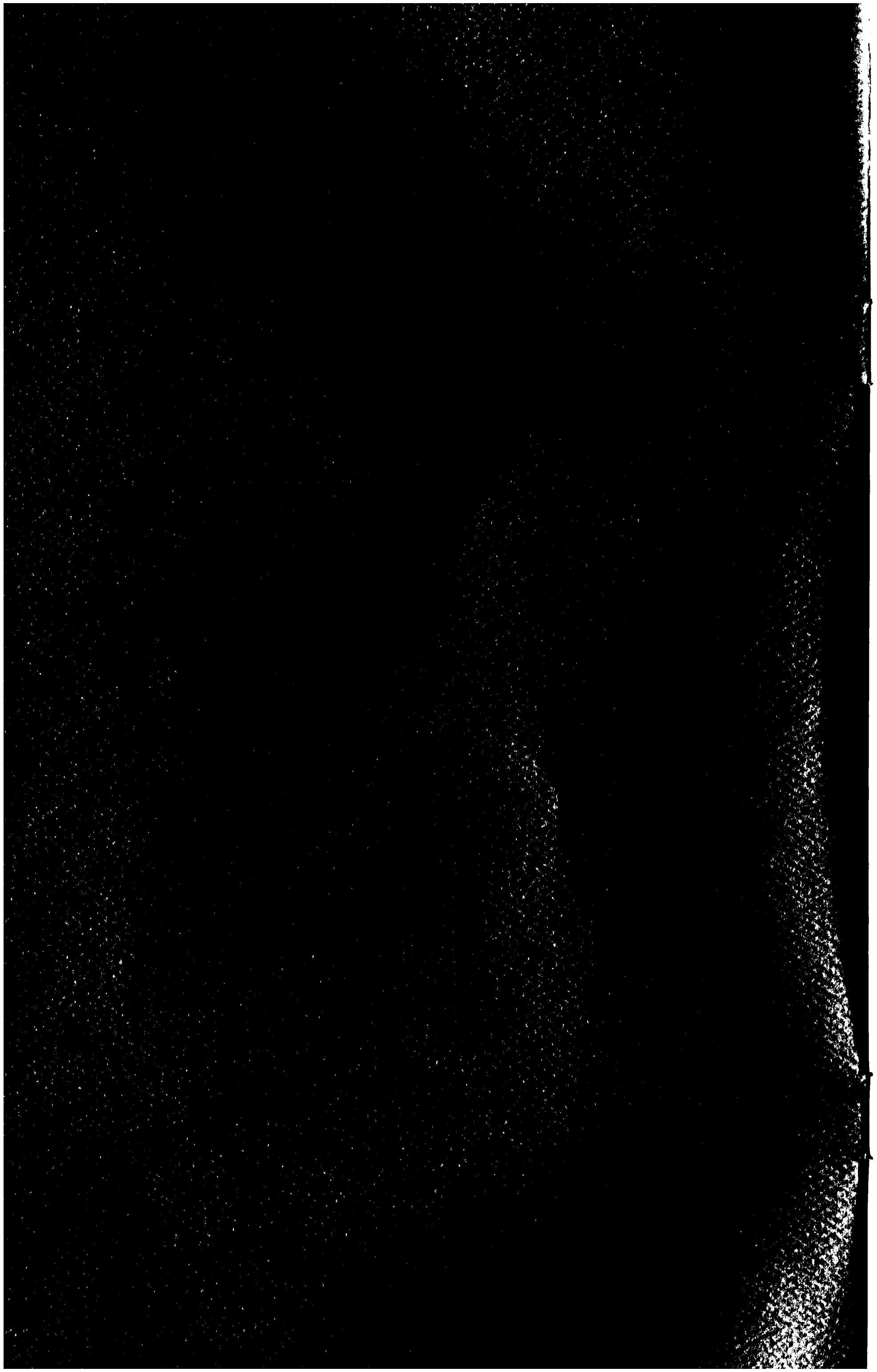


The Underground Subject

An introduction to ground water issues in Texas.

the Texas Water Commission

What do you know about ground water? Even more specifically, what do you know about Texas ground water?

What is ground water?

Perhaps you visualize ground water as an underground river or lake. Ground water can occur like this in areas of cavernous limestones or the volcanic lava flows of the past. However, most ground water is really just water filling up the spaces between rock grains or within cracks in rocks.

Ground water is usually in motion, flowing under the force of gravity to lower areas where it may surface as a spring, or into a stream or the ocean.

Rain and snowmelt trickling down through the soil are the source of ground water. Plants use much of the water that enters the soil and a small amount is held on the soil grains by attractive forces. Any surplus continues downward to the "zone of saturation," where all openings in the rock are filled with water. The top of this zone is called the **water table**. At this level, pressure is the same as that of the atmosphere (roughly 15 pounds per square inch).

The amount of water a rock can contain depends upon how porous it is. **Porosity** is the amount of open space inside a rock compared to the total volume of the rock. For water to move freely through a rock, the openings must be interconnected, and the openings must be large enough so that wall friction does not greatly slow the water's flow.

If a rock has many connected openings of a size big enough to allow water to move freely, the rock is called **permeable**. Large volumes of water can be pumped from permeable rocks. Crystalline rocks such as granite, with no intergranular spaces, may be permeable if broken by fractures large enough to allow water to pass freely.

However, clay and similar fine-grained materials have high porosity, but yield water very slowly, because their pores are so small that wall friction greatly hinders water movement. Also, rocks containing large openings, such as solution channels in limestones and lava tubes in volcanic flows, may have low overall porosity, but can have very high permeability because the large size of the openings permits water to flow at a high speed.

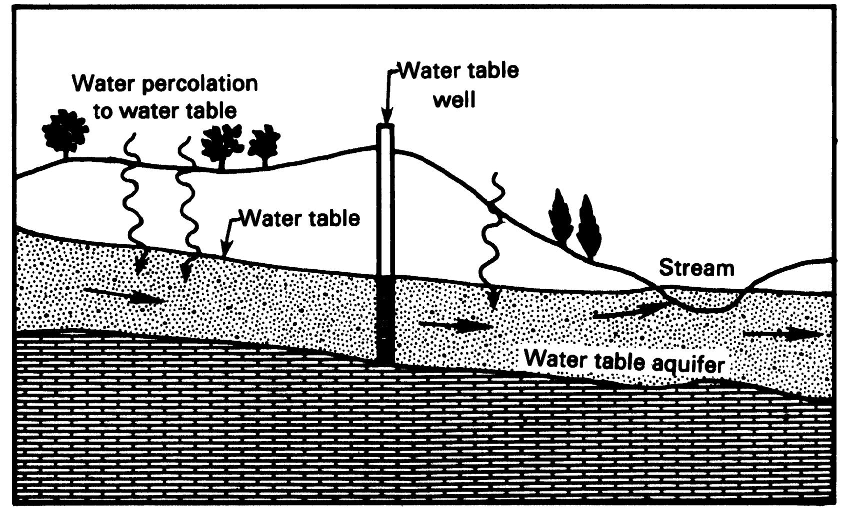
Ground water does not occur downward all the way to the core of the earth. In most areas, salt water underlies fresh water. Then, beneath water-bearing rocks everywhere, at some depth, the rocks are water-tight because the pressure of overlying rock becomes too great. This depth may be a few hundred feet, but is more than likely tens of thousands of feet.

What is an aquifer?

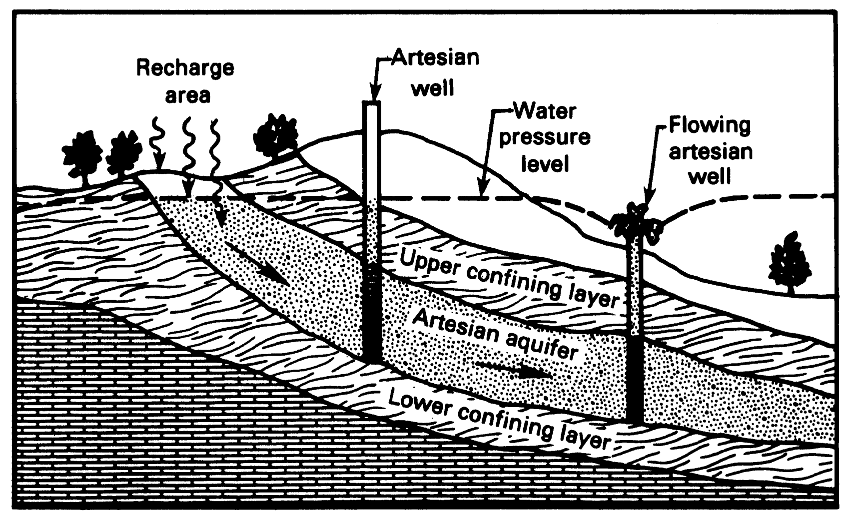
An **aquifer** is a rock layer that will yield enough water to serve as a water supply for some use. It may be a few feet or hundreds of feet thick. It could be just beneath the surface, or hundreds of feet down, and it might underlie a few acres, or thousands of square miles.

More than three quarters of Texas is underlain by seven major and sixteen minor aquifers. A **major aquifer** produces large quantities of water in a comparatively large area of the state. **Minor aquifers** either yield large quantities of water in small areas or small quanitites of water in large areas. Minor aquifers are especially important in Texas because in some regions they supply the only significant source of water.

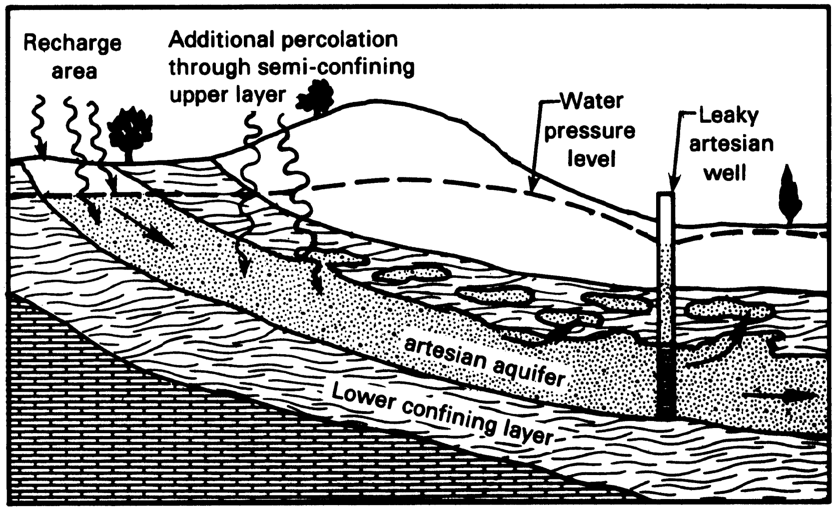
Aquifers in Texas can be divided into three general types. Unconfined or **water table aquifers** are those in which atmospheric pressure changes move freely downward through an unsaturated zone of soil or rock to the water table. Water table



Water table (unconfined) aquifer



Artesian (confined) aquifer



Leaky Artesian (Gulf Coast) aquifer

aquifers provide water to wells by draining the aquifer material surrounding the well. Water table aquifers such as the Ogallala Aquifer are primarily found in the western part of Texas.

Confined or **artesian aquifers** are those overlain by impermeable rock layers that prevent free movement of water. Therefore, the water is under pressure and drilling a well into a confined aquifer is like puncturing a water pipe: the water under pressure gushes into the well, sometimes even rising to the surface and overflowing. Artesian aquifers such as the Edwards and Carrizo aquifers are primarily found in the central and eastern portions of the state.

Finally, there is the **Gulf Coast aquifer**, formed of alternating layers of clay, silt, sand and gravel. Water can pass between these layers at various points, forming a large, leaky artesian aquifer system. The Chicot and Evangeline aquifers are examples of the Texas Gulf Coast aquifer.

What are some ground water problems?

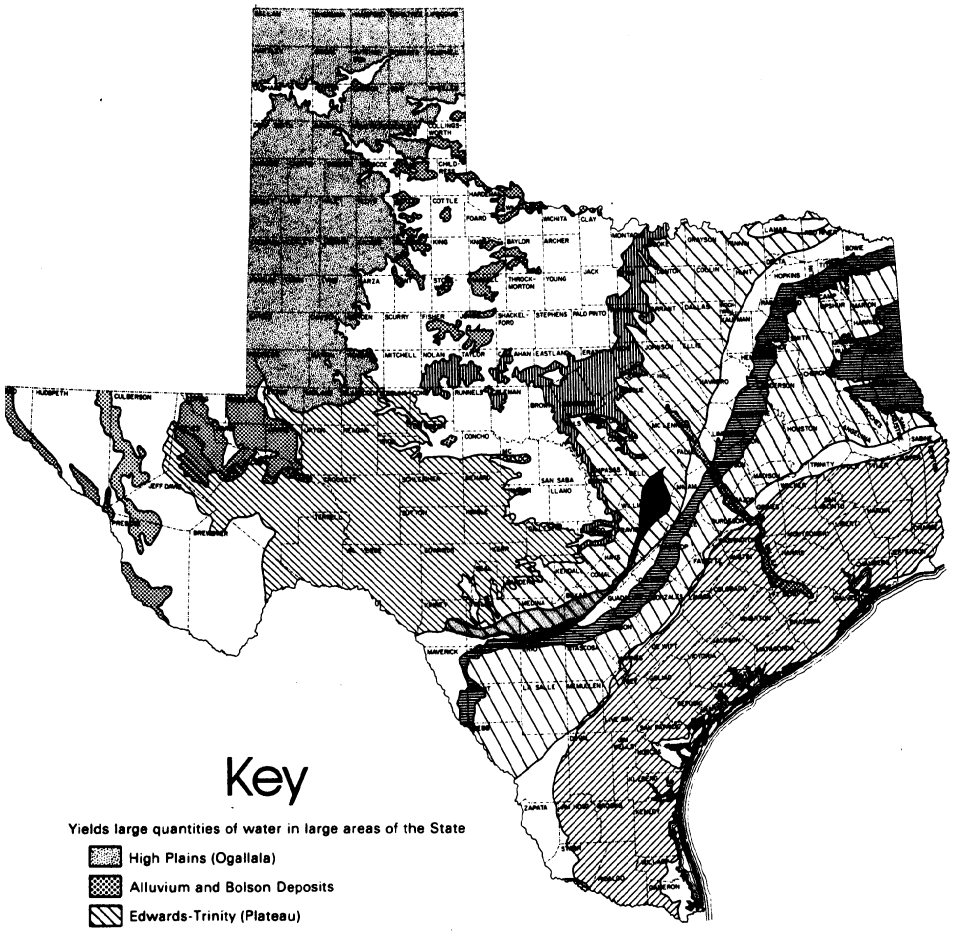
Ground water supplies about 60 percent of the total water used in Texas. This reliance on ground water is the result of the widespread geographic occurence of aquifers and the comparatively high cost of developing surface water storage and treatment facilities.

Excessive use of ground water has resulted in problems with overdraft. These overdraft problems are in turn compounded by ownership law and contamination problems.

Overdraft

Overdraft of ground water comes about when water is withdrawn faster than it is replaced or

Major Texas Aquifers

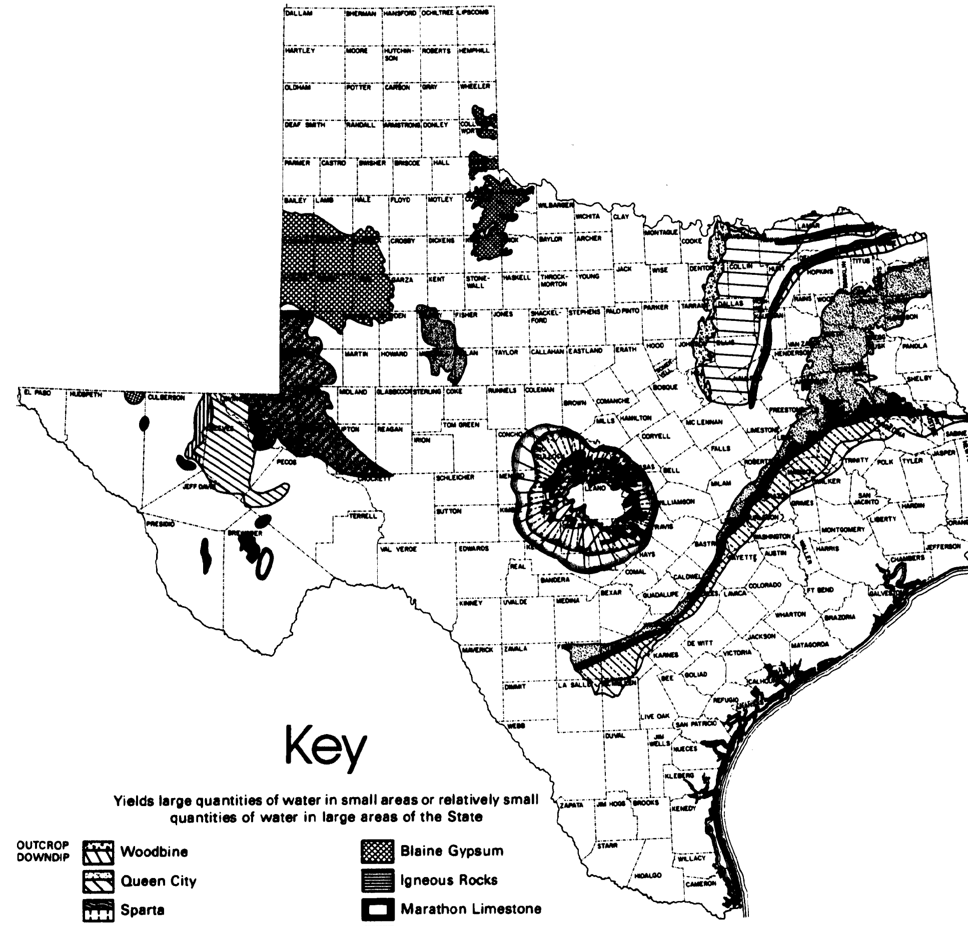


Key

Yields large quantities of water in large areas of the State

- High Plains (Ogallala)
- Alluvium and Bolson Deposits
- Edwards-Trinity (Plateau)
- Edwards (Balcones Fault Zone-San Antonio Region)
- Edwards (Balcones Fault Zone-Austin Region)
- OUTCROP / DOWNDIP — Trinity Group
- OUTCROP / DOWNDIP — Carrizo-Wilcox
- Gulf Coast

Minor Texas Aquifers



Key

Yields large quantities of water in small areas or relatively small quantities of water in large areas of the State

OUTCROP / DOWNDIP

- Woodbine
- Queen City
- Sparta
- Edwards-Trinity (High Plains)
- Santa Rosa
- Hickory Sandstone
- Ellenburger-San Saba
- Marble Falls Limestone
- Blaine Gypsum
- Igneous Rocks
- Marathon Limestone
- Bone Spring and Victorio Peak Limestones
- Capitan Limestone
- Rustler
- Nacatoch Sand
- Blossom Sand

Note: Other Aquifers Undifferentiated (Not Shown) recharged. This results in a continuing decline of ground water levels.

Texas pumps more water from its aquifers than can be recharged each year. About 11 million acre feet is withdrawn, but only 5.3 million acre feet is recharged. This overdraft is occurring at both the regional and local levels.

Regional overdraft generally occurs in dry areas of low recharge. Withdrawal from even a few wells may be enough to exceed natural recharge. Commonly, overdraft sets in before developers are aware of the problem.

The adverse effects of overdraft include:

- Increased energy costs for pumping as water levels decline;
- Added maintenance costs for lowering pumps and deepening wells;
- Land subsidence where the land sinks to fill the spaces previously filled with water; and
- Salt-water intrusion into spaces previously filled with fresh water in coastal sites or where inland salt waters are nearby.

Local overdraft generally happens where water is pumped out of a small area in a confined aquifer faster than more water can move laterally to refill the pumping center. The bad effects are like those of regional overdraft, but are confined to a smaller area. With reduced pumping, water levels recover rapidly.

Ownership

There are several doctrines of ground water ownership in the United States. Texas uses the Common-Law Doctrine. This means that overlying landowners have absolute ownership of percolating ground waters under their property, with ground water used or sold as private property. (This is the opposite of surface water, which in Texas is owned by the State.)

Because of the draining effect present from well pumping, difficulties set in under this doctrine. A landowner has a right to pump all the water he can capture from beneath his land regardless of the effect on the wells of his next door neighbors. Consequently, it is possible for one landowner to dry up an adjoining landowner's well and yet in Texas the landowner with the dry well cannot take legal action.

Like several other states which regulate under the Common-Law Doctrine, Texas has not adopted an overall rule of "reasonable use" with respect to ground water. The exceptions to absolute ownership which do exist in Texas are recognized only for the following situations:

1. If an adjoining neighbor trespasses to remove water either by drilling a well directly on the landowner's property or by drilling a slanted well on adjoining property so that it crosses the underground property line;

2. If there is malicious or uncalled-for water pumping for the sole purpose of injuring an adjoining landowner;

3. If landowners waste artesian well water by allowing it to run off their land or to percolate back into the water table;

4. If anyone allows contamination of ground water; and

5. If land subsidence and surface problems result from negligent overpumping from adjoining lands.

There is provision in Texas law for creation of underground water conservation districts and subsidence districts at the local level. Such districts

are voted in by the area residents. Many but not all of these districts have the power to regulate the spacing and pumping of wells. However, to date most districts have chosen to stress conservation education instead of regulation.

Contamination

Contamination of ground water is a severe problem because contaminants generally travel unnoticed until found in a water-supply well. Once contaminated, an aquifer is difficult and expensive to clean up. The contaminants scatter in the ground water, are hard to remove, and may last for decades. In almost all cases, prevention is simpler and cheaper than cure.

Contaminants include various inorganic chemicals, organic chemicals, biological matter, radioactive compounds, and even physical loads such as heat. The impacts on ground water from these contaminants may range from aesthetic effects (such as unpleasant taste or warm temperature) to actual health hazards.

Water table aquifers are the most easily contaminated since there are no upper confining layers to slow contaminates from filtering down. However, artesian and leaky artesian aquifers are at risk as well. For instance, abandoned unplugged wells or other poorly constructed wells can serve as a route through the upper confining layers for contaminants to reach the ground water.

Hundreds of types of potential sources of ground water contamination have been identified. Ground water problems can originate on the land surface through:

- infiltration of polluted surface water;
- land disposal of either solid or liquid wastes;
- waste piles;
- dumps;
- disposal of sewage and water treatment plant sludges;
- animal feedlots;
- fertilizers and pesticides;
- accidental spills; and
- particulate matter from airborne sources.

Ground water problems can also originate under the ground surface above the water table from:

- septic tanks, cesspools, privies and drainfields;
- leakage from underground storage tanks;
- leakage from underground pipelines;
- holding ponds and lagoons;

- sanitary landfills;
- waste disposal in excavations;
- artificial recharge of aquifers;
- sumps and dry wells; and
- graveyards.

Finally, ground water problems can originate underground below the water table or in the artesian portion of an aquifer through:

- waste disposal in wells;
- abandoned wells;
- drainage wells;
- underground product storage and waste disposal;
- fluid injection for secondary recovery of oil and gas;
- mines;
- exploratory wells and shafts; and
- improperly constructed water supply wells.

These sources do not always threaten ground water supplies. However, unless managed properly, they usually have the potential to do so.

the Texas Water Commission

The Texas Water Commission is designated as the primary state agency responsible for the protection of ground water in Texas.

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