University of Wisconsin-Extension
GEOLOGICAL AND NATURAL HISTORY SURVEY

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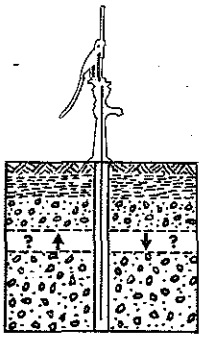
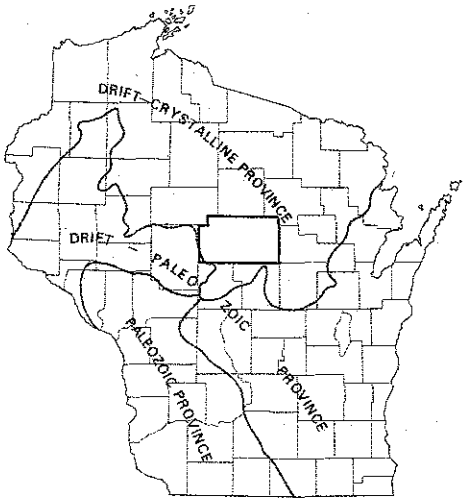
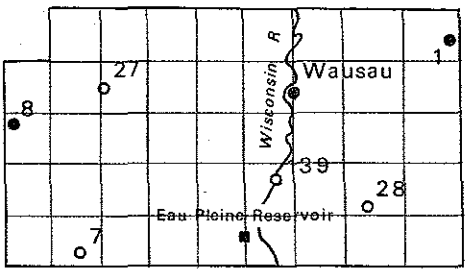


GROUND-WATER LEVELS IN MARATHON COUNTY





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WHAT YOU SHOULD KNOW ABOUT GROUND WATER

HOW GROUND WATER OCCURS AND ORIGINATES

Hidden beneath the land surface of the county—below a certain level called the water table—are natural reservoirs full of clean water that we call ground water. Contrary to popular belief, ground water does not flow in veins. There are some underground streams and lakes in cavernous limestone or lava rock, but they are rare and do not occur in your county. Ground water simply fills numerous small openings, pores or cracks in subsurface rocks.

The source of ground water is precipitation. When rain falls or snow melts, the first water is taken by plants and soil. After their thirst is satisfied and after some water runs off into streams, the excess water percolates down and joins the ground water stored in subsurface rocks.

HOW GROUND WATER MOVES

Rocks not only store water, they also transmit it. Upon joining the body of ground water, the percolating water moves through the openings in rocks and is constantly in motion. However, the ground water does not flow as freely and rapidly as water in surface streams. It has to squeeze through the intricate maze of interconnected openings that offer natural frictional resistance to the flow. Therefore, the ground water moves through this system (called an aquifer) very slowly. Flow is measured in feet per day or in feet per year (compared to the flow in streams, which is measured in feet per second).

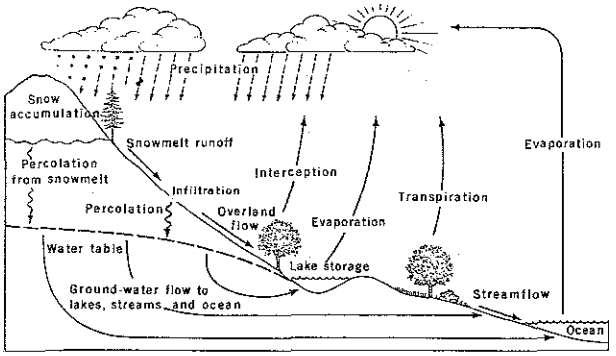
Much of the water in an underground reservoir infiltrates the ground within a radius of a few tens of miles from where it is found. It does not travel for hundreds of miles, and it certainly does not come "all the way from Canada." Most ground water originates within the county, although some comes from adjoining counties. After entering the aquifer, the water tends to move toward lower-lying places—being driven by gravity and a difference in pressure between the higher- and lower-lying places—and ultimately discharges into streams or springs. Ground water also can move upward when it is confined under artesian pressure (a pressure higher than atmospheric pressure).

In Marathon County, ground water flows from uplands toward the major streams and ultimately toward the Wisconsin River. Only in the easternmost tier of townships is the flow of ground water toward the Wolf River.

WHY STREAMS FLOW IN THE WINTER

Have you ever wondered why streams continue to flow in the middle of winter even though air and ground temperatures are below freezing and even though there is no rainfall? The answer is that winter streamflow is largely ground water continuously seeping into streams, and ground water is relatively warm, having a constant temperature between 46°F to 52°F. This shows that ground water and surface water do not represent isolated systems, as is commonly believed. Nor is ground water isolated from other water in nature's gigantic solar-

driven machine, called the hydrologic cycle. After entering a stream, ground water continues in its path until it reaches its home base, the sea, where the sun causes water to evaporate and rise into the atmosphere. Moisture-laden clouds are blown by winds over the land, clash with cold air and produce rain. The water falls again on the land and replenishes the streams and ground-water reservoirs, thus closing the never-ending water cycle.



Schematic diagram of the hydrologic cycle

(adapted from: Water in Environmental Planning, W.H. Freeman and Co., 1978)

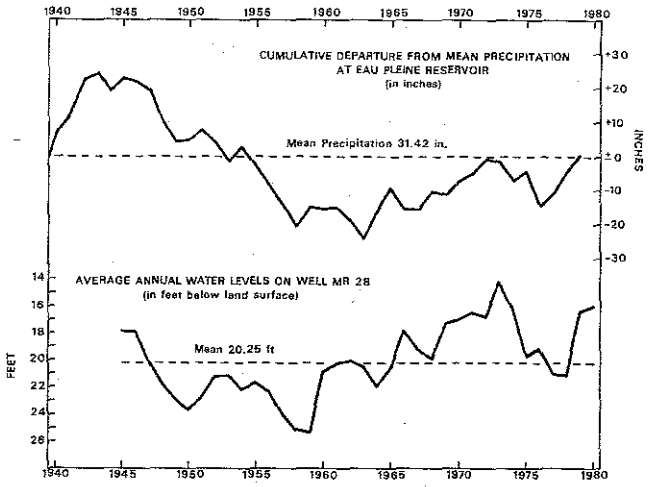
HOW DEEP IS GROUND WATER?

The surface of a ground-water reservoir, the water table, is not the same throughout the county and it varies both in time and place. The water table tends to be closest to the land surface in river valleys and marshes, and at greater depths beneath hills and ridges. It usually resembles a flattened form of the surface relief. Ground-water levels are fluctuating almost constantly, and decline and rise within a relatively short period of time, mainly in response to changes in the amount of rainfall and withdrawal of water from wells. Water levels respond to changes in precipitation only after a certain period of time, depending on the character of rocks and depth to ground water.

Besides short-term fluctuations, variations in precipitation cause seasonal variations of water levels. Water levels rise relatively rapidly in the spring due to recharge from snowmelt and spring rains and then gradually decline throughout the summer when evapotranspiration exceeds precipitation, which means that less water is available for infiltration. A small rise occurs in the fall due to fall rains. It is followed by a decline during the winter, when precipitation is stored on the land surface as snow. In addition, alternating series of wet and dry years produce gradual, long-term changes in water levels.

Based on records from water wells, the depth to ground water in the county ranges from 1 to 50 feet below the land surface. Only occasionally does the water level drop below 50 feet. Some of the wells in the county are included in a statewide network of observation stations where the changes in water levels are measured at regular intervals (see information on the other side).

HISTORICAL TRENDS IN WATER LEVELS

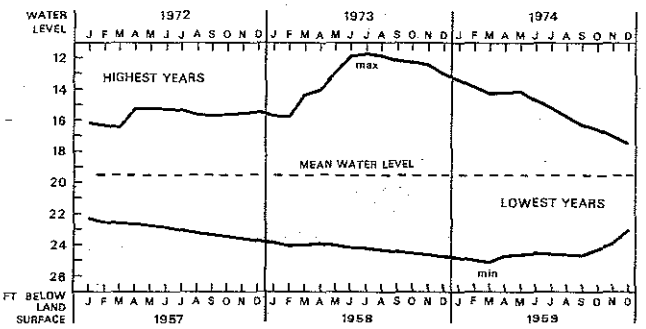


One of the main purposes of collecting data on water levels in observation wells is to determine the relationship of precipitation and other natural factors to fluctuations in water level. The similarity of the water-level record on well Mr 28, obtained during a period of 35 years, and the cumulative departure from average precipitation (cumulative departure being the difference between measured rainfall and average value for a selected period of time—in our case, a year—summed, or cumulated, for the entire period of record) shows the dominant role that precipitation plays in water-level fluctuations. The water level in well Mr 28, which is typical for upland areas of the county, does not respond immediately to individual rains but rather to the cumulative amount of precipitation during the 10 to 12 preceding months. The wells in low-lying areas, however, respond directly to the amount of rainfall within a few days. Near river channels, the water levels in wells may rise abruptly, responding within a few hours or even minutes to the increase in river water during the period of flood.

The similarity between trends in precipitation and trends in water levels permits both the estimate of future behavior of ground-water levels and reconstruction of past water-level fluctuations from precipitation graphs for earlier periods without water-level records.

The general trend of precipitation and of average annual water levels indicates that the water levels were steadily declining from their peak in the middle 1940's until they reached their minimum in late 1950's. During the last 20 years the trend has been generally increasing, even though the water levels temporarily dropped in 1974-1978. It is probable that the water levels will continue to rise for about 1 or 2 years and then start to decline, with at least two significant lowerings approximately 5 years apart.

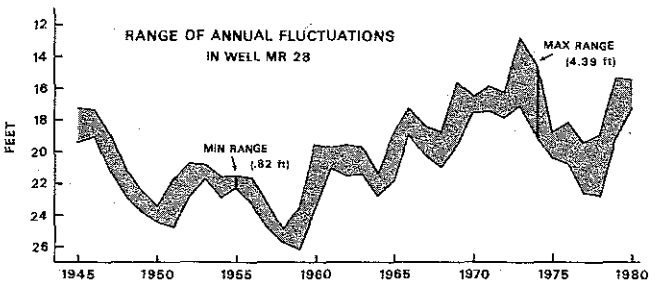
EXTREME WATER LEVELS



The change from high to low ground-water levels is irregular and usually gradual. Ground-water levels do not change like the total amount of rainfall, for example, which can change from extremely high to extremely low from one year to another. Minimal water levels do not occur immediately after maximum levels and vice versa. A number of years intervenes with moderately low or high levels in between. Generally, the high or low levels occur in intervals ranging from 4 to 10 years. The highest levels in the county were recorded in the 1970's and the lowest levels in the late 1950's or middle 1960's. On well Mr 28, the longest duration of extremely high water levels was from April 1972 to August 1974 and extremely low water levels lasted from March 1957 through January 1960.

An understanding of fluctuating ground-water levels is very important for the agriculture, economy, and water supplies of the county. Extended periods of low levels considerably deplete soil moisture and ground-water storage, which may result in crop damage and reduced crop production, water rationing, drying up of shallow wells and wetlands, and hauling water to water-short areas. High levels, on the other hand, may cause waterlogged soils in low areas, and flooding of basements, septic tank systems, landfills, and construction sites.

ANNUAL FLUCTUATIONS



The range of ground-water fluctuations is very important for the management of water supplies in the county. Maxi-

mum difference in water levels over a long period of time can be expected to be about 20 to 25 feet. Within a single year, fluctuations may range from less than 1 foot to 15 feet. The annual fluctuations of wells that respond slowly to precipitation such as Mr 28, are fairly uniform and are, on the average, between 1 and 7 feet. In rapidly responding wells, the range may be about twice this (2-15 feet).

Minimum water levels occur in February for most wells and, less frequently, in March, for slowly responding wells. Usually, maximum water levels are attained in May or April for quickly responding wells, and in June and July for slowly responding wells.

SUMMARY DATA FOR OBSERVATION WELL MR 28

Characteristics	Feet below land surface	Date
Mean Water Level	20.25	(calculated)
Highest Recorded Level	12.76	July 28, 1973
Lowest Recorded Level	26.09	March 30, 1959
Maximum Range of Fluctuations	13.32	(calculated)
Average Annual Fluctuation	2.12	(calculated)
Highest Monthly Mean	20.10	July
Lowest Monthly Mean	20.66	March
Highest Average Monthly Level	12.77	July 1973
Lowest Average Monthly Level	26.04	March 1959
Highest Average Annual Level	14.37	1973
Lowest Average Annual Level	25.40	1959

OBSERVATION WELLS IN MARATHON COUNTY

Well Number	Location	Measur. Started
Mr 1	Tn. of Harrison, NW¼NE¼ Sec. 25; 7 miles SSW of Antigo. Discontinued:	1948 1970
Mr 7	Tn. of McMillan, SE¼SE¼ Sec. 33; 2 miles NE of Marshfield.	1950
Mr 8	Tn. of Hull, SW¼SW¼ Sec. 18; at Colby. Discontinued:	1953 1976
Mr 27	Tn. of Johnson, SE¼SE¼ Sec. 24 4 miles S of Athens.	1944
Mr 28	Tn. of Reid, NE¼NE¼ Sec. 31; 12 miles E of Mosinee.	1944
Mr 139	Tn. of Kronenwetter, NW¼SE¼ Sec. 10; 3 miles SSW of Rothschild.	1968

AVAILABILITY OF DATA

Data on water-level measurements for all wells and on precipitation measurements are available at:

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