



west virginia department of environmental protection



# 2019 Annual Water Resources Report

Joint Legislative Oversight Commission on State Water Resources

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

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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).

## 2018 – 2019 Water Resources Availability

Water was generally abundant throughout 2018, with many areas of the state experiencing record rainfall. Statewide average rainfall is approximately 44 inches; 2018 rainfall was 65 inches, the highest amount in 124 years of record keeping (Figure 1). Precipitation is 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). Rainfall thru September 2019 has been closer to average, with total precipitation just slightly below normal in many localities (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 have slowly returned to normal ranges, occasionally dipping lower in regions impacted by the dry periods indicated below (Figure 4).

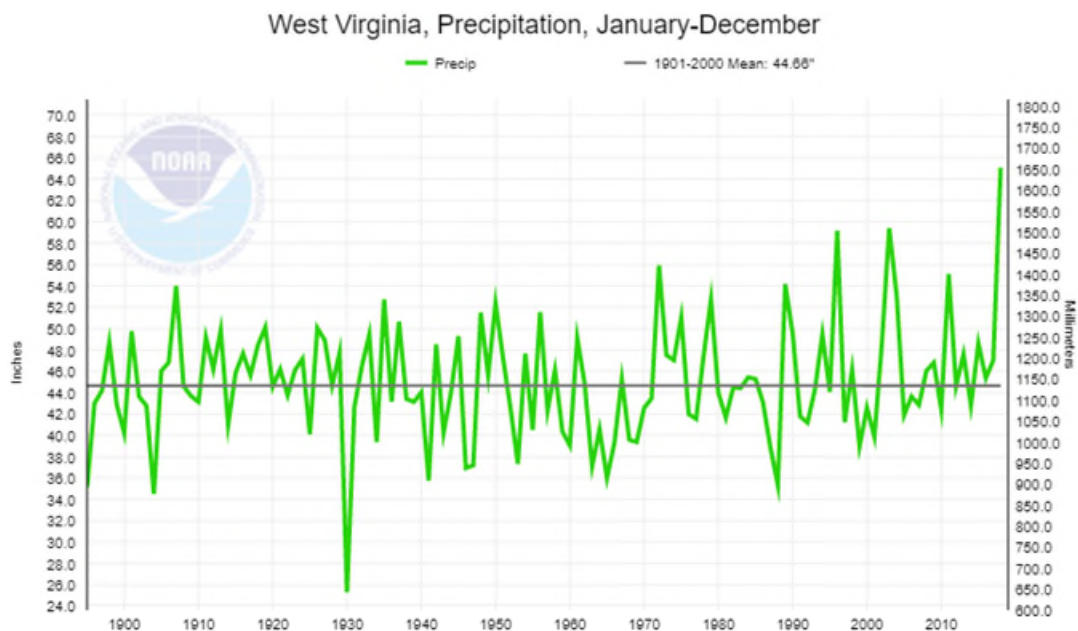


Figure 1. West Virginia's annual precipitation from 1895 – 2018. Note 2018 record (NOAA).

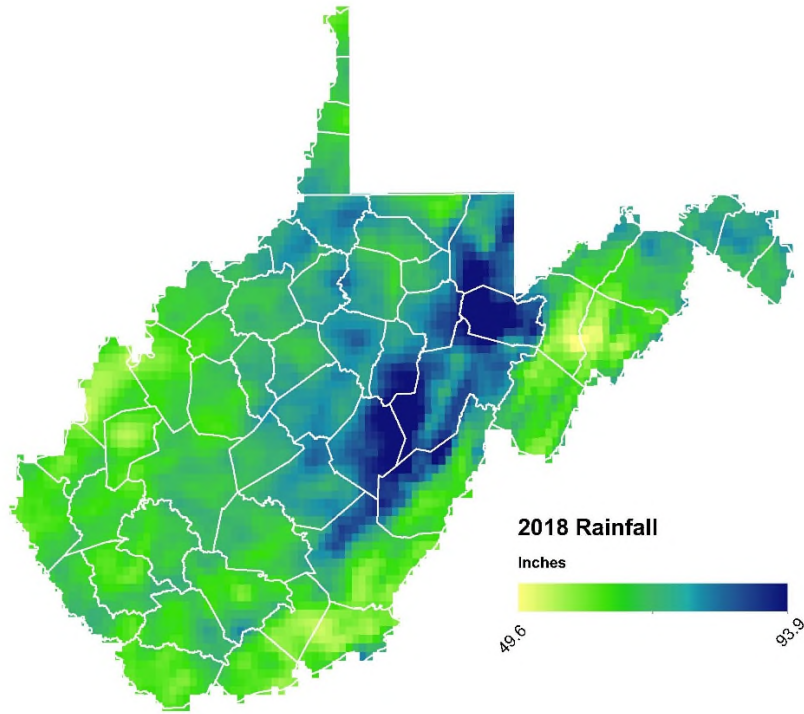


Figure 2. Total 2018 precipitation (Oregon State PRISM).

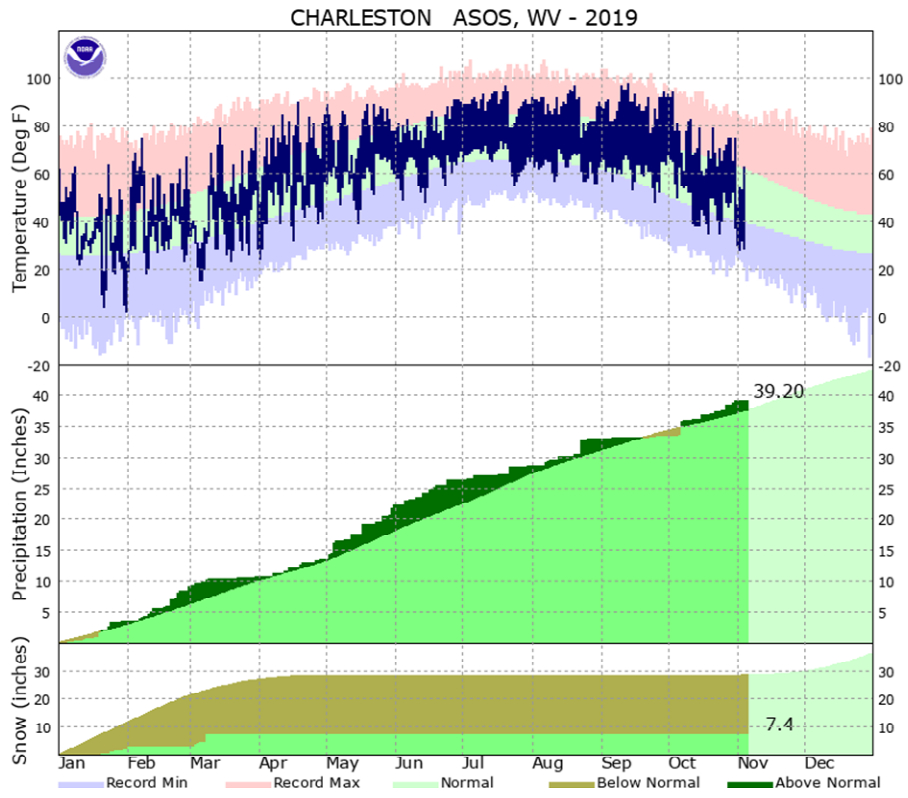


Figure 3. Climate data for Charleston, WV from January – November 2019 (NOAA).

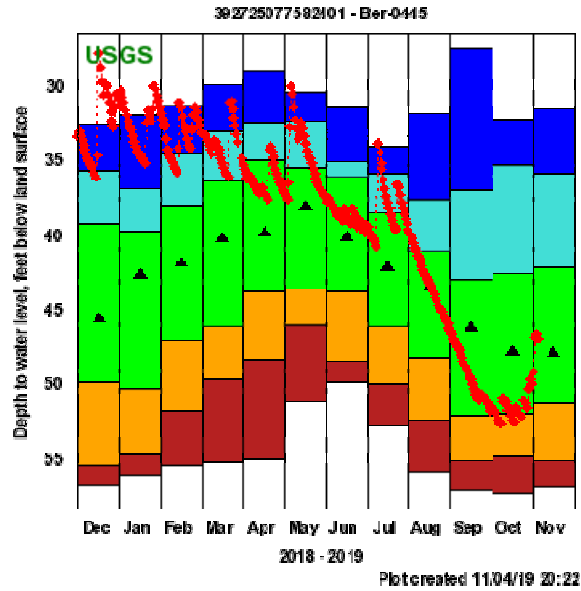


Figure 4. Groundwater levels December 2018 – October 2019 in Martinsburg, WV. Note record levels in late 2018 (USGS).

Despite the generally wet conditions, there were times during 2018 and 2019 (to date) that West Virginia experienced abnormally dry and/or moderate drought conditions (Figure 5). Two of these periods occurred during January 2018 and March-April 2019. The largest and longest dry period, from August-October 2019, impacted 100% of the state.

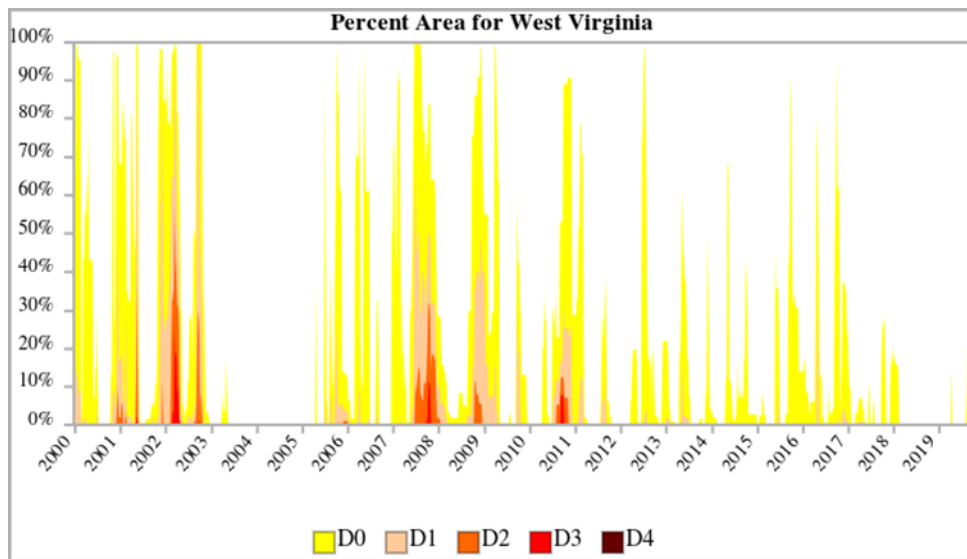


Figure 5. Drought conditions in West Virginia since 2000 (Drought.gov).

## 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 2019 reports beginning January 1, 2020. 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 2018, 387 Large Quantity Users withdrew water from 725 individual sites (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 2017 amounts, by +32.4%, +11.6%, and +2.3% respectively.

Groundwater withdrawals remain relatively consistent, comprising approximately 5% of the total water use in West Virginia (Table 2). The public water supply is the single largest user of groundwater (comprising nearly 20% of all PWS withdrawals), 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).

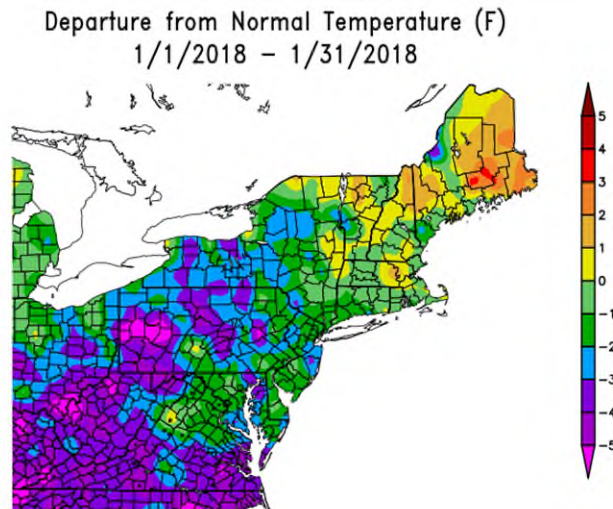
| Water Use Sector        | LQUs | Total Gallons WD       | % of Total WD  | % Change from 2017 |
|-------------------------|------|------------------------|----------------|--------------------|
| Agriculture/Aquaculture | 13   | 7,342,326,962          | 1.18%          | 16.40%             |
| Chemical                | 13   | 134,058,672,936        | 21.47%         | -1.77%             |
| Industrial              | 21   | 14,795,031,981         | 2.37%          | 2.33%              |
| Mining                  | 71   | 14,755,098,334         | 2.36%          | -2.81%             |
| Oil & Gas               | 15   | 4,321,192,565          | 0.69%          | 32.41%             |
| Petroleum               | 1    | 303,734,621            | 0.05%          | 8.60%              |
| Public Water Supply     | 209  | 67,903,655,278         | 10.87%         | 11.68%             |
| Recreation              | 21   | 1,264,305,547          | 0.20%          | -1.39%             |
| Thermoelectric          | 9    | 378,664,719,354        | 60.63%         | -12.89%            |
| Timber                  | 3    | 1,120,874,025          | 0.18%          | -1.44%             |
| <b>TOTAL</b>            |      | <b>624,529,611,603</b> | <b>100.00%</b> | <b>-7.32%</b>      |
|                         |      |                        |                |                    |
| Hydroelectric           | 11   | 234,743,229,993,045    |                | 0.32%              |

Table 1. Total 2018 water withdrawals (WD) from the LQU database (WVDEP).

| Water Use Sector        | Surface WD             | % of SW WD    | Groundwater WD        | % of GW WD   |
|-------------------------|------------------------|---------------|-----------------------|--------------|
| Agriculture/Aquaculture | 7,105,060,562          | 1.20%         | 237,266,400           | 0.77%        |
| Chemical                | 124,745,574,481        | 21.01%        | 9,313,098,455         | 30.14%       |
| Industrial              | 13,951,636,745         | 2.35%         | 843,395,236           | 2.73%        |
| Mining                  | 8,677,784,916          | 1.46%         | 6,077,313,418         | 19.67%       |
| Oil & Gas               | 4,253,799,127          | 0.72%         | 67,393,438            | 0.22%        |
| Petroleum               | 57,162                 | 0.00%         | 303,677,459           | 0.98%        |
| Public Water Supply     | 54,538,588,243         | 9.19%         | 13,365,067,035        | 43.26%       |
| Recreation              | 933,896,714            | 0.16%         | 330,408,833           | 1.07%        |
| Thermoelectric          | 378,313,760,704        | 63.73%        | 350,958,650           | 1.14%        |
| Timber                  | 1,112,465,297          | 0.19%         | 8,408,728             | 0.03%        |
| <b>TOTAL</b>            | <b>593,632,623,951</b> | <b>95.05%</b> | <b>30,896,987,652</b> | <b>4.95%</b> |
| Hydroelectric           | 234,743,229,993,045    |               | -                     |              |

Table 2. Breakdown of Surface Water (SW) and Groundwater (GW) withdrawals from the 2018 LQU database (WVDEP).

One of the most striking observations in the annual trend analysis is the nearly 12% jump in Public Water Supply Use from 2017 to 2018. After discussing the results with local water operators, the Water Use Section believes that an abnormally cold January 2018 was the root cause of additional water loss from burst pipes and leaks (Figure 6). A similar spike in public water supply in 2015 may also be attributable to below-normal winter temperatures. We will closely monitor data from 2019 to see if use returns closer to baseline if we experience a milder winter. This situation shows that the Water Use Section needs to improve LQU data collection from public water suppliers to account for loss and leaks that are not put to beneficial use and may otherwise skew data.



Generated 2/20/2018 at HPRCC using provisional data.

NOAA Regional Climate Centers

Figure 6. Abnormally low temperatures in West Virginia during January 2018 (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 2020. 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, the Section now believes that water stress may be possible on smaller spatial or temporal scales. We are pursuing additional research in this area.

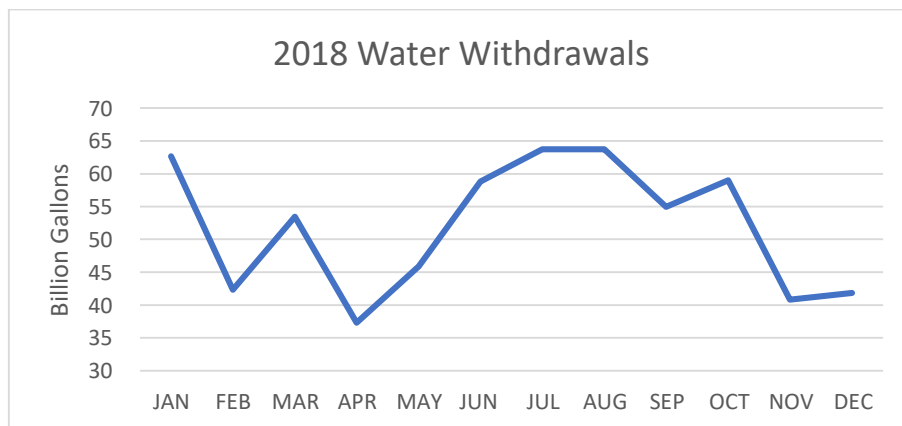


Figure 7. 2018's monthly trends in total withdrawal from the LQU Database (WVDEP).

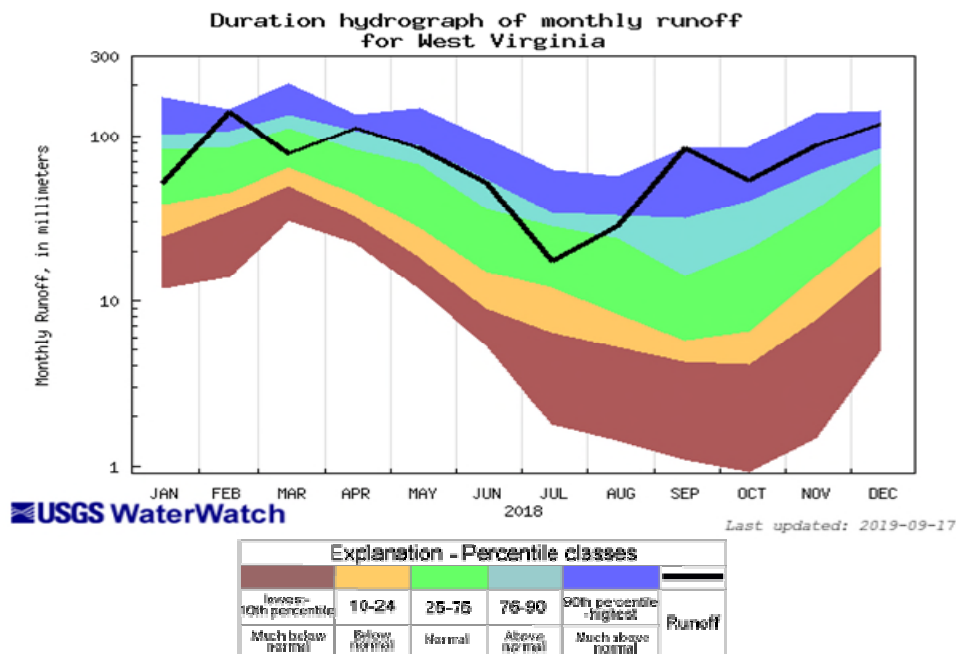


Figure 8. West Virginia 2018 monthly hydrograph. Note logarithmic scale (USGS).



## 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 in excess of 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 2019, the Water Use Section received and reviewed 556 individual water management plans. 75 new pad-level plans were created, along with the reviewal and approval of 94 Water Management Plan modifications, all relating to the withdrawal of surface and groundwater used in horizontal well drilling operations regulated by WV Code 22-6a. 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 a total of 41 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 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 has increased over 4 years – 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 will be submitted to the USGS WUDR program by September 2020.

| Water Use Sector        | Total Gallons WD       | Cons. Coeff. | Gallons Cons.         | % of Cons.   |
|-------------------------|------------------------|--------------|-----------------------|--------------|
| Agriculture/Aquaculture | 7,342,326,962          | 0.12         | 881,079,235           | 1.49%        |
| Chemical                | 134,058,672,936        | 0.2          | 26,811,734,587        | 45.34%       |
| Industrial              | 14,795,031,981         | 0.13         | 1,923,354,158         | 3.25%        |
| Mining                  | 14,755,098,334         | 0.17         | 2,508,366,717         | 4.24%        |
| Oil & Gas               | 4,321,192,565          | 1            | 4,321,192,565         | 7.31%        |
| Petroleum               | 303,734,621            | 0.27         | 82,008,348            | 0.14%        |
| Public Water Supply     | 67,903,655,278         | 0.18         | 12,222,657,950        | 20.67%       |
| Recreation              | 1,264,305,547          | 0.5          | 632,152,774           | 1.07%        |
| Thermoelectric          | 378,664,719,354        | 0.025        | 9,466,617,984         | 16.01%       |
| Timber                  | 1,120,874,025          | 0.25         | 280,218,506           | 0.47%        |
| <b>TOTAL</b>            | <b>624,529,611,603</b> |              | <b>59,129,382,823</b> | <b>9.47%</b> |
| Hydroelectric           | 234,743,229,993,045    | 0            | -                     |              |

Table 3. Current consumption coefficients applied to 2018 withdrawal data (WVDEP).

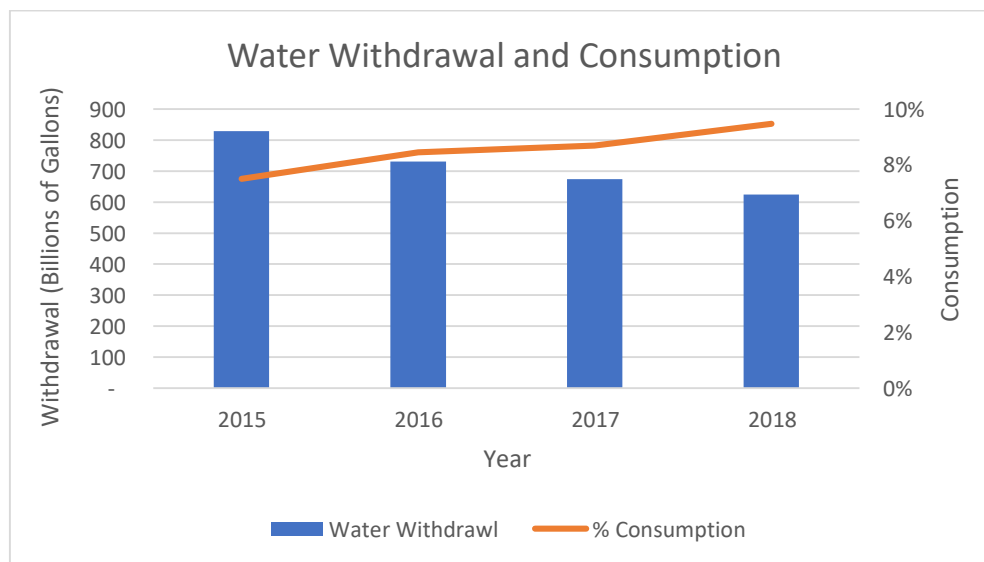


Figure 9. An increase in water consumption estimates contrasts with the decline in total LQU water withdrawal. Note different axis scales (WVDEP).

### 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 geological and hydrological data (Figure 10). The Water Use Section and USGS will collaborate on the final report and data models, expected in fall 2021.

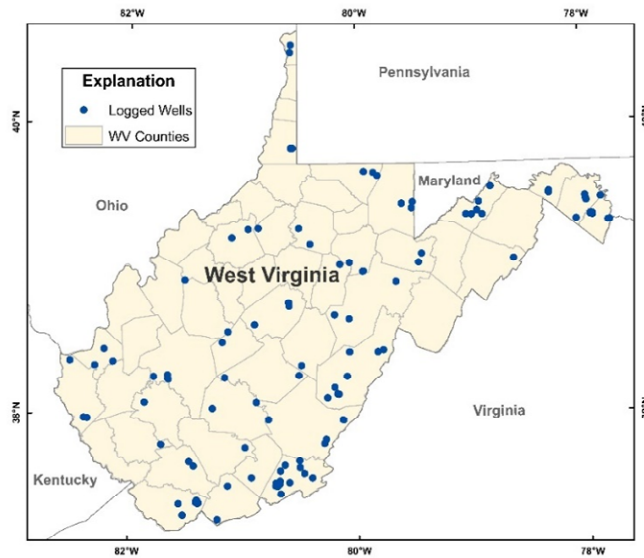


Figure 10. Location of USGS-WVDEP borehole geophysics well logs 2015-2019 (USGS).

### Abandoned Underground Coal Mine Aquifers

The Water Use Section has been involved in many 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 PSDs in southern West Virginia 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 W.V. Geological and Economic Survey (WVGES) to map the extent of potential mine pools (Figure 11). Since then, we have worked with the U.S. Geological Survey to obtain data from more than 770 water samples from 294 mines. A report summarizing mine pool water quality and hydrogeology is expected in February 2020. Future research could focus on the sustainable yield from this water resource and monitoring inter-basin flow resulting from mine pools that transcend surface watershed boundaries.

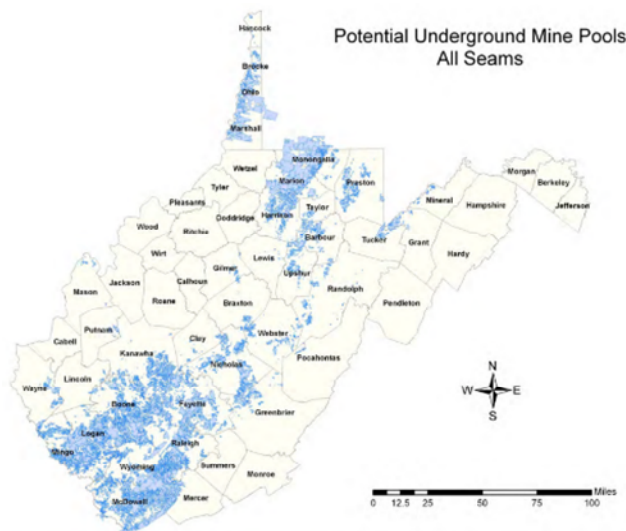


Figure 11. Estimated extent of Abandoned Underground Coal Mine Aquifers (WVGES & WVDEP).

## 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/>

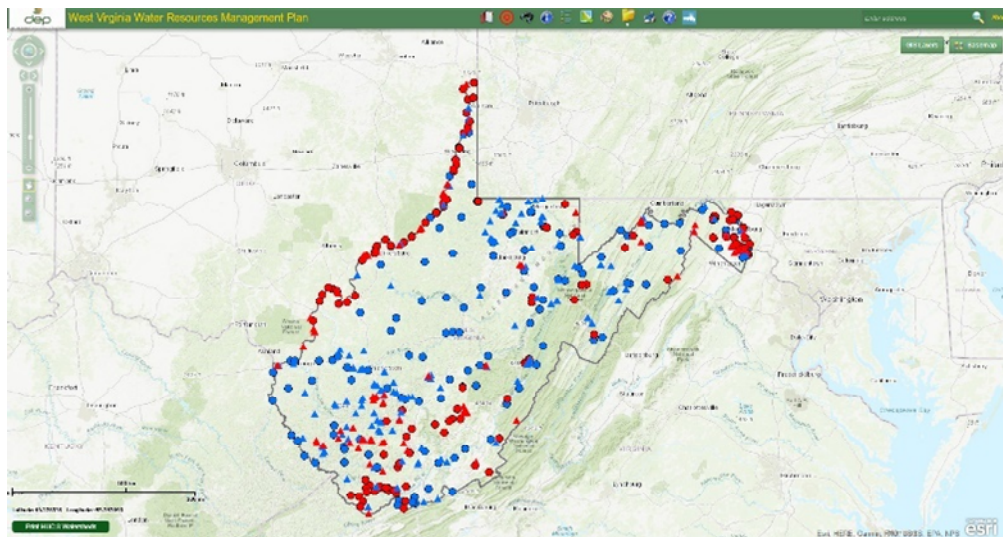


Figure 12. Large Quantity Users from the Water Resources Mapping Tool. Blue – surface water; red – groundwater (WVDEP).

## 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/>

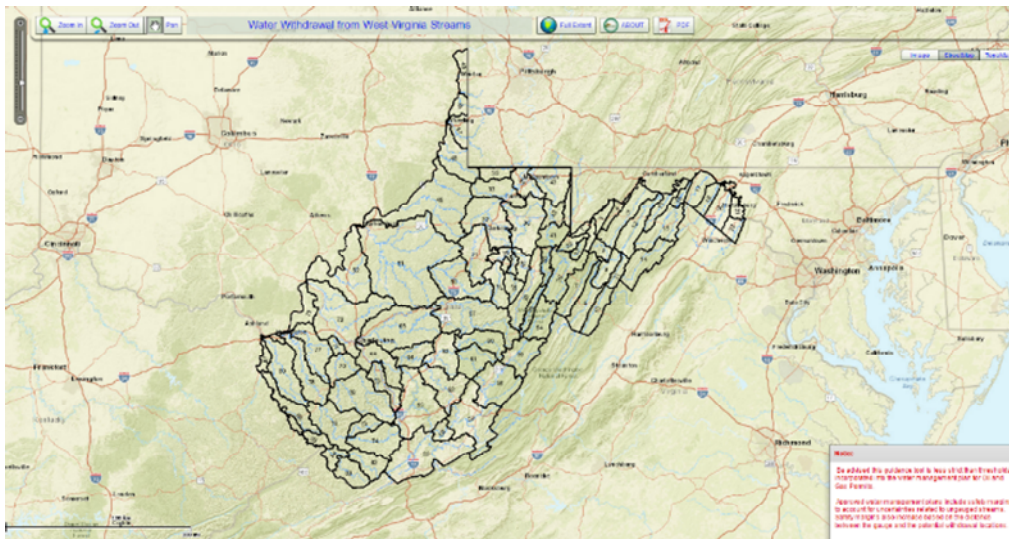


Figure 13. The 86 hydrologic zones of the Water Withdrawal Guidance Tool (WVDEP).

## 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 more accurately report on water use and trends, 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.

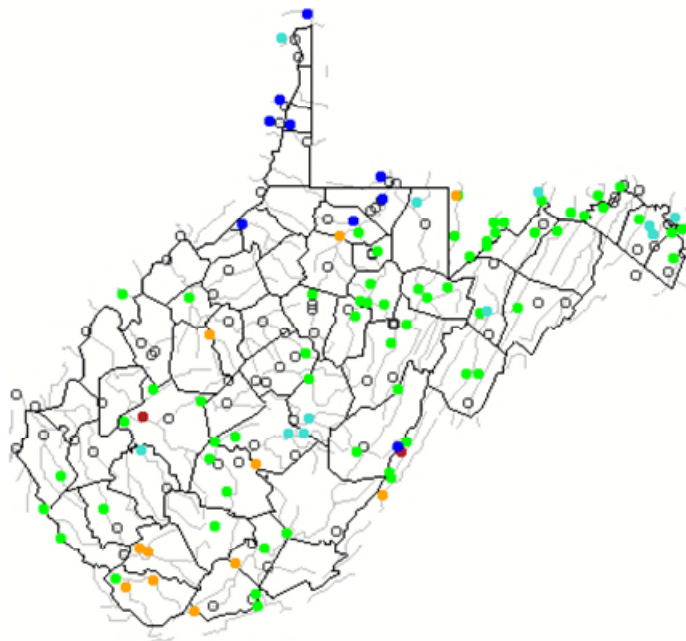


Figure 14. The stream gauge network in West Virginia (USGS).

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