An Investigation of Private Drinking Water Quality

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ESRI Health GIS Conference

Colorado Springs, Colorado

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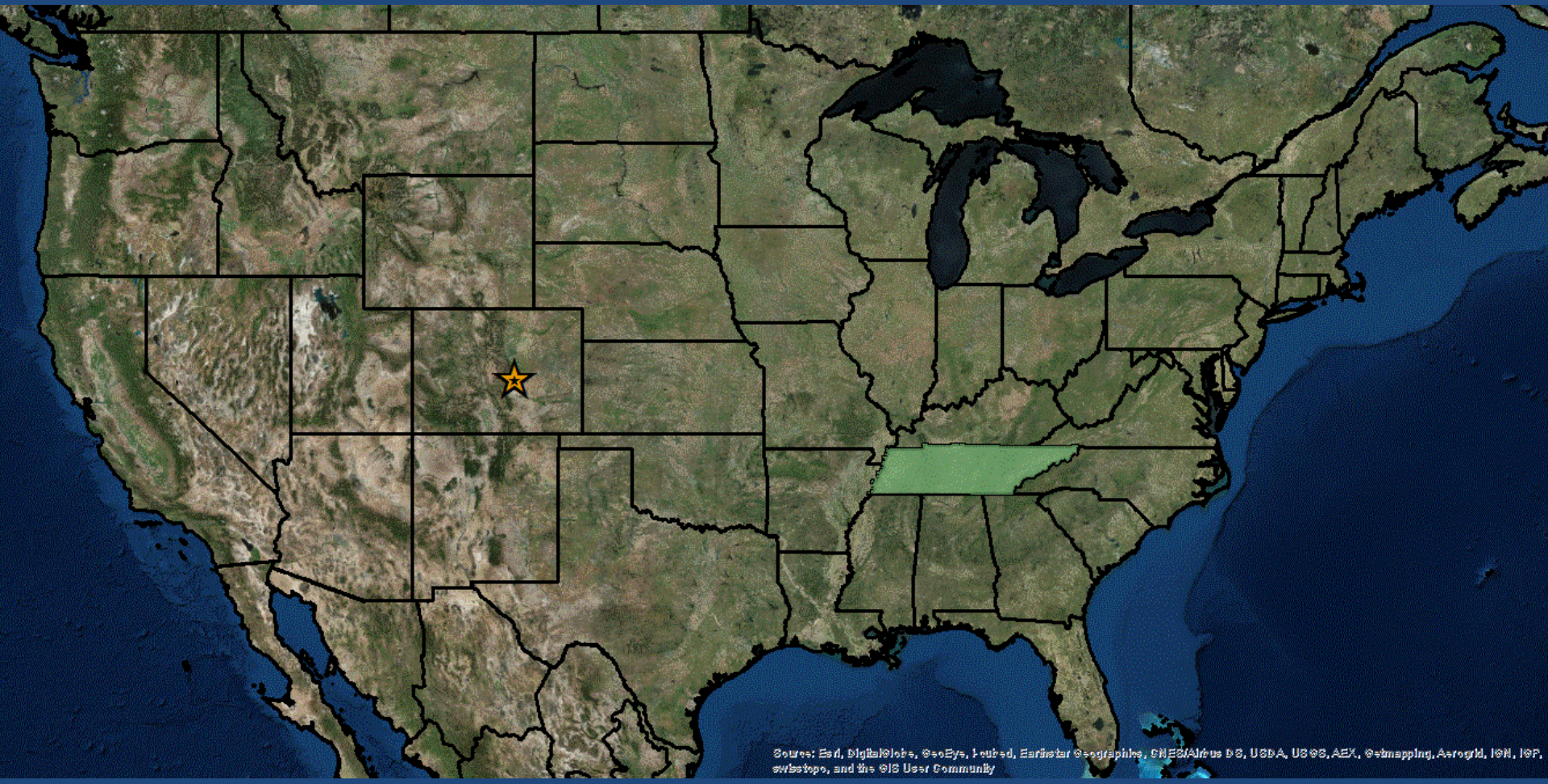

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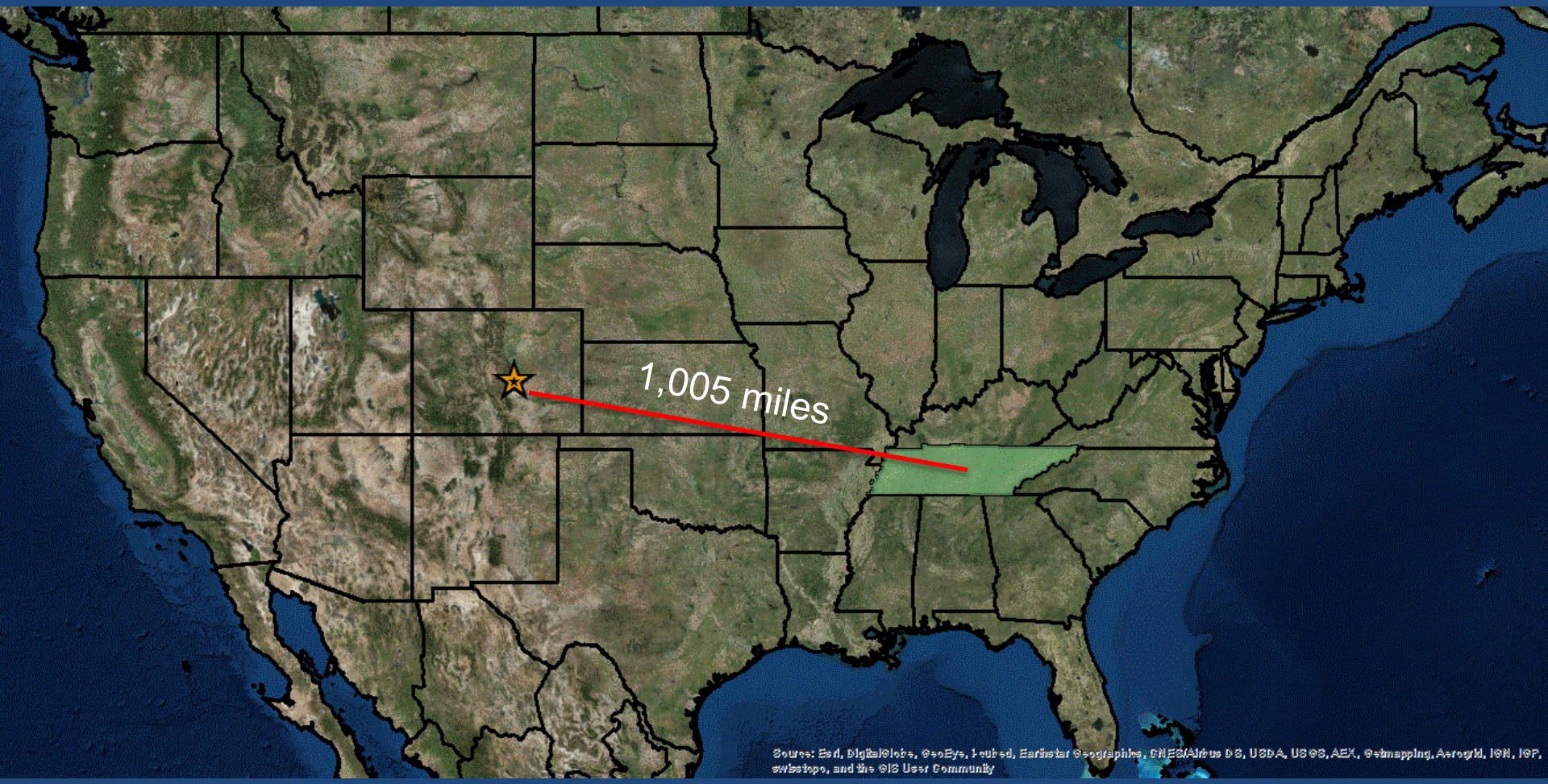

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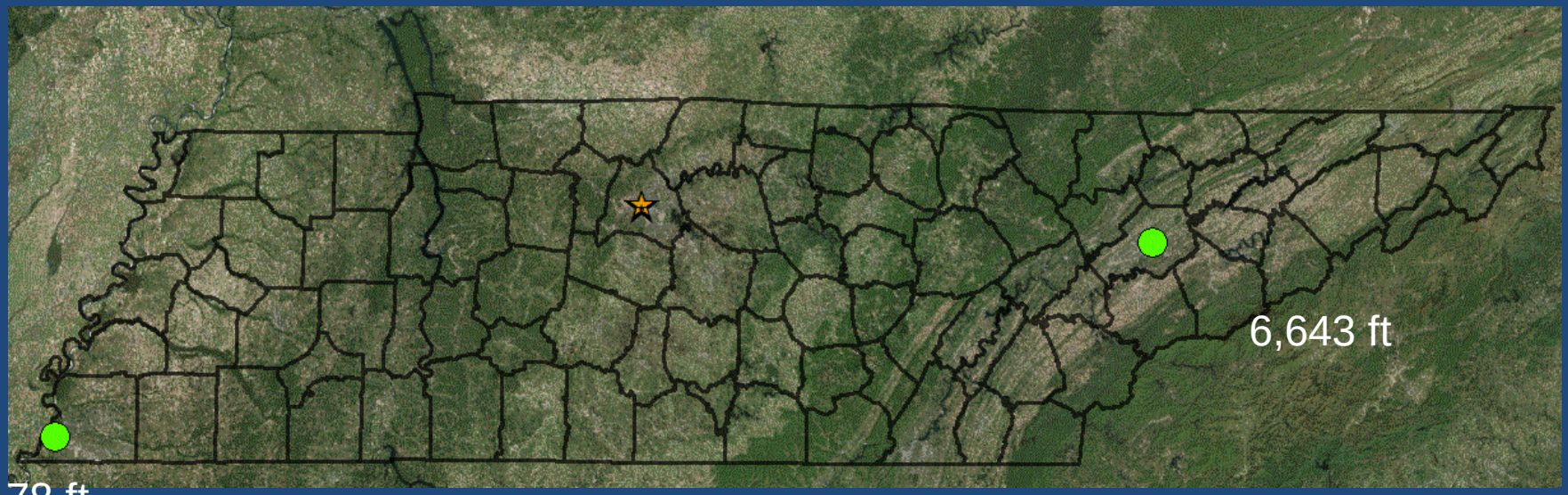

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Appalachian Mountains

Rocky Mountains

Background

- Public water regulated by state/tribe and EPA
  - PWS serves at least 15 service connections or 25 people daily for 60 days or more per year
- Maximum contaminant levels
  - Public water systems
  - Set by EPA to safeguard human health

http://water.epa.gov/drink/contaminants/

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Source Water Testing

- Water supply wells tested by TDEC
  - Groundwater quality report
- Representative of state geography
- Multiple parameters
  - Bacteria, metals, pesticides, radon and other radionuclides

http://www.tn.gov/environment/water/docs/water-supply/2012gw305b.pdf

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Radon

- Naturally occurring radioactive, carcinogenic gas
  - breakdown of uranium or thorium
  - Half life of about 4 days
- In indoor air
  - 2nd leading cause of lung cancer
  - Concentrations of 4 piC/L in air
- In water
  - Ingestion linked to some cancers
  - 10,000 piC/L in water = +/- 1 piC/L in air

http://water.epa.gov/lawsregs/rulesregs/sdwa/radon/regulations.cfm

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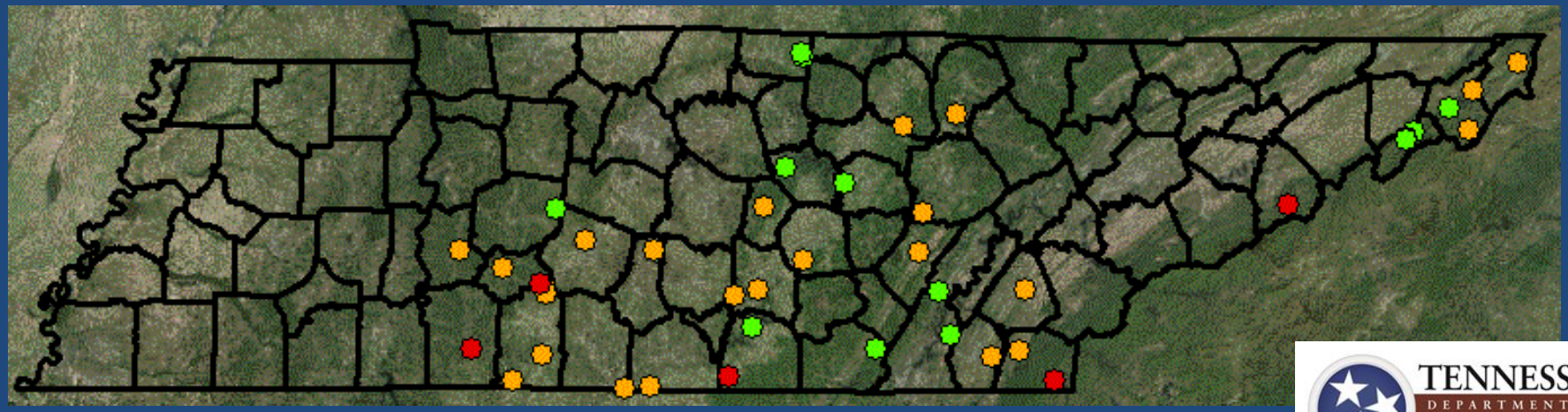
TDEC Radon Results

- EPA Draft MCL
  - 300 piC/L or 4,000 piC/L AMCL
- 92 samples, 37% over 300 piC/L
  - Range 30.6 – 9,910 piC/L
  - 5 over 1,000 piC/L



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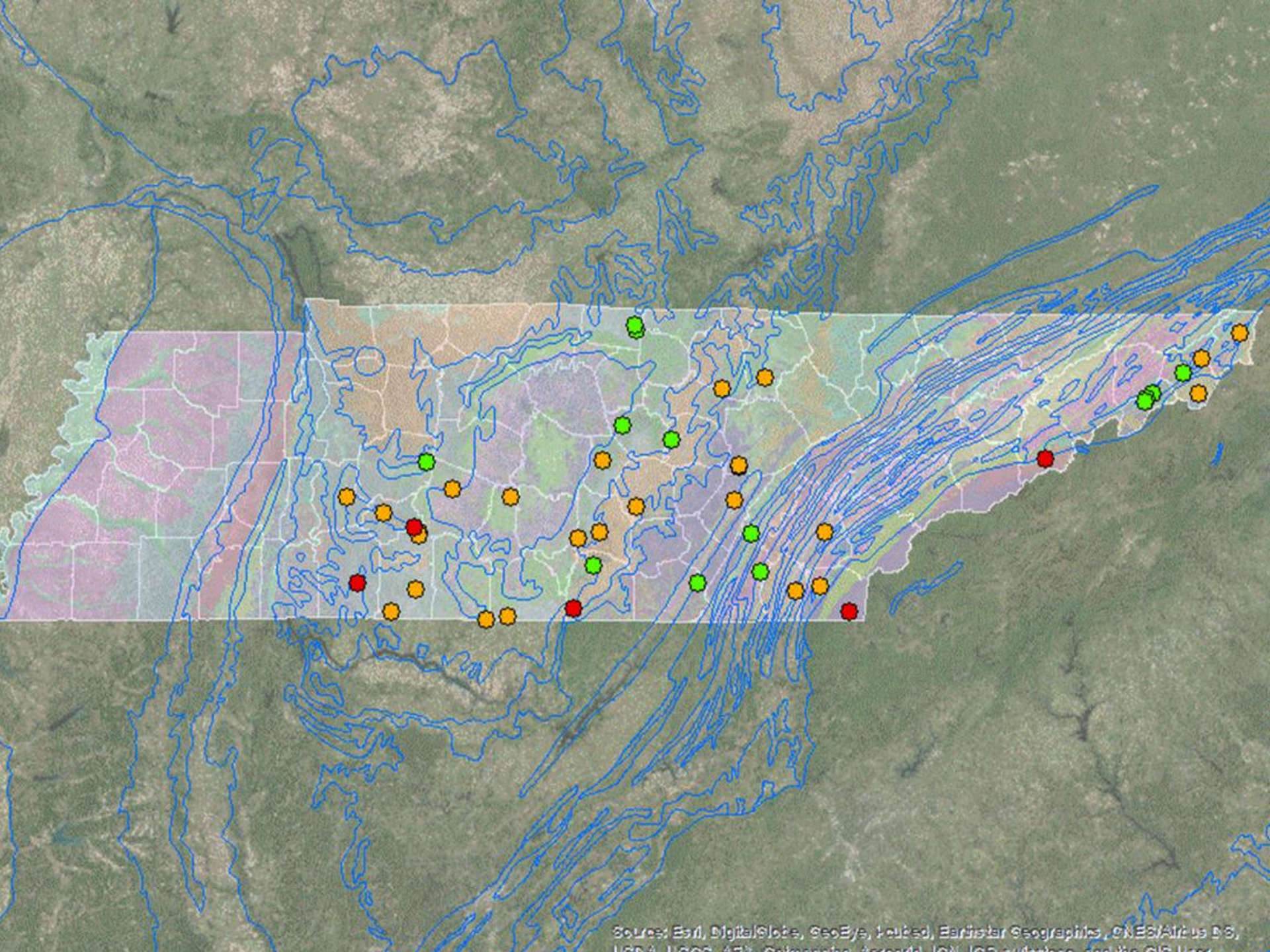
Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS,

What about private water supply?

- Nationally, 15% use private water supply
  - 11% in Tennessee (640,000)
- Water quality not regulated
  - Well installers notify
- 15% treat water
  - Filtration
- Sensitive populations?

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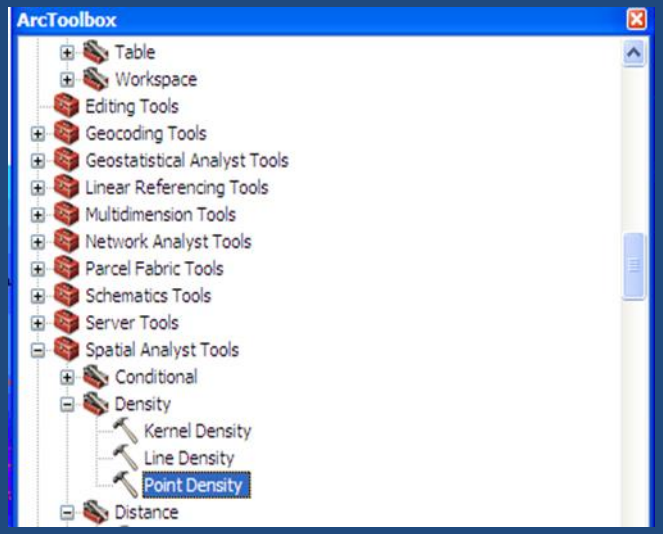
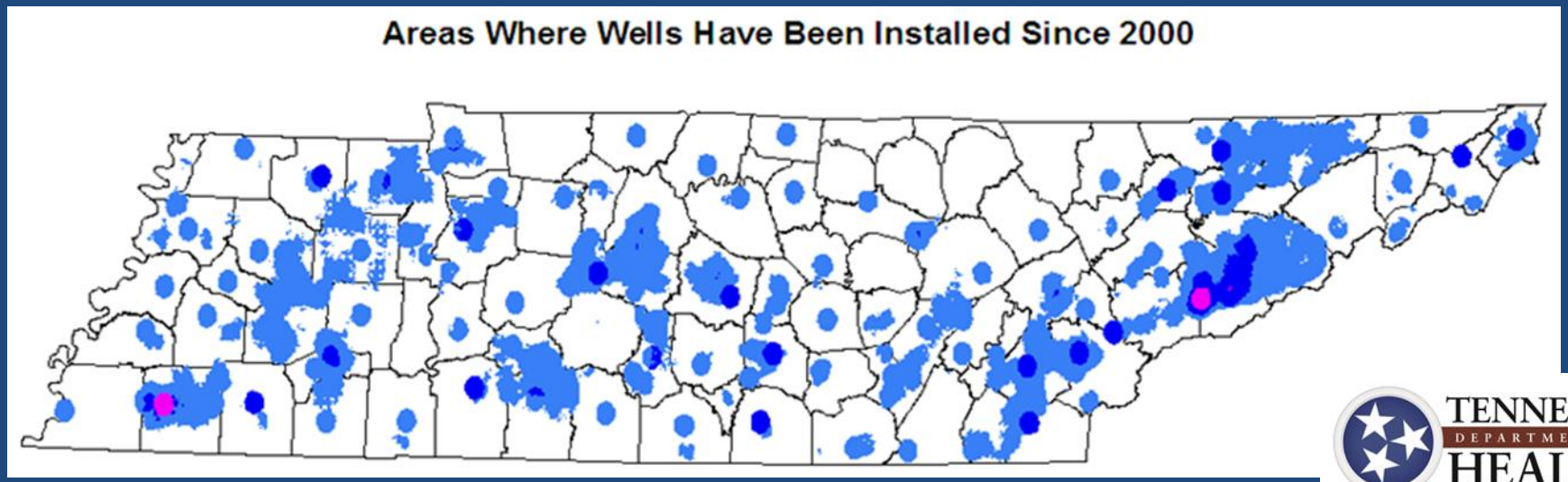
Methods

- Identify locations
  - Known public wells
  - Identify nearby private wells
    - Areas without public water
    - GIS of water well drilling NOI
    - Door to door





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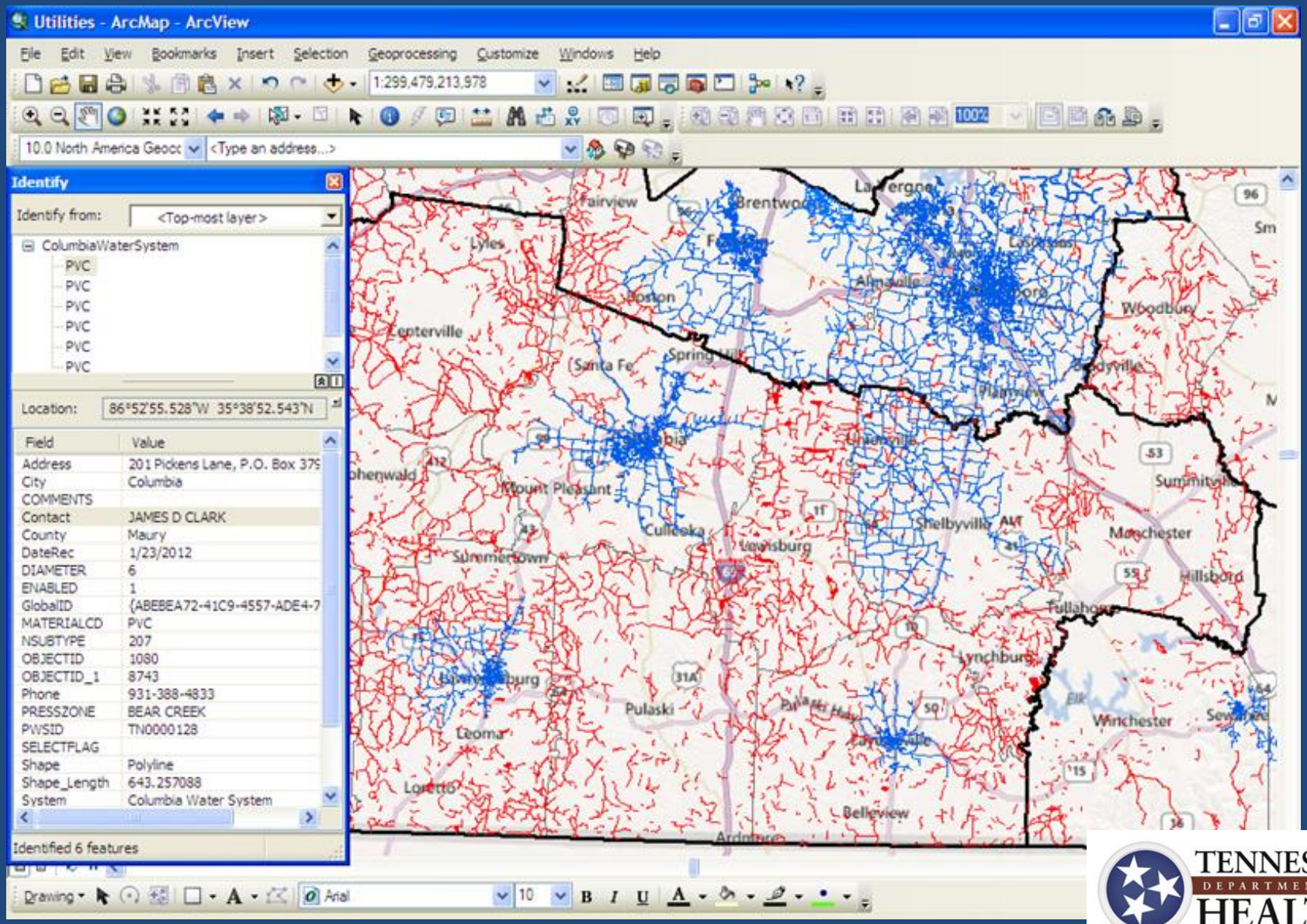
Areas without public water



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Sample Water

- EPA Standard Methods
  - Bacteria, nitrates, metals, radon
- Comparison with geologic formation and land use

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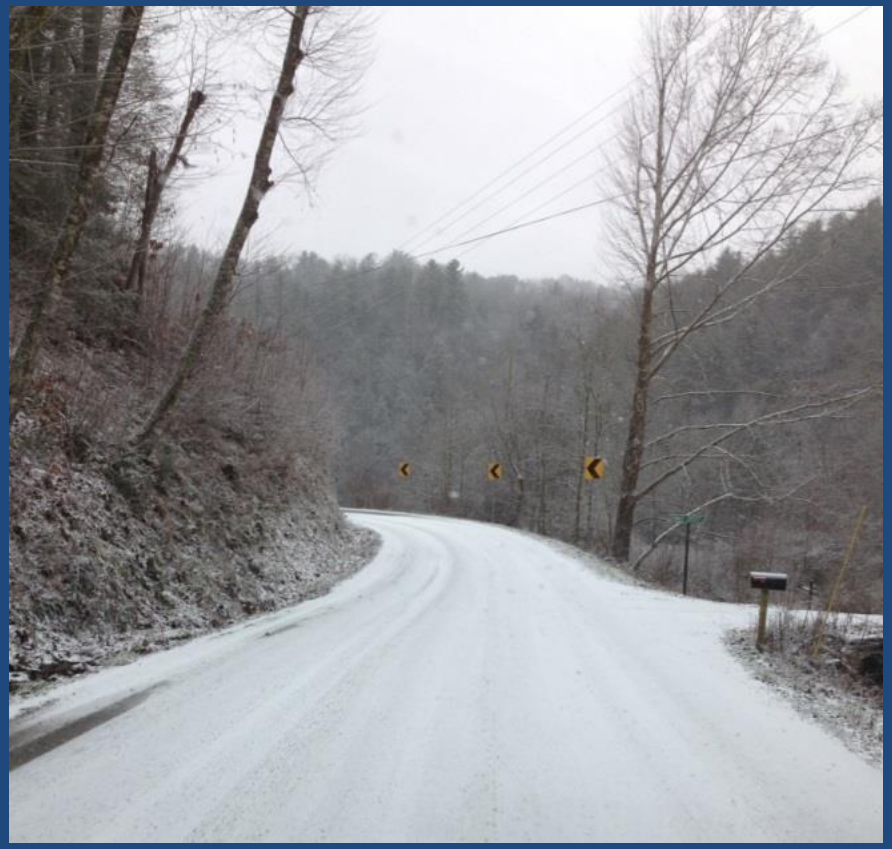
Results

- Water sampling
  - 143 wells
  - 7 springs
  - 9 surface streams
- January to July 2014
- 6 geographic regions



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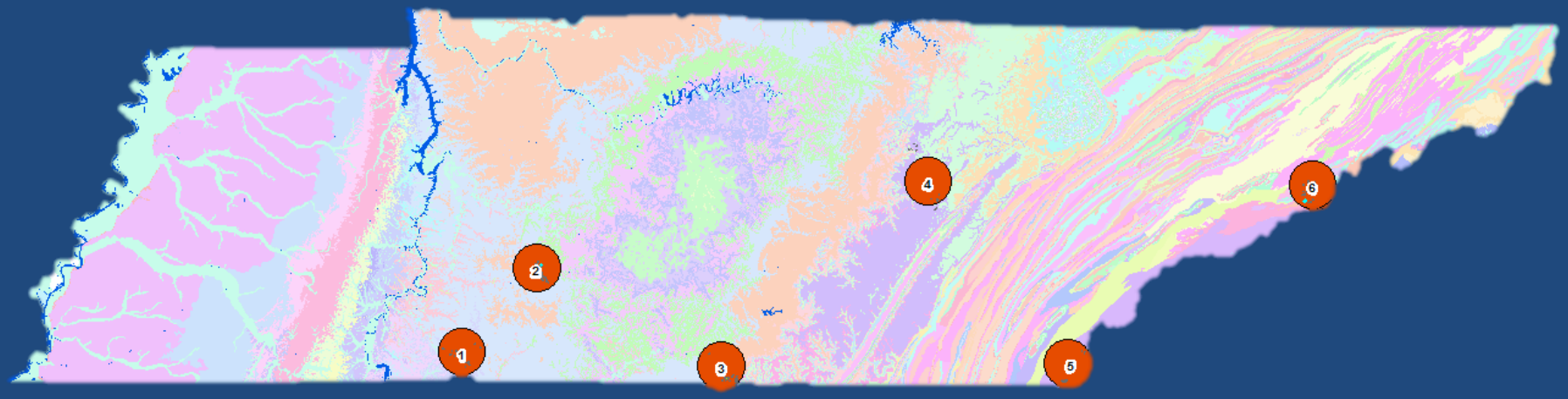
WELL-X-TROL

Geologic location



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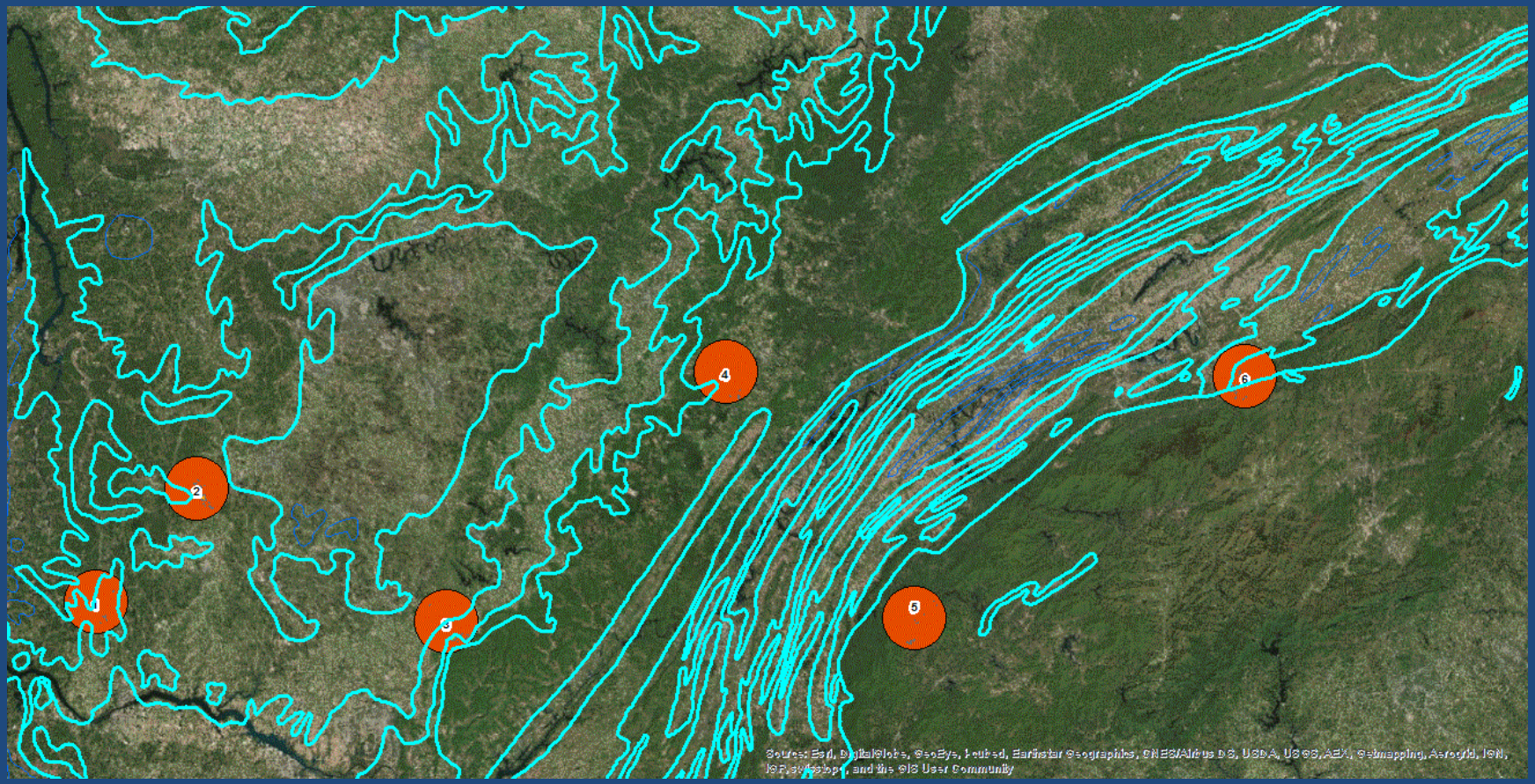
Aquifers



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Coliform Bacteria

- 50 total coliform positive (35.0 %)
  - Range 1 - >2,420 MPN/100mL
- 15 fecal coliform positive (10.5%)
  - Range 2 – >2,100 MPN/100 mL
- 11 *E. coli* positive (7.7%)
  - Range: 1 – 1,986 MPN/100 mL
  - EPA MCL = 0
- The maximum from the same well

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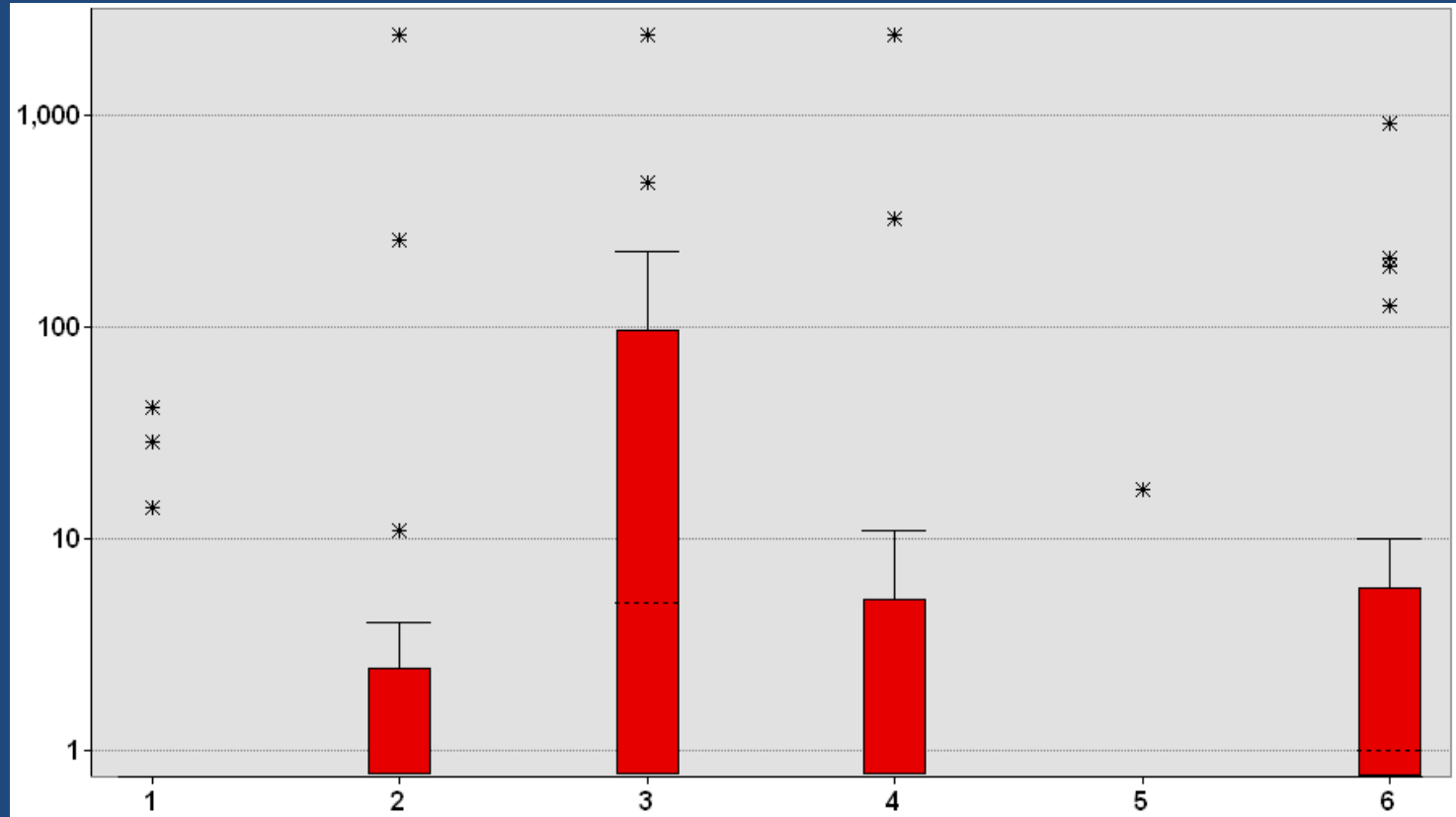
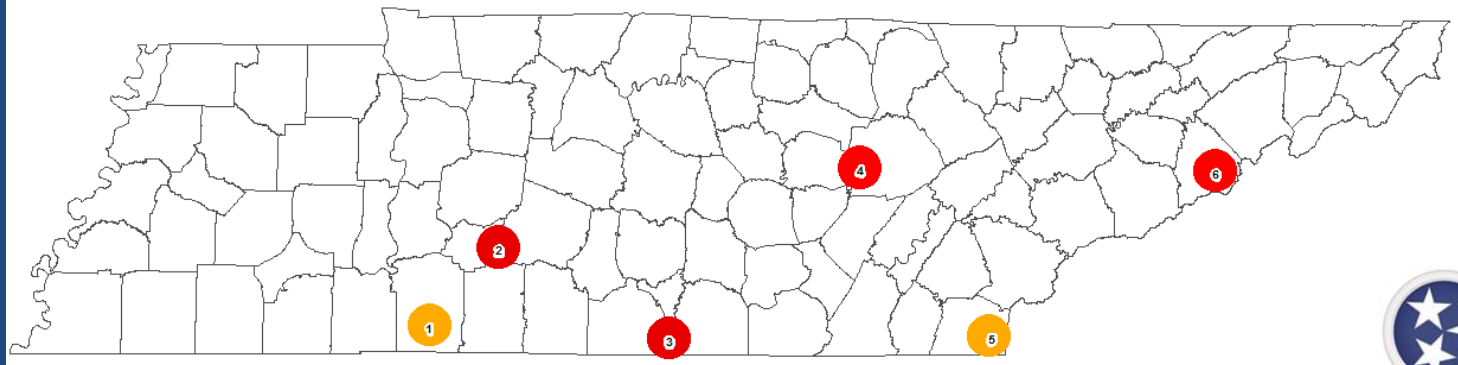
Coliform Distribution





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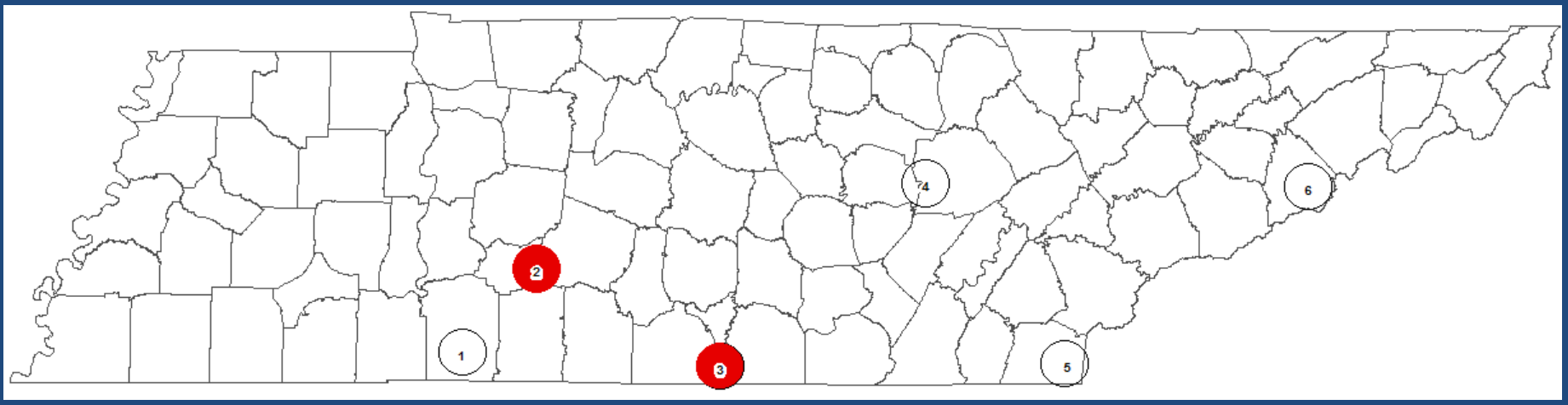
E.coli and Fecal Coliform



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Heterotrophic Bacteria

- Should not be used as indicator for health
- 85 positive (59.4 %) for heterotrophic bacteria
  - Range 1 - 623 CFU/mL
  - EPA Recommendation = 500 CFU/mL
- Higher HPC = lower *E.coli* detections
  - <73.8 CFU/100ml had higher coliform concentrations

http://www.who.int/water_sanitation_health/dwq/HPCFull.pdf

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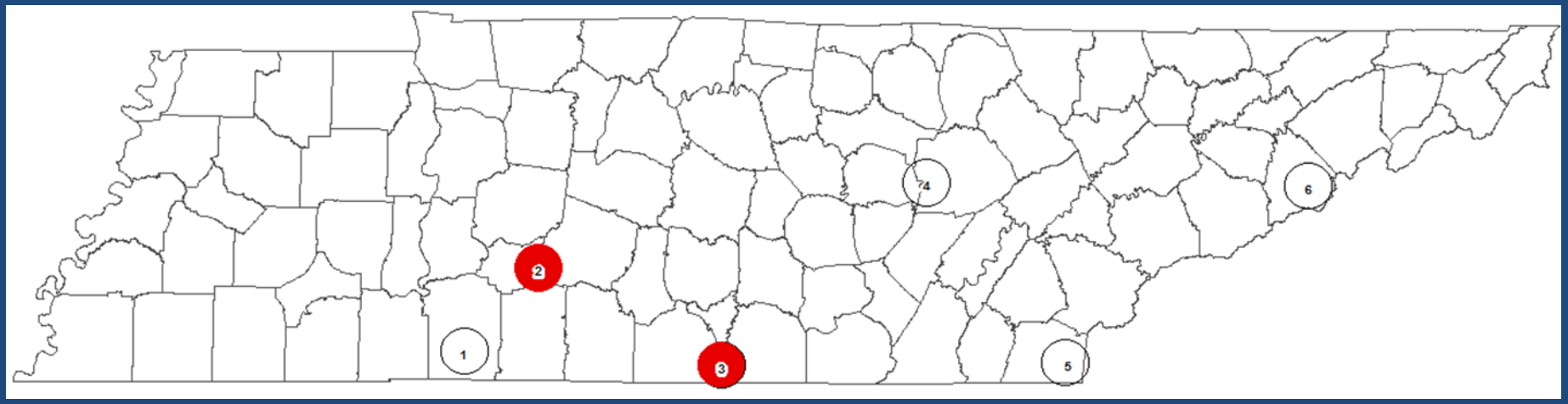
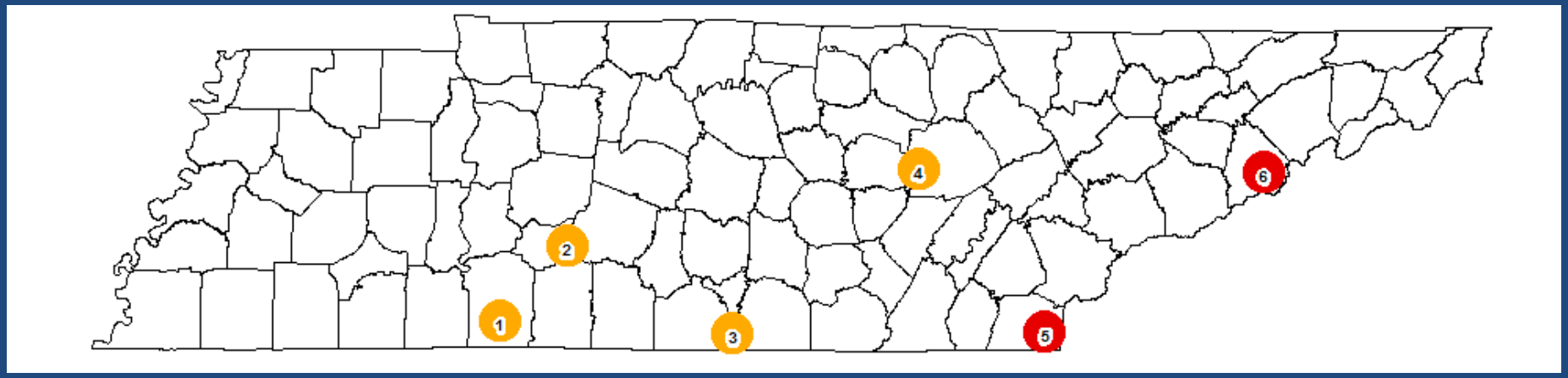
Coliform and HPC



E. coli and Fecal Coliform



HPC

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Nitrates

- Nitrate/Nitrite, Total Nitrogen
  - Nitrate EPA MCL 10 mg/L
  - Nitrite EPA MCL 1 mg/L

- Maximum 11 mg/L

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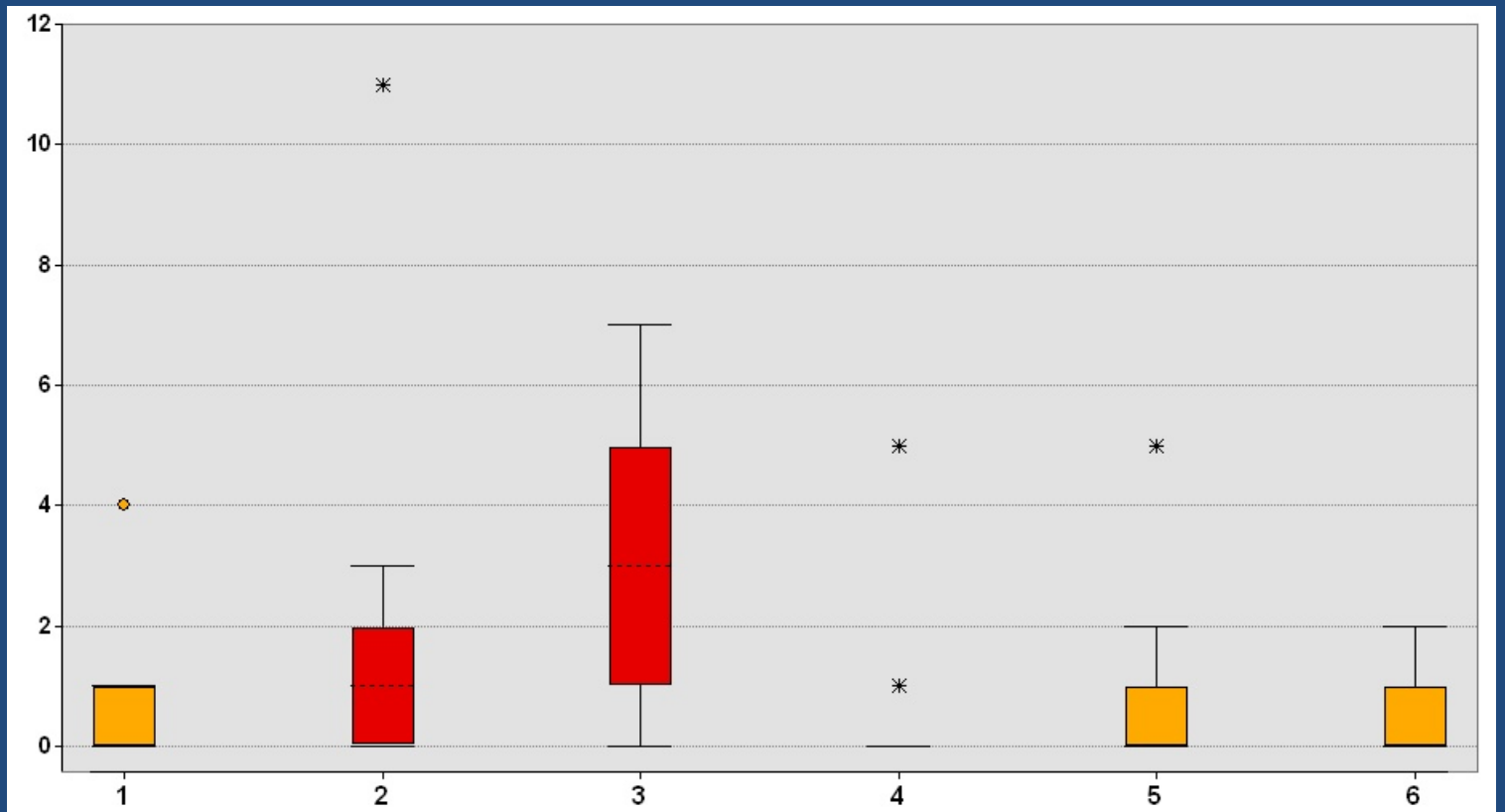
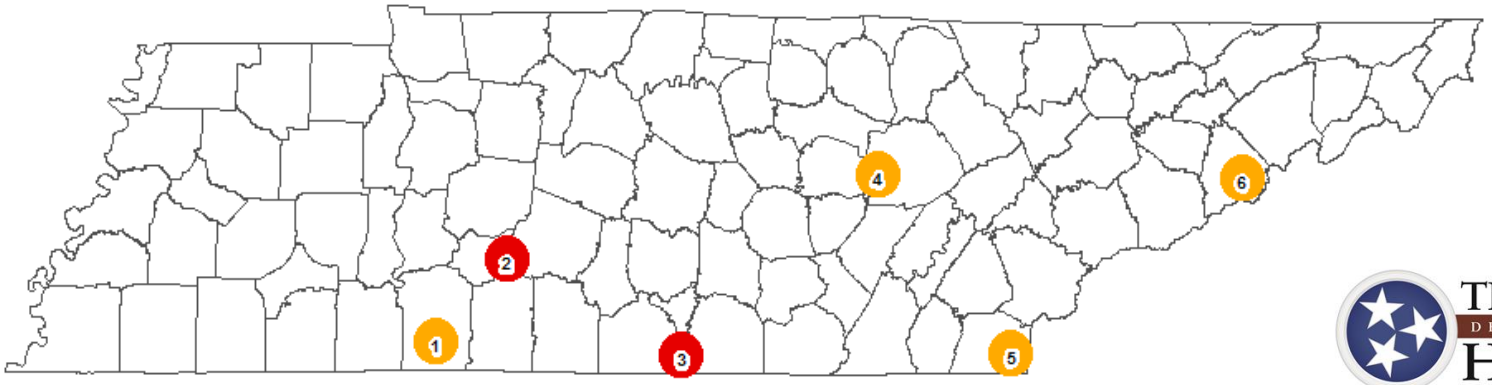
Nitrate/Nitrite (mg/L)





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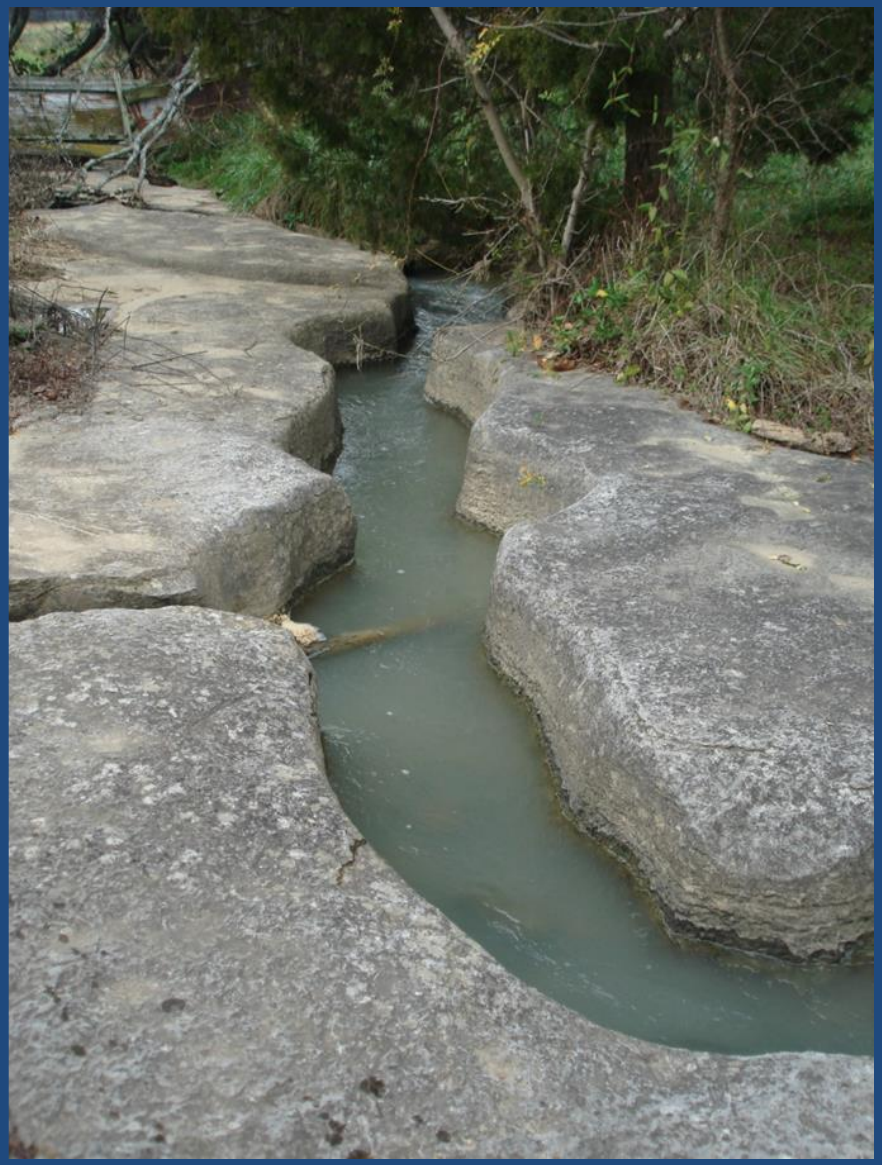
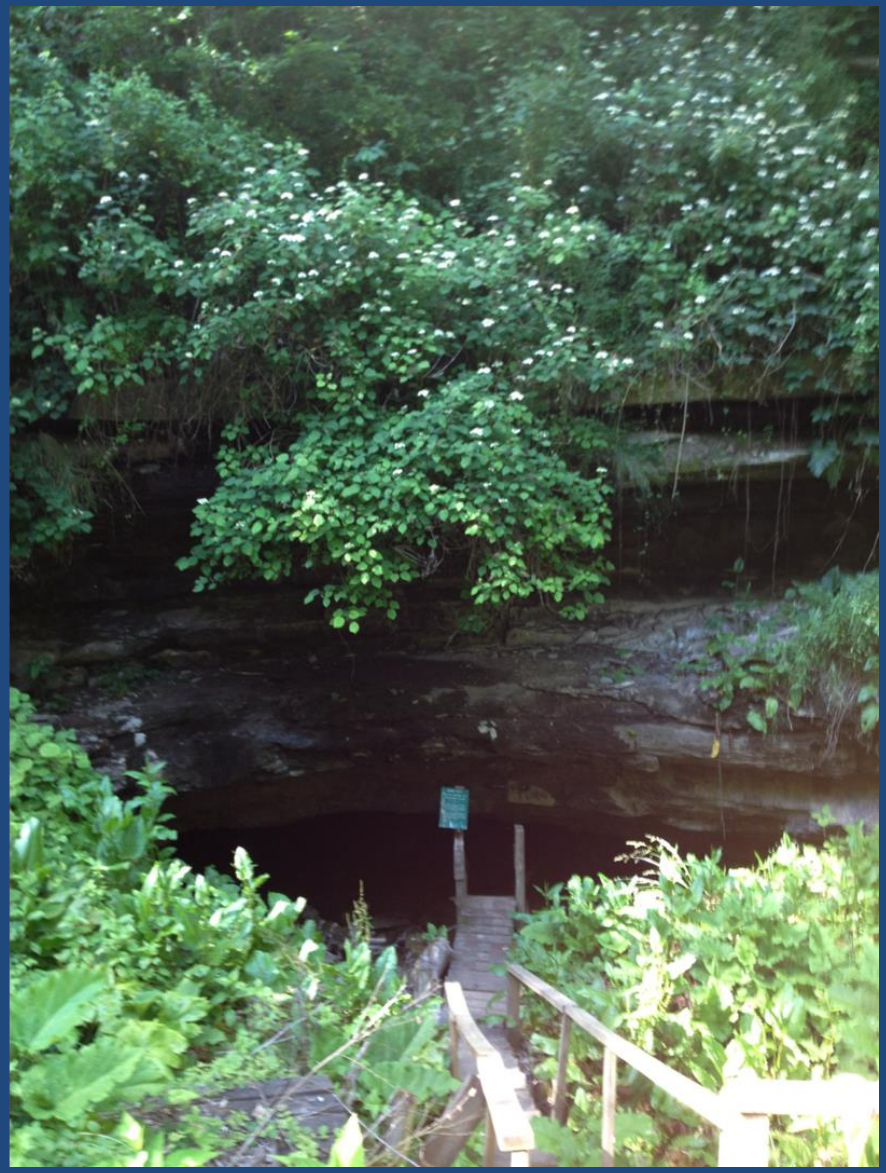
Karst

Dissolution of limestone and other calcite rock formations



Direct conduit for contaminants to enter water under the ground

Contaminants transported rapidly to aquifer or out to surface water



Land use

Well Hygiene

Metals

- 23 metals
  - naturally occurring
- EPA Primary MCL
  - Human health impacts
- Secondary MCL
  - Taste, odor, staining
    - Examples: Aluminum, Iron, Manganese, Zinc

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Primary MCL Metals

- Lead
  - 66 wells
  - 2 over the 0.015 mg/L action advisory
- Mercury
  - 3 wells, one over MCL
- Arsenic
  - 11 wells, none over the MCL
- Barium
  - 139 wells, one over 2.0 mg/L MCL
  - Maximum detection 4.6 mg/L
- Chromium
  - 46 wells, one over 0.1 mg/L MCL
  - Maximum 0.22 mg/L

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Secondary MCL Metals Results

Metal	Secondary MCL (mg/L)	Average (mg/L)	Maximum (mg/L)
Aluminum	0.05 to 0.2	0.186198	10
Copper	1.0	0.030157	1.9
Iron	0.3	0.736906	31
Manganese	0.05	0.10031	3.8
Zinc	5	0.044479	6

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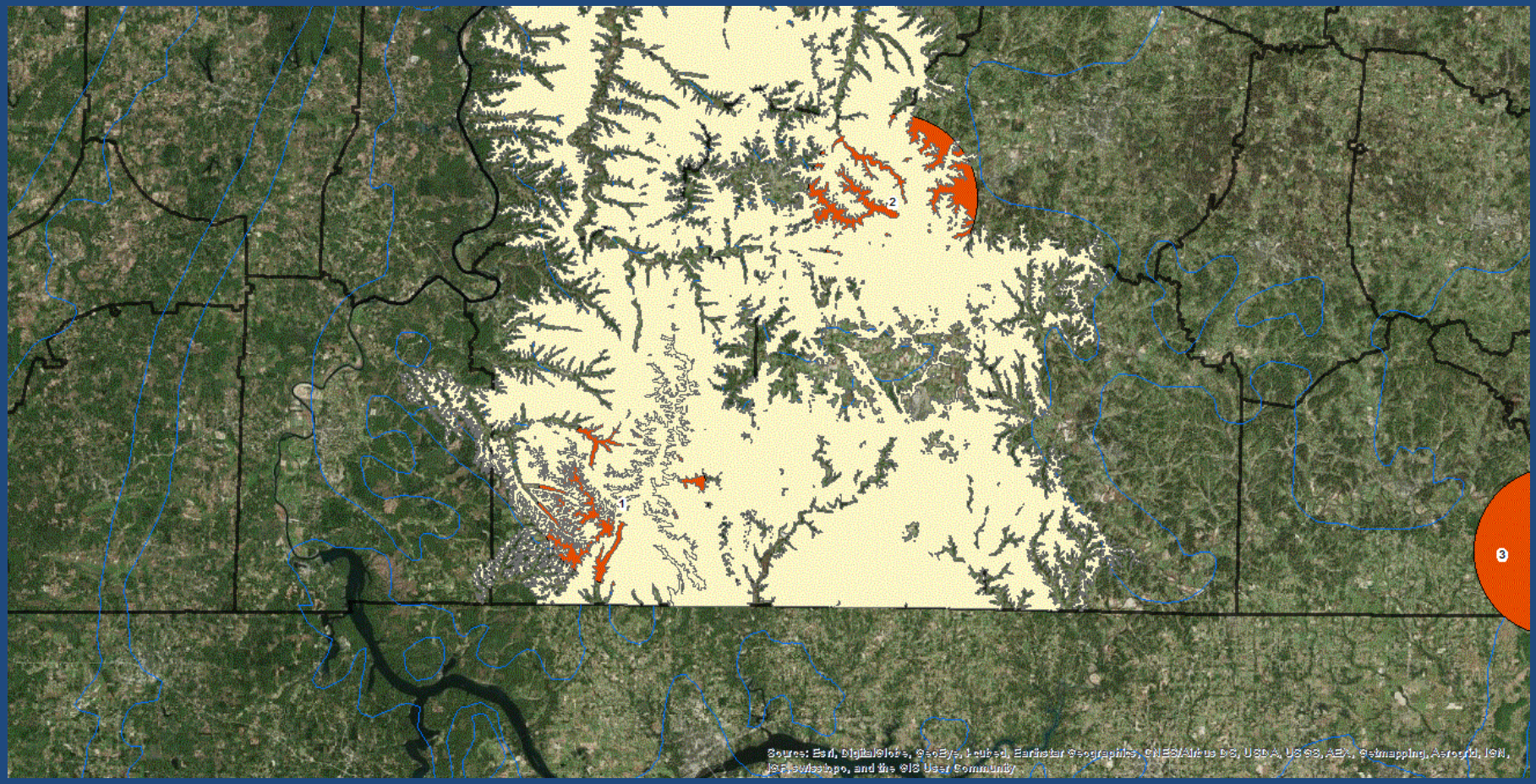
Iron City



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Radon Results

- Radon detected in every well, N= 143
  - Range 30.6 - 8,878 piC/L
- 115 above 300 MCL (80.4%)
- 18 above 4,000 AMCL (12.6%)

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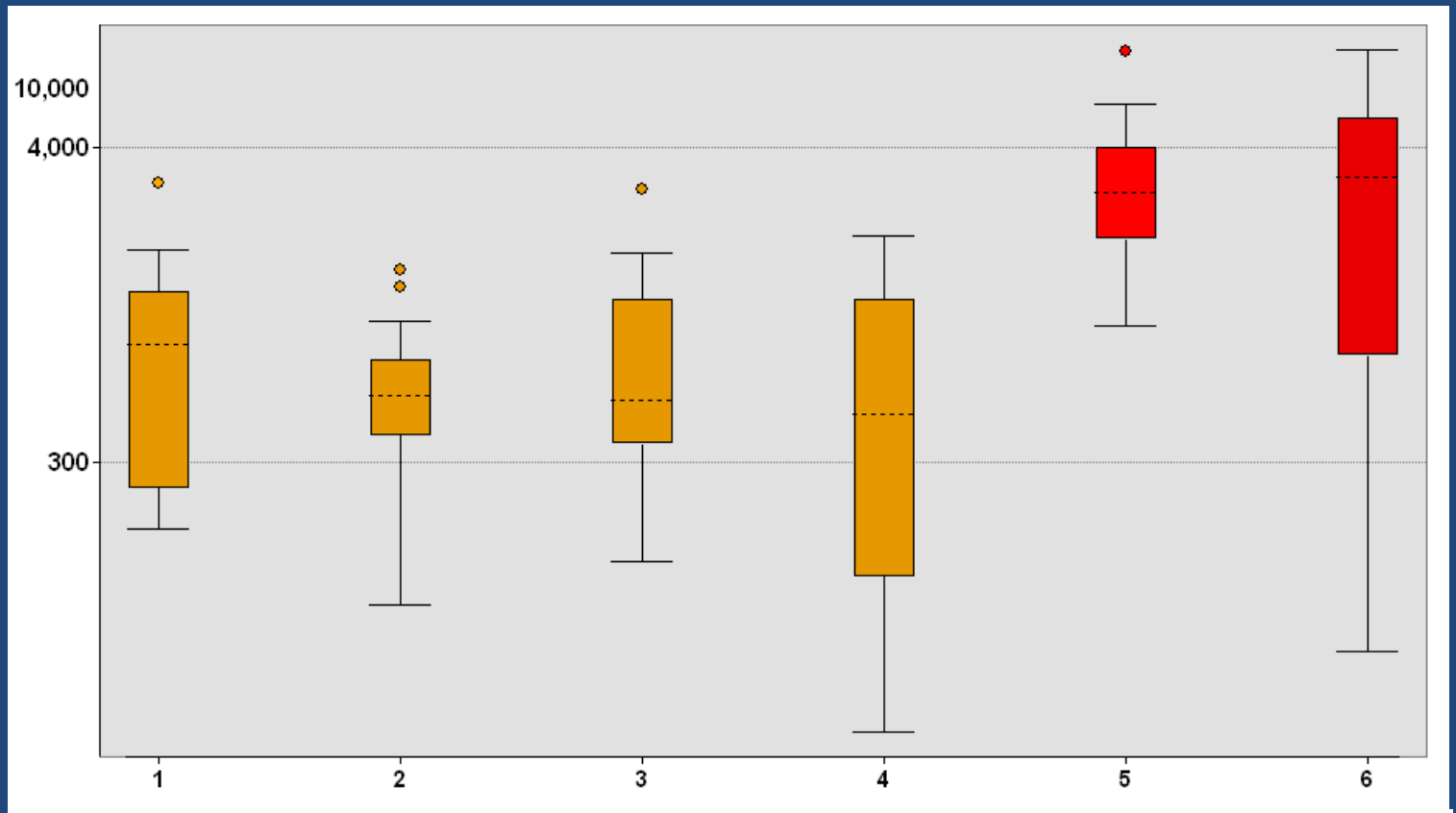
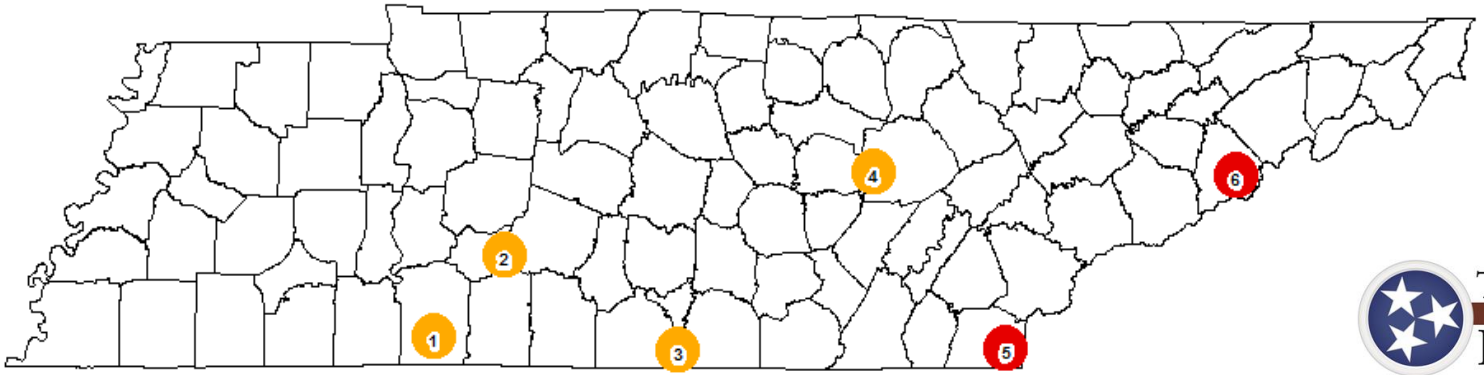
Radon Concentration (piC/L)





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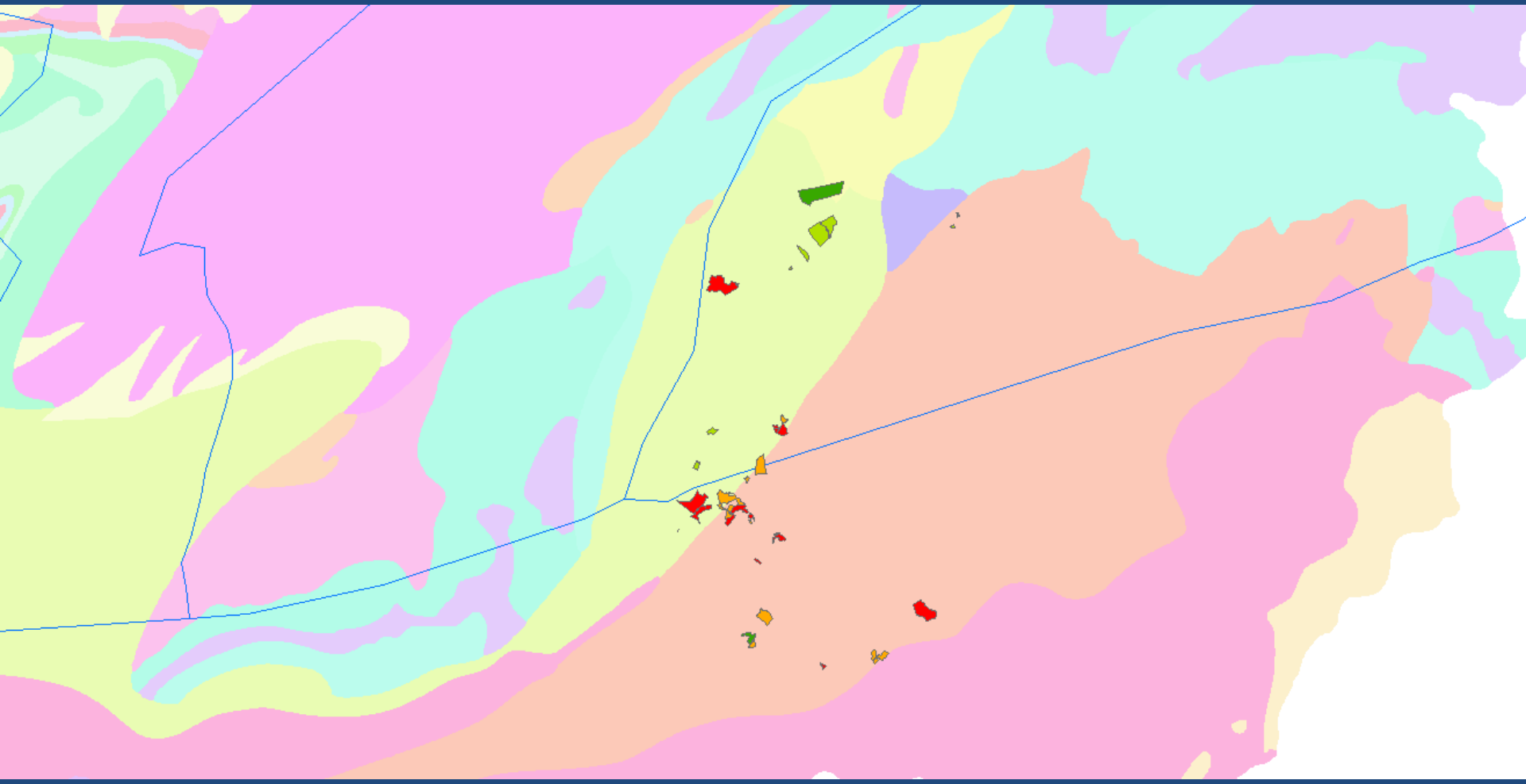
Geologic Formation and aquifer



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Springs

Surface streams

Water treatment

Future Work

- More data to create localized risk maps
  - TDEC, USGS
- Outreach
  - Rural Health Association
  - Kid Central TN
    - http://www.kidcentraltn.com/

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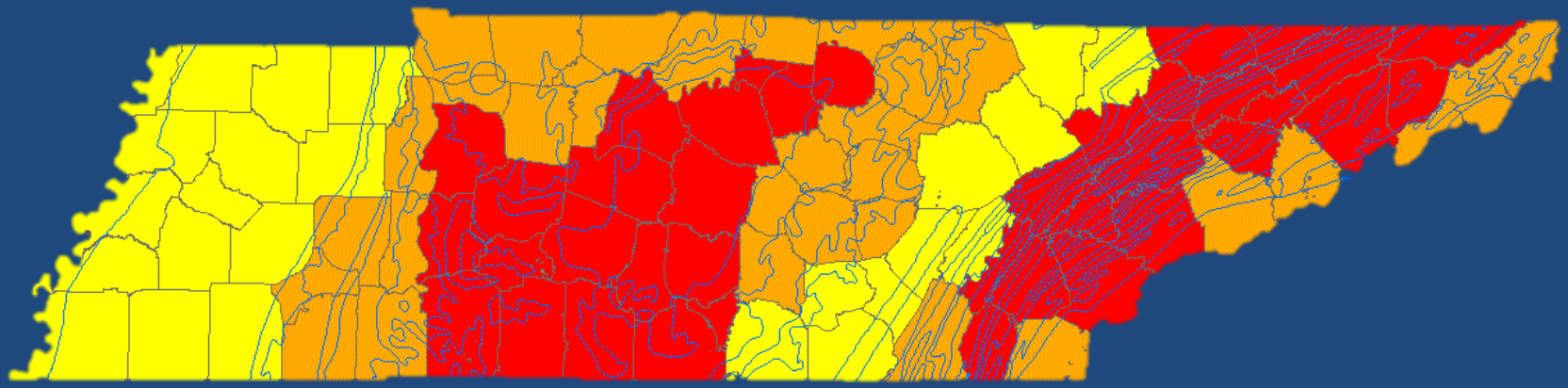
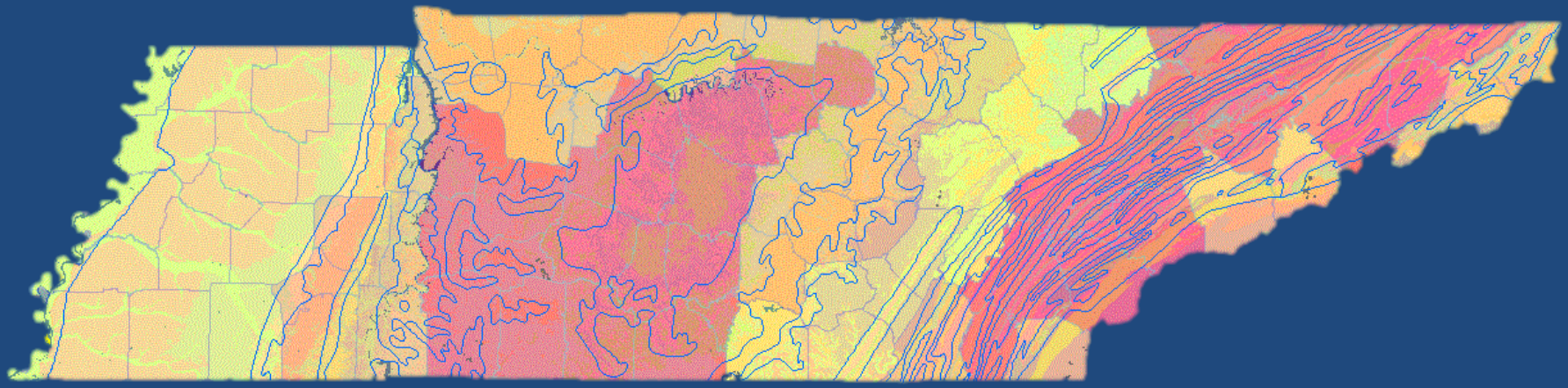
Radon Risk Maps





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Acknowledgements

- CDC National Center for Environmental Health
  - EHS-Network Water
- Tennessee Department of Environment and Conservation (TDEC)
  - Water Supply Program
- Division of Laboratory Services, TDH
- Private well owners

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