THE SECRET LIFE OF GROUNDWATER

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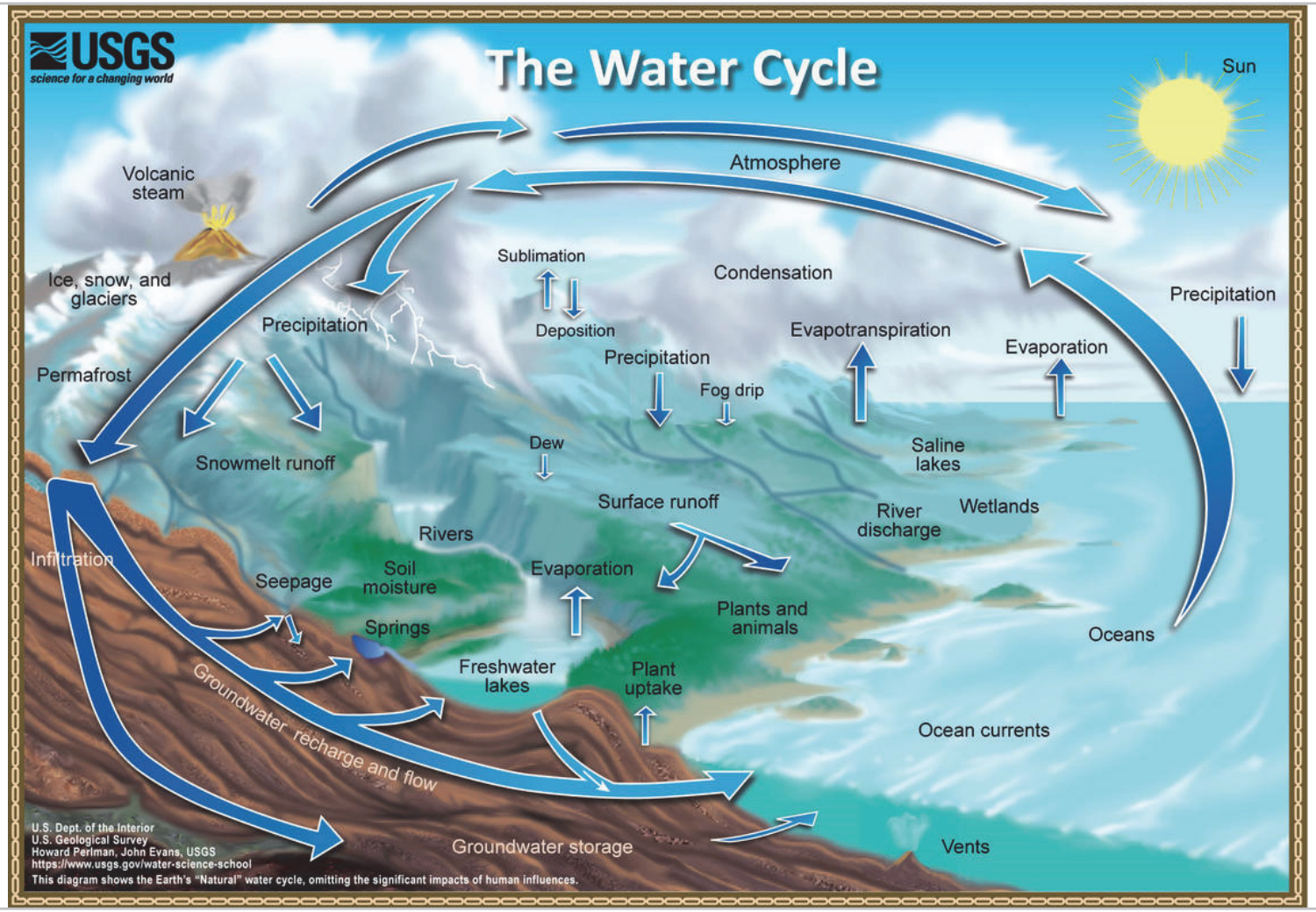
Groundwater flow according to Athanasius Kircher (Kricher, 1665)
Image from www.un-igrac.org/sites/default/files/resources/files/Groundwater_around_world.pdf

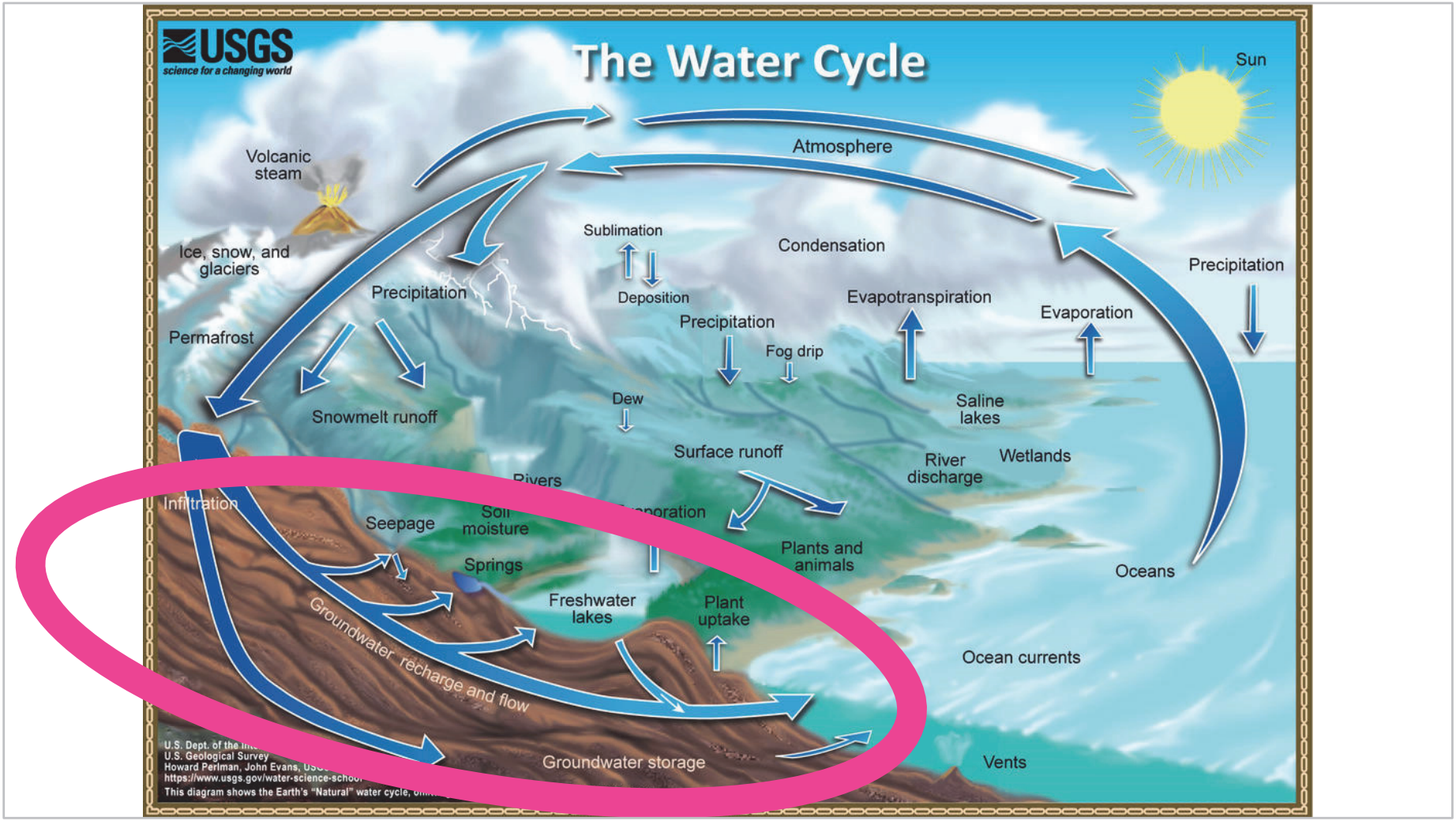
Groundwater has often been perceived as a complete mystery. Imagination and mythology used to drive perceptions of groundwater flow.

This is a depiction of groundwater flow from the 1600s. Back then, people believed that water moved from the sea floor up to mountains through mysterious channels where it emerged as springs. The Texas Supreme Court, in more recent history, has even called groundwater 'secret, occult, and concealed.'



Now, based on scientific observation, we have the water cycle as we know it today. I'm sure y'all are all familiar with the water cycle, how water moves around the earth and atmosphere. The basics, if you need a refresher, evaporation, condensation and precipitation.

The water cycle is so much more than just that. Scientists continue to collect data to understand all parts of the water cycle because it's essential to life on earth and understanding all parts of it can help us make smart decisions around use and conservation to ensure we have water available for generations to come.



Today we'll focus on the groundwater portion of the water cycle.

Groundwater is a very important resource in Texas for things like irrigation, public water supply, and environmental needs; in fact, there is more groundwater use in the state than there is surface water use.

Groundwater is a resource we can't see, which makes it a little more difficult to study.

You can really only see evidence of groundwater when you start digging holes in the ground or get curious about water bubbling up from the surface.

Video from Cody Bjornson, Texas Water Development Board

This is a video of a spring, water bubbling up from the ground then feeding into the adjacent river. The folks in the video are taking measurements of the spring to understand how much it contributes to the surface water flow.

Water table appears in a whole dug on a beach
Image from www.usgs.gov/special-topic/water-science-school/science/aquifers-and-groundwater?qt-science_center_objects=0#qt-science_center_objects

Early stages of excavation for a hand-dug water well, Niger, Aftica
Image from www.gwiwestafrica.org/en/example-excavation-hand-dug-well-early-stages-niger

Here we have examples of water seeping through sand, dirt, and rocks while digging holes in the ground.

Hand-operated well pump.
Image from www.pinterest.com/pin/682436149765969797/

Artesian (flowing) well.
Image from www.usgs.gov/media/images/a-flowing-artesian-well-sycamore-valley-missouri-usa

After a well is drilled (or dug by hand), you can see groundwater as it's pumped from a well, or sometimes, you'll even see flowing wells. I'll explain how these flowing wells occur a bit later.

Big Well in Greensburg, Kansas. The largest hand-dug well in the states.
Image from Larry French, Texas Water Development Board

Now, you can't actually see water in this well, this is more just a fun example of a well. The Big Well is the biggest hand-dug well in the United States in Greensburg Kansas. It's about 30 feet wide and about 100 feet deep and was used as a water supply until about the 1930s. Now it's a tourist attraction in Kansas.

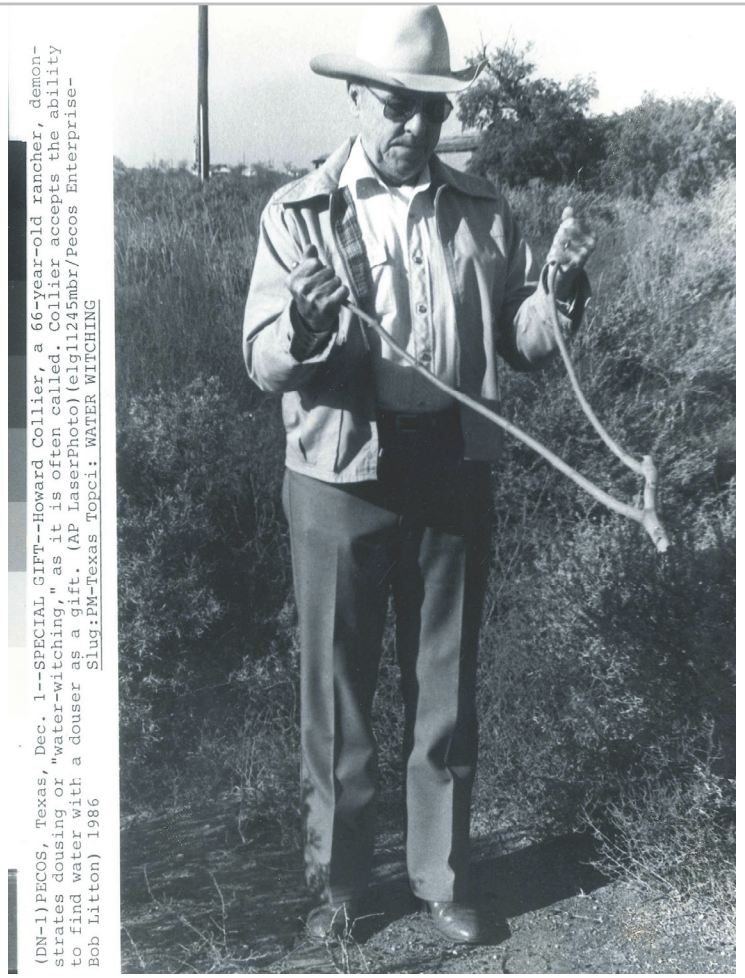
Big Well in Greensburg, Kansas. The largest hand-dug well in the states.
Image from Larry French, Texas Water Development Board

Fun Fact, it's considered one of the 8 Wonders of Kansas!

HOW DO WE KNOW WHERE TO FIND WATER?

So, we know groundwater exists, but how do we know how to find it?

Dowser from an 18th Century French book about superstitions.
Image from en.wikipedia.org/wiki/Dowsing



(DN-1)PECOS, Texas, Dec. 1--SPECIAL GIFT--Howard Collier, a 66-year-old rancher, demonstrates dousing or "water-witching," as it is often called. Collier accepts the ability to find water with a douser as a gift. (AP LaserPhoto)(elg11245mbr/Pecos Enterprise-Bob Litton) 1986
Slug:PM-Texas Topci: WATER WITCHING

Photo By Bob Litton. All Rights Reserved
Image from boblitton.wordpress.com/tag/water-witching/

Back in the day, folks relied on magic to find groundwater. The technique is called dowsing, or water witching. It's traditionally done with a wishbone-shaped tree branch held in two hands. As you walk across the land, the branch starts to pull downward when there's water underneath. This is not a scientifically-proven technique, but is still used to this day by farmers, ranchers, and water well drillers.

But, understanding how and where to find groundwater isn't magic, It's science.

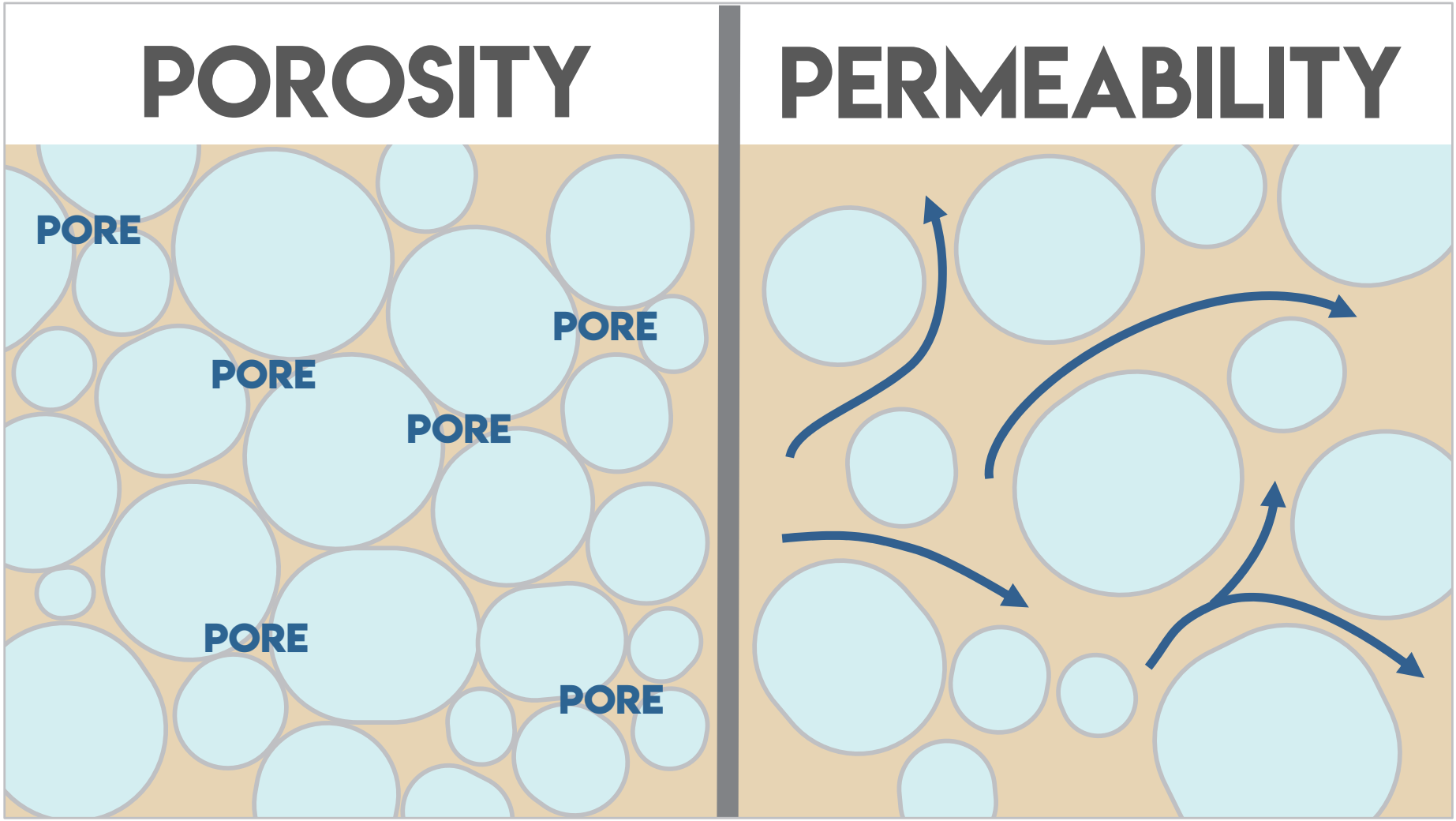
Studying geology and hydrogeology helps us understand how groundwater is stored in and moves through an aquifer and can help us understand the impacts humans have on groundwater resources.

DIRT & ROCKS

An aquifer is a **geologic media** that can yield **economically usable** amounts of water

So, what is an aquifer? Aquifers are essentially dirt and rocks (geologic formations) that are filled (or saturated) with water. Aquifers are water-bearing rocks underneath the land surface. The official definition in the US is ‘a geologic media that can yield economically usable amounts of water.

Aquifers are formed very slowly over time and are filled up when rain falls an infiltrates into the aquifer. When these pore spaces become saturated with water, they become an aquifer.



Porosity and permeability are two important terms in hydrogeology, They help us understand the ability of an aquifer to store and produce water.

Porosity is the measure of the volume of empty space inside the rock and represents the volume of water a rock formation can hold.

Permeability is a measure of how readily water can flow within the rock.

Hickory Aquifer

sandstone

The next three slides are examples of aquifers in Texas (these are the unsaturated parts of the aquifers; the rock formations that are exposed at the land surface, aka outcrops)

Hickory Aquifer, Llano uplift area, near Honey Creek (HW 71)

Edwards-Trinity (Plateau) Aquifer

limestone

Edwards-Trinity Plateau Aquifer (Fort Terrett Mbr), Interstate 10 near Kerrville

Ogallala Aquifer

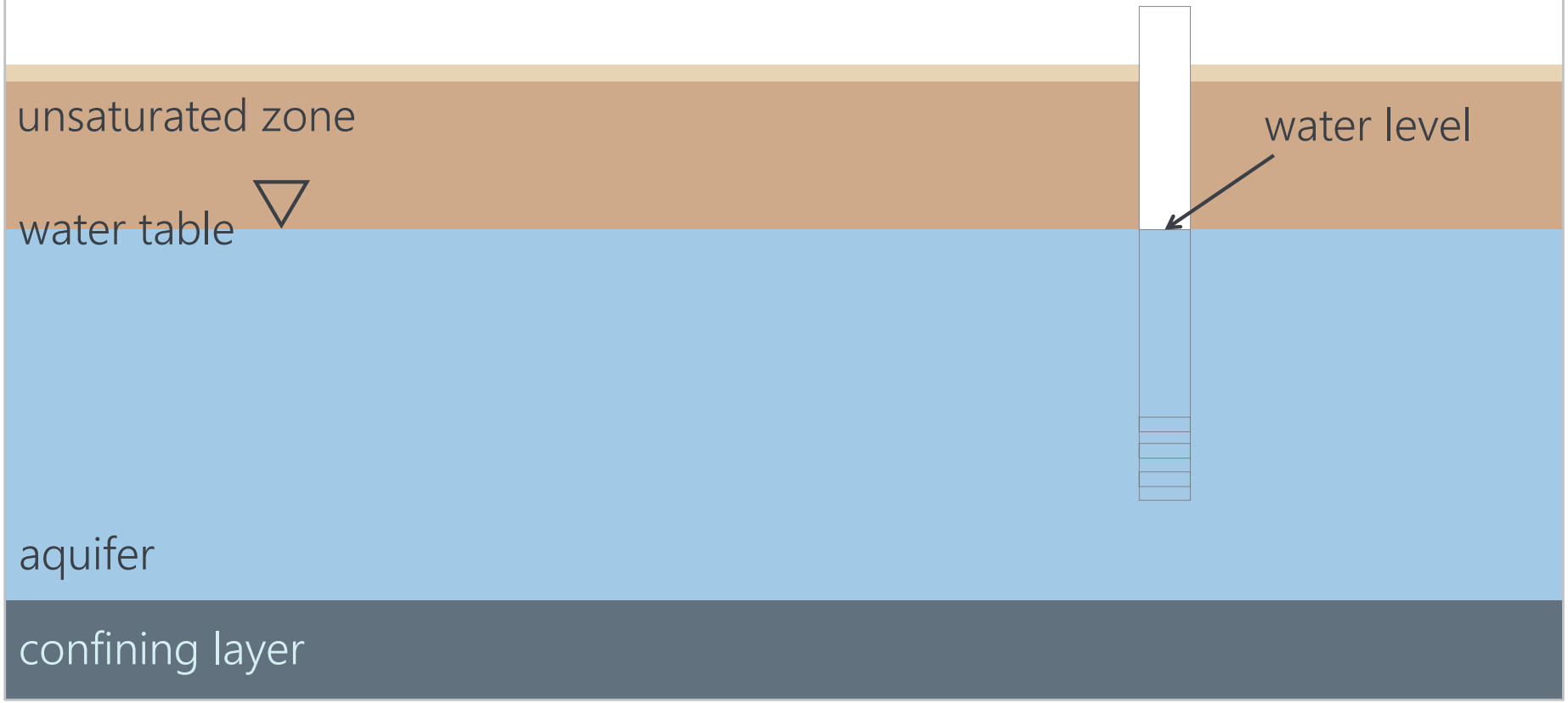
sand and gravel

Ogallala Aquifer near the entrance to Palo Duro Canyon State Park

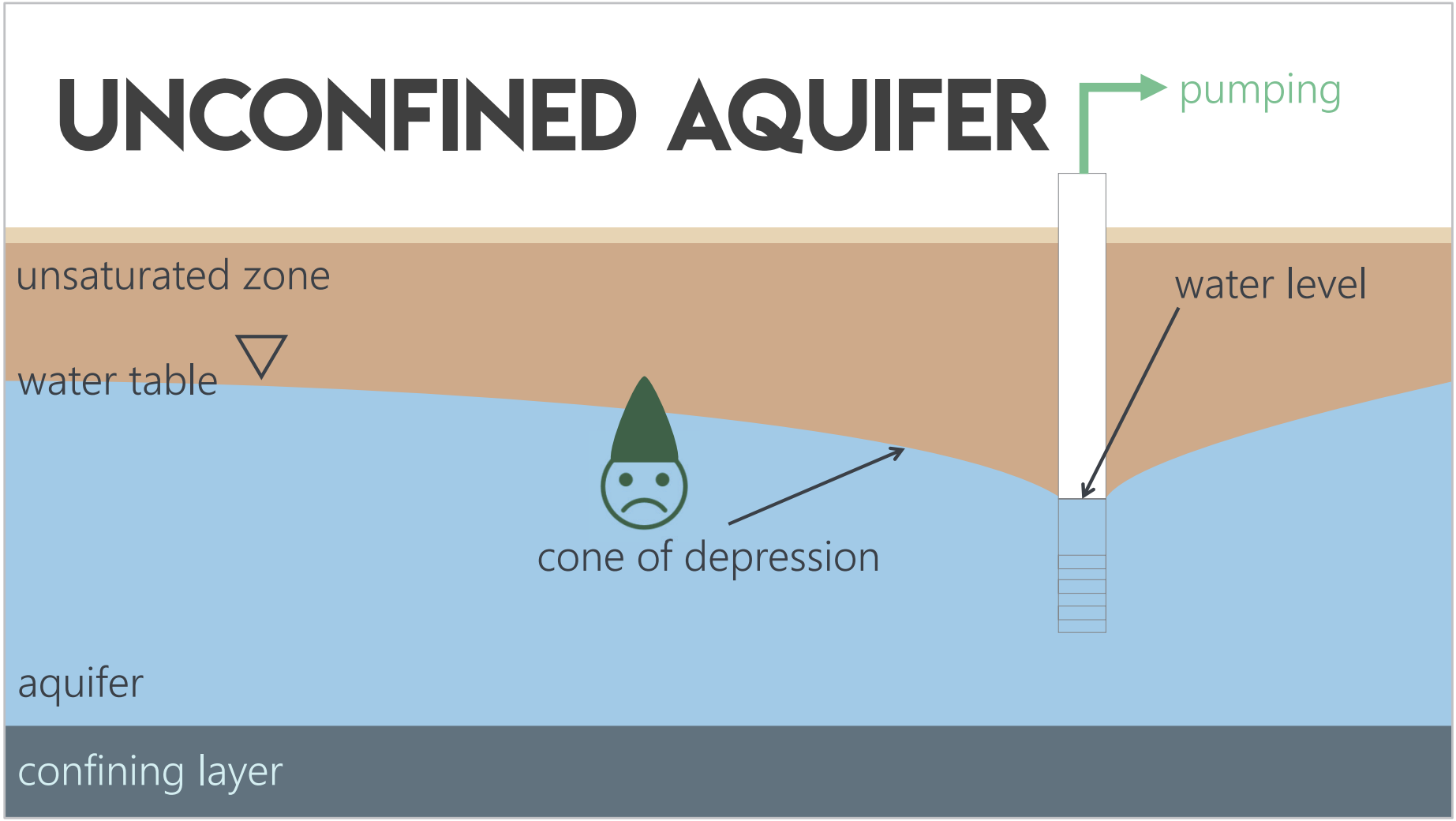
TWO GENERAL TYPES OF AQUIFERS

There are two types of aquifers: unconfined and confined

UNCONFINED AQUIFER

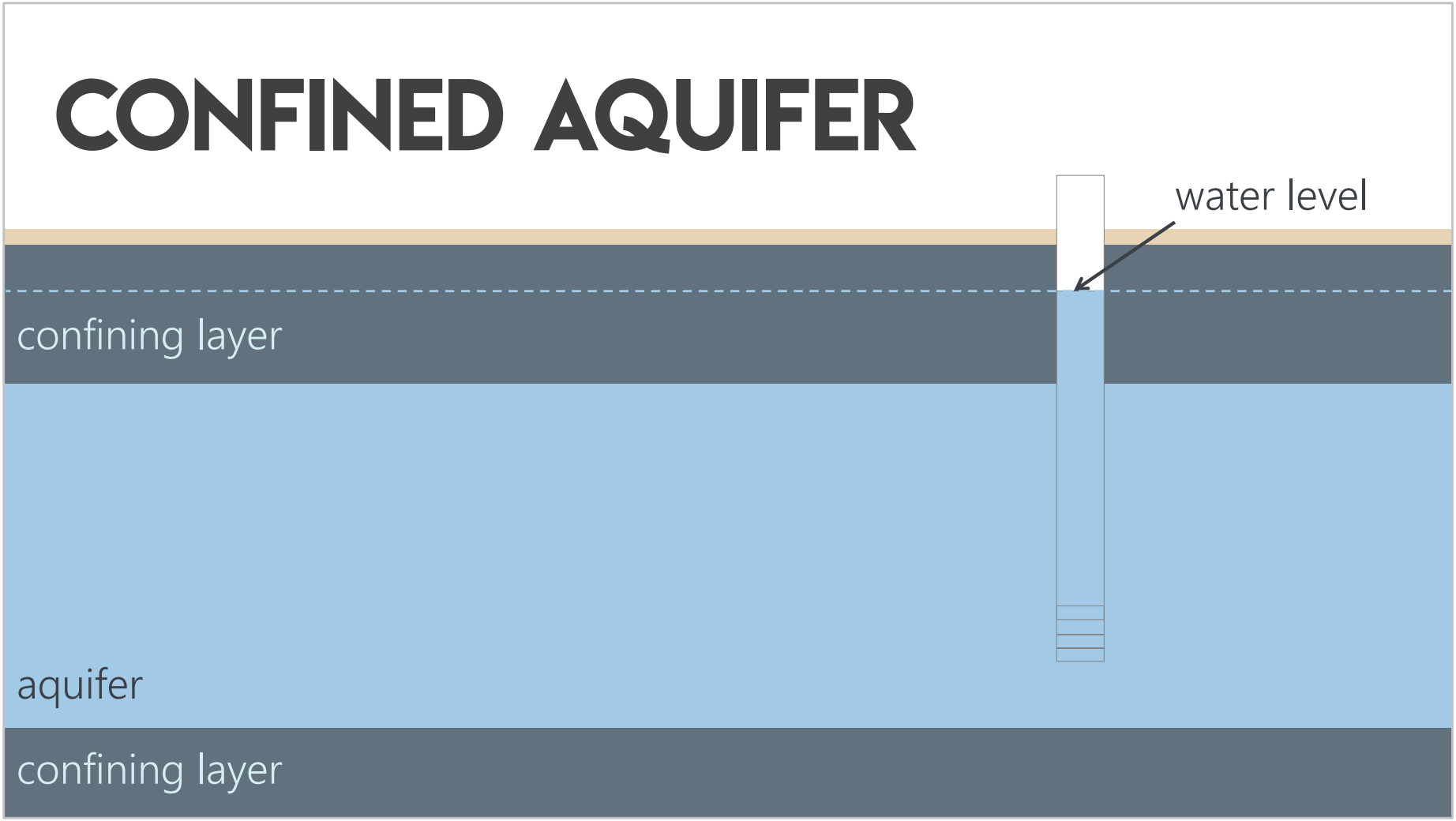


An unconfined aquifer is an aquifer that is bounded by a confining layer at the bottom, but not at the top.



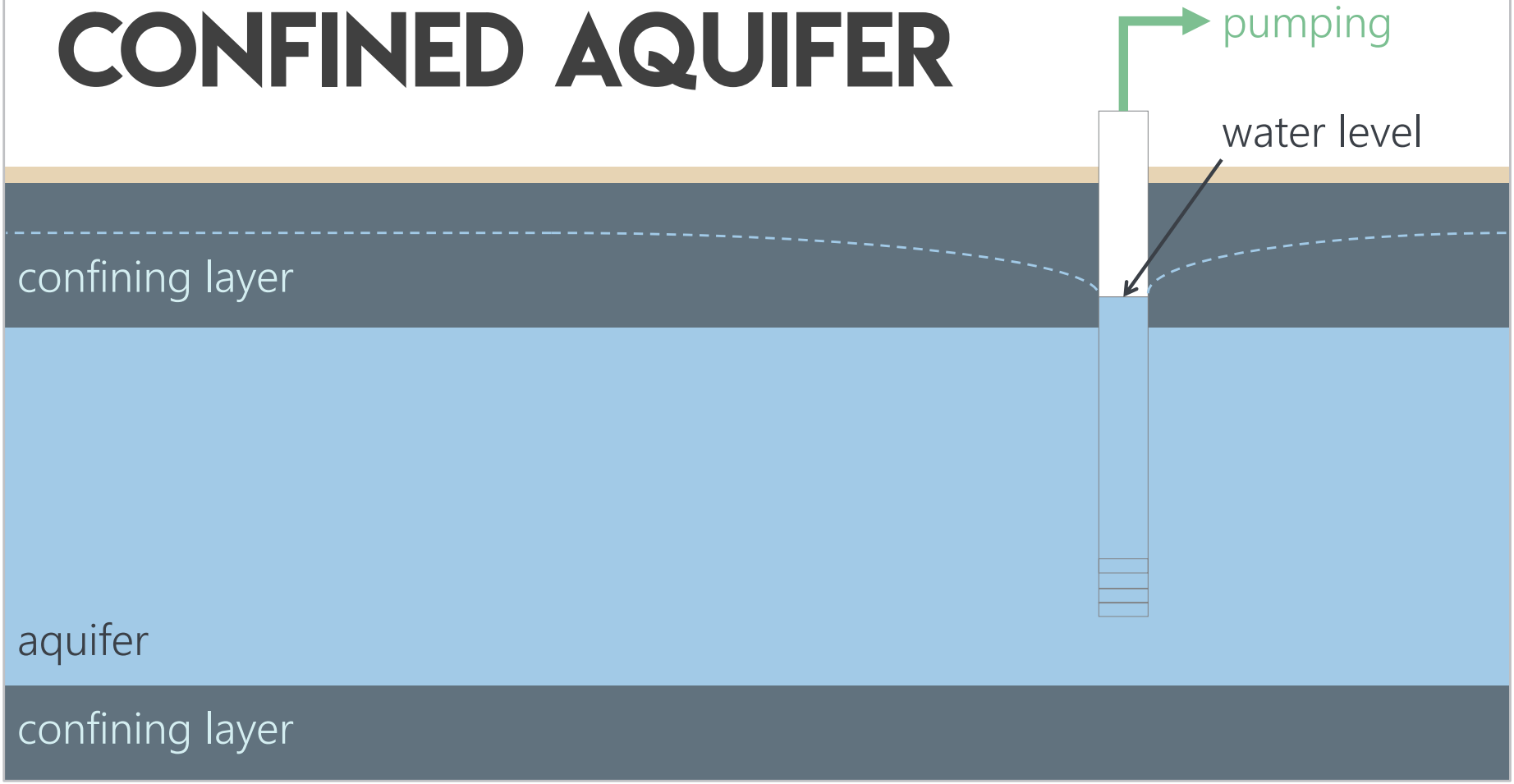
When you start pumping out of an unconfined aquifer, the water level in your well drops, creating a ‘cone of depression’.

CONFINED AQUIFER



A confined aquifer is an aquifer that is bounded by confining layers at its bottom and top, and where the water level rises above the top of the aquifer. The water level in a confined aquifer is called the 'potentiometric surface'. Also called an artesian aquifer. You can envision this type of aquifer by imagining filling up a Ziploc bag completely with water, and then poking a straw into the bag.

CONFINED AQUIFER



Similar to an unconfined aquifer, when you start pumping , the water level in a well begins to drop, and you see a similar ‘cone of depression’ in the potentiometric surface.

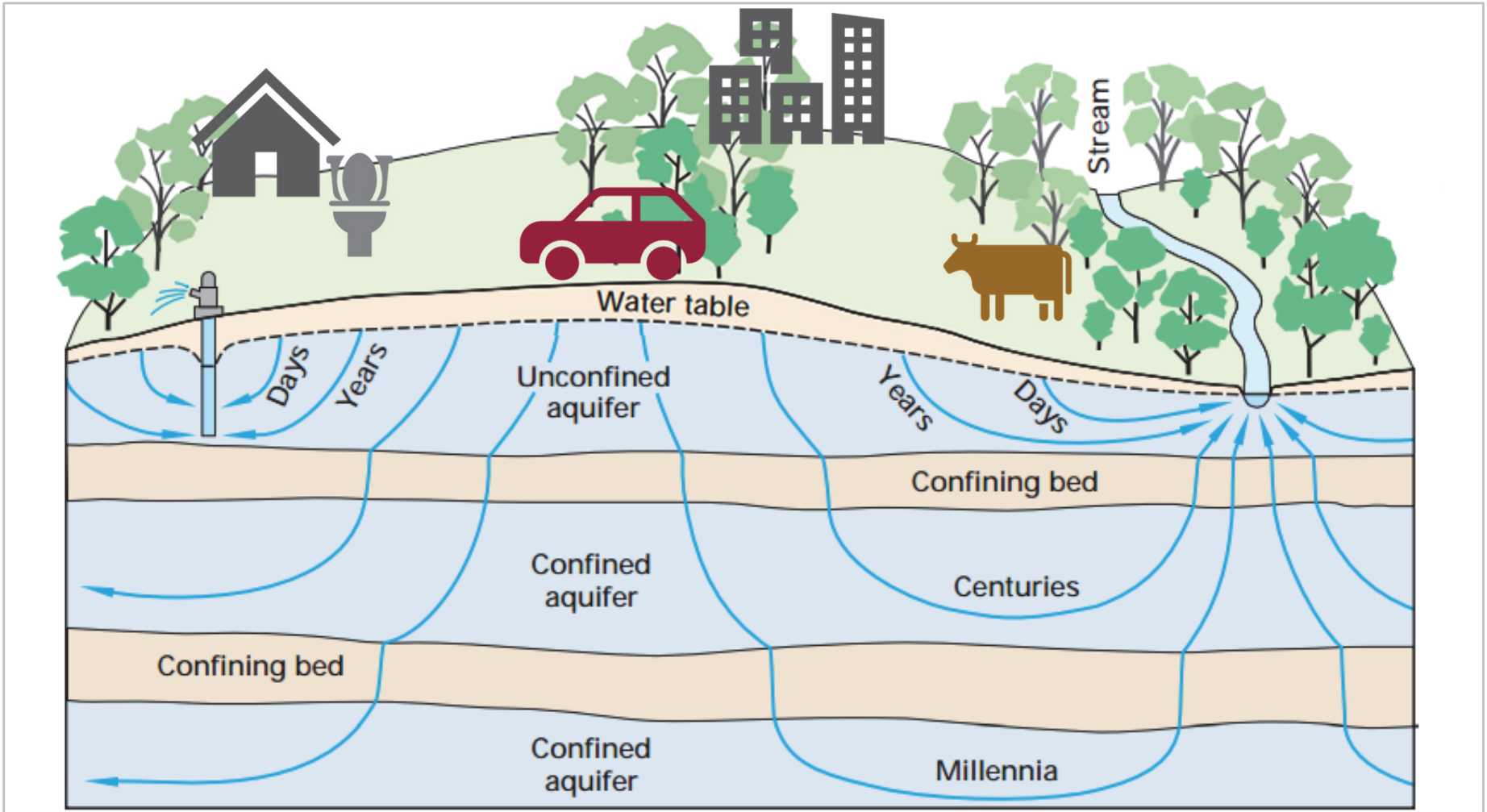


Diagram from pubs.usgs.gov/circ/circ1139/htdocs/natural_processes_of_ground.htm

Oftentimes, there are multiple types of aquifers in any given location. You can also see in this diagram that the time it takes for water to flow underground can vary from days to thousands of years.

This diagram shows a scene mainly uninterrupted by humans. But we have all sorts of infrastructure and other things going on at the land surface that could impact water supplies. Septic systems, urban development, cars and gas stations, and farming/ranching practices all have the potential to contaminate groundwater supplies.

Understanding an aquifer and how it behaves can help us understand what happens when contaminants or pollutants get into our groundwater, and what we can do to prevent or remedy the situation.

ACTIVITY

Point/nonpoint source pollution impacts on aquifers

ADDITIONAL RESOURCES

Texas Water Development Board Educational Groundwater Videos
www.twdb.texas.gov/groundwater/video/index.asp

Texas Water Development Board Educational Resources
www.twdb.texas.gov/conservation/education/kids/index.asp

US Geological Survey Water Science School
www.usgs.gov/special-topic/water-science-school/science/groundwater-flows-underground?qt-science_center_objects=0#