MISCELLANEOUS MAP SERIES

GENERALIZED WATER-TABLE ELEVATION OF CHIPPEWA COUNTY, WISCONSIN

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1988

Introduction

This map is part of the Chippewa County Groundwater Resource Investigation, a joint project of the Wisconsin Geological and Natural History Survey and the Chippewa County Board of Supervisors. The intent of this project was to compile and interpret hydrogeologic data for Chippewa County. Information from the resulting maps can be used by Chippewa County's soil-and-water-resource and land-use planners.

The water cycle

Gravity and solar energy play active roles in a continuous water recycling process called the **water cycle** (fig. 1).

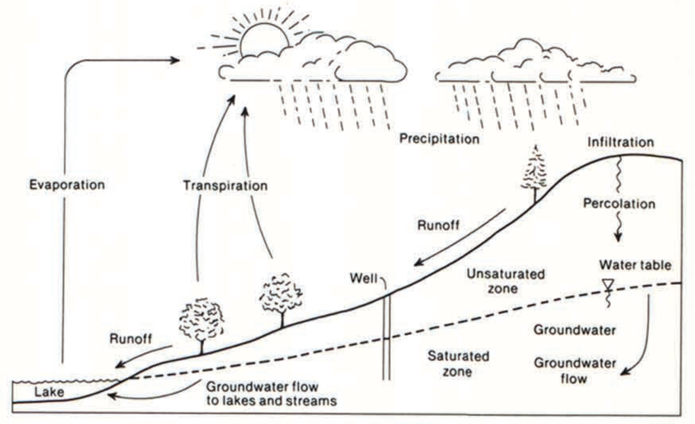

Figure 1. Schematic diagram of the water cycle.

Water falling on land flows downhill as runoff, evaporates, transpires through plants, or infiltrates into the ground. As this infiltrating water percolates downward through rock or soil, it travels through pore spaces and open cracks or fractures in the subsurface material. When these pores and cracks are completely filled with water, the material is said to be **saturated.**

The **water table** is the surface of this saturated zone. The amount of infiltrating precipitation partly determines the position, or elevation, of the water table, which fluctuates seasonally, and from one year to another. Above the water table, pores and cracks are partly or completely filled with air, and the material is said to be **unsaturated**.

Groundwater is the water contained in the saturated zone below the water table. Gravity moves groundwater slowly through pore spaces; eventually, the groundwater discharges to a land surface or water body where solar energy evaporates it into the atmosphere, thus continuing the water cycle.

In Wisconsin, the water cycle generally operates with 30 to 32 inches of precipitation during an average year, from which about 75 percent (22 to 26 inches) returns to the atmosphere by evapotranspiration. The remainder either runs off on the surface or infiltrates into the ground as recharge to groundwater. The ratio of surface runoff to groundwater recharge varies considerably around the state, depending upon factors such as topography, soil type, vegetative cover, rainfall intensity, and individual farming and general land-use practice.

Movement of groundwater

The rate of movement of groundwater is controlled by the nature of the materials through which it flows. Large pores or fractures in the subsurface can hold more water than small ones, but in order for water to flow, these pores or fractures must be interconnected. If conditions in the saturated subsurface material allow a well to yield fresh water economically, the material is called an **aquifer**.

For example, sandy soils may have relatively large pore spaces that are well connected with each other, allowing water to seep more rapidly than it can in clayey soils that have poorly connected pores. Rocks such as limestone and dolomite are usually highly fractured; if these fractures are open and interconnected, water flows quickly. Other rocks, such as crystalline granite, usually have fewer and smaller fractures than limestone and dolomite, and they transmit less water.

Groundwater can move as quickly as several feet per day in porous sand, or as slowly as less than 1 inch per year in clay or in dense crystalline rock. However, no matter how rapidly or slowly the groundwater flows, its natural direction of movement is from upland recharge areas (where water infiltrates into the subsurface) to lowland discharge areas (springs and seeps). Discharge areas are often associated with surface-water bodies, so groundwater has a significant role in the development and environmental health of lakes, streams, and wetlands.

Contamination of groundwater

Areas with either thin soils over a rock aquifer or sandy soils with a shallow water table are especially susceptible to groundwater contamination from land-use activities. Because groundwater comes from water that percolates down from the land surface, any water-soluble material that is put on or in the ground has the potential to be transported to the groundwater. Soil is usually a good natural filter, attenuating harmful material from the recharging water as it moves downward. However, thin or sandy soils do not effectively remove many potential contaminants contained in liquid or solid waste products, or in other materials - such as road salt, manure, chemical fertilizers, pesticides, and herbicides - that are applied to the land surface. Once a contaminant reaches the water table, very little attenuation takes place; dilution will disperse but not remove it.

Because groundwater can seep as slowly as a few inches per year, contamination that occurs today may not become evident for several or even hundreds of years. Once contaminated, groundwater is difficult to purify and may take many years, decades, or centuries to clean itself by the dilution process.

Data compilation and interpretation

Data were compiled at a scale of 1:24,000, using United States Geological Survey quadrangles (7.5-minute series, topographic) as base maps. All available Wisconsin Geological and Natural History Survey geologic logs were plotted onto these base maps. The Wisconsin Department of Natural Resources well constructor's reports were examined and checked against each other, and the most representative, reliable, and useful data available for each section were plotted. For some areas, there were no reports, and for others, only a few; however, for most areas at least 1 report per 2 square miles was available.

Because well constructor's reports provide measurements taken at different times of the year and in different years, water level as determined from a well constructor's report was not usually used as an exact data point. Instead, the water level was considered to be part of a range of values. The elevations of springs, groundwater seepage areas, seepage lakes, and rivers were used as data points. It was not practical to show the location of the data points on the water-table elevation map.

In some parts of Chippewa County (those areas shaded on the map), the surficial materials are densely packed, medium textured, and/or clayey, and they transmit water extremely slowly. The location of the boundary between the shaded and unshaded map areas is based on data from well constructor's reports. In some places the boundary appears to be sharp, within ± 0.25 mile; in others, the boundary appears to be gradational, with aquifer characteristics changing over several miles.

Wells in these shaded areas are usually cased through the low-yield layers, and are finished in stratigraphically lower, more productive layers of sand and gravel or sandstone. Water level as measured in these relatively deep wells (80 to 300 feet) is up to 120 feet lower than surficial indicators of water-table elevation. This is due to the natural downward movement of groundwater under these topographically high areas. Therefore, data from deep wells in these areas are not usable for water-table elevation mapping; interpretation is based exclusively on surficial features and data from shallow wells (where available).

Limitations of the map

Because shallow groundwater flow is perpendicular to the lines of equal water-table elevation, this map shows a generalized picture of the direction of shallow groundwater flow. The accuracy of the interpretation varies throughout the study area, increasing with greater data density, and decreasing with greater hydrogeologic complexity. The water-table elevation lines are solid where enough data are present to enable the lines to be located with a reasonable degree of confidence. The horizontal position of the line is believed to be accurate to within ± 0.25 mile. The lines are dashed where data are less abundant or reliable; their horizontal position is believed to be accurate to within ± 0.50 mile. In areas where question marks are present, more data are required. This usually occurs near the tops of hills, where data are scarce.

Water-table elevation in the shaded area of this map should not be used to determine the minimum depth for new wells in these areas: wells finished in these densely packed materials will not yield enough water, even though they are technically below the water table.

It was beyond the scope of this project to field check the published and unpublished data (such as the locations and water levels given on the Department of Natural Resources well constructor's reports) that were used to construct this map. Therefore, this map should *not* be considered definitive for site-specific applications.

EXPLANATION

1020 — Average elevation of water table in feet, solid where believed accurate within ± 0.25 mile on the land surface; dashed where believed accurate within ± 0.50 mile on the land surface; 20-ft contour interval. Datum is mean sea level.

—?—?—?— Inferred elevation of water table

? — Elevation of water table unknown (insufficient data)

(arrow) General direction of shallow groundwater flow

(shaded box) Surficial materials that transmit water extremely slowly; very densely packed, medium textured, and/or clayey.

Data have not been field checked. Water-table elevation was generalized from multiple years of information.

Preliminary drafting by J.A. Gassen.

Cartography by D.L. Patterson.

Wisconsin Geological and Natural History Survey Map 88-1

SOURCES OF DATA

Wisconsin Department of Natural Resources well constructor's reports (1936-86)

Wisconsin Geological and Natural History Survey published and unpublished geologic logs (1896-1986)

United States Geological Survey quadrangles (7.5-minute series, topographic; 1971-79)

Water-level observation wells from the Groundwater Level Monitoring Network operated and maintained by the United States Geological Survey and Wisconsin Geological and Natural History Survey

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Scale 1:100 000

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

1 0 1 2 3 4 5 MILES