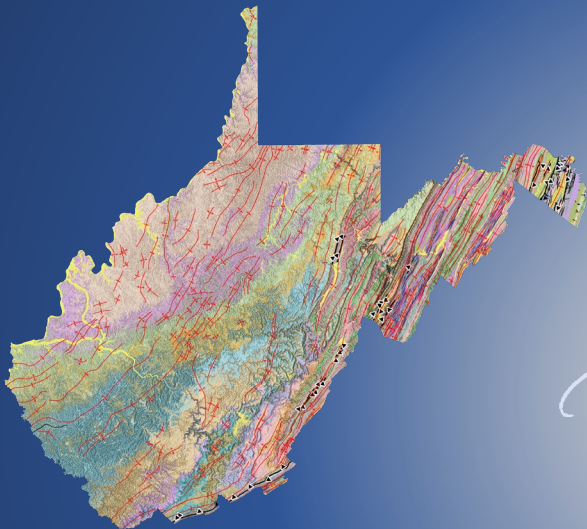


West Virginia
Geological Survey



2021 ANNUAL REPORT



West Virginia
WEST VIRGINIA

Cover Photos

Top: Crossbedded rocks in the Shavers Fork River, Tucker County
(Photo by WVGES Geologist J.W. Perkins)

Inset: Geologic Map of West Virginia draped over a digital-elevation-model slope shade



Artist's vision of Mont Chateau from early postcard

(Image courtesy of the West Virginia and Regional History Center)

**West Virginia Geological and Economic Survey
Mont Chateau Research Center
1 Mont Chateau Road
Morgantown, WV 26508-8079**

Phone: (304) 594-2331

FAX: (304) 594-2575

E-mail: info@wvgs.wvnet.edu

Web Site: <http://www.wvges.wvnet.edu>



EXECUTIVE SUMMARY

Jessica P. Moore, Director and State Geologist

As the staff of the West Virginia Geological and Economic Survey prepare their reports of geoscience research and activities during Fiscal Year 2021, I return time and time again to one theme: Transition.

The date on my calendar may say 2021, but we are all still transitioning back from the year 2020, when our activities as a society ground to a halt. The Covid-19 pandemic swept across the globe, significantly curtailing the movement of people from place to place. Oil prices, the bellwether of energy consumption, traded at negative values for the first time in history. We are slowly emerging from the specter of the global pandemic, but things are different on the other side. This is especially true for energy systems. Public demand for renewable resources continues to increase year after year, altering the type and volume of resources needed for the so-called “energy transition”. This is a challenging time for traditional industries but does present a unique opportunity for geoscience research. Now, West Virginia’s coal resources are being examined for their potential to yield critical minerals and carbon materials in addition to their thermal capacity. The pore spaces of conventional oil and gas reservoirs are evaluated for their potential to store carbon dioxide rather than their ability to produce methane and crude. And even the prolific Appalachian basin organic shale reservoirs, which themselves were a new and novel exploration target just a few short years ago, are now being evaluated for development of hydrogen resources in addition to the production of natural gas and associated liquid hydrocarbons.

The pandemic also changed the way we work. This transition was abrupt: over the course of a few days in the spring of 2020, WVGES staff moved operations from our beloved headquarters at Mont Chateau in Morgantown to the safety of our individual homes. Much of the credit for this near-seamless transition belongs to the WVGES Information Technologies staff. Their quick thinking and proactive measures ensured that our geologists could continue their work remotely. This abrupt transition necessitated changes to workflow structure, resulting in some unexpected benefits for the agency. An industry donation of valuable geophysical log data sat unprocessed in our file repository—too large a job to tackle under normal day-to-day operations, but ideal for remote work. Over the course of several months, WVGES staff transported boxes of geophysical logs to their telework locations, compared them to the state’s existing collections, and reserved the new and unique pieces of data to be digitally scanned and made available to the public. More than 5,000 records were added to our collections through this effort.

The year was not without significant operational challenges, though. The project most impacted by the shift to at-home work was our cooperative mapping efforts through the U.S. Geological Survey’s STATEMAP program. Travel restrictions precluded a majority of the field work necessary to produce bedrock geologic maps, essentially negating the 2020 field season. Unable to go out in the field, mapping staff pivoted and worked on the necessary job of digitally edge matching previously mapped quadrangles to each other and to newer mapping, another task that would have taken much longer had they been able to conduct field work. Fortunately, the mapping staff of the Geoscience Program were

able to mobilize back into the field through early spring and summer of 2021, completing their contractual obligations with only minor delay.

The final transition I'd like to highlight is what former WVGES Director and State Geologist, Mitch Blake, coined the "Boomer Bust". Workforce demographics in the geosciences are historically tied to energy trends. Many people entered the geoscience workforce in the period following World War II, resulting in groundbreaking geological research and development of unifying theories such as plate tectonics in the 1960s. This led to improved understanding of geologic processes, and, as drilling technologies became more sophisticated, increased exploration of the subsurface for oil and gas resources. The workforce continued to grow, with more women entering the field in the 1970s. This trend reversed abruptly due to energy market fluctuations in the early 1980s, as many geoscientists exited the workforce and the number of geology majors decreased at the university level. Fast forward to today: innovations in the geosciences and increased awareness of the linkages of society and earth systems is compelling a new generation of workers to focus on earth science research. At the same time, the workers who began their careers in the latter part of the 20th century are reaching retirement age, with relatively few mid-career geoscientists bridging the gap. Hence, the "bust" following exit of the Boomer generation.

Dr. Blake knew this phenomenon would affect WVGES just as it has many other agencies and organizations, and took proactive steps to mitigate the impact. Over the course of Fiscal Years 2020 and 2021, eight senior WVGES staff members retired, constituting a multi-hundred year loss of institutional knowledge. Fortunately, as mentioned above, many bright young scientists are entering the geoscience workforce and through the foresight of Dr. Blake and the Department of Commerce, the agency has been fortunate to hire several talented individuals. The future looks bright for WVGES, but it wouldn't have been possible without the strong foundation laid by our predecessors. Calendar year 2022 will mark the 125th anniversary of the West Virginia Geological and Economic Survey, and it is a milestone worth celebrating. Here's to many more years of geoscience research in the Mountain State.





Poor Farm Cave, Pocahontas County (Photo by WVGES Geologist J.W. Perkins)

THE WEST VIRGINIA GEOLOGICAL AND ECONOMIC SURVEY (WVGES)

Research and Other Projects

WVGES worked on many projects between July 2020 and June 2021, Fiscal Year 2021 (FY21). Below is a brief list of our many accomplishments during that time.

Mine-Pool Geothermal Study

- Concluded that pump-storage facilities have the potential to enhance the national electric grid while being environmentally responsible in lowering the nation's overall carbon footprint using a virtually free, previously overlooked, and currently untapped energy source
- Expanded a previous mine-pool study to identify mined areas as potential pump storage sites and low-temperature geothermal reservoirs
- Mapped the availability of water-flooded mines to serve as low-carbon energy sources
- Explored potential for pump storage in areas with stacked mine voids
- Created a geodatabase of incorporated town polygons and a selection of industrial sites throughout the state buffered and overlain on the Coal Bed Mapping Project (CBMP) mine map database
- Identified thirteen possible mine pairs as potential pump storage sites: a mixture of drift, slope and shaft 'target' mines paired with a mixture of upper reservoir mines or surface reservoirs
- Recommended a more viable use of West Virginia water-filled underground mines: utility scale geothermal energy
- Recognized that the extensive occurrence of mining across the state also provides significant potential for geothermal heating and cooling systems
- The WV Office of Energy in conjunction with the US Department of Energy funded the study
- The final report is available at

http://www.wvgs.wvnet.edu/www/coop_rpts/reports/West_Virginia_Mine_Pool_Pump_Storage-WVGES_2020.pdf



Mine Pools for Electricity Generation
Pump Storage power generation is accomplished via a two-reservoir (abandoned mine) configuration with the reservoirs sited at different elevations. Electricity is generated using a turbine driven by water released from the upper reservoir into a lower reservoir. Water is pumped into the upper reservoir during low-demand, low-cost times using surplus electricity in the grid and released to generate power during peak demand, higher rate times.

Perhaps a better solution is utilizing the geothermal properties of these mine pools. The large thermal mass of mine waters can serve as an excellent source of utility scale geothermal energy. An additional benefit of geothermal heating and cooling is that it requires a fraction of the water needed to generate electricity resulting in much less to no erosion of the mine infrastructure thereby preserving the longevity of the mine roof and floor.

Deep Direct-Use Geothermal Project

- In April of 2021, the Biden Administration released a Fact Sheet outlining key resources to stimulate investment in coal and power plant communities primarily impacted by the clean energy transition
- A key component of the plan involves a significant amount of Federal funding from the U.S. Department of Energy (approximately 7.9 million dollars) for geothermal research at West Virginia University
- WVGES worked with the WVU Energy Institute on a precursor project, evaluating the feasibility of the Tuscarora Sandstone as a low-temperature geothermal reservoir for the WVU Evansdale Campus
- WVGES will serve in an advisory role on the new project, which proposes to drill a 15,000 ft. research well outside of Morgantown
- Very few deep wells exist in this part of the state, making this project important for geothermal research as well as investigations of deep saline storage of CO₂ and understanding of the Utica-Point Pleasant petroleum system.



Coal research includes the ongoing collection and integration of mine maps and data from industry and sister agencies, such as Miners Health, Safety and Training. It also includes new and novel research into the potential for critical mineral enrichment in Pennsylvanian-aged coal measures and energy generation using mine pools.

21st Century Power Plant (21CPP) Initiative Research Grant

- Project will deploy modular coal-fired power generation, utilizing waste coal and biomass as feedstocks, with on-site Carbon Capture Utilization and Storage capabilities
- Funding for the project is via the U.S. Department of Energy. Research will be conducted by Battelle Memorial Institute, Carbon Solutions, LLC, and the Pennsylvania and West Virginia geological surveys in conjunction with industry partner Consol Energy.

Coalbed Mapping Program

- Maps and updates of West Virginia coal bed data continue for all 85 mineable coal beds with associated splits and places them into a GIS database
- Creates a reliable, up-to-date, and accurate database of mined and mineable coal for environmental and safety uses
- Allows the state tax department to accurately value properties for tax assessment
- Continues to collect drilling data from industry and other contributors to improve the overall data model
- Allows online access to shape files for coal mine location by mining type, coal thickness, elevation, and percent parting grids, mined and remaining areas and overburden information.
- Is free and easily available to citizens, businesses, and government agencies on the WVGES website at <http://www.wvgs.wvnet.edu/coal/cbmp/coalims.html>

Underground Mine Mapping Project

- Continues to process new and legacy mine maps collected from various sources including industry archived datasets and private collections
- Received 100 new mine maps representing 521 individual mines in FY21
- Examined each new map to check if it is already in the system. If new mined areas are identified they and any associated data are entered into the data model
- Scanned large-format historical mine maps to create high-resolution images
- Added many small portions of existing mines along with several 'new' mines in depleted areas where mine maps have been difficult to collect
- Increased the accuracy of the data model
- Made the information available to the public, industry, and government to serve and protect miners, landowners, and citizens from potential hazards while aiding more accurate property valuation
- Worked in cooperation with the West Virginia Office of Miners Health, Safety and Training

Mine Information Database System (MIDS)

- Houses publicly accessible information collected from mine maps including mine name, company name, mined seam, county and quad and various notes.
- Contains 49,849 documents representing 91,483 mines
- WVGES encourages comments and mine-map submissions from the public to improve the database. If you have a mine map that you would like to donate or allow us to scan please contact us at info@wvgs.wvnet.edu
- Accessible from the WVGES website at <http://www.wvgs.wvnet.edu/www/mids/main.php>

WVGES West Virginia Geological & Economic Survey
login | search | advanced search Document Number

West Virginia Mine Information Database System
Search Page

County: Any, Unknown, Barbour, Berkeley, Boone
Quad Filter: Unknown
Bed: WVGES Specific: Any (Needs Addressed), 2 GAS, 2 GAS LS1, 2 GAS LS2
Company or Mine Name:
Permit Number (Federal or State):
Map Year (Range): to
Corner Notes:
Show Mines Added After: January 1 2021
Show Mines

The West Virginia Mine Information Database System (MIDS) contains records of every mine map available at the West Virginia Geological and Economic Survey in Morgantown, WV. The database is comprised of over 49,000 documents and over 91,000 mines. Most of the mine map records contained in MIDS are available at the West Virginia Geological and Economic Survey in the form of paper maps, aperture cards (microfilm), and digitally scanned mine map images. Need help? [Click Here.](#)

This work is presented in conjunction with the [West Virginia Office of Miners' Health, Safety and Training](#)

Please send web site questions, comments, or suggestions to webmaster@wvgs.wvnet.edu

WV Geological & Economic Survey
1 Mont Chalese Road
Morgantown, WV 26508
Phone: (304) 594-2331
Fax: (304) 594-2575
info@wvgs.wvnet.edu

WVGES
Welcome Page

Coal Bed Mapping Project Chemistry Database

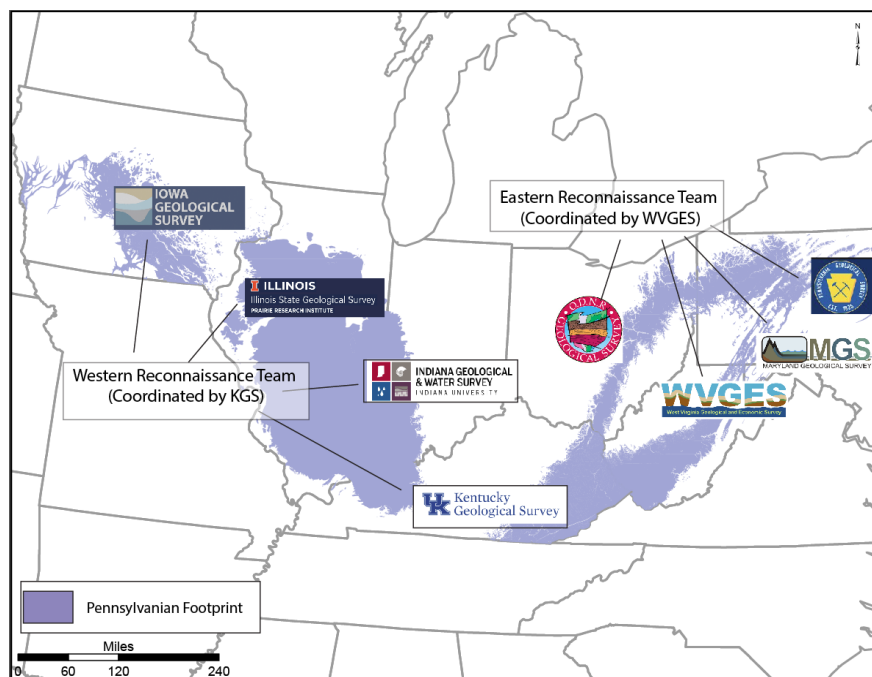
- Contains coal analyses, accessory minerals, and critical mineral data, including Rare Earth Elements. Available upon request for focused searches
- Includes a large archive of samples, many of which have been reanalyzed for recent projects
- Provides non-confidential laboratory analyses of coal samples from industry donations and decades of WVGES sample collection

Earth (Mapping Resources Initiative) MRI for Critical Minerals

- In FY21, WVGES was awarded \$125,000 from the U.S. Geological Survey to coordinate a geochemical renaissance study across an eight-state region
- Study aims to evaluate the critical mineral potential of clay-rich strata associated with coal beds. The clay-rich material is often discarded during the mining process and could potentially be processed for beneficial reuse
- Goal of the study is to identify potential sources of critical minerals, especially rare earth elements, but also other critical mineral resources such as lithium
- Work focuses on the Pennsylvanian-aged coal measures, which were deposited in an equatorial climate with humid, ever-wet conditions creating laterite deposits similar to those being mined in China today
- The study concludes in June of 2022, but preliminary data can be accessed at the following link: [Earth MRI Funds Critical Minerals Project in West Virginia \(usgs.gov\)](https://www.usgs.gov/centers/erdc/projects/earth-mri-funds-critical-minerals-project-west-virginia)

Critical Minerals, as defined by Federal Executive Order 13817, include 31 elements, oxides, or mineral compounds used in modern technological applications, including renewable energy sources, communications devices, household products, and defense tools. A majority of the critical minerals come from non-domestic sources, which has significant economic and security implications for the country.

The Earth MRI project uses a mineral systems approach to define areas of enrichment, and the mineral systems potentially containing rare earth elements (REEs).



Preserving the State's Collections

WVGES Museum

- In 2021, the Museum was updated, reorganized, and expanded, fulfilling its purpose to present the natural history of the Mountain State in an exciting and welcoming atmosphere. The most notable improvements include:
- Addition of life-size skeleton replicas of *Tarbosaurus* (a close relative of the *Tyrannosaurus rex*) and Woolly Rhinoceros
- Addition of display cases with lighting, displaying Paleozoic fossils and mineral collections, allowing for organizing museum specimens by time period: upstairs level contains all Paleozoic fossils, and downstairs contains Mesozoic and Cenozoic specimens
- Two new interactive displays: A meteorite display including authentic samples with information available on a touch-screen, and a topographical "sandbox" where visitors can see the effect erosion has on topography
- Informational panels that accompany the various specimens were improved and now provide more in-depth and detailed information on fossil/animal groups, rock types, and mineral families
- Expansion of museum gift store, offering a wider variety of goods
- Mont Chateau history slide show with historic photos and memos
- Expanded information on the petroleum resources of West Virginia and the history of extraction efforts in the state
- Finally, a WV fossil repository was established to maintain a research-level collection of specimens essential and unique to the state. This repository promises to be a resource to future scientists seeking to understand our past
- Associated web pages <http://www.wvgs.wvnet.edu/www/museum/museum.htm>



Maintaining WVGES' Sample Repository

This collection represents the most comprehensive group of rock-core and well-cuttings samples in West Virginia

- Over 28,000 linear feet of core from coal, oil and gas exploration as well as cuttings samples from thousands of wells and boreholes. Also includes hundreds of samples collected during fieldwork by agency geologists
- Housing, cataloguing, curating, and updating this large, complex, and irregular collection is difficult. Space is always an issue. Our facilities are near-capacity and not climate-controlled, but it is imperative that physical material be preserved for current and future research
- Efforts to inventory the collection, such as using barcode technology to develop a modern, comprehensive, web-accessible catalog is ongoing
- Publicly accessible; requests from industry, federal government, and academia are common
- Many samples are decades old and collected from locations that are no longer accessible
- Legacy samples are of new interest as scientists develop new analytical techniques and realize new discoveries, making the WVGES collection that much more relevant
- Additionally, results and analyses from outside researchers must be submitted to WVGES resulting in advanced analytical data sets at no cost to the taxpayer

Adding to the Collection via the Horizontal Well Act

- Physical samples (rock core and drill cuttings) are submitted by operators to WVGES in compliance with WV Code 22-6-22, the Horizontal Well Act of 2012
- Recent acquisitions include the first Utica/Point Pleasant core samples, from two wells in the active drilling fairway in Marshall County. Prior to this acquisition, the state held only one core that captured the interval, and that well is from a location in Wood County, outside of the main productive fairway
- We are thankful to the West Virginia Legislature for their foresight in the addition of the legislation to the Horizontal Well Act, as well as to the companies operating in the basin for their timely correspondence and compliance. These assets form the cornerstone of a modern collection that records a momentous period in Appalachian oil and gas exploration



Donations of Geological Material and Data

WVGES appreciates donations of geologic material and data from individuals, industry, and academia. Preserving data and samples has heightened importance as exploration companies enter and exit the basin with assets continually changing hands. WVGES seeks to maintain and foster deep relationships with industry partners and stakeholders. Additionally, as a generation of geoscientists and engineers retire, many have contributed personal collections of records, maps, and geophysical logs. Below are some notes on the generous donations that have been added to the WVGES collection over the past fiscal year:

- Donation of core, cuttings, and associated data from Cabot Oil & Gas in support of the Conasuaga Shale Research Consortium project (described below)
- Donation of Marcellus drill cuttings from both Arsenal Resources and Chevron Appalachia. These cuttings have expanded the WVGES collection since many samples are from Marcellus wells in areas previously underrepresented in the WVGES collection
- A comprehensive set of farm-line and property maps from a region spanning from northern WV to the southern coal fields, donated by Ed Rothman. These maps have greatly enhanced WVGES's ability to gather information on historical abandoned wells since coverage was lacking in the southern portion of the state
- A comprehensive set of well logs donated by Tom White (of Haney and White) from several counties across the state. Work that is ongoing found that upwards of 60% of this donation resulted in new material to WVGES holdings
- Anonymous donation of well logs from an industry source resulting in thousands of geophysical logs in paper and digital format being added to the WVGES collection
- Donation of microfilm from John Bulmer. This collection includes historical well records.
- Assimilating these donated data into existing WVGES file systems is a significant, multi-year task
- Remote work during the COVID-19 pandemic resulted in several WVGES geoscientists processing a huge number of these data sets in FY21

Donations of Software

- The IHS Markit University Grant Program generously donated networked software licenses for both the seismic data interpretation Kingdom® software, as well as the subsurface mapping program Petra™
- Modern software applications are essential to assimilate, analyze, and map disparate datasets
- Enables WVGES to develop analysis skills and keep current with other state geological surveys
- Allows WVGES to interpret, map, and package data used by a variety of stakeholders
- Their acquisition can be financially challenging for government organizations
- These donated network licenses are valued at more than \$750,000, a generous award at no cost to the taxpayers of West Virginia, and an amount WVGES would be unable to afford

National Geological and Geophysical Data Preservation Program Grant

WVGES utilized funding from the USGS National Geological and Geophysical Data Preservation Program (NGGDPP) to rescue and preserve at-risk scientific data while also making those data publicly available in modern formats. The USGS NGGDPP program requires and evaluates submitted proposals each year and, if approved, provides funding on a yearly project basis. WVGES has successfully been awarded funding multiple times and was most recently awarded a year of funding that began in May 2021.

Past projects include:

- Inventory, catalog, and bar coding of the WVGES oil and gas cores and cuttings collection. This allows researchers to more easily access the collection
- Photography of oil and gas cores. Photographs are available here: <http://www.wvgs.wvnet.edu/pipe2/CoresList.aspx>
- Rescuing physical samples at risk of loss due to poor storage conditions. NGGDPP program provides funding to purchase new boxes and heavy duty shelving. WVGES staff re-box samples from deteriorating boxes into new boxes
- Scanning physical data (predominantly paper media) to digital data and serving these data to the public. For example, WVGES scanned a collection of hand-colored well logs that only existed in paper format. These scans are now available through the WVGES website
- Spatially locating historical field sites
- Identifying and compiling historical and modern data to aid in developing geologic models for critical mineral enrichment. Tabulating data (1,139 samples from 44 of 55 counties in WV) contained in WVGES publications, academic work, and a modern dataset collected by the US Department of Energy
- Verifying data collected from 1907 to 2018 where major oxides were reported for 1,028 samples and trace elements (including rare earth elements) reported for 124 samples

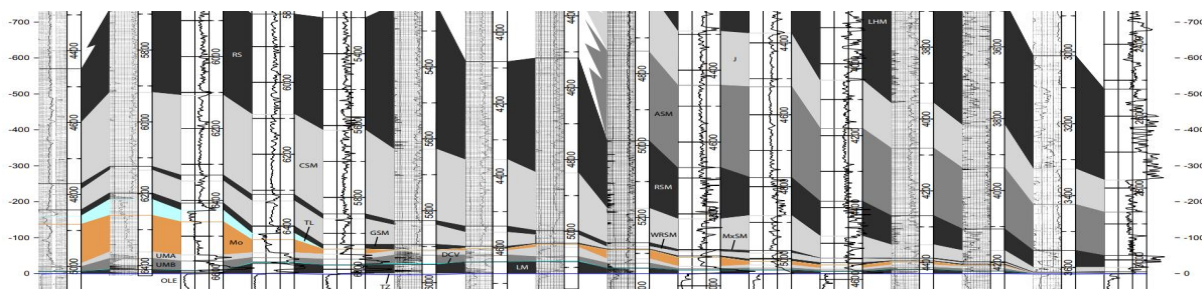
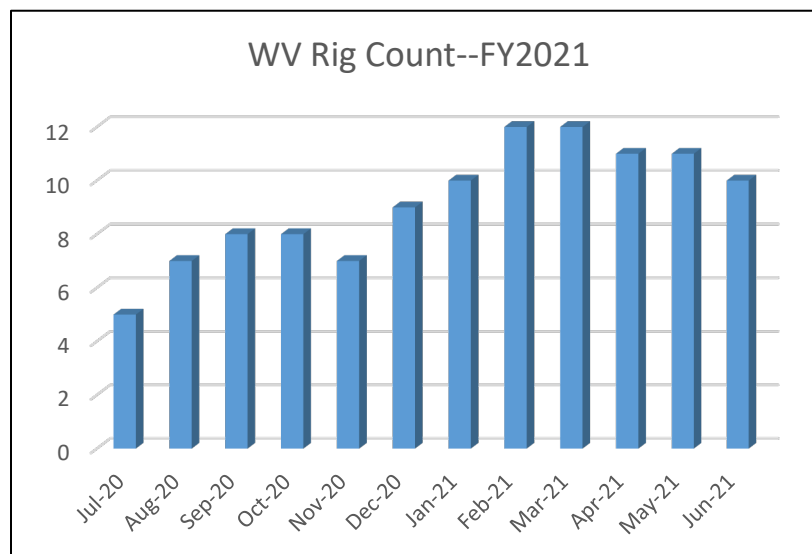
The current WVGES NGGDPP project has six components:

- Cataloging of a large oil & gas well log collection. Paper logs will be scanned and digital logs will be processed and uploaded to the WVGES website
- Rescuing physical samples at risk of loss from poor storage conditions (ex. damaged, deteriorating, or improperly sized boxes). Continued re-boxing of oil & gas cores
- Core photography of a coal exploration drillhole. This core has been utilized for sampling to examine critical minerals in West Virginia
- Creation of an interactive map showing geological mapping coverage across the state of West Virginia. Map will be publicly available
- Compilation of modern and legacy critical minerals datasets. This large geochemical database will be made available via the WVGES website
- Scanning of a set of aerial photos that were flown after the 1985 flood in West Virginia. Photos are currently only available as hardcopy

The OIL & GAS PROGRAM is responsible for research into current oil & gas trends, fields, and evaluating specific horizons using well logs, cores, and associated samples & data. Managing physical samples as well as database curation allows requests from researchers, industry and governments to be easily accommodated. Historical documents and legacy samples are of new interest as scientific advances are made.

Oil and Gas drilling trends continued to decline. In West Virginia the number of permitted wells in FY21 decreased by around 40% from the previous fiscal year

- 193 deviated wells were permitted, down from 317 in FY20
- Marshall County has the most permits (64), followed by Wetzel (53), and Tyler (42)
- The Marcellus is still the major drilling target and accounts for 87% of the total drilling permits, with 168 wells permitted to be drilled. Marshall and Wetzel counties account for the majority of Marcellus activity
- The Utica Point/Pleasant is the second major target, with 18 permits issued in FY21
- The permits for wells targeting the Utica/Point Pleasant are located almost exclusively in Marshall County (14 of 18 permits)



Conasauga Shale Research Consortium (CSRC) Project

- Evaluated the Rogersville Shale, located 11,000 to 16,000 feet below the surface (deeper than the Utica-Point Pleasant shale interval), as a potential unconventional oil and gas play in the Appalachian Basin and concentrated in West Virginia and Kentucky
- Improved correlation and mapping of the Rogersville Shale was achieved using well logs, cores, and associated samples & data
- Data from this interval are generally very sparse because few wells have penetrated this deep. Available data sets were greatly increased through a generous donation from Cabot Oil & Gas of well data from a deep well in Putnam County, WV. These data were incorporated into the overall CSRC dataset
- A core from this interval from a well in Wayne County, WV, held in the WVGES collection, indicated elevated total organic carbon (TOC), used as an indicator for potential hydrocarbons
- Project is a collaboration between WVGES, Kentucky Geological Survey and West Virginia University with funding from the US Department of Energy

Midwest Regional Carbon Initiative, Carbon Dioxide (CO₂) Research

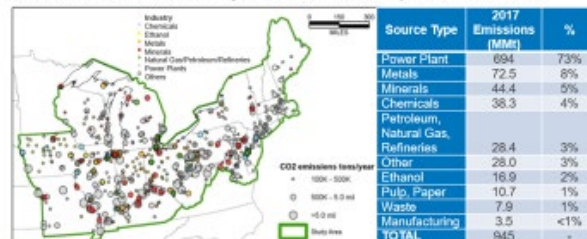
- This project continues the work of the multi-decadal Midwest Regional Carbon Sequestration Partnership by combining forces with the Midwest Geologic Carbon Storage program in cooperation with geological surveys and other stakeholders from 21 states in the Atlantic and Midwest regions
- The goal of the project is leveraging knowledge gained through hydrocarbon exploration to identify reservoirs amenable to carbon capture utilization and storage (CCUS)
- This will be accomplished by defining broad carbon storage systems, constructing detailed geologic models and simulations, delineating and constructing roadmaps for infrastructure development and policy, and packaging technical results in the form of searchable databases, maps, and web pages
- Results and digital products of the research will aid corporations in achieving their carbon neutrality goals and will also elucidate new development opportunities that require identification of CO₂ storage targets
- Targets in the Appalachian basin include shallow depleted oil fields for enhanced hydrocarbon recovery and eventual CO₂ storage via CO₂ flood, deep-saline reservoirs, or a combination of both for “stacked” storage
- The project is funded by U.S. Department of Energy in long-standing partnership with Battelle Memorial Institute

Midwest Regional Carbon Initiative

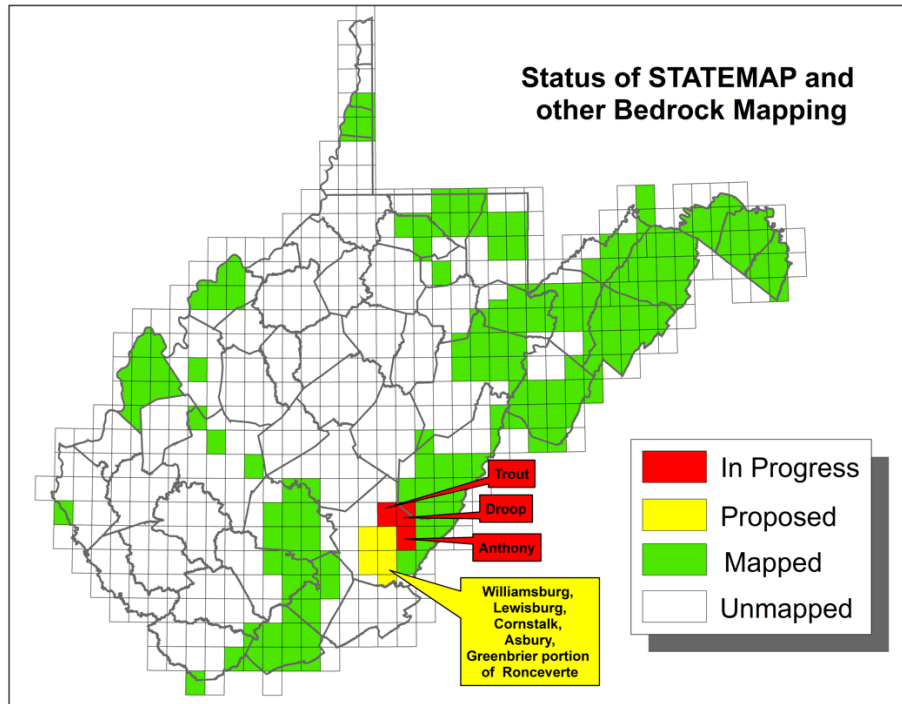


Diversity of CO₂ Sources at Play

- More than 1/3 of the nation's CO₂ point sources
- Regional emissions from various industrial sources, power plants make up nearly 3/4 of the overall emissions
- Future emissions sources maybe different then present sources



Bedrock Mapping through the STATEMAP Program



- The annual meeting of the STATEMAP Advisory Committee, a group of industry, academia, and government professionals, was held virtually in September 2020. Meeting attendance was robust and resulted in delineation of new priority areas to map. The bedrock mapping program was partially funded (1:1 match) by the US Geological Survey's USGS STATEMAP Program
- New geologic mapping was proposed in the Asbury, Cornstalk, Lewisburg, Williamsburg and the portions of the Fort Spring and Ronceverte quadrangles in Greenbrier County to the US Geological Survey for funding in December 2020 (shown in yellow on the map). Additional funding was requested to improve previously published geologic maps by edge-matching, digital database updates, addressing geologically difficult problem areas via focused field work, and using newly available Lidar imagery
- Field work was completed for bedrock mapping on the Anthony, Droop, and Trout 7.5-minute quadrangles in Pocahontas and Greenbrier counties, shown in red on the map above. Maps will be completed and delivered in FY22.
- Notification of partial funding was received in April 2021 to map the Asbury, Cornstalk, Lewisburg, Williamsburg quadrangles and a portion of the Ronceverte quadrangle in Greenbrier County (shown in yellow on the map). WVGES received notification of additional funding to improve previously published geologic maps by edge-matching, digital database updates, addressing geologically difficult problem areas via focused field work, and using newly available LiDAR imagery
- Maps and reports for the Denmark, Lobelia, and Woodrow quadrangles in Greenbrier, Pocahontas, and Webster counties were delivered to the USGS STATEMAP program in July 2020 and published in August 2020 as WVGES Open File Reports. They are available as paper maps, PDF files, and geographic information systems (GIS) geodatabases

Adopting the National Geologic Map Schema Digital Database Format

- An overarching goal of the USGS National Cooperative Geologica Mapping Program (NCGMP) is the creation of a continental-scale 3D seamless geological map. This will be achieved, in part, through the adoption of a national Geologic Map Schema (GeMS) digital map database format. This database format has many complexities and will be mandatory for all map submissions to the USGS in the future
- The GeMS workflow will be integrated into new maps and older maps will be reformatted to GeMS format
- The WV GIS Technical Center provided a customized training, held in May 2021, for WVGES staff to integrate GeMS into our workflow
- GeMS work is fully funded by the USGS through a supplemental grant from the STATEMAP Program

Geoscience Education and Outreach activities

- The goal of WVGES outreach is to captivate and inspire future generations of geoscientists in Appalachia and beyond
- Due to Covid-19, GeoCamp was cancelled, but plans are in place for future events
 - Assisting with organizing and conducting a geoscience-focused STEM camp located near Morgantown for high school students from throughout the U.S.; scholarships are available
 - Hiking, caving, and whitewater rafting are some of the many geo-activities
 - Classes include rock identification, orienteering, and practical field exercises
 - Conducted in conjunction with the US Geological Survey and Adventure WVU

Visiting Geologist

Activities include:

- WVGES staff visited five selected state parks
- Presentations were given on state and local geology
- Guided field trip hikes to showcase local park geology
- Conducted in cooperation with the WV Division of Natural Resources

GEOSCIENCE AND MAPPING PROGRAM

WVGES continues to create new 1:24,000-scale bedrock geologic maps. These foundational products provide an understanding of the rocks present at the surface and an idea of the rocks below the surface. Mapping of karst areas remains a high priority both for understanding groundwater flow and potential hazards. WVGES is currently mapping areas in Greenbrier County, WV and published 3 new maps in FY21.

Supporting K- 12 Science Teachers

Activities include:

- Geoscience is a required West Virginia course in 9th grade, and WVGES helps teachers with class content. WVGES maintains a website of freely available educational resources for K-12 Teachers: <http://www.wvgs.wvnet.edu/www/geoeduc/geoeduc.htm>
- WVGES engaged with teachers at the West Virginia Science Teachers Association Fall meeting in 2019 and had hoped to the same in October 2020, but this meeting was cancelled due to COVID.

Geologic Transect updated with new Gigapans

Activities include:

- WVGES is continually adding to the publicly available “story map” website (https://www.wvgs.wvnet.edu/www/geology/geologic_transect.html) which displays some of the geology along a west to east corridor. The map includes high resolution gigapan images of representative outcrops along with identification information and descriptions.

Virginia Virtual Field conference, October 2020

Activities include:

- Mostly located in West Virginia along US 48 (Corridor H), the virtual fieldtrip included stops through the Valley and Ridge and Allegheny Plateau physiographic regions. Virtual field trip stops hosted by WVGES and others. The field trip can be viewed here: <https://earth.google.com/web/data=Mj8KPQo7CiExdU9fWkhIRExCRjIwY1dmNE9xWVBaZF9wcFFaVHMzQkYSFgoUMEUxNUE4NTYxMjE2MEIzMzQyQkY>

Environmental Concerns and Hazards

- Locating and describing underground mining for mine subsidence insurance through the Coal Bed Mapping Program
- Increasing the understanding of groundwater flow and the potential effects of oil and gas drilling and other industrial construction in the karst terrains of Greenbrier and Pocahontas counties through bedrock mapping as part of the STATEMAP grant
- Investigating carbon capture, utilization, and storage potential, as discussed under the Midwest Regional Carbon Initiative
- Studying landslide susceptibility in conjunction with the WV GIS Tech Center, discussed later in this report
- Monitoring seismicity in the state through a permanent monitoring station at the WVGES Mont Chateau office, part of a Seismic-Monitoring Network of six statewide seismic-monitoring stations overseen by the USGS
 - Reporting two earthquakes in West Virginia during FY21
 - Recording smaller earthquakes in neighboring states with the WV Seismic Network
 - *Posting earthquake information on the WVGES website at* <http://www.wvgs.wvnet.edu/www/earthquakes/seismic.html>



The **INFORMATION SERVICES PROGRAM** is responsible for the agency's publications, website and feedback presence, network infrastructure and desktop operations, interactive mapping applications, and other programming applications in support of all WVGES projects.

IT applications are essential and ubiquitous in the geosciences. COVID-19 highlighted the importance of Information Technology, staff connectivity, website access and maintenance, as well as the continued management of the many databases WVGES oversees.

Interactive Mapping Applications

- All oil & gas wells in West Virginia, including Marcellus Formation and Utica Shale Plays
- Lithostratigraphy of Middle and Upper Devonian Organic-Rich Shales
- All WV Mining
- Results of the Coal Bed Mapping Project
- Geologic Transect across WV
- And others, see <http://ims.wvgs.wvnet.edu>

Oil and Gas Drilling web services including “Pipeline” and Pipeline+” data portal management

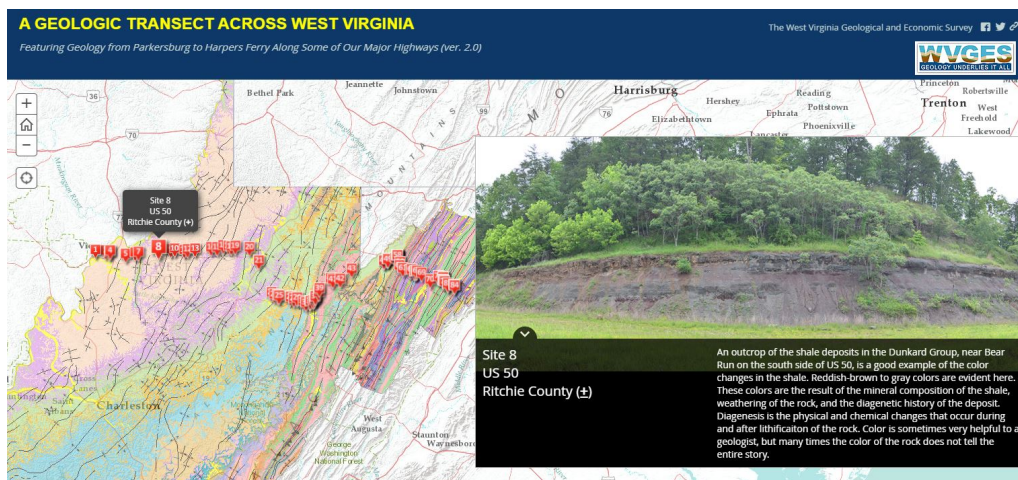
- Daily updating of the state's oil and gas-well database
- Daily spreadsheet updates for Marcellus shale wells and horizontal wells
- Continuously scanning well logs and making those available to the public
- Yearly publication of the entire oil and gas database, used by industry in their exploration models (Current version released May 2021)

By the numbers:

Website: 1,064,461 website visits; 58,493,087 page views; over 3,000 webpages

Service Requests: Staff responded to more than 6,200 requests for information

Facebook Page: 56 total posts; 29,208 total reach



Hardware and Software Support for Office and Field

Activities include:

- Developing and expanding remote-work capabilities
- Acquiring and installing new desktop and laptop computers
- Continuing to advance processing capabilities for extremely large, high-resolution imagery (LiDAR) datasets
- Providing support for staff who are virtually attending meetings, workshops, and conferences, including the Geologic Mapping Forum, Digital Mapping Techniques, and corresponding workshops with other state and federal geologic mappers and GIS professionals
- Presenting and learning best practices for the collection of data in the field, integrating newly acquired data with legacy data, and building geologic databases and maps
- Helping mappers employ new techniques, hardware, and methods to collect and utilize digital data in the field
- Standardizing data collection with handheld mapping units and developing data-entry forms using built-in GPS technology and field photography, allowing mappers to acquire and integrate data in a more systematic manner
- Using high-resolution LiDAR imagery on mapping devices along with direct observation to identify previously hidden landforms



New Publications in FY21

AR-2020 – Annual Report: Fiscal Year 2020

OF-2001 – Bedrock Geologic Map of the Droop 7.5' Quadrangle, Pocahontas and Greenbrier Counties, West Virginia, J.W. Perkins, J.K. Tudek, D.L. Spurgeon, S.E. El-Ashkar, S.J. Hostetler, S.R. Brown, R.T. Toth, L.A. Woodward, C. Lindsay; Digital Cartography by S.E. Gooding

OF-2002 – Bedrock Geologic Map of the Trout 7.5' Quadrangle, Greenbrier County, West Virginia, J.K. Tudek, S.J. Hostetler, E.C. Rhenberg, D.L. Spurgeon; Digital Cartography by S.E. Gooding

OF-2003 – Bedrock Geologic Map of the Anthony 7.5' Quadrangle, Greenbrier County, West Virginia, S.R. Brown, G.D.M. Andrews, J.W. Perkins, S.E. Gooding; Digital Cartography by S.E. Gooding

RI-36 - Estimates of Natural Gas Resources and Recovery Efficiency Associated with Marcellus Development in West Virginia: S.E. Pool, R.M. Boswell, J.T. Saucer, B.J. Carney. RI-36 is a peer-reviewed study in which more than 270 digital well log suites were evaluated to estimate original gas-in-place (OGIP) for the Devonian Marcellus organic-rich shale play in West Virginia. Observed and predicted Marcellus production are taken into account and in-place estimates are calibrated accordingly. The study also examines the Genesee-Burket and introduces the idea of a Marcellus Reservoir Unit and a separate Genesee-Burket Reservoir Unit. Marcellus OGIP volumes are higher than those in other recent studies but are reasonable given production and calculated recovery efficiencies. The full publication is freely available on the WVGES website: <http://www.wvgs.wvnet.edu/www/MUDvnnSh/MUDvnnSh.htm>

Facility Maintenance

- Installed buried telecommunication cables through existing conduit thereby improving reliability
- Sealed the upper parking lot
- Improved outside lighting for safety
- Painted portions of the building
- Continued a landscape beautification project
- Work volunteers created a monarch butterfly habitat
- Completed several other smaller projects
- Many thanks to WVGES maintenance staff and agency volunteers for preserving the historic nature of the Mont Chateau property.

Historical Preservation of Building and Property

- In June 2021 the West Virginia Archives and History Commission visited WVGES for their quarterly meeting. Due to the unique and historic nature of the building and property, both the Agency and the Commission are proceeding with a nomination for Mont Chateau to the National Register of Historic Places. A Historical Property Inventory form has been submitted, and the full application and nomination process is expected to take several months.

Equal Employment Opportunity

- The agency has undertaken major initiatives to achieve pay equity among similarly-classified and experienced professionals regardless of race, religion, gender, sexual orientation, national origin, age, or disability
- A major issue within our recruiting efforts continues to be that the agency operates within an outdated pay scale that does not attract those, including females and minorities, within the Geoscience field. This includes new graduates, as they have learned they can secure more lucrative positions within the private sector. Although we are making great strides to increase pay and put an end to pay inequality, budgetary constraints remain
- In recent years the staff has been composed of far less than 50% women; however, out of the last 10 full time and part time hires, 5 have been filled by women, including the State of West Virginia's first ever appointed female Director & State Geologist, bringing the ratio to 42.5% overall. This has helped to further close the disparity gap between males and females
- A significant disparity in WVGES staff exists between white and other ethnic identifiers as well as an increasingly smaller imbalance of males to females. Some of these hiring percentages are not possible to adjust due to the number of employees within the specific job group
- We will continue to devote a serious and sustained effort to educate the community through our outreach programs. These programs reach everyone from K-12 to higher education, as well as the general public
- Specific efforts that will be pursued in FY2022 include making contact with Historically Black Colleges and Universities (HBCUs) in West Virginia, as well as helping to design and participating in a Diversity, Equity and Inclusion study of State Geological Survey employees across the nation, which will be conducted by the Association of State Geologists

PARTNERSHIPS

The WVGES Family

- The State GIS Coordinator in Charleston
- WV GIS Technical Center specialists at West Virginia University in Morgantown
- WVGES professionals in Morgantown

State Agency Partners

- Secretary of State's Office
- Office of Miners Health, Safety and Training
- State Tax Department, Property Tax Division
- Department of Homeland Security
- Division of Emergency Management
- Department of Health and Human Services
- Department of Environmental Protection
- Water Development Authority
- Infrastructure and Jobs Development Council
- National Guard
- Intelligence Fusion Center, Hazard Mitigation section

Federal Agency Partners

- US Geological Survey
- US Department of Energy
- US Department of the Interior
- US Department of Agriculture
- Federal Emergency Management Agency

Other States' Geological Surveys

- Kentucky, Pennsylvania, Ohio, Maryland, Virginia, Indiana, Illinois, Iowa

Industry partners

- Battelle Memorial Institute
- AEP, Antero, Blue Racer, Chevron, Dominion, EQT, First Energy, Mountaineer NGL Storage, Noble Energy, Southwestern, XTO Energy, CONSOL

Partnerships with Community and Professional Organizations

- WV Association of Geospatial Professionals
- WV Oil and Natural Gas Association
- National States Geographic Information Council
- Charleston Area Alliance
- Geographical Information Systems Certification Institute

Committee and Council Memberships

- State Information Technology Council, representing the Department of Commerce
- State GIS Steering Committee
- U.S. Potential Gas Committee
- Communications Committee and Board of Directors for the WV Association of Geospatial Professional

PROFESSIONAL DEVELOPMENT and PRESENTATIONS TO GOVERNMENT AGENCIES and SCIENTIFIC CONFERENCES

Cohosted and presented at conferences, meetings, and other activities around the state

- WV Association of Geospatial Professionals annual GIS meeting
- WV Information Technology Council
- WV Broadband Deployment Council
- E911 Council
- WV Association of Professional Surveyors
- Geographical Information Systems Certification Institute Board of Directors
- National States Geographic Information Council (NSGIC) Leadership Group
- NSGIC's NextGen 911, county working groups

Eastern Section American Association of Petroleum Geologists Meeting

- Poster: Constraining Recovery Efficiency via Production Data: Marcellus Play WV, Authors: Ray Boswell (U.S. DOE/NETL), B.J. Carney (NNE), Susan Pool (WVGES)
- Presentation: Constraining Estimates of In-place Resources and Recovery Efficiency using Production Data: An Example from the Marcellus Play in Northern WV, Authors: Ray Boswell (U.S. DOE/NETL), B.J. Carney (NNE), Susan Pool (WVGES)

West Virginia Science Teachers Association (WVSTA)

- Presented "What can the WVGES do for you?" showcasing the educational materials WVGES provides at <http://www.wvgs.wvnet.edu/www/geoeduc/geoeduc.htm> for K-12 teachers and students
- Planned future development of Geo-Educational material for West Virginia teachers
- Helped teachers with the required 9th-grade Geoscience course

Data Preservation Program Update Meetings

- Presented the type of work, workflow, and other details of this ongoing project
- Exchanged ideas and suggestion with other state geological surveys on common goals, challenges, and techniques to preserve samples and data, and methods to distribute those data to the public
- Met with the US Geological Survey and Partner States



The Office of the State Geographic Information System (GIS) Coordinator

This program is responsible for planning, organizing, coordinating and delivering high level Geographic Information System (GIS) advice to agencies in state government; it is headed by the statewide GIS Coordinator, based in Charleston.

Encouraging and Implementing GIS data sharing among agencies

- Fostering efficient and effective use of the state's geospatial capabilities and enhancing data sharing and exchange among state and local agencies
- Providing technical assistance to state, county, and local government agencies as well as the public in their search for GIS contract services, funding, and GIS application development
- Including the Division of Homeland Security, Division of Emergency Management, Department of Environmental Protection, the Water Development Authority, Infrastructure and Jobs Development Council, the National Guard, the WV Intelligence Fusion Center, Hazard Mitigation section, and others

Virtual and In-Person GIS workshops providing GIS advice, training, and outreach to the state's geospatial community

- Providing address geocoding support for the COVID-19 pandemic emergency for WV DHHR
- Informing, training, and advising county and local governments in the latest GIS technology
- Educating those organizations that have yet to embrace GIS technology
- Creating and continuing popular GIS courses emphasizing inter-agency collaboration
- Presenting virtually the GIS Foundations Course as well as ArcGIS Pro and ArcGIS training during the COVID-19 pandemic
- Mapping potential fiber deployments for broadband service in schools with the state Development Office
- Creating a statewide trail map with the Development Office
- Hosting the Statewide Addressing and Mapping System on the WVGISTC web servers in support of the WV Emergency Management Division
- Developing the Flood Assessment Structure Tool with FEMA's National Hazard Modeling Team
- Providing training on the WV Flood Tool, used by floodplain managers and FEMA personnel
- Continuing technical support for statewide multi-hazard risk assessments for 287 communities in West Virginia to supplement local hazard mitigation plans
- Providing technical advisory services to the state geospatial community, fielding more than 15 calls per week regarding GIS data and applications



State-wide, high-resolution elevation data (LiDAR) acquisition through the USGS and FEMA

- Providing input on areas being flown and processed
- Providing input on areas being delivered
- Processing and publishing 2-foot contours from the 2012 FEMA LiDAR-derived elevation data for Morgan and Berkeley counties
- Quality checking and organizing all new FEMA-purchased QL2 LiDAR-derived elevation products for West Virginia
- Providing elevation products for download using the WV Elevation Download Tool (www.mapwv.gov/elevation).
- Generating new statewide elevation and hill shade grids from the best-available elevation sources and published to the State Data Clearinghouse.
- Creating value-added products valued at \$10 million
- Status Graphic: https://data.wvgis.wvu.edu/pub/RA/resources/Status/FEMA-purchased_LidarCoverage.pdf
- Part of the US Geological Survey's 3D Elevation Program

GIS services in communities with less than 5000 inhabitants study

- A feasibility study derived from state Concurrent Senate Resolution 61

Geo-Enabled Elections project

- Supporting the Secretary of State's Office in their search for GIS contract services, funding, and GIS application development

National Emergency Number Association's GIS Data Stewardship for Next Generation NG9-1-1 Workgroup

- Helping develop a nationwide address spatial data infrastructure

Collaboration with Division of Emergency Management and County governments

- Assisted with the design of quality control standards and prompt address data updates dissemination to first responders

Collaboration with County and Regional governments

- Assisting county and regional governments in the acquisition of aerial imagery and GIS services

WV GIS Technical Center

The West Virginia GIS Technical Center, located in the Department of Geology and Geography, West Virginia University, provides focus, direction, statewide coordination, and leadership to users of geographic information systems (GIS), digital mapping and remote sensing within the State of West Virginia. The Center was established by Executive Order 4-93 to provide coordination and technical support in the development and operation of geographic information systems (GIS) for the State. Statewide geospatial activities are coordinated through the WV Office of GIS Coordination, WV Geological and Economic Survey. *Below are selected highlights for GIS Data Development, GIS Map Applications, Web Portals, and GIS Services.*

GIS Data Development

The Center plays a crucial role in not only serving critical spatial data to state users but in updating and integrating local geospatial data within state and national geospatial databases. These data layers are utilized by **state agencies, communities, and the general public** for applications that include emergency response, risk assessments, economic development, broadband infrastructure, transportation, energy resources, natural resources, community planning, tax assessments, and health studies. This past year the Center focused on the development of the geospatial data layers listed below to enhance the State's Spatial Data

Infrastructure. The continued development and publishing of GIS layers through the state clearinghouse node hosted by the Center supports the Mineral Lands Mapping Program and other vital programs in the State that depend on current and accurate mapping layers.

State Contracts for GIS Development

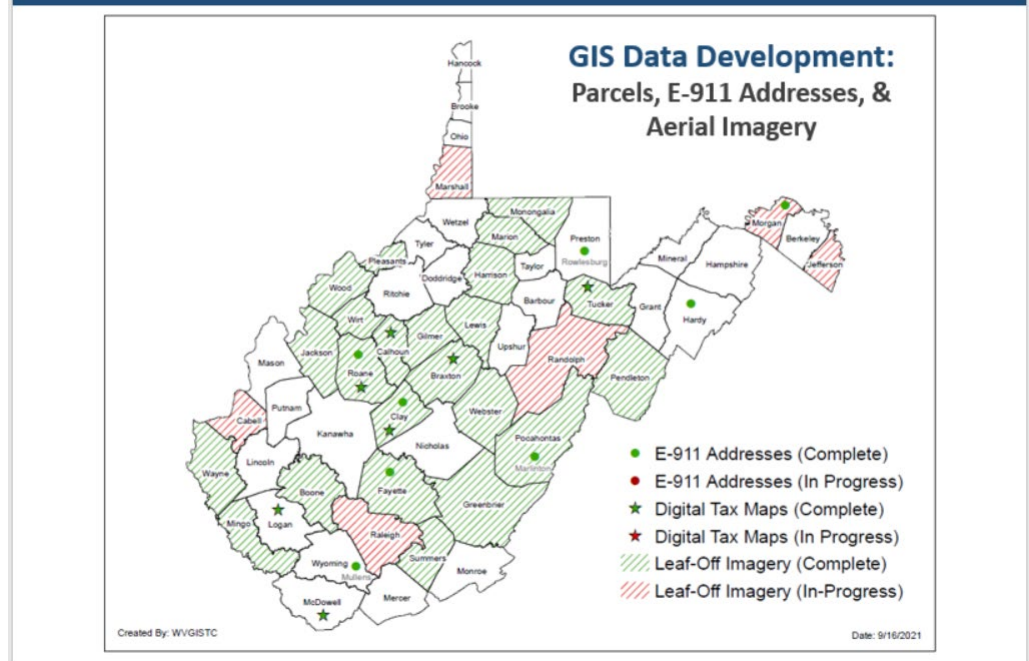


Figure 1. Two statewide GIS contracts through WVU Procurement currently support parcel, address, and aerial imagery [data development](#) for multiple communities in West Virginia



- **Mineral Parcel Mapping:** The Mineral Parcels Map Project is a collaborative effort with the WV Property Tax Division and WV Geological and Economic Survey. This past year the WV GIS Technical Center (WVGISTC) reviewed 36,259 mineral records, mapped 7,602 unique mineral parcels, and georeferenced 992 well plats. WVGISTC progressed in mapping unmapped mineral records for three counties: Ritchie (28%), Doddridge (31%), and Harrison (41%) counties.
- **Landslides:** A statewide landslide susceptibility map was created from 66,000 landslides captured from the new LiDAR-derived elevation data of which 1,082 landslides have been field verified. Although most of the landslide types are classified as slides, other landslides mapped include debris flows, rock falls, lateral spreads, and multiple failures.
- **E-911 Addresses and Digital Parcels:** A major state contract through WVU Procurement was awarded to a GIS professional services company to enable 15 communities to correct deficiencies with their E-911 addresses or tax maps. During this reporting year, digital tax map projects were completed for Clay, McDowell, Roane, and Tucker counties, while E-911 addressing projects were completed for Clay, Morgan, Preston, Roane, and Wyoming counties. Status Graphic: [GIS Reference Data Development](#).
- **Aerial Imagery:** A state contract executed through WVU Procurement has allowed for 22 counties to capture spring leaf-off imagery at six- or four-inch resolutions between 2019 and 2021. The best available, leaf-off countywide imagery is mosaicked together and published as a [statewide aerial imagery map service](#). Status Graphic: [County Aerial Imagery Year Acquired](#).
- **Elevation:** Published high-resolution 1-meter digital elevation models and 1-foot contours derived from the 2018 FEMA LiDAR data for Mason, Putnam, Randolph, Roane, Tucker, and Wirt counties. Quality checked and organized all the new FEMA-purchased QL2 LiDAR-derived elevation products for West Virginia which are downloadable from the WV Elevation Download Tool (www.mapwv.gov/elevation). Created new statewide elevation and hillshade grids from the best available elevation sources and published to the State Data Clearinghouse. The statewide FEMA-purchased LiDAR and derived products are valued at \$10 million; the State should receive the final QL2 LiDAR deliveries for the remainder of the State in October 2021. Status Graphic: [FEMA-Purchased LiDAR Elevation Status](#) and [elevation source metadata](#).
- **Flood-Risk Buildings:** Completed a [statewide building inventory](#) of primary structures in the 1-percent-annual-chance (or 100-year) floodplain. Published to the WV Flood Tool's RiskMAP View 98,000 building-level risk assessments for a 1-percent-annual-chance flood event. Added other flood-risk and mitigated property layers to the WV Flood Tool in support of flood reduction efforts.
- **Highway Plans:** Scanned 9,851 highway plan sets for an ongoing project with the WV DOT.

- **Recreational Trails:** Inventoried and published recreational trails for West Virginia consisting of 4,665 miles of land trails and 3,434 miles of [flatwater/whitewater trails](#). Customized trail maps were made for several state and local agencies including a [WV Rail-Trails map](#).
- **Public Lands:** Coordinated with the Division of Natural Resources and other stakeholders to review the state public lands and local parks for submission to the Protected Areas Database of the United States.
- **Essential Facilities/Community Assets:** Published updated essential facilities and community assets to the State Data Clearinghouse.

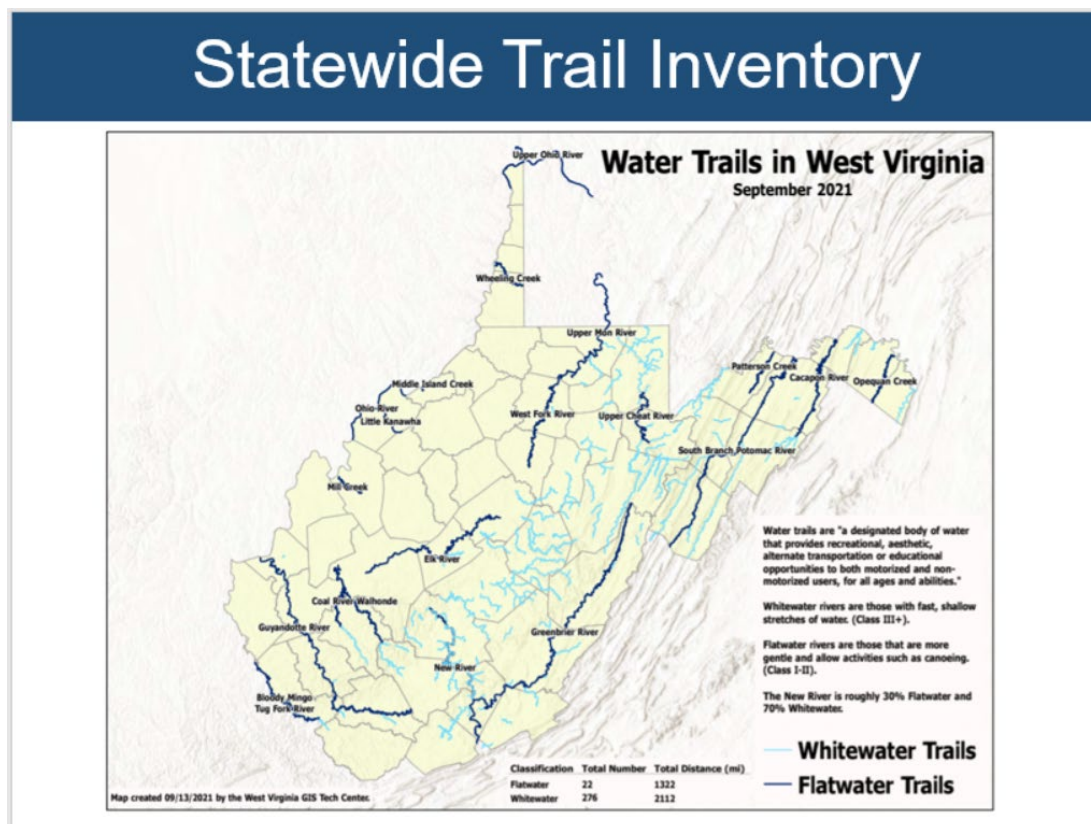


Figure 2. WVGISTC inventoried and published recreational trails for West Virginia including 3,434 miles of [flatwater/whitewater trails](#)



GIS Map Applications

Continued application and web programming assistance was provided for state and federal agencies in support of West Virginia and its citizens. These applications support multiple state agencies via e-governance solutions to meet their regulatory and information exchange requirements. (Table 1). This past year, for example, the Center modernized the trail inventory application which displays over 8,000 miles of land and water trails for West Virginia. Additionally, during this fiscal year, the Center modernized desktop applications for the WV Property Viewer, WV Flood Tool, WV Interagency Tool, WV Wetlands Functional Assessment Tool, WV Trail Inventory Viewer, and WV Elevation Download Tool. The Center also supported federal initiatives for the Marcellus Shale Energy and Environment Laboratory (www.mseel.org) and terrestrial biosphere carbon (www.carbonscapes.org).

APPLICATION	PURPOSE	SPONSOR
<i>WV Elevation & Lidar Download Tool</i>	Download LiDAR, digital elevation models, and contours (www.mapwv.gov/elevation)	WV VIEW
<i>WV Flood Tool</i>	Flood hazard determinations, floodplain management, building-level risk assessments (www.mapwv.gov/flood)	WV DHSEM, FEMA
<i>SHPO Map Viewer</i>	Conduct Cultural Resource Section 106 reviews (www.mapwv.gov/SHPO)	SHPO
<i>Statewide Addressing & Mapping System (SAMS)</i>	Update address sites and road centerlines required for emergency response (www.mapwv.gov/address)	WV DHSEM, E-911 Address Coordinators
<i>WV Hunting and Fishing</i>	Search and identify hunting and fishing adventures (http://www.mapwv.gov/huntfish)	WV DNR
<i>WV Trail Inventory</i>	View publicly accessible recreational trails in the State (http://www.mapwv.gov/trails)	WV DOT
<i>WV Highway Plans Locator</i>	View and download archival highway plans (http://www.mapwv.gov/dotplans)	WV DOT
<i>WV Conservation Interagency Conservation Tool</i>	Determine conservation planning measures for endangered species in support of environmental site evaluations (www.mapwv.gov/ICT)	WV DNR, NRCS
<i>WV Property Viewer & Property Record Search</i>	Search and display property information for entire State (www.mapwv.gov/property). Includes delinquent properties managed by the WV State Auditor's Office.	WV Tax, WV State Auditor
<i>Wetlands Functional Assessment</i>	A standardized tool for assessing wetlands (https://mapwv.gov/wetlands)	WV DEP
<i>WV Water Quality Impact Portal (WVWQIP)</i>	Obtain information about past and current water quality in the 14 Marcellus Shale gas development counties (https://www.mapwv.gov/wvwqip)	WV DEP, EPA

Table 1. Statewide Map Applications supported by Center

Web Portals

The Center maintains two major web portals to distribute spatial data and information in the State. Presently the **WV GIS State Clearinghouse** (<http://wvgis.wvu.edu>) catalogs over 300 unique datasets and 120 web services valued at more than \$65 million dollars, while **MapWV.gov** (<http://mapwv.gov>) provides a public gateway to online mapping resources in the Mountain State. These geospatial services are distributed through virtualized servers and storage devices located at the Center with an expanded storage capability of 197 TB. These servers are continuously tuned and configured to attain high-availability performance.

Web statistics reveal that MapWV.gov usage increased significantly for FY21 as web map services continued to grow in popularity. A factor for the traffic increase may be attributed to the higher demand from users working remotely due to the pandemic. Average page views per day surged from slightly under 86,000 last year to in excess of 131,000 this year. Total page views jumped from 8.3 million to slightly over 12 million, almost 50% more pages than the previous year. Similarly, the WV GIS Technical Center's Data Clearinghouse saw a significant increase in traffic, from slightly over 530,000 page views to 713,000 page views. As evident by the web statistics, the WV Property Viewer is the most popular viewer application and has experienced significant user demand.



Figure 3. The WV Property Viewer and Property Search Tool for searching and viewing property records (www.mapwv.gov/property) continues to grow in popularity

Services

This past year the WV GIS Technical Center continued to assist the WV Geospatial Community with advisory, training, and outreach services. These services are coordinated with the WV Office of GIS Coordination and WV Association of Geospatial Professionals.

- Due to the COVID-19 pandemic, the GIS Technical Center transitioned its regularly scheduled GIS Foundations and ArcGIS Pro courses from in-person to remote training.
- Provided GIS technical services for the WV Geological and Economic Survey on migration to the GeMS (Geologic Map Schema).
- Supported and presented at the WV Association of Geospatial Professionals (WVAGP) annual conference (virtual) June 29-30, 2021. During the conference, activity reports and GIS presentations from governmental, professional, and private organizations were given as well as workshops for ArcGIS Pro and GIS in Addressing.
- Supported the WV Emergency Management Division and communities with mapping support for the Statewide Addressing and Mapping System hosted on the Center's servers.
- Training and outreach services were provided on numerous occasions in support of the WV Flood Tool, an important web application used by floodplain managers and FEMA personnel.
- Continued technical support for statewide multi-hazard risk assessments for 287 communities in West Virginia to supplement local hazard mitigation plans.
- Presented on geospatial activities and projects at state and national conferences/webinars.
- Provided technical advisory services to the state geospatial community. The Technical Center responds to an estimated 15 public calls per week from the public and clients regarding GIS data and applications.

Statewide Floodplain Building Inventory

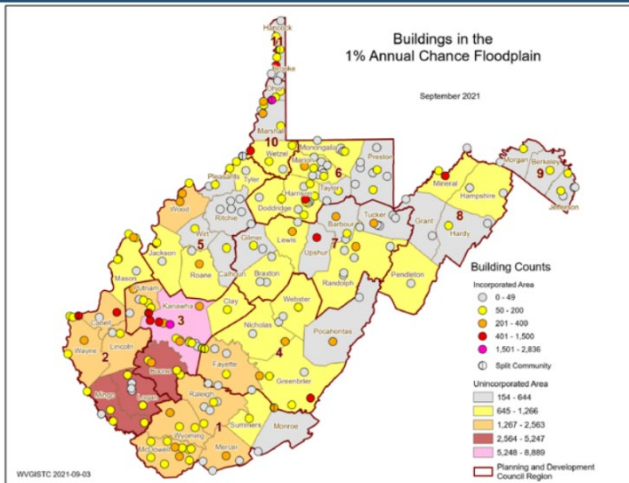


Figure 4. Completed a [statewide building inventory](#) of primary structures in the 1-percent-annual-chance (or 100-year) floodplain

Mineral Parcel Mapping

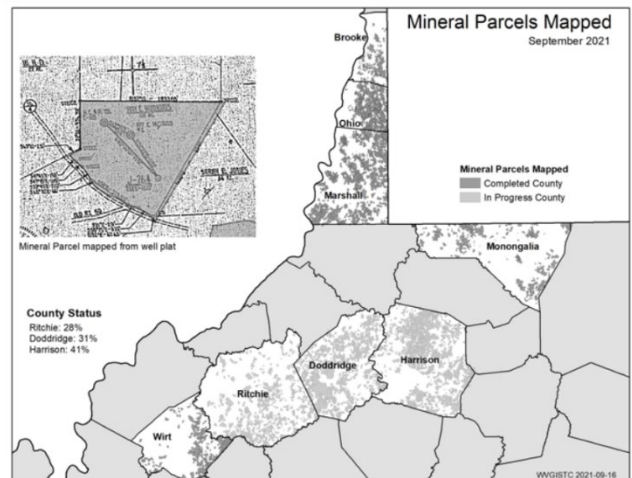


Figure 5. The Mineral Parcels Map Project is a collaborative effort with the WV Property Tax Division and WV Geological and Economic Survey to map mineral parcels.

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**Principal Staff Directory and Points of Contact
as of June 2021**

Director and State Geologist
GIS Program and Statewide GIS Coordinator
Coal Resources
Geoscience and Geologic Mapping
Oil and Gas Resources
Information Services and Publications
Public Service

Jessica Pierson Moore
Tony Simental
James Q. Britton
Philip A. Dinterman
Jessica Pierson Moore
Richard B. Binns
Kenneth C. Ashton



West Virginia Geological and Economic Survey
Mont Chateau Research Center
1 Mont Chateau Road • Morgantown, WV 26508-8079
304.594.2331 • fax: 304.594.2575
<https://www.wvgs.wvnet.edu/> • info@wvgs.wvnet.edu
39°39'30" N, 79°50'57" W

Hours: 8 a.m. to 5 p.m. Monday through Friday (*closed holidays*)

Back cover image: Portion of the Trout quadrangle draped over LiDAR imagery. The Alderson Limestone (unit labelled Mga) clearly shows advanced sinkhole development in the lower part of the image.

