that the best way to communicate this information to our client was by means of a GIS geo-database. A geo-database can contain multiple layers of geo-referenced data that can be queried and displayed according to location as well as any other attributes of the feature.

In this project, I was given the task of identifying potential sources of polycyclic aromatic hydrocarbon (PAH) constituents that had been identified in the local community using Sanborn Fire Insurance Maps dating to the late 1800s. These maps are extremely accurate and very detailed in describing historical uses of properties; however, they are delivered to us on multiple letter sized sheets of paper. In order to easily compare these antique maps to modern maps on a large scale, one must devise a way to display the data in a known coordinate system.

METHOD

The ultimate goal was to transfer the data from the Sanborn maps to the GIS project as efficiently as possible. The maps were physically cut out of the pages so that they could be stitched together to create a map that covered a much larger area. Once this had been completed, they were organized to form a timeline series of large scale maps of the town. They were painstakingly examined street by street to identify and mark any land uses that could have produced the PAH constituents found in the soils and sediments. These points were then digitized (transferred to the GIS software) by comparing the location of the point on the Sanborn map to features and landmarks on recent, high resolution, geo-referenced, aerial photography obtained from the United States Geological Survey's (USGS) Seamless Data Server. This was a challenging task due to the changes in street names, rerouting of streets and streams, and the lack of historic landmarks (i.e. buildings, parks, etc.) that one might use to identify a location on an aerial photograph.

The product of this research consisted of a database containing hundreds of point features, "SanPoints," with attributes including type of industry, latitude/longitude, elevation, and the years of operation according to the Sanborn maps. A computer generated map was then created in order to display these points relative to other features. In addition to the point data, select images of the Sanborn maps were scanned in order to be added to the GIS presentation. It was first necessary to geo-reference these image files. Geo-referencing is the process of assigning a coordinate system to a feature by creating reference points that tie a point on the image to a point on an existing map. The image is then adjusted in a process called "rubber-sheeting" so it aligns properly. Because the accuracy of the geo-referencing is dependent partly on the geographic accuracy of the original image, the Sanborn map images aligned almost perfectly.

The historic maps could then be digitally overlaid onto any base map layer including street maps, USGS topographic maps, satellite imagery or even other historic maps. This allows the user to display a translucent historical map over the current aerial photography or simply to swipe one layer away to reveal the aligned image below. Essentially, with the click of a mouse, the user can view and share a time sequenced set of overlaid images that display the changes in the land use through time. A screenshot example of this is displayed in Figure 1.

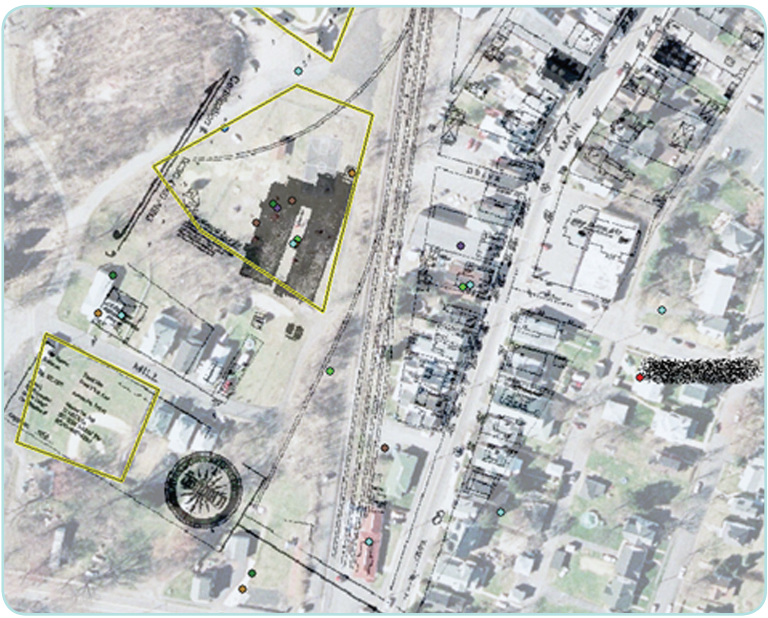

Figure 1. Aerial photo with Sanborn map overlay

OTHER DATA SOURCES

After completing the first phase of the research, I continued to search for other sources of data to support my findings. Another advantage of GIS is the ability to share information electronically. Many federal and state government agencies are using GIS portals to share information by means of internet websites. These websites allow the provider to host databases for the user to download data so it can be used in his/her GIS project. In some cases, a user is given access to connect his/her GIS project directly to the database, thus eliminating the need to download multiple datasets that are not wanted. The ESRI software is now automatically connected to their database where they host a wealth of data including high resolution aerial photography, USGS topographic maps, digital elevation models (DEMs), and Landsat satellite imagery.

I was able to find and procure a multitude of available data that supported my findings. Some data were made available through the state's Spatial Data Access server. The USGS provided the surface geology data through the website of the state's Department of Conservation and Natural Resources (DCNR). These data corresponded with my research, supporting the conclusion that many of the schools, recreational areas and homes had been built in areas that were covered or surrounded by coal mining refuse. The local citizens had been living on and around PAHs at significant concentrations for generations.

CONCLUSION

Through diligent research and analysis of the available information, we determined that, throughout history, there were multiple potential sources of PAHs other than the industrial property. The properties upon which the citizens reside had been surrounded by or built on mining and industrial activities that produced the PAHs found in soil samples in the neighborhood versus an air pathway for constituents with such low volatilities that there was no credible air pathway.

The deliverable product to our client was a GIS geo-database that contained a multitude of data suggesting other more technically-defensible sources for PAHs found in the neighborhood. From this database, we could produce for our client, maps and presentations that displayed the historic land use dating from the late 1800s to the present. The point data, identifying the sites of potential PAHs associated with the coal mining, could be queried according to many attributes including, but not limited to:

1. The location in relationship to a particular location within the city boundaries;
2. The estimated years of operation of an industry at a particular location; and
3. The location's elevation and direction relative to another point or points.

The GIS was also utilized to develop maps that could be used to visually show the client the spatial relationships between the different data that had been collected. In Figure 2, the map displays the location of specific locations within the City relative to identified areas of potential contamination. Each shaded polygon on the map indicates a different source of data identifying that area as a potentially contaminated site. Each yellow point on the map indicates a specific location of interest within the city.

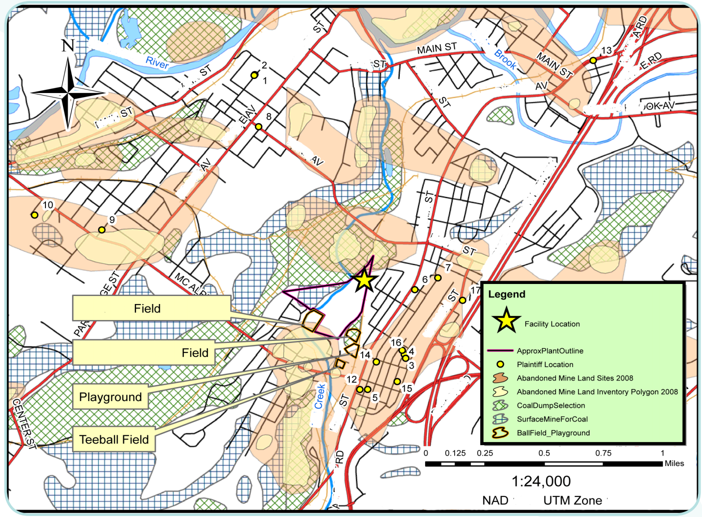

Figure 2. GIS map showing potential areas of contamination

For more information on **AquAeTer**'s GIS capabilities, you can contact Richard Rogers by phone at (615) 373-8532 or by e-mail at rrogers@aquaeter.com.

Richard W. Rogers

Richard Rogers has over five years of experience with GIS Mapping, Data Management and Drafting. Richard received a B.S. in Geosciences from Austin Peay State University in Clarksville, Tennessee.

Based out of **AquAeTer's** Nashville area office, Richard is a Project Geologist whose experience includes water use surveys, groundwater sampling, passive soil gas studies, soil borings and drum sampling. He is also an experienced GIS analyst who has provided support for projects such as surface and groundwater modeling, outfall mapping, and litigation support. Richard has also been involved with Phase I and Phase II Environmental Assessments, as well as data management and analysis.

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ASHLEY P. HOUSLEY

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Ms. Housley is a Project Hydrogeologist and Geologic Engineer based out of our Nashville area office. She received a B.S. in Geological Engineering and a M.S. in Hydrology from the University of Mississippi. During her five years of professional experience she has worked with groundwater and subsurface exploration, groundwater flow models, fate and transport models, landfill permitting and closure, groundwater monitoring and sampling, watershed management planning, groundwater contamination assessments, and water use permitting. Prior to consulting, Ms. Housley reviewed and issued Environmental Resource Permits for stormwater treatment systems. She is experienced in a wide range of software including MODFLOW2000, LAK3, SFR1, MT3D, ArcGIS 9.1, MODRET, PONDS, ICPR, PHREEQC, GMS, Sigma-Plot, and gINT.

Groundwater Modeling to Assess Lake Augmentation

AquAeTer is very excited to have Ms. Ashley Housley as an addition to our technical team. Part of Ms. Housley's prior experience includes work in the State of Florida on a pilot project for the Southwest Florida Water Management District (the District). The District wanted to determine the feasibility of groundwater augmentation to increase surface water levels in Lake Lotela, an 800-acre lake that was experiencing water levels well below the accepted minimum levels set forth by the District.

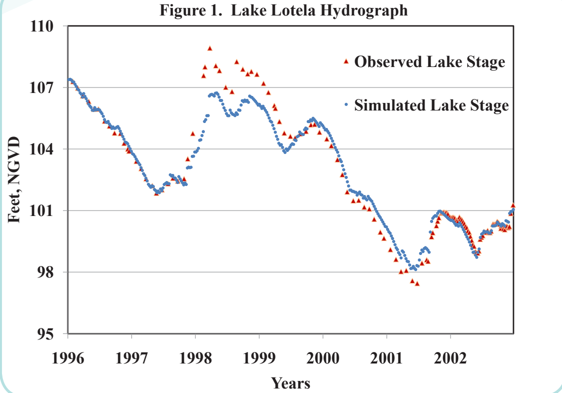
Florida's hydrologic system is stressed due to current groundwater withdrawals. With water needs estimated to increase in the future, state and local governments are working together in an on-going effort to develop alternative water supply sources to replace a portion of the current groundwater withdrawals and help meet future demands. Additionally, the District is developing guidance and minimum lake levels to protect regional lakes from significant harm that may be attributed to groundwater withdrawals.

Lake Lotela lies atop a sand ridge that serves as a groundwater recharge area (and a groundwater divide) in a hydrogeologically dynamic region with numerous karst features. The majority of the lakes along the sand ridges in the area originated by the collapse of sinkhole related features, and many of the larger lakes with sandy bottoms are in hydraulic connection with the underlying upper Floridan aquifer, the main source of groundwater in Florida.

To assess the feasibility of groundwater augmentation of Lake Lotela, Ms. Housley developed and calibrated a transient, three-dimensional, finite-difference MODFLOW2000 groundwater flow model. All directly or indirectly connected upstream and downstream lakes were simulated with the Lake Package (LAK3) and interconnected by streams simulated with the Streamflow-Routing Package (SFR1) for MODFLOW. The Lake and Streamflow packages were linked such that outflow from a stream became inflow to an adjacent downstream lake, or outflow from a lake became inflow to an adjacent downstream stream.

The transient simulation was calibrated to a seven-year time period and covered an area of 132 square miles. The model contained three hydrostratigraphic units vertically discretized into layers which represented the surficial aquifer system, the intermediate confining unit, and the upper Floridan aquifer. The model was divided into 366 stress periods equal to seven days (i.e., weekly stress periods), with one time step per stress period. Daily rainfall and evapotranspiration (ET) data were available for the model time period, as was pumping information for over 600 groundwater withdrawal wells. Lateral groundwater levels used as boundary conditions were taken from a larger regional model widely used by the District.

Figure 1. Lake Lotela Hydrograph



The calibrated model was used to approximate the water budget within the Lake Lotela drainage basin, and an error analysis of the water budget was assessed. The simulated versus observed Lake Lotela hydrograph is shown in Figure 1. The model and water budget were then used to determine the most feasible source of augmentation water, and multiple simulations were analyzed to determine an appropriate augmentation rate and schedule. Since the augmentation rate was designed to not exceed the ET rate, all augmentation water should be returned to the underlying aquifer. This would ensure that augmentation of Lake Lotela would be a benefit to the lake with no adverse impacts to the aquifer.

As a result of the modeling, The District is now armed with the information needed to restore Lake Lotela water levels to accepted minimum levels without causing adverse impacts to already stressed surface waters and aquifers in the area. The model can now be easily modified to simulate water budgets at nearby lakes, or assess augmentation possibilities at other stressed lakes in the area.

With her modeling capabilities, Ms. Housley can assist other water districts throughout the country who are considering additional sources to meet growing demands for water supply. Ms. Housley also has experience modeling contaminant fate and transport with MT3DMS in MODFLOW, which allows simulation of advection, dispersion/diffusion, and chemical reactions of contaminants in groundwater flow systems. For more information on **AquAeTer's** hydrogeologic modeling capabilities, please contact Ashley Housley at (615) 373-8532 or by e-mail at ahousley@aquaeter.com.