The UNIVERSITY of OKLAHOMA
Mewbourne College of Earth and Energy
ConocoPhillips School of Geology and Geophysics
ConocoPhillips

Kyle E. Murray, PhD, Hydrogeologist

Presents:

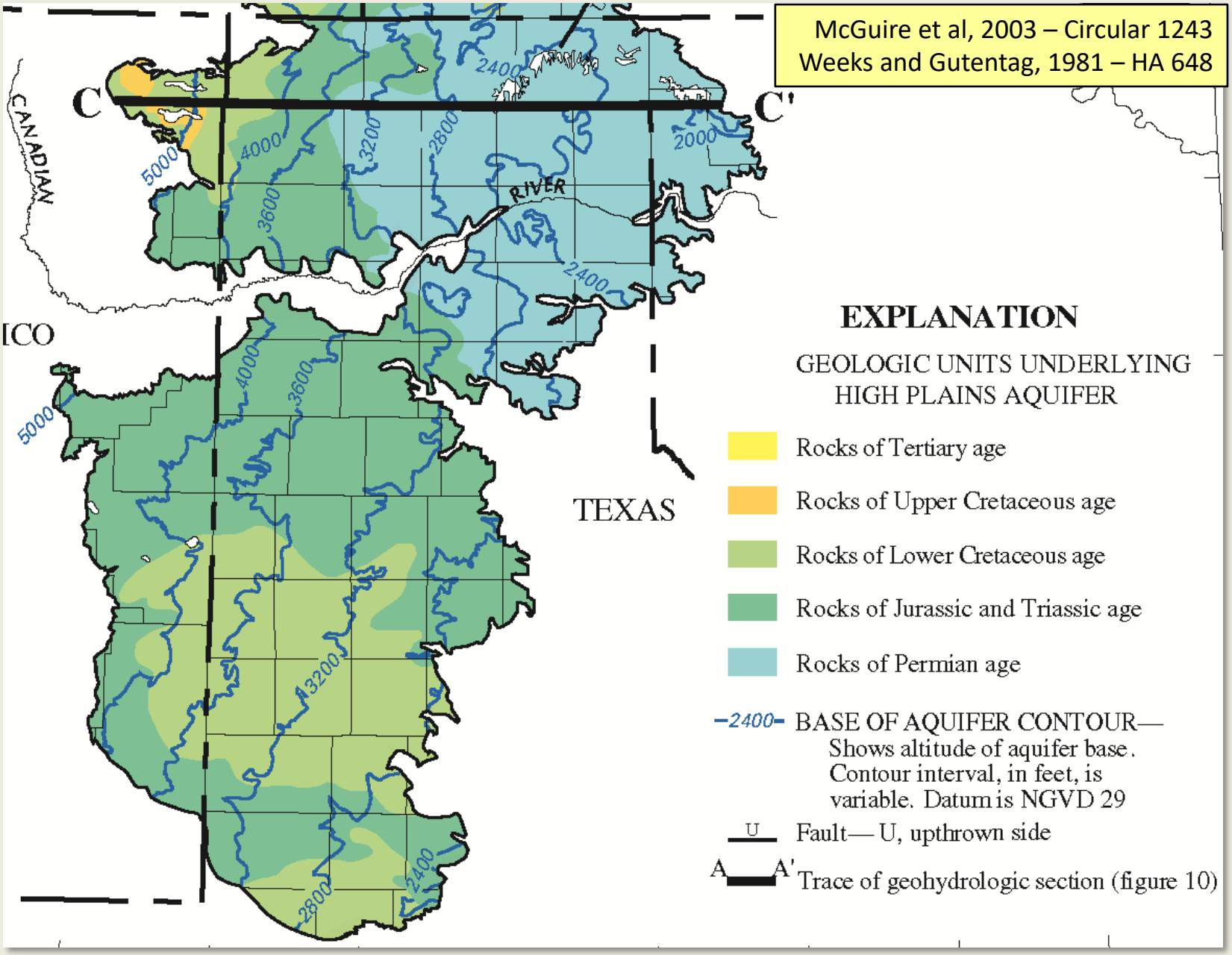
Perspectives (on High Plains Aquifer) from Oklahoma

American Geosciences Institute (AGI) Critical Issues Forum
Addressing Changes in Regional Groundwater Resources:
Lessons from the High Plains Aquifer

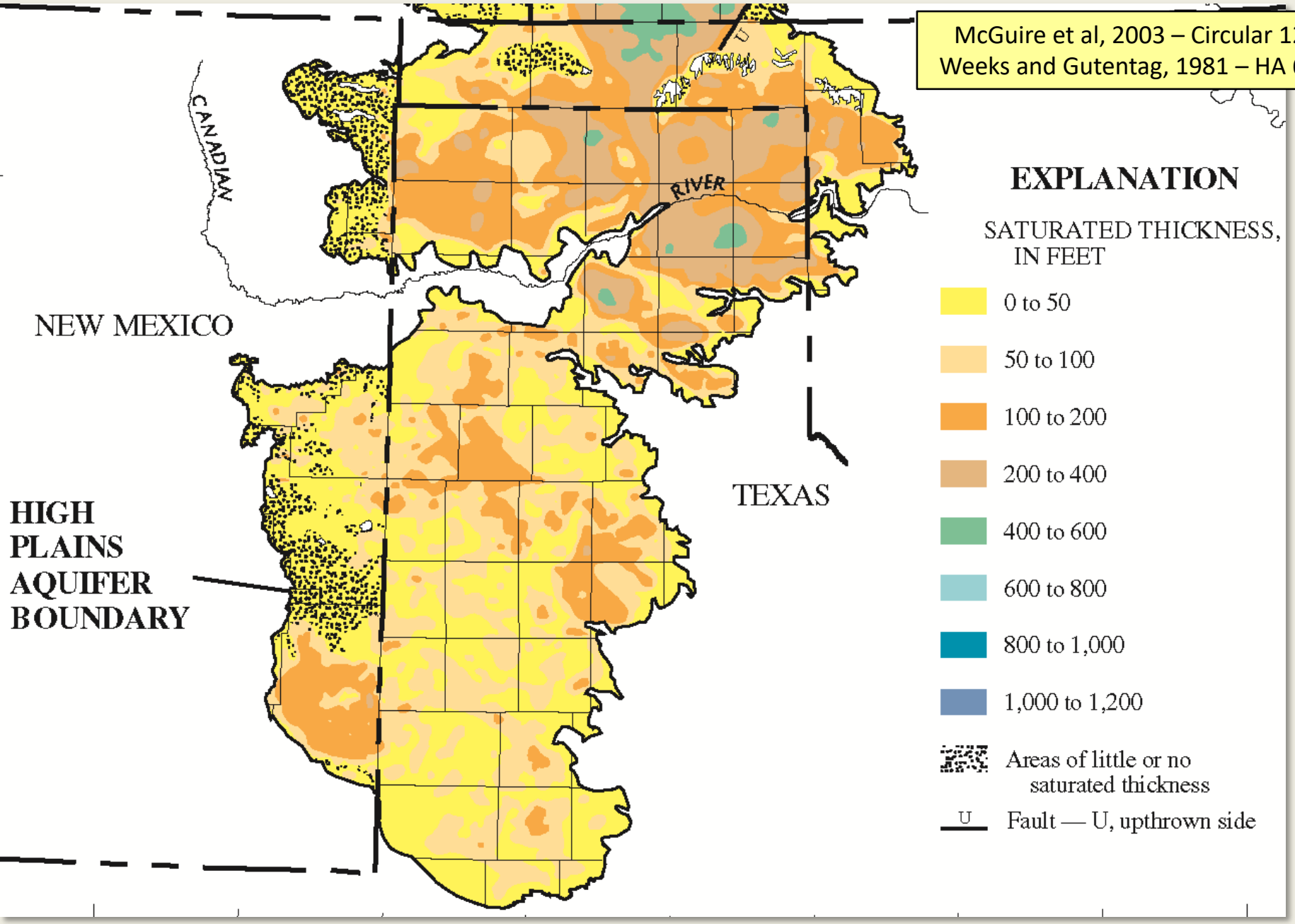
Golden, CO
Oct 27, 2016

Geologic Framework for the High Plains (Ogallala)

McGuire et al, 2003 – Circular 1243
Weeks and Gutentag, 1981 – HA 648



Saturated Thickness of the High Plains (Ogallala), 2000



Water Law and Groundwater Permitting in Oklahoma

Groundwater use is a legal property right tied to ownership of the land. Applicants must satisfy four legal requirements to obtain a groundwater use permit:

- applicant owns or leases the land from which the water will be withdrawn;
- dedicated land overlies a fresh groundwater basin;
- water will be put to a beneficial use; and
- waste of the water would not occur

High Plains Aquifer (HPA) Oklahoma Storage and Recharge

	Value	Units	Description
A	**90,590,000**	acre-feet (ac-ft)	HPA OK groundwater in storage, OWRB 2012
B	**4,184,876**	acres	HPA OK land area
C	**0.7**	in/yr	HPA OK recharge rate, Mar 12, 2002 Final Order
D	**244,118**	ac-ft/yr	HPA OK recharge rate, D=B*C/12

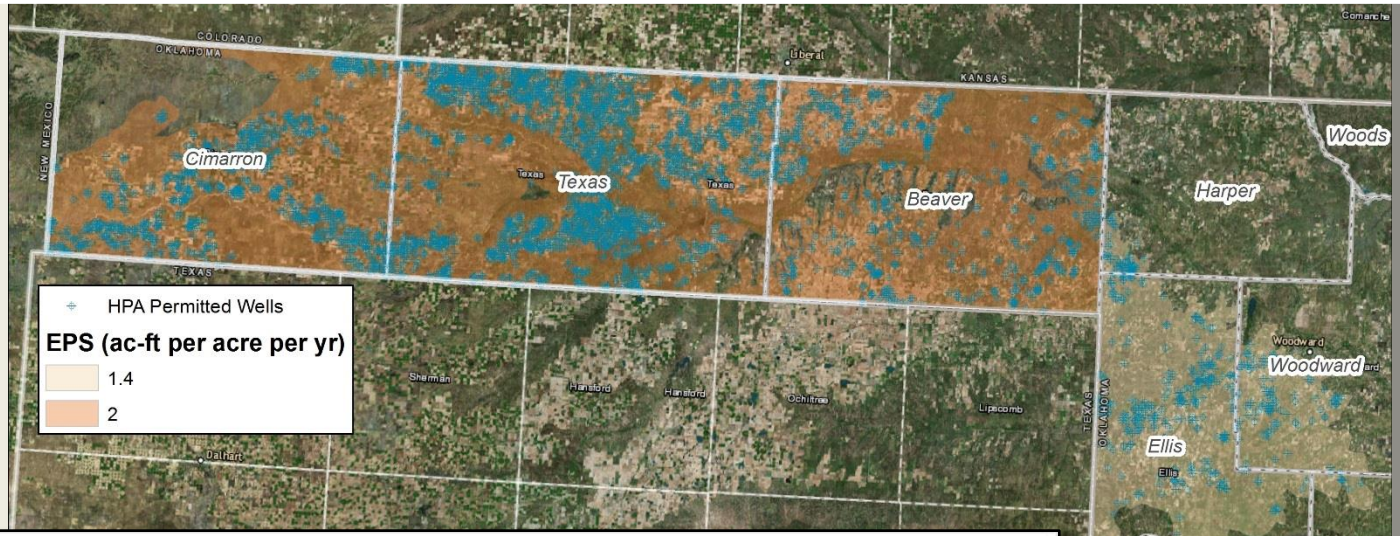
Maximum Annual Yield (MAY): shall be based upon a minimum basin or subbasin life of 20 years from the order establishing the final determination of the maximum annual yield.

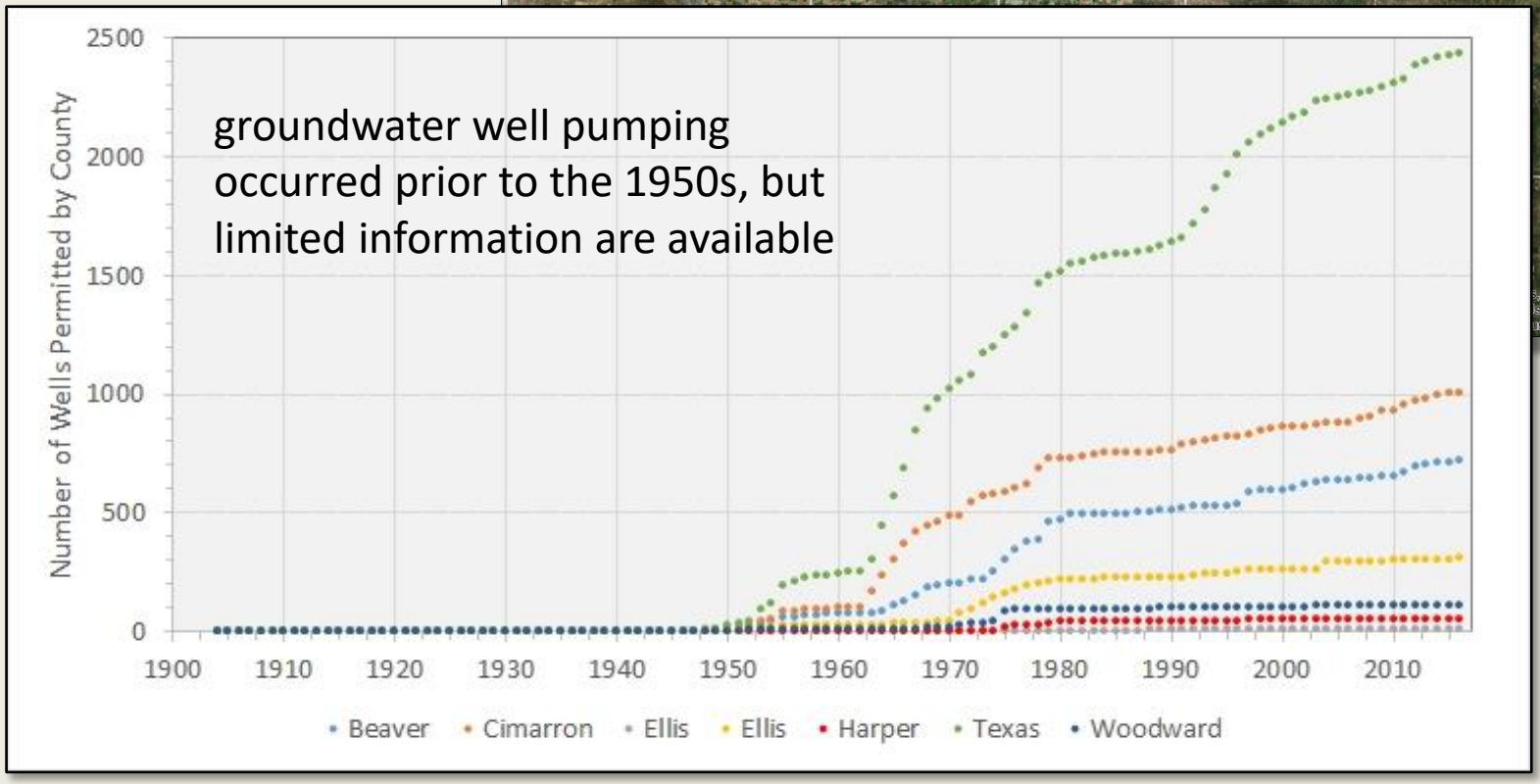
Equal Proportionate Share (EPS): maximum annual yield of water from a groundwater basin or subbasin which shall be allocated to each acre of land overlying such basin or subbasin.

Tentative Order for MAY and EPS for HPA OK on Feb 13, 2001

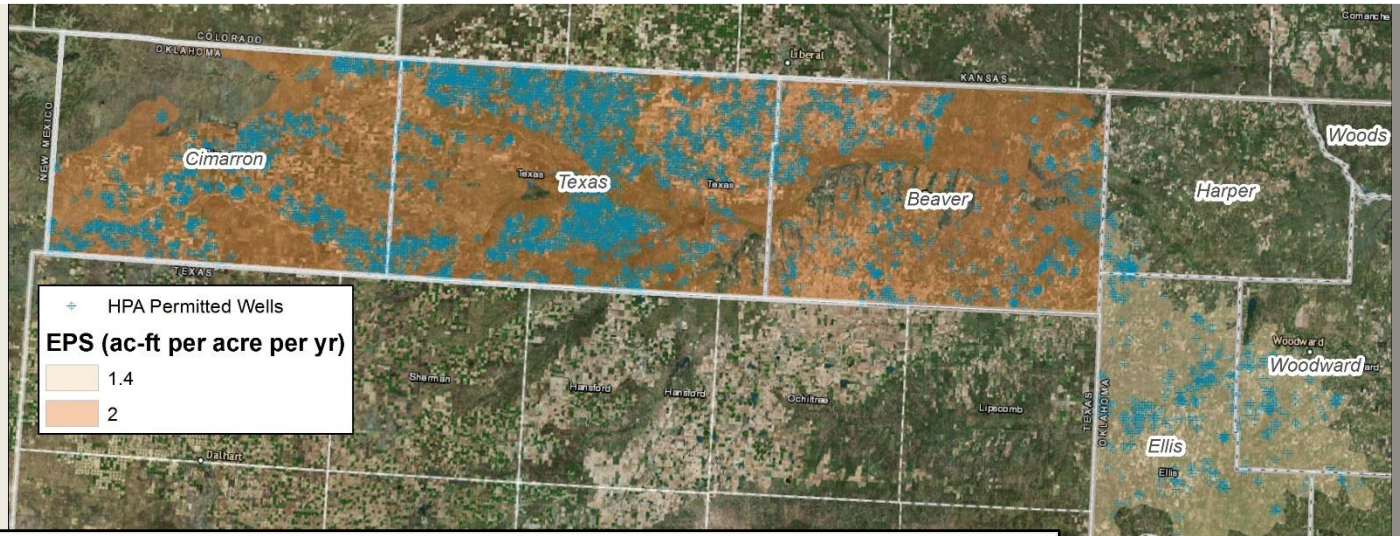
Final Order for MAY and EPS for HPA OK on Mar 12, 2002

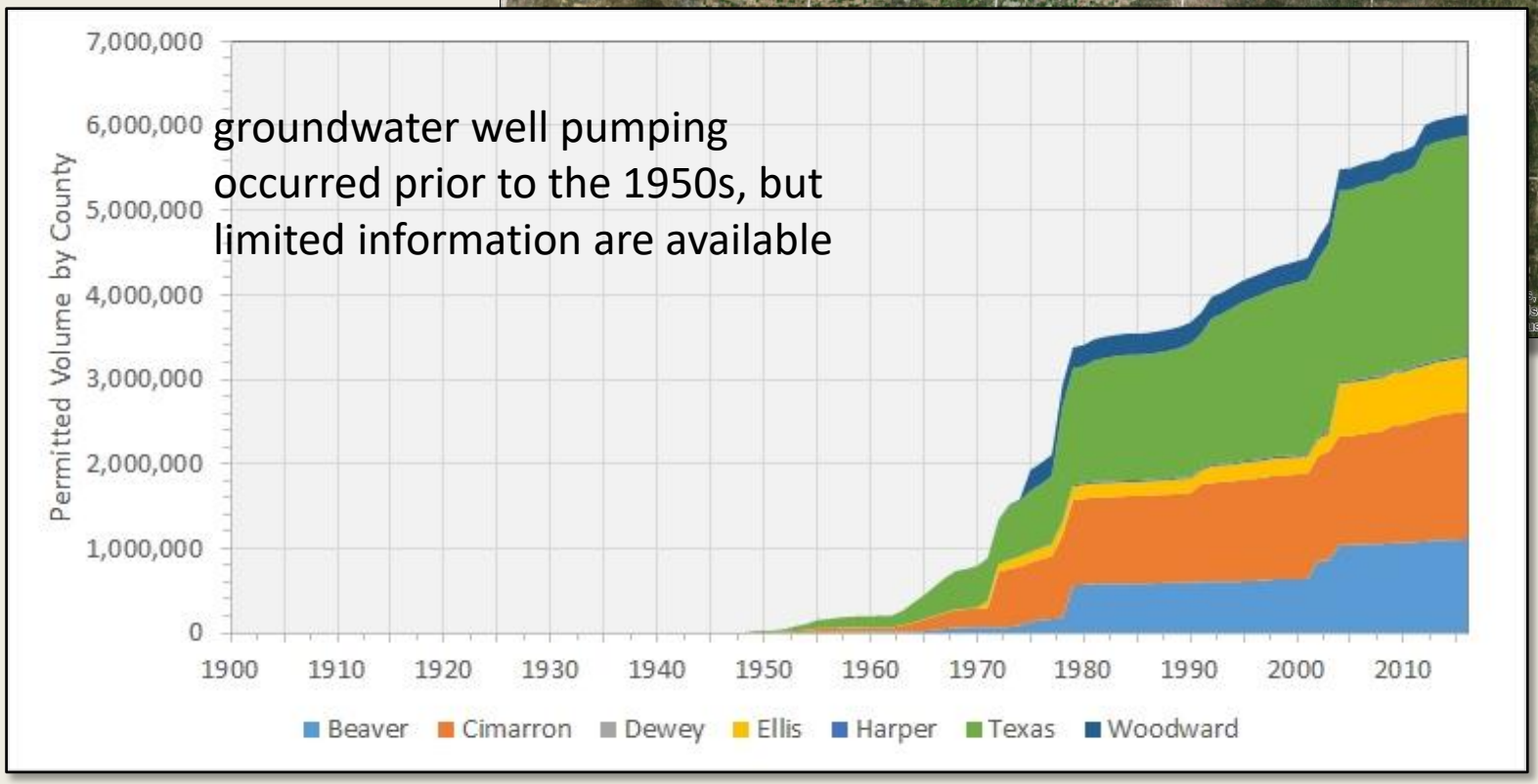
Permitted Wells in High Plains Aquifer of Oklahoma





Permitted Volumes from High Plains Aquifer of Oklahoma





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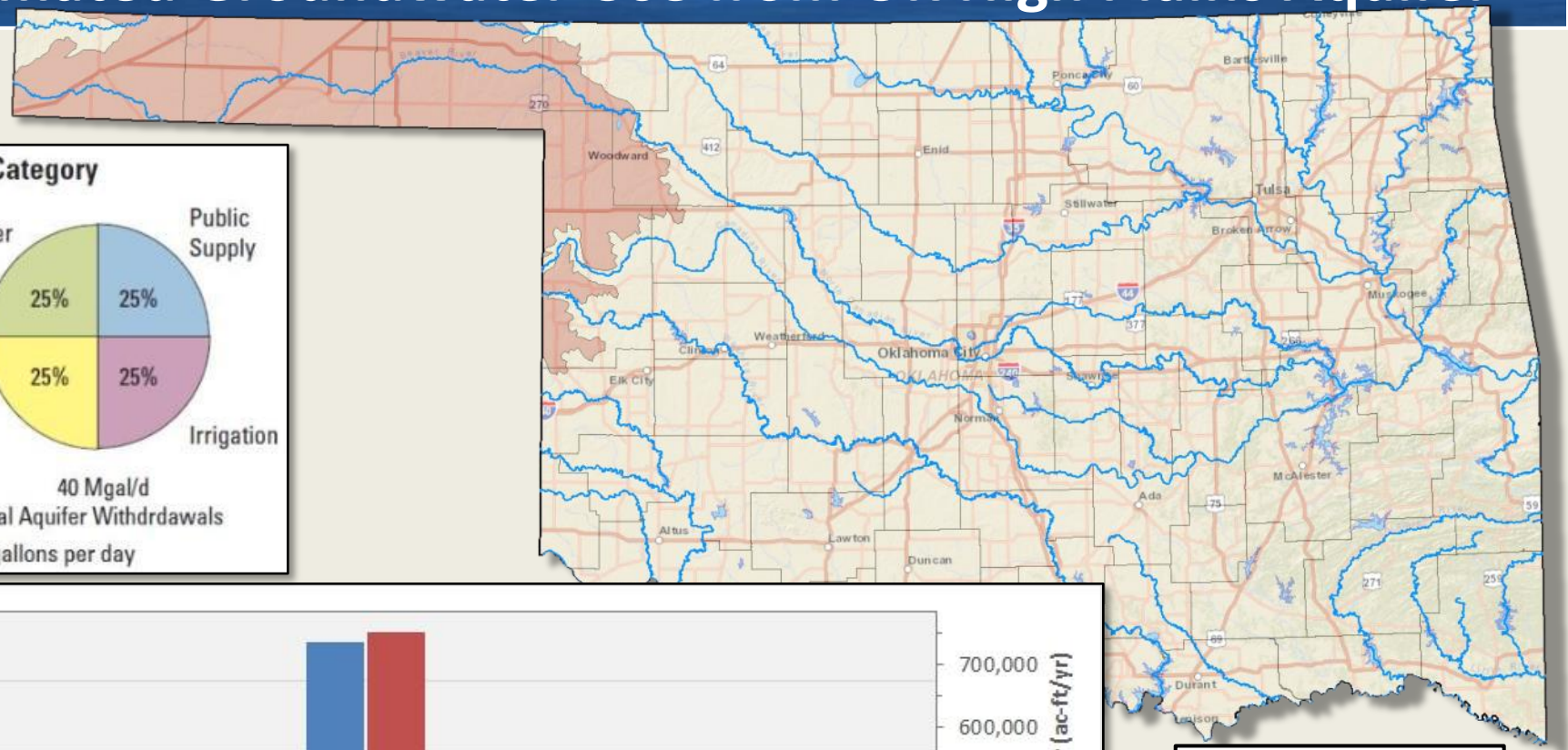
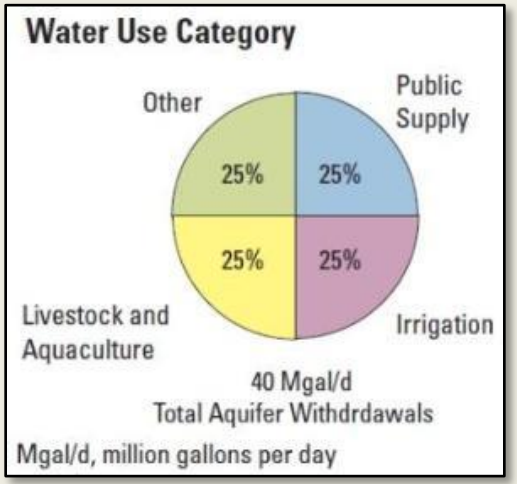
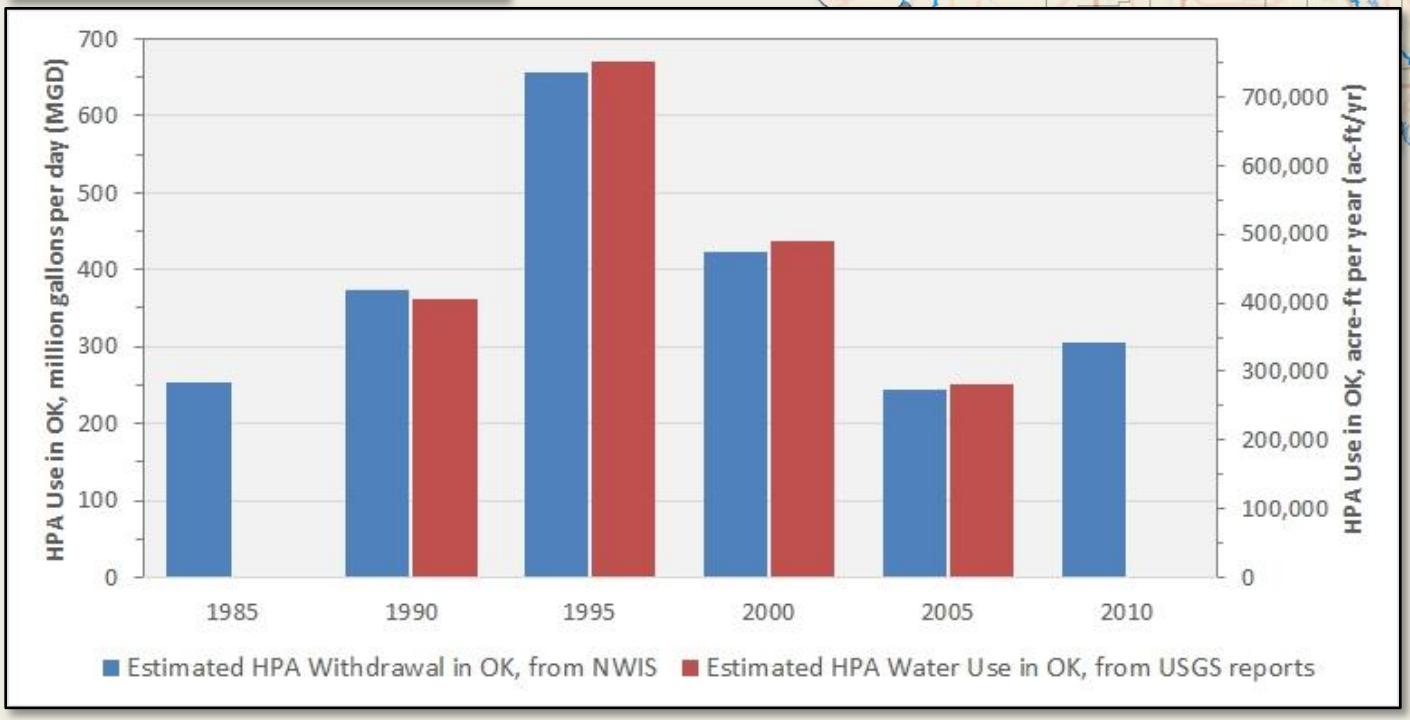
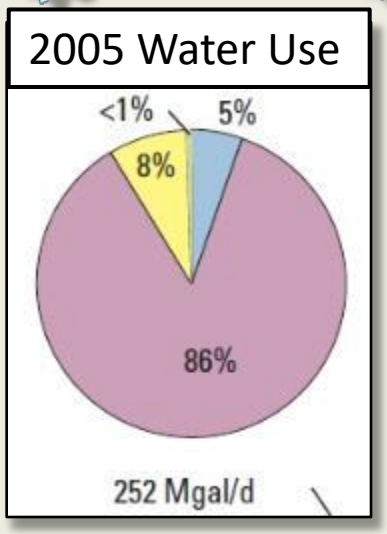
E	**2.0**	ac-ft/ac-yr	HPA OK Panhandle EPS, Mar 12, 2002 Final Order
F	**3,279,783**	acres	HPA OK Panhandle land area
G	**6,559,566**	ac-ft/yr	HPA OK Panhandle MAY, G=E*F
H	**1.4**	ac-ft/ac-yr	HPA OK Northwestern EPS, Mar 12, 2002 Final Order
I	**905,093**	acres	HPA OK Northwestern land area
J	**362,037**	ac-ft/yr	HPA OK Northwestern MAY, J=H*I
K	**4,675,797**	ac-ft/yr	HPA OK Permitted withdrawals in 2002
L	**6,135,265**	ac-ft/yr	HPA OK Permitted withdrawals in 2016

Estimated Groundwater Use from OK High Plains Aquifer



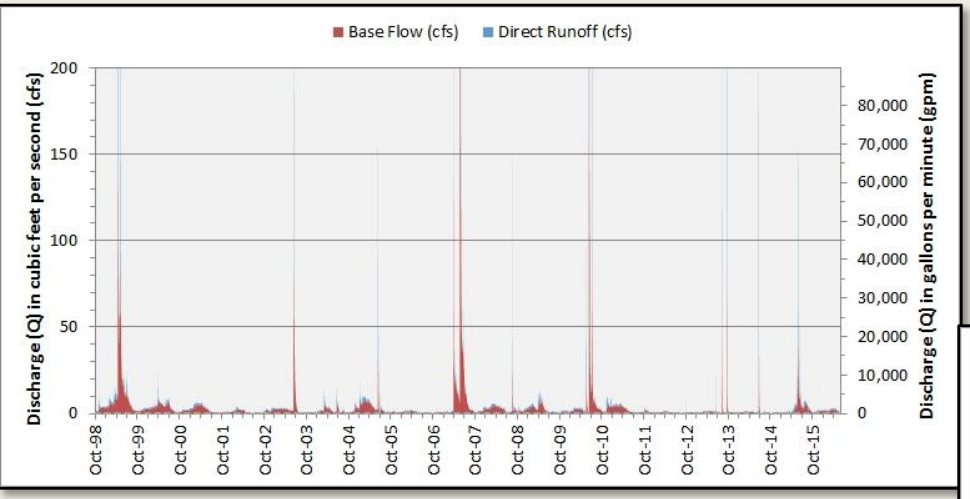






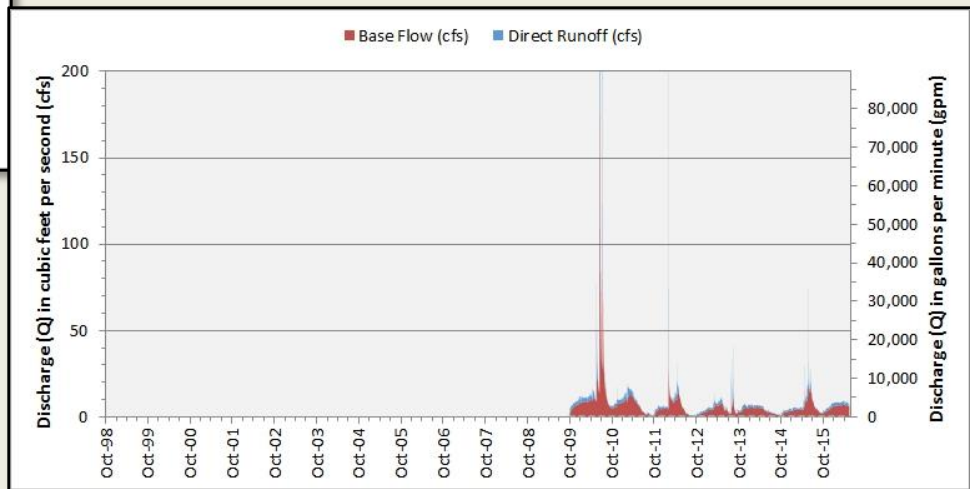
Baseflow & Groundwater Recharge, OK High Plains Aquifer

Gage Location	Mean discharge (cfs)	Mean runoff (cfs)	Mean baseflow (cfs)	Mean discharge (gpm)	Mean runoff (gpm)	Mean baseflow (gpm)	Mean discharge (ac-ft-yr)	Mean runoff (ac-ft/yr)	Mean baseflow (ac-ft/yr)	baseflow index (BFI) (%)
USGS Station 07235600, Wolf Creek near Gage, OK	9.7	2.9	6.7	4,332	1,310	3,021	6,992	2,115	4,877	69.75%
USGS Station 07235000, Wolf Creek near Lipscomb, TX	8.6	4.7	3.8	3,850	2,131	1,719	6,214	3,440	2,774	44.65%



The Web-based Hydrograph Analysis Tool (WHAT) https://engineering.purdue.edu/~what/ is a well-documented tool for processing discharge data and estimating the runoff versus baseflow components.

Assuming that baseflow and recharge are equivalent, groundwater recharge would be 0.0782 in/yr if distributed proportionally over the watershed/aquifer area.



WL Change pre-develop to 2000 in the High Plains (Ogallala)

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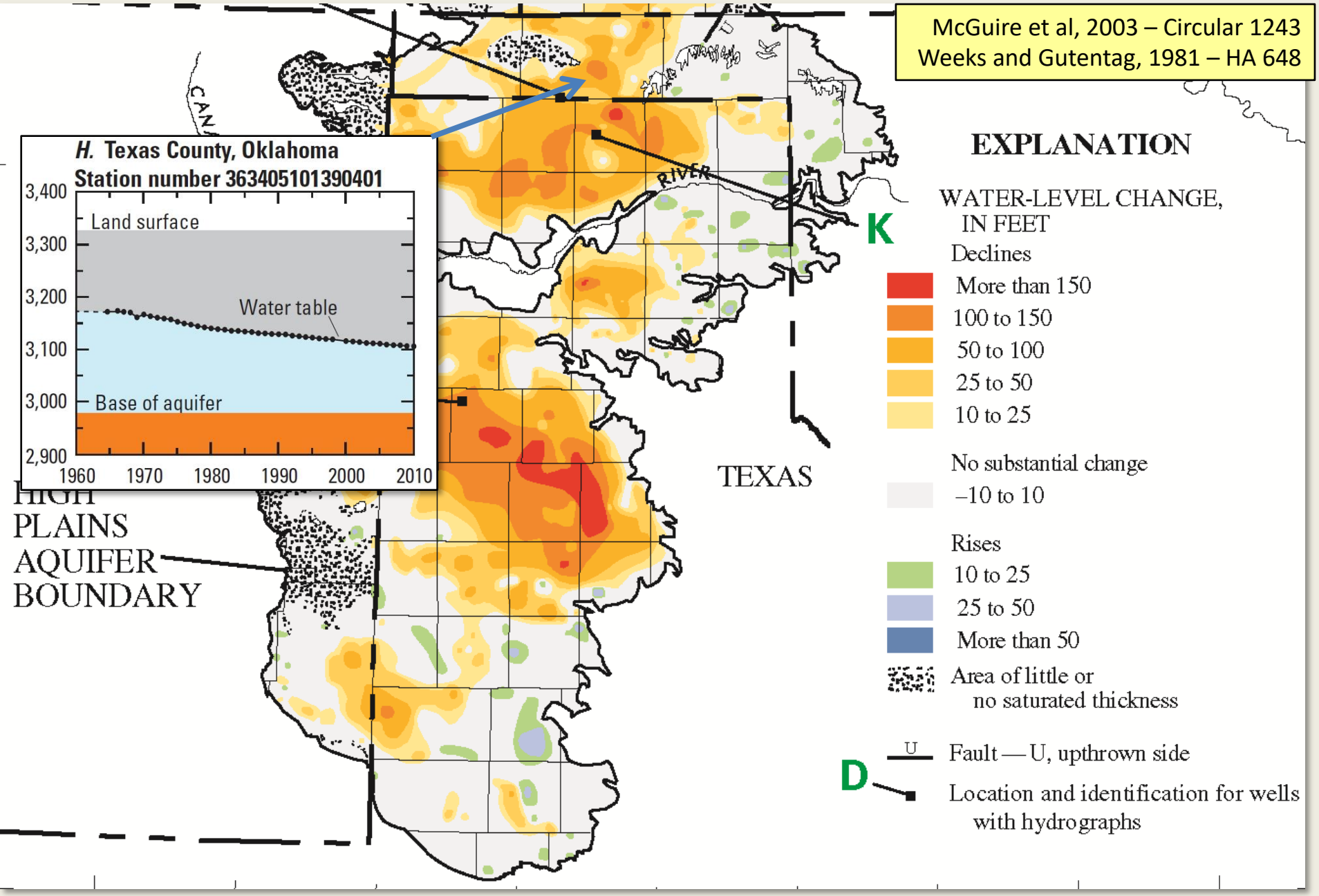
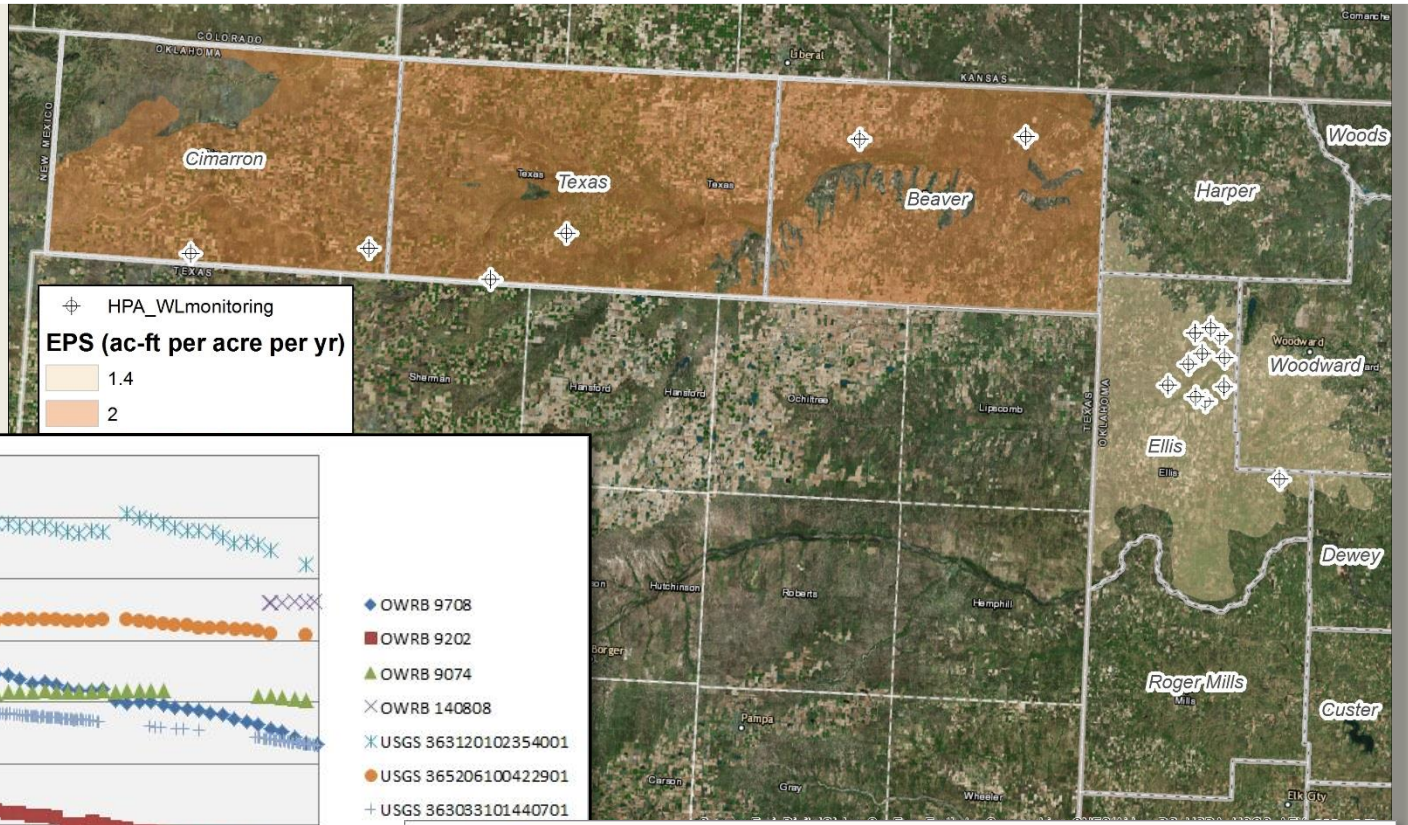
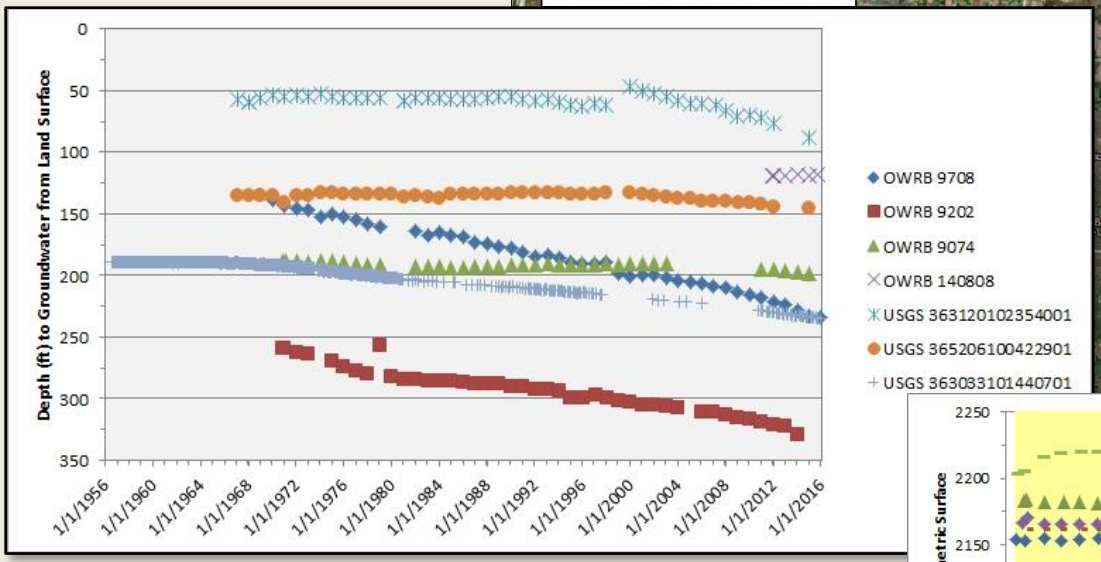


Water Levels in OK High Plains Aquifer

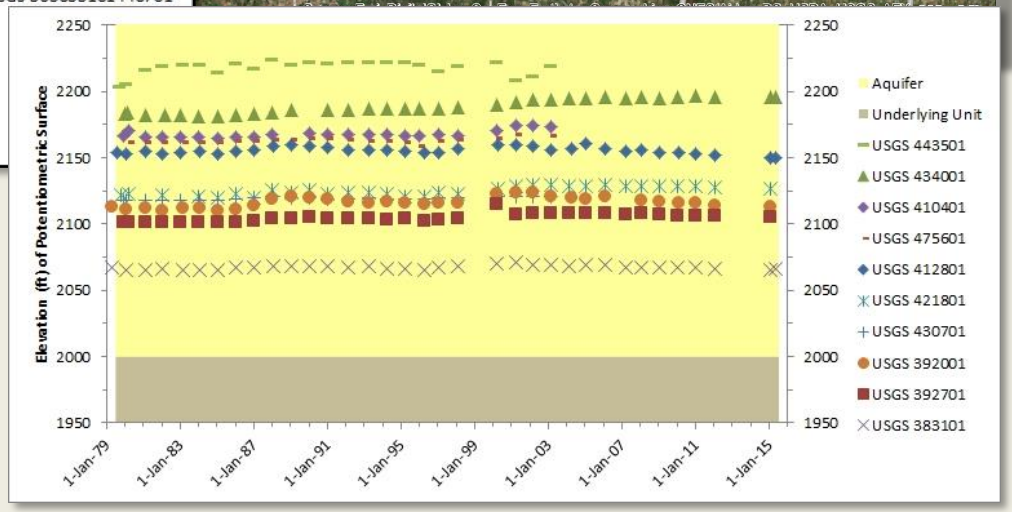


OK Panhandle Wells



Average ΔWL from 2002–2016: -9.83 ft

OK Ellis County Wells



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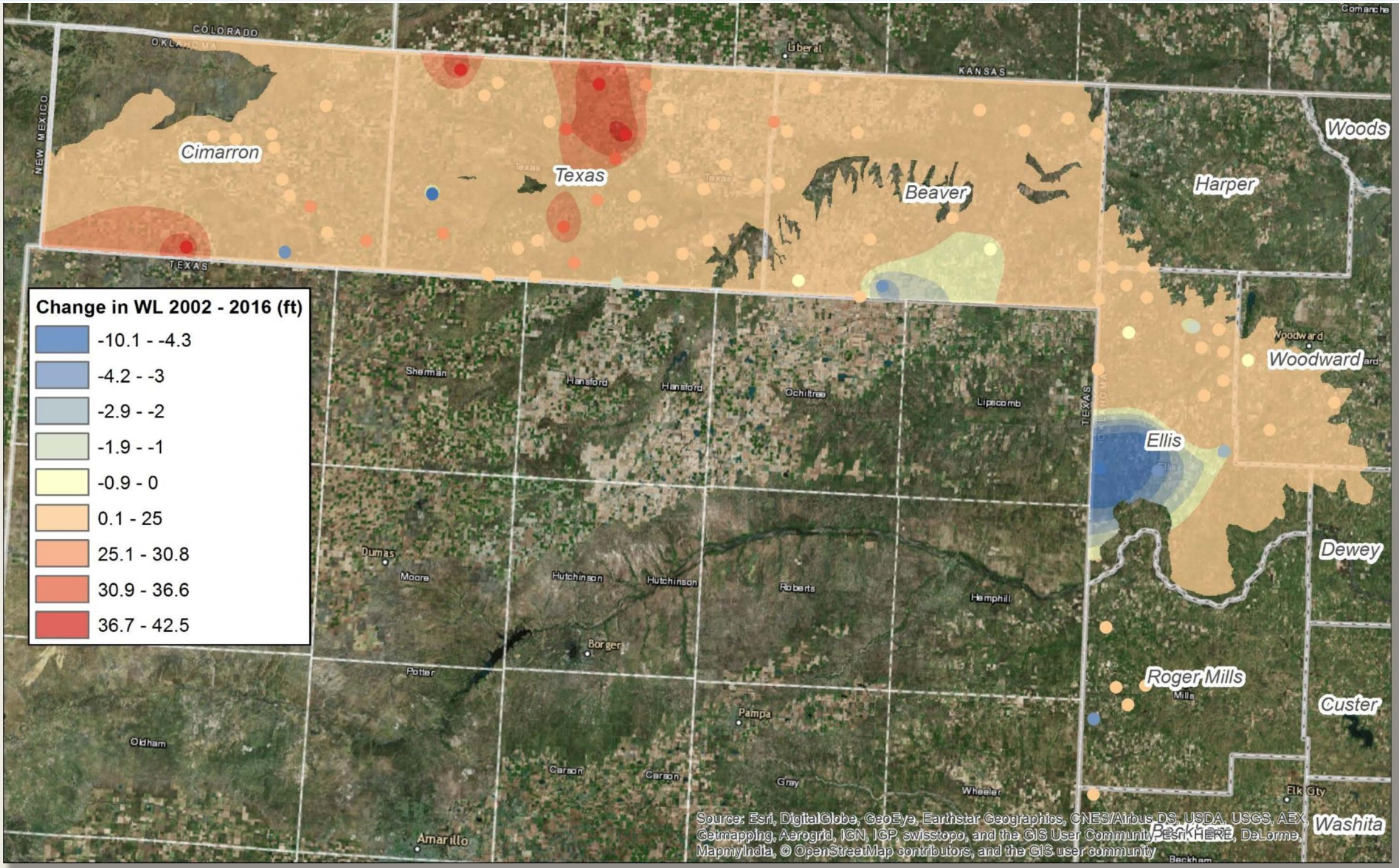
M	**421,087**	ac-ft/yr	HPA OK Avg Q 1985–2010 (for 14yrs -5,895,218 ac-ft)
N	**0.08**	in/yr	HPA OK estimated recharge rate
O	**27,271**	ac-ft/yr	HPA OK estimated recharge rate, O=B*N/12
P	**-4,113,733**	ac-ft	HPA OK change in storage 2002–2016, ΔVol

Water Level Change in OK HPA, 2002 - 2016



-4,113,733 ac-ft, HPA OK change in storage 2002–2016, ΔVolume