Appendix: Loudoun County Water Level Monitoring – A Review of Conditions as of January 2026

The groundwater monitoring program has a long history of more than two decades. The effort was promed by the drought on 1999 and the Adhoc Groundwater Committee formed by the County. This lead to a grant from EPA in 2001 known as Water Resources Mpnitoring Program.

Sp[ecifically, the County formed the Water Resources Technical SAdvisory Committee. Reporting to the Land Use Committee, the BOS eventually adoped a resolution to collect such data.

WRMP Goals: *To monitor water quality and quantity in Loudoun County. To provide the basic quantitative data needed to better understand and manage the County's water resources and thus help protect human health and the environment by assuring adequate, sustainable, clean, and safe water. To install a monitoring infrastructure that will continue into the future. From this foundation of basic data, trends in quantity and quality can be identified and, with other incorporated information, be used to help evaluate the effects on water resources of climatic variability, increasing use of groundwater, land use changes, and the efficacy of best management practices. The County, through the Board of Supervisors, will then have sound, scientific-based information needed to make informed policy and regulatory decisions about the long-term use, protection, and restoration of water resources for drinking, recreation, and natural habitat.*

ACTION ITEM Item 09B-Water Resources Technical Advisory Committee.

WHEREAS, such a long-term commitment shall require data collection, data analysis and attention to mandates and unexpected variables;

WHEREAS, the product of data collection, analysis and reaction to mandates and unexpected variables will influence future water resource program and policy implementation strategies;

WHEREAS, water resource implementation strategies will provide future recommendations to ensure the long-term "sustainability, optimal use and protection" of the County's water resources,

IT IS THEREFORE RESOLVED, that the Loudoun County Board of Supervisors hereby supports and adopts the workplan developed by the Water Resource Technical Advisory Committee to guide the County's short and long-term water resource protection and preservation program development, implementation strategies.

IT IS FURTHER RESOLVED that the Loudoun County Board of Supervisors is committed to the refinement of the water resource programs and implementation components as warranted through long-term data collection and analysis. Thus, to rescind the commitments made herein shall require action by the Board of Supervisors through a majority vote.

This appendix summarizes the history and the groundwater findings from that program. While less than originally envisioned, the water level data reveal that most wells have maintained a consistent water level. There is not a widespread change throughout western Loudoun, though there are clear indications that some wells have been impacted by nearby pumping.

Background:

- Groundwater Water-Level Monitoring Program for 24 years, originating in 2002
- One of several elements of US EPA grant (2001-2009) for the Water Resources Monitoring Program (WRMP)
- Motivated by the 1999 drought conditions which lead to the formation of the Ad-hoc Groundwater Advisory Committee (GAC) as authorized by the Loudoun County Land Use Committee

Water Level Monitoring Network:

- Monitoring wells include both donated wells and wells drilled specifically for WRMP and paid through WRMP funds
- Original plan was to expand the network to 35 or 40 wells through "well Donation" program, though was never accomplished.
- Network development:
  - 2002-2006 – Set up 6 donated wells
  - 2007-2011 - Contract drilling for 11 additional wells paid through WRMP grant
  - Peaked at 16 wells in 2015 with hopes for continued expansion through donations and currently 14 active wells
  - Lost four wells due to development in recent years (Waterford, Bolen Park, Horkan and Harmony PS)
  - Added well in 2020 at
- The Loudoun County wells are complimented by three USGS in or near Loudoun County which provide real-time monitoring
- Loudoun Water operates several groundwater wells with water level recording, but has not disclosed details

Funding:

- During 2001-2010 EPA Grant funded drilling, water quality sampling, monitoring equipment purchase and staff time. Estimated $218K contracted (drilling, sample analysis) and $86K in staff time.
- Equipment cost 2001-2024 ($9K) from unspecified B&D budget
- Equipment purchases:
  - Original data logger equipment was included in contracted services 2002-2008 (Telog)
  - 13 data loggers @ $1,426 each for $18,540 in Sept 2009 (In-Situ). In 2010 there was inventory of 34 data loggers
  - 3 data loggers @ $495 each for $1,485 in April 2017 (Hobo)
  - 10 data loggers @ $373 each for $3,730 in May 2018 (Hobo) replace exhausted equipment which battery life of 10 years
  - 5 well caps @ $75 each for $375 in February 2022 to replace broken and missing caps
- Consider requesting funding from USGS NGWMN Program National Ground-Water Monitoring Network (Oct 2019)

Deliverables:

- Data readings of water level data every 4 hours. Data are averaged to a single daily average value
- Web delivery (graphs of daily water level, statistics (high/low values) and Annual Monitoring Data Reports (graphs and tables)
- Biannual site visits to each well to download data and obtain manual water level readings for calibration/verification

Benefits:

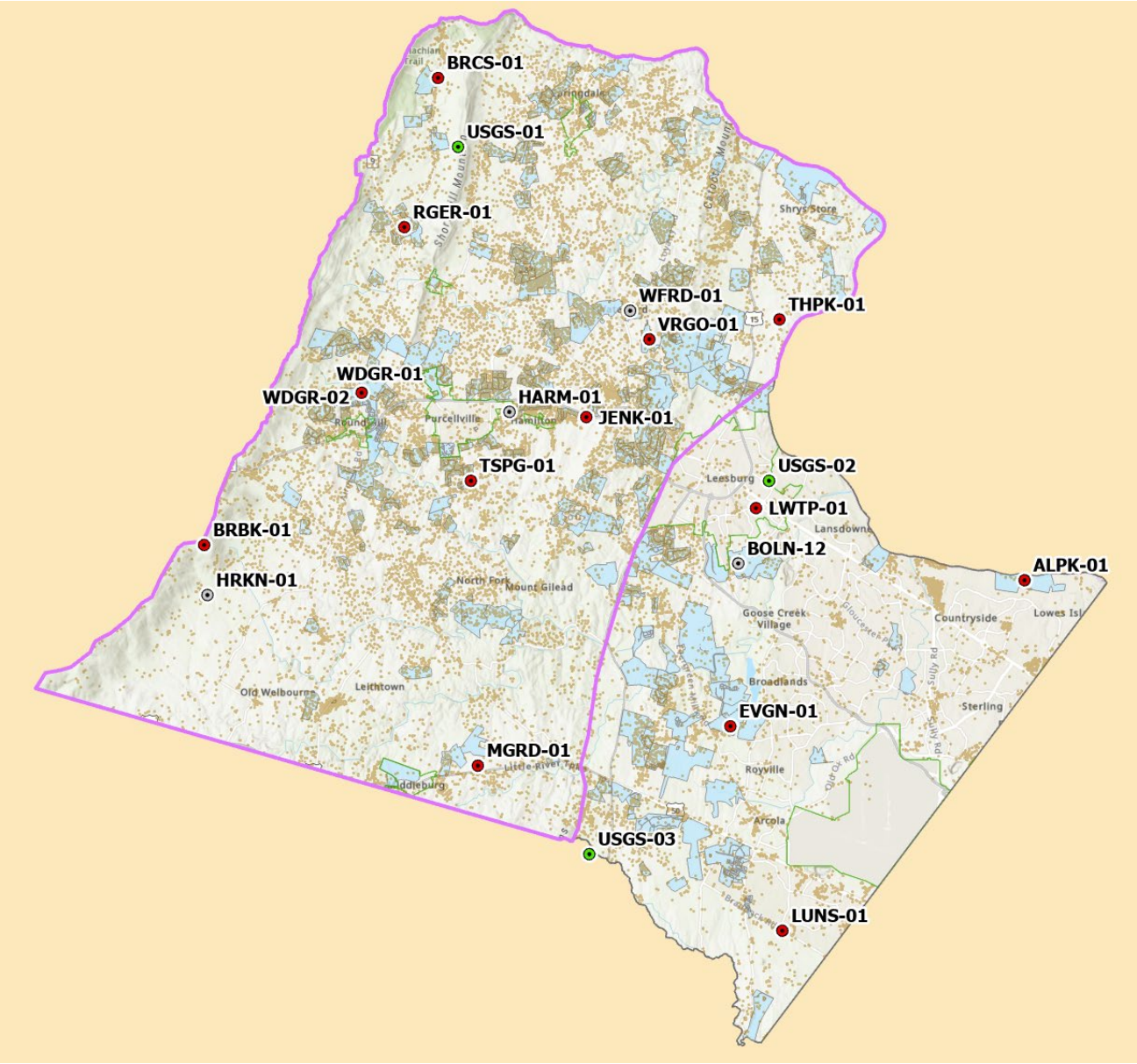
- Provide daily water level data used by residents (private water supply wells), landowners (farming, construction planning), HOA and golf courses (operations of irrigation wells)
- Daily water-level data provides indicator of seasonal trend and long-term sustainability
- Data could be used for dry/wet seasonal condition trend analysis, but this has not been researched

Potential Users of Loudoun County Groundwater Water Level Data:

- Dept B&D and Dept General Services in Watershed Management Planning and Data Monitoring reporting

- Dept General Services in support of Environmental and Water Programs
- Dept Health to understand groundwater availability and data supporting hydrostudy and well permitting
- Loudoun Water in conjunction with their wells for overall water availability status reported monthly at Board Mtgs
- Town staff, residents, golf courses, HOA, breweries, and farmers to understand status of water availability and sustainability

County Water Level Well Monitoring Map



Loudoun_County_GIS\Groundwater_2024\Groundwater_2024\Groundwater_2024_County_Well_Monitoring_Network.aprx

Nearby Well Influences

The below table catalogues the number of nearby residential or irrigation wells to the County water level monitoring well network. Two wells that stand out are the VRGO and LUNS wells which have wells within 75-100 foot buffer ring around the monitoring well. Other influences are document in each well section below.

SITE_NAME	S_NAME	0-50 ft	50-75 ft	75-100	100-150	150-200	200-300	300-400	400-500	500-600	600-700	700-800	800-900	900-1000	Comments
HARMONY	HARM-01					1			1	2	2	2	3	1	Earthquake shift
WATERFORD	WFRD-01					3	6	4	3	13	8	10	10	10	
RUGGIERI	RGER-01					1	1		1	2	1	1	4	1	
BRCES	BRCS-01									1	2		1		
BOLEN_12	BOLN-12													1	
MGORDON_1	MGRD-01							1		2	2		2		
WOODGROVE_DEEP	WDGR-01														
WOODGROVE_SHALLOW	WDGR-02														
TELGRAPH_SPRINGS	TSPG-01					1	1	3	2	1	2		4	2	
HORKAN	HRKN-01													3	
BRPARK	BRBK-01								1					2	
ALGONKIAN	ALPK-01					1					1		1		Influenced by Potomac River 1,000 ft away
TEMPLE_HALL	THPK-01														Limestone
LEESBURG_WWTP	LWTP-01														
EVERGREEN	EVGN-01								1						
VIRGO	VRGO-01			1			1			1	2	1	1		Influenced by nearby pumping
LUNSFORD_MS	LUNS-01			2				1							Influenced by nearby pumping
SCOTT_JENKINS	JENK-01					1					1	1			
USGS Short Hill	USGS-01														
USGS Leesburg	USGS-02									1					Land Use shift
USGS Prince William	USGS-03						1		1				2		

Recent Trend in Water Levels

The below summary is explained in following pages. In determining the "recent" trends, a linear regression approach was used to help place the arrow graphic.

Well	Recent Trend
ALKP	Slightly Increasing
BOLN	Slightly Increasing
BRCS	Slightly Increasing
BRPK	Increasing
EVGN	Slightly Increasing
HARM	Slightly Decreasing
HRKN	None
JENK	None (yet)
LUNS	Slightly Increasing (but may actually be no trend)
LWTP	Slightly Increasing possibly due to modified stormwater management
MGRD	Slightly decreasing
RGER	None
THPK	Significantly decreasing
TGSP	Slightly increasing
VRGO	Significantly decreasing
WDGR--01	Slightly increasing
WDGR-02	Indeterminant
WFRD	None

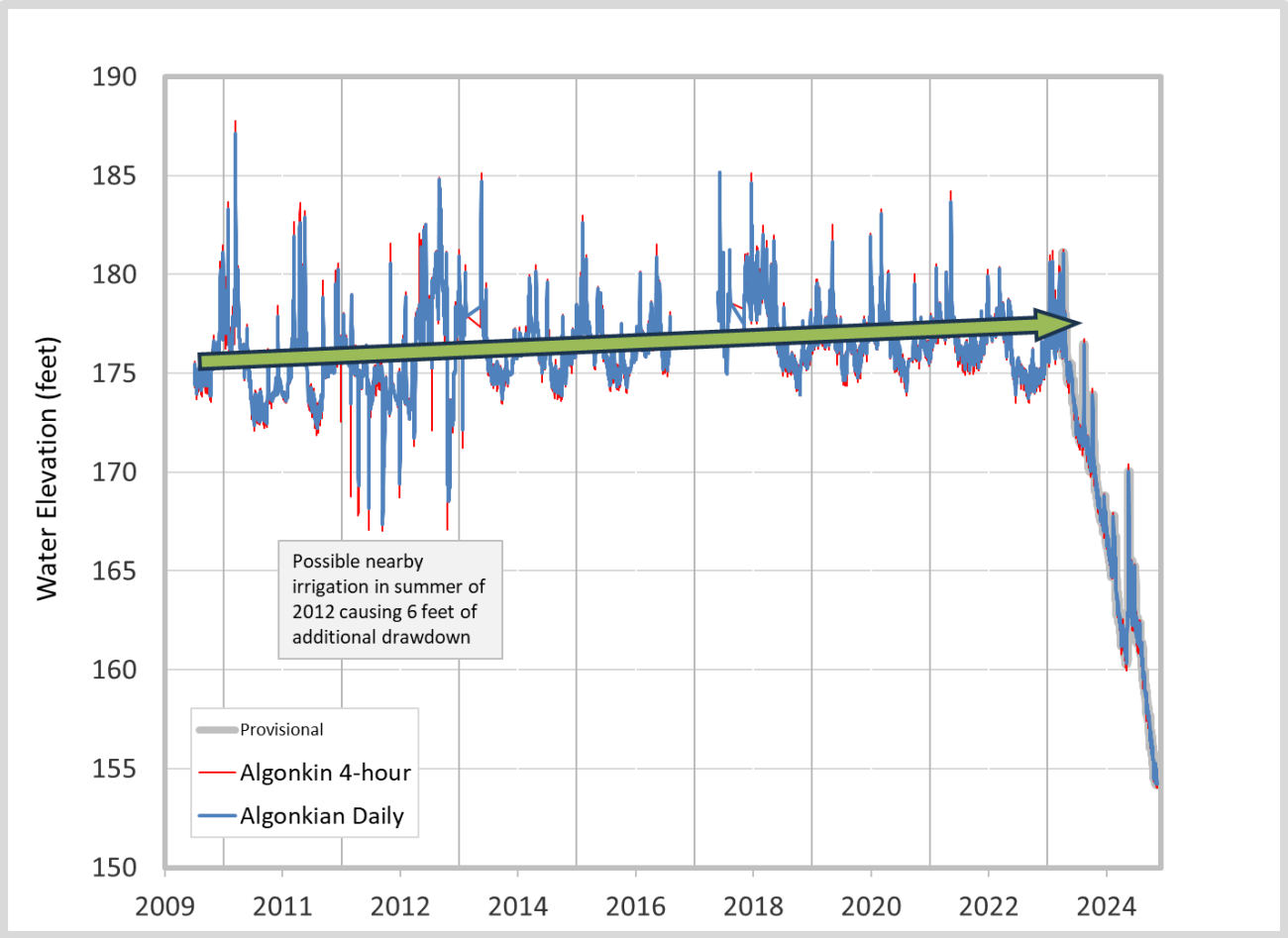
For the past 2 decades water levels in western Loudoun have remained relatively steady with slight increases over time. This is expected as the water levels in the fractured bedrock reflect the recent recharge. Groundwater residence time is only a year or two, and for most severe droughts, these do not last more than a year.

There are believed to be "pockets" of water level decline. The "red blob map" suggests that these decreases may be 10 to 40 feet, though it is unclear if such decreases are persistent or a reflection of the time when the data were collected. Also, much of the data are from driller's record which are not the most reliable source of data.

The exceptions to the above description are a few wells which are impacted by nearby pumping. To determine which wells are affected by pumping dual plots of the daily average value and the 6 reading per day at 4 hours increments are shown. This provides visual inspection as to when (all year or just during summer irrigation) and the general magnitude of the impact (typically ranging from 1 to 5 feet).

In each chart a generalized trend arrow (or two) is presented. Standard linear regression was used to help position the graphic. Where available, driller static water level data are included.

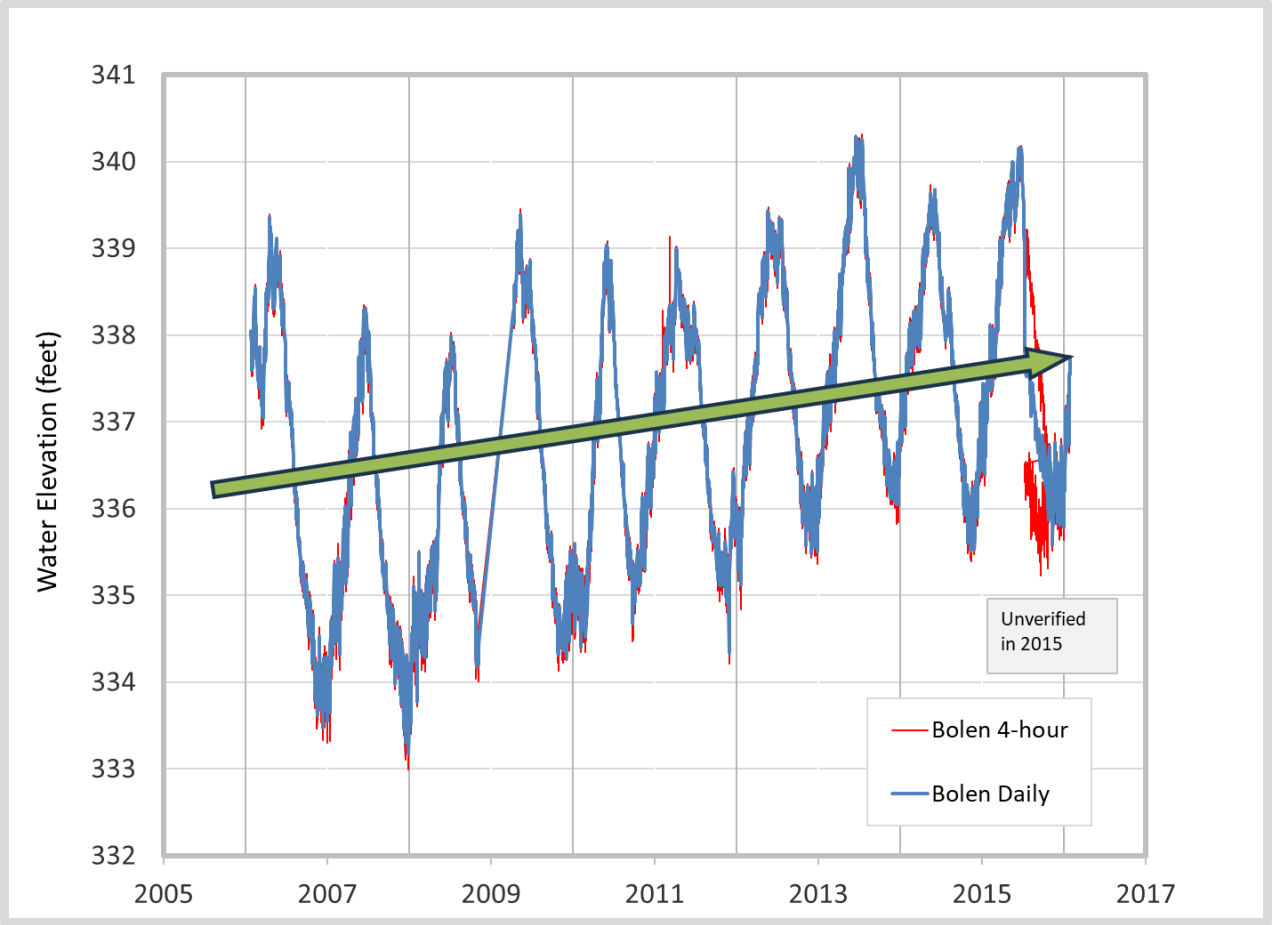
ALPK



This well is in the golf course and very close to Potomac River. In 2012 levels appear to have been impact by golf course irrigation activities. The recent data are suspect as the post 5/24 data were not corrected with field measurements.

Overall recent trend – Slightly Increasing

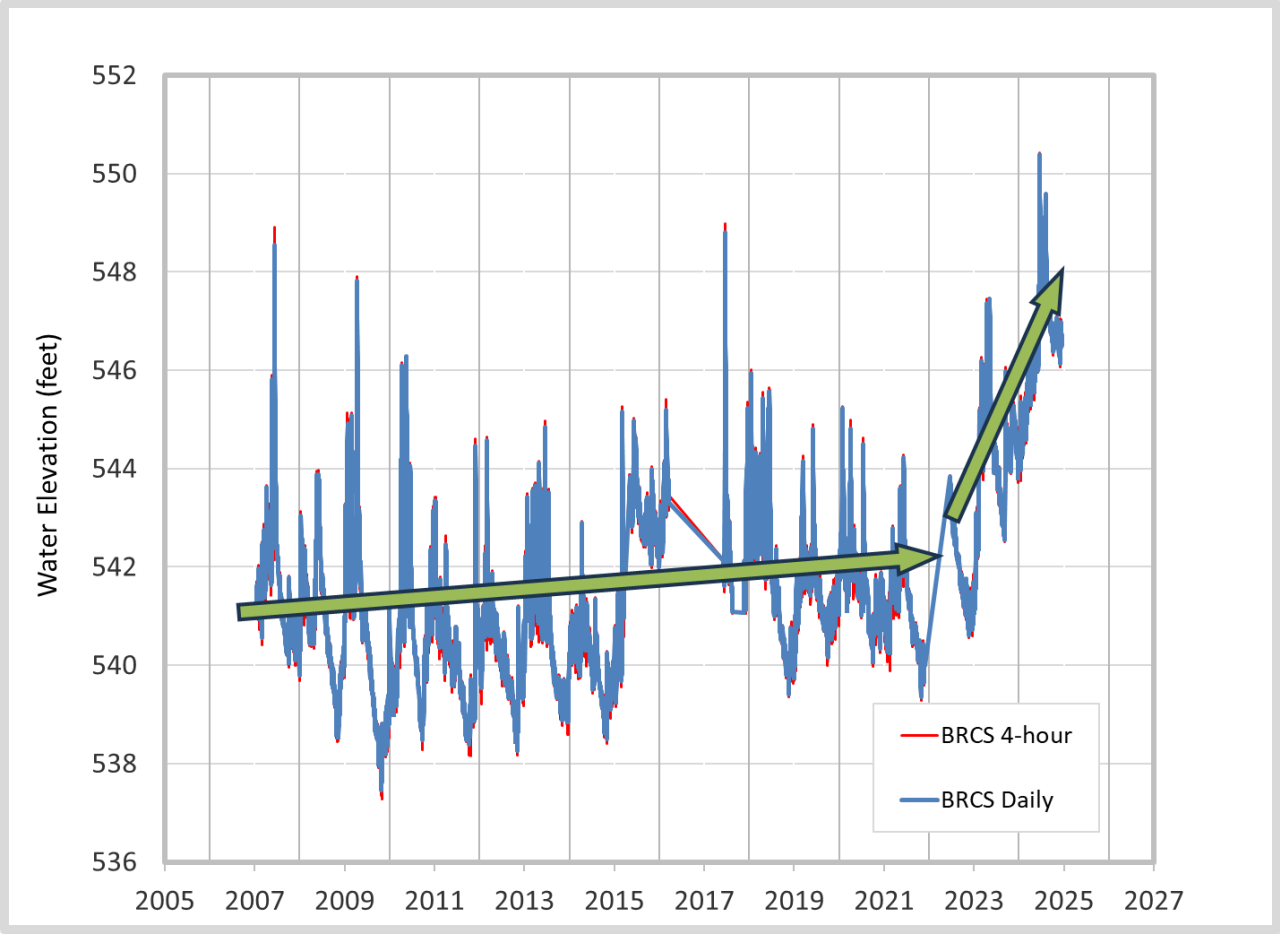
BOLN



This well was lost due to park development.

Overall recent trend – Slightly Increasing

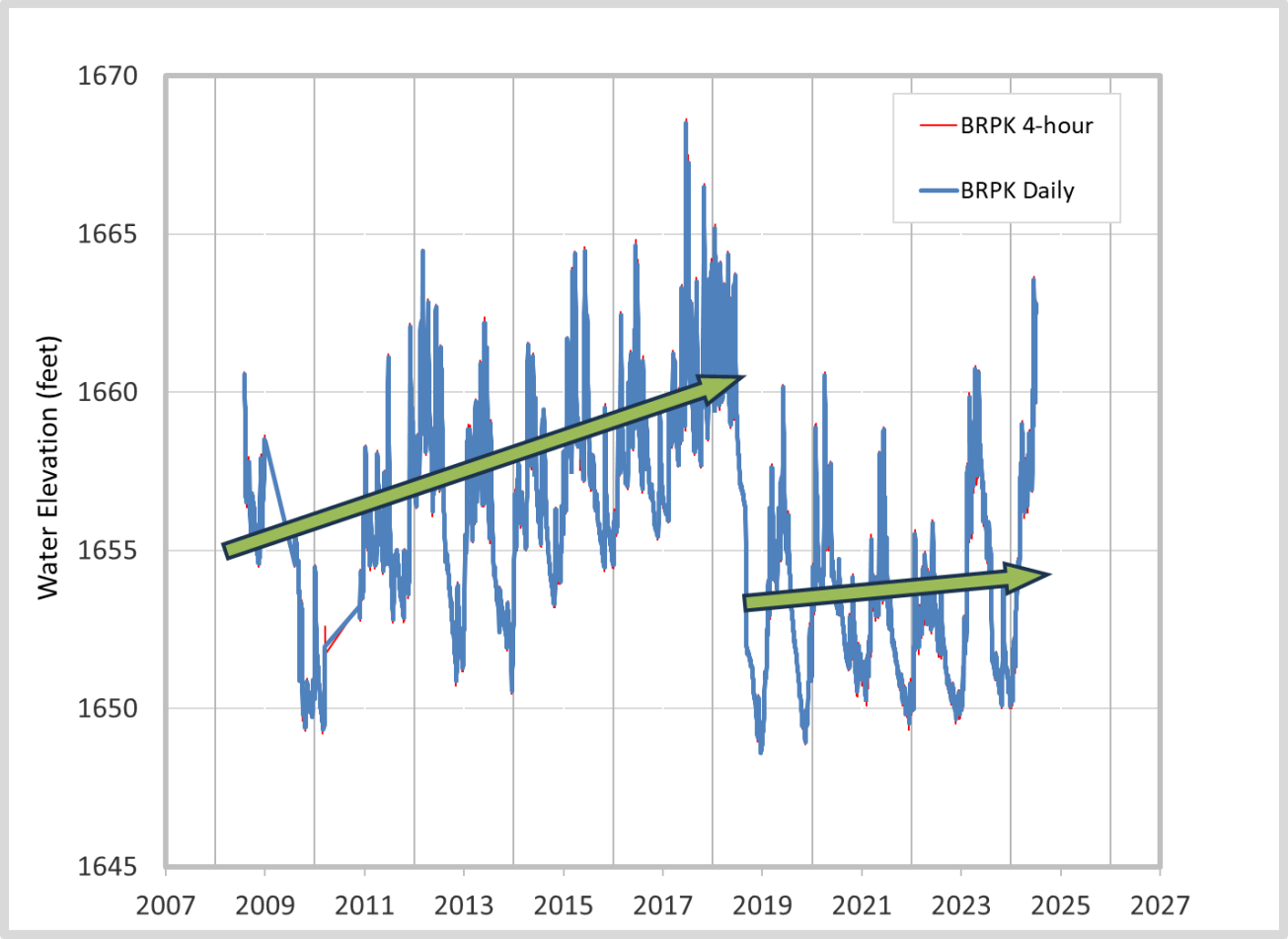
BRCS



Located near entrance of new state park, there appears to be a change starting in 2022. The nearby as use has not changed and the rise of 6 feet is unknown.

Overall recent trend – Slightly Increasing

BRPK



Located very high at a Boy Scout camping area there appears to be a break in 2018. That year there was greater than usual rainfall, but does not explain the fall off.

Manual readings were taken as follows:

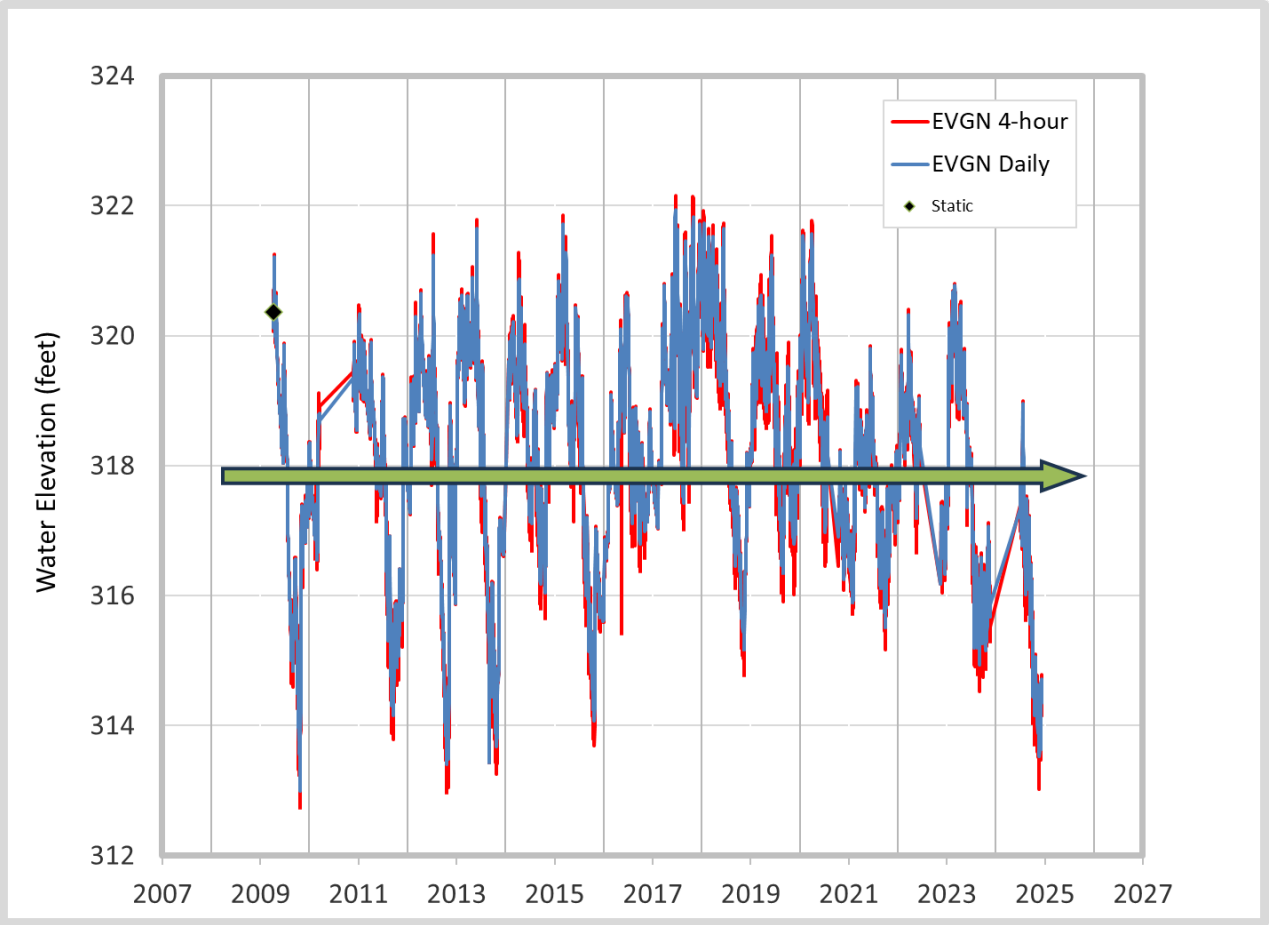
Date_and_Time	Water_Level_FT_ASL
7/2/2009 20:00	1660.60
10/14/2009 4:00	1654.60
7/8/2010 16:00	1654.46
10/13/2010 0:00	1650.43
2/16/2011 0:00	1650.24
10/24/2011 14:00	1653.28
4/3/2012 10:00	1655.58
4/23/2013 6:00	1657.03
4/2/14 10:00	1660.96
11/24/14 12:23	1651.54
10/22/2015 12:02	1654.24
3/30/2016 12:46	1657.54
9/27/2016 8:51	1654.40
2/16/2017 10:43	1658.03
4/14/2017 7:57	1659.79
5/3/18 10:20	1660.94
10/19/18 10:20	1659.10
7/11/19 0:00	1656.76

10/3/19 6:20	1650.36
10/13/21 10:20	1652.13
5/25/22 5:33	1654.82
10/24/22 17:33	1650.06
5/18/23 9:33	1653.65
10/10/23 13:33	1650.03
4/18/24 9:33	1658.10

These data suggest that this is not equipment failure.

Overall recent trend – Increasing

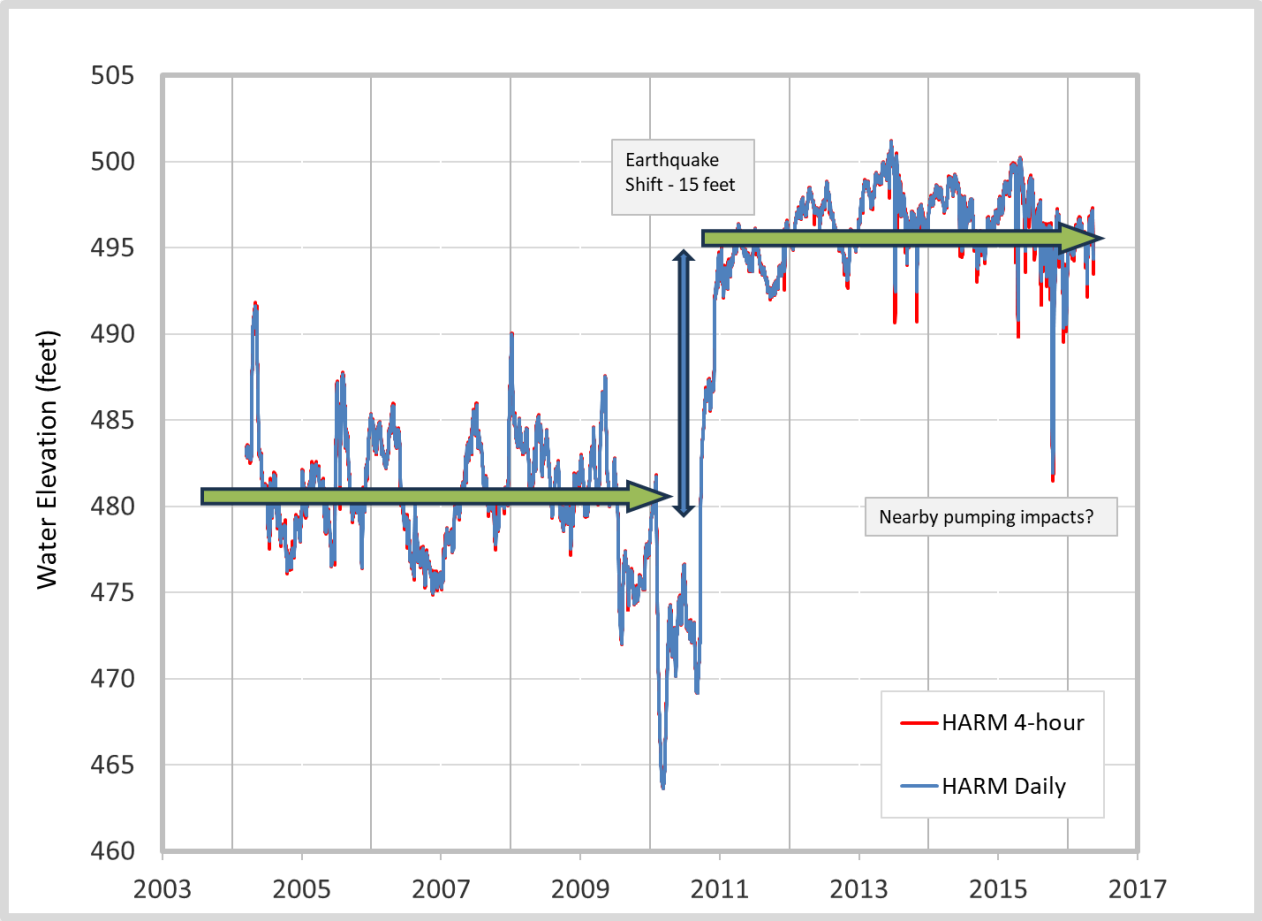
EVGR



This well reflects the higher than average rainfall in 2018. Since then there may be declining levels, though more data is needed to confirm this.

Overall recent trend – Slightly Increasing

HARM



This well is unique in that the earthward in 2010 causes a 15 ft upward shift in the local water level. It is the only well in the network to exhibit this behavior.

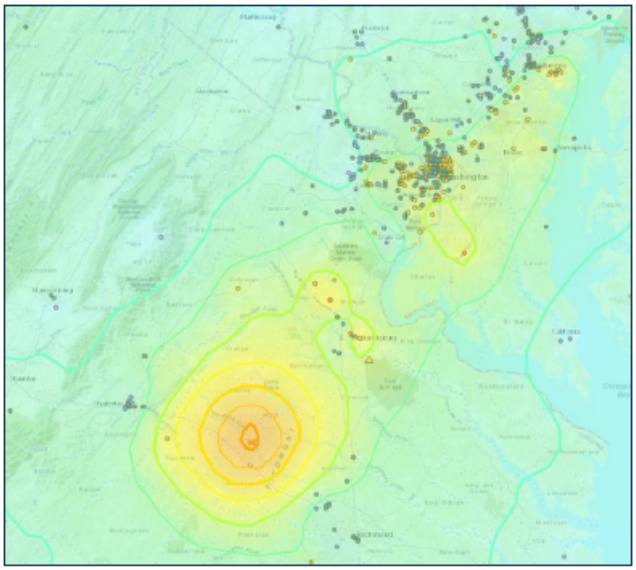
County staff looked into this as reported in the 2023 Annual Water Resources Monitoring Data Report.

Moment to Remember

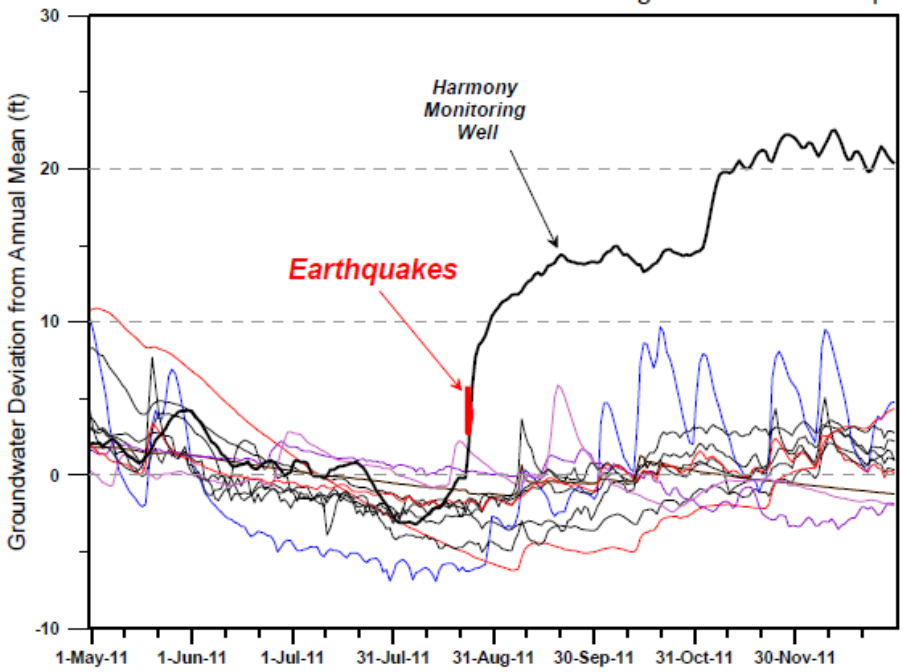
Effect of Earthquake on Groundwater Level at Monitoring Wells

The effect of the earthquake in central Virginia was observed in the Loudoun County Water Level Monitoring network. This occurred in 2011 near Mineral in central Virginia about 80 miles from Loudoun County. The first quake in August 23, 2011 was magnitude 5.8 on the Richter scale where the earthquake damaged several sites in Washington D.C., including Washington Monument and National Cathedral. Over the next day, three smaller earthquakes occurred. The earthquake occurred as reverse faulting on a north or northeast-striking plane within a previously recognized seismic zone, the "Central Virginia Seismic Zone." The Central Virginia Seismic Zone has produced small and moderate earthquakes since at least the 18th century. The previous largest historical shock from the Central Virginia Seismic Zone occurred in 1875.





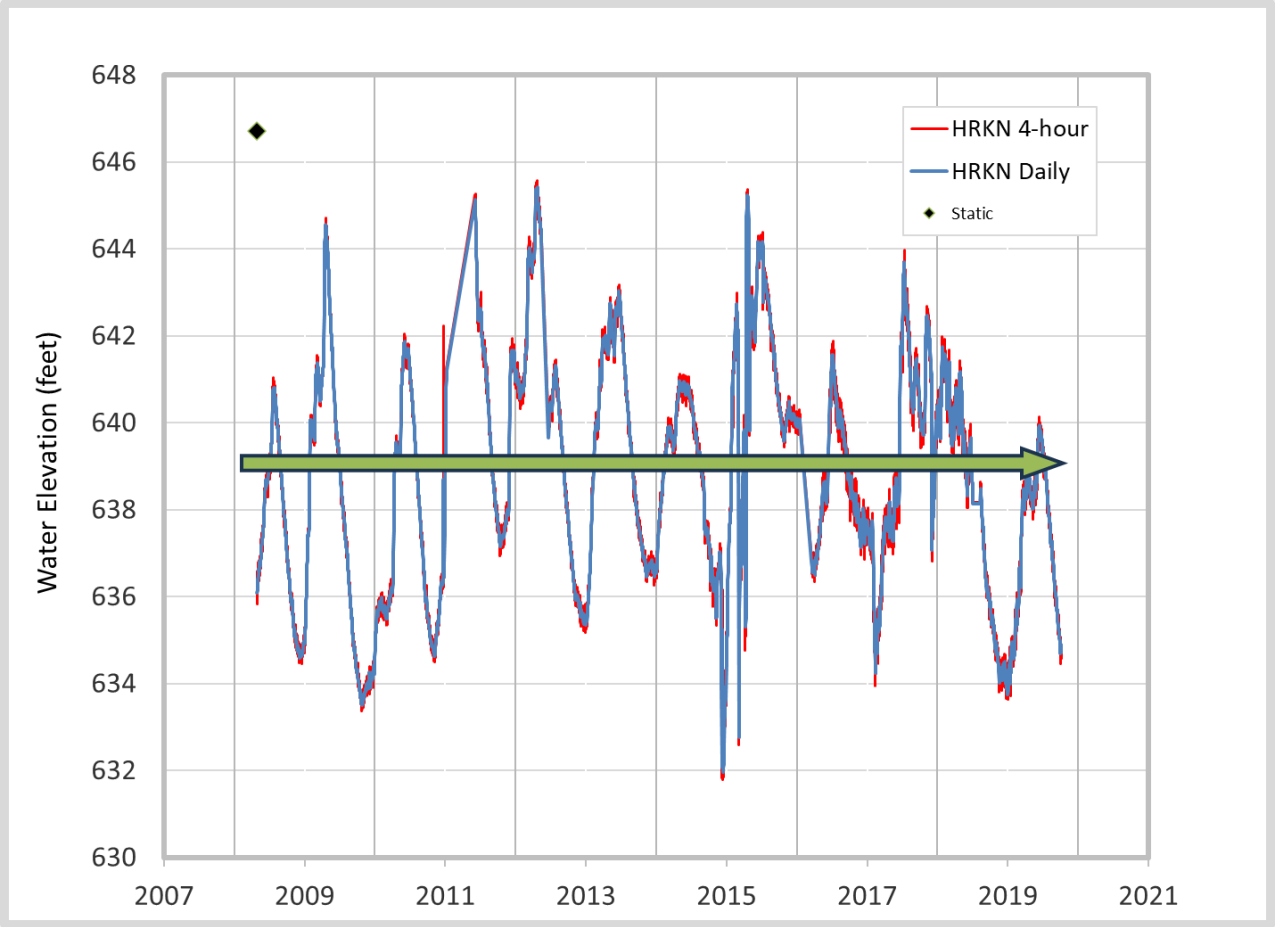
At the Harmony School well water level rose immediately after the quake. Located in central western Loudoun, this well was taken offline in 2017. Other wells in the monitoring network did not respond.



https://lfportal.loudoun.gov/LFPortalInternet/0/edoc/633754/2023%20Water%20Resources%20Monitoring.pdf

Overall recent trend – Slightly Decreasing

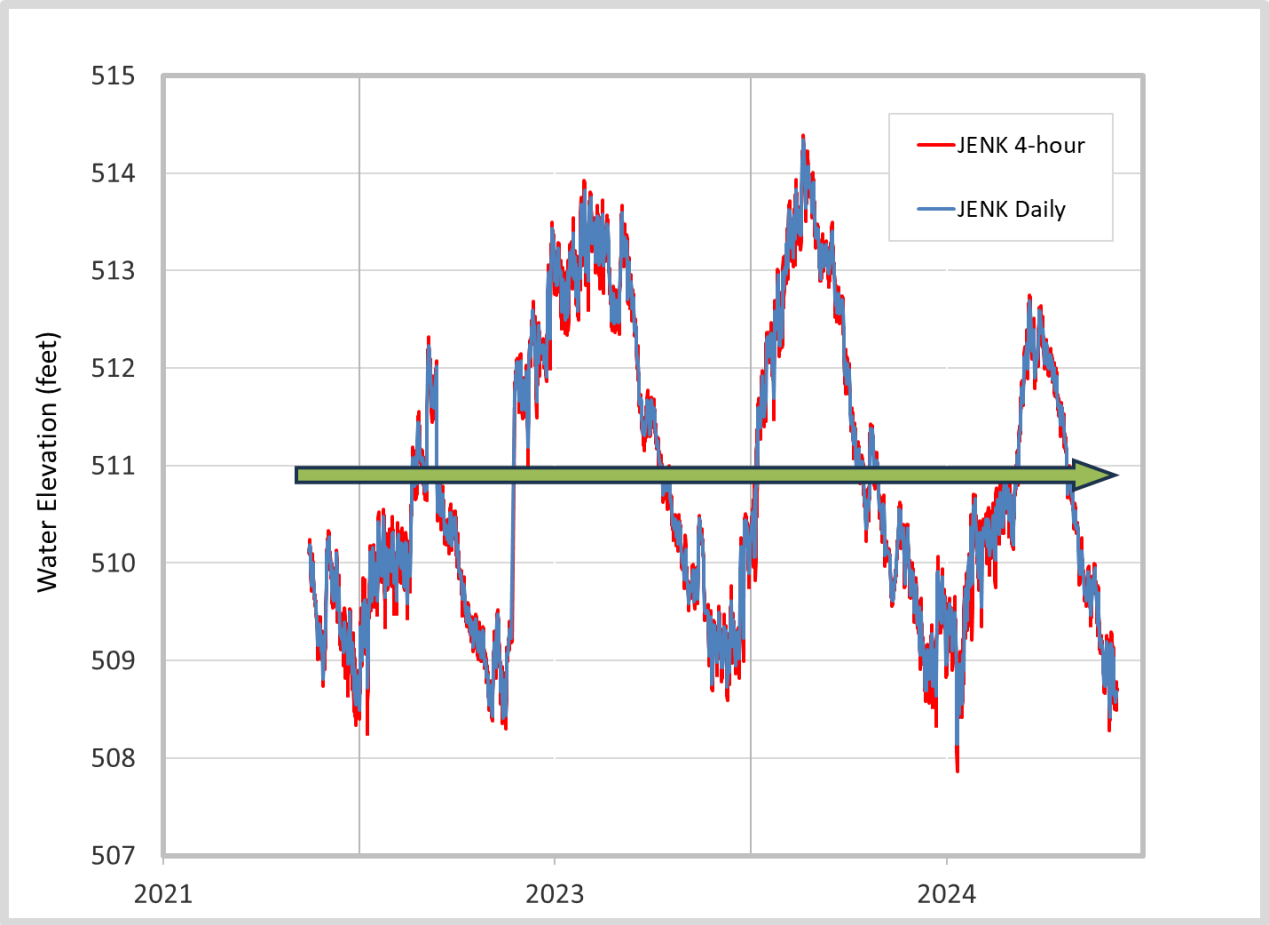
HRKN



This well also displays elevated level around 2018 when greater than average precipitation occurred.

Overall recent trend – None

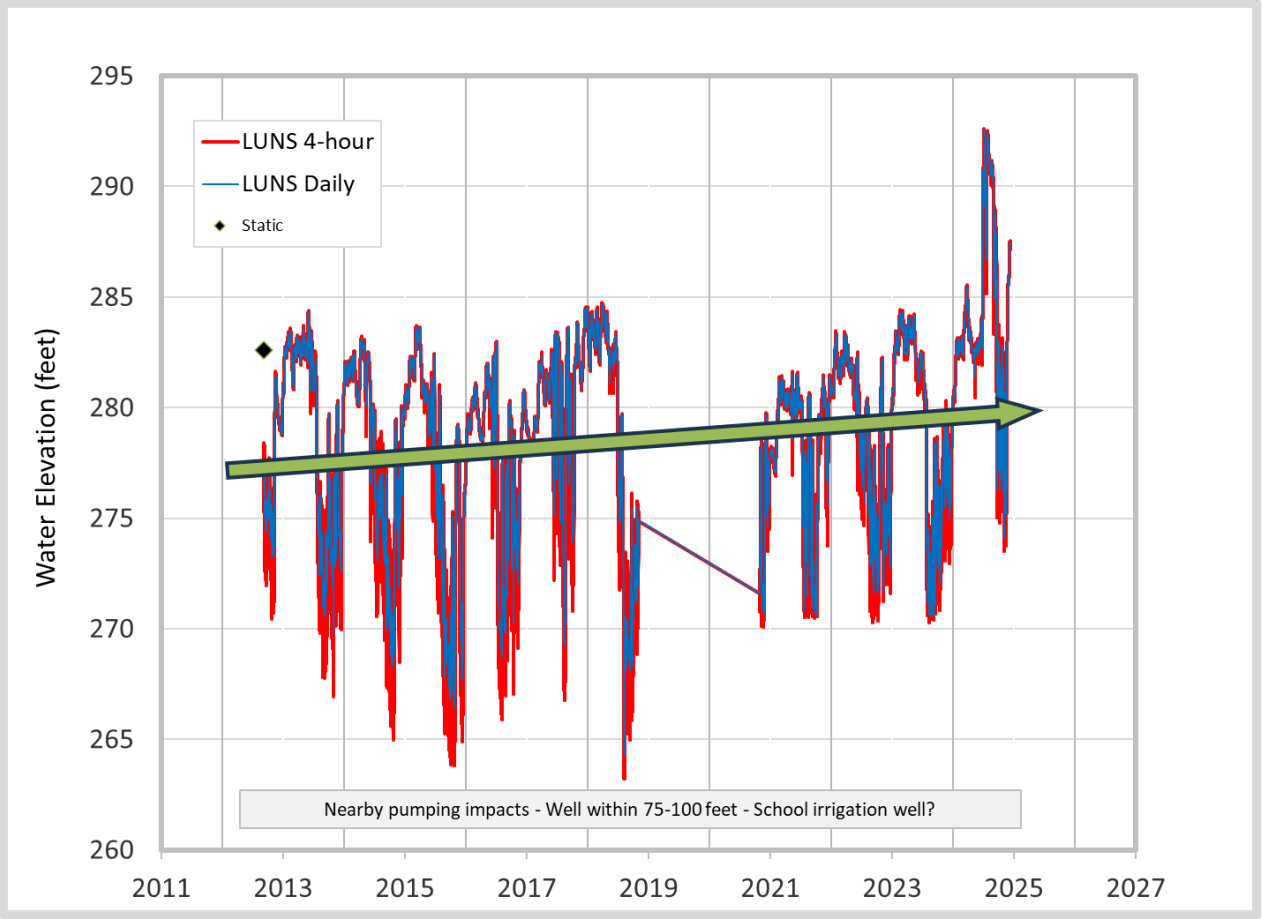
JENK



This is a newer well.

Overall recent trend – None (yet)

LUNS

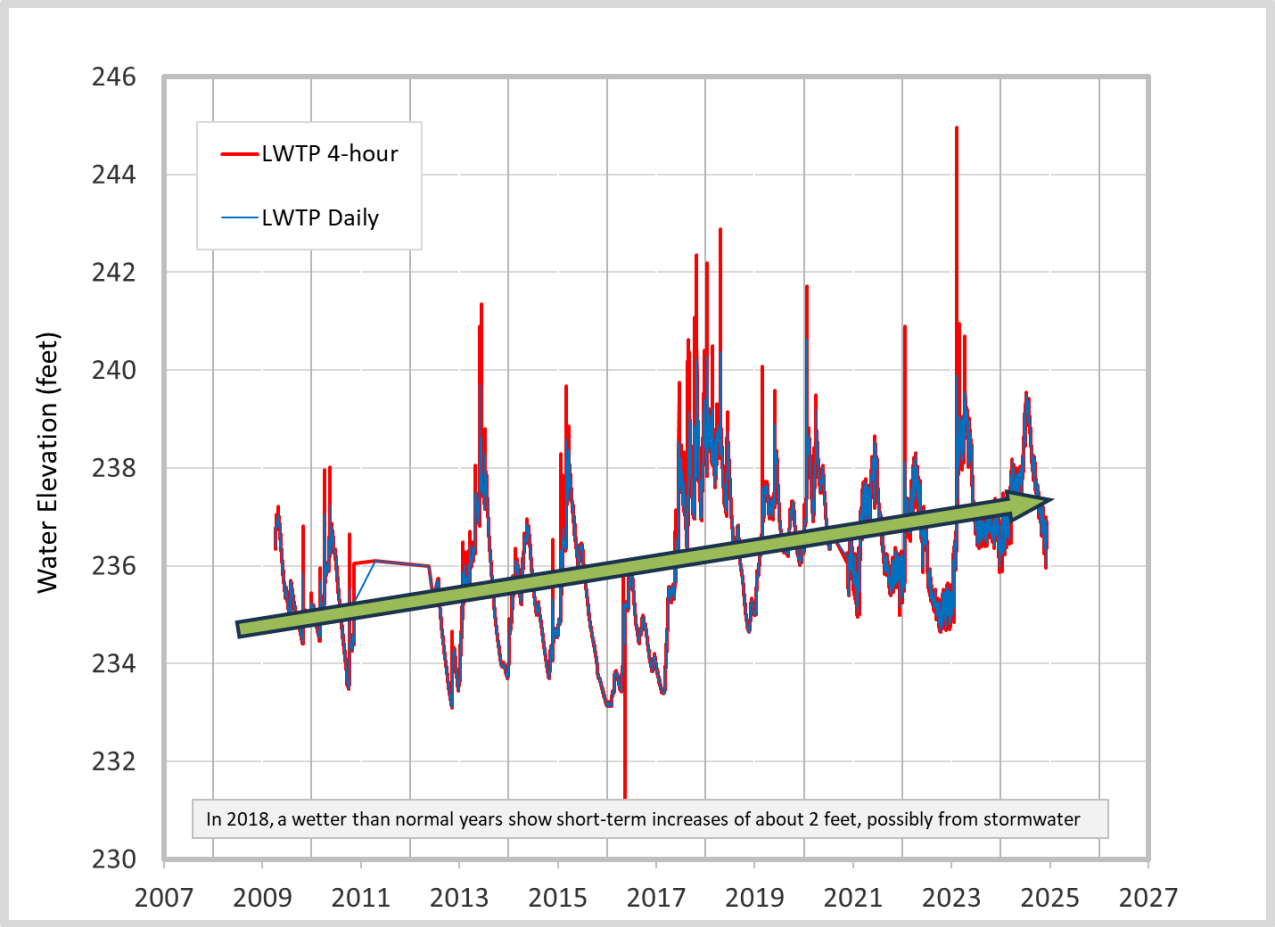


Located on school property, this well is impacted by nearby (75-100) feet irrigation pumping. The additional drawdown is 3 to 4 feet and only occurs in the summer/autumn months.

Data since 5/2024 has not been verified with manual measurements.

Overall recent trend – Slightly Increasing (but may actually be no trend)

LWTP



While levels are higher in 2018 with increased rainfall, this well appears to be impacted by rapid stormwater rises of about 2 feet within minutes. The increase trend may be the new wet ponds across the road.



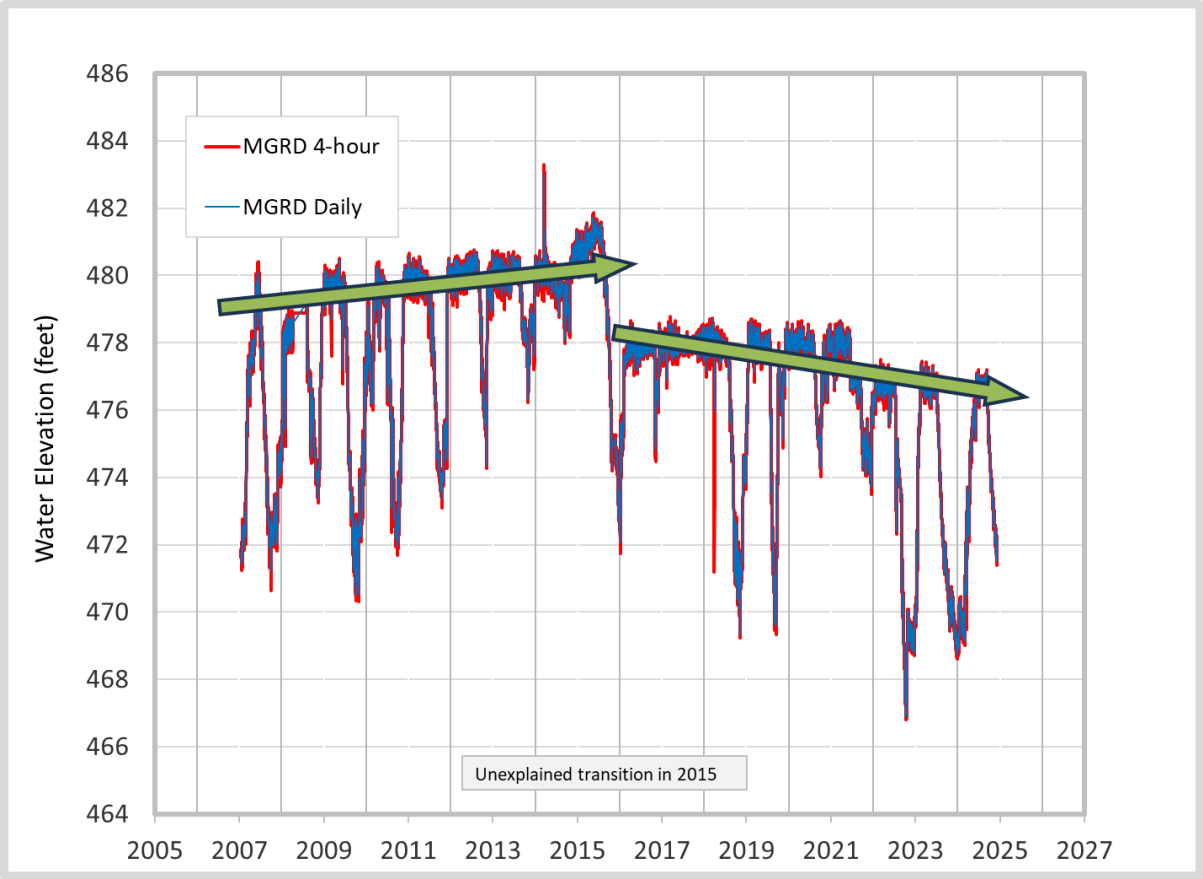
2009



2025

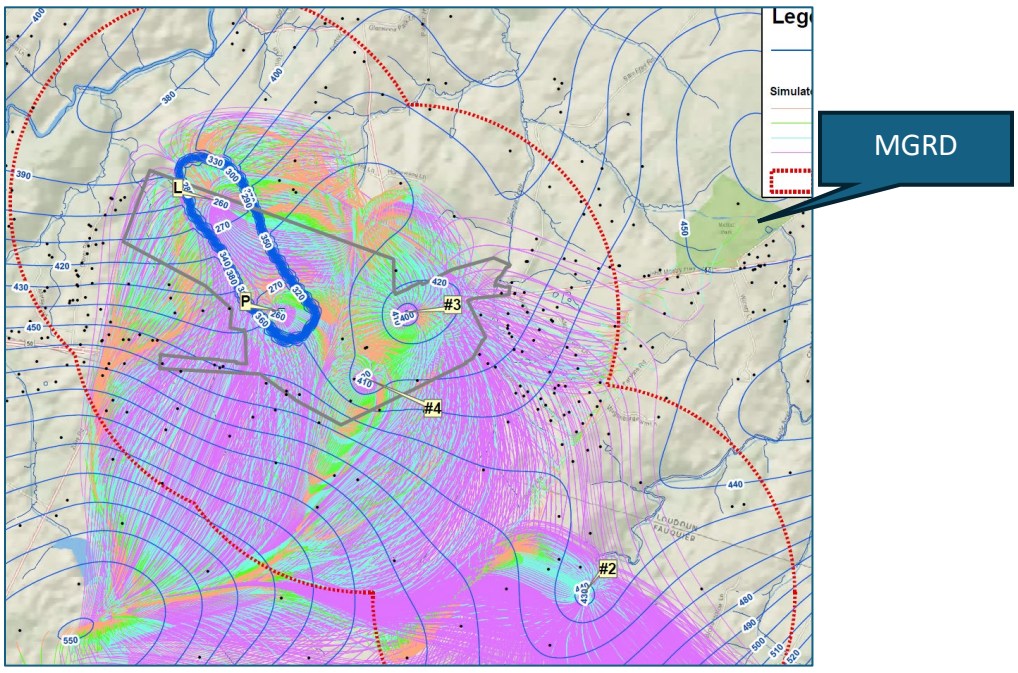
Overall recent trend – Slightly Increasing possibly due to modified stormwater management

MGRD



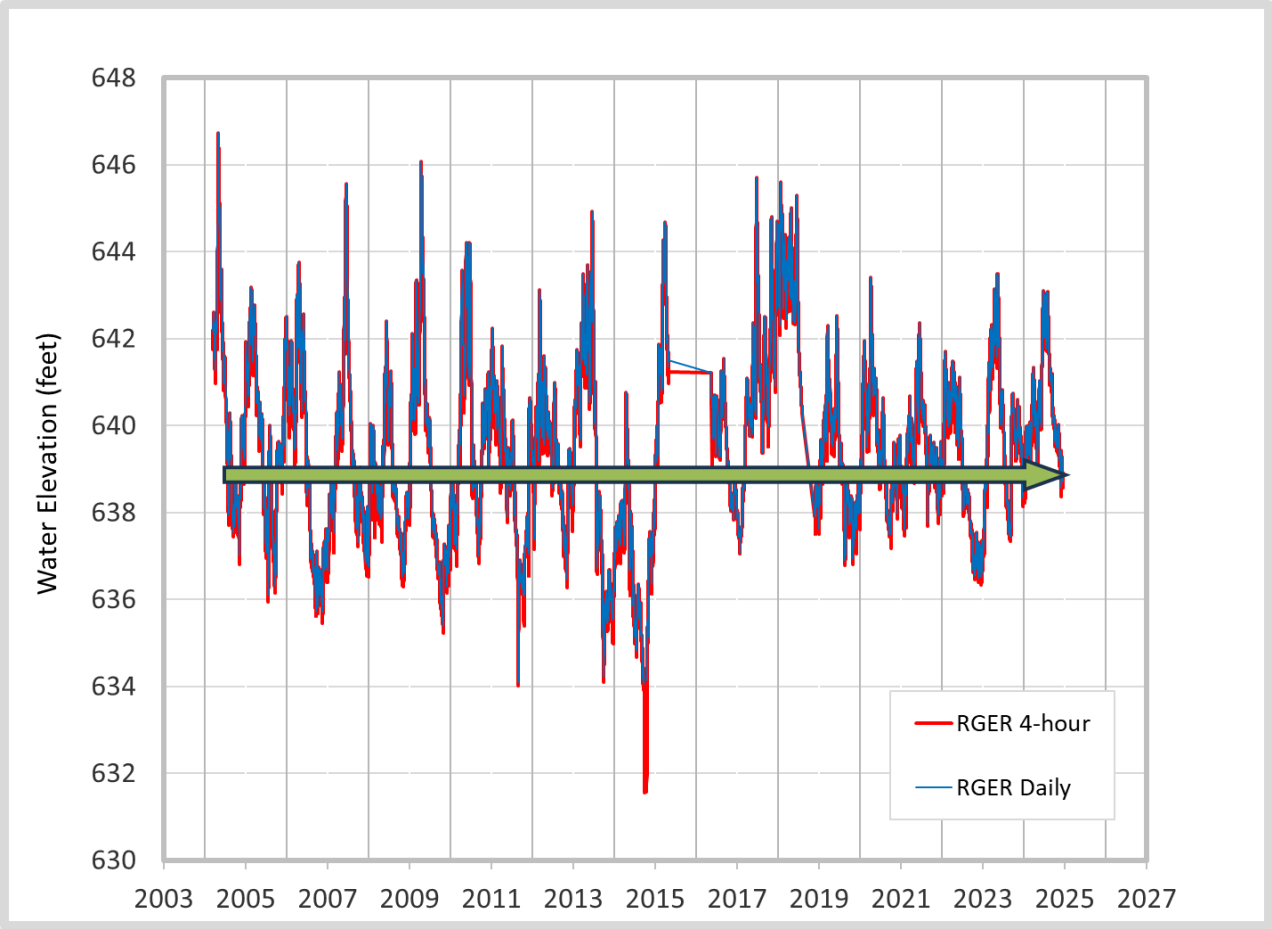
This well is unique in that when first drilled it was flowing artesian. Field notes that it has only been flowing artesian once since 2015.

Located on Carter's Lane the well appears to be outside of the influence from the town wells.



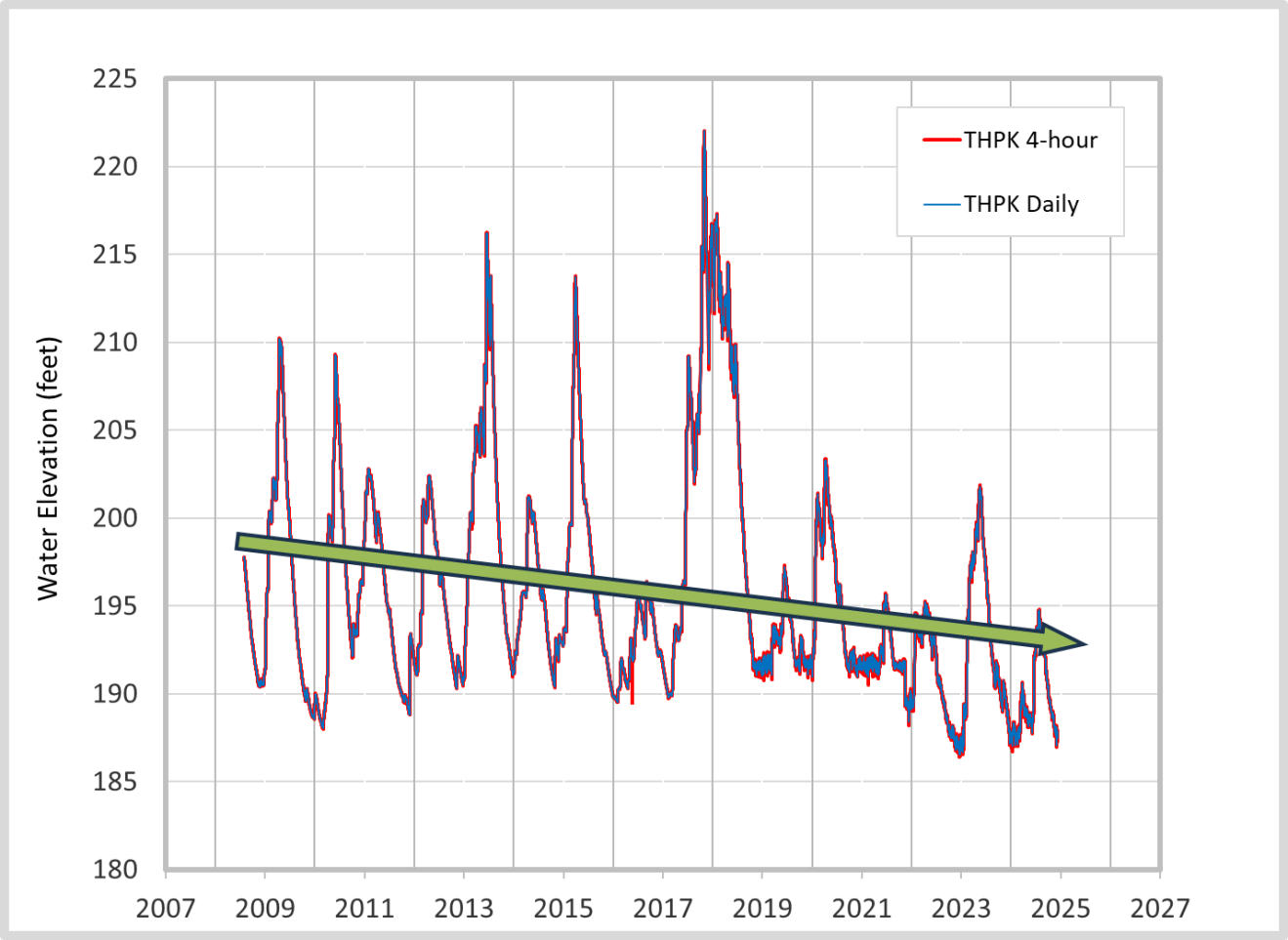
Overall recent trend – Slightly decreasing

RGER



Overall recent trend – None

THPK

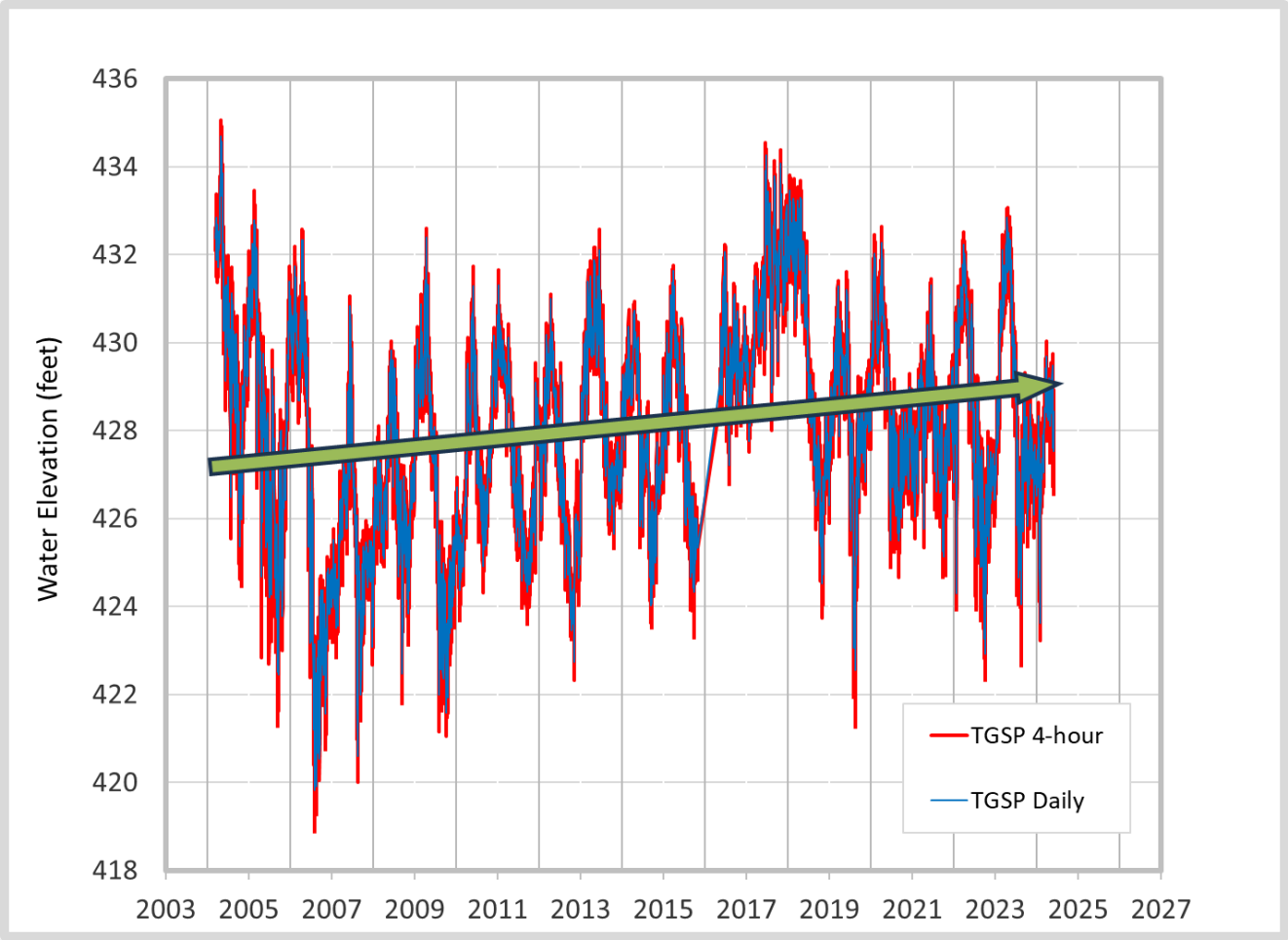


This well is uniquely situated within the limestone conglomerate. The increased levels in 2018 are in response to greater than average precipitation.

This is the most dramatic well showing a 5-ft decline in 18 years or 2.5 feet per decade

Overall recent trend – Significantly decreasing

TGSP

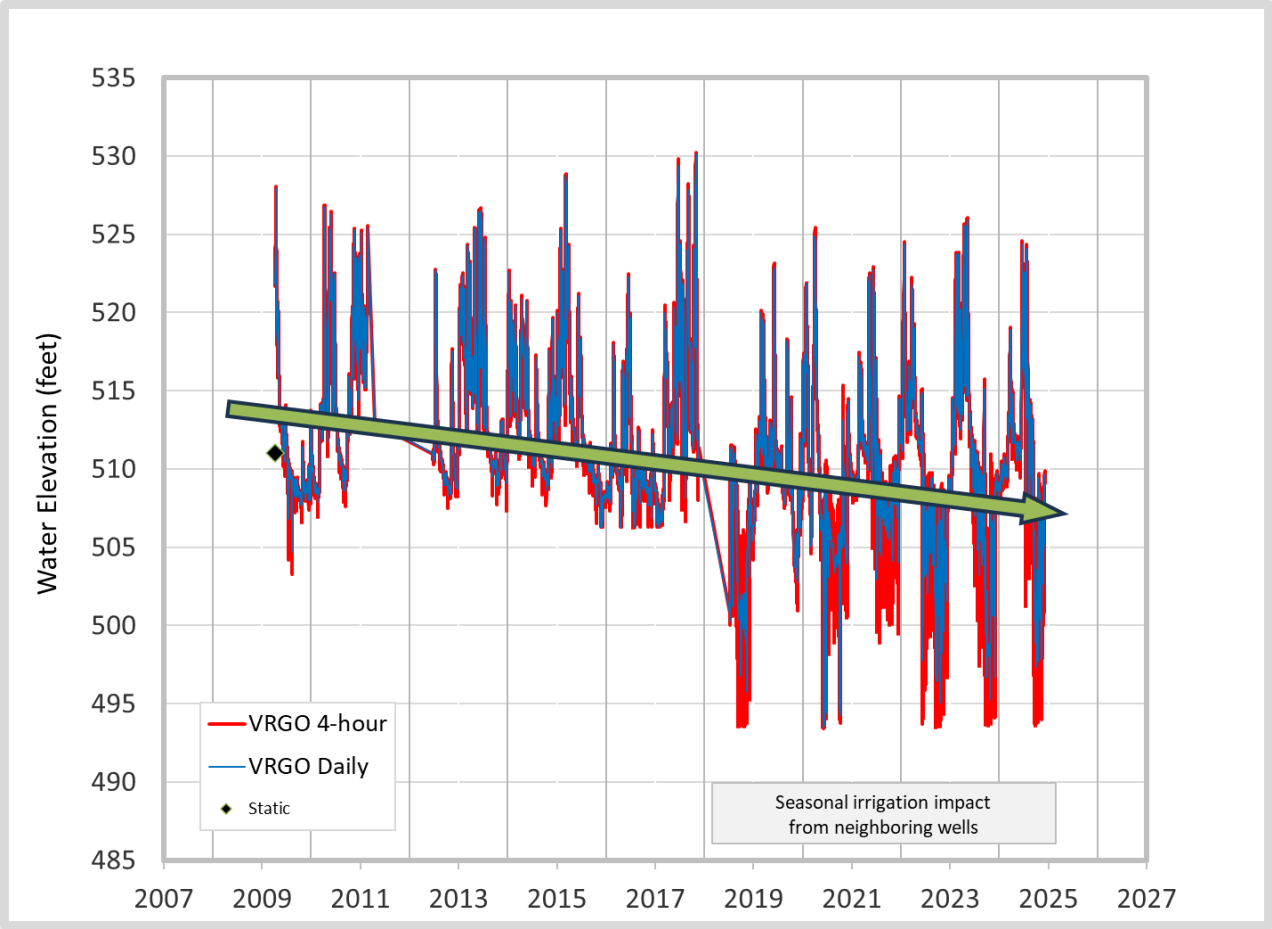


The increased levels in 2018 are in response to greater than average precipitation.

This is in residential area and 4-hour data suggest this is not irrigation, but rather residential well pumpage of 1 foot or two.

Overall recent trend – Slightly increasing

VRGO

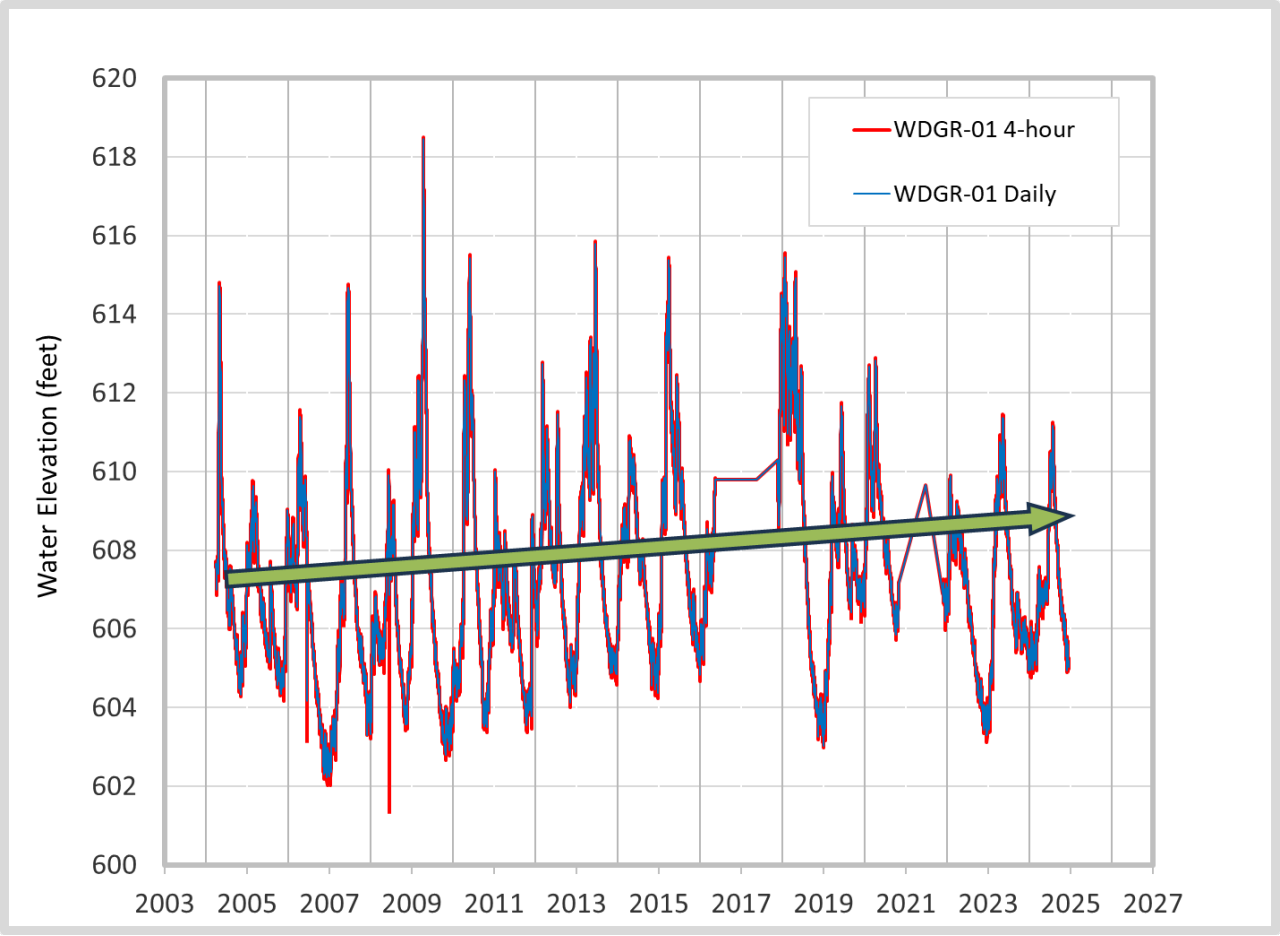


Starting in 2018, neighboring irrigation wells impact readings up to 5 feet.

Overall the water level declined 6 feet over almost 16 years or 5.8 feet per decade

Overall recent trend – Significantly decreasing

WDGR-01 0 Deep

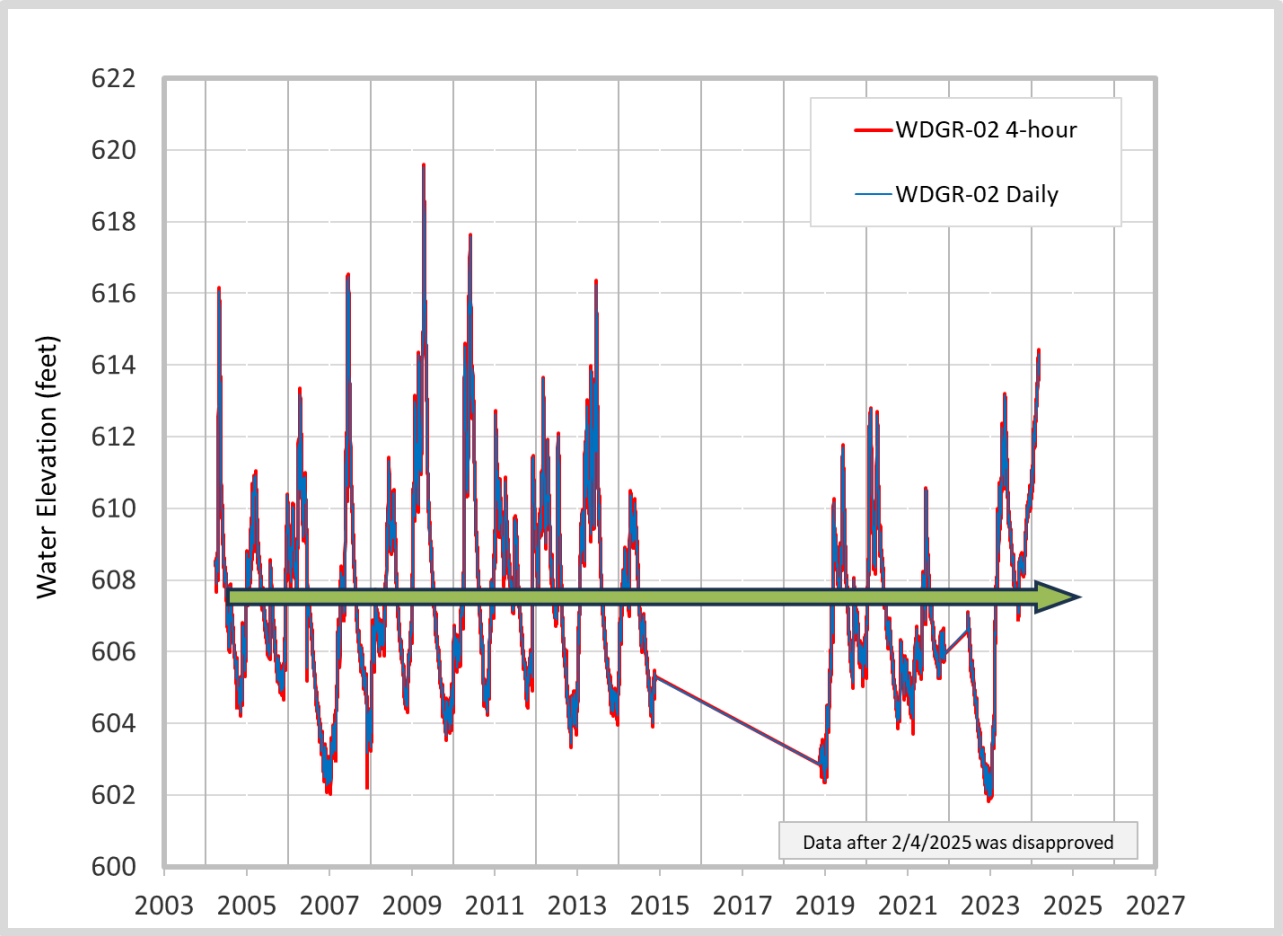


Woodgrove has two wells, intended to provide heads from shallow and deep well to better understand vertical gradients. WDGR-01 is deep and WDGR-02 is shallow.

The increased levels in 2018 are in response to greater than average precipitation.

Overall recent trend – Slightly increasing

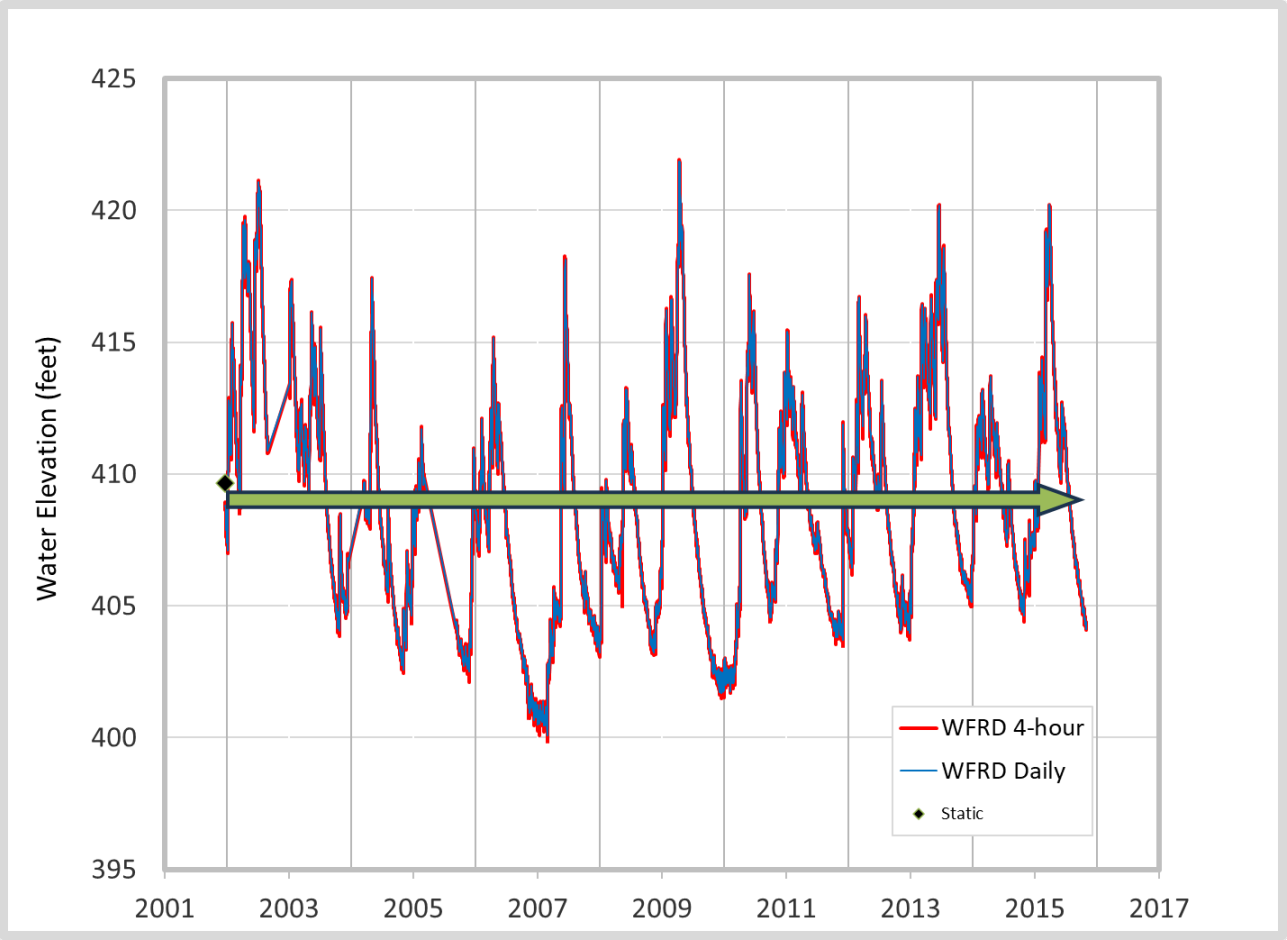
WDGR-02



Data in the more shallow well is less complete and recent transducer data was disapproved without manual field measurements.

Overall recent trend – Indeterminant

WFRD



Overall recent trend – None