Statewide Characterization of Oklahoma's Major Aquifers

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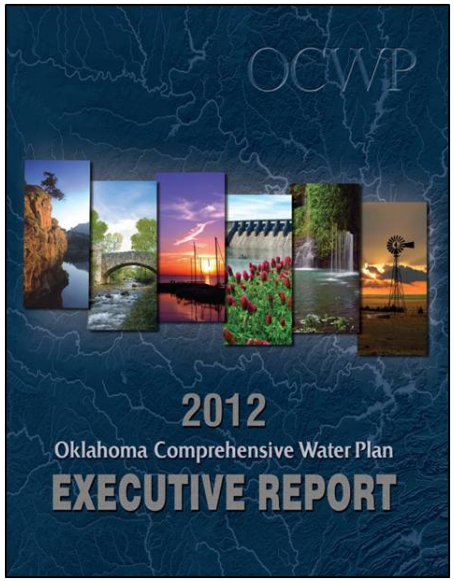
Groundwater Monitoring Background

- Majority of Groundwater Monitoring: Compliance
- Water level monitoring since 1950s
- Ambient water quality monitoring piecemeal, largely unfunded
- No holistic, long-term, aquifer-based, statewide groundwater quality/quantity monitoring program prior to 2012

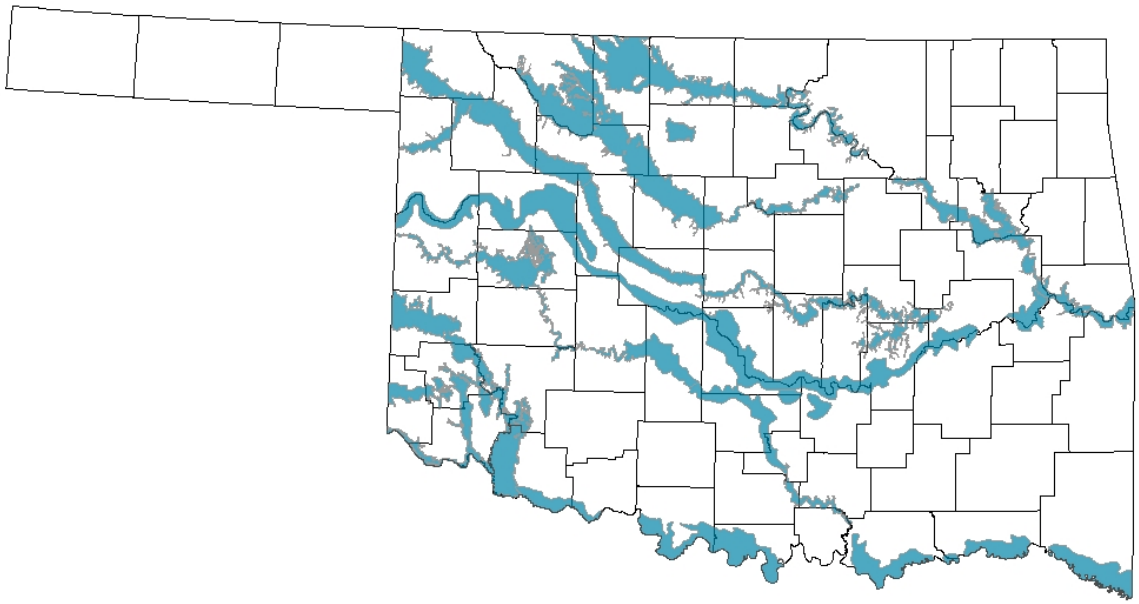
Groundwater Monitoring & Assessment Program (GMAP)

- Legislative funding following adoption of OCWP High Priority Recommendations (2012)



- Baseline of water quality and quantity
- Random, spatially distributed network
- Characterize aquifers and identify concerns

Oklahoma's Aquifers: Alluvium & Terrace

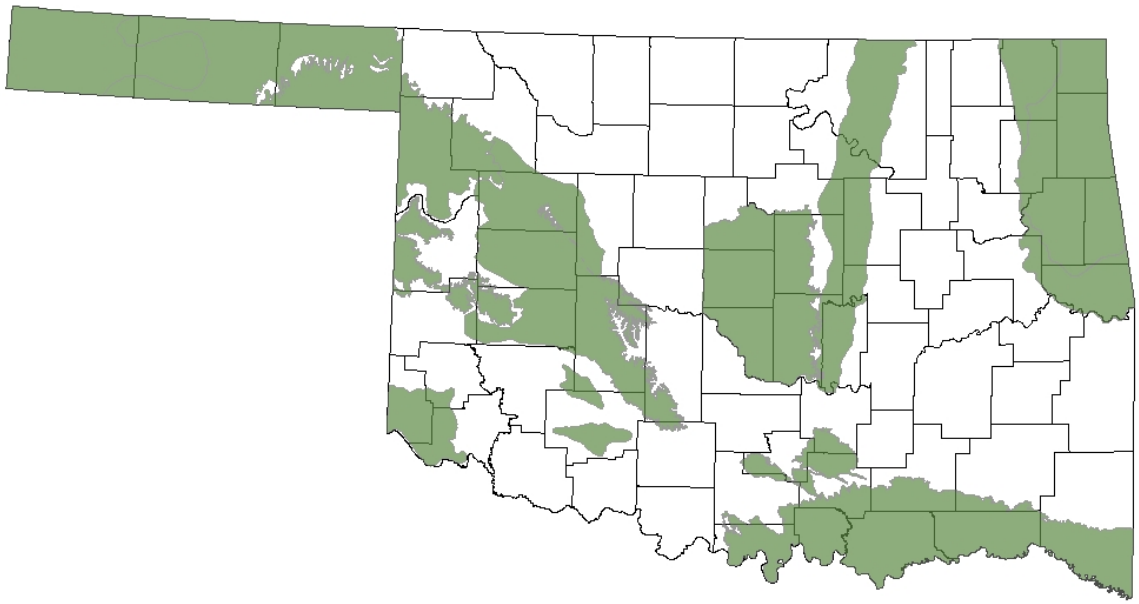


› Shallow, unconsolidated sand & gravel aquifers

› Generally in communication with a river or stream, but not always (e.g., Enid Isolated Terrace)

› Highly vulnerable to surface contamination

Oklahoma's Aquifers: Bedrock



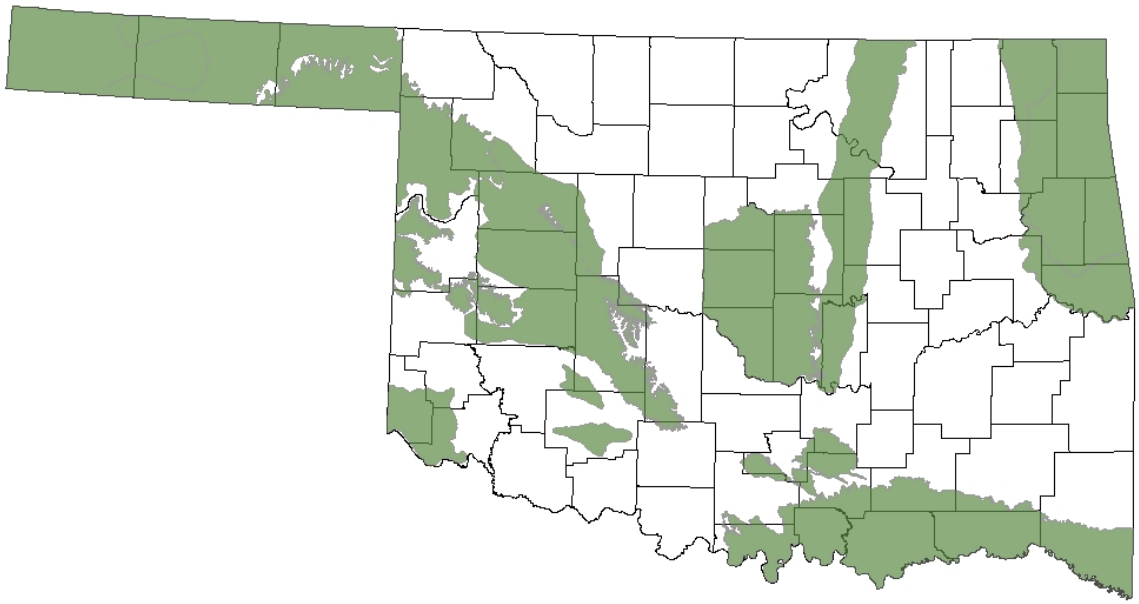
› Made of water-bearing rock formations underlying surface

› Semiconsolidated or consolidated

› Unconfined, confined, or both

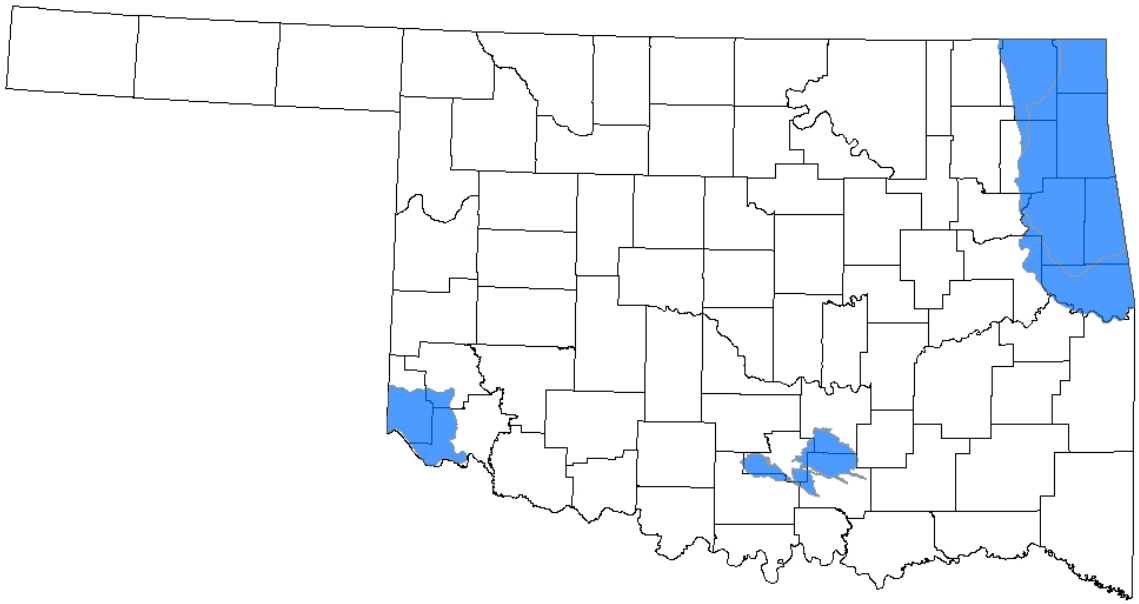
› Characteristics vary widely based on hydrogeology

Oklahoma's Aquifers: Bedrock



- Massive sandstone
- Interbedded sandstone/shale
- Semi-consolidated sand/silt/caliche
- Gypsum
- Dolomite
- Limestone

Oklahoma's Aquifers: Karst



› Formations dominated by limestone, dolomite, or gypsum

› Fractured or cavernous

› Karst areas home to caves, springs, can hold large quantities of water

› Responsive to weather, vulnerable to surface contamination

Laboratory and Field Parameters

General Chemistry					
Dissolved Oxygen (mg/L)	Well Depth (ft)	Depth to Water (ft)	Total Diss. Solids (mg/L)		
Specific Conductance (µS/cm)	pH	Hardness (mg/L)	Alkalinity (mg CaCO3/L)		
Major Ions (mg/L)					
Calcium	Magnesium	Potassium	Sodium	Silica	Bromide
Chloride	Fluoride	Sulfate	Calculated Bicarbonate (mg/L)		
Nutrients (mg/L)					
Nitrate + Nitrite	Total Dissolved Phosphorus	Ammonia			
Isotopes (‰)					
Deuterium	Oxygen-18				
Metals & Trace Elements, Dissolved (µg/L or mg/L)					
Aluminum	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium
Chromium	Cobalt	Copper	Iron	Lead	Lithium	Manganese
Mercury	Molybdenum	Nickel	Selenium	Silver	Strontium	Titanium
Thallium	Thorium	Uranium	Vanadium	Zinc		

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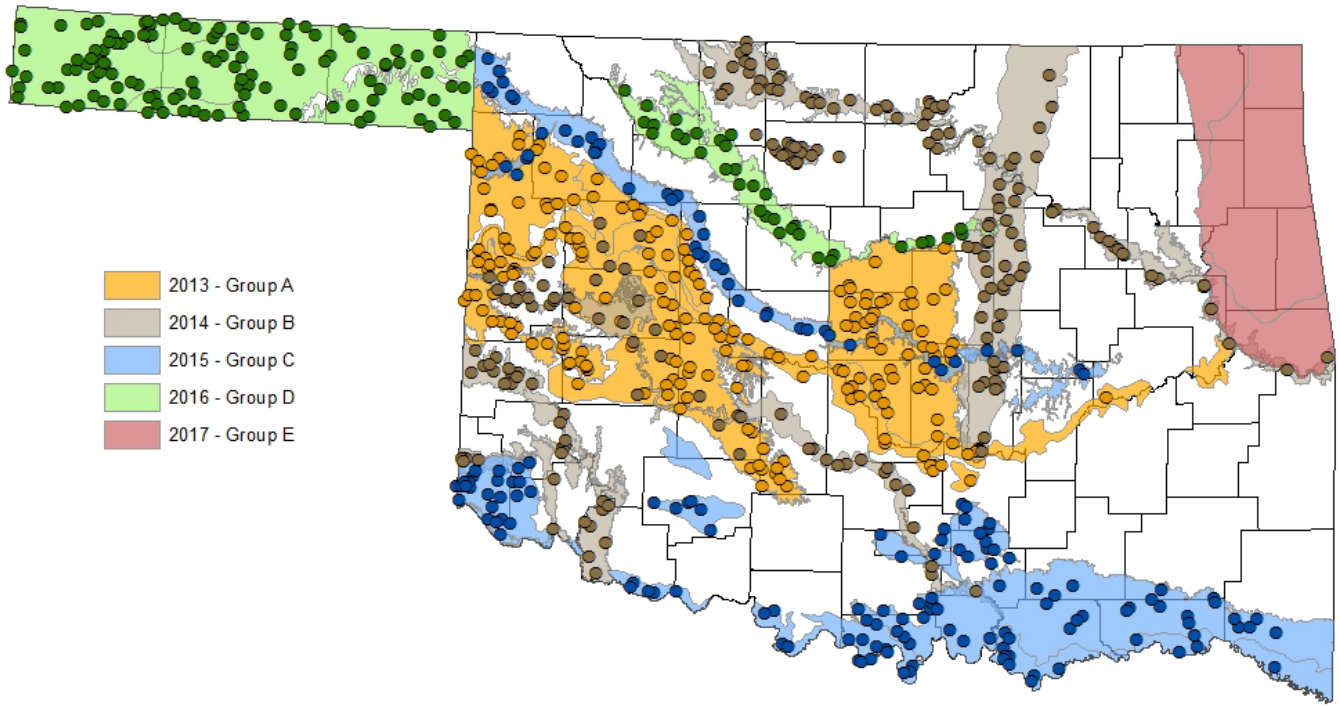
Baseline Sampling Schedule



Trend network implementation scheduled for Fall 2018

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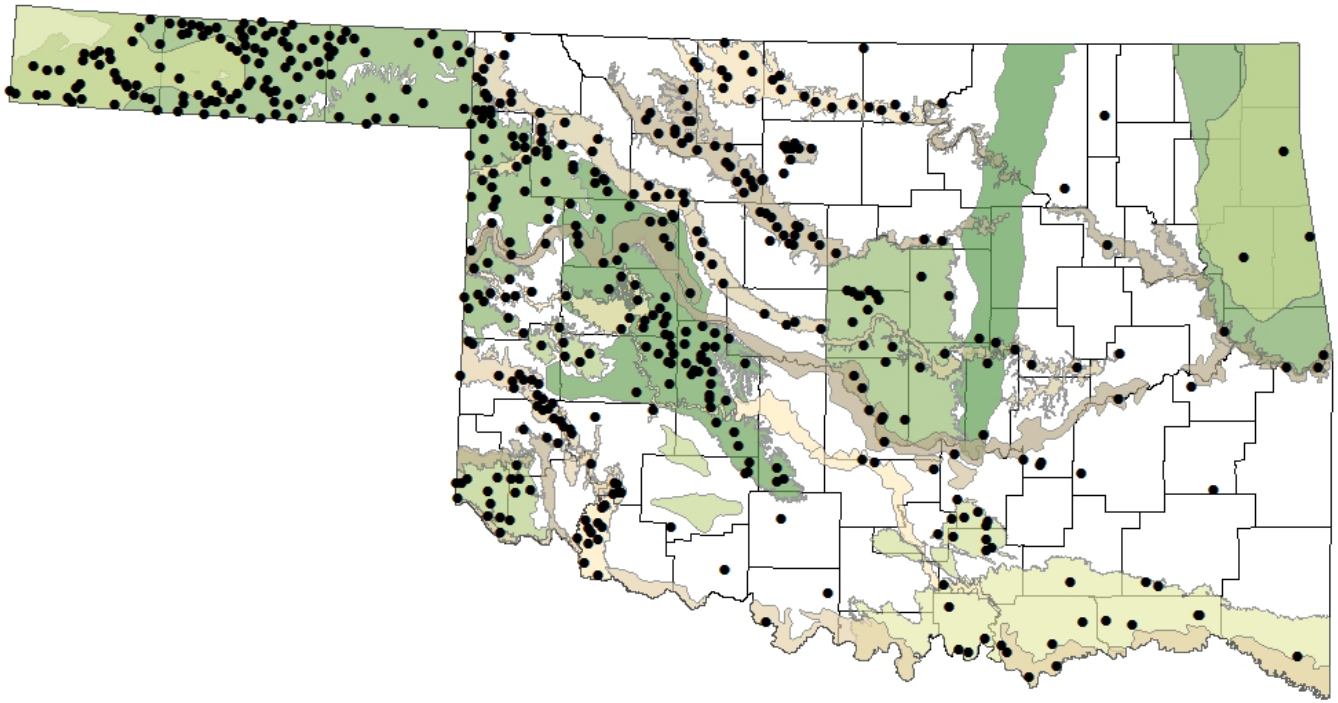
Quantity Program Expansion



Water level network in 2013

Number of wells doubled in capacity from historical network

(530 to 1,100 wells)

Spatially representative distribution of wells

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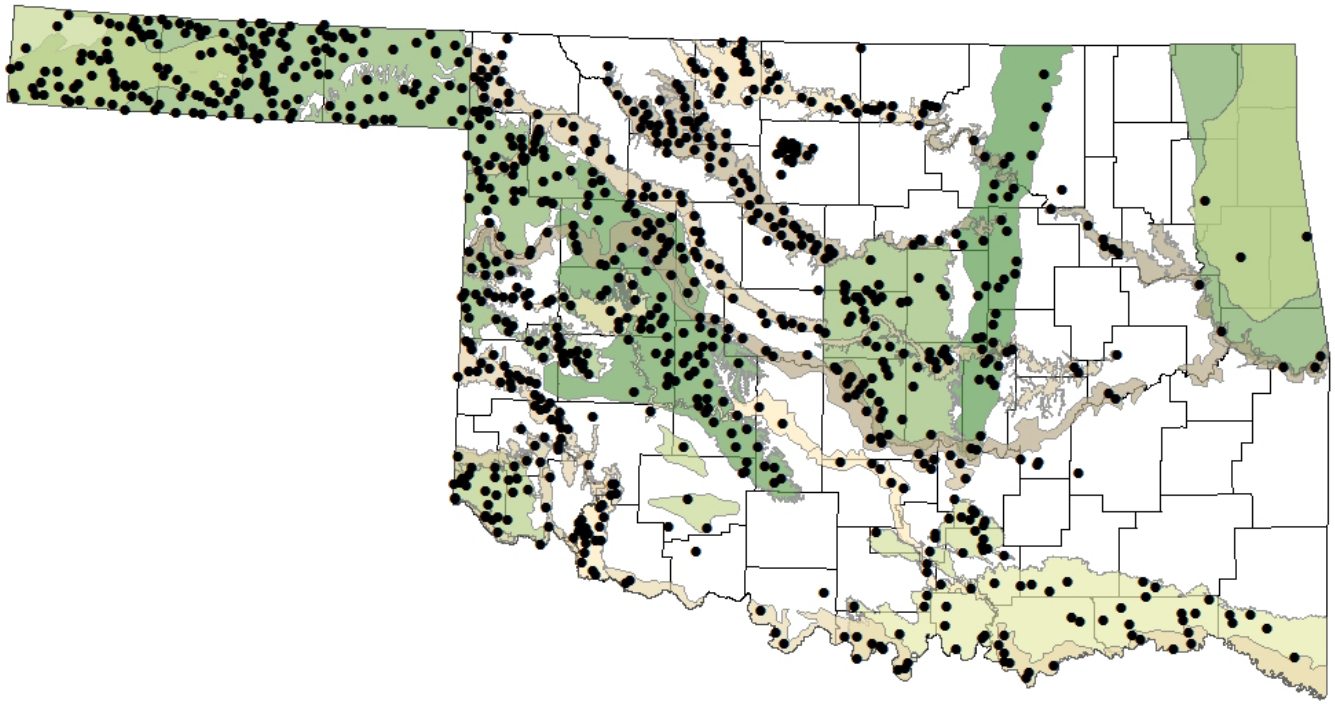
Quantity Program Expansion



Water level network in 2017

Number of wells doubled in capacity from historical network

(530 to 1,100 wells)

Spatially representative distribution of wells

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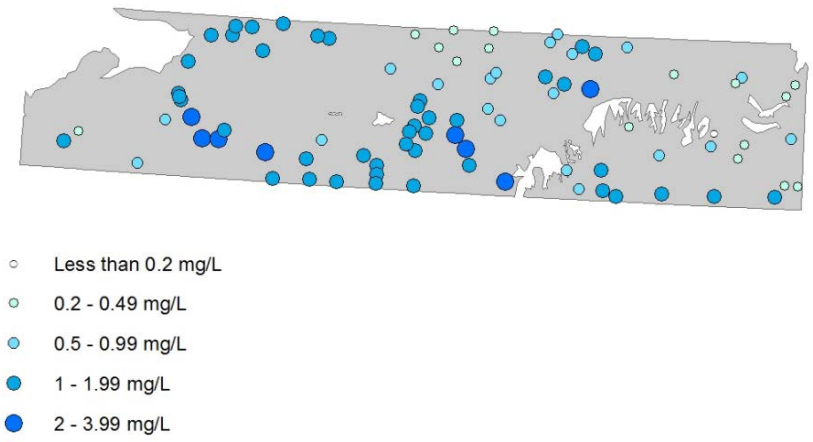
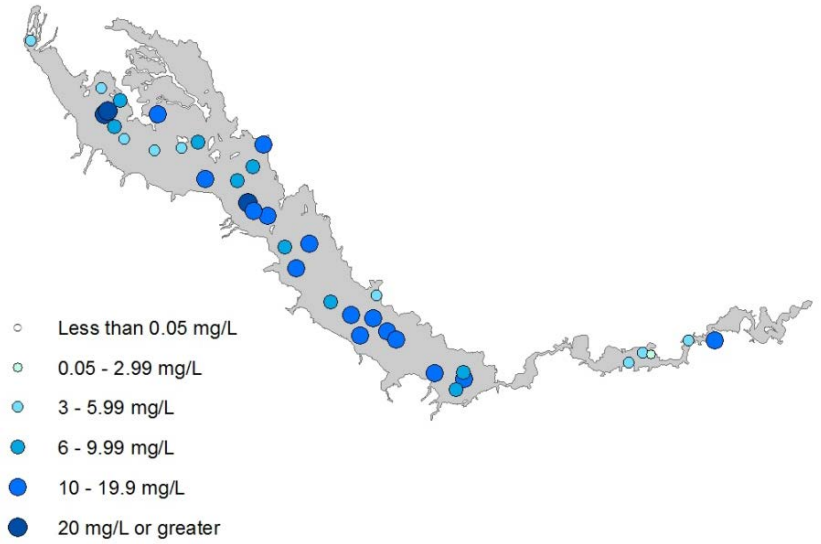
Quality Data



Fluoride concentrations in the panhandle portion of the Ogallala aquifer (sampled 2016)

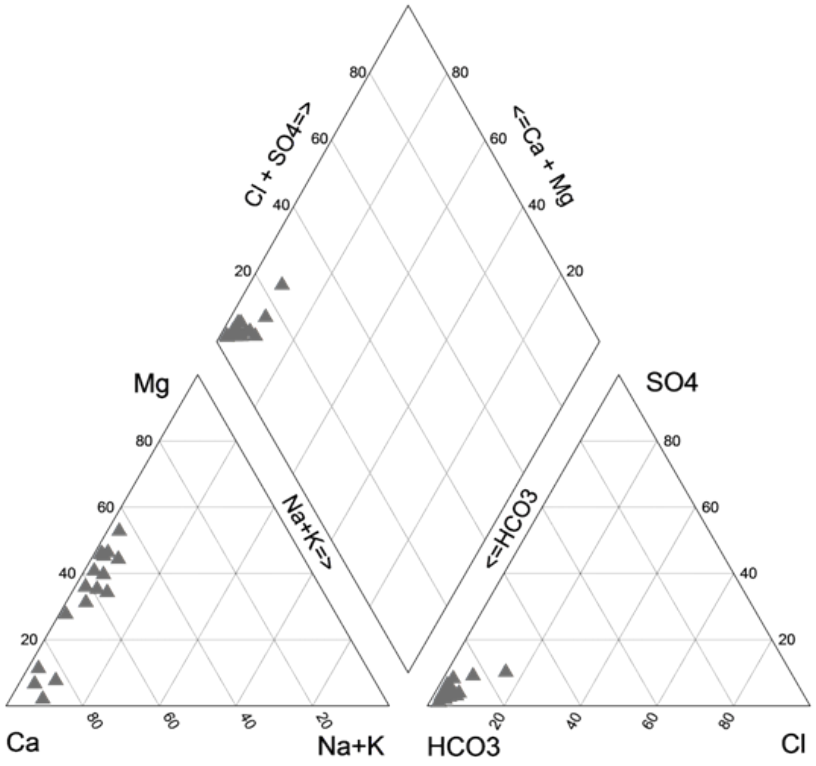
SMCL=2 mg/L, MCL=4 mg/L



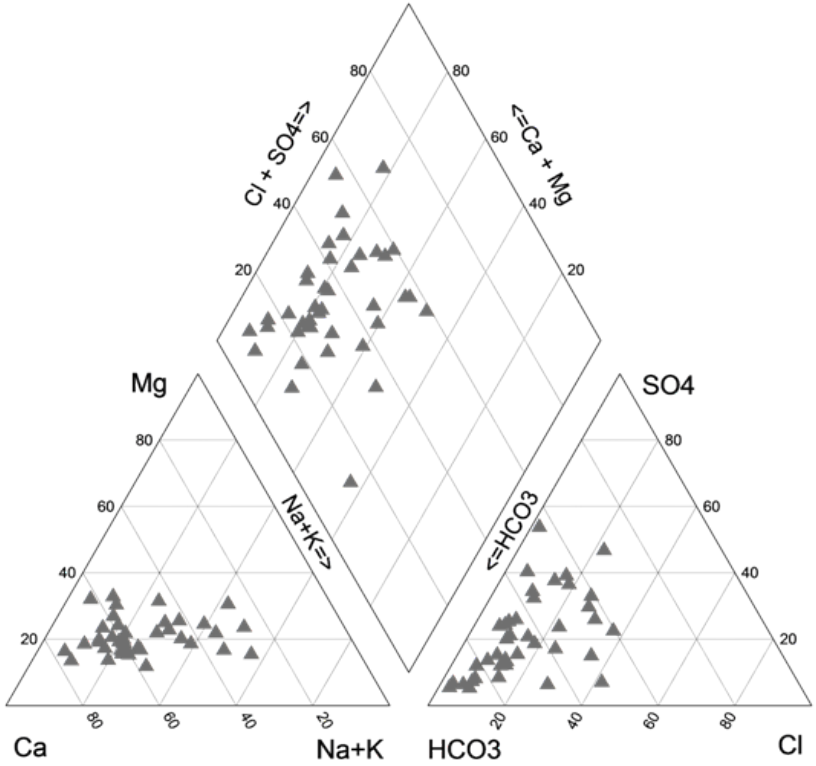
Nitrate + nitrite concentrations in the Cimarron alluvial & terrace aquifer (sampled 2016)

MCL=10 mg/L (as nitrate)

Quality Data



Piper plot of the Arbuckle-Simpson aquifer (sampled 2015)

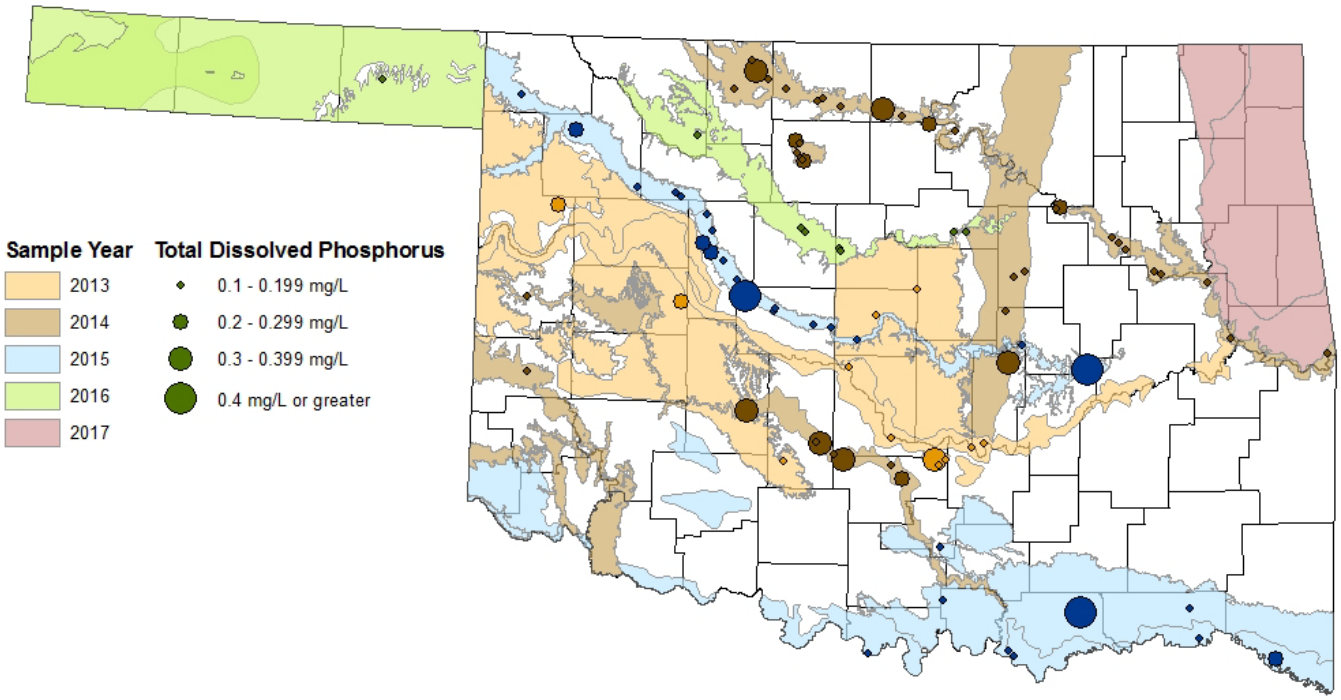


Piper plot of the North Canadian alluvial & terrace aquifer (sampled 2015)

Quality Data

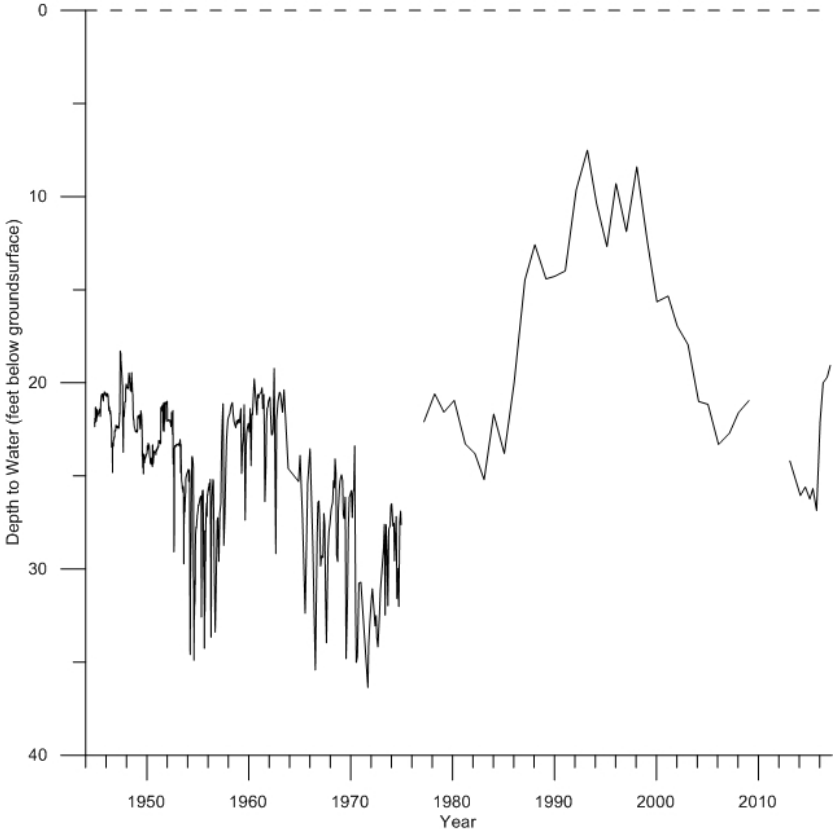
- Common water quality concerns:
  - Nitrate + nitrite: >MCL in 16/22 aquifers
  - Arsenic: >MCL in 6 aquifers
  - Uranium: >MCL in 4 aquifers
  - Other >MCL: fluoride, lead, selenium (1 aquifer ea.)
  - TDS, pH, chloride, sulfate, iron, manganese: >SMCL in 10 or more aquifers
  - 16 aquifers classified very hard or extremely hard (mean hardness >180 mg/L)

Quality Data

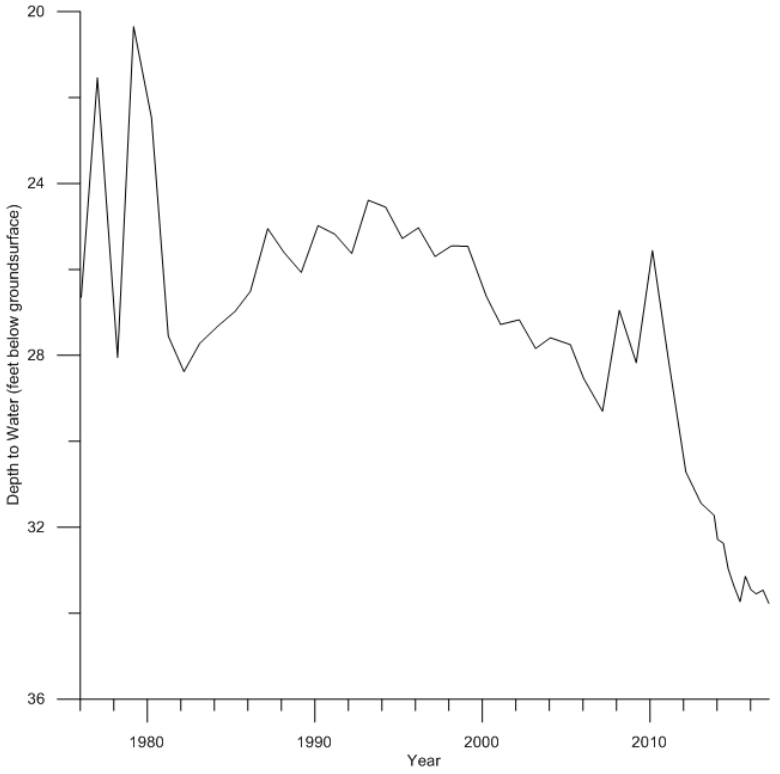


Occurrence of total dissolved phosphorus values 0.1 mg/L or greater

Quantity Data



Hydrograph of a long-term monitoring well drilled in Tillman Terrace aquifer, Tillman County



Hydrograph of a long-term monitoring well drilled in Garber-Wellington aquifer, Oklahoma County

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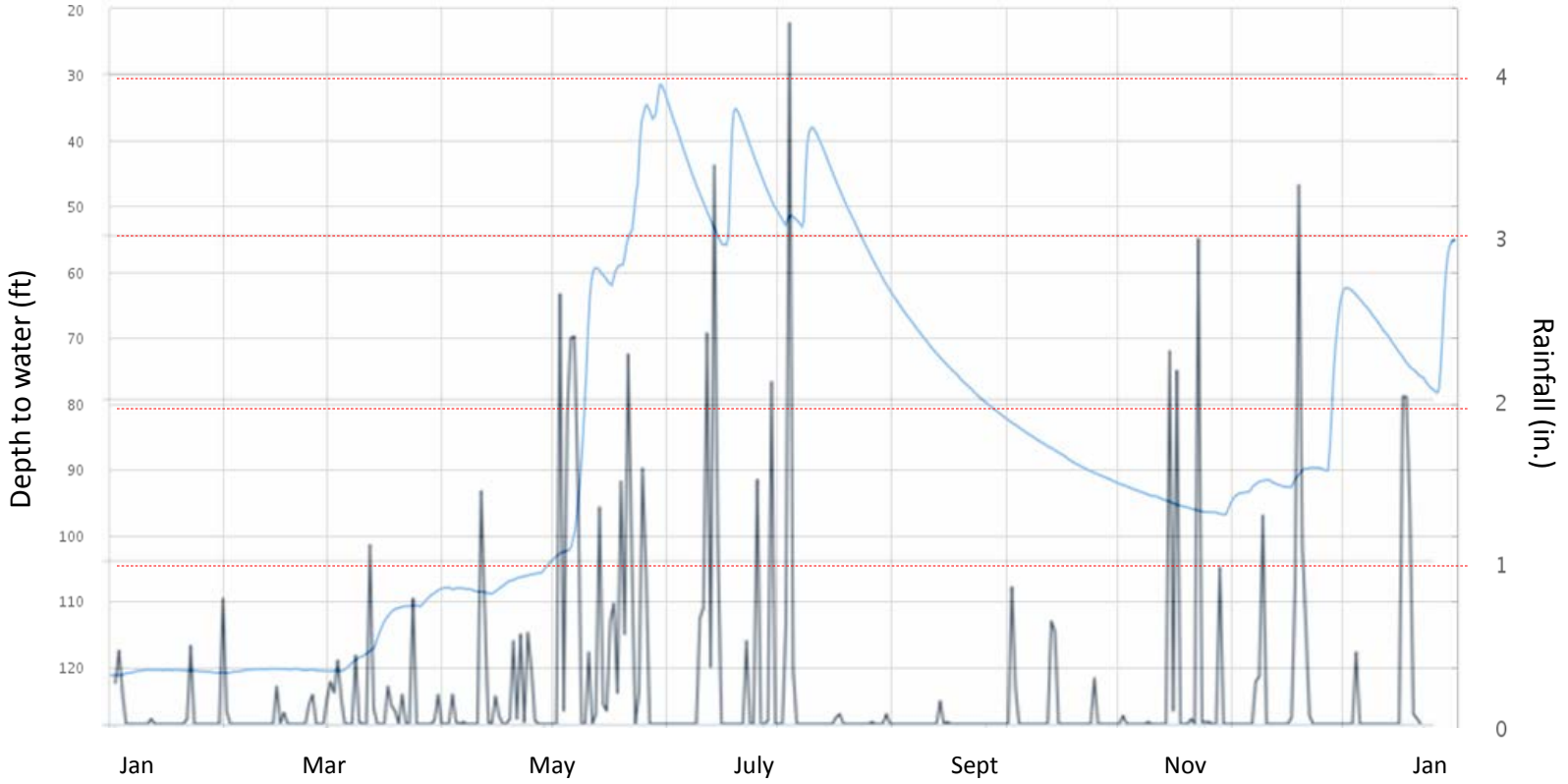
Quantity Data



2015 water levels at Fittstown Mesonet site, Pontotoc County

2015 precipitation at Fittstown Mesonet site, Pontotoc County

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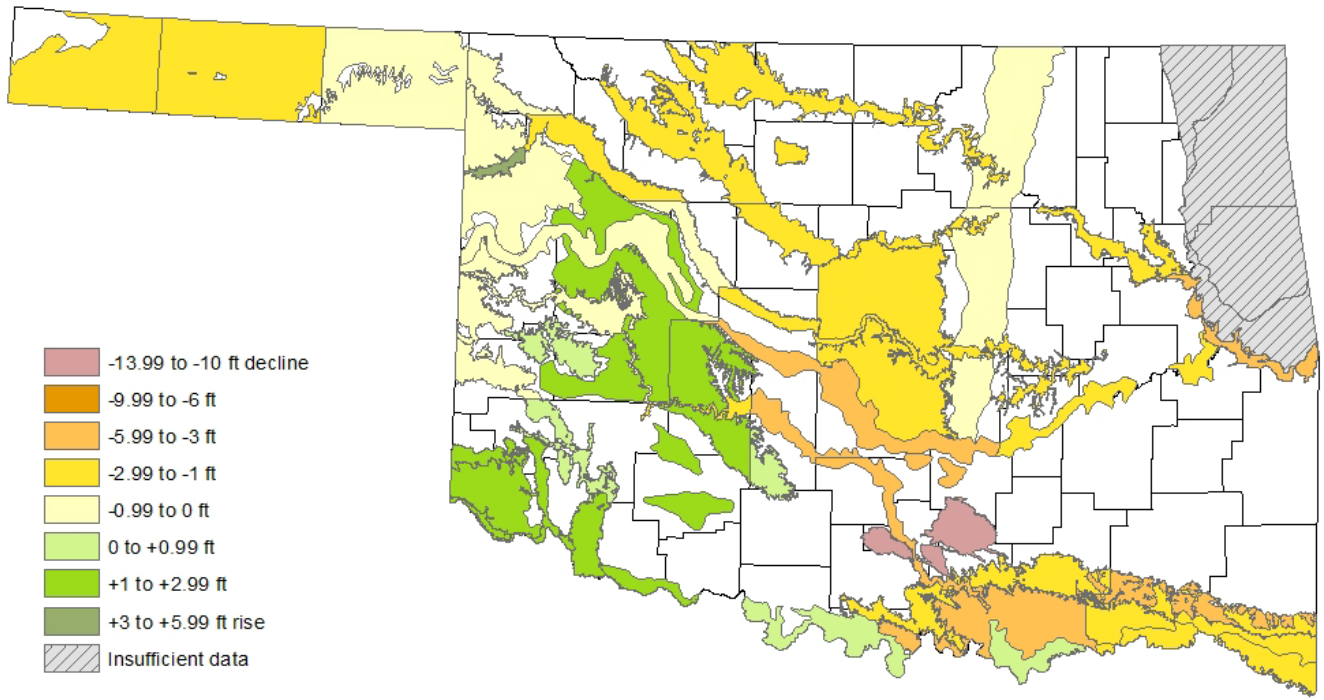
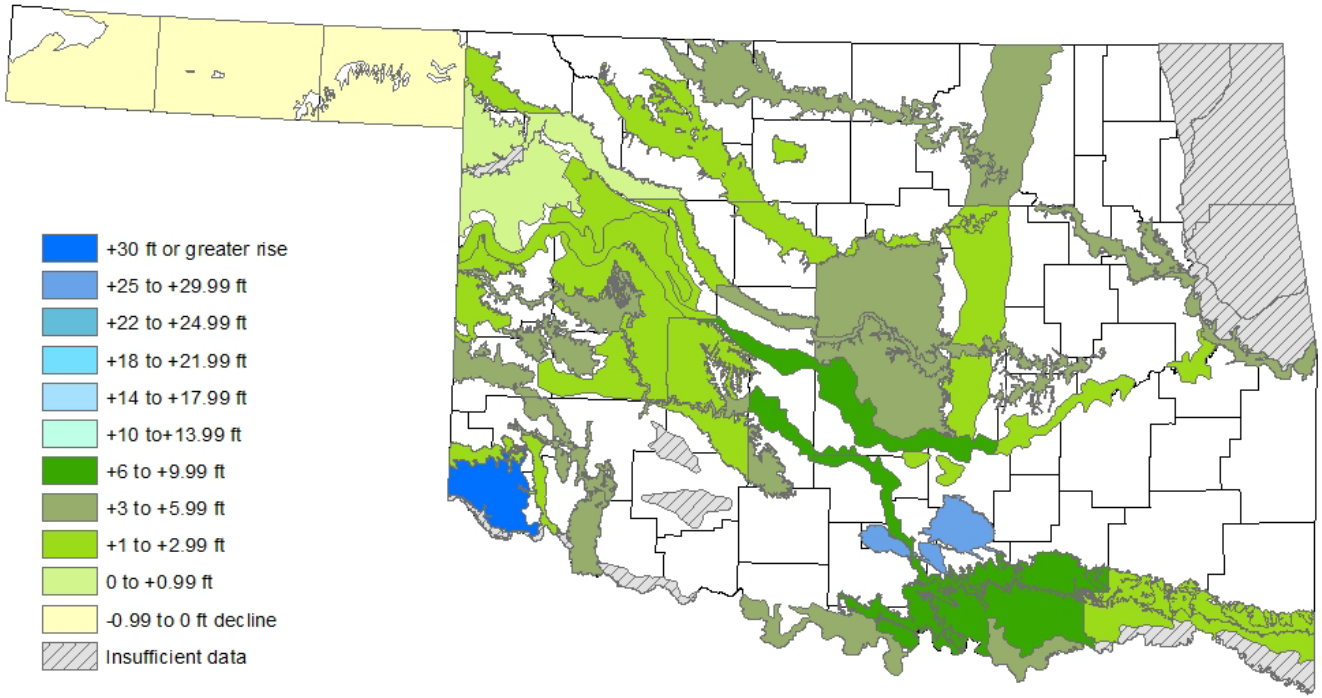
Quantity Data



Statewide one-year changes in water level by aquifer and climate region, 2016-2017

Quantity Data



Statewide one-year changes in water level by aquifer and climate region, 2015-2016

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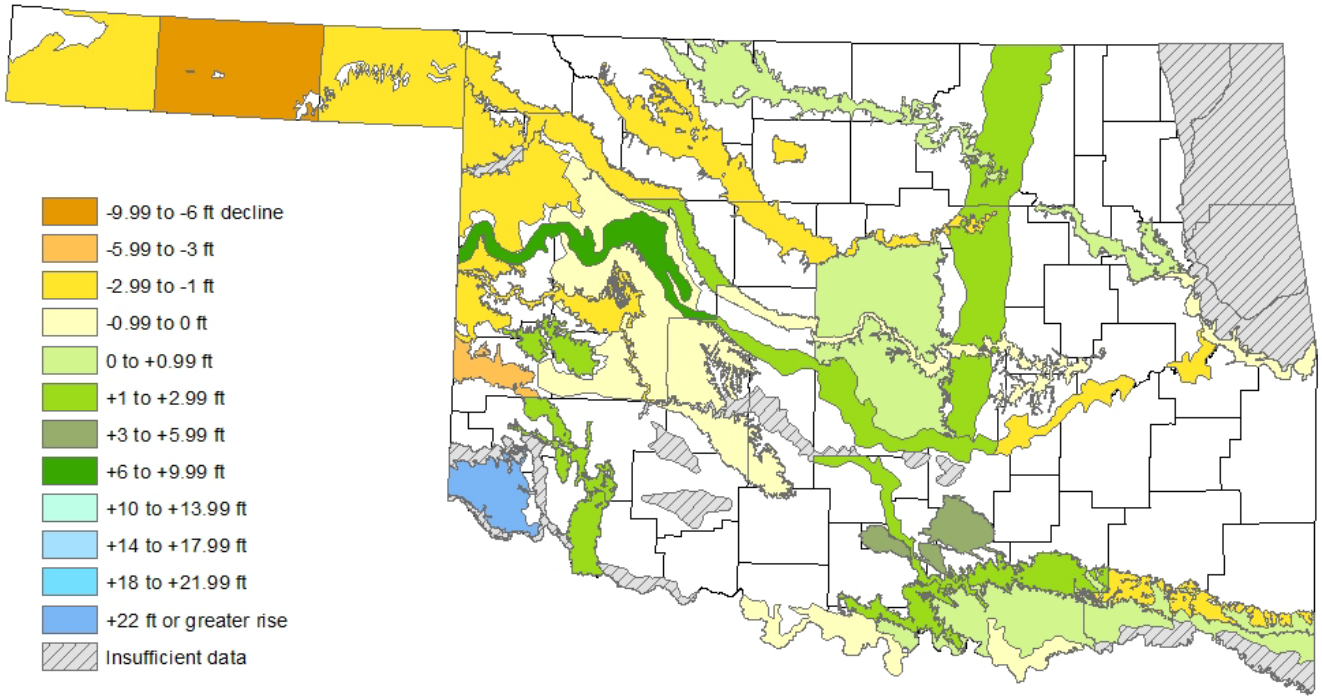

Statewide five-year changes in water level by aquifer and climate region, 2012-2017

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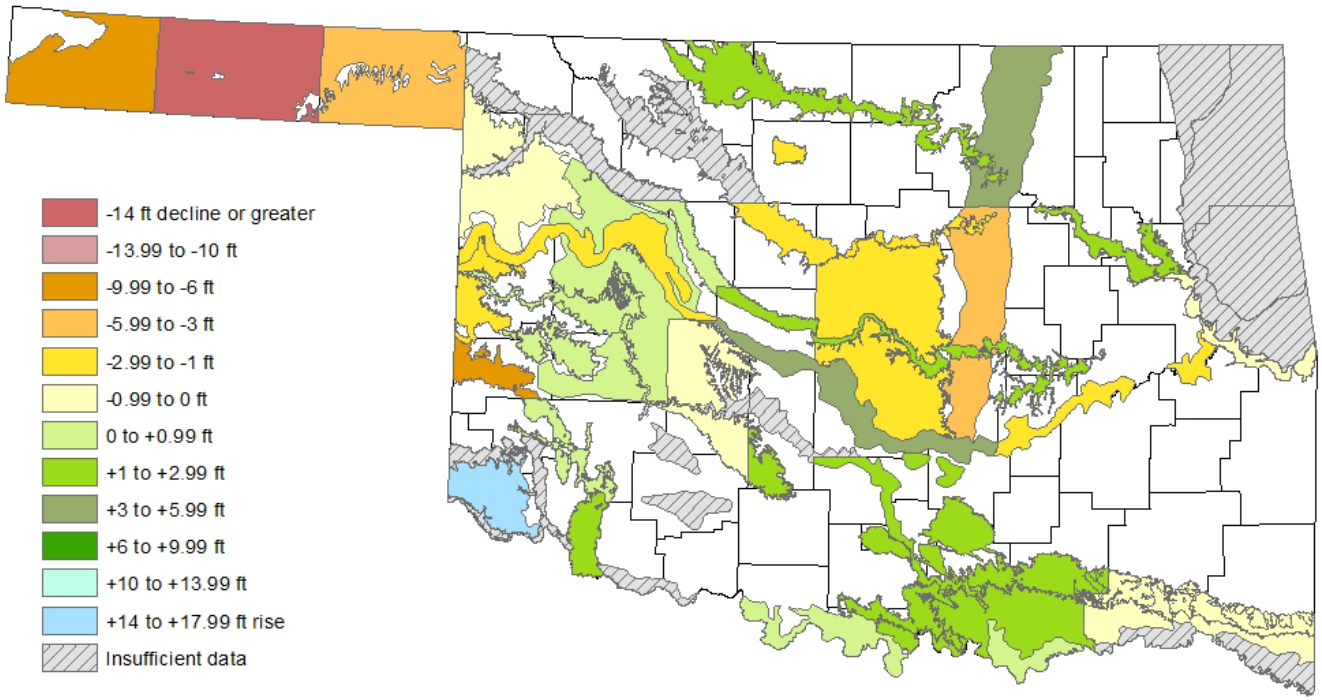
Quantity Data



Statewide ten-year changes in water level by aquifer and climate region, 2007-2017

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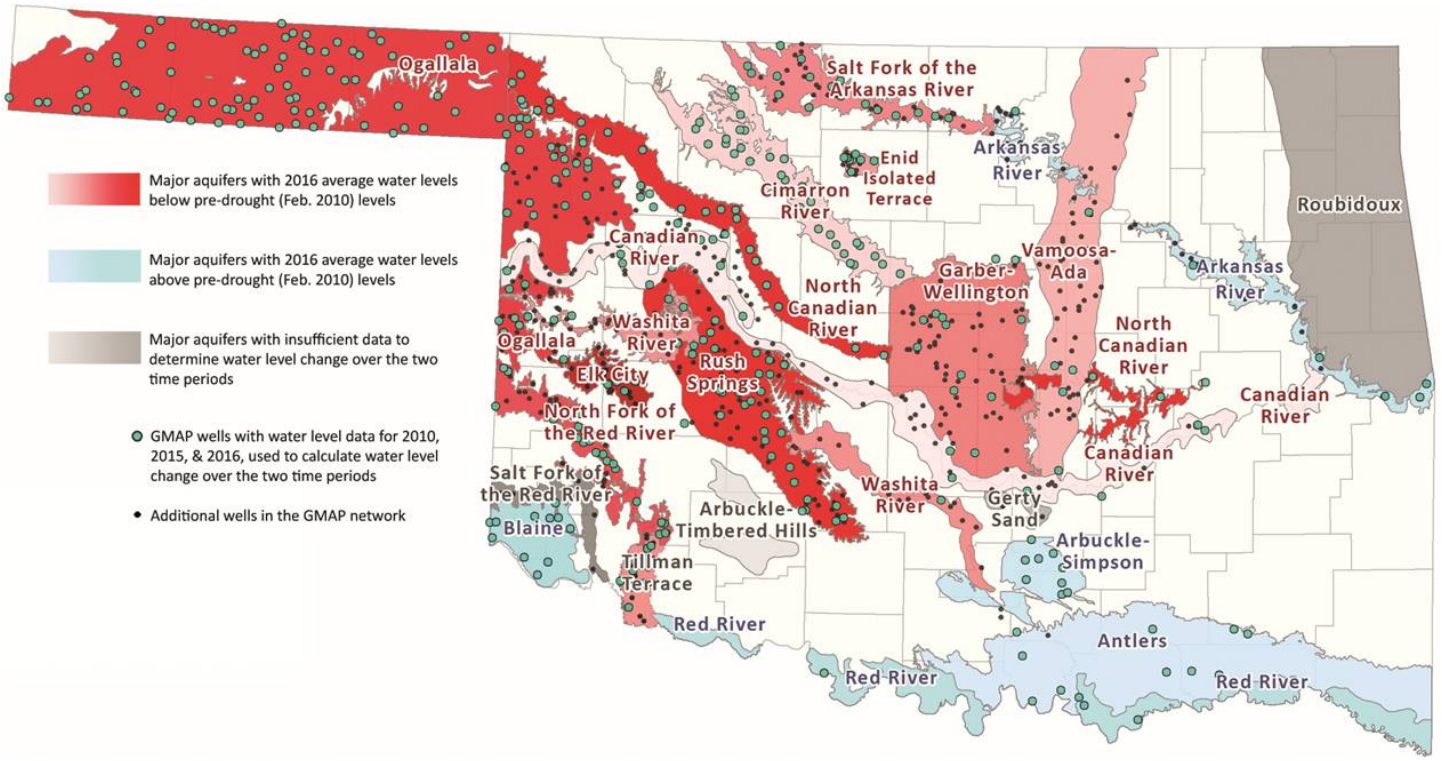
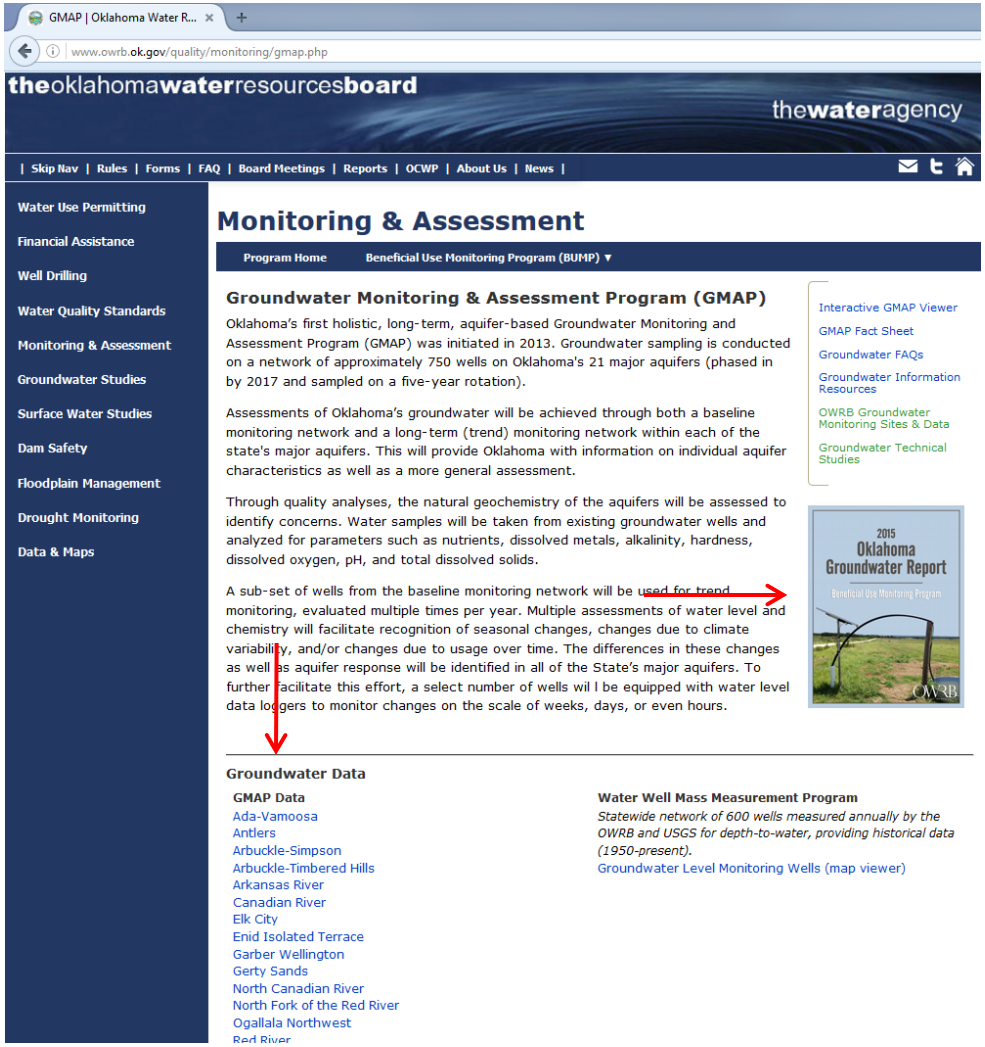
Quantity Data



Aquifer response to historic 2015 rainfalls compared to pre-drought (Feb. 2010 levels)

Where to Find Data



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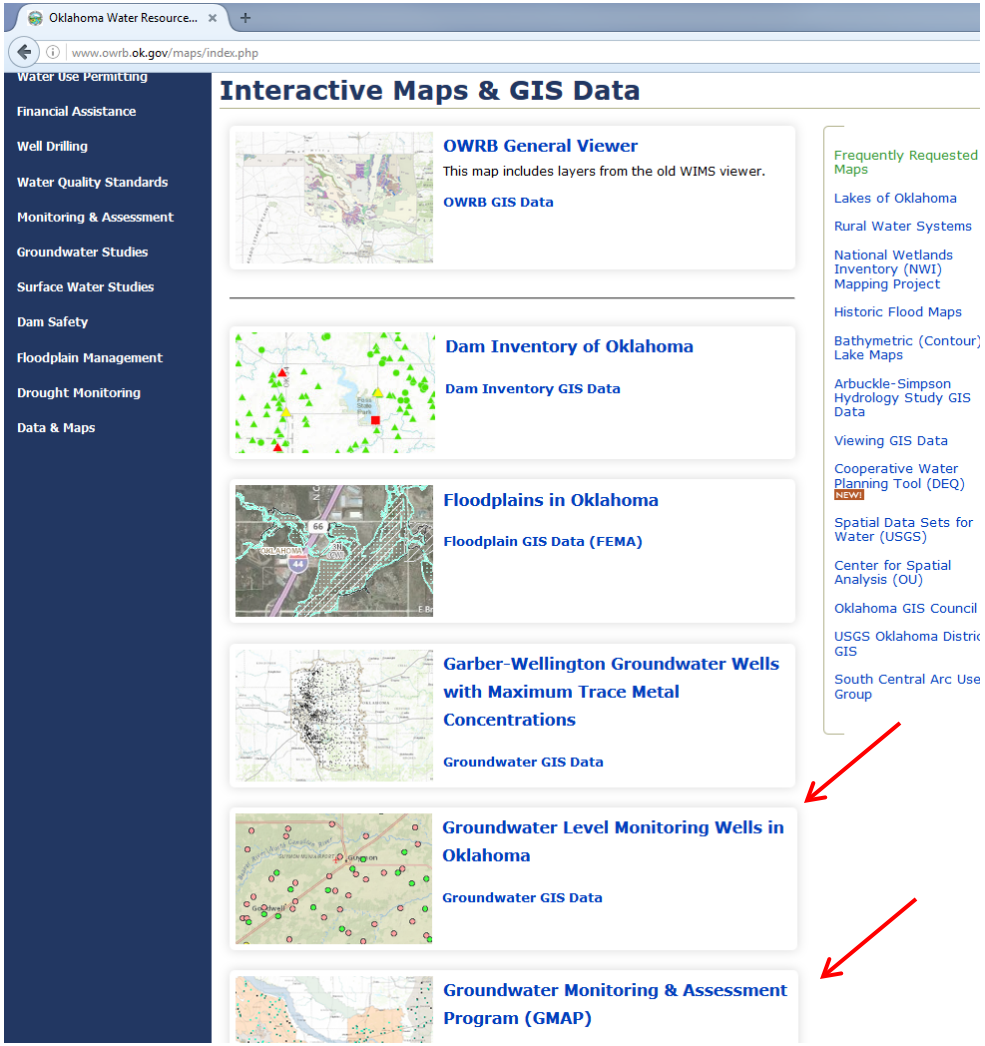
Where to Find Data



http://www.owrb.ok.gov/maps

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Where to Find Data

Groundwater	Date
Hydrogeological Framework, Numerical Simulation of Groundwater Flow, and Effects of Projected Water Use and Drought for the Beaver-North Canadian River Alluvial Aquifer, Northwestern Oklahoma	2015
Hydrogeology and Simulation of Groundwater Flow in the Garber-Wellington Aquifer	2013
Hydrogeology and Simulation of Groundwater Flow in the Arbuckle-Simpson Aquifer	2011
Arbuckle-Simpson Hydrology Study Final Report to the US Bureau of Reclamation	2009
Hydroclimatic Reconstruction of the Arbuckle–Simpson Aquifer using Tree Rings	2009
Arbuckle-Simpson (FFY 2007) Hydrology Study Annual Report	2008
Arbuckle-Simpson (FFY 2006) Hydrology Study Annual Report	2007
Arbuckle-Simpson (FFY 2005) Hydrology Study Annual Report	2006
Hydrogeologic Investigation of the Ogallala Aquifer in Roger Mills & Beckham Counties, Western Oklahoma	2002
Update of the Hydrologic Survey of the Tillman Terrace Groundwater Basin, Southwest Oklahoma	2002
Impact of Concentrated Animal Feeding Operations on Oklahoma City's Water Supplies	2002
Hydrogeologic Investigation Report of the Boone Groundwater Basin, Northeast Oklahoma	2001
Hydrogeologic Investigation Report of the Kiamichi, Potato Hills, Broken Bow, Pine Mountain, and Holly Creek Minor Groundwater Basins in Southeast Oklahoma	2001
Groundwater Levels in Observation Wells in Oklahoma, 1998-2000	2001
Hydrologic Report of the El Reno, Fairview, Isabella and Loyal Minor Groundwater Basins in Central Oklahoma	2000
Rapid Recharge of Parts of the High Plains Aquifer Indicated by a Reconnaissance Study in Oklahoma (OWRB/USGS)	2000
Water Flow in the High Plains Aquifer in Northwestern Oklahoma (OWRB/USGS)	2000
Groundwater Level Changes in Oklahoma, 1978-1998	1999
Hydrologic Report of the Woodbine, Marietia, and Texoma Minor Bedrock Groundwater Basins and the Haworth Terrace and Utile River Alluvial and Terrace Minor Groundwater Basins	1998
Statewide Groundwater Vulnerability Map of Oklahoma	1999
Vulnerability Assessment of Twelve Major Aquifers in Oklahoma	1998
Hydrologic Report of the Southwest Oklahoma Groundwater Basin in Caddo, Kiowa and Jackson Counties	1998

http://www.owrb.ok.gov/reports

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Groundwater Quality Contacts

- Data Requests
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- Mark Belden, GMAP Manager
  - mark.belden@owrb.ok.gov
- Chris Adams, WQ Data Manager
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Thank you

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