



Groundwater

101

**JUST FOR
KIDS**



LOST PINES
GROUNDWATER
CONSERVATION DISTRICT



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GROUNDWATER 101

INTRODUCTION

Groundwater is super important in Texas!

50%

OF ALL TEXANS
DEPEND ON
GROUNDWATER
FOR DRINKING
WATER

20%

OF ALL PUBLIC
SUPPLY OF
WATER COMES
FROM
GROUNDWATER

But what is groundwater?

This guide will help you understand what groundwater is, where it comes from, how much of it there is, and how it is managed.

WHAT IS Groundwater?



Groundwater is water that lives underground in the spaces between soil, gravel, and cracks in rocks. Imagine the ground is like a big sponge with lots of tiny holes and spaces. When it rains, water trickles down into these spaces and fills them up. This water is called groundwater. To understand groundwater better, it's helpful to know a bit about the types of rocks and soil underground. There can be loose materials with lots of space for water, hard rocks with cracks that water can fill, or porous sediment that lets water move through easily, as shown in Image 1.

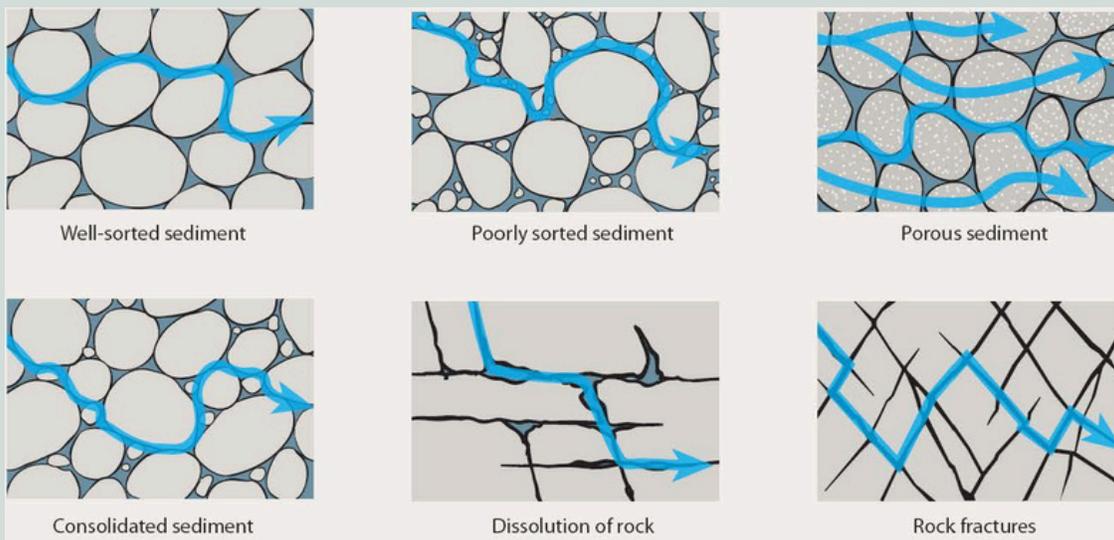


Image 1: Groundwater in different sediments and rocks.

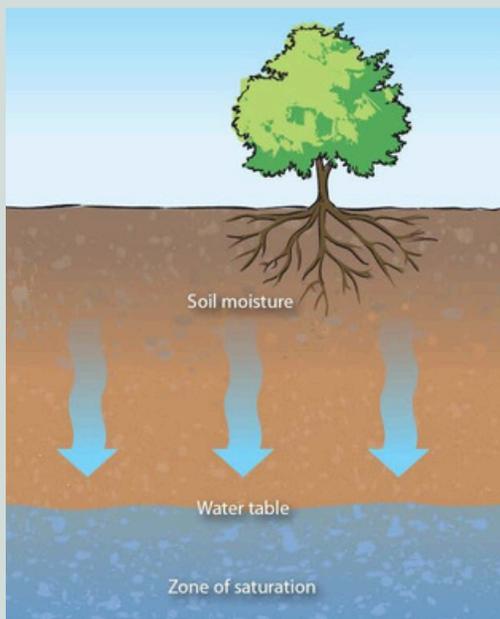


Image 2: Soil moisture going down to the water table and filling up the zone of saturation below.



WHAT IS AN Aquifer?

An aquifer is like a big, underground reservoir where groundwater is stored. It's made of materials like sand, gravel, certain types of rocks, and karst (which is rock that has lots of holes and tunnels). These materials have lots of spaces that can hold and move water, making them perfect for storing groundwater. In Texas, there are 9 major aquifers and 21 minor aquifers. The Lost Pines Groundwater Conservation District (LPGCD) has six of the nine major aquifers and seven of the 21 minor aquifers. These aquifers help provide water for people, plants, and animals in the area.

CONFINED VS UNCONFINED

As shown in Image 3, aquifers come in two types: unconfined and confined. Imagine an unconfined aquifer like a sponge that's open to the air. Water in an unconfined aquifer is directly in contact with the atmosphere through spaces in the soil or rock. A confined aquifer is like a sponge wrapped in plastic. It's below the land surface, completely saturated with water, but it's covered by a layer of rock or clay that water can't easily pass through. This layer keeps the water trapped below, so it doesn't have direct contact with the atmosphere.

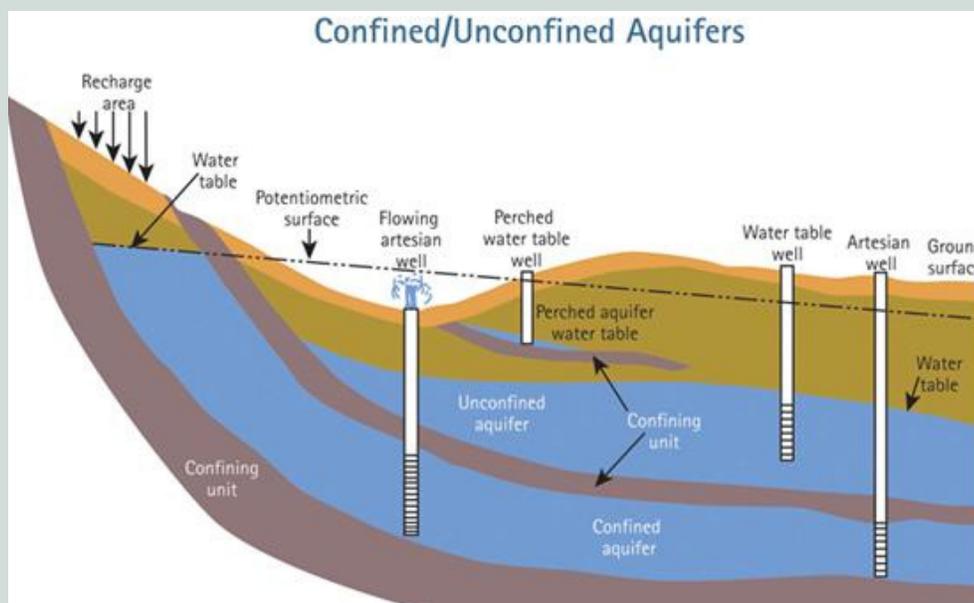


Image 3: Confined and unconfined aquifers.

Aquifers are the zone below the water table. Rainfall and streams can add water to these aquifers, and sometimes the water flows out into streams, making them fuller (these are called gaining streams). But if the water level in the aquifer gets too low, the stream might lose water to the aquifer instead, making it a losing stream.



Aquifers

PERCHED WATER TABLES

A perched water table is a special type of unconfined aquifer, as seen in Image 4. Think of it like a small puddle sitting on a layer of rock or clay. This happens when groundwater is separated from the main body of groundwater by a layer that isn't fully soaked with water. Rainfall seeps down from the land surface until it hits this less permeable layer. The water can't move through this layer quickly, so it starts to pile up, creating a perched water table.

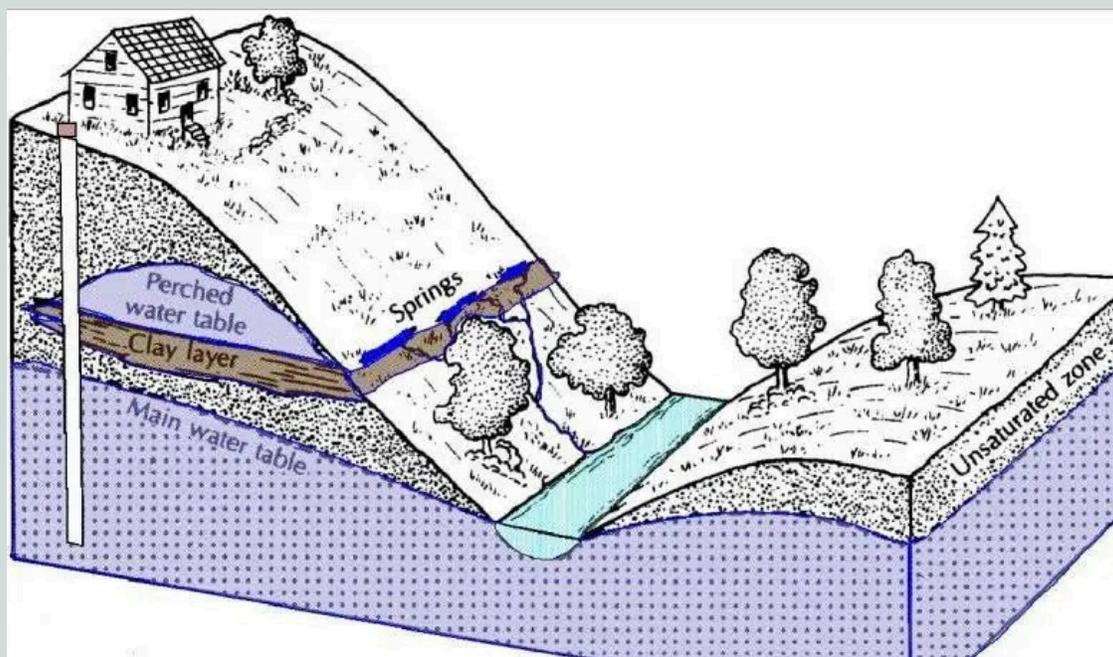


Image 4: A perched water table.

Perched water tables are usually quite shallow, ranging from about a foot to five feet thick. Whether they can be used for things like wells depends on the local conditions. They're not typically used for big production wells but can sometimes provide water for homes. Since they are close to the surface, perched water tables are more likely to get contaminated by things on the ground, like chemicals or pollutants.



Aquifers

AQUITARDS

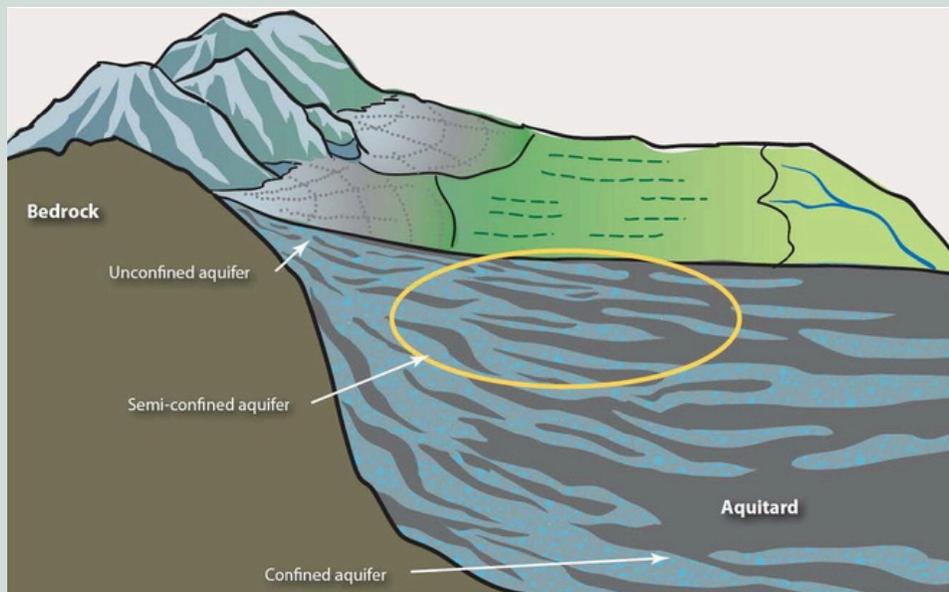


Image 5: Aquitard vs aquifer.

An aquitard is a layer of rock or sediment that slows down the movement of groundwater. Think of it as a barrier that makes it harder for water to flow. While aquifers are great at holding and moving lots of water, aquitards aren't as good at this.

Imagine you have a layer of fine sand between two layers of clay. The clay doesn't let much water through, but the sand does, so the sand layer is the aquifer. However, if that same fine sand was between layers of gravel, which lets water through very quickly, the sand would slow down the water compared to the gravel. In this case, the sand would be considered an aquitard.

So, whether something is an aquifer or an aquitard depends on the materials around it. The more permeable, or water-friendly, material is called the aquifer, and the less permeable material is called the aquitard, as seen in Image 5.

ARTESIAN WELLS

An artesian aquifer is a special kind of groundwater storage. It's like a water-filled sandwich with layers of rock or clay that don't let water through on top and bottom. These layers squeeze the water, creating pressure. If you drill a well into an artesian aquifer, the water will naturally rise up in the well, sometimes even reaching the surface without a pump. This is called an artesian well.

However, if too much water is taken out of the well and not enough is added back, the pressure will drop, and the well might stop flowing on its own. To keep an artesian well working, there needs to be a balance between the water being used and the water being added to the aquifer.



How much GROUNDWATER IS THERE?

In Texas, there's a huge amount of groundwater stored beneath the surface. It's estimated to be about 16.8 billion acre-feet in total, which is enough to fill about 11 billion Olympic-size swimming pools. Most of this water is in major aquifers, with about 12.6 billion acre-feet, while minor aquifers hold around 4.24 billion acre-feet. But how much water an aquifer can actually hold depends on its porosity—how many tiny spaces there are between the particles. The more pores there are, the more water the aquifer can hold. The size, shape, and how well-connected these pores are also matter. This affects how fast water can move through the aquifer and how contaminants might spread underground.

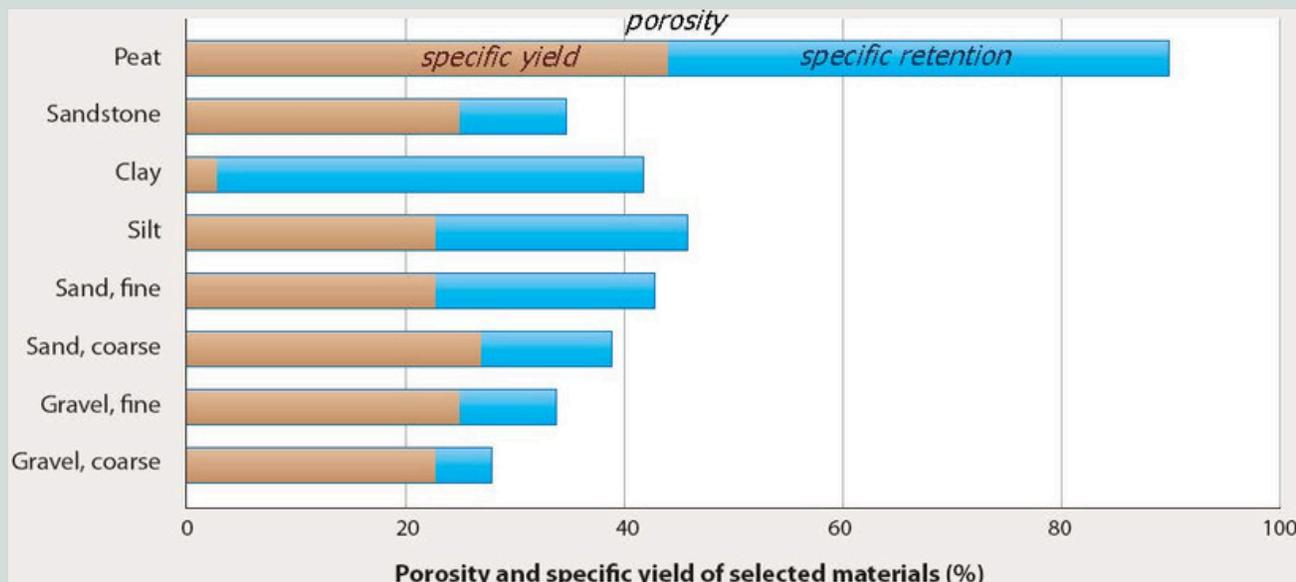


Image 6: Porosity and specific yield of different materials.

When we talk about groundwater available for things like drinking water or irrigation, we're talking about the water that can flow out of these connected pores or fractures in the rock. There are two important terms to understand here: specific retention and specific yield. Specific retention is the water that remains trapped in the sediments even when the groundwater level drops. It's like the water left in a sponge after you squeeze it. Specific yield is the water that can be pumped out of the sediments when you lower the groundwater level near a well. It's the water that's more easily accessible and useful for human needs. These properties, specific retention and specific yield, vary a lot depending on the type of material the aquifer is made of, as shown in Image 6. For example, in a flowerpot filled with peat soil, which is very porous, the specific yield would be how much water drains out when you water the plant. Peat soils retain a lot of water compared to clay soils, which hold onto water tightly and release very little. Understanding these properties helps us manage our groundwater resources better, ensuring there's enough clean water for everyone's needs without harming the environment.

Aquifers in the LOST PINES GROUNDWATER CONSERVATION DISTRICT



In the Lost Pines Groundwater Conservation District (LPGCD), there are several important aquifers that provide water for communities and agriculture, as seen in Image 7. The LPGCD is home to six major aquifers out of the nine found in Texas, along with seven minor aquifers, alluviums, and formations. The major aquifers are significant because they yield large quantities of water and are crucial for sustaining water supplies in the region. In addition to the major aquifers, the LPGCD also includes several minor aquifers and alluvial deposits. These aquifers may yield smaller amounts of water or water that is of poorer quality compared to the major aquifers.

Major Aquifers:

- Carrizo-Wilcox Aquifer
- Hooper Aquifer
- Simsboro Aquifer
- Calvert Bluff Aquifer
- Queen City Aquifer
- Sparta Aquifer

Minor Aquifers and Alluviums:

- Colorado River Alluvium
- Trinity Aquifer
- Yegua-Jackson Aquifer
- Midway Group
- Reklaw Formation
- Weches Formation
- Cook Mountain Formation

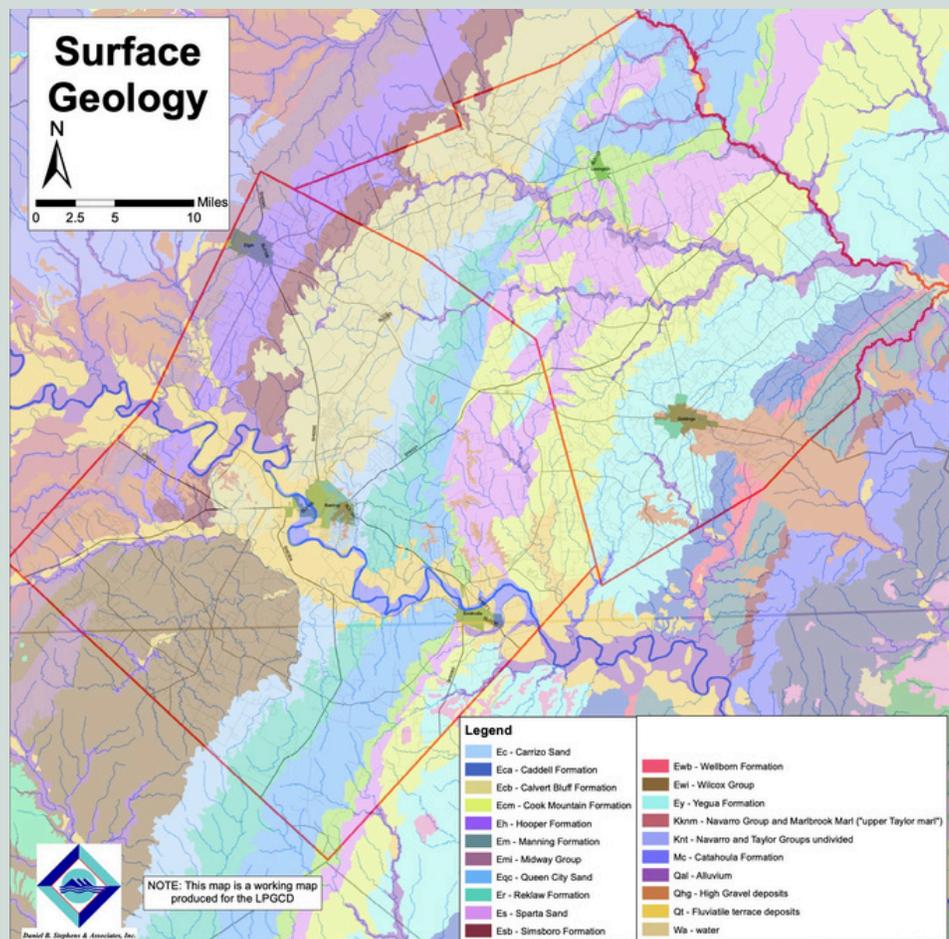


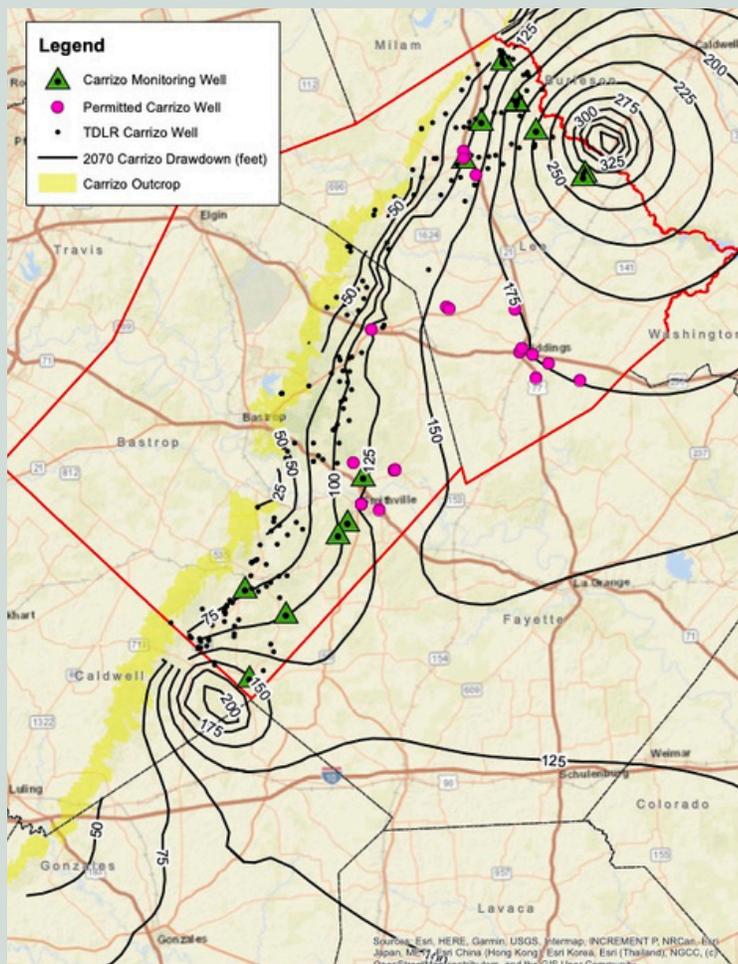
Image 7: Major and minor aquifers in Lost Pines Groundwater Conservation District.



GROUNDWATER Flow

HOW MUCH DOES GROUNDWATER FLOW?

Groundwater is like a hidden river underneath the ground. It moves from places where there's a lot of water to places where there's less water. Just like a river flows downhill because of gravity, groundwater also moves from higher elevations to lower elevations. This is because gravity pulls it downwards. But here's the tricky part: groundwater can also move uphill! Groundwater moves from places with high pressure to places with low pressure. Pressure is like the force that pushes water around underground. When there's more water in one place, it has more pressure and pushes water to places with less pressure. This can make groundwater flow in different directions, not just straight down.



Scientists use special maps called Groundwater Availability Models (GAMs), as shown in Image 8, to understand how groundwater moves underground. These maps show lines that are like a topographic map, but instead of showing hills and valleys, they show where the water level is at different heights underground. By measuring water levels in many places over time, scientists can figure out how fast and in which direction groundwater is flowing. This helps us manage our water resources better. Whether it's for drinking water, growing crops, or keeping our rivers healthy, knowing how groundwater moves helps us use it wisely. Understanding how groundwater moves is like solving a big puzzle under the ground. With maps and measurements, scientists can piece together the story of how water travels beneath our feet, keeping our world hydrated and balanced.

Image 8: Groundwater Availability Map (GAM) of the Carrizo Aquifer.

GROUNDWATER Flow



HOW FAST DOES GROUNDWATER FLOW?

Imagine a science experiment where we explore how water moves through different types of soil. Let's break it down step by step:

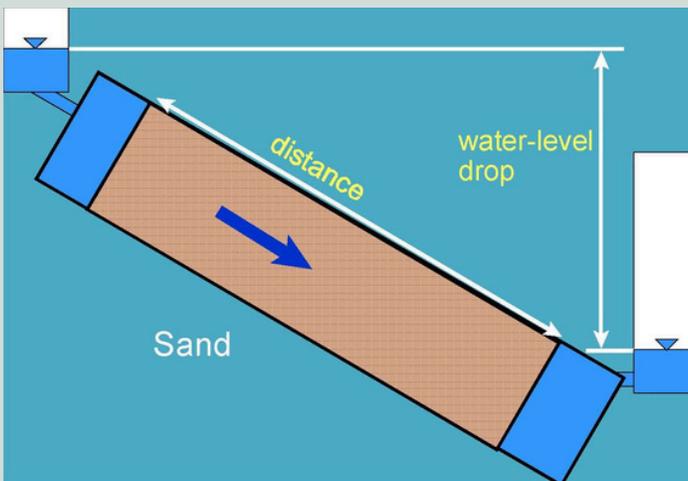


Image 9: Sand column showing hydraulic conductivity.

In our lab, we set up a column filled with sand, as seen in Image 9. At the top and bottom of the column, there are water containers with overflow mechanisms to keep the water levels constant. We observe that water flows through the sand at a certain speed. This speed tells us how fast water can move through sand, which has larger pores.

Next, we replace the sand with clay or loam, which are much finer materials, as seen in Image 10. These soils have smaller pores that slow down the water. Even though water still comes out, it flows much more slowly through clay or loam compared to sand. This difference happens because the tiny pores in clay or loam create more friction for the water. The ability of different materials to transmit water is called hydraulic conductivity. Sand, with its larger pores, has higher hydraulic conductivity, allowing water to move faster. Clay or loam, with their smaller and tighter pores, have lower hydraulic conductivity, slowing down the water flow.

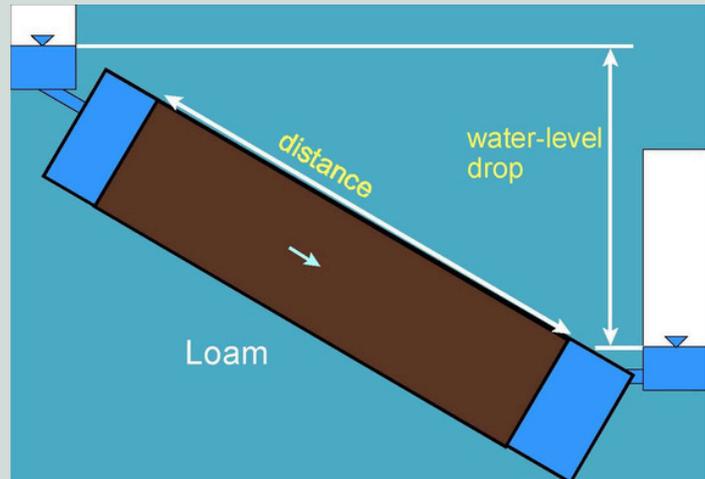
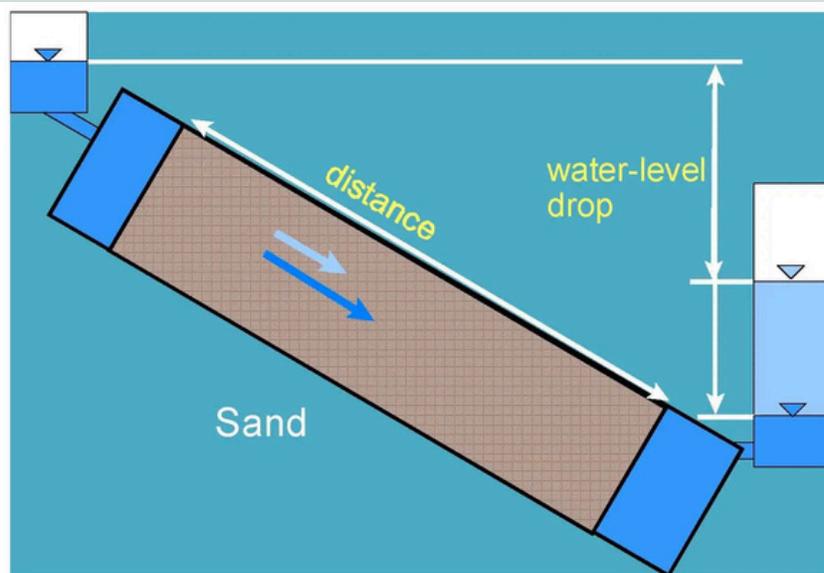


Image 10: Loam column showing hydraulic conductivity.

GROUNDWATER Flow



HOW FAST DOES GROUNDWATER FLOW?



Darcy's law:

groundwater flow = hydraulic conductivity x pressure gradient

Image 11: Column of sand showing Darcy's Law.

Another factor affecting water flow is the gradient of the water level. If we raise the water level on the downhill side of our column experiment, the difference in water level between the top and bottom of the column decreases. This reduces the pressure difference and slows down the water flow even more. Scientists use Darcy's Law to explain how water moves through different materials, as seen in Image 11. It says that groundwater flow depends on the gradient in water pressure and the hydraulic conductivity of the material. The steeper the gradient and the higher the hydraulic conductivity, the faster water flows. By studying these experiments and Darcy's Law, scientists can understand how water moves through soil underground. This helps us manage groundwater resources and make sure we use water wisely for drinking, farming, and keeping our environment healthy. Understanding these concepts is like solving a puzzle that helps protect our water for future generations.

GROUNDWATER Flow



WHERE DOES GROUNDWATER COME FROM?

The water cycle, also called the hydrologic cycle, is like a big, magical loop that moves water all around our planet. It goes up into the sky, falls back to the ground, and then moves through the earth. When it rains or snows, some of the water flows over the ground and into rivers and lakes. Some water stays frozen in glaciers for a long time.

Some of the water soaks into the ground. Plants drink up this water through their roots and then release it back into the air. The rest of the water seeps down deeper until it reaches a place called the water table. This is where groundwater lives. Groundwater flows underground and eventually makes its way into lakes, streams, or even the ocean.

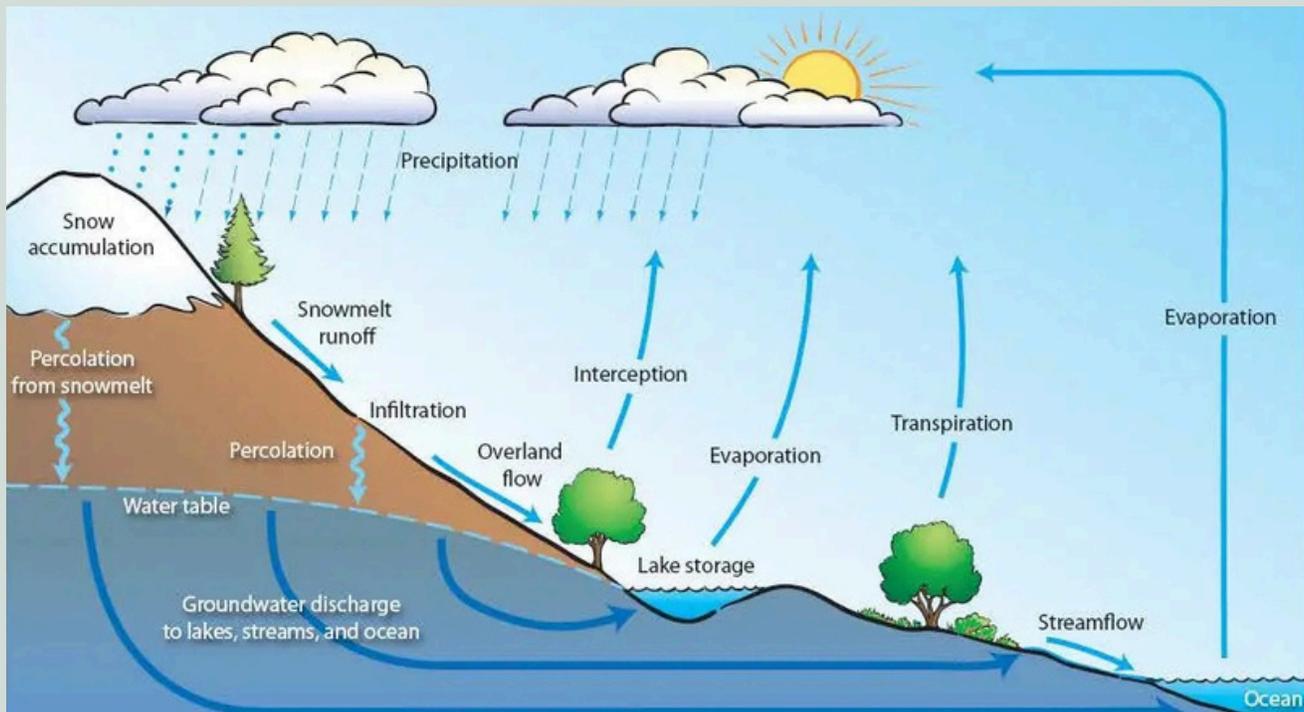


Image 12: The Hydrologic Cycle.

GROUNDWATER Flow



WHERE DOES GROUNDWATER COME FROM?

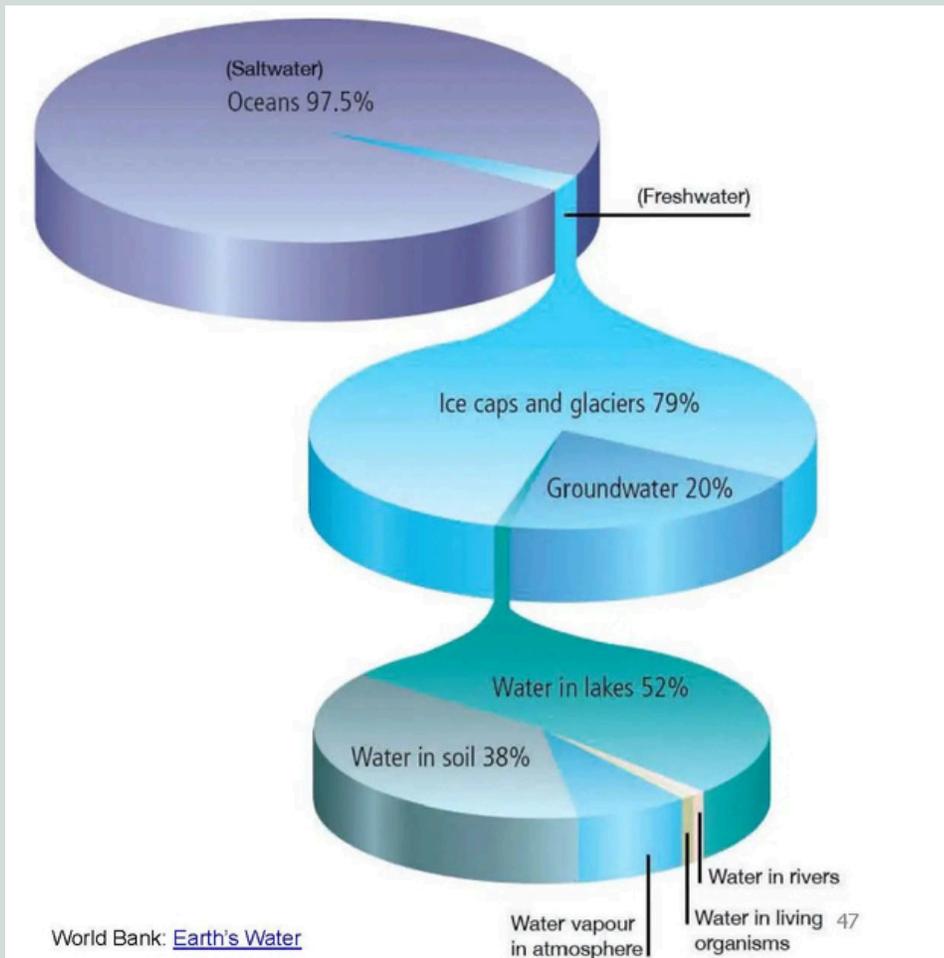


Image 13: Earth's water.

It is important to note that most of the water on Earth is salty ocean water.

Only a small part, about 2.5%, is fresh water.

Most of this fresh water is frozen in ice caps and glaciers.

A good chunk of the fresh water that's left is actually groundwater.

Therefore, groundwater is actually a really big part of the hydrologic cycle.

GROUNDWATER Flow



WHERE DOES GROUNDWATER GO?

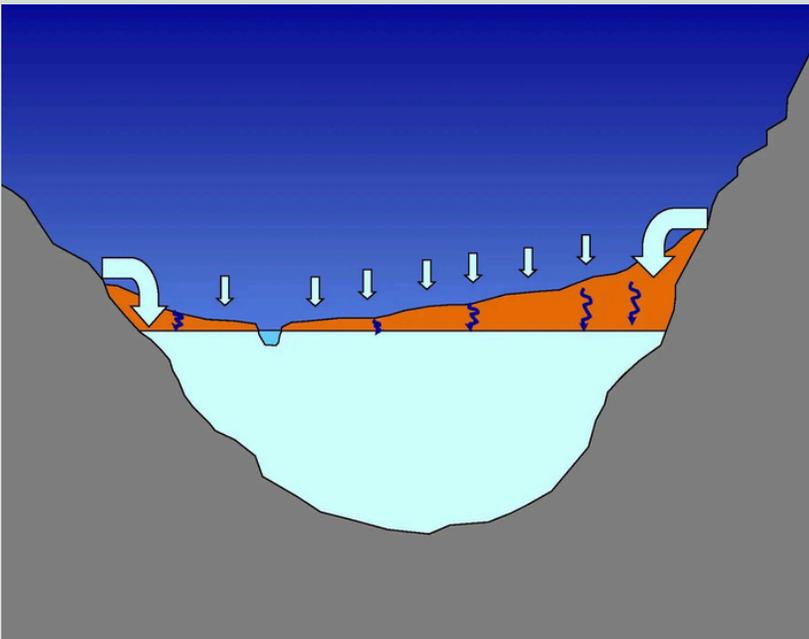


Image 14: Groundwater pre-pumping.

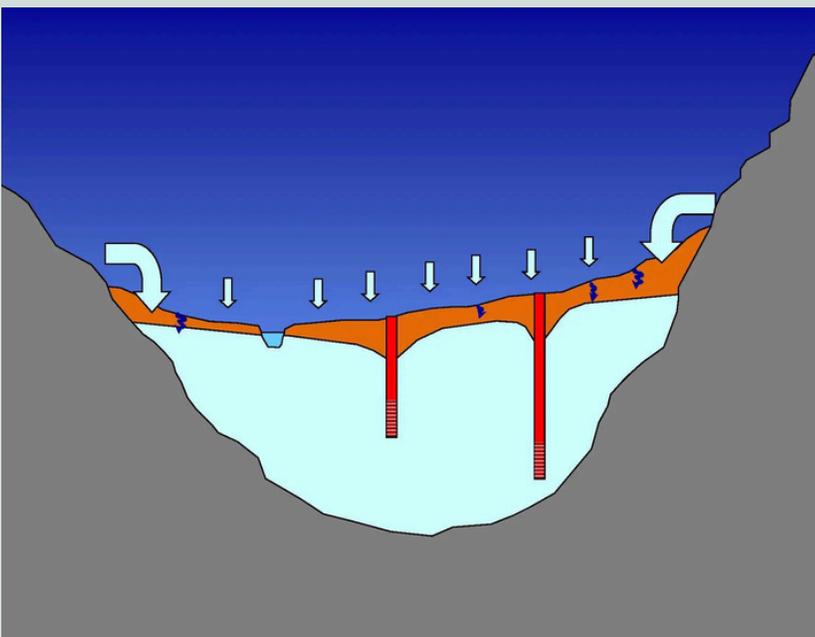


Image 15: Groundwater post-pumping and cones of depression.

In the early 20th century, people started pumping a lot of groundwater from wells, as seen in Image 14 and Image 15. This created a cone of depression, which is a fancy way of saying the water level in the ground went down.

During the summer, a lot of water is pumped out for watering crops and for cities to use. In the winter, less water is pumped out, and the groundwater can recharge or fill back up.

But sometimes, more water is taken out in the summer than what gets recharged in the winter. When this happens, the water level keeps dropping, making it harder for rivers to stay connected to the groundwater.

So, groundwater is super important and part of a big, never-ending water cycle that helps keep our planet hydrated and healthy!



HOW IS GROUNDWATER

Managed?

GROUNDWATER CONSERVATION DISTRICTS - GCD

In Texas, water rights depend on where the water comes from. Surface water, like rivers and lakes, belongs to the state of Texas. If someone wants to use surface water, they need permission from the state. Groundwater, which is water found underground, usually belongs to the landowner above it. This means landowners can pump and use the groundwater under their property without needing permission from the state. This idea in Texas is called the Rule of Capture. It means if you can pump the water out of the ground, you can keep it, even if it affects other wells nearby. Understanding water rights is important in Texas. It helps keep our water clean and available for everyone who needs it. By following these rules, we can protect our groundwater and make sure it's here for generations to come.

To manage and protect groundwater, Texas has Groundwater Conservation Districts, or GCDs, like the Lost Pines Groundwater Conservation District (LPGCD). These are local government units set up by Texas law to control how groundwater is used. Texas has 99 GCDs. GCDs have important jobs:

- They create plans and rules to limit how much groundwater people can pump.
- They set rules about where wells can be and how big they can be.
- They give permits for new wells that are not exempt from their rules.
- They watch for land sinking (subsidence) caused by taking too much groundwater.
- They keep the water clean and stop it from being wasted.
- They record how much groundwater is used and where it comes from.
- They work with other groups to plan how to manage water in different areas.



HOW IS GROUNDWATER

Managed?

GROUNDWATER MANAGEMENT AREA - GMA

Texas is divided into different Groundwater Management Areas (GMAs) for joint planning and managing groundwater resources. The Lost Pines Groundwater Conservation District (LPGCD) is part of GMA 12.

DESIRED FUTURE CONDITION - DFC

A DFC is a goal set by GMAs for what they want groundwater levels to be in the future. It helps make sure there will be enough groundwater for years to come.

REGIONAL WATER PLANNING GROUP - RWPG

These groups work together to create a plan for managing water in their region. The plans help develop a state water plan to make sure everyone has enough water.



GROUNDWATER 101

C o n c l u s i o n

Groundwater is super important for Texas! It's water that lives under the ground in special places called aquifers. These aquifers are like big, underground sponges that soak up water and hold it there. Some aquifers are huge, and others are smaller, but they all help store water for Texans to use.

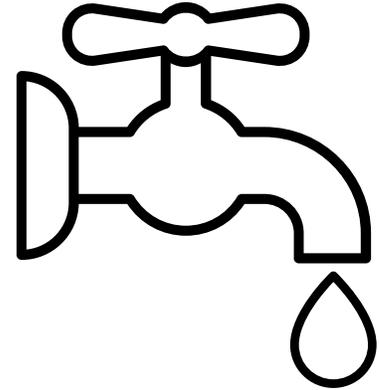
Half of all people in Texas get their drinking water from groundwater, and farmers use it a lot to grow crops too. So, knowing about groundwater is really important!

There are different types of aquifers. Some let water move freely, like when you pour water on a sponge and it spreads out. Others trap water tightly, like when water gets stuck in a bottle with a lid on.

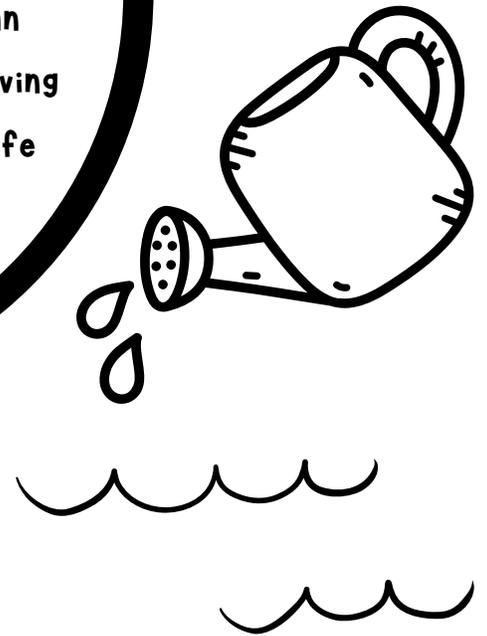
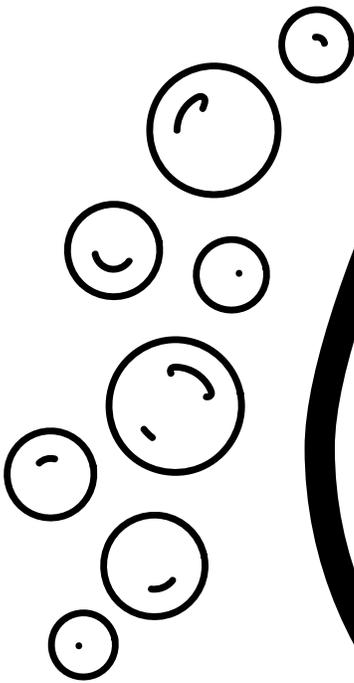
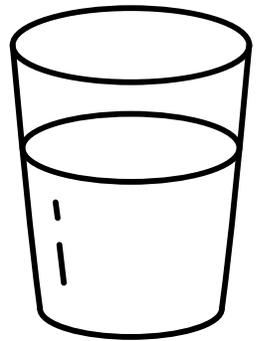
To make sure we don't use up all the groundwater, Texas has special groups called Groundwater Conservation Districts, or GCDs. They make rules about how much water people can use and where they can get it from. This helps keep our water clean and safe for everyone.

People work together to take care of our groundwater. By learning about how it works and following the rules, we can make sure there's always enough clean water for people to use in Texas. Together, we can protect our groundwater and keep Texas healthy and strong!

Water Conservation Pledge



I
pledge
to conserve
water and to
use water wisely. I
pledge to take shorter
showers, to use a broom to
sweep sidewalks, to use less
water in the bathtub, to turn off the
faucet while brushing my teeth, and to use
water carefully in the garden. I pledge to
remind my parents to use water wisely if
they are wasting it. When I become an
adult I pledge to continue my water saving
habits because I know that water is life
and Texas does not have enough
water to waste.



Signature _____



LOST PINES
GROUNDWATER
CONSERVATION DISTRICT

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THINK SMART

SAVE WATER

SAVE MONEY