Status of Mapping in West Virginia for Public Water and Wastewater Infrastructure

By Lewis Baker, August 8, 2007

Purpose

This report was written to fulfill the requirement for a one hour Independent Study course under Dr. James Leonard of the Geography Department at Marshall University, summer of 2007.

Acknowledgement

During the writing of this paper I interviewed numerous professionals, listed as references at the end of the paper. They were generous with their time and advice. Any omissions or errors are my own.

Introduction

This paper briefly explores the status of mapping of West Virginia's water and wastewater infrastructure, where gaps exist as well as the opportunity for major improvements via Geographic Information System (GIS) technology.

There is no question that our modern society is supported by its basic infrastructures, none more important than our public water and wastewater systems. It is also a given that important physical structures such as these should be properly operated and maintained, and one key element of this infrastructure's O&M are storage and access to its maps, engineering drawings, schematics, etc.

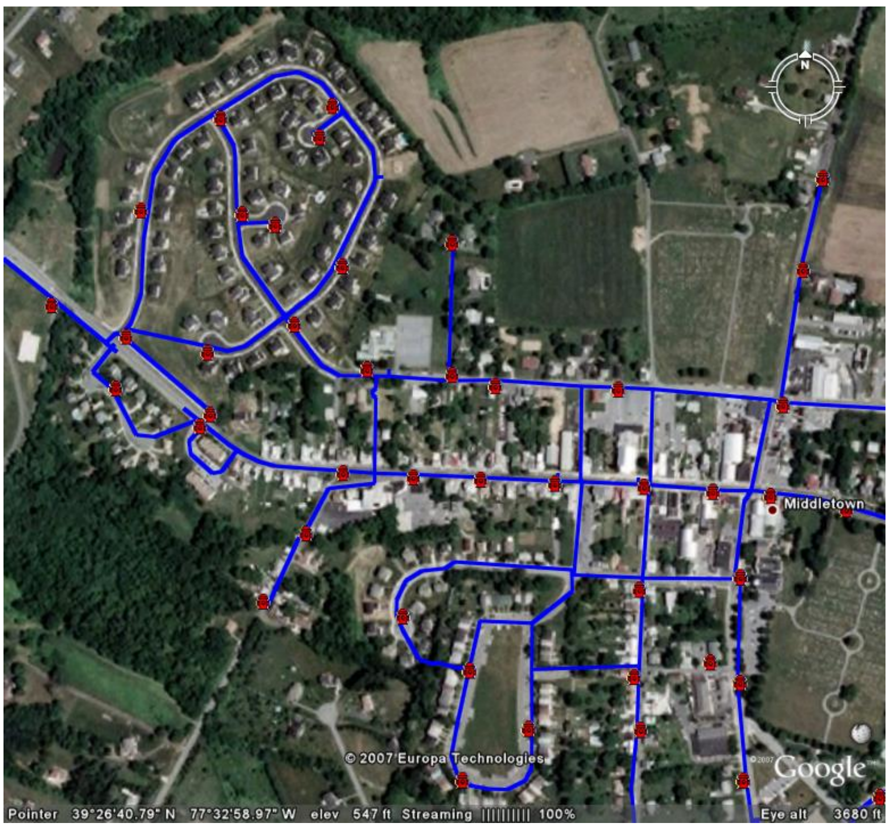
Some of the state's largest water and wastewater utilities manage up-to-date records with computer databases and computerized mapping. These utilities and their engineering firms may use Computer Aided Design (CAD) systems in this effort, and when their CAD drawings are properly geo-referenced they can be uploaded to a GIS for mapping.

Many, if not most, of the state's water and wastewater utilities rely on their engineering firms to provide CAD drawings for proposed water or sewer projects. These are usually paper copies, and may be kept by the utility offices for future reference. As a project reaches completion, invariably any number of modifications must be made from the original design. Unfortunately, many of the utilities do not obtain copies of the "as-built" drawings from their engineers, which should certainly be added to the utility's records.

Too often a water or wastewater utility office will discover its paper maps and drawings are seriously out-of-date or incomplete, or even nonexistent. This problem may be related to turnover of employees at the utility (or at the engineering firm if it keeps the records) who were responsible for an infrastructure that was built over many decades. Sometimes the records may get lost due to "acts of God", such as fires or floods.

In West Virginia there currently is no known organized state-wide effort to address the gaps in mapping of vital water and wastewater infrastructure. This paper briefly explores the costs and benefits of such an effort, and some other states where this is being done.

Discussion



An example of an infrastructure GIS map. It is from Applied Digital Mapping, for Middletown, Maryland, and may be found as a demo on Google Earth. Water lines are in blue, and hydrants are in red. The base map is color aerial photography. Detailed mapping of each water and wastewater system could be labor intensive, but may be sped up by scanning in existing maps, importing CAD drawings, working from aerial photos, and GPS locating hydrants, manholes, etc.

West Virginia – American Water (WVAW), the largest public water provider in the state certainly recognizes good record keeping can support more than the operation and maintenance of its existing infrastructure. It also supports planning for the future. As was stated in a report for the Appalachian Regional Commission (Drinking Water and Wastewater Infrastructure in Appalachia), "WVAW maintains a detailed database of potential service areas and line extensions to prioritize and plan its line investments."

GIS mapping of individual utilities may serve those utilities fairly well, for their own needs, however relatively few public water and wastewater systems in West Virginia have GIS mapping of their own. Any computerized mapping that does exist for most of these systems is likely to be stored as CAD files at engineering firms, and may be limited for recent projects on portions of the utility's infrastructure.

Smaller utilities in West Virginia could also benefit from a GIS. County and regional planners, as well as state and federal funding agencies, could work more effectively with the smaller water and wastewater utilities in planning new projects to serve the most new customers while minimizing overall project costs.

There are many benefits to having up-to-date, readily accessible information. The costs involved in creating statewide mapping for water and wastewater systems would no doubt be greatly outweighed by the benefits. The mapping effort will, of course, need to be carefully planned and coordinated so as to be useful to many agencies and stakeholders. Its benefits should also begin to materialize as quickly as possible.

In an emergency, quick access to good information is critical. Federal agencies such as Federal Emergency Management Agency and the Department of Homeland Security recognize this and have developed a GIS for emergency planning and response called Hazards-United States (HAZUS).

If, for example, a toxic or explosive chemical spill threatens a public water supply or sewer system, an effective response would be time critical. When hours or even minutes may make the difference, time should not be wasted locating the relevant intakes, valves, manholes, pump stations, etc. Data files for water and wastewater infrastructure are available in HAZUS for some states, but not yet for WV.

Local planners and emergency responders recognize the need for GIS mapping. The WV Statewide Addressing and Mapping Board (WVSAMB) has been working to implement an enhanced emergency calling system, or E 9-1-1, which will map coordinates for every residence and building in the state, matching the phone numbers against map coordinates for these locations.

An initial statewide GIS of West Virginia's water and wastewater infrastructure could be relatively quickly constructed at minimal cost by building upon the E 9-1-1 address matching system. Unfortunately, there have been some delays and controversy in completing the E 9-1-1 mapping. Hopefully any problems will be worked out quickly.

The E 9-1-1 aerial coverage is currently available online, with local roads and streams digitized and labeled. Global positioning system (GPS) map coordinates are being gathered for the state's buildings, as well as locations for key emergency items such as fire stations, fire hydrants, dry hydrants, and fire ponds.

The immediate need for this data is for enhanced emergency response. Secondary uses could be many. One use would be to provide documentation that many, if not most of the state's buildings are close enough to fire protection infrastructure to qualify for greatly reduced insurance rates. Another use of E 9-1-1 data could an initial mapping of water distribution systems.

Public water utilities could draw in their water lines along the appropriate routes, connecting the lines to fire hydrant point locations. Service areas could be quickly drawn as buffers zones of appropriate width along these water lines and around the addresses of their customers. Wastewater systems could create similar maps of their collection lines if manholes were GPS located (not currently part of E 9-1-1), and their service areas drawn as buffer zones along these lines and around their customer's building addresses.

Efforts by the state's Division of Environmental Protection (WVDEP) and watershed associations (such as the Upper Guyandotte Watershed Association) to map sources of water pollution in un-sewered areas (such as failing septic systems, straight pipes, and home aeration units) would be aided by the creation of up-to-date wastewater service areas maps.

Kentucky once again provides a good example, where citizens in the KY PRIDE non-profit association may obtain maps from KIA WRIS for current and proposed wastewater service areas. In turn, KY PRIDE's members map failing septic systems and straight pipes, and provide this information to KIA WRIS for use in wastewater project prioritization.

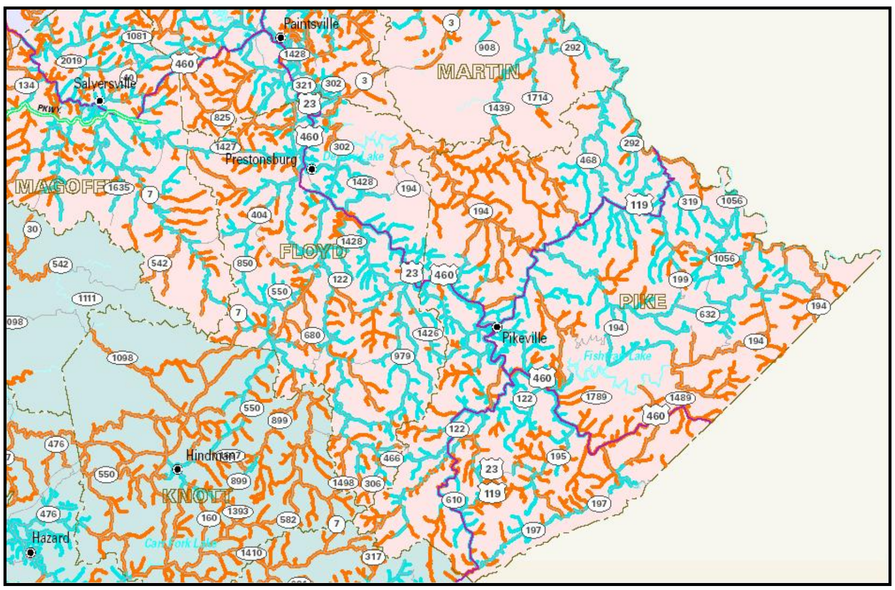
Currently, some of the US Census data being used in West Virginia for new watershed protection plans, emergency contingency plans and infrastructure project proposals is out-of-date and imprecise. Statewide, up-to-date mapping of the existing water and wastewater infrastructure could help improve the usefulness of these planning efforts.

Census data is available for the number of households served by public water and sewer, down to the census tract (neighborhood) level, and it is used in many of the new plans. Unfortunately, this data was collected in the 1990 census (not since), and the tracts (large, odd shapes in rural areas) do not conform to utility service areas or watersheds. Even an initial GIS built upon the E9-1-1 system could improve these planning documents.

A very robust and ultimately a more useful infrastructure GIS would go beyond the current E 9-1-1 mapping effort, and would incorporate detailed "as-built" mapping, based on engineering drawings and surveyor's measurements, as well as databases of materials, capacity of pipe for flow, maintenance history, etc. A good example of a more robust statewide GIS for WV’s water and wastewater infrastructure is found in the state of Kentucky.

The Kentucky Infrastructure Authority’s Water Resources Information System (KIA WRIS) is well organized and operated. It was authorized by legislation signed by Governor Patton in 1996, which also established an overall goal of providing s water and wastewater services to all of Kentucky’s citizens by 2020.

The KIA WRIS depends heavily on the GIS staff at each of Kentucky’s 15 Area Development Districts (ADDs). The ADDs are similar to WV’s Regional Planning and Development Councils (RPDC). Region One RPDC in Princeton, WV has begun developing GIS coverage of water and water systems, and hopefully this can be duplicated, and coordinated, across West Virginia.



This is a portion of a statewide map of Kentucky’s public water supplies, from 1999. Existing and proposed water lines (light blue and orange, respectively) are depicted. Kentucky’s eastern coalfield counties are shown here.

In Kentucky the ADDs’ GIS staff use recent aerial photography for base maps, and have digitized road centerlines. They have also input water and wastewater infrastructure using a variety of information sources. This infrastructure was digitized from old paper maps, and even utility employee’s personal knowledge. Over time, KIA’s WRIS is improved by importing precise CAD files of the “as-built” infrastructure from engineering firms, who in turn may benefit from digital down-loads.

In Kentucky the engineering firms are required to submit “as-built” CAD files to KIA WRIS. In West Virginia, engineering firms may submit CAD files to state agencies, but there is no requirement.

West Virginia's Environmental Engineering Division of the Bureau for Public Health (WVBPH) does keep an archive of water and wastewater infrastructure mapping, going back to the 1940s. This archive stored primarily on micro-fisch films, with few digital files, and is mostly for proposed projects rather than "as-builts". Still, whenever there are no other readily available maps, these are indispensable.

Whether engineering firms in West Virginia will support a requirement to provide digital "as-built" files may depend in part on proprietary considerations for their work. If so, how ever this was already addressed in Kentucky may be a guide for West Virginia.

It will take a concerted effort by interested stakeholders in West Virginia to reach a consensus on the technical aspects involved in a workable statewide GIS coverage of the water and wastewater utilities. One important aspect is the quality of the mapping information input to the GIS, so that the precision with which various infrastructure items were drawn is documented. This "metadata", or data about the data, will document the who, what and how regarding various sources of map information.

This is important, and should be worked out early on. Initial mapping efforts may be imprecise, relatively inexpensive and yield quick results. More accurate and more detailed mapping may be brought in over time, but it is very important to recognize the amount of inaccuracy which was acceptable in each dataset. Some mapping errors may be avoided, by not assuming data from different sources is all of the same quality. Attention paid to GIS details, such as metadata, will help minimize costs over time.

The cost of creating a WV WRIS has been guessed to be "measured in six figures", or more. If so, where should the money come from? To the extent possible, the cost and time to implement should be minimized. Therefore, building upon the E 9-1-1 system may be a wise beginning. In 2003 Verizon provided $15 million for the project through an agreement with the state Public Service Commission (WVPSC).

To go well beyond the current capabilities of the E 9-1-1, to a GIS similar to Kentucky's, may require certainly additional "six figures" to begin, plus significant monies for its maintenance and improvements over time.

Beyond the remaining funding for E 9-1-1, the expenditure of which is no doubt already accounted for, additional funds could come from the state's general revenue. If so, each million dollars would average approximately $1.20 in taxes from each West Virginia household, or about 10 cents per month.

If monies were raised from a surcharge on existing customers of public water and wastewater utilities, each one million dollars for a WV WRIS would add approximately 7 cents per month to those bills. (This figure is based on an estimated 80% of households having public water and 60% or more having public wastewater.)

Another source of monies could be similarly small surcharges on agency funding for new projects, although this money goes primarily to publicly owned utilities rather than privately owned ones. Other sources of funding could include grants from federal programs or private foundations concerned with protecting the environment, public health, or public security.

Conclusions

In West Virginia there has been relatively little progress in statewide GIS mapping efforts for its water and wastewater infrastructure. The sooner this gap in the state's GIS mapping efforts is addressed, the sooner real benefits may be realized.

In West Virginia, the E 9-1-1 GIS may be a vehicle for quickly standing up an early version of a statewide GIS for the water and wastewater infrastructure. Kentucky's WRIS may provide a good model for a more robust GIS to be built over time.

Early benefits could include enhanced emergency response or even public security, when public water or wastewater service is an issue. These utilities should realize reduced costs over time, as improved record keeping allows for better preventive maintenance programs. Planning and funding agencies should be able to more effectively prioritize new water and wastewater projects. Environmental and drinking water protection efforts by the agencies, utilities and citizen groups could be enhanced by having access to up-to-date mapping of public water and wastewater systems. Public water customers could benefit by reduced fire insurance rates, while customers of both public water and sewer systems could benefit from cost savings over time at their utilities.

References

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In addition to personal communications during August, the following documents were referred to:

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http://www.ugwawv.org/downloads/UG_WBP_07_06.pdf

West Virginia E9-1-1 Addressing Reference Guide (Draft), West Virginia Statewide Addressing and Mapping Board, July 2006
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Counties Waiting for GPS Devices, by Rusty Marks, Charleston Gazette, June 26, 2007
http://sundaygazettemail.com/section/News/2007062521

Kentucky Infrastructure Authority, Water Resources Information System website, http://kia.ky.gov/wris/, accessed August 6, 2007

Applied Digital Mapping's example of a municipal water and wastewater infrastructure GIS, ADM Muni Demo file can be shown on Google Earth. To download Google Earth® go to http://earth.google.com/download-earth.html (recommend using Version 3)

Kentucky's non-profit association Personal Responsibility in a Desirable Environment, KY PRIDE's website is at http://www.kypride.org/

US EPA's Safe Drinking Water Information System (SDWIS) has population served data per water supply. It indicates 1.4 million citizens (80% of state population) were served by community public water supplies in 2005.

WV DEP's National Pollutant Discharge Elimination System (NPDES) permit database indicates there were approximately 0.5 million customers of community wastewater systems in August 2007. This would be approximately 66% of occupied households in WV, however some of the customers would be commercial rather than residential. Residences served by public wastewater systems may be closer to 60% of WV population in 2007.