

Statewide Characterization of Oklahoma's Major Aquifers

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Oklahoma Clean Lakes & Watersheds Conference

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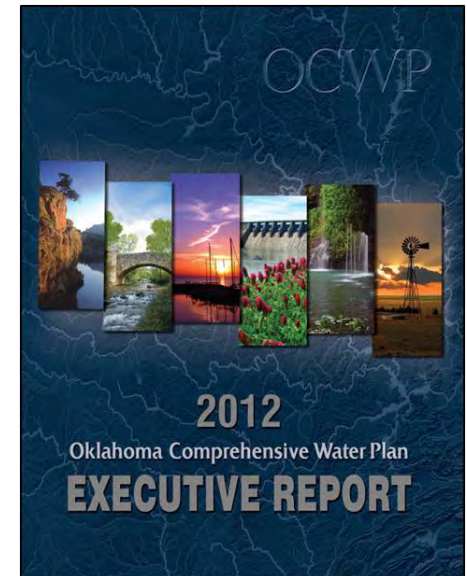


Groundwater Monitoring Background

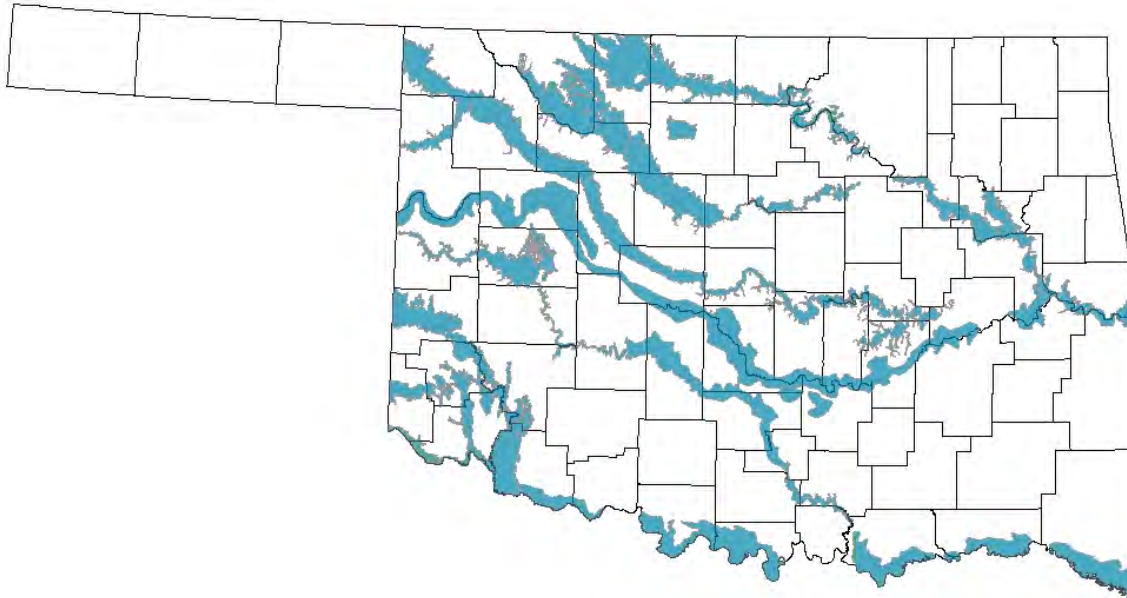
- Majority of Groundwater Monitoring: Compliance
- Water level monitoring since 1950s
- Ambient water quality monitoring piecemeal, largely unfunded
- No holistic, long-term, aquifer-based, statewide groundwater quality/quantity monitoring program prior to 2012

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

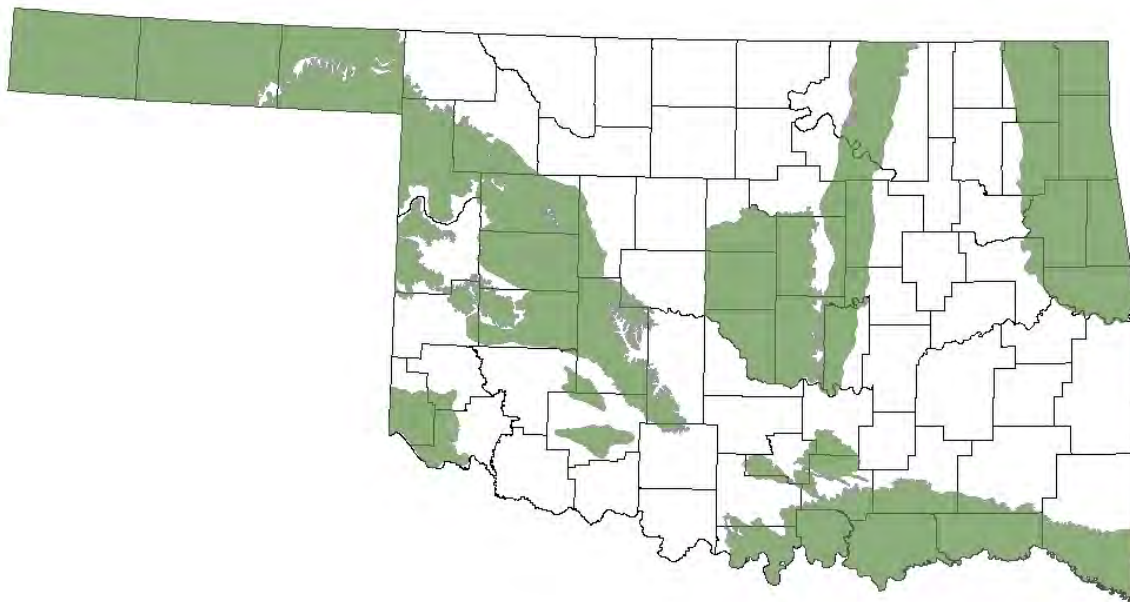


Oklahoma's Aquifers: Alluvium & Terrace



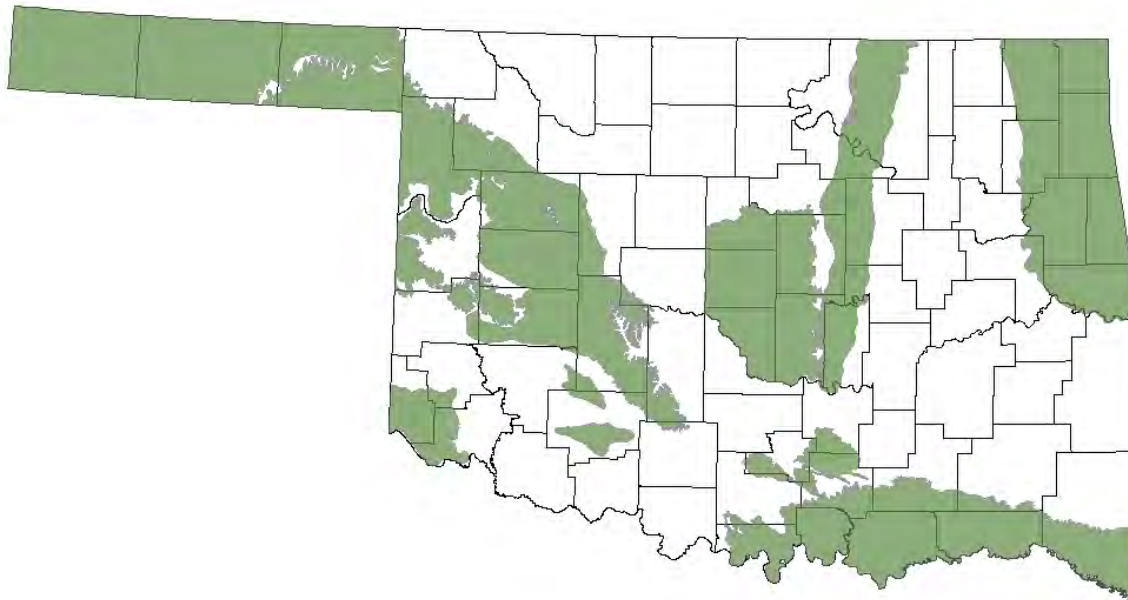
- › Shallow, unconsolidated sand & gravel aquifers
- › Generally in communication with a river or stream, but not always (e.g., Enid Isolated Terrace)
- › Highly vulnerable to surface contamination

Oklahoma's Aquifers: Bedrock



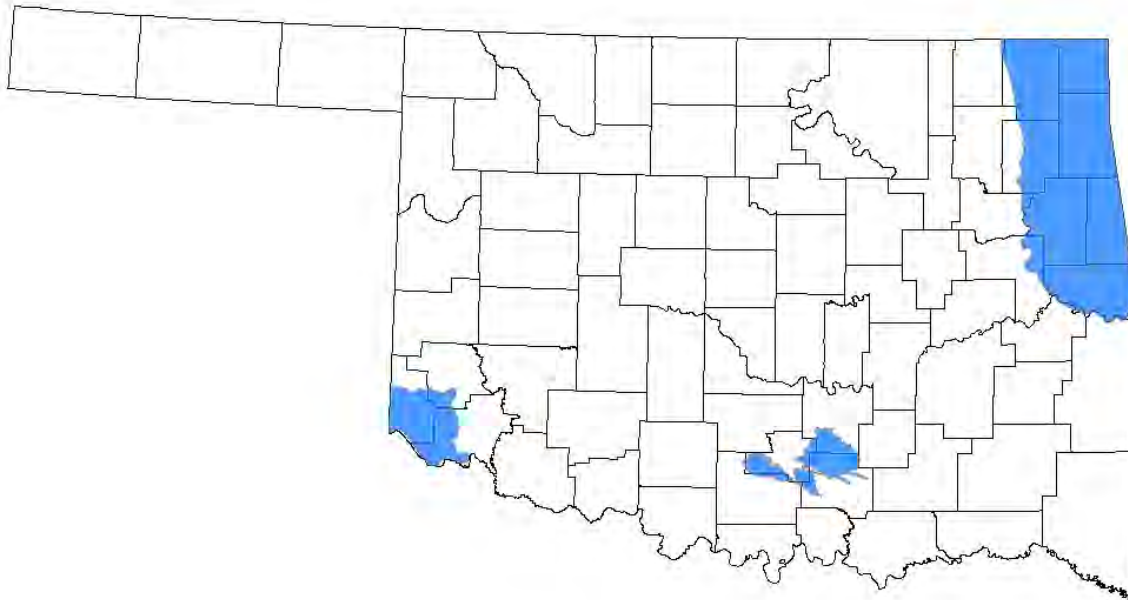
- › Made of water-bearing rock formations underlying surface
- › Semiconsolidated or consolidated
- › Unconfined, confined, or both
- › Characteristics vary widely based on hydrogeology

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

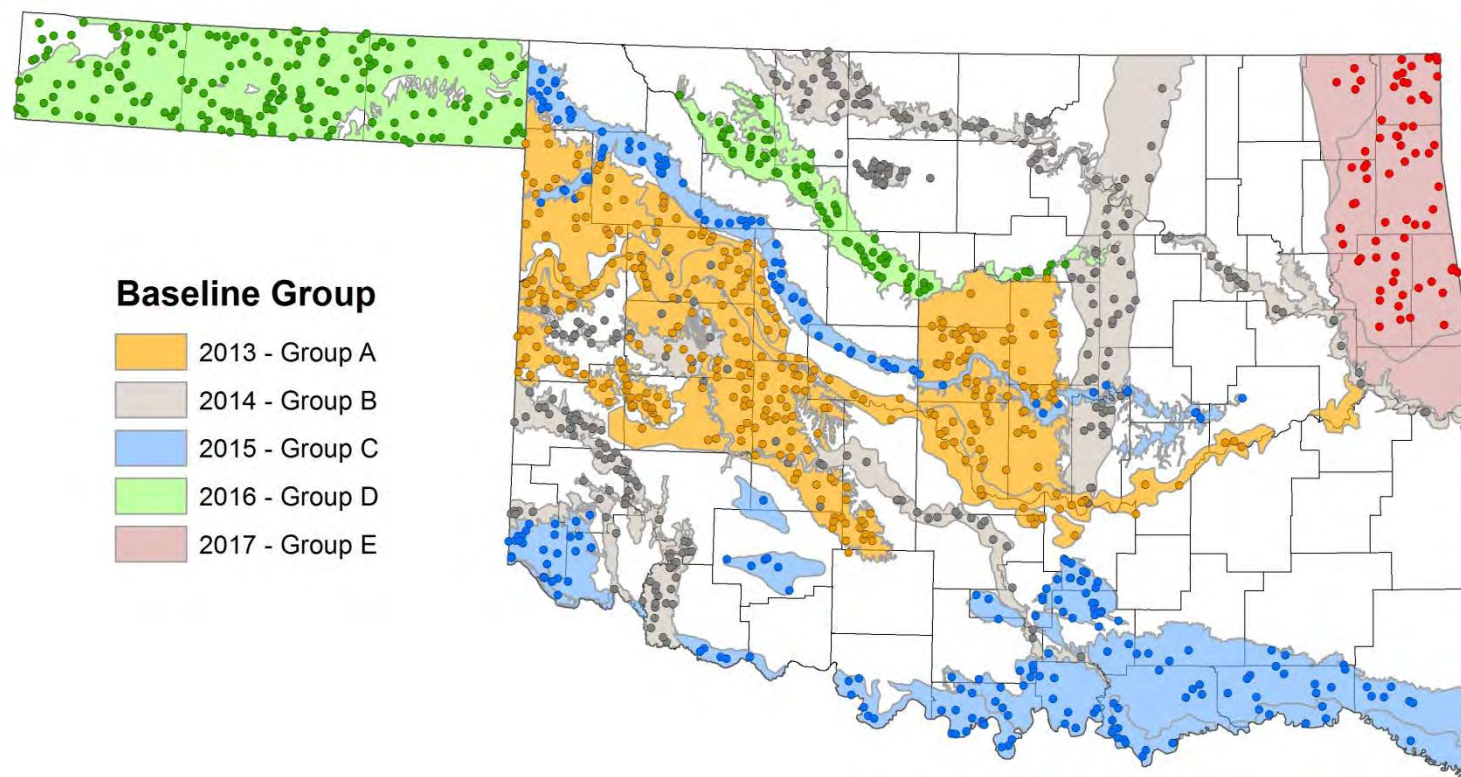
› Karst areas home to caves, springs, can hold large quantities of water

› Responsive to weather, vulnerable to surface contamination

Laboratory and Field Parameters

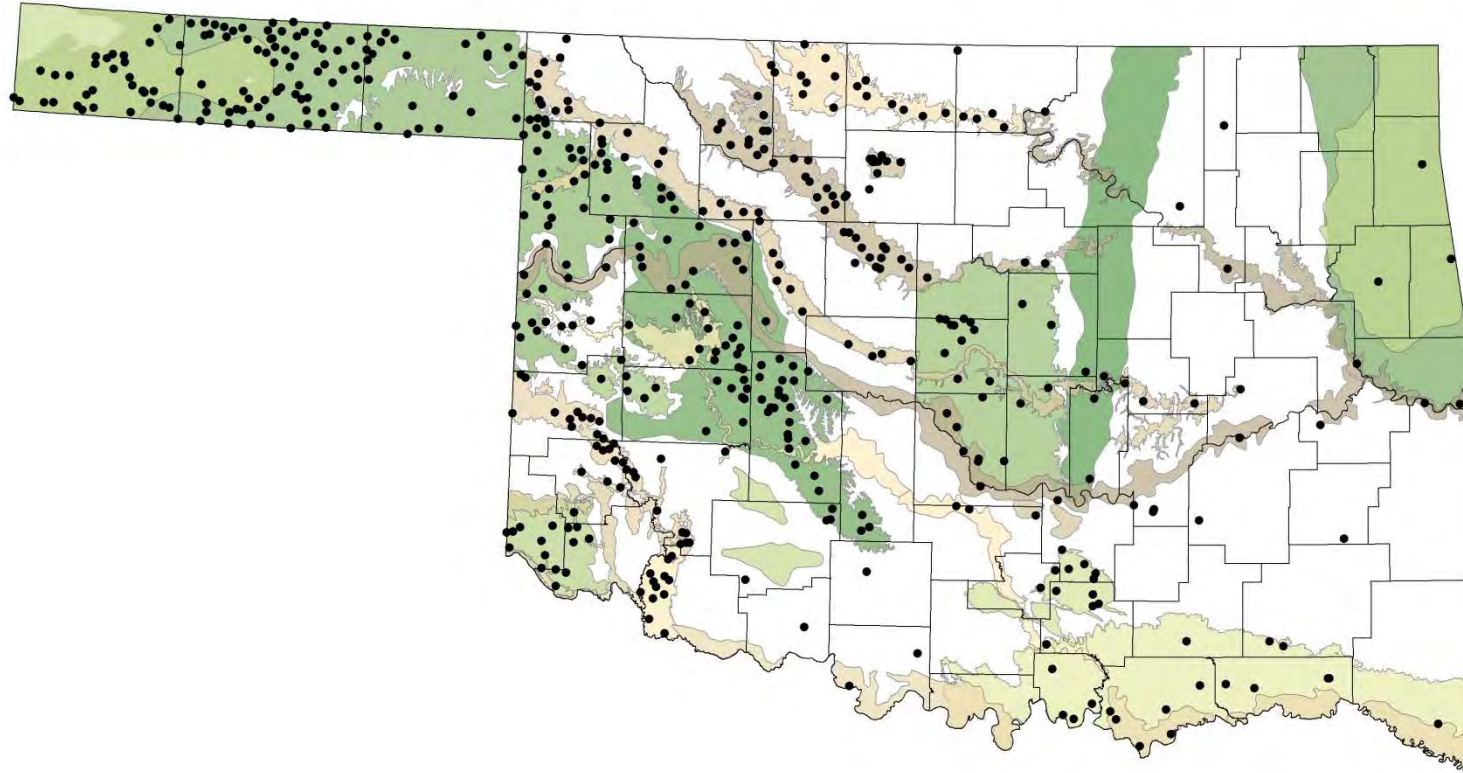
General Chemistry						
Dissolved Oxygen (mg/L)		Well Depth (ft)	Depth to Water (ft)		Total Diss. Solids (mg/L)	
Specific Conductance (µS/cm)		pH	Hardness (mg/L)		Alkalinity (mg CaCO3/L)	
Major Ions (mg/L)						
Calcium	Magnesium	Potassium	Sodium	Silica	Bromide	
Chloride	Fluoride	Sulfate	Calculated Bicarbonate (mg/L)			
Nutrients (mg/L)						
Nitrate + Nitrite		Total Dissolved Phosphorus			Ammonia	
Isotopes (‰)						
Deuterium		Oxygen-18			Radium-226/228	
Metals & Trace Elements, Dissolved (µg/L or mg/L)						
Aluminum	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium
Chromium	Chromium-VI	Cobalt	Copper	Iron	Lead	Lithium
Manganese	Mercury	Molybdenum	Nickel	Selenium	Silver	Strontium
Titanium	Thallium	Thorium	Uranium	Vanadium	Zinc	

Baseline Sampling Schedule



Baseline sampling complete as of Nov. 2017, however, select baseline wells are to be implemented fall 2018 to fill data gaps.

Quantity Program Expansion



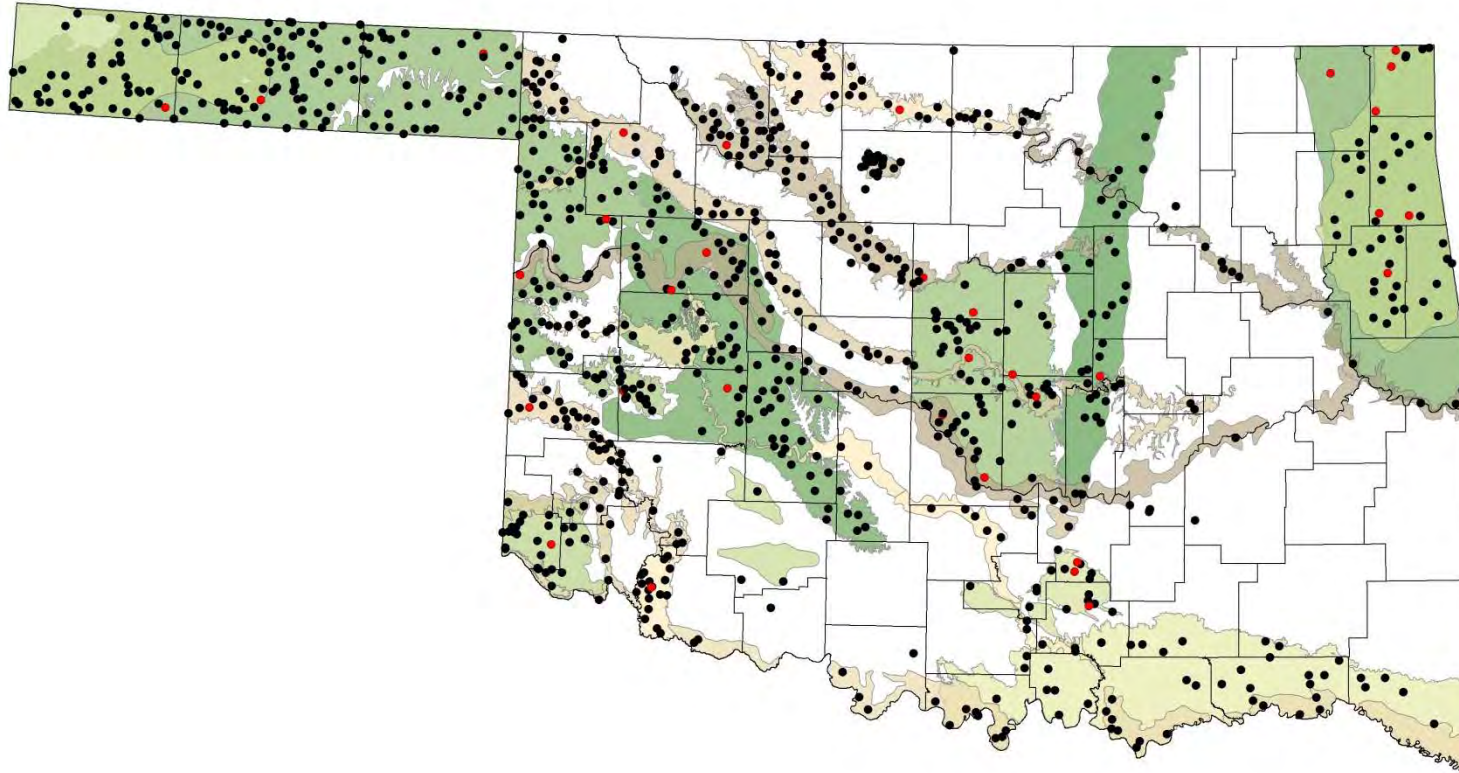
Water level network
in 2013

Number of wells
nearly doubled in
capacity from
historical network
(504 to 903 wells)

Spatially
representative
distribution of wells

41 wells equip with
continuous data
recorders. (red)

Quantity Program Expansion



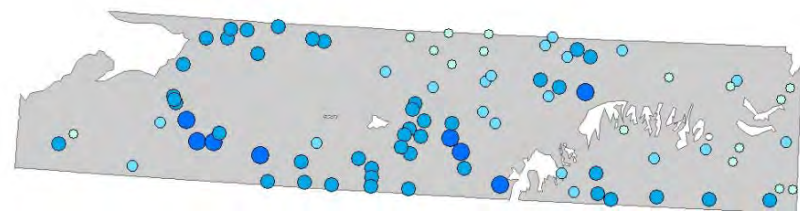
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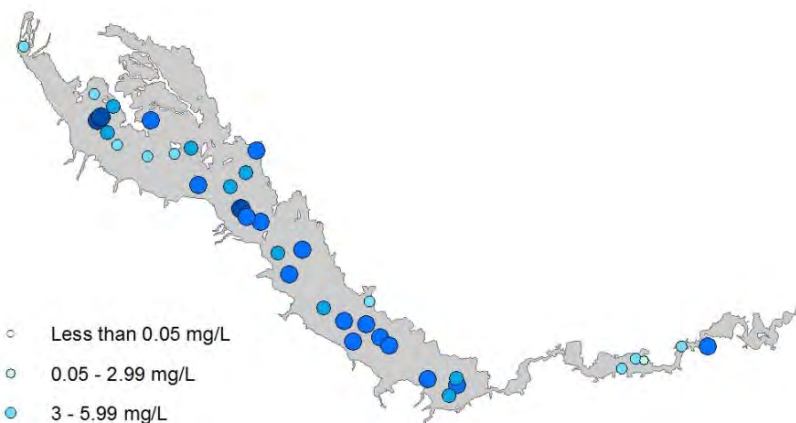
Quality Data



- Less than 0.2 mg/L
- 0.2 - 0.49 mg/L
- 0.5 - 0.99 mg/L
- 1 - 1.99 mg/L
- 2 - 3.99 mg/L

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

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

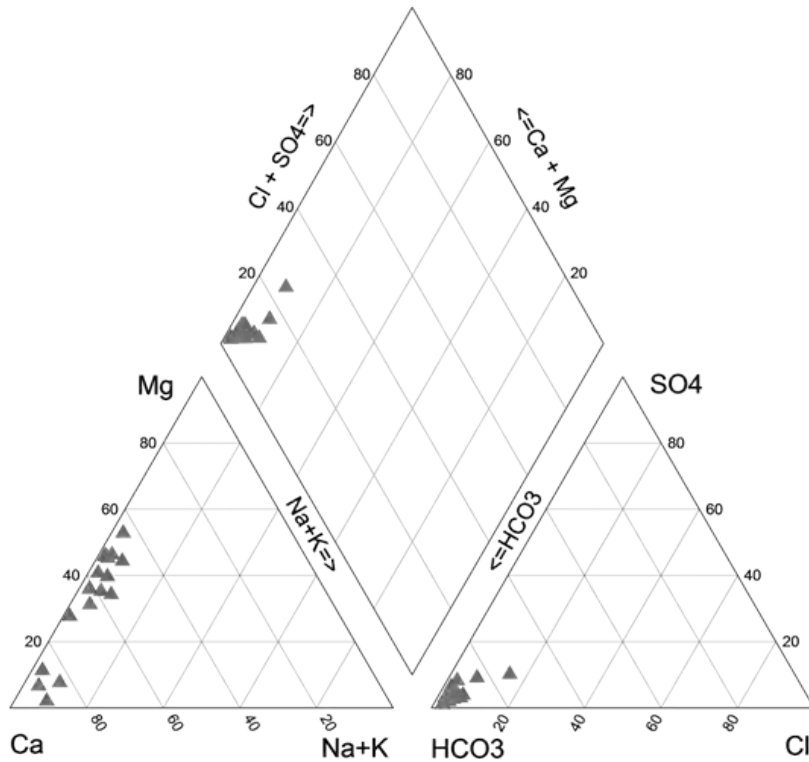


- Less than 0.05 mg/L
- 0.05 - 2.99 mg/L
- 3 - 5.99 mg/L
- 6 - 9.99 mg/L
- 10 - 19.9 mg/L
- 20 mg/L or greater

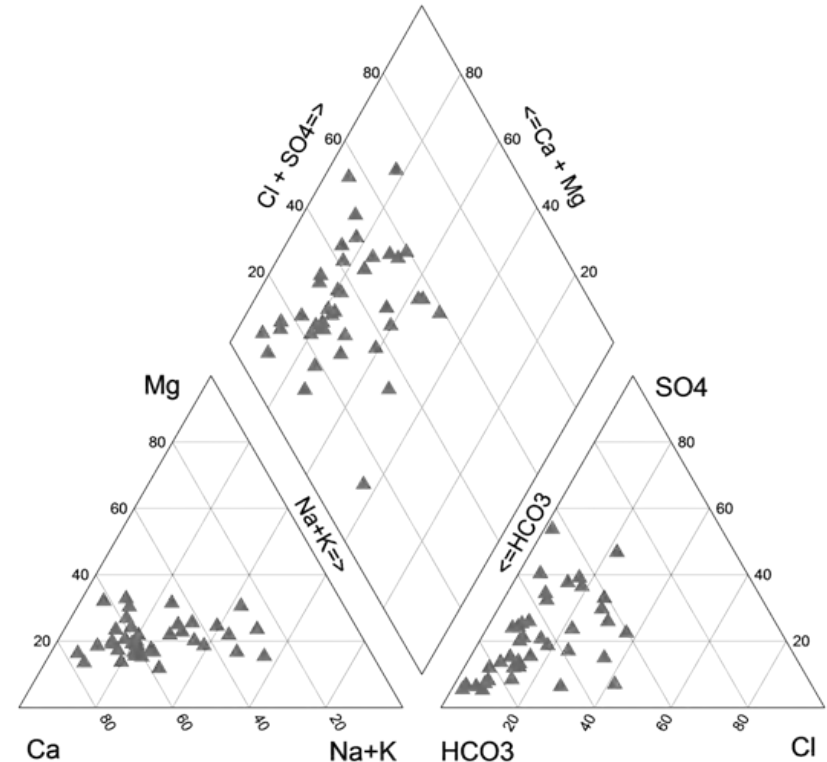
Nitrate + nitrite concentrations in the Cimarron alluvial & terrace aquifer (sampled 2016)

MCL=10 mg/L (as nitrate)

Quality Data



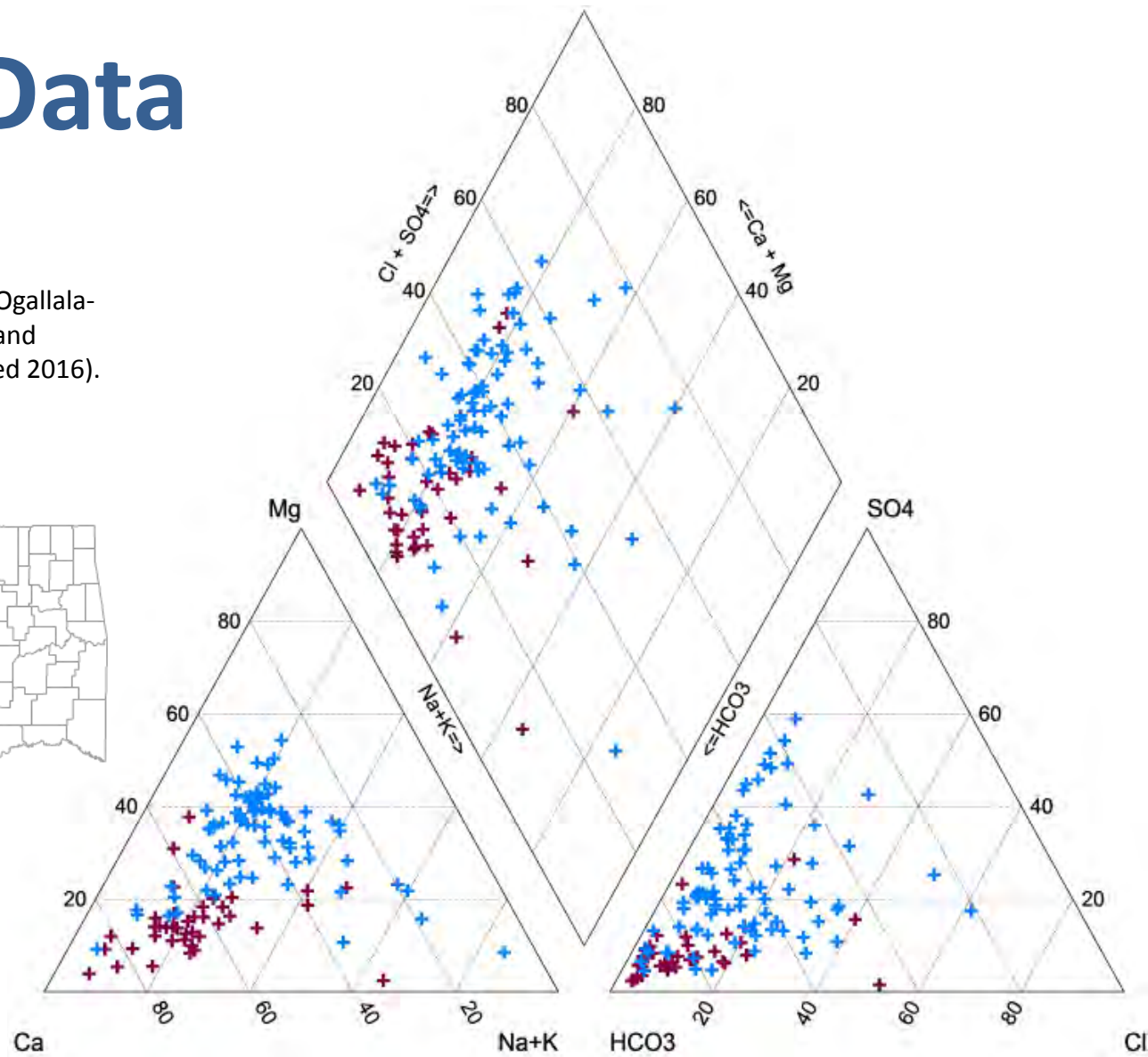
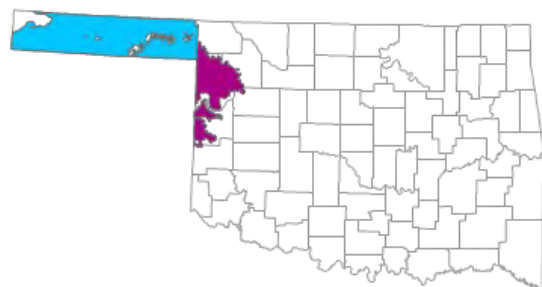
Piper plot of the Arbuckle-Simpson aquifer (sampled 2015)



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

Quality Data

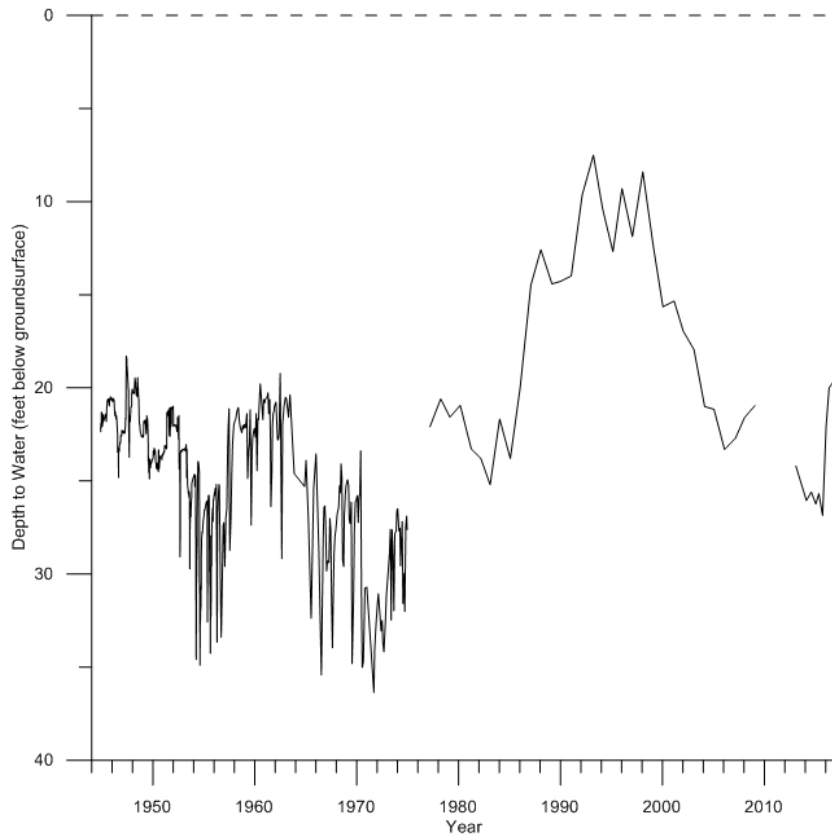
Piper plot of constituents of the Ogallala-Northwest (Red, sampled 2013) and Ogallala-Panhandle (Blue, sampled 2016).



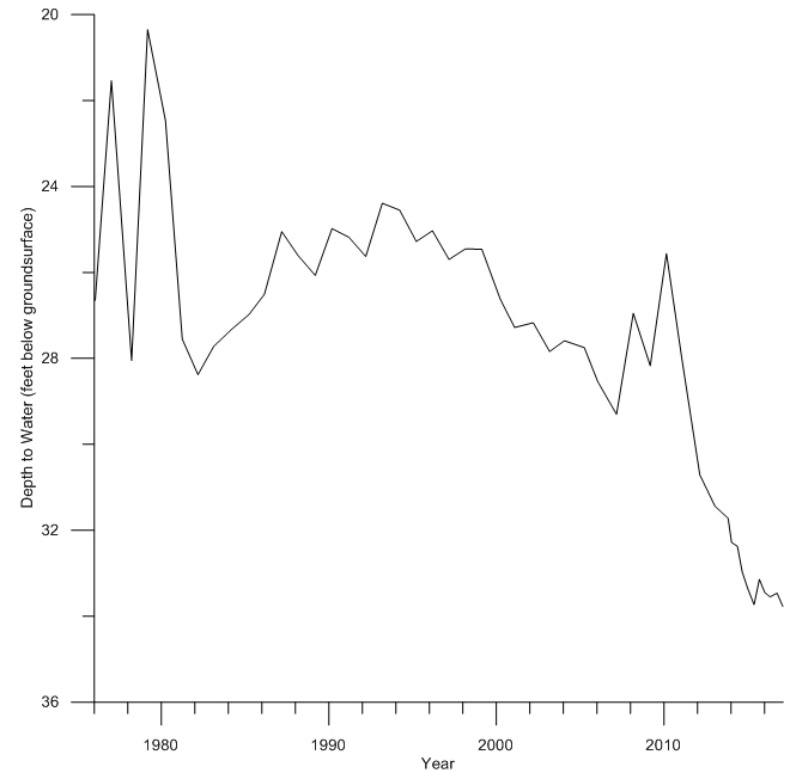
Quality Data

- Common water quality concerns:
 - Nitrate + nitrite: >MCL in 16/24 aquifers
 - Arsenic: >MCL in 6 aquifers
 - Uranium: >MCL in 5 aquifers
 - Fluoride: >MCL in 2 aquifers
 - Other >MCL: lead, radium (combined 226+228) selenium (1 aquifer ea.)
 - TDS, pH, chloride, sulfate, iron, manganese: >SMCL in 13 or more aquifers
 - 21 aquifers classified very hard or extremely hard (mean hardness >180 mg/L)

Quantity Data

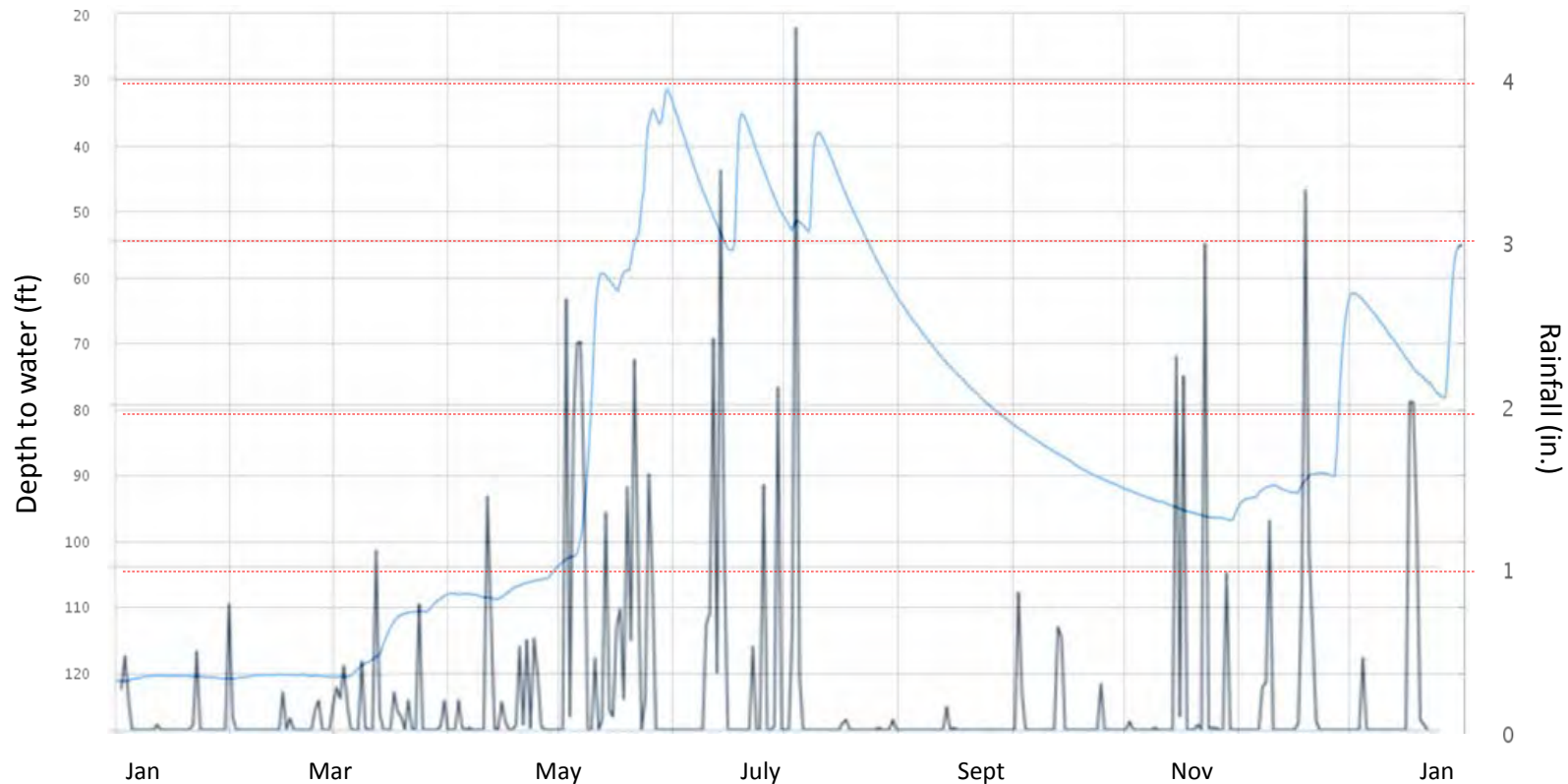


Hydrograph of a long-term monitoring well drilled in Tillman Terrace aquifer, Tillman County



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

Quantity Data

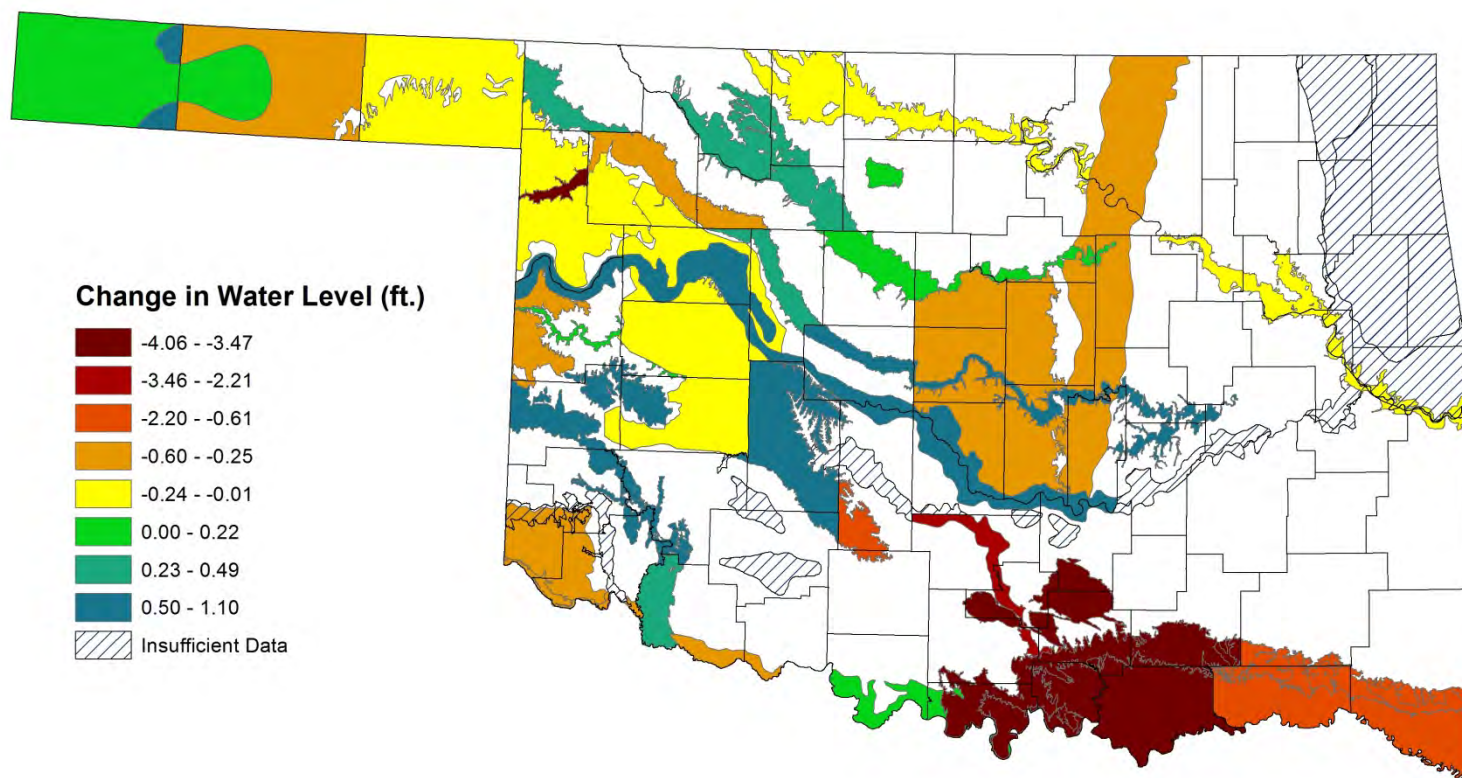


2015 water levels at Fittstown Mesonet site, Pontotoc County

2015 precipitation at Fittstown Mesonet site, Pontotoc County

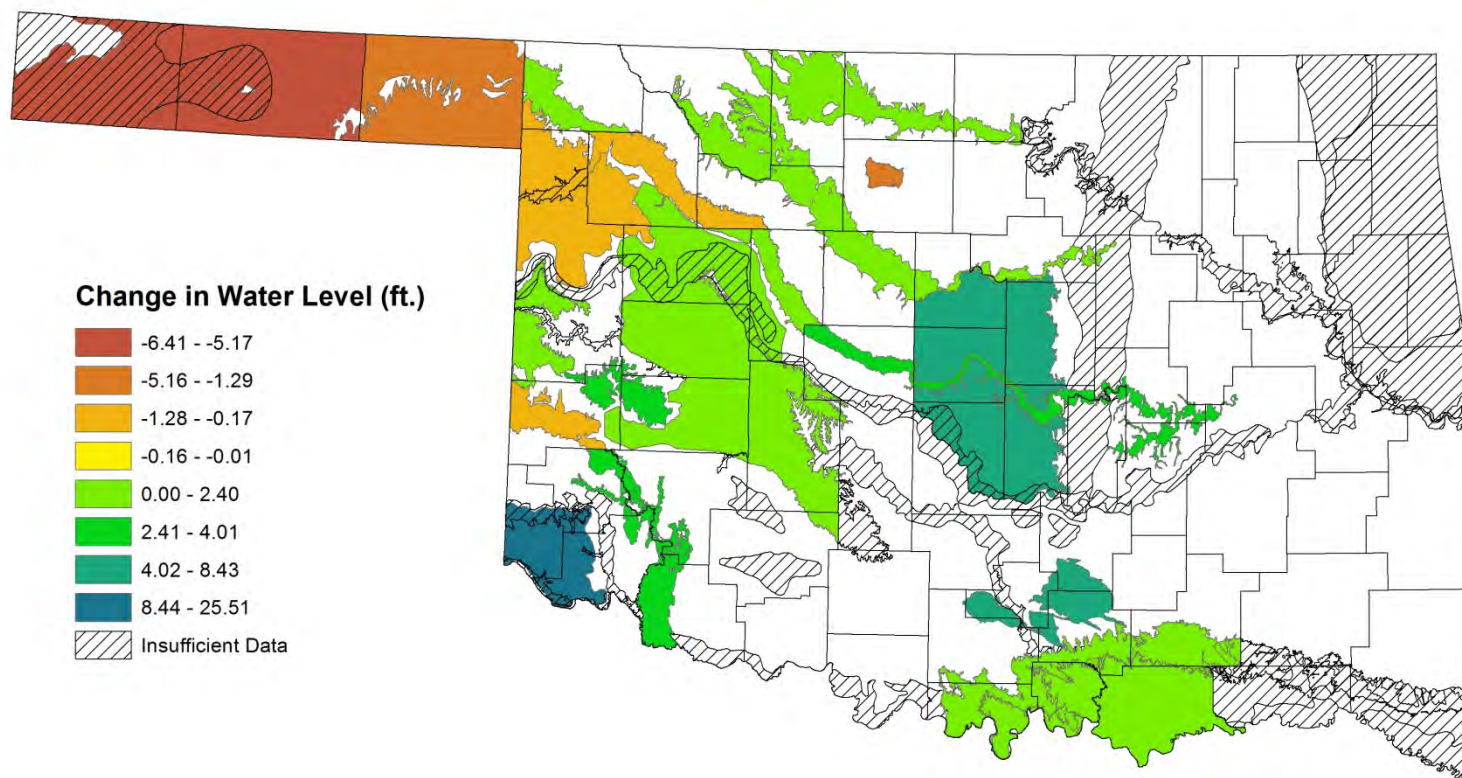
Quantity Data

Statewide one-year changes in water level by aquifer and climate region, 2017-2018



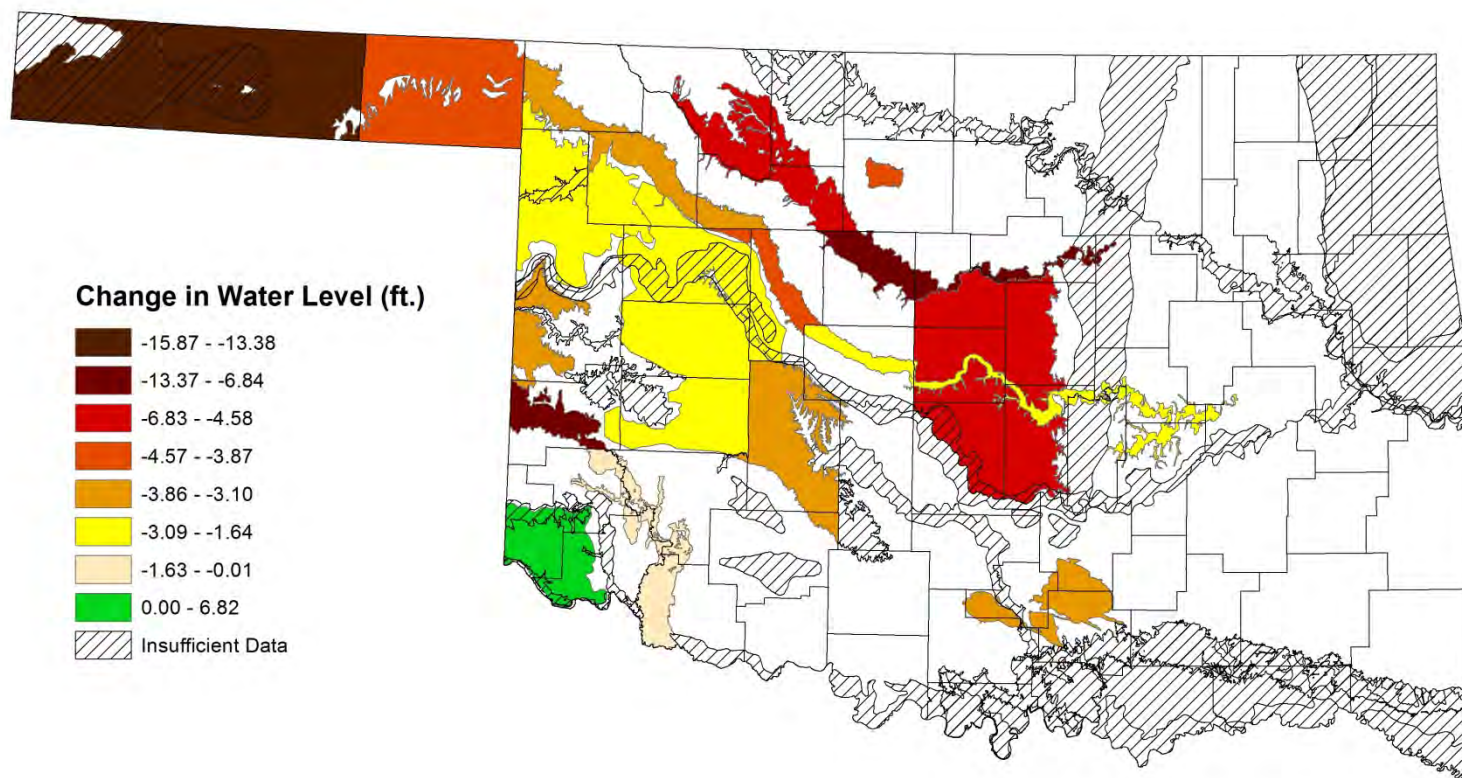
Quantity Data

Statewide one-year changes in water level by aquifer and climate region, 2013-2018



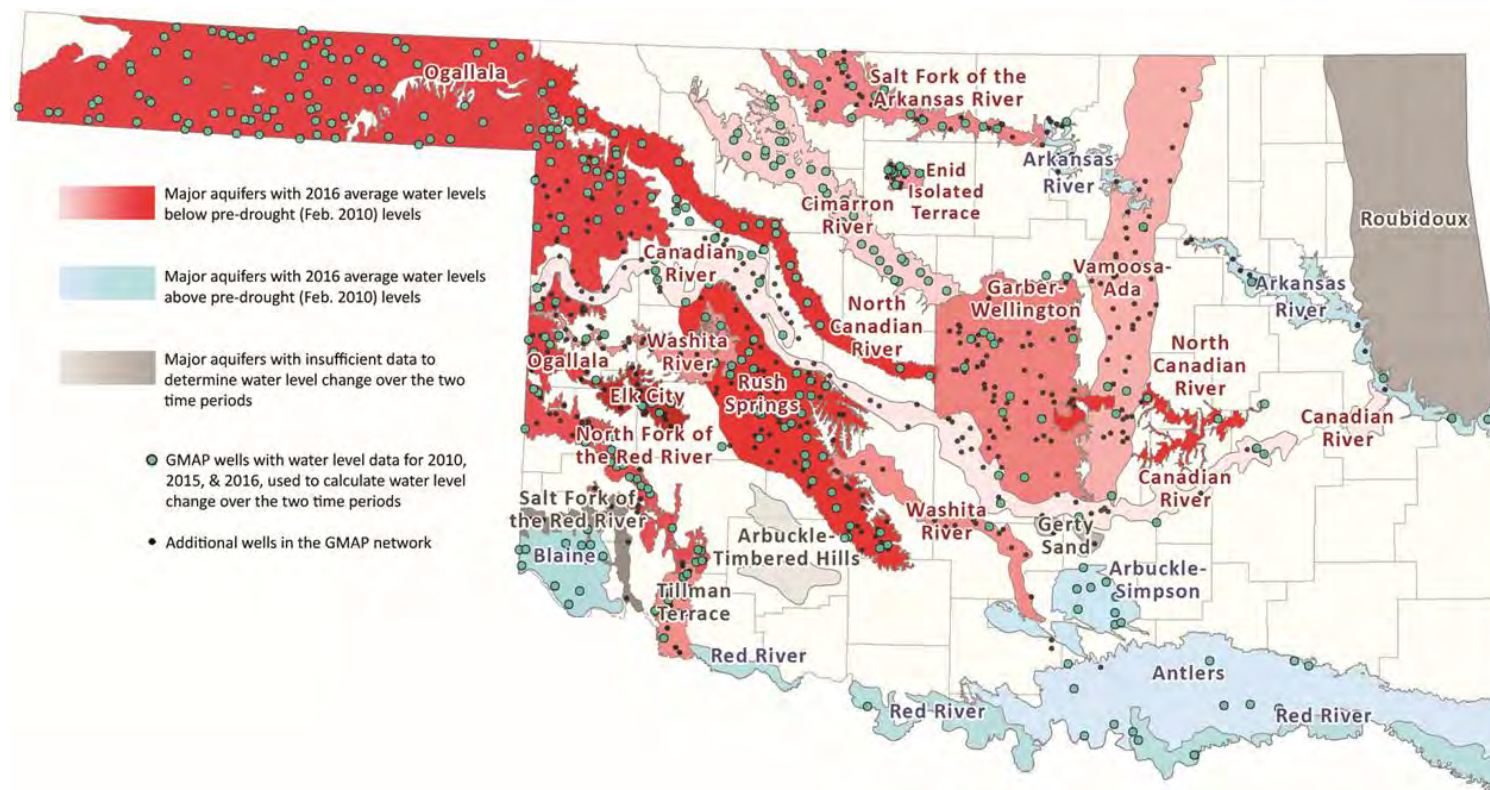
Quantity Data

Statewide one-year changes in water level by aquifer and climate region, 2008-2018



Quantity Data

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



QUALITY TREND

Water Quality Trend Schedule		
1-year Schedule		
Arbuckle-Simpson	Enid Isolated Terrace	Red River
Arkansas River	Gerty Sand	Salt Fork of the Arkansas River
Canadian River	North Canadian River	Salt Fork of the Red River
Cimarron River	North Fork of the Red River	Tillman Terrace
	Washita River	
3-year Schedule		
Antlers	Garber Wellington	
Elk City	Rush Springs	
5-year Schedule		
Ada-Vamoosa	Ogallala	

Bedrock Aquifer
Alluvial/Terrace Aquifer

QUALITY TREND

Water Quality Trend Numbers				
Aquifer	Total Baseline Target	25%	33%	40%
ABSMP	21	5	8*	8
ADVDM	40	10	13	16
ALRS	31	8	10	12
ARKS	30	7	10	12
BNCR	40	10	13	16
CMRN	38	9	12	15
CNDN	23	6	10*	9
ELKC	16	4	6*	6
ENID	10	3	5*	4
GRTY	10	3	5*	4

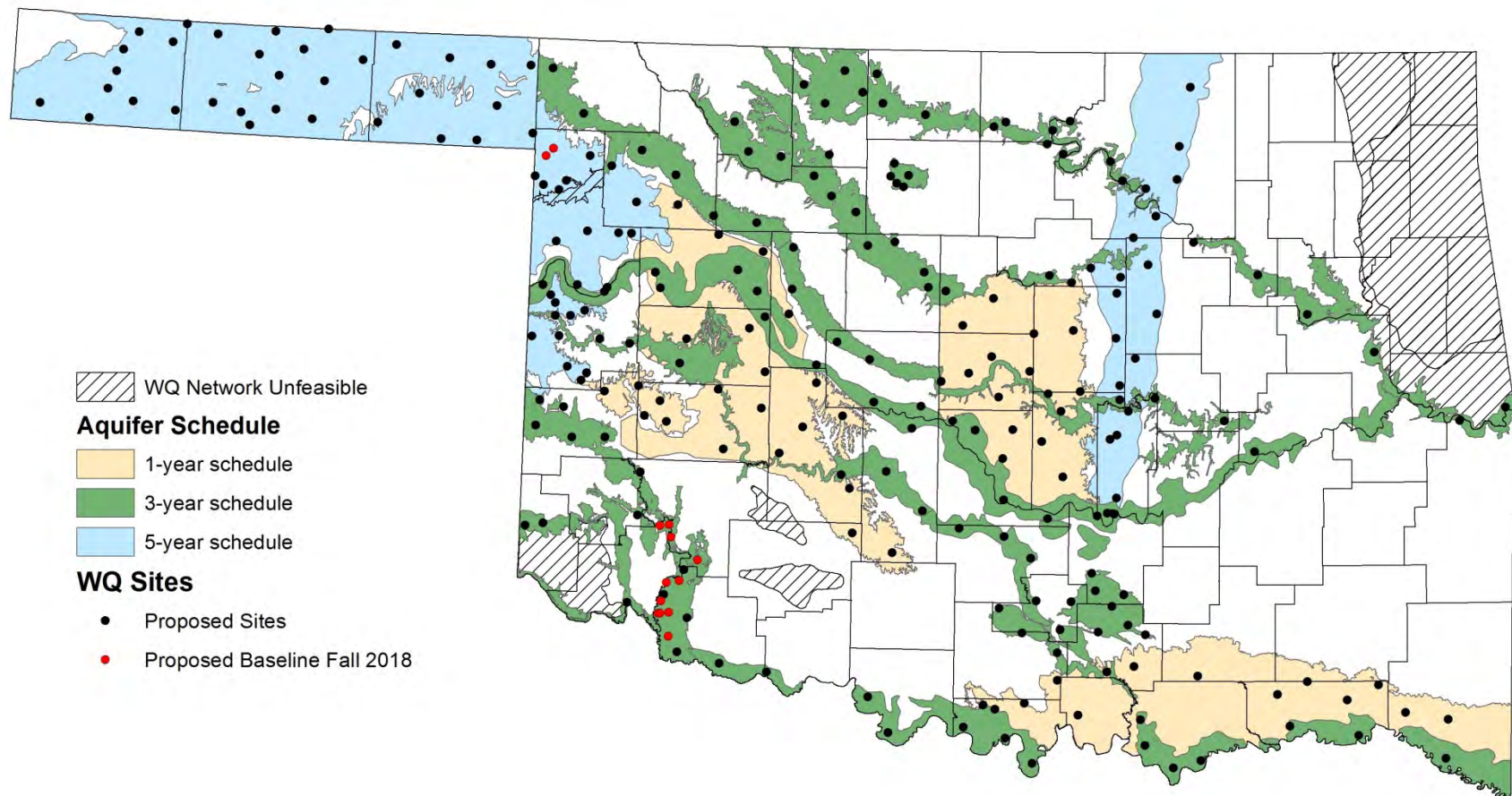
Bedrock Aquifer

Alluvial/Terrace Aquifer

Water Quality Trend Numbers				
Aquifer	Total Baseline Target	25%	33%	40%
GSWF	50	12	16	20
NFRR	23	6	9*	9
OGLLNW	48	12	16	19
OGLLP	88	22	29	35
REDR	40	10	13	16
RSPG	42	10	14	17
SFAR	29	7	10	12
SFRR	10	3	5*	4
TILL	10	3	5*	4
WASH	36	9	12	14

*Numbers adjusted
(upward) from
actual 33% number

QUALITY TREND



Where to Find Data

The screenshot shows the Oklahoma Water Resources Board website. The header includes the board's name and the Oklahoma Water Agency logo. A navigation bar lists various services like Board Meetings, Rules, Forms, etc. The left sidebar contains a menu with categories such as Water Use Permitting, Financial Assistance, Well Drilling, Water Quality Standards, Monitoring & Assessment (highlighted), Groundwater Studies, Surface Water Studies, Dam Safety, Floodplain Management, Drought Monitoring, and Interactive Maps & Data. The main content area is titled 'Monitoring & Assessment' and features a sub-menu with 'Program Home' and 'Beneficial Use Monitoring Program (BUMP)'. The 'Program Home' section describes the Groundwater Monitoring & Assessment Program (GMAP), its history, and its goals. It includes a paragraph about the program's purpose and a sub-section for 'Groundwater Data' listing various aquifers and rivers. A red arrow points from the 'Groundwater Data' link in the sidebar to the 'Groundwater Data' section in the main content area. Another red arrow points from the '2018 Oklahoma Groundwater Report' link in the 'Resources' section to a corresponding image of a water well.

theoklahomawaterresourcesboard thewateragency

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Water Use Permitting
Financial Assistance
Well Drilling
Water Quality Standards
Monitoring & Assessment
Groundwater Studies
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Monitoring & Assessment

Program Home Beneficial Use Monitoring Program (BUMP) ▼

Groundwater Monitoring & Assessment Program (GMAP)

Oklahoma's first holistic, long-term, aquifer-based Groundwater Monitoring and Assessment Program (GMAP) was initiated in 2013. Groundwater sampling is conducted on a network of approximately 750 wells on Oklahoma's 21 major aquifers (phased in by 2017 and sampled on a five-year rotation).

Assessments of Oklahoma's groundwater will be achieved through both a baseline monitoring network and a long-term (trend) monitoring network within each of the state's major aquifers. This will provide Oklahoma with information on individual aquifer characteristics as well as a more general assessment.

Through quality analyses, the natural geochemistry of the aquifers will be assessed to identify concerns. Water samples will be taken from existing groundwater wells and analyzed for parameters such as nutrients, dissolved metals, alkalinity, hardness, dissolved oxygen, pH, and total dissolved solids.

A sub-set of wells from the baseline monitoring network will be used for trend monitoring, evaluated multiple times per year. Multiple assessments of water level and chemistry will facilitate recognition of seasonal changes, changes due to climate variability, and/or changes due to usage over time. The differences in these changes as well as aquifer response will be identified in all of the State's major aquifers. To further facilitate this effort, a select number of wells will be equipped with water level data loggers to monitor changes on the scale of weeks, days, or even hours.

Groundwater Data

GMAP Data
Ada-Vamoosa
Antlers
Arbuckle-Simpson
Arbuckle-Timbered Hills
Arkansas River
Canadian River
Cimarron River
Dakota Dockum
Elk City
Enid Isolated Terrace
Garber Wellington
Gerty Sands
North Canadian River

Water Well Mass Measurement Program
Statewide network of 600 wells measured annually by the OWRB and USGS for depth-to-water, providing historical data (1950-present).
Groundwater Level Monitoring Wells Viewer

Resources

[Interactive GMAP Viewer](#)
[GMAP Fact Sheet](#)
[Groundwater FAQs](#)
[Groundwater Information Resources](#)
[OWRB Groundwater Monitoring Sites & Data](#)
[Groundwater Technical Studies](#)
[Request Data by Email](#)

2018 Oklahoma Groundwater Report

<http://www.owrb.ok.gov/gmap>

Where to Find Data

Oklahoma Water Resources Board

www.owrb.ok.gov/maps/

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Water Use Permitting
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Interactive Maps & GIS Data

- OWRB General Viewer
- Groundwater in Oklahoma
- Dam Inventory
- Fish Monitoring Sites
- Floodplain Zoning & Community Participation
- Groundwater Level Monitoring Wells
- Groundwater Monitoring & Assessment Program
- Groundwater Wells, Standards, & Protection

- All OWRB Data
- Aquifer Study Data
- Bathymetric Data
- Floodplain Data (FEMA)
- Groundwater Data
- Oklahoma Comprehensive Water Plan Data
- Surface Water Data
- Water Rights Data
- Water Supply Data

More OWRB Maps

- Arbuckle-Simpson Hydrologic Study
- Garber-Wellington Groundwater Wells with Maximum Trace Metal Concentrations
- Historic Flood Maps
- Lakes of Oklahoma, 3rd Edition
- National Wetlands Inventory
- Rural Water Systems
- Aquifers in Oklahoma
- Major Aquifers in Oklahoma
- Groundwater Basins with MAY
- Statewide Groundwater Vulnerability Map
- OWRB Groundwater Level Observation Wells
- OWRB Stream System Management Basins
- Interstate Stream Compacts
- Major Rivers & Lakes in Oklahoma
- Shaded Relief Map of Major Surface Water Resources
- OCWP Basins Identified as Water Supply Hot Spots

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

Where to Find Data

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

Groundwater Quality Contacts

- Data Requests
 - WQDataRequest@owrb.ok.gov
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 - mark.belden@owrb.ok.gov
- Sarah Yepez, Environmental Programs Specialist
 - sarah.yepez@owrb.ok.gov
- Chris Adams, WQ Data Manager
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Thank you

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