Addressing Groundwater Goals of the Missouri Regional Planning Area: Phase 2

Progress Report

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Geoff Bohling
Don Whittemore
Ed Reboulet
Brownie Wilson

KU KANSAS GEOLOGICAL SURVEY
The University of Kansas

Phase 2 Objectives

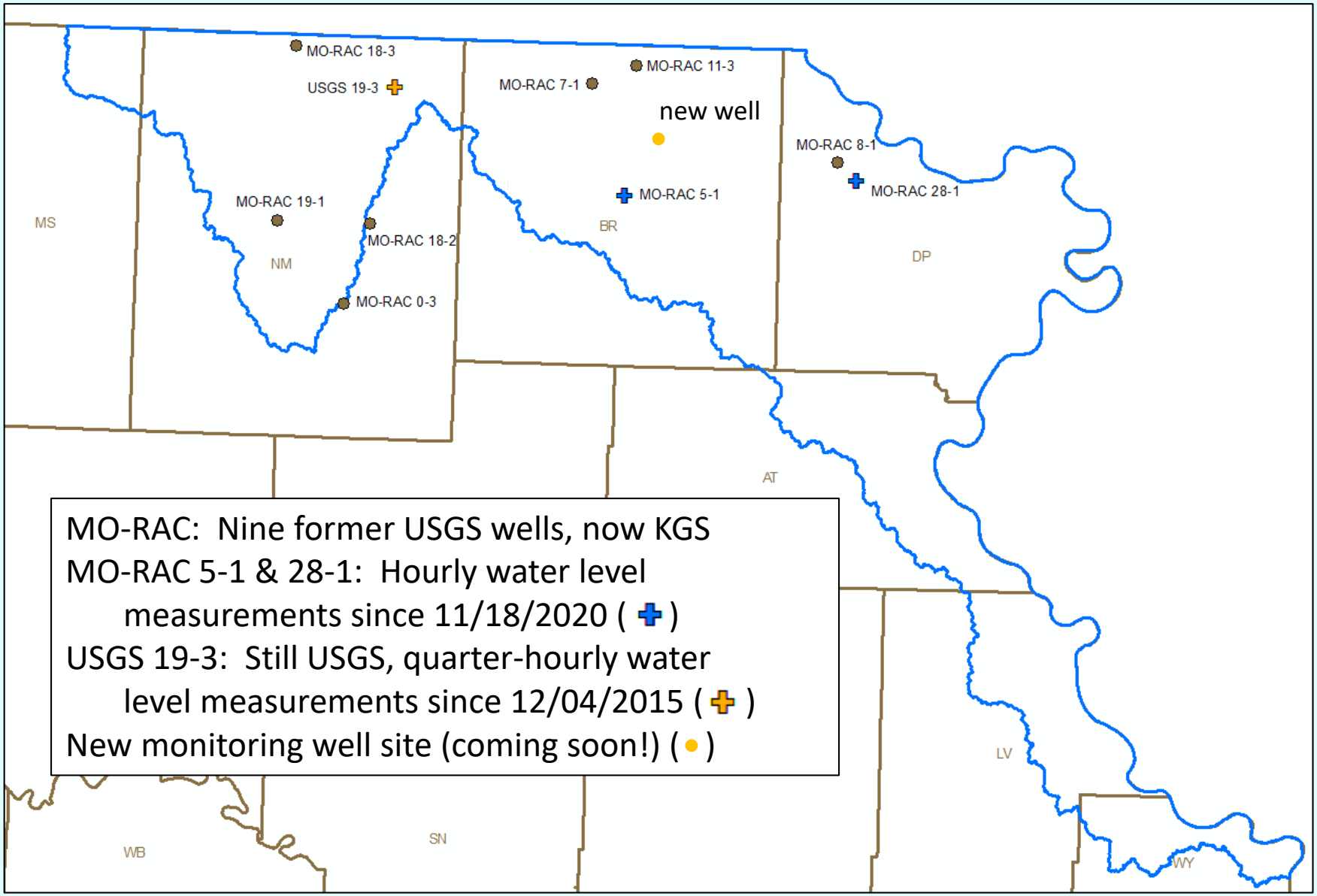
- Establish a groundwater level and groundwater quality monitoring network in the Missouri Regional Planning Area (MRPA)
- Provide improved estimates of safe yield and establish a groundwater quality baseline

Progress since last report

1. Continued continuous water level monitoring in two of the former USGS wells and manually measured water levels in all nine of them
2. Identified new monitoring well location northeast of Hiawatha, in active pumping area
3. Likely nitrate sources considered
4. Links to monitoring well data added to project website
5. Updated analysis of drillers' logs and bedrock in progress (new logs + more depth intervals)

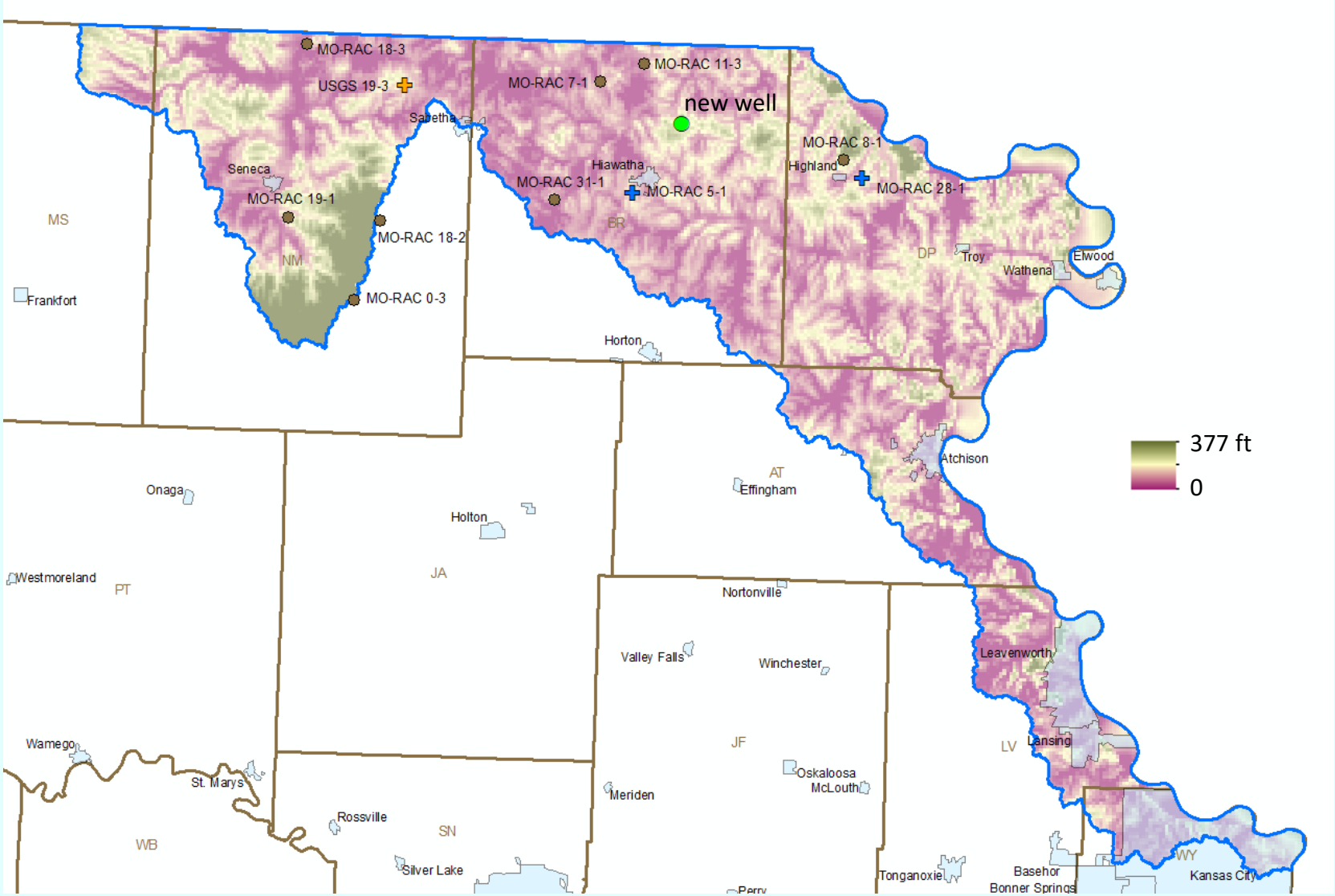
Water Levels

Well Locations

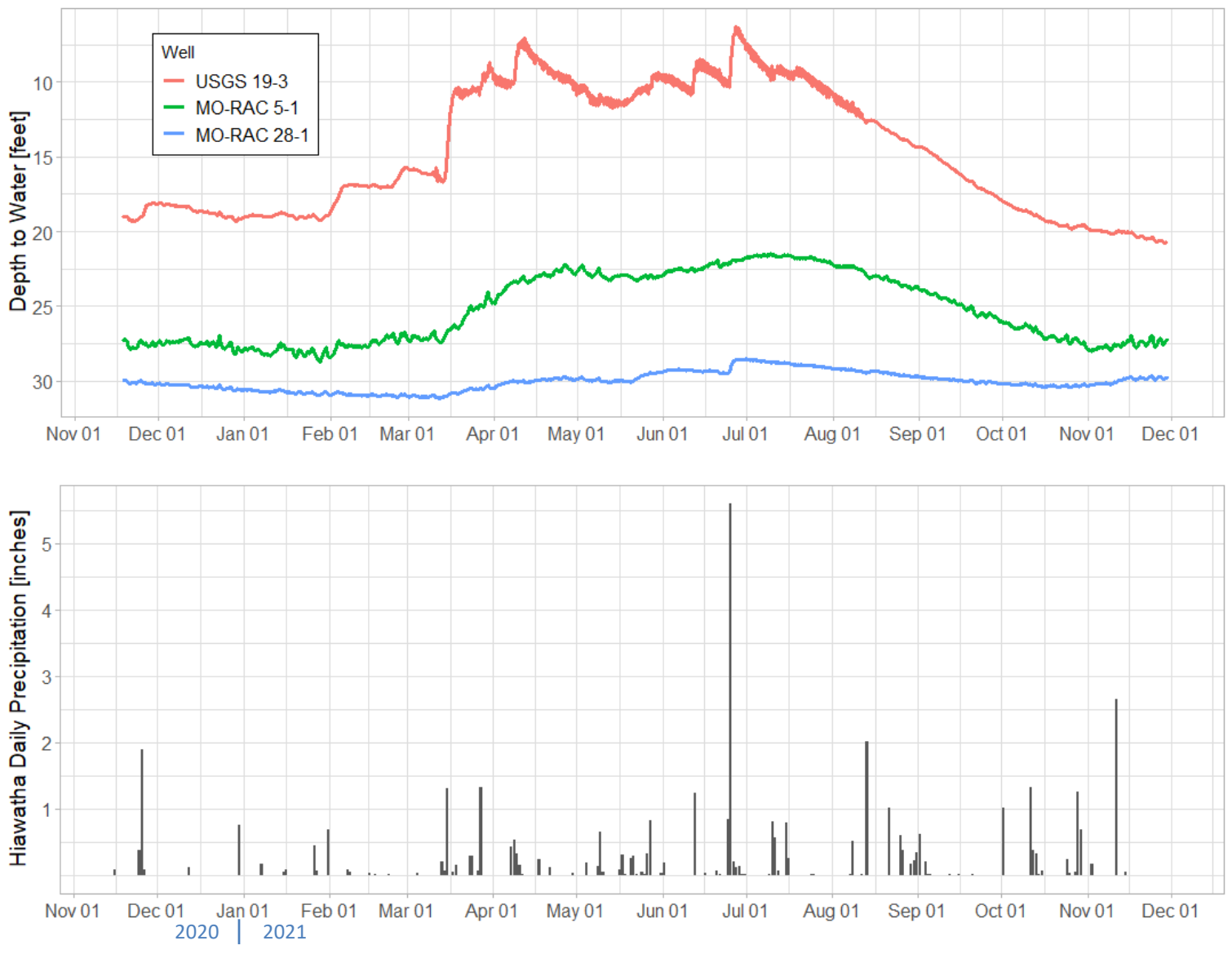


MO-RAC: Nine former USGS wells, now KGS
MO-RAC 5-1 & 28-1: Hourly water level measurements since 11/18/2020 (✚)
USGS 19-3: Still USGS, quarter-hourly water level measurements since 12/04/2015 (✚)
New monitoring well site (coming soon!) (●)

Well Locations with Sediment Thickness

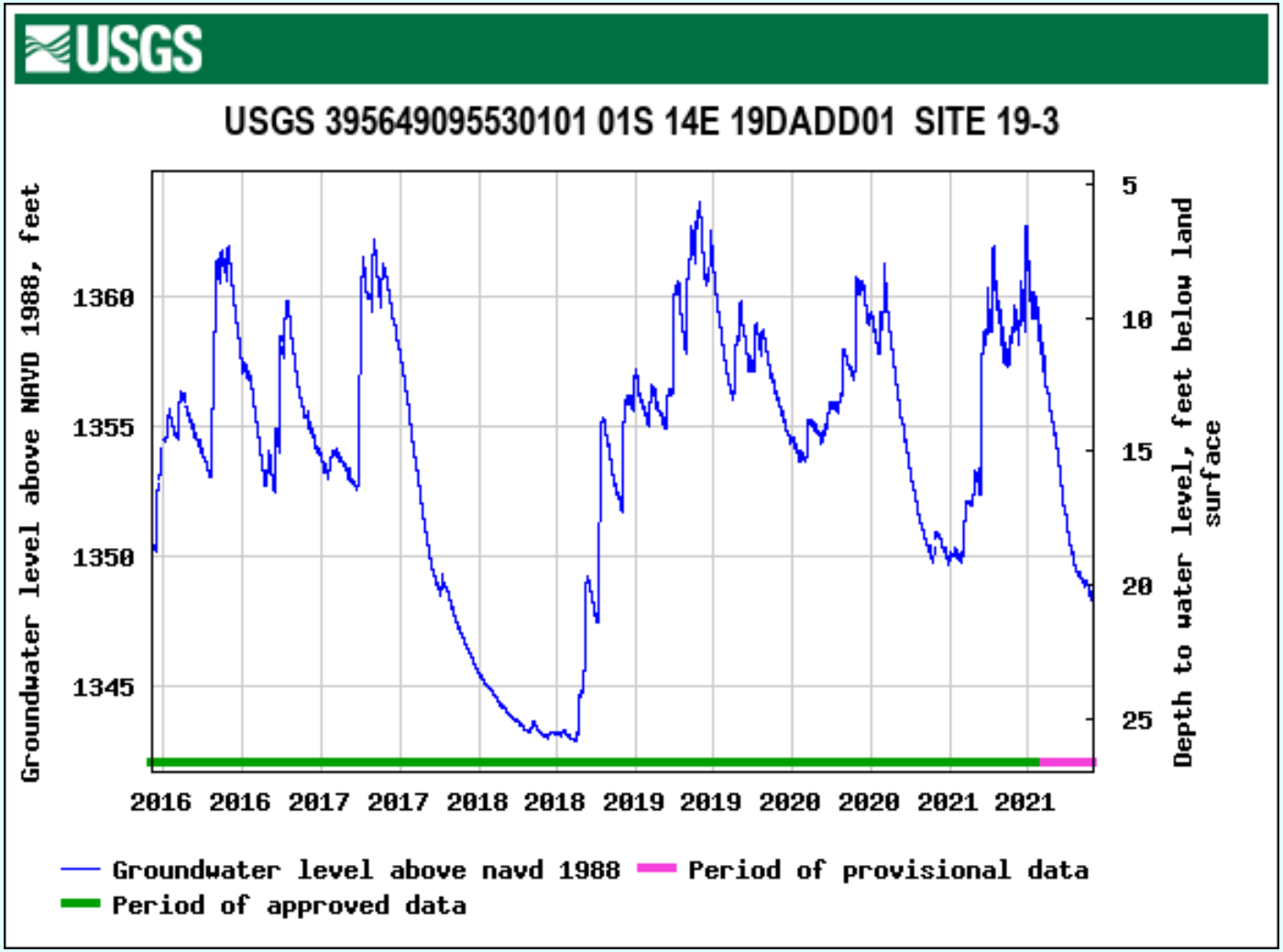


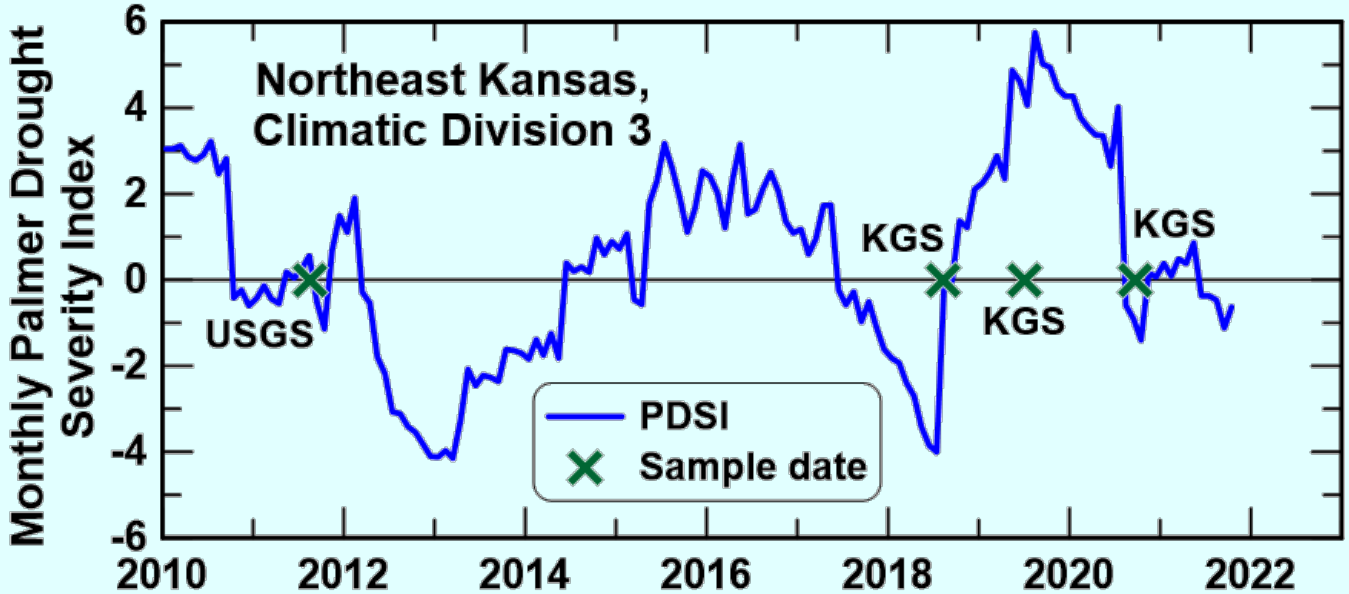
Continuous Measurements 11/18/20 – 11/29/21



Complete Record at USGS 19-3

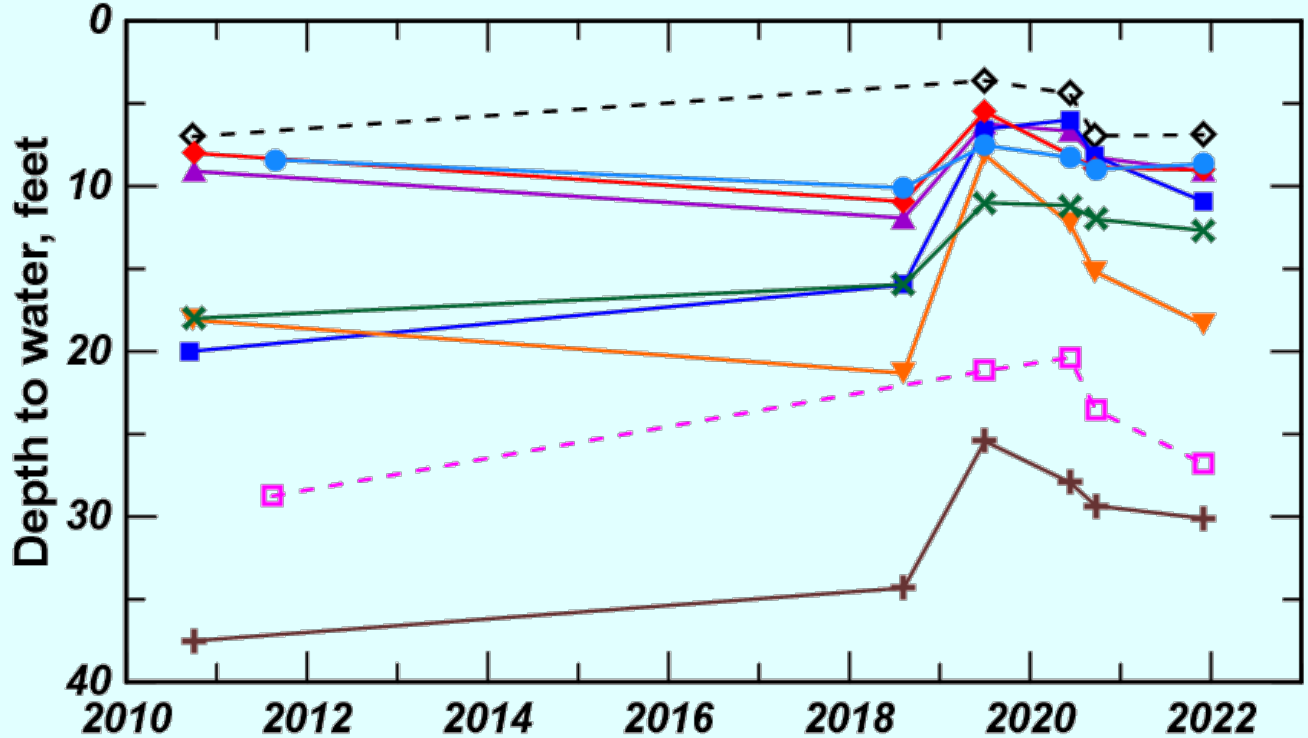
Northeast Nemaha County





Climate Conditions and Sampling Dates

Positive values indicate wetter than normal; negative values drier than normal.



Changes in Water Levels

Nitrate in Municipal Groundwater Supplies and Identification of Nitrate Source

Public Water Supply Systems with Their Own Wells Nitrate-Nitrogen Concentration – Nemaha County

Public Water Supply	NO_3-N average, mg/L	Source	Years
Bern	1.2	Well 4	2017-2018
	1.8	Wells 5 & 6	2017-2018
Nemaha County Rural Water District 1	1.4	Wells 3 & 4	2017-2018
	3.7	Well 5	2017-2018
	4.6	Wells 6 & 7	2017-2018
Nemaha County Rural Water District 3	<0.1	Wells 2 & 3	2017-2018
	0.26	Wells 4 & 5	2017-2018
	0.3	Wells 6, 7, 8	2017-2018
Oneida	<0.1	Well	2017-2018
Seneca	3.6	Reservoir (of well water)	2017-2018

Public Water Supply Systems with Their Own Wells
Nitrate-Nitrogen Concentration

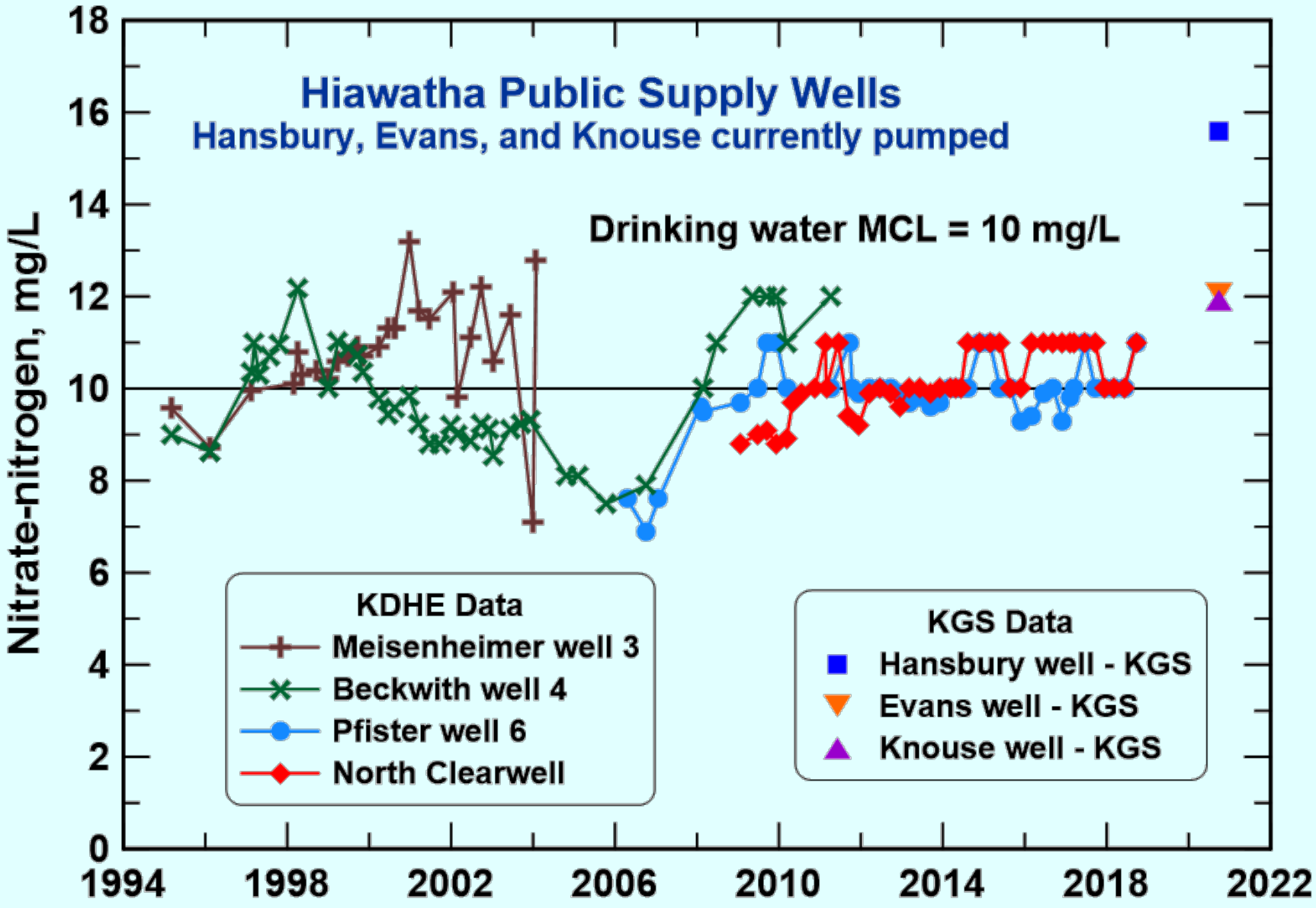
Public Water Supply	NO_3-N average, mg/L	Source	Years
Doniphan County			
Highland	9.8	Well 4	2017-2018
Troy	6.4	Well 3 water plant	2017-2018
	0.40	Wells 6 & 7 water plant	2017-2018
White Cloud	5.5	Pump house	2017-2018
Leavenworth County			
Fort Leavenworth	0.23	Water plant lab tap	2017-2018

Maximum contaminant level for NO_3-N for drinking water is 10 mg/L.

Public Water Supply Systems with Their Own Wells
Nitrate-Nitrogen Concentration – Brown County

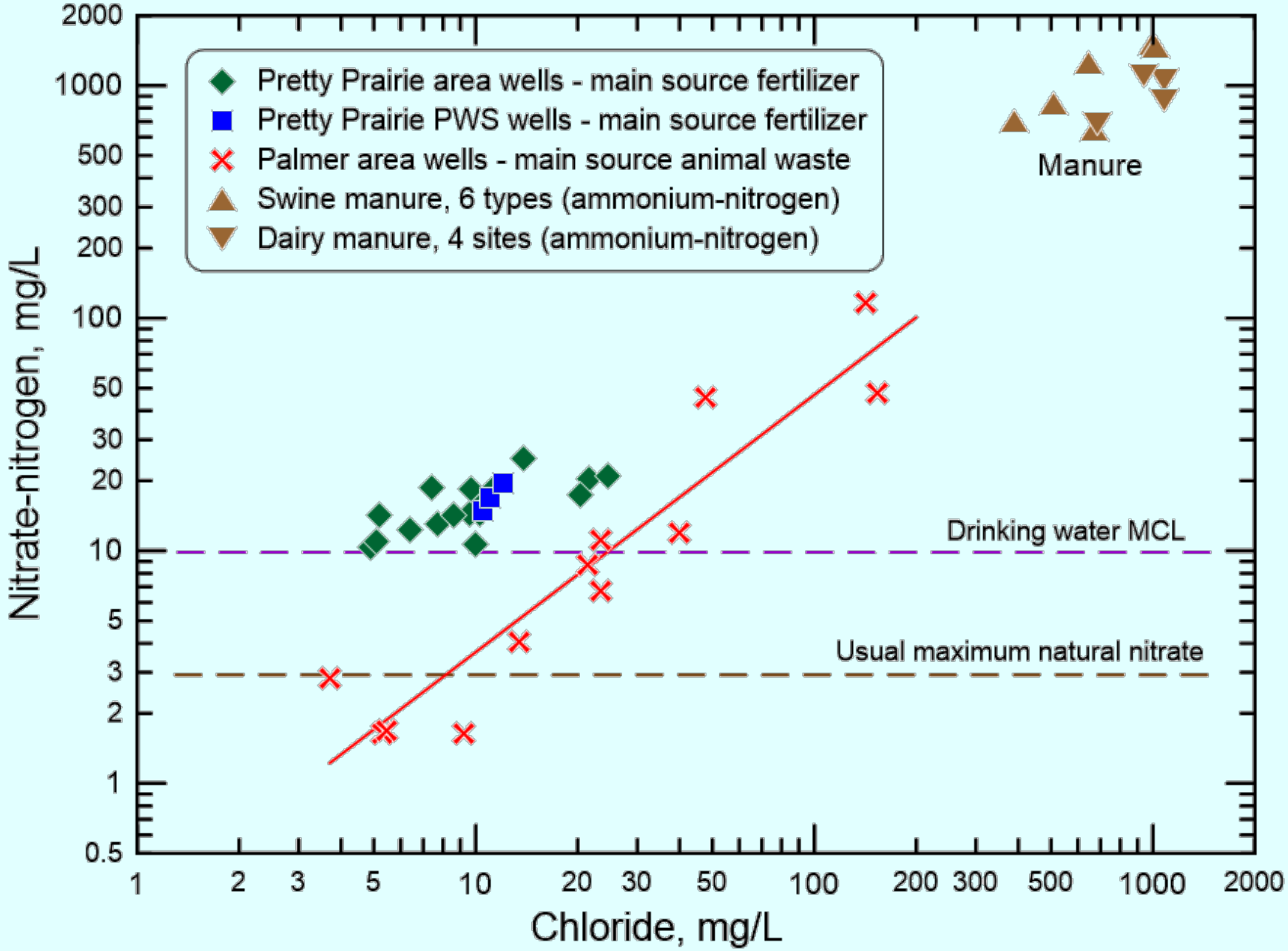
Public Water Supply	NO_3-N average, mg/L	Source	Years
Brown County Rural Water District 1	7.6	Wells 1-6 pump house	2017-2018
Hiawatha	10.1	Well 6	2017-2018
	10.6	North Clearwell	2017-2018
	11.5	Beckwith Well	2010-2011
	11.2	Well 3	2002-2003
Public Wholesale Water Supply District 27	5.3	Well water entry point	2018

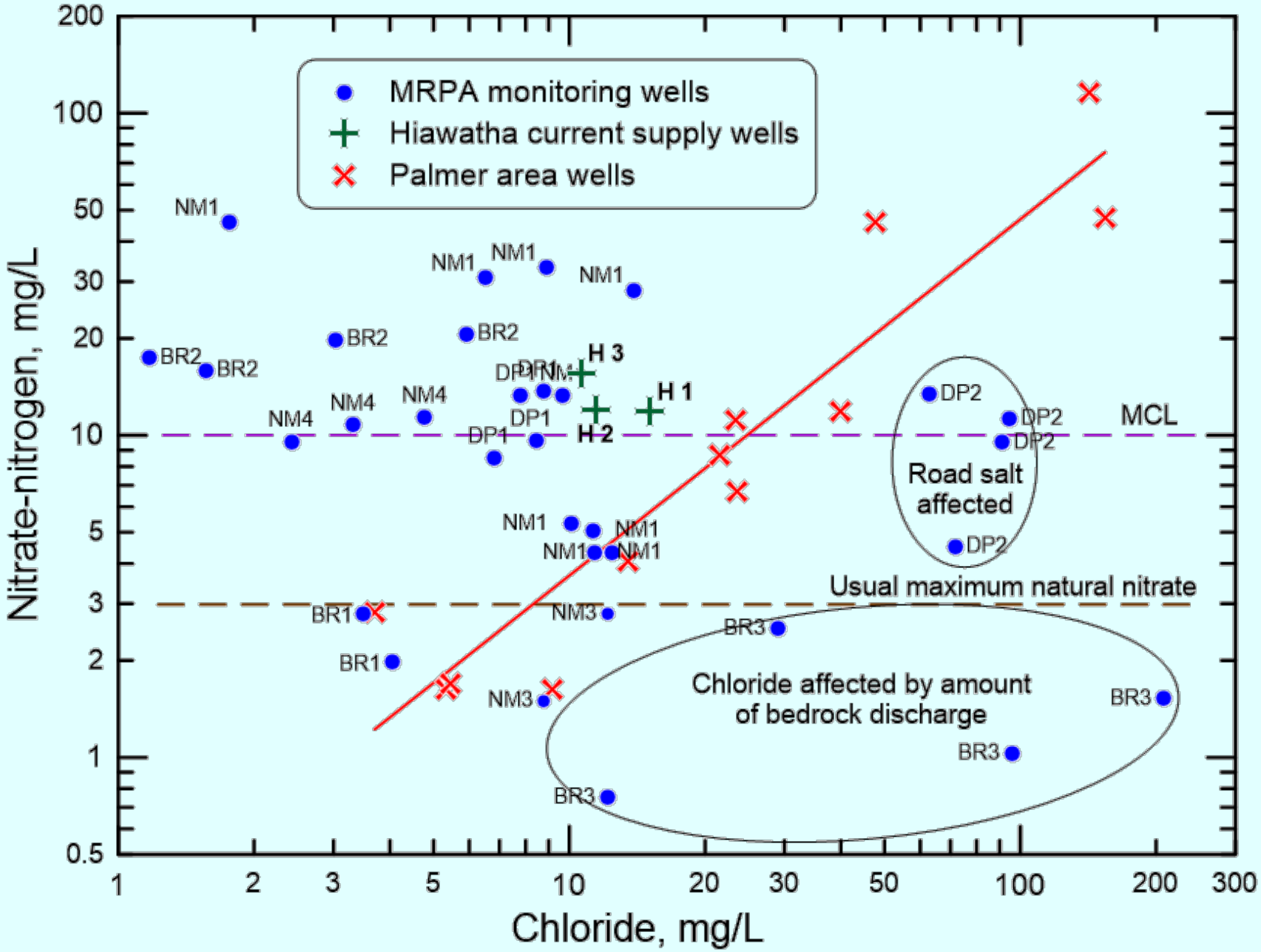
Maximum contaminant level for NO_3-N for drinking water is 10 mg/L.

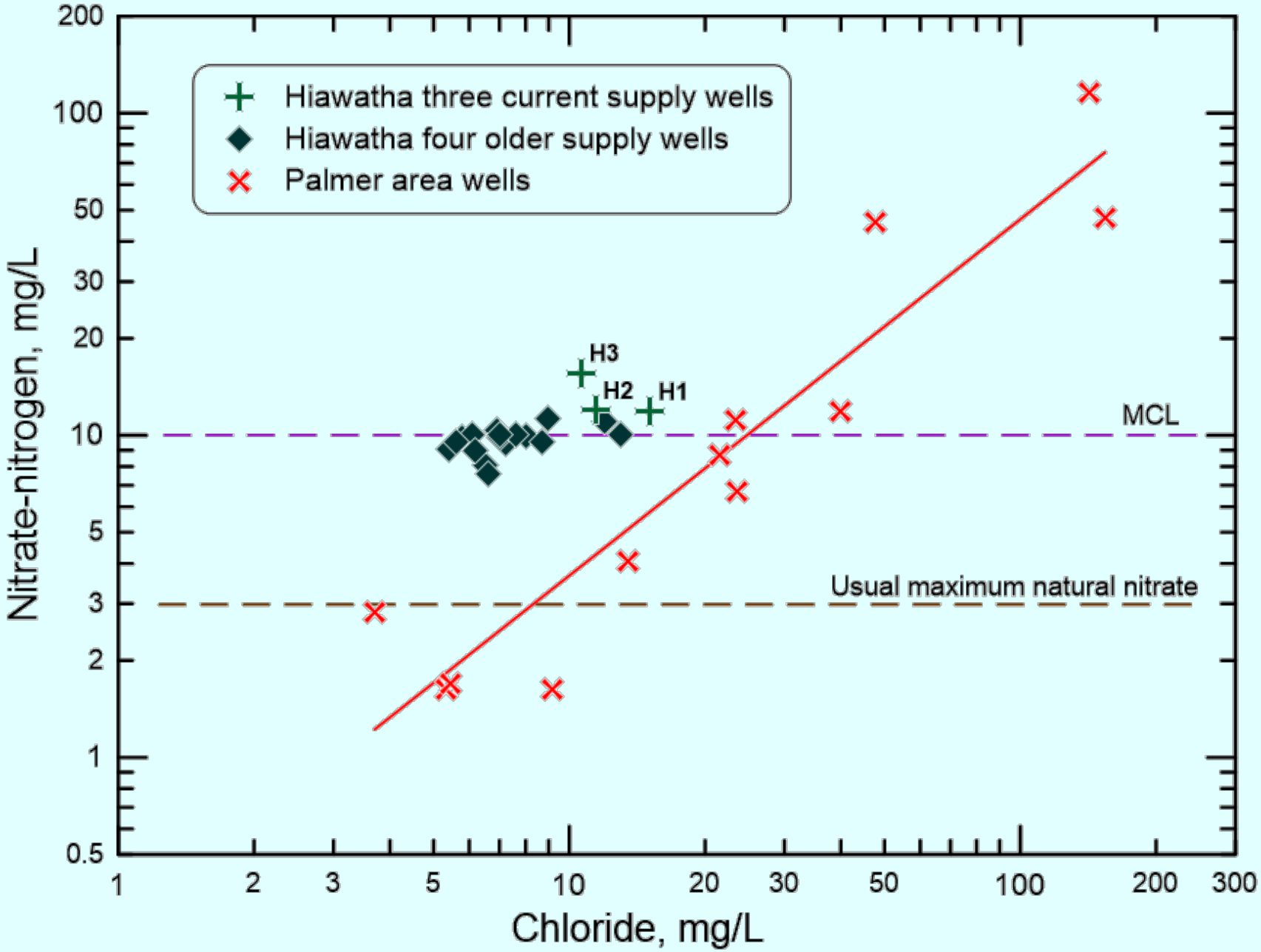

Hiawatha Public Supply Wells
Hansbury, Evans, and Knouse currently pumped
Drinking water MCL = 10 mg/L
Nitrate-nitrogen, mg/L
0
2
4
6
8
10
12
14
16
18
1994
1998
2002
2006
2010
2014
2018
2022
KDHE Data
Meisenheimer well 3
Beckwith well 4
Pfister well 6
North Clearwell
KGS Data
Hansbury well - KGS
Evans well - KGS
Knouse well - KGS

Source of Groundwater Nitrate Contamination in the Missouri Regional Planning Area

- Natural nitrate concentrations in Kansas aquifers are usually less than 3 mg/L as nitrate-nitrogen.
- The main sources of nitrate-nitrogen exceeding 3 mg/L are animal waste and nitrogen fertilizers.
- Chloride is associated with nitrate in animal waste but not with common nitrogen fertilizers.
- A plot of nitrate versus chloride concentration can reveal the general sources of groundwater nitrate contamination.
- Comparison of the nitrate-chloride plot for wells in the Pretty Prairie, Reno County (with center pivot irrigation) and Palmer, Washington County (with several livestock operations) areas with KGS MRPA study data indicates that the main source of high nitrate concentration for the monitoring wells and Hiawatha public supply wells is fertilizer.


Pretty Prairie area wells - main source fertilizer
Pretty Prairie PWS wells - main source fertilizer
Palmer area wells - main source animal waste
Swine manure, 6 types (ammonium-nitrogen)
Dairy manure, 4 sites (ammonium-nitrogen)
Manure
Drinking water MCL
Usual maximum natural nitrate
Nitrate-nitrogen, mg/L
Chloride, mg/L
2000
1000
500
300
200
100
50
30
20
10
5
3
2
1
0.5
1
2
3
5
10
20
30
50
100
200
300
500
1000
2000


MRPA monitoring wells
Hiawatha current supply wells
Palmer area wells
Nitrate-nitrogen, mg/L
Chloride, mg/L
MCL
Usual maximum natural nitrate
Road salt affected
Chloride affected by amount of bedrock discharge
H 1
H 2
H 3
NM1
NM3
NM4
BR1
BR2
BR3
DP1
DP2
200
100
50
30
20
10
5
3
2
1
0.5
1
2
3
5
10
20
30
50
100
200
300


Hiawatha three current supply wells
Hiawatha four older supply wells
Palmer area wells
H3
H2
H1
MCL
Usual maximum natural nitrate
Nitrate-nitrogen, mg/L
Chloride, mg/L
200
100
50
30
20
10
5
3
2
1
0.5
1
2
3
5
10
20
30
50
100
200
300

Isotope Identification of Groundwater Nitrate Source in the Missouri Regional Planning Area

- Isotopes of nitrogen and oxygen in nitrate (NO_3) can assist in identifying nitrate sources in water.
- Nitrogen has two natural stable isotopes: ^{14}N (99.6%), ^{15}N (0.4%).
- Oxygen has three natural stable isotopes: ^{16}O (99.76%),

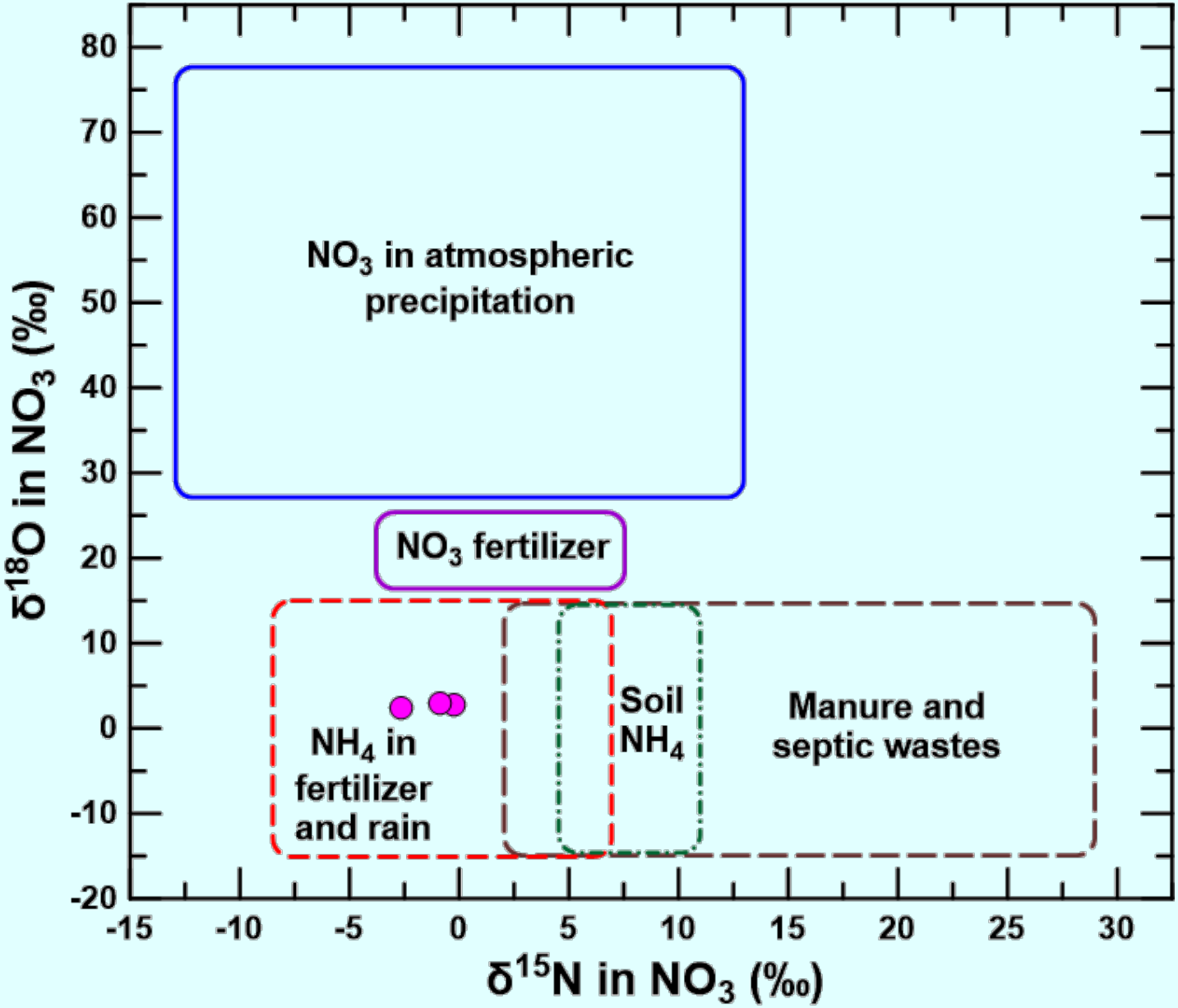
  ^{17}O (0.04%), ^{18}O (0.20%).
- The concentrations of the heaviest isotopes of N and O differ from the normal percentages in nitrate from different sources.
- Isotopic abundance is expressed as δ (delta) in units of parts per thousand (‰) for the ratio in a sample relative to a standard.
- Example: $\delta^{15}N = \{[(^{15}N_W / {}^{14}N_W)/(^{15}N_S / {}^{14}N_S)] - 1\} \times 1000$

  If the ratio in a sample is the same as in the standard, $\delta^{15}N = 0$.

  If ratio in a sample is greater than in standard, $\delta^{15}N$ is + (>0).

  If ratio in a sample is less than in standard, $\delta^{15}N$ is – (<0).
- A plot of $\delta^{15}N$ versus $\delta^{18}O$ is used to identify nitrate sources.

Nitrate Source Identification for Hiawatha Public Supply Wells



Website

Water Level Measurements Added to Website

https://www.kgs.ku.edu/Hydro/Missouri/index.html

Water Level Data Page

https://www.kgs.ku.edu/Hydro/Missouri/mrpa/index.html

"Wizard well page" leads to manual measurements (in Wizard database)

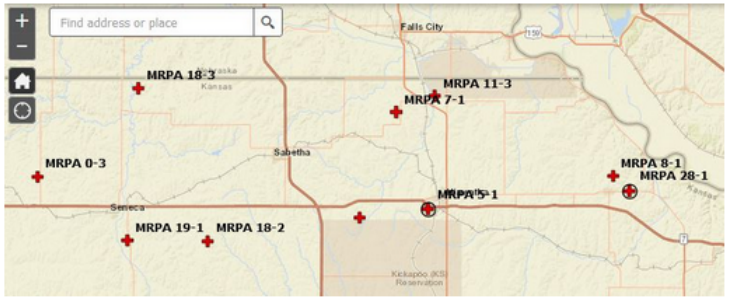
"Continuous measurements" leads to . . . surprise! . . . continuous measurements

Missouri River Monitoring Well Network

In 2018, the KGS took over ownership of a network of wells, origionally installed by the USGS in 2011, in the Missouri Regional Planning Area (MRPA) to help better understand the groundwater resources in the Missouri River basin within Kansas. Depth-to-water measurements are taken periodically throughout the year and several of the sites have been equipped to provide continuously recorded water levels in near real-time. Funding for the project is through the Kansas Water Plan Fund..

Interactive Map

Use our interactive map to explore the data received, or use the data links below.



Data

Site 18-3, Nemaha County north of Baileyville
Wizard well page

Site 0-3, Northern Nemaha County along stateline
Wizard well page

Site 19-1, Nemaha County south of Seneca
Wizard well page

Site 18-2, Nemaha County southeast of Seneca
Wizard well page

Site 7-1, Brown County northwest of Hiawatha
Wizard well page

Site 11-3, Brown County north of Hiawatha
Wizard well page

Site 31-1, Brown County between Fairview and Hiwatha
Wizard well page

Site 5-1, Brown County west of Hiawatha
Wizard well page
Continuous Measurements

Site 8-1, Doniphan County north of Highland
Wizard well page

Site 28-1, Doniphan County east of Highland
Wizard well page
Continuous Measurements

MO-RAC 5-1

Plot is daily average depth

Hourly data are listed and can be downloaded

Date range is past couple weeks by default; I've changed date range by editing "from" and "to" boxes and clicking "Update Date Range"

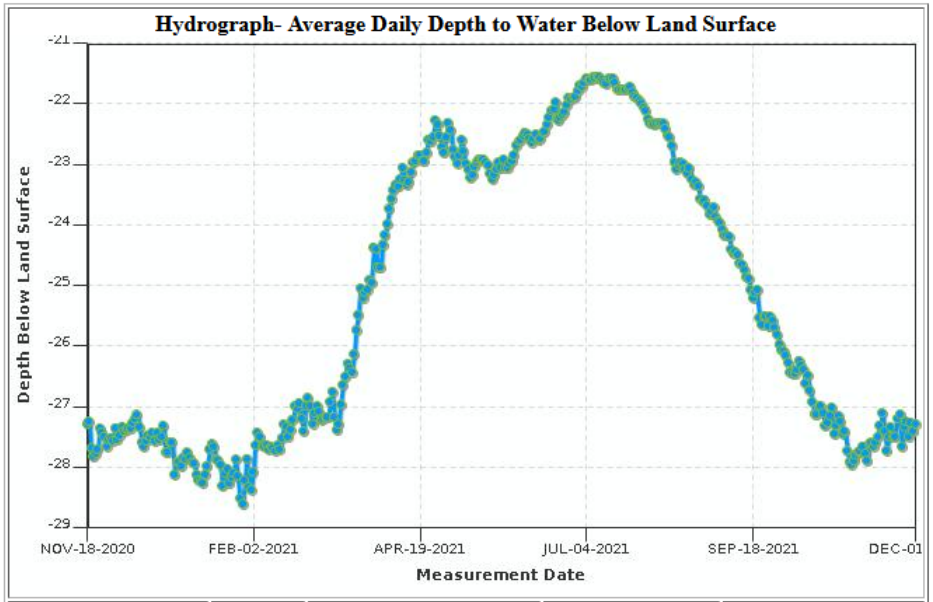
Kansas Geological Survey | Hydrology | Wizard Water Well Query | Online Help | WIZARD Well Continuous Water Levels

395016095332501 - MO-RAC 5-1 Index Well
Funded by the Kansas Water Plan.

Measurement start date: 2020-11-18

From 2020-11-18 to 2021-12-01

Update Date Range | Download to file



Date and Time	Agency	Depth to Water (ft)	Pressure (PSI)	Temperature (F)
11/18/2020 10:00	KGS	-27.36	5.07	54.69
11/18/2020 11:00	KGS	-27.35	5.07	54.44
11/18/2020 12:00	KGS	-27.32	5.09	54.42

Wrap-Up

Phase II Project Tasks

- Water Quantity
  1. Assess robustness of existing (Phase I) data interpretation
  2. Improve location accuracy for some wells
  3. *Identify* and equip existing wells for continuous water level monitoring
  4. *Install new monitoring wells* in critical locations
  5. *Interpret groundwater level surface* and estimate aquifer storage and safe yield
- Water Quality
  1. Interpret existing water-quality data and trends
  2. *Select groundwater quality monitoring locations and collect samples*
  3. *Analyze samples*
  4. *Interpret new data* and plan for future sampling
- Information Dissemination
  1. Make information publicly available through project website

Focus for Next Few Months

- Install new monitoring well northeast of Hiawatha
- Work on locating additional monitoring wells (existing and new), especially further south
- Complete revised analysis of water well drillers' logs
- Update website to serve new data

Schedule

We are here . . . still

Task	Year 1	Year 2	Year 3	Year 4	Year 5
Water Quantity 1					
Water Quantity 2					
Water Quantity 3					
Water Quantity 4					
Water Quantity 5					
Water Quality 1					
Water Quality 2					
Water Quality 3					
Water Quality 4					
Info. Dissemination					

Project web site:

http://www.kgs.ku.edu/Hydro/Missouri/index.html