Report as of FY2006 for 2006PA65B: "Rural Drinking Water Quality in Pennsylvania"

Publications

- Articles in Refereed Scientific Journals:
  - Clemens, Stephanie, Bryan Swistock, and William Sharpe. (2007). The Master Well Owner Network: Volunteers Education Pennsylvania Well Owners. Journal of Extension (in press).

Report Follows

Principal Findings and Significance
Samples and survey information were collected from 450 private wells located in 52 counties throughout Pennsylvania. Samples were analyzed for coliform bacteria, *E. coli* bacteria, pH, lead, nitrate, arsenic, triazine pesticides, total dissolved solids (TDS) and hardness. Two survey forms were used to collect information about each private well including construction, maintenance, nearby land uses and homeowner opinions.

An additional online survey was used to collect data from another 837 private well owners across Pennsylvania from September 2006 through March 2007. Responses were collected from well owners in 63 of the 67 counties in the state. This survey was identical to the survey data collected from the well testing study above.

Well and Wastewater Characteristics and Management
Water well characteristics and management history were derived from both the well testing study (n=450) and the online well survey (n=839). The ranges reported in the bullets below represent the results from both studies.

- The average depth of wells from both studies was about 170 feet with maximum depths over 700 feet. Approximately 20% of well owners could not provide an estimate of well depth.
- The majority of wells (66% to 82%) had been drilled after 1970.
- Over 50% of the well owners in both studies were unable to estimate the amount of water delivered from their private well. A small percentage (4% to 7%) reported that their well had gone dry sometime in the past.
- Only 9% to 18% of well owners had a copy of their well completion report from the professional well driller that drilled their well.
- Most wells were poorly constructed. About 15% of the wells in both studies were buried in pits below the ground surface. Only 16% of wells had a sanitary well cap and 16% were also reported to have a grout seal around the casing. However, only 4% to 5% had both sanitary well construction features.
- 53% to 70% of the homes in these studies had some type of water treatment equipment installed on their private well. The average cost of water treatment equipment was $1,147 to $1,400 with a maximum of $7,000. Data from the well testing study found that about 10% of the wells with water treatment equipment had at least one piece of equipment that was not needed according to the water quality results. Water softeners were, by far, the most common type of water treatment installed on private wells across the state.
- About 50% of the well owners in both studies reported that they occasionally or regularly use bottled water for drinking instead of their well water.
- Over 90% of the homes in the well testing study had on-site wastewater disposal. About 70% of these were traditional septic tanks and leach fields. The remainder were mostly sand mounds with a small percentage of alternative systems. Nearly 30% of well owners with septic systems reported that their septic tank had never been pumped or maintained. Another 34% indicated that their tank was pumped infrequently (> 4 year interval).

Well Water Quality
The online survey of 839 private well owners found that 80% reported at least one water quality problem with their well water. Most of the reported problems were obvious aesthetic contaminants like hardness or iron. The water quality testing from 450 private wells found that 40% had raw water that failed to meet at least one health-based, primary drinking water standard. After accounting for those that have proper water treatment or drink bottled water, about 30 percent of the study participants were still drinking unhealthy water. The percent of homes that failed each water test were:

- 33% failed the drinking water standard for coliform bacteria
- 14% failed the drinking water standard for *E. coli* bacteria
- 18% failed the recommended drinking water standard for pH
- 6% failed the drinking water standard for lead
- 5% failed the recommended drinking water standard for total dissolved solids
- 3% failed the drinking water standard for nitrate
- 2% failed the drinking water standard for arsenic
- 1% failed the drinking water standard for triazine pesticides

Prevalence for most pollutants was similar to past studies with the notable exceptions of lead and nitrate. Lead contamination (6%) was much less prevalent than a similar well water quality study conducted by Penn State in 1990 when nearly 20% of private wells failed the lead drinking water standard. This suggests that the Federal Lead Ban of 1991 has been successful in reducing exposure to lead in private water systems. Reduced prevalence of nitrate may be due to under sampling of southeast counties which will be resolved through additional testing in 2007. The few wells with high arsenic levels were located in the glaciated regions of northern Pennsylvania which agrees with a recent study conducted by the U.S. Geological Survey.

Logistic regression was used to relate well water quality to well construction parameters and nearby land uses. Results suggest that some well construction components, including well depth, presence of casing above ground and slope around casing, were important factors in explaining the presence of coliform bacteria in wells. Nearby activities such as the distance to a pasture and the maintenance interval of the on-site septic system were also important variables. An additional 250 wells will be added to the database during 2007 to allow more robust statistical analyses of the causes of contamination for bacteria and other parameters. Regression results also indicated that nitrate concentrations in wells were correlated strongly with the distance to the nearest cornfield. Other results from this analysis include:

- Homes with a septic system were more likely to have bacterial contamination than those on centralized wastewater systems. This trend was more pronounced for *E. coli.*
- Wells at homes with septic systems that had malfunctioned were more than twice as likely to have bacterial contamination.
- Wells that had a history of turbidity problems were much more likely to have bacteria.

Well Owner Education and Opinions

In the absence of statewide regulations, education plays an important role in promoting proper management of private water supplies. However, while education can create awareness of problems and management strategies, it can only be successful if well owners translate this knowledge into actions. Data from this study indicate the following:

- About one third of the well owners in each study reported that their well water quality had never been tested. Fewer than 10% of well owners were following the standard recommendation to have their well tested annually.
- Only 30% of the well owners with drinking water that failed a primary drinking water standard were previously aware of the problem. Those well owners that were previously aware of problems were very likely to utilize water treatment or bottled water to avoid the problem, especially if the pollutant caused a health problem.
- The effect of education in producing well management actions was documented by comparing Master Well Owner volunteer wells to homeowner wells. Education did result in an increase in the use of sanitary well construction, frequency of water testing, use of certified labs and awareness of water quality problems.

- Despite all of the problems found with drinking water from private wells, 64% to 81% of well owners from these two studies reported that they were satisfied enough with their private well that they were unwilling to pay any fee for connection to a community water supply.
- Although most well owners were satisfied with their private well, more than half were concerned about the future of their well water quality or quantity. Specific concerns varied regionally but new housing development was consistently the top concern across the state.

The surveys from both the well study and the online survey included four questions to measure support among current well owners for state regulations related to private wells. Current well owners were generally supportive of all well regulations with 63 to 80 percent strongly or somewhat agreeing. The greatest support was for proper location of new wells and well driller certification requirements.

STUDENTS SUPPORTED

- Jessica Tillia, Environmental Resource Management, B.S., December 2006
- Shawn Rummell, PhD candidate in Ecology, 2006

PRESENTATIONS AND OTHER INFORMATION TRANSFER ACTIVITIES

Results from this project were presented to well owners, Cooperative Extension educators, Master Well Owner volunteers and local government officials at the following activities:

- Master Well Owner Volunteer Training, March 11, 2006, Lewisburg, PA
- Master Well Owner Volunteer Training, April 29, 2006, Allentown, PA
- Master Well Owner Volunteer Training, May 20, 2006, Washington, PA
- Rural Water Quality in Pennsylvania, Lock Haven Rotary Club, June 6, 2006, Mill Hall, PA
- Well water sampling program, August 12, 2006, Williamsport, PA
- Master Well Owner display, August 17, 2006, Ag Progress Days
- Northeast Pennsylvania Water Quality Issues, Wayne County Extension Board Meeting, November 1, 2006, Honesdale, PA
- Northcentral PA Water Quality, Northcentral Landowners Banquet, November 5, 2006, Port Allegheny, PA
- Safe Drinking Water Clinic, November 15, 2006, Schuylkill County
- Safe Drinking Water Clinic, November 16, 2006, McKean County
- Water Quality and Management of Private Wells in Pennsylvania, PA Ground Water Association Winter Conference, January 26, 2007, Grantville, PA
- Using the Master Well Owner Network to Assess Well Water Quality and Management in Pennsylvania, USDA CSREES National Water Quality Conference, January 31, 2007, Savannah, GA

AWARDS

- Universities Council on Water Resources, Education and Public Service Award, 2007

ADDITIONAL FUNDING ACQUIRED USING USGS GRANT AS SEED MONEY

- The Center for Rural Pennsylvania, $48,399, February 1, 2007 to January 31, 2008, The Effect of Management Practices on Rural Drinking Water Quality.