Delaware Geological Survey

Ground Water in Delaware

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Background

Because of its "renewability" water is unique among earth resources that sustain and enhance life. No other mineral resource that we extract on a long-term and continuous basis can be counted on for at least some degree of replenishment within a human lifetime. This attribute allows a great deal of flexibility in management of the resource. In Delaware local rainfall, approximately 40" to 44" per year, renews part or all of our water supply on a regular basis. However, not all of the rain that falls is available for use. From this total rainfall must be subtracted the water that evaporates (about 20"/ year), the amount that is used by plants (about 3"/year), and the amount that runs overland to surface streams during storms (about 4"-5"/year). The remainder, approximately 13" to 15" is Delaware's bank of water for the year. This water is stored in a system of ground-water reservoirs, or aquifers, that underlie most of the State. Not only do these ground-water reservoirs provide water to wells but they also maintain the flow in surface streams during times of no rainfall. Streamflow between rainfall events is nothing more than the discharge of excess ground water.

THE COASTAL PLAIN

South of about Delaware Route 2 (between Wilmington and Newark) the State is underlain by unconsolidated sediments that rest upon a "basement" or hard rock surface. The thickness of these sediments ranges from a thin edge in northern Delaware where they overlap the southern edge of the Piedmont to several thousand feet in southern Delaware.

Geologists have determined the age and geologic history of most of these materials and have applied formal names (formations) to the various geologic units present. For water supply purposes the units are also classified by their water-bearing characteristics (hydrologic units). The coarser grained materials, sand and gravel, have both porosity (intergranular voids that hold water) and permeability (interconnection between voids). In some sands it is not uncommon for the voids or porosity to account for 30% of the bulk rock volume. These coarser grained materials, saturated nearly everywhere with water, are the aquifers that provide most of the State's water supply. Yields range from a few gallons per minute to several hundred gallons per minute from properly constructed wells. The finer grained materials (silt or clay) act as barriers to water movement, both vertically and horizontally, and are known as confining layers. Confining layers may contain water within their pore spaces, but the lack of interconnected openings prevents water from moving rapidly in response to pumping or other pressure changes.

The oldest sediments (resting upon the basement rocks) used for water supply in the Coastal Plain are known as the Potomac Formation and comprise about 75% of the total Coastal Plain material. The Potomac is predominantly silt and clay but interbedded sands provide much of the ground water used in northern Delaware. Like most of the Coastal Plain sediments, the Potomac thickens in a southerly direction and, south of central New Castle County, is also overlain by younger materials. South of southern New Castle County the Potomac is too deep to be used for most normal purposes and also contains brackish water.

There are some other major aquifers that overlie the Potomac; however, it is important to note that in the area from northern Kent County to just south of Cheswold there are no deep, high-yielding fresh-water bearing units. South of Cheswold several aquifer systems are present and are heavily used, particularly in the Dover area. Another aquifer system underlies the coastal areas and is the object of much recent study to determine both water quality and long-term yield.

Blanketing almost the entire Coastal Plain is a relatively thin layer of mostly sands and gravels (Columbia Formation) presumably derived from melt-water streams flowing across Delaware during the last ice age. These sediments act as the recharge sponge for the underlying aquifers. They fill rapidly during periods of rainfall and slowly release water both to streams and to deeper sands. In central and southern Delaware the Columbia is presently a source of irrigation and many public water supplies. Indeed the Columbia contains much of the fresh water in the State and also is the most vulnerable to pollution.

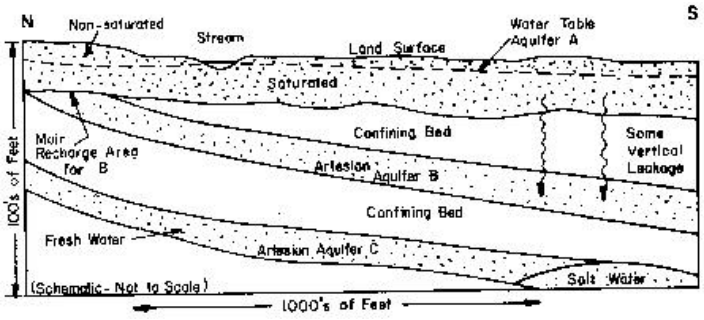
THE PIEDMONT

The crystalline or hard rocks of northern Delaware, which are an extension of the basement rocks beneath the Coastal Plain, have much lower water-bearing capacities than do the Coastal

Plain sediments. Water is stored in fractures or openings that constitute a small volume of the total rock mass. Predicting the occurrence of these openings is difficult. Yields are generally small but usually sufficient for domestic wells (a few gallons per minute). Higher yields (tens of gallons per minute) may sometimes be obtained using specialized techniques for locating drilling sites. The marble valleys of the Hockessin and Pleasant Hill areas are an exception in that high yields are initially obtained. However, the recharge area of the marble is small so that the total yield available is only a few million gallons per day on a long-term basis.

WATER-TABLE AND ARTESIAN AQUIFERS

Sandy Coastal Plain units exposed at the land surface are usually water saturated a few feet below land surface. The top of this zone of saturation is known as the water table and its elevation or its distance below land surface responds rapidly to rainfall.



Deeper sandy zones, isolated from the water table by confining beds (see "Aquifer C" in adjacent figure), generally have a water level, or "piezometric surface," higher than the elevation of the top of the bed. Obviously the water in the aquifer is prevented from reaching this height by the overlying confining beds. This is known as an artesian aquifer. The intake to the aquifer is usually many miles away and, in Delaware, is that portion of the unit that extends updip (upslope) and directly underlies either the land surface or the permeable Columbia Formation. The intake area may also be the water-table portion of the same aquifer.

In the Piedmont, because of the irregular distribution of openings in the rock, the water-table is not continuous over the entire region. The weathered, unconsolidated surface materials overlying the hard rock are often dry but may develop a temporary water table during wet periods. Water in fractured zones may be under both water-table and artesian conditions depending on location and the fractures tapped by individual wells.

OCCURRENCE OF SALT WATER

Salt or brackish water is found in Delaware's aquifers because of intrusion due to pumping, improper disposal of dredge spoils, proximity to bodies of salty surface water, or because of previous high sea levels. Natural occurrences of salt water are found south of southern New Castle County at depths exceeding 500 to 1,000 feet. The depths of the interface between fresh and salt water is a result of the balance between fresh-water inflow and the underlying denser salt water.

In the coastal areas and in some areas adjacent to the Delaware estuary, both lateral and vertical movement of salt water may be induced by pumping of fresh water. The position of the fresh-salt water interface in these areas is seldom known with certainty because of the difficulty and cost of obtaining data. Ground-water withdrawals in coastal areas must therefore be done with caution because of the inherent threat of saltwater intrusion.

WATER AVAILABILITY

The question that is often asked is how much water is available from Delaware's ground-water reservoirs? The answer depends to some degree on the compromises or the effects of withdrawals that can be accepted. One approach is to consider the total recharge component of rainfall (after subtracting runoff and evaporative losses) as available for use. This works out to be an average of about 0.5 million gallons per day (mgd) per square mile in northern Delaware and up to 1 mgd in some parts of southern Delaware. However, if all of this were somehow used then streams would probably go dry. If more than this were used on a continual basis then ground-water "mining" would occur. Another approach is to limit withdrawals to an amount that would not allow levels to drop below a certain point (perhaps the top of an aquifer). From a water budget approach it appears that with proper management up to 60 mgd can be pumped from aquifers in New Castle County, about 130 mgd in Kent County, and about 200 mgd in Sussex County.

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