Generalized Water-Table Elevation Map of Trempealeau County, Wisconsin

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Miscellaneous Map 47

Explanation

- 920 — average elevation of water table in feet, solid where considered accurate within ±0.3 mile on the land surface; dashed where considered accurate within ±0.7 mile on the land surface; 20-ft contour interval. Datum is mean sea level.
- surface-water divide
- groundwater divide, approximately located
- general direction of shallow groundwater flow

Geologic materials contributing water to well (All geologic information is taken from Wisconsin Department of Natural Resources well constructor's reports on file at the Wisconsin Geological and Natural History Survey. Materials contributing water to the well are those units that are saturated and penetrated by the open, or screened, part of the well.)

- sand and/or gravel
- sandstone
- shale or shale and sandstone

Data have not been field checked. Water-level elevation data were generalized from information collected over a period of approximately 50 years.

Introduction

This map is part of the Trempealeau County Groundwater Resource Investigation, a joint project of the Wisconsin Geological and Natural History Survey and the Trempealeau County Board of Supervisors. The purpose of this project was to compile and interpret hydrogeologic data for Trempealeau County. The resulting information can be used by those interested in soil- and water-resource and land-use planning.

The water cycle

Solar energy and gravity drive a continuous water recycling process called the water cycle (fig. 1).

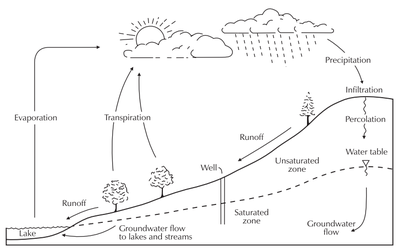

Figure 1. *The water cycle (modified from Dunne and Leopold, 1978).*

Water falling on the land surface can flow downhill as overland runoff, evaporate, transpire through plants, or infiltrate into the ground. As the infiltrating water seeps downward through rock or soil, it travels through pore spaces and open cracks or fractures in the subsurface materials. When these pores and cracks are completely filled with water, the material is said to be saturated.

The water table marks the top of this saturated zone, where hydraulic pressure in the pores is equal to atmospheric pressure. Groundwater is the water contained in the saturated zone below the water table. Above the water table, pores and cracks are partly or completely filled with air and partly filled with water, and the material is said to be unsaturated. The amount of infiltrating precipitation is one of the factors that determines the position, or elevation, of the water table, which fluctuates seasonally and from one year to another.

Groundwater, under the influence of gravity, moves slowly through pore spaces, eventually discharging to the land surface, to a well, or to a surface-water body. Solar energy causes some water to evaporate, thus returning it to the atmosphere and continuing the water cycle.

In the Trempealeau–Black River basin, the water cycle generally operates with approximately 31 inches of precipitation during an average year, from which approximately 76 percent (23.5 inches) returns to the atmosphere by evaporation and transpiration by plants (Young and Borman, 1973). The remainder either flows over the land surface and collects in surface-water bodies or infiltrates into the ground as recharge to the groundwater system. The ratio of overland runoff to groundwater recharge varies considerably around the state, depending upon factors such as topography, the permeability of the unsaturated materials, vegetative cover, rainfall intensity, and individual farming and general land-use practices.

Groundwater occurrence and movement

A saturated subsurface material that yields sufficient water to a well is called an aquifer. Permeability is a measure of the relative ease with which water can flow through an aquifer; it is dependent on the nature of the material through which the water is flowing. Large pores or fractures can hold more water than small ones, but for water to flow effectively, these pores or fractures must be connected.

Groundwater can move as rapidly as several feet per day in porous sand and sandstone, or as slowly as inches per year in clay or in unfractured granite. Sandy soil and sandstone frequently have relatively large pore spaces that are well connected with each other, allowing water to move more easily than it can in clayey soil that has small, poorly connected pores. Rocks such as granite have low permeability except where they are fractured. If the fractures are well connected, these rocks can transmit water easily; however, if there are just a few poorly connected fractures, these rocks transmit little water.

No matter how rapidly or slowly the groundwater flows, its natural direction of movement is in response to gravity from upland recharge areas, where water infiltrates into the subsurface, to lowland discharge areas (lakes, rivers, springs, and seeps), where groundwater emerges again. Many surface-water bodies are groundwater discharge areas, so groundwater quality has a significant impact on the water quality of lakes, streams, and wetlands. Wells are manmade groundwater-discharge points.

A surface-water divide is a line of separation, commonly a ridge or narrow tract of high ground that divides the surface waters that flow naturally into one basin from those that flow naturally into a different basin. All of the major creeks and rivers in Trempealeau County flow into the Mississippi River. The Trempealeau River drains much of the county; however, there are three minor surface-water divides in Trempealeau County that separate the basins of the Buffalo River, Beaver Creek, and Black River from that of the Trempealeau River.

A groundwater divide is similar to a surface-water divide, in that it is a ridge defined by contours of the water table. Shallow groundwater moves away from the divide. A groundwater divide does not necessarily coincide with a surface-water divide; however, the three groundwater divides in Trempealeau County approximately coincide with the surface-water divides. Over much of Trempealeau County, groundwater follows short flow paths from upland recharge areas to discharge areas along the Mississippi River and its tributaries—the Buffalo, Trempealeau, and Black Rivers, and Beaver Creek.

Geology of Trempealeau County

The bedrock geology of Trempealeau County consists of Precambrian crystalline rock (commonly called granite by well drillers) overlain by a thick, layered sequence of Cambrian sandstone and shale and Ordovician dolomite (Young and Borman, 1973). Precambrian rock is not exposed at the land surface in Trempealeau County; however, it is exposed in the Black River valley in Jackson County, about 15 miles east of Trempealeau County. The overlying sequence of sandstone and dolomite dips gently toward the southwest at 10 to 15 feet per mile and gradually thickens in that direction, reaching a maximum thickness of approximately 1,600 feet (Young and Borman, 1973). The Cambrian sandstone and shale underlie all Trempealeau County and occur at the land surface in the northern and eastern parts of the county. In the western and southern parts of the county, the Cambrian sandstone and shale are capped by younger Ordovician dolomite. Bedrock is within ten feet of the land surface over much of Trempealeau County.

Glaciers that advanced into Wisconsin during the late Pleistocene (between 25,000 and 10,000 years ago) did not extend as far south as Trempealeau County. Earlier glacial advances (perhaps hundreds of thousands to millions of years ago) did enter the county; however, any deposits from those glaciers have subsequently been eroded from the land surface. During the most recent glacial advance in the late Pleistocene, water from the melting ice to the north and east followed the Buffalo, Trempealeau and Black River drainages and deposited in these valleys sand and gravel sequences that are up to 100 feet thick (Cates, in press). Silt-sized particles, carried by the glacial meltwater, were picked up by the wind and deposited across the landscape. These deposits, called loess, are generally less than 5 feet thick and cover the bedrock over much of Trempealeau County (Cates and Madison, 1993).

Many wells in Trempealeau County are completed in sandstone (68%) or a mixture of sandstone and shale (21%). In the major river valleys, the sand and gravel aquifer provides adequate water supply (11% of the wells). The shallow groundwater system appears to be a single unconfined aquifer at the scale of this water-table map (1:100,000). The water table closely mimics topography, suggesting direct hydraulic connection between the sandstone and dolomite and the overlying surficial deposits.

Contamination of groundwater

Because groundwater originates from precipitation that percolates down from the land surface, any water-soluble material or liquid that is put on or in the ground has the potential to be transported to the saturated zone. The unsaturated zone can serve as a natural filter and may remove many harmful materials from the recharging water by a variety of physical, chemical, and biological processes. In general, thick sequences of fine-grained materials are better able to attenuate contaminants. Conversely, areas with thin or sandy soils over bedrock or thin or sandy soils with a shallow depth to groundwater are especially susceptible to groundwater contamination. Once a contaminant reaches the saturated zone, it has the potential to move with the groundwater and discharge to wells or surface-water bodies. Concentration of contaminants in the saturated zone can be reduced by the processes of dilution, adsorption onto fine-grained particles, and by chemical or biological breakdown.

Contamination that happens today may not become evident for a long time because groundwater can move as slowly as a few inches per year. Once contaminated, groundwater is difficult to clean and may take many years, decades, or centuries to be purified.

Data compilation and interpretation

Data were compiled by Jill Maliszewski, Jeremy Craven, Peter Roffers, and Michelle Bridson, who used U.S. Geological Survey quadrangles (7.5-minute series, topographic; scale 1:24,000) as base maps. All available Wisconsin Geological and Natural History Survey geologic logs were plotted onto these maps. The Wisconsin Department of Natural Resources well constructor's reports were examined and checked against each other, and the most reliable, representative, and useful data available for each section were plotted. Water levels from 780 well data points were used in constructing the water-table map. Data density varies considerably across the county, ranging from very few data points in upland areas to at least one well constructor's report per 1 to 2 square miles in the valley bottoms. The elevations of springs, groundwater seepage areas (such as wetlands), lakes that intersect the water table, and rivers were used as data points in most areas.

Domestic wells are not ideal measuring points for determining water-table elevation. Most wells are open over long intervals and are completed far below the top of the saturated zone. Well constructor's reports for domestic wells provide good estimates of water-table elevation in areas where groundwater flow is more horizontal than vertical and poor estimates in areas where groundwater flow is more vertical than horizontal. To determine whether vertical groundwater flow was significant, water levels were compared for wells of different depths. Over much of Trempealeau County, wells completed at different depths had similar water levels; however, in many upland areas, vertical groundwater gradients seemed significant. In those areas, the well with the shallowest open interval was assumed to provide the closest estimate of the elevation of the water table, and data from the deeper wells were not used.

Well constructor's reports provide measurements taken at different times of the year and in different years. Because of the seasonal variations in water levels as well as changes in water levels with depth, a water level determined from a well constructor's report was not used as an exact data point. Instead, the water level was considered to be part of a range of values.

Limitations of the map

This map depicts, in a general way, the direction of shallow groundwater flow, which is primarily perpendicular to lines of equal water-table elevation. "Shallow" refers to depth below the water table, and not to depth below the land surface. The accuracy of the interpretation varies throughout the county, increasing with greater data density and decreasing with greater hydrogeologic complexity. The water-table elevation lines are solid where enough data are available to locate the lines with a reasonable degree of confidence (within ±0.3 mile on the map). The lines are dashed where data are less abundant or where hydrologic conditions are more complex; these lines are considered to be accurate to within ±0.7 mile on the map.

It was beyond the resources of this study to field check the locations and water levels given on the Department of Natural Resources well constructor's reports that were used to construct this map. This map is a summary of available water-level data for Trempealeau County. It is intended for use at the published scale of 1:100,000 but should not be considered definitive for site-specific applications.

References

Cates, K.J., in press, Depth to bedrock map of Trempealeau County, Wisconsin: Wisconsin Geological and Natural History Survey Miscellaneous Map 41, scale 1:100,000.

Cates, K.J., and Madison, F.M., 1993, Soil-attenuation-potential map of Trempealeau County, Wisconsin: Wisconsin Geological and Natural History Survey, Soil Attenuation Map 14, scale 1:100,000.

Dunne, T., and Leopold, L.B., 1978, *Water in Environmental Planning*: W.H. Freeman and Company, San Francisco, 818 p.

Young, H.L., and Borman, R.G., 1973, Water resources of Wisconsin—Trempealeau–Black River Basins: U.S. Geological Survey, Hydrologic Investigations Atlas HA-474, 4 plates.

Sources of data

U.S. Geological Survey quadrangles (7.5-minute series, topographic; 1969–84) were used to determine surface-water and well-water elevations.

Water-level observation wells from the Groundwater Level Monitoring Network, operated and maintained by the U.S. Geological Survey and Wisconsin Geological and Natural History Survey.

Wisconsin Department of Natural Resources well constructor's reports (1938–87).

Wisconsin Geological and Natural History Survey published and unpublished geologic logs (1938–85).

This map is an interpretation of the data available at the time of preparation. Every reasonable effort has been made to ensure that this interpretation conforms to sound scientific and cartographic principles; however, the map should not be used to guide site-specific decisions without verification. Proper use of the map is the sole responsibility of the user.

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Scale 1:100,000

1 0 1 2 3 4 5 6 7 8 9 10 KILOMETERS

1 0 1 2 3 4 5 MILES

Base map from U.S. Geological Survey County Map Series (Topographic), 1985.