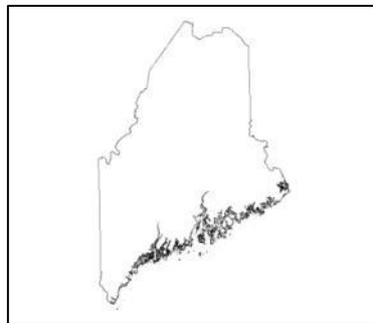


Geologic Site of the Month
October, 1999

Ground Water, Wells and the Summer of 1999



Text by
Maine Geological Survey



Introduction

The summer of 1999 was one of the driest on record in Maine. In fact, the [National Weather Service](#) station in Portland recorded only 44 percent of normal precipitation, the driest season in 129 years! The extended lack of rainfall raised concerns about ground water levels. Several municipal water districts including Stonington, Castine, and Lisbon Falls were forced to impose water conservation measures to ensure a reliable water supply. Many homeowners had their private wells go dry and many more were forced to limit their water use to some extent. So what is the relationship between ground water, wells, and the "drought of 1999"?



Ground Water

Ground water, as the name implies, is water found below the land surface in the pore spaces between sand grains and in fractures in the bedrock (Figure 1). The water table is the level below which all the pore spaces are filled with water. The area below the water table is called the saturated zone, while the area above the water table, where the pore spaces are filled partly with water and partly with air, is called the unsaturated zone. If you have a dug, driven point, or gravel-packed well the static water level in your well corresponds to the water table.

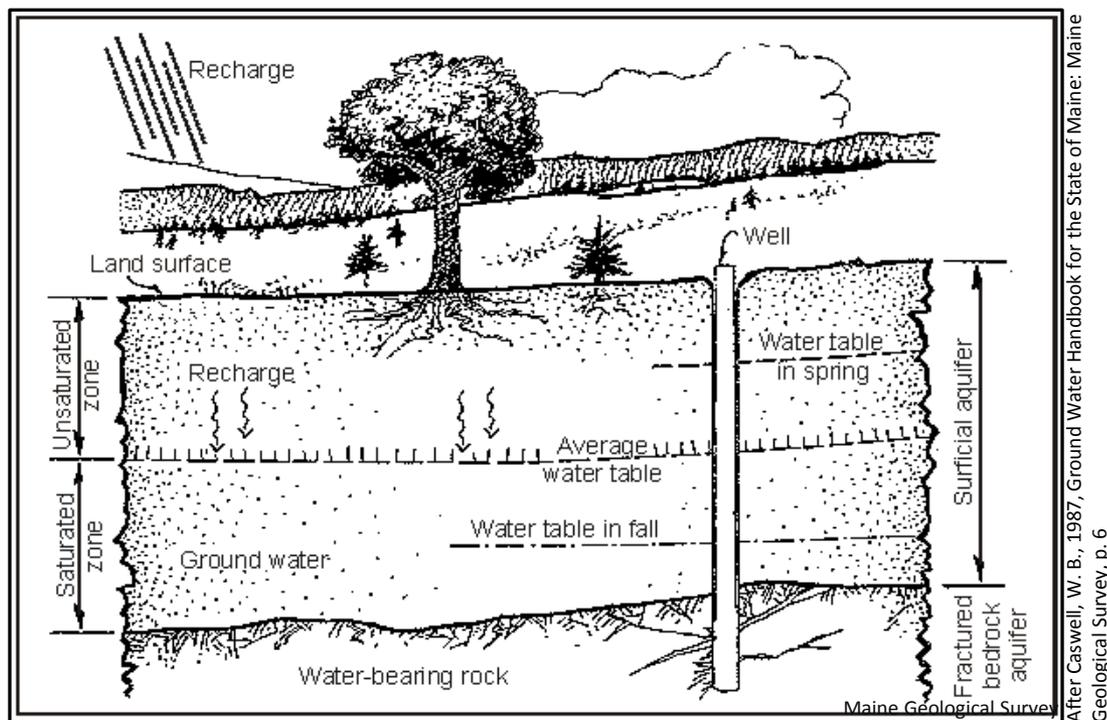


Figure 1. Diagram of water table showing saturated and unsaturated zones.



Ground Water

Ground water is replenished or recharged by rainwater and melting snow that soak into the soil. This water percolates downward and eventually reaches the water table. The actual level of the water table is a balance between the amount of water entering as recharge and the amount of water leaving by streamflow and uptake by plant growth. In a typical year, the water table is highest in the late spring during snowmelt, declines during the summer when recharge is lower and plant growth is high, rises again during the late fall rains and then declines slowly over the winter when frozen ground inhibits recharge.

During the dry summer of 1999 recharge from rainwater was especially low and, consequently, the water table dropped to lower than normal levels. The precipitation associated with Hurricane Floyd helped ease the situation. However, the rain from Floyd was so intense that much of it ran off as streamflow and didn't contribute to ground water recharge.

An aquifer is a water-bearing geologic formation capable of yielding a usable amount of ground water to a well. In Maine there are two types of aquifers; loose surficial materials (such as sand, gravel, and other sediments) and fractured bedrock. The yield of a well, measured in gallons per minute, is the amount of water that can be continuously pumped from a well without causing the well to go dry. The yield of a well in the surficial aquifer is dependent on the porosity and permeability of the surficial material (see section below on Porosity and Permeability). The yield of a drilled bedrock well is dependent on the size of the fractures intercepted by the well and how well interconnected those fractures are.



Wells

Figure 2 shows a schematic cross section of the aquifers in Maine. Several types of wells, common in Maine, are shown in the diagram.

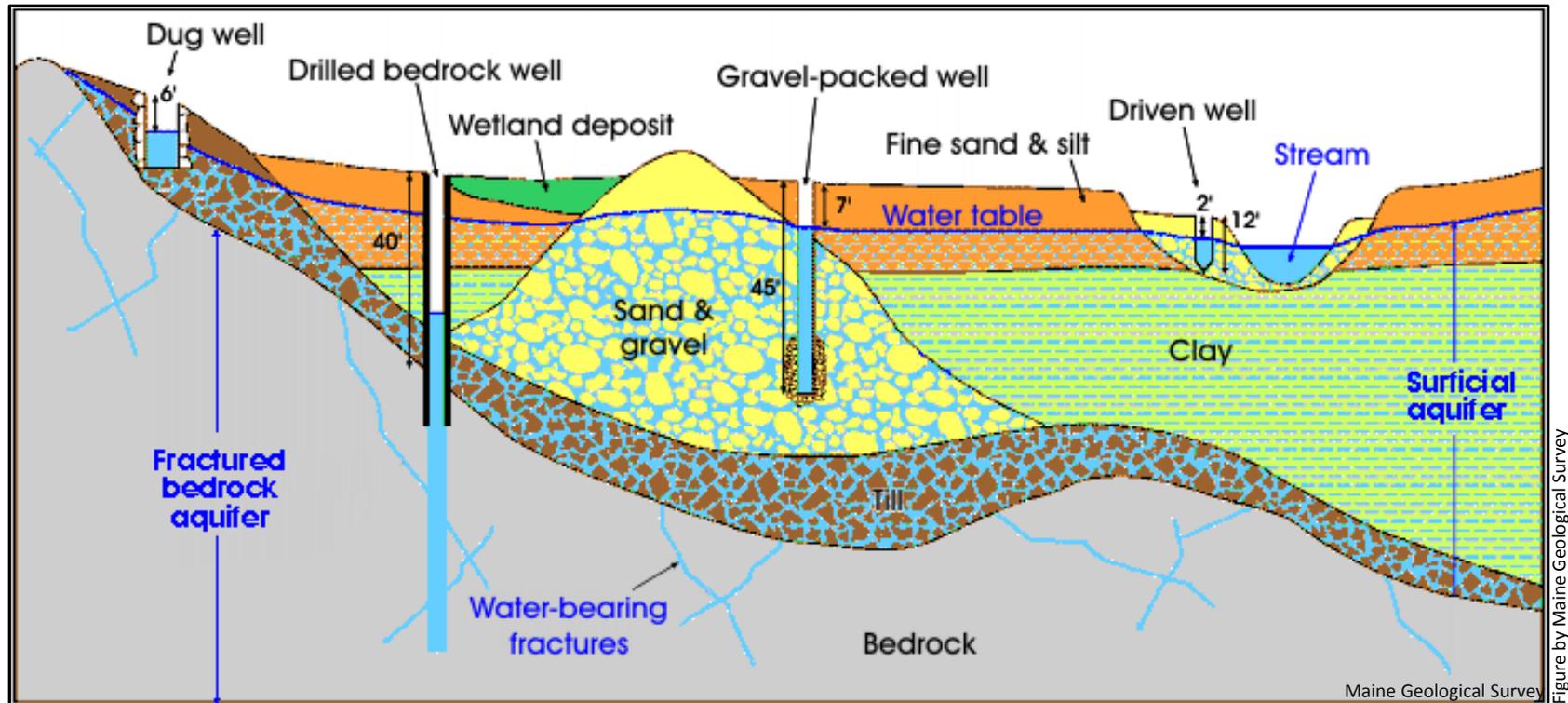


Figure 2. Schematic cross section of aquifers in Maine showing dug, drilled, and driven wells.

Wells

A dug well is a large diameter hole excavated by hand or backhoe. The hole is kept from caving in by installing a lining that may be stone, tile, or cement blocks. The hole must be deep enough to extend below the water table. Although the yield is often low, dug wells generally supply enough ground water for a household because of the large amount of water stored in the well.

A driven well or well point can be installed into sand and gravel where the water table is within about 20 feet of the ground surface. A 2 to 3 inch diameter pipe, equipped with a well screen at its lower end, is driven into the deposit until the screen is below the water table. This pipe acts as a casing, and water is pumped directly from the aquifer. Although the yield may be relatively high, driven wells generally only supply a single household because very little water is stored in the well casing.

Dug wells and driven wells are typically installed to only a few feet below the water table. This makes them sensitive to drought conditions. Many homeowners in Maine had these types wells go dry this summer when the water table dropped below the bottom of the well.

A gravel-packed well is usually installed into coarse-grained sediment and is drilled with a much larger diameter than the final casing and screen diameter. To increase the yield and pumping efficiency of the well, the space around the well screen is filled with selected gravel that increases the permeability in the immediate vicinity of the well. Gravel-packed wells are capable of producing water at hundreds or even thousands of gallons per minute. Such high-yielding gravel-packed wells are commonly drilled for municipal or industrial water systems.



Wells

Gravel-packed wells, while still installed in the surficial aquifer, are less sensitive to drought conditions than dug wells. Generally, these wells are fairly deep and the well screen is many feet below the water table. Rather than making these wells go dry, drought causes gravel-packed wells to draw water from a greater distance to maintain yield.

Another type of well common in Maine is the drilled bedrock well, commonly called an artesian well. This well is drilled into the underlying rock with steel casing to isolate the well from potential surface-water contamination. In this type of well, water is found when the well hole intersects water-bearing fractures in the bedrock. Notice in the diagram how the water level in this well is not the same level as the water table. The well casing isolates the bedrock well from the overlying sediments. The water level is controlled by water pressure in the fractures in the bedrock and is not related to the water table in the overlying materials.

Bedrock wells are the least sensitive to drought conditions. The fractures feeding the well may be hundreds of feet deep and may draw recharge from distant hillsides. However, bedrock wells situated on hilltops or in other areas of limited recharge may experience problems during a drought.

The problems experienced by many homeowners and municipalities during the summer of 1999 highlight the delicate balance between precipitation and ground water levels (Figure 3).



Drought in the Summer of 1999

The line graph shows fairly consistent water levels from October 1998 to February 1999. The beginning of ground water recharge conditions due to snow melt and rainstorms is represented by the rise in the curve from February to March. The drought of the summer of 1999 is reflected in the decreasing slope of the line from March to August. Following the strong rainfall during the month of September 1999, ground water levels have begun to rise again due to recharge by the heavy precipitation events during that month. However, fall rains will replenish ground water, dried up wells will recover, and the memory of the water problems will fade. Hopefully, the lessons learned from the 'drought of 1999' will not be forgotten, and steps will be taken to ensure a reliable water supply through future dry spells.

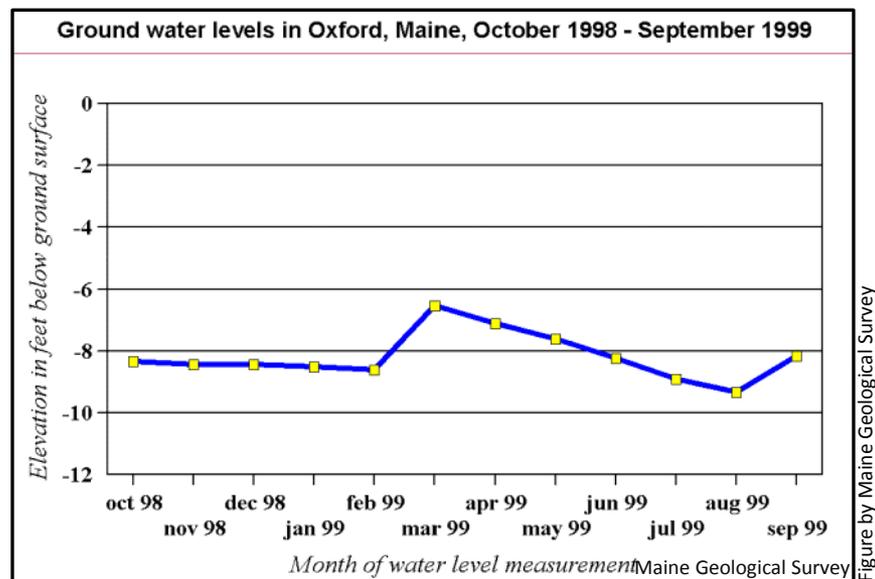


Figure 3. Ground water level measured in feet below the land surface in a monitoring well in Oxford, Maine, from October 1998 to September 1999. These data are collected and are reported monthly by the U.S. Geological Survey.



Porosity and Permeability

Figure 4 is an enlarged view of a section of Figure 2. Note that the section shown is below the water table and that ground water completely fills the pore spaces between the sediment grains.

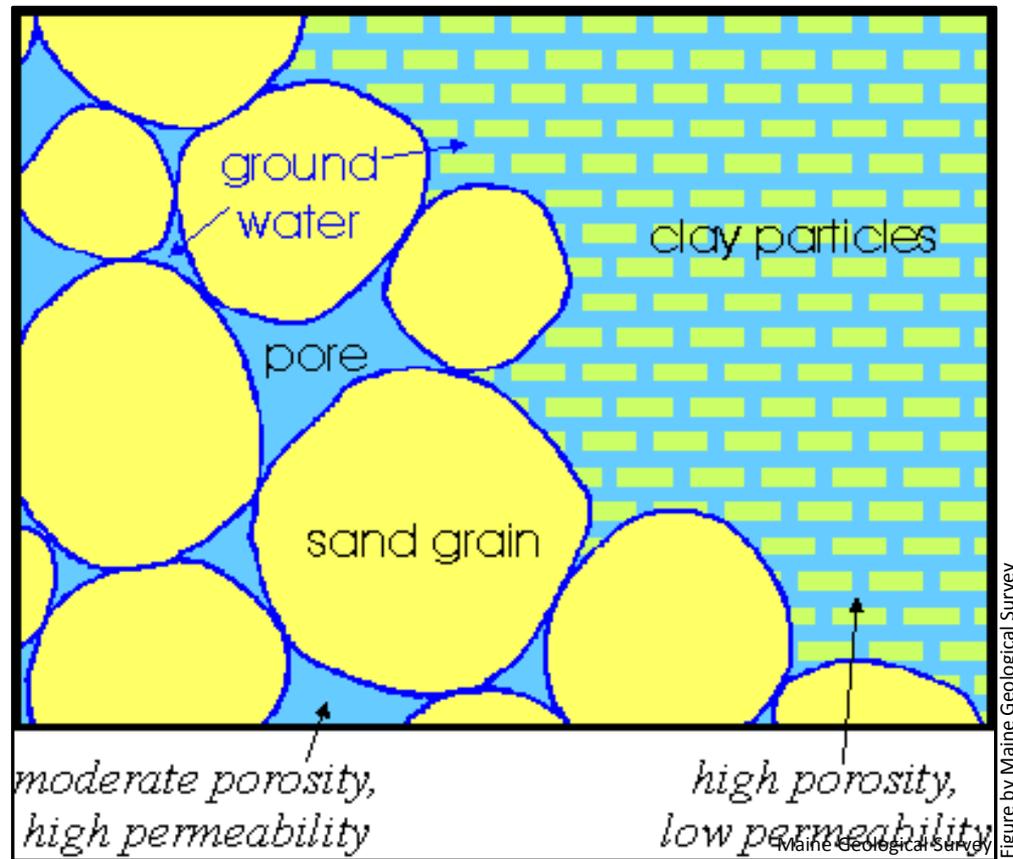


Figure 4. Enlarged view of Figure 2 showing pore spaces filled with water.

Porosity and Permeability

In an aquifer, the more pore space there is, the more water the aquifer can hold. This is called the porosity of a deposit. Permeability refers to the ability of a surficial deposit to transmit water. Permeability depends on the size of the spaces between the sediment grains.

Permeability is related to porosity, but is not the same. Porosity determines the capacity of the material to hold water. Permeability determines its ability to yield water. For example, clay is made of tiny particles with a large amount of pore space between them. However, the pore spaces are so small that they create a resistance to flow which reduces ground water permeability. Sand and gravel may not be as porous as clay, but the pore spaces are larger and better connected and the materials are much more permeable.

Permeability is an important characteristic since it determines how well water can actually move through the ground to a pumping well.



References and Additional Information

[Drought Watch](#) (U.S. Geological Survey)

[Definitions of drought](#) (U.S. Geological Survey)

[Water Resources of Maine](#) (U.S. Geological Survey)

[Ground Water Handbook for the State of Maine](#) (Maine Geological Survey)

