

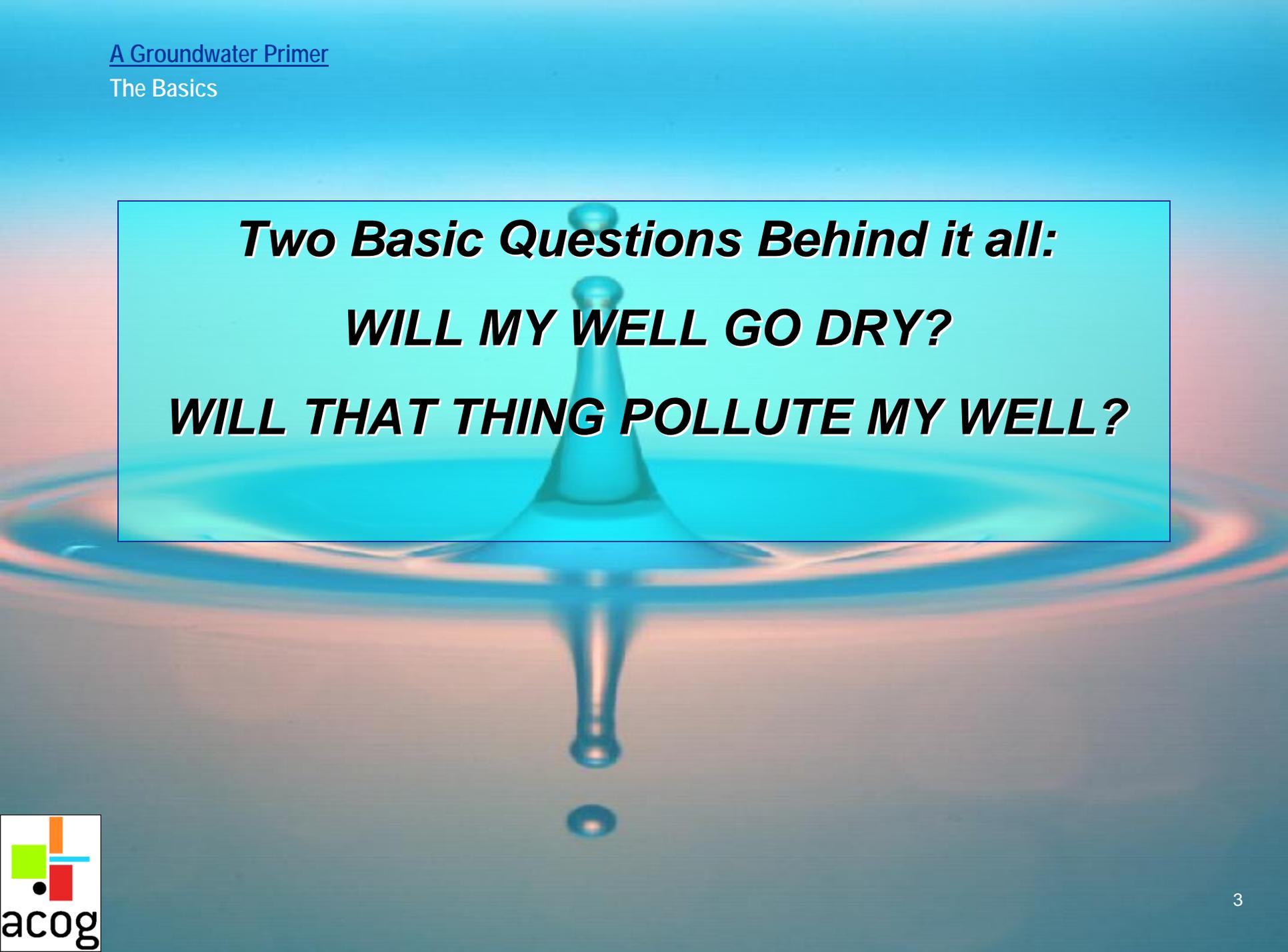
GROUNDWATER IN CENTRAL OKLAHOMA



John M. Harrington
Director, Water Resources ACOG

Because the existence, origin, movement and course of such water, and causes which govern and direct their movements, are so secret, occult and concealed . . . an attempt to administer any set of legal rules in respect to them would be involved in hopeless uncertainty, and would, therefore, be practically impossible.

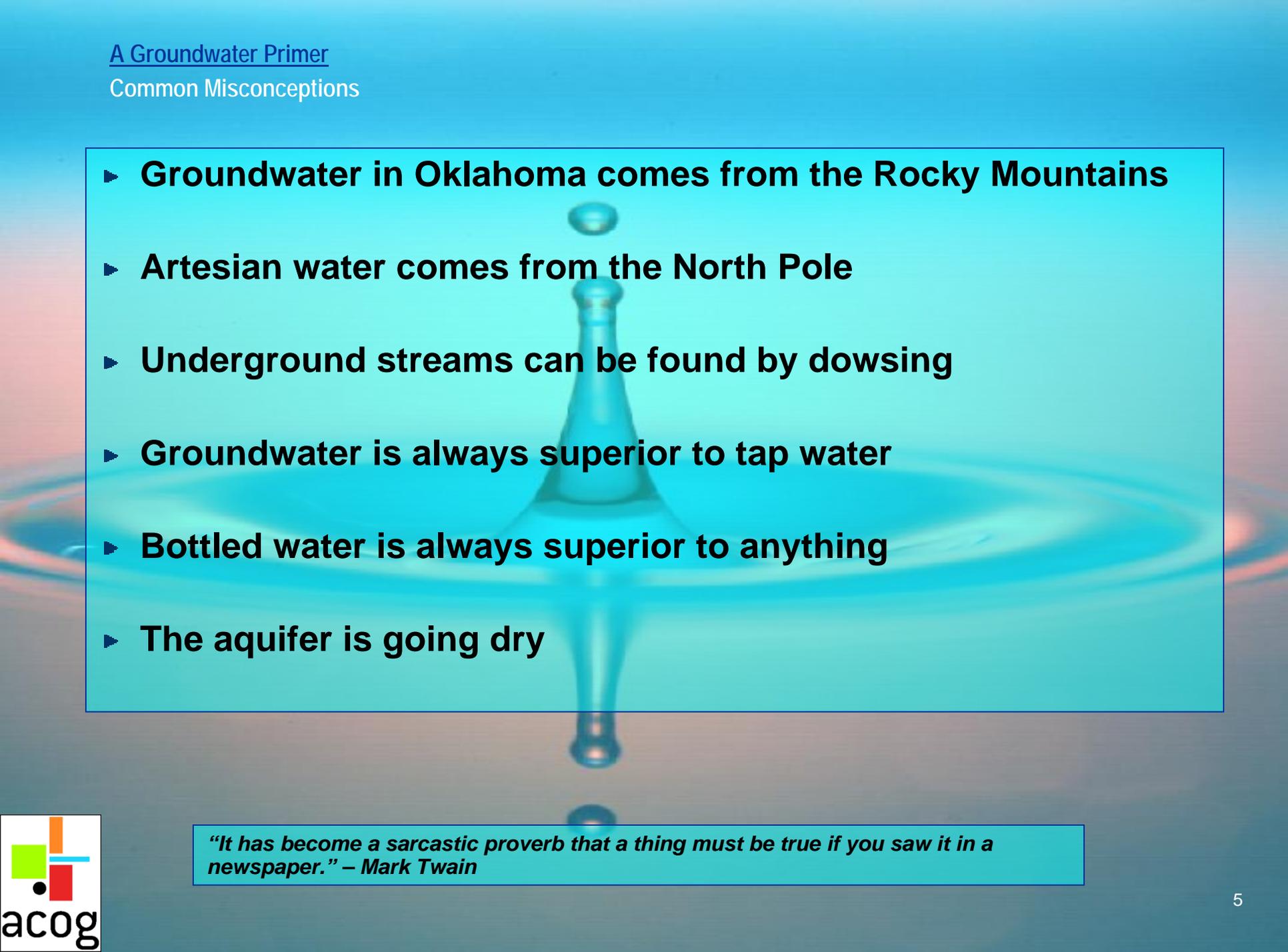
Houston & T.C. Ry. Co. v. East
81 S.W. 279 (Tex. Sup. Ct. 1904)



Two Basic Questions Behind it all:
WILL MY WELL GO DRY?
WILL THAT THING POLLUTE MY WELL?

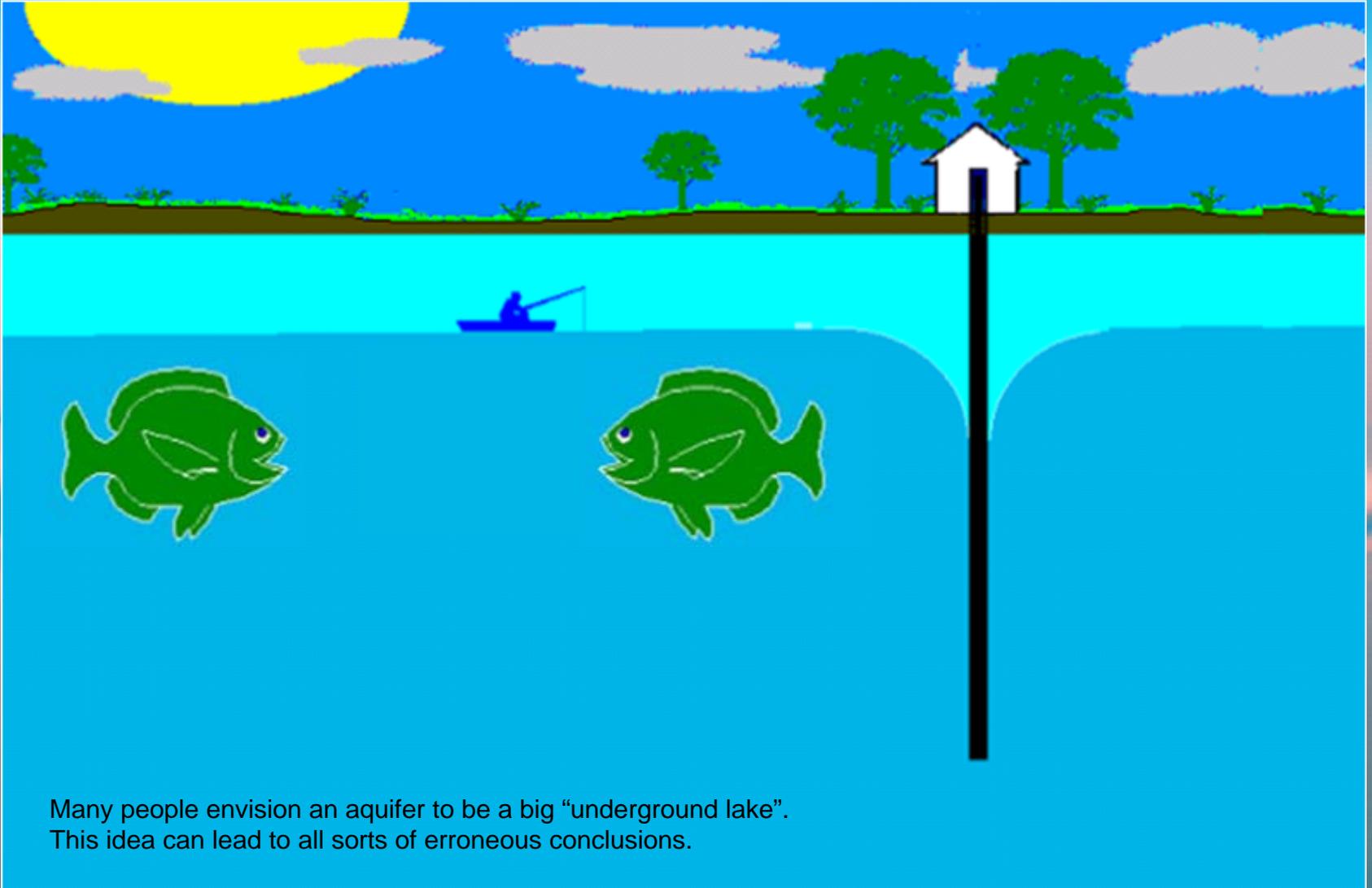
The Outline

- ***What is Groundwater?***
- ***Basic Geology in Central Oklahoma***
- ***Issues - Water Quantity***
- ***Issues - Water Quality***

- 
- ▶ **Groundwater in Oklahoma comes from the Rocky Mountains**
 - ▶ **Artesian water comes from the North Pole**
 - ▶ **Underground streams can be found by dowsing**
 - ▶ **Groundwater is always superior to tap water**
 - ▶ **Bottled water is always superior to anything**
 - ▶ **The aquifer is going dry**

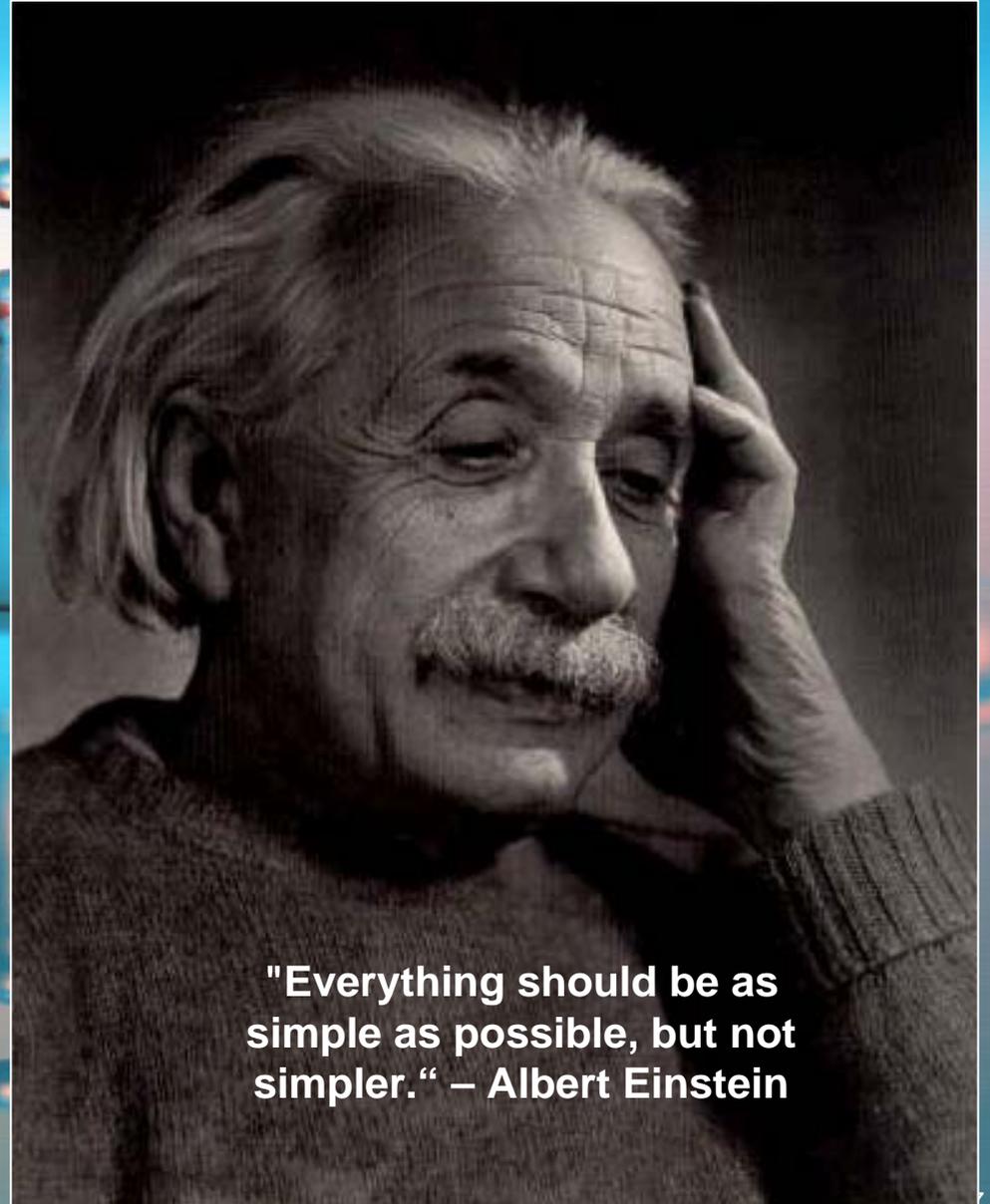
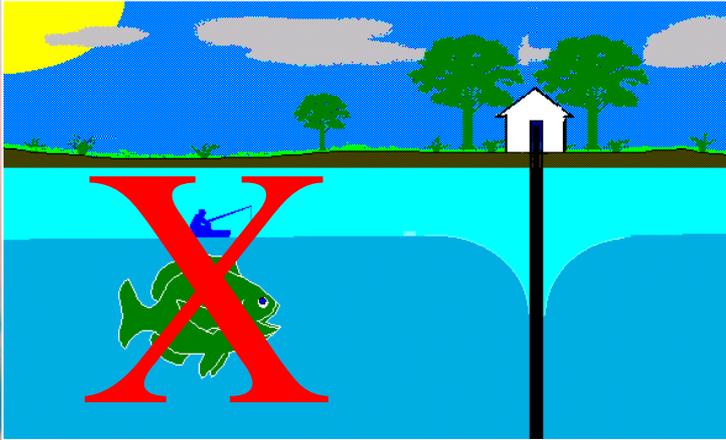
"It has become a sarcastic proverb that a thing must be true if you saw it in a newspaper." – Mark Twain

A Groundwater Primer
Common Misconceptions



Many people envision an aquifer to be a big “underground lake”.
This idea can lead to all sorts of erroneous conclusions.

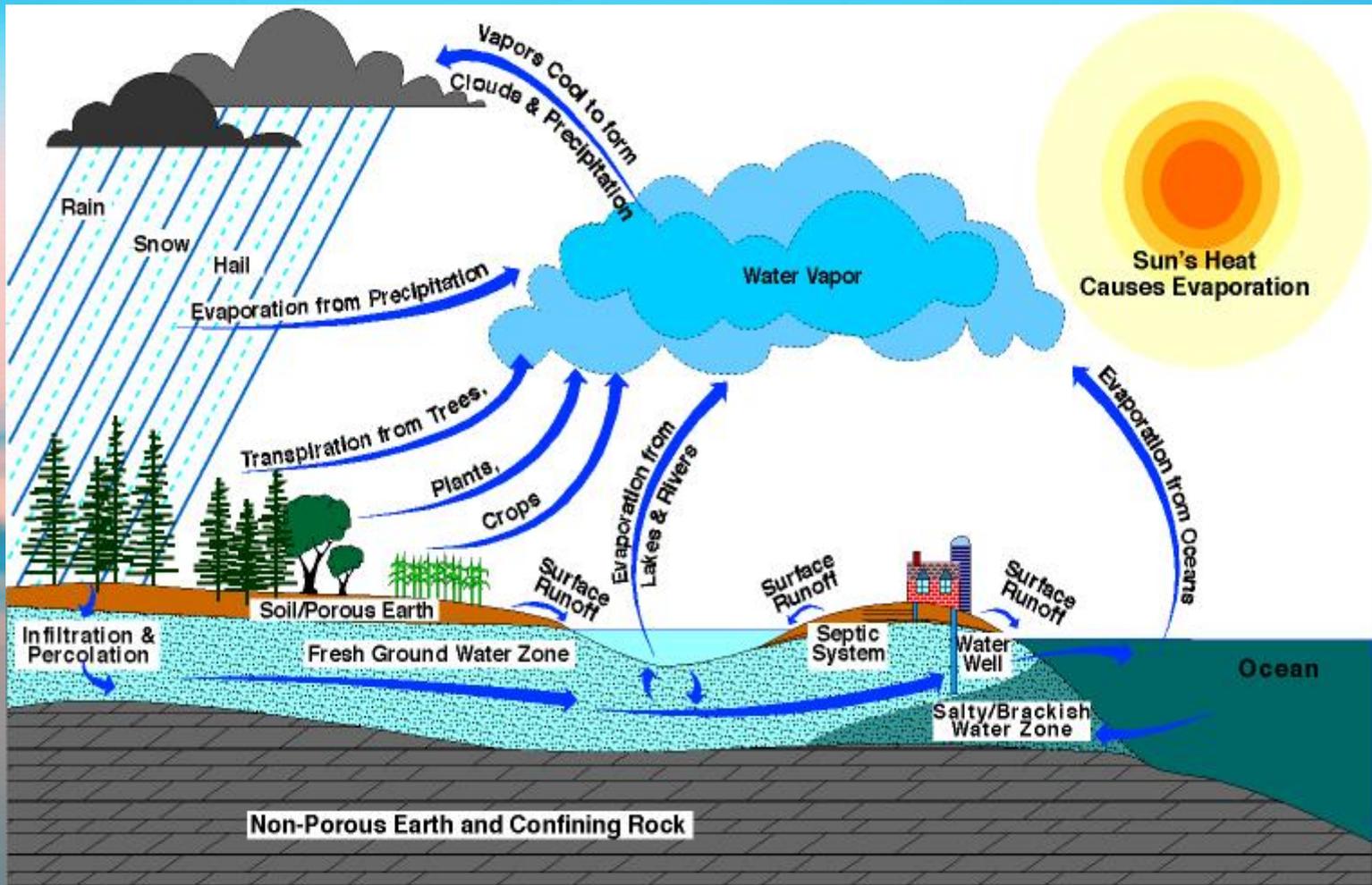
A Groundwater Primer
Common Misconceptions



"Everything should be as simple as possible, but not simpler." – Albert Einstein

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Hydrologic Cycle



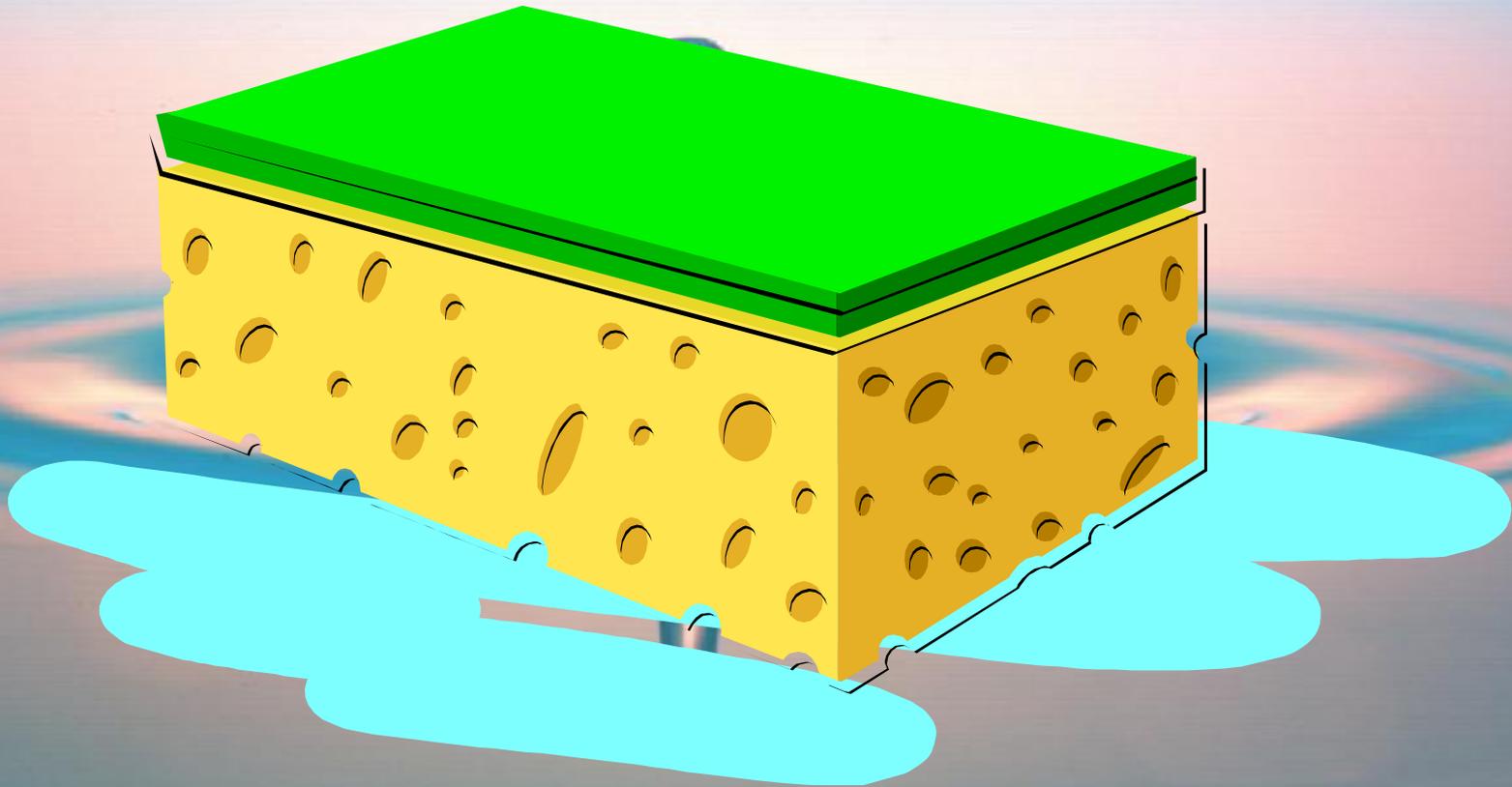
The water in the GW aquifer comes from precipitation – all part of the hydrologic cycle!

What is an aquifer?

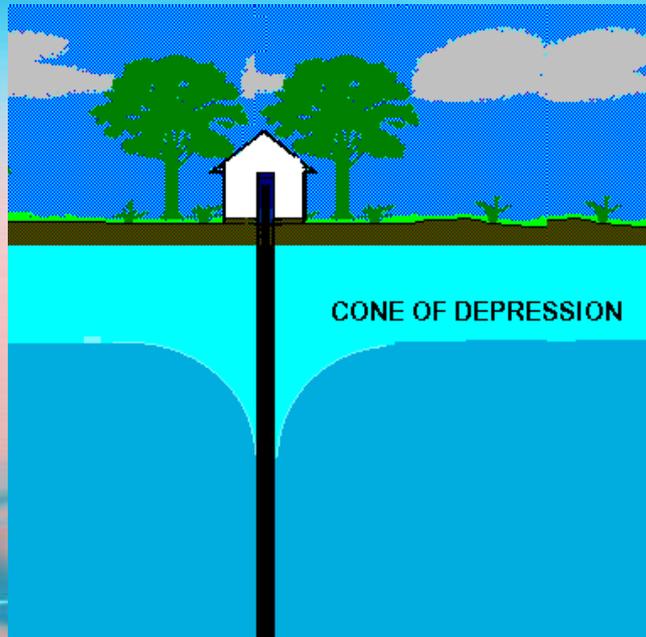
Aquifer = Water + Rock

And since an aquifer is 80% rock, if you don't understand the geology, you don't understand the aquifer....

Think of an Aquifer as a Sponge.....



A sponge can be wet in some places and dry in other places. A lake can't be dry in some places and not in other places.....



Every well affects the area around it by drawing down the static water level. This change in the static water level is sometimes called the “cone of depression”.

The size and shape of these cones are dependant on several physical parameters of the aquifer, including transmissivity, storage, rate of pumping, and duration of pumping.

Knowing these physical parameters of the aquifer, one can calculate the impact of a well on an aquifer, using the formula:

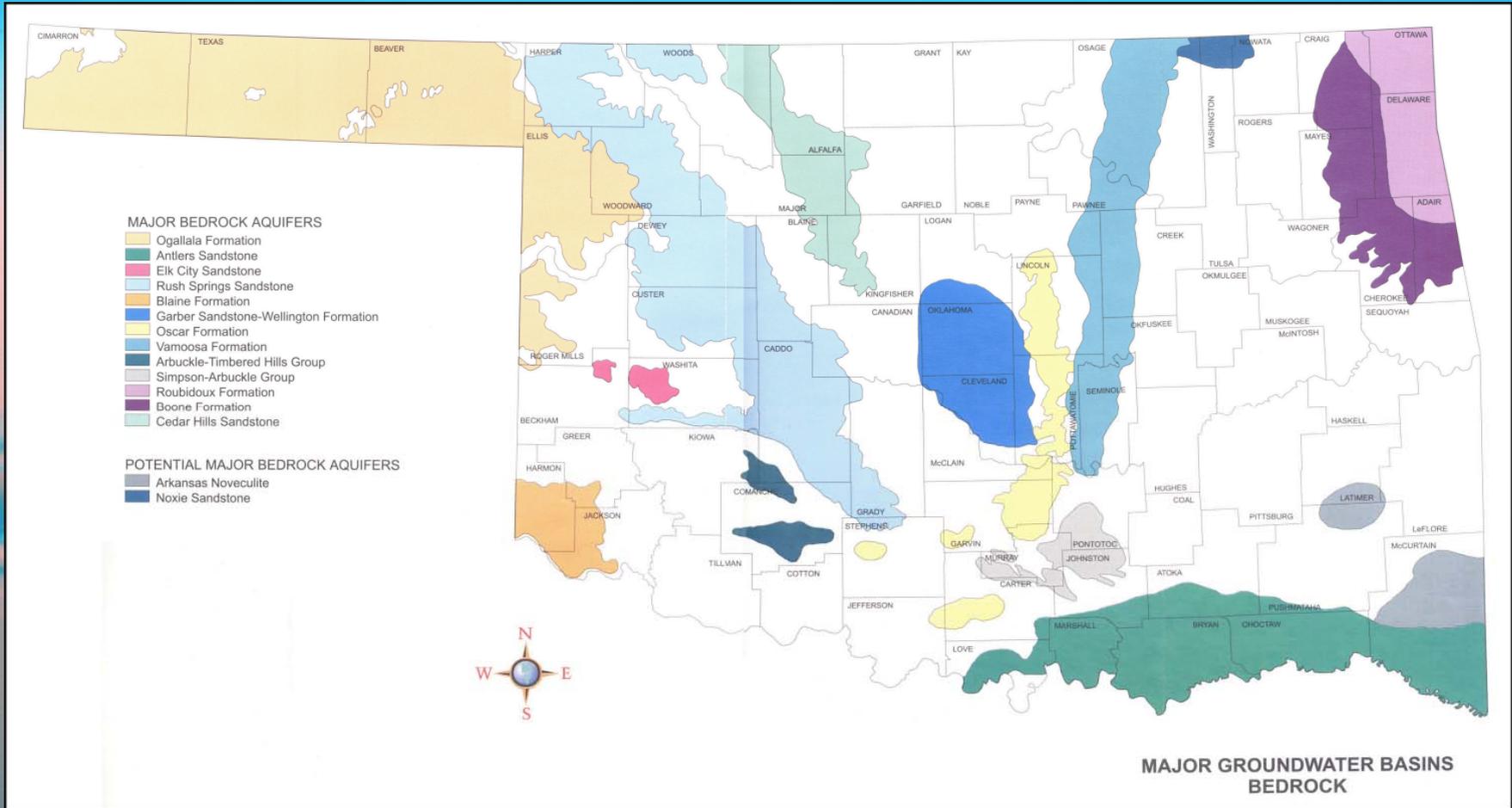
$$s = \frac{114.6 Q W(u)}{T}$$

Lakes can't have cones of depression.....

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Bedrock Aquifers

There are lots of aquifers in Oklahoma – all with different water quality and properties!!!

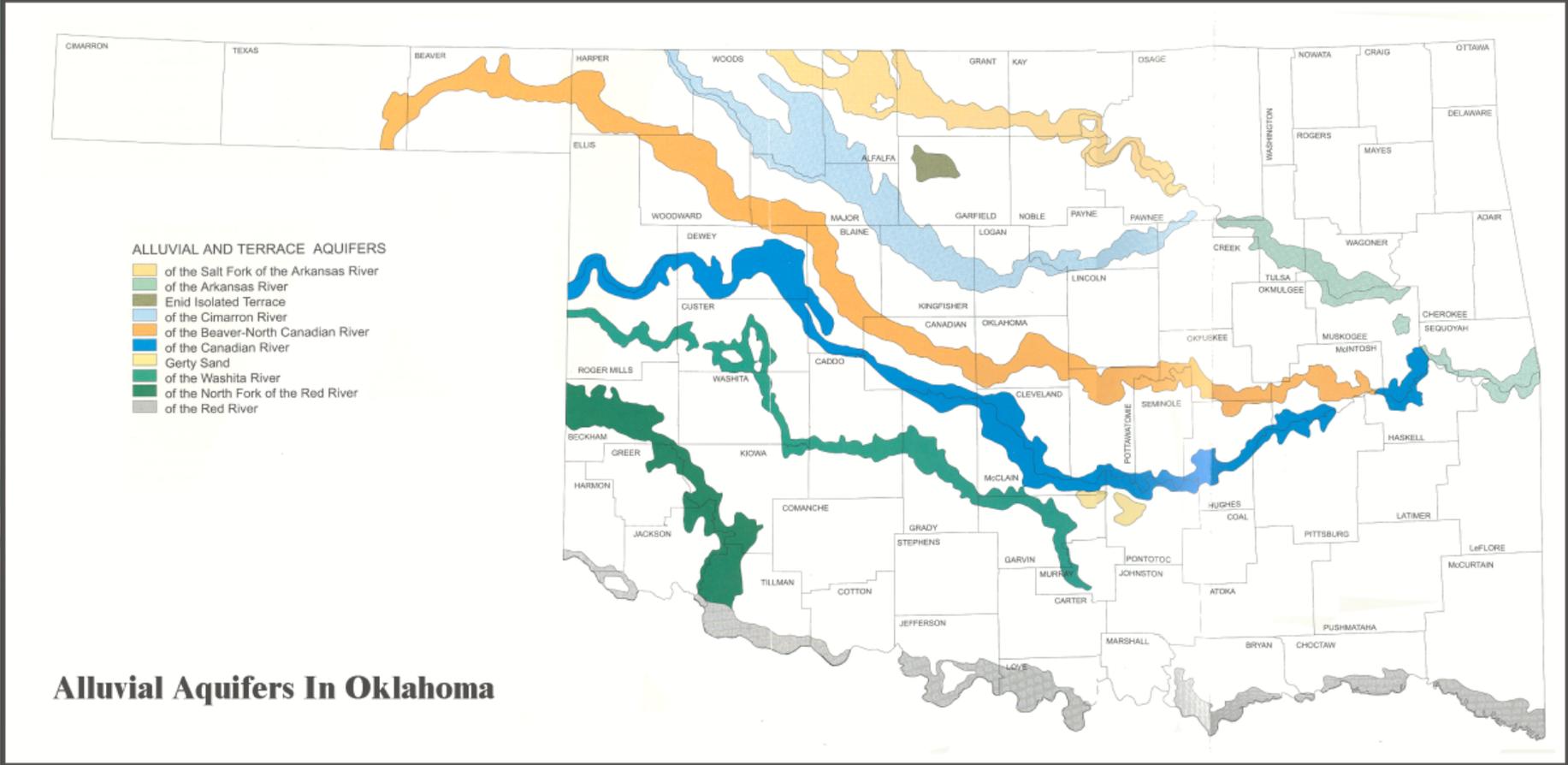


Where is the aquifer?

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Alluvial Aquifers

Alluvial aquifers are recent deposits found next to major rivers and streams.



Where is the aquifer?

BASIC HYDROGEOLOGY IN CENTRAL OKLAHOMA

ROCK NAME	ROCK TYPE	HYDRAULIC SYSTEM	WATER QUANTITY	WATER QUALITY
GARBER SANDSTONE	Porous Sandstone	Aquifer	250 gpm	Calcium Bicarbonate, Metals
QUATERNARY ALLUVIUM	Porous Sandstone	Aquifer	500 gpm	Sodium Bicarbonate, Nitrate Issues
HENNESSEY SHALE	Tight Shale	Fracture Porosity	100 gpm	Sodium Bicarbonate, Gyp Water
DUNCAN SANDSTONE	Tight Sandstone	Fracture Porosity	100 gpm ?	Sodium Bicarbonate

How good is my well? Is the water full of nitrates, arsenic, calcium?? Depends on the geology you are dealing with!!

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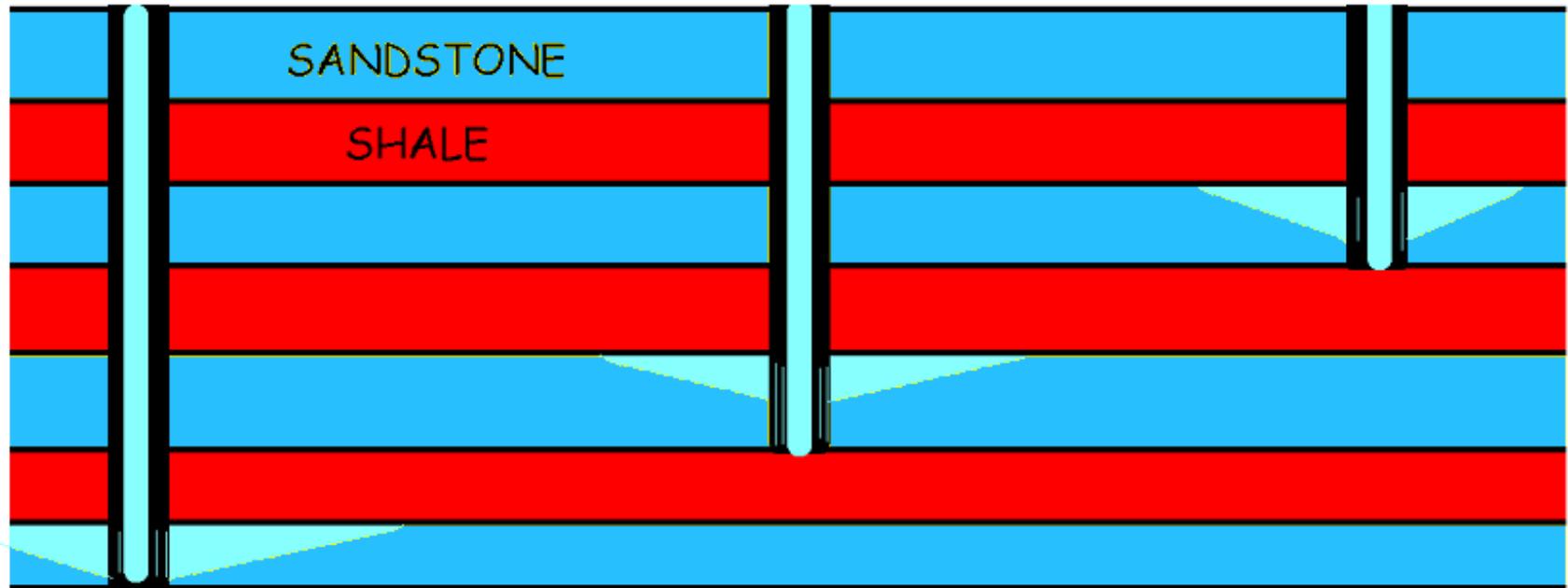
Garber Sandstone



A good picture of what we depend on for much of our water resources...

Types of Groundwater Systems Stratigraphic or Layered Systems

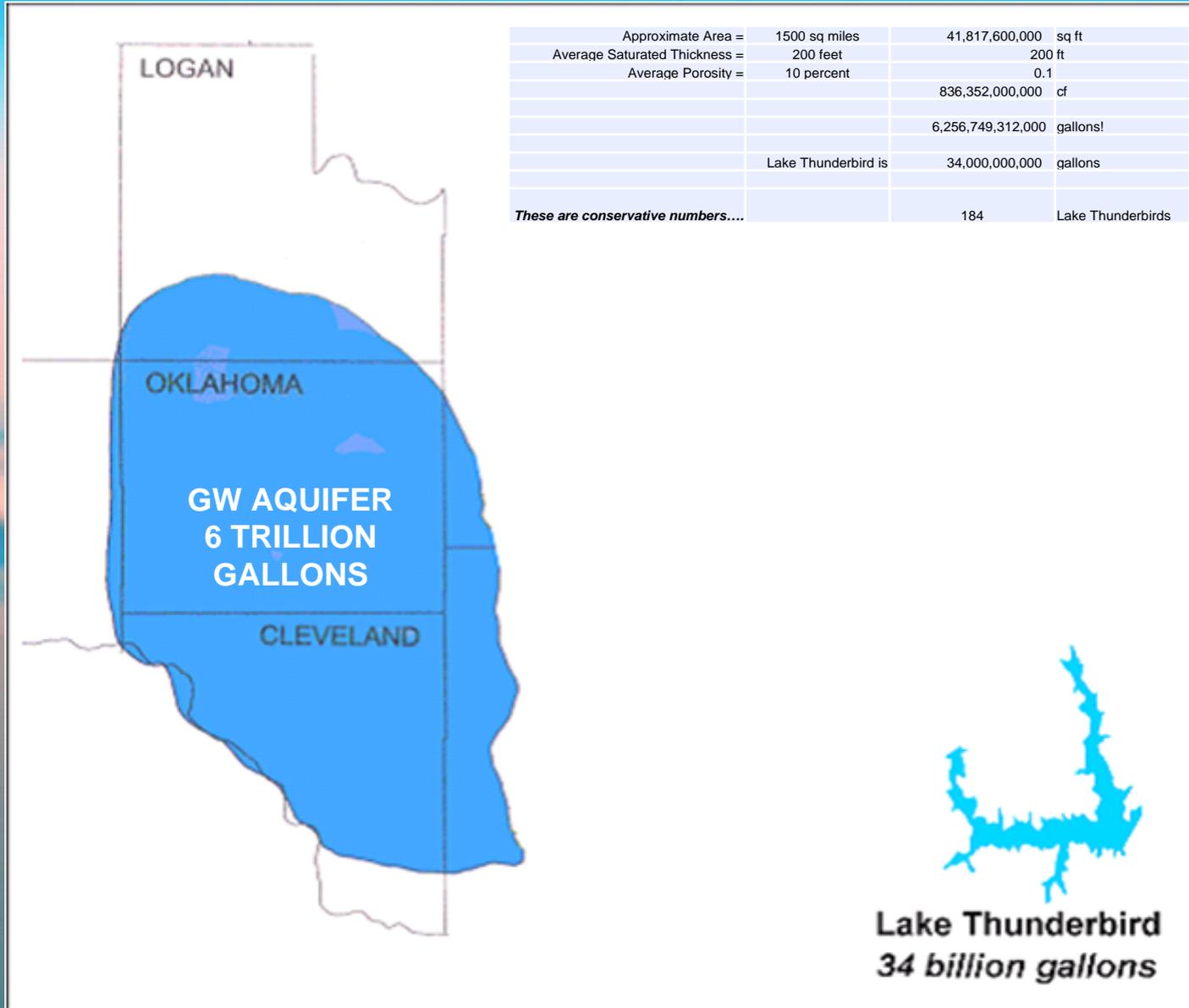
CONES OF DEPRESSION IN A LAYERED AQUIFER



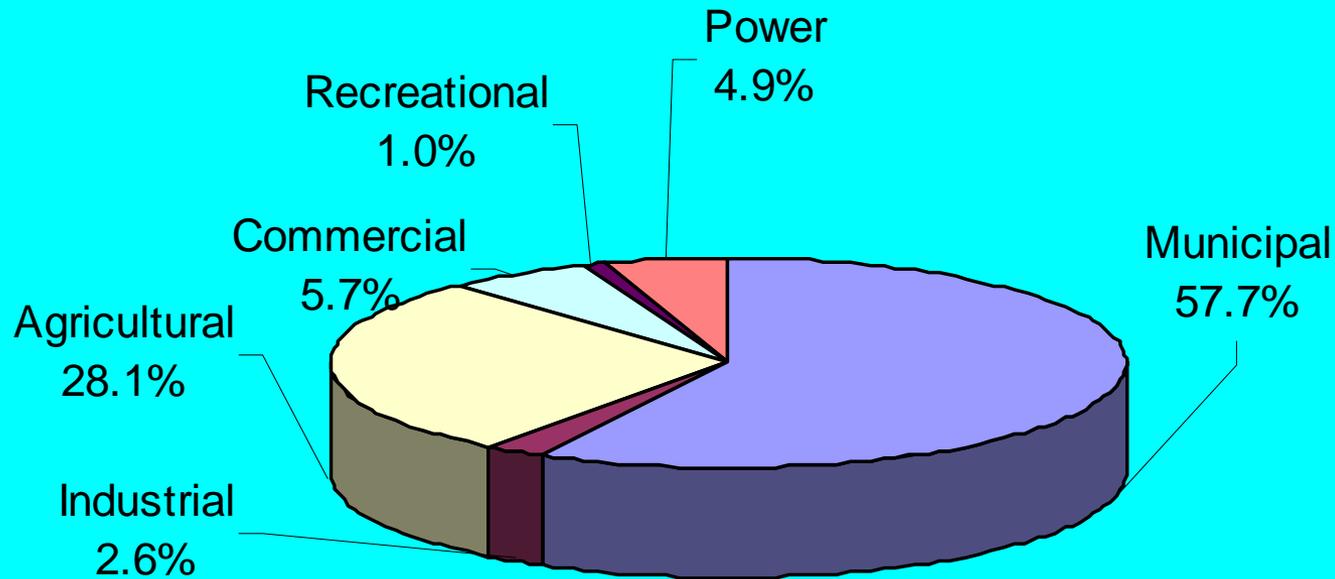
The GW aquifer is layered – many deeper wells may encounter six or seven separate sands, all with different water quality. The sands are isolated from each other by nearly impermeable shales. Therefore, water producing from deep wells will not have any impact on shallow domestic wells.

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How Much Water, Really?



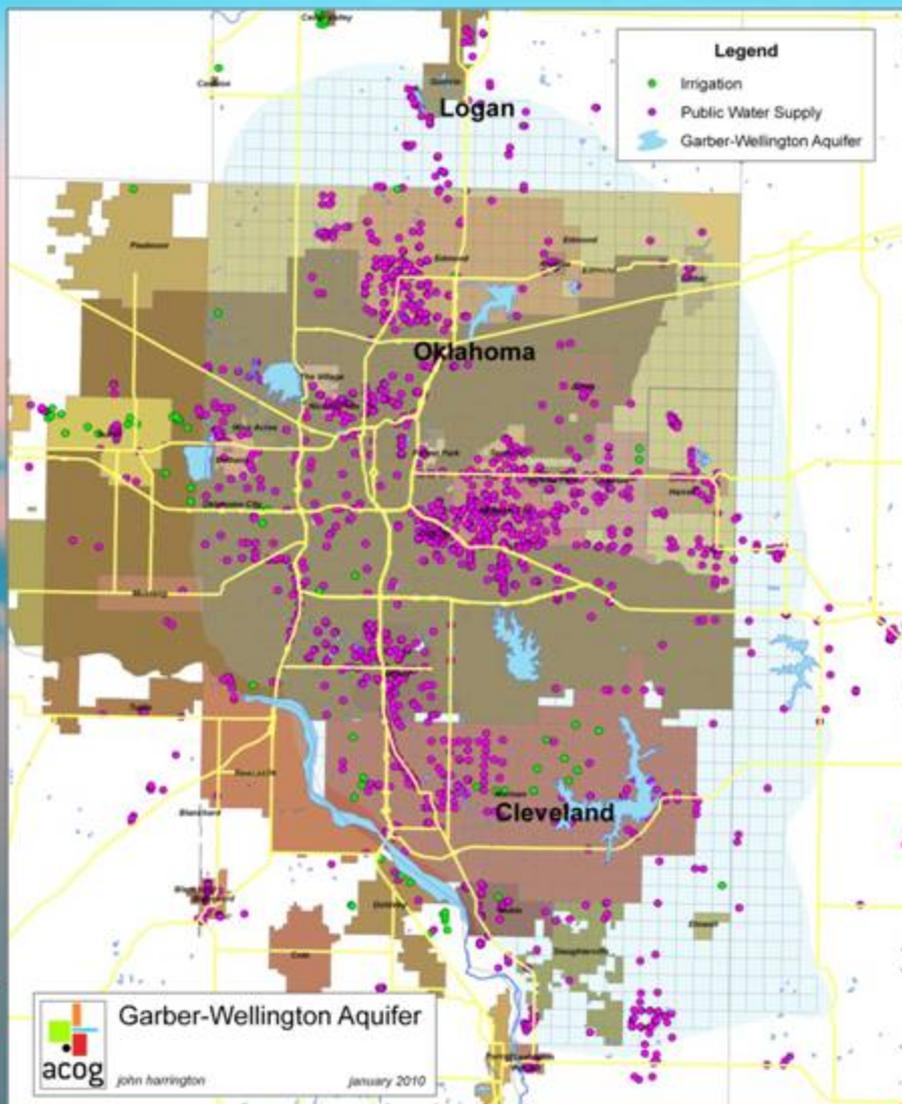
Groundwater in Central Oklahoma



Permitted Use							ANNUAL TOTAL
COUNTY	Municipal	Industrial	Agricultural	Commercial	Recreational	Power	in Millions of Gallons
Canadian	1,431	628	13,871	109	297	3,481	19,817
Cleveland	14,448	215	3,707	2,501	84	18	20,973
Oklahoma	34,253	1,476	3,469	2,742	503	1,081	43,525
TOTAL	54,176	2,488	26,371	5,381	927	4,580	93,923

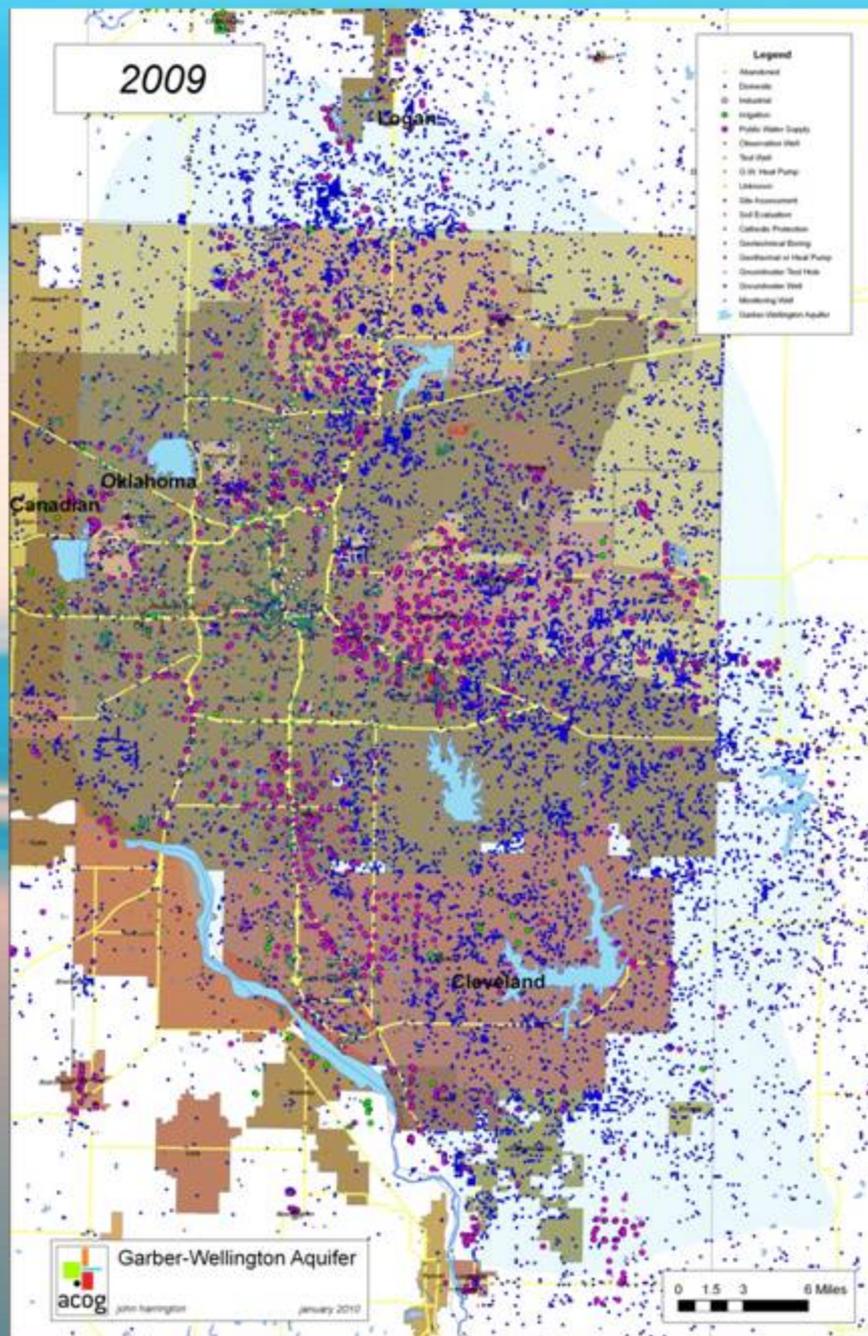
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Where is the Garber-Wellington Aquifer?



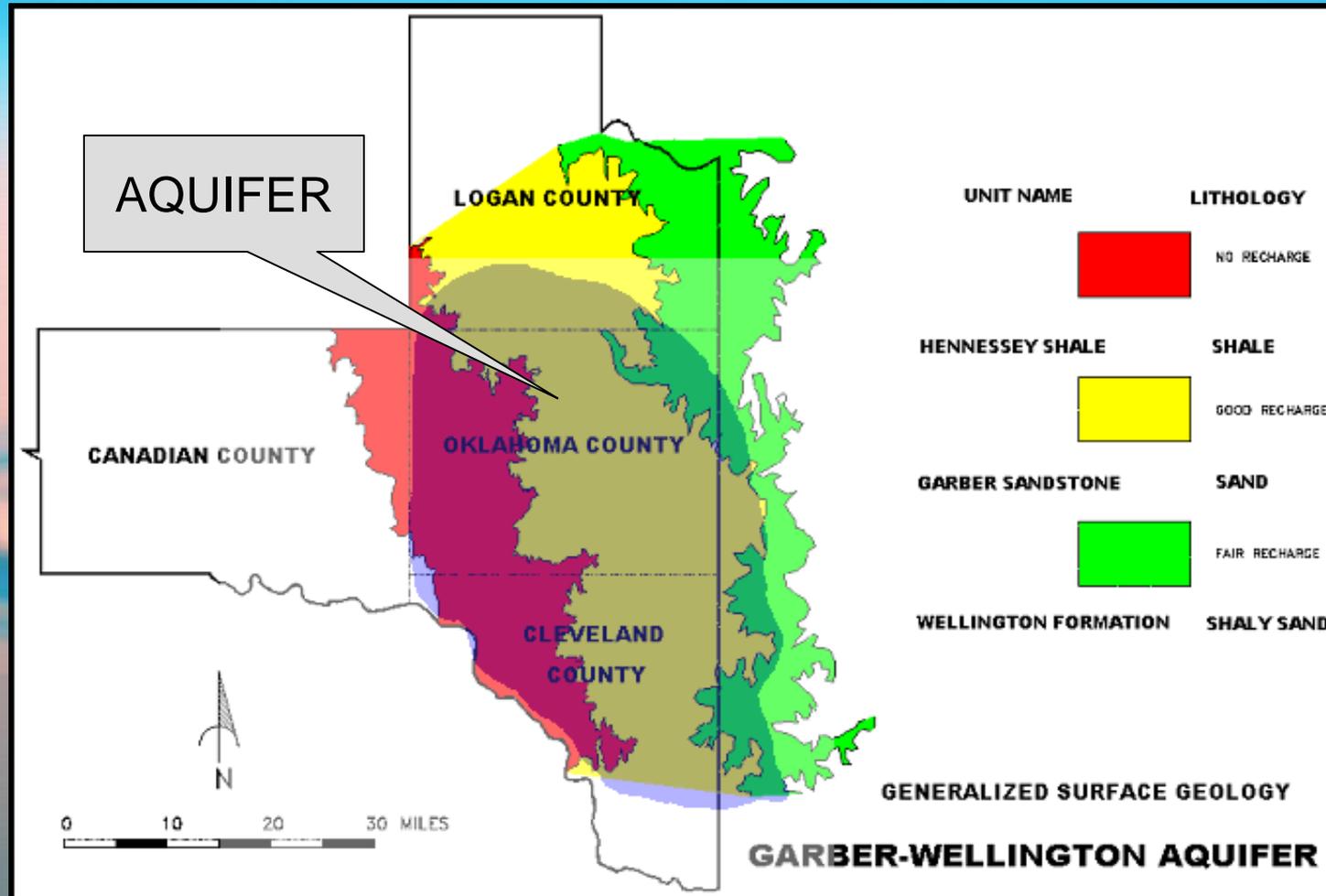
The Garber-Wellington Aquifer in central Oklahoma covers about 2,000 square miles and has over 1500 public water supply wells.

Drilling on the Aquifer 1989-2009



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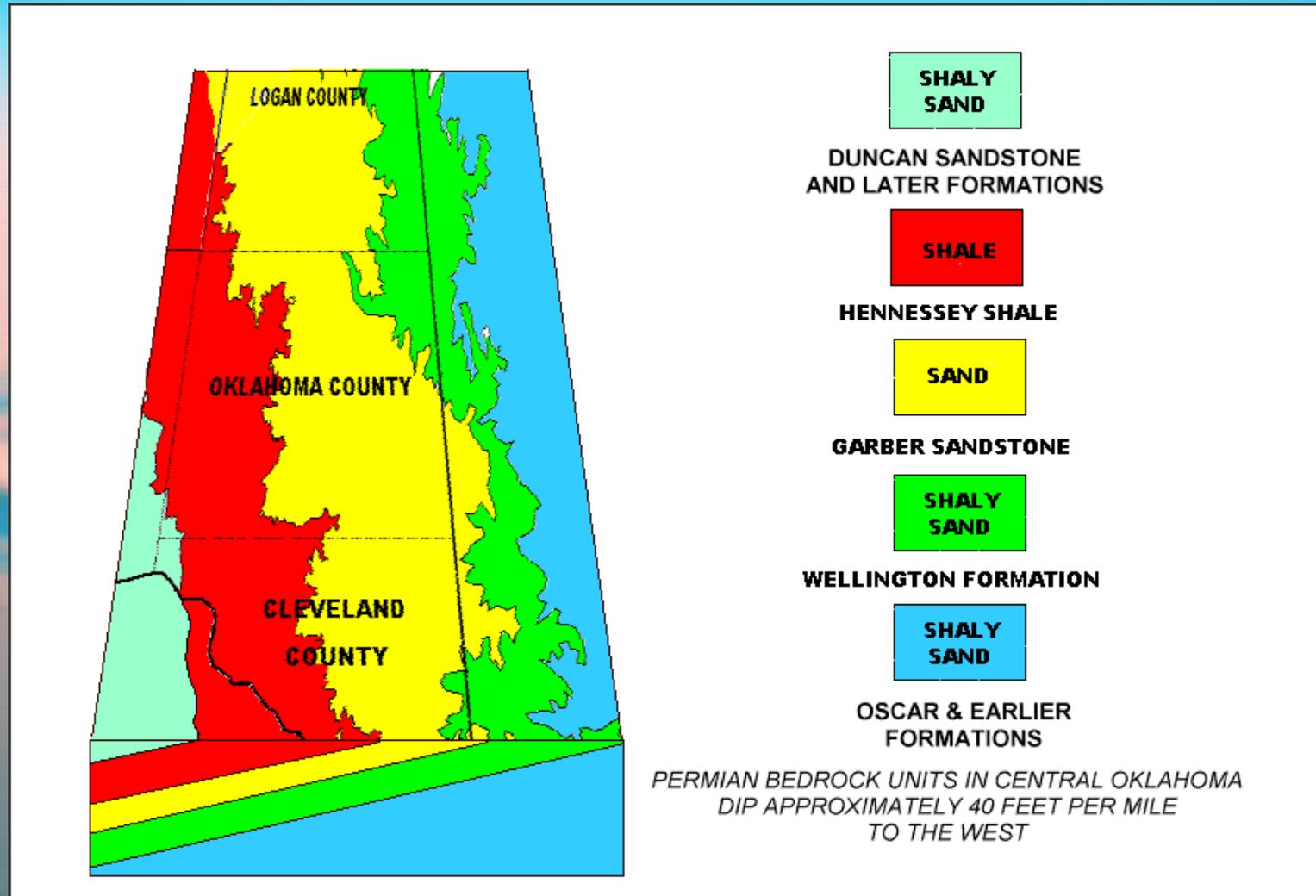
Generalized Surface Geology



Depending on the location, you can be standing on the Garber sands, the Wellington formation, or on the Hennessey Shale which confines the western half of the aquifer. This affects both water quality and quantity.

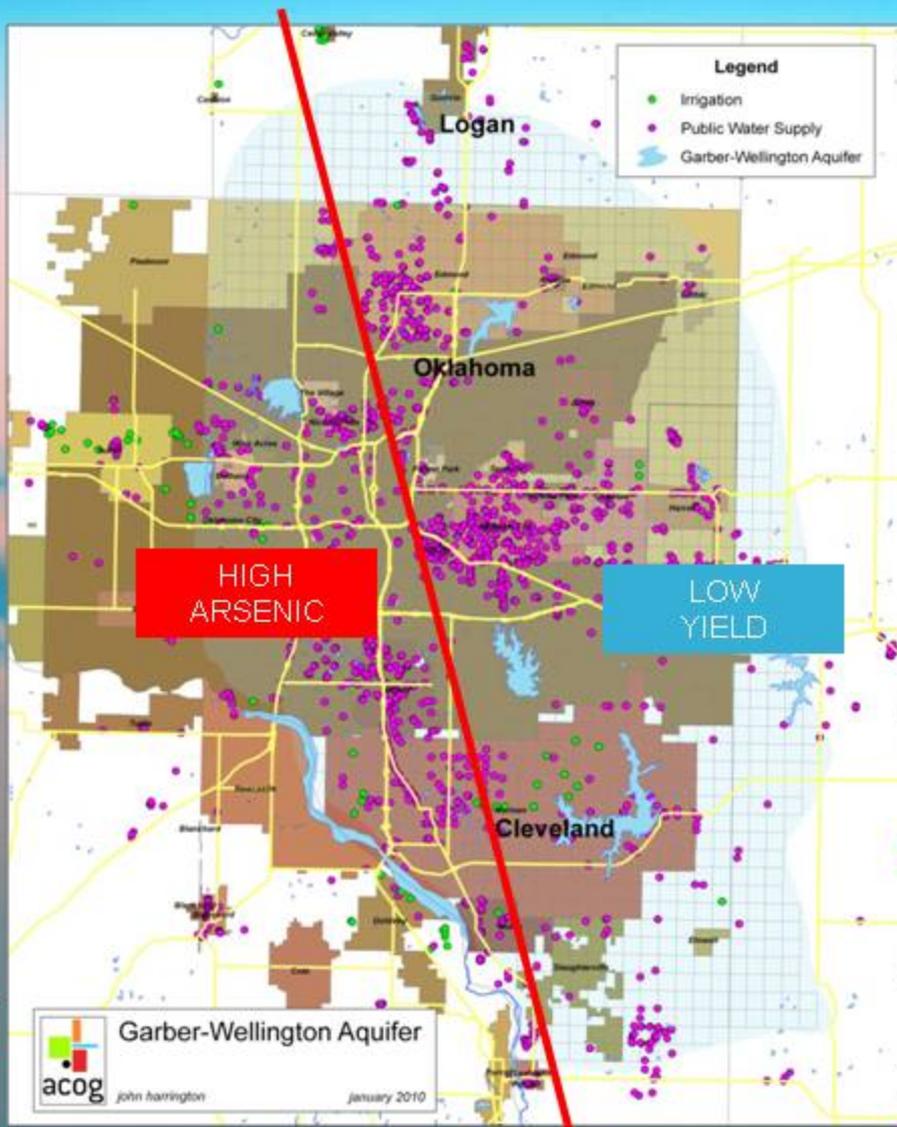
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Block Diagram Showing Westward Dip



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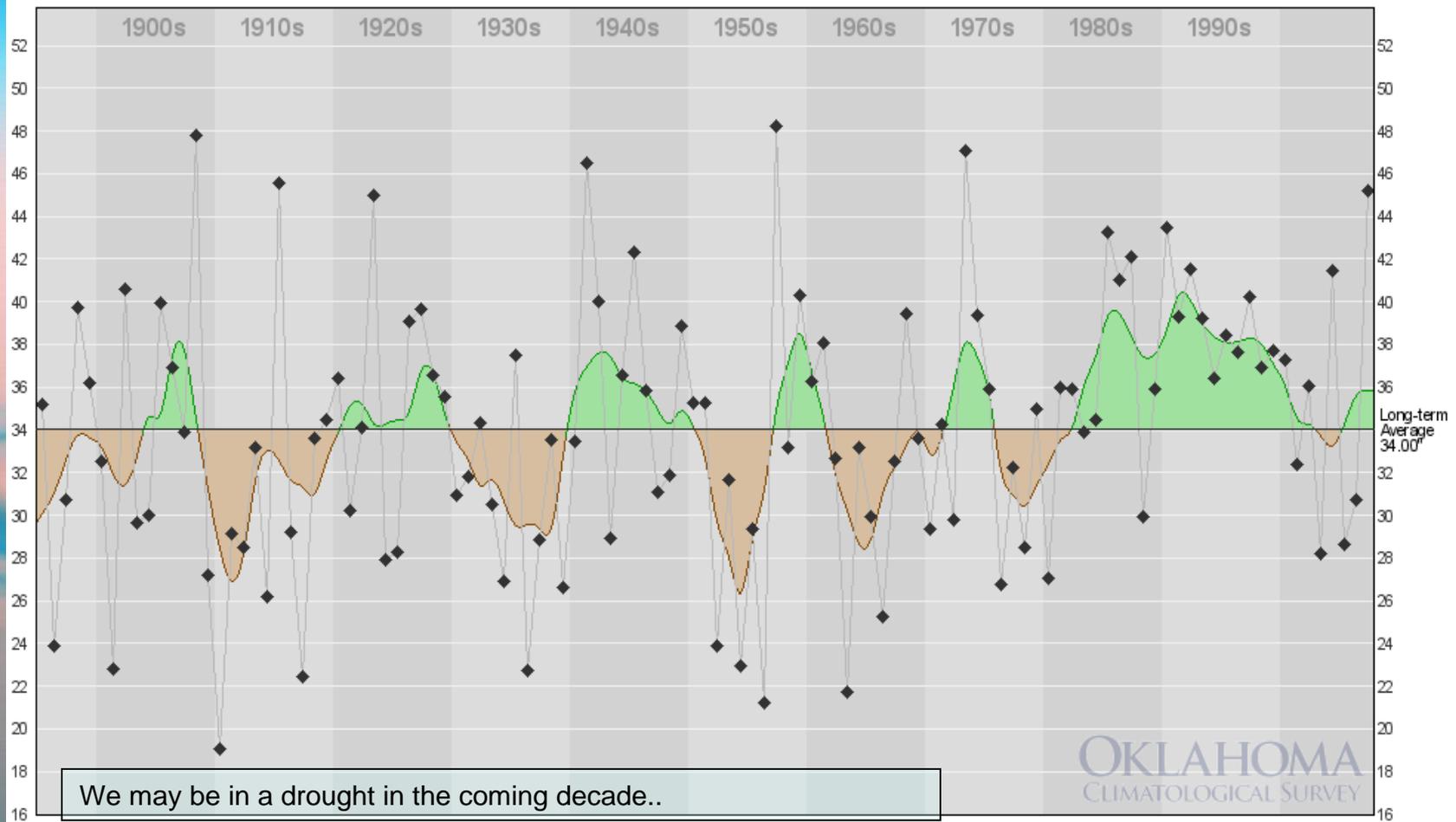
Water Quality Issues



Some issues with the aquifer relate to water quality. More stringent arsenic regulations have made public water supply drilling on the west side of the aquifer far more difficult. Drilling on the east side has better water quality, but not as much saturated rock, leading to smaller well yields.

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Droughts and Other Nasty Stuff...



USDA Annual Precipitation History with 5-year Tendencies
Oklahoma Statewide: 1895-2007

- Wetter historical periods
- Drier historical periods
- Individual Annual precipitation value



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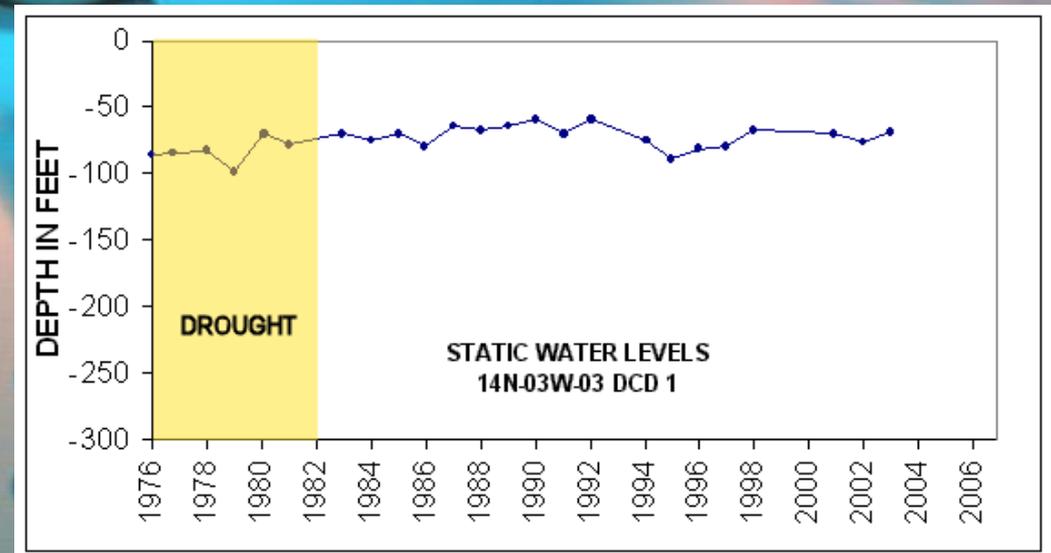
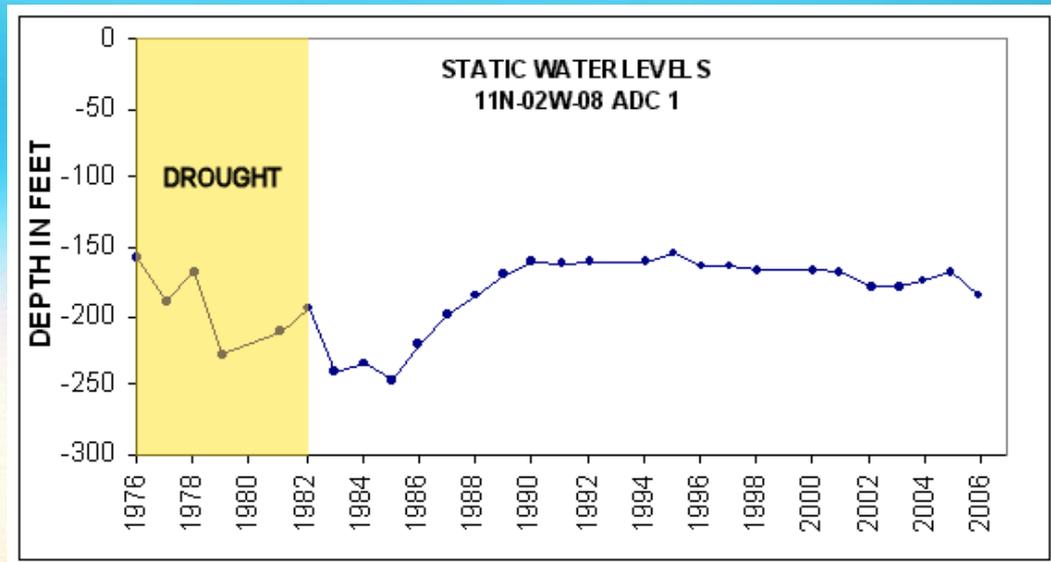
Droughts and Other Nasty Stuff...



The top graph is the static water level from a well just west of Tinker Industrial Park. It shows the effect of the last drought cycle – an 80 foot drawdown and five years to recover.

But similar wells in the aquifer can show completely different stories. The bottom chart is a well on the Logan/Oklahoma Co line, just west of Kelley. The drought hardly shows.

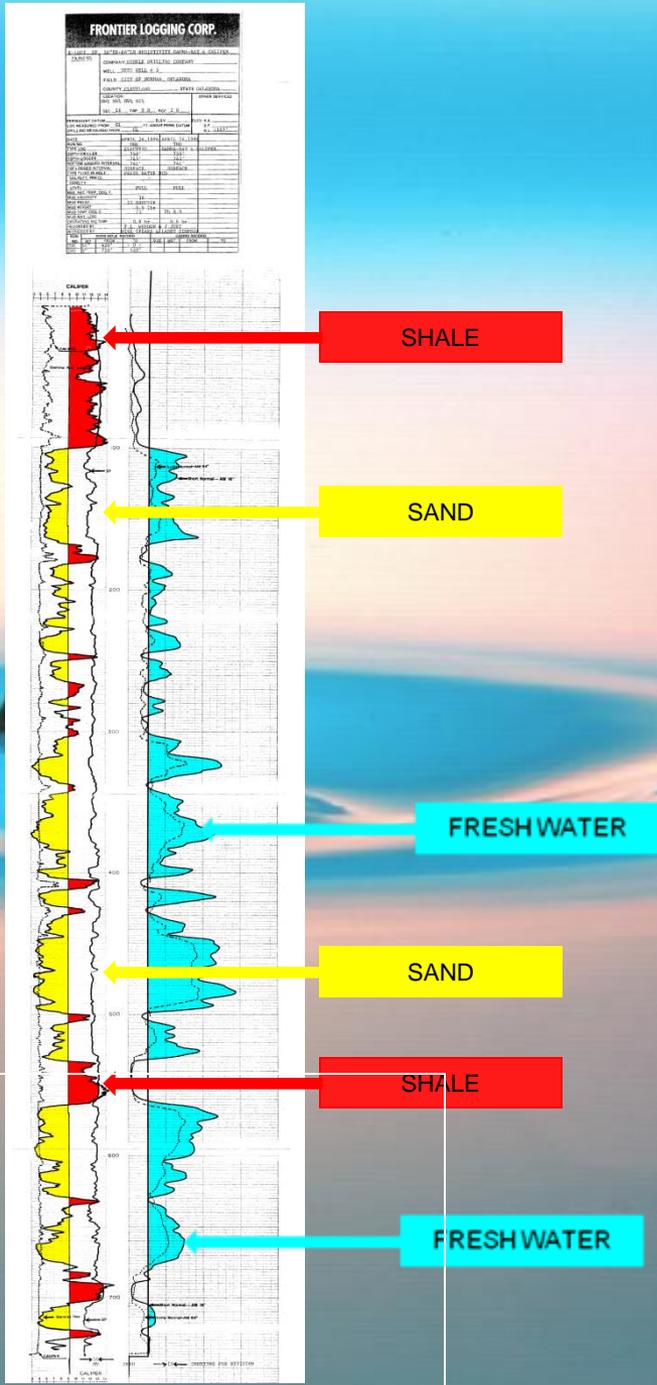
Both wells show a variability of ten or twenty feet from year to year.



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Brackish Water in the Aquifer

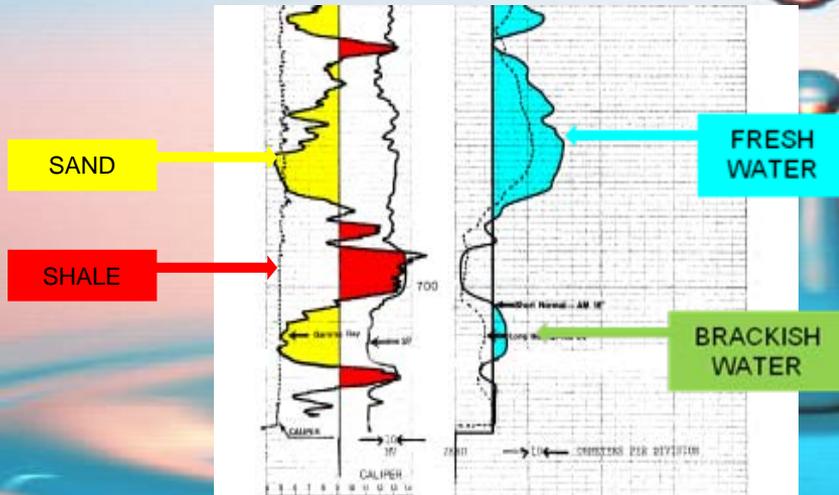
Well logs measure various physical properties about the rock the drill bit goes through. The two most common well logs are the gamma radiation and the electrical resistivity log.



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Brackish Water in the Aquifer

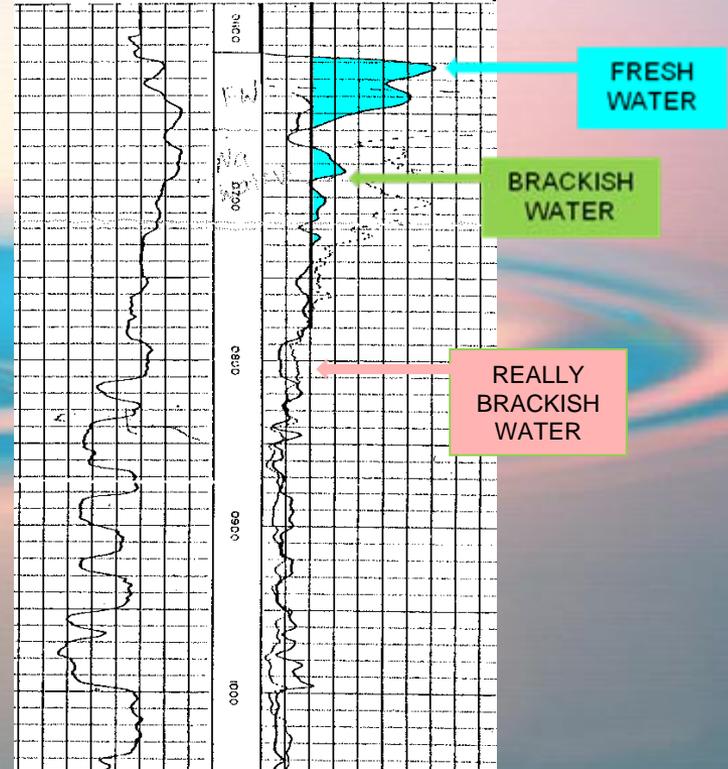
09N02W16ABBB



09N02W24ACD

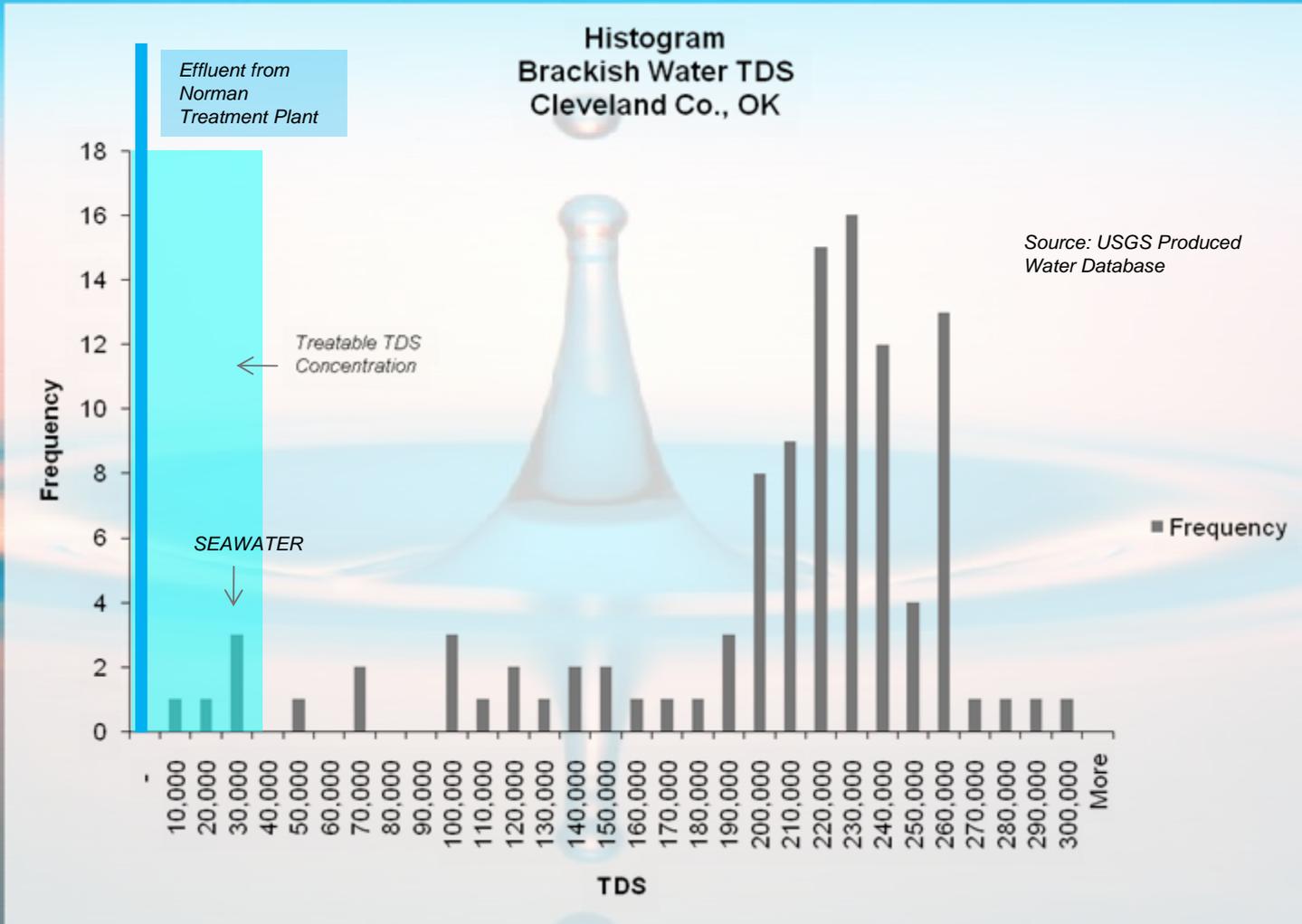
SPONTANEOUS-POTENTIAL millivolts	DEPTH	RESISTIVITY -ohms. m ³ /m
- 20 + MV		SHORT NORMAL AM-16"
	0	50
	0	500
		LATERAL AO-19"
	0	50
	0	500
	0	5000
		CSG.

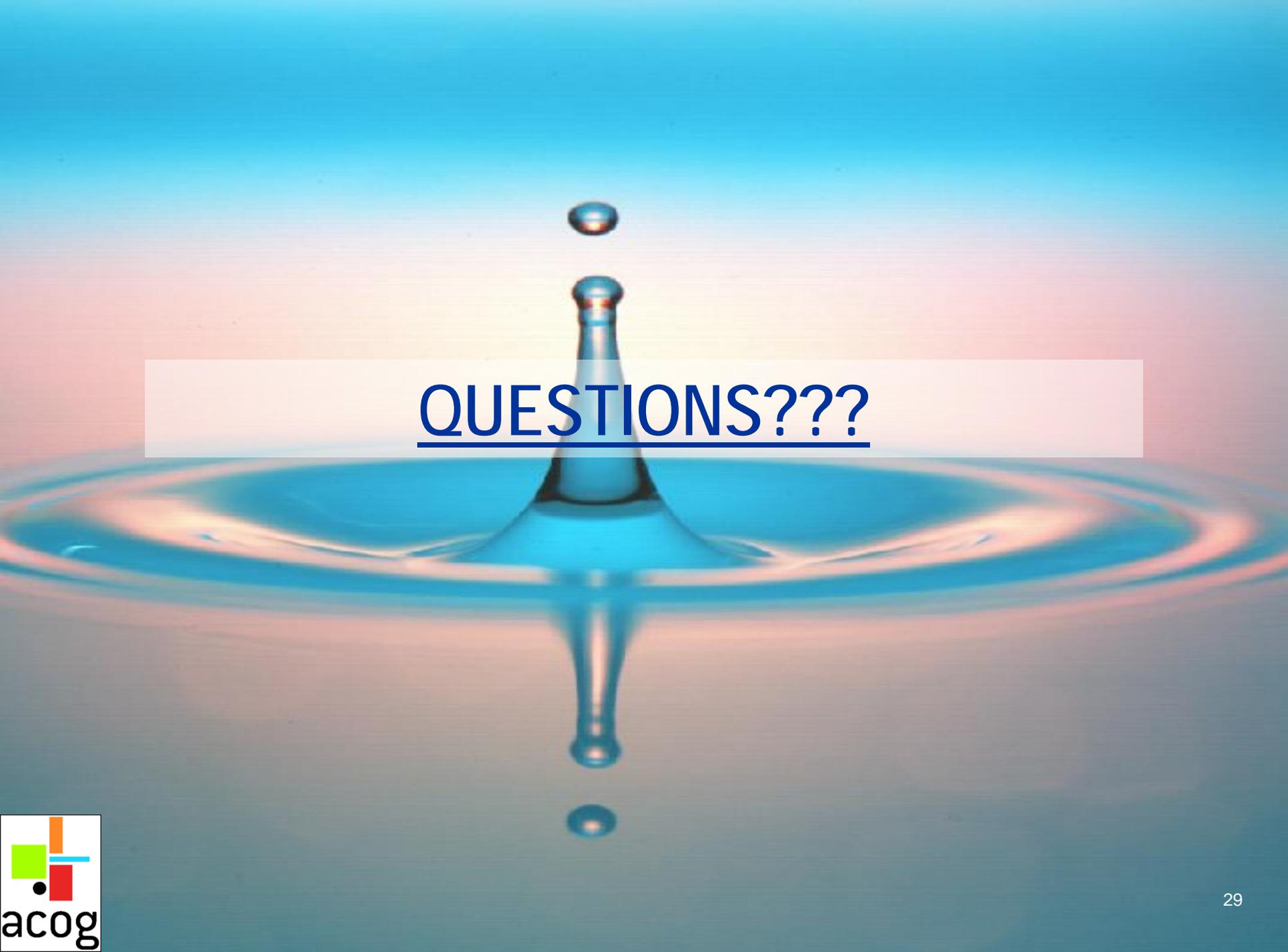
A RILEY REPRODUCTION
U. S. PATENT PENDING



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Brackish Water in the Aquifer





QUESTIONS???