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Household Water Supply Challenges in Rural Virginia

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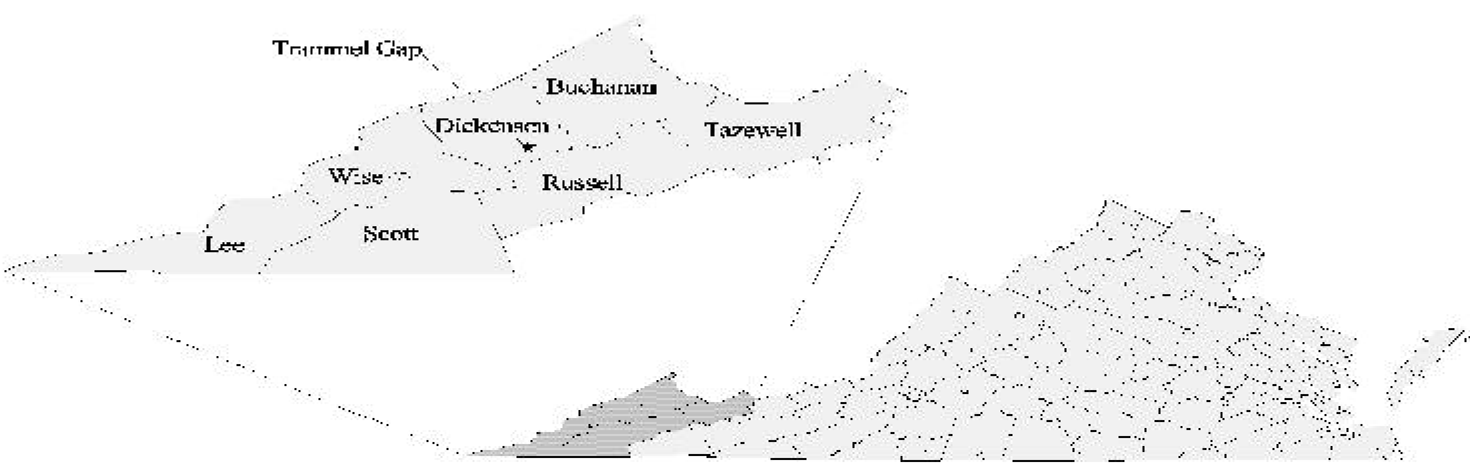
Most Virginians take for granted an ample household water supply, either publicly provided by a local planning district or obtained from a private well. However, some citizens of the Commonwealth do not have access to a safe, convenient water source in their homes. According to State Delegate Clarence Phillips, of the nearly 30,000 households in Virginia that fall into this latter group, about two-thirds are in the coalfields of Southwest Virginia (Buchanan, Dickenson, Wise, Russell, Scott, Lee, and Tazewell counties, Figure 1) (Mays 1997 and Ross et al. 1996). Utilization of groundwater is often undesirable due to the natural aquifer conditions and past mining activities. Developing surface water systems, mainly streams, can be limited as the result of contamination by raw sewage from improperly functioning septic systems and nonpoint sources of pollution (Younos, Wright, and Reaves 1999). Extending public water lines to coalfield communities is generally cost prohibitive due to the rough, elevated terrain and the low number of households in each community (Younos and Reaves 1998).

The Trammel Gap community in Dickenson County is a typical ridge-top community that has no public water system or adequate groundwater. It is a cluster of ten houses situated on an isolated ridge at an elevation of approximately 2,800 feet above sea level. Its residents obtain their drinking water either through rooftop rainfall collection and cistern storage or through water hauling from a water treatment plant. Cost estimates to extend a public water line from the toe of the mountain to the ridge-top community are $30,000 per household.

Figure 1. Coalfield Counties and Trammel Gap



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Virginia Tech

Due to economic dependence on the coal industry, the affected communities often have limited financial means and a low tax base, making affordability of public potable water more difficult (Younos, Wright, and Reaves 1999). Virginia's challenge is to find cost-effective water supplies for these often isolated households and communities.

In March 1997, the Virginia General Assembly in House Joint Resolution 592 requested that the State Water Commission study various options for providing safe, reliable, and affordable water supplies to individual households and small communities in Southwest Virginia. The Virginia Water Resources Research Center at Virginia Tech was a partner in identifying options and initiated a number of studies to meet the objectives of HJR 592. Study components included the feasibility of (1) rainfall harvesting and small surface-catchment systems; (2) rainfall harvesting and cistern storage systems; (3) water hauling; and (4) developing mine cavity water (coal-seam water).

A Feasibility Study of Rainfall Harvesting and Small Surface-Catchment Systems

This study assessed the feasibility of constructing a reservoir to catch rainwater, conveying the water to the top of the ridge, storing it in a holding tank, and distributing it to ridge-top households via pipelines. In addition to the distribution of the water, water treatment would also be necessary to ensure meeting the National Drinking Water Standards for public water systems. However, since the exact water quality of the area is not known, the type and cost of a water treatment system was not included in the feasibility study. The estimated cost for the system, excluding water treatment, was $46,480 per household, which exceeds the cost for extending the public water line. Given the cost estimate, the study concluded that a surface-water catchment system for a community the size of the one at Trammel Gap is not economically feasible (Younos et al. 1998a).

Evaluation of Rooftop Rainfall Collection-Cistern Storage Systems

A rainfall collection-cistern storage system can be considered a viable water source in isolated southwest Virginia communities. However, little research has been conducted to assess the water quality or reliability associated with cisterns. A survey of Dickenson County residents indicated that more than 30 percent of the households in the surveyed area depended on cisterns for drinking water and that 20 percent of the cisterns ran dry at least once a month. Water testing indicated that, while some cistern waters were of good quality, more than 65 percent of cisterns failed to meet drinking water standards for coliform bacteria. Poor maintenance was suspected to be a primary factor. Based on survey and water testing results, recommendations were made for cistern maintenance and renovation in Dickenson County with the expectation that results would be applicable to other areas of Virginia (Younos et al. 1998b).

Feasibility of Water Hauling

Water hauling is a viable option for isolated communities where it is unlikely that public water lines would be extended in the foreseeable future, according to an economic feasibility study that assessed the cost of water hauling in Southwest Virginia. An end-product of this study was a user-friendly computer program that evaluates the financial feasibility of alternative scenarios of large-scale water hauling and distribution to small communities (Reaves, Younos, and Ramsey, 1998). A large-scale water hauling system is defined as one where a tanker truck hauls a large quantity of treated drinking water to storage tanks in small communities. Two options include a single 20,000 gallon community tank or multiple individual household tanks (5,000 gallons or less). For either option, the system can be designed so that any pipelines that are installed for the water hauling system could later be utilized as public water lines if they were extended to the area.

The computer program can be tailored to the local community. County-level users can input their own community's characteristics and determine the economic feasibility of water hauling in their area. Four alternatives are available: (1) community tanks with individual households paying both initial and operational costs; (2) community tanks where individuals pay only operational costs, assuming some type of grant or community funding to cover initial costs; (3) individual tanks where households pay all costs; and (4) individual tanks where households pay only operational costs. The economic feasibility of these systems to the Trammel Gap community was assessed using the computer program. Results indicate that the monthly cost would range from $200 to $400 per household, depending on whether a community tank or individual tanks are used and whether individual households are responsible for all initial investment costs (Table 1).

Table 1. Cost of alternative payment methods

Alternative	Monthly cost per household ($)
Community tank, consumer pays initial and operating costs	406
Community tank, consumer pays only operational costs	222
Individual tanks, consumer pays initial and operating costs	376
Individual tanks, consumer pays only operational costs	209

Table 2. Cost of hauling water to multiple communities using alternative payment methods

Alternative	Number of households: 11 Round trip mileage: 10	Number of households: 15 Round trip mileage: 5	Number of households: 15 Round trip mileage: 10	Number of households: 15 Round trip mileage: 15	Number of households: 15 Round trip mileage: 20
	--------------------	--------------------	$	--------------------	--------------------
Community tank, consumer pays initial and operating costs	124	97	109	122	134
Community tank, consumer pays only operational costs	72	59	71	84	96
Individual tanks, consumer pays initial and operating costs	96	74	85	97	109
Individual tanks, consumer pays only operational costs	62	48	61	72	83

If a single tanker truck can be utilized to serve multiple communities, per household costs can be reduced to well below $100. The reduction in costs becomes a function of distance and the number of households requiring water (Table 2). Water hauling does not appear to be economically feasible for either single or multiple communities if households are required to pay all costs of the system. Since neither the households nor the communities are able to afford the cost, the need for grant-based assistance is underscored.

The Potential for Developing Mine Cavity Water

Given proper conditions (geological, chemical, and physical), water stored in mine cavities can be a potential source of water for small communities where other sources are unavailable. A site in Dickenson County was chosen for a case study with the expectation that the methods could be applied to other areas in the coalfield region. Guidelines for developing mine cavity water include (1) identifying a potential source near a community where water is needed; (2) addressing institutional issues such as ownership, liability, permits, and financing; (3) performing water quality analysis to determine if the water source could be developed cost effectively; and (4) determining economically affordable water treatment options (Younos, Wright, and Reaves 1999). Results indicate that the mine cavity water source can meet the demand of the nearby community. Water quality analyses show that the water is of good quality and is suitable for development as a drinking water source. Additional cost-benefit analysis is needed, however, to determine if the development of mine cavity water is more economically feasible than extending public water lines or hauling water to the case study site.

Conclusion

Although most citizens of the Commonwealth have an adequate, high-quality water supply available year-round, some isolated rural communities do not. The Virginia Water Resources Research Center has undertaken a number of studies to assess different potential water sources for communities in the coalfield areas in Southwest Virginia. In many instances, those counties that are the most economically depressed do not have public water sources or adequate private water supplies. Cost analyses indicate that it is not economically feasible for individual households to invest in many of the options that are available to them. Therefore, seeking outside funding sources is important to assist rural communities in providing a safe, adequate water supply for their citizenry. Other options, such as using mine cavity water, need further study.

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