



west virginia department of environmental protection



2020 Annual Water Resources Report

Joint Legislative Oversight Commission on State Water Resources
November 2020

Prepared by the
West Virginia Department of Environmental Protection
Division of Water and Waste Management
Water Use Program

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Water Resources Protection and Management Overview

The Water Resources Protection and Management Act (W.V. Code §22-26) was passed into law in 2004. The Act recognized the need to protect and conserve the water resources of the state and directed the West Virginia Department of Environmental Protection (WVDEP) to develop a State Water Resources Management Plan. WVDEP formed the Water Use Section to initiate a comprehensive review of the state's waters resources. The State Water Resources Management Plan was published in 2013 and adopted by the Legislature in 2014. The Water Use Section has continued 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. This annual report is submitted to the Joint Legislative Oversight Commission on State Water Resources in accordance with W.V. Code §22-26-8(e).

2019 – 2020 Water Resources Availability

After a record-breaking year of precipitation in 2018, annual precipitation was back into West Virginia's normal range during 2019. Going back to the late 19th century, average annual rainfall in West Virginia has been between 44 and 46 inches. In 2018 West Virginia experienced 65 inches of rain, but 2019 found West Virginia back near the average of 48 inches annual precipitation (Figure 1). Precipitation was greatest in the high mountains west of the continental divide and lowest in the rain shadow from those same mountains, occurring in the Eastern Panhandle (Figure 2). Precipitation thru November 2020 has been above average, and higher than that of 2019 (Figure 3). Groundwater recharge is typically between 15-18% of annual precipitation. As a result of extreme 2018 precipitation, groundwater levels throughout much of the state were also at record levels by the latter part of that year. Groundwater levels in 2019 slowly returned to average range but have remained below average throughout 2020 (Figure 4).

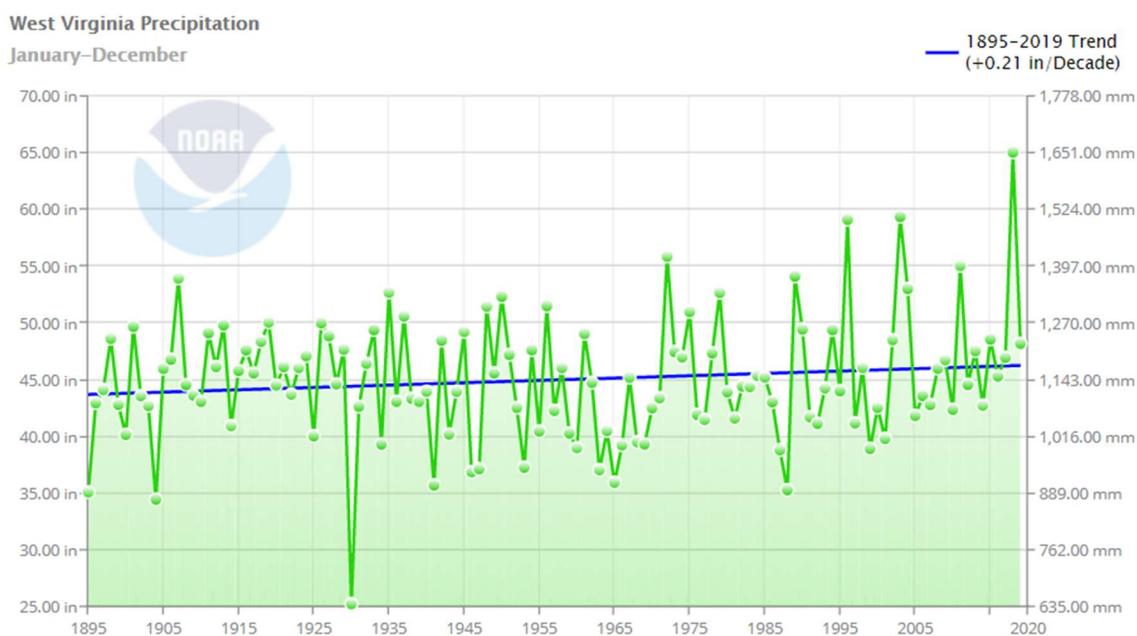


Figure 1. West Virginia's annual precipitation from 1895 – 2019. (from NOAA).

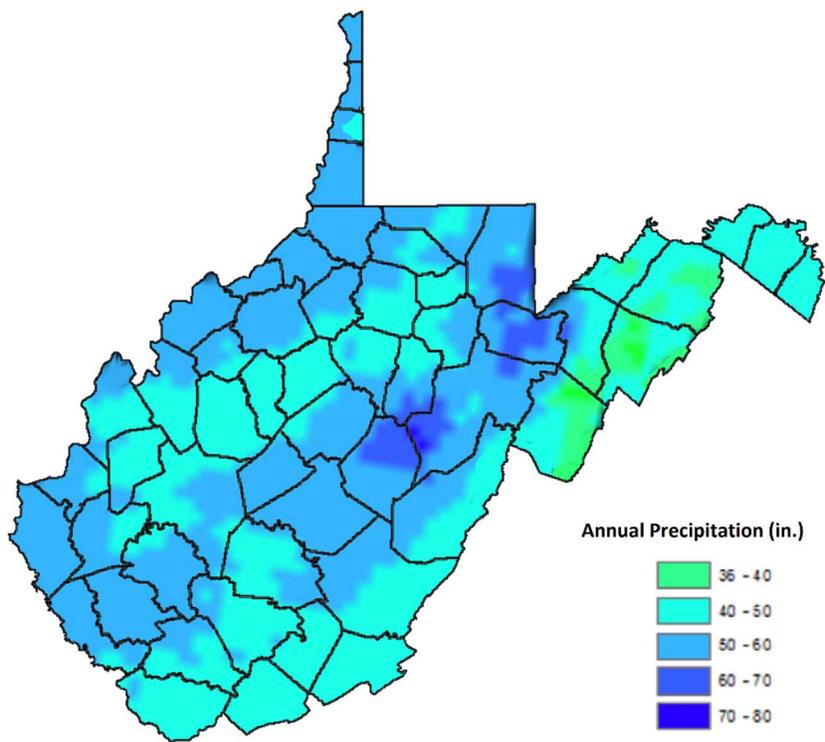


Figure 2. Total 2019 precipitation (Oregon State PRISM).

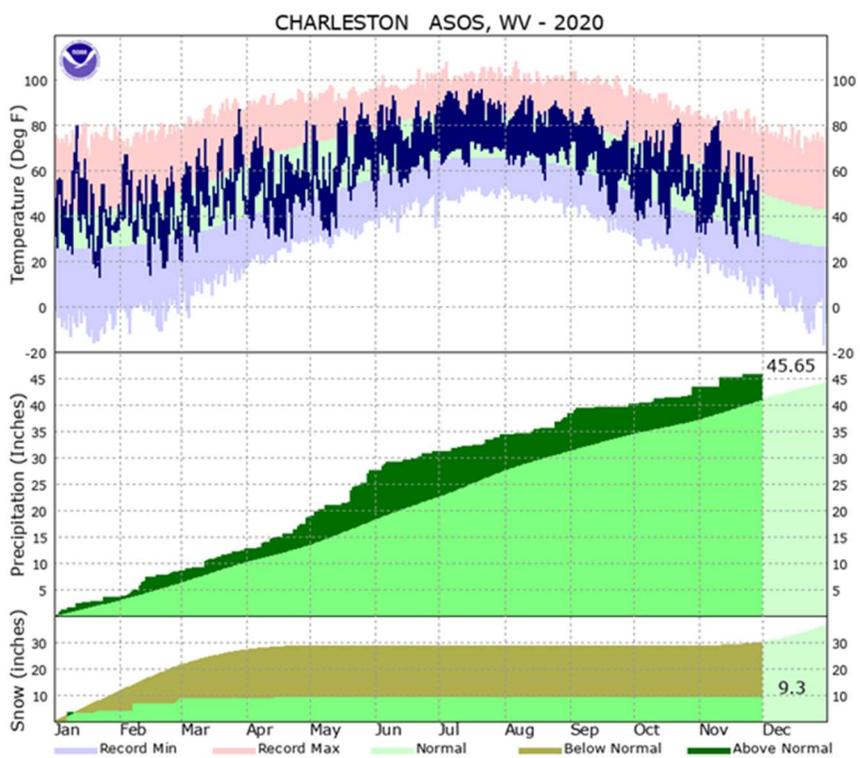


Figure 3. Climate data for Charleston, WV from January – November 2020 (NOAA).

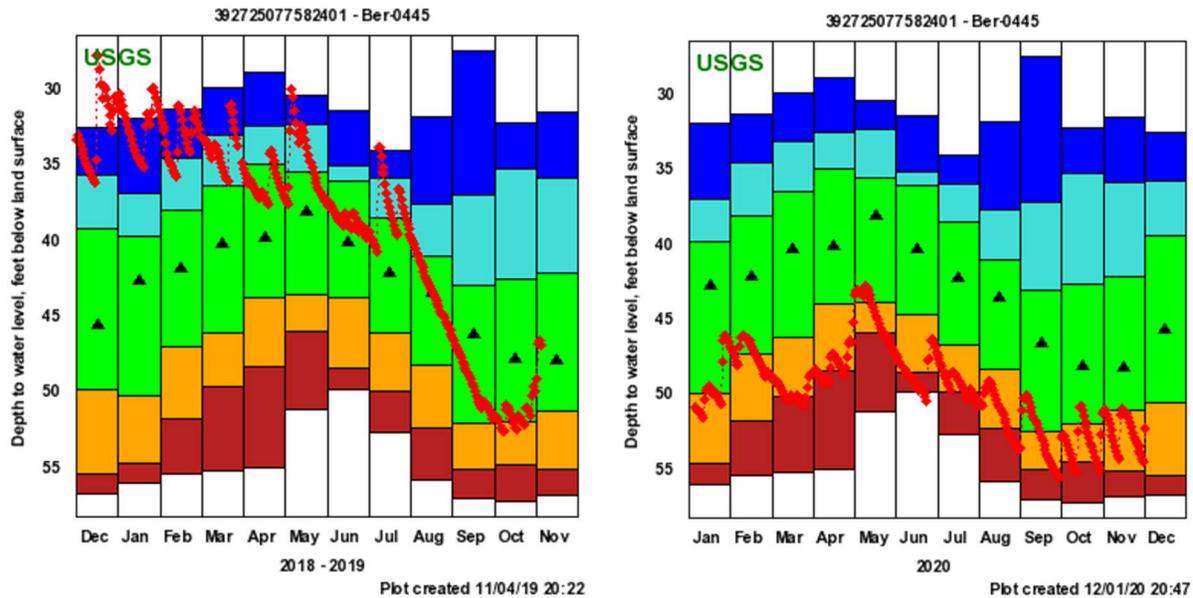


Figure 4. Groundwater levels Dec 2018 – Nov 2019 & Jan 2019 – Nov 2020 in Martinsburg, WV (USGS).

Despite generally average conditions, there were times during 2019 and 2020 (to date) that West Virginia experienced abnormally dry and/or moderate drought conditions (Figure 5). Two of these periods occurred during January 2019 and March-April 2020. The largest and longest dry period, during late 2019, impacted 100% of the state, and similarly late 2020 has also had a dry period.

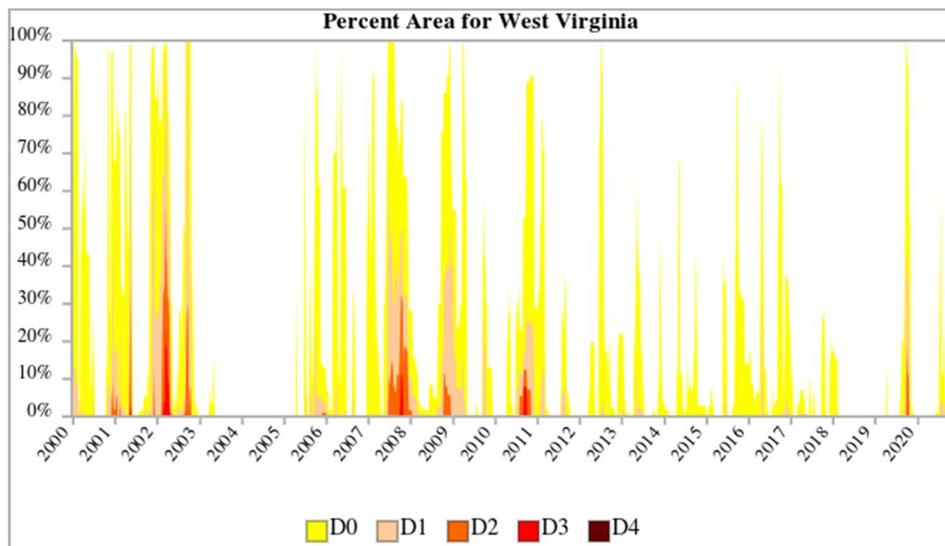


Figure 5. Drought conditions in West Virginia since 2000 (Drought.gov).

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 the Water Use Section. LQU surveys are collected between January 1 and March 31 of the year following water withdrawal; we will receive 2020 reports beginning January 1, 2021. The Section has been collecting LQU information since 2006 and monitoring trends in water use. We share water withdrawal data with research partners including state universities and the U.S. Geological Survey.

The LQU data represents our best insight into water use throughout West Virginia but is by no means definitive. The Water Use Section 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. The Water Use Section conducts limited audits and field visits to verify reported information and register new LQUs.

Annual Data & Trends

In 2019, 394 Large Quantity Users reported withdrawing water (Table 1). Total withdraws from West Virginia water resources continues to decline, driven primarily by the decrease (-12.9%) in water used by thermoelectric operations, the largest water use sector overall – excluding hydroelectric. However, the estimate for the annual water withdrawal that is consumed (not returned to the local waterbody) is on the rise, when calculated as a total volume and as a percentage of overall withdrawal. This is likely because many of the water use sectors with the highest estimated consumption ratios – oil & gas operations, public water supply, and industrial water use – have increased their water withdrawal over time.

Groundwater withdrawals have increased slightly from last year, comprising 5.12% of 2019's total water use in West Virginia (Table 2). The public water supply remains the single largest user of groundwater with over 13 billion gallons used, followed by the chemical and mining sectors. Groundwater use is concentrated in the alluvium along the Ohio River, southern coalfields, and karst aquifer systems of eastern WV (Figure 11).

WVDEP Water Use Category	LQUs	2019 Total Gallons WD	% Total WD	% Change from 2018
Agriculture/Aquaculture	14	11,366,372,753	1.75%	54.81%
Chemical	13	133,655,672,743	20.55%	-0.30%
Industrial	22	19,958,107,366	3.07%	34.90%
Mining	72	13,260,094,521	2.04%	-10.13%
Oil & Gas	16	4,548,804,221	0.70%	5.27%
Petroleum	1	301,407,497	0.05%	-0.77%
Public Water Supply	206	68,377,376,711	10.51%	0.70%
Recreation	27	1,170,135,868	0.18%	-7.45%
Thermoelectric	9	396,571,231,051	60.98%	4.73%
Timber	3	1,075,306,386	0.17%	-4.07%
TOTAL	394	650,284,509,117	100.00%	4.12%
Hydroelectric	11	237,066,964,475,109		

Table 1. Total 2019 water withdrawals (WD) from the LQU database (WVDEP).

WVDEP Water Use Category	Surface WD	% SW	Groundwater WD	% GW of total WD
Agriculture/Aquaculture	8,769,467,753	1.42%	2,596,905,000	22.85%
Chemical	124,775,679,099	20.24%	8,879,993,644	6.64%
Industrial	19,241,840,915	3.12%	716,266,451	3.59%
Mining	6,231,168,181	1.01%	7,028,926,340	53.01%
Oil & Gas	4,335,341,088	0.70%	213,463,133	4.69%
Petroleum	522,900	0.00%	300,884,597	99.83%
Public Water Supply	55,160,166,789	8.95%	13,217,209,922	19.33%
Recreation	836,470,279	0.14%	333,665,589	28.52%
Thermoelectric	396,163,369,131	64.25%	407,861,920	0.10%
Timber	1,066,696,474	0.17%	8,609,912	0.80%
TOTAL	616,580,722,609	100.00%	33,703,786,508	5.18%
Hydroelectric	237,066,964,475,109		0	

Table 2. Breakdown of Surface Water (SW) and Groundwater (GW) withdrawals from the 2019 LQU database (WVDEP).

Discussions with local water operators over the last few years have led to the observation that above-average spikes in water use correlate with unseasonably cold winters. The prevailing theory is that this is a result of water loss from burst pipes and leaks during unusually cold months. While January 2018 was abnormally cold, January 2019 was a more typical for West Virginia (Figure 6). However, reported Public Water Supply Withdrawal was up nearly half a billion gallons from 2018, despite the much colder January 2018 temperatures. In 2021, the Water Use section will endeavor to explain rising public water supply use from year to year. It could very well be from water loss but may not be related to burst pipes in cold winter months.

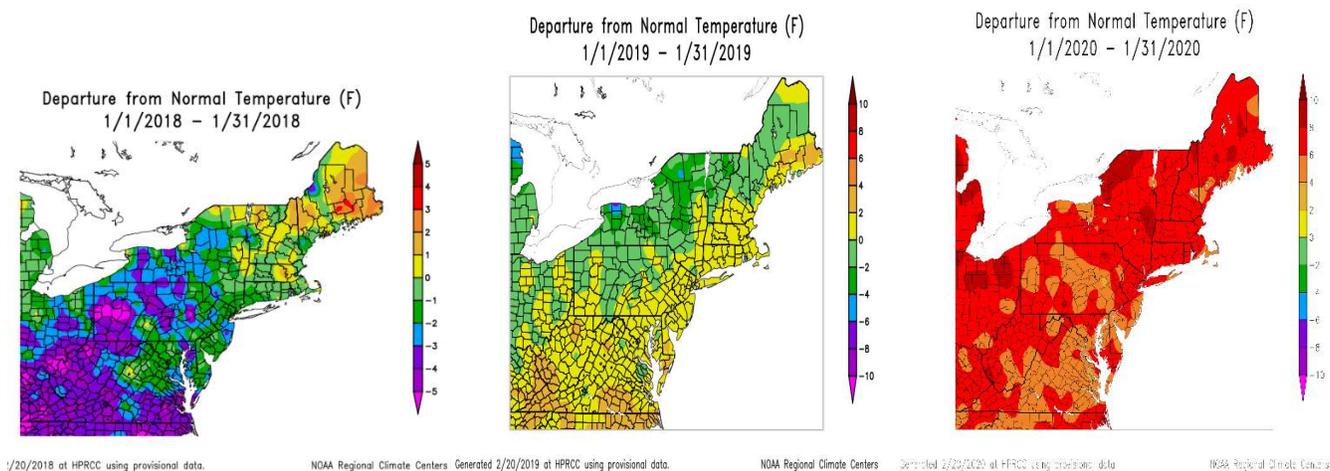


Figure 6. Departure from normal temperatures in West Virginia in January from 2018-2020 (NOAA).

Seasonal Trends

Total monthly water withdrawals are generally highest in the summer and winter. 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. However, of approximately 130 golf courses in WV, only 15 currently report as LQUs. Therefore, the Water Use Section believes that many golf courses may be missing from the current database and will work toward improving reporting rates in 2021. This will likely shift the bulk of recreation water use to the summer months for irrigation.

A majority of the water use sectors have peak withdrawals in late summer and early fall (Figure 7). This season typically coincides with the lowest water levels of the year throughout West Virginia (Figure 8). This seasonal flux in demand for water – and a mismatch with potential supply – highlights a need for further analysis. Previous work by the Water Use Section has shown that on an annual level the state enjoys abundant water resources. However, we now believe that water stress may be possible on smaller spatial or temporal scales. We are pursuing additional research in this area.

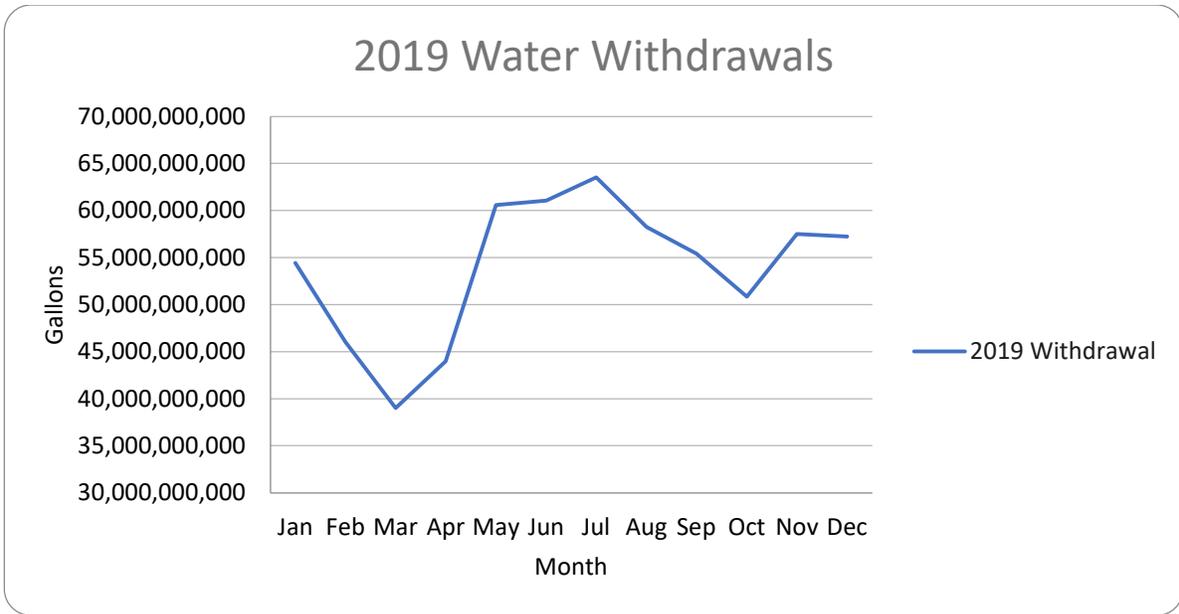
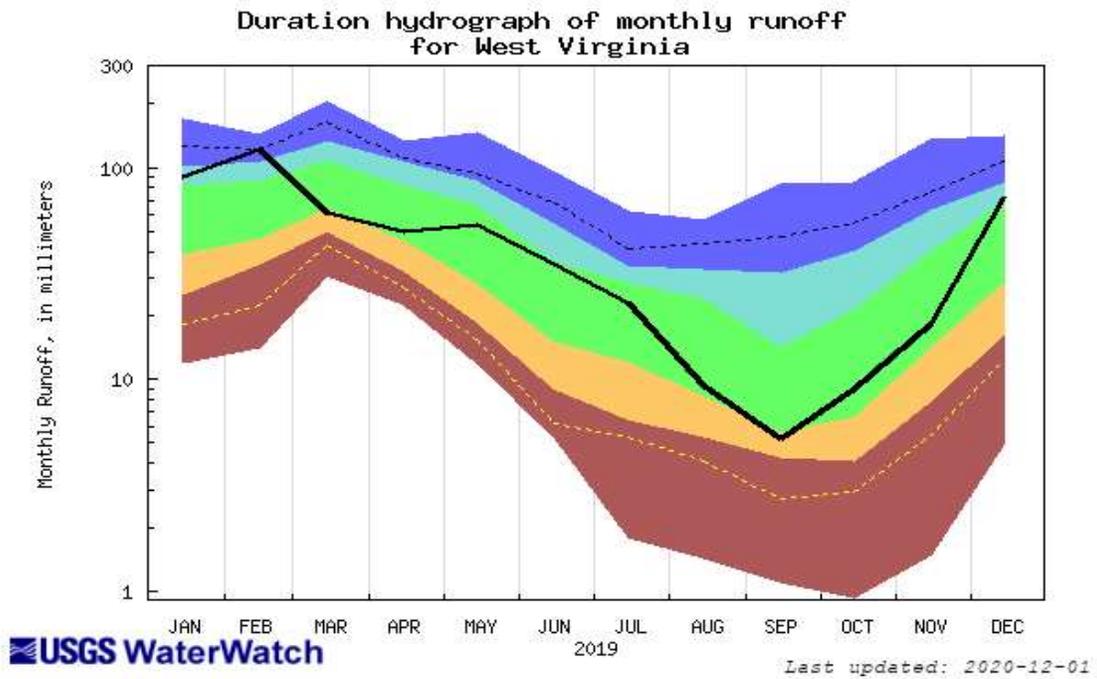


Figure 7. 2019 monthly trends in total withdrawal from the LQU Database (WVDEP).



Explanation - Percentile classes						
lowest-10th percentile	5	10-24	25-75	76-90	95	90th percentile - highest
Much below Normal		Below normal	Normal	Above normal	Much above normal	Runoff

Figure 8. West Virginia 2019 monthly hydrograph. Note logarithmic scale (USGS).

Oil and Gas Water Management Plans

The Water Use Section of the West Virginia Department of Environmental Protection is responsible for the processing, analysis, and approval of operator-submitted water management plans. Pursuant to W. Va. Code §22-6A-7 and the Horizontal Well Development Rule 35CSR8, natural gas operators developing horizontal wells that use water more than two hundred ten thousand (210,000) gallons during any thirty-day period, shall submit a Water Management Plan (WMP) 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 DEP evaluates each proposed water source (surface water, groundwater, purchased water, or recycled frac water) for suitability based on a variety of considerations.

For Fiscal Year 2020, the Water Use Section received and reviewed all individual Water Management Plans 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 Large Quantity User program.

Water Resources Research

To carry out mandates from the Water Resources Protection and Management Act, the Water Use Section has routinely collaborated on research initiatives with various state, federal, and nonprofit partners. These projects support the data and informational needs of the Water Use Section to understand, protect, and conserve state water resources. Previous projects have included stream gauge statistical analysis, water budgets, and water infrastructure. The Water Use Section is currently funding and managing four projects:

Water Use and Consumption

In 2017 the Water Use Section received a grant from the United States Geological Survey (USGS) to provide information in support of their Water Use Data Research (WUDR) program. The WUDR program provides a comprehensive overview of water use across the nation, aggregated by county, every five years. In addition to supplying WUDR staff with annual Large Quantity User water withdrawal data, the Water Use Section has conducted field audits across all water use sectors. The on-site audits determine the consumptive portion of their water withdrawal, e.g. the portion that does not return to the local waterbody. Current estimates suggest water consumption is approximately 9% of the total statewide water withdrawal (Table 3). While the total water withdrawal is decreasing in WV, the estimated consumptive portion of the remaining withdrawal increased from 2015 to 2018, as both a percentage and a volume (Figure 9). This rise in consumption may have implications for water resources management beyond the apparent “savings” from the total withdrawal. A report compiling the results of these audits and recommending new consumption coefficients that can be applied to water use in West Virginia was submitted to the USGS WUDR program in September 2020.

WVDEP Water Use Category	2019 Total Gallons Withdrawn	Consumptive Coeff.	Gallons Consumed	% Consumed
Agriculture/Aquaculture	11,366,372,753	0.12	1,363,964,730	2.25%
Chemical	133,655,672,743	0.2	26,731,134,549	44.07%
Industrial	19,958,107,366	0.13	2,594,553,958	4.28%
Mining	13,260,094,521	0.17	2,254,216,069	3.72%
Oil & Gas	4,548,804,221	1	4,548,804,221	7.50%
Petroleum	301,407,497	0.27	81,380,024	0.13%
Public Water Supply	68,377,376,711	0.18	12,307,927,808	20.29%
Recreation	1,170,135,868	0.5	585,067,934	0.96%
Thermoelectric	396,571,231,051	0.025	9,914,280,776	16.35%
Timber	1,075,306,386	0.25	268,826,597	0.44%
TOTAL	650,284,509,117		60,650,156,665	9.33%
Hydroelectric	237,066,964,475,109	0	0	0%

Table 3. Current consumption coefficients applied to 2019 withdrawal data (WVDEP).

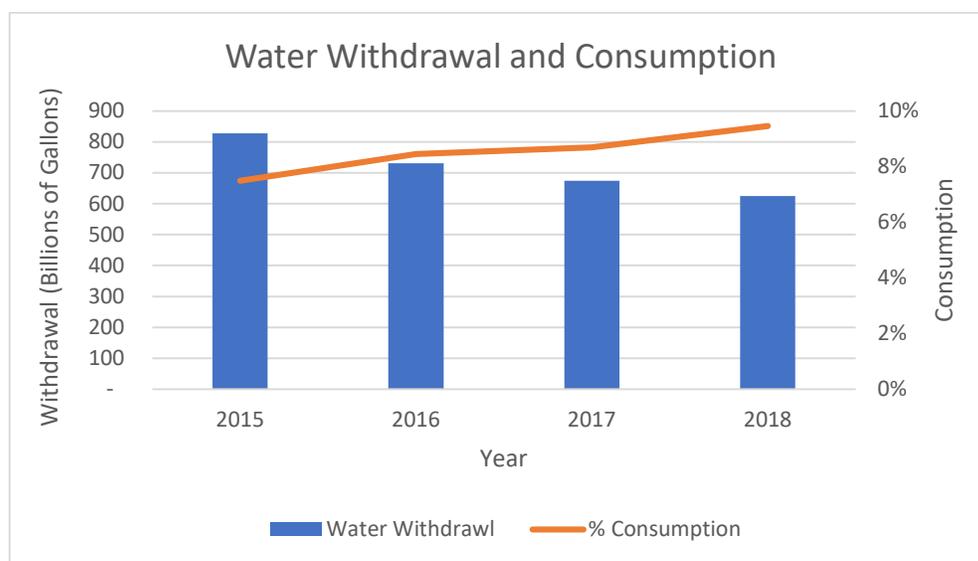


Figure 9. An increase in water consumption estimates contrasts with the decline in total LQU water withdrawal. Note different axis scales (WVDEP).

Geophysical Groundwater Well Logging

The Water Use Section and the U.S. Geological Survey (USGS) have continued a collaborative five-year project to assess geophysical and hydrologic properties of groundwater wells throughout West Virginia. The data from this project will be used to characterize the 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 increase knowledge of the depth and location of these water bearing features throughout the state.

Fieldwork for the project was completed on September 30, 2019 with over 120 well logs containing

Figure 11. Estimated extent of Abandoned Underground Coal Mine Aquifers (WVGES & WVDEP).

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.” The Water Use Section and West Virginia University are working together to improve our understanding of water stress throughout the state and, if needed, support the designation of critical planning areas. The two-year study, initiated in fall 2019, will provide improved spatial and temporal resolution of current and potential water use along with an understanding at what point water withdrawals have consequences for in-stream biology and ecosystem services that include dilution, filtration, and drinking water.

Online Water Resources Information

In cooperation with WVDEP’s TAGIS group, the Water Use Section maintains a suite of internet-based tools that display water resources management data in online Geographic Information Systems (GIS).

Water Resources Management Mapping Tool

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 (Figure 12). The tool is available at:

<http://tagis.dep.wv.gov/WVWaterPlan/>

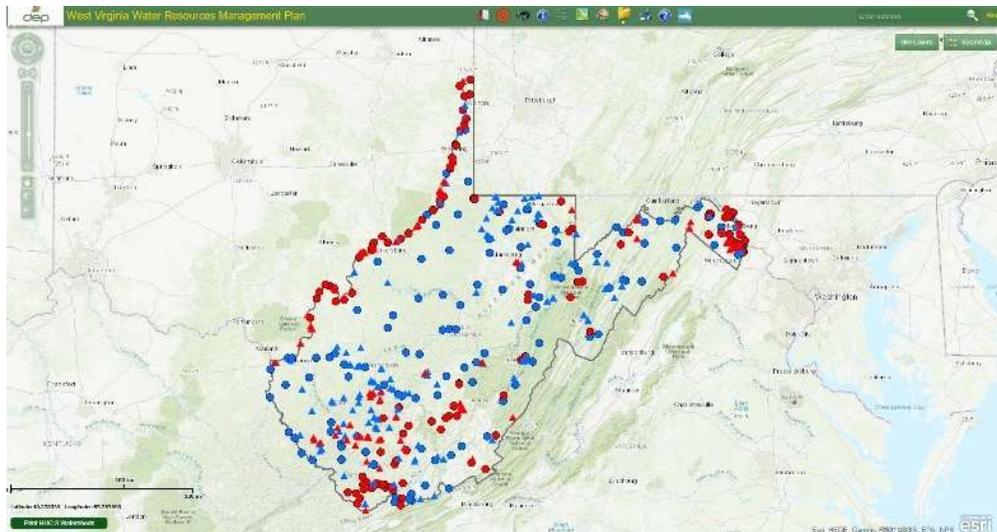


Figure 12. Large Quantity Users from the Water Resources Mapping Tool. Blue – surface water; red – groundwater (WVDEP).

Water Withdrawal Guidance Tool

TAGIS and the Water Use Section also maintain a Water Withdrawal Guidance Tool. Developed in 2009, this tool helps direct potential water withdrawals towards only those surface waters with sufficient flow (Figure 13). The Section is currently investigating improvements to this tool, including the incorporation of groundwater resources, stream ecology, and higher spatial resolutions. The tool is

available at: <https://tagis.dep.wv.gov/wwts/>

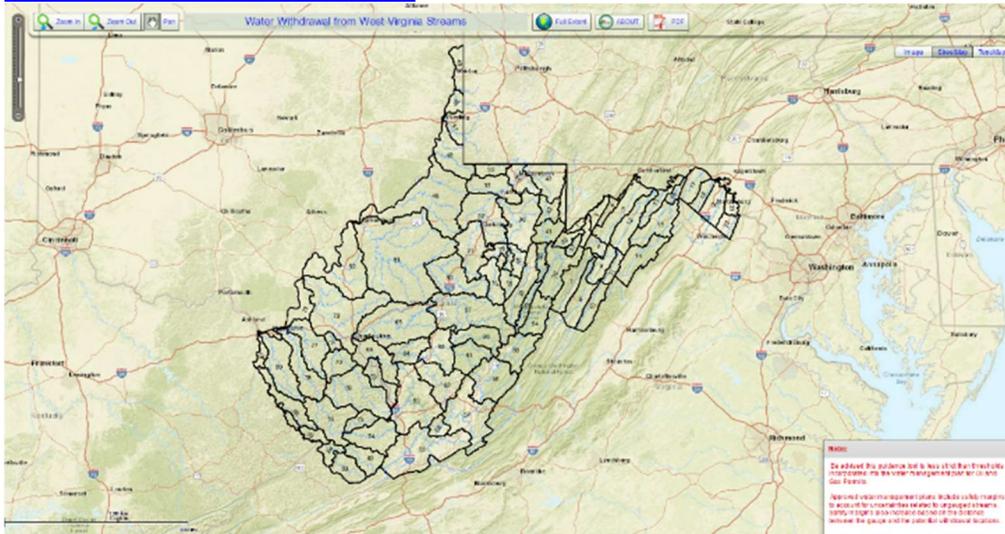


Figure 13. The 86 hydrologic zones of the Water Withdrawal Guidance Tool (WVDEP).

Water Resources: Plans & Priorities

The Water Use Section 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.

Update Water Withdrawal Guidance Tool

The Water Withdrawal Guidance Tool (WWGT) was initially launched in 2009 with the assistance of Marshall University. The WWGT has found limited use in certain DWWM permitting applications; however, a 2011 Legislative Audit of the WVDEP indicated that the WWGT should be considered for implementation as a mandatory requirement for all water withdrawals. The Water Use Section believes that the current iteration of the WWGT may not stand up to the increased legal and environmental scrutiny that would follow the use of the tool in such manner. Therefore, the Section is pursuing modifications and improvements needed to strengthen the tool, including the incorporation of stream ecology, groundwater resources, and higher spatial/temporal resolutions.

Detailed Public Water Supply Information

The public water supply is the most complex water use sector and higher resolution of withdrawal information is needed. Current figures for the public water supply include water deliveries to domestic, commercial, and industrial customers. To report on water use and trends more accurately, commercial and industrial portions of the public supply should be aggregated with their self-supplied counterparts in similar water use sectors. Additionally, leaks and losses are estimated to be between 20-30% of the total public supply withdrawal. These leaks and losses serve no beneficial purpose and vary greatly from year to year, skewing data for trend analysis. The Water Use Section will seek to improve the Large Quantity User survey as it relates to Public Water Supplies to obtain more detail and clarity on their water withdrawals.

Upgrade Data Entry and Management

The Water Use Section is collaborating with other groups within WVDEP's Division of Water and Waste Management and the WV Business Technology Office to develop new data entry and data management programs. Feedback on the current Electronic Submission System (ESS) remains mixed and data entry error rates for Large Quantity Users approaches 40%. The Section is pursuing a new system to improve the public's experience, reduce errors, and provide better data analytics to Water Use Section staff.

Water Resources Program Needs

The Water Use Section respectfully requests the continued support from the Legislature and all concerned state agencies regarding funding and cost-sharing solutions for the 188 stream gauges and 18 groundwater level monitoring wells in the network managed by the U.S. Geological Survey (Figure 14). The Water Use Section is deeply reliant upon these federal resources. The Section uses stream gauges to generate thresholds for water management plans under the Horizontal Well Control Act. Similarly, the Water Use Section's Water Withdrawal Guidance Tool fetches data from the stream gauge servers to provide recommendations for withdrawals across the state. The Water Use Section 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 West Virginia.

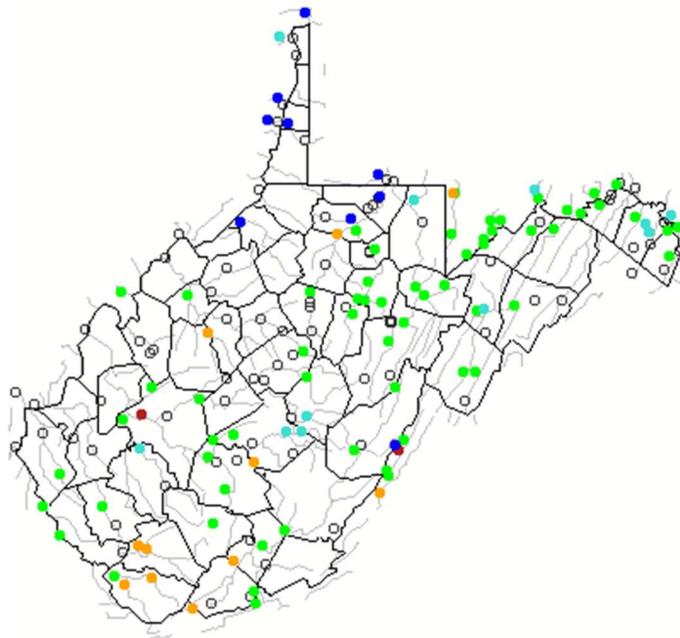


Figure 14. The stream gauge network in West Virginia (USGS).

Water Use Program Staff

Laura Cooper

Assistant Director, Division of Water and Waste Management
Environmental Resources Program Manager 2
Laura.K.Cooper@wv.gov

Christopher Smith

Environmental Resources Analyst
Water Quality Standards (*temporarily assisting Water Use Program*)
Chris.B.Smith@wv.gov

<vacant>

Environmental Resources Specialist II

<vacant>

Environmental Resources Specialist III

