INDIANA GEOLOGICAL & WATER SURVEY
INDIANA UNIVERSITY

# Indiana Geological & Water Survey:
## Knowledge & Networks

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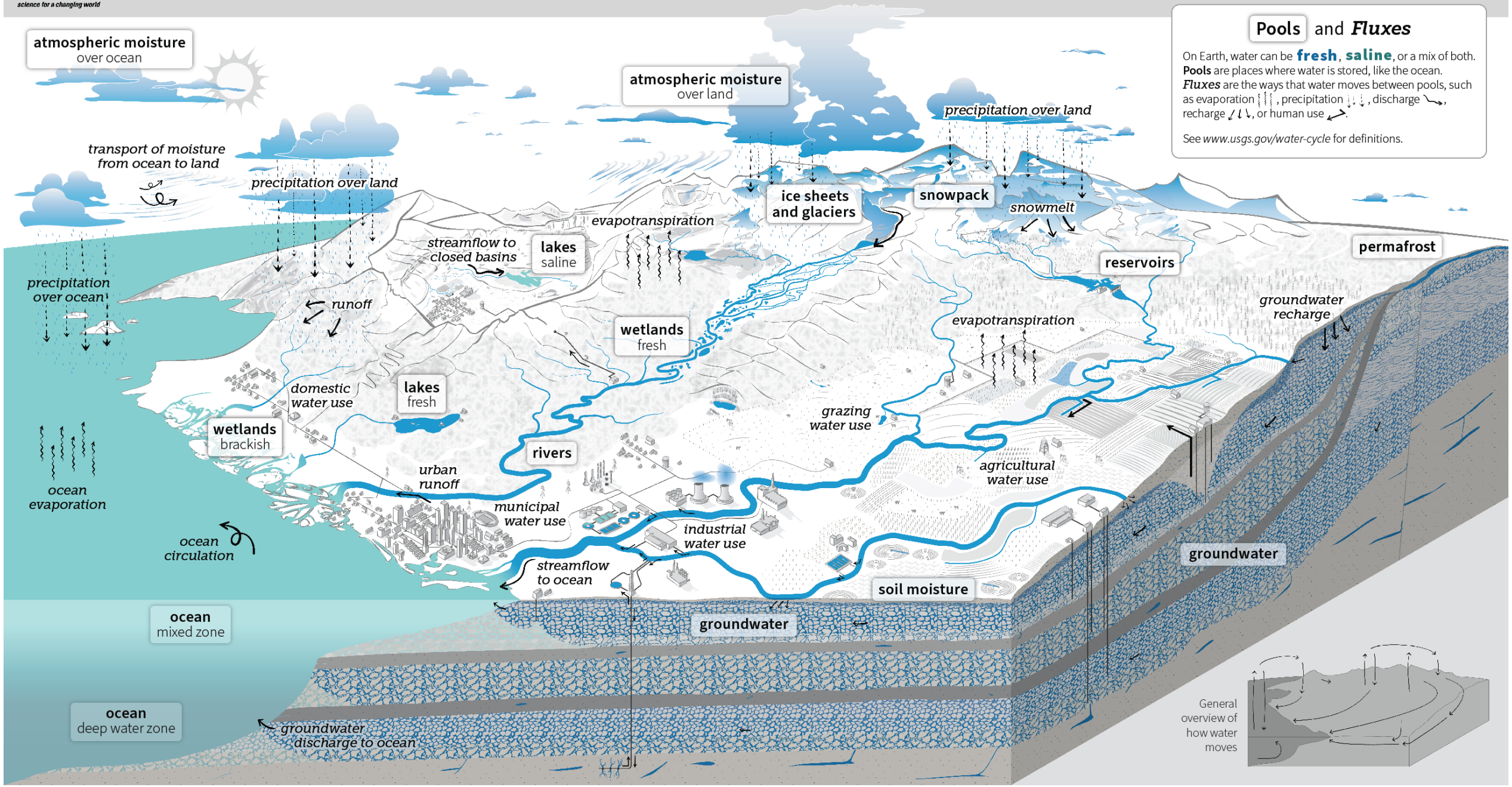
# Knowledge Transfer – Who you talk to?

USGS
science for a changing world




## Pools and *Fluxes*

On Earth, water can be **fresh**, **saline**, or a mix of both. **Pools** are places where water is stored, like the ocean. ***Fluxes*** are the ways that water moves between pools, such as evaporation, precipitation, discharge, recharge, or human use.

See *www.usgs.gov/water-cycle* for definitions.

# The Water Cycle

**Pools** store water. 96% of all water is stored in **oceans** and is

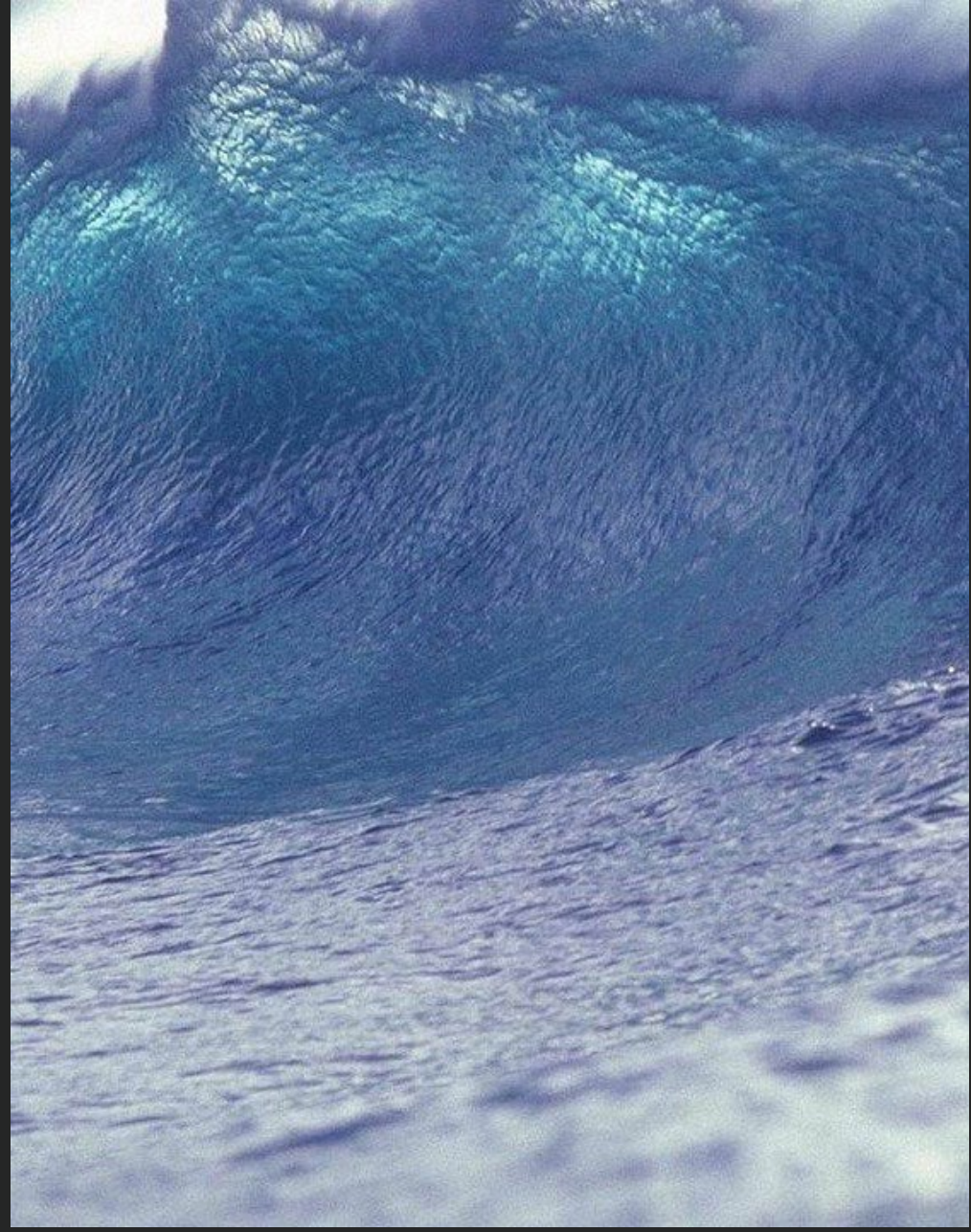
**Fluxes** move water between pools. As it moves, water can

We alter the water cycle. We redirect rivers. We build dams

We affect **water quality**. In agricultural and urban areas,

# Present & Future Work Changes

- Silver Tsunami-massive retirement of the Baby Boomers
- Duration in positions (3.8 - 4.3 years in 2022)
- COVID-19 – Work after the pandemic
- Remote work policies & future work
- Smart Machines- Machine Learning
- Work for purpose & passion- not money



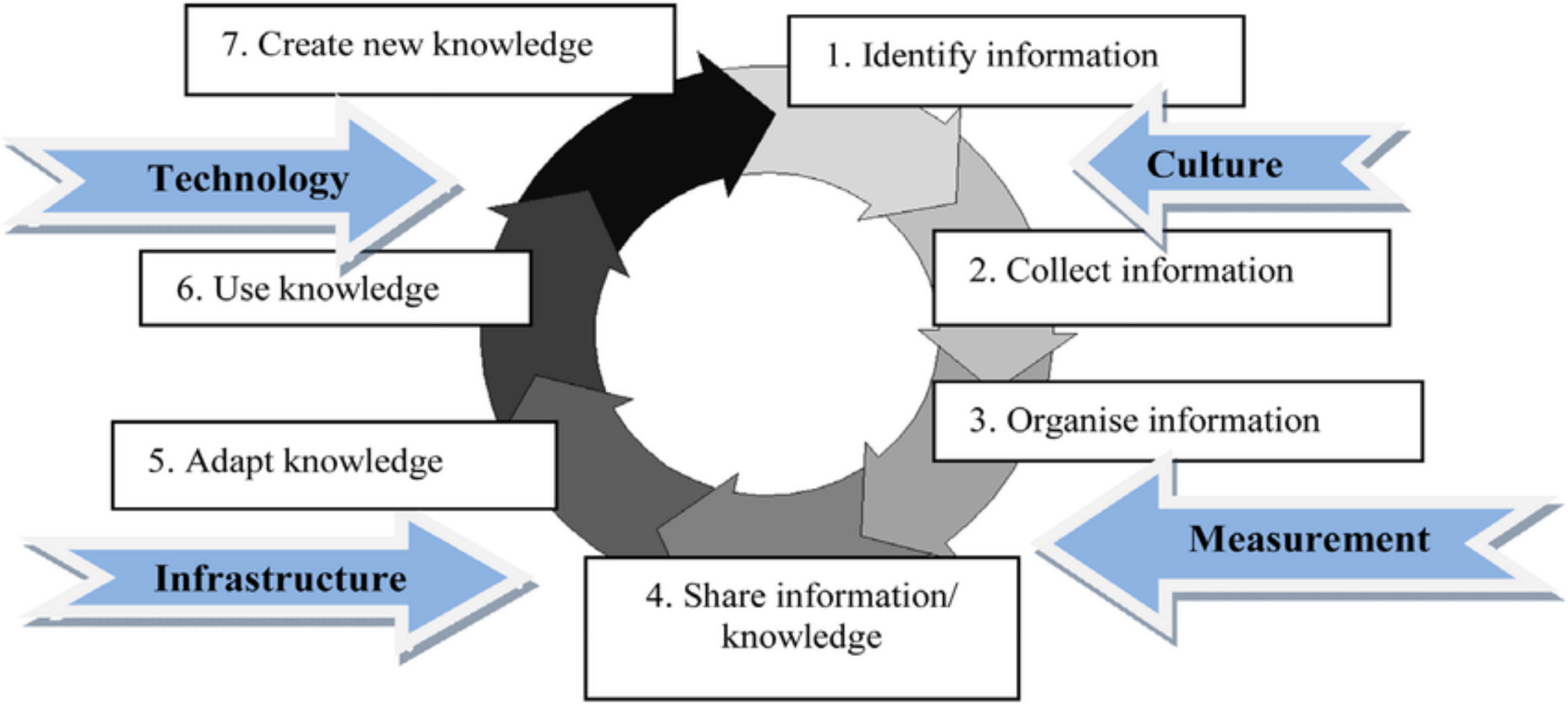
# Importance of a Knowledge Transfer Plan

- *“Don’t worry your still new”*
- *“I have only been here X years”*

  – How long can people in your organization use that line?

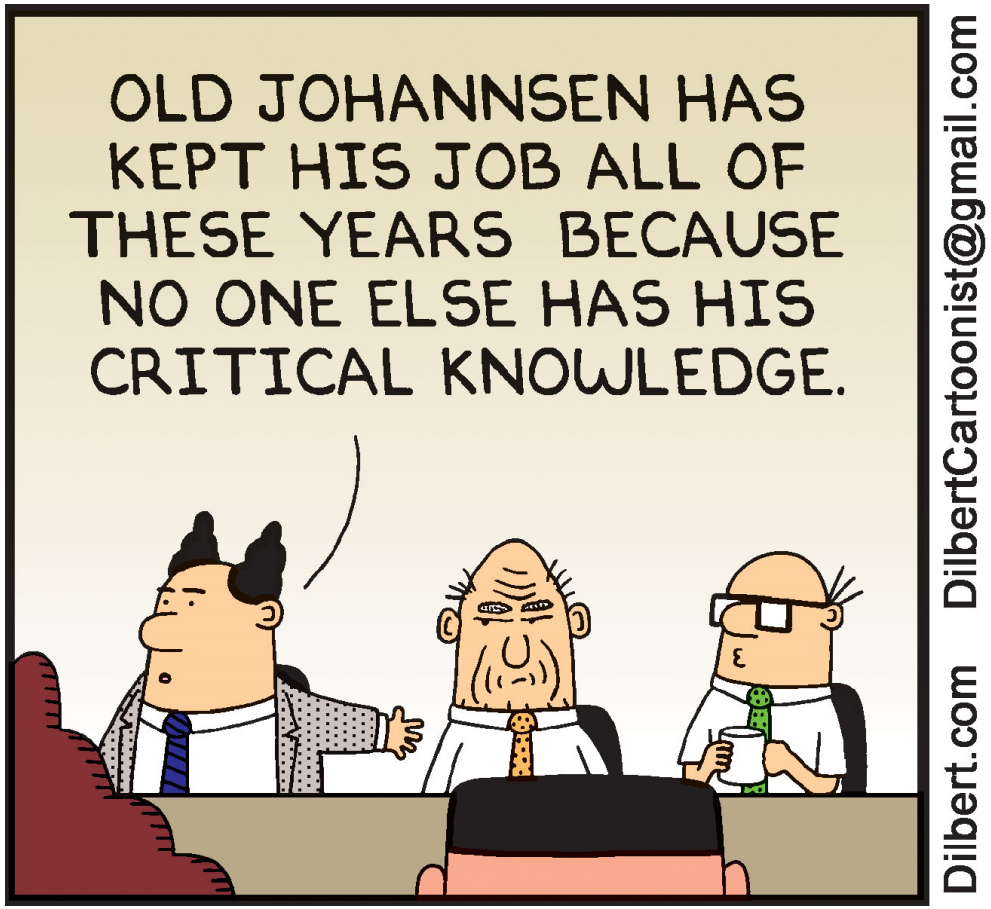
- *“That is the way I have always done it.”*
- *“That is just the way so and so does it.”*

  – Are you/they the only one doing it that way?




**Steps in the knowledge transfer process in a knowledge transfer-enabling environment. Source: O'Dell, and Grayson (1998).**

# Communication & Collaboration

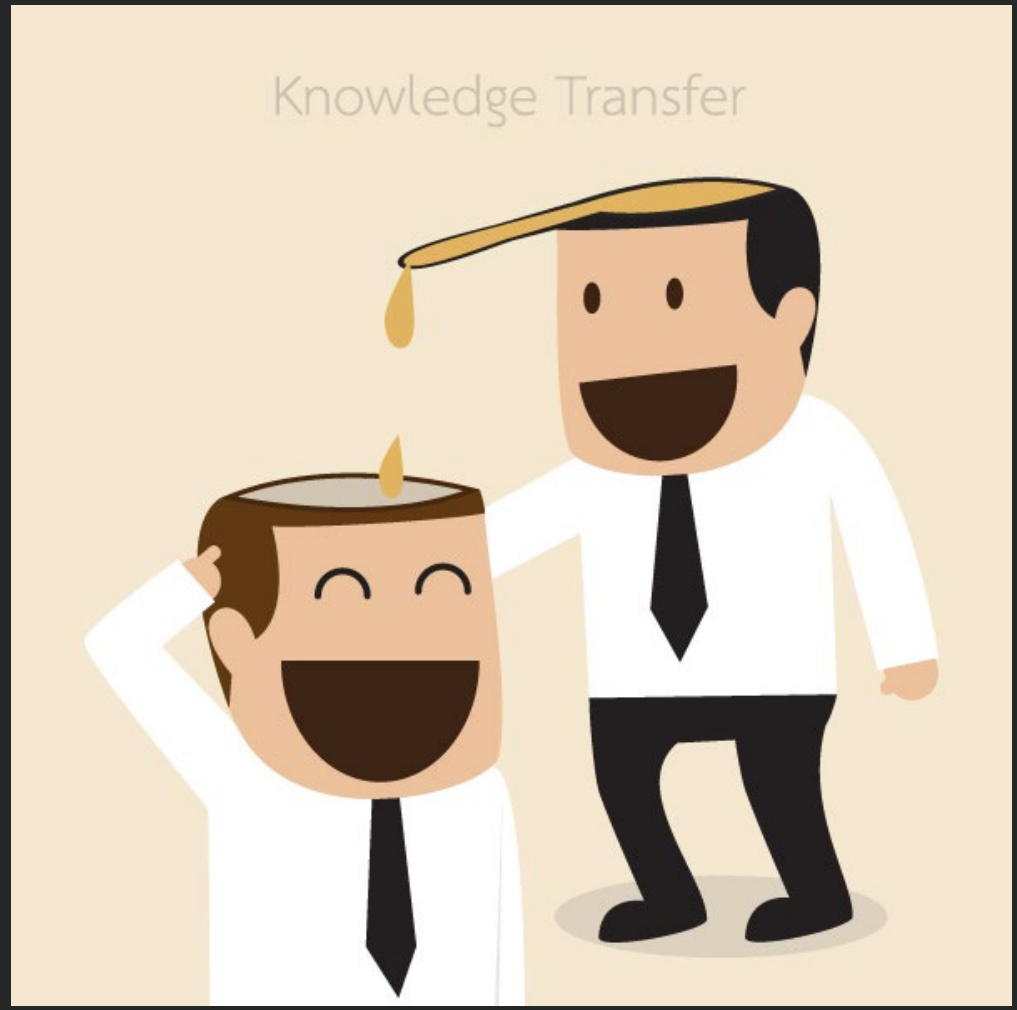



Direct transfer of knowledge

- Person to person
  - Overlap in tenure
  - Mentoring
    - Apprenticeship programs
    - Work shadowing
  - Coaching
  - Training
  - Presentations
  - Videos

# Hope for the best, Plan for the worst!

- Direct transfer of knowledge
  - Step-by-step trainings for early career, newbies
    - User Manuals
    - Guides
    - Notes
  - Documentation
    - methodologies,
    - Records
    - standards
    - procedures,
    - history,
    - data locations, etc.
  - Activity Reports
  - Publications
  - METADATA



# When it goes bad!

- Sudden loss of knowledgeable staff
- Loss of database, technological failure
- Loss of asset –storm, flood, development, change in owner
- Human Error

# Knowledge Transfer of NGWMN

1. Deciding what information do you need to keep?
   What is helpful for the day to day? Simple & Complex

- Data
  - Minimum required elements (Water Levels, Lithology, Casing, Screen & Site Data)
  - Datums
  - QA/QC
- Project history
  - Analyzes & information
  - Research project details -how it was set up; what was its purpose; data collection
  - Database Conversions
  - Historic Data storage
- Site Information
  - Geologic framework
  - Landowner information, access, permissions, etc.

# Collect and Organize Data

2. Where to store that data?
   - Data Dictonary
   - Database type (Access, SQL, SDE, etc)
   - API to connect multiple databases?
   - Folder Organization

3. Processes for knowledge transfer
   - Metadata
   - Database Dictionary
   - Documentation of Scripts- GitHub
   - Videos of data ingest, transformations, Services, and pushes

| | B | C | D | E | |
|---|---|---|---|---|---|
| 1 | ***Database Field Name*** | ***Internal*** | ***New Table*** | ***dataType*** | ***Description*** |
| 2 | igsSiteID | Yes | iwbnSite | numeric | |
| 3 | SiteName | | iwbnSite | text | |
| 4 | **CountryCd** | | iwbnSite | Text (2-digit) | Federal Country Code |
| 5 | **CountryNm** | | iwbnSite | text | |
| 6 | **StateCd** | | iwbnSite | Numeric (integer) | |
| 7 | **StateNm** | | iwbnSite | text (default) | |
| 8 | **CountyCd** | | iwbnSite | Numeric (integer) | |
| 9 | **CountyNm** | | iwbnSite | Numeric (integer) | |
| 10 | InCountyCd | | iwbnSite | Numeric (integer) | |
| 11 | **AgencyCd** | | iwbnSite | Numeric (integer) | USGS agency Code Default value=IN015 |
| 12 | **AgencyNm** | | iwbnSite | text | |
| 13 | ClimateDiv | | iwbnSite | domain/dropdown | https://psl.noaa.gov/data/usclimdivs/data/ |
| 14 | noAssetsRelate (?) | | iwbnSite | Numeric (integer) | Number of Assets (wells, soil depths(indivic |
| 15 | source | | iwbnSite | domain | |
| 16 | fieldCheck | Yes | iwbnSite | boolean | |
| 17 | landType | | iwbnSite | domain | |
| 18 | namedSurvey | | iwbnSite | domain | |
| 19 | unitName | | iwbnSite | domain | |
| 20 | topoQuad | | iwbnSite | domian | |
| 21 | townshipNum | | iwbnSite | number | |
| 22 | townshipDir | | iwbnSite | text | |
| 23 | rangeNum | | iwbnSite | number | |
| 24 | rangeDir | | iwbnSite | text | |

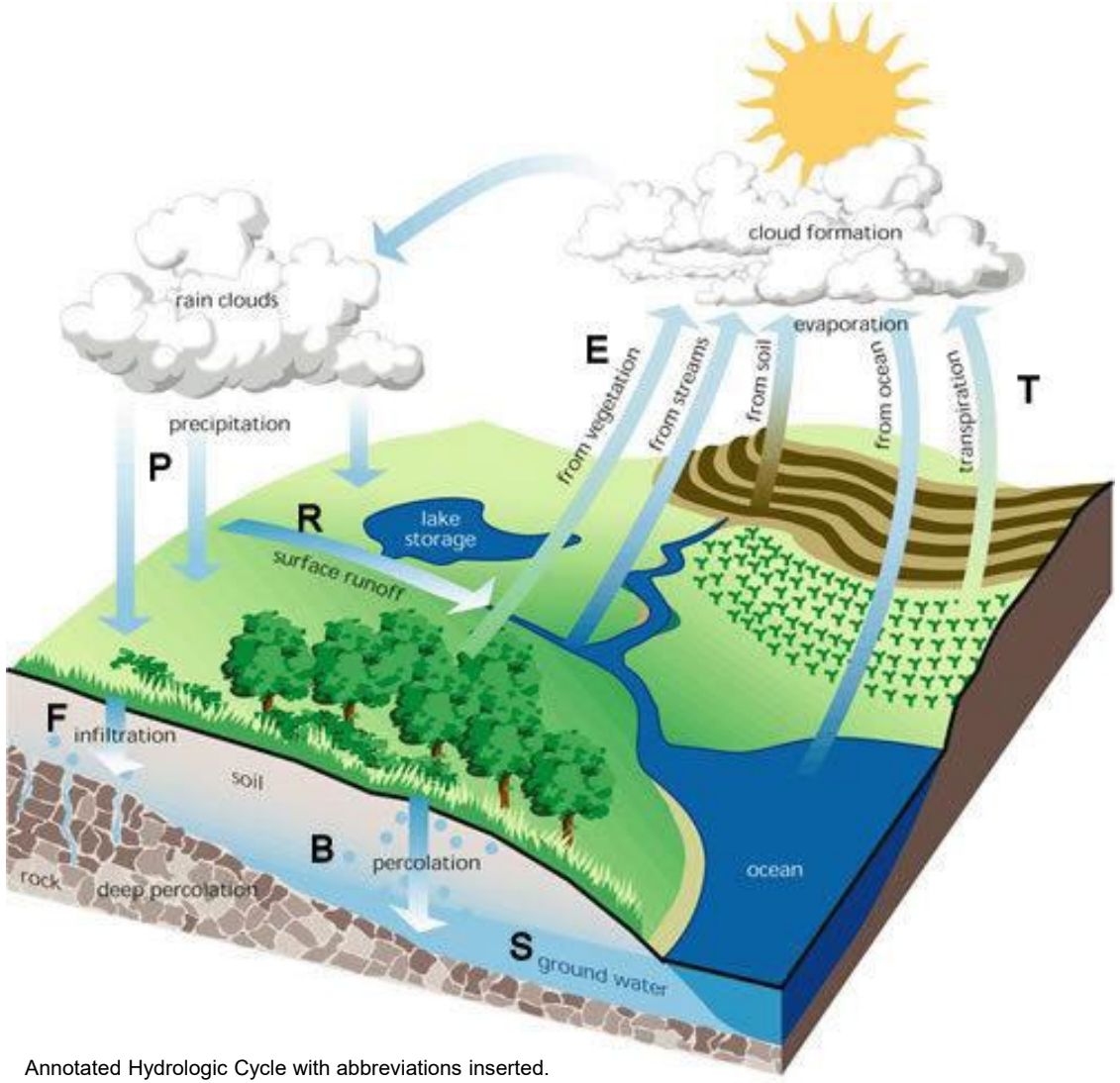
# Roadblocks to adoption

Institutional Barriers

1. Culture
   - Academic culture that favors a close to chest data policy
2. IT Department
   - Looks at data storage, data demands, long term costs, etc.
3. Tools
   - Purchase of tool or database and reluctant to give it up due to cost to implement 20 years ago
4. Lack of Vision
   - Lack of a unifying vision for water, and shared values for its various uses, stifles opportunities for collaboration and integration, even where there are natural synergies
   - Lack of a onboarding plan that supports integration and adaptation of existing data to new efforts

# Indiana Water Balance Network and NGWMN

# The Water Balance – Budgets made fun!




Annotated Hydrologic Cycle with abbreviations inserted.
Source: (adapted from) FISRWG 1998

$$P+S+E+T+R+F=0$$

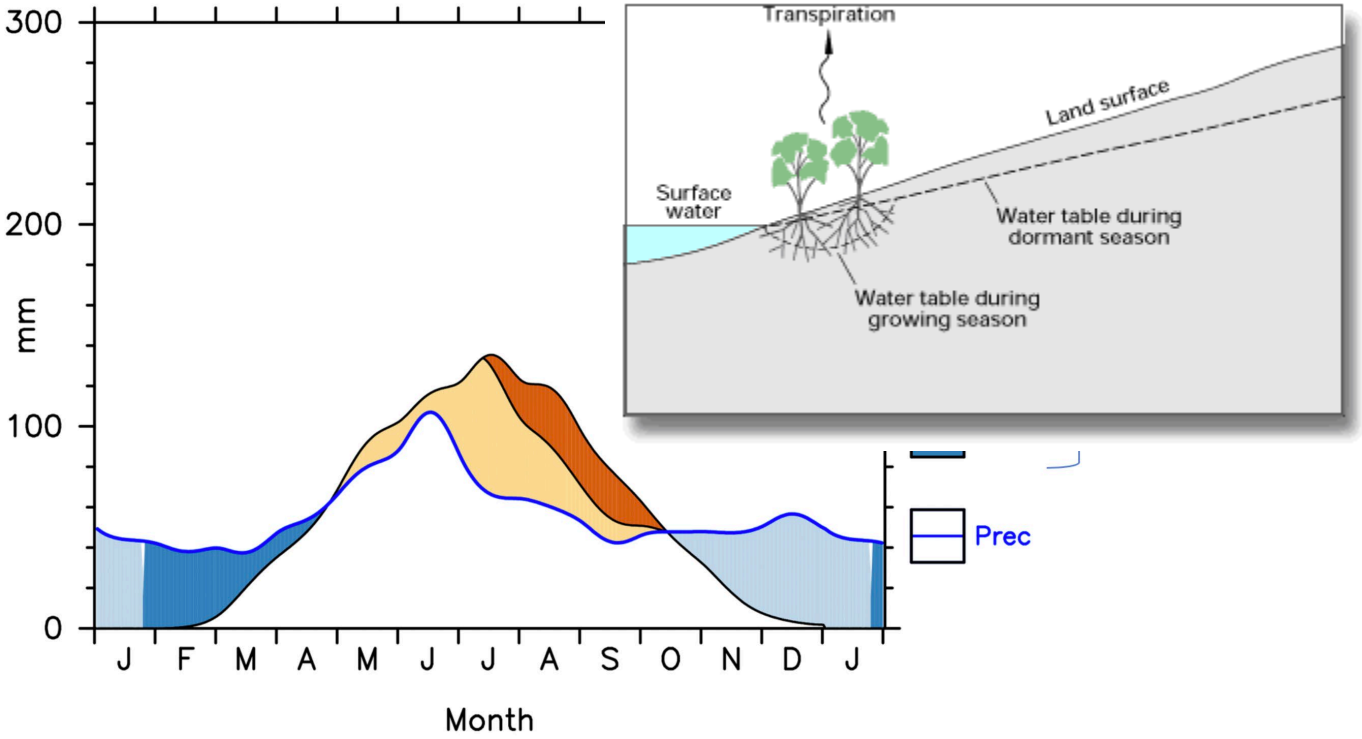



Image University of Nebraska

# IWBN Paired with NGWMN Wells and other wells…

| Well Name | NewName (county | Site Name | Well Alias | Lat | Long | Equipment | Contact Info | Contact Required? | Ptrans or Baro | NGWMN | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| IGWS Well 1901 | 291901 | Atlanta_S | IGWS Well 1901<br>NGWMN #13 | 40.209563 | -86.026938 | Long measuring tape | Commissioner, Town of Atlanta<br>(317) 658-2144<br>AndyEmmert@Atlantaindiana.com | No | Ptrans and Baro | Y | Come anytime, can d need to contact, wat consider contamina |
| (IGWS Well 1703) | 531703 | Bloomington_N | Upland Well<br>NGWMN #12 | 39.1939904 | -86.513105 | Hiking boots | Michael Chitwood<br>(812)-855-3888<br>michitwo@iu.edu | No | Ptrans | Y | Shortcut: Take ravine the road. Walk withc trail at the next clear until you get to the c left |
| IGWS Well 0701 | 530701 | Bloomington_N | Sycamore Valley<br>Near Well<br>Well 0701 | 39.190294 | -86.502823 | Hiking boots | Michael Chitwood<br>(812)-855-3888<br>michitwo@iu.edu | No | Vented | N | Park in the IU RTP an parking circle followi across the stream fro |
| IGWS Well 0702 | 530702 | Bloomington_N | Sycamore Valley<br>Far Well<br>Well 0702 | 39.190294 | -86.502823 | Hiking boots | Michael Chitwood<br>(812)-855-3888<br>michitwo@iu.edu | No | Vented | N | Park in the IU RTP an parking circle followi Below the rain gauge |
| IGWS Well 1601 | 531601 | Brownsburg_N1 | SBW Farm Well<br>SBW MW 1601<br>MW=Monitoring Well<br>NGWMN #9 | 39.8944763 | -86.3730135 | | Jack Maloney<br>in-person | No | Baro and Ptrans | Y | 4", roughly 2.5 miles marked by white PV |
| IGWS Well 1602 | 321602 | Brownsburg_N1 | SBW Weather Station Well<br>SBW SB 1602<br>SB = Soil Bore | 39.8944839 | -86.3738842 | | Jack Maloney<br>in-person | No | Vented | N | Check live feed, 15ft casing |
| (IGWS SBE 1603) | 321603 | Brownsburg_NE1 | SBE Weather Station Well | 39.8803083 | -86.355013 | Desiccant beads to fill syringe, regular pads | Mike Starkey<br>in-person | No | Vented Ptrans | N | 7ft SW of weather st loose beads in a syri |
| IGWS SBC 1702 | 321702 | Brownsburg_N2 | School Branch Control Weather Station Well<br>MW SBC 1702 | 39.8949286 | -86.3809847 | | Jack Maloney<br>in-person | No | Vented | N | Directly beside weat |
| (IGWS Well 1605) | 021605 | FortWayne_N1 | Deep Well<br>NGWMN #2 | 41.3478 | -85.118248 | | Jason Kissel:<br>jkissel@acredlandtrust.org | Email the day before | Ptrans | Y | Front gate must be u park in lot just north Acres Land Trust, 4" |
| (IGWS Well 1606) | 021606 | FortWayne_N1 | Shallow Well | 41.3478 | -85.118248 | | Jason Kissel:<br>jkissel@acredlandtrust.org | Email the day before | Ptrans | Y | Front gate must be u park in lot just north Acres Land Trust, 2" |
| (IGWS Well 1604) | 021604 | FortWayne_N2 | Irving Well<br>NGWMN #3 | 41.3477148 | -85.139121 | | Irving<br>If vehicle access needed, call<br>(888)-637-4518 | No | Ptrans no Baro | | To baromerge use Du staircase then trail to land, for vehicle acce tell them you need a |
| IGWS Well 2201 | 122201 | Frankfort_S | Cyclone Well<br>IGWS Well 2201<br>NGWMN # | 40.3270737 | -86.4301355 | Long measuring tape | Ty Brown<br>(765)-414-3333<br>ty.brown@dragoindiana.com | No | Ptrans (Missing) | Y | Can drive right to we |
| (IGWS Well 1607) | 211607 | Glenwood_N | Shelbyville Moraine WS well<br>Weather Station Shallow | 39.6385734 | -85.291632 | | Matt & Kati Huffman<br>(765) 561-7219<br>(765) 561-4198 (Kati) | | Vented | N | PVC Pipe just beside |
| (IGWS Well 1608) | 211608 | Glenwood_N | Weather Station<br>Intermediate<br>Intermediate Well | 39.6385734 | -85.291632 | | Matt & Kati Huffman<br>(765) 561-7219<br>(765) 561-4198 (Kati) | | Vented | N | PVC 2 ft south of WS missing and damage |
| (IGWS Well 1609) | 211609 | Glenwood_N | Dug Well<br>Deep Well | 39.6383908 | -85.2916502 | | Matt & Kati Huffman<br>(765) 561-7219<br>(765) 561-4198 (Kati) | | Ptrans | Y | 67ft south of WS on l mount (jab ground w 15ft deep |
| (IGWS Well 1610) | 211610 | Glenwood_N | Weather Station<br>Intermediate<br>Intermediate Well | 39.6385734 | -85.291632 | | Matt & Kati Huffman<br>(765) 561-7219<br>(765) 561-4198 (Kati) | | Vented | N | PVC 2 ft south of WS missing and damage |
| IGWS Well 2202 | 212202 | Glenwood_N | Drilled Well<br>IGWS Well 2202<br>NGWMN # | 39.639066 | -85.291602 | | Matt & Kati Huffman<br>(765) 561-7219<br>(765) 561-4198 (Kati) | | Ptrans | Y | |
| (IGWS Well 1611) | 491611 | Indianapolis_N | Marian Ecolab WS well<br>NGWMN #7 | 39.838356 | -86.20442 | Long socks and pants (poison ivy), weed cutter to trim around WS | Stephanie Schuck:<br>sschuck@marian.edu<br>(317)-903-9307 | Email the day before to make sure gate is unlocked | Vented Ptrans | N | Just beside weather download needed, c road, WS on your left large shed |
| | 45 | LakeStation_W | Well | 41.58305 | -87.37188 | Boots, hike in wetland | Lake Erie Land Company - NiSource],<br>219-395-5300 | | Ptrans and Baro | N | Tall blue PVC pipe, c park outside fence, t is 7434 |
| | 18 | Muncie_N | IGWS Well 1601?<br>NGWMN #4 | | | | jlowe@bsu.edu<br>765-285-1805 | | | | |
| | 70 | Rushville_S | Flat Rock River Weather Stat | 39.5799721 | -85.464938 | | m | | | | |
| | 55 | Martinsville_N | | | | | | | | | |
| | 55 | Martinsville_N | NGWMN #5 | | | | | | | | |
| | 55 | Martinsville_N | | | | | | | | | |
| | 33 | NewCastle_NE | NGWMN #10 | | | | | | | | |
| | | Nappanee_N | | | | | | | | | |

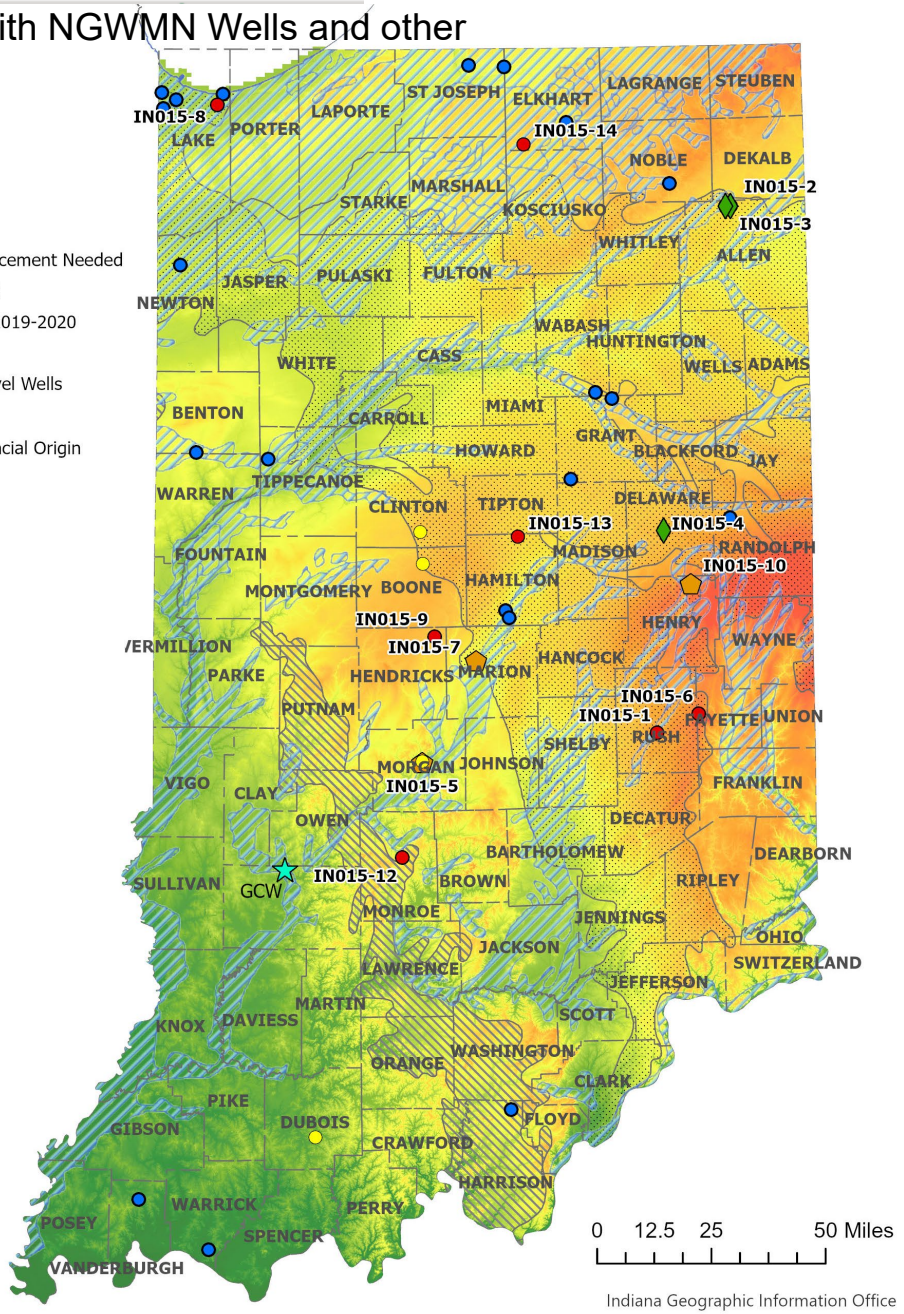
## Legend

- NGWMN (IGWS Wells)
- Pressure Transducer Replacement Needed
- Telemetry Support Needed
- Drilled Wells for NGWMN 2019-2020
- GCW
- NGWMN Indiana Water-level Wells
- County Border
- Aquifers of Alluvial and Glacial Origin

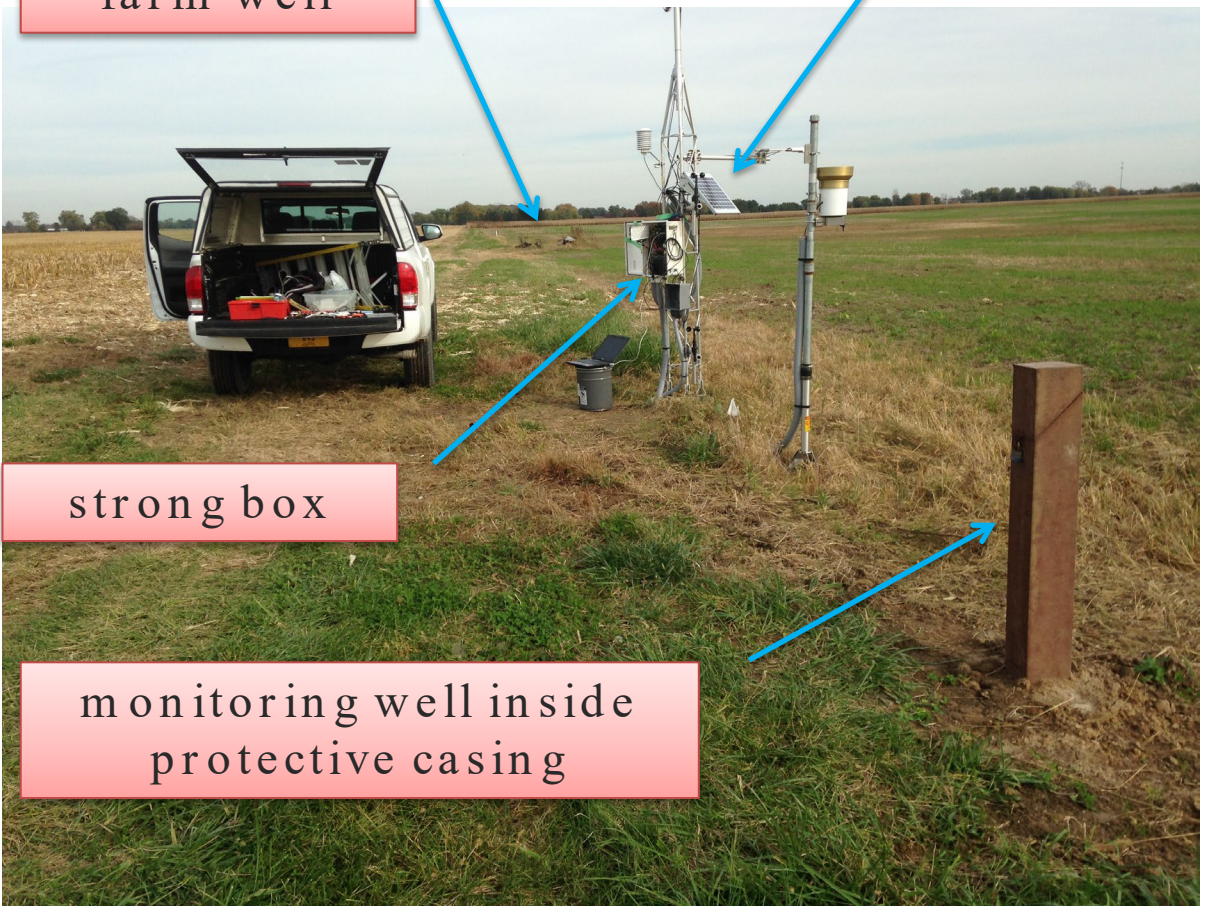
## Surface Elevation

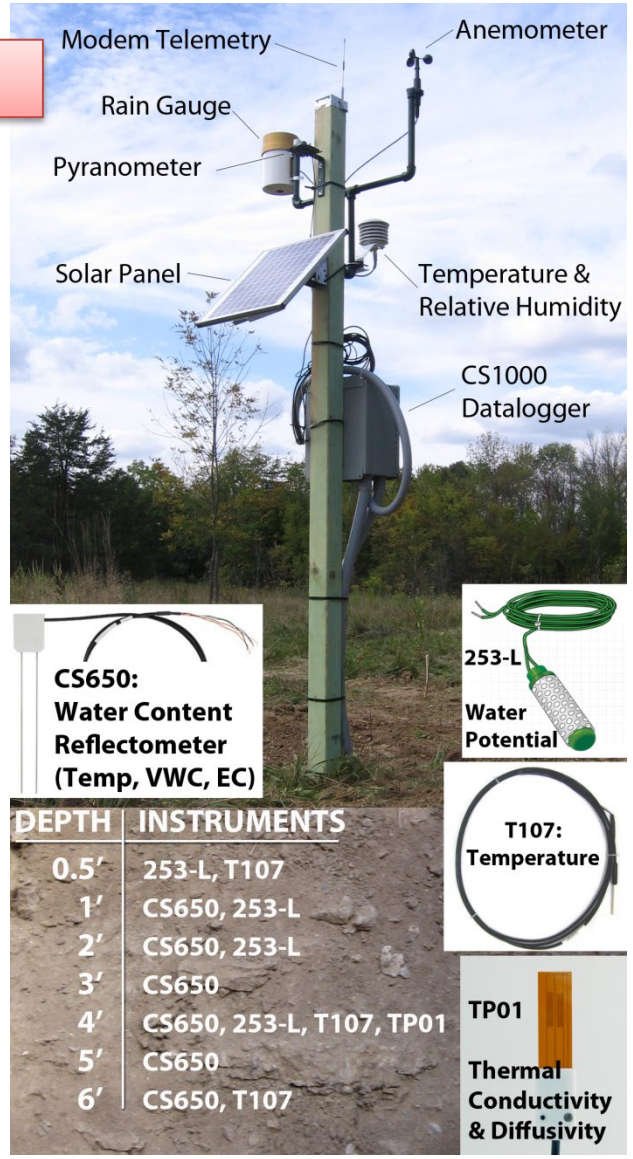
Value

- 661.94
- 320.73
- Mississippian aquifers
- Other rocks
- Silurian-Devonian aquifers



# Indiana Water Balance Network
# Monitoring approach

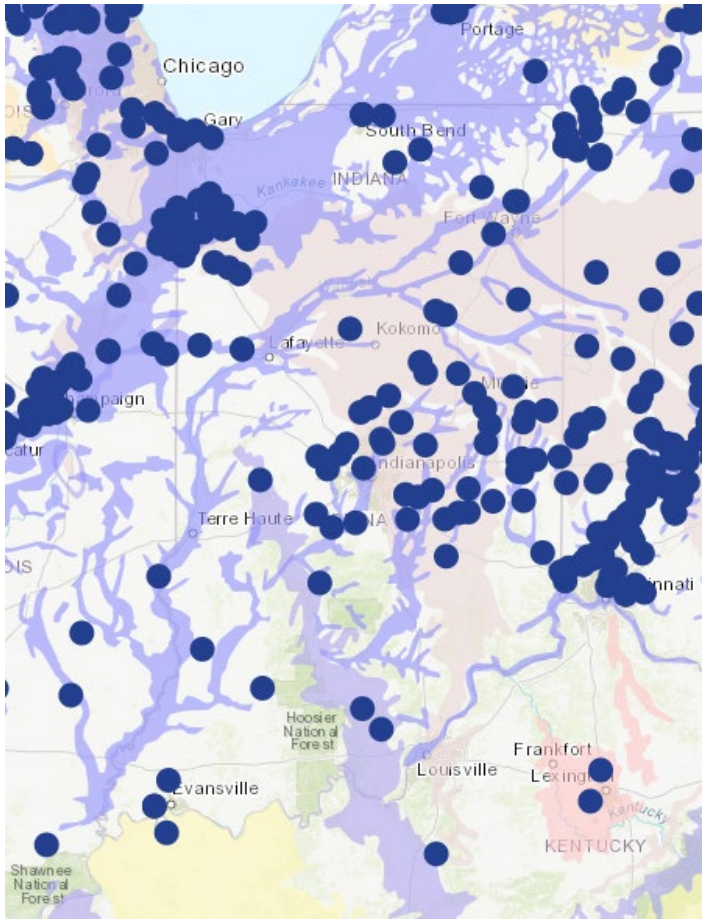


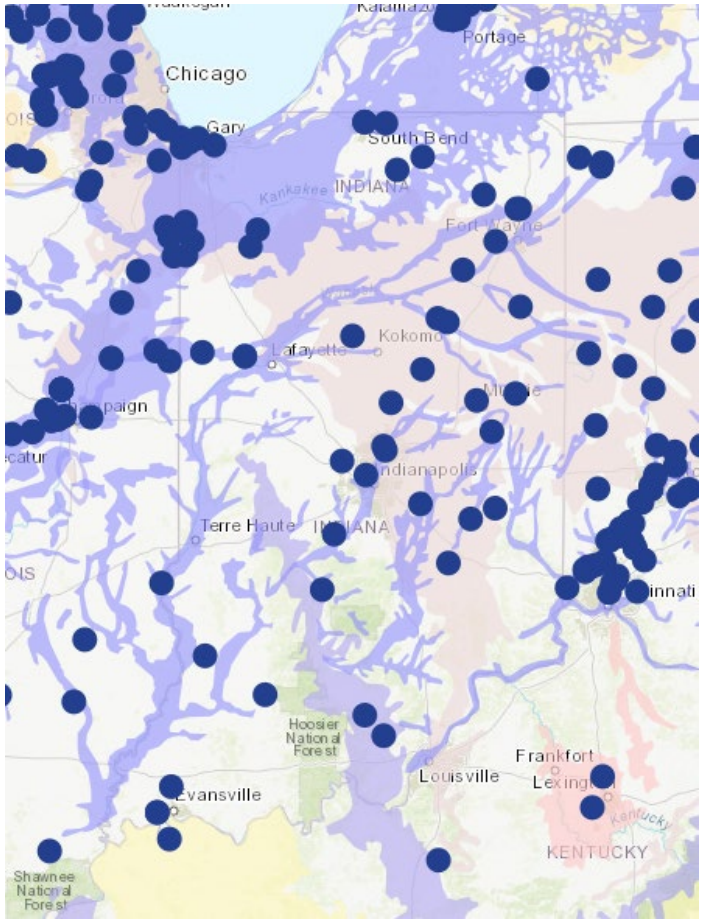

Potential evapotranspiration

Soil moisture , matric potential, thermal properties, and temperature

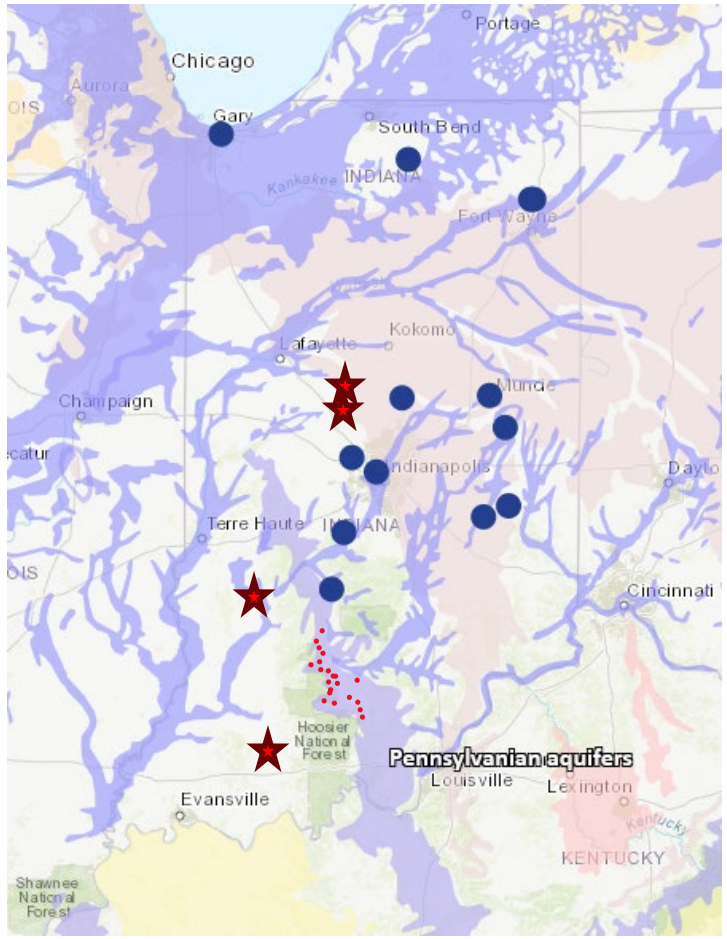
# Water Quality & Water Quantity Monitoring




All Monitoring



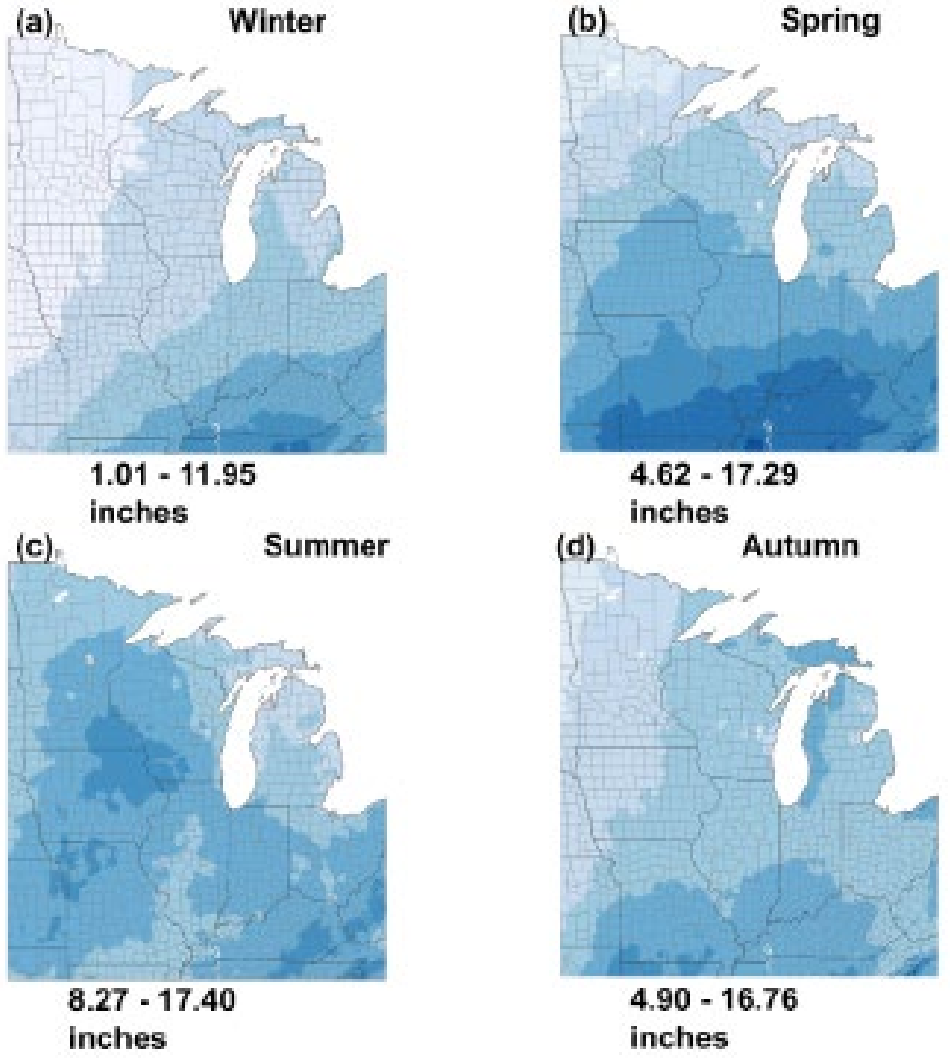

Water Level Monitoring




IGWS Monitoring

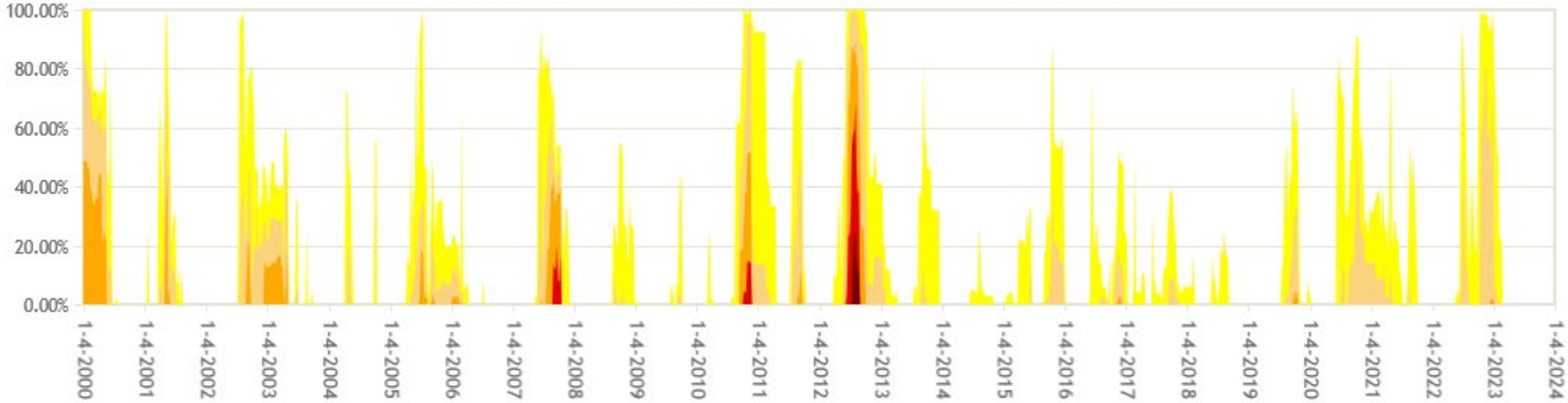
# Water Balance Partitioning

- Indiana's yearly precipitation
  - 37 inches in northern Indiana to
  - 42.22 for Central Indiana
  - 47 inches in southern Indiana

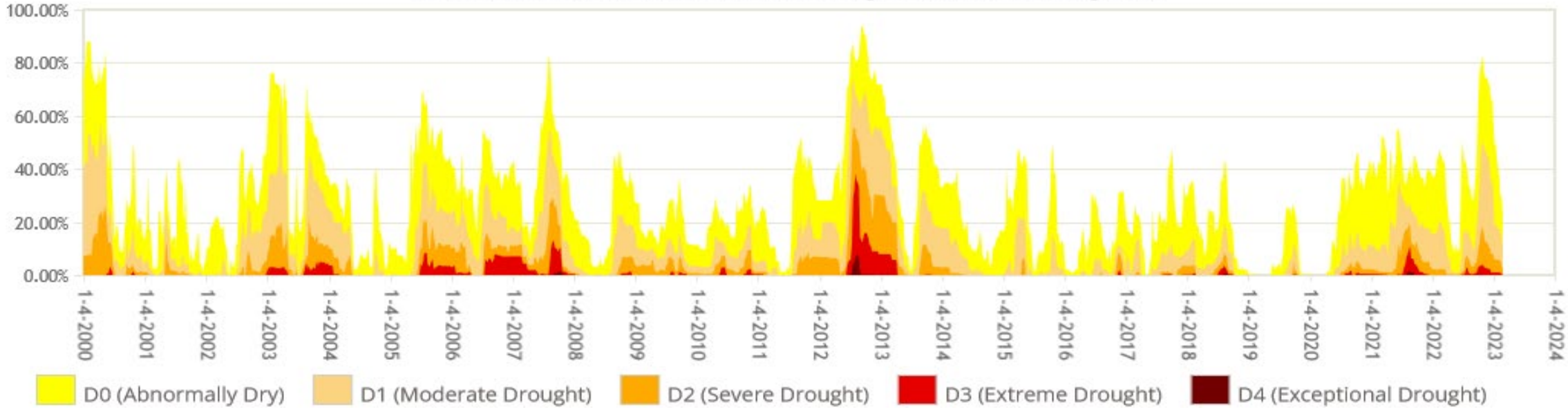




S. Letsinger st al. (2021) Implications to aquifer storage from shifts in timing of water-balance partitioning: Indiana, United States

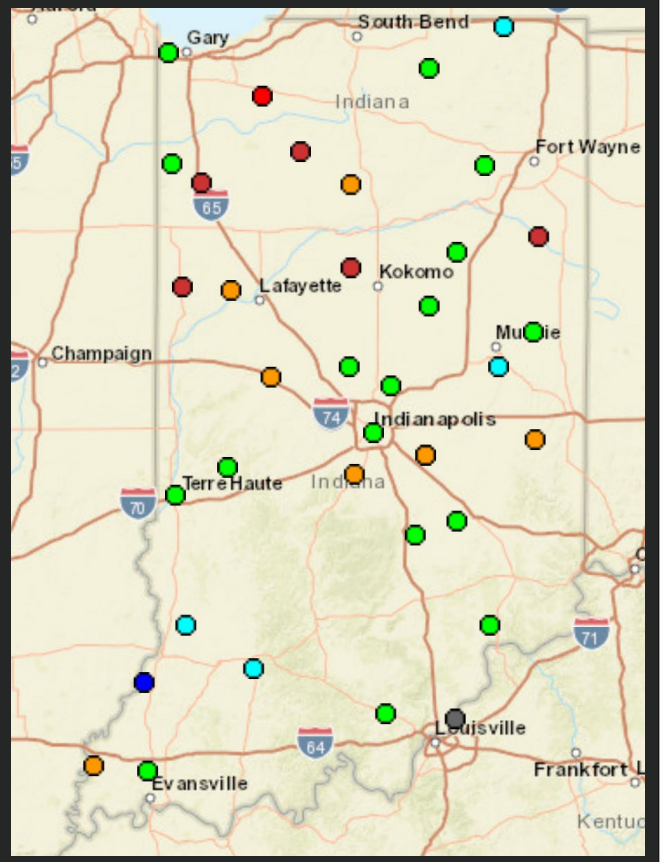
## Indiana Percent Area in U.S. Drought Monitor Categories

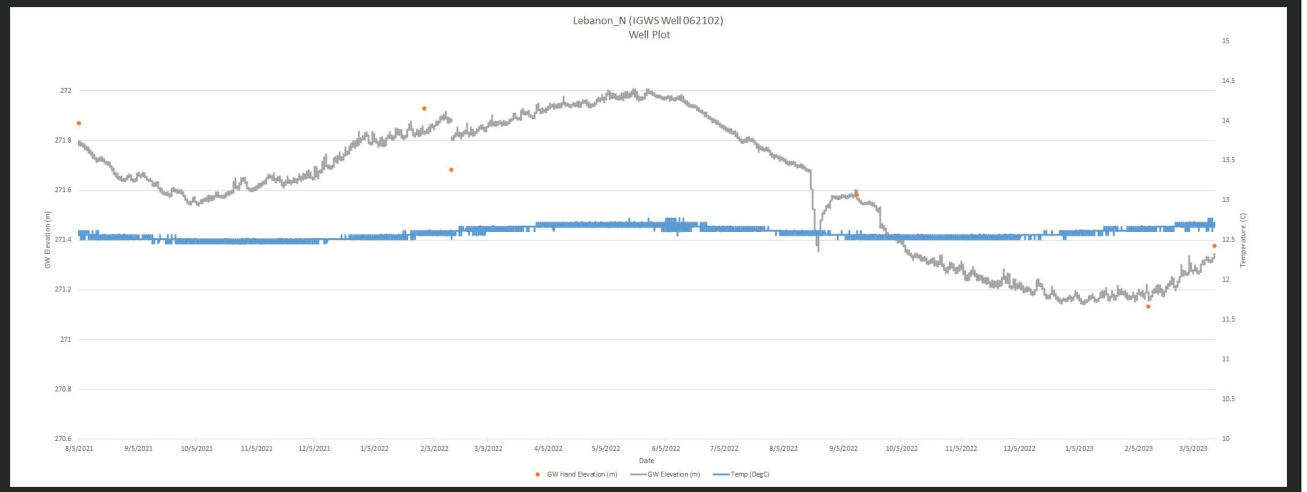


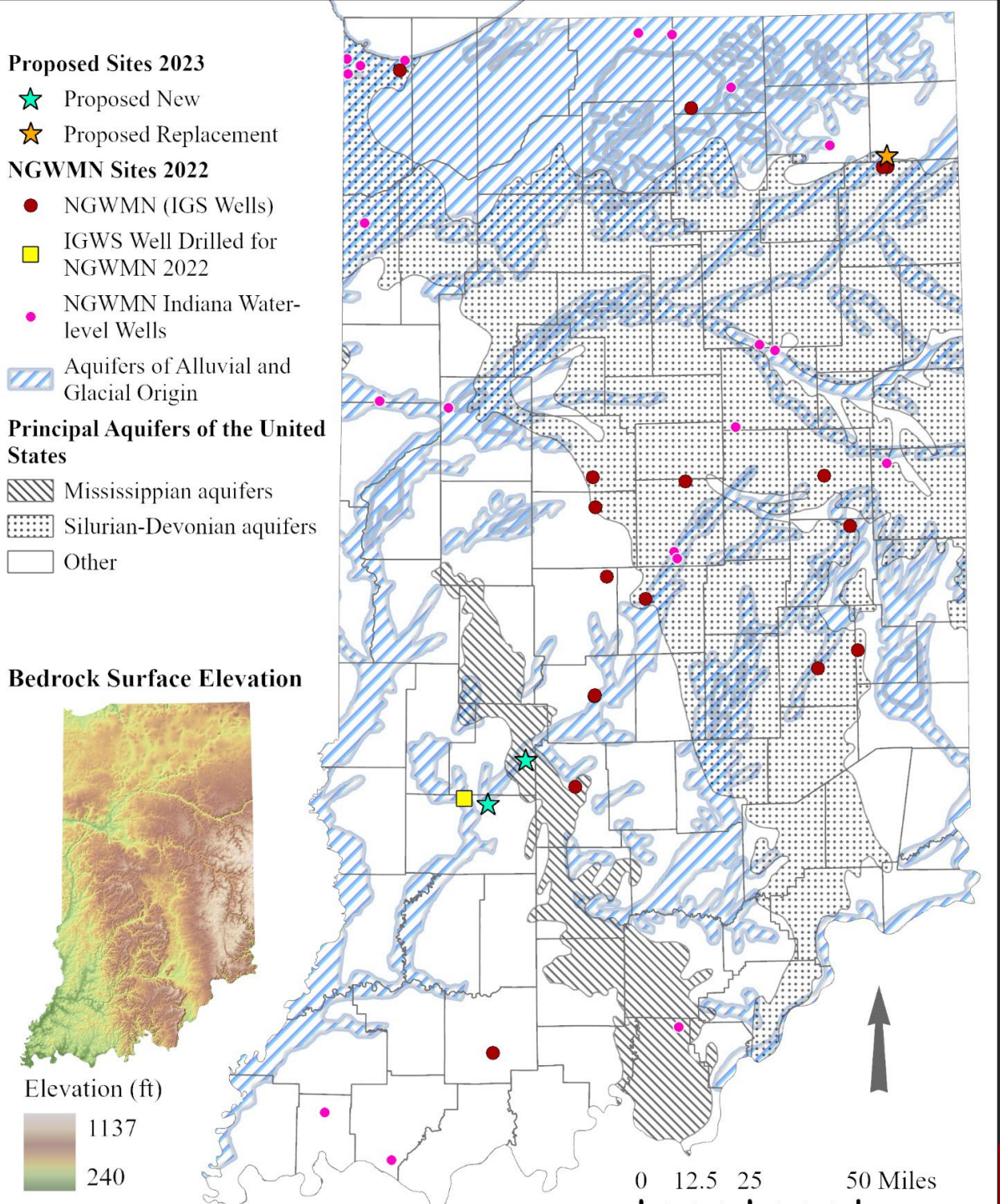

## Midwest Percent Area in U.S. Drought Monitor Categories



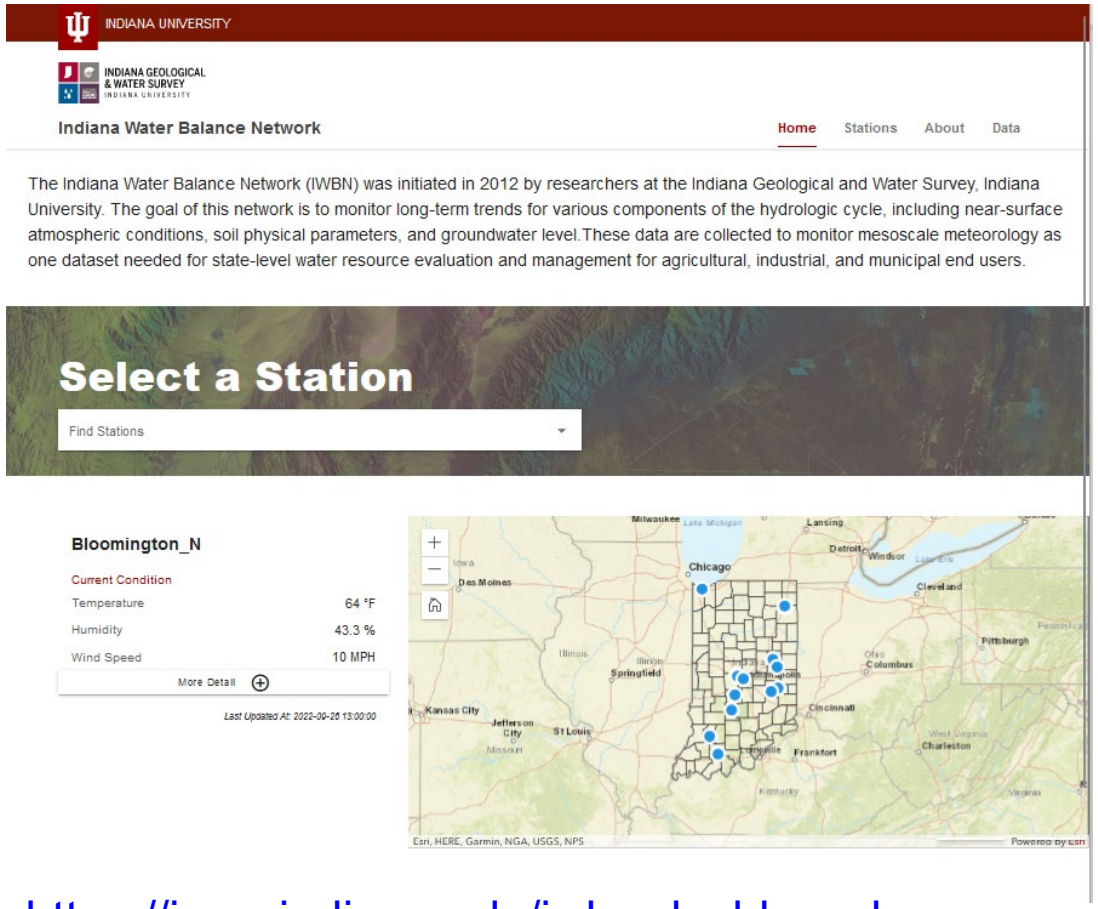
# Filling Gaps



# Data on the Web




https://igws.indiana.edu/iwbn-dashboard

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Indiana Water Balance Network

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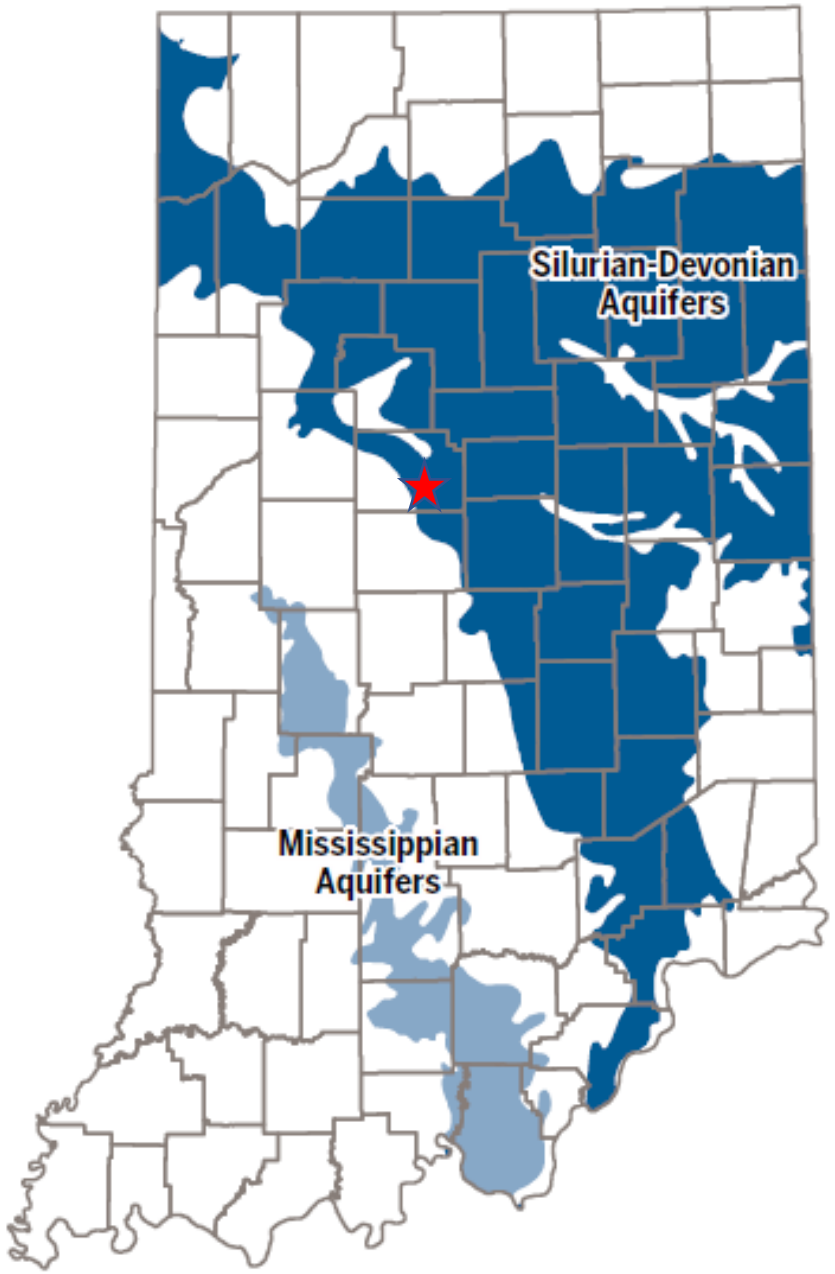
## Station locations and site descriptions

The IWBN captures long-term trends for meteorology, soil moisture, and groundwater level. Therefore, locating monitoring sites consider landscape properties and environmental complexities that impact each hydrologic component. These complexities include obstacles that affect measurements of wind speed and solar radiation, vegetation variability that might influence soil-water dynamics, and groundwater pumping from nearby wells that can alter natural trends in groundwater levels. Monitoring sites are named according to the cardinal direction relative to the nearest incorporated city or town, and the sequence of monitoring initiation in the case of multiple nearby sites.

### Station List

| Station Name | Site Alias | Latitude | Longitude | Soil Type | Last Update |
|---|---|---|---|---|---|
| Bloomington_N | Griffy Woods | 39.19 | -86.51 | Clay | 2022-09-26 13:00:00.000000 |
| Brownsburg_N1 | School Branch West | 39.89 | -86.37 | Loam | 2022-09-26 13:00:00.000000 |
| Brownsburg_N2 | School Branch Control | 39.89 | -86.38 | Loam | 2022-09-26 13:00:00.000000 |
| Brownsburg_NE1 | School Branch East | 39.88 | -86.36 | Loam | 2022-09-26 13:00:00.000000 |
| FortWayne_N1 | Wabash Moraine | 41.25 | -85.12 | Clay loam | 2022-09-26 13:00:00.000000 |
| FortWayne_N3 | Eel River Yoder | 41.26 | -85.13 | Sandy loam | 2022-09-26 13:00:00.000000 |
| Glenwood_N | Shelbyville Moraine | 39.64 | -85.29 | Silty clay loam | 2022-09-26 13:00:00.000000 |
| Indianapolis_N | Marian University Ecolab | 39.82 | -86.2 | Sandy loam | 2022-09-26 13:00:00.000000 |
| LakeStation_W | Lake Station | 41.58 | -87.27 | Silty clay loam | 2022-09-26 12:00:00.000000 |
| Martinsville_N | Bradford Woods | 39.5 | -86.43 | Silt loam | 2022-09-26 13:00:00.000000 |
| Muncie_N | Ball State University | 40.22 | -85.42 | Clay loam | 2022-09-26 13:00:00.000000 |
| NewCastle_NE | Henry County | 40.05 | -85.31 | Loam | 2022-09-26 13:00:00.000000 |
| Rushville_S | Flat Rock River | 39.58 | -85.47 | Sandy clay loam | 2022-09-26 12:00:00.000000 |
| Washington_E | Daviess County | 38.67 | -87.07 | Silt loam | 2022-09-26 13:00:00.000000 |
| Jasper_S | Cedar Crest | 38.31 | -86.87 | Silt loam | 2022-09-26 13:00:00.000000 |

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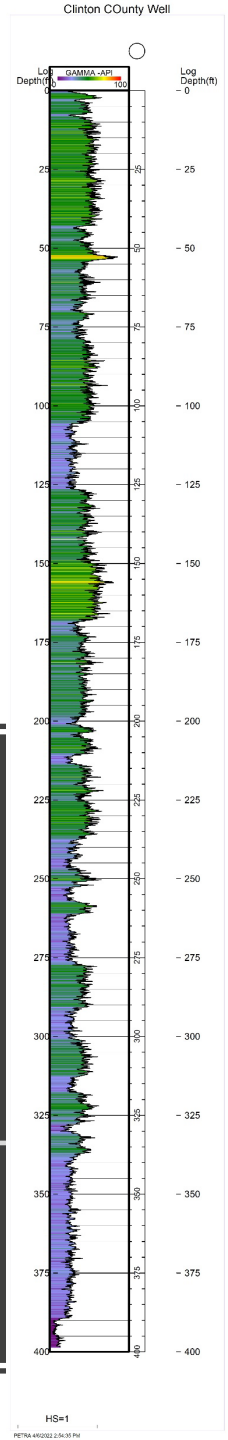
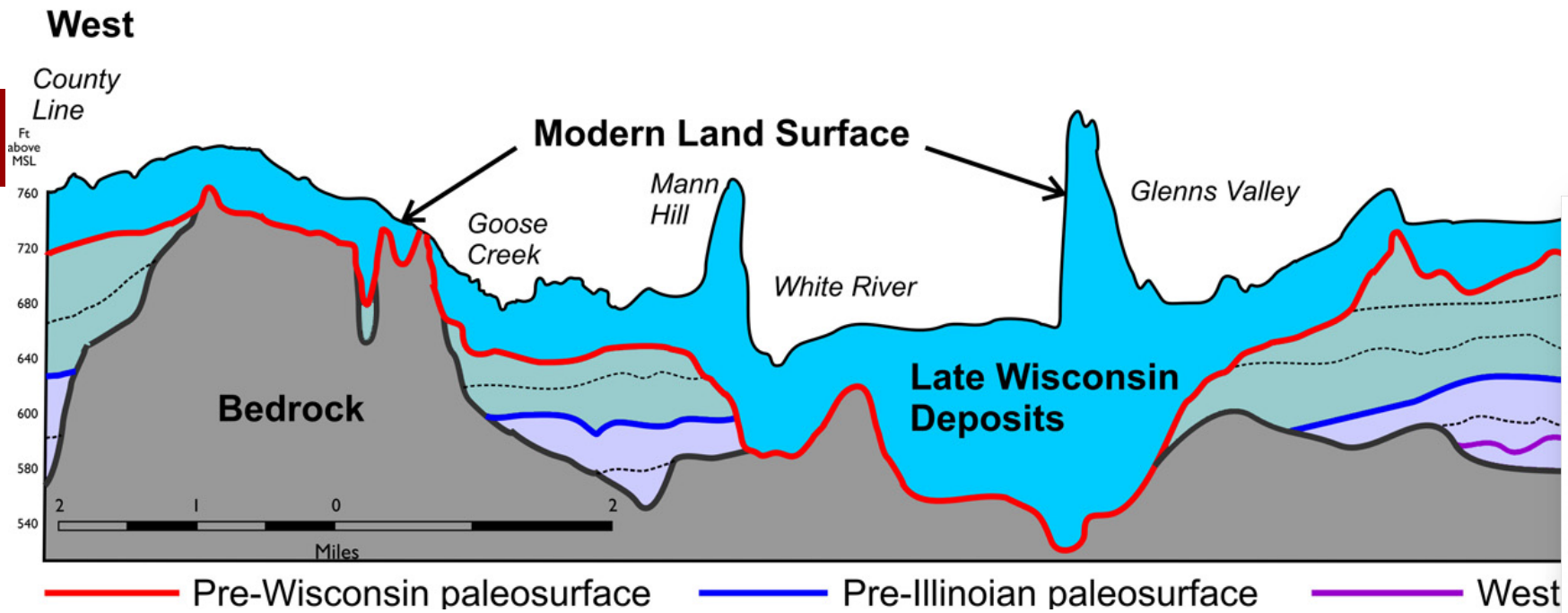
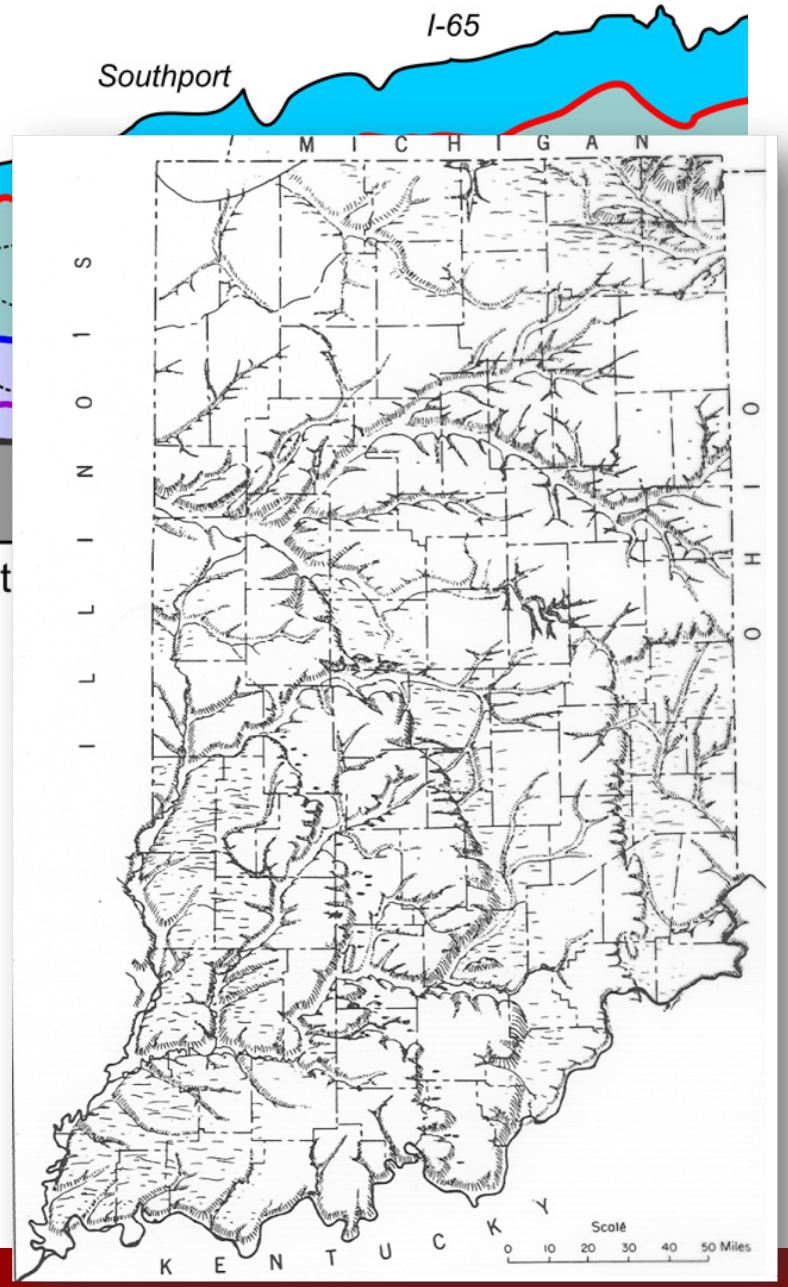
# NGWMN

National Groundwater Monitoring Network

Franklin County Well

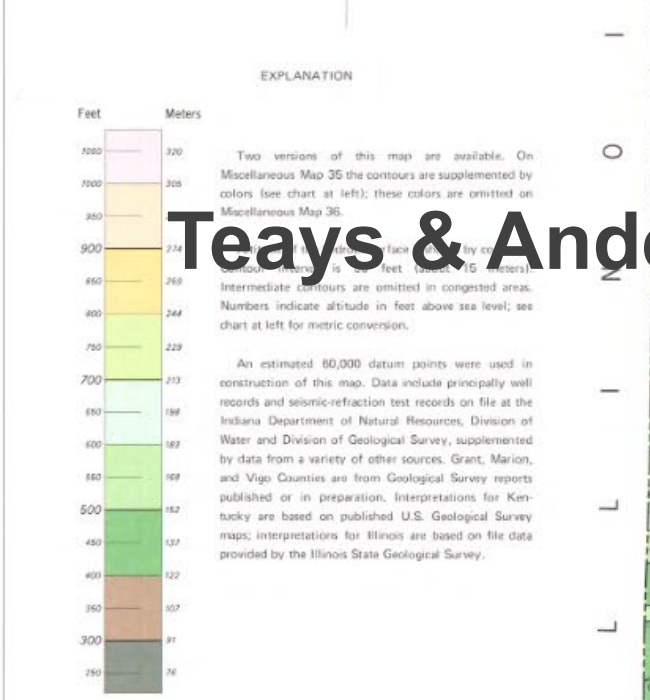


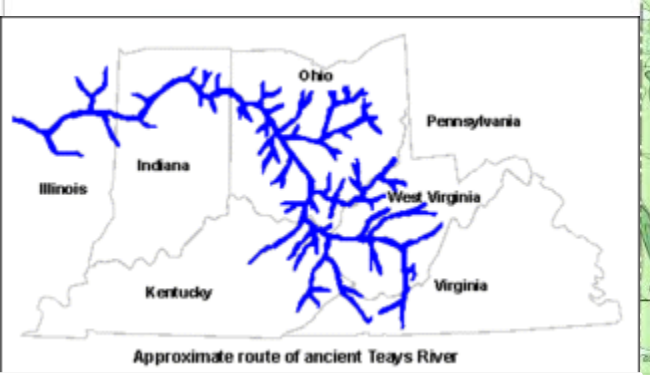


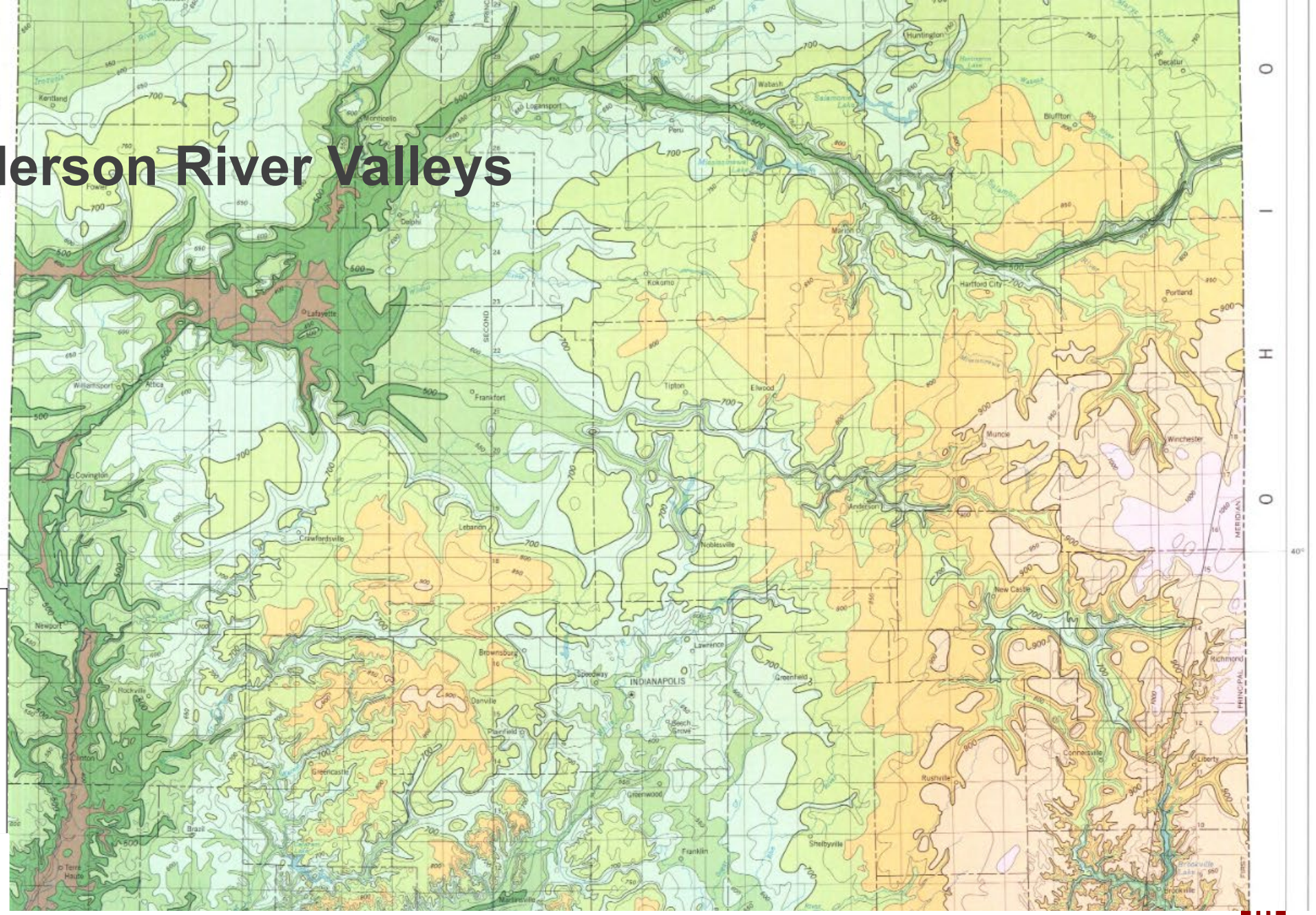

- The past have very different terrain from today
- Potential to hold and move large volumes of water underground (determined by material)
- Potential Recharge area for bedrock aquifers

# Teays & Anderson River Valleys



Approximate route of ancient Teays River



View dashboard | Report a spring | Download data

springsSampling

Search

Export all

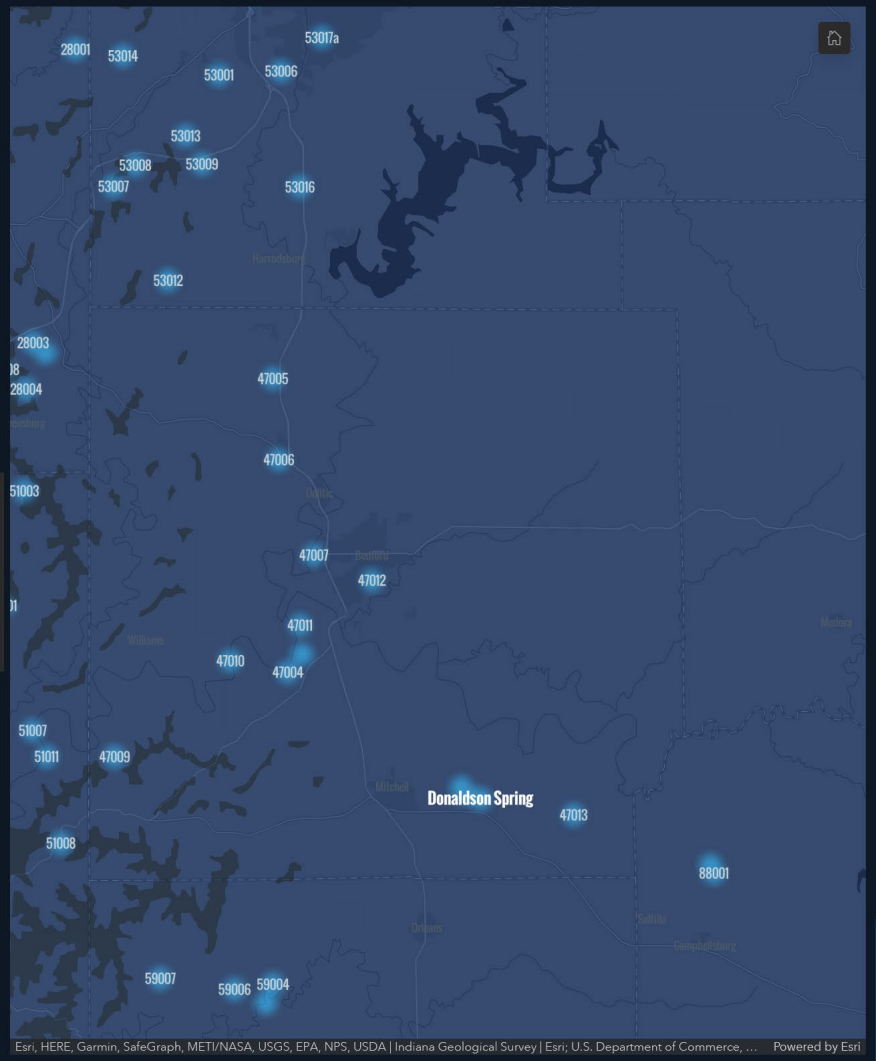
| siteNumber | samplingType | collectionMethod | samplingMedia | samplingDate | samplingTime | analyteName | |
|---|---|---|---|---|---|---|---|
| 13007 | Sample-Routine | grab | water | 10/6/2022, 12:00 AM | | Temperature, water | 12.6 |
| 13007 | Sample-Routine | grab | water | 10/6/2022, 12:00 AM | | Specific conductance | 307.3 |
| 13007 | Sample-Routine | grab | water | 10/6/2022, 12:00 AM | | Dissolved oxygen (DO) | 10.35 |
| 13007 | Sample-Routine | grab | water | 10/6/2022, 12:00 AM | | pH | 7.21 |
| 13007 | Sample-Routine | grab | water | 10/6/2022, 12:00 AM | | Eh | 349.22 |
| 13007 | Sample-Routine | grab | water | 10/6/2022, 12:00 AM | | Alkalinity, carbonate | 74.305 |
| 13007 | Sample-Routine | grab | water | 10/6/2022, 12:00 AM | | Bicarbonate | 90.43 |
| 13007 | Sample-Routine | grab | water | 10/6/2022, 12:00 AM | | Carbonate | 0.068 |
| 13007 | Sample-Routine | grab | water | 10/6/2022, 12:00 AM | | Fluoride | 0.098 |
| 13007 | Sample-Routine | grab | water | 10/6/2022, 12:00 AM | | Chloride | 7.016 |
| 13007 | Sample-Routine | grab | water | 10/6/2022, 12:00 AM | | Nitrate | 3.297 |
| 13007 | Sample-Routine | grab | water | 10/6/2022, 12:00 AM | | Sulfate | 67.673 |
| 13007 | Sample-Routine | grab | water | 10/6/2022, 12:00 AM | | Calcium | 43.353 |
| 13007 | Sample-Routine | grab | water | 10/6/2022, 12:00 AM | | Magnesium | 9.113 |
| 13007 | Sample-Routine | grab | water | 10/6/2022, 12:00 AM | | Potassium | 0.219 |
| 13007 | Sample-Routine | grab | water | 10/6/2022, 12:00 AM | | Sodium | 6.716 |



**well water quality; it also applies to spring water quality and testing.**

Indiana Springs

Select a site
(47003) Donaldson Spring

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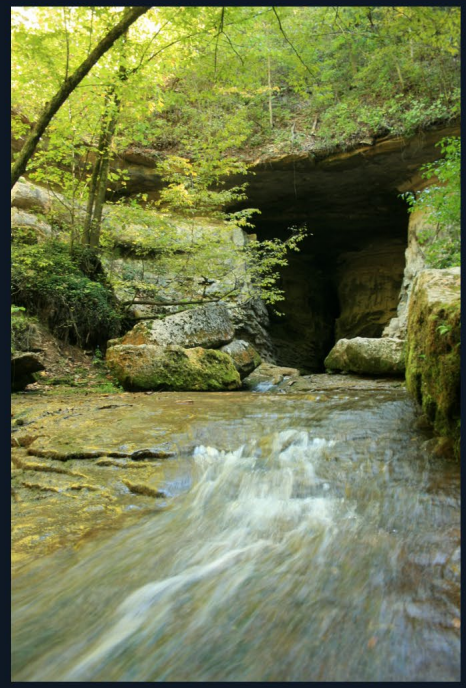
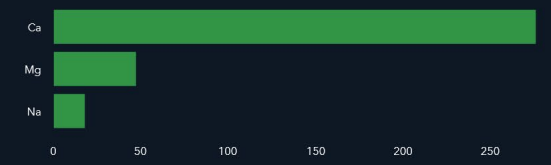
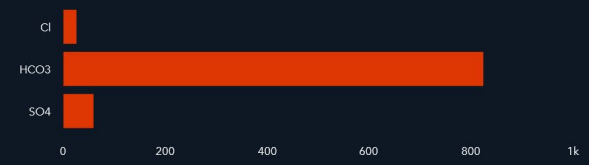


Cations (mg/L)




Anions (mg/L)




Total Particulate Organic Carbon = 2.8 mg/L

August 29, 2020

1 of 3

Nitrate (NO3)

2.1 mg/L

August 29, 2020

1 of 3

Strontium (Sr)

0.5 mg/L

August 29, 2020

Silicon (Si)

4.5 mg/L

August 29, 2020

1 of 3

Manganese (Mn)

0.002 mg/L

August 29, 2020

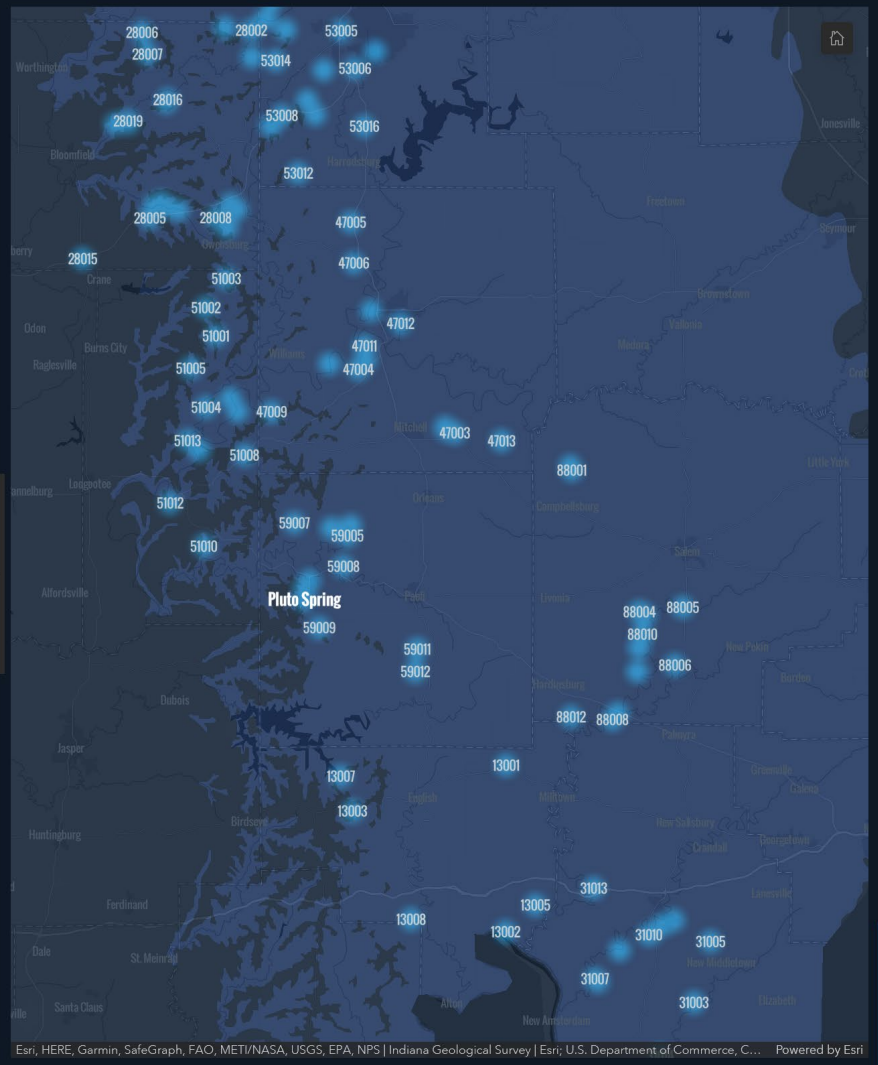
Lithium (Li)

Not detected

August 29, 2020

# Indiana Springs

Select a site
(59001) Pluto Spring

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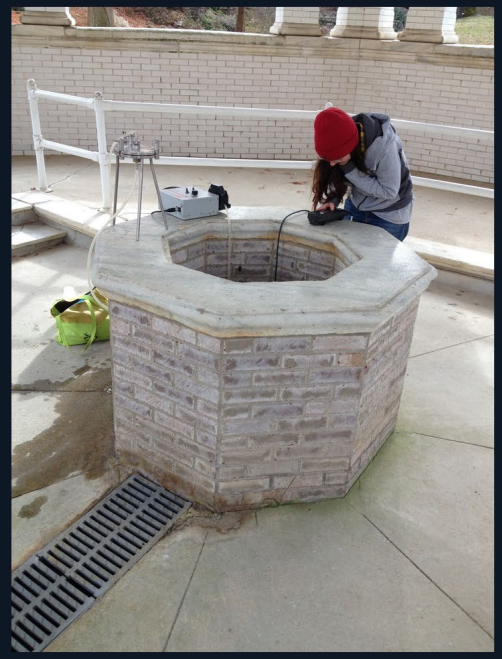
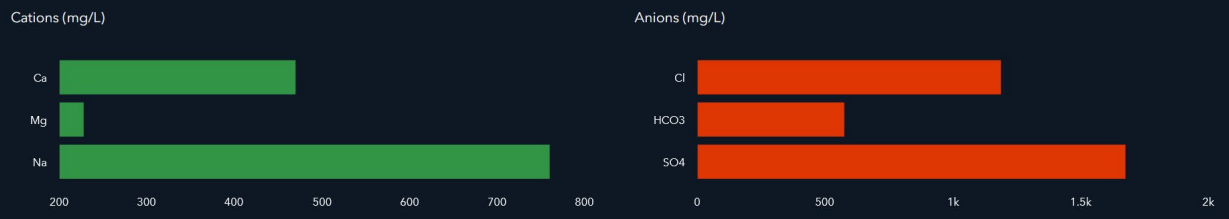
4 of 8






Total Particulate Organic Carbon = 0.3 mg/L

November 22, 2019

1 of 2

Nitrate (NO3)

0.3 mg/L

September 29, 2022

1 of 2

Strontium (Sr)

12.1 mg/L

September 29, 2022

1 of 4

Silicon (Si)

4.2 mg/L

September 29, 2022

1 of 2

Manganese (Mn)

0.022 mg/L

September 29, 2022

1 of 2

Lithium (Li)

170 ug/L

September 29, 2022

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# Thank you!

# Questions?

# Ginger Davis

gindavis@iu.edu

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