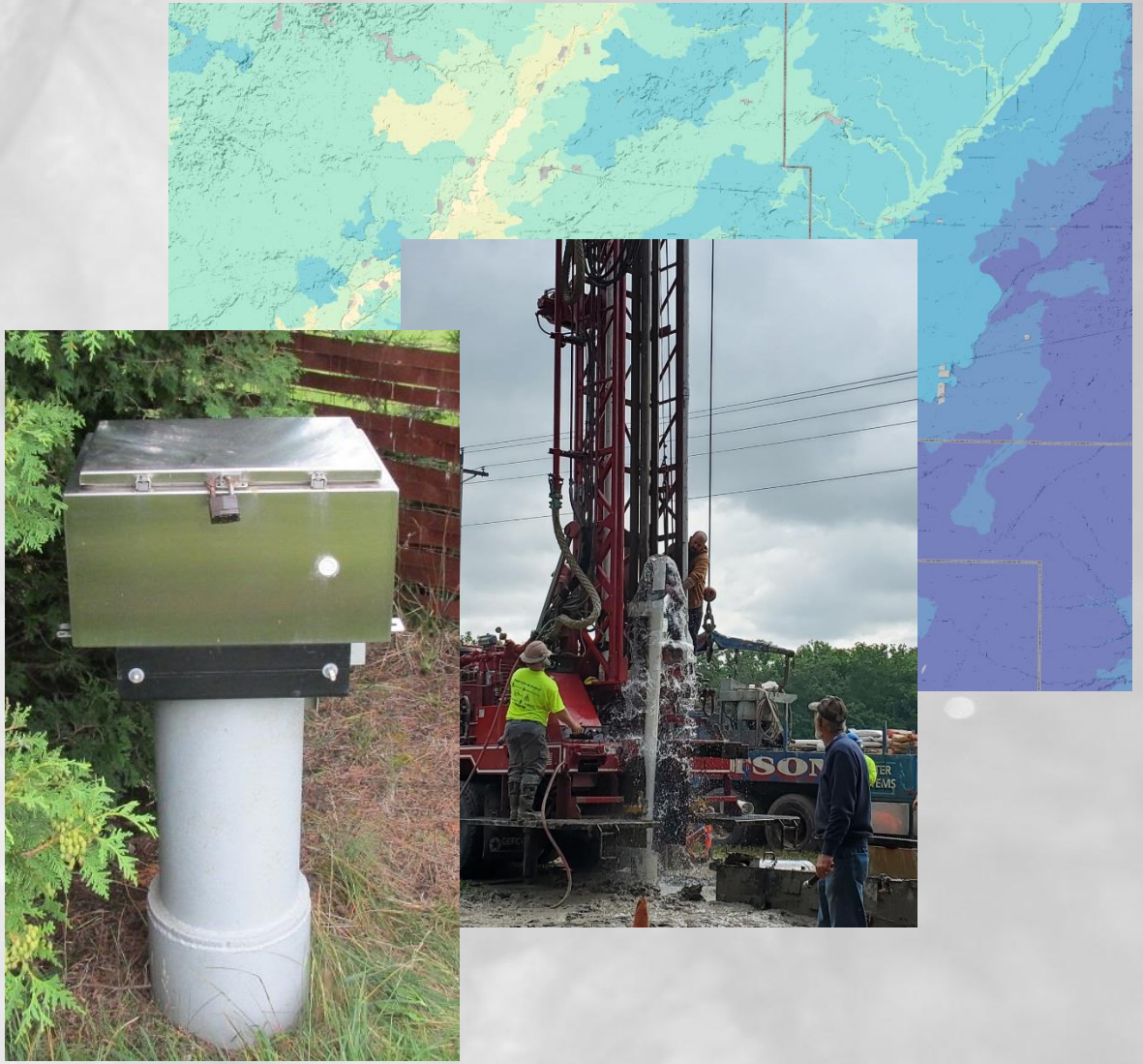
OHIO GEOLOGICAL SURVEY

DEPARTMENT OF NATURAL RESOURCES

THE OHIO GEOLOGICAL SURVEY'S GROUNDWATER PROGRAM

OKI Groundwater Committee 2024



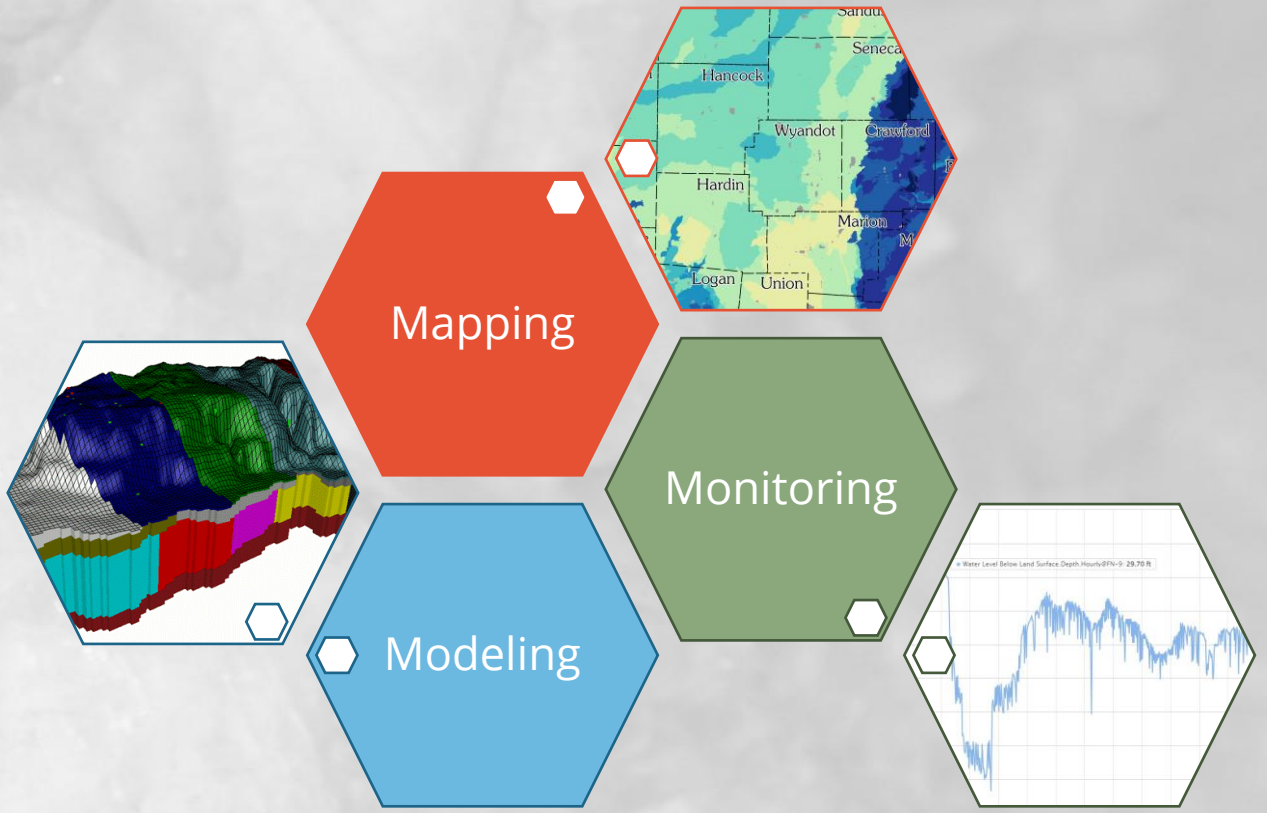
CRAIG NELSON

HYDROGEOLOGIST & GROUP SUPERVISOR

2045 Morse Rd., Bldg. B-2
Columbus, OH 43229

OVERVIEW

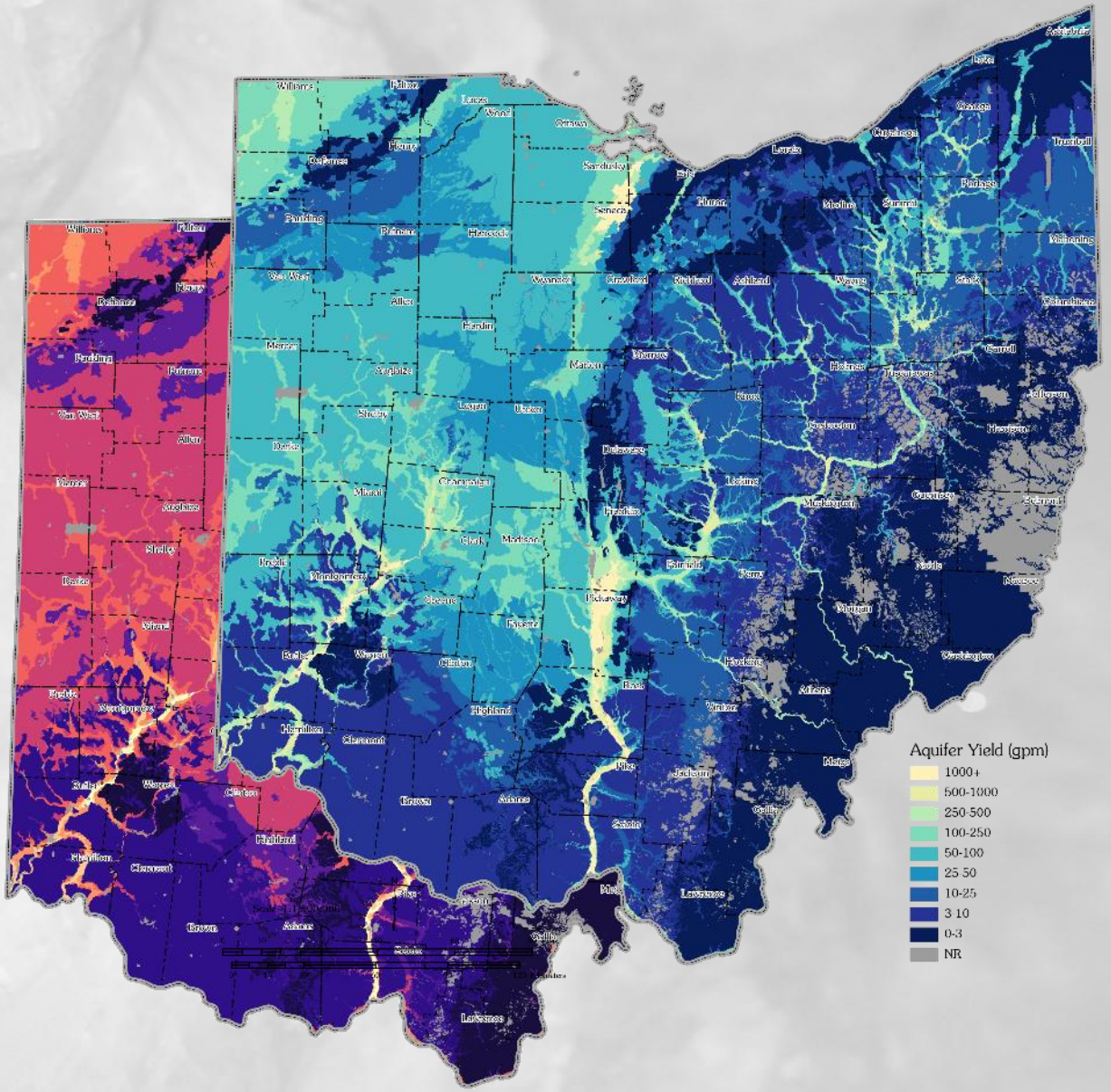
- Groundwater quantity only
- Moved to Geological Survey from Div. of Water in 2017
- Staff:
  - 1 Supervisor
  - 3 Hydrogeologists
  - 2 Groundwater Specialists
- Primary Data Provision:
  - Ohio Water Well Log Database
  - Ohio Observation Well Network



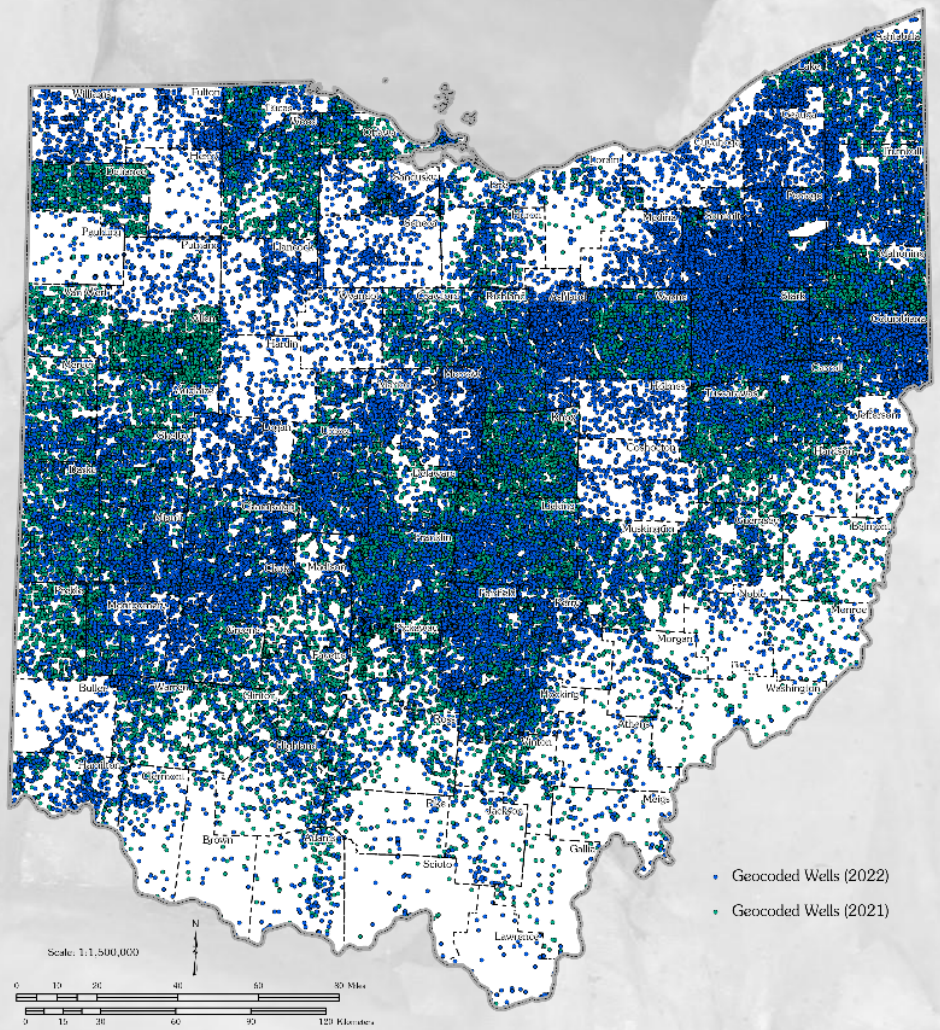
I. GROUNDWATER MAPPING

AQUIFER YIELD MAPPING

- **Funding Source:** OWDA
- **Duration:** 2 years
- **Deliverables:**
  - Water well improvements
  - Statewide, seamless digital map
  - Aquifer Yield wall map
  - Hydraulic Conductivity wall map
  - Geodatabase of hydraulic conductivity (K) data



WELL GEOCODING



Wells Geocoded 2021-2022

- 111,505 wells geocoded in 2021 (exact LBRS database matches)
- 67,484 wells geocoded in 2022:
  - 7,729 exact LBRS database matches
  - 59,729 using an ArcGIS geocoding service via Python geocoder library

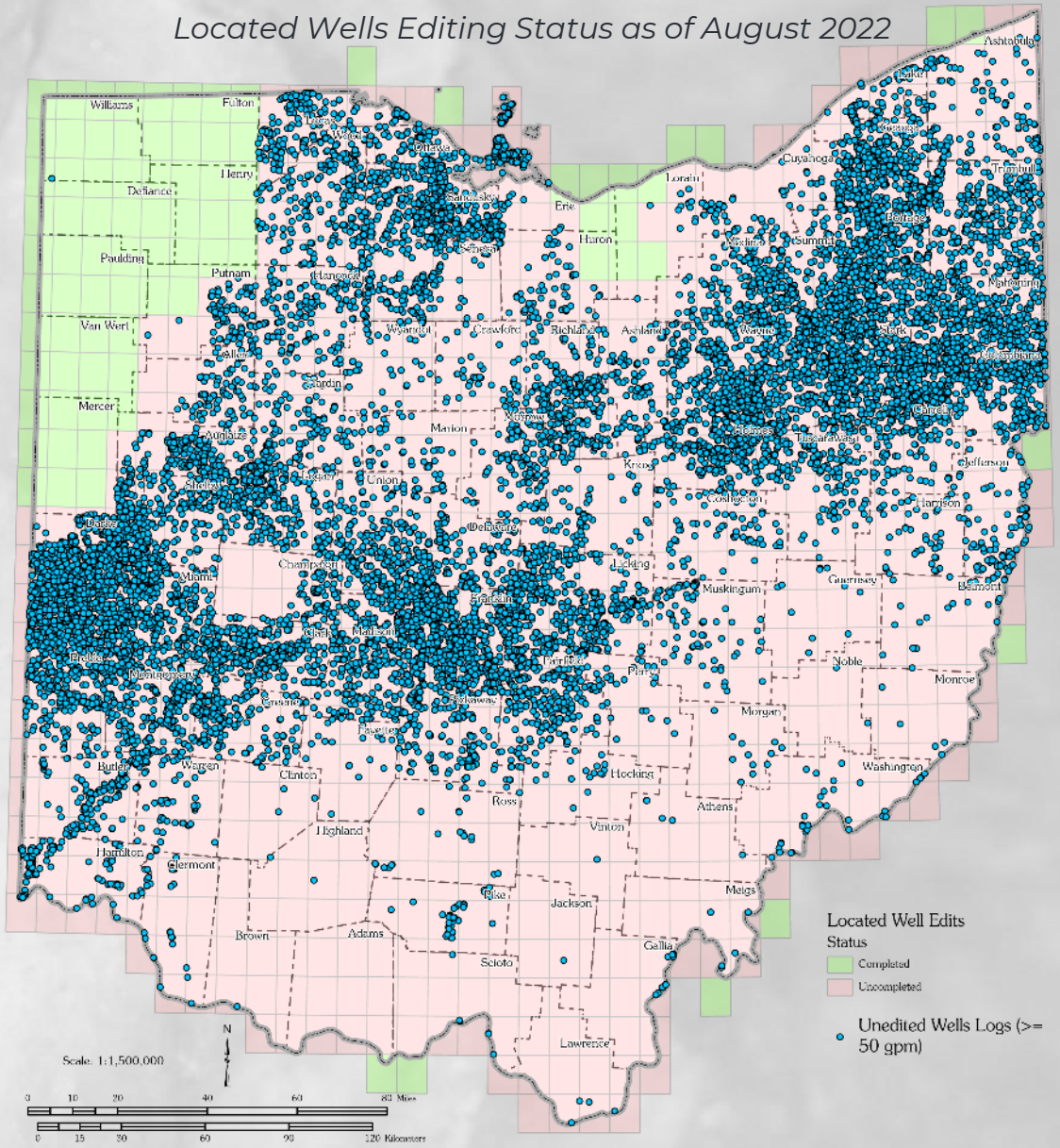
```
import geocoder
import csv

inputfilepath = 'M:/Water_Group/Aquifer_Yield/Geocoding/Round_8_Input.csv'
outputfilepath = 'M:/Water_Group/Aquifer_Yield/Geocoding/Round_8.csv'

minlat = 38.40
maxlat = 41.98
minlong = -84.82
maxlong = -80.51

    #reads csv file as a list
with open(inputfilepath, 'r') as inputcsv:
    reader = csv.reader(inputcsv, delimiter=',')
    addresses = list(reader)

    #writes an output csv file with geocoded lat longs
with open(outputfilepath, 'w', newline='') as outputcsv:
    writer = csv.writer(outputcsv)
    writer.writerow(['WELL_LOG_NO', 'LATITUDE', 'LONGITUDE'])
    for address in addresses[1:]:
        latlong = geocoder.arcgis(address[1]).latlng
        if latlong[0] > minlat and latlong[0] < maxlat and latlong[1] > minlong and latlong[1] < maxlong:
            writer.writerow([address[0], latlong[0], latlong[1]])
```

Short Python script utilizing Geocoder library and ArcGIS geocode

WELL CORRECTIONS

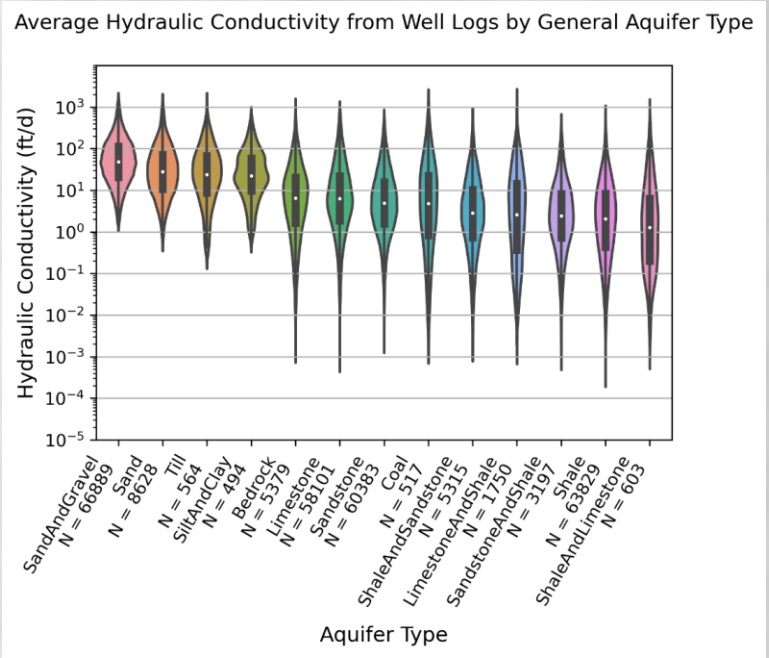
- Quad-by-quad editing of well location, drilling log, and well test data
- Located wells with pump test rates >= 50 gpm
- Unlocated wells with pump test rates >= 60 gpm
- Approximately 40,000 wells edited

Located Wells Editing Status as of August 2022

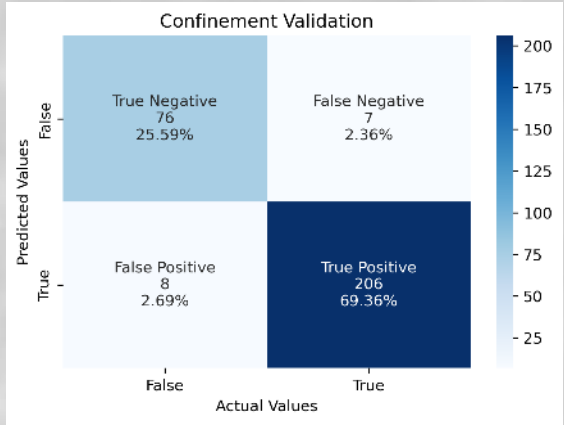


WELL COMPLETION TEST MODEL

- Calculates specific capacity from located ODNR well logs (n=619,646)
- Calculates transmissivity, T, using iterative Theis solution (requires b, L, confinement, partial penetration, etc.)
- Calculates K from T using b derived from well drilling log geo forms

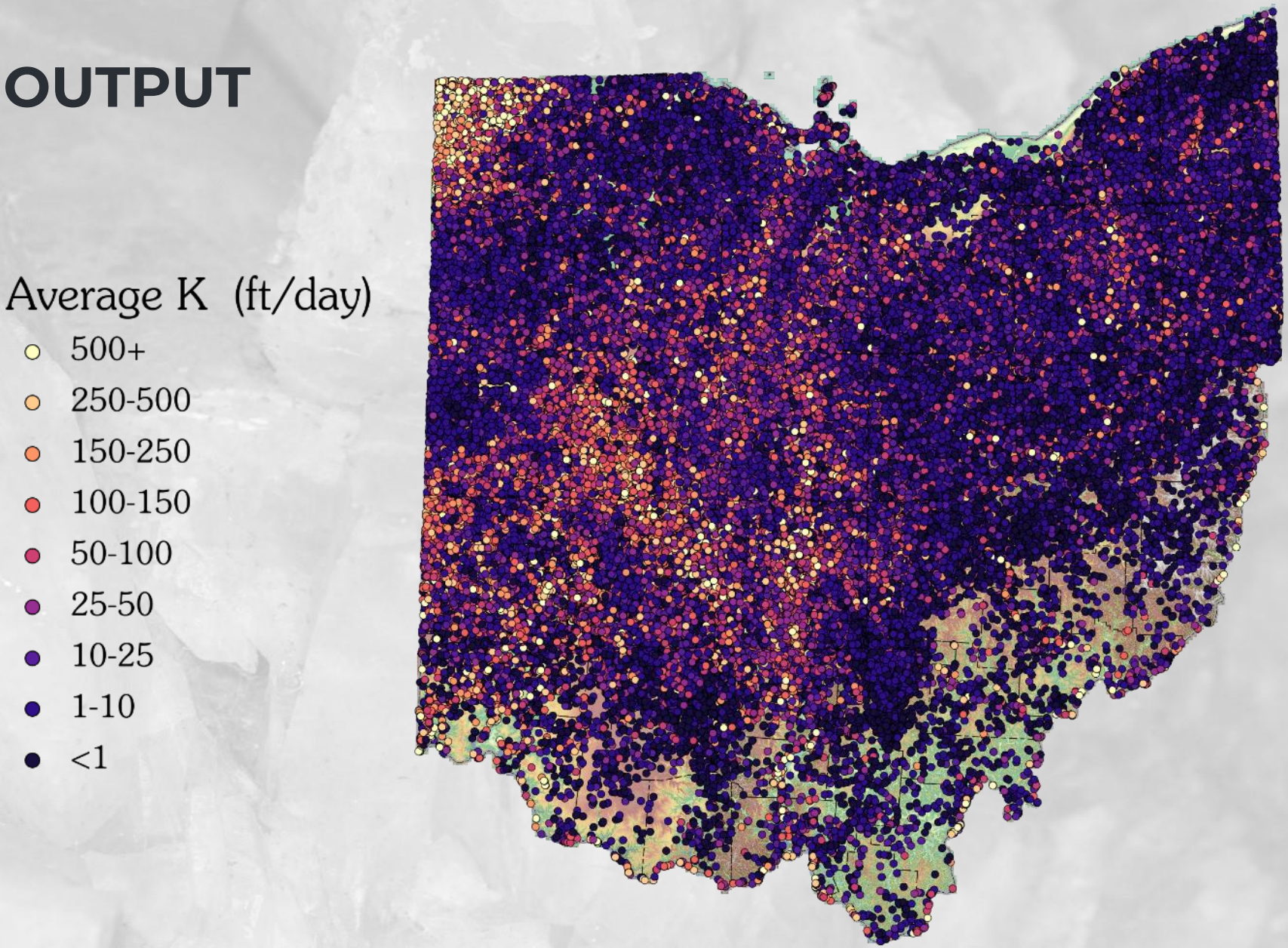



```
        return None
    elif row['IsConfined'] == True:
        return row[DrawField]
    elif row['IsConfined'] == False:
        return (row[DrawField] - ((row[DrawField]**2)/(2 * row['bMi

def corrMax(row):
    if row['bMax'] == None:
        return None
    elif row['IsConfined'] == True:
        return row[DrawField]
    elif row['IsConfined'] == False:
        return (row[DrawField] - ((row[DrawField]**2)/(2 * row['bMa

dfWells['sCorrMin'] = dfWells.apply(lambda row: corrMin(row), axis=
dfWells['sCorrMax'] = dfWells.apply(lambda row: corrMax(row), axis=

# Define some functions to aid in the correction for partial aquife
def G(L,b):
    ans = 2.948 - (7.363 * (L / b)) + (11.447 * ((L / b) ** 2)) - (
    return ans

def sp(L,b,r):
    ans = ((1 - (L / b)) / (L / b)) * (np.log(b / r) - G(L, b))
    return ans
```



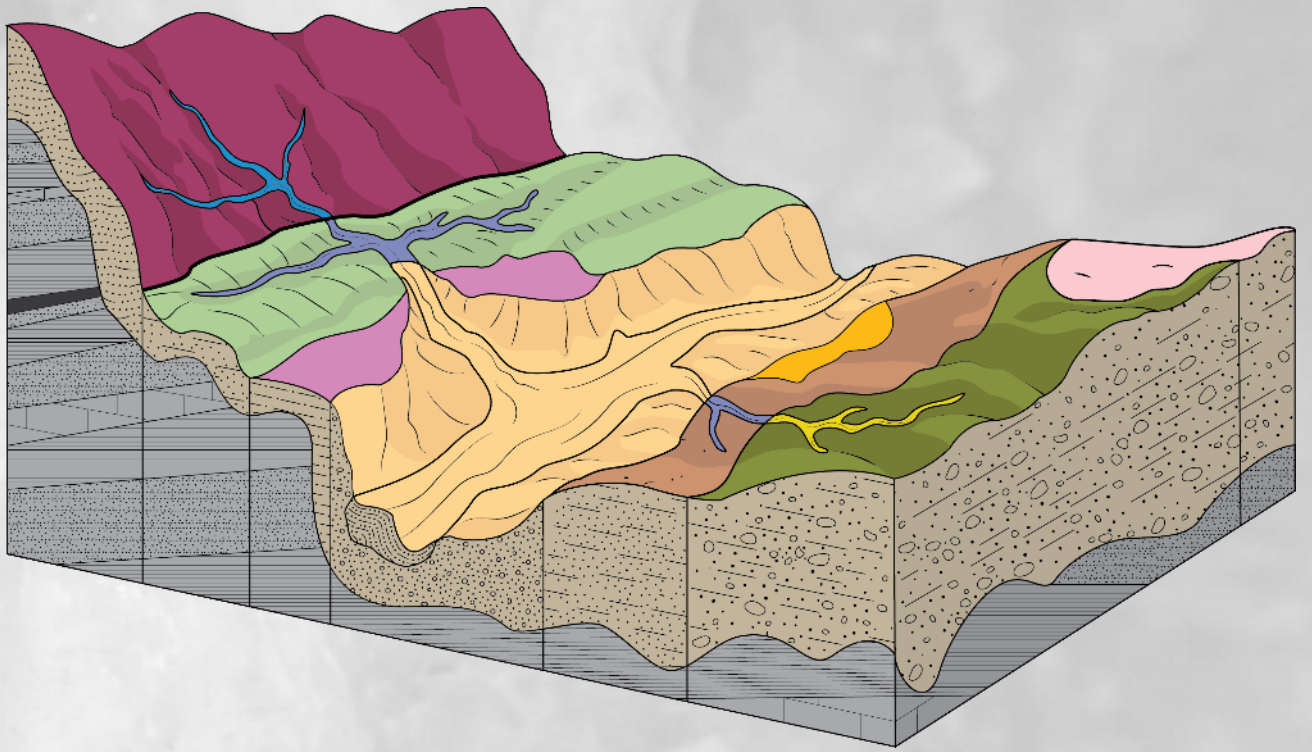
Example code and validation matrix for confinement in test dataset

MODEL OUTPUT



MAPPING: PRIMARY & SECONDARY AQUIFERS

- **Primary**: Higher-yielding aquifer unless there is a disqualifying factor for most uses (depth, quality, discontinuity)
- **Secondary**: Lower-yielding or alternate aquifer suitable for some uses (e.g., shallower unit, surficial deposits)
- **Reason Aquifer is Secondary:** Considerations include depth, lower yield, thin, discontinuous, water quality considerations, etc.



MAPPING: AQUIFER TYPE

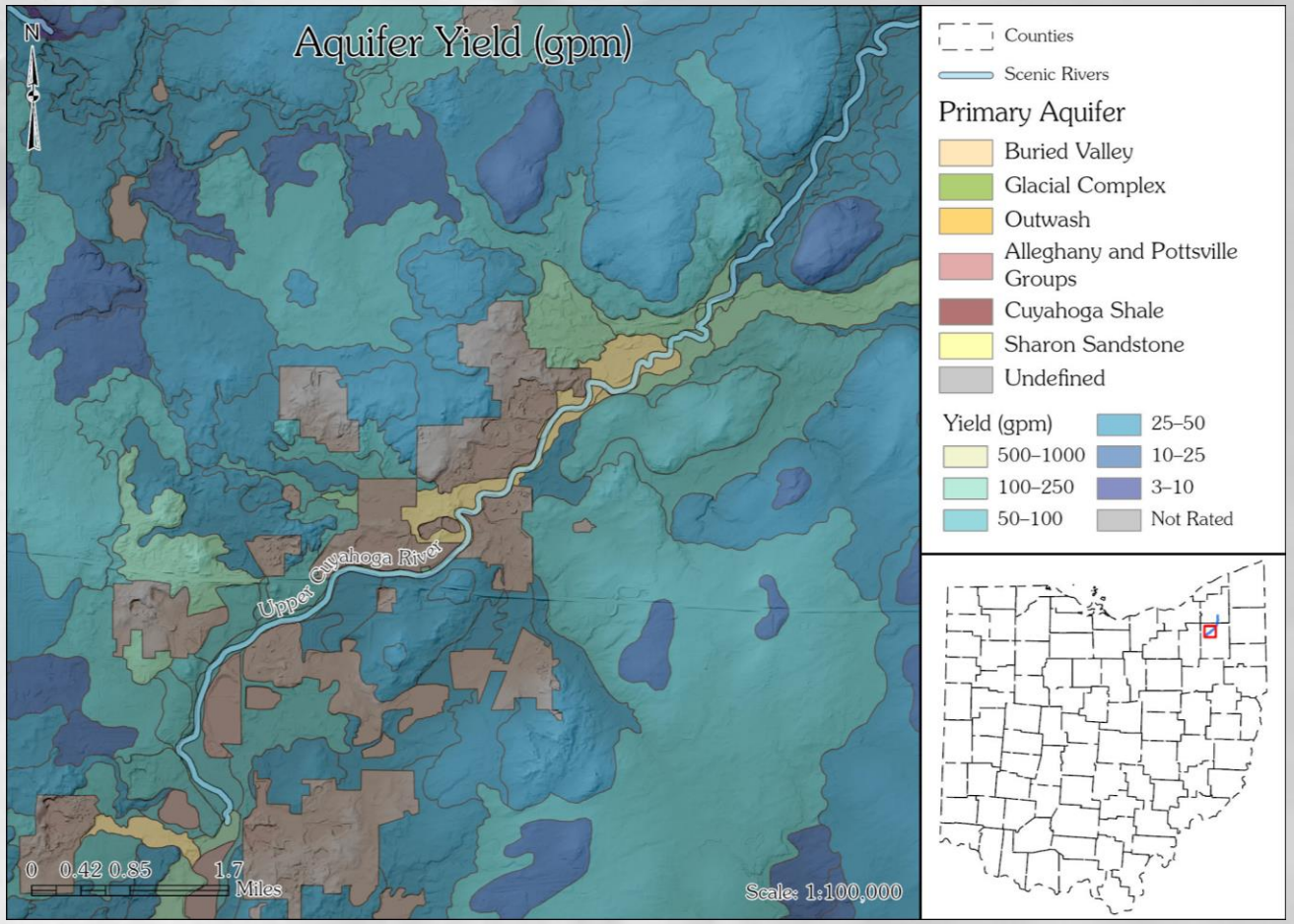
- Defines aquifer types with more granularity than existing maps
- Grouped on lithologic/hydrostratigraphic units
- Some aquifers defined by age, others by specific units

GV Aquifer	AY Code	AY Aquifer	Units/Group
Sand and Gravel	A	Alluvial Deposits	Glacial sand-and-gravel deposits
	BDD	Beach Ridge, Dune, and Deltaic Deposits	
	BV	Buried Valley	
	GC	Glacial Complex	
	O	Outwash	
	SD	Other Surficial Deposits	
Interbedded Sedimentary Rocks	ISR-dmc	Interbedded Sedimentary Rocks (Permian or Upper Pennsylvanian)	Dunkard, Monongahela Group, Conemaugh Group
	ISR-ap	Interbedded Sedimentary Rocks (Middle and Lower Pennsylvanian)	Alleghany and Pottsville
Interbedded Sandstone and Shale	ISS-lc	Interbedded Sandstone and Shale (Upper and Lower Mississippian)	Logan and Cuyahoga
	ISS-lc-sst	Interbedded Sandstone and Shale, sandstone-dominant (Upper and Lower Mississippian)	Logan and Cuyahoga (Logan)
	ISS-lc-sha	Interbedded Sandstone and Shale, shale-dominant (Upper and Lower Mississippian)	Logan and Cuyahoga (Cuyahoga)
	ISS-sbb	Interbedded Sandstone and Shale (Lower Mississippian and Upper Devonian)	*Sunbury, Berea, Bedford undivided
Sandstone	SST-Penn	Sandstone, coarse-grained or conglomeritic (Pennsylvanian)	Massillon Sandstone, Sharon Sandstone/Conglomerate
	SST-bh	Sandstone, coarse-grained, massively bedded (Mississippian)	Cuyahoga (Black Hand Member)
	SST-Dev	Sandstone, fine-grained (Devonian)	Berea Sandstone
Shale	SHA-Miss	Shale (Mississippian)	Sunbury Shale
	SHA-Dev	Shale (Devonian)	Bedford Shale, Antrim Shale, Ohio Shale, Olentangy Shale
	SHA-Sil	Shale (Silurian)	Estill Shale
Limestone	LS-Dev	Limestone (Devonian)	Traverse Group (Ten Mile Creek and Silica Formation), Delaware Limestone, Dundee Limestone, Detroit River Group
	LS-cbus	Limestone, massively bedded (Devonian)	Columbus Limestone
	LS-Sil	Dolomite (Silurian)	Bass Islands, Salina Grp, Tymochtee & Greenfield, Lockport, Peebles/Lilley/Bisher, Cedarville/Springfield/Euphemia, Clinton & Cataract Group
Limestone and Shale	LSH-Sil	Limestone and Shale (Silurian)	Massie/Laurel/Osgood/Dayton/Brassfield
Limestone and Shale	LSH-Ord	Limestone and Shale (Ordovician)	Cincinnati through Kope

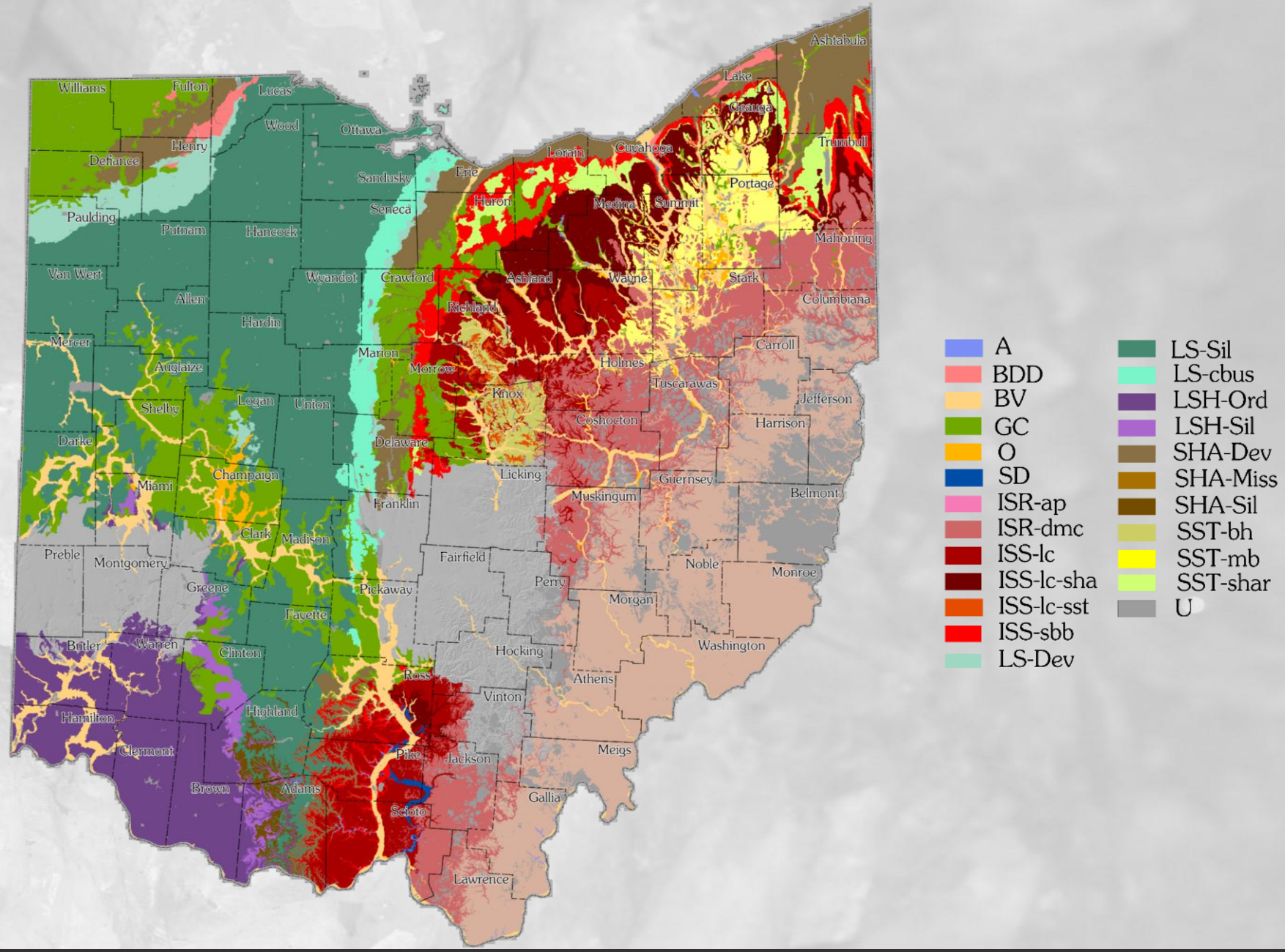
MAPPING: YIELD

- Data sources:
  - Water wells
  - Groundwater Resources Maps
  - GV Aquifer Ratings
  - Pumping Tests
  - Statewide Aquifer Maps

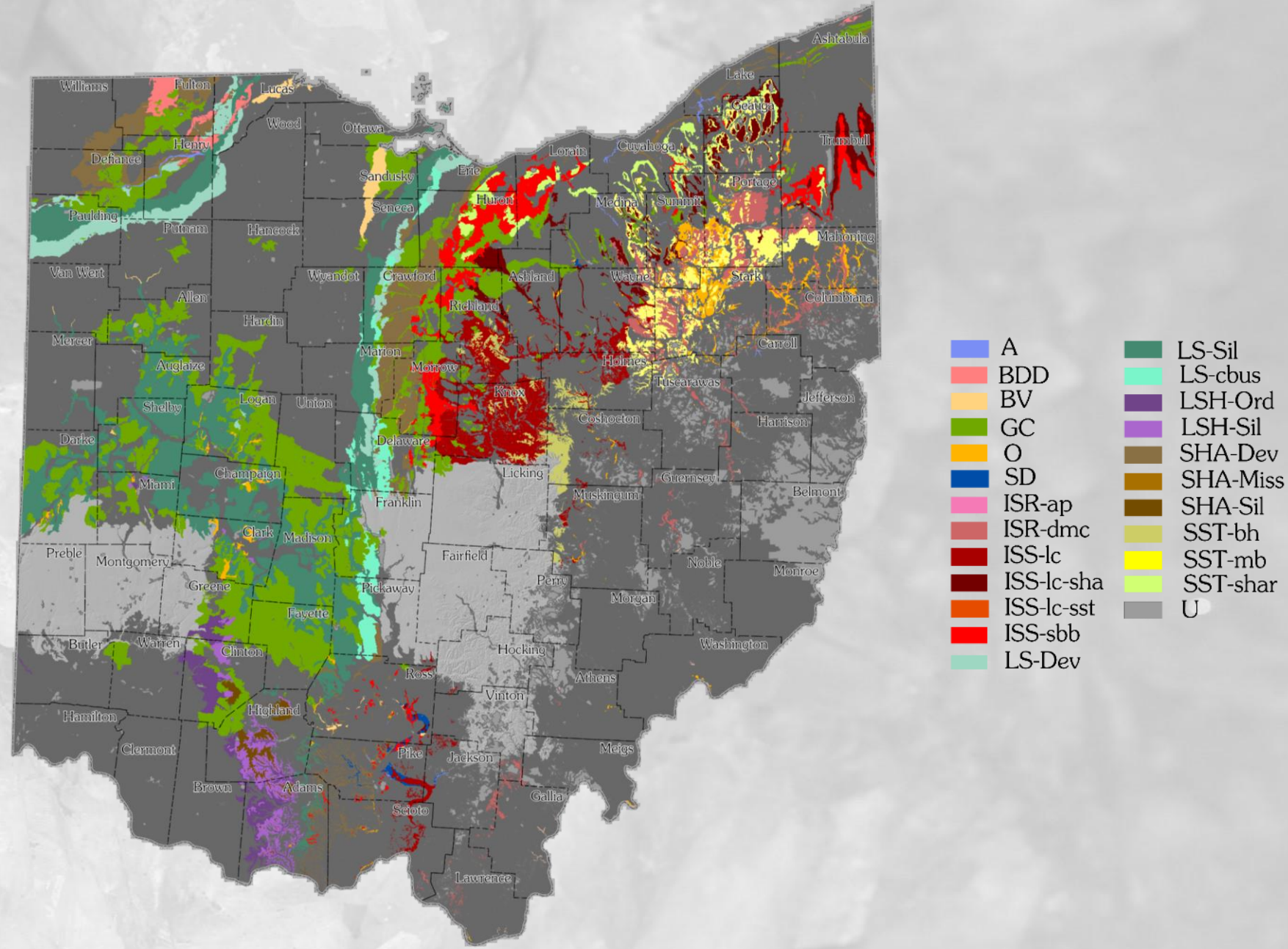
Well Yield (gpm)	Uses
0–3	Gardening, small domestic (holding tank and water management needed)
3–10	Small domestic (holding tank probably needed)
10–25	Domestic
25–50	Large domestic, small businesses, trailer parks, small-scale farming
50–100	Small businesses, trailer parks, small community, medium-scale farming
100–250	Traditional farming & irrigation, medium community
250–500	Low-flow, center-pivot irrigation; large community
500–1000	Center-pivot irrigation, large public water systems, large-scale industrial
1000+	Large municipal water systems, large-scale industrial or commercial agricultural



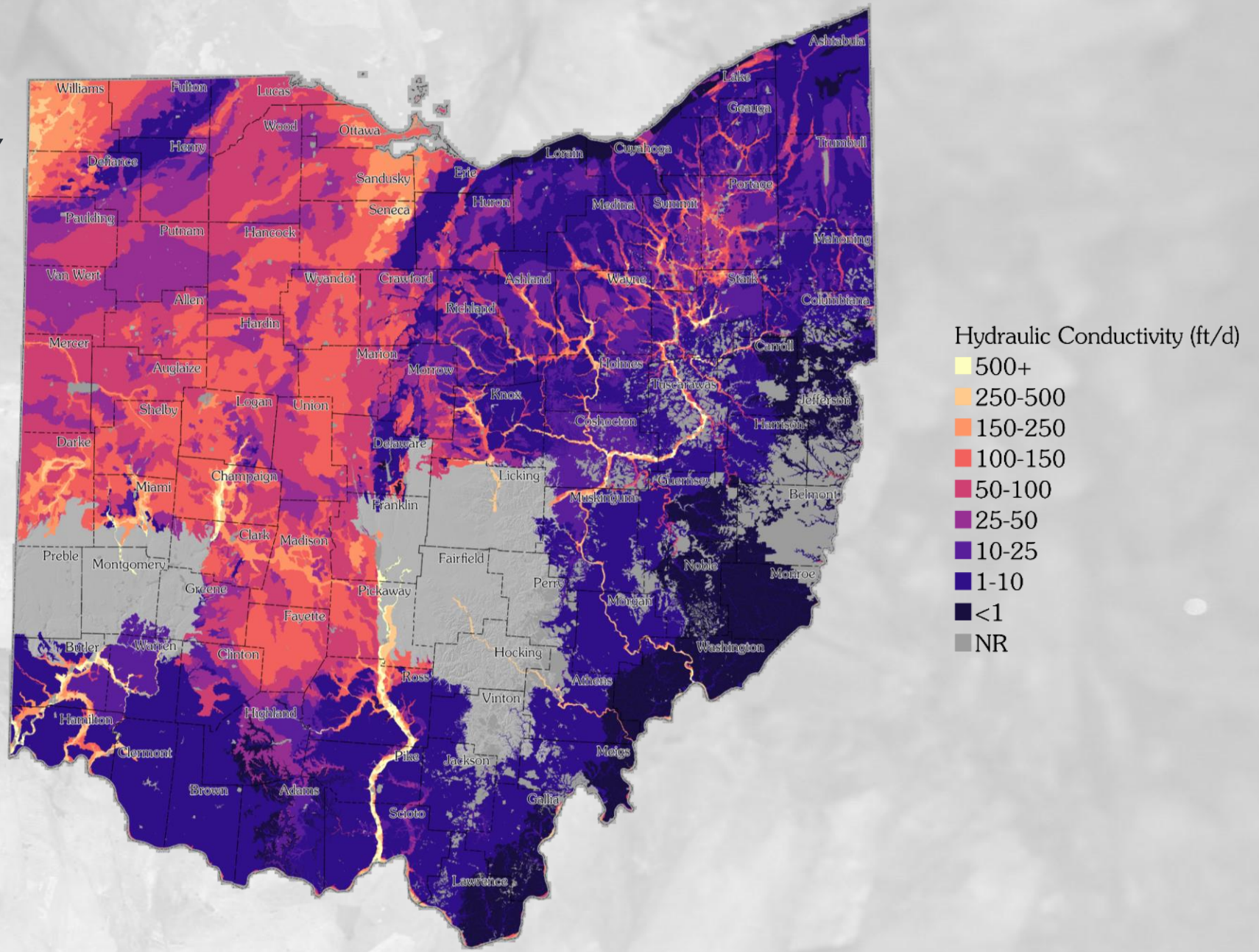
PRIMARY AQUIFER



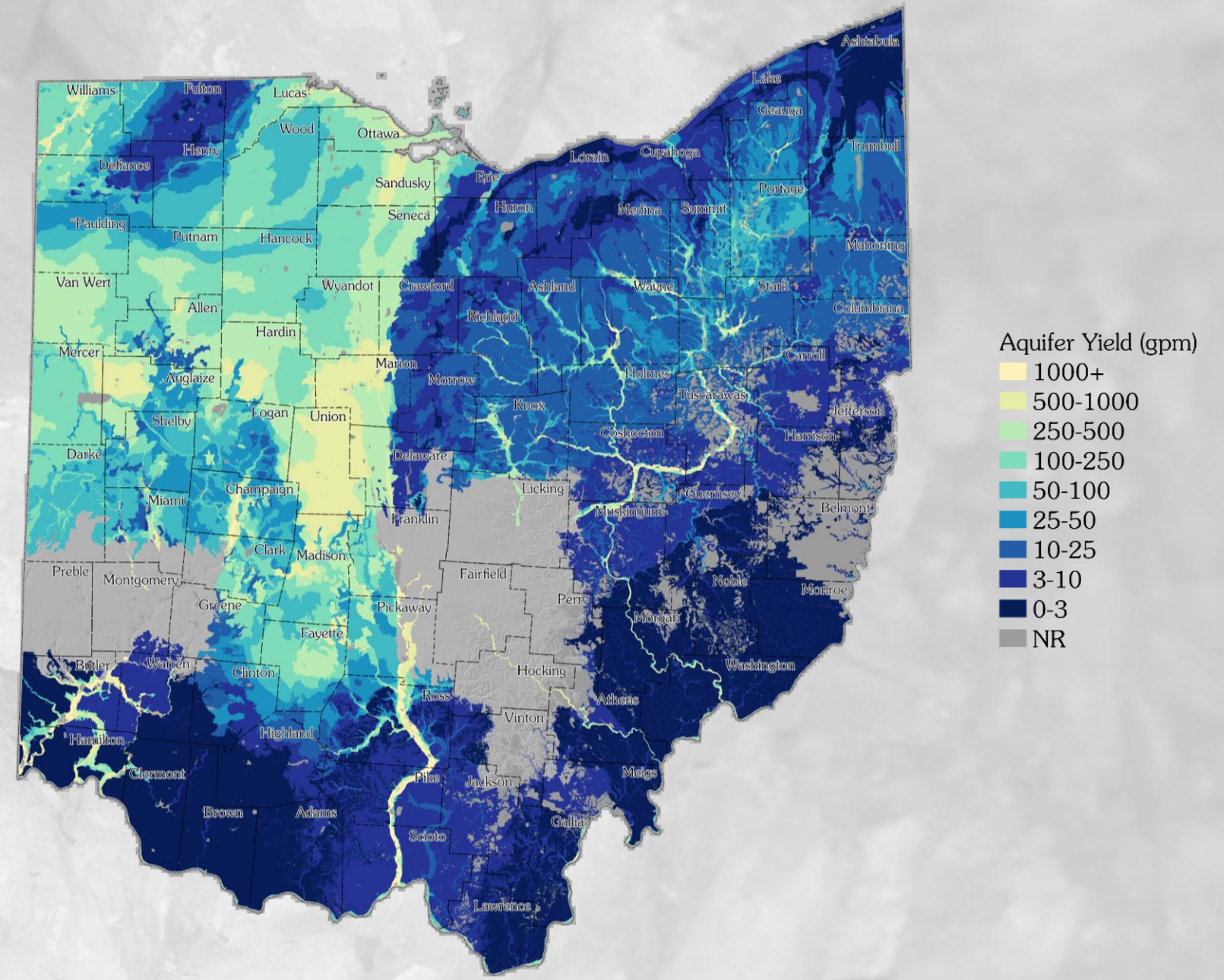
SECONDARY AQUIFER



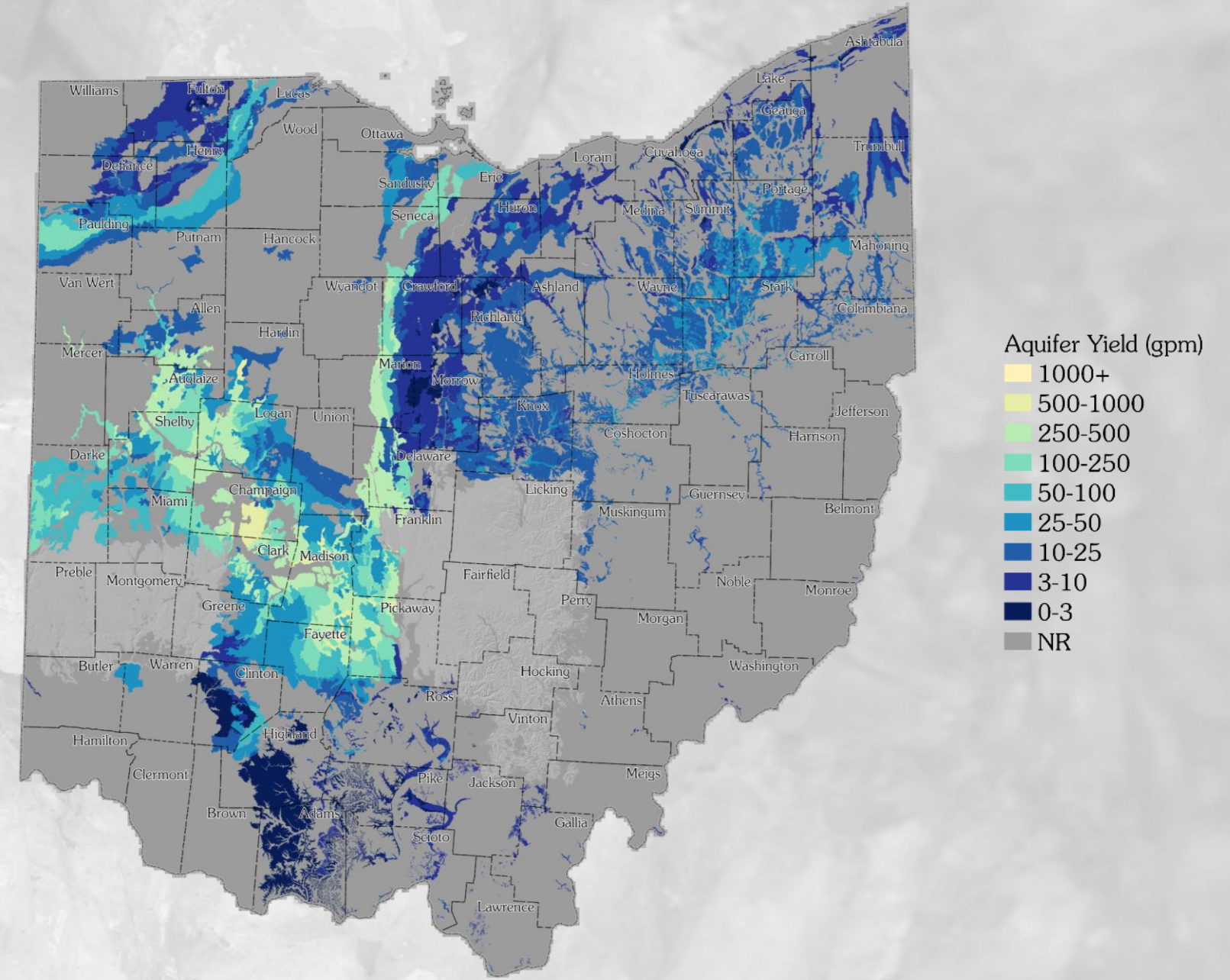
HYDRAULIC CONDUCTIVITY



PRIMARY YIELD



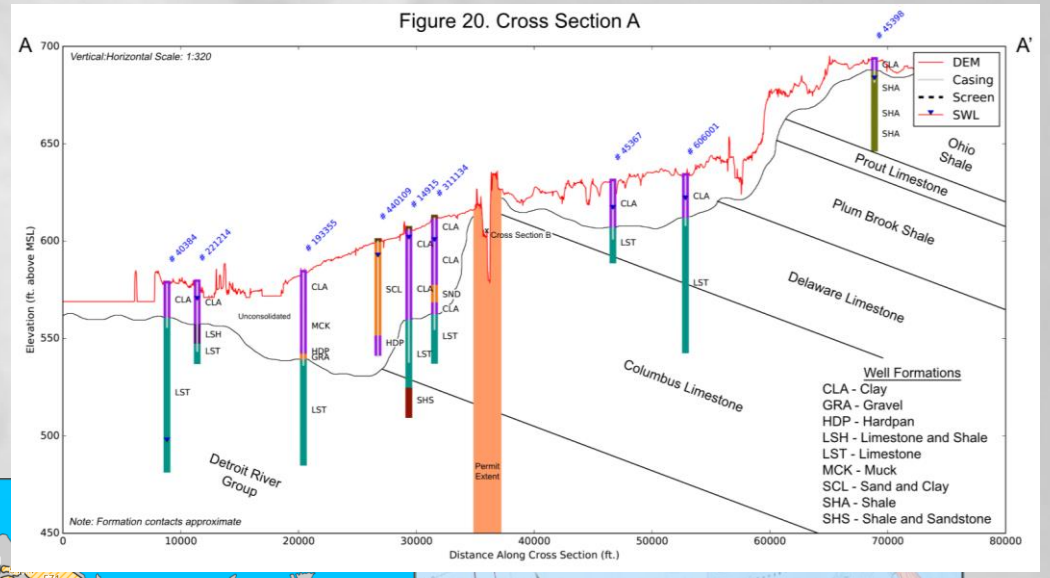
SECONDARY YIELD

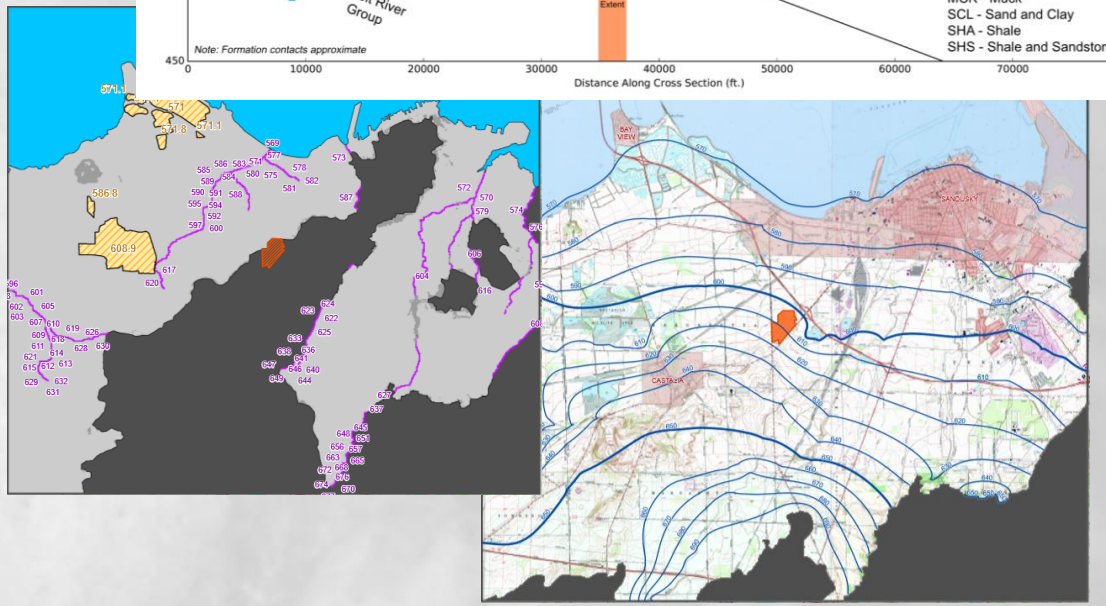


II. GROUNDWATER MODELING

ODNR GROUNDWATER MODELING REQUIREMENTS

- Div. of Mineral Resources Management Permits:
  - Surface Mines that result in dewatering
- Div. of Water Withdrawal Permits:
  - ≥ 1mgd in Lake Erie Watershed
  - ≥ 2mgd (consumptive use) in Ohio River Watershed



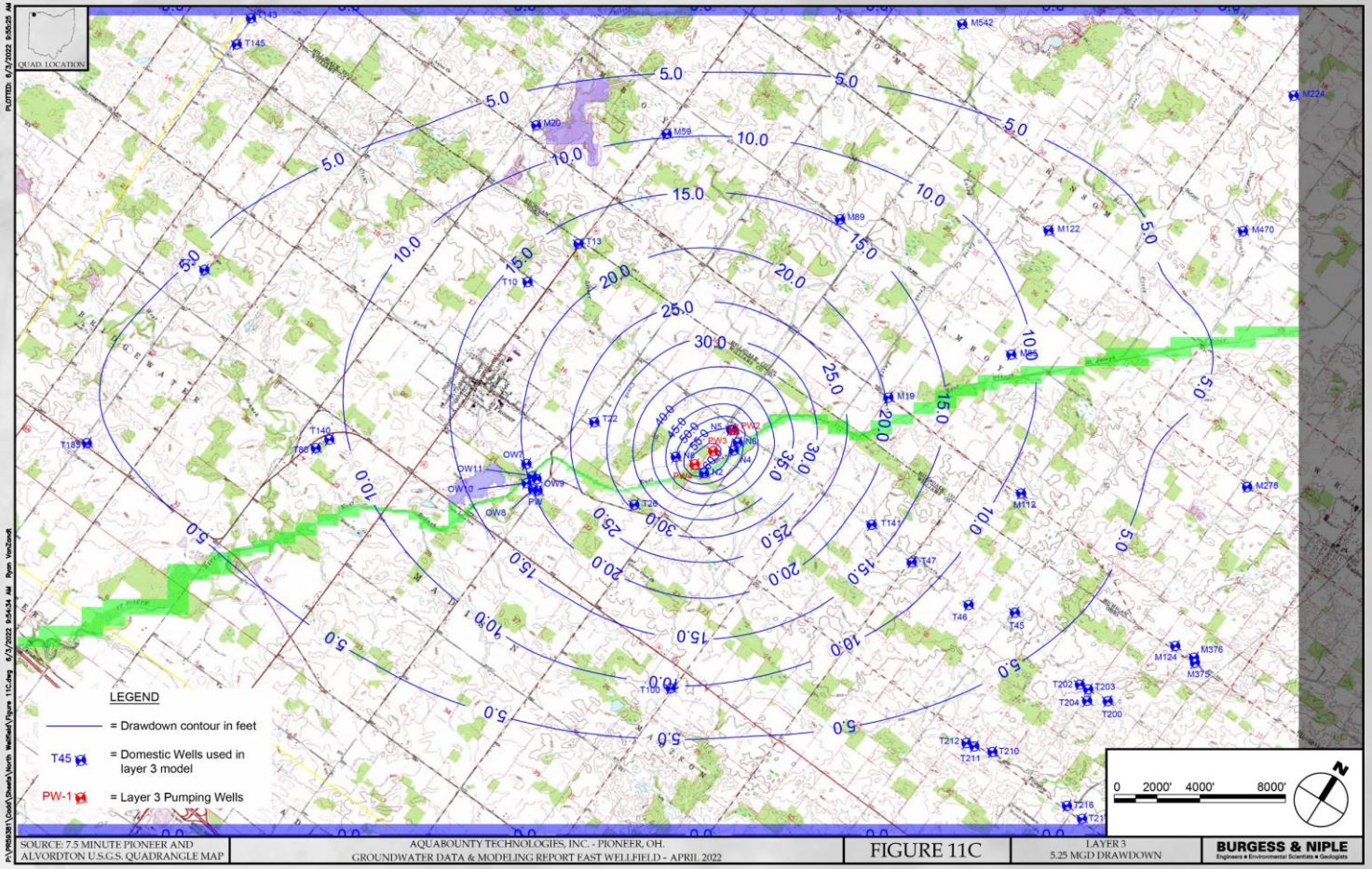


THE AQUABOUNTY PERMIT

2022
- AQB submits 1st Permit application (3 mgd)
- ODNR approves with conditions
- AQB submits 2nd Permit application (5.25 mgd)
- ODNR approves with conditions
- Groundbreaking at Pioneer facility

2023
- ODNR approves AQB's Monitoring Plan
- Williams County commissioners deny AQB's use of right of way for utility lines (3 times)
- Construction paused

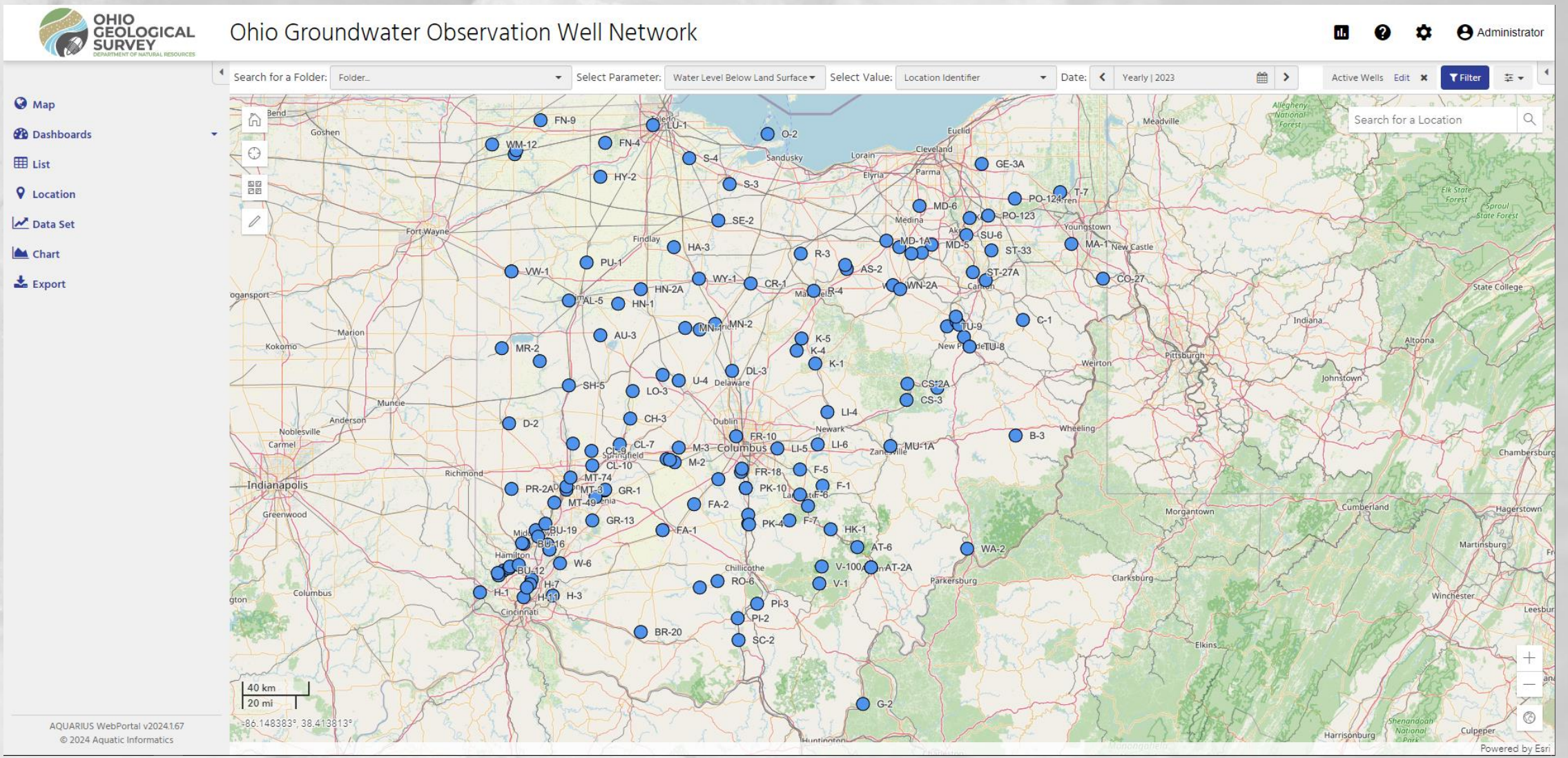
2024
- Judge reverses commissioners' decision
- Commissioners vote 2-1 to appeal reversal
- AquaBounty announces plan to sell Indiana facility and focus on Ohio



(Burgess & Niple, 2022)

III. GROUNDWATER MONITORING

OBSERVATION WELL NETWORK



OBSERVATION WELL NETWORK

Summary | Files 1 | Go To Map

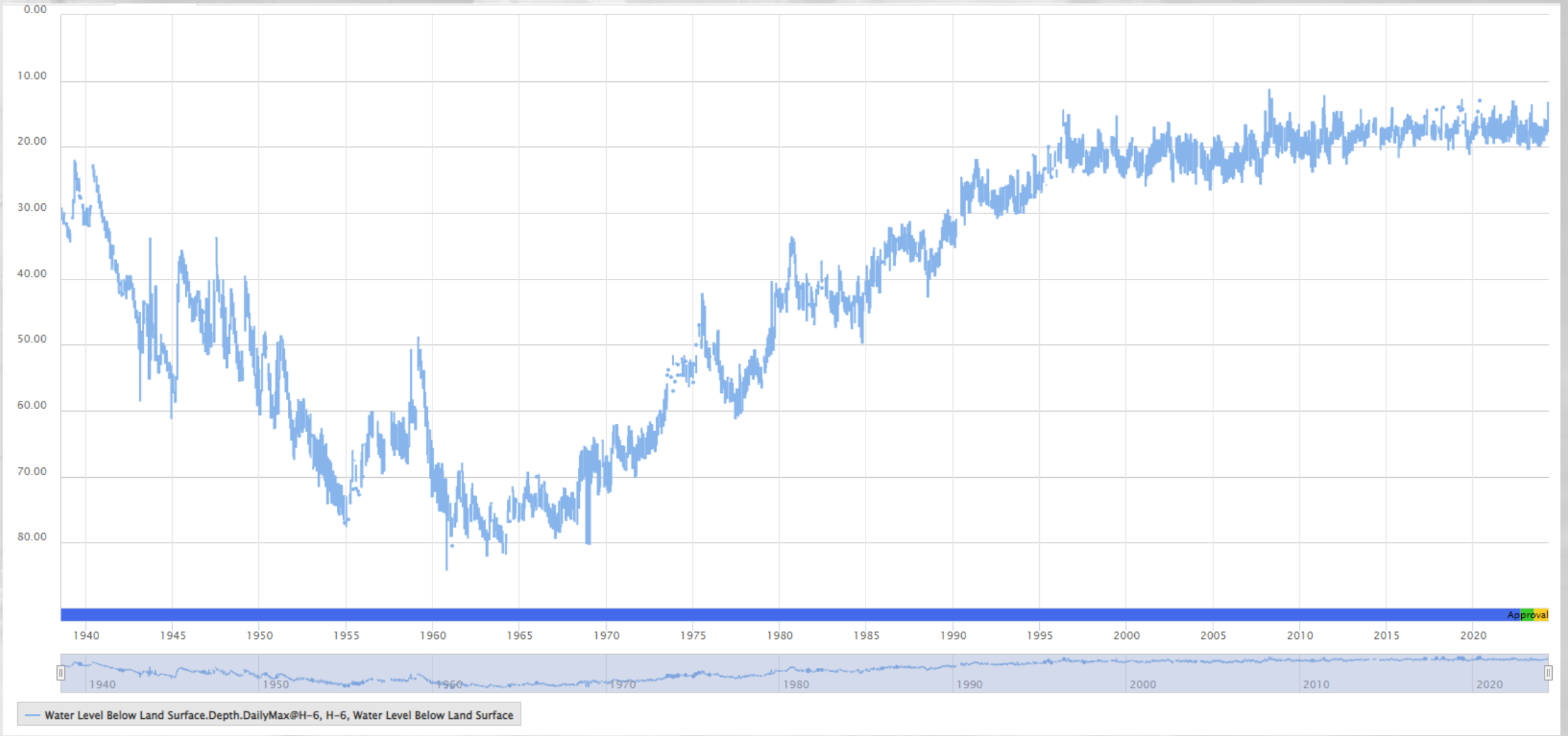
Location: H-6

Location Name	H-6
Latitude / Longitude	39.26909, -84.4286 (WGS 84)
Elevation	573.27 ft
Time Zone	UTC-05:00
ClimateRegion	SOUTHWEST
DepthCompleted	167
DrainageBasin	OHIO RIVER
Status	ACTIVE
Location	GLENDALE WATER WORKS ON SHARON RD. AT MOSTELLER RD.
PeriodOfRecord	7-26-38 TO PRESENT CONTINUOUS
WaterQuality	True
AquiferAge	QUATERNARY
AquiferType	SAND AND GRAVEL
HydrologicUnitCode	05090203
Township	SYCAMORE
GeophysicalLog	Y
PumpingInfluence	Y
DepthCurrent	167
County	HAMILTON
WellLogLink	
Tags	No tags are associated with this Location.
Workflows	No workflows are associated with this Location.

Export last 7 days (CSV) | Export all Data (CSV)

Images

OBSERVATION WELL NETWORK



CONFLICTS

2022

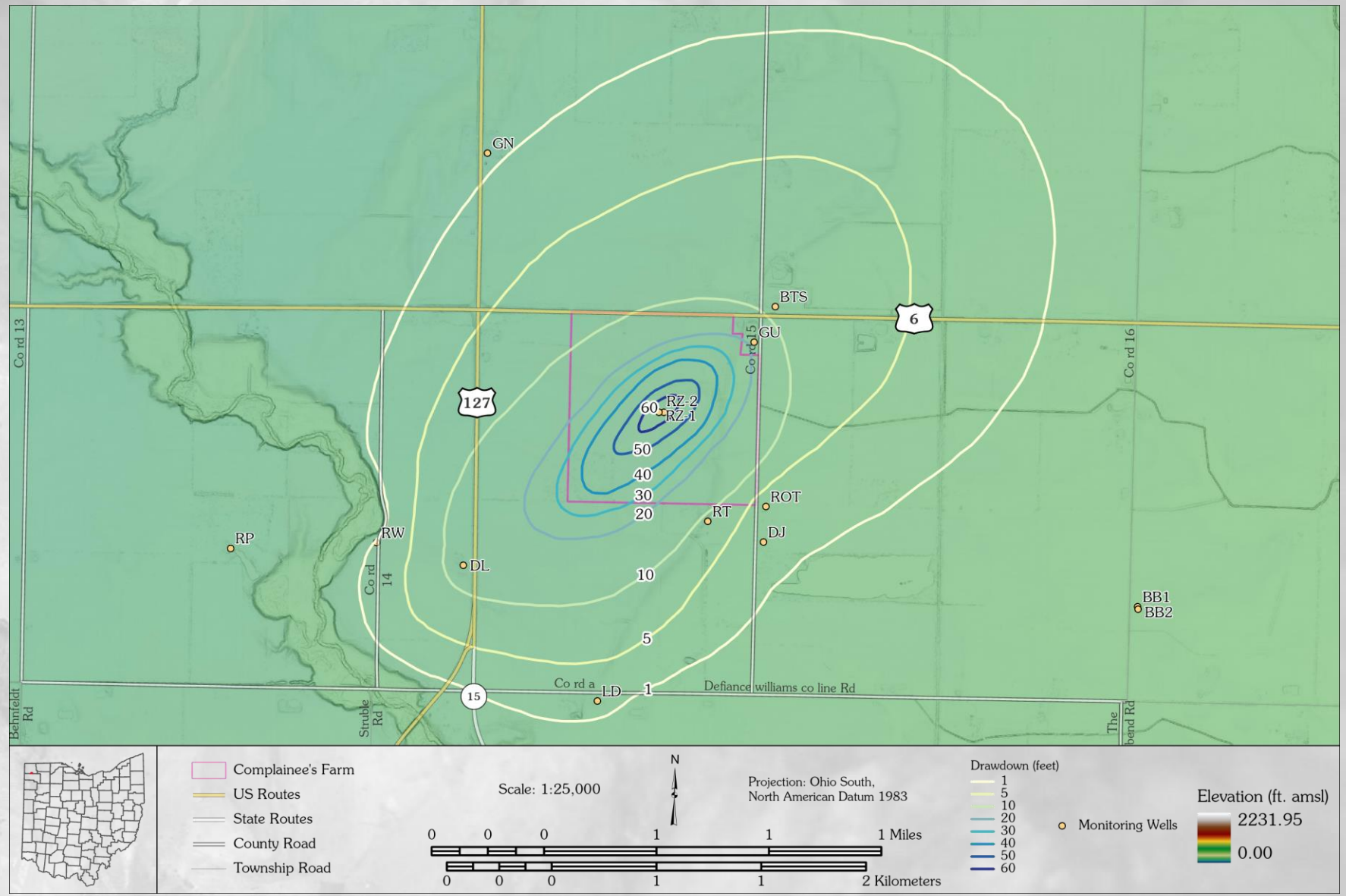
- Complaints of dewatering by local irrigator

2023

- ODNR investigation

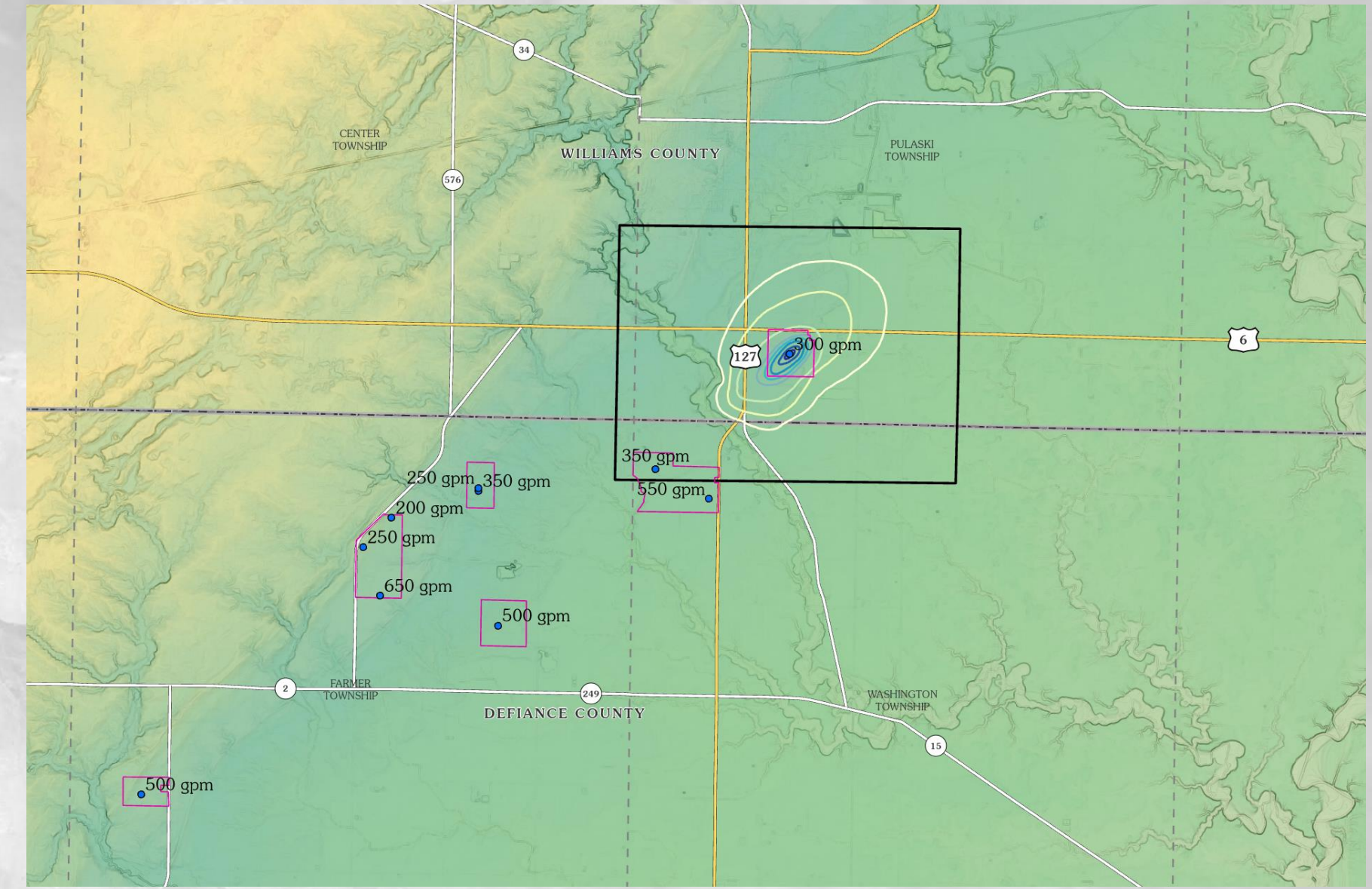
2024

- Awaiting request for public meeting



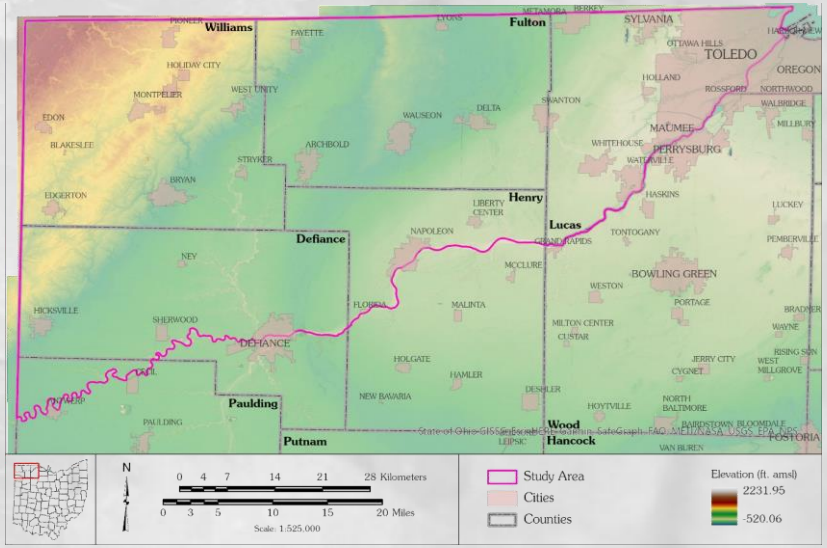
CONFLICTS

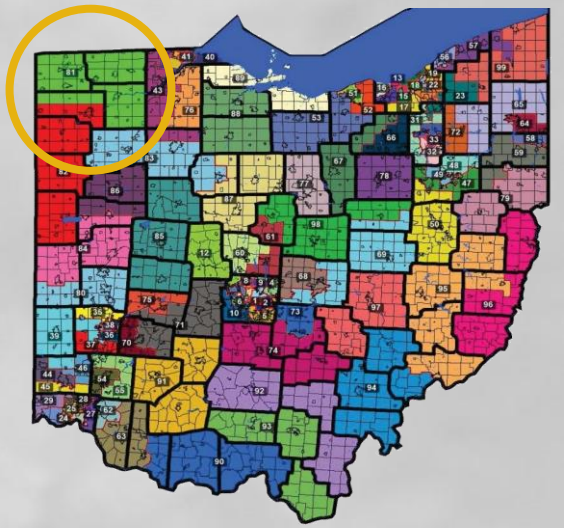
- Irrigator adding additional wells
- Other withdrawals increasing
- Heightened public awareness



NORTHWEST OHIO PROJECT

- State Fiscal Year (SFY) 24–25 Biennium Budget Bill
- Sponsored by Representative Jim Hoops (R – District 81)
- $500,000 budget
- Funded through Ohio Dept. of Development



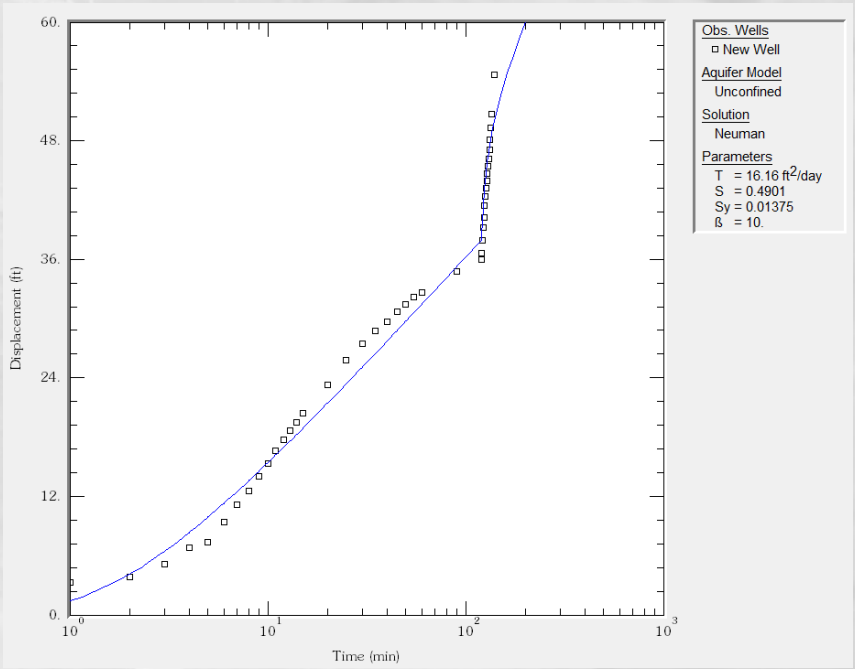


One-time Priority Project

"… to support a study, including the acquisition of any necessary equipment, to determine an **estimate of storage capacity** and **maximum annual yield** of the network of aquifers that are in the state of Ohio and north of the Maumee River, but that may also cross into other states."

PROJECT SCOPE

- Install ~10 new state observation wells
- Perform aquifer tests on newly installed wells
  - Step tests
  - Pumping tests
- Publish hydrogeologic report
- Update yield and conductivity maps



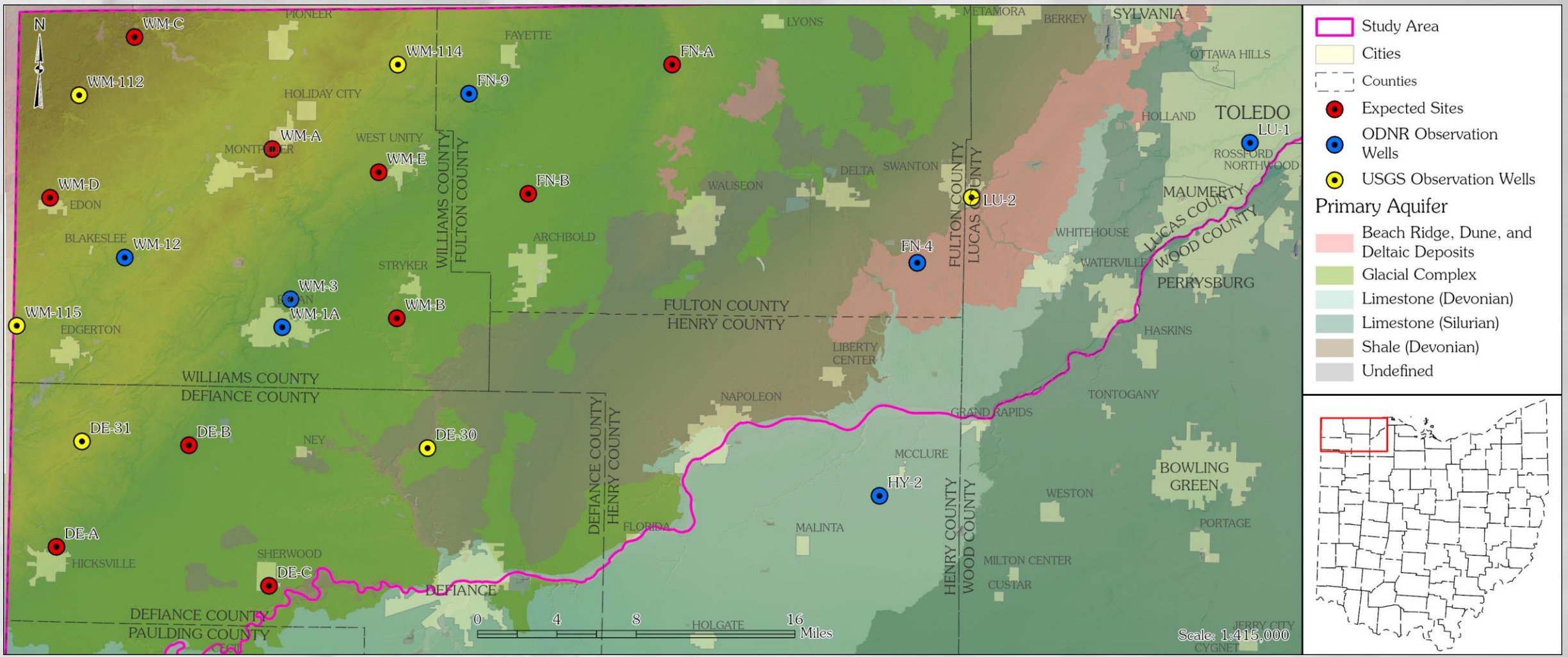
Aquifer Test Specifications

Step Test:	*5 steps, max 450gpm*
Pumping Test:	*24 hrs., max 300gpm*
Piezometer(s):	*5"*

Well Specifications

Borehole Diameter:	*12.25”*
Casing Diameter:	*8”*
Screen Length:	*10’*
Average Depth:	*175 feet*

EXPECTED SITES



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