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Understanding Groundwater, Part 1: A limited, dynamic resource

BY SHARON MCCARTHY AND CHRIS MITCHELL | May 19, 2023

Editor's Note: "Understanding Groundwater" is the first of three articles on water use in Harvard. The second will focus on drought, and the third will focus on protecting our water resources.

Living in Harvard, an area of orchards, farms, Bare Hill Pond, and open space, has many characteristics to be grateful for, and they're visible every time we look around. However, it's equally important to be grateful for what's not visible but upon which we depend—our water. All residents of Harvard rely on groundwater drawn from the ground and pumped into our homes, schools, businesses, and public buildings. It's too easy to take for granted the water coming out of the tap or the water coming out of a sprinkler for our lawns and gardens. However, groundwater is a limited resource; it's a dynamic resource that is cyclically depleted and replenished.

What exactly is groundwater?

It's best visualized by remembering those holes dug at the beach that fill up with seawater. Although the beach surface is solid, the sand is permeable and can hold water in the spaces between the particles of sand. The top of the water in the hole is called the water table; the area beneath the water table is called the aquifer. The water stored in aquifers comes from rain and snow, which percolate into the porous ground. (See "How groundwater occurs in rocks," below.)

Aquifers can store huge quantities of water, but an aquifer is not static. The water in aquifers moves in response to various physical factors, highly dependent on the permeability of the aquifer material. For example, it moves faster through sand or gravel (highly permeable material) than through clay and shale (relatively impermeable material). Groundwater can also seep into streams and ponds, following routes to lower elevations. There are different types of aquifers. An aquifer found in cracks in the bedrock is called a "bedrock aquifer"; an aquifer that occurs in sand and gravel is called a "sand and gravel aquifer."

The groundwater in Harvard, for the most part, is from bedrock aquifers. Bedrock aquifers have limited storage capacity. All water in Harvard comes from wells drilled into an aquifer. Across town, the depth of drilled wells can vary from 50 to 600 feet or more below grade, with shallower wells likely in a sand and gravel aquifer and deeper wells in a bedrock aquifer.

The level of the water table at a well can change over time due to weather and precipitation, and water usage. Depending on local conditions and replenishment rate, a lower water table can be short-lived or, in some circumstances, can last for decades, or, occasionally, a well can run dry. Pumping (i.e., water usage) creates an area around the well where the water table is lower than the surrounding water table. See illustration below.

It's possible that excessive withdrawal from a deeper well can lower the water table at an adjacent property, especially if the adjacent property has a shallower well. If a well runs dry, the property owner must incur the expense of drilling a new, deeper well.

Historically, in Harvard, replenishing our aquifer from precipitation has generally been adequate. However, the frequency and duration of drought conditions due to climate change mean that the past may not predict the future. More frequent and severe droughts have and will occur as temperatures increase, and increasing evaporation rates combined

with less rain and snowfall are drying out our soils. Furthermore, dried, hard-packed soils do not absorb water at the same rate as uniformly moist soils; even though precipitation may increase, the water might run off rather than seep into the ground. The aquifers under Harvard are bounteous but not limitless. During the 2022 drought, United States Geological Survey documented that the local water table dropped more than 4 feet.

All of the groundwater in Harvard is interconnected and part of a shared resource; it is not owned by any one of us. The water under your house today could be under a neighbor's house or supplying a local farm in the future on its way toward lower-lying places. Not over-pumping your well not only protects you and your home, but also helps to protect the community's precious resource.

In Part 2, we'll discuss drought, how it's defined, and how it impacts not only your well but also the ecosystem.

For more information

For a primer on groundwater and aquifers from the USGS's Water Science School, go to: www.usgs.gov/special-topics/water-science-school/science/aquifers-and-groundwater.

For information about aquifers and the consequences of drawing too much water out of them, go to http://rdnwaterbudget.ca/water-101/aquifers-groundwater/.

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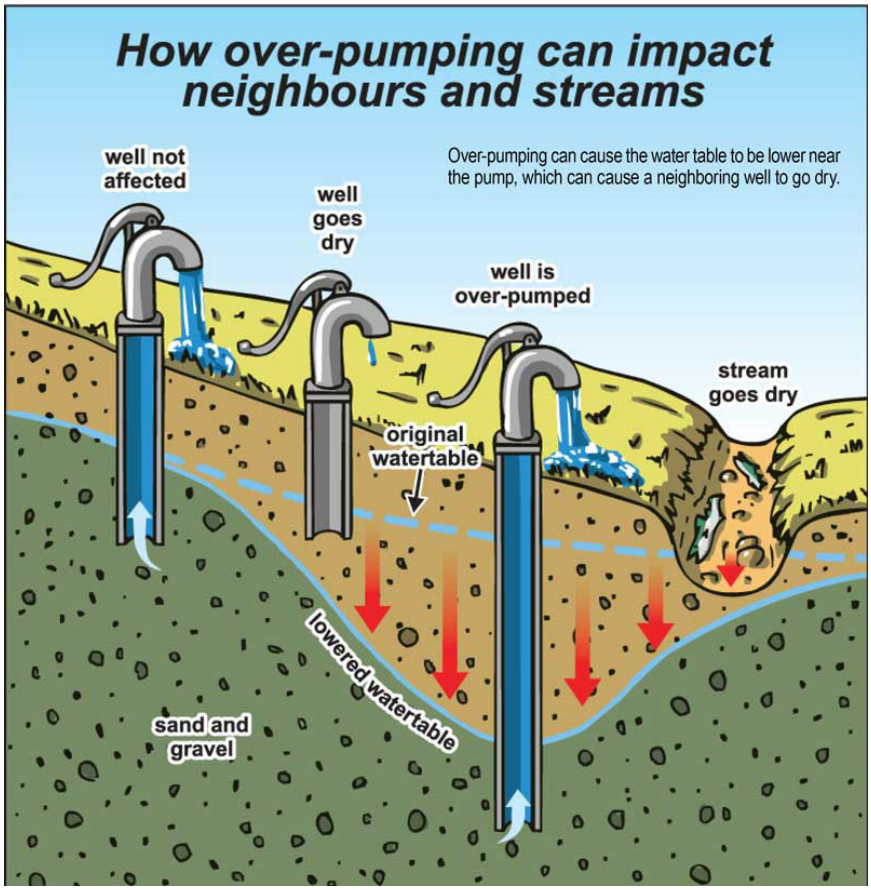
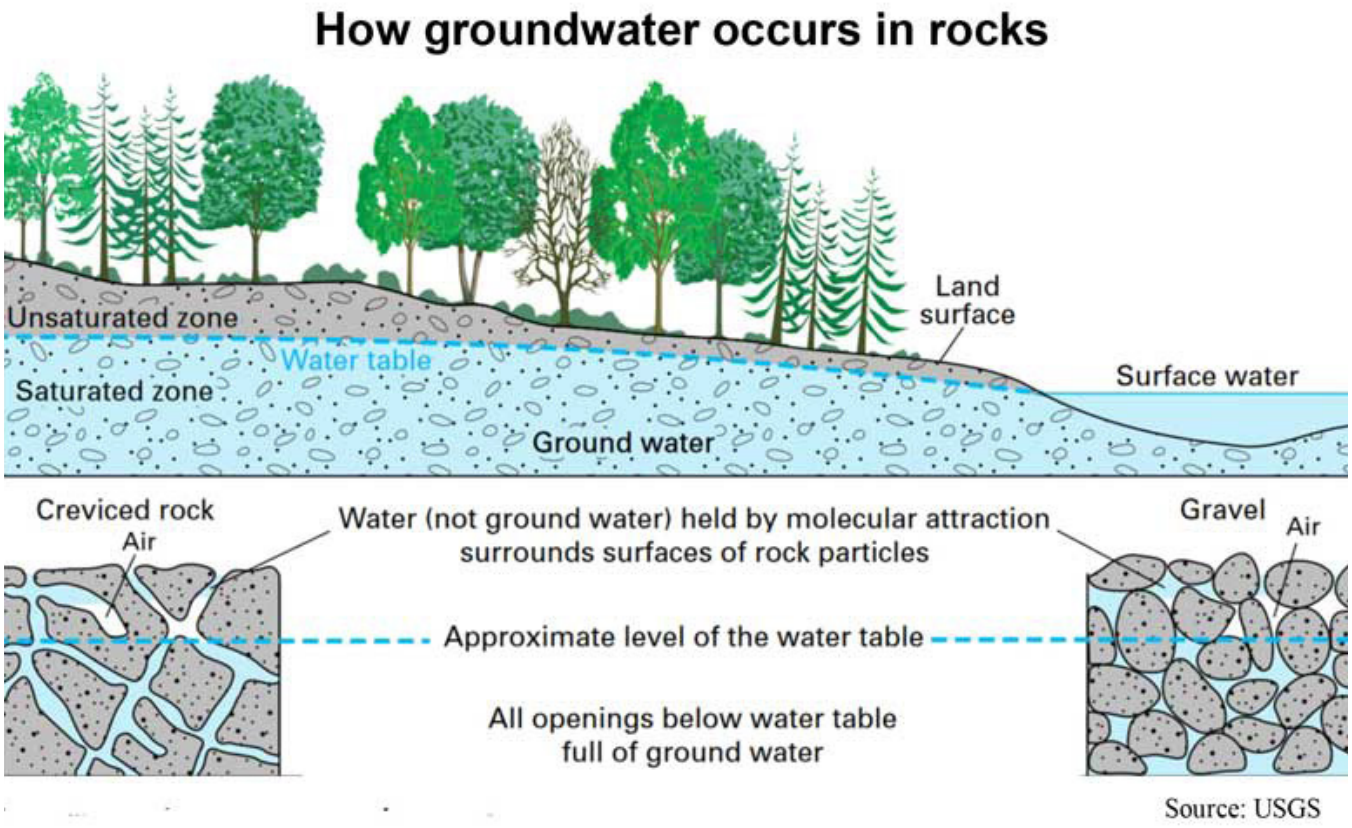


Source: Regional district of Nanaimo, British Columbia<



Groundwater regulations

Across the commonwealth, local health boards are delegated by state statute (MGL Ch.111 s.122) with the responsibility of protecting groundwater.

The local boards of health have jurisdiction to adopt private well regulations that establish criteria for private well siting, construction, water quality, and quantity in private wells.

By contrast, the Massachusetts Department of Environmental Protection regulates municipal water supplies. Harvard Board of Health regulations can be found in Chapter 145 of the Code of the Town of Harvard, and our drinking water standards can be found in Article II: Private Wells. In addition, Chapter 117 of the Code of the Town of Harvard, adopted at the Fall Town Meeting in 2022, empowered the Harvard Board of Health to restrict water use from private wells during a drought.