2024 Annual Water Resources Report

Joint Legislative Oversight Commission on State Water Resources
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Prepared by the

West Virginia Department of Environmental Protection
Division of Water and Waste Management
Standards Section - Water Use

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Water Resources Protection and Management Overview

The Water Resources Protection and Management Act (WV Code §22-26*)* was passed into law in 2004. The Act recognized the need to protect and conserve the water resources of the state for the use and benefit of citizens and directed the West Virginia Department of Environmental Protection (WVDEP) to develop a State Water Resources Management Plan. WVDEP formed the Water Use Section within the Division of Water and Waste Management in 2008 to initiate a comprehensive review of the state's water resources. The State Water Resources Management Plan was published in 2013 and adopted by the Legislature in 2014. Now within the Water Quality Standards and Assessment Section-Standards Unit, the Water Use Program continues to implement the provisions and recommendations within the Act and Plan with several ongoing programs, projects, and studies in support of WVDEP's responsibility for the state's waters, a valuable public natural resource. This annual report is submitted to the Joint Legislative Oversight Commission on State Water Resources in accordance with WV Code §22-26-8(e).

2023 – 2024 Water Resources Availability

The following section relies on national datasets and related analyses from various federal agencies with data source specifics referenced accordingly in figures below. Going back to the late 19th century, average annual rainfall in WV has been approximately 45 inches. Total annual precipitation has been highly variable with a slight increase over the long record period (129 years and counting), with the driest in the early 1930s and late 1960s and the wettest since 2015 (Figure 1). More specifically, the driest consecutive five year interval was 1962–1966, averaging 39.6 inches per year, and the wettest was 2016–2020, averaging 51.9 inches. Total statewide precipitation was slightly lower in 2023 at 40 inches (compared to 49 inches in 2022). Nationally, annual precipitation was also lower, ranking the driest third of the historical record. Total precipitation percentiles for WV in 2023 ranged from near average to much below average (Figure 2). In Charleston, WV there was only 36.87 inches of precipitation in 2023 (Figure 3).

In 2023, temperatures were above average across most of the contiguous US (Figure 4). In general, temperatures in WV have risen one degree Fahrenheit since the beginning of the 20th century. This change in temperature will affect both the number and intensity of extreme precipitation events with more potential for flooding and drought. Winter and spring precipitation amounts are projected to increase, creating an increased risk of flooding. Naturally occurring droughts are projected to be more intense in the future due to temperature-caused increases in the rate of soil moisture loss during dry spells. Less snowpack affects both surface water runoff and groundwater infiltration. Warmer temperatures cause more surface water to evaporate and plants to require more water so there is less to seep into the ground to replenish aquifers. The speed of heavy rains from extreme downpours, result in more run-off instead of infiltration into the soils, thus do not support the typically more gradual aquifer recharge from lighter and longer rain events.

WV experiences a wide array of extreme weather, including tornadoes, thunderstorms, snowstorms, hurricane remnants, and flooding. Flooding, caused by extreme precipitation over the rugged topography, is the costliest and most severe natural hazard for the state. The Central Appalachian Mountains run through the eastern portions of the state, creating a disparity in precipitation. As typical, 2023 precipitation was greatest in the high mountains west of the continental divide (over 60 inches observed) and lowest in the rain shadow from those same mountains (under 30 inches in some

spots) in the Eastern Panhandle (Figure 5). Although 5 of the top 10 wettest years on record have occurred since 2000, intermittent drought conditions can and still occur between periods of extreme precipitation (Figure 6).

Groundwater recharge is typically between 15-18% of annual precipitation. The US Geological Survey (USGS) Ber-0445 station is a 154 feet deep well in an unconfined aquifer in Berkeley County, WV where groundwater levels have been recorded since 1970 and continually monitored since 2006. Measurements to date range from a high of 20.09 feet in September 2018 to a low of 68.45 feet in December 1969. In 2023, the groundwater levels were highest on January 1st at 44.92 feet and lowest on November 21st at 56.64 feet (Figure 7a). As of October 23, 2024 at this location, the groundwater level was 48.43 feet below land surface which is normal (25-75 percentile rank) based on over 48 years of data (Figure 7b).

Drier conditions were present for most of 2023 in WV (Figure 8a). Although WV started 2023 without dryness or drought, mid January thru first part of March saw abnormally dry (D0) conditions which also occurred again late March through mid April. Moderate drought (D1) started mid April until it escalated to severe drought (D2) in late August for the remainder of the year. Note, there had not been severe drought conditions (D2) since October 2019. Also, over half the state experienced moderate drought (D1) in June 2023.

WV started 2024 with severe drought (D2) (Figure 8b). Although from early February through early May there was no abnormal dryness (D0), moderate drought conditions (D1) reappeared in mid June which escalated to exceptional drought (D4) by the end of August. Also note, there had not been extreme drought conditions (D3) since September 2010 but covered the majority of the state in September 2024.

A helpful resource is https://www.drought.gov/states/west-virginia where the US Drought Monitor map is updated each Thursday to show the location and intensity of drought and dryness at various levels across the country. This website also provides a state based snapshot summary of drought related information as well as an email alert system. A number of physical indicators are important for monitoring drought, such as precipitation, temperature, streamflow, and soil moisture conditions, all of which are available also on this website. For reference, the 1930-1931 drought resulted in nearly 100% of the state experiencing what would be referred to as exceptional drought (D4) and there has not been a drought of this caliber since prior to 2000 based on the US Drought Monitor website and graph.

The USGS National Water Dashboard at https://dashboard.waterdata.usgs.gov/app/nwd/en/ is another helpful tool to support local water information and planning on multiple fronts with layers including but not limited to groundwater levels, aquifers, streamflow, watersheds, gaging stations, and weather conditions such as drought (Figure 9).

Large Quantity User Water Withdrawals

Any person that withdraws more than 300,000 gallons in 30 days from state's waters – except for farm use – and any person that bottles water for resale regardless of quantity withdrawn is considered a Large Quantity User (LQU) per the Water Resources Protection and Management Act. These LQUs use the WVDEP Electronic Submission System (ESS) to report their withdrawals annually to Water Use. LQU surveys are collected between January 1 and March 31 of the year following water withdrawal; Water

Use will receive 2024 reports beginning January 1, 2025. Water Use has been collecting LQU information since 2006 and monitoring trends. Water Use shares water withdrawal data with research partners including state universities and the USGS.

The LQU data represents our best insight into water use throughout WV but is by no means definitive. Water Use does not collect any water withdrawal information on users below the LQU threshold; the cumulative impact of such withdrawals is unknown. For existing LQUs, as with any user-input dataset, the opportunity for error or omission exists. Water Use conducts limited audits and field visits to verify reported information and register new LQUs.

Annual Data and Trends

In 2023, 345 LQUs reported withdrawing over 607 billion gallons of water (Table 1). Additionally, 10 hydroelectric facilities reported more than 232 trillion gallons withdrawn. Total withdrawal from WV water resources slightly decreased (1.1%) from 2022 to 2023. Thermoelectric operations continue to be the largest water use sector at more than 375 billion gallons overall excluding hydroelectric. The chemical and public water supply users continue to round out the top 3 in total quantity at over 131 billion and 63 billion gallons in 2023, respectively. An over 73% drop was observed in the timber category due to a decrease in withdrawals by the largest facility, potentially due to seasonal dryness or a business change.

Table 1. Total 2023 water withdrawals from the LQU database (WVDEP).

WVDEP Water Use Category	LQUs	Total 2023 Withdrawal (Gallons)	Category %	% Change from 2022
Agriculture/Aquaculture	12	7,236,362,471	1.19%	-9.63%
Chemical	11	131,729,647,028	21.69%	5.29%
Industrial	16	11,227,382,886	1.85%	-12.28%
Mining	64	13,514,251,738	2.23%	-0.09%
Oil & Gas	15	3,034,636,366	0.50%	-5.53%
Petroleum	1	278,082,884	0.05%	-8.37%
Public Water Supply	193	63,212,013,560	10.41%	0.56%
Recreation	21	1,051,066,794	0.17%	-6.34%
Thermoelectric (coal)	9	375,777,535,623	61.88%	-2.78%
Timber	3	207,807,171	0.03%	-73.50%
TOTAL	**345**	**607,268,786,521**	**100.00%**	**-1.14%**
Hydroelectric	10	232,057,512,536,992		

Most LQUs continue to withdraw from the surface (95.2%) with only 4.8% using groundwater (Table 2). Thermoelectric (coal) continues to use the most surface water with over 375 billion gallons in 2023. The public water supply remains the single largest user of groundwater with over 14 billion gallons used, followed by the chemical and mining sectors. The majority of groundwater use is concentrated in the alluvium along the Ohio River, southern coalfields, and karst aquifer systems of eastern WV (Figure 10), due to the large amount of water stored in those aquifers.

Table 2. Breakdown of surface water and groundwater 2023 withdrawal data (WVDEP).

WVDEP Water Use Category	**Surface Water WD (Gallons)**	**Category % of SW**	**Groundwater WD (Gallons)**	**Category % of GW**
Agriculture/aquaculture	7,120,140,071	1.23%	116,222,400	0.40%
Chemical	123,728,360,832	21.41%	8,001,286,196	27.22%
Industrial	10,567,374,376	1.83%	660,008,510	2.25%
Mining	8,153,365,735	1.41%	5,360,886,003	18.24%
Oil & Gas	2,922,190,875	0.51%	112,445,491	0.38%
Petroleum	5,679,408	0.00%	272,403,476	0.93%
Public water supply	49,115,712,959	8.50%	14,096,300,601	47.95%
Recreation	725,467,266	0.13%	325,599,528	1.11%
Thermoelectric (coal)	375,338,029,473	64.95%	439,506,150	1.50%
Timber	194,636,922	0.03%	13,170,249	0.04%
SUB TOTAL	577,870,957,917	100.00%	29,397,828,604	100.00%
Breakdown % of Total WD	**95.16%**		**4.84%**	
Hydroelectric	232,057,512,536,992			

The 2023 estimate for water consumption is approximately 44.7% of the total statewide water withdrawal (Table 3) which is slightly lower than 2022's at 45.4% (Figure 11).

Table 3. Current consumption coefficients applied to 2023 withdrawal data (WVDEP).

WVDEP Water Use Category	2023 Total Gallons Withdrawal	Consumptive Coefficient	2023 Calculated Gallons Consumed	Category % of Consumed
Agriculture/aquaculture	7,236,362,471	0.03	217,090,874	0.08%
Chemical	131,729,647,028	0.12	15,807,557,643	5.82%
Industrial	11,227,382,886	0.59	6,624,155,903	2.44%
Mining	13,514,251,738	0.48	6,486,840,834	2.39%
Oil & Gas	3,034,636,366	1	3,034,636,366	1.12%
Petroleum	278,082,884	0.16	44,493,261	0.02%
Public water supply	63,212,013,560	0.15	9,481,802,034	3.49%
Recreation	1,051,066,794	0.41	430,937,386	0.16%
Thermoelectric (coal)	375,777,535,623	0.61	229,224,296,730	84.45%
Timber	207,807,171	0.39	81,044,797	0.03%
SUB TOTAL	**607,268,786,521**		**271,432,855,828**	**100.00%**
			% of Consumption **44.7%**	
Hydroelectric	232,057,512,536,992			

Total monthly water withdrawals are generally highest in the summer and winter (Figure 12) and this trend was relatively remarkable in 2023 data. Energy demands during these times of the year increase the need for thermoelectric water withdrawals. These seasons are also peak for public supply water withdrawals – likely owing to burst pipes in winter and increased outdoor water use in the summer. The recreation water use sector also has a substantial increase in wintertime water use, driven by snowmaking at ski resorts. The summer's higher demand for water coincides with the typically lowest water levels of the year throughout WV.

Oil and Gas Water Management Plans

Water Use staff is responsible for the processing, analysis, and approval of operator-submitted water management plans for the Office of Oil and Gas. Pursuant to WV Code §22-6A-7 and the Horizontal Well Development Rule 35CSR8, natural gas operators developing horizontal wells that use water more than 210,000 gallons during any 30-day period, shall submit a Water Management Plan as part of the well work permit application. H6A well work permit applicants must identify all potential water sources with the inclusion of a Water Management Plan along with their horizontal well permit application. The WVDEP evaluates each proposed water source (surface water, groundwater, purchased water, or recycled frac water) for suitability based on a variety of considerations.

In 2023 and 2024, Water Use continued to receive and review all individual Water Management Plan applications associated with WV Code §22-6A well work, including new pad-level plans and existing Water Management Plan modifications, all relating to the planned withdrawal of surface and groundwater used in horizontal well drilling operations. The actual volume of water used in these operations is captured by the LQU program.

Water Resources Research

To carry out mandates from the Water Resources Protection and Management Act, Water Use routinely collaborates on research initiatives with various state, federal, and nonprofit partners. These projects support the data and informational needs to understand, protect, and conserve state water resources. Previous projects have included stream gauge statistical analysis, water budgets, water consumption, and water infrastructure. A few key related references to date include, but are not limited to:

- USGS SIR 2008-5105 Wiley, J.B., 2008, Estimating selected streamflow statistics representative of 1930–2002 in West Virginia: (ver. 1.1, July 2021): U.S. Geological Survey Scientific Investigations Report 2008–5105, 24 p., https://doi.org/10.3133/sir20085105.
- USGS SIR 2010-5185 Wiley, J.B., and Atkins, J.T., Jr., 2010, Estimation of selected seasonal streamflow statistics representative of 1930–2002 in West Virginia (ver. 1.1, July 2021): U.S. Geological Survey Scientific Investigations Report 2010–5185, 20 p., https://doi.org/10.3133/sir20105185.
- USGS SIR 2012-5186 Chambers, D.B., Kozar, M.D., White, J.S., and Paybins, K.S., 2012, Groundwater quality in West Virginia, 1993–2008: U.S. Geological Survey Scientific Investigation Report 2012–5186, 47 p., available only at http://pubs.usgs.gov/sir/2012/5186/.
- USGS SIR 2012-5121 Wiley, J.B., 2012, Comparison of base flows to selected streamflow statistics representative of 1930–2002 in West Virginia: U.S. Geological Survey Scientific Investigations Report 2012–5121, 18 p., https://pubs.usgs.gov/sir/2012/5121/pdf/sir2012-5121.pdf.
- WVGES May 2012 McColloch, J. S. et al., West Virginia Mine Pool Atlas, https://dep.wv.gov/WWE/wateruse/Documents/MinePoolAtlas.pdf.
- WVDEP 2013 Water Laws, Water Regulations and Water Rights https://dep.wv.gov/wwe/wateruse/documents/wv_waterlaws.pdf.
- USGS SIR 2022-5094 Kozar, M.D., McAdoo, M.A., and Haase, K.B., 2022, Groundwater quality and geochemistry of the western wet gas part of the Marcellus Shale Oil and Gas Play in West Virginia: U.S. Geological Survey Scientific Investigations Report 2022–5094, 88 p., https://doi.org/10.3133/sir20225094.

The more recent publications and current Water Use projects are described below.

Abandoned Underground Coal Mine Aquifers

Water Use has been involved in multiple projects to determine the location, quantity, quality, and sustainability of water within Abandoned Underground Coal Mine Aquifers (AUCMA), also known as mine pools. Several municipalities and public service districts in southern WV obtain their water supply from groundwater in mine pools and there has been additional interest in putting these accessible water resources to beneficial use. In 2012, WVDEP collaborated with the West Virginia Geological and Economic Survey (WVGES) to map the extent of potential mine pools (Figure 13). Since then, we have worked with the USGS to obtain data from more than 770 water samples from 294 mines. Water Use received the *Groundwater Quality in Abandoned Underground Coal Mine Aquifers Across West Virginia* report in the fall 2023 from the USGS (USGS SIR 2023-5091). AUCMAs cover a large part of the state and could supply substantial quantities of water for a variety of uses such as agriculture, industrial, residential and public use. The USGS was able to determine general water quality information about the regions of the AUCMAs and better understand their water quality and quantity variety by utilizing existing statewide data. However, smaller scale or more targeted water quality sampling will be

needed to determine if this type of local source meets the intended local use requirements on a case by case basis. The northern, younger, Upper Pennsylvanian coal beds generally produce net acidic waters (poor quality). The southern, older, Lower Pennsylvanian coal beds primarily produce net alkaline waters (good quality). Local effects such as mine age, depth of coal mine, degree of flooding and subsequent mine recovery may also alter water quality in ways that deviate from this regional interpretation. Since spatially and stratigraphically statewide the general water quality of AUMCAs vary greatly, more local characterization by economic developers and water managers is needed to facilitate water quality with application needs. Where water uses and methods are continually changing, there is a common continued need for detailed site-specific studies to not only determine the presence of adequate water resources for current purposes but protect for future priorities.

Monroe County Hydrogeologic Assessment

Since 2017, the USGS has been working on a hydrogeologic framework assessment project which started locally based on concerns with water availability, anticipated economic development and contamination susceptibility. The USGS SIR 2023-5121 report *Hydrogeology, Karst, and Groundwater Availability of Monroe County, West Virginia* identified five aquifers with potentially multiple water bearing zones within each over two different physiographic provinces of a very geologically complex area. The objective of this study was to develop aquifer maps useful for active management of the groundwater resources in Monroe County. Interpretive maps inclusive of aquifer boundaries, water table elevations, and dye-trace results provide important insights into sources of groundwater and groundwater flow paths. Aquifer mapping advanced the conceptual understanding of the interconnectedness between the groundwater system and activities at the land surface. This investigation established a baseline of aquifer status for fractured-rock aquifers and will be used to better understand, manage, and protect ground-water resources of Monroe County. The inventory of aquifer conditions are important for assessment of source waters to public supplies where regional geologic structure may significantly influence the understanding of areas contributing to localized withdrawals. Data collected as part of this study have transfer potential to similar karst aquifers elsewhere in the Appalachian Plateaus and Valley and Ridge Physiographic Provinces within the Appalachian Mountain Region.

Geophysical Groundwater Well Logging

Water Use and the USGS have continued a collaborative five-year project to assess geophysical and hydrologic properties of groundwater wells throughout WV. The data from this project will be used to characterize the complex and various types of aquifers within the state through a better understanding of the bedding planes, joints, faults, and other fractures through which most of our groundwater flows or is stored. This research will greatly increase knowledge of the depth and location of these water bearing features throughout the state. All the fieldwork for the project was completed by September 30, 2019, with over 120 well logs containing geological and hydrological data (Figure 14). The USGS final report and data models were anticipated in spring 2022, however due to staffing issues and other high priority local projects such as perfluoroalkyl and polyfluoroalkyl substances (PFAS), completion of this project is now planned for winter 2024/spring 2025. Although aspects of the study are time consuming and manpower intensive, the borehole geophysics data collected for this project are the only mechanism which allow a detailed characterization of the fracture-controlled bedrock aquifers upon which so many residents, commercial, and industrial entities rely as a primary source of water. Results of the study will aid in future assessment and management of groundwater resources within the state.

Water Security

Initiated in fall 2019, a 2023 report on *Quantifying Water Security in West Virginia and the Potomac River Basin* by Eric Sjostedt, Michael Strager and Nicolas Zegre is based on master's thesis work at West Virginia University (WVU). The thesis included two studies to provide insight into water resources management in WV. The first study compared existing water use data in WV to identify strengths and limitations of current water resource accounting practices with recommendations on how to improve water security. It determined the LQU water use dataset made up 73% of all USGS annual report water use, implying it does a good job of representing large-scale water users in WV. Overall, the greatest differences between the USGS and LQU datasets came from the Thermoelectric and Agriculture water use sectors, with 31% and 29.9%, respectively. Due to the lack of mandatory reporting from aquaculture, agriculture, irrigation, livestock, and poultry water use sectors under LQU, the million gallons/year shown in the LQU dataset are only estimated from the voluntarily reported data and are not representative of the actual total water use of these agricultural water uses for the state. Insight into water use below 300,000 gallons, including domestic water supply estimates would also benefit LQU data. Water Use will continue to consider these improvement suggestions in better understanding contemporary water use to support the development of sustainable management of water resources for both quantity and quality. The second study identified WV as a vital headwater state in the Gulf of Mexico drainage basin from the Ohio and Mississippi Rivers as well as to the Potomac River. It included a community-scale water tower model of the Potomac River basin that showed the impact of hinterland high-elevation forested land cover on the Washington DC metropolitan area source water which provides spatial insight as to where land conservation and restoration may want to be considered in the future.

Act Research Continues

In October 2023, USGS started a new 2.25 year project with cooperative match to better estimate groundwater and surface water withdrawals and water use in the northern Shenandoah Valley. The project will collect and compile existing reported water use information as well as develop methods to estimate water use with emphasis on rural residential/domestic self-supply and agriculture, building upon some of the WVU 2023 report recommendations, which is a preliminary step towards producing a water budget and predictive groundwater model. As of fall 2024, Water Use is also in discussion with USGS on another cooperative match, two year project proposal to delineate statewide surface water budgets for the major river basins in WV, which will also support future groundwater modeling efforts.

Water Stress and Critical Planning Areas

The Water Resources Protection and Management Act directs WVDEP to "establish criteria for designation of critical water planning areas comprising any significant hydrologic unit where existing or future demands exceed or threaten to exceed the safe yield of available water resources." Overall water quantity is a current national priority with continued research opportunities to support water preservation through the application of sound science in future policy decisions. Water Use will continue to work with partners on local projects and studies to improve our understanding of water stress throughout the state and, if needed, support the designation of critical planning areas. It is important to use data to spatially inform where water use could potentially expand and/or it should be curtailed to minimize negative impacts for the benefit of state residents while protecting the water

resources. Responsible water resources management by nature will be required to evolve with the dynamics of availability and use.

Online Water Resources Information

In cooperation with WVDEP's Technical Applications and GIS Unit (TAGIS) group, Water Use maintains a suite of internet-based tools that display water resources management data in online Geographic Information Systems (GIS). The Water Resources Management Mapping Tool acts as a clearinghouse for all manner of data relevant to water management, including LQU withdrawals, watershed delineations, karst, monitoring wells, springs, mine pools, NPDES, geology, and more. The tool is available at http://tagis.dep.wv.gov/WVWaterPlan/. TAGIS and Water Use also maintain a 2009 Water Withdrawal Guidance Tool available at https://tagis.dep.wv.gov/wwts/ to help direct potential water withdrawals towards only those surface waters with sufficient flow. It helps individuals know when it is environmentally safe to withdraw water from a stream based on summer base flow for a period of record which should afford appropriate flow to protect aquatic habitat.

Water Use continues to utilize available national resources. The USGS Groundwater and Streamflow Information Program also recently updated their internet interface to better share their surface and groundwater gaging and monitoring network data to support improved water resources management statewide. There is also potential to develop more helpful applications upon request. For example and without WVDEP request or funding, USGS most recently provided a 2023 report and tool based on WV Public Water System Drought Risk at https://www.usgs.gov/tools/interactive-map-west-virginia-public-water-system-drought-risk, which is a publicly available, near real-time drought-awareness web tool created to compare the estimated withdrawal rate for 109 PWS to forecast streamflows from the National Water Model to support decision-making for emergency and water managers. Similarly, the USGS provided the Virginia and WV Groundwater Levels and Trends tool (https://rconnect.usgs.gov/vawv-groundwater/). The 2019 USGS Northeast Region Drought Streamflow Probabilities tool (https://vawv-gis.usgs.gov/webapps/drought-ne/) allows users to explore drought probabilities for select streams five to 11 months in advance. USGS WaterWatch has multiple existing real time user friendly applications for current streamflow, flood, drought, past flow and animation. They also have an Archive of Streamflow Maps and a Streamflow Map Animation for the US applications. The State Dashboard application shows all available data in an extremely user-friendly format (https://waterwatch.usgs.gov/index.php?st=wv&id=wwsa4state&full=1&ct=wwsa4state). StreamStats v4.17.0 (https://streamstats.usgs.gov/ss/) provides access to an assortment of GIS analytical tools that are useful for water-resources planning and management, and for engineering and design purposes. The explanation and metadata provided throughout these web applications is also thorough.

Water Resources: Plans and Priorities

Water Use is developing future projects and plans to support our continued efforts to improve water resources management, data collection, and analysis consistent with the Water Resources Protection and Management Act. Water Use continues to discuss with the USGS and other research entities on a variety of potential proposals to enhance water quantity data and use. All current projects are also encouraged to include recommendations for future pursuits within their findings.

Upgrade Data Entry and Management

Water Use continues to collaborate with other groups within WVDEP's Division of Water and Waste Management (DWWM) and the WV Business Technology Office to develop new data entry and data management programs. Feedback on the current ESS remains mixed and data entry error rates for LQU approaches 40%. A system with a new interface to improve the user experience, reduce errors, and provide better data analytics is being pursued by Water Use staff. The new system and data migration project is currently in progress and targets to be in production for the 2026 reporting season.

Water Resources Program Needs

Nationally, the USGS stream gaging network is a multipurpose network that comprises more than 10,000 stream gages. The stream gages are primarily operated and maintained by the USGS, but most are funded in partnership with one or more of about 1,800 Federal, State, Tribal, regional, and local partners. This unique cooperation results in nationally consistent and impartial data that also aids local decision making. The shared costs result in the operation of far more stream gages than would be possible if financed solely by USGS appropriations. These partnerships also enable fixed costs (such as costs associated with data storage and delivery infrastructure) to be broadly distributed, resulting in more economical stream-gaging information for all. It encompasses several smaller networks that produce specific information or support specific needs. The data are quality assured and served online-most in near real time-to meet many diverse needs. Data users include emergency responders, water managers, environmental and transportation agencies, universities, utilities, recreational enthusiasts, and consulting firms. Specific uses of the data include the following:

- planning, forecasting, and warning about floods and droughts;
- managing water rights and transboundary water issues;
- operating waterways for power production and navigation;
- monitoring environmental conditions to protect aquatic habitats;
- describing impacts to streamflow from changing land and water uses;
- assessing water quality and regulating pollutant discharges;
- determining if streams are safe for recreational activities; and,
- designing reservoirs, roads, bridges, drinking water and wastewater facilities.

Locally, Water Use is deeply reliant upon these federal resources. Water Use uses stream gauges to generate thresholds for water management plans under the Horizontal Well Control Act. Similarly, the Water Withdrawal Guidance Tool fetches data from the stream gauge servers to provide recommendations for withdrawals across the state. Water Use has other requirements under the Water Resources Protection and Management Act, including a surface water inventory, estimating safe yield/water budget, identifying potential problems with water availability, monitoring detrimental low-flow conditions, and assessing/projecting public water supply capabilities. Many of these duties are heavily dependent, if not entirely contingent, upon the stream gauge and groundwater level monitoring network for understanding the supply of water throughout WV.

Water Use respectfully requests the continued support from the Legislature and all concerned state agencies regarding funding and cost-sharing solutions for the 183 stream gauges and 19 groundwater level monitoring wells in the local network managed by the USGS (Figure 15). Like in other states, the

WV streamgage network primary funding partners are: WV; US Army Corps of Engineers; USGS; and, Energy and water companies. Following the June 2016 floods, network partners worked with the *Joint Legislative Committee on Flooding* to expand the network by 39 monitoring locations, improve operational efficiency and information access, and stabilize funding through a line item in the annual state budget administered through the WV Emergency Management Division. Prior to the line item, multiple state and federal agencies had to individually determine each year how to financially support key resources for their daily work which was inefficient and unstable.

Although the total network costs for 2024 are about $2.5 million, the operational cost for the network shared by multiple funding partners continues to change over time. In 2020 and 2021, the WV line-item portion was $800,000. Although able to operate within the FY2022 budget of $820,000, a funding partner loss and increase to overall costs due to pandemic resulted in the state FY2023 cost being $891,780. WVDEP paid the additional $71,780 difference to prevent any local gages from being discontinued and ensure continuity of data. Where the current state FY2024 budget remained at $820,000 again, there was another shortfall of $118,000 which was funded through individual agreements with state agency participants (WVDEP, West Virginia Department of Transportation Division of Highways, Department of Health, Division of Natural Resources, and Conservation Agency) to again prevent a reduction in network activities that would jeopardize data quality and continuity. We have learned it is important at the state level to build in periodic small cost increases since funding partners share operational costs for the network through the line item commitment. Over the past couple years there has been approximately a 3% annual increase to maintain the existing network. Another complication is although the other funding partners' cumulative costs have increased to $1,033,550 the USGS portion mandated by Congress has remained static at $575,230 since 2023. The anticipated costs for the state share for FY2025 are $965,000. The WV Stream Gaging Council will continue to communicate priorities and plan the state budget appropriately as it has since 2005. The recent total funding history is as follows:

Table 4. WV Stream Gaging Network Cost.

Fiscal Year	WV	USGS	Other	Total Annual Funding
2020	$800,000	$560,234	$827,730	$2,187,964
2021	$800,000	$561,765	$846,740	$2,208,505
2022	$820,000	$562,800	$892,880	$2,275,680
2023	$891,780	$575,230	$952,090	$2,419,100
2024	$938,000	$575,230	$984,333	$2,497,563
2025	$965,000	$575,230	$1,033,550	$2,573,780
2026	*~$990,000*	*$575,230*	*~$1,085,227*	*~$2,650,457*

The Water Use along with other WVDEP program staff continue to participate in the quarterly WV Gaging Council meetings to support continued cooperation and prioritization of statewide water resources data maintenance and development where possible.

Water Use Staff

Dawn Newell
Environmental Resources Program Manager 2
Water Quality Standards, 401 Certification and Water Use
Dawn.A.Newell@wv.gov

Emiko Hori
Environmental Resources Specialist 3
Water Use
Emiko.Hori@wv.gov

Blaine Barringer
Environmental Resources Analyst
Water Use
Gabriel.B.Barringer@wv.gov

Mary DeWees
Environmental Resources Associate
Water Quality Standards, 401 Certification and Water Use
Mary.A.DeWees@wv.gov

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McAdoo, M.A., Connock, G.T., and Kozar, M.D., 2023, Groundwater quality in abandoned underground coal mine aquifers across West Virginia: U.S. Geological Survey Scientific Investigations Report 2023–5091, 31 p., https://doi.org/10.3133/sir20235091.

Figures

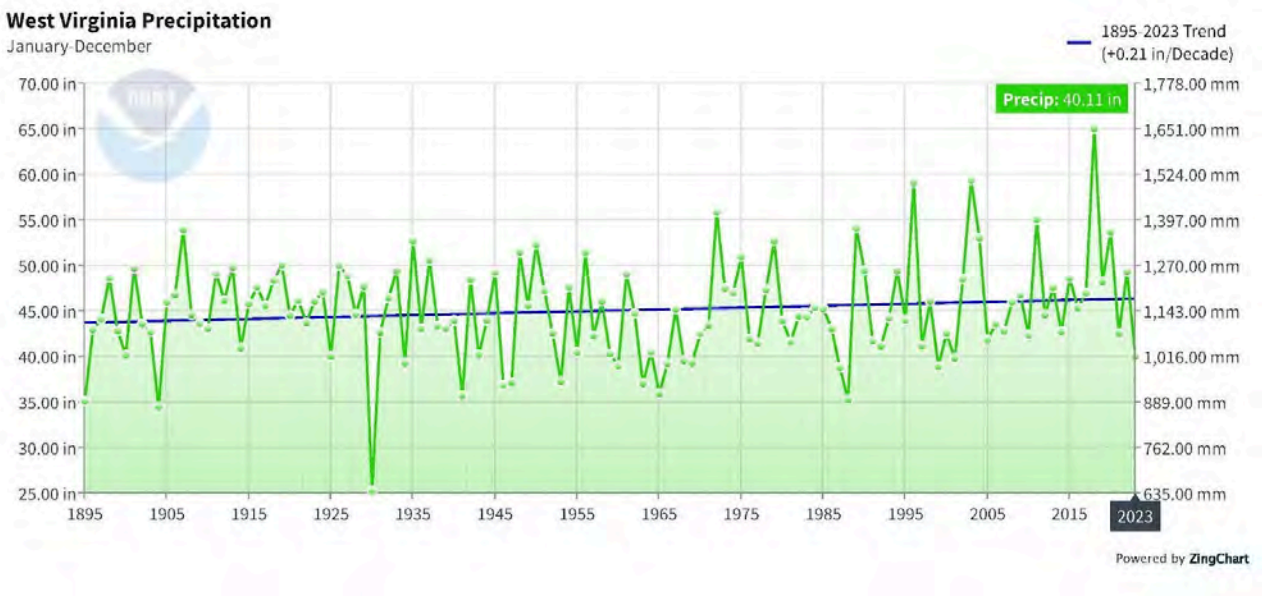

Figure 1. WV's annual precipitation from 1895 – 2023 (from National Oceanic and Atmospheric Administration).

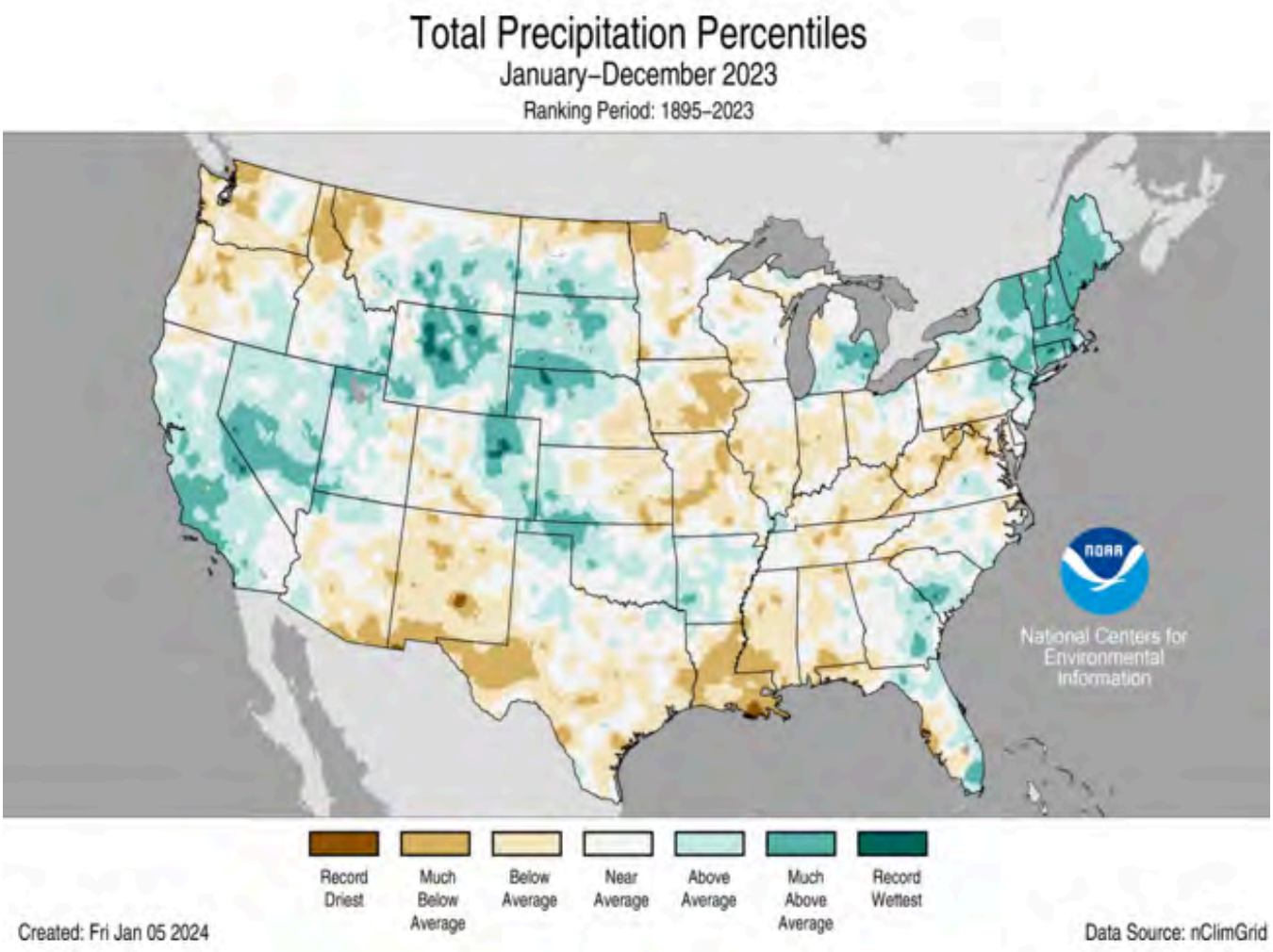

Figure 2. 2023 Total Precipitation Percentiles (from National Centers for Environmental Information).

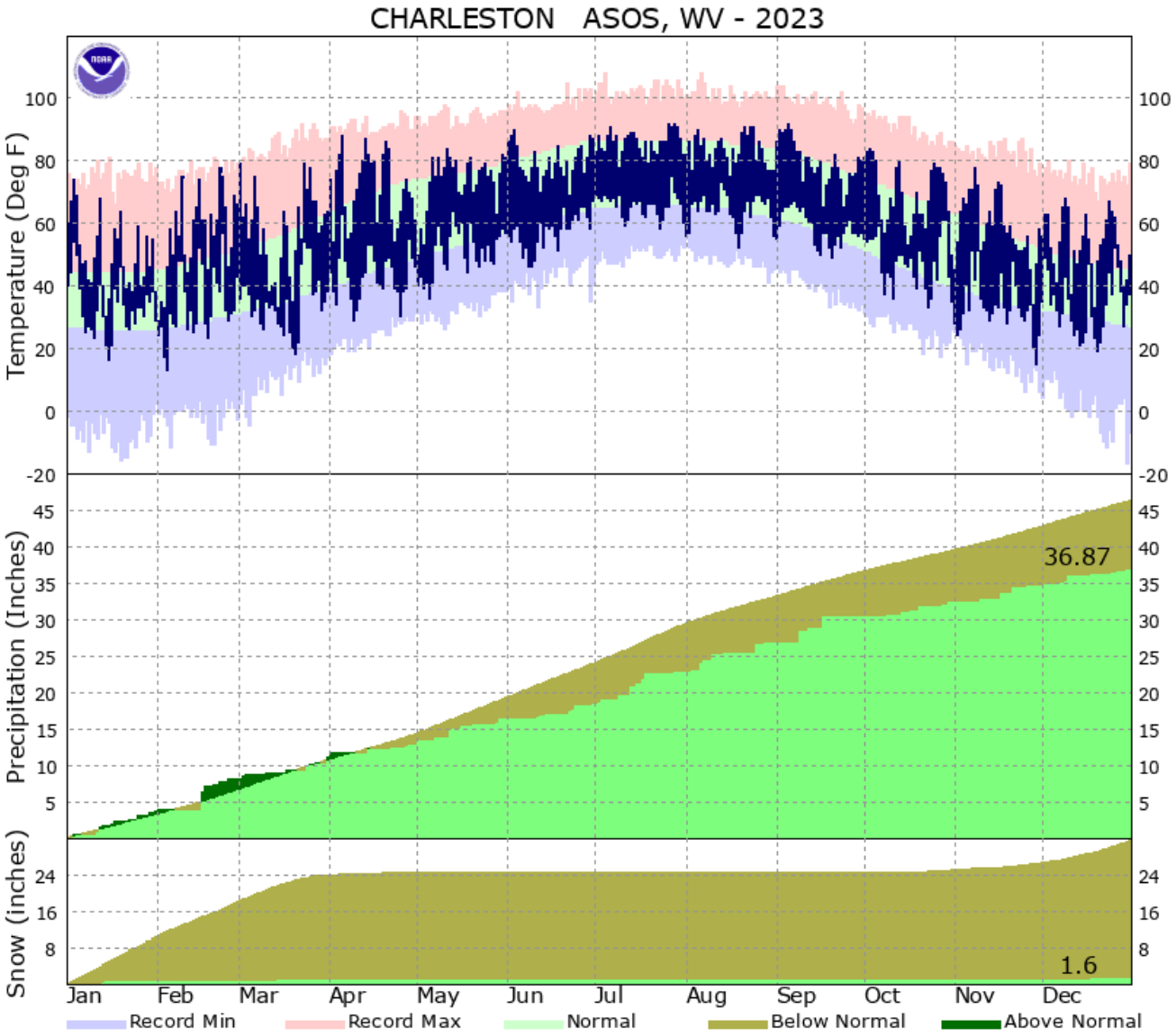

Figure 3. Climate data for Charleston, WV from January - December 2023 (from National Weather Service).

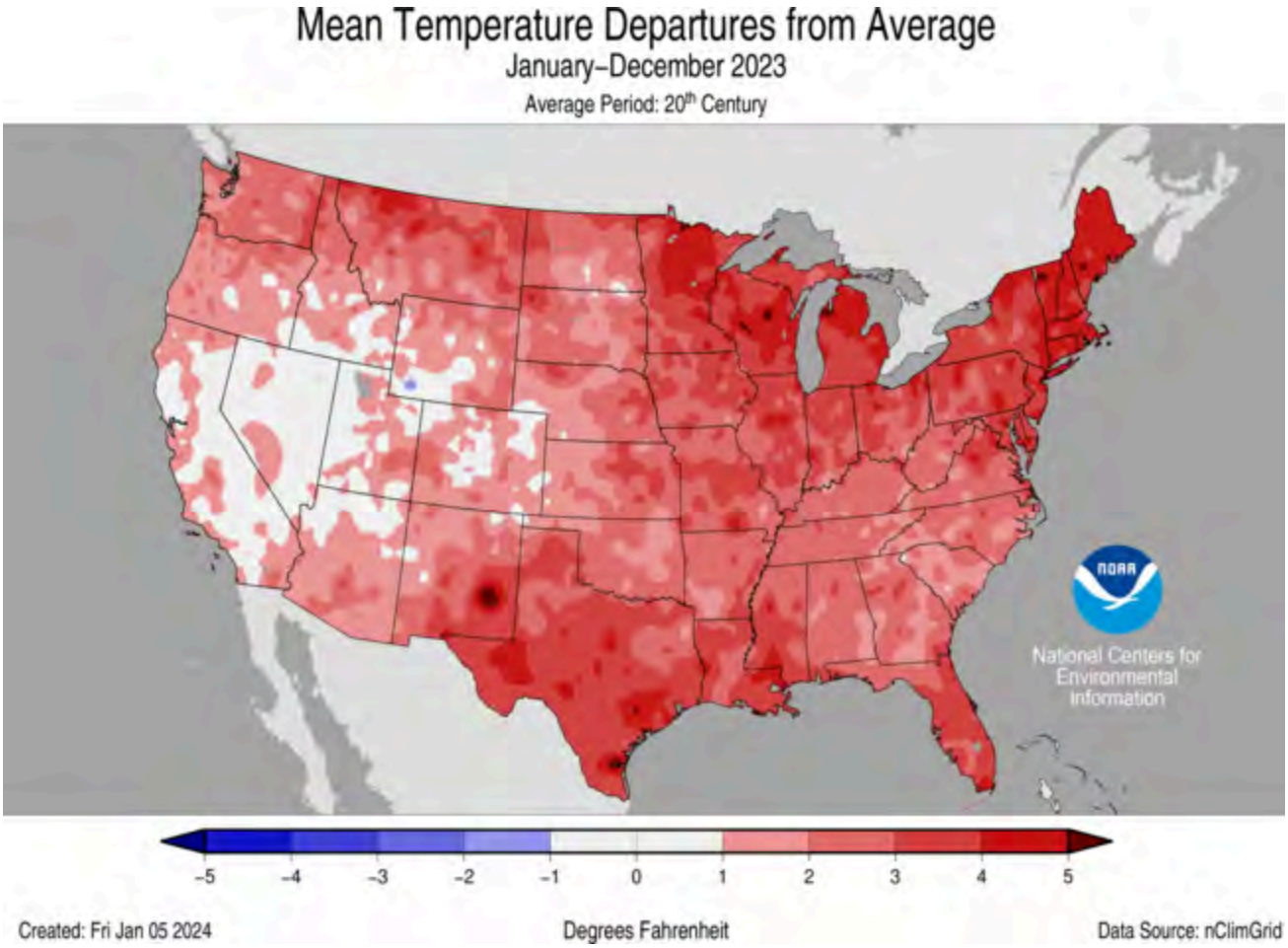

Figure 4. Mean temperature departures from average (from National Centers for Environmental Information National Oceanic and Atmospheric Administration).

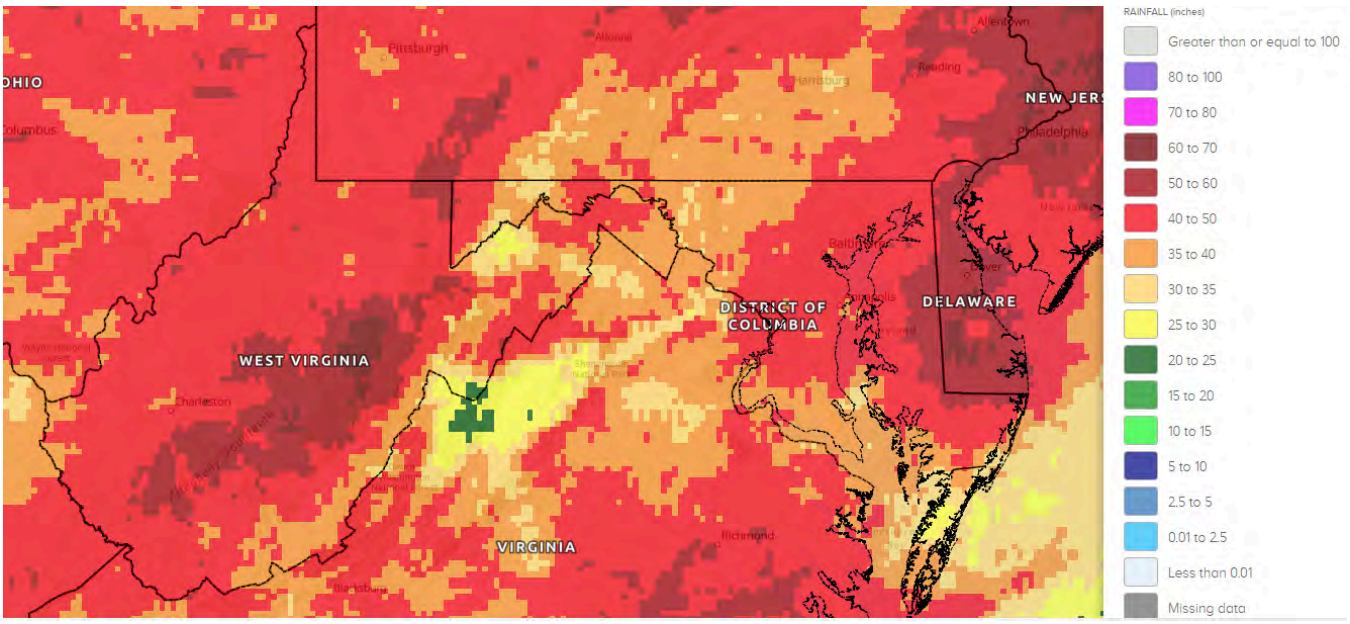

Figure 5. Observed 2023 precipitation (from National Weather Service).

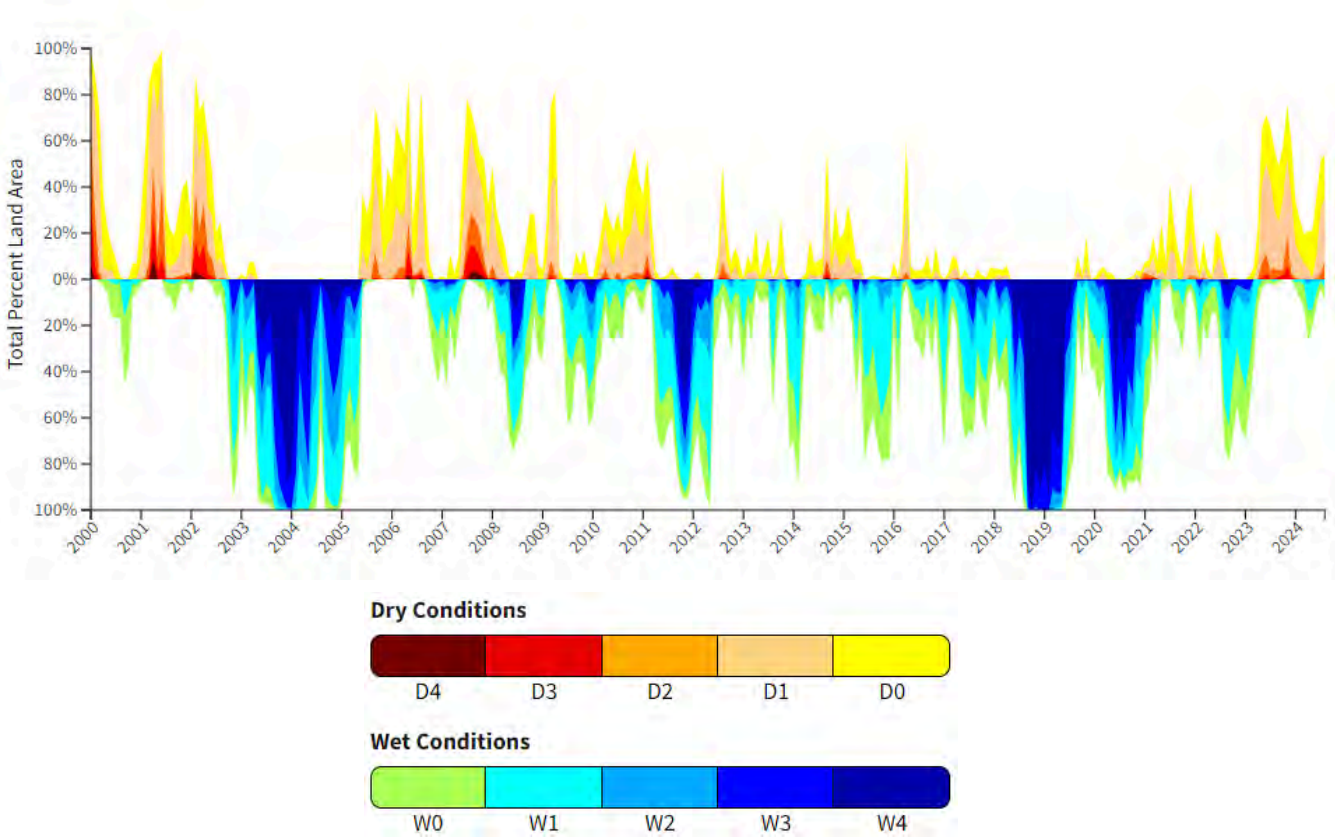

Figure 6. Drought conditions in WV since 2000 (from US Drought Monitor).

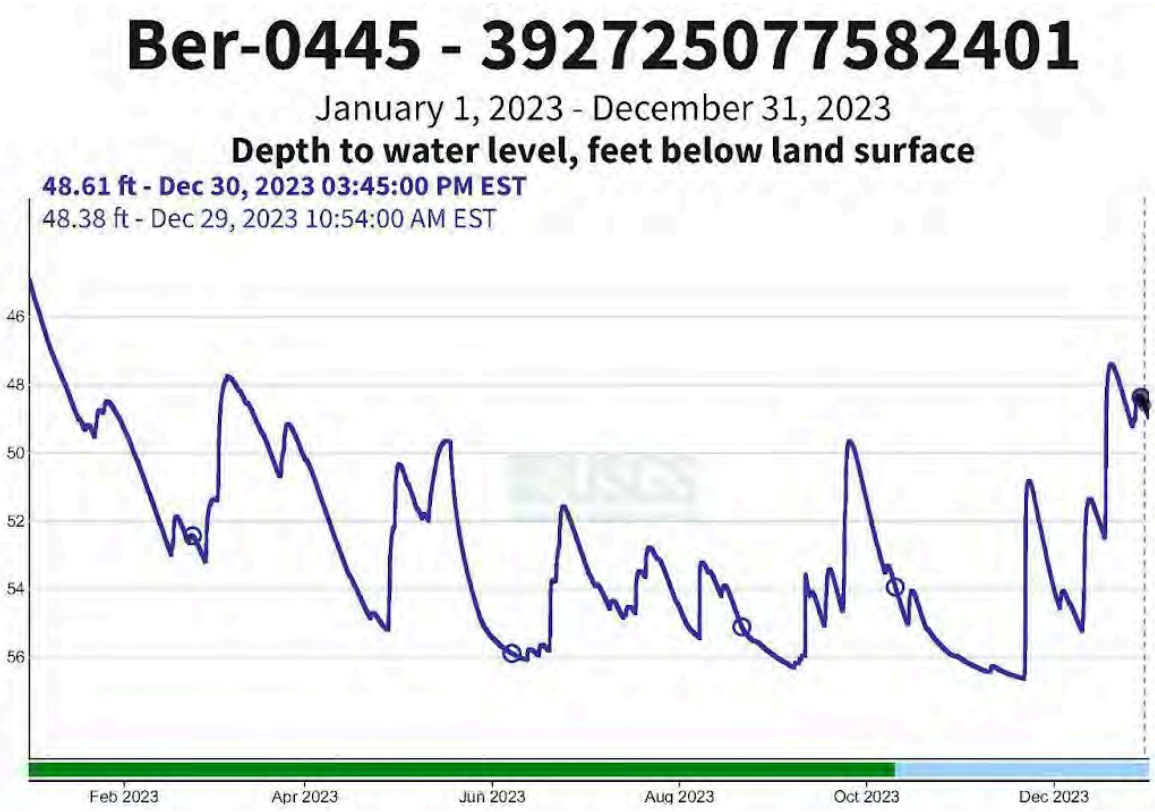

Figure 7a. Groundwater levels 2023 in Martinsburg, WV (from USGS).

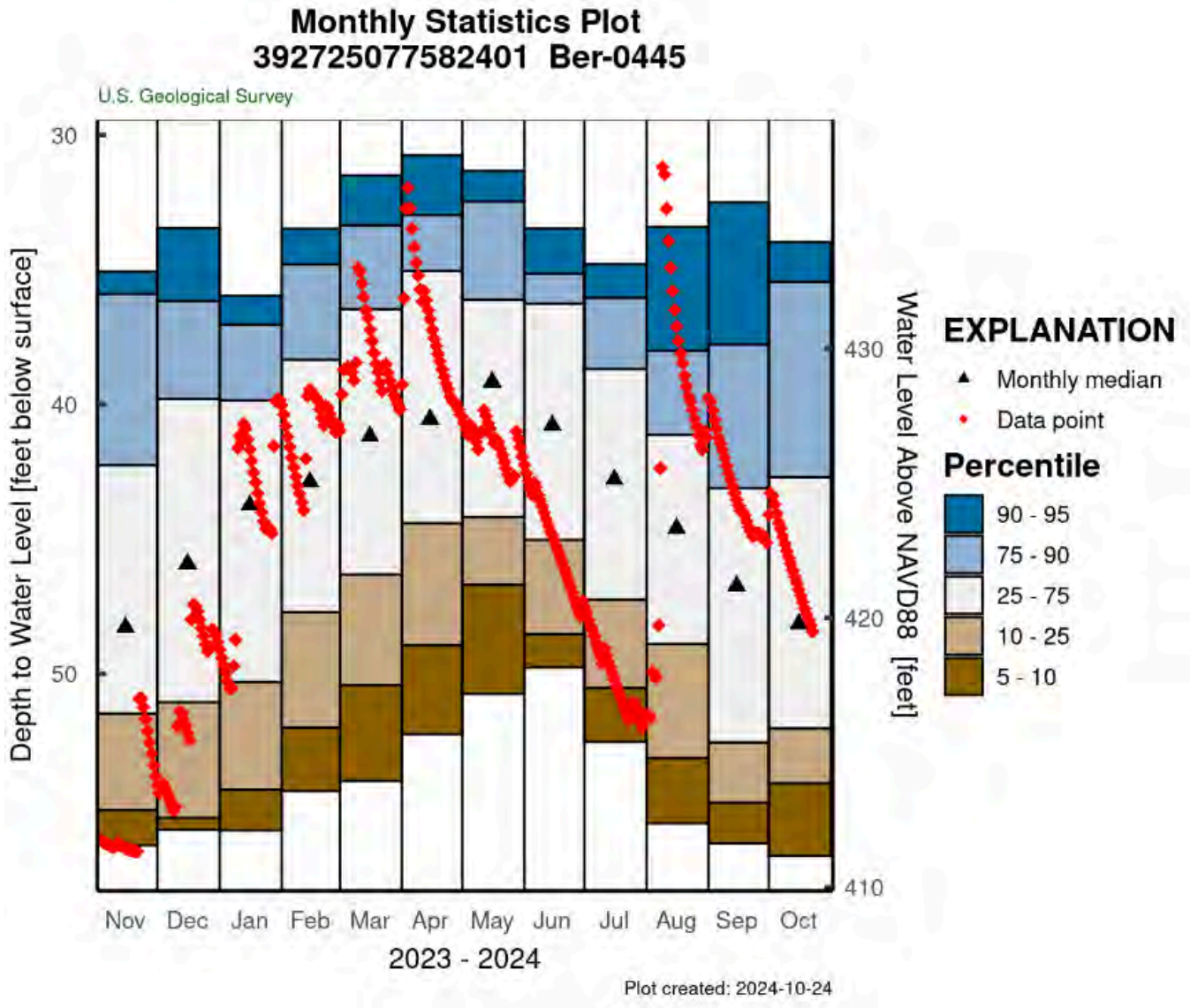

Figure 7b. Recent groundwater level statistics (from USGS).

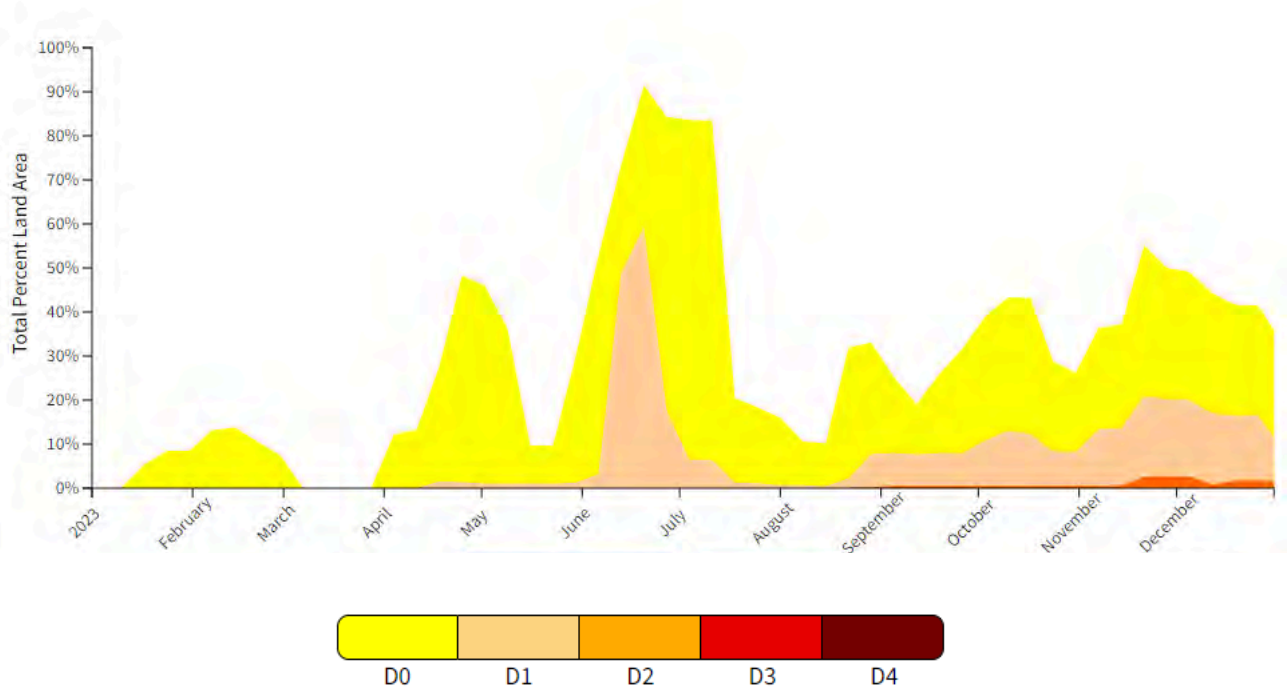

Figure 8a. Drought conditions in WV in 2023 (from US Drought Monitor).

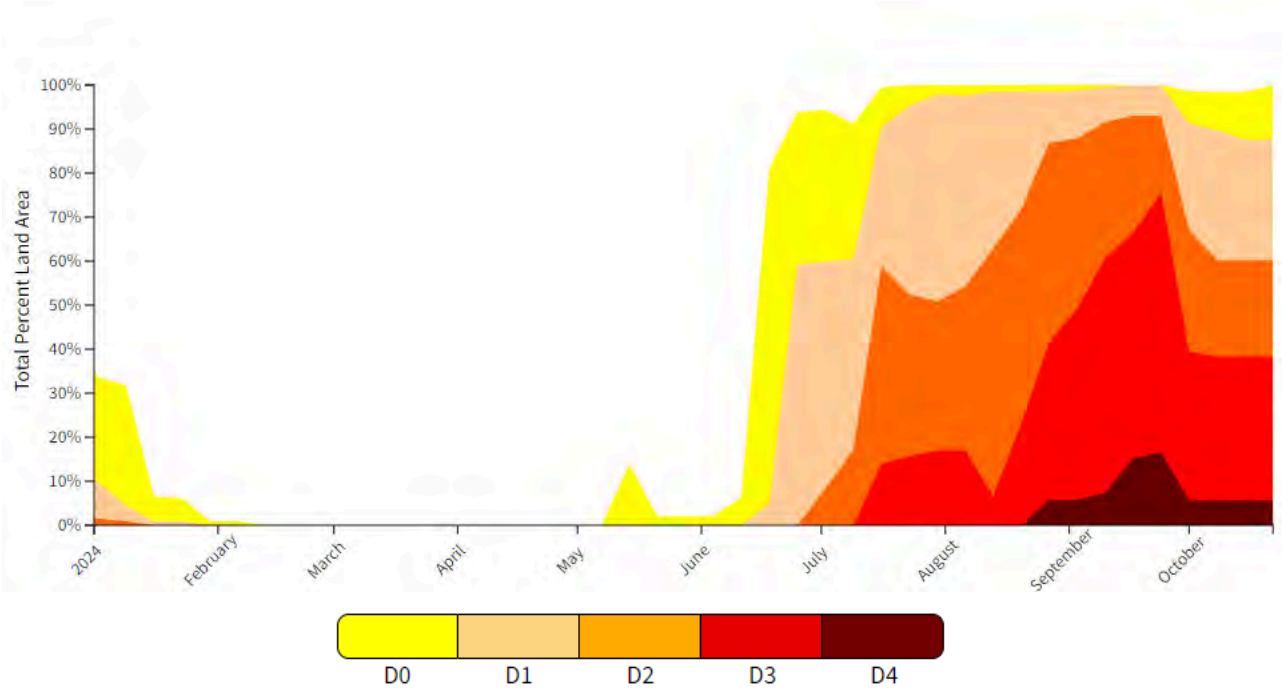

Figure 8b. Drought conditions in WV in 2024 (from US Drought Monitor).

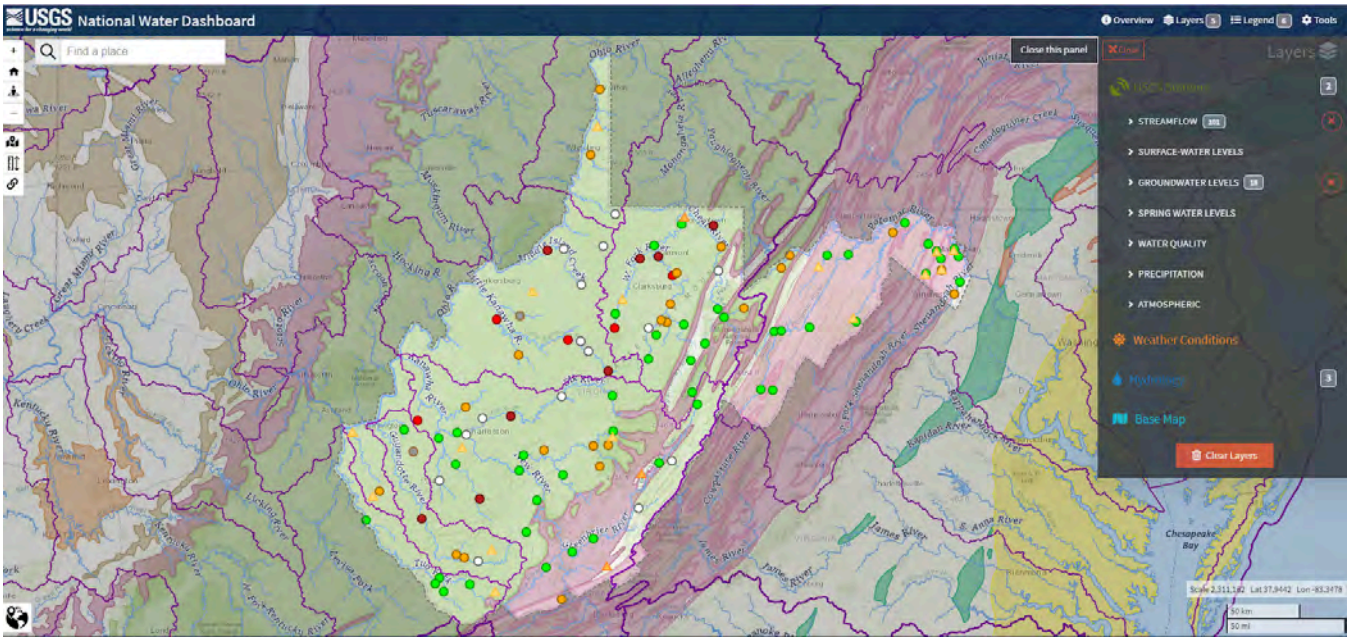

Figure 9. National Water Dashboard (from USGS).

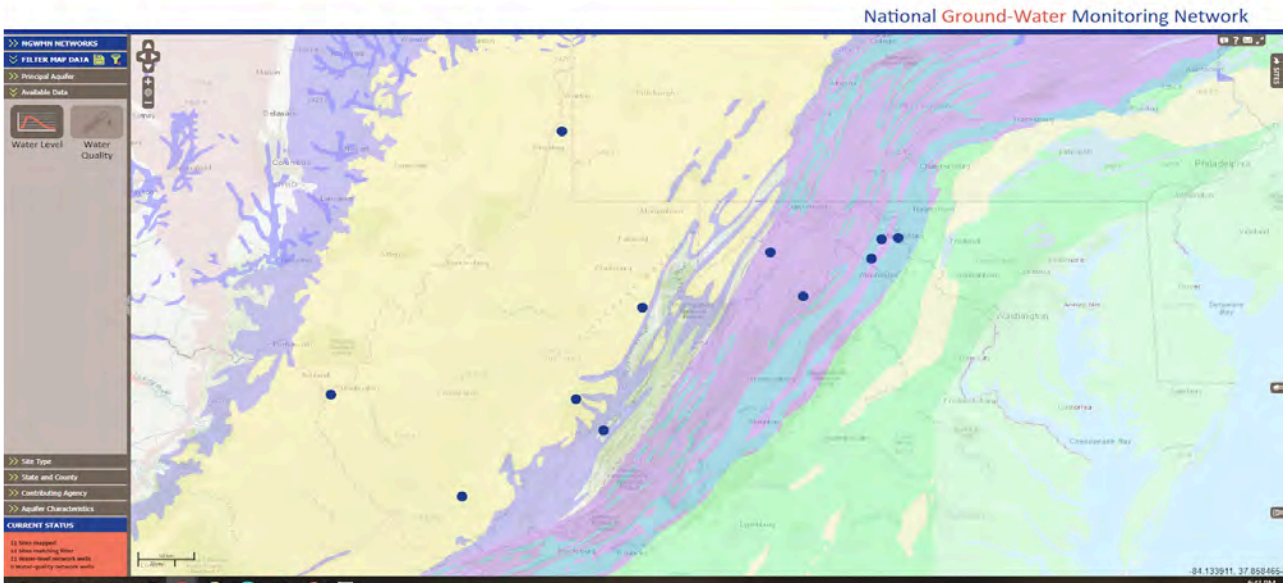

Figure 10. Groundwater use is concentrated in the alluvium along the Ohio River, southern coalfields, and karst aquifer systems of eastern WV (from the National Ground-Water Monitoring Network).

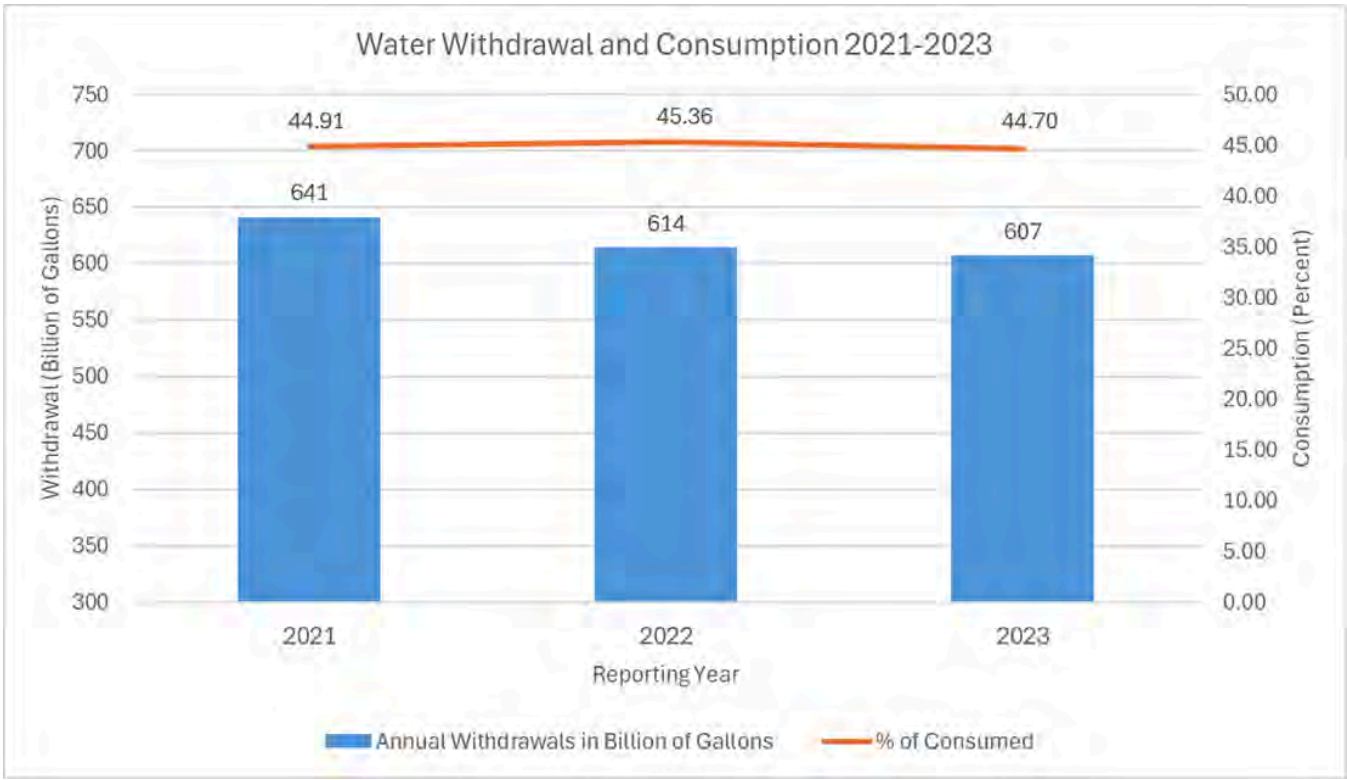

Figure 11. Water withdrawal and consumption 2021-2023.

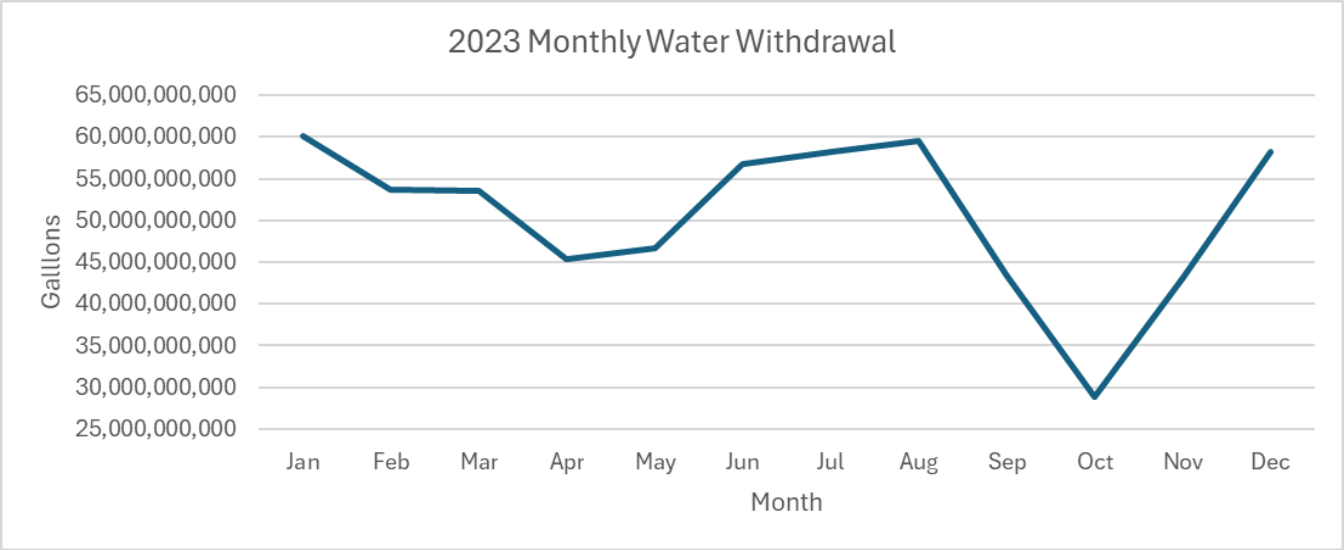

Figure 12. 2023 Monthly trends in total withdrawal from the LQU database (WVDEP).

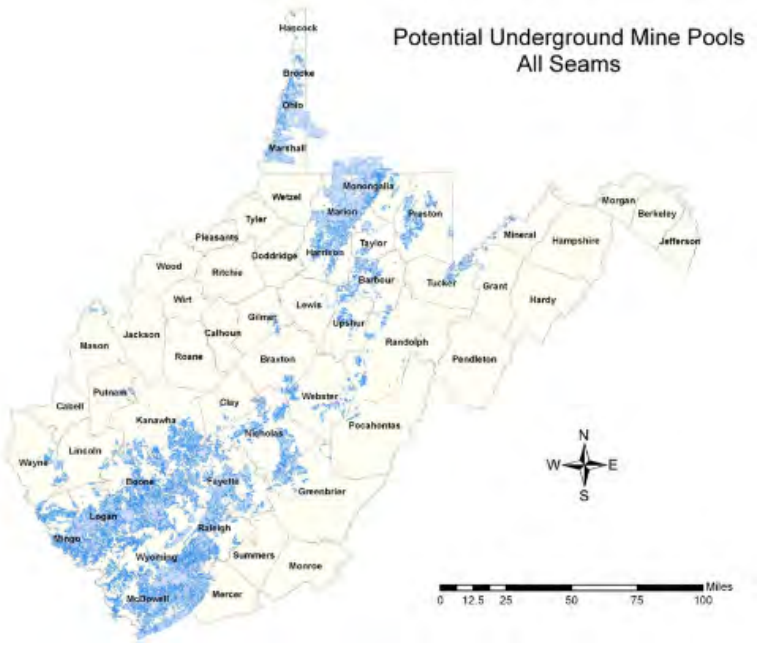

Figure 13. Estimated extent of Abandoned Underground Coal Mine Aquifers (WVGES & WVDEP).

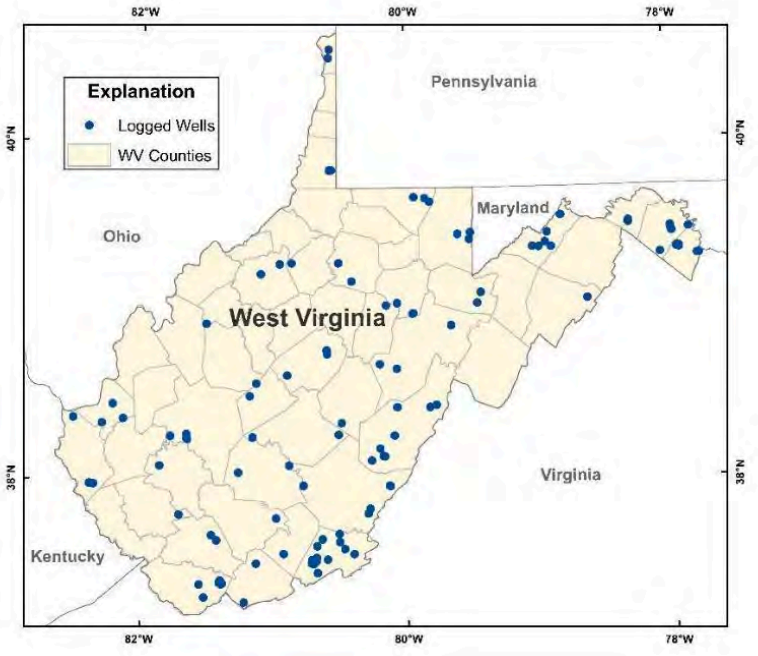

Figure 14. Location of USGS-WVDEP borehole geophysics well logs 2015-2019 (USGS).

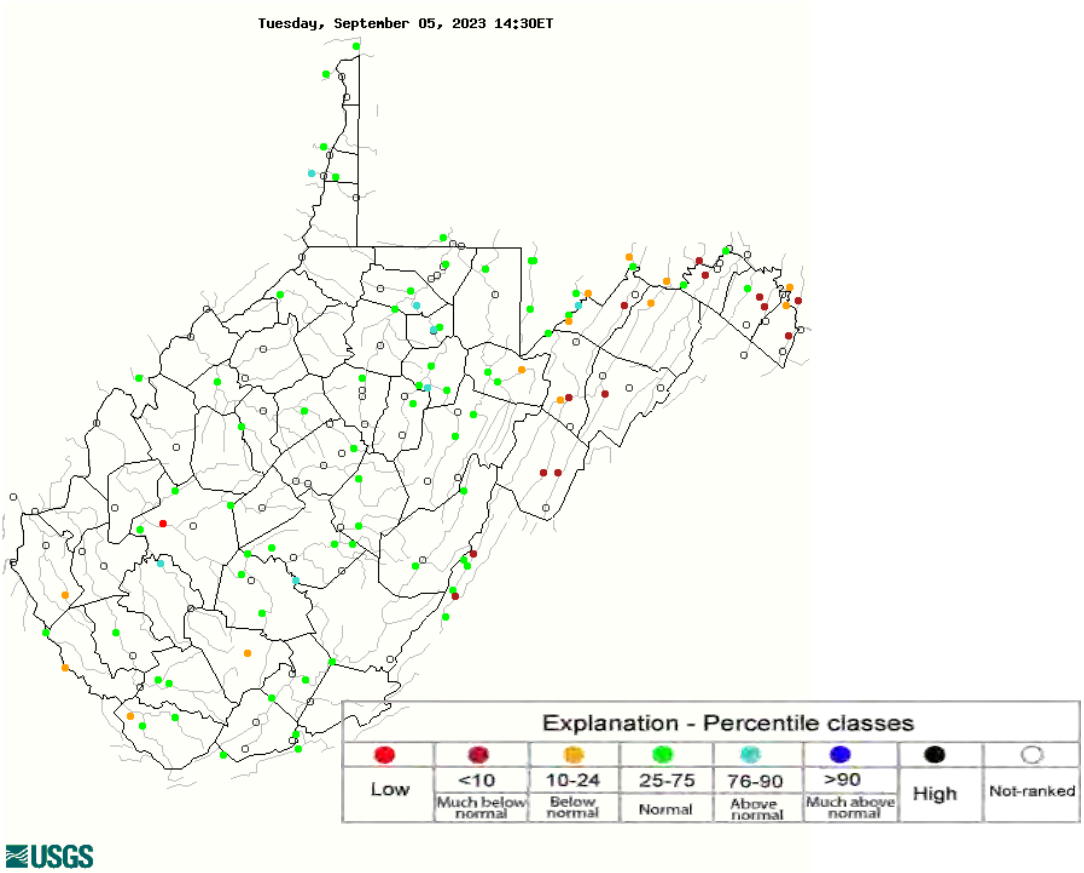

Figure 15. The stream gauge network in WV (from USGS).