

Growing Water Demand

A Concern for Piedmont and Mountain Regions

Many regions in North Carolina have experienced tremendous increases in population growth and industrial development in the past decade. As shown in Figure 1, latest projections by the Bureau of Economic Development point to a continuation of this growth pattern, with the Piedmont and Mountain regions of the state being no exception to this trend (from Heath, Ralph C., Better Utilization of Ground Water in the Piedmont and Mountain Regions of the Southeast, 1978). Census records show that the populations of the Piedmont and Mountain regions are increasing at a rate of a little over one percent per year with an anticipated doubling of the population by the year 2020. One of the many implications of this dramatic growth pattern is the apparent depletion of municipalities' current water supplies. As seen in Figure 2, most public water supplies in the regions are from surface water sources; specifically, streams, lakes and reservoirs. To keep pace with demand, new surface water sources will have to be developed on a large scale. Conservative estimates for the region as a whole indicate a three-fold increase in all water uses over the next forty years. Obviously, this necessitates extensive development of additional sources.

Difficulties arise with continued pursuit of a surface water impoundment strategy in the Piedmont and Mountain regions of North Carolina.

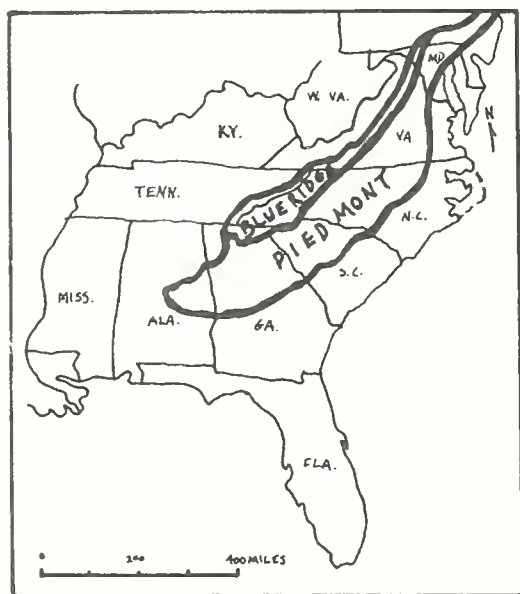


Figure 1. The Piedmont and Mountain regions.

The major problems cited in recent groundwater studies in the state include: 1)reservoir development competes with farming, housing and industrial development for a limited land resource, 2)many of the best reservoir sites are already in use, 3) less suitable sites would probably require more land area and be more prone to contamination, and 4) construction of reservoirs is costly. As a consequence of these significant drawbacks of surface water development, state and local officials are now critically examining alternative sources of water. One suggestion is to assess the potential of existing groundwater supplies and develop these to supplement surface water supplies. The remainder of this report examines the overall viability of adopting such a strategy to help meet future water demands in the Piedmont and Mountain regions of North Carolina.

Some Characteristics of Groundwater

In general, groundwater has many attractive features as a source of supply. Groundwater has a relatively low cost of development since it is stored naturally, thereby eliminating the cost of impoundment facilities. These costs are further reduced because the supply frequently is available at the point of demand, so the cost of transmission is reduced significantly. Groundwater is also considered cleaner than surface water supplies since it is filtered by the natural geologic strata. This would result in savings due to reduced treatment. Another important characteristic of groundwater is its ability to sustain moderate yields during the annual drought periods commonly occurring in North Carolina. Finally, use of groundwater generally permits other land use activities provided there is no contamination or paving of the crucial recharge area.

In spite of these anticipated benefits, groundwater remains an underutilized water supply source in the Piedmont and Mountain regions. Data from a recent survey show that only about 13 percent of the 132 public water supplies serving communities of at least 500 individuals in the region rely on groundwater (Figure 2). Use of water by public water supplies amounted

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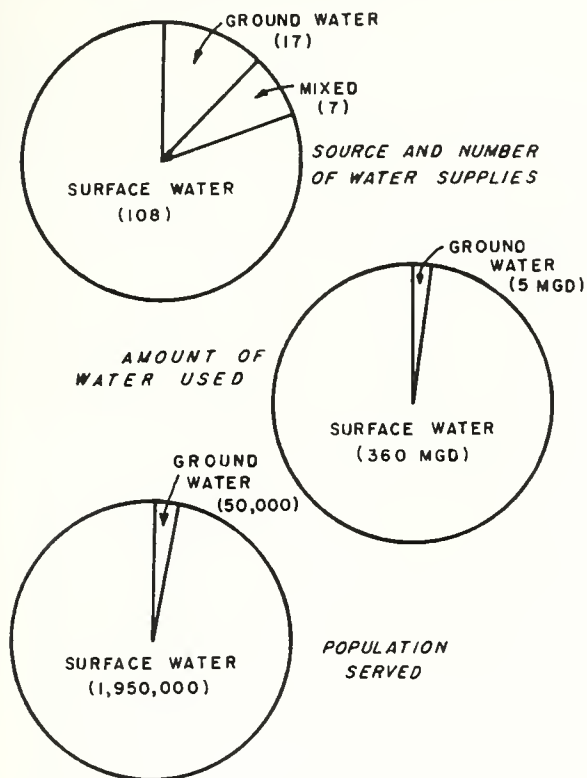


Figure 2. Relative importance of surface and groundwater sources for public water supplies in the Piedmont and Mountain regions of North Carolina.

to about 365 million gallons per day (mgd) in 1975. Of this total, only about 5 mgd (1.4 percent) was groundwater. The population served by public water supplies was about two million, and of these only 50,000 (about three percent) used groundwater. Clearly, groundwater is a source yet to be tapped.

Groundwater Availability

It is not clear why the region's ground water supplies have not been developed. Studies conducted by the North Carolina Department of Natural Resources and Community Development (NRCD) indicate not only that the water supply exists but that it is available in many places for pumping. The NRCD findings show that areas of the Piedmont similar to the Upper Cape Fear River Basin suggests that the groundwater system may possibly support large yields. For example, many wells in the Georgia Piedmont produce more than 100 gallons per minute (gpm) and some yield nearly 500 gpm. Similarly, studies conducted in 1972 indicated yields from 100 to 300 gpm for bedrock wells in the Piedmont and Blue Ridge regions from Maine to Virginia (N.R.C.D. Cape Fear River Basin Study: 1981-1983).

In considering groundwater availability, site-specific values for storage and recharge

based on the prevailing bedrock lithology should be used. Groundwater is stored in the regolith and in the underlying fractured bedrock (Figure 3). The regolith averages about 50 feet in depth and contains approximately 1.5 billion gallons per square mile of potentially available water. Seasonally, this value ranges from 1.3 to 1.7 billion gallons per square mile. Storage capacity in the fractured bedrock is low and decreases to nearly zero below a depth of about 400 feet. Under natural conditions, precipitation represents 100 percent of the input to surface and groundwater supplies. Precipitation data from National Weather Service stations at Graham, Greensboro and High Point averaged 45.9 inches per year for the period from 1971 to 1980. About 19 percent of this amount infiltrates to the water table to recharge the groundwater system.

Capturing Groundwater

The ultimate success in developing large supplies of water from wells depends on selecting sites at which the bedrock contains the largest number of fractures and the thickest regolith structure. Geologists have long recognized the relation between bedrock fractures and land surface topography. Valleys develop where the bedrock is most highly fractured. Consequently, high yielding wells will be located in draws or narrow valleys that have a high water table. Often such sites encompass a stream, which, under conditions of maximum groundwater

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development, would serve as a source of recharge. This theory was supported in a study completed in 1983 by the NRCD. Three test wells were constructed for evaluating site selection criteria. The sites were located near Gibsonville, Greensboro and High Point. Selection of the particular sites was based on the topography and drainage patterns, as well as the height of the water table, the thickness of the regolith, and the degree of bedrock fracturing. It was concluded that all of these features were significant in determining the best well location. Of the three test wells, two produced above-average yields. (The third well was abandoned after it reached a metamorphosed basaltic dike that was not expected to yield much water.)

The important point revealed by the NRCD study is that if large supplies of groundwater are to be developed in the Piedmont and Mountain regions, well locations must be selected with the same care presently employed in determining an appropriate dam site for a surface water supply. Too often in the past, municipal supply wells have been drilled on land which cities al-

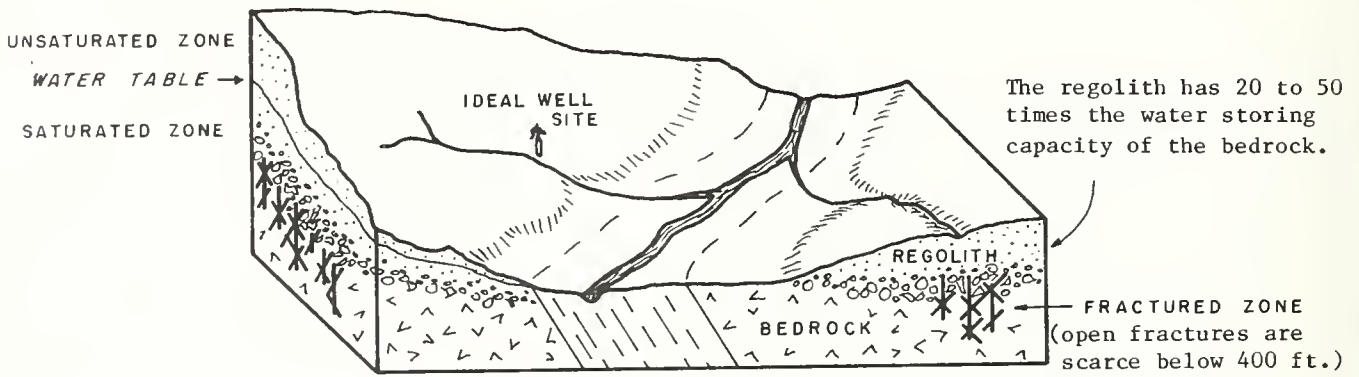


Figure 3. Generalized drainage pattern and associated landforms, along with principal components of the groundwater system typical of northwestern Guilford County, indicating the ideal well site (modified from Heath, 1978).

ready owned or that could be readily obtained. According to Heath (1978), in many cases this land did not contain ideal well sites, and efforts to develop groundwater supplies were unsuccessful.

Steps in Well Site Selection

Due to the complexity of the groundwater system in the Piedmont and Mountain regions, sound hydrogeologic criteria are of utmost importance in selecting sites for wells. The NRCD suggests the following steps to maximize yields: 1) determine possible correlations between the highest yielding wells and various geologic and geomorphic features, 2) determine the location of zones or areas of abundant fractures which will transmit water, and 3) determine local areas of thick regolith affording the greatest potential for groundwater storage.

An explanation of an ideal well site is summarized in Figure 3. Its features include lines of wells in the valleys of perennial streams, wells drilled at sites where the topography indicated cross fractures, and consideration of the characteristic bedrock.

Conclusion

With prudent planning and pumping schedules designed to account for the seasonal variation in recharge rates, significant quantities of water can be obtained from the groundwater resources in the Piedmont and Mountain regions of North Carolina. By withdrawing the groundwater which would otherwise be discharged to streams, and tapping the water in drainable storage for short periods; municipalities will have a pure, dependable water source to help meet their future demands.

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3: a process involving much design and discussion but little implementation
4: a little-known profession sanctioned and promoted by the American Planning Assoc.

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