

GIS and Environmental Health: Locating Wells for a Groundwater Monitoring Program in Mahoning County

Wesley Vins, Kimberly Vaughn, Matthew Stefanak

Background

Local health departments have often been handicapped by their limited ability to respond to public concerns about drinking water contamination. The cost of water testing is usually too high to allow extensive testing for chemical contaminants and health department staff often lack background information about water quality in the area to determine if water quality has been affected.

The District Board of Health has overcome some of these handicaps in recent years, thanks to a \$200,000 endowment from Browning-Ferris Industries of Ohio and ongoing operational support from the Mahoning County Solid Waste Management District. The Board of Health established a Laboratory Services Division in 1993 to provide timely, accurate, and affordable water and waste testing for public health-related concerns.

A priority objective for Laboratory Services is semi-annual testing of homeowners' water wells in the vicinity of the sanitary landfills that together import almost one million tons of solid waste each year into Mahoning County. Early in the planning process of identifying private water wells for semi-annual monitoring, Laboratory Services contracted with the Ohio Department of Natural Resources (ODNR) to create a well log database at ODNR that allows Board of Health staff to have internet-based access to information about the 10,000 wells in Mahoning County for which well logs exist. The database allows users to identify wells by homeowner name, street address, or political subdivision of the property.

Semi-annually for the last three years, Laboratory Services has been testing about 100 wells within a one-quarter mile radius of the six active and closed landfills in Mahoning County. Water line extensions around two of these landfills have induced a number of homeowners to abandon their wells and connect to the community water supply. The diminishing number of wells used for drinking water in the immediate vicinity of these landfills has prompted the Board of Health to identify and recruit additional well users within a broader radius around the landfills for the groundwater monitoring program.

Environmental health concerns often have important spatial and geographic dimensions. By capturing these spatial dimensions and linking them with other important attributes, geographic information systems (GIS) can be powerful tools for detecting relationships between potential sources of environmental exposure and health effects (Roper, 1999). GIS has previously been employed in other environmental programs at the District Board of Health. GIS maps of positive rabies cases were developed to show the movement of raccoon-strain rabies into Mahoning County in 1997 (Stefanak, 1999). This information helped to determine points for surveillance and the oral vaccine baiting area for the fall and spring bait distributions.

The purpose of this paper is to describe how GIS technology was used to locate and plot water wells within concentric radii around landfill perimeters and prioritize efforts to recruit well owners for participation in an expanded testing program.

Methods

Street address ranges that fell within one mile of the perimeter of each active and closed landfill in Mahoning County were identified from street maps produced by the Mahoning County Engineer. The ODNR well log database was then queried to locate well logs for all water wells within the identified street address ranges. Using the Haines and other local reference directories, the names of current property owners for wells with a well log on file with ODNR were verified and updated if ownership had changed since the well log was filed. The current well owners' names and street addresses were then entered into an Excel spreadsheet. Addresses were matched to address ranges contained in the 1995 Mahoning County TIGER file produced by the U.S. Bureau of the Census. Geographic coordinates (latitude and longitude) and distances from the landfills in quarter-mile increments were assigned to each address in the Excel spreadsheet using a geocoding feature of Atlas GIS Version 2.1 (Strategic Mapping, Inc., 1992) running on a 400 MHz stand-alone personal computer at the Mahoning County Planning Commission. Atlas GIS was used to number and locate the wells within quarter-mile radii around the landfills up to a one-mile distance from landfill perimeters. The well locations were then plotted within quarter-mile radii on maps generated for each of the six landfills.

Service area maps from Consumers Ohio Water Service, the public water supplier serving areas around two of the landfills, were consulted and overlaid with the street address ranges within one mile of the landfills to determine which well owners had access to public water supplies and thus would not be candidates for the expanded groundwater monitoring program. In the final phase, wells in the Excel spreadsheet currently enrolled in the semi-annual testing program were coded to determine what fraction of all wells within one mile of each of the landfills had been tested.

Results

Approximately 127 hours of District Board of Health and Mahoning County Planning Commission staff time during the months of June-August 1999 were required to complete the project. Figure 2 depicts the location of all wells identified around the Central Waste, Inc. landfill in Smith Township. Similar maps were generated with Atlas GIS for the other five landfills in Mahoning County. Table 1 shows the complete inventory of wells located through the project within a one-mile radius of the landfills and the fraction of these wells currently tested by the Laboratory Services groundwater monitoring program. The number of wells within the proposed one-mile monitoring radius (1,142) was reduced by 340 when properties with access to public water supplies were excluded, leaving 802 wells as potential candidates for an expanded groundwater monitoring program. Of these 802 wells, 101 (13%) are currently being tested.

In the course of the project inventory, it was revealed that 3,688 of the 10,325 (36%) Mahoning County well logs on file at ODNR lacked a complete street address. Some of these wells may be located within the inventory area but would have been excluded from our street address range query of the ODNR well log database, resulting in a less-than-complete inventory of wells in the proposed one-mile monitoring radius. In a subsequent agreement with ODNR, Youngstown State University undergraduate environmental studies interns at the District Board of Health were able to complete the street address information for approximately 50 percent of these 3,688 wells using the Haines and other local reference directories. ODNR has agreed to update their well log database with this information and geocode the entire well log inventory for Mahoning County.

Site	Number of Wells Within One Mile	Number of Wells Sampled Semi-annually	Percentage of Wells Sampled
Central Waste, Inc.	80	19	24%
County Land Development Sanitary Landfill	246	20	8%
Hilltop and Crory Road Landfills	339	14	4%
Mahoning Landfill	311	32	10%
Carbon Limestone Sanitary Landfill	166	16	10%
TOTALS	1142	101	9%

Discussion

In 1854, John Snow plotted the geographic distributed of cholera deaths in London and demonstrated the association between these deaths and contaminated water supplies. Modern GIS technology has enabled us to depict spatial relationships between potential sources of groundwater pollution and drinking water sources in Mahoning County

with relative ease and precision. The maps and well inventories generated by this project have been used in presentations at township trustee meetings in each of the townships with a landfill and to the County Solid Waste Management Policy Committee. The compelling visual presentation of this data has helped to reaffirm political and funding support for the expanded groundwater monitoring program. The well inventory database will be used to recruit more homeowners to the semi-annual testing program through letters and phone contacts with homeowners. As a consequence, the District Board of Health expects to increase the number of wells enrolled in the semi-annual testing program by 50 percent by June 2001.

References

1. Roper WL, Mays GP. GIS and public health policy: a new frontier for improving community health. *J Public Health Management Practice*, 1999, 5(2), vi-vii.
2. Stefanak MA, Vaughn KA, Shaheen JF. Positive raccoon-strain rabies in Mahoning County, Ohio, 1997. *J Public Health Management Practice*, 1999, 5(2), 33-34

Wesley Vins, RS, is a Sanitarian at the Mahoning County District Board of Health, Youngstown, Ohio. Kimberly Vaughn, MS, is GIS Administrator at the Mahoning County Planning Commission, Youngstown, Ohio. Matthew Stefanak, MPH, RS, is Health Commissioner of the Mahoning County General Health District, Youngstown, Ohio.

INSET MAP

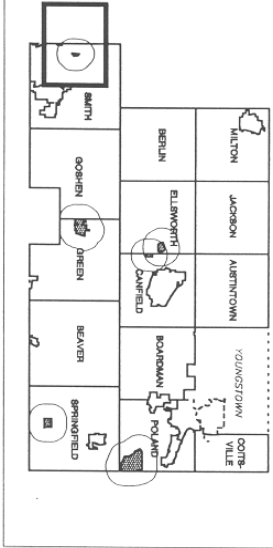
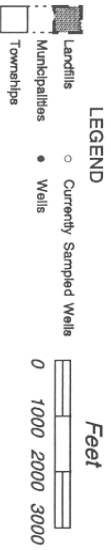
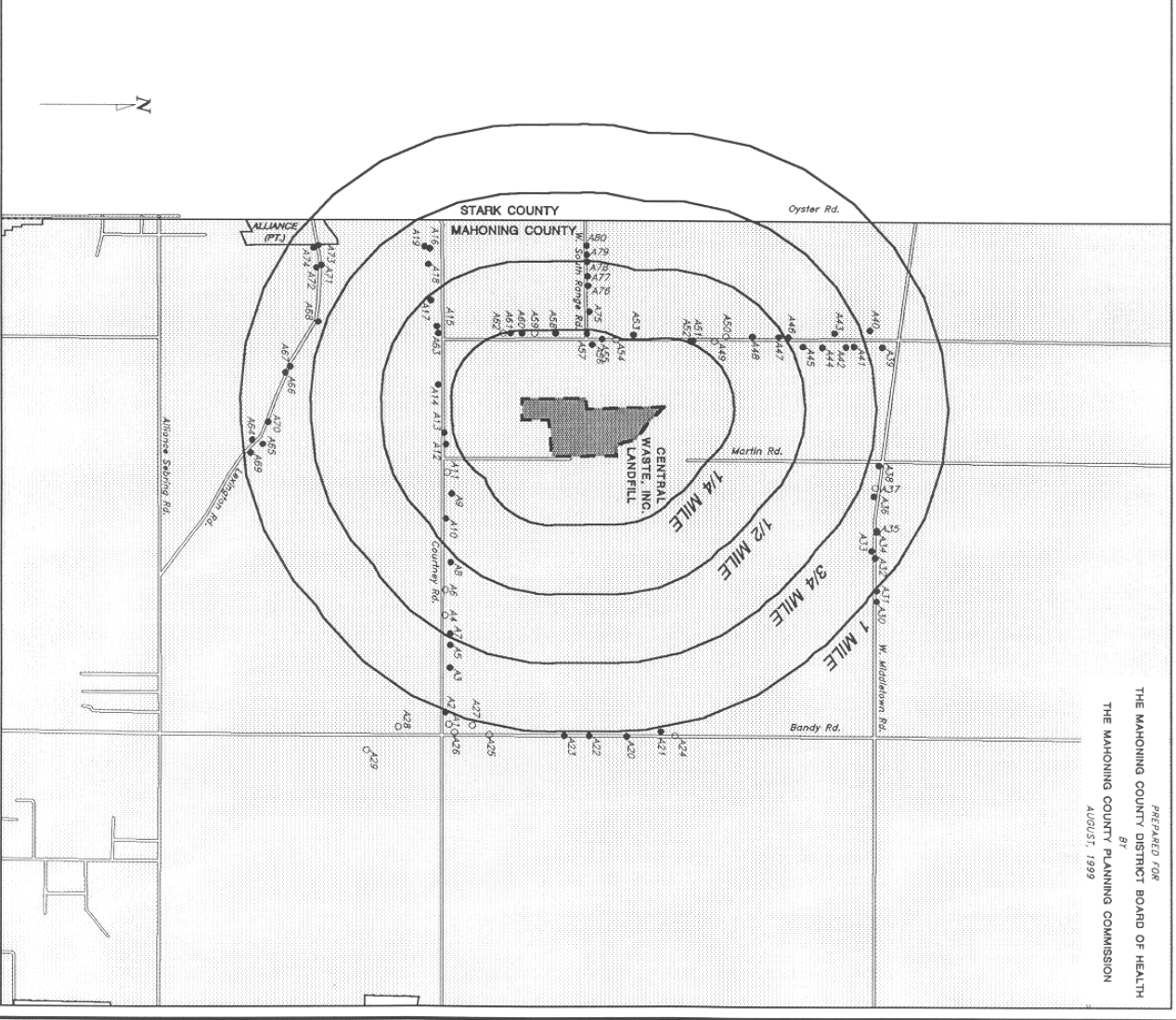


Figure 2.
Mahoning County District Board of Health
Residential Well Inventory
8/17/99

Site: Central Waste Inc. Landfill



SOURCES: U.S. Geologic Survey Topographic Mapping, 1985.
 Mahoning County District Board of Health, 1999.



PREPARED FOR
 THE MAHONING COUNTY DISTRICT BOARD OF HEALTH
 BY
 THE MAHONING COUNTY PLANNING COMMISSION
 AUGUST, 1999