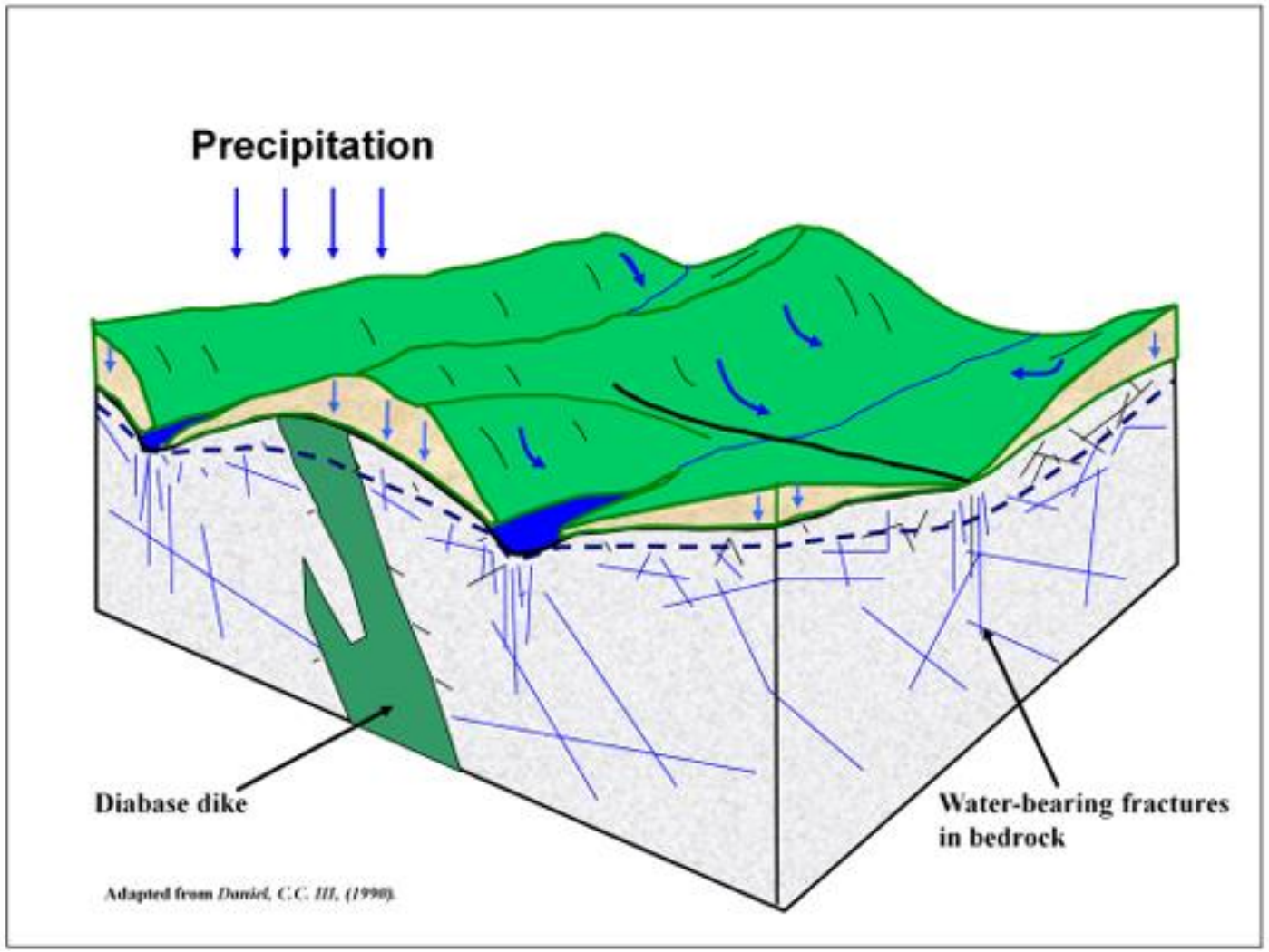
Groundwater in Loudoun County

A quick take on a complex subject

David Ward
October 29, 2024

Earthward Consulting

Topics



Groundwater Timeline

Conceptual Model

Groundwater Water Level

Drought

Recharge

Hydrostudy

https://www.loudoun.gov/DocumentCenter/View/4849/Groundwater-Basics?bidId=

Groundwater Timeline

1963-1977 - US Geological Survey installs three groundwater monitoring wells in/near Loudoun County.

1987 – First regulations in Loudoun County requiring detailed investigation of proposed groundwater development – "Hydrostudy".

1999 - Ad Hoc Groundwater Committee leading to Water Resources Technical Advisory Committee (WRTAC) which continued through 2019.

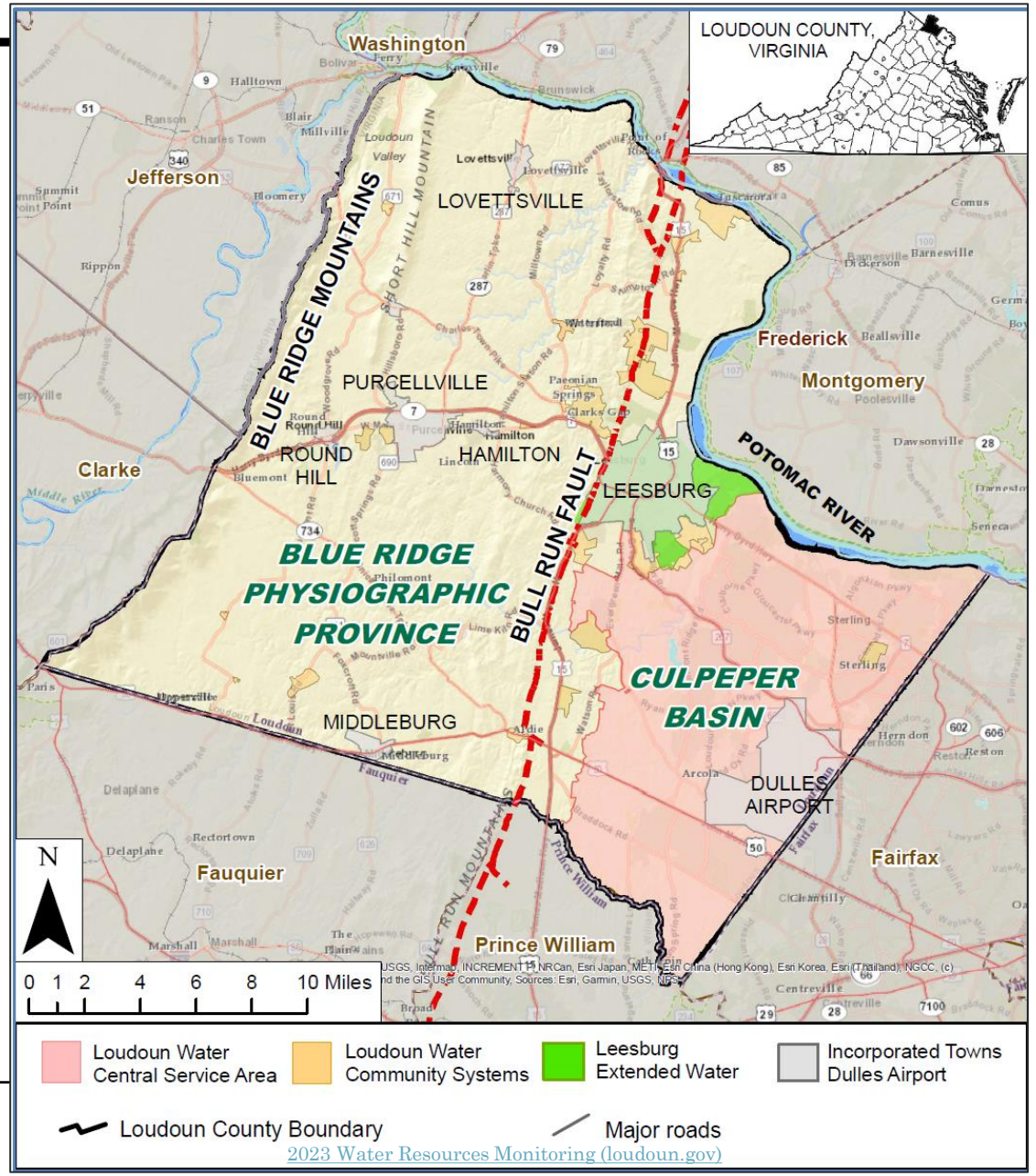
2002 – First groundwater monitoring well drilled by Loudoun County initiates groundwater monitoring wells, peaking at 18 with plans for 30. Currently 14 wells are active.

2007 - Statistical assessment report of groundwater data and initial assembly of "Hydrostudy" data (aquifer parameters).

2008-2010 – Specialized groundwater water quality sampling by Loudoun County (probabilistic, limestone, western hills).

2008-2024 – Annual Water Resources Monitoring Data Reports.

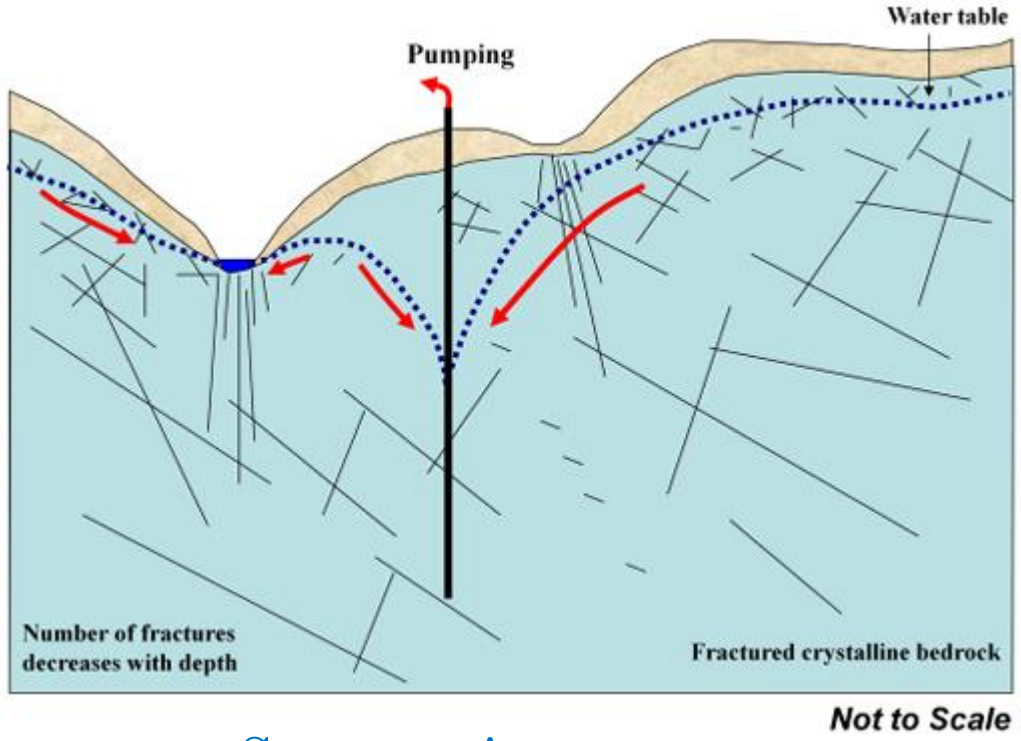
2008-2018 – Watershed Management Plans (Comprehensive, Upper Broad Run, Western Hills)



https://lfportal.loudoun.gov/LFPortalinternet/0/edoc/593000/2023%20Water%20Resources%20Monitoring.pdf

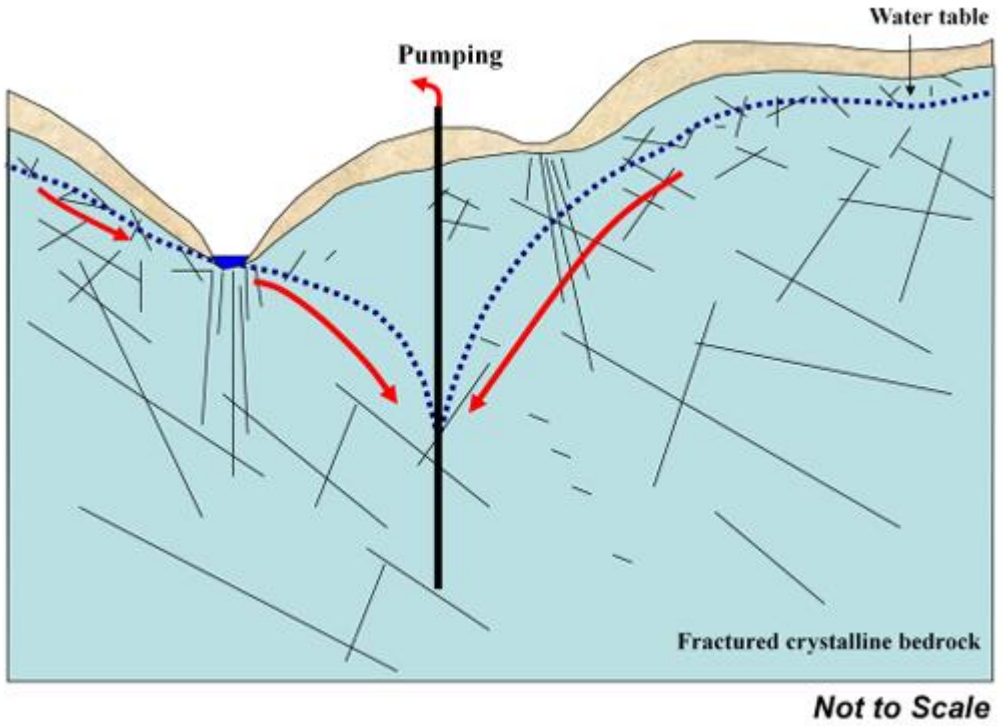
Loudoun County VIRGINIA
WHERE TRADITION MEETS INNOVATION

How does pumping a well affect stream (pond) in western Loudoun?



Stream gains water

Stream looses water



Loudoun County
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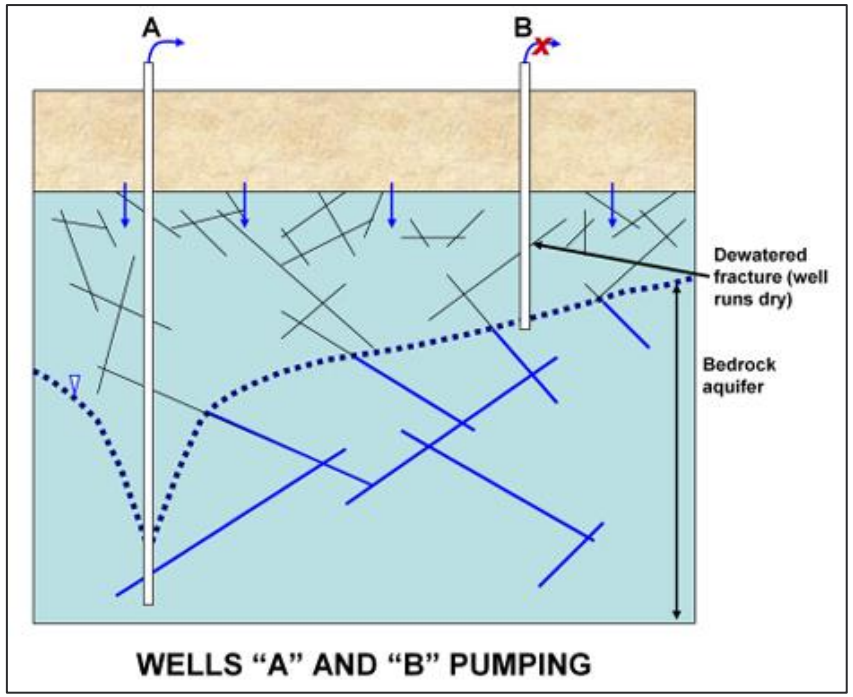
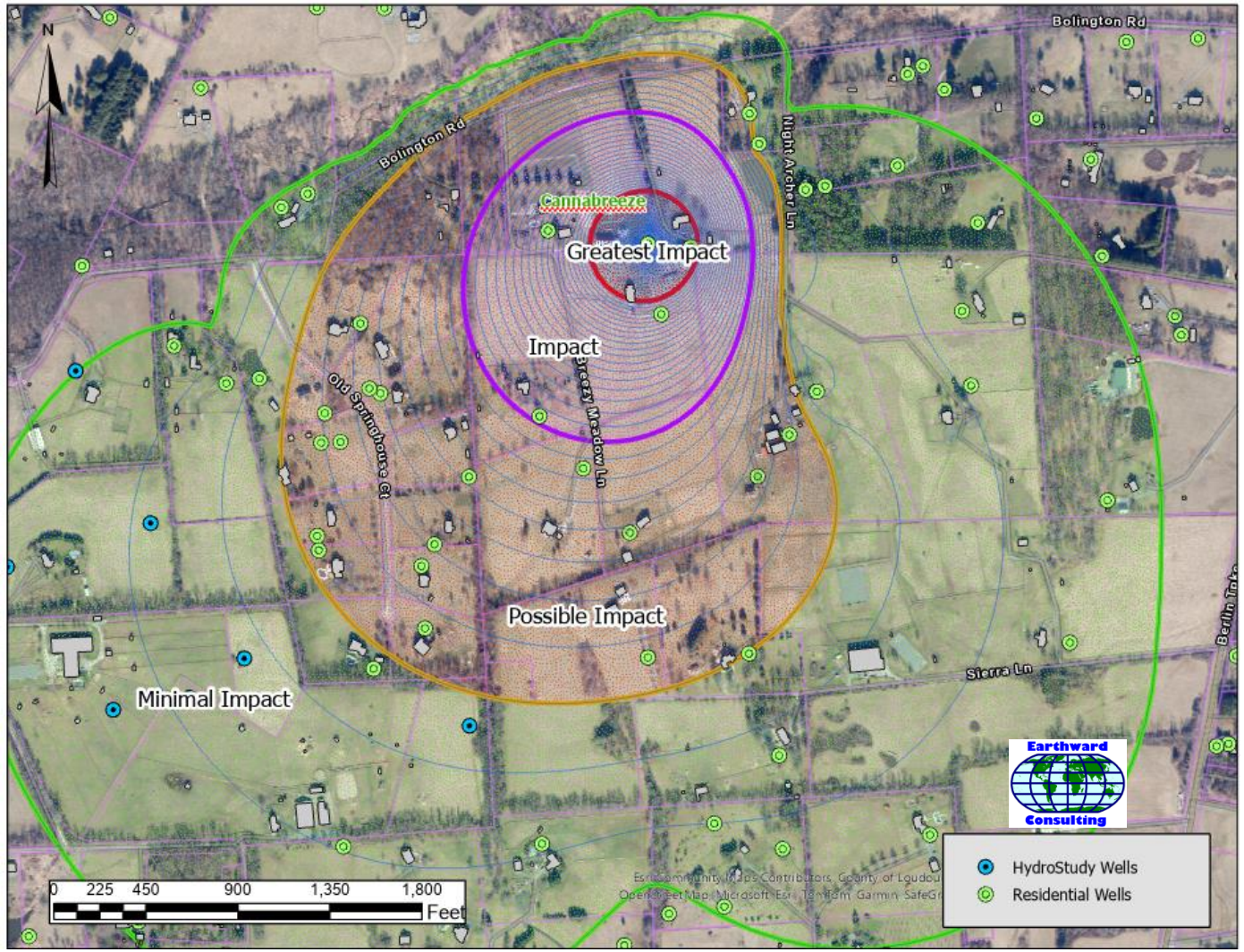
Neighbors well runs dry?





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Western Loudoun Groundwater Flow Conceptualization

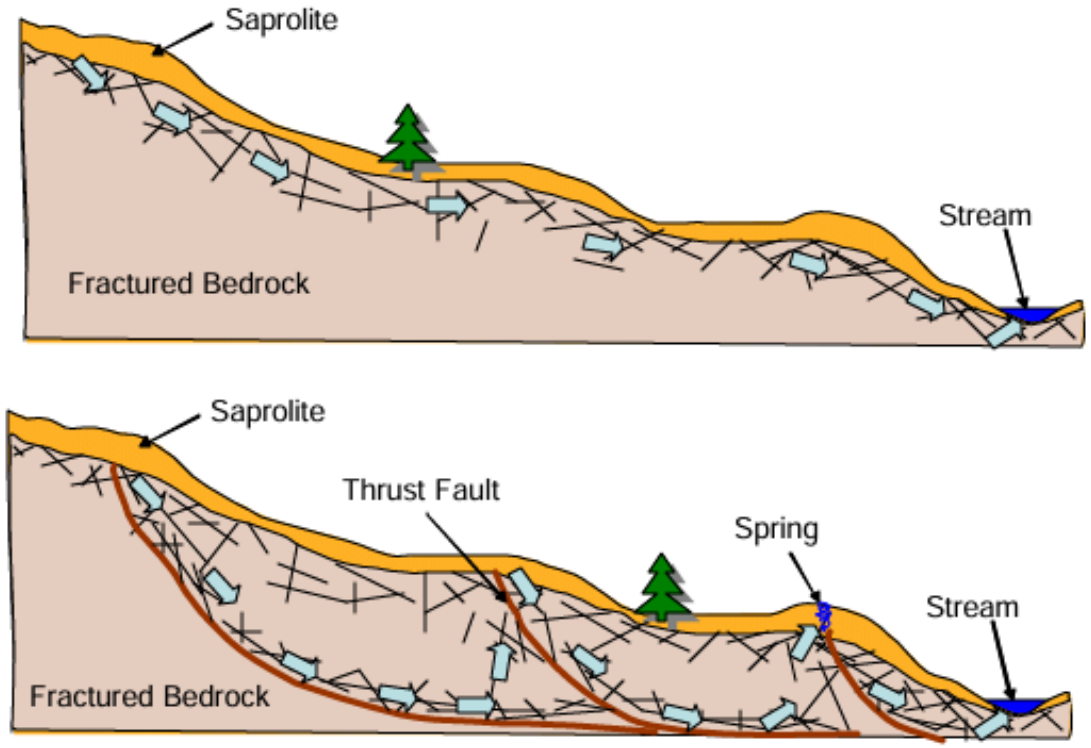
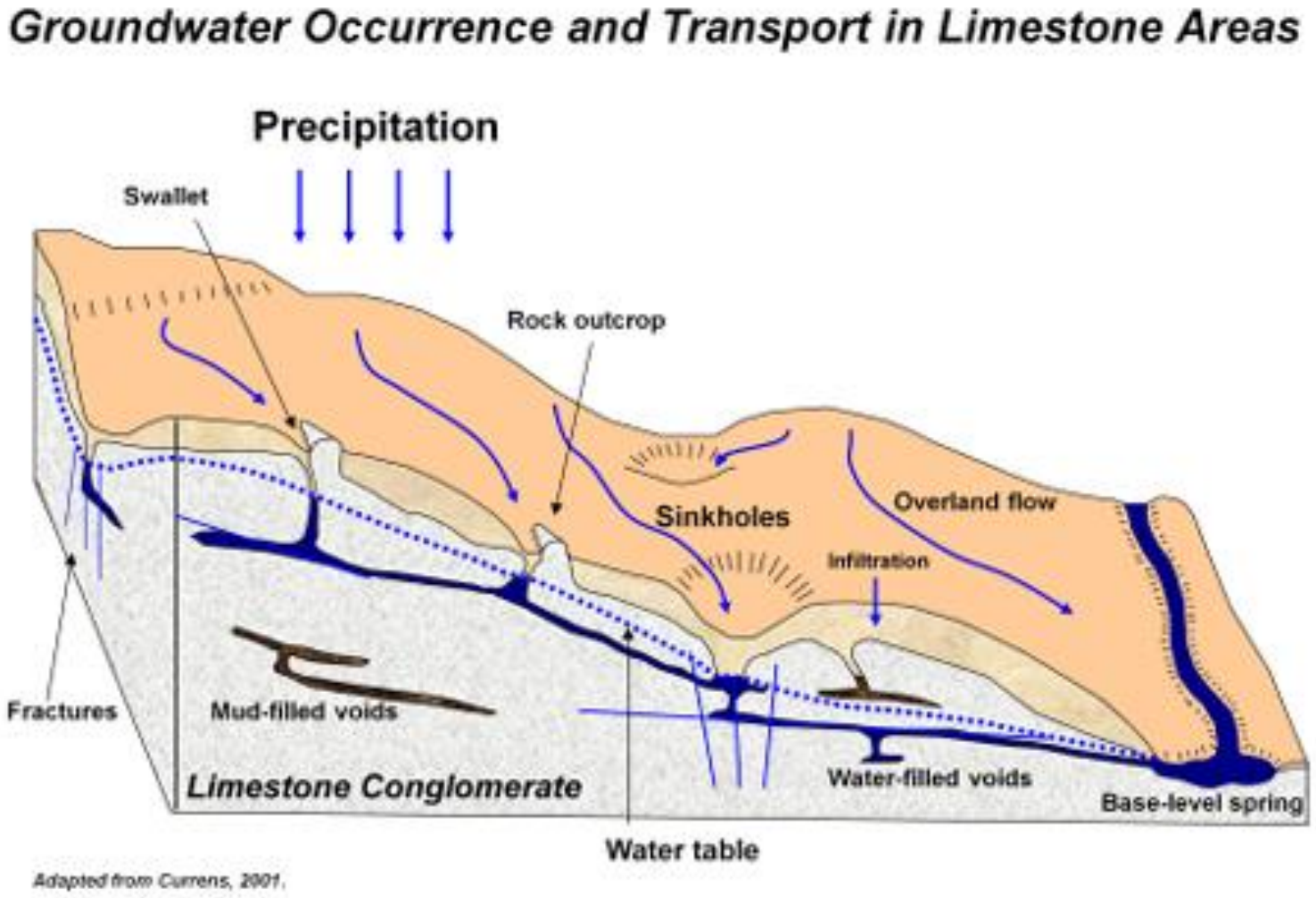


Figure 1. Conceptualization of the "bowl" model in which flow through fractures can occur over distances the size of a watershed (top diagram); whereas in the "ice-cube tray" model (lower diagram) flow is compartmentalized by the occurrence of thrust faults. The arrows indicate the preferential flow path in each model.

POTENTIAL RAMIFICATIONS OF COMPARTMENTALIZED FLOW IN THE BLUE RIDGE PROVINCE Thomas J. Burbey,Virginia Water Research Symposium 2003

Groundwater movement in limestone conglomerate



- Conduit (open channel) flow
- Wells are substantially more vulnerable to pollution
- Sinkhole formation
- Much higher well yields
- Lower baseflow conditions
- Streams are more flashy

Loudoun County VIRGINIA
WHERE TRADITION MEETS INNOVATION

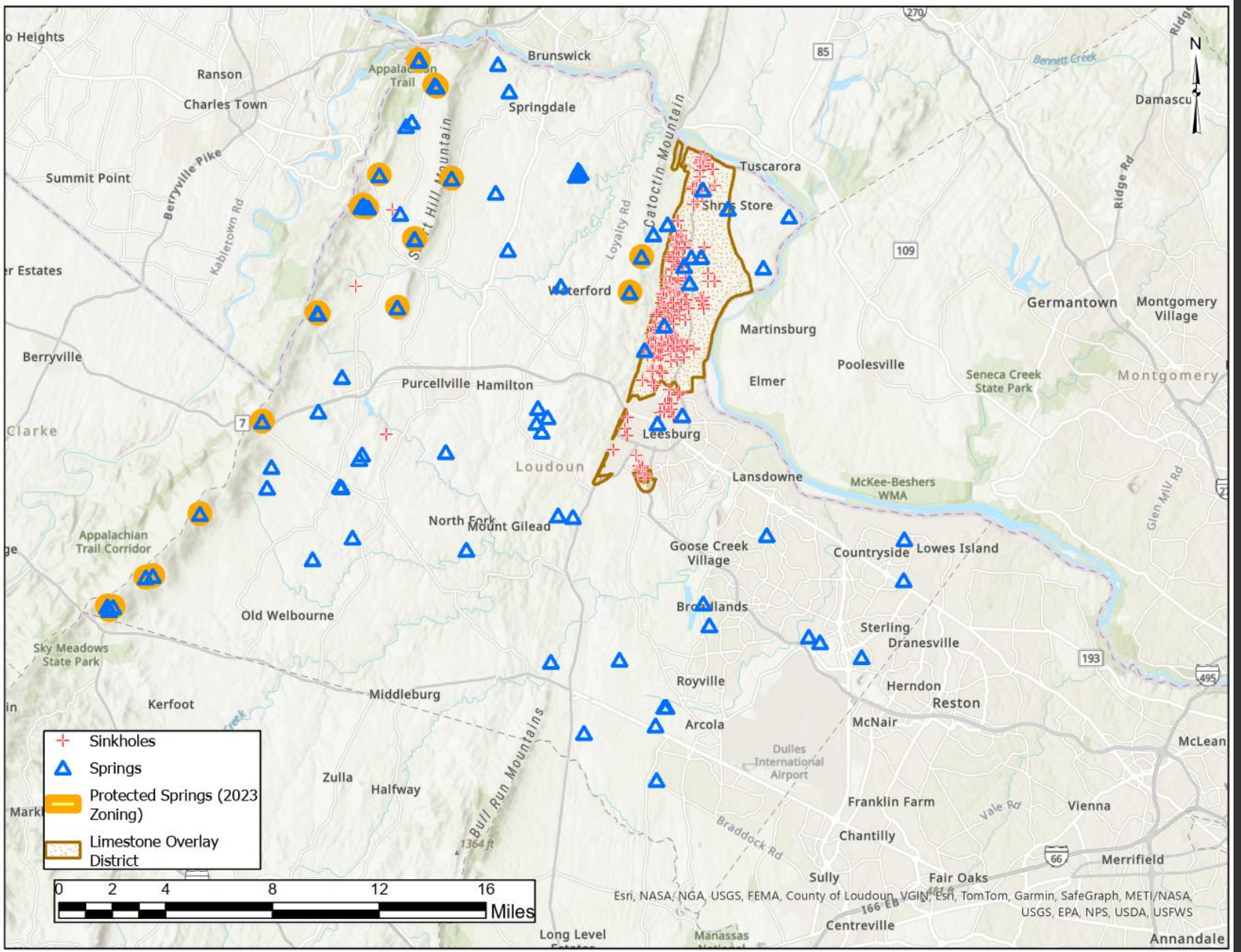
https://www.loudoun.gov/DocumentCenter/View/4849/Groundwater-Basics?bidId=

Springs and Sinkholes

Locations are legacy soil mapping sites.

No monitoring of spring water levels or discharges.

Approximately one year later, the sinkhole reopened at the same location. The sinkhole is approximately 20 feet in diameter and 15 to 18 feet in depth. (photograph date: June 29, 2006; source: Leesburg Today)



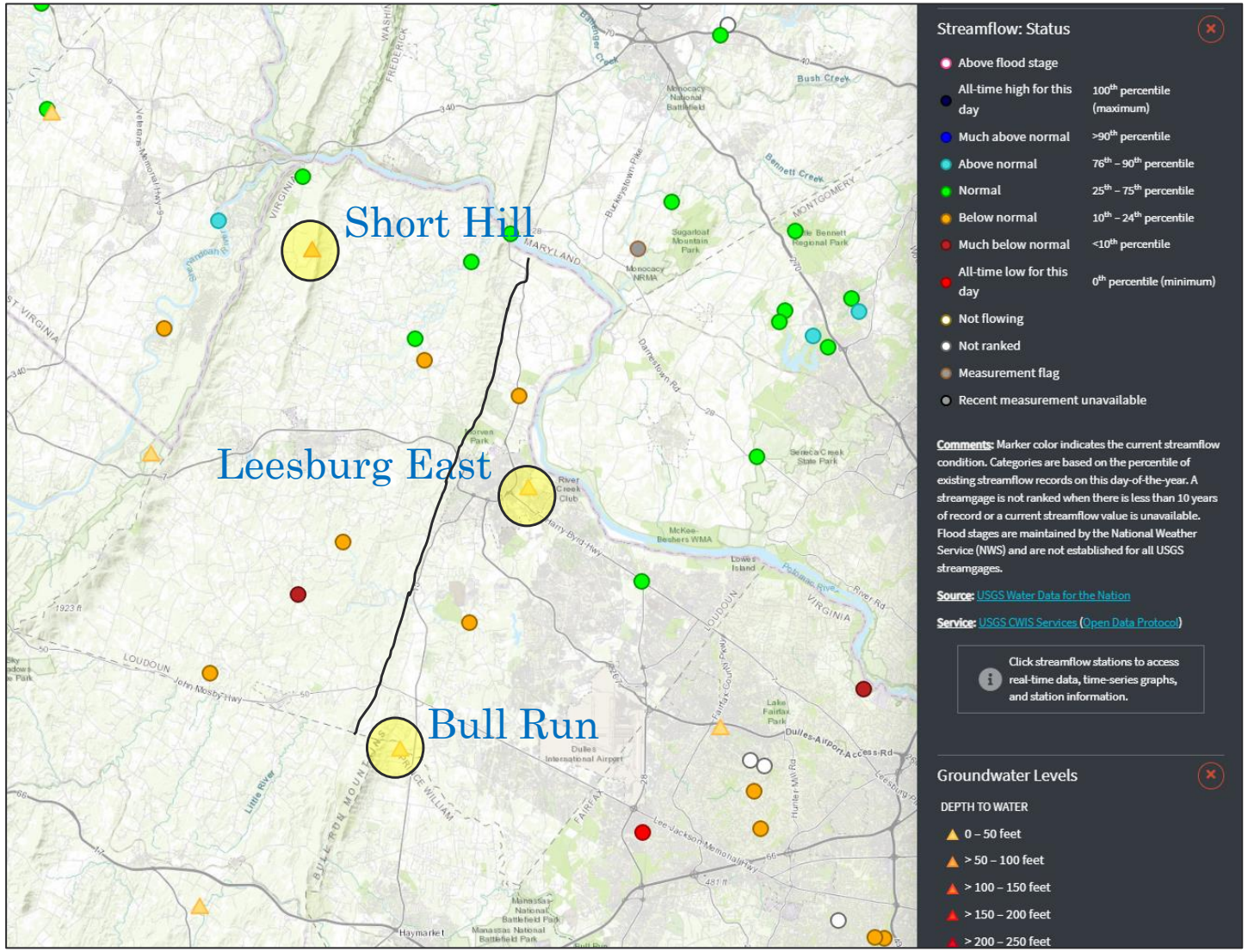
Groundwater Water Level Monitoring

1) US Geological Survey (USGS) - 3 wells since 1960's
2) Loudoun County - 14 wells since early 2002
3) Loudoun Water – Dozens of community wells (Beacon Hill, Creighton Farms, Elysian Heights, Raspberry Falls, Rokeby, and Selma Estates)

USGS Groundwater Water Level Monitoring Wells

Initiated 1963

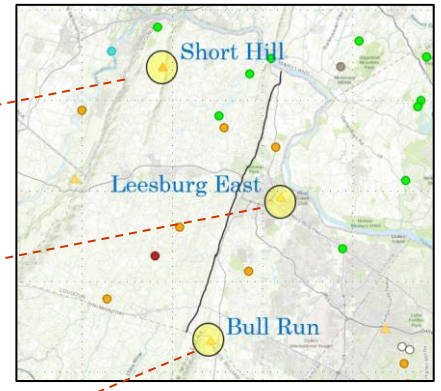
Periodic field measurements, followed by automated “real-time” data



dashboard.waterdata.usgs.gov

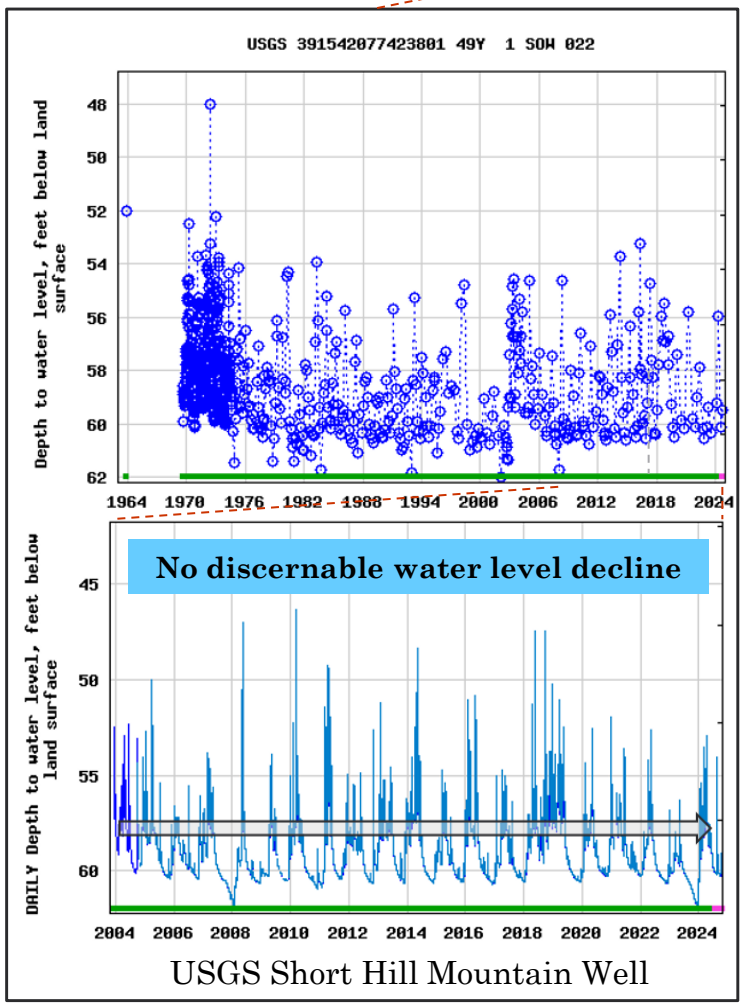
USGS Groundwater Water Level Monitoring Wells

dashboard.waterdata.usgs.gov

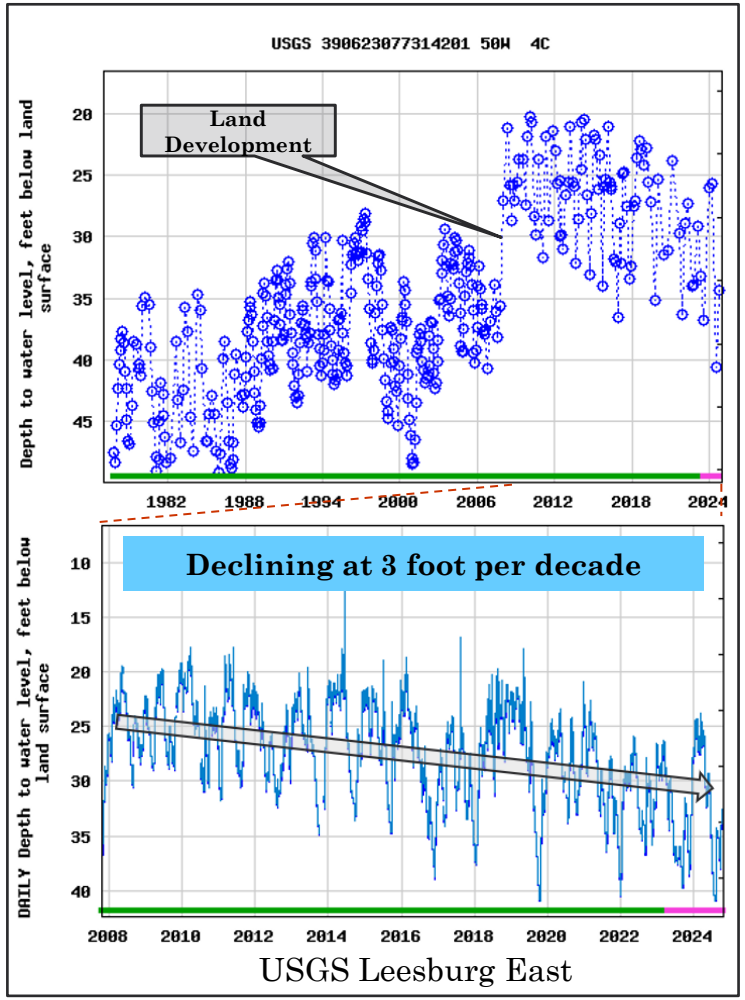


Periodic/historical

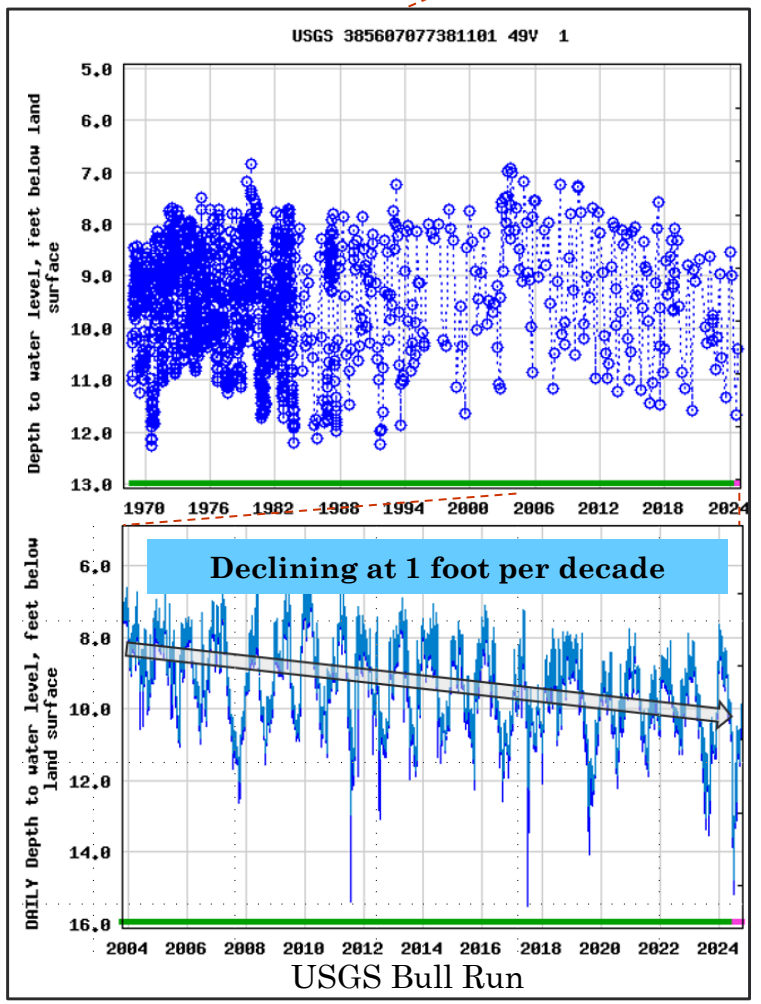
Recent/Realtime



USGS Short Hill Mountain Well



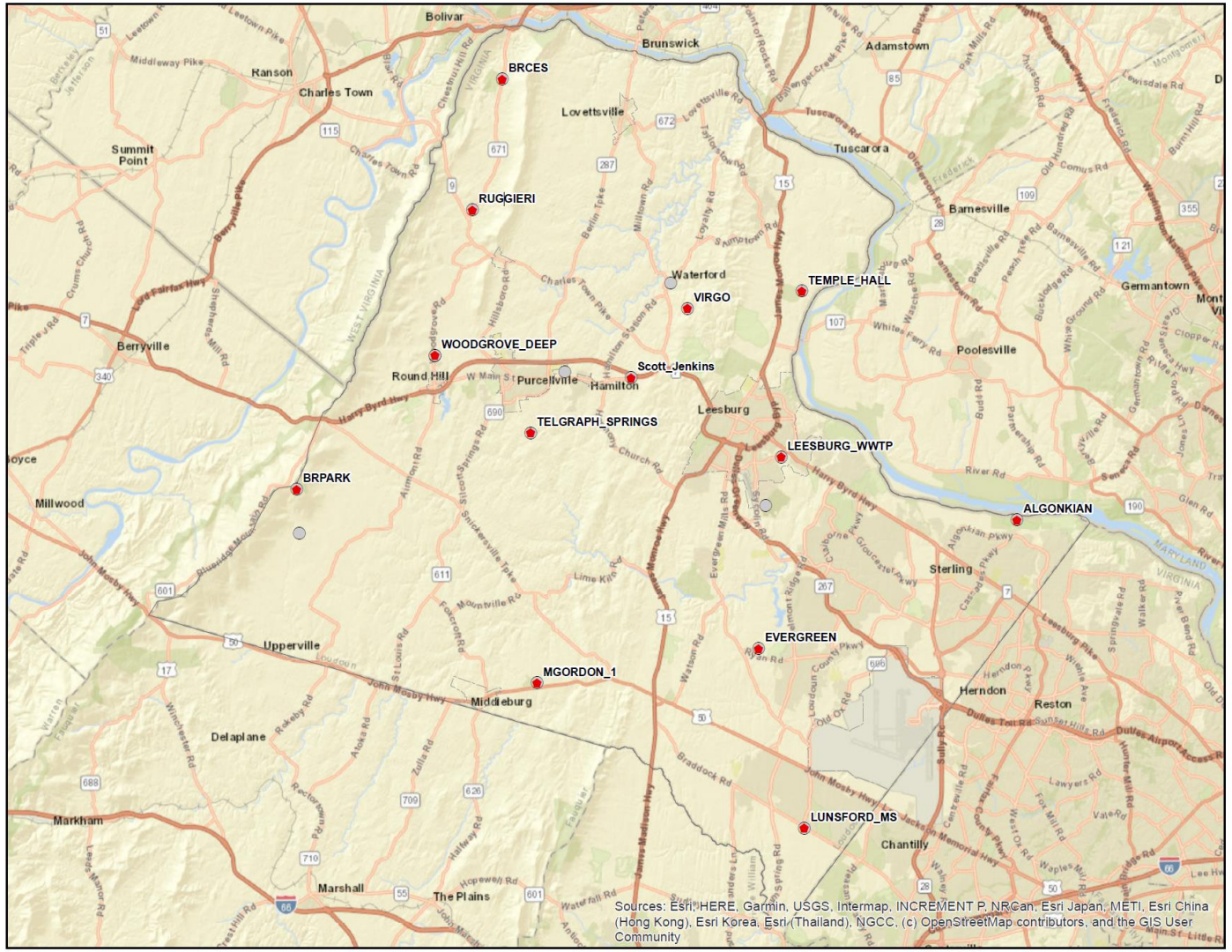
USGS Leesburg East



USGS Bull Run

Loudoun County Groundwater Monitoring Network

- Initiated 2002
- Over 500,000 readings
- Peaked at 18, initially planned for 30, now at 14 wells
- Initially funded through EPA grant



Loudoun County VIRGINIA
WHERE TRADITION MEETS INNOVATION

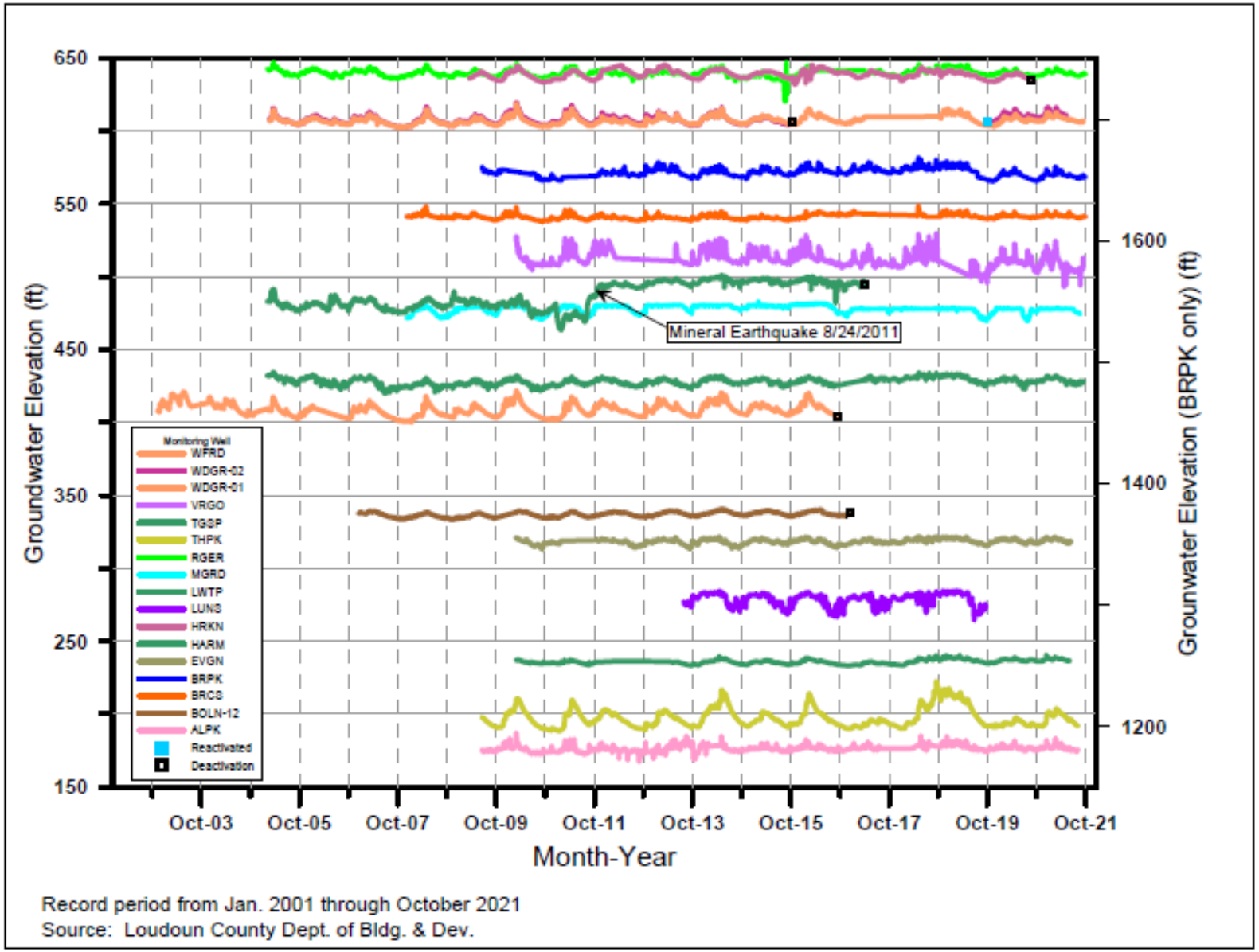
County Monitoring Well Network

No obvious long-term "major" decline in water levels

Over 500,000 readings

Isolated issues:

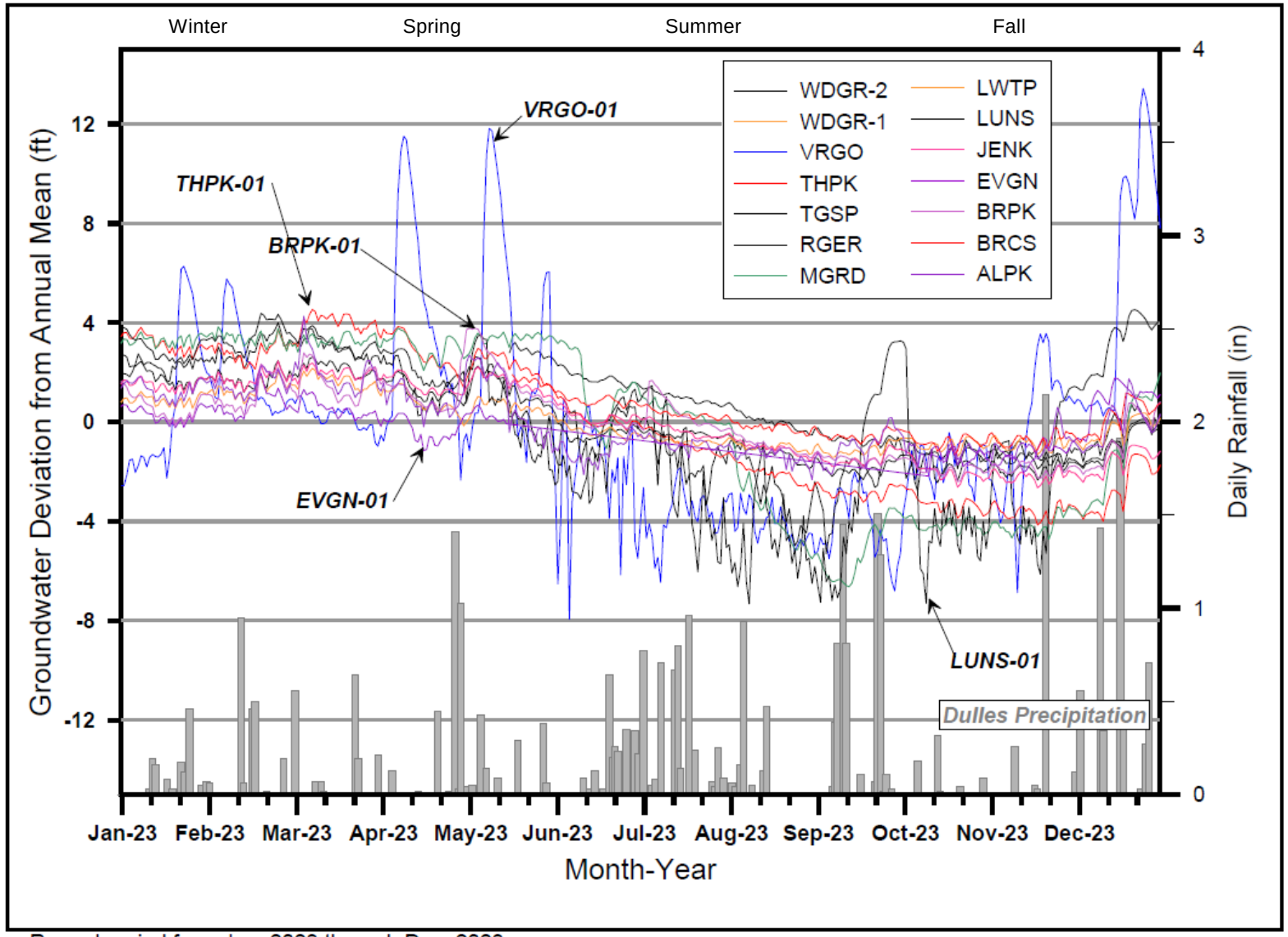
- Earthquake shift (Harmony)
- Nearby pumpage (Virgo)
- Flowing artesian (near Middleburg)



Record period from Jan. 2001 through October 2021
Source: Loudoun County Dept. of Bldg. & Dev.

Groundwater Deviation

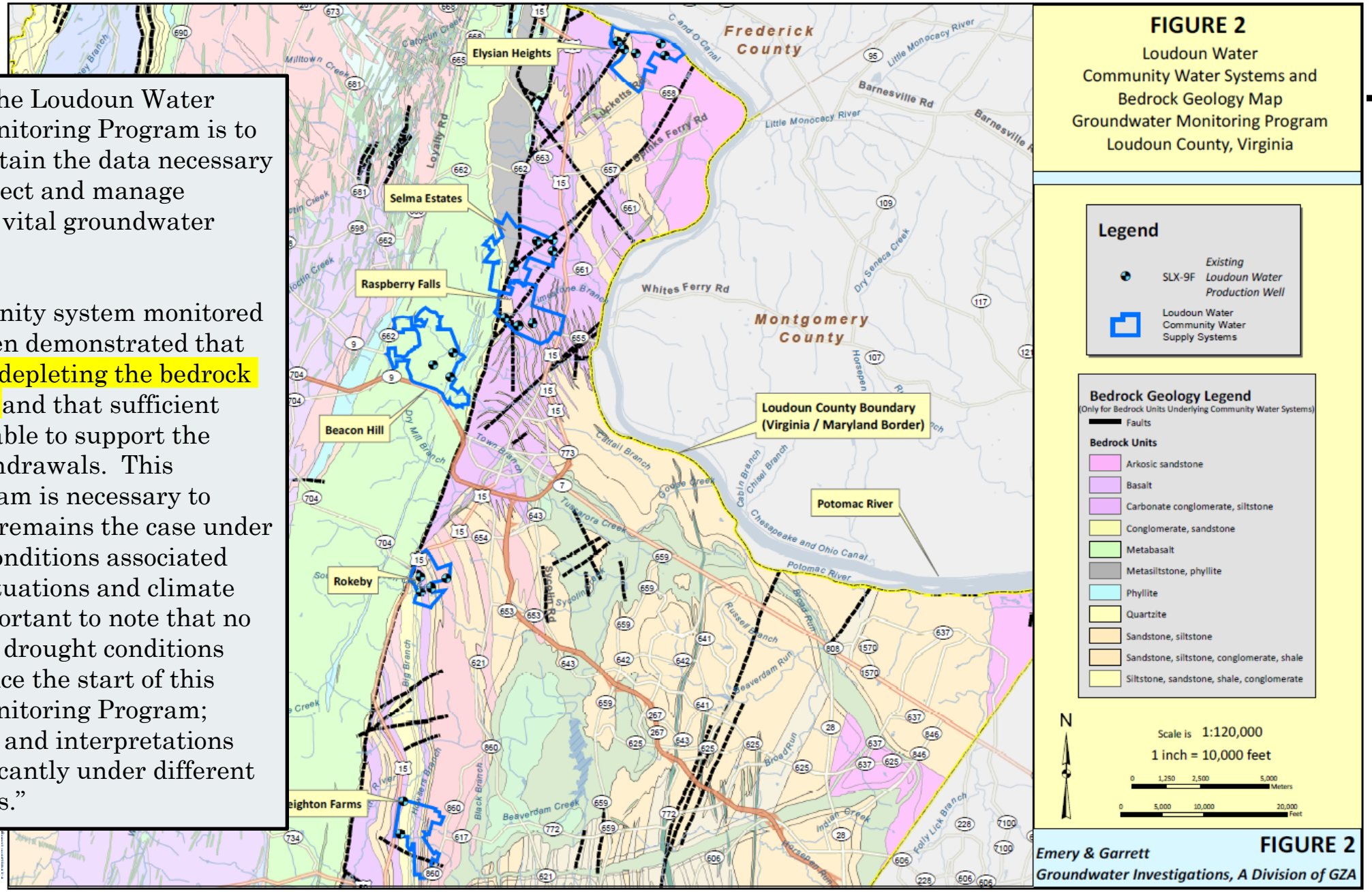
- Deviation is the change from long-term average
- Daily fluctuations are generally 5 to 10 feet
- Response to rainfall is generally rapid (days) and groundwater age is very young (years to decades, not centuries)
- Select wells are impacted by nearby pumping (VRGO, LUNS)



Record period from Jan. 2023 through Dec. 2023
Source: Loudoun County Dept. of Bldg. & Dev.

"The purpose of the Loudoun Water Groundwater Monitoring Program is to systematically obtain the data necessary to effectively protect and manage Loudoun Water's vital groundwater supplies.

For every community system monitored to date, it has been demonstrated that the wells are not depleting the bedrock aquifers capacity and that sufficient recharge is available to support the groundwater withdrawals. This monitoring program is necessary to determine if this remains the case under all climatologic conditions associated with climate fluctuations and climate change. It is important to note that no significant dry or drought conditions have occurred since the start of this Groundwater Monitoring Program; therefore, results and interpretations could vary significantly under different climate conditions."



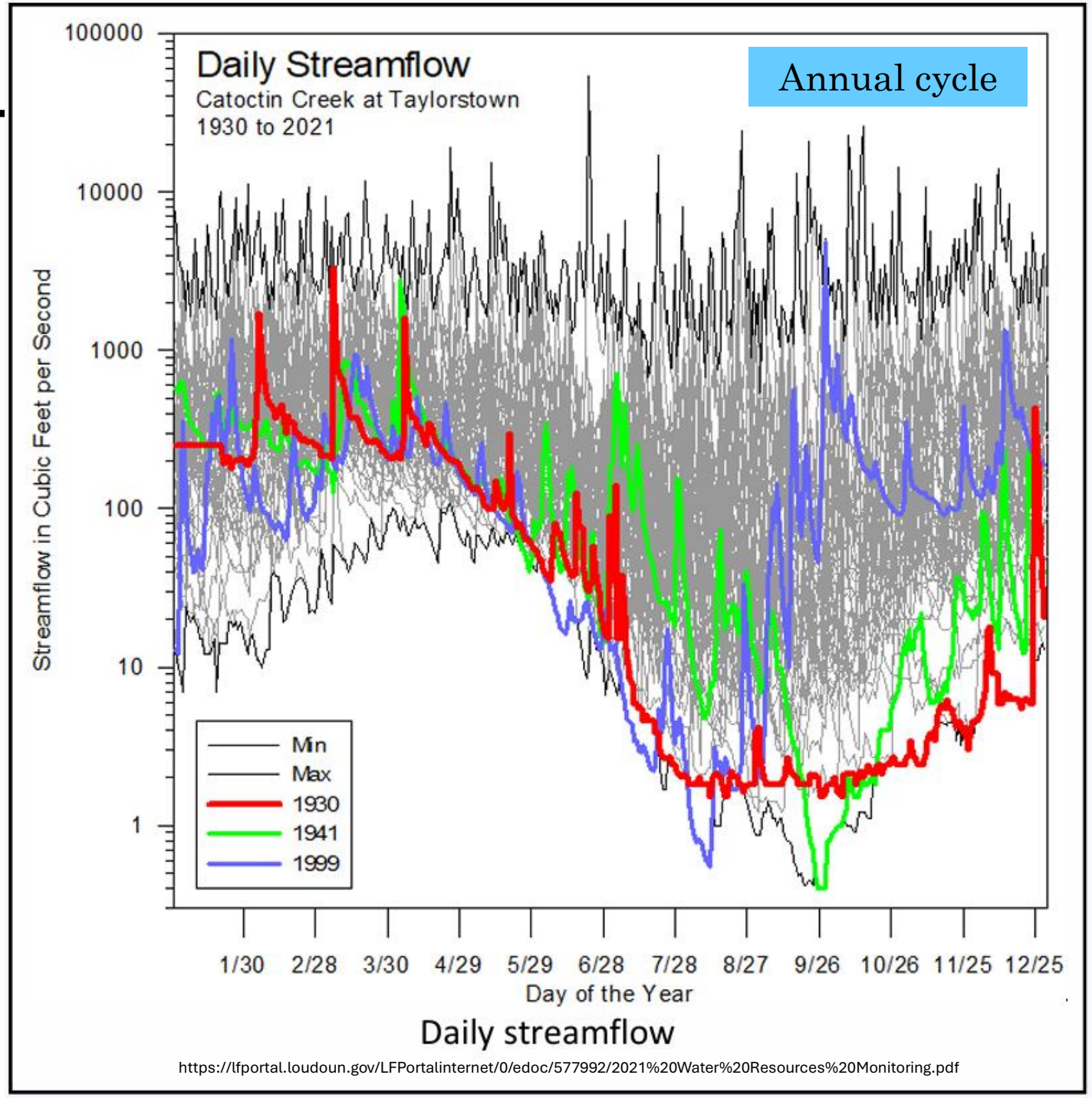
Drought Streamflow

Using the long-term stream gage data on Catoctin Creek at Taylorstown dating back to 1930 and precipitation data from Washington DC since 1900 and Loudoun County in recent decades there three years of noteworthy dryness; 1930, 1941 and 1999.

In 1930, 20.08 inches was recorded at Bentley Gregg's rain gauge in Lincoln. Leesburg got even less than that, said Jules R. Lintner, the county extension agent at the time.

During 1941 and 1999 the lowest flow rates were recorded values, however there was prolonged low flow from summer to mid-winter.

https://www.loudounhistory.org/loudoun-history-timeline-1900s/



Drought 1930

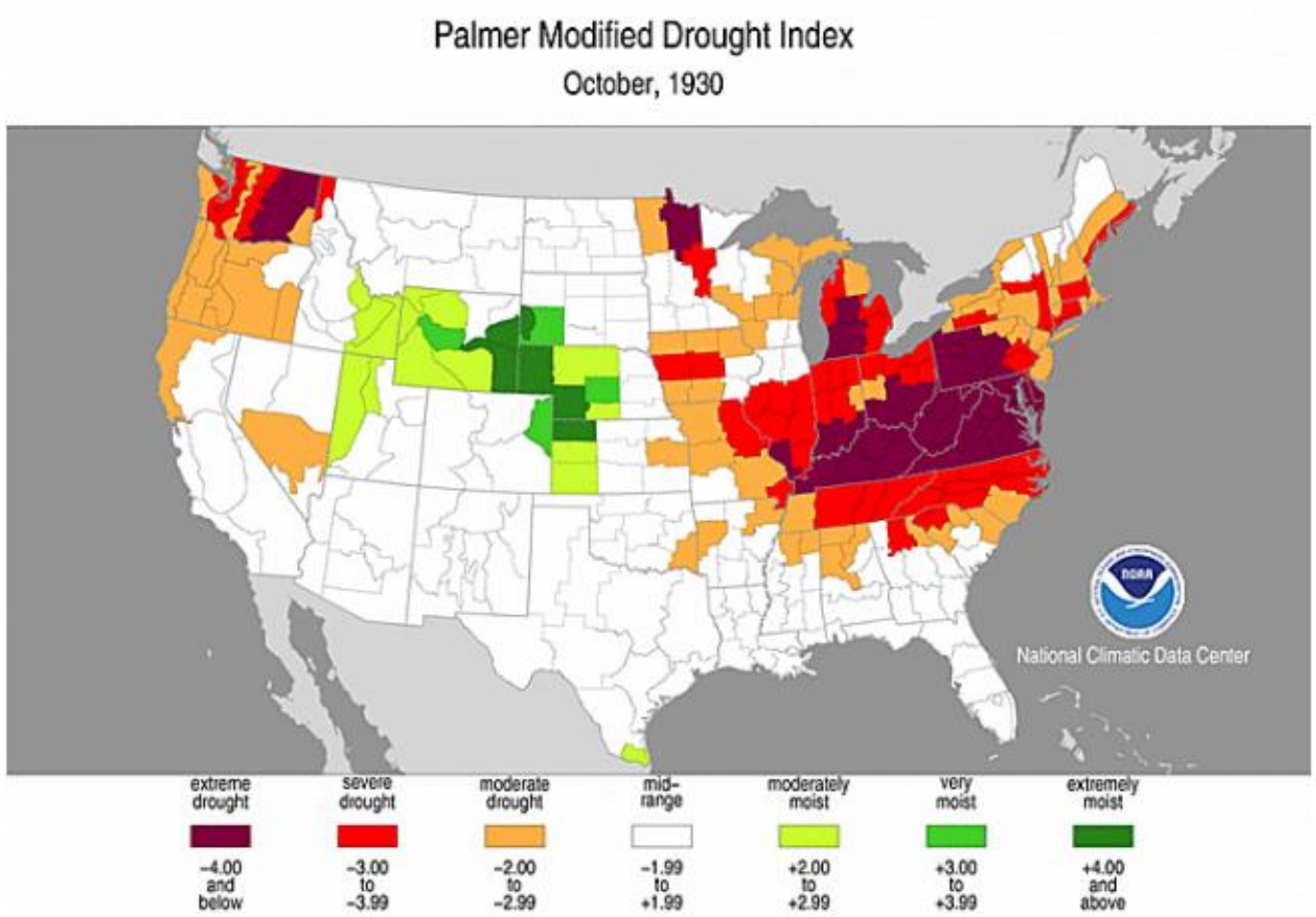
Loudoun County suffers through the worst drought in its history, with temperature reaching over 100 degrees for three straight weeks.

Loudoun fields received one-fifth or less of the average rainfall.

One issue of the Times-Mirror lists 415 properties for public auction.

Goose Creek and Beaver Dam are dry, and you can walk across the Potomac without getting your feet wet.

https://www.loudounhistory.org/loudoun-history-timeline-1900s/



https://www.ncei.noaa.gov/access/monitoring/historical-palmers/maps/psi/193001-193012

Precipitation 1930

The “dry spell” in 1930 is most pronounced when shown as cumulative precipitation.

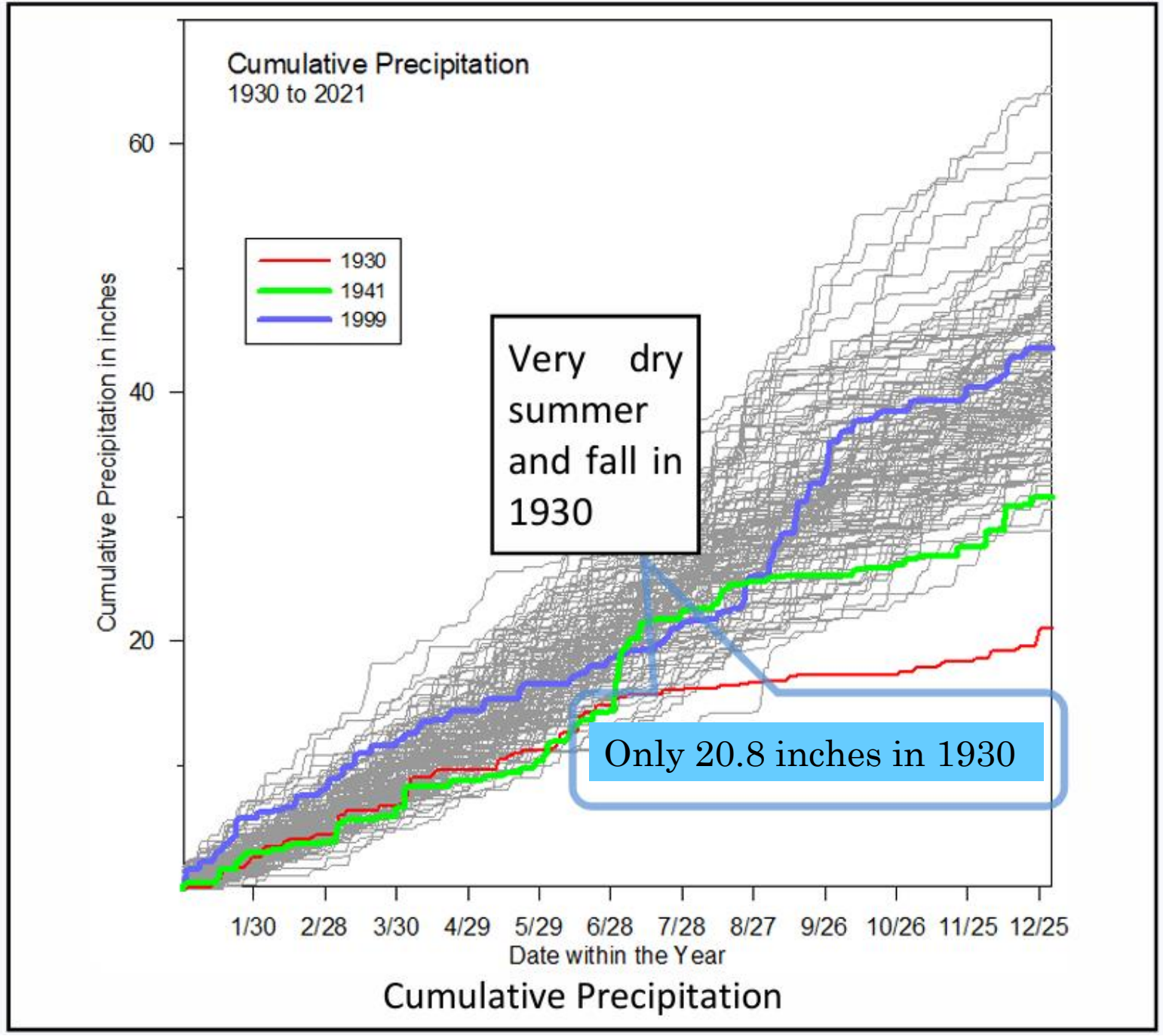
Loudoun had the least rain among the three counties in 1930 -- 20.08 inches at Bentley Gregg's rain gauge in Lincoln. Leesburg got even less than that, said Jules R. Lintner, the county extension agent at the time.

July through November was by far the driest stretch. None of the rain gauges in the Piedmont registered more than 1.6 inches for that five-month period.

Records suggest that the region went through two extremely harsh droughts in the 19th century, but we have no statistics for either one. Lintner, speaking at the Planters Club in September 1930, stated that "the county is a barren waste, not seen since the drought of 1816-1817." And the 1885 minutes of the Catoctin Farmers Club mention a "severe draught" that year; grass for grazing stock was scarce by June, and in late August, club members spoke of wheat harvests averaging a bushel an acre. A typical harvest netted 15 bushels an acre at the time.

https://www.loudounhistory.org/history/drought-survivors-recall-1930/

Other droughts of 1938-42, 1962-71, 1980-82, 1999, 2002 were less severe



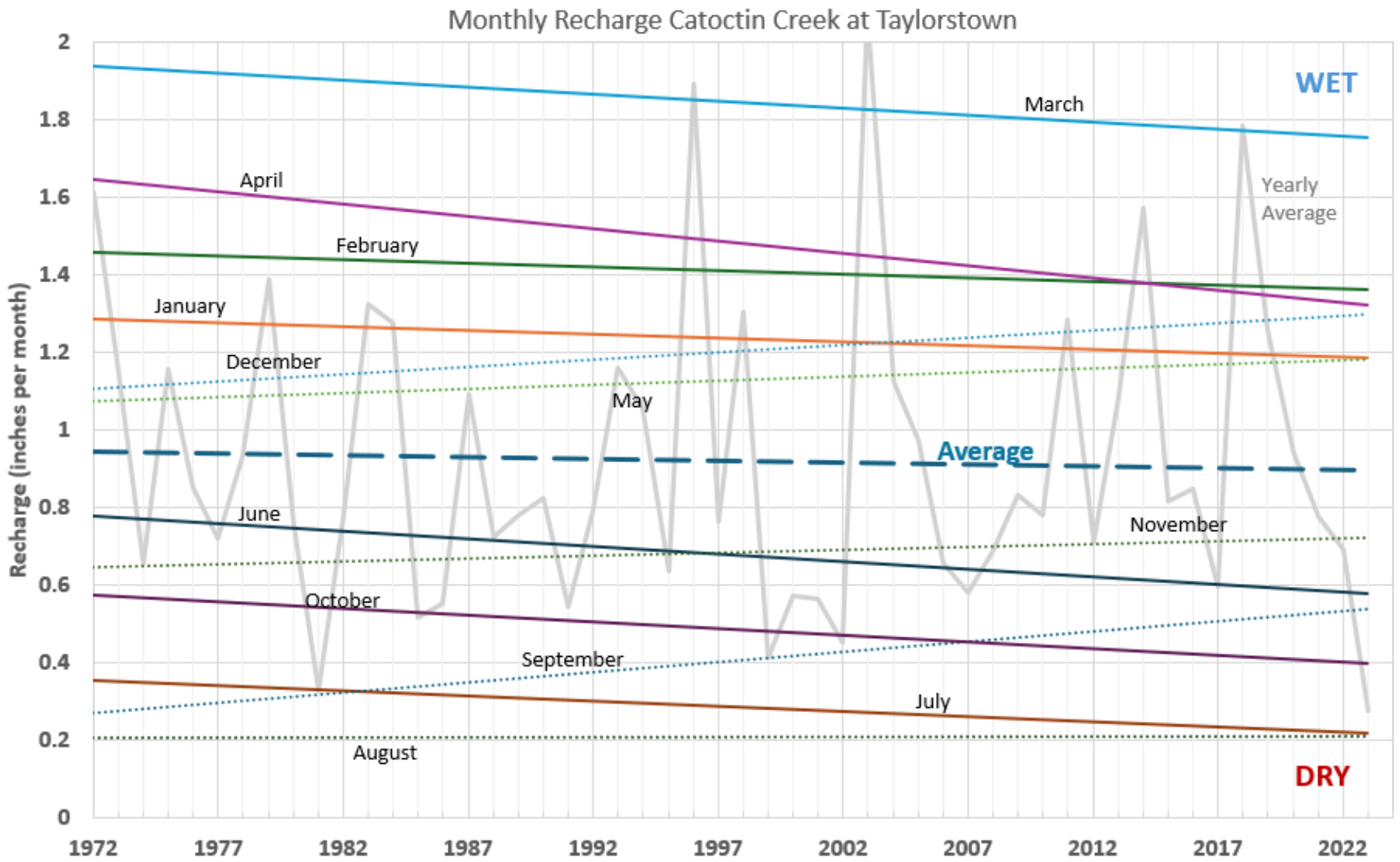
https://lfportal.loudoun.gov/LFPortalinternet/0/edoc/577992/2021%20Water%20Resources%20Monitoring.pdf

Recharge Calculated From Daily Streamflow

Calculation of monthly recharge to groundwater using baseflow component of daily streamflow measurement.

Storm runoff is removed by hydrograph separation.

In 50 years, only ~5% decrease in recharge rate – nominally 12 inches.

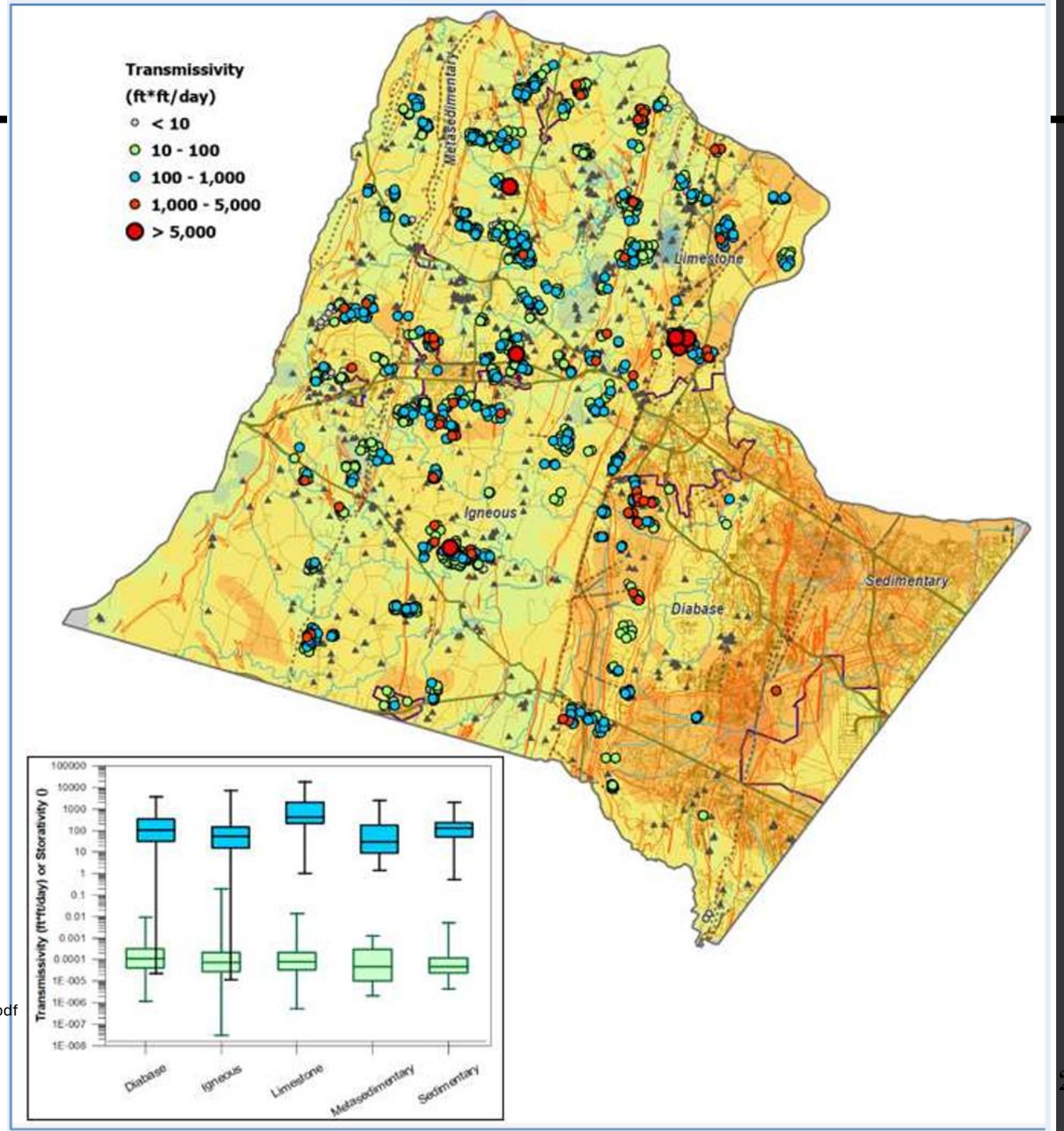


Hydrostudy

Almost 200 Hydrostudy reports contains a stand-alone analysis of the pumping test from which the ability to transmit water (transmissivity) and the long-term ability to store water (storativity) are determined.

In the rural subdivisions, wells are drilled and tested on 1/3 to 1/2 of the lots.

Each well is analyzed for air lift yield and then pumped continuously while other observations are monitored.



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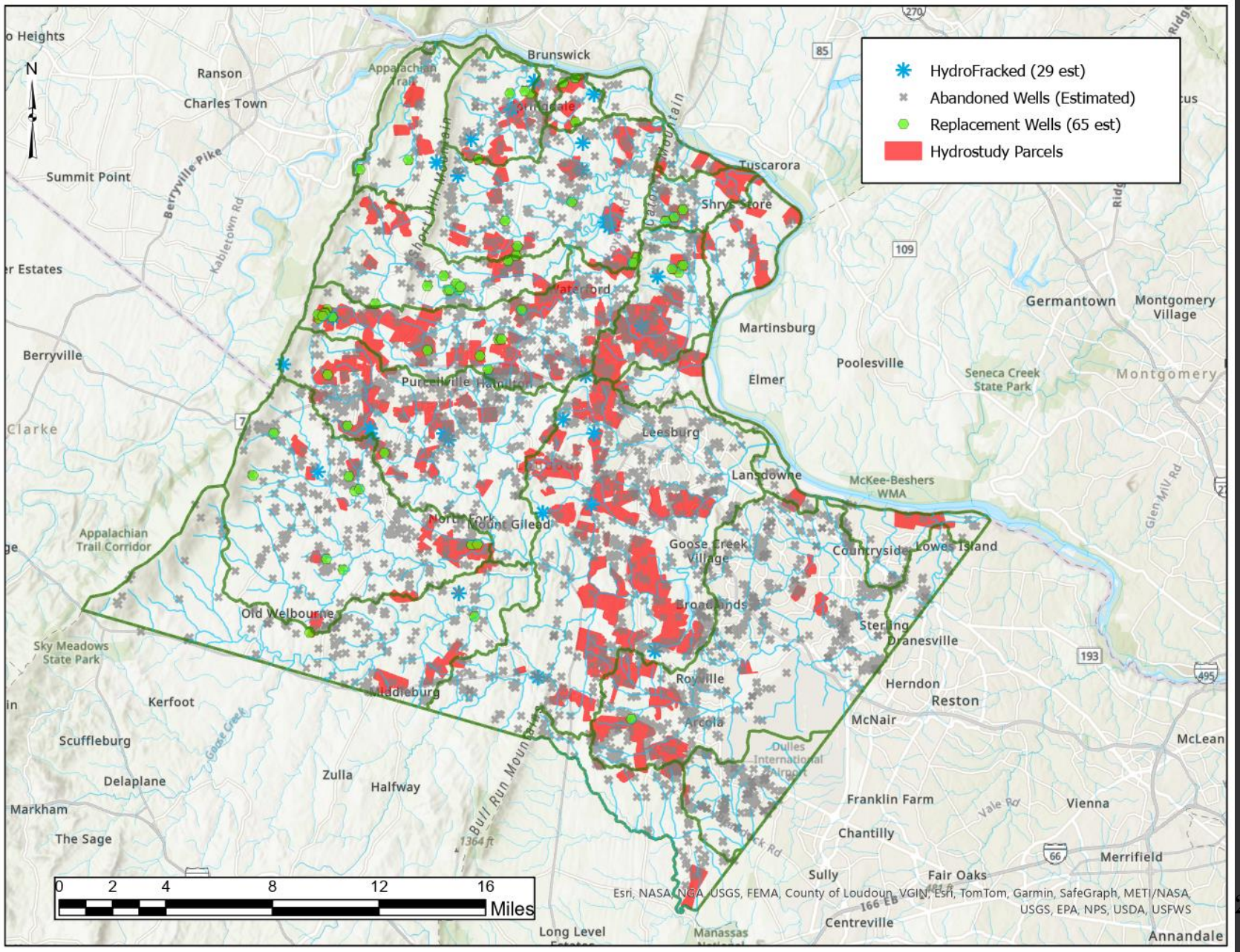
Abandoned and Replacement Wells

Data on replacement, hydrofracked and abandoned wells by Health Dept is a rough estimate.

Driller do not always report dry holes.



Earthward Consulting

Loudoun Groundwater

- Extensive amount of hydrogeological data collected over several decades, mostly available.
- No indication of catastrophic long-term loss of groundwater, just gradual lowering of water table.
- Historically droughts have impacted agriculture.
- Modest reduction on groundwater recharge.
- Complex geologic structure resulting in localized variability of yield and sustainability.

GOTCHA: Multiyear Drought in the Future

Earthward Consulting

Thank you

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