

PA Groundwater Quality Monitoring Network

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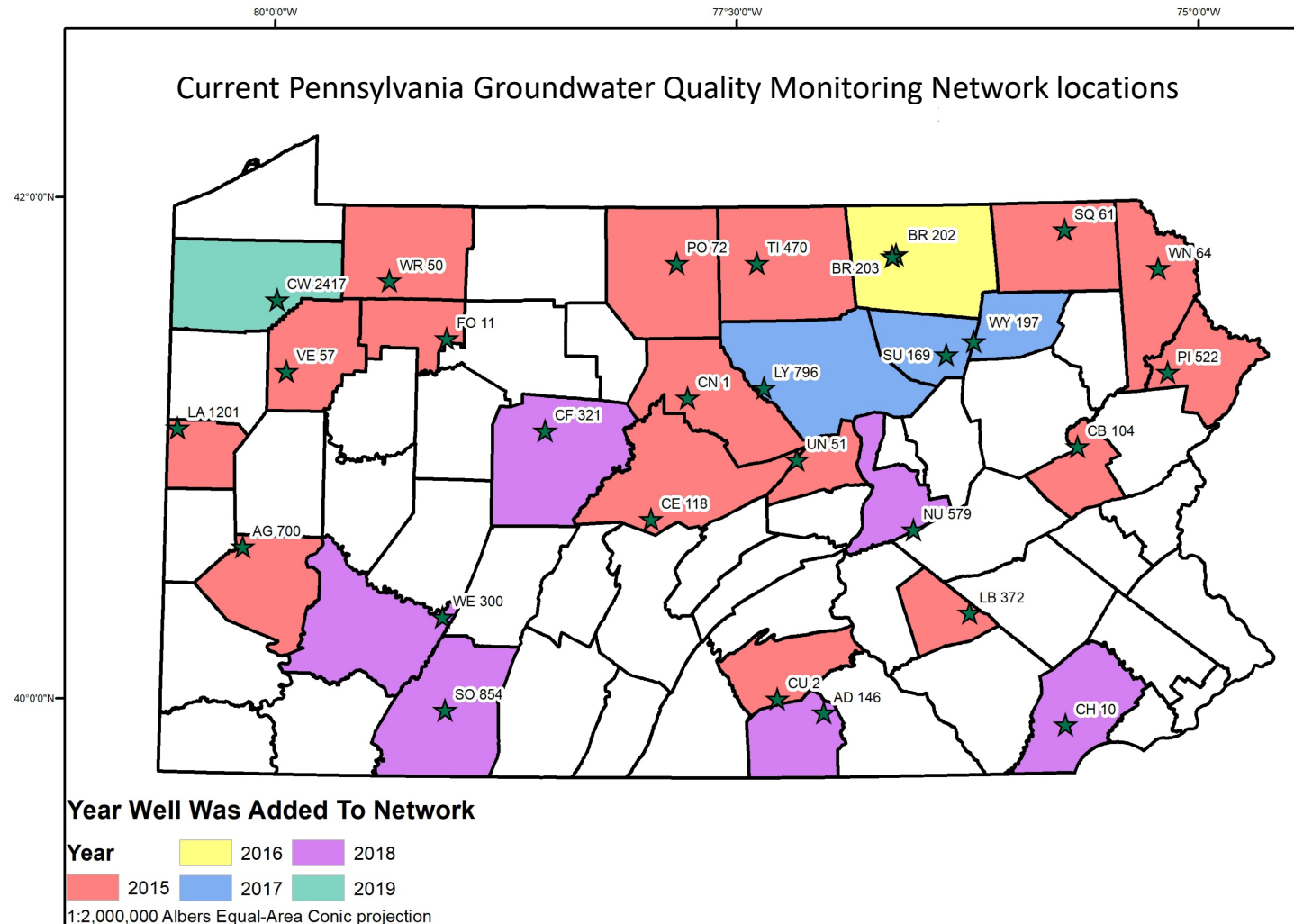
Overview

Creation of the Network

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Interactive Mapping
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Creation of the Network



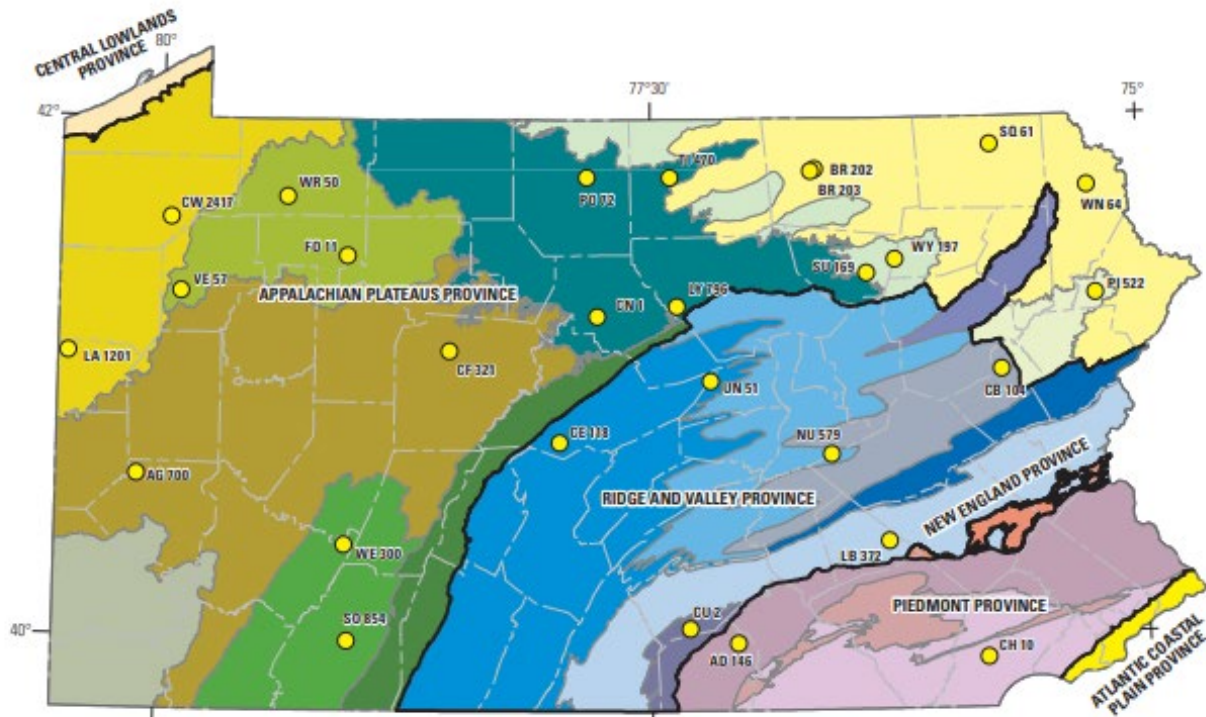
Characterization of Ambient Groundwater Quality Within a Statewide, Fixed-Station Monitoring Network in Pennsylvania, 2015–19

Report and Data Release

- Report titled “Characterization of Ambient Groundwater Quality Within a Statewide, Fixed-Station Monitoring Network in Pennsylvania, 2015–19” released January 2022
- Accompanying Data Release titled “Data for Characterization of Ambient Groundwater Quality within a State-wide, Fixed Station Monitoring Network in Pennsylvania, 2015-2019” released at same time



Sample locations



Base from U.S. Geological Survey, 1:2,000,000-scale digital data,

Physiographic provinces data from Pennsylvania Bureau of Topographic and Geologic Survey, 2008a

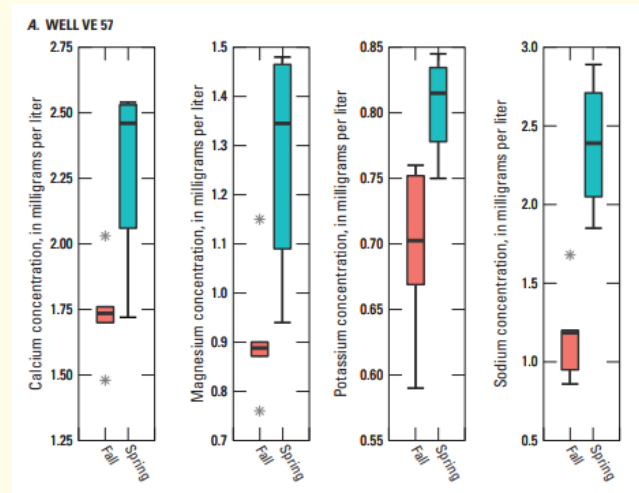
- 28 wells were sampled; 221 total groundwater samples were analyzed for report.
- Samples were collected between March 2015 and November 2019.

General Water quality

- Exceedances of MCLs and SMCLs include nitrate (3 percent of samples), iron (32 percent), manganese (36 percent), aluminum (5 percent), and radon (64 percent).
- 42 percent of samples had pH outside of 6.5-8.5 SMCL range.
- No VOC exceedances.
- Most wells had relatively stable water quality; some showed seasonal differences.

Seasonal Differences

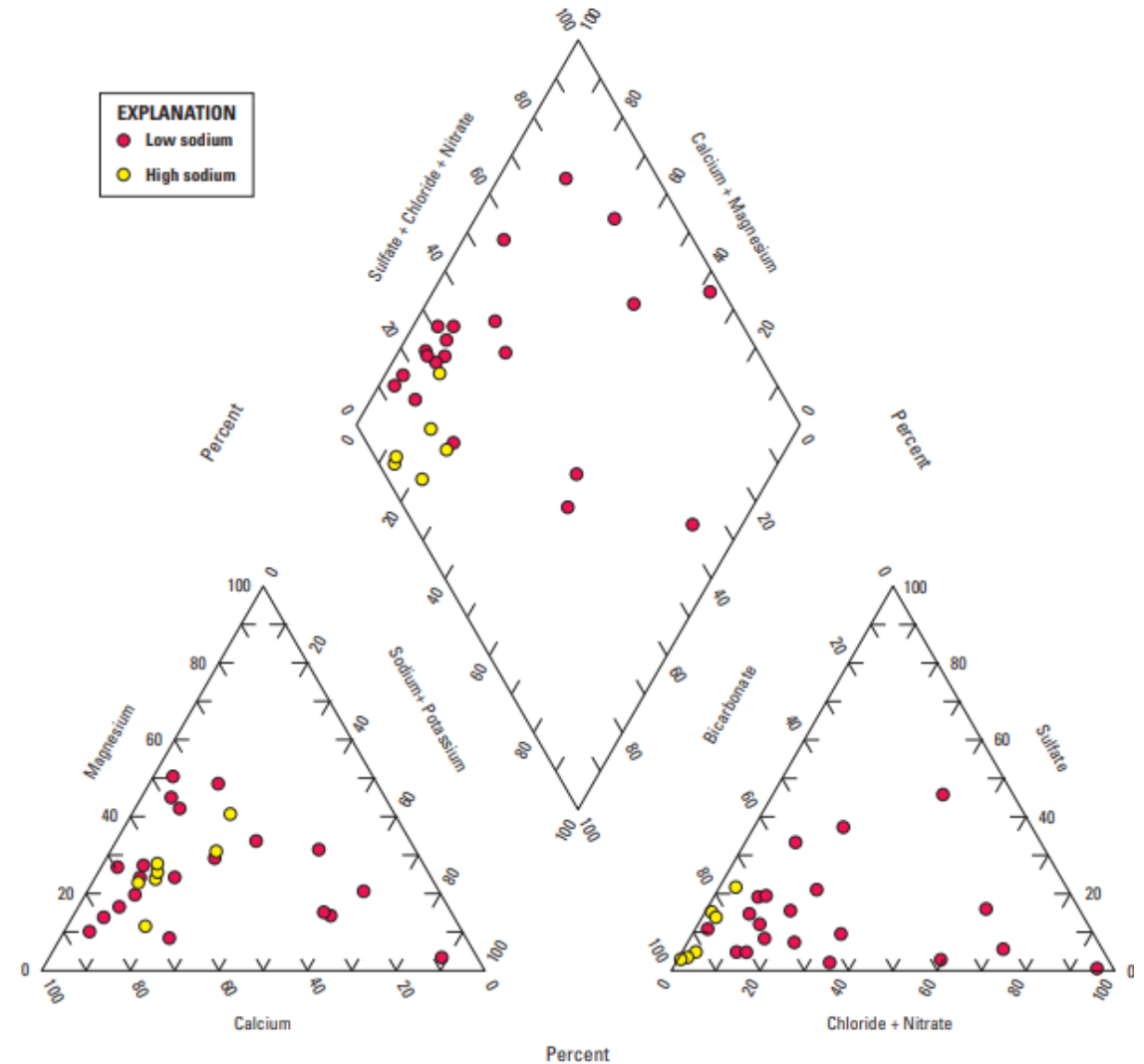
Well	Count of constituents showing a significant seasonal difference
VE 57	16
WR 50	16
UN 51	8
WN 64	8
TI 470	3
CE 118	2
CN 1	2
LA 1201	2
CB 104	1
FO 11	1
LB 372	1
PI 522	1
PO 72	1
SQ 61	1
AG 700	0
CU 2	0



- Wells with 4 or more spring and fall samples were analyzed for seasonal changes.
- Some wells (VE57, WR50, etc.) showed consistent seasonal differences, while others (CU2, AG700, etc.) did not.
- Constituents including sodium, barium, calcium, magnesium, and sulfate showed statistically significant results in at least 3 of 16 wells with long term records.

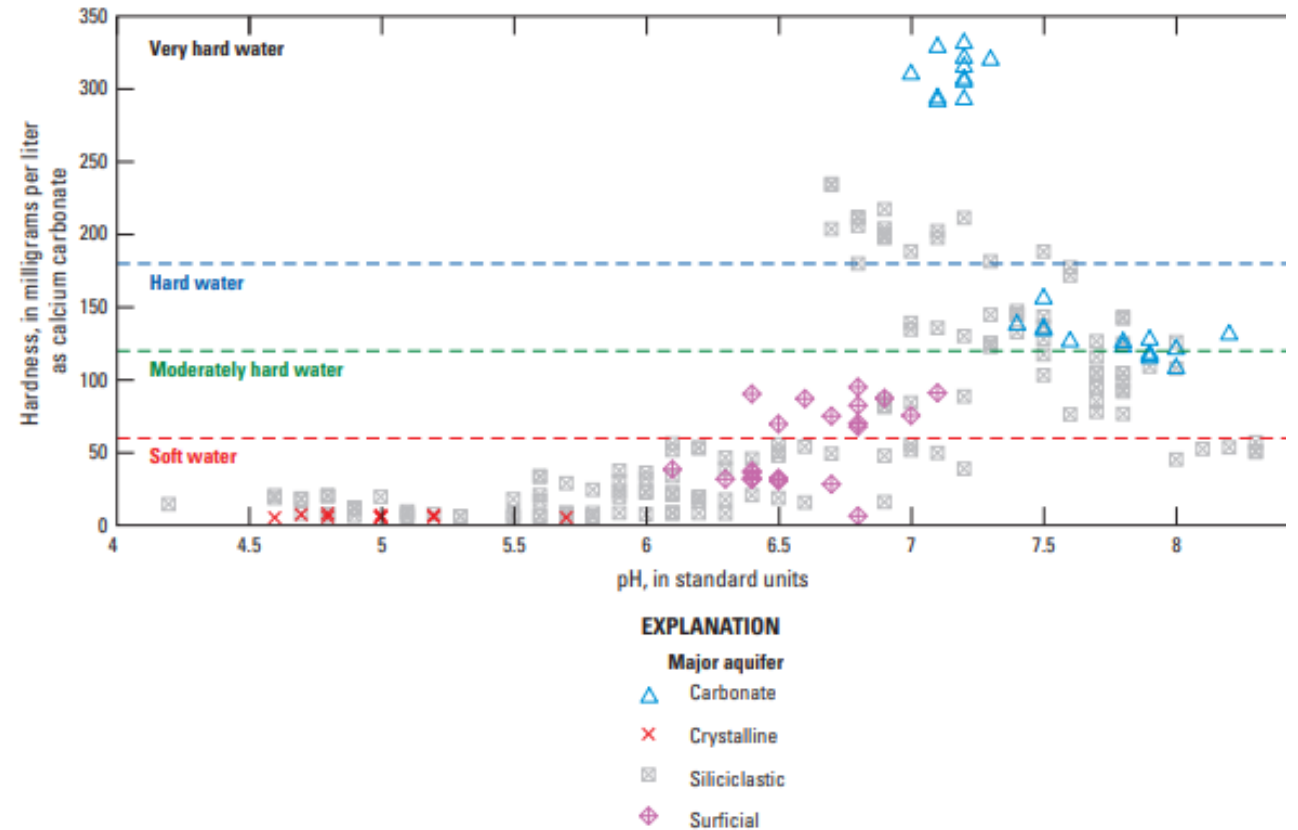
Water type of samples

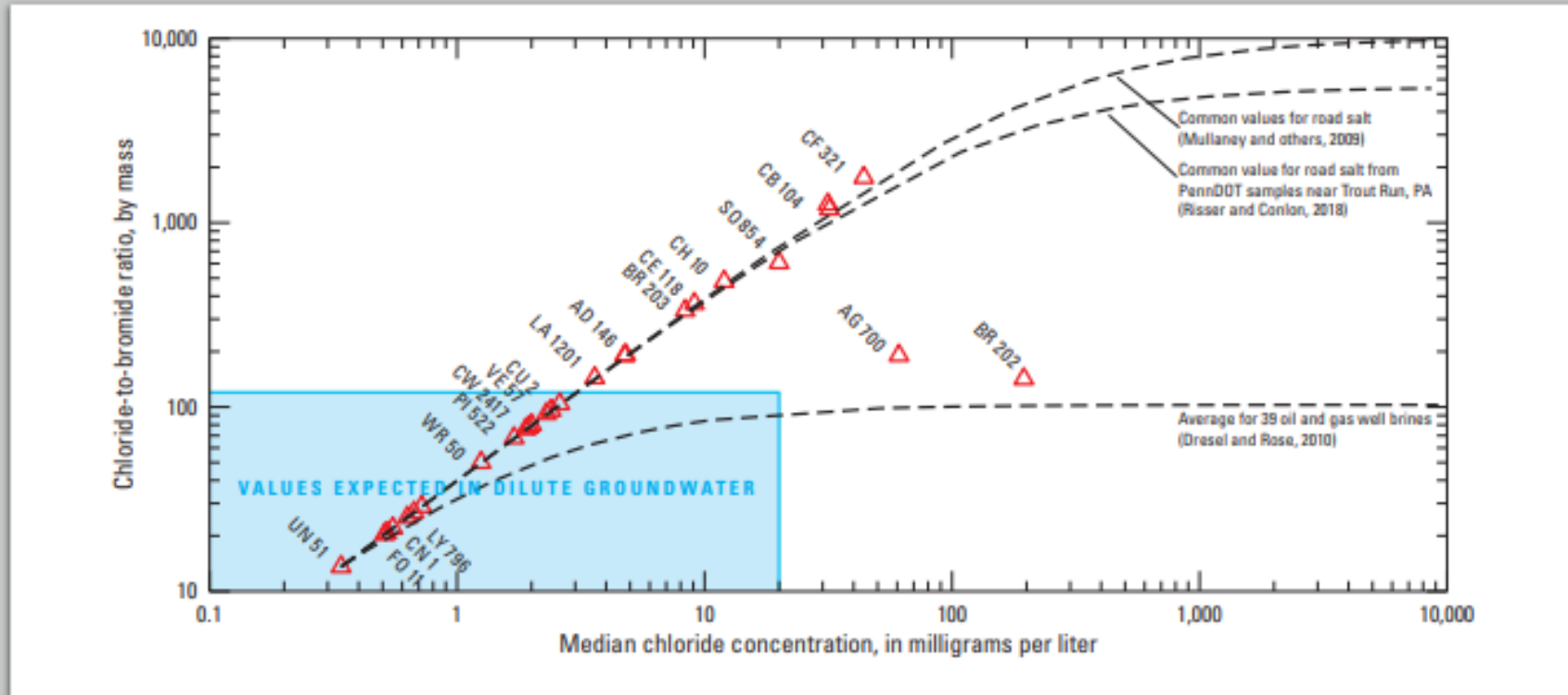
- Majority of wells have calcium- or bicarbonate-dominant water types, typically sampled from siliciclastic and carbonate aquifers.
- Sodium/potassium-dominant water types found in wells with high specific conductance.
- High sodium is greater than 1:1 relationship to chloride



Influence of rock type

- Wells in carbonate settings had hardest water, highest pH
- Wells in crystalline settings had softest water and lowest pH
- Wells in siliciclastic settings contained a wide range of pH and water hardness (also dissolved solids).





Salt mixing curves

- Most wells plot along expected curve for dilute groundwater
- AG700 and BR202 plot closer to gas well brines, suggesting mixing of brine sources and cation exchange

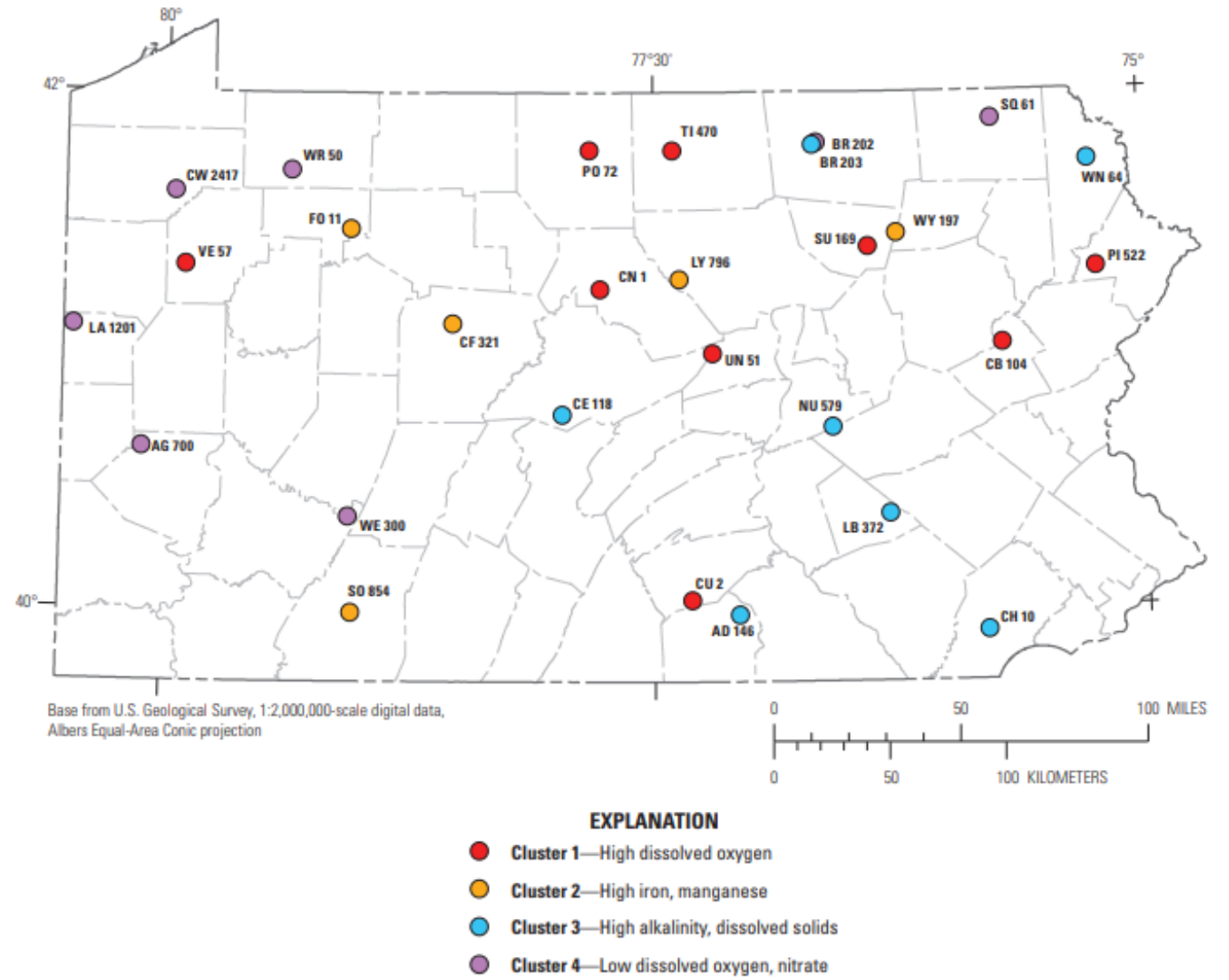
Principal Components Analysis

- Three PCs explain 74.46% of variance in water quality dataset.
 1. Dissolved solids (major ions)
 2. Redox (iron/manganese, low DO)
 3. Sodium/Chloride, other salts
- Results of individual wells can be sorted into groups with this information through hierarchical clustering.

Parameter	PC1 (TDS)	PC2 (Redox)	PC3 (Na-Cl)
Specific conductivity at 25 °C	0.93	0.30	0.07
Alkalinity	0.91	0.26	-0.17
Strontium	0.89	0.04	-0.19
Dissolved solids dried at 180 °C	0.88	0.30	0.09
Calcium	0.82	0.39	-0.13
Magnesium	0.82	0.28	-0.07
pH	0.74	0.27	-0.34
Fluoride	0.74	-0.32	-0.30
Barium	0.74	-0.42	0.28
Sodium	0.72	0.30	0.46
Potassium	0.72	-0.09	0.29
Lithium	0.71	-0.35	-0.01
Silica	0.66	-0.02	-0.05
Sulfate	0.64	0.27	-0.14
Phosphorus	0.56	-0.33	-0.39
Chloride	0.48	0.47	0.60
Iron	0.41	-0.75	0.19
Manganese	0.39	-0.85	0.20
Nitrate	-0.28	0.81	-0.02
Dissolved oxygen	-0.69	0.38	0.04
Eigenvalue	10.06	3.54	1.29
Variance explained	50.32	17.70	6.44
Cumulative variance	50.32	68.03	74.46

Hierarchical Clustering

- Four main clusters of wells based on PCA results.
- Clusters show impacts of geology, land use, and other external factors that affect water quality.



Filtered vs. Unfiltered samples

- Major ions, nitrate, and some trace elements showed no difference between paired filtered and unfiltered results.
- Some trace elements and nutrient species showed differences between paired filtered and unfiltered results.

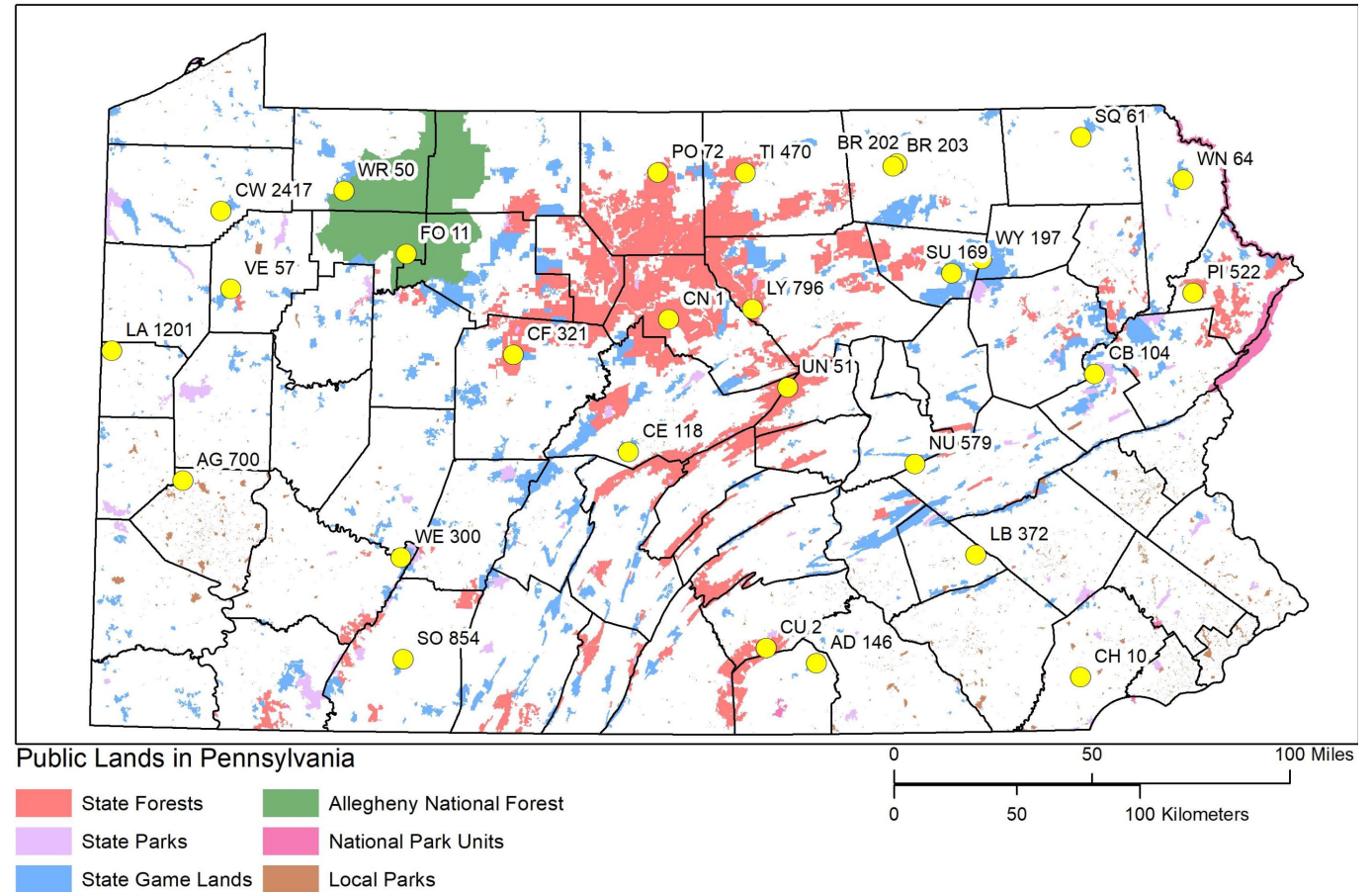
Table 3. Results of Wilcoxon rank-sum tests that compare the paired filtered and unfiltered samples for selected constituents for 221 samples collected from 28 wells within the Pennsylvania Groundwater Monitoring Network, 2015–19.

[µg/L, micrograms per liter; mg/L, milligrams per liter; N, nitrogen]

Constituent	Units	Number of comparisons	P-value	Minimum difference	Median difference	Maximum difference
Aluminum	µg/L	49	0	-52	11.1	1,439
Arsenic	µg/L	73	0	-0.72	0.06	7.64
Barium	µg/L	220	0	-20	0.4	67.9
Cadmium	µg/L	57	0	-0.067	0.003	0.1
Iron	µg/L	125	0	-400	180	22,900
Manganese	µg/L	164	0	-70	1.04	213.3
Phosphorus	mg/L as phosphorus	91	0	-0.01	0.001	0.064
Silica	mg/L	219	0	-7.87	-0.07	5.838
Ammonia	mg/L as N	72	0.0001	-0.03	0	0.108
Potassium	mg/L	219	0.0004	-0.52	0.01	0.385
Copper	µg/L	111	0.0005	-2.08	0	6.89
Zinc	µg/L	38	0.0011	-8.64	0.5	152.7
Calcium	mg/L	219	0.0810	-5.2	0.01	4.3
Nickel	µg/L	31	0.0951	-1.34	0.01	1.89
Lithium	µg/L	96	0.1160	-10	0	10
Sulfate	mg/L	203	0.1510	-2	0	2
Sodium	mg/L	219	0.1658	-12	0.001	9
Magnesium	mg/L	219	0.1691	-2	0	0.6
Strontium	µg/L	181	0.3094	-30	0	60
Chloride	mg/L	202	0.4189	-109	0	4
Nitrate	mg/L as N	129	0.6016	-0.4	0	0.18
Molybdenum	µg/L	46	0.6100	-2.04	0.001	14.271
Boron	µg/L	66	0.8621	-10	0	11
Selenium	µg/L	13	0.8799	-0.9	-0.1	0.5
Fluoride	mg/L	144	0.9678	-0.88	0	0.06
Thallium	µg/L	109	0.9998	-0.02	0	0.7

Evolution of the Network

- Expansion of the Network, focusing on public lands – reach out to land operators/stewards in selected locations.
- Plan to visit potential locations over summer 2022
- Additional analyses for advanced characteristics of wells i.e., Groundwater age tracers



PA Groundwater Monitoring Network Data

Constituent:
Fluoride

Information

Plot of Fluoride from samples of well LB 372

Key

- Mapper is currently in review.
- No date for release yet; issues with cloud hosting policy development

The median value for Fluoride detections in well LB 372 is 0.06 mg/l, which is lower than the median value of 0.11 mg/l across the Network.

Interactive Mapping Tool

Well Name: LB 372
Most recent value: 0.08 mg/l
Sample Date: 2021-10-14
Number of samples collected at this site: 14
 Additional site data can be accessed [here](#)

Fluoride, in milligrams per liter

- 0.2 to 0.4 mg/l
- 0.4 to 0.6 mg/l
- 0.6 to 0.8 mg/l
- 0.8 to 1 mg/l
- Below Reporting Limit

Legend:

- County Boundaries
- Marcellus Shale Extent
- Major Aquifer Type
- Physiographic Province

Scale: 50 km / 50 mi

Leaflet | Tiles © Esri — Esri, DeLorme, NAVTEQ, TomTom, Intermap, IPC, USGS, FAO, NPS, NRCAN, GeoBase, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), and the GIS User Community

Pennsylvania major aquifer data from: Lindsey, B.D., Bickford, T.M., 1999, <https://pubs.er.usgs.gov/publication/wri994076>
 Pennsylvania physiographic provinces data from: Pennsylvania Department of Conservation and Natural Resources, 2008, <https://www.pasda.psu.edu/uci/DataSummary.aspx?dataset=1153>
 For more information about the Pennsylvania Groundwater Monitoring Network, please contact Matthew Conlon at mconlon@usgs.gov

Features of Mapper

Selection of commonly detected constituents – map plots most recent sample season values.

Plot of constituent over time when selecting a well – includes median, number of samples, and number of non-detects, as well as comparison to Network-wide median.

Basemaps including counties, Marcellus shale extent, major aquifers, and physiographic provinces.

Access to real-time USGS webpages for selected sites.

Updates automatically as data is added to NWIS.



Data Release for Mapper

- A Data Release is being prepared that will contain all analytical data collected for project; this will be linked to mapper for ease of access to data.
 - Data Release will be updated following each sampling season with newly-collected data.

Questions?





Contact information

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Links

Report: [USGS SIR
2021-5119](#)

Data Release:
[ScienceBase Data
Release landing
page](#)

Mapper (in
review): [GWMN
Map](#)