

Groundwater

Groundwater is important to our health, economy and ecosystems. About one-third of Canadians, including up to 80 percent of the rural population in some regions, rely on groundwater for potable water supply. The agriculture and industrial sectors account, respectively, for 43 percent and 14 percent of groundwater use.



Water occurs beneath the ground surface in pore space between particles of sediment and soil, in crevices and cracks of fractured rock, and in karst openings in limestone. The occurrence of water beneath the surface can be divided into the unsaturated zone and saturated zone (Figure 1). The unsaturated zone extends from the ground surface to the water table, which defines the top of the saturated zone. All pores and fractures are filled with groundwater in the saturated zone, and it is in the saturated zone that aquifers occur.

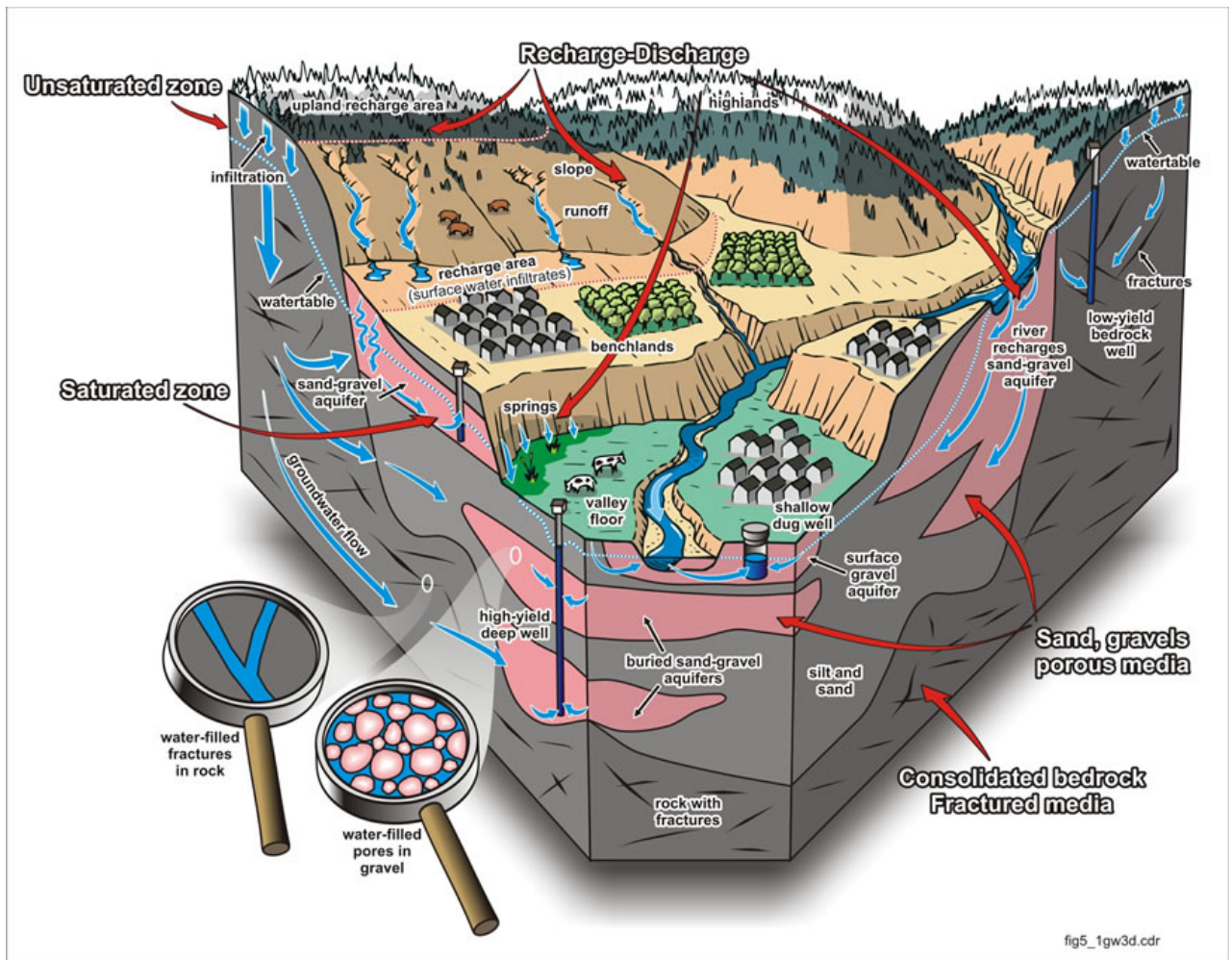


Figure 1. Typical Groundwater Setting

Source: Natural Resources Canada. 2008. Groundwater Mapping Program

Groundwater is recharged when precipitation enters the ground and percolates downward through the unsaturated zone to replenish aquifer storage. The rate of groundwater flow is controlled by the degree to which pores and fractures are interconnected. Groundwater flow is relatively slow through fine-grained materials such as clay or massive unfractured crystalline rock of the Canadian Shield, and these types of earth materials can form impermeable layers or aquitards that block or impede groundwater flow. Groundwater movement is much faster through sand and gravel and along fractures or through karst openings in limestone.

In Figure 1, saturated and unsaturated zones are defined by water table or piezometric levels. In general, the flow of groundwater is driven by gravity: it moves from areas of high hydraulic head to areas of lower hydraulic head (for example, toward lowland areas, as shown in Figure 1). At the regional scale, however, groundwater always moves from high to low topographic points. Groundwater can

discharge to springs and rivers in valleys and lowlands or find its way to wetlands, lakes and the ocean, where it evaporates into the atmosphere and forms the precipitation that continues the water cycle.

An aquifer is an underground formation of permeable material that can extend over an area ranging from a few hectares to thousands of square kilometres and yields groundwater for domestic, agricultural, industrial or other useful purposes. There are two main types of aquifers, porous media aquifers and fractured aquifers. Porous media aquifers allow groundwater to move through pore space between particles of sand and gravel, as in moraines, or between the particles in porous rocks such as sandstone. In fractured media aquifers, groundwater moves along crevices and cracks in rocks such as limestone. In some places, the fractures in limestone are accentuated by chemical weathering to form karst features, where groundwater flow occurs in larger channels and caverns.

Aquifers can either be unconfined near-surface bodies, which are connected directly to the unsaturated zone, or confined bodies, which are separated from the unsaturated zone by an impermeable layer that prevents direct recharge. Groundwater in unconfined aquifers is often in direct connection with wetlands, rivers and lakes, and therefore provides discharge to these surface-water features. Groundwater from confined aquifers can discharge to the surface under pressure, creating artesian flow where the impermeable confining layer is breached.

Definitions of underlined terms

Aquitard: A confining bed that retards but does not prevent the flow of water to or from an adjacent aquifer; a leaky confining bed. (Source: Glossary of Geology, First Edition. Gary, M., McAfee, R., Jr. and Wolf, C. Editors. American Geological Institute, 1974)

Artesian: An adjective referring to groundwater confined under hydrostatic pressure. (Source: Glossary of Geology, First Edition. Gary, M., McAfee, R., Jr. and Wolf, C. Editors. American Geological Institute, 1974)

Confined Aquifer: An aquifer bounded above and below by confining beds; an aquifer containing confined groundwater ((Source: Glossary of Geology, Fifth Edition. Neuendorf, K., Mehl, J. and Jackson, K. American Geological Institute. 2005.)

Fracture: A general term for any break in a rock, whether or not it causes displacement, due to mechanical failure by stress. (Source: Glossary of Geology, First Edition. Gary, M., McAfee, R., Jr. and Wolf, C. Editors. American Geological Institute, 1974)

Hydraulic head: The height of the free surface of a body of water above a given subsurface point. Source: Glossary of Geology, Fifth Edition. Neuendorf, K., Mehl, J. and Jackson, K. American Geological Institute. 2005.)

Karst: a type of topography that is formed over limestone and gypsum by dissolution and that is characterized by holes, caves and underground drainage.

Moraine: Ridge made of the accumulations of till and constructed by direct action of the glacier.

Piezometric Level: (potentiometric surface) A surface representing the static head of groundwater and defined by the level to which water will rise in a well. The water table is a particular type of potentiometric surface. (Source: Glossary of Geology, Fifth Edition. Neuendorf, K., Mehl, J. and Jackson, K. American Geological Institute. 2005.)

Unconfined Aquifer: An aquifer having a water table; an aquifer containing unconfined groundwater. (Source: Glossary of Geology, Fifth Edition. Neuendorf, K., Mehl, J. and Jackson, K. American Geological Institute. 2005.)

Water Table: The surface between the saturated zone and the unsaturated zone; that surface of a body of unconfined groundwater at which the pressure is equal to that of the atmosphere. (Source: Glossary of Geology, First Edition. Gary, M., McAfee, R., Jr. and Wolf, C. Editors. American Geological Institute, 1974)