Mace's Believe It or Not!

BIZARRE TEXAS GROUNDWATER FACTS!

Robert E. Mace, Ph.D., P.G.
Texas Water Development Board

presented to

Milam & Burleson Counties Ground Water Summit

August 11, 2016

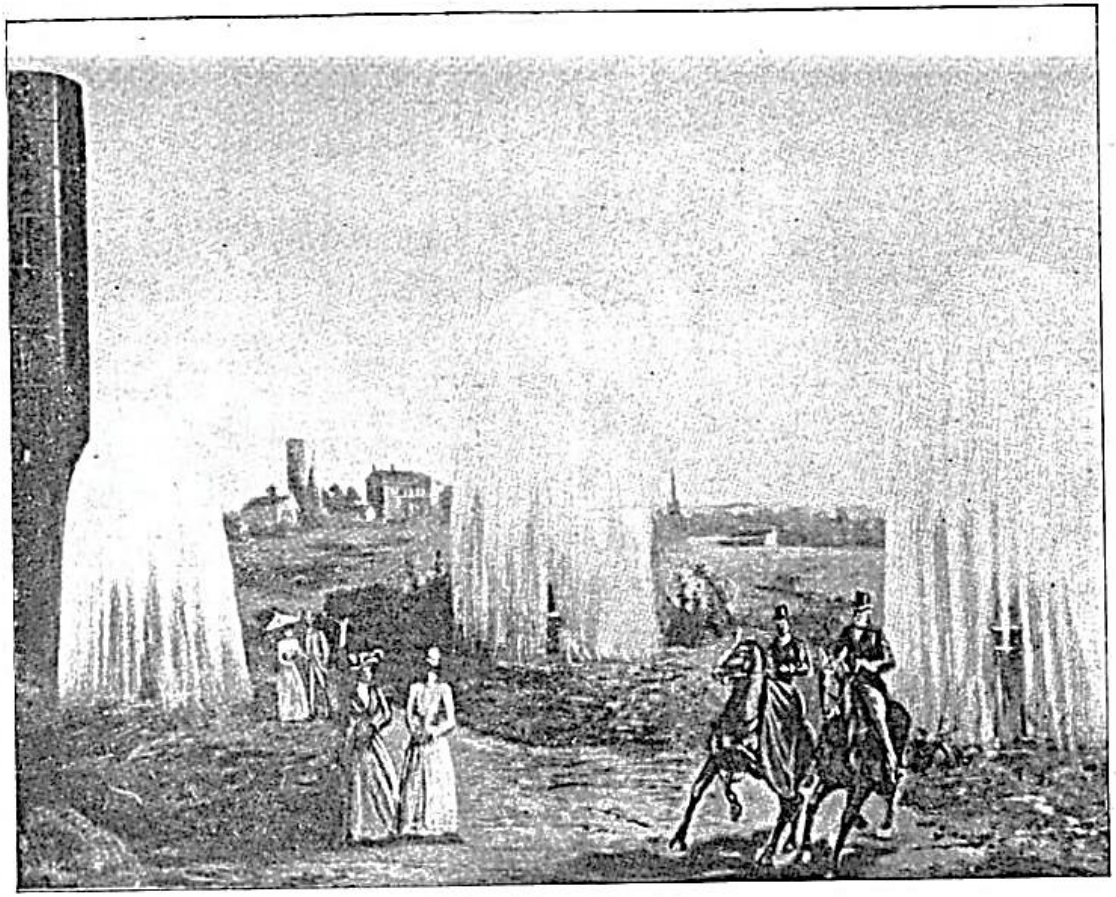
The following presentation is based upon professional research and analysis within the scope of the Texas Water Development Board's statutory responsibilities and priorities but, unless specifically noted, does not necessarily reflect official Board positions or decisions.

Texas Water Development Board

Believe it or Not!

Waco used to be known as Geyser City!

PLATE VII.



FLOWING WELLS AT WACO, TEXAS.


TEXAS HISTORICAL COMMISSION
TEXAS
BELL'S HILL SCHOOL
IN MARCH 1886, JOSEPH D. BELL DRILLED WACO'S FIRST ARTESIAN WELL, AND THE AREA AROUND THE WELL BECAME KNOWN AS BELL'S HILL. THE WACO SCHOOL DISTRICT OPENED THE SIXTH DISTRICT SCHOOL AT 6TH AND FRANKLIN STREETS IN 1889; IT WAS MOVED TO A NEW STRUCTURE AT 15TH AND BURNETT BY 1904. ALL DISTRICT SCHOOLS WERE GIVEN OFFICIAL NAMES IN 1906, AND THE SIXTH DISTRICT SCHOOL BECAME THE BELL'S HILL SCHOOL. THE SCHOOL BUILDING COLLAPSED IN 1923 BECAUSE THE SOIL BENEATH IT WAS UNSTABLE. A NEW STRUCTURE WAS ERECTED AT THE FORMER LOCATION OF THE BELL WATER COMPANY'S WELL IN 1925. THE FACILITY WAS EXPANDED IN 1954, WITH FURTHER EXPANSIONS AND ADDITIONS MADE IN 1988. IN 1998 THE SCHOOL SERVED APPROXIMATELY 600 STUDENTS.
(1998)


Bell's Well destroyed the school!

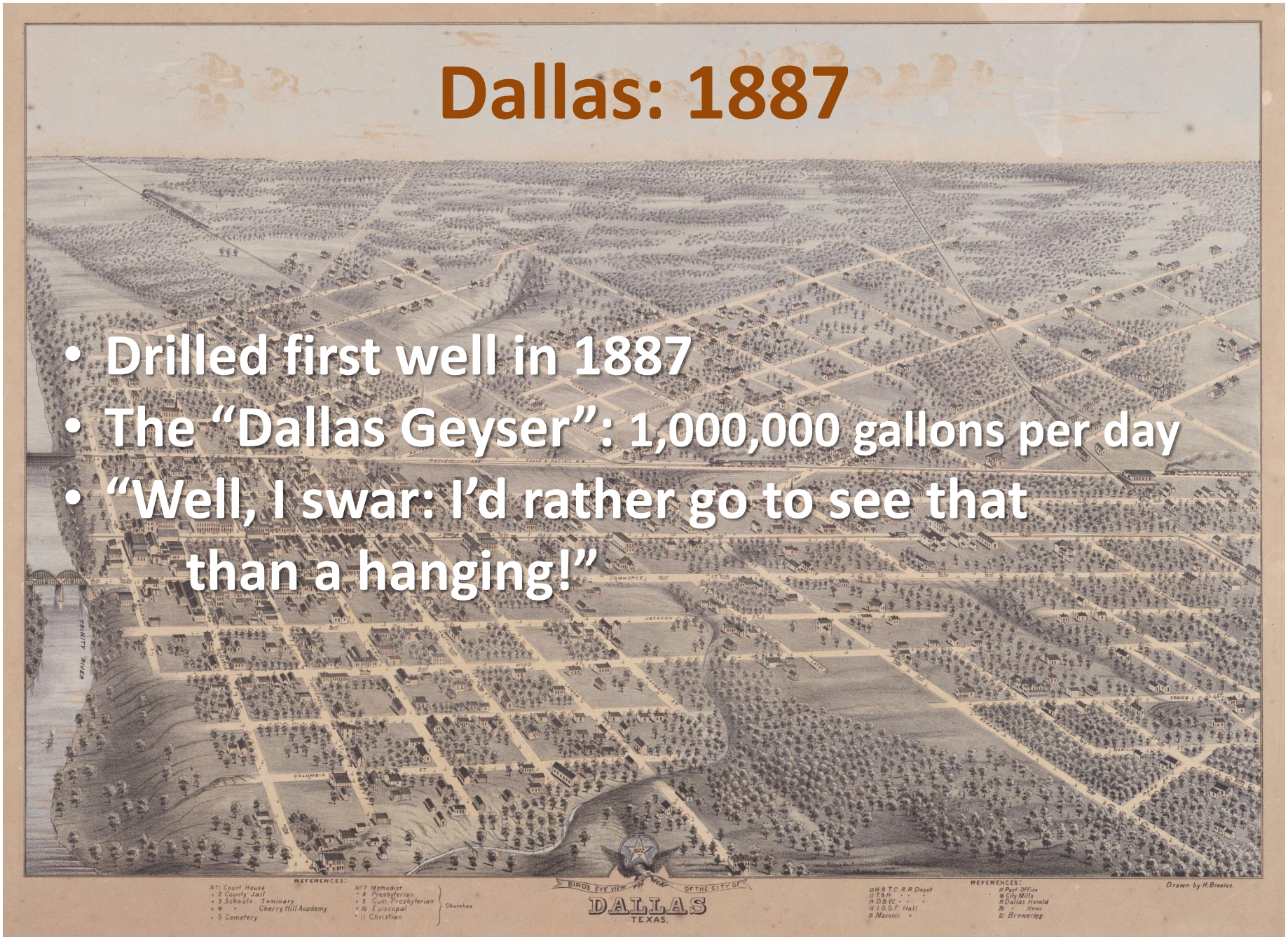
In 1886, J. D. Bell drilled the first artesian well in Waco, and the surrounding land became known as Bell's Hill. Bell's Hill became a fast-growing neighborhood thanks to the influx of workers for local railroads like the Missouri, Kansas, and Texas (MKT) and the Cotton Belt Line. In 1889, the Sixth District School was built at Fifteenth Street and Burnett Avenue. The school was later renamed Bell's Hill Elementary. Nearly identical in design to Sanger Avenue Elementary, which was built around the same time, the school featured elements of the Ruskinian Gothic and Colonial Revival styles. This included contrasting rough-hewn stone with red bricks, parapets flanking a large arched entryway, and a prominent cupola covered in cedar shakes. Despite its obvious sturdy construction, the building eventually collapsed in 1923 due to instability caused by extracting artesian water from the nearby soil.

Dr Pepper used to be called the Artesian Mfg and Bottling Co!


One of the first bottles
used by the company

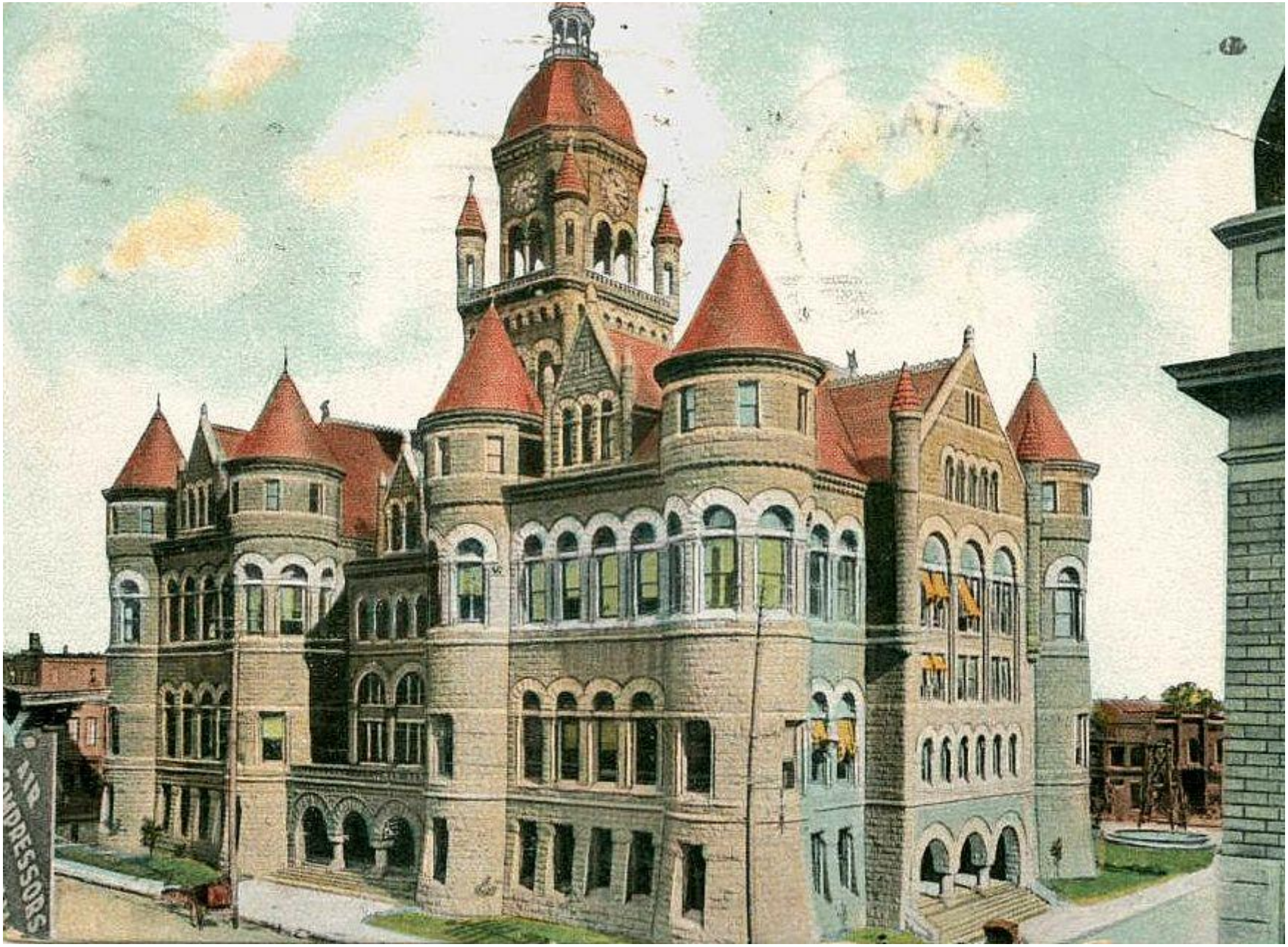
Folks once proposed drilling 270 artesian wells to turn Dallas into a seaport town!

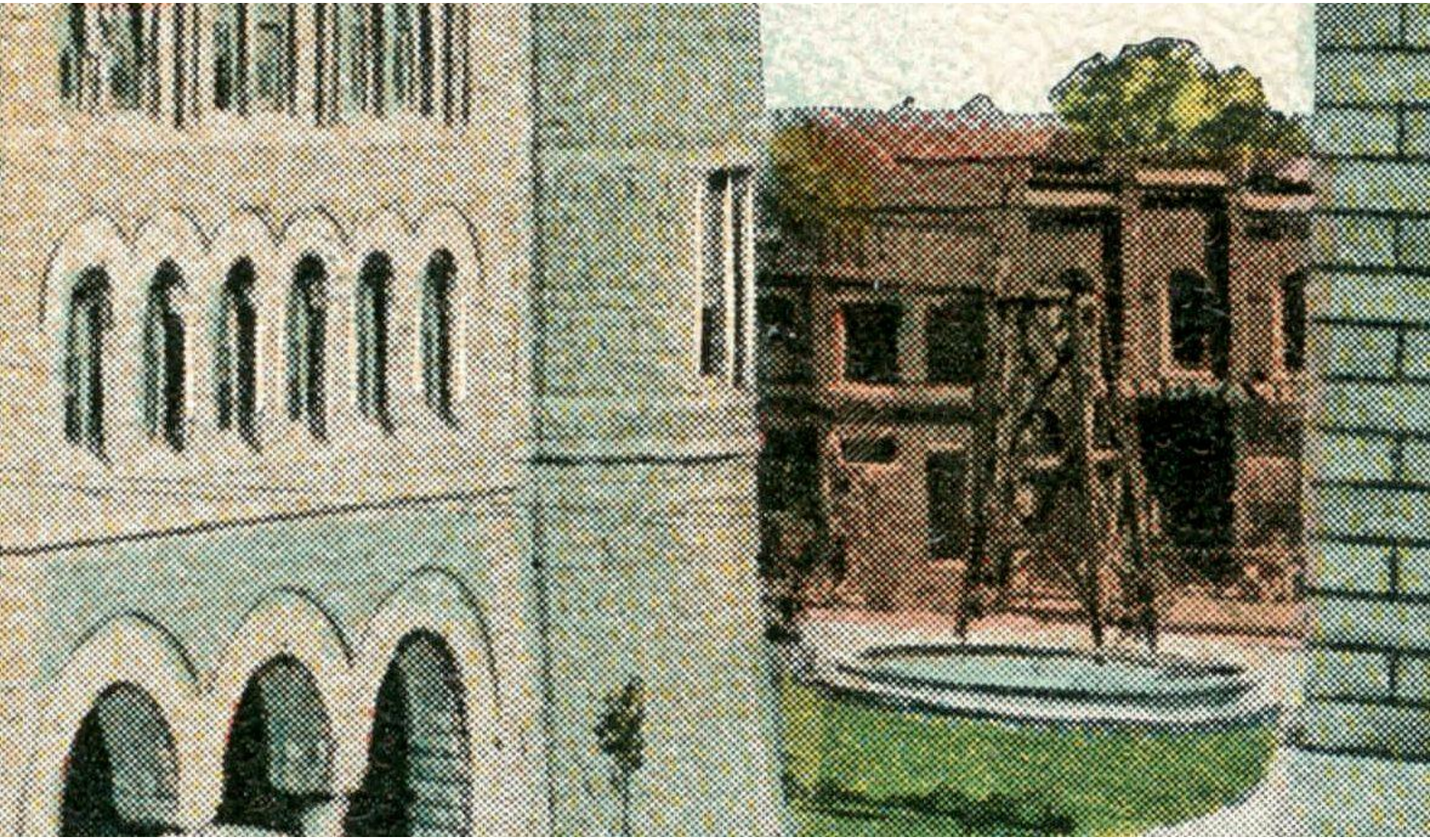
Dallas: 1887

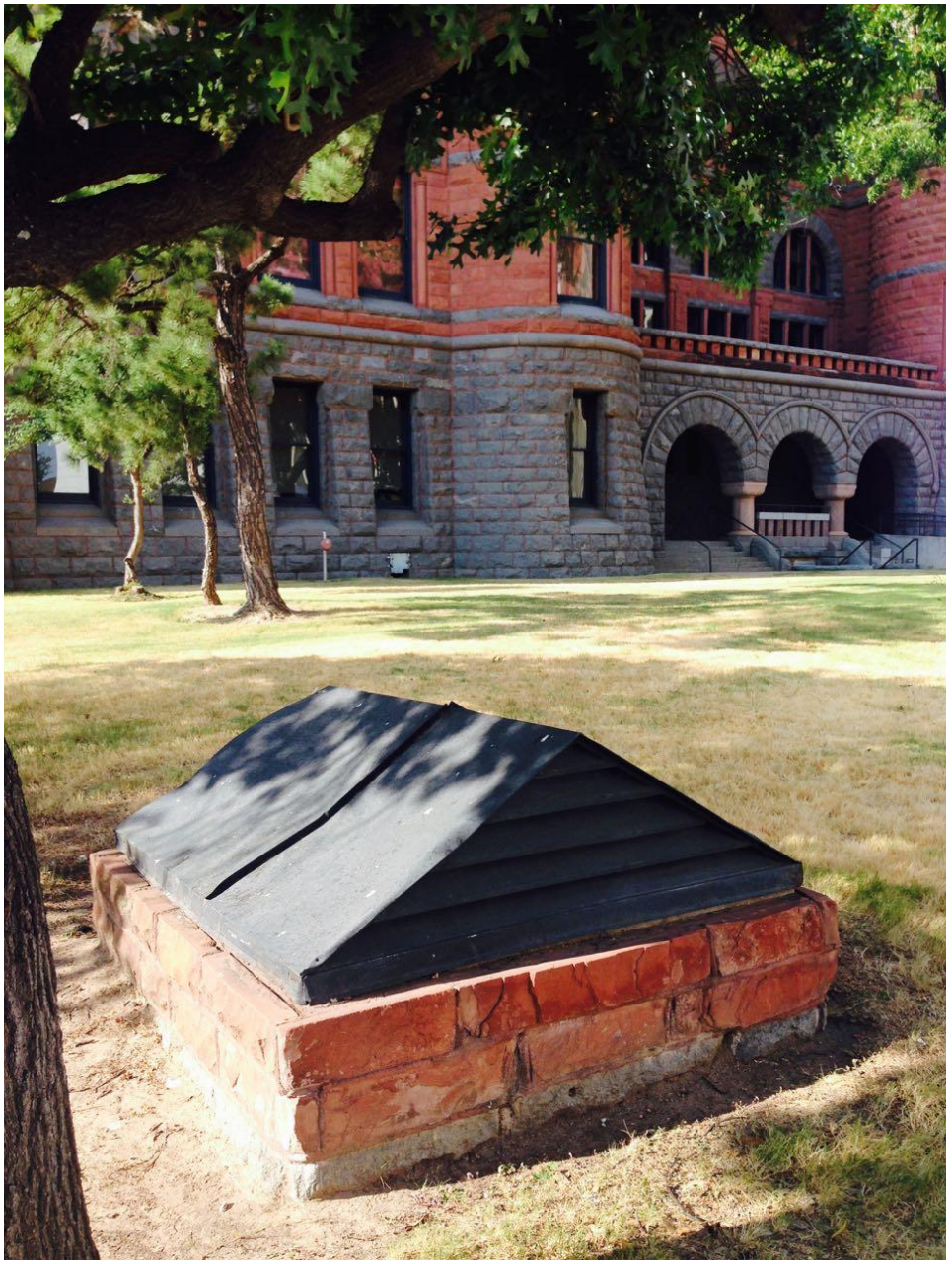


- Drilled first well in 1887
- The "Dallas Geyser": 1,000,000 gallons per day
- "Well, I swar: I'd rather go to see that than a hanging!"

You can still visit the wellhead at Big Red!


AIR
COMPRESSORS



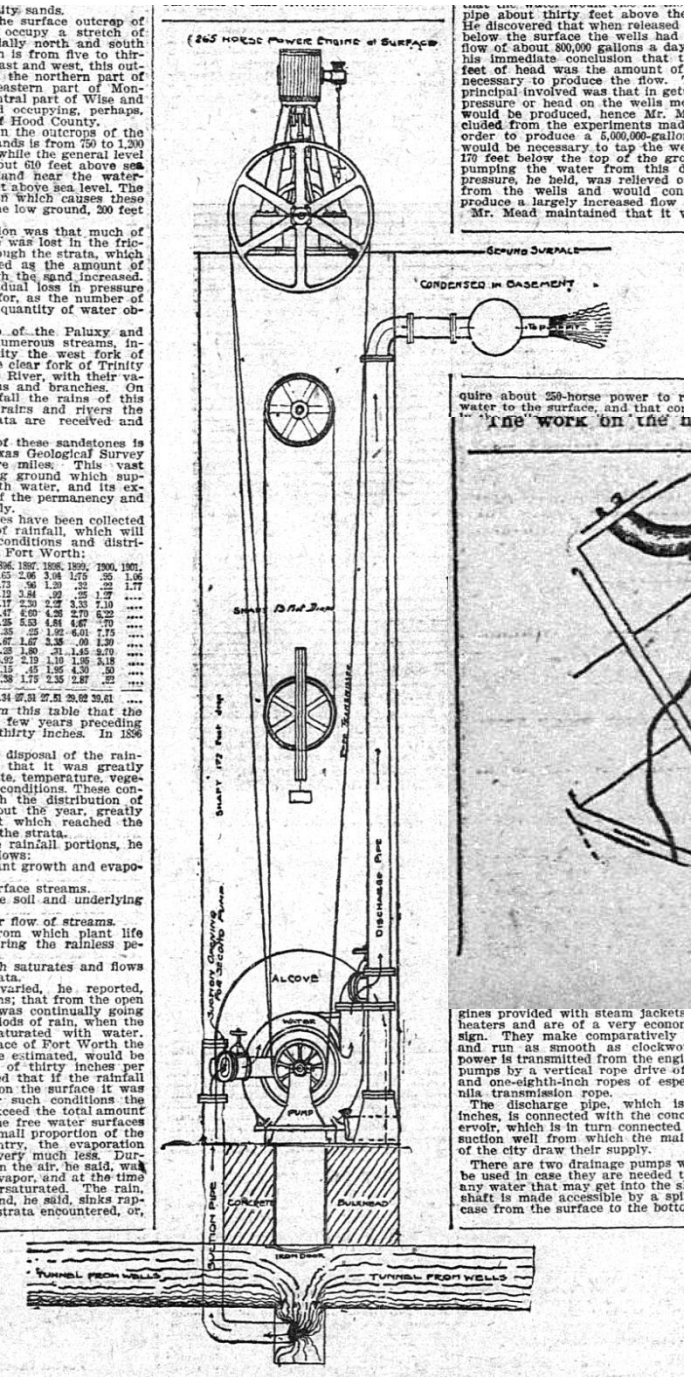


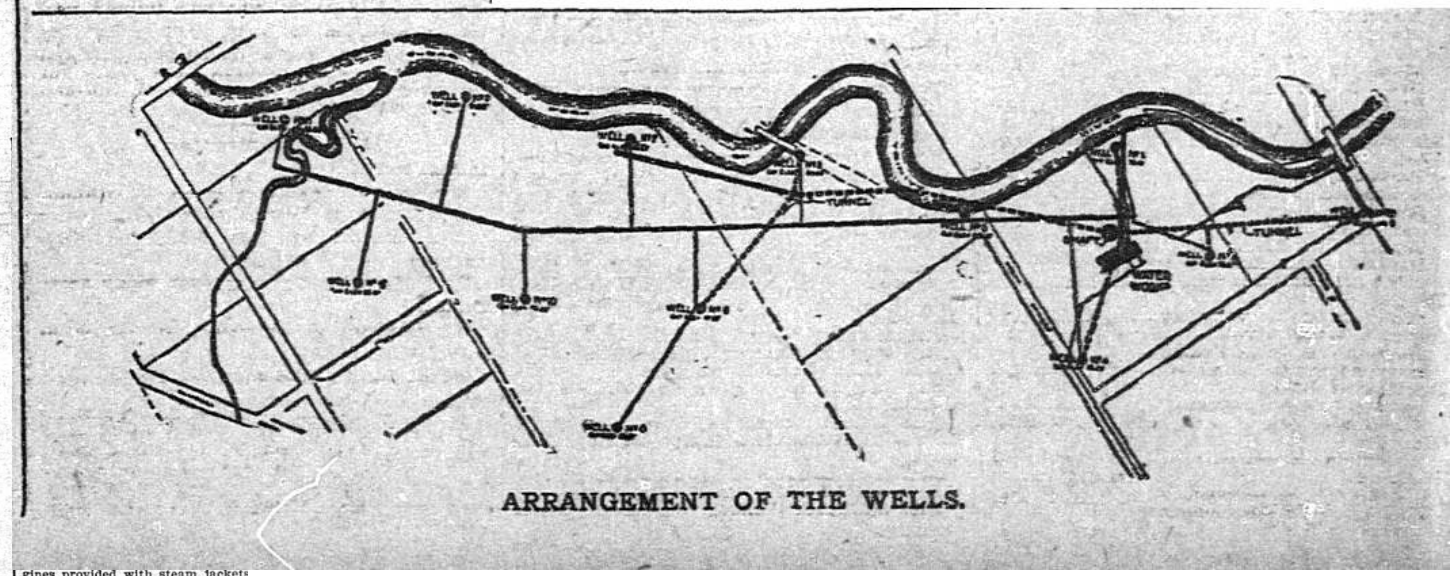
The discovery of artesian water in Texas led directly to the development of large breweries in Texas!

Texas Brewing Company, Fort Worth, circa 1900

Fort Worth attempted to circumvent declining water levels in the Trinity Aquifer by "following the water"!

- **13-feet in diameter, 172 feet deep shaft**
- **Over a mile in tunnels**
- **13 wells**
- **Abandoned by 1910**





1903, Dallas Morning News

Pitless pumps are called pitless pumps because them pumps don’t have pits!

ity sands.
he surface outcrop of
occupy a stretch of
lally north and south
is from five to thir-
ast and west, this out-
the northern part of
astern part of Mon-
tral part of Wise and
occupying, perhaps,
f Hood County.
n the outcrops of the
nds is from 750 to 1,200
while the general level
out 610 feet above sea
and near the water-
t above sea level. The
n which causes these
e low ground, 200 feet

ion was that much of
was lost in the fric-
ugh the strata, which
ed as the amount of
h the sand increased.
dual loss in pressure
for, as the number of
quantity of water ob-

of the Paluxy and
umerous streams, in-
ity the west fork of
clear fork of Trinity
River, with their va-
ts and branches. On
fall the rains of this
rains and rivers the
ata are received and

f these sandstones is
xas Geological Survey
e miles. This vast
g ground which sup-
th water, and its ex-
f the permanency and
ly.
es have been collected
f rainfall, which will
conditions and distri-
Fort Worth:

1896.	1897.	1898.	1899.	1900.	1901.
.65	2.06	3.04	1.75	.95	1.06
.73	.90	1.39	.32	.09	1.77
.12	3.84	.92	.25	1.27	....
.17	2.30	2.27	3.33	7.10	....
.47	2.69	4.26	2.70	6.22	....
.25	5.53	4.84	4.67	4.70	....
.35	.25	1.92	6.01	7.75	....
.87	1.67	3.38	.00	1.39	....
.28	1.80	.21	1.45	2.70	....
.92	2.19	1.10	1.95	3.18	....
.15	.45	1.95	4.30	.50	....
.98	1.79	2.35	2.87	.22	....
.34	27.51	27.51	29.02	39.61	....

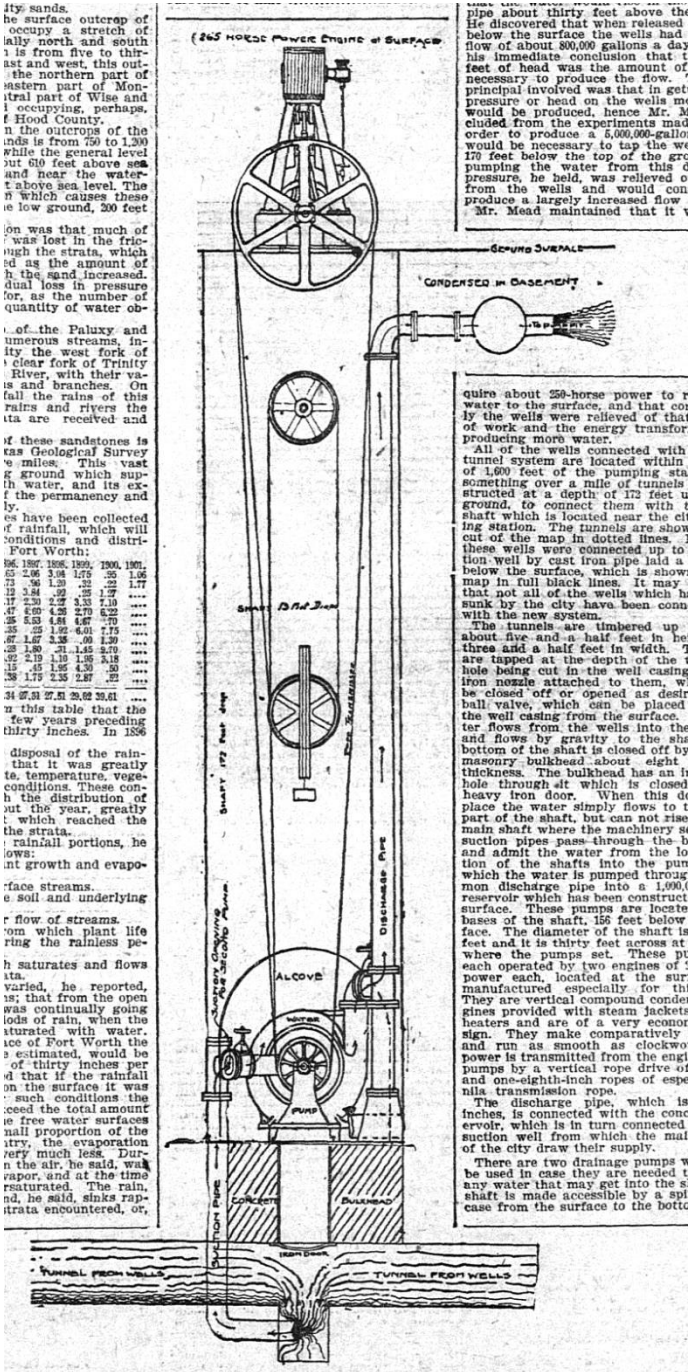
n this table that the
few years preceding
thirty inches. In 1896

disposal of the rain-
that it was greatly
te, temperature, vege-
conditions. These con-
h the distribution of
out the year, greatly
which reached the
the strata.
rainfall portions, he
lows:
nt growth and evapo-

rface streams.
e soil and underlying

r flow of streams.
om which plant life
ring the rainless pe-

h saturates and flows
ata.
varied, he reported,
as; that from the open
was continually going
lods of rain, when the
aturated with water.
ace of Fort Worth the
e estimated, would be
of thirty inches per
d that if the rainfall
on the surface it was
such conditions the
ceed the total amount
e free water surfaces
nall proportion of the
ntry, the evaporation
very much less. Dur-
n the air, he said, wa
vapor, and at the time
rsaturated. The rain,
nd, he said, sinks rap-
strata encountered, or,



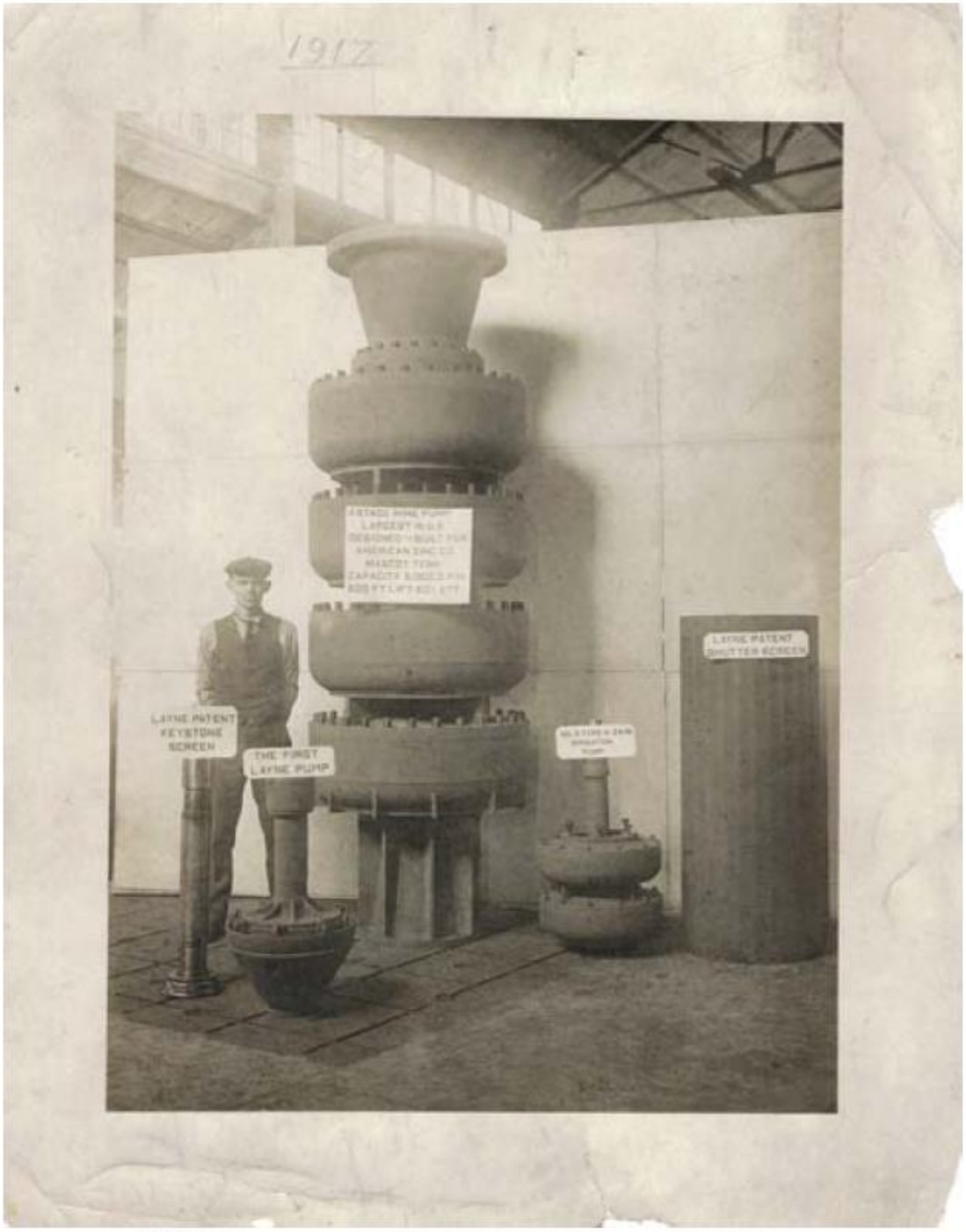
pipe about thirty feet above the
He discovered that when released
below the surface the wells had
flow of about 800,000 gallons a day
his immediate conclusion that t
feet of head was the amount of
necessary to produce the flow.
principal involved was that in get
pressure or head on the wells m
would be produced, hence Mr. M
cluded from the experiments mad
order to produce a 5,000,000-gallo
would be necessary to tap the we
170 feet below the top of the gro
pumping the water from this d
pressure, he held, was relieved o
from the wells and would con
produce a largely increased flow
Mr. Mead maintained that it w

quire about 250-horse power to r
water to the surface, and that co
ly the wells were relieved of that
of work and the energy transfor
producing more water.
All of the wells connected with
tunnel system are located within
of 1,600 feet of the pumping sta
something over a mile of tunnels
structed at a depth of 172 feet u
ground, to connect them with t
shaft which is located near the cit
ing station. The tunnels are show
cut of the map in dotted lines.
these wells were connected up to
tion well by cast iron pipe laid a
below the surface, which is show
map in full black lines. It may
that not all of the wells which h
sunk by the city have been conn
with the new system.
The tunnels are timbered up
about five and a half feet in he
three and a half feet in width.
are tapped at the depth of the t
hole being cut in the well casing
iron nozzle attached to them, w
be closed off or opened as desir
ball valve, which can be placed
the well casing from the surface.
ter flows from the wells into the
and flows by gravity to the sha
bottom of the shaft is closed off by
masonry bulkhead about eight
thickness. The bulkhead has an i
hole through it which is closed
heavy iron door. When this d
place the water simply flows to t
part of the shaft, but can not rise
main shaft where the machinery s
suction pipes pass through the b
and admit the water from the lo
tion of the shafts into the pum
which the water is pumped throug
mon discharge pipe into a 1,000,
reservoir which has been construct
surface. These pumps are locate
bases of the shaft, 156 feet below
face. The diameter of the shaft is
feet and it is thirty feet across at
where the pumps set. These pu
each operated by two engines of
power each, located at the sur
manufactured especially for thi
They are vertical compound conde
gines provided with steam jackets
heaters and are of a very econor
sign. They make comparatively
and run as smooth as clockwo
power is transmitted from the engi
pumps by a vertical rope drive of
and one-eighth-inch ropes of espe
nila transmission rope.
The discharge pipe, which is
inches, is connected with the conc
ervoir, which is in turn connected
suction well from which the mai
of the city draw their supply.

There are two drainage pumps w
be used in case they are needed t
any water that may get into the s
shaft is made accessible by a spi
case from the surface to the botto

The first pitless pump was invented in Texas when Mahlon Layne crawled out of a well pit for a Texas rice well!

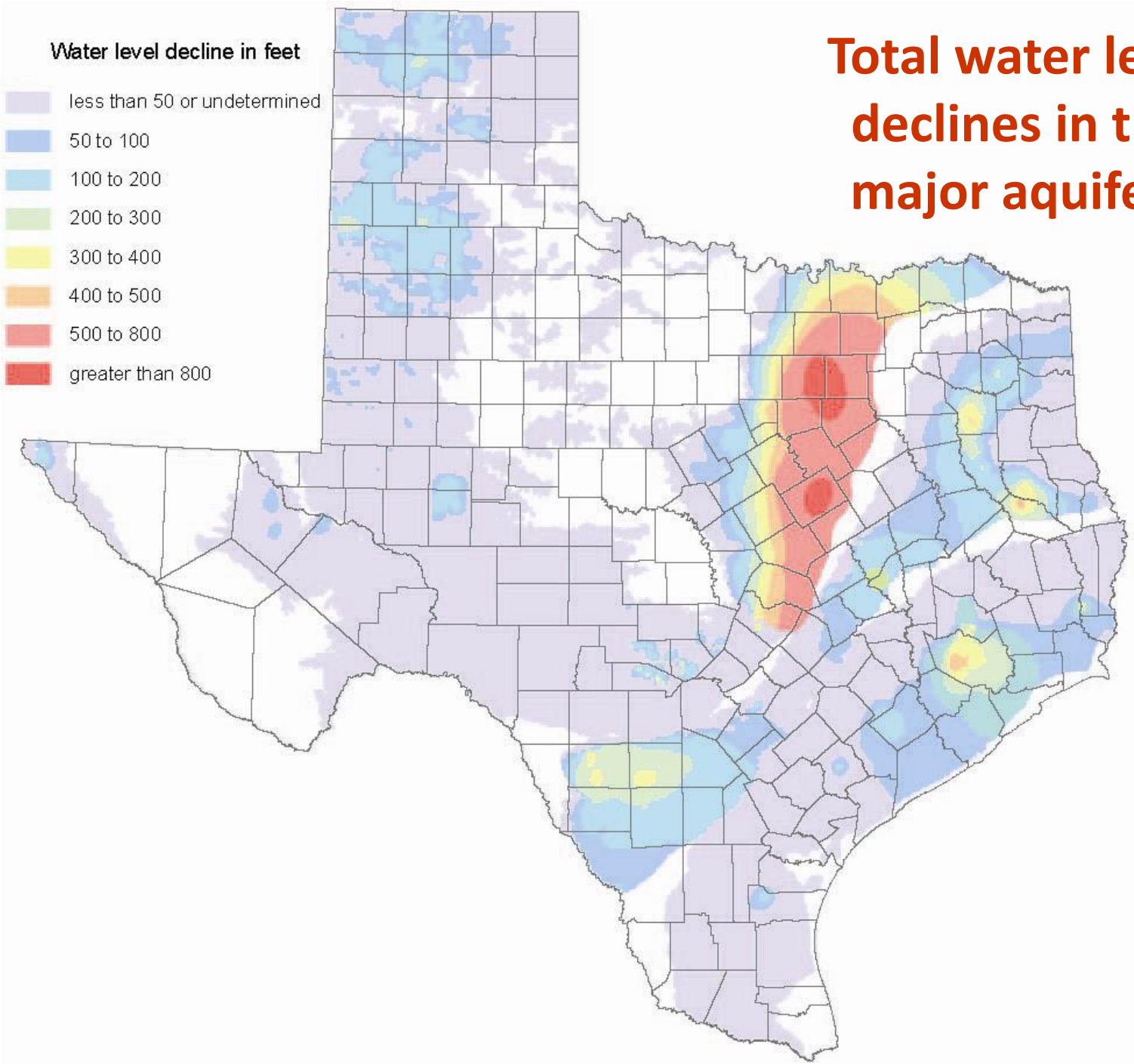
Layne Bowler Pump Company Inc. (1903)



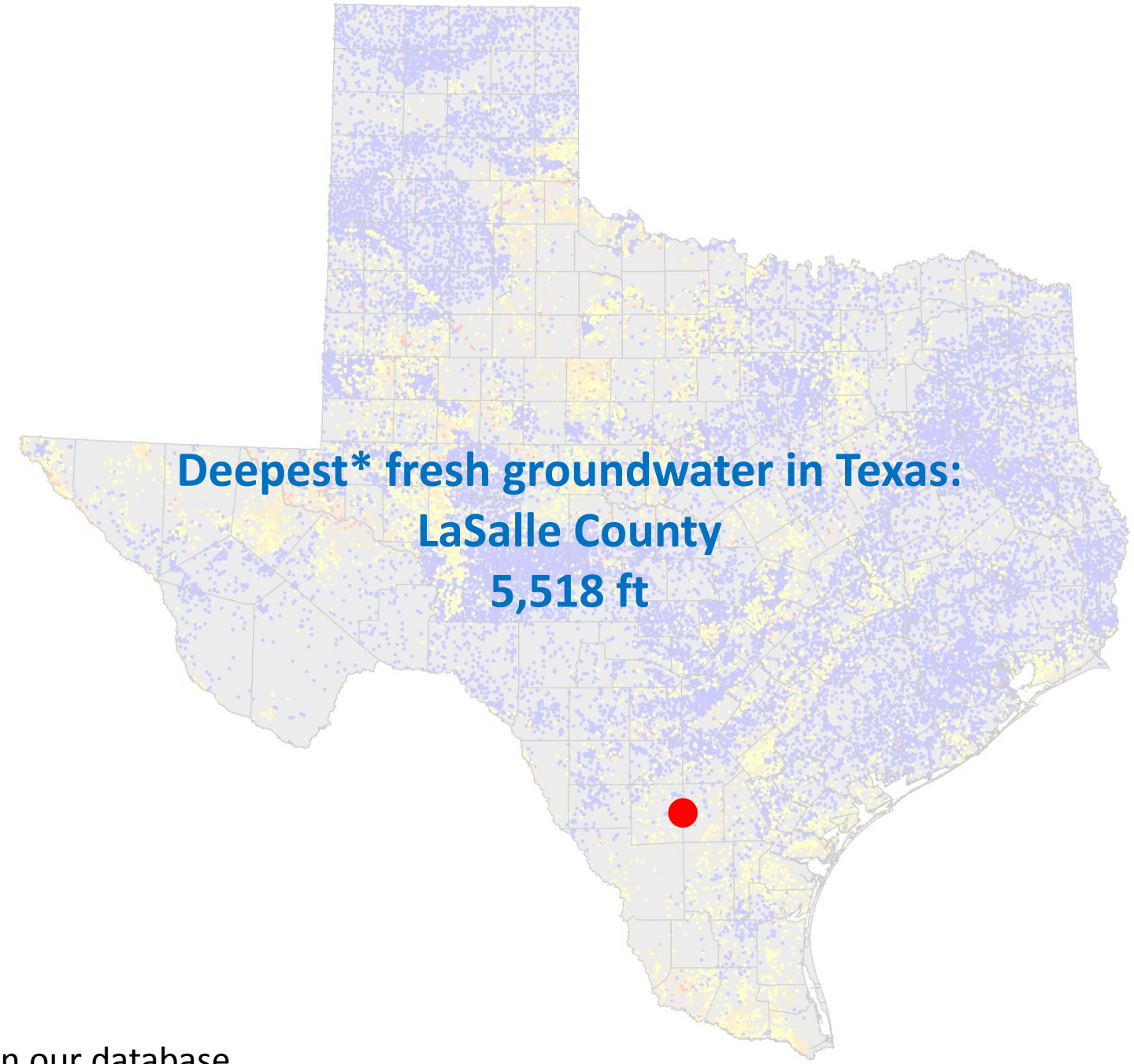
Mahlon E. Layne
1902

1,000 feet of drawdown in the Trinity, but no measured declines in the recharge zone!

Total water level declines in the major aquifers



The deepest water well in Texas is over a mile deep!



*deepest in our database

The water in Dallas was once so salty discerning Dallasites drank water from Glen Rose!

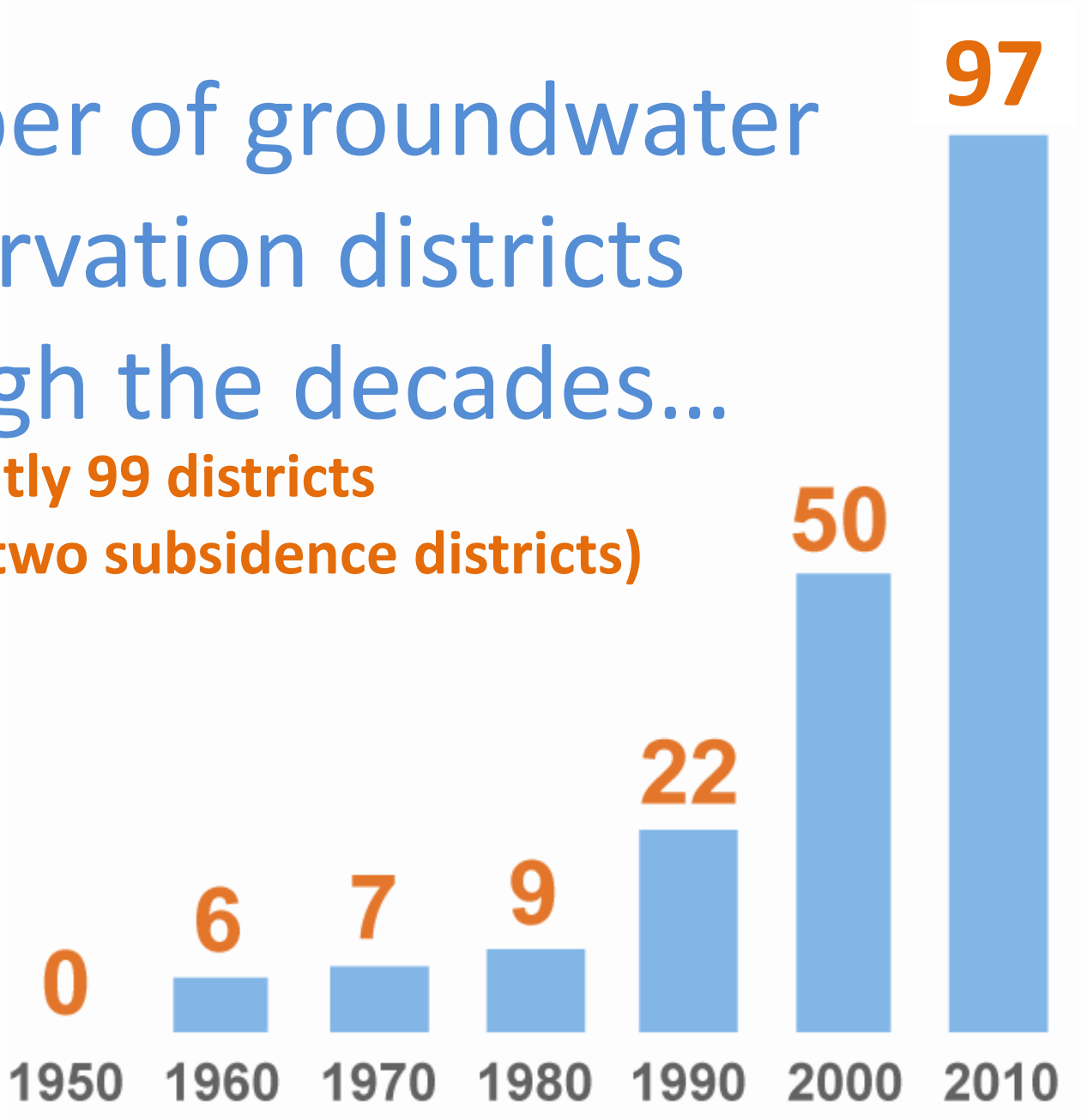
DAP082501-8/25/56-DALLAS:Pretty Gloria Ryden,an airline hostess,trys a glass of salt free spring water offered to her by Bob Valentine,manager of one of the stores that has bottled the water to sell in Dallas,since the city water has become so salty.The water sells for 20 cents a half gallon. UNITED PRESS TELEPHOTO

Gary Westbrook's favorite use of water is for cattle and baptisms!

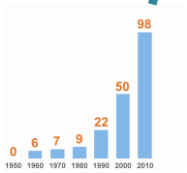
The number of groundwater districts is growing exponentially!

Number of groundwater conservation districts through the decades…

currently 99 districts
(+ two subsidence districts)



3,136.4 districts by 2060



You can still dip your toes in the mineral water in Marlin!

WHERE SICK FOLKS GET WELL AND WELL FOLKS LEARN HOW TO STAY WELL.

THE TORBETT SANATORIUM, HOT WELL PAVILION, MAJESTIC-ANNEX HOTEL AND BATH HOUSE, MARLIN, TEXAS.

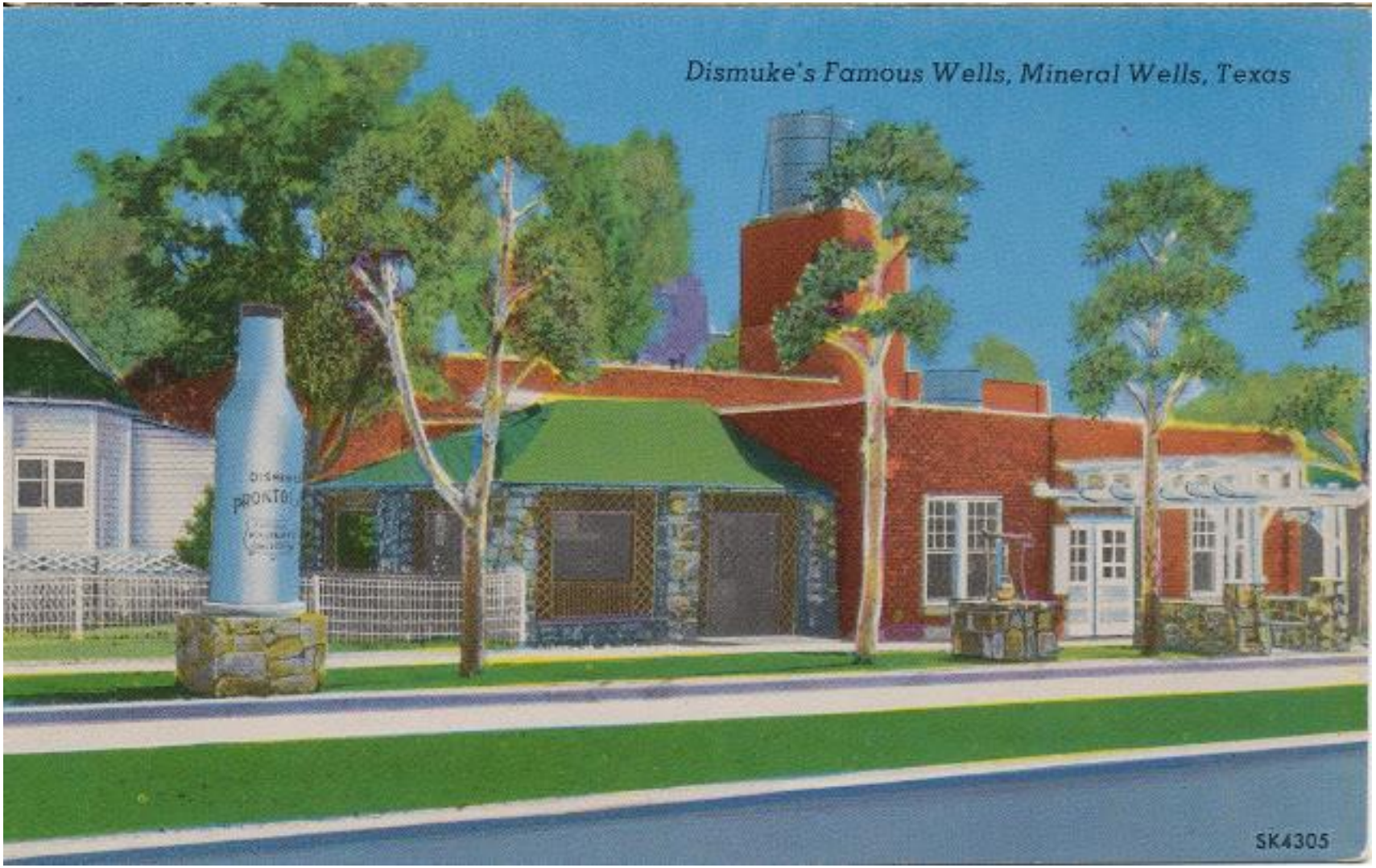

CHAMBER OF COMMERCE
VISITOR

HOT WELL NO. 1. FLOWING WATER, FREE. MARLIN, TEXAS.


Marlin, Texas
Mineral Water City
of Texas

Sam Houston spent a month soaking in the springs at Sour Lake shortly before he died!

You can still pony up to the water bar in Mineral Wells!


Dismuke's Famous Wells, Mineral Wells, Texas
PRONTO
SK4305


CRAZY WATE
CRAZY SODAS!
CRAZY GOODS!


CRAZY WATER
No. 3
Natural Mineral Water
Medium Content pH 7.5
Alkaline Water
CRAZY WATER
No. 2
Natural Mineral Water
Low/Med. Content pH 7.5
Alkaline Water
CRAZY WATER
No. 4
Natural Mineral Water
High Content pH 8.2
Alkaline Water

You can assess total dissolved solids of your mineral water by how long it takes you to go!


THERE'S PLENTY OF ACTION HERE AT MINERAL WELLS
WOMEN
MEN
MINERAL WELLS, TEXAS
MINERAL WATER
GETS RESULTS!
SQUAWK
SQUAWK
WE'RE PRACTICALLY ALWAYS ON THE GO -
© CURT TEICH & CO., INC.
OB-H438

My
bookshelf
of
groundwater
references
is organized
by color!


GROUNDWATER
Applied Statistics
TEXAS WATER ATLAS
MINING GEOSTATISTICS
Aquatic Chemistry
APPLIED GROUNDWATER MODELING
KARST GEOMORPHOLOGY AND HYDROLOGY
Physical and Chemical Hydrogeology
WATER CHEMISTRY
Water for Texas
Springs of Texas
Structural Analysis and Synthesis
THE GEOCHEMISTRY OF NATURAL WATERS
Groundwater and Wells
Applied Geophysics
GEOPHYSICS
Quantitative Hydrogeology
NEURAL NETWORKS
Dynamics of Fluids in Porous Media
Introduction to GROUNDWATER MODELING
Applied Geostatistics
SOLOMONS ORGANIC CHEMISTRY
DIFFUSION
Artificial Neural Systems
GEOSTATISTICS
Engineering Hydrology
FORTRAN 77
CALCULUS AND ANALYTIC GEOMETRY
Frank M. White
Fluid Mechanics
EARTH
PARTICLE EXPLOSION
PRINCIPLES OF STRUCTURAL GEOLOGY
General Chemistry
APPLIED HYDROGEOLOGY
VADOSE ZONE PROCESSES
EVOLUTION OF THE EARTH
Geomorphology and Hydrology of Karst Terrains
Groundwater Mechanics

The ‘61 Stater Water Plan noted the importance of groundwater during nuclear war!

TEXAS BOARD OF WATER ENGINEERS

Durwood Manford, Chairman
R. M. Dixon, Member
O. F. Dent, Member

A PLAN FOR MEETING THE 1980 WATER REQUIREMENTS OF TEXAS

Prepared under the direction of
John J. Vandertulip, Chief Engineer

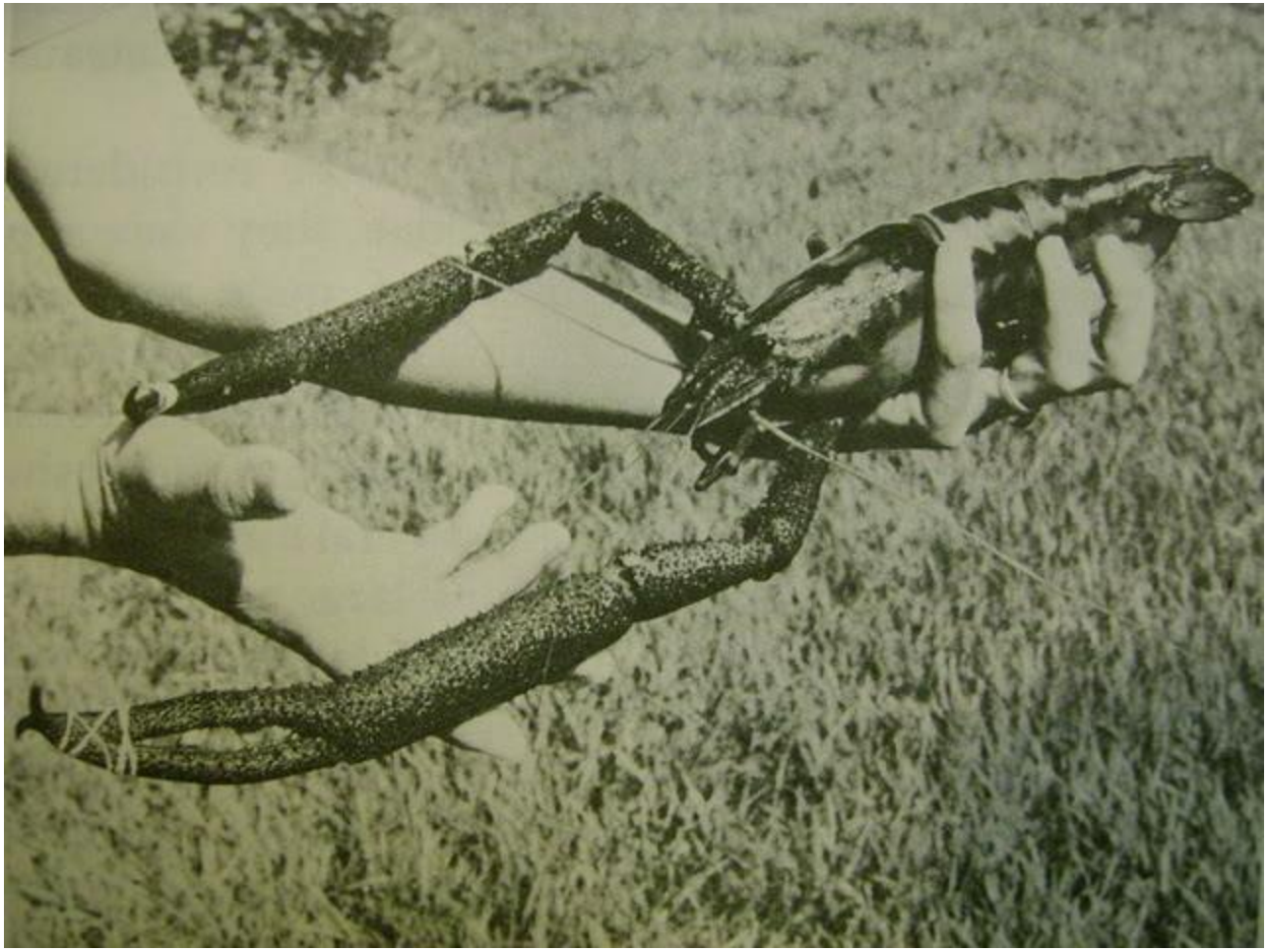
For Submittal to the
Fifty-Seventh Legislature

May 1961

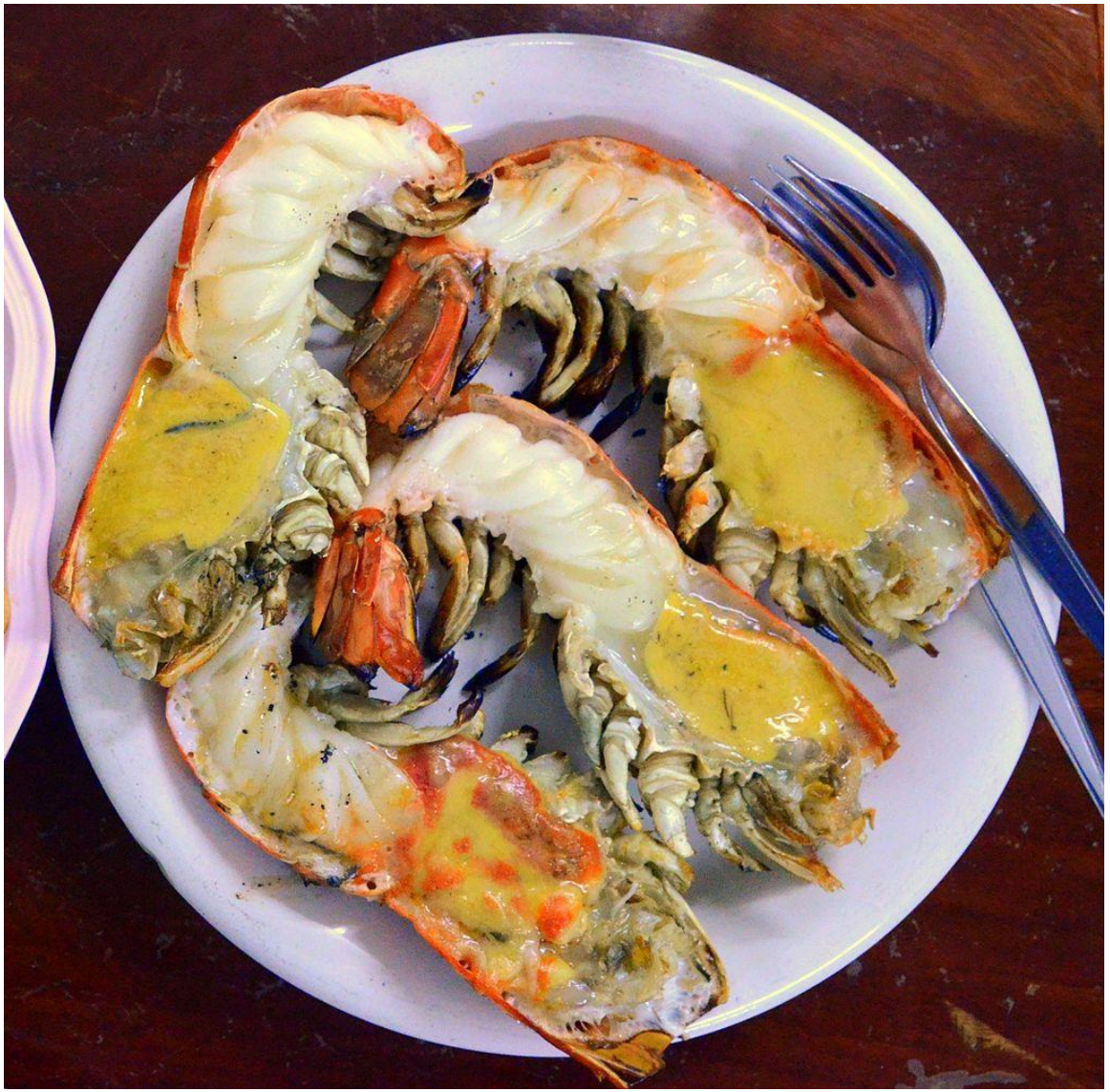
7. Nuclear fallout during a national emergency could contaminate exposed surface-water reservoirs. The development of underground supplies for such emergencies needs further consideration by this agency and every municipality in Texas.

World's largest freshwater shrimp was fed by springs from the Edwards Aquifer!

Giant Freshwater Prawn
Big Claw River Shrimp



Caught in the Devil's River!



Yum!

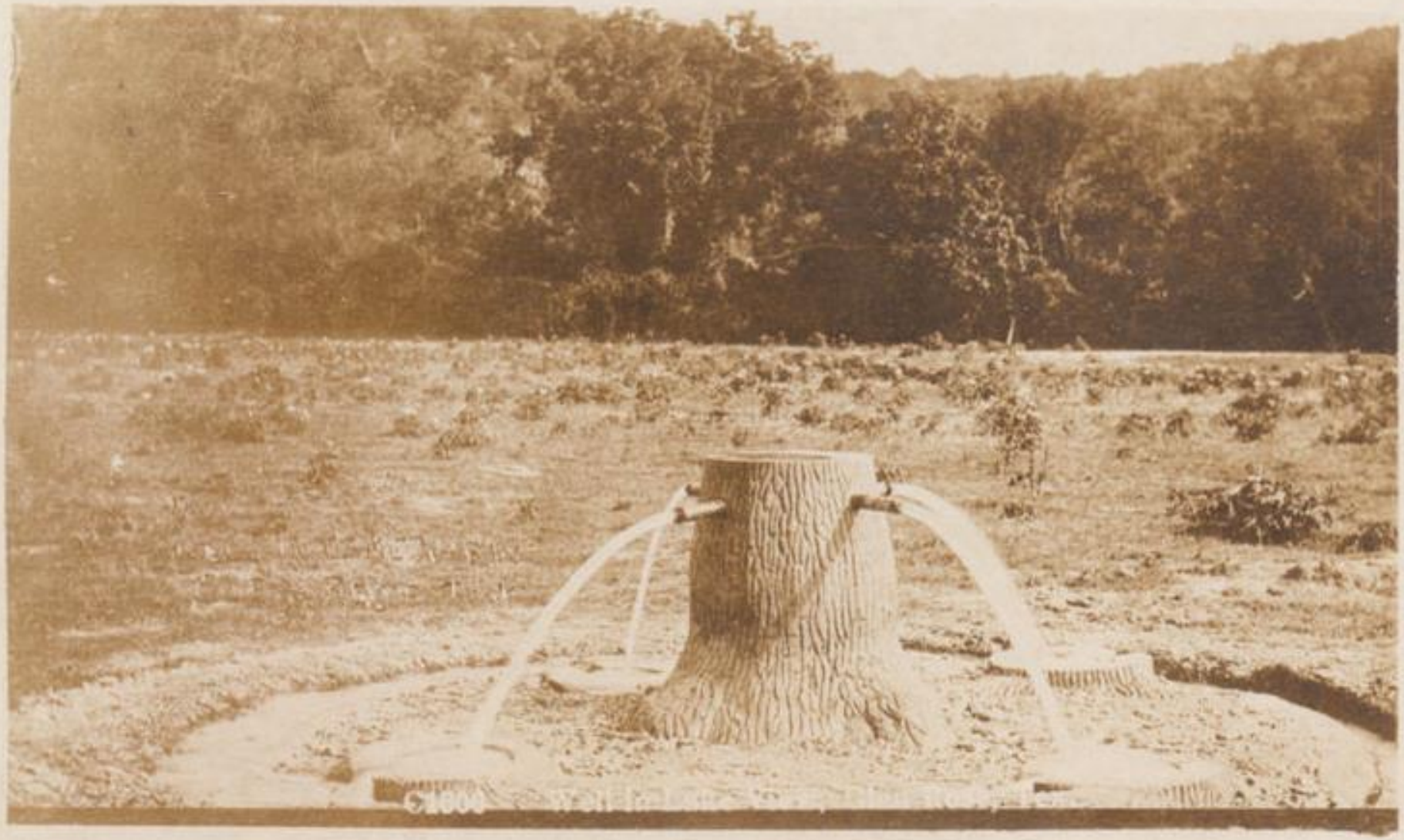
You can go fishing in the Edwards Aquifer!

TOOTHLESS BLINDCAT

TOOTHLESS BLINDCAT. The toothless blindcat is a troglobitic catfish of the family Ictaluridae. It was named *Trogloglanis pattersoni* by Eigenmann in 1919. It is considered to be the most highly specialized member of the family. It is unique in having no eyes, no pigment, no air bladder, and a sucker-type mouth. It is found only in southern Bexar County at depths of 1,350 to 2,000 feet below the surface, in the water-filled caverns of the Balcones Fault Zone Edwards Aquifer. It was discovered originally by George W. Brackenridge in one of his wells.

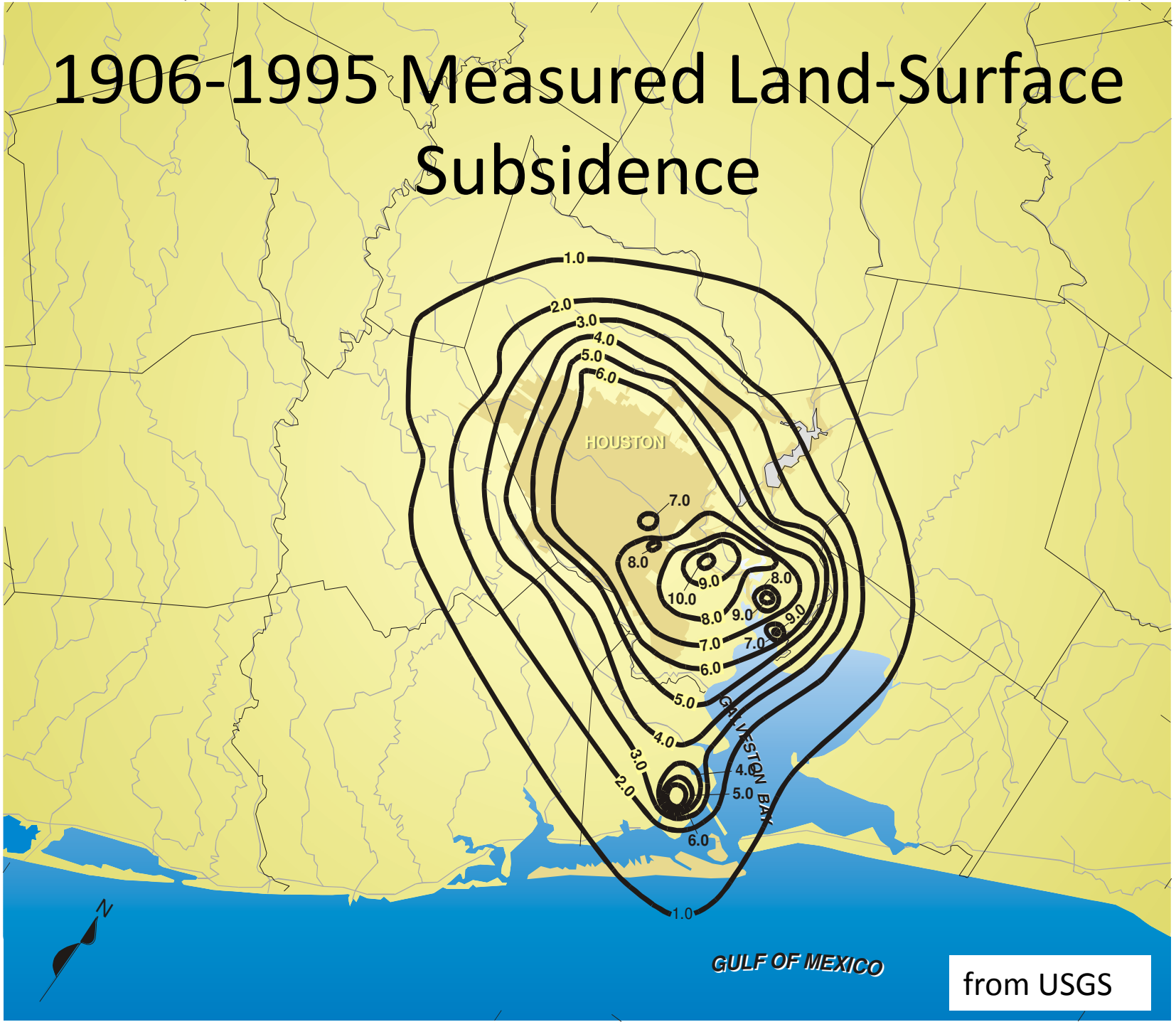
The DNA of these critters can be traced back to ~Cretaceous times!

There used
to be
a stump well
near Glen Rose!



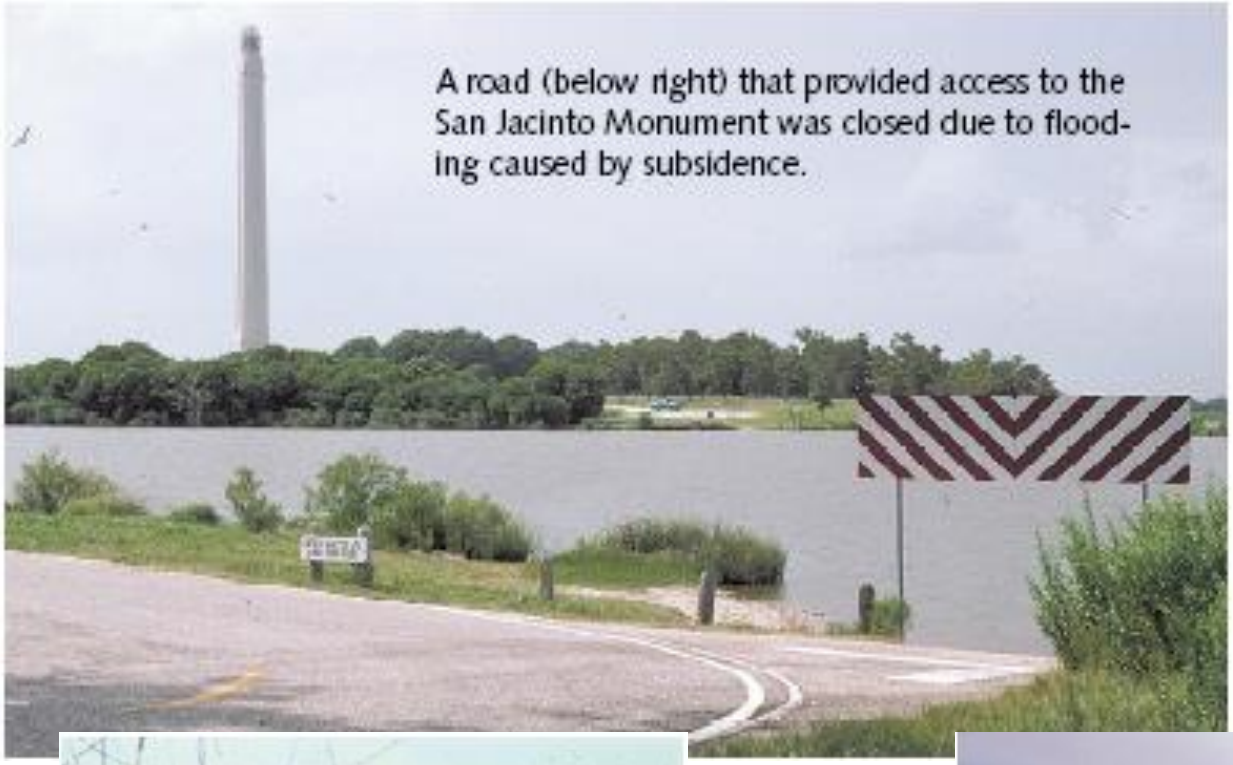
Houston has sunk upwards of 10 feet due (in part) to groundwater pumping!

1906-1995 Measured Land-Surface Subsidence



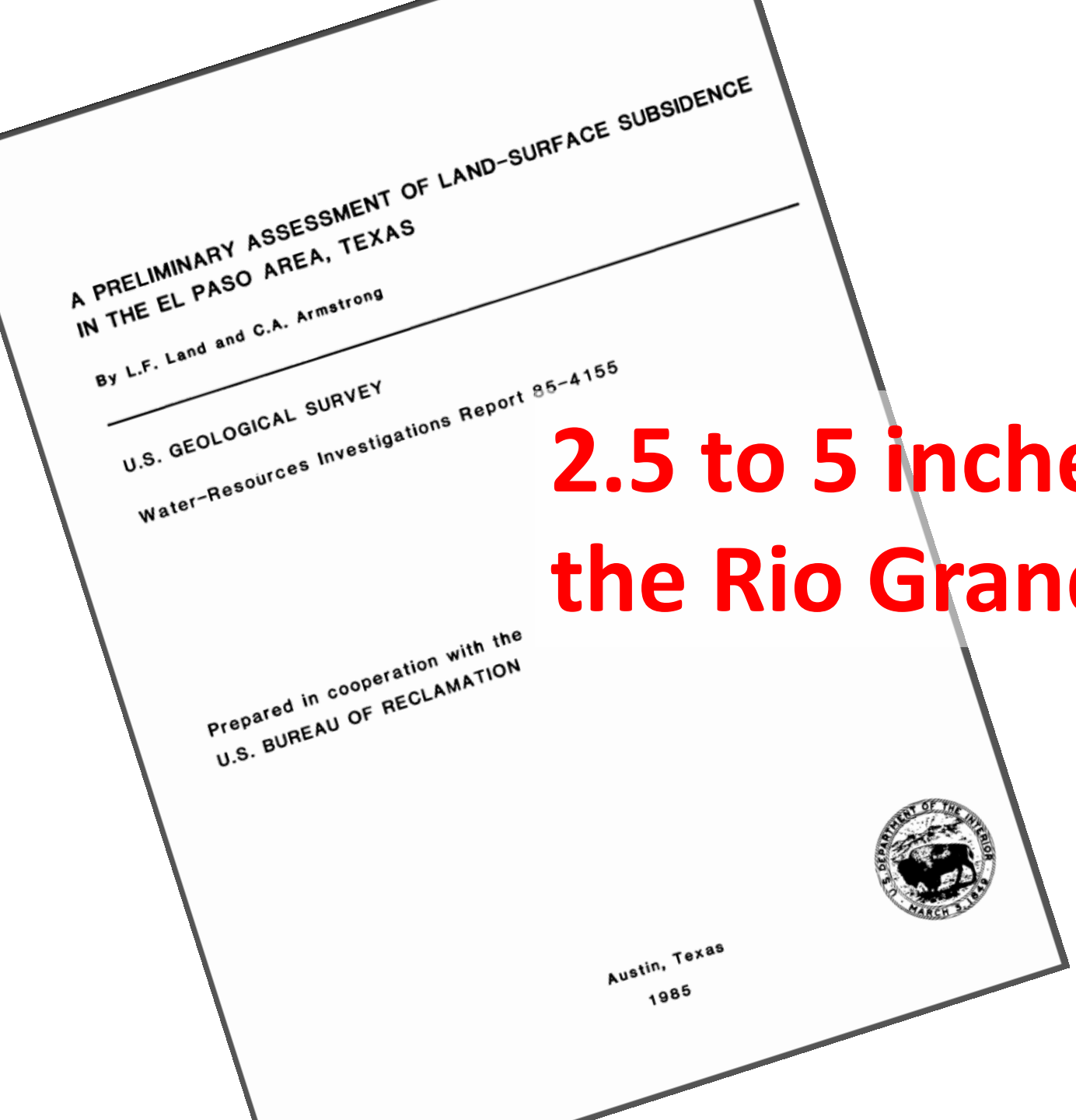
from USGS

land subsidence



photos from USGS's Circular 1182

El Paso
has sunk too!


A PRELIMINARY ASSESSMENT OF LAND-SURFACE SUBSIDENCE IN THE EL PASO AREA, TEXAS

By L.F. Land and C.A. Armstrong

U.S. GEOLOGICAL SURVEY

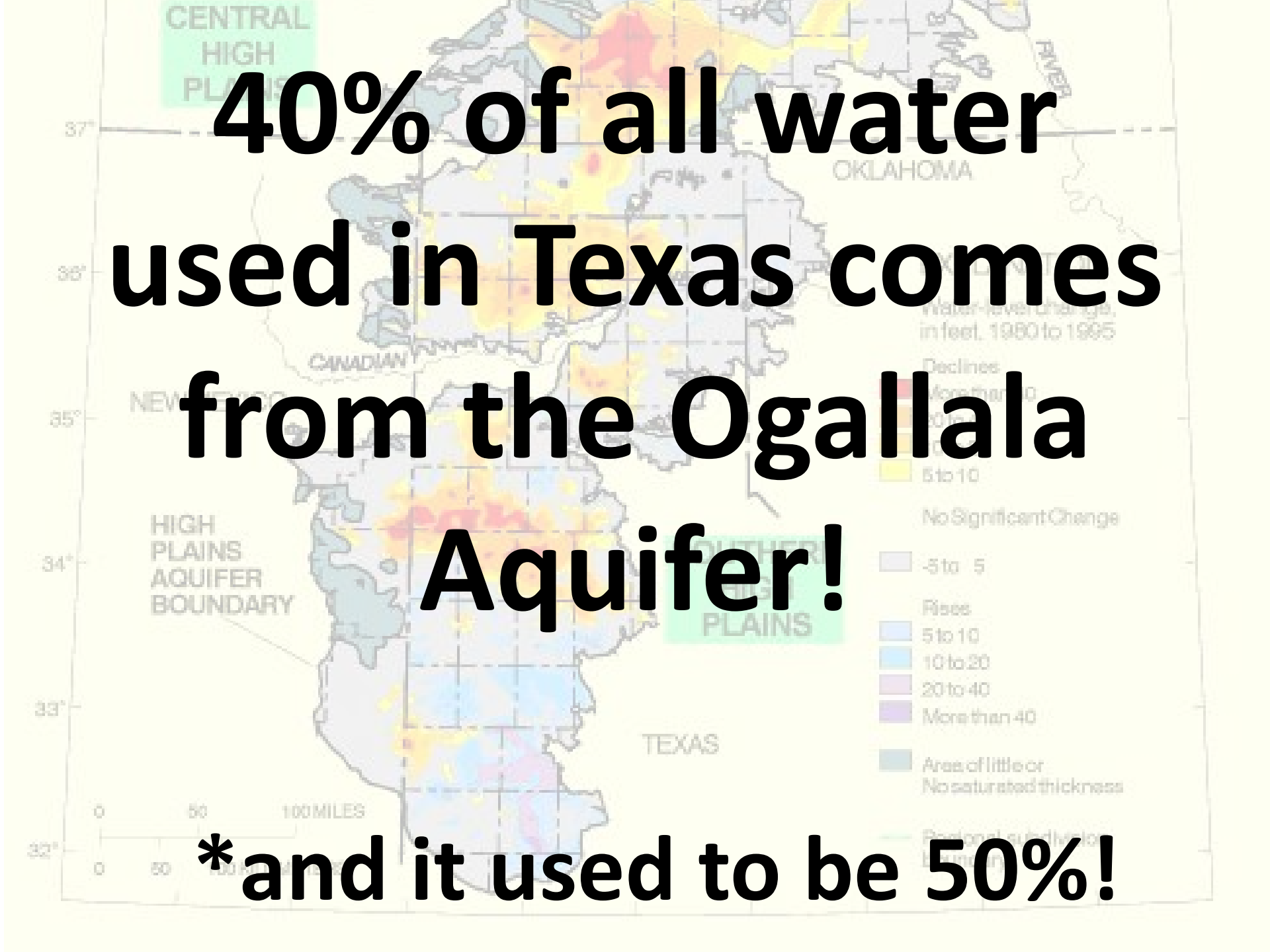
Water-Resources Investigations Report 85-4155

Prepared in cooperation with the U.S. BUREAU OF RECLAMATION

Austin, Texas

1985

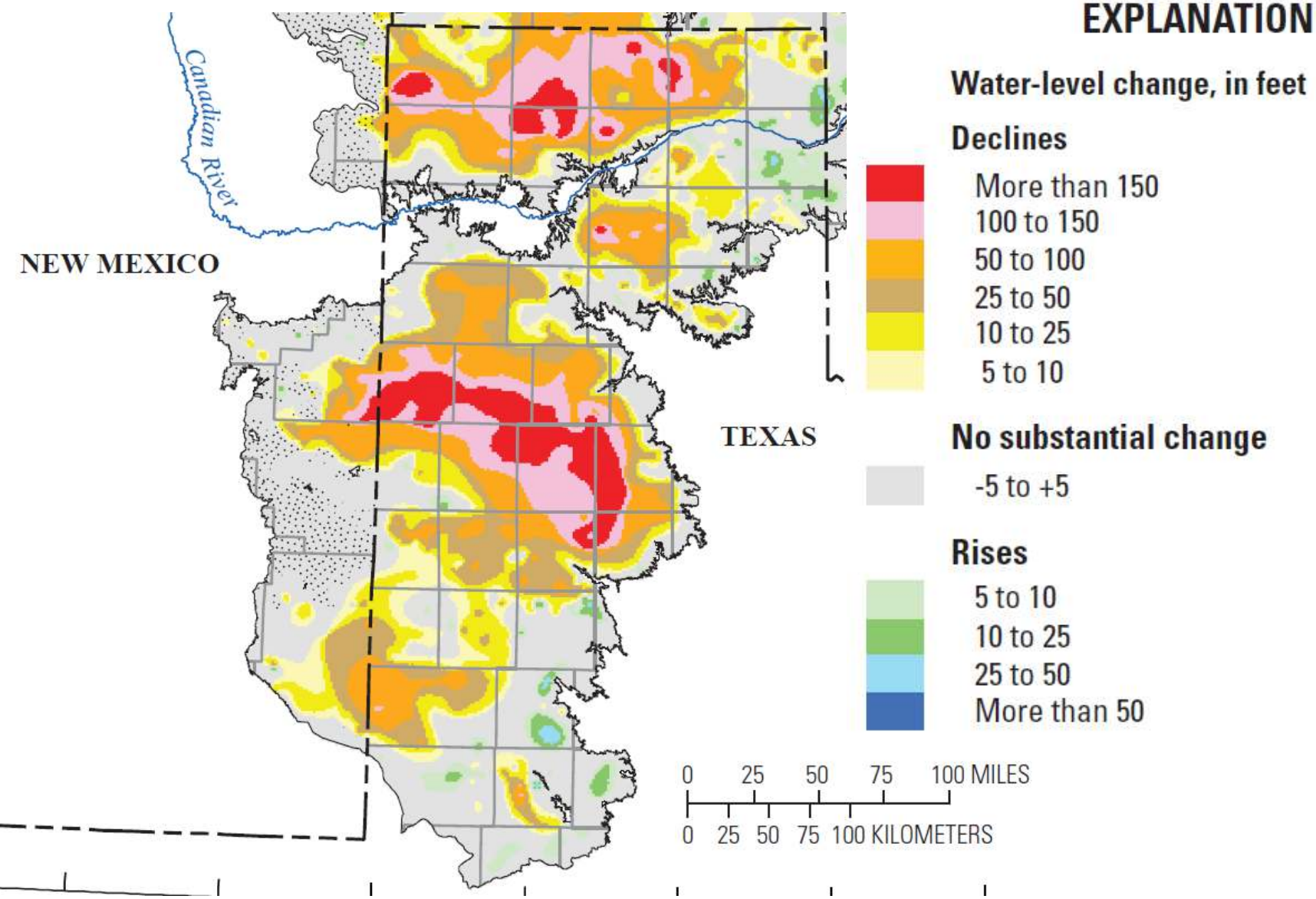
2.5 to 5 inches along the Rio Grande



40% of all water used in Texas comes from the Ogallala Aquifer!

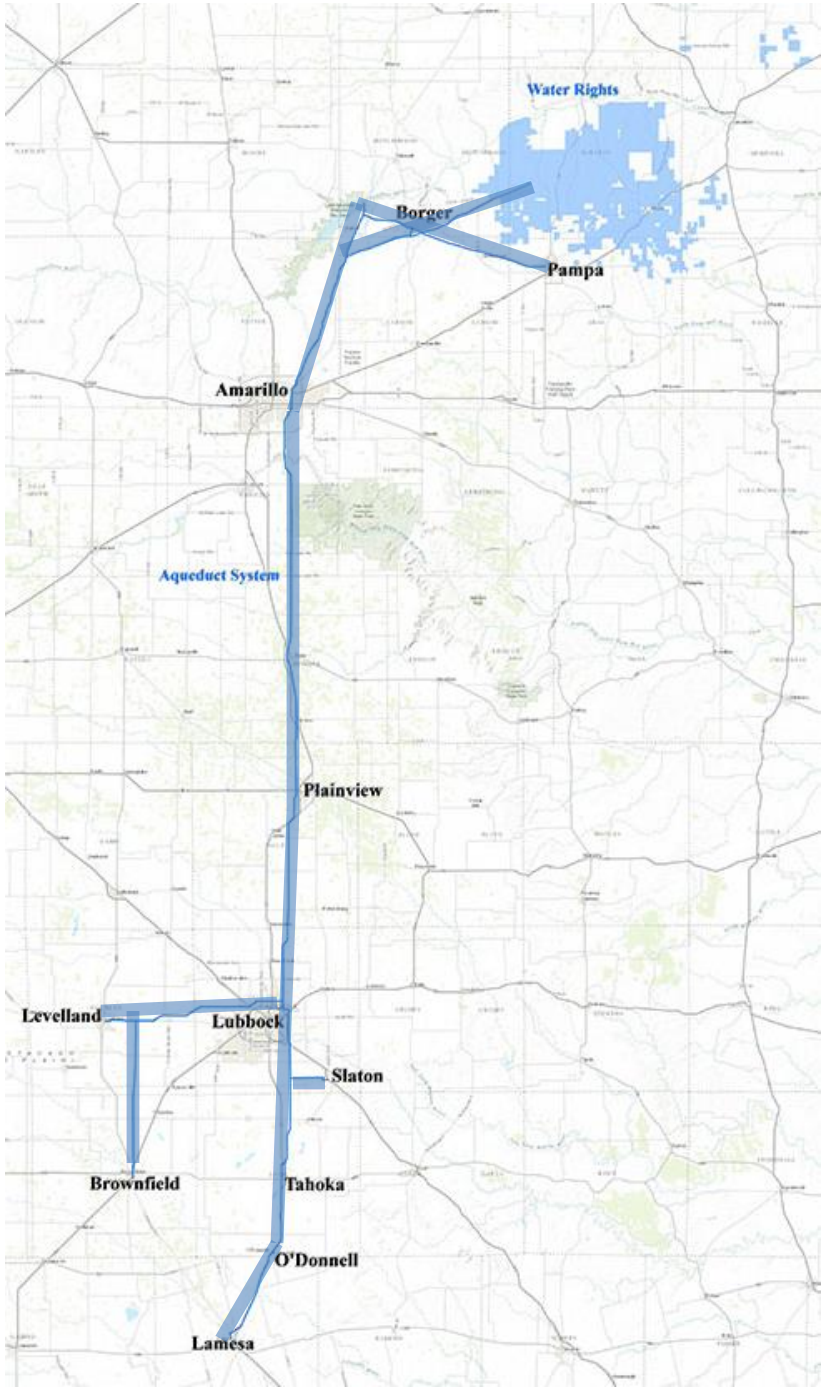
*and it used to be 50%!

Water levels are rising in parts of the Ogallala!


Canadian River
NEW MEXICO
TEXAS
EXPLANATION
Water-level change, in feet
Declines
More than 150
100 to 150
50 to 100
25 to 50
10 to 25
5 to 10
No substantial change
-5 to +5
Rises
5 to 10
10 to 25
25 to 50
More than 50
0 25 50 75 100 MILES
0 25 50 75 100 KILOMETERS

The longest transport of water in Texas is by the Canadian River Municipal Water Authority!

(if you don't count Shiner Bock…)



Canadian River Municipal Water Authority

Ogallala Aquifer

(+ Lake Meredith when available…)

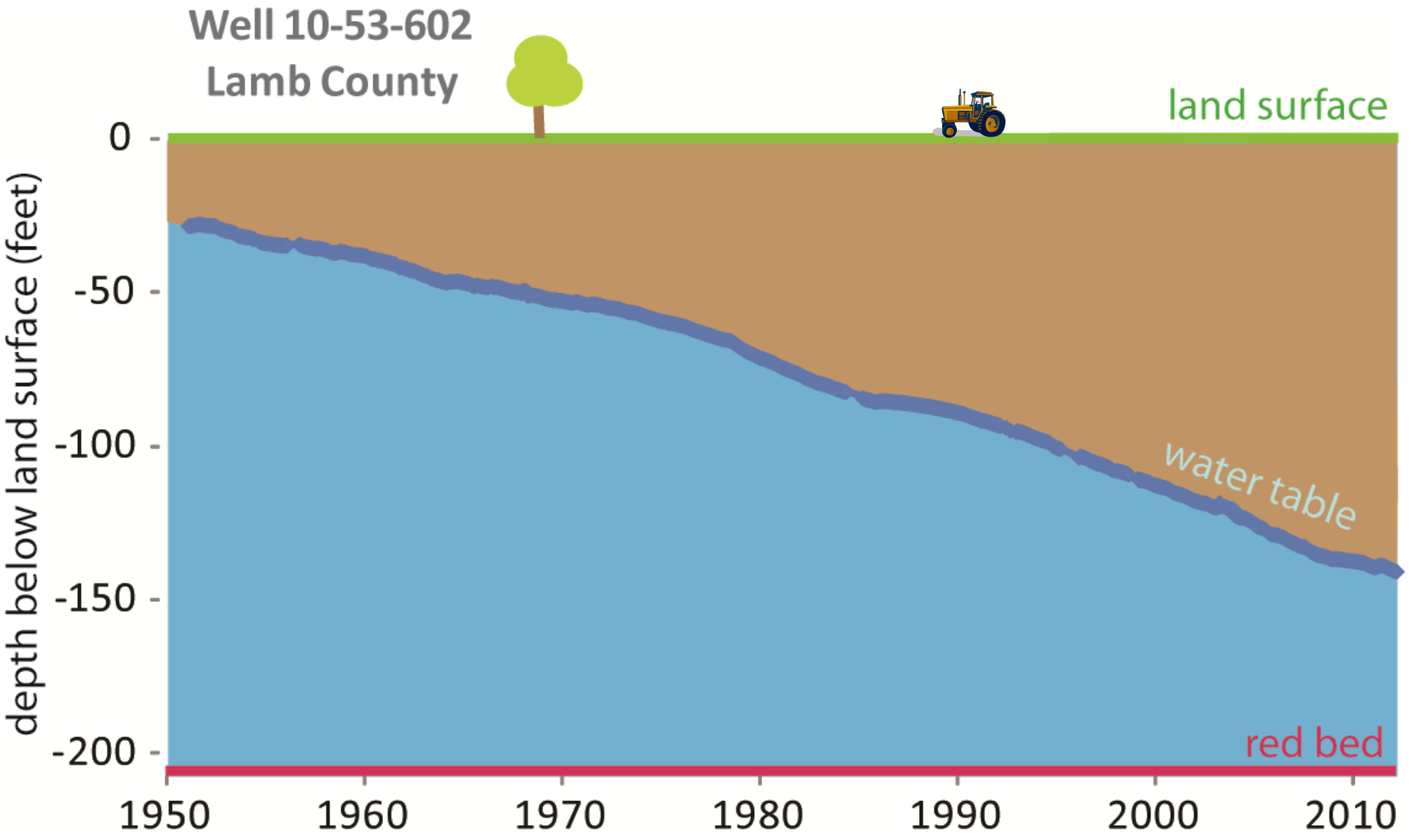
- 322 miles

There's more recharge to the Ogallala than the Edwards!

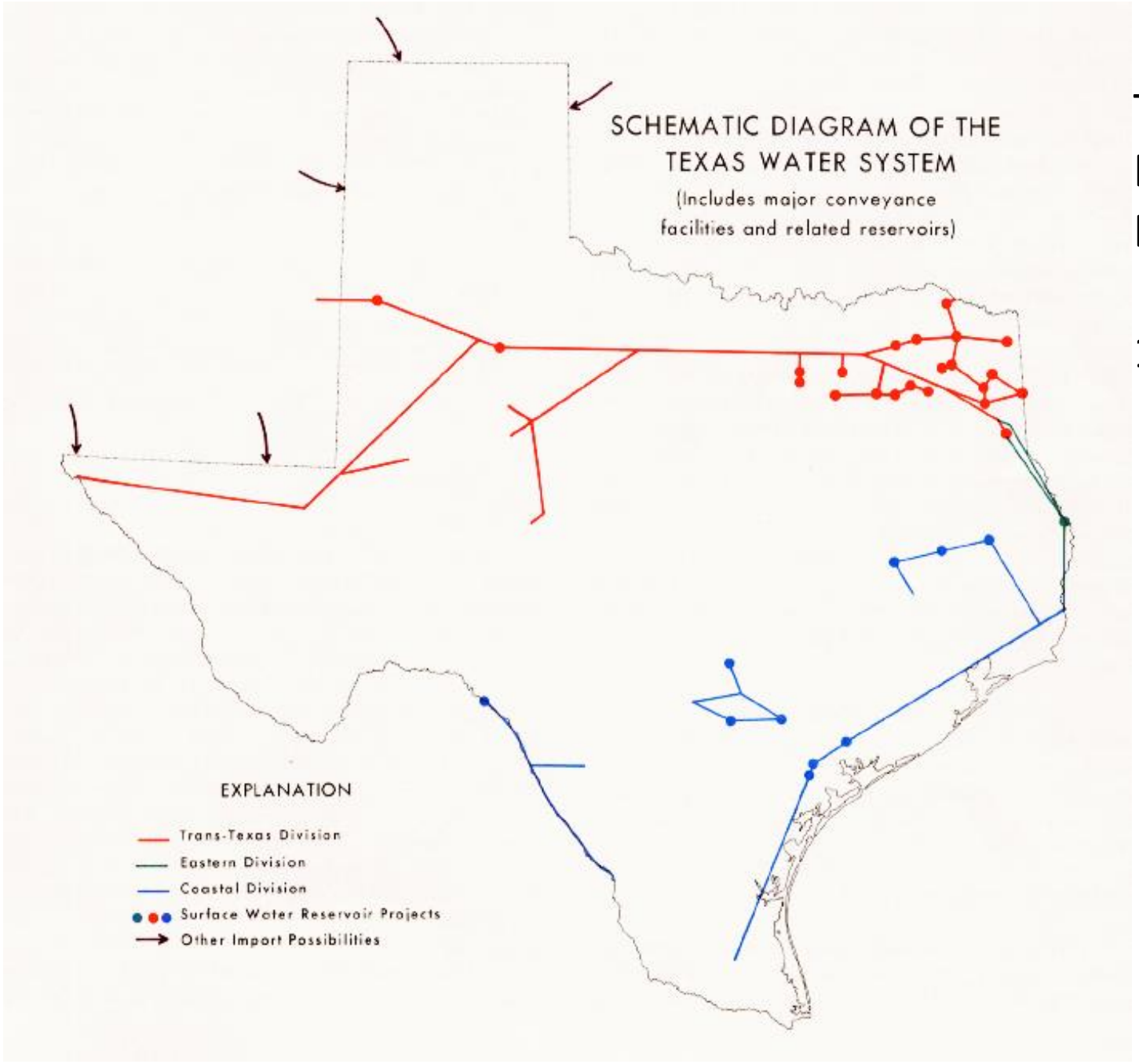
Ogallala: ~1,100,000 AFY
Edwards: ~640,000 AFY

but…

The water table is dropping faster in the Ogallala aquifer than recharge!


Well 10-53-602
Lamb County
land surface
water table
red bed
depth below land surface (feet)
0
-50
-100
-150
-200
1950
1960
1970
1980
1990
2000
2010

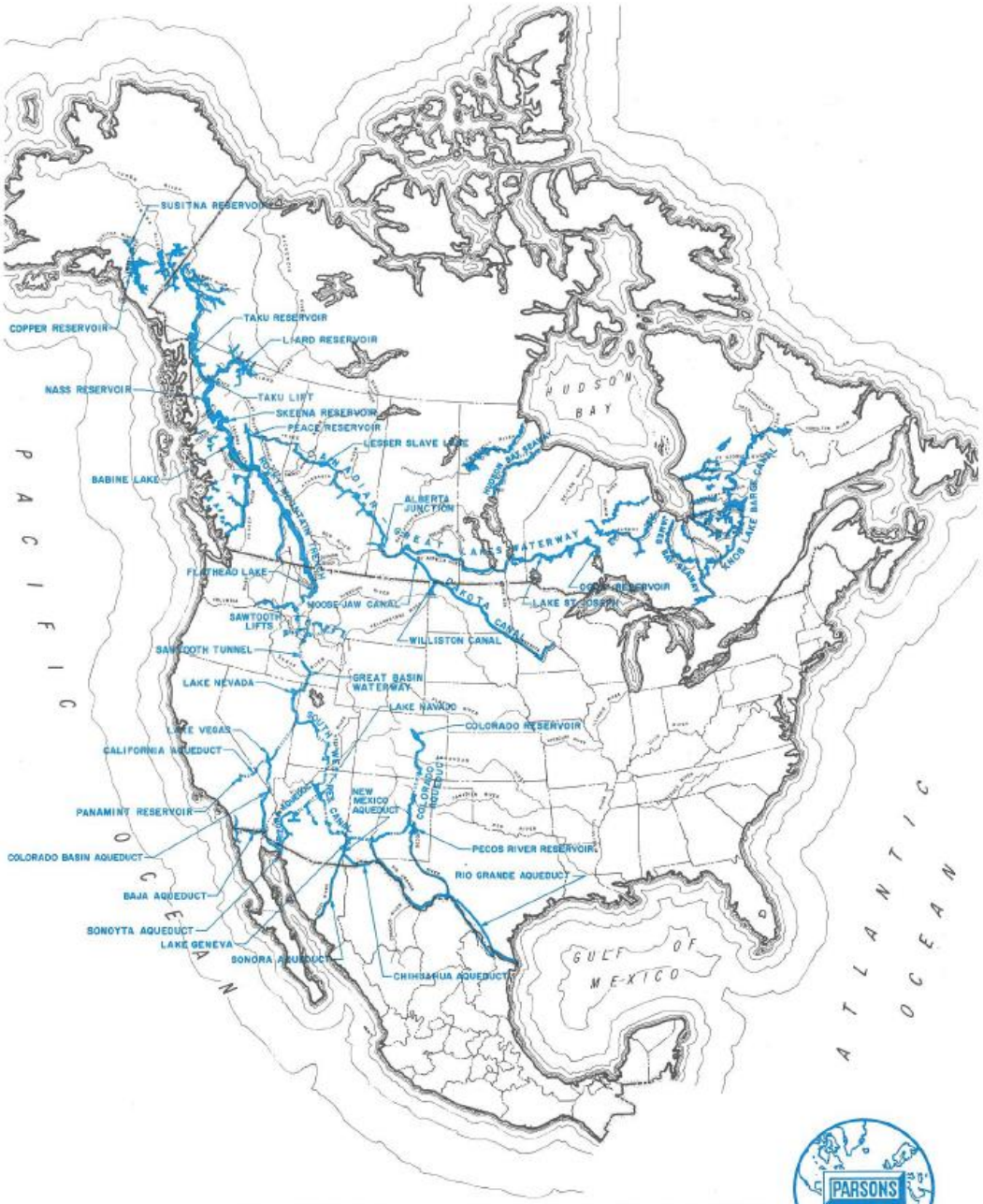
Texas almost brought the Mississippi River to Texas to solve the “Ogallala Problem”!



Texas Water Development Board

1968

Others wanted to bring water from Alaska and Canada to Texas!



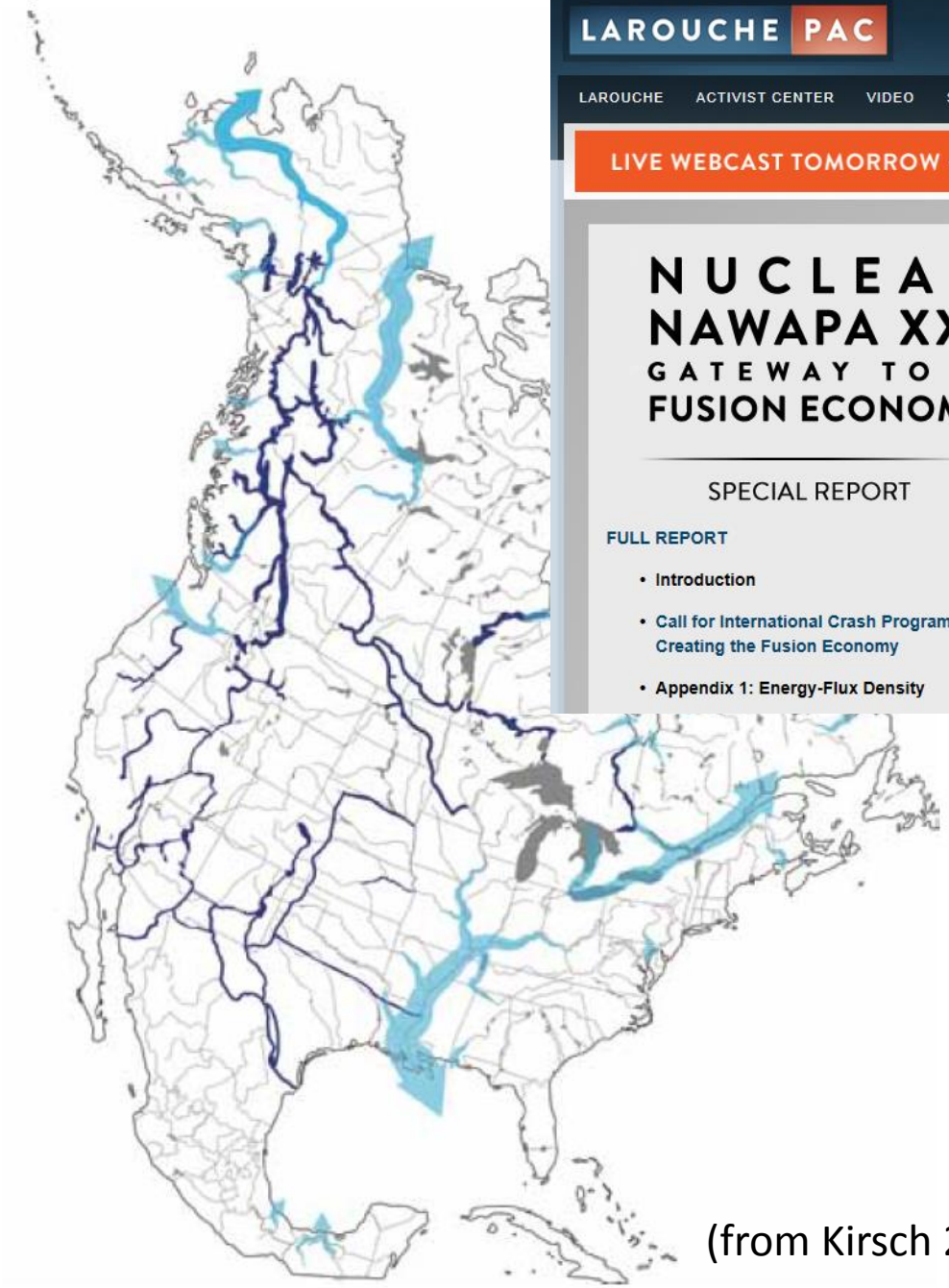
NORTH AMERICAN WATER AND POWER ALLIANCE

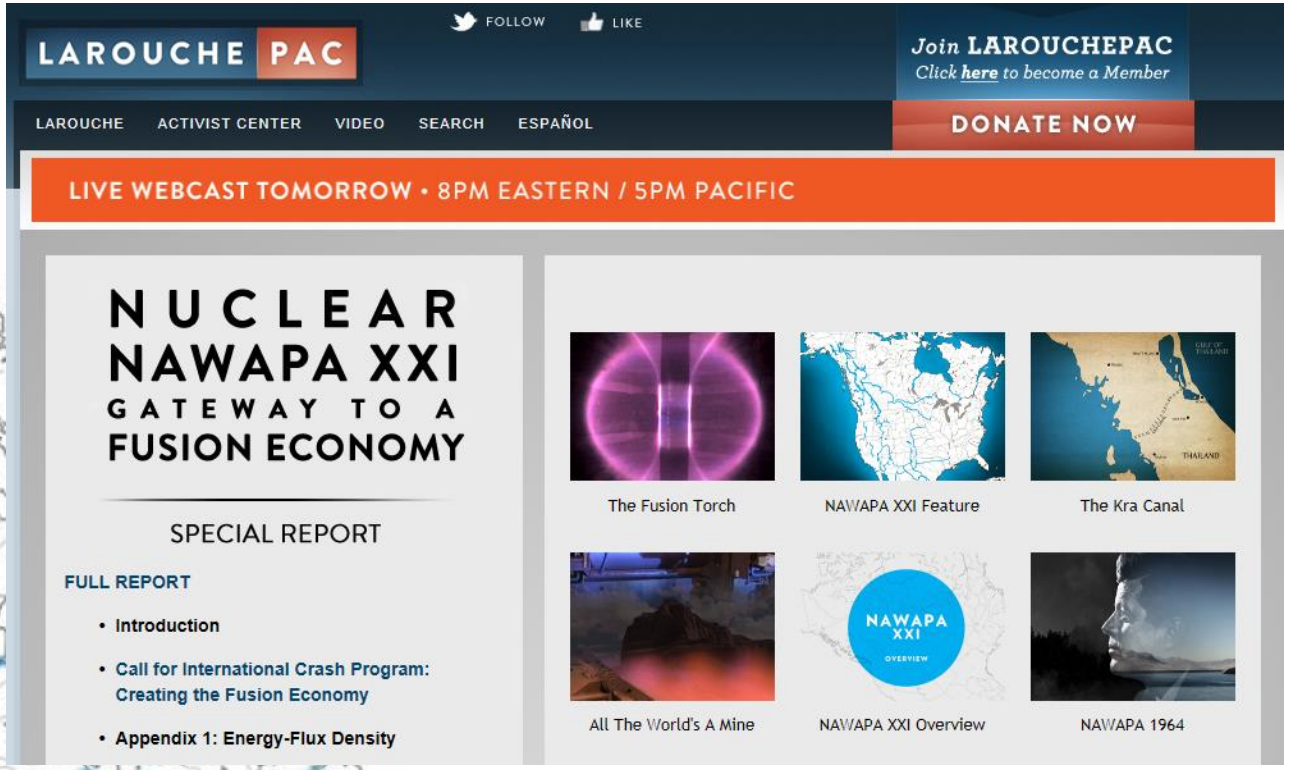
CONCEPTUAL PLAN

PARSONS

And some still want to!

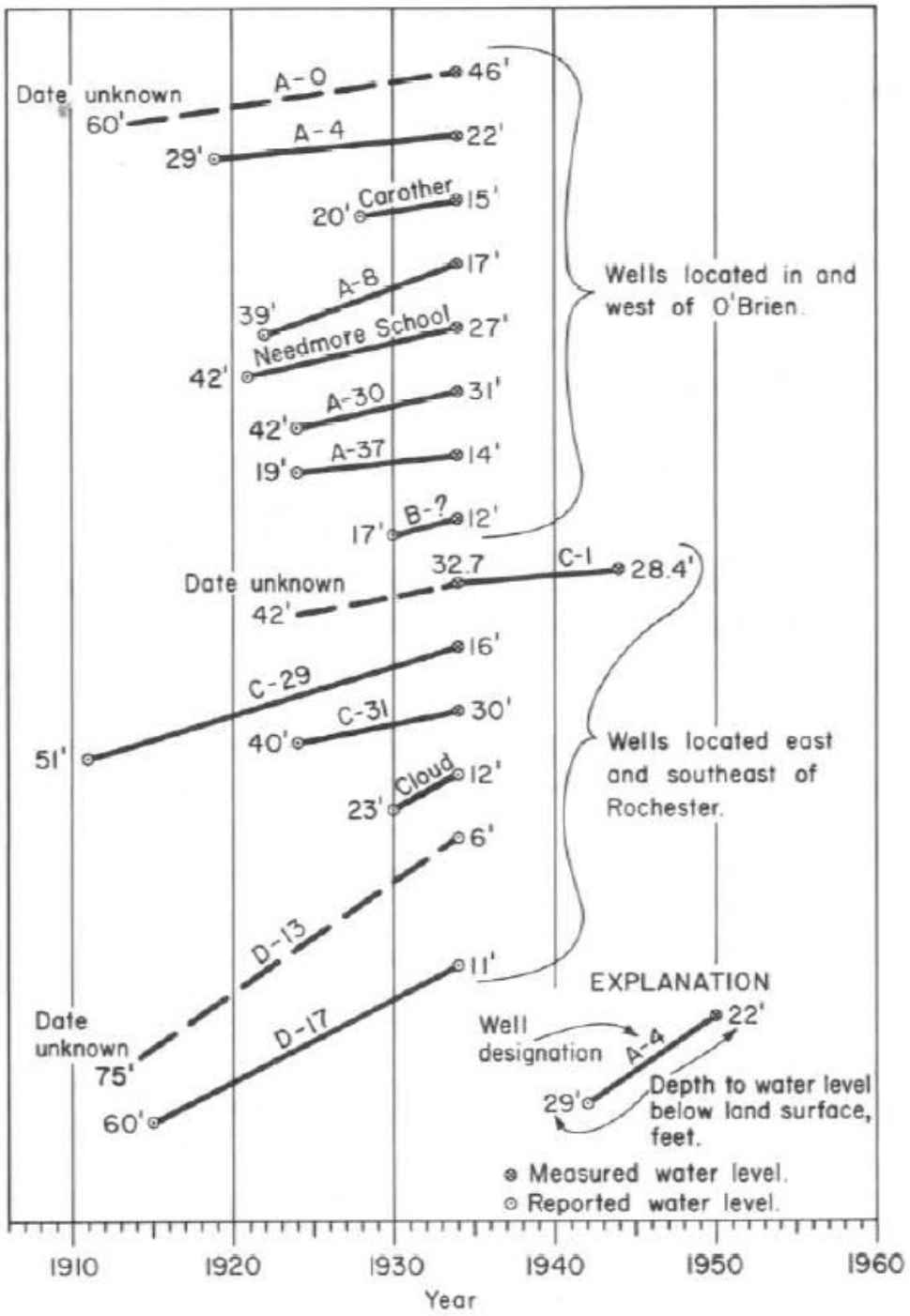
Continental NAWAPA XXI Runoff Collection and Distribution System



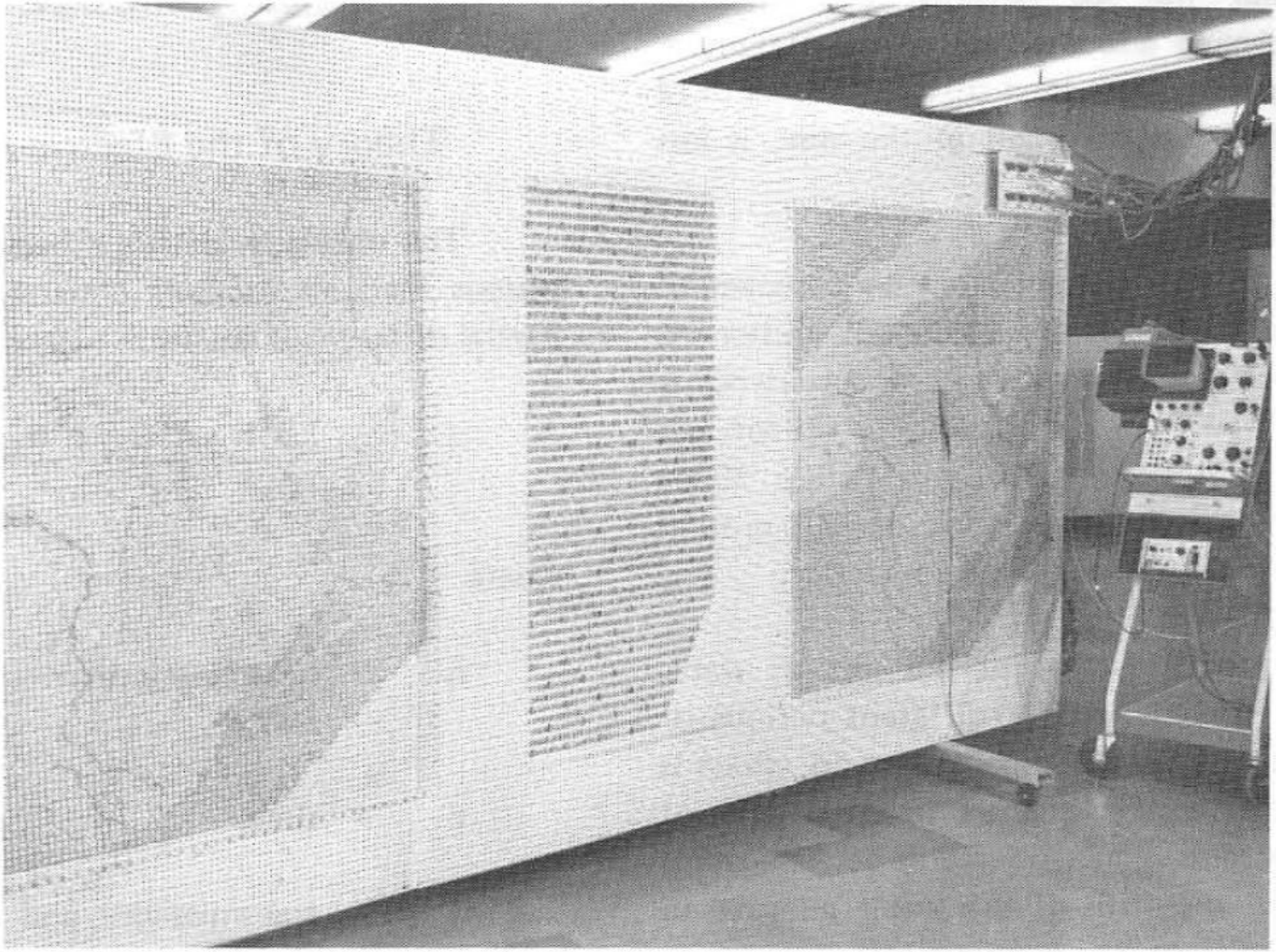


(from Kirsch 2013)

The Seymour Aquifer is a man-made aquifer


Date unknown
60'
A-0
46'
29'
A-4
22'
20'
Carother
15'
39'
A-8
17'
Needmore School
42'
27'
42'
A-30
31'
19'
A-37
14'
17'
B-?
12'
Wells located in and west of O'Brien.
Date unknown
42'
32.7
C-1
28.4'
51'
C-29
16'
40'
C-31
30'
23'
Cloud
12'
6'
D-13
11'
D-17
Date unknown
75'
60'
Wells located east and southeast of Rochester.
EXPLANATION
Well designation
A-4
22'
29'
Depth to water level below land surface, feet.
Measured water level.
Reported water level.
1910
1920
1930
1940
1950
1960
Year

Groundwater flow follows the same equations as those of electricity and heat!



A. Front view of model and oscilloscope

The town of Burkburnett (near Wichita Falls) uses 93 wells for water supply!


BEACH'S FEEDSTORE.
BURKBURNETT, TEX.
APRIL 24TH 1919

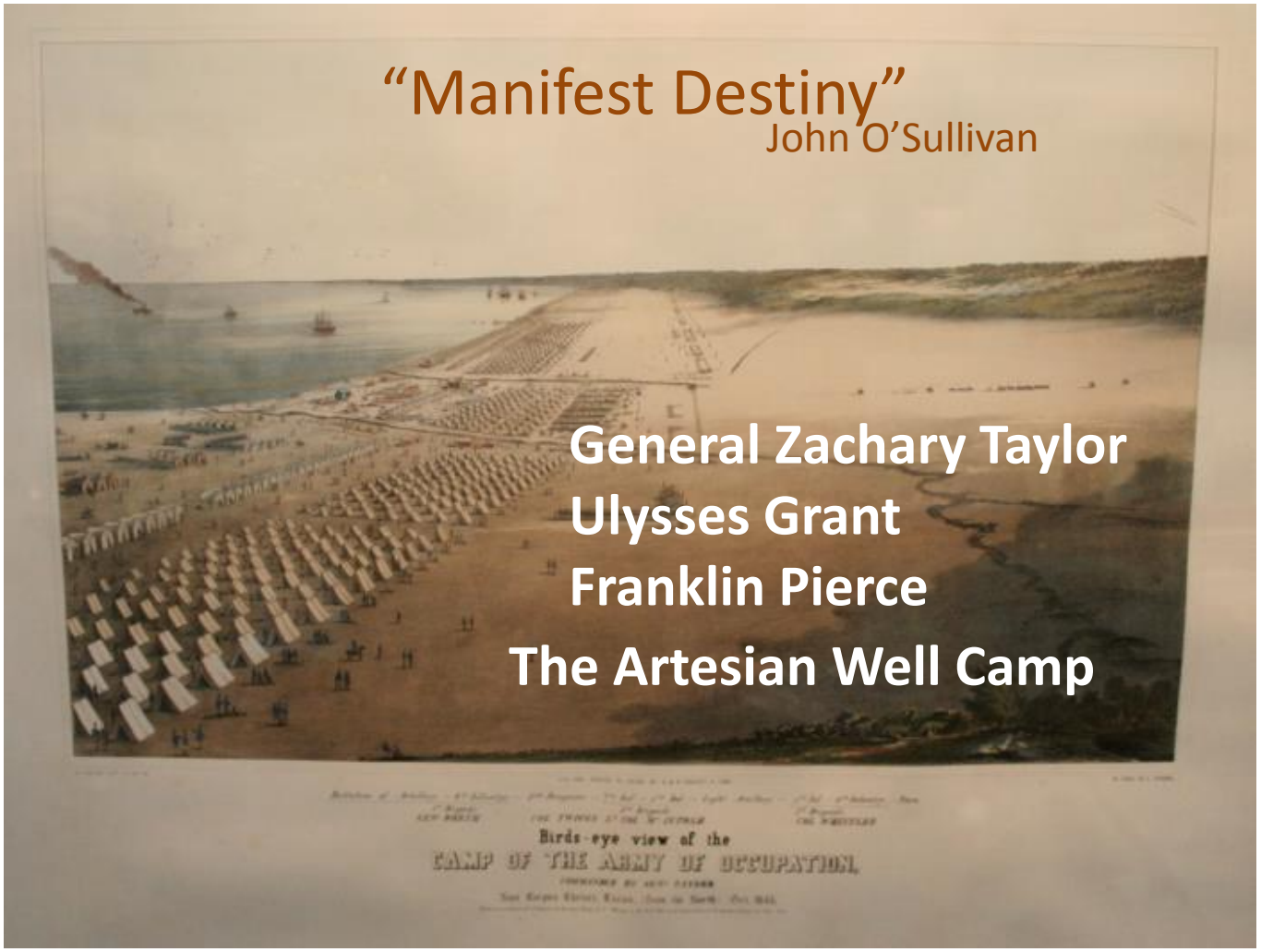
Dell City had Texas' first (and the nation's fifth) desalination plant in 1967!

1961

One of the first things I dealt with at the TWDB was a drive-by water witching!

The first artesian well drilled in Texas was in Corpus Christi!

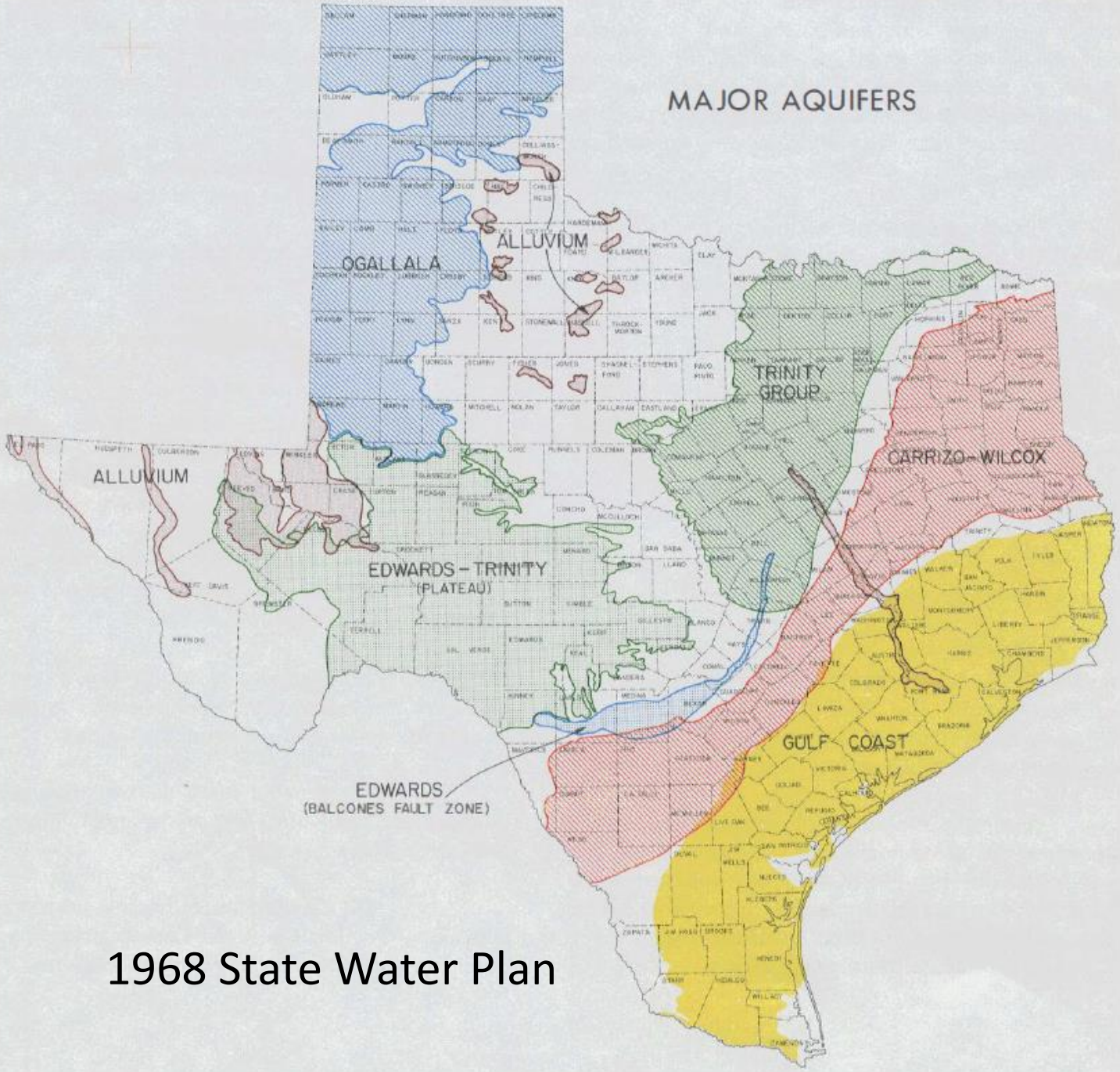
“First” artesian well in Texas: Corpus Christi, 1845



First municipal park in Texas!


ARTESIAN
PARK
FIRST PARK IN
CORPUS CHRISTI
1854

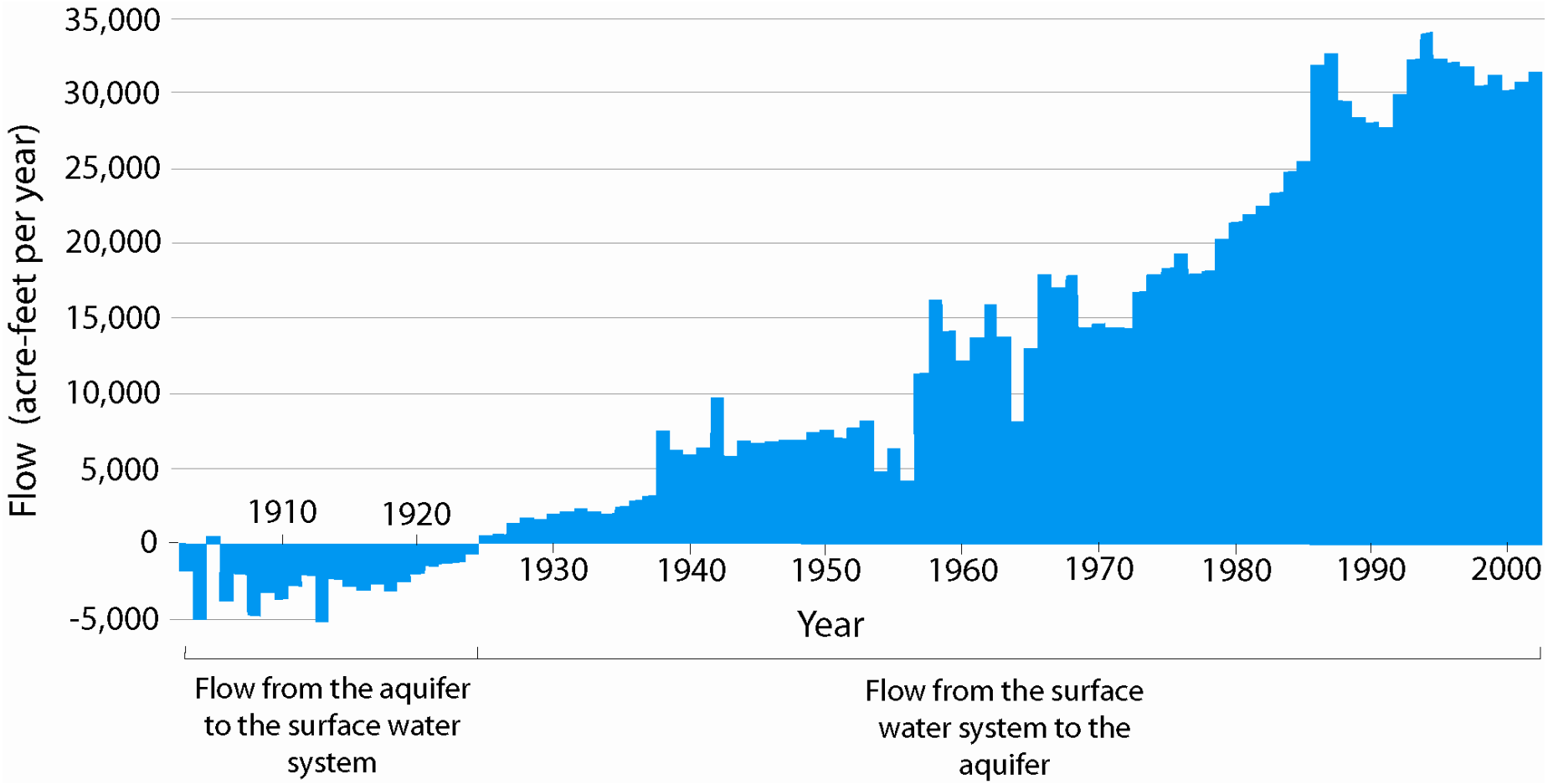
The Brazos River Alluvium used to be a major aquifer!



1968 State Water Plan

There's about a 40,000 acre-feet per year swing in the gain-loss in the Rio Grande where it flows over the Hueco Bolson!

Rio Grande-Hueco Bolson



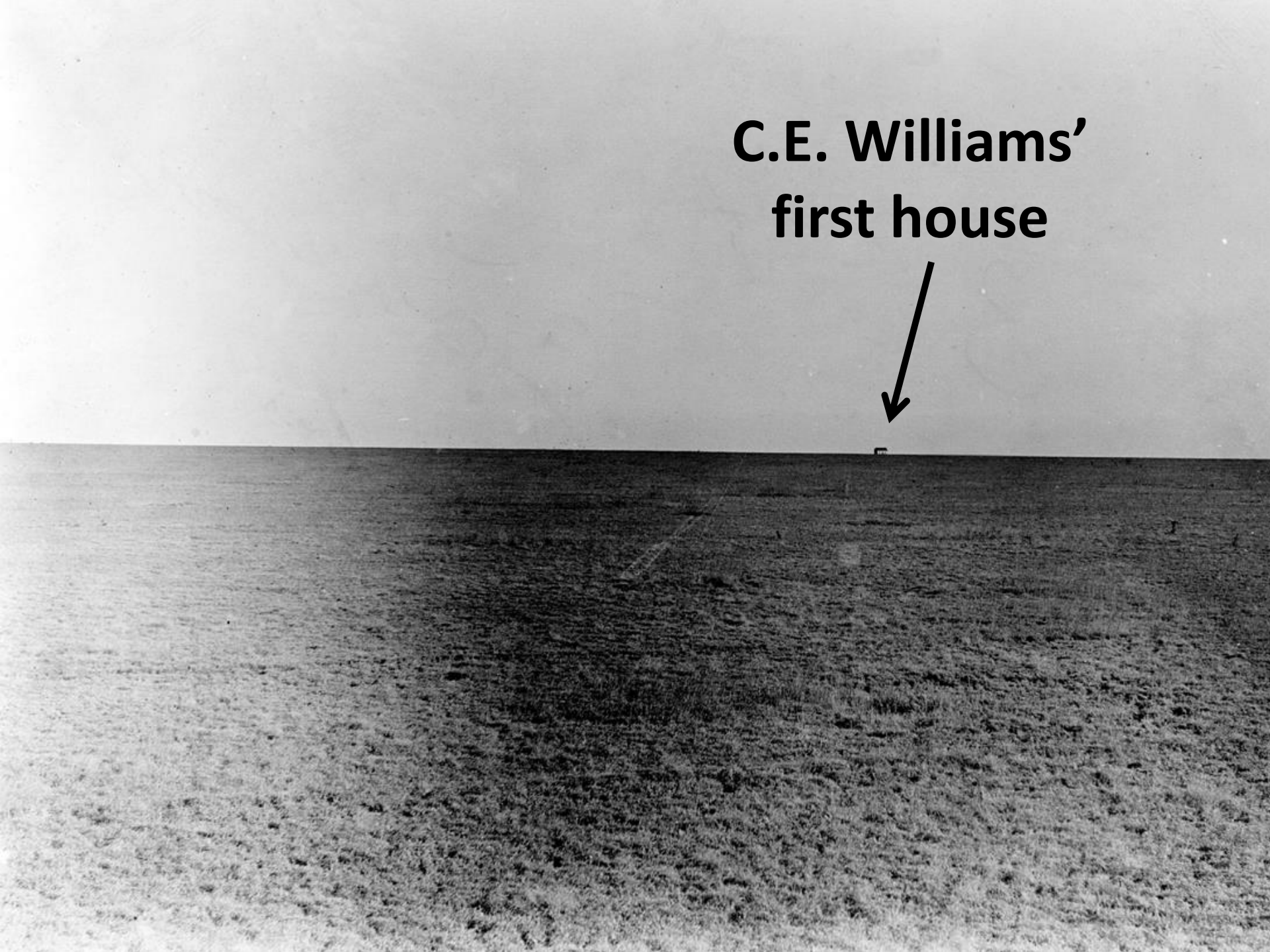
Mace's Believe It or Not!

Robert E. Mace, Ph.D., P.G.
Texas Water Development Board

presented to

American Ground Water Trust's
Texas Aquifer Conference
June 8, 2016

This is what the Southern High Plains used to look like!


C.E. Williams'
first house

Ole McDonald
had a farm
***and* a well!**

McDonald Irrigation Well, 1200 Gallons per Minute, Hereford, Texas.