



West Virginia
Carbon Capture and Storage Opportunities
Associated with Potential Locations for
Coal-To-Liquid Facilities

By

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1.0 Introduction

Gasification is a manufacturing process that converts hydrocarbons such as coal, petroleum coke and biomass to synthesis gas (syngas), which can be processed to produce chemicals, liquid fuels, hydrogen and electricity. Interest in gasification to produce liquid transportation fuels using coal-to-liquids (CTL) continues to grow worldwide, while other related approaches, such as gas-to-liquids (GTL), and biomass-to-liquids (BTL) are under evaluation. CTL describes both coal gasification, combined with Fischer-Tropsch (F-T) synthesis to produce liquid fuels, and the newer direct coal liquefaction technologies (DCL). Currently, more than 420 gasifiers operate in some 140 facilities worldwide, with 19 plants in the United States ([Gasification Technologies Council, 2008](#)). CTL enables the use of domestic coal, alone or combined with biomass, to produce transportation fuels with significantly reduced environmental impacts. The opportunities presented by the large reserves of coal in the United States and in particular West Virginia coupled with concerns with managing CTL's carbon dioxide (CO₂) emissions have come to the center stage. A 20,000 barrel per day CTL plant is expected to produce 4.7 million metric tons per year of CO₂, which can be captured using commercially proven technologies, before it would otherwise be vented to the atmosphere.

One aspect of carbon capture and storage (CCS) from a CTL facility in West Virginia is to identify cost-effective and environmentally safe strategies for long-term geologic storage (GS) of large quantities of CO₂. Fully developing the opportunity to couple GS with CTL will require addressing several challenges, including characterizing target formations, developing infrastructure and a workforce, gaining the confidence of the public and of regulators, and establishing sufficient and stable supplies of CO₂. Of these challenges, the most critical will be to define the geological storage resource within a framework of economic costs and benefits.

A geospatial (GIS) framework and associated tools were developed to evaluate value-added CCS projects associated with potential CTL location, and the overall geological storage resource within West Virginia. An inventory was developed of potential WV value-added CCS sites including oil and gas fields with potential for enhanced oil recovery, and deep coal seams with the potential for enhanced coal bed

natural gas recovery. In addition, while not value-added geologic storage, selected deep saline formations were evaluated due to their large potential storage volumes. Total volume of GS resource within West Virginia is estimated at 4,873 to 14,994 million metric tons, while total state-wide CO₂ emissions have been estimated at 114.3 million metric tons ([US EIA, 2008](#)).

A total of 765 potential sites for a CTL facility were ranked in terms of available infrastructure (e.g., major water supply (rivers), railroads, power lines and existing pipelines), and availability of value-added GS resource (e.g., oil and gas fields, and deep unmineable coal seams). Information developed in the GS site inventory was incorporated into georeferenced relational database management (RDBMS) and GIS systems for display and analysis of any location within West Virginia. All information is available through the Internet using visualization and analysis tools at West Virginia Carbon Sequestration web page <http://www.wvcarb.org>.

Future work should consider more detailed evaluation of potential GS sites, especially the potential for enhanced hydrocarbon recovery and improvement in our knowledge of saline aquifers. Since many locations are located on the border of the State (e.g., Ohio River), it is important to consider storage sites in adjacent states and develop the information and regulatory environment to permit multi-state coalitions.

2.0 Coal to Liquid Technical Background

Interest in coal-to-liquids (CTL) continues to grow worldwide, while other related approaches, such as gas-to-liquids (GTL), biomass-to-liquids (BTL) and integrated coal gasification combined cycle (IGCC), are under evaluation. However, the opportunities presented by the large reserves of coal in the United States coupled with concerns such as CTL's capital requirements, operating costs, water consumption and carbon dioxide (CO₂) emissions have come to the center stage. CTL describes both coal gasification, combined with Fischer-Tropsch (F-T) synthesis to produce liquid fuels, and the less developed, direct coal liquefaction technologies. Coal gasification is applied widely in the production of fertilizers and a broad range of chemicals (e.g., waxes, phenolics such as phenol and cresols, solvents such as alcohols and ketones, polyethylene, polypropylene, alpha olefins, coke, tar, sulphur and noble gases).

In the past, CTL has substituted for imported oil: during the 1930s and 1940s, when coal-rich Germany needed a secure source of transport fuels; and, since the 1950s in South Africa, where 40 million metric tons of coal per year are still converted into 160 000 barrels per day (b/d) of crude oil equivalent. Following the oil price shocks of the 1970s, significant coal liquefaction R&D was undertaken in the USA, Europe, Japan and Australia, although much of this development work was subsequently put on hold during the period of low oil prices from the mid-1980s and through the 1990s.

Coal may be used to produce liquid fuels suitable for transportation applications by the removal of carbon or addition of hydrogen, either directly or indirectly. The first approach is usually known as carbonisation or pyrolysis and has low yields; the second is called liquefaction. As the cost of converting coal into useful liquid fuels is higher than the cost of refining crude oil, it is the relatively low price of the raw coal feedstock that provides the main incentive to pursue the technology.

Direct liquefaction is potentially the most efficient route currently available, yielding in excess of 70% by weight of the dry, ash-free (daf) coal feed, under favorable conditions (>3 bbl per metric ton of coal). Although many different direct processes exist, common features are the dissolution of a high proportion of the coal in a solvent at high temperature and pressure followed by hydrocracking of the dissolved coal with hydrogen gas over a catalyst (Figure 2.1). The overall energy efficiencies of the very best modern processes are generally in the range 60-70% and the technology has been demonstrated at large pilot plants. Although no commercial plants yet exist, Shenhua Group's first CTL facility is under construction in China using direct liquefaction technology.

F-T-based pyrolysis processes are less efficient, but commercially proven. The F-T process coal is heated to around 950°C as decomposition occurs the volatile matter is driven off to produce synthesis gas (a mixture of carbon monoxide and hydrogen) which is then reacted over a cobalt or iron-based catalyst at temperature and pressure to produce the desired liquid products such as naphtha, diesel, lube, and waxes (Figure 2.2). The syngas stream, primarily carbon monoxide (CO) and H₂, can originate from different sources, such as natural gas methane partial-oxidation or steam reforming, coal or coke gasification, or biomass gasification (not yet commercially demonstrated). It is this indirect process using natural gas and coal that has been commercialized by Sasol in

South Africa and will be used in several new coal projects proposed in China. For a modern plant, overall energy efficiency is typically >40% (~ 2 bbl per metric ton of coal).

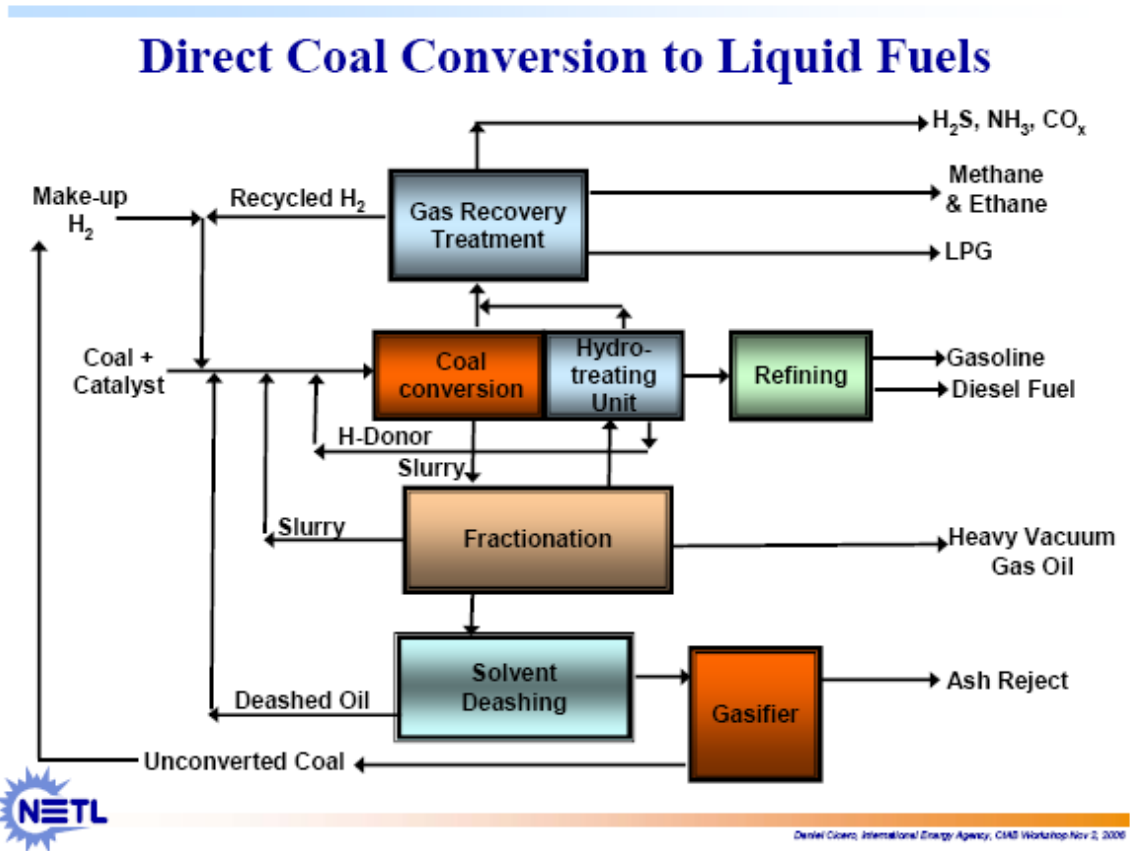


Figure 2.1 - Presentation by Daniel C. Cicero at International Energy Agency Workshop on Coal-to-Liquids, 2 November 2006

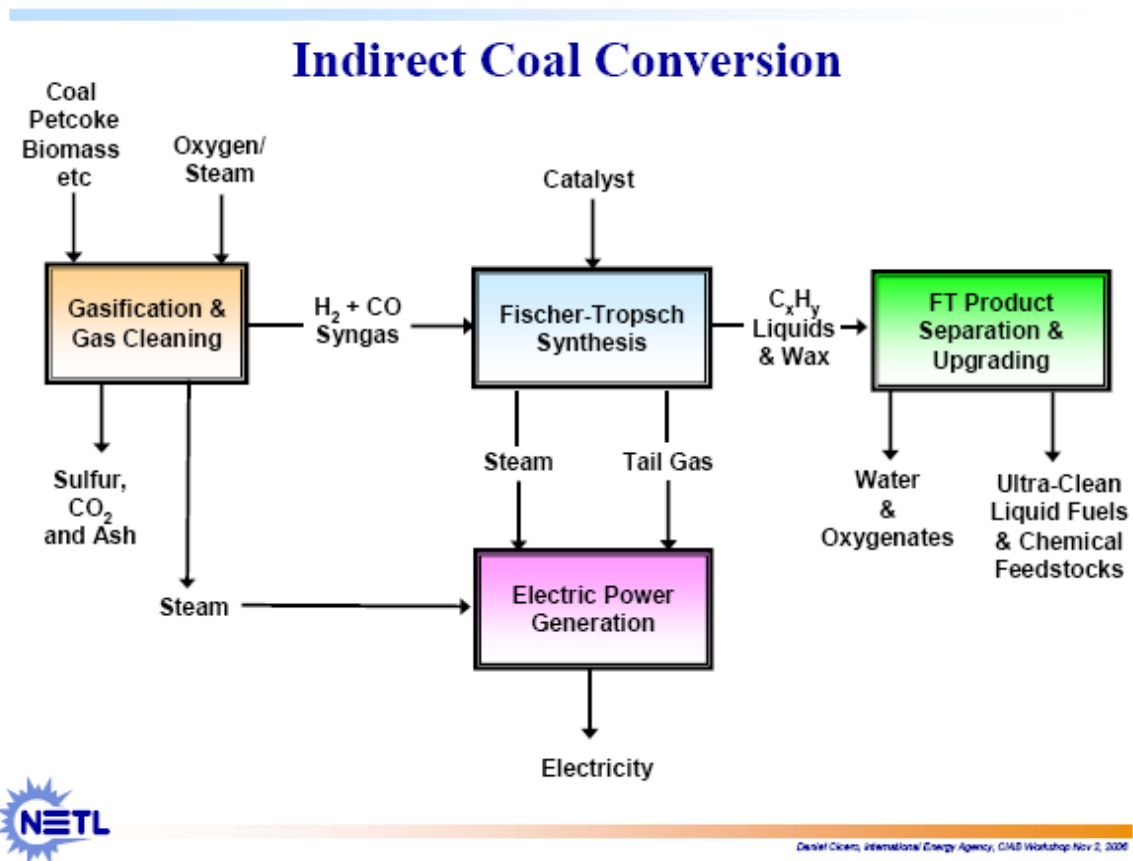


Figure 2.2 - Presentation by Daniel C. Cicero at International Energy Agency Workshop on Coal-to-Liquids, 2 November 2006

3.0 Carbon Capture and Storage Technical Background

Carbon capture and storage (CCS) encompasses the processes of capture and storage of CO₂ that would otherwise reside in the atmosphere for long periods of time. CCS involves the separation and capture of CO₂ at the point of emissions followed by storage in deep underground geologic formations. Terrestrial sequestration involves the net removal of CO₂ from the atmosphere by plants and microorganisms and its storage in vegetative biomass and in soils. There is significant opportunity to use terrestrial sequestration both to reduce CO₂ and to obtain the ancillary benefits such as habitat and water quality improvements that often result from such projects.

It is expected that large numbers of new power plants and processing facilities from coal and other non-liquid hydrocarbons including coal-to-liquid (CTL) will be built in the coming decades, in both the developing world as well as in some areas of the developed world, such as the U.S. and Canada. These new facilities, along with existing plants having the potential for being appropriately retrofitted, will create opportunities for deploying efficient CCS technologies.

About 28 billion tons of CO₂ was emitted globally into the atmosphere in 2006, the US share of which was about 5.6 billion tons. About half of this came from large stationary sources, primarily coal-fired power plants from which CO₂ is at low concentration (20%) and with present technology is not considered to be capturable at a reasonable economic cost. CTL plants emit a relatively concentrated CO₂ stream which can be captured, compressed and transported for geologic storage. A typical CTL plant will produce 0.65 ton CO₂/barrel of liquid products, a 20,000 barrel per day CTL plant is expected to produce 4.7 million tons/year of CO₂.

In West Virginia total CO₂ emitted into the atmosphere in 2005 was estimated at 114.3 million metric tons of which 85.3 million metric tons was from electric power generation ([US EIA, 2008](#), Figure 3.1).

The process of CO₂ geologic storage includes monitoring, mitigation, and verification (MM&V) as well as risk assessment at the sequestration site. Effective application of these MM&V technologies will ensure the safety of sequestration projects with respect to both human health and the environment, and provide the basis for establishing carbon credit trading markets for sequestered CO₂. Risk assessment research focuses on identifying and quantifying potential risks to humans and the environment associated with CO₂ sequestration and helping to ensure that these risks remain low.

Geologic storage is most efficient at depths greater than 2400 to 2600 feet (~0.8 km). CO₂ increases in density with depth and becomes a supercritical fluid at pressures that naturally exist at depth (Figure 3.2). Supercritical fluids take up much less space, and diffuse better than either gases or ordinary liquids through the tiny pore spaces in storage rocks. CO₂ will be trapped as a supercritical fluid in tiny pore spaces in the storage rock (Figure 3.3).

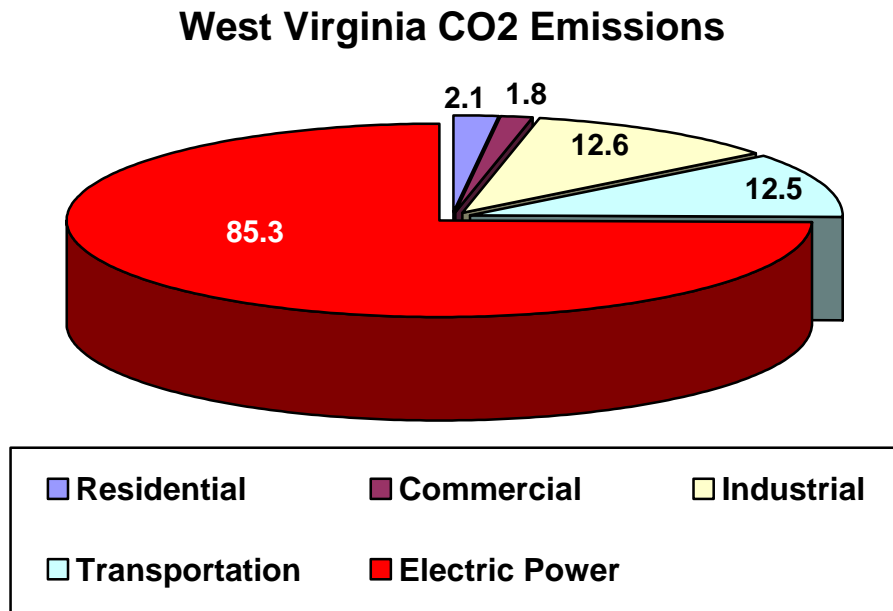


Figure 3.1— Estimated West Virginia CO₂ emissions by sector for 2005. Source ([US EIA, 2008](#))

Geologic storage (GS) of CO₂ can occur in three major geological targets in sedimentary basins (Figure 3.4). These are:

- oil and gas reservoirs;
- deep coal beds; and
- deep saline formations, saturated with brackish water or brine.

3.1 Methodology

The methodology used for geologic storage estimates follows the methodology published in the US Department of Energy’s [2008 Carbon Sequestration Atlas of the United States and Canada \(Atlas II\)](#). The peer-reviewed rationales presented were used to simplify assumptions for estimating the amount of CO₂ that can be stored in subsurface geologic environments. The methodologies described were designed to integrate results for three types of geologic formations: saline formations, unmineable coal seams, and oil and gas reservoirs. These methodologies are developed to be consistent across North America for a wide range of available data. A CO₂ *resource* estimate is defined as the volume of

porous and permeable sedimentary rocks available for CO₂ storage and accessible to injected CO₂ via drilled and completed wellbores. Carbon dioxide resource assessments do not include economic or regulatory constraints; only physical constraints to define the accessible part of the subsurface are applied. Economic or regulatory constraints would be used to generate CO₂ *capacity* estimates. It should also be noted that for the development of specific commercial-scale geologic storage sites, economic and regulatory constraints must be considered to determine the portion of the CO₂ resource that is available under various development scenarios. Only under the most favorable economic and regulatory scenarios, can 100 percent of the estimated CO₂ resource may be considered CO₂ capacity.

Methods for estimating subsurface volumes are widely and routinely applied in petroleum, groundwater, underground natural gas storage, and Underground Injection Control disposal-related estimations. Therefore, the volumetric method is the basis for CO₂ resource calculations. The volumetric formula uses porosity, area, and thickness with various efficiency terms included to account for ranges of variations in the geologic volumetric properties and the fraction of the accessible pore volume that is most likely to be contacted by injected CO₂.

3.2 Oil and Gas Reservoirs

Mature oil and gas reservoirs have held crude oil and natural gas over millions of years. They consist of a layer of permeable rock with a layer of nonpermeable rock (caprock) above, such that the nonpermeable layer forms a trap that holds the hydrocarbons in place. Oil and gas fields have many characteristics that make them excellent target locations for geologic storage of CO₂. The geologic conditions that trap oil and gas are also the conditions that are conducive to CO₂ sequestration.

As a value-added benefit, CO₂ injected into a mature oil reservoir can enable incremental oil to be recovered. A small amount of CO₂ will dissolve in the oil, increasing the bulk volume and decreasing the viscosity, thereby facilitating flow to the wellbore. Typically, primary oil recovery and secondary recovery via a water flood produce 30-40 percent of a reservoir's original oil in place (OOIP). A CO₂ flood allows recovery of an additional 10-15 percent of the OOIP. The suitability of oil and gas reservoirs are the best known of the potential geologic storage options because they are

better known as a result of exploration for and production of hydrocarbons. CO₂ geologic storage in oil and gas reservoirs can be evaluated based on reservoir depth and size.

Over the past 30 years enhanced oil recovery (EOR) using CO₂ flooding has proven as a valuable technology in areas with natural CO₂ supplies. Miscible and immiscible CO₂ flooding can revitalize mature oil fields. At present, limited availability of CO₂ supplies in most of the United States constrains CO₂ EOR production. However, coal -to-liquids plants could produce and capture large quantities of CO₂, which can be sold to oil and gas producers for enhanced recovery uses. The CO₂ generated by CTL plants could be a value added product, while at the same time storing it in reservoirs deep beneath the earth's surface.

3.3 Unmineable Coal Seams

Unmineable coal seams are too deep or too thin to be economically mined. All coals have varying amounts of methane adsorbed onto pore surfaces, and wells can be drilled into unmineable coalbeds to recover this coalbed methane (CBM). Initial CBM recovery methods, such as dewatering and depressurization, leave a considerable amount of methane in the formation. Additional recovery can be achieved by sweeping the coalbed with CO₂. Depending on coal rank two to thirteen molecules of CO₂ are adsorbed for each molecule of methane released, thereby providing an excellent storage site for CO₂ along with the additional benefit of enhanced coalbed methane (ECBM) recovery. Similar to maturing oil reservoirs, unmineable coalbeds are good candidates for CO₂ storage.

The suitability of coal for CO₂ geologic storage can be evaluated on technical, economic and regulatory (resource protection) criteria. The first depends on coal properties and behavior in the presence of CO₂, the second depends on technology and economic environment, and the third depends on the presence of other resources, such as groundwater, and the future use of the coal as an energy mineral, that need to be protected, and for public safety.

3.4 Saline Formations

Saline formations are layers of porous rock that are saturated with brine. They are much more extensive than coal seams or oil- and gas-bearing rock, and represent an enormous potential for CO₂ storage. However, much less is known about saline formations because they lack the characterization experience that industry has acquired through resource recovery from oil and gas reservoirs and coal seams. Therefore, there is a greater amount of uncertainty regarding the suitability of saline formations for CO₂ storage.

The suitability of the CO₂ storage capacity in deep saline aquifers is complex as a result of the various physical and chemical mechanisms involved that act on different time scales, such as dissolution and mineral precipitation. In stratigraphic and structural traps, the CO₂ storage capacity can be estimated following similar procedures as oil and gas reservoirs, but still involves an outstanding of temperature, pressure and salinity constraints. In the large areas without well defined traps a general rough solution can be achieved through time-discounted estimates of dissolution potential. As time goes on, increasingly secure physical and chemical trapping mechanisms come into play and the overall security of storage increases (Figure 3.5). However, it is critical to understand the displacement and migration saline brines and injected CO₂ within these deep formations. The geologic storage potential in West Virginia saline formations is very large, but will require significant local refinement and numerical modeling to further constrain.

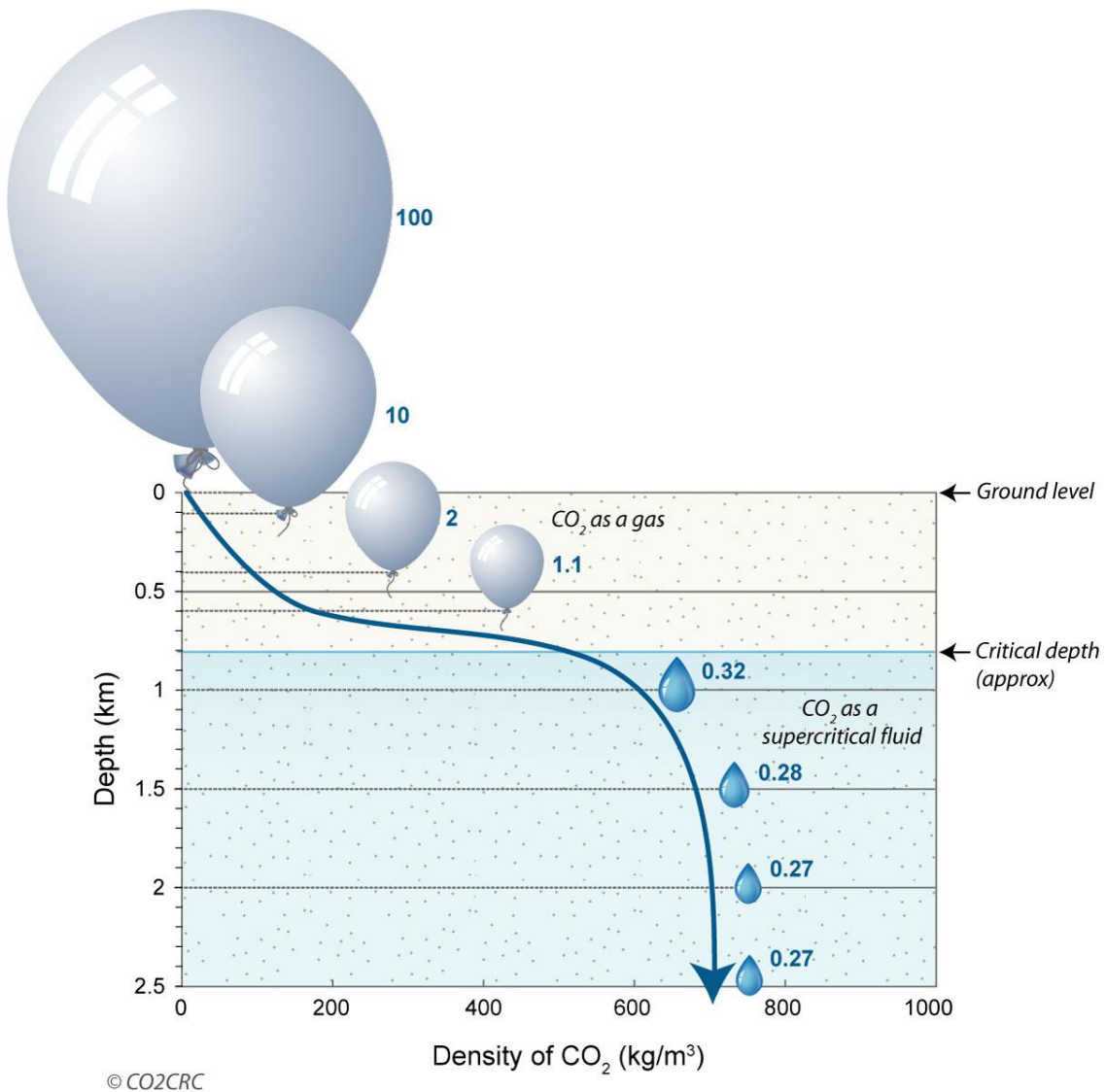


Figure 3.2-- CO₂ injected at depths below 0.8 km (2600 feet) increases in density with depth and becomes a supercritical fluid. Supercritical fluids take up much less space, as shown in this figure, and diffuse better than either gases or ordinary liquids through the tiny pore spaces in storage rocks. The blue numbers in this figure show the volume of CO₂ at each depth compared to a volume of 100 at the surface.

Image Source CO2CRC (<http://www.co2crc.com.au/imagelibrary/>)

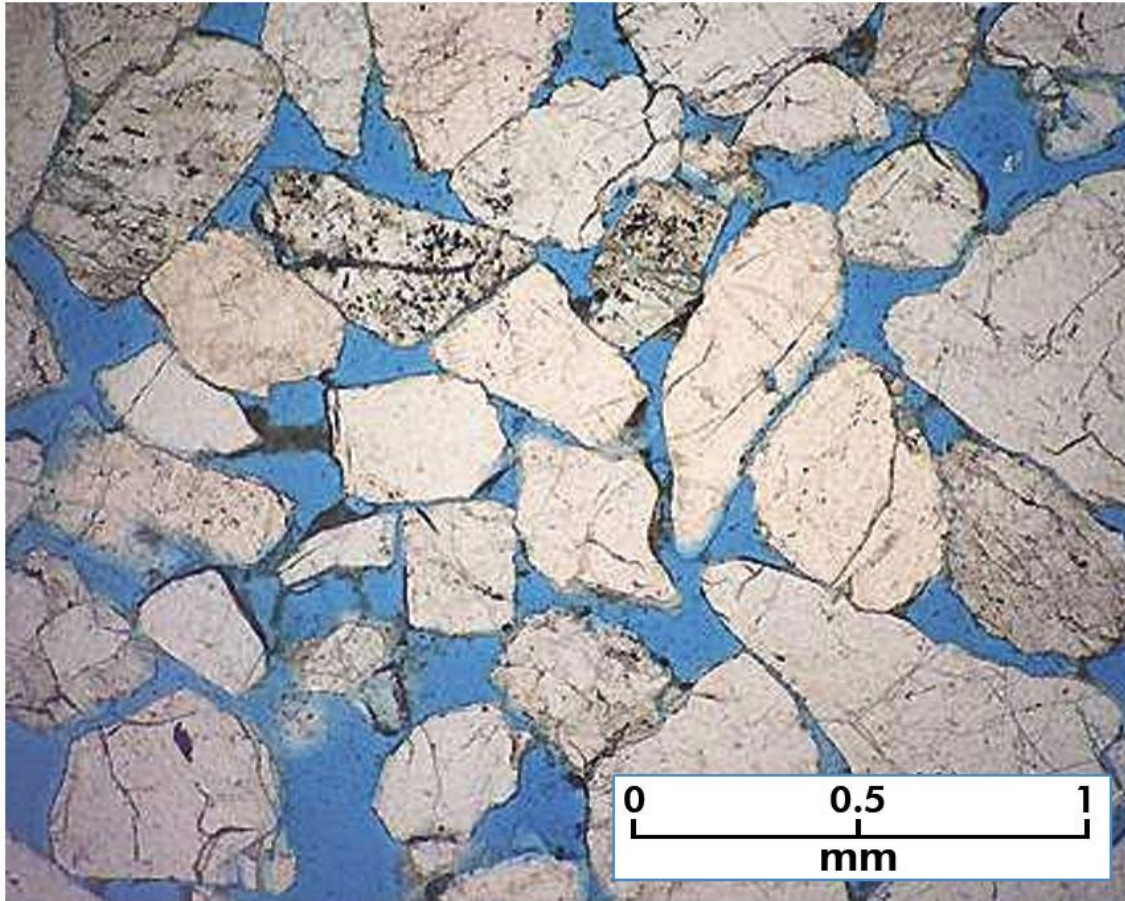


Figure 3.3 -- CO₂ will be trapped as a supercritical fluid in tiny pore spaces in the storage rock, as is shown by the blue spaces between the white grains of quartz in this photograph of a microscopic section of storage sandstone.

Image Source CO2CRC (<http://www.co2crc.com.au/imagelibrary/>)

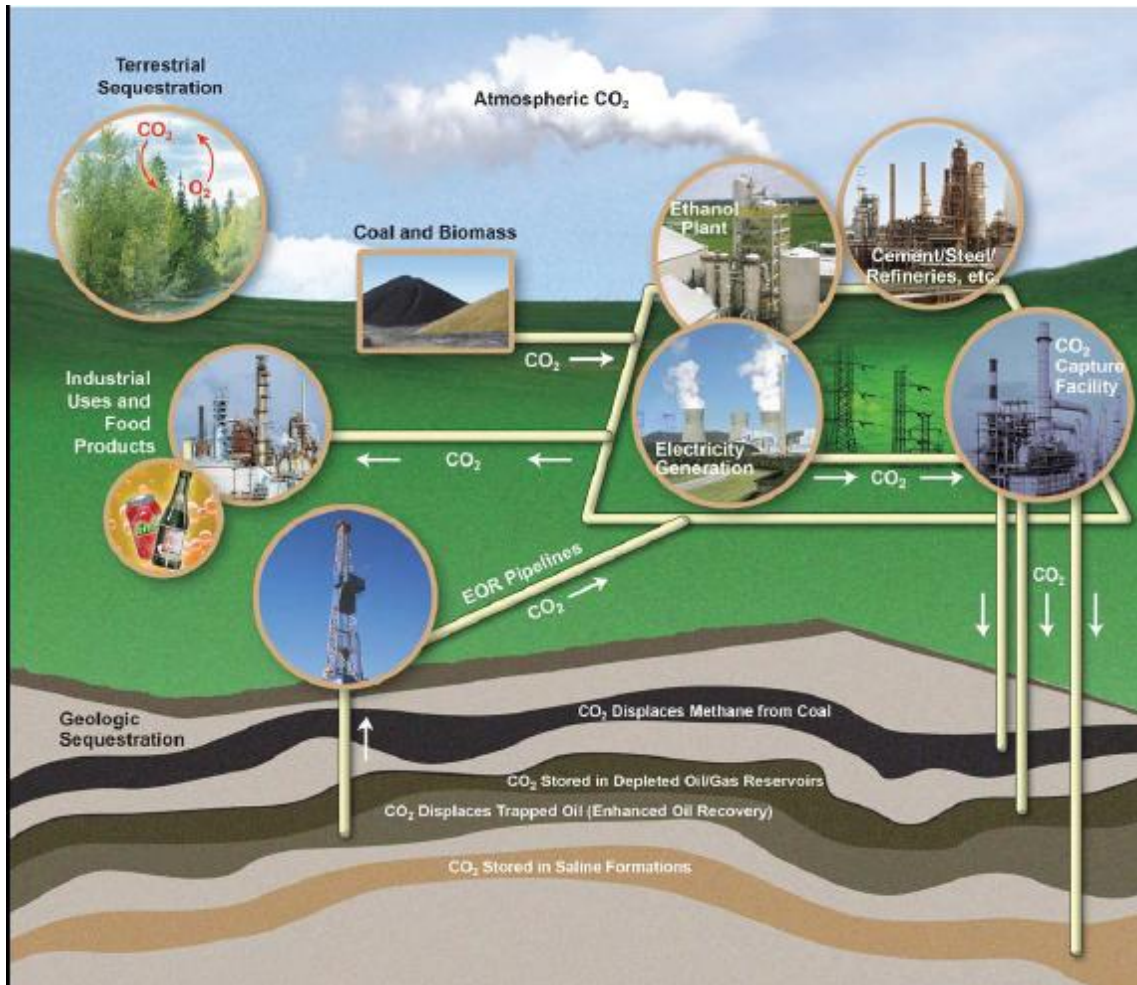


Figure 3.4 -- Illustration of carbon capture and storage (CCS) process showing major pathways for geologic storage and terrestrial storage. Source Carbon Sequestration Atlas of the United States and Canada, US Department of Energy, National Energy Technology Laboratory, March, 2007).

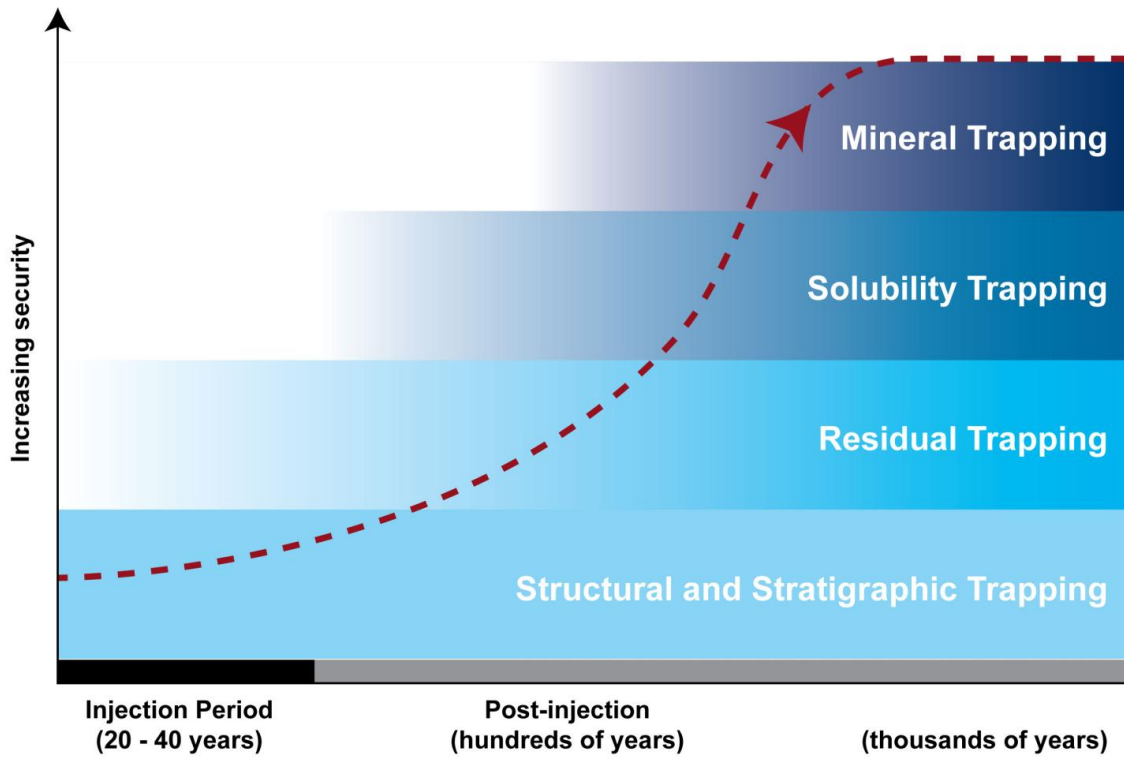


Figure 3.5 -- As time goes on, increasingly secure trapping mechanisms come into play and the overall security of storage increases. This is especially important in saline formations where relatively well understood structural and stratigraphic trapping operates over short time frames.

Image Source CO2CRC (<http://www.co2crc.com.au/imagelibrary/>)

4.0 West Virginia Geologic Storage Potential

Opportunities and constraints were examined for CCS projects that could simultaneously reduce greenhouse gas emissions, increase oil and natural gas production, and provide a value-added revenue stream for a coal conversion project. Such opportunities include using carbon dioxide (CO₂) for enhanced oil or natural gas production. WV contains numerous targets of opportunity for value-added CCS. These include sinks such as oil fields ready for enhanced oil recovery (EOR), and the potential for enhanced coal bed methane (ECBM) production and even enhanced shale gas production.

Fully developing this opportunity will require addressing several challenges, including characterizing target formations, developing a workforce, gaining the confidence of the public and of regulators, and establishing sufficient supplies that CO₂ will be considered as a commodity. Of these challenges, the most critical will be to define the geological storage resource within a framework of economic costs and benefits.

A geospatial (GIS) framework and associated tools were developed to evaluate value-added CCS projects, and the geological storage potential within West Virginia. An inventory was developed of potential WV value-added CCS sites including oil and gas fields with potential for enhanced oil recovery, and deep coal seams with the potential for enhanced coalbed methane recovery. In addition, while not value-added geologic storage sites, selected deep saline formations were evaluated due to their large potential storage volumes.

All information developed in the site inventory was incorporated into georeferenced relational database management (RDBMS) and GIS systems and display using online visualization and analysis tools.

The following potential geologic storage targets were evaluated and placed within a GIS framework.

4.1 Oil and Gas Reservoirs

West Virginia has a long history of both oil and gas production stretching back into the 19th century. In this study, an initial estimate indicates that West Virginia has numerous oil and gas fields with the potential for long-term geologic storage of CO₂. CCS sites that offer the potential economic benefit of additional oil or gas production are important early targets for establishing a CTL industry in WV. Revenue from oil and gas production can offset the significant costs of capture, compression, transport and injection of the CO₂ emitted from the CTL process, and significantly increase the economic feasibility of a low CO₂ -emitting CTL plant. Total estimated CO₂ storage resource in the known conventional oil and gas reservoirs of West Virginia is 13.5 to 14.9 million metric tons.

4.2 Unminable Coal Seams.

The evaluation of unminable coal seams in West Virginia was limited to the deep coal seams (>2,400 feet) in the western part of the state that were penetrated by oil and gas wells searching for deeper hydrocarbon resources. With limited data on the methane content of these coals the volume of CO₂ that could be store in these unites was based on a low methane content (100 standard cubic feet per ton) and low differential adsorption rate of two CO₂ molecules for on methane molecule. Total estimated CO₂ storage resource in the deep unminable coal seams in the western part of the West Virginia is 177 million metric tons.

4.3 Saline Formations

The geologic storage potential in West Virginia saline formations is very large, but will require significant local refinement and numerical modeling to further constrain.

Currently, a number of saline formations are used for waste-fluid disposal and natural gas

storage in West Virginia. Thus, a long history of technological disposal and regulatory factors exists that could be applied to CO₂ injection. In order to maintain injected CO₂ in its supercritical state (i.e., liquid), the injection horizon depth must be at or greater than 2,500 ft. Maintaining CO₂ in its liquid phase is desirable because, as a liquid, it takes up less volume than when it is in the gaseous phase (Figure 3.2). One ton of CO₂ at surface temperature and pressure (when it is in its gaseous phase) occupies approximately 18,000 cubic feet. The same amount of CO₂ will occupy only 50 cubic feet when injected into a formation at a depth of approximately 2,600 ft. Sequestration depths of at least 2,500 ft also insure there is an adequate interval of rocks (confining layers) above the potential injection zones to act as geologic seals.

West Virginia has numerous deep-saline formations that have some level of potential as injection zones. In ascending order, these include parts of of the Conasauga Group, Copper Ridge Dolomite (both vugular porosity zones and the “B” zone sand within this unit), Rose Run sandstone, Beekmantown dolomite, “Clinton” sandstone, Lockport Dolomite, porous carbonate zones within the Salina Group, Bass Islands Dolomite, Oriskany Sandstone, and Devonian black shale units.

While not a value added process and not incorporated into the present analysis of individual sites, the very large potential storage resource should be considered in evaluating a potential CCS project. Total estimated CO₂ storage resource in selected deep saline formations in the western part of the West Virginia is 3,343 to 13,463 million metric tons.

5.0 Coal-to-Liquids (CTL) Facility Site Rating Model

A GIS methodology was developed to evaluate the suitability of a list of 762 potential sites for a CTL facility in terms of existing infrastructure (pipelines, power lines, railroads, rivers), and potential sequestration sites for GS in oil and gas fields, and in deep coal beds. Sites are rated on a relative scale from lowest to highest potential on a relative scale from 1 to 100. The suitability of each site is calculated based on a weighted sum of the distances from each of these variables.

In order to develop ratings for potential sites that define their suitability for hosting a coal-to-liquids facility, we have developed a series of distance decay equations. The final rating contains two major elements: distance from infrastructure and distance required to sequester pre-determined amounts of carbon dioxide. The carbon sequestration portion of the model will also take into account the potential value added resource extraction.

5.1 Infrastructure Requirements

Each site will be rated in terms of its Euclidean distance from specific types of infrastructure. That rating will take the following form:

$$WI_{\{rail,power,pipes,water\}} = X + \frac{1}{d^n}$$

Where d = distance to nearest infrastructure of that type, X = cost per mile per infrastructure type, $n = 1$ and WI = infrastructure weight.

This is a distance decay function. As distance (d) increases, the value of the weight decreases. The rate of decay can be adjusted by changing the value of the power (n) of d . This value will be calculated for four types of infrastructure critical for locating a CTL plant: major water supply (rivers), railroads, power lines and existing pipelines.

5.2 Value Added Carbon Capture and Storage (CCS)

The carbon capture and storage (CCS) equation takes the form of a distance decay function with the addition of a time parameter. For each potential geologic storage site (coal, oil, natural gas, and saline formations), we calculate the following equation:

$$WS_{\{oil,gas,coal\}} = \sum (X \times \frac{1}{d_{\{1,5,10,20\}}}) + (Z \times \frac{Q_{\{1,5,10,20\}}}{C})$$

Where X = Cost of CO₂ pipeline per mile, d = sequestration neighborhood size, Z = sequestration type weight (where oil>coal>gas), Q = quantity of sequestration within neighborhood, C = quantity of CO₂ produced by 10 years of production of a 20K BBL/day CTL plant and WS = sequestration weight per sequestration type.

It was arbitrarily decided that the predetermined quantity of CO₂ would be ten years of emissions from a 20,000 barrels per day plate using coal gasification, combined with Fischer-Tropsch (F-T) synthesis to produce liquid fuels (0.65 ton CO₂/bbl of liquid products). This combined time and quantity over a distance incorporates the significant capital costs of building the CCS infrastructure (i.e., compressors, pipeline and injection wells).

The value of Z reflects the potential added value of recovering a natural resource from that sequestration strata – i.e., oil will decay slower than natural gas because enhanced oil recovery (EOR) can provide more economic return. If technical challenges can be overcome, enhanced coalbed methane recovery (ECBM) from deep coal beds, also has the potential for economic return. The potential economic return from geologic storage of CO₂ in saline formations and gas fields is rated very low. As a result the following is reflected in the model weights: oil > coal > gas = brine.

5.3 Final Weight

The final weight per site will be determined by the equation:

$$R = \sum WS_{oil} + WS_{gas} + WS_{coal} + I$$

where I is the sum of the infrastructure weights.

$$I = \sum WI_{\{rail,power,pipes,water\}}$$

The final CTL site suitability rating was scaled from 1-100.

5.3 Final Weight

A GIS methodology was used to evaluate the suitability of a list of 762 potential sites in West Virginia for a CTL facility in terms of existing infrastructure (pipelines, power lines, railroads, rivers), and potential value-added sequestration sites in West Virginia for GS in oil and gas fields, and in deep coal beds (Figure 5.1, Appendix 1). Saline aquifers as GS targets were not factored into the site suitability rankings. Site suitability is on a relative scale from lowest to highest potential on a relative scale from 1 to 100. The top ten percent (10%) of potential sites for a CTL facility based on this methodology form two clusters in the northern Monongalia and upper Kanawha river basins (Figure 5.2). The high concentration of favorable sites in these two locations is the result of coincidence of infrastructure and value added GS targets. However, potential sites for a CTL facility along the borders of West Virginia are negatively affected by the political limits on the radial search mechanism. In simpler words, no consideration was given to favorable GS targets across the state boundaries in Ohio, Pennsylvania and Kentucky. From a technical standpoint, it would be worthwhile to consider adjoining states. However, crossing state and regulatory boundaries (i.e. different EPA regions, different Underground Injection Control (UIC) primacy) raises serious regulatory and political questions that would have to be addressed.

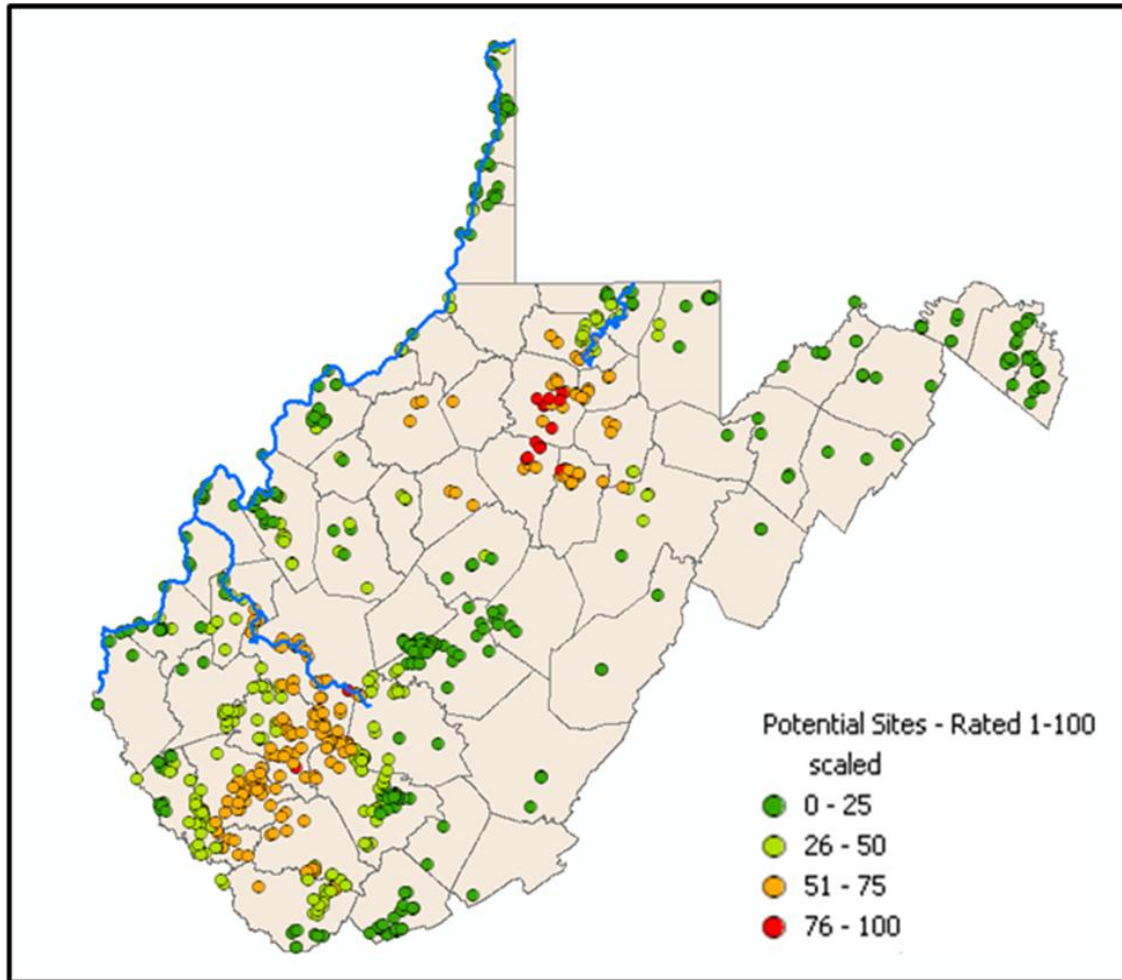


Figure 5.1 – Relative raking of 762 potential sites in West Virginia for a CTL facility in terms of existing infrastructure (pipelines, power lines, railroads, rivers), and potential value-added sequestration sites in West Virginia for GS in oil and gas fields, and in deep coal beds. The concentration of less favorable potential sites for a CTL facility along the borders of West Virginia are in part the result of limit the radial search mechanism to only West Virginia. The listing of all sites evaluated is provided in Appendix 1.

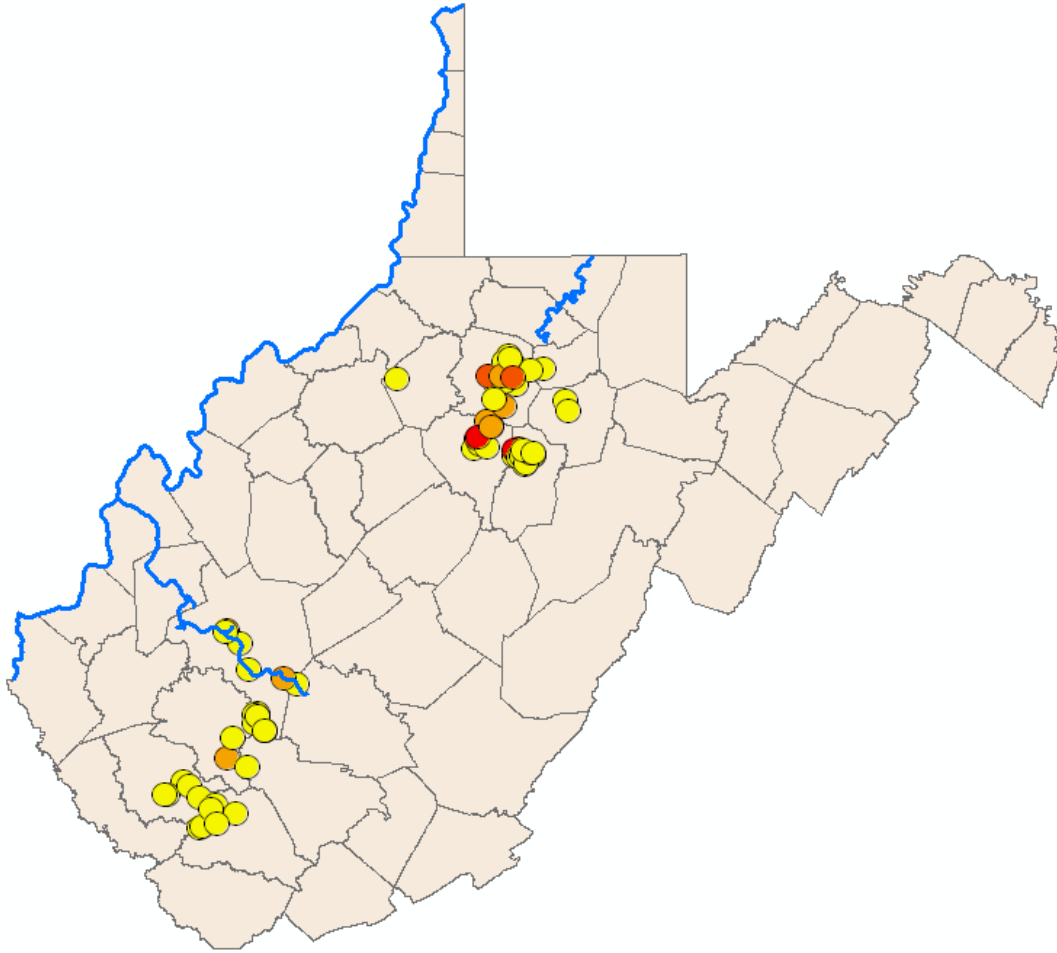


Figure 5.2 – Top ten percent of 762 potential sites in West Virginia for a CTL facility in terms of existing infrastructure (pipelines, power lines, railroads, rivers), and potential value-added sequestration sites in West Virginia for GS in oil and gas fields, and in deep coal beds. . The concentration of most suitable potential sites for a CTL facility based on this methodology are in two clusters in the northern Monongalia and upper Kanawha river basins. The listing of all sites evaluated is provided in Appendix 1.

6.0 Carbon Sequestration Explorer

Data and geospatial information on geologic storage resources gathered in the course of evaluating potential sites in West Virginia for a CTL facility can be accessed through the *West Virginia Carbon Sequestration Explorer*. The *Explorer* is an online accessible map-based computing environment that provides paths to geospatial information and services for search, visualization, and analysis. Geological data, focused on the assessment of large-scale geological sequestration, include measurements of potential storage volumes for oil and gas fields, and deep coal beds (> 2,400 feet) in West Virginia. Due to the poor geospatial understanding of the critical GS parameters of saline aquifers they are not included at this time. The data gathered have been arranged (gridded at 1,000 meters or less), so that the carbon storage resource can be generated and displayed for any point in West Virginia. Information is accessed and assembled through an Internet map server and provided to the decision-makers and the general public at distances for 1 mile, 5, 10 and 20 miles.

The online user can access the *West Virginia Carbon Sequestration Explorer* through the *Evaluation Tools* tab in the upper left-hand corner of the *West Virginia Carbon Sequestration* page (<http://www.wvcarb.org/>) (Figure 6.1). The *West Virginia Carbon Sequestration* page provides additional links to background and summary information on CCS and to CTL.

The *West Virginia Carbon Sequestration Explorer* is an Internet-based mapping tool that provides the user online access to a geographic information system (GIS). The user can display the distribution and estimated CO₂ geologic storage resource for oil fields (Figure 6.2), gas fields (Figure 6.3), deep coal beds (Figure 6.4) or any combination of layers. The tools allow the user to zoom and move through the state at any scale. In addition the carbon sequestration buffer allows the user to query the data to determine the CO₂ geologic storage resource in metric tons of CO₂ within West Virginia using a variable distance from any point in the state (figures 6.5-6.7). The user can use the tools to zoom in and move to evaluate areas of interest (figures 6.6 – 6.7). The approach does not incorporate potential CO₂ geologic storage resource in the surrounding states, so locations on the borders of West Virginia do not evaluate this CO₂ geologic storage resource which may be immediately adjacent to the emission source.

7.0 Summary and Recommendations

West Virginia has a large quantity of CO₂ geologic storage resource in oil and gas fields, deep coal seams (> 2,400 feet) and saline aquifers. The CO₂ geologic storage resource amounts to many decades of the total state-wide CO₂ emissions. It should be possible to locate viable geologic storage targets in West Virginia and surrounding states.

To completely evaluate CO₂ *resource* estimates will require access to large quantities of subsurface information (e.g., well bore schematics, well logs and other engineering and geologic data). Much of this information is difficult to obtain in a form for analysis. A major effort will be required to create a public information environment to completely evaluate and regulate large-scale CCS. Carbon dioxide resource assessments do not include economic or regulatory constraints; only physical constraints to define the accessible part of the subsurface are applied. Economic or regulatory constraints are required to generate CO₂ *capacity* estimates and develop specific commercial-scale geologic storage sites.

One regulatory and political constraint is that many potential sites for a CTL facility coupled with CCS are located along the borders of West Virginia (e.g., Ohio River). Sites in Ohio, Pennsylvania and Kentucky may provide additional cost-effective and safe GS opportunities. However, these states have different Underground Injection Control (UIC) regulations and primacy. Both Kentucky and Pennsylvania do not have primacy for injection wells, and the primary enforcement responsibility lies with the two different regions of the Environmental Protection Agency (Figure 7.1). Crossing state and regulatory boundaries to facilitate CCS will require close cooperation across multiple levels of state and federal units.

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West Virginia Carbon Sequestration

Impetus & Challenges Technical Background Carbon Capture & Storage WV Storage Potential Evaluation Tools

Carbon Sequestration, Coal to Liquids, and the future of carbon in West Virginia.

Coal is uniquely positioned to be an integral part of a transition away from petroleum-based fuels. West Virginia, with substantial coal reserves, abundant water, an established energy infrastructure and a trained workforce, is in a position to capitalize economically on the coal-to-liquids technology (CTL). West Virginia's goal is to displace 1.3 billion gallons of imported oil annually by 2030 through use of indigenous fuels. Building five CTL plants could meet WV's goal.

CTL plants could be a large contributor -- a 20,000 barrel per day CTL plant could produce 300 million gallons of clean diesel and other transportation fuels each year. A 20,000 barrel per day plant would require 3.6 million metric tons of coal a year (roughly 900,000 metric tons of coal per year is required for each 5,000 barrels per day capacity increment for a CTL plant). Providing the coal to support five CTL plants would increase the State's annual coal production by 15% from current levels.

The infrastructure requirements for a CTL plant are significant. Railroad or barge access would be important to minimize coal transportation costs. Access to water would be needed to meet the plants process water and cooling requirements. Proximity to electric transmission lines, natural gas pipelines, and carbon capture and storage (CCS) are additional requirements.

This web site provides information to begin to address the potential challenges of advancing CTL technology to meet the State's oil displacement goal.

NRECE WEST VIRGINIA DIVISION OF ENERGY WVGS Technical Center WVGES West Virginia University

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Figure 6.1 – The *West Virginia Carbon Sequestration* page (<http://www.wvcarb.org/>) provides information on carbon capture and storage opportunities and its focus on evaluating the CO₂ geological storage resource from any potential Coal-To-Liquids (CTL) facility in West Virginia. In the upper left-hand corner is a tab that provides access to the *West Virginia Carbon Sequestration Explorer* (Figure 6.2).

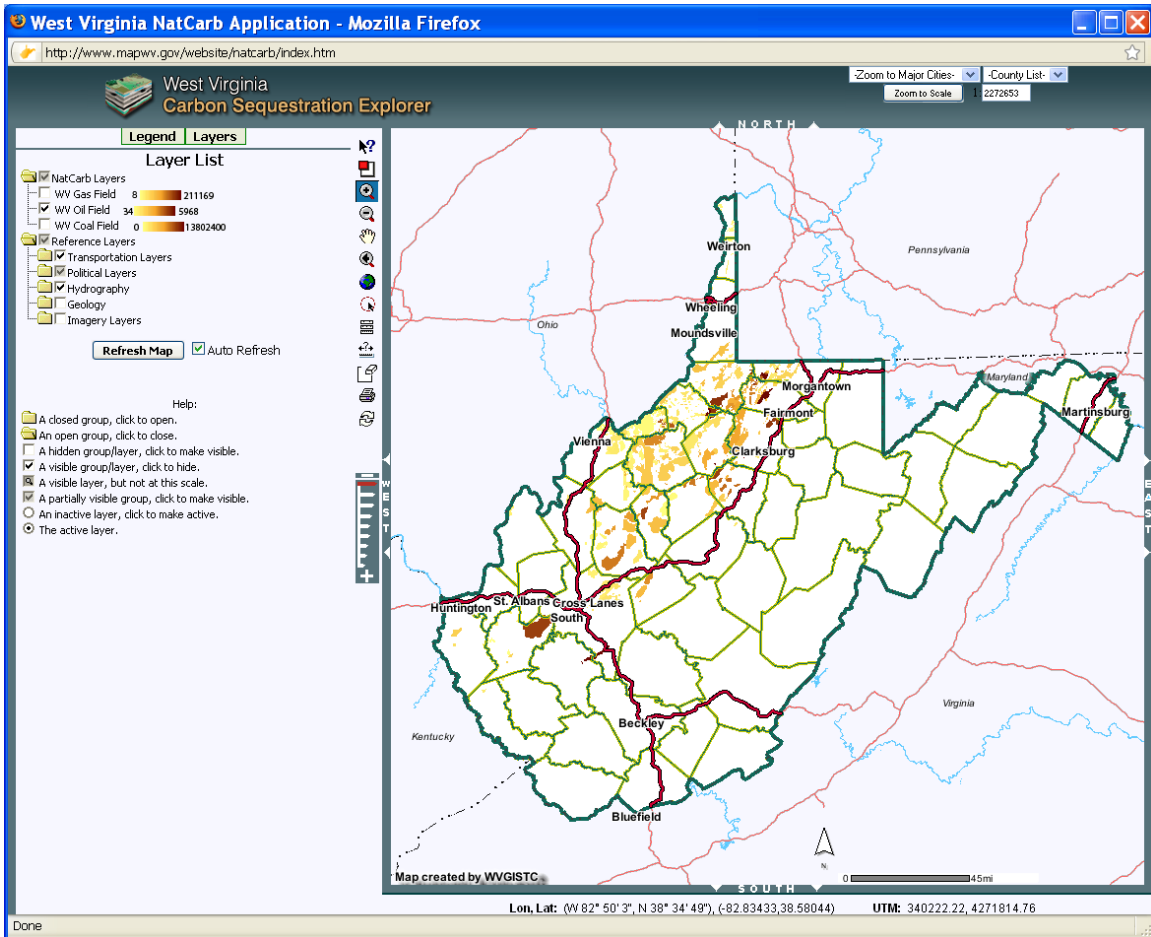













Figure 6.2 – The *West Virginia Carbon Sequestration Explorer* showing the distribution of oil fields that were evaluated for CO₂ geological storage resource. The control tools for the *Virginia Carbon Sequestration Explorer* allows the user to zoom in  or zoom out  to a box drawn on the map; to move the view (pan) to a different area ; to return to the previous view ; to return to the full view of the state , to set the buffer value to determine geological storage resource  (Figure); to set the map units , to measure distances , to erase the dynamic content , to print the image to a file  (.pdf format), and to refresh the dynamic content . In addition a scale control is provided to zoom in and out.

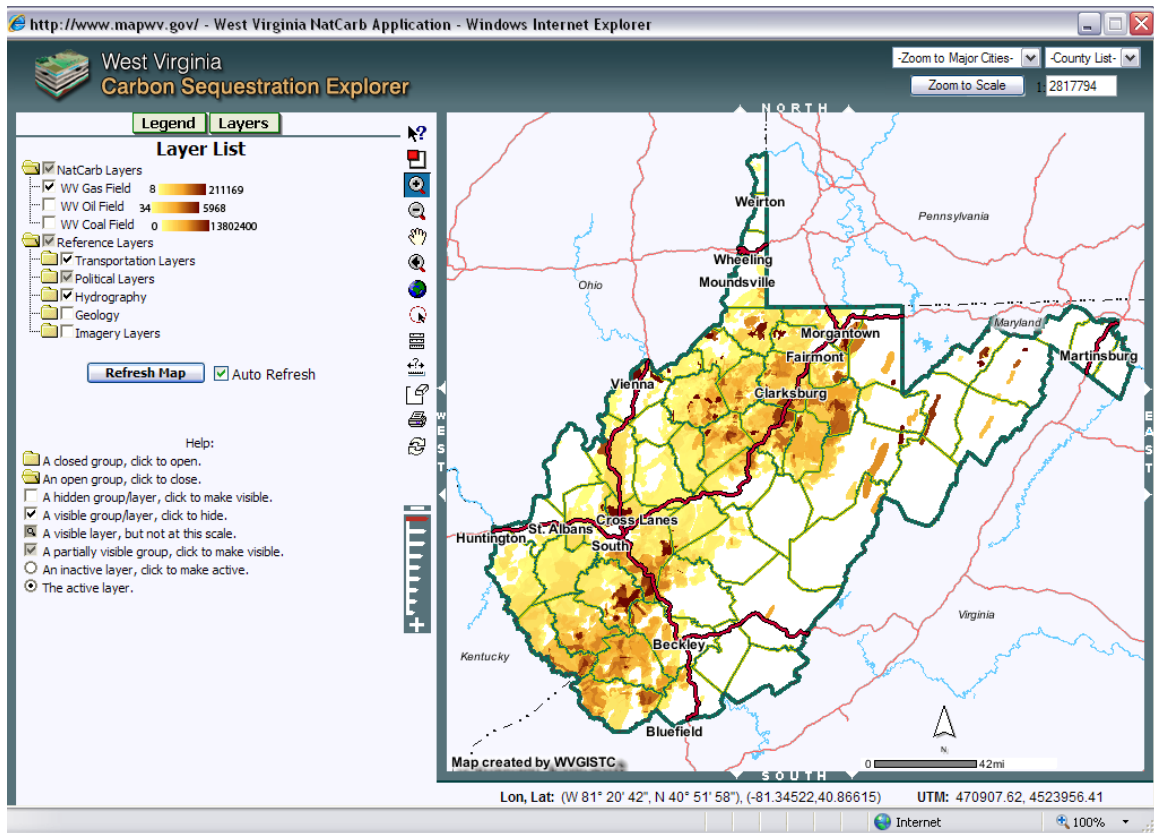













Figure 6.3 – The *West Virginia Carbon Sequestration Explorer* showing the distribution of gas fields that were evaluated for CO₂ geological storage resource. The control tools for the *Virginia Carbon Sequestration Explorer* allows the user to zoom in  or zoom out  to a box drawn on the map; to move the view (pan) to a different area ; to return to the previous view ; to return to the full view of the state , to set the buffer value to determine geological storage resource  (Figure); to set the map units , to measure distances , to erase the dynamic content , to print the image to a file  (.pdf format), and to refresh the dynamic content . In addition a scale control is provided to zoom in and out.

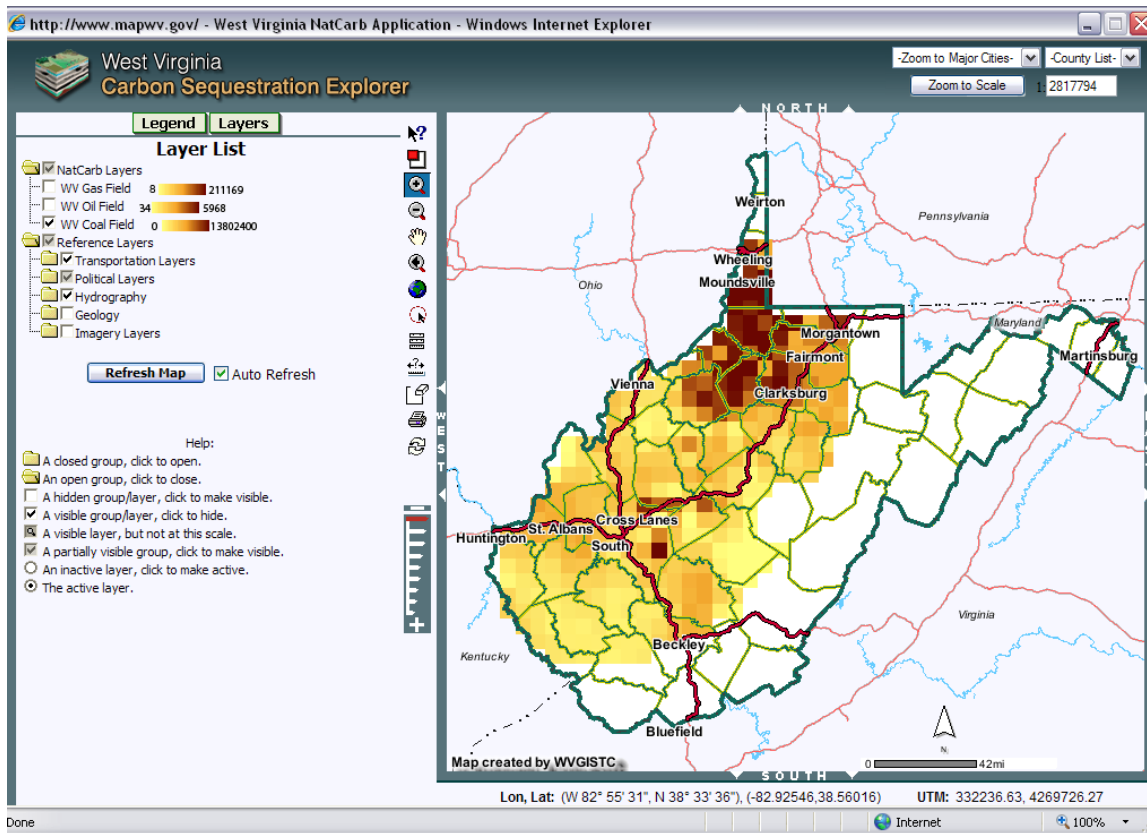













Figure 6.4 – The *West Virginia Carbon Sequestration Explorer* showing the distribution of deep coal seams (> 2,400 feet) that were evaluated for CO₂ geological storage resource. The control tools for the *Virginia Carbon Sequestration Explorer*

allows the user to zoom in  or zoom out  to a box drawn on the map; to move the view (pan) to a different area ; to return to the previous view ; to return to the full view of the state , to set the buffer value to determine geological storage resource  (Figure); to set the map units , to measure distances , to erase the dynamic content , to print the image to a file  (.pdf format), and to refresh the dynamic content . In addition a scale control is provided to zoom in and out.

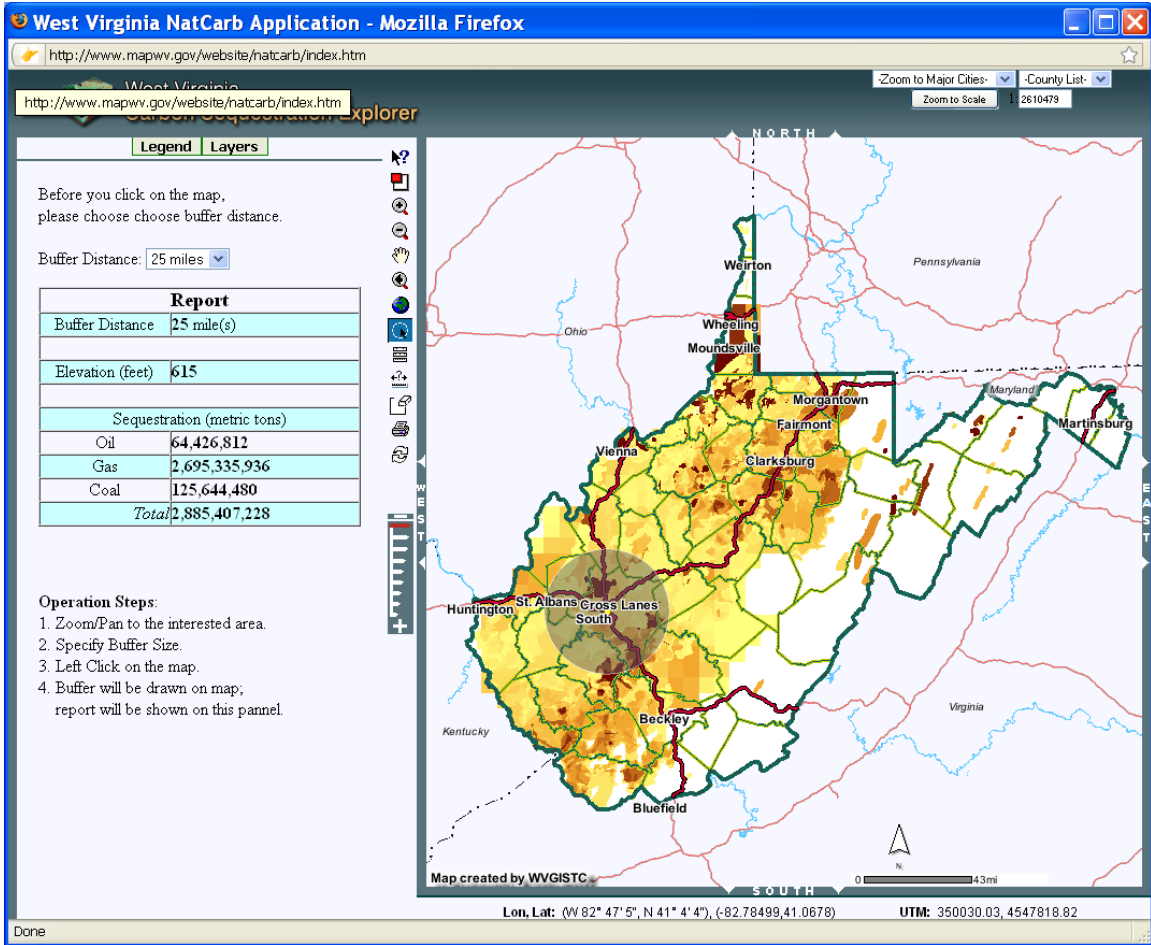


Figure 6.5 – The *West Virginia Carbon Sequestration Explorer* showing the use of the geological storage resource tool to determine the CO₂ geologic storage resource potential with a radius of 25 miles from a user determined location. The CO₂ geologic storage resource is provided in metric tons for oil, gas and deep coal seams within the user determined distance. The user is querying the geospatial database that covers the state.

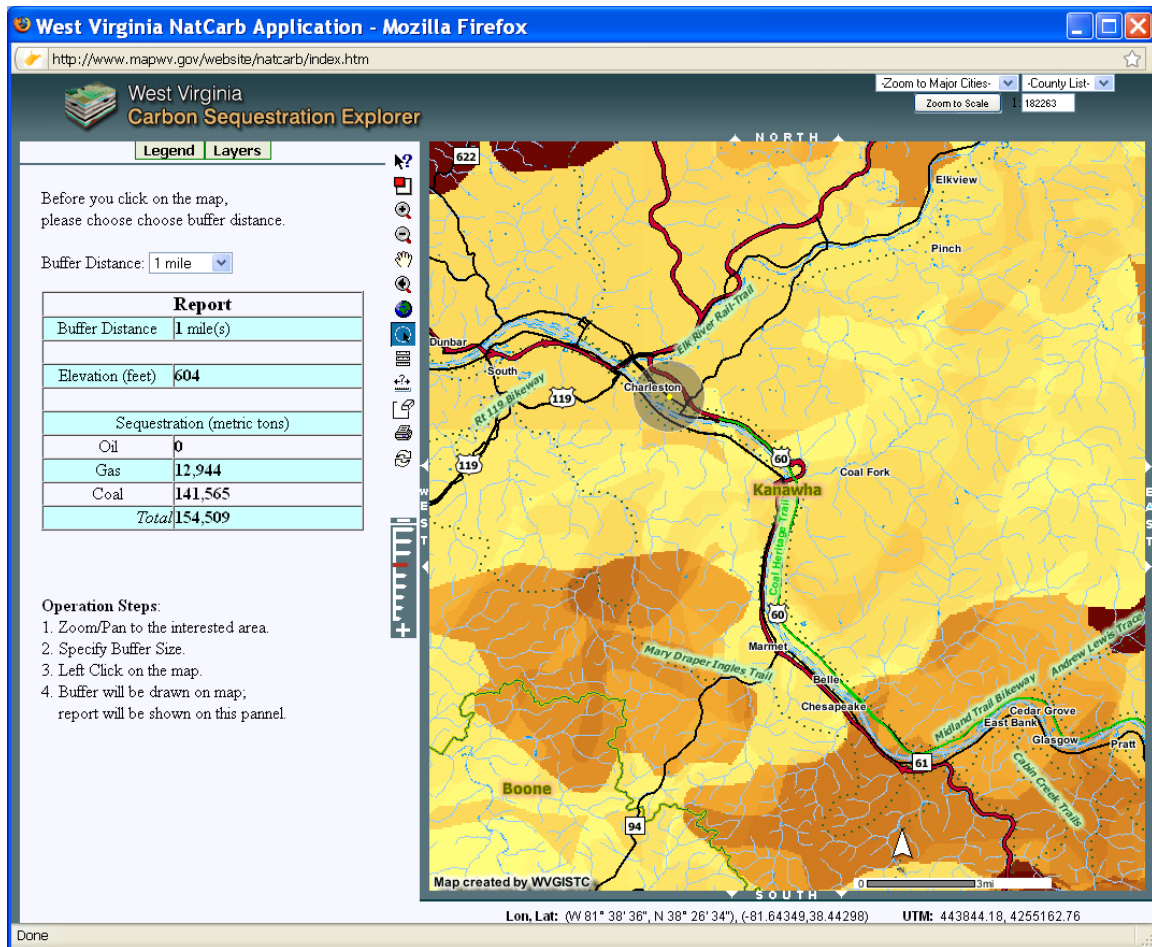


Figure 6.6 – The *West Virginia Carbon Sequestration Explorer* showing the use of the geological storage resource tool to determine the CO₂ geologic storage resource potential with a radius of 1 mile from a user determined location. The CO₂ geologic storage resource is provided in metric tons for oil, gas and deep coal seams and all layers are displayed within the user determined distance. The user is querying the geospatial database that covers the state.

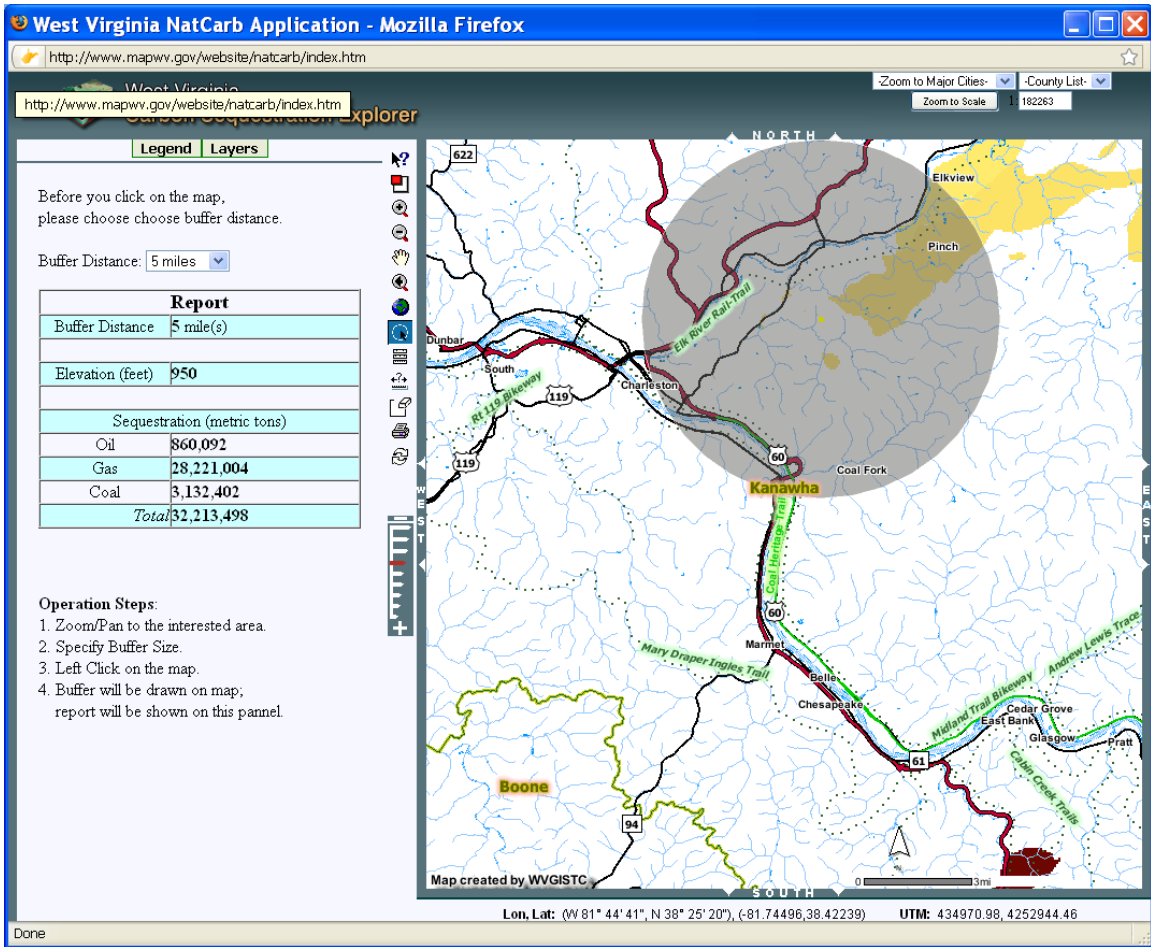


Figure 6.7 – The *West Virginia Carbon Sequestration Explorer* showing the use of the geological storage resource tool to determine the CO₂ geologic storage resource potential with a radius of 5 mile from a user determined location. Only oil fields are displayed on the image. The CO₂ geologic storage resource is provided in metric tons for oil, gas and deep coal seams within the user determined distance. The user is querying the geospatial database that covers the state.

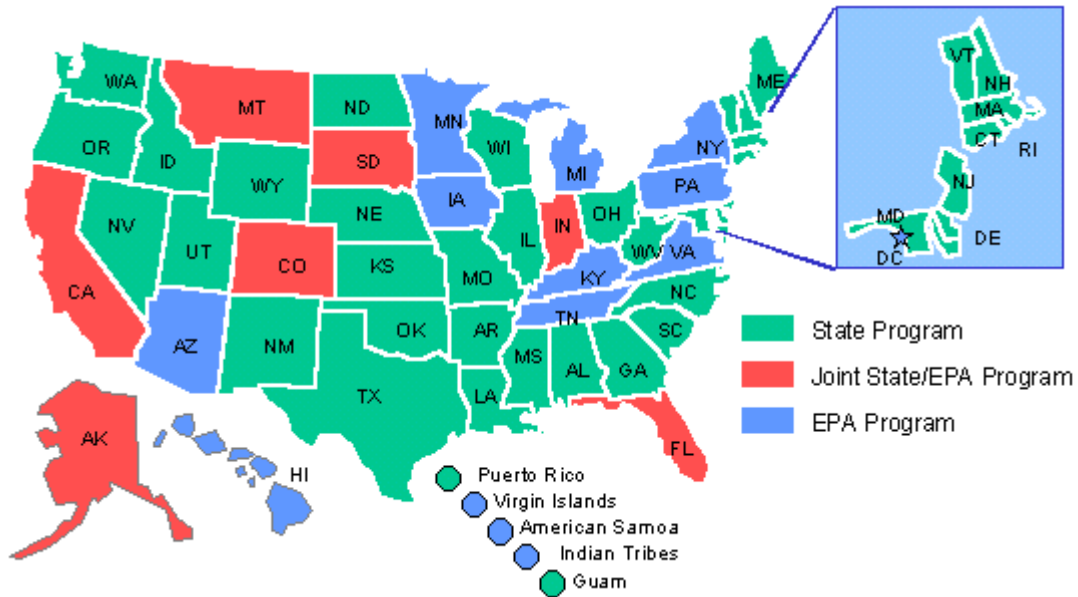


Figure 7.1 – A total of 33 states and 3 territories have primacy for all classes of injection wells. EPA shares responsibility with 7 states (i.e., EPA has authority over some classes and the state has authority for others). Currently, EPA implements the program for all well classes in 10 states including Kentucky, Pennsylvania and Virginia. Kentucky is regulated by EPA Region 4 while Pennsylvania and Virginia are regulated by EPA Region 3. Figure from <http://www.epa.gov/safewater/uic/primacy.html>. Crossing state and regulatory boundaries may create impediments to CCS along the borders of West Virginia.

Appendix 1

Source	Longitude	Latitude	Suitability Rating (Scaled 1-100)	Name	Secondary Name/ID
Catalog of Industrial Parks - WVDO	-82.123	37.759	39.60	Mingo County Wood Products Industrial Park	
Catalog of Industrial Parks - WVDO	-80.736	39.998	25.37	Marshall County Industrial Park Phase 2	
Catalog of Industrial Parks - WVDO	-79.288	39.202	13.22	Mountain Top Industrial Park	
Catalog of Industrial Parks - WVDO	-78.785	39.484	11.31	Fort Ashby Business & Technology Park	
Catalog of Industrial Parks - WVDO	-79.941	39.688	22.30	Fort Martin Industrial Park	
Catalog of Industrial Parks - WVDO	-80.852	39.632	39.32	Wetzel County Business & Industrial Park	
Catalog of Industrial Parks - WVDO	-80.644	40.167	3.87	Wheeling - Ohio County Air Industrial Park, Phase*	
Catalog of Industrial Parks - WVDO	-82.305	38.409	22.98	Barboursville Industrial Park	
Catalog of Industrial Parks - WVDO	-82.305	38.409	23.51	Barboursville Industrial Park	
Catalog of Industrial Parks - WVDO	-82.305	38.409	9.48	Barboursville Industrial Park	
Catalog of Industrial Parks - WVDO	-82.305	38.409	19.95	Barboursville Industrial Park	
Catalog of Industrial Parks - WVDO	-79.923	39.011	49.87	Belington Industrial Park	
Catalog of Industrial Parks - WVDO	-80.219	39.303	74.02	Mid-Atlantic Aerospace Complex	
Catalog of Industrial Parks - WVDO	-80.219	39.303	64.91	Mid-Atlantic Aerospace Complex	
Catalog of Industrial Parks - WVDO	-77.866	39.356	10.17	Burr Business Park	
Catalog of Industrial Parks - WVDO	-77.866	39.356	1.98	Burr Business Park	
Catalog of Industrial Parks - WVDO	-81.085	38.912	40.44	Calhoun County Industrial Park	
Catalog of Industrial Parks - WVDO	-81.097	37.291	7.82	Cumberland Industrial Park	
Catalog of Industrial Parks - WVDO	-77.961	39.516	3.31	Cumbo Yard Industrial Park	
Catalog of Industrial Parks - WVDO	-81.163	37.929	32.43	Fayette County Business Park	
Catalog of Industrial Parks - WVDO	-81.800	38.270	48.30	Forks-Of-Coal Industrial Park	
Catalog of Industrial Parks - WVDO	-80.402	37.860	1.46	Greenbrier Valley Airport Industrial Park	
Catalog of Industrial Parks - WVDO	-80.619	40.388	13.44	Half Moon Industrial Park	
Catalog of Industrial Parks - WVDO	-78.755	39.355	10.89	Hampshire County Industrial Park	
Catalog of Industrial Parks - WVDO	-82.472	38.407	19.55	LSC Industrial Park	
Catalog of Industrial Parks - WVDO	-81.837	38.906	18.98	Jackson County Maritime And Industrial Centre	
Catalog of Industrial Parks - WVDO	-77.991	39.394	15.77	John D. Rockefeller IV Science & Technology Center	
Catalog of Industrial Parks - WVDO	-78.949	39.445	8.55	Keyser-Mineral County Industrial Park	
Catalog of Industrial Parks - WVDO	-80.396	39.101	78.47	Lewis County Industrial Park	
Catalog of Industrial Parks - WVDO	-77.915	39.398	5.41	Liberty Business Park	

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Catalog of Industrial Parks - WVDO	-80.745	39.908	16.31	Marshall County Business Park	
Catalog of Industrial Parks - WVDO	-82.108	38.925	9.77	Mason County Development Authority Industrial Park	
Catalog of Industrial Parks - WVDO	-80.305	39.350	68.60	Meadowbrook Business Park	
Catalog of Industrial Parks - WVDO	-80.615	40.043	9.64	Millennium Centre Technology Park	
Catalog of Industrial Parks - WVDO	-78.304	39.473	1.65	522 Business Park	
Catalog of Industrial Parks - WVDO	-79.975	39.606	36.68	Morgantown Industrial & Research Park	
Catalog of Industrial Parks - WVDO	-81.851	38.405	55.47	Peerless Industrial Park	
Catalog of Industrial Parks - WVDO	-80.997	39.277	54.09	Pennsboro Industrial Park	
Catalog of Industrial Parks - WVDO	-80.034	39.159	74.38	Philippi Industrial Park	
Catalog of Industrial Parks - WVDO	-81.158	37.784	20.29	Pinecrest Business & Technology Park	
Catalog of Industrial Parks - WVDO	-81.117	37.792	13.73	Raleigh County Airport Industrial Park	
Catalog of Industrial Parks - WVDO	-78.938	39.072	4.21	Robert C. Byrd - Hardy County Industrial Park	
Catalog of Industrial Parks - WVDO	-81.832	38.452	50.63	Scary Creek Industrial Center	
Catalog of Industrial Parks - WVDO	-81.832	38.452	51.59	Scary Creek Industrial Center	
Catalog of Industrial Parks - WVDO	-81.930	38.453	30.90	Teays Valley Business and Industrial Park	
Catalog of Industrial Parks - WVDO	-80.552	40.389	3.23	Three Springs Business Park	
Catalog of Industrial Parks - WVDO	-78.586	39.087	6.12	Wardensville Industrial Park	
Catalog of Industrial Parks - WVDO	-80.654	40.178	5.33	Wheeling - Ohio County Air Industrial Park, Phase*	
Catalog of Industrial Parks - WVDO	-79.523	39.660	4.69	Northpointe Business & Industry Park	
Catalog of Industrial Parks - WVDO	-80.658	38.337	12.38	Nicholas County Industrial Park	
Catalog of Industrial Parks - WVDO	-79.286	38.782	4.24	Upper Tract Industrial Park	
Catalog of Industrial Parks - WVDO	-80.735	38.889	54.85	Gilmer County Industrial Park	
Catalog of Industrial Parks - WVDO	-81.603	38.359	54.93	NorthGate Business Park	
Catalog of Industrial Parks - WVDO	-81.580	38.338	52.57	Washington Heights Business Park	
Catalog of Industrial Parks - WVDO	-79.922	39.645	21.78	Airport Office & Research Park	
Catalog of Industrial Parks - WVDO	-80.196	39.431	51.84	I-79 Technology Park	
Catalog of Industrial Parks - WVDO	-81.526	39.211	18.50	Parkersburg Business Park	
Catalog of Industrial Parks - WVDO	-82.097	37.809	40.95	Earl Ray Tomblin Industrial Park	
Catalog of Industrial Parks - WVDO	-81.981	38.554	23.49	Putnam Business Park	
Catalog of Industrial Parks - WVDO	-78.449	39.526	3.59	Wolfe Rte. 9 Industrial Park	
Catalog of Industrial Parks - WVDO	-77.913	39.550	10.59	I/CON Industrial Park	
Catalog of Industrial Parks - WVDO	-79.136	38.989	12.64	Grant County Industrial Park	
Catalog of Industrial Parks - WVDO	-80.738	38.667	19.65	Huffman Industrial Park	
Catalog of Industrial Parks - WVDO	-80.738	38.667	19.18	Huffman Industrial Park	
Catalog of Industrial Parks - WVDO	-81.167	37.888	29.67	Mount Hope South Industrial Park	
Catalog of Industrial Parks - WVDO	-81.098	39.476	39.64	Bens Run Industrial Park	
Catalog of Industrial Parks - WVDO	-80.741	37.417	0.66	Fountain Springs Industrial Park	

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Catalog of Industrial Parks - WVDO	-80.182	39.291	63.50	Jerry Run Industrial Park	
Catalog of Industrial Parks - WVDO	-80.182	39.291	61.01	Jerry Run Industrial Park	
Catalog of Industrial Parks - WVDO	-81.041	39.532	24.48	Davenport Business Park	
Catalog of Industrial Parks - WVDO	-80.097	38.263	7.32	Edray Business Park	
Catalog of Industrial Parks - WVDO	-81.536	39.219	20.13	Parkersburg Business Park Phase 2	
Catalog of Industrial Parks - WVDO	-80.199	39.007	69.37	Upshur County Development Authority Industrial Pa*	
Catalog of Industrial Parks - WVDO	-80.028	39.641	29.45	Chaplin Hill Business Park	
Catalog of Industrial Parks - WVDO	-80.654	40.230	5.12	Brooke Industrial Park	
Catalog of Industrial Parks - WVDO	-81.564	37.505	53.28	John D. Rockefeller IV Industrial Park	
Catalog of Industrial Parks - WVDO	-82.310	38.411	9.10	Barboursville Business Complex	
Catalog of Industrial Parks - WVDO	-77.916	39.534	5.90	Falling Waters Industrial Center	
Catalog of Industrial Parks - WVDO	-78.452	39.532	7.59	Robert C. Byrd Industrial Park (Paw Paw)	
Catalog of Industrial Parks - WVDO	-78.742	39.041	4.60	Baker Industrial Park	
Catalog of Industrial Parks - WVDO	-80.523	38.412	16.42	Webster County Business Park	
Catalog of Industrial Parks - WVDO	-81.086	37.379	20.85	Virginian Industrial Park	
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Catalog of Industrial Parks - WVDO	-78.408	39.307	2.07	Capon Bridge Industrial and Technology Park	
Catalog of Industrial Parks - WVDO	-82.104	38.424	20.11	Morris Memorial Business Park	
Catalog of Industrial Parks - WVDO	-79.448	39.144	15.94	Tucker County Industrial Park	
Catalog of Industrial Parks - WVDO	-81.705	38.355	51.21	South Charleston Technology Park	
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Catalog of Industrial Parks - WVDO	-81.130	37.794	15.86	Raleigh County Airport Industrial Park West Phase*	
Catalog of Industrial Parks - WVDO	-81.130	37.794	16.84	Raleigh County Airport Industrial Park West Phase*	
Catalog of Industrial Parks - WVDO	-81.130	37.794	16.79	Raleigh County Airport Industrial Park West Phase*	
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Catalog of Industrial Parks - WVDO	-81.488	39.199	17.76	Polymer Technology Park	

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Catalog of Industrial Parks - WVDO	-81.741	38.933	18.71	Jackson Crossing Business and Industrial Park	
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Catalog of Industrial Parks - WVDO	-80.297	39.283	84.83	Harrison County Business & Technology Centre	
Catalog of Industrial Parks - WVDO	-80.809	38.323	7.64	Glade Creek Park	
Catalog of Industrial Sites - WVDO	-81.442	38.792	19.68	Harlan Boggs Farm Site	3
Catalog of Industrial Sites - WVDO	-81.126	37.764	21.88	Airport Road Site	7
Catalog of Industrial Sites - WVDO	-81.126	37.764	16.39	Airport Road Site	7
Catalog of Industrial Sites - WVDO	-80.330	39.338	79.71	Anchor Hocking Site	9
Catalog of Industrial Sites - WVDO	-80.330	39.338	75.70	Anchor Hocking Site	9
Catalog of Industrial Sites - WVDO	-82.290	38.414	10.89	Barboursville Site	11
Catalog of Industrial Sites - WVDO	-81.173	37.273	10.15	Earl Goodwin Site	13
Catalog of Industrial Sites - WVDO	-81.173	37.273	9.73	Earl Goodwin Site	13
Catalog of Industrial Sites - WVDO	-82.118	38.913	13.51	Bartow Jones Site	14
Catalog of Industrial Sites - WVDO	-82.118	38.913	8.94	Bartow Jones Site	93
Catalog of Industrial Sites - WVDO	-81.197	37.763	39.98	Beckley Junction Site	15
Catalog of Industrial Sites - WVDO	-81.534	39.176	11.08	Best Line Construction Company Site	17
Catalog of Industrial Sites - WVDO	-81.725	38.921	21.54	Boice Farm Site	18
Catalog of Industrial Sites - WVDO	-78.022	39.394	4.47	Bryarly Manor Orchards Site	22
Catalog of Industrial Sites - WVDO	-81.262	38.230	44.08	Bull Push Site	23
Catalog of Industrial Sites - WVDO	-81.262	38.230	45.82	Bull Push Site	23
Catalog of Industrial Sites - WVDO	-79.852	38.926	44.93	CSX Yard Site (Elkins)	25
Catalog of Industrial Sites - WVDO	-82.401	38.425	23.05	CSX Yard at 26-27th Street Site	26
Catalog of Industrial Sites - WVDO	-82.401	38.425	23.91	CSX Yard at 26-27th Street Site	26
Catalog of Industrial Sites - WVDO	-81.485	39.207	16.33	Davisville Road Site	30
Catalog of Industrial Sites - WVDO	-79.808	38.546	22.98	East Fork Industrial Site	31
Catalog of Industrial Sites - WVDO	-81.485	39.208	16.40	Eastwood Site	33
Catalog of Industrial Sites - WVDO	-81.706	38.758	27.90	Casto Site	36
Catalog of Industrial Sites - WVDO	-81.518	39.241	29.92	Erickson Site	38
Catalog of Industrial Sites - WVDO	-80.842	38.340	11.71	Fockler Valley Site	39
Catalog of Industrial Sites - WVDO	-81.788	38.819	19.58	Harlan Casto Site	42
Catalog of Industrial Sites - WVDO	-80.757	38.500	10.57	Frame Site	46
Catalog of Industrial Sites - WVDO	-82.180	38.758	9.93	Rolfe Lee Site	10
Catalog of Industrial Sites - WVDO	-82.180	38.758	10.62	Rolfe Lee Site	10
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Catalog of Industrial Sites - WVDO	-81.801	39.075	10.54	Gatrill Farm Site	48
Catalog of Industrial Sites - WVDO	-81.786	38.832	19.22	Richardson Farm Site	49
Catalog of Industrial Sites - WVDO	-81.282	37.734	39.01	Glen White Bottom Site	51

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Catalog of Industrial Sites - WVDO	-80.046	39.365	63.06	Grafton Country Club Road Site #1	53
Catalog of Industrial Sites - WVDO	-81.148	37.786	21.81	Gray Flats Site	54
Catalog of Industrial Sites - WVDO	-82.616	38.124	12.84	Hammonds Bottom Site	55
Catalog of Industrial Sites - WVDO	-82.616	38.124	23.76	Hammonds Bottom Site	55
Catalog of Industrial Sites - WVDO	-81.041	37.365	8.53	Lacky Site	56
Catalog of Industrial Sites - WVDO	-82.029	38.440	28.00	Henderson Site	58
Catalog of Industrial Sites - WVDO	-80.886	37.678	3.49	Hinton Yard Site	59
Catalog of Industrial Sites - WVDO	-81.849	38.885	27.41	Hoffman Farm Site	61
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Catalog of Industrial Sites - WVDO	-81.222	37.698	31.06	Coal City Road Site	70
Catalog of Industrial Sites - WVDO	-80.396	39.106	81.84	I-79 Exit 105 Site	71
Catalog of Industrial Sites - WVDO	-80.396	39.106	75.31	I-79 Exit 105 Site	71
Catalog of Industrial Sites - WVDO	-78.982	39.445	18.99	Keyser Yard Site	74
Catalog of Industrial Sites - WVDO	-80.150	39.320	55.00	Knotts Site	75
Catalog of Industrial Sites - WVDO	-80.150	39.320	70.01	Knotts Site	128
Catalog of Industrial Sites - WVDO	-80.529	40.375	3.34	Colliers Way Site	77
Catalog of Industrial Sites - WVDO	-81.219	37.748	26.38	Crab Orchard Site	78
Catalog of Industrial Sites - WVDO	-81.656	37.664	73.96	Crouch Farm Site	79
Catalog of Industrial Sites - WVDO	-81.245	37.736	28.63	Lester Square Site	80
Catalog of Industrial Sites - WVDO	-80.690	40.166	20.82	Lipscher Site	81
Catalog of Industrial Sites - WVDO	-80.675	38.699	31.05	Morris Farm Site	85
Catalog of Industrial Sites - WVDO	-78.789	39.636	13.11	Maryland Junction Yard Site	86
Catalog of Industrial Sites - WVDO	-81.906	37.762	71.67	McDonald Airfield Site	87
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Catalog of Industrial Sites - WVDO	-79.882	38.823	27.01	Laurel Lands Site	90
Catalog of Industrial Sites - WVDO	-82.098	38.911	6.65	Deerfield Site	93
Catalog of Industrial Sites - WVDO	-81.199	37.735	24.65	Pack Site	97
Catalog of Industrial Sites - WVDO	-81.691	38.773	26.61	Fairhavens IV Site	10
Catalog of Industrial Sites - WVDO	-79.992	38.692	16.60	Upper Tygart Industrial Site	10
Catalog of Industrial Sites - WVDO	-80.599	40.087	6.50	Roneys Point Site	10
Catalog of Industrial Sites - WVDO	-80.014	39.591	40.76	Round Bottom Site	10
Catalog of Industrial Sites - WVDO	-81.057	37.782	9.01	Scott Site	11N
Catalog of Industrial Sites - WVDO	-82.098	38.922	6.91	Thompson Site	122
Catalog of Industrial Sites - WVDO	-81.937	37.823	59.32	Three-Mile Curve Site	123
Catalog of Industrial Sites - WVDO	-81.710	38.357	60.91	Courtland Site	125
Catalog of Industrial Sites - WVDO	-81.189	37.849	21.70	White Oak No. 10 Site	129
Catalog of Industrial Sites - WVDO	-80.838	39.278	67.00	Wilhelm Run Site	13N
Catalog of Industrial Sites - WVDO	-78.261	39.573	1.07	Shirley Farms West Site	111
Catalog of Industrial Sites - WVDO	-81.305	38.169	62.72	Longacre Bottom Site	113
Catalog of Industrial Sites - WVDO	-81.305	38.169	74.31	Longacre Bottom Site	113
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Catalog of Industrial Sites - WVDO	-81.364	38.189	78.82	Technology Center Site	12N
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Catalog of Industrial Sites - WVDO	-80.267	39.024	87.11	Ross Site No. 1	204
Catalog of Industrial Sites - WVDO	-80.204	39.000	74.59	Peak Land Development Site	206
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Catalog of Industrial Sites - WVDO	-80.042	39.368	51.70	Grafton Country Club Road Site #2	207
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Catalog of Industrial Sites - WVDO	-80.419	39.029	73.96	Trefz Farm Site	224
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Catalog of Industrial Sites - WVDO	-81.731	38.923	20.53	Sandy Creek Farms Site	141
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Catalog of Industrial Sites - WVDO	-81.416	38.712	27.16	Big Lick Run Site	156
Catalog of Industrial Sites - WVDO	-81.122	37.280	14.14	Ward Goodwin Site	157
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Catalog of Industrial Sites - WVDO	-81.388	38.700	22.15	George Harper Site	16N
Catalog of Industrial Sites - WVDO	-80.415	39.126	81.08	Jackson Streight Site	161
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Catalog of Industrial Sites - WVDO	-81.101	39.471	26.03	Dominion Resources Site	18N
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Catalog of Industrial Sites - WVDO	-81.210	37.298	11.20	Mercer County Airport Site	188
Catalog of Industrial Sites - WVDO	-82.559	38.364	10.44	Tri-State Airport Site	189
Catalog of Industrial Sites - WVDO	-80.126	39.487	47.46	CSX Fairmont Yard Site	19N
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Catalog of Industrial Sites - WVDO	-81.119	37.288	11.34	Tinco Site #2	233
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Catalog of Industrial Sites - WVDO	-81.531	39.179	25.46	MeadWestvaco Mineral Wells Site	239
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Catalog of Industrial Sites - WVDO	-77.875	39.375	2.93	Jefferson Orchards Site	
Catalog of Industrial Sites - WVDO	-80.321	39.343	68.61	Spelter Site	
Catalog of Industrial Sites - WVDO	-80.267	39.313	68.77	Bonasso Site	
Catalog of Industrial Sites - WVDO	-80.279	39.257	68.87	Suarez Site	
Catalog of Industrial Sites - WVDO	-80.333	39.340	71.24	Secret Site No. 1	
Catalog of Industrial Sites - WVDO	-80.052	39.195	68.26	Philippi Development Site	

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Catalog of Industrial Sites - WVDO	-80.624	40.615	17.64	Hofstetter Site	
Catalog of Industrial Sites - WVDO	-80.619	40.547	5.82	Hutson Estate Site	
Catalog of Industrial Sites - WVDO	-80.017	39.186	58.95	Newman Bottom Site	
Catalog of Industrial Sites - WVDO	-79.155	39.399	4.90	Elk Garden Site	
Catalog of Industrial Sites - WVDO	-80.598	40.340	14.41	1500 East Site	
Catalog of Industrial Sites - WVDO	-81.807	38.921	21.54	Pleasant View Ridge Site	
Catalog of Industrial Sites - WVDO	-79.648	39.631	10.62	Wilhelm Farm Site	
Catalog of Industrial Sites - WVDO	-79.507	39.663	4.27	TAZ Site	
Catalog of Industrial Sites - WVDO	-79.533	39.663	5.03	Pres-Mon Site	
Catalog of Industrial Sites - WVDO	-81.651	38.670	39.86	Parsons Site	
Catalog of Industrial Sites - WVDO	-80.271	38.991	70.01	Rohr Property/ Brushy Fork Road Site	
Catalog of Industrial Sites - WVDO	-80.254	38.997	71.96	Delta West LLC - Intersection of Route 33 & Brush*	
Catalog of Industrial Sites - WVDO	-81.112	37.781	13.30	Raleigh County Commission - Tract 1 Site	
Catalog of Industrial Sites - WVDO	-80.236	38.972	67.99	Fato Site	
Catalog of Industrial Sites - WVDO	-80.217	39.004	84.03	CJ Martin Site	
Catalog of Industrial Sites - WVDO	-81.690	38.750	29.37	McGrew Site	
Catalog of Industrial Sites - WVDO	-80.864	38.614	18.69	Frametown Exit Industrial Site	
Catalog of Industrial Sites - WVDO	-80.648	38.684	19.91	Route 15 Business/Industrial Site	
Catalog of Industrial Sites - WVDO	-80.339	39.175	82.81	Barcinas Site No. 1	
Catalog of Industrial Sites - WVDO	-80.839	38.934	55.24	Manley Site	
Catalog of Industrial Sites - WVDO	-80.335	39.264	71.55	CBC Acres Site	
Catalog of Industrial Sites - WVDO	-80.385	39.205	72.54	Cecil Highland Farm Site	
Catalog of Industrial Sites - WVDO	-81.551	39.205	13.86	Pettyville Site	
Catalog of Industrial Sites - WVDO	-80.077	38.975	58.65	HD Lambert Site	
Catalog of Industrial Sites - WVDO	-81.613	38.377	55.16	Ronald Lane Site	
Catalog of Industrial Sites - WVDO	-81.394	39.055	18.17	Thorn Roberts Site	
Catalog of Industrial Sites - WVDO	-80.280	39.306	79.67	OCRI LLC Site	
Catalog of Industrial Sites - WVDO	-81.431	39.339	20.83	Mid-Ohio Valley Regional Airport South Ramp Acrea*	
Catalog of Industrial Sites - WVDO	-81.134	37.333	10.15	Crumpecker Hill Site	
Catalog of Industrial Sites - WVDO	-77.897	39.548	8.13	Route 11 @ Dupont Road Site	
Catalog of Industrial Sites - WVDO	-81.250	37.273	10.83	Seay Site	
Catalog of Industrial Sites - WVDO	-80.560	40.413	4.63	Castelli Site	
Catalog of Industrial Sites - WVDO	-82.087	38.959	11.97	Lakin Site	
Catalog of Industrial Sites - WVDO	-80.797	39.913	22.90	Moundsville North Plant Site	
Catalog of Industrial Sites - WVDO	-80.251	39.019	74.69	Mark Carroll Site	
Catalog of Industrial Sites - WVDO	-78.028	39.382	9.14	Talbott Site	
Catalog of Industrial Sites - WVDO	-80.350	39.286	81.02	Old Anchor Hocking Site	
Catalog of Undustrial Buildings - WVDO	-81.833	38.445	62.14	Kanawha Valley Distribution Center	
Catalog of Undustrial Buildings - WVDO	-81.624	38.360	76.27	Rex Building	

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Catalog of Undustrial Buildings - WVDO	-81.566	38.316	67.03	Owens Industrial Park Building 3	
Catalog of Undustrial Buildings - WVDO	-81.097	38.924	42.37	Grantsville Tire Building	
Catalog of Undustrial Buildings - WVDO	-81.714	38.819	25.03	Kronemer Building	
Catalog of Undustrial Buildings - WVDO	-80.718	40.079	5.37	Wheeling Machine Roll Shop	
Catalog of Undustrial Buildings - WVDO	-81.408	39.065	32.38	Wirt Industrial Center	
Catalog of Undustrial Buildings - WVDO	-80.851	38.943	65.69	Kinney Shoe Building (Glennville)	
Catalog of Undustrial Buildings - WVDO	-80.363	39.265	81.26	Clarksburg Terminal Building Units 1 & 2	
Catalog of Undustrial Buildings - WVDO	-78.756	39.354	10.65	Hampshire County Multi-Tenant Building	
Catalog of Undustrial Buildings - WVDO	-78.267	39.553	0.87	Vanguard Building	
Catalog of Undustrial Buildings - WVDO	-80.610	40.281	4.88	Vie-Con Building	
Catalog of Undustrial Buildings - WVDO	-80.717	40.061	14.15	Americo Warehouse/Mfg Complex	
Catalog of Undustrial Buildings - WVDO	-77.975	39.454	14.70	Schmidt Baking Building	
Catalog of Undustrial Buildings - WVDO	-81.349	38.800	21.86	Roane/Spencer Industrial Building	
Catalog of Undustrial Buildings - WVDO	-82.410	38.433	11.40	Allied Warehousing Services Building #5	
Catalog of Undustrial Buildings - WVDO	-81.360	38.817	25.37	Kellwood Building	
Catalog of Undustrial Buildings - WVDO	-81.175	37.281	23.25	Tinco Building	
Catalog of Undustrial Buildings - WVDO	-81.697	38.762	27.87	Skyland Building	
Catalog of Undustrial Buildings - WVDO	-81.093	37.291	7.68	Cumberland Industrial Park Building	
Catalog of Undustrial Buildings - WVDO	-80.458	37.750	16.38	Greenbrier Architectural Woodwork Building	
Catalog of Undustrial Buildings - WVDO	-79.931	39.011	49.96	Talbott Planing Mill	
Catalog of Undustrial Buildings - WVDO	-81.104	37.362	25.42	Maidenform Building	
Catalog of Undustrial Buildings - WVDO	-81.153	37.276	9.39	Sizemore Building	
Catalog of Undustrial Buildings - WVDO	-82.018	37.947	48.11	Logan Manufacturing Facility	
Catalog of Undustrial Buildings - WVDO	-81.098	39.478	36.53	Bens Run Industrial Park Shell Building	
Catalog of Undustrial Buildings - WVDO	-80.551	40.373	16.65	Colliers Steel Building	
Catalog of Undustrial Buildings - WVDO	-80.852	39.634	24.92	Wetzel County Business & Industrial Park Building	
Catalog of Undustrial Buildings - WVDO	-81.526	39.239	18.70	York Photo Lab Facility	
Catalog of Undustrial Buildings - WVDO	-81.838	38.439	51.58	Allied Warehousing Services Building	
Catalog of Undustrial Buildings - WVDO	-81.709	38.917	31.07	Silverton Building	
Catalog of Undustrial Buildings - WVDO	-81.076	38.910	40.55	BF Goodrich Facility	
Catalog of Undustrial Buildings - WVDO	-81.323	38.181	57.33	Upper Kanawha Valley Technology Community Building	
Catalog of Undustrial Buildings - WVDO	-80.570	40.611	31.67	Bell Research Building	
Catalog of Undustrial Buildings - WVDO	-79.537	39.661	5.11	Coastal Lumber Dimension Mill	
Catalog of Undustrial Buildings - WVDO	-77.868	39.349	1.40	TST/Impreso	
Catalog of Undustrial Buildings - WVDO	-82.312	38.455	28.00	Chiron Building	

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Catalog of Undustrial Buildings - WVDO	-81.820	38.450	49.96	M&B Properties, Inc. Warehouse	
Catalog of Undustrial Buildings - WVDO	-81.834	38.493	61.01	Former Putnam Fabricating Building	
Catalog of Undustrial Buildings - WVDO	-82.410	38.433	11.40	Allied Warehousing Services Building #6	
Catalog of Undustrial Buildings - WVDO	-81.058	39.206	51.30	United Manufacturing Building	
Catalog of Undustrial Buildings - WVDO	-81.519	39.336	19.58	Hyperlogistics Facility	
Catalog of Undustrial Buildings - WVDO	-80.117	39.465	45.10	Minnotte Machining Corp Building	
Catalog of Undustrial Buildings - WVDO	-80.172	39.523	41.44	Nickolich Building	
Catalog of Undustrial Buildings - WVDO	-82.499	38.400	6.27	Hanshaw Building	
Catalog of Undustrial Buildings - WVDO	-80.244	38.964	66.67	Darby Building	
Catalog of Undustrial Buildings - WVDO	-79.286	38.784	4.22	Upper Tract Industrial Park Shell Building	
Catalog of Undustrial Buildings - WVDO	-81.817	38.452	52.76	PM Enterprises Building	
Catalog of Undustrial Buildings - WVDO	-80.398	37.864	1.46	Rahall Technology Center	
Catalog of Undustrial Buildings - WVDO	-81.023	39.273	50.31	Quality Concrete & Precast, Inc. Buildings	
Catalog of Undustrial Buildings - WVDO	-81.469	39.393	22.58	Walker Systems Inc. Building	
Catalog of Undustrial Buildings - WVDO	-80.843	38.298	17.36	OC Cluss Building	
Catalog of Undustrial Buildings - WVDO	-80.379	39.261	82.49	Dimaria Building	
Catalog of Undustrial Buildings - WVDO	-78.304	39.474	1.53	Lippert Components Inc Building	
Catalog of Undustrial Buildings - WVDO	-78.456	39.535	4.49	Consolidated Orchard Building	
Catalog of Undustrial Buildings - WVDO	-80.477	39.025	74.26	J & L Crystal Glass Company Building	
Catalog of Undustrial Buildings - WVDO	-77.915	39.409	2.43	IRS Storage Facility	
Catalog of Undustrial Buildings - WVDO	-78.952	39.440	15.40	Carroll Building	
Catalog of Undustrial Buildings - WVDO	-78.783	39.485	18.02	Mineral County Multi-Tenant Building	
Catalog of Undustrial Buildings - WVDO	-82.490	38.401	11.12	Business Center at Commerce Park	
Catalog of Undustrial Buildings - WVDO	-80.363	39.264	100.00	American Vending Building	
Catalog of Undustrial Buildings - WVDO	-78.017	39.387	10.80	Berkeley Business Park	
Catalog of Undustrial Buildings - WVDO	-81.796	38.923	23.69	Edwards Transportation Building #2	
Catalog of Undustrial Buildings - WVDO	-81.794	38.923	24.60	Edwards Transportation Building #1	
Catalog of Undustrial Buildings - WVDO	-81.629	38.352	65.57	Jarrett-Aim Communications Warehouse Building	
Catalog of Undustrial Buildings - WVDO	-77.867	39.360	3.74	Burr Park Office Flex Buildings	
Catalog of Undustrial Buildings - WVDO	-81.634	38.359	68.13	Fidelity Building	
Catalog of Undustrial Buildings - WVDO	-82.414	37.846	28.76	Heilig Meyers Building	
Catalog of Undustrial Buildings - WVDO	-81.093	37.361	14.33	Dean Company Building	
Catalog of Undustrial Buildings - WVDO	-78.757	39.355	12.58	Kinney Shoe Building	
Catalog of Undustrial Buildings - WVDO	-81.858	38.411	59.75	C 84 Buildings	
Catalog of Undustrial Buildings - WVDO	-80.736	40.009	11.07	BIPCO Facility	
Catalog of Undustrial Buildings - WVDO	-81.069	37.430	10.11	USDA Wood Education & Resource Center	

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Catalog of Undustrial Buildings - WVDO	-80.453	39.037	74.51	JADAD Building	
Catalog of Undustrial Buildings - WVDO	-82.401	38.425	14.18	Tri-State Ice Arena Building	
Catalog of Undustrial Buildings - WVDO	-77.954	39.502	6.42	Shockey Commerce Center	
Catalog of Undustrial Buildings - WVDO	-77.993	39.304	1.02	Kodak Building	
Catalog of Undustrial Buildings - WVDO	-80.594	40.422	12.02	Central Machine Shop Building	
Catalog of Undustrial Buildings - WVDO	-80.546	40.389	2.51	R & D Building	
Catalog of Undustrial Buildings - WVDO	-80.627	40.053	9.42	Coronet Foods Triadelphia Plant	
Catalog of Undustrial Buildings - WVDO	-80.712	40.066	7.61	Coronet Foods 15th Street Plant	
Catalog of Undustrial Buildings - WVDO	-80.718	40.081	10.62	Coronet Foods Main Plant	
Catalog of Undustrial Buildings - WVDO	-80.097	38.264	7.31	Edray Business Park Building No. 1	
Catalog of Undustrial Buildings - WVDO	-81.955	38.547	28.00	Kanawha Manufacturing Buffalo Plant	
Catalog of Undustrial Buildings - WVDO	-80.463	39.061	90.01	PAXAR Building	
Catalog of Undustrial Buildings - WVDO	-81.522	38.222	69.91	Shelton's Fas Chek	
Catalog of Undustrial Buildings - WVDO	-81.430	39.341	21.32	Former Army Aviation Support Facility	
Catalog of Undustrial Buildings - WVDO	-82.248	38.416	27.89	Central Sales Company Building	
Catalog of Undustrial Buildings - WVDO	-82.503	38.398	24.11	Coyne Textile Building	
Catalog of Undustrial Buildings - WVDO	-77.969	39.467	4.63	Baltimore Street Manufacturing Building	
Catalog of Undustrial Buildings - WVDO	-77.988	39.399	0.99	Tiger Building	
Catalog of Undustrial Buildings - WVDO	-78.010	39.400	1.13	Tabler Station Warehouse and Distribution Facility	
Catalog of Undustrial Buildings - WVDO	-80.616	40.388	8.32	USG/HK Building	
Catalog of Undustrial Buildings - WVDO	-80.125	39.500	59.93	Everlasting Covenant Warehouse	
Catalog of Undustrial Buildings - WVDO	-81.839	38.437	49.69	Former Anderson Window Manufacturing Plant	
Catalog of Undustrial Buildings - WVDO	-81.640	38.363	50.82	Eureka Building	
Catalog of Undustrial Buildings - WVDO	-79.523	39.660	4.69	Northpointe Shell Building	
Catalog of Undustrial Buildings - WVDO	-81.817	38.451	51.39	Central Van & Storage Building	
Catalog of Undustrial Buildings - WVDO	-80.339	39.525	65.56	MOEC Building	
Catalog of Undustrial Buildings - WVDO	-79.684	39.476	17.79	Penmarva Building	
Catalog of Undustrial Buildings - WVDO	-82.443	38.312	21.40	Nelson Building	
Catalog of Undustrial Buildings - WVDO	-77.887	39.274	5.61	Cold Storage Building No. 2	
Catalog of Undustrial Buildings - WVDO	-77.868	39.358	2.57	Patrick Building	
Catalog of Undustrial Buildings - WVDO	-77.863	39.292	0.00	Kidde Building	
WVDEP Mine Permit Database (provided by WVDOE)	37.997	-81.450	72.76	STANLEY HERITAGE SURFACE MINE	S303593
WVDEP Mine Permit Database (provided by WVDOE)	37.994	-81.463	65.21	STANLEY HERITAGE SURFACE MINE	S303593
WVDEP Mine Permit Database (provided by WVDOE)	38.092	-81.954	29.50	SUGARTREE BRANCH PERMIT	S501692
WVDEP Mine Permit Database (provided by WVDOE)	38.095	-81.935	30.69	SUGARTREE BRANCH PERMIT	S501692
WVDEP Mine Permit Database (provided by WVDOE)	37.750	-82.285	21.95	MT-13	S503993
WVDEP Mine Permit Database (provided by WVDOE)	38.162	-81.762	40.73	NELLIS MINE	S504090

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WVDEP Mine Permit Database (provided by WVDOE)	38.067	-81.722	48.74	EAST OF STOLLINGS SURFACE MINE	S505792
WVDEP Mine Permit Database (provided by WVDOE)	38.057	-81.724	48.74	EAST OF STOLLINGS SURFACE MINE	S505792
WVDEP Mine Permit Database (provided by WVDOE)	38.020	-81.479	66.74	SAMPLES MINE EXTENSION	S300495
WVDEP Mine Permit Database (provided by WVDOE)	38.055	-81.497	66.35	SAMPLES MINE EXTENSION	S300495
WVDEP Mine Permit Database (provided by WVDOE)	38.025	-81.499	66.65	SAMPLES MINE EXTENSION	S300495
WVDEP Mine Permit Database (provided by WVDOE)	37.955	-81.670	62.12	FALCON SURFACE MINE	S400500
WVDEP Mine Permit Database (provided by WVDOE)	38.199	-81.709	47.73	BOONE NORTH NO. 1 SURFACE MINE	S501701
WVDEP Mine Permit Database (provided by WVDOE)	38.209	-81.702	48.94	BOONE NORTH NO. 1 SURFACE MINE	S501701
WVDEP Mine Permit Database (provided by WVDOE)	38.195	-81.699	47.94	Bull Creek Surface Mine	S501702
WVDEP Mine Permit Database (provided by WVDOE)	38.114	-81.907	32.29	NORTH RIDGE SURFACE MINE	S502095
WVDEP Mine Permit Database (provided by WVDOE)	38.068	-81.940	33.24	Ballard Fork Chilton Surface M	S502202
WVDEP Mine Permit Database (provided by WVDOE)	37.866	-81.702	62.05	(OLD) S-67-83 & S-86-84	S502294
WVDEP Mine Permit Database (provided by WVDOE)	38.072	-81.682	51.72	BLACK CASTLE CONTOUR SURFACE	S502300
WVDEP Mine Permit Database (provided by WVDOE)	38.065	-81.676	52.50	BLACK CASTLE CONTOUR SURFACE	S502300
WVDEP Mine Permit Database (provided by WVDOE)	38.046	-81.693	51.90	BLACK CASTLE CONTOUR SURFACE	S502300
WVDEP Mine Permit Database (provided by WVDOE)	38.051	-81.694	51.57	BLACK CASTLE CONTOUR SURFACE	S502300
WVDEP Mine Permit Database (provided by WVDOE)	38.062	-81.708	49.90	BLACK CASTLE CONTOUR SURFACE	S502300
WVDEP Mine Permit Database (provided by WVDOE)	38.201	-81.798	36.61	LOCUST FORK SURFACE MINE	S502301
WVDEP Mine Permit Database (provided by WVDOE)	38.040	-81.687	52.93	LEXERD SURFACE MINE	S502401
WVDEP Mine Permit Database (provided by WVDOE)	37.969	-81.596	65.85	HOPKINS FORK SURFACE	S502496
WVDEP Mine Permit Database (provided by WVDOE)	38.109	-81.922	33.88	Boone Block Surface	S502497
WVDEP Mine Permit Database (provided by WVDOE)	38.005	-81.806	47.62	CONSTITUTION MTR SURFACE MINE	S502597
WVDEP Mine Permit Database (provided by WVDOE)	38.004	-81.806	47.66	CONSTITUTION MTR SURFACE MINE	S502597
WVDEP Mine Permit Database (provided by WVDOE)	38.007	-81.787	47.51	CONSTITUTION MTR SURFACE MINE	S502597
WVDEP Mine Permit Database (provided by WVDOE)	38.006	-81.808	48.69	CONSTITUTION MTR SURFACE MINE	S502597
WVDEP Mine Permit Database (provided by WVDOE)	38.035	-81.650	56.89	WILLIAMS MT SURFACE MINE	S502995
WVDEP Mine Permit Database (provided by WVDOE)	38.020	-81.648	59.02	FROZEN HOLLOW SURFACE	S503095
WVDEP Mine Permit Database (provided by WVDOE)	38.023	-81.638	60.20	FROZEN HOLLOW SURFACE	S503095
WVDEP Mine Permit Database (provided by WVDOE)	37.946	-81.748	51.86	RED CEDAR SURFACE MINE NO. 1	S503097
WVDEP Mine Permit Database (provided by WVDOE)	37.944	-81.730	54.48	WEST CAZY SURFACE MINE	S503195

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WVDEP Mine Permit Database (provided by WVDOE)	37.973	-81.752	51.03	GLORY SURFACE MINE	S500102
WVDEP Mine Permit Database (provided by WVDOE)	38.069	-81.701	50.48	SHORT RIDGE SURFACE MINE	S500105
WVDEP Mine Permit Database (provided by WVDOE)	38.099	-81.963	28.53	Westridge No. 3 Surface Mine	S500203
WVDEP Mine Permit Database (provided by WVDOE)	38.104	-81.939	30.65	Surface Mine No. 42	S500307
WVDEP Mine Permit Database (provided by WVDOE)	38.030	-81.596	62.60	ORGAS #3	S500394
WVDEP Mine Permit Database (provided by WVDOE)	38.051	-81.969	29.94	WESTRIDGE SOUTH NO. 1 SURFACE	S500404
WVDEP Mine Permit Database (provided by WVDOE)	38.162	-81.696	48.33	Boone North No. 2 Surface Mine	S500803
WVDEP Mine Permit Database (provided by WVDOE)	37.940	-81.682	61.73	CALLISTO SURFACE MINE	S500900
WVDEP Mine Permit Database (provided by WVDOE)	38.210	-81.695	50.19	BOONE NORTH #3 SURFACE MINE	S500906
WVDEP Mine Permit Database (provided by WVDOE)	38.082	-81.693	52.33	LAXARE EAST SURFACE MINE	S501200
WVDEP Mine Permit Database (provided by WVDOE)	38.033	-81.725	49.96	RAMO SURFACE MINE	S501400
WVDEP Mine Permit Database (provided by WVDOE)	37.912	-81.635	64.32	COOK MOUNTAIN MINE	S501594
WVDEP Mine Permit Database (provided by WVDOE)	38.052	-81.485	72.38	Pine Tree Flats Surface Mine	S301502
WVDEP Mine Permit Database (provided by WVDOE)	38.362	-80.996	16.96	MONOC 4 SURFACE MINE	S200396
WVDEP Mine Permit Database (provided by WVDOE)	38.382	-81.018	18.41	WINOC NO. 1 SURFACE MINE	S200494
WVDEP Mine Permit Database (provided by WVDOE)	38.357	-81.079	21.98	Surface Mine No. 4A	S200502
WVDEP Mine Permit Database (provided by WVDOE)	38.358	-81.062	20.83	Surface Mine No. 4A	S200502
WVDEP Mine Permit Database (provided by WVDOE)	38.358	-81.062	20.83	Surface Mine No. 4A	S200502
WVDEP Mine Permit Database (provided by WVDOE)	38.357	-81.066	21.03	Surface Mine No. 4A	S200502
WVDEP Mine Permit Database (provided by WVDOE)	38.366	-80.973	15.68	IKE FORK NO. 2 SURFACE MINE	S200599
WVDEP Mine Permit Database (provided by WVDOE)	38.372	-81.086	22.18	Cannel Coal Point Removal	S200605
WVDEP Mine Permit Database (provided by WVDOE)	38.388	-81.003	16.98	WINOC NO. 2 SURFACE MINE	S200697
WVDEP Mine Permit Database (provided by WVDOE)	38.364	-81.039	19.66	SURFACE MINE NO. 2A	S201496
WVDEP Mine Permit Database (provided by WVDOE)	38.360	-81.028	18.99	SURFACE MINE NO. 2A	S201496
WVDEP Mine Permit Database (provided by WVDOE)	38.364	-80.930	13.39	LILLY FORK SURFACE MINE	S302193
WVDEP Mine Permit Database (provided by WVDOE)	38.359	-80.941	13.97	LILLY FORK SURFACE MINE	S302193
WVDEP Mine Permit Database (provided by WVDOE)	38.342	-80.959	15.49	LILLY FORK SURFACE MINE	S302193
WVDEP Mine Permit Database (provided by WVDOE)	38.374	-80.947	14.17	LILLY FORK SURFACE MINE	S302193
WVDEP Mine Permit Database (provided by WVDOE)	38.361	-81.057	20.49	SURFACE MINE NO. 3	S200995
WVDEP Mine Permit Database (provided by WVDOE)	38.337	-81.034	19.91	SURFACE MINE NO. 3	S200995

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WVDEP Mine Permit Database (provided by WVDOE)	38.347	-81.057	20.78	SURFACE MINE NO. 3	S200995
WVDEP Mine Permit Database (provided by WVDOE)	38.187	-81.249	43.83	FOURMILE FK SURFACE MINE	S300296
WVDEP Mine Permit Database (provided by WVDOE)	38.196	-81.125	30.64	Bridge Fork Surface Mine	S300400
WVDEP Mine Permit Database (provided by WVDOE)	38.181	-81.138	31.78	Bridge Fork West Surface Mine	S300301
WVDEP Mine Permit Database (provided by WVDOE)	37.896	-81.305	40.33	MT 5 Surface Mine	S301003
WVDEP Mine Permit Database (provided by WVDOE)	37.965	-81.330	48.14	LICK KNOB SURFACE MINE	S301496
WVDEP Mine Permit Database (provided by WVDOE)	37.990	-80.913	5.60	Clifftop Surface Mine No.1	S300505
WVDEP Mine Permit Database (provided by WVDOE)	37.887	-81.296	38.59	MT-5B Surface Mine	S301006
WVDEP Mine Permit Database (provided by WVDOE)	37.959	-81.383	53.67	EAGLE LAND NO. 1 SUR. MINE	S302195
WVDEP Mine Permit Database (provided by WVDOE)	38.030	-81.228	38.83	Open Fork Surface Mine	S301601
WVDEP Mine Permit Database (provided by WVDOE)	37.993	-81.372	57.41	Skitter Creek No. 2 Mine	S302299
WVDEP Mine Permit Database (provided by WVDOE)	37.992	-81.372	57.40	Skitter Creek No. 2 Mine	S302299
WVDEP Mine Permit Database (provided by WVDOE)	37.981	-81.363	54.98	Skitter Creek No. 2 Mine	S302299
WVDEP Mine Permit Database (provided by WVDOE)	38.051	-81.237	41.72	Glenco Hollow Surface Mine	S301705
WVDEP Mine Permit Database (provided by WVDOE)	37.929	-81.297	40.76	Patience Surface Mine No. 4	S300105
WVDEP Mine Permit Database (provided by WVDOE)	37.923	-81.297	40.46	Patience Surface Mine No. 4	S300105
WVDEP Mine Permit Database (provided by WVDOE)	37.936	-81.285	39.39	PAX SURFACE MINE #3	S300295
WVDEP Mine Permit Database (provided by WVDOE)	37.929	-81.287	39.48	PAX SURFACE MINE #3	S300295
WVDEP Mine Permit Database (provided by WVDOE)	37.948	-81.289	40.74	PAX SURFACE MINE #3	S300295
WVDEP Mine Permit Database (provided by WVDOE)	37.969	-81.347	50.98	SKITTER CREEK NO. 1 MINE	S302794
WVDEP Mine Permit Database (provided by WVDOE)	37.974	-81.382	56.85	Republic No. 2 Surface Mine	S300101
WVDEP Mine Permit Database (provided by WVDOE)	37.969	-81.347	50.98	SKITTER CREEK NO. 1 MINE	S302794
WVDEP Mine Permit Database (provided by WVDOE)	37.930	-81.299	41.10	Pax Surface Mine No. 4	S300103
WVDEP Mine Permit Database (provided by WVDOE)	37.993	-81.372	57.41	Skitter Creek No. 2 Mine	S302299
WVDEP Mine Permit Database (provided by WVDOE)	37.992	-81.372	57.40	Skitter Creek No. 2 Mine	S302299
WVDEP Mine Permit Database (provided by WVDOE)	37.981	-81.363	54.98	Skitter Creek No. 2 Mine	S302299
WVDEP Mine Permit Database (provided by WVDOE)	38.223	-81.492	57.98	Area "A"	S301001
WVDEP Mine Permit Database (provided by WVDOE)	37.974	-81.382	56.85	Republic No. 2 Surface Mine	S300101
WVDEP Mine Permit Database (provided by WVDOE)	38.100	-81.537	62.58	Wildcat Surface Mine	S300600
WVDEP Mine Permit Database (provided by WVDOE)	38.091	-81.523	63.29	Wildcat Surface Mine	S300600

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WVDEP Mine Permit Database (provided by WVDOE)	38.162	-81.497	59.08	LEASE 1	S300195
WVDEP Mine Permit Database (provided by WVDOE)	38.161	-81.506	58.87	LEASE 1	S300195
WVDEP Mine Permit Database (provided by WVDOE)	38.106	-81.401	62.58	Fourmile Fk Surface Mine No. 2	S300405
WVDEP Mine Permit Database (provided by WVDOE)	38.217	-81.504	60.05	Quincy Manufactured Home Park	S301300
WVDEP Mine Permit Database (provided by WVDOE)	37.972	-81.468	64.16	Kayford South Surface Mine	S300800
WVDEP Mine Permit Database (provided by WVDOE)	38.004	-81.402	60.46	Republic No. 3 Surface Mine	S301203
WVDEP Mine Permit Database (provided by WVDOE)	38.211	-81.647	62.16	FOURMILE FK SURFACE MINE	S300796
WVDEP Mine Permit Database (provided by WVDOE)	38.223	-81.635	55.90	FOURMILE FK SURFACE MINE	S300796
WVDEP Mine Permit Database (provided by WVDOE)	38.226	-81.482	58.11	No. 1 Mine	S301501
WVDEP Mine Permit Database (provided by WVDOE)	38.224	-81.469	56.47	Upper Kanawha Valley Upland Ar	S301703
WVDEP Mine Permit Database (provided by WVDOE)	38.122	-81.403	62.19	Fourmile Surface Mine No. 3	S301805
WVDEP Mine Permit Database (provided by WVDOE)	38.052	-81.485	72.38	Pine Tree Flats Surface Mine	S301502
WVDEP Mine Permit Database (provided by WVDOE)	38.104	-81.493	62.97		S301606
WVDEP Mine Permit Database (provided by WVDOE)	38.034	-81.418	63.23	Briar Mountain Surface Mine	S302005
WVDEP Mine Permit Database (provided by WVDOE)	37.987	-81.404	58.56	Republic No. 1 Surface Mine	S302500
WVDEP Mine Permit Database (provided by WVDOE)	38.195	-81.637	52.86	LENS CK MINE #1, PIT #2	S302894
WVDEP Mine Permit Database (provided by WVDOE)	37.997	-81.450	72.76	STANLEY HERITAGE SURFACE MINE	S303593
WVDEP Mine Permit Database (provided by WVDOE)	37.994	-81.463	65.21	STANLEY HERITAGE SURFACE MINE	S303593
WVDEP Mine Permit Database (provided by WVDOE)	37.887	-81.912	47.15	ANNA BRANCH #2 SURFACE MINE	S500104
WVDEP Mine Permit Database (provided by WVDOE)	37.844	-81.868	53.07	GEORGES CREEK SURFACE MINE NO.	S500201
WVDEP Mine Permit Database (provided by WVDOE)	37.838	-81.918	50.91	BANDMILL NO.1 SURFACE MINE	S500194
WVDEP Mine Permit Database (provided by WVDOE)	37.830	-81.895	53.00	BANDMILL NO.1 SURFACE MINE	S500194
WVDEP Mine Permit Database (provided by WVDOE)	37.735	-82.084	53.52	PROPOSED HOLDEN 22 SURFACE MIN	S500395
WVDEP Mine Permit Database (provided by WVDOE)	37.735	-82.093	49.05	PROPOSED HOLDEN 22 SURFACE MIN	S500395
WVDEP Mine Permit Database (provided by WVDOE)	37.738	-82.102	51.30	PROPOSED HOLDEN 22 SURFACE MIN	S500395
WVDEP Mine Permit Database (provided by WVDOE)	37.736	-82.102	43.75	PROPOSED HOLDEN 22 SURFACE MIN	S500395
WVDEP Mine Permit Database (provided by WVDOE)	37.812	-81.778	62.76	GUYAN SURFACE MINE	S500701
WVDEP Mine Permit Database (provided by WVDOE)	37.862	-81.842	52.92	Adkins Fork Surface Mine	S500503
WVDEP Mine Permit Database (provided by WVDOE)	37.811	-81.855	58.81	NORTHWEST RUFFNER	S500593
WVDEP Mine Permit Database (provided by WVDOE)	37.739	-81.901	65.29	SURFACE MINE NO. 2	S500604

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WVDEP Mine Permit Database (provided by WVDOE)	37.824	-81.824	58.58	SURFACE MINE NO. 4	S500502
WVDEP Mine Permit Database (provided by WVDOE)	37.811	-81.820	69.31	SURFACE MINE NO. 4	S500502
WVDEP Mine Permit Database (provided by WVDOE)	37.816	-81.805	61.79	SURFACE MINE NO. 4	S500502
WVDEP Mine Permit Database (provided by WVDOE)	37.814	-81.801	60.65	SURFACE MINE NO. 4	S500502
WVDEP Mine Permit Database (provided by WVDOE)	37.807	-81.803	60.78	SURFACE MINE NO. 4	S500502
WVDEP Mine Permit Database (provided by WVDOE)	37.766	-81.960	54.11	WV-3	S501300
WVDEP Mine Permit Database (provided by WVDOE)	37.712	-82.078	44.31	PHOENIX NO. 4 SURFACE MINE	S501301
WVDEP Mine Permit Database (provided by WVDOE)	37.761	-81.897	67.92	WADE # 3	S501596
WVDEP Mine Permit Database (provided by WVDOE)	37.796	-81.793	67.61	GUYAN RIDGE 3A	S500904
WVDEP Mine Permit Database (provided by WVDOE)	37.813	-81.817	59.08	SURFACE MINE NO. 3	S501499
WVDEP Mine Permit Database (provided by WVDOE)	37.734	-81.917	60.57	SURFACE MINE # 1	S501396
WVDEP Mine Permit Database (provided by WVDOE)	37.779	-82.120	40.55	SCARLET	S501494
WVDEP Mine Permit Database (provided by WVDOE)	37.877	-81.800	53.62	SPRUCE NO. 1 MINE	S501397
WVDEP Mine Permit Database (provided by WVDOE)	37.725	-82.090	46.03	22 SHORT SURFACE MINE	S501401
WVDEP Mine Permit Database (provided by WVDOE)	37.771	-81.876	60.56	WADE # 3	S501596
WVDEP Mine Permit Database (provided by WVDOE)	37.788	-81.885	56.26	WADE # 3	S501596
WVDEP Mine Permit Database (provided by WVDOE)	37.794	-81.885	59.29	WADE # 3	S501596
WVDEP Mine Permit Database (provided by WVDOE)	37.728	-81.975	53.73	ROCKHOUSE BRANCH SURFACE MINE	S501798
WVDEP Mine Permit Database (provided by WVDOE)	37.690	-82.017	50.50	PHOENIX SURFACE MINE NO. 2	S501998
WVDEP Mine Permit Database (provided by WVDOE)	37.676	-82.047	49.60	LITTLE MUNCY SURFACE MINE	S501994
WVDEP Mine Permit Database (provided by WVDOE)	37.672	-82.041	46.25	LITTLE MUNCY SURFACE MINE	S501994
WVDEP Mine Permit Database (provided by WVDOE)	37.747	-82.121	39.56	SURFACE	S503695
WVDEP Mine Permit Database (provided by WVDOE)	37.659	-82.011	50.30	SURFACE MINE NO. 7	S507492
WVDEP Mine Permit Database (provided by WVDOE)	37.724	-82.083	42.72	PHOENIX NO. 5 SURFACE MINE	S502701
WVDEP Mine Permit Database (provided by WVDOE)	37.726	-82.100	40.41	LOGGY BRANCH SURFACE MINE	S502399
WVDEP Mine Permit Database (provided by WVDOE)	39.568	-80.164	46.57	GRANT TOWN SURFACE MINE	S200501
WVDEP Mine Permit Database (provided by WVDOE)	39.511	-80.184	56.39	BARRACKVILLE SURFACE MINE	S200904
WVDEP Mine Permit Database (provided by WVDOE)	39.505	-80.181	48.58	BARRACKVILLE SURFACE MINE	S200904
WVDEP Mine Permit Database (provided by WVDOE)	39.514	-80.177	46.57	BARRACKVILLE SURFACE MINE	S200904
WVDEP Mine Permit Database (provided by WVDOE)	39.498	-80.308	56.44	EAST RUN SURFACE MINE NO. 1	S100398

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WVDEP Mine Permit Database (provided by WVDOE)	39.539	-80.166	40.33	Wilson Mine Site	S200106
WVDEP Mine Permit Database (provided by WVDOE)	37.442	-81.420	40.57	12 SEAM AUGER MINE	S401996
WVDEP Mine Permit Database (provided by WVDOE)	37.440	-81.428	51.46	12 SEAM AUGER MINE	S401996
WVDEP Mine Permit Database (provided by WVDOE)	37.450	-81.426	50.34	12 SEAM AUGER MINE	S401996
WVDEP Mine Permit Database (provided by WVDOE)	37.269	-81.527	16.16	Proposed Cactus Ridge Surface	S401999
WVDEP Mine Permit Database (provided by WVDOE)	37.458	-81.980	32.41	MUD FORK STRIP NO. 2	S402095
WVDEP Mine Permit Database (provided by WVDOE)	37.354	-81.517	29.27	Navaro Surface Mine No. 2	S400200
WVDEP Mine Permit Database (provided by WVDOE)	37.348	-81.529	28.73	Navaro Surface Mine No. 2	S400200
WVDEP Mine Permit Database (provided by WVDOE)	37.341	-81.511	26.86	Navaro Surface Mine No. 2	S400200
WVDEP Mine Permit Database (provided by WVDOE)	37.356	-81.514	29.90	Navaro Surface Mine No. 2	S400200
WVDEP Mine Permit Database (provided by WVDOE)	37.481	-81.564	46.75	Puncheoncamp Thin Seam Mine #2	S400305
WVDEP Mine Permit Database (provided by WVDOE)	37.219	-81.613	14.61	Amonate Auger No. 2	S400403
WVDEP Mine Permit Database (provided by WVDOE)	37.285	-81.621	21.99	Newhall surface mine	S400698
WVDEP Mine Permit Database (provided by WVDOE)	37.283	-81.612	20.93	Newhall surface mine	S400698
WVDEP Mine Permit Database (provided by WVDOE)	37.455	-81.374	36.01	Pinnacle Ridge Surface Mine	S400899
WVDEP Mine Permit Database (provided by WVDOE)	37.436	-81.469	38.78	Big Br. Highwall Mine Poca #12	S400905
WVDEP Mine Permit Database (provided by WVDOE)	37.422	-81.465	37.24	Big Br. Highwall Mine Poca #12	S400905
WVDEP Mine Permit Database (provided by WVDOE)	37.439	-81.455	43.97	Big Br. Highwall Mine Poca #12	S400905
WVDEP Mine Permit Database (provided by WVDOE)	37.434	-81.446	44.12	Big Br. Highwall Mine Poca #12	S400905
WVDEP Mine Permit Database (provided by WVDOE)	37.389	-81.483	33.75	ECKMAN SURFACE MINE NO. 1	S401096
WVDEP Mine Permit Database (provided by WVDOE)	37.471	-81.990	32.87	Bull Creek Surface Mine No. 1	S401197
WVDEP Mine Permit Database (provided by WVDOE)	37.400	-81.530	38.26	Big Four Surface Mine	S401201
WVDEP Mine Permit Database (provided by WVDOE)	37.473	-81.399	38.49	Poca No. 11 Contour Auger No.2	S401301
WVDEP Mine Permit Database (provided by WVDOE)	37.262	-81.485	16.78	Route 161 Surface Mine	S401500
WVDEP Mine Permit Database (provided by WVDOE)	37.262	-81.486	16.35	Route 161 Surface Mine	S401500
WVDEP Mine Permit Database (provided by WVDOE)	37.380	-81.504	45.52	Harmon Branch Auger	S400700
WVDEP Mine Permit Database (provided by WVDOE)	37.403	-81.535	41.45	Big Four Surface Mine No. 2	S400406
WVDEP Mine Permit Database (provided by WVDOE)	37.628	-81.953	55.90	NO. 3 SURFACE MINE	S400400
WVDEP Mine Permit Database (provided by WVDOE)	37.659	-82.011	50.30	SURFACE MINE NO. 7	S507492
WVDEP Mine Permit Database (provided by WVDOE)	37.596	-81.985	51.80	Patton No. 11	S400401

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WVDEP Mine Permit Database (provided by WVDOE)	37.586	-82.106	38.59	Thacker Remining #1	S400600
WVDEP Mine Permit Database (provided by WVDOE)	37.586	-82.105	39.24	Thacker Remining #1	S400600
WVDEP Mine Permit Database (provided by WVDOE)	37.584	-82.114	38.40	Thacker Remining #1	S400600
WVDEP Mine Permit Database (provided by WVDOE)	37.585	-82.102	49.61	Thacker Remining #1	S400600
WVDEP Mine Permit Database (provided by WVDOE)	37.735	-82.084	53.52	PROPOSED HOLDEN 22 SURFACE MIN	S500395
WVDEP Mine Permit Database (provided by WVDOE)	37.735	-82.093	49.05	PROPOSED HOLDEN 22 SURFACE MIN	S500395
WVDEP Mine Permit Database (provided by WVDOE)	37.738	-82.102	51.30	PROPOSED HOLDEN 22 SURFACE MIN	S500395
WVDEP Mine Permit Database (provided by WVDOE)	37.736	-82.102	43.75	PROPOSED HOLDEN 22 SURFACE MIN	S500395
WVDEP Mine Permit Database (provided by WVDOE)	38.071	-81.973	30.85	HOBET 21 WEST RIDGE SURFACE	S500396
WVDEP Mine Permit Database (provided by WVDOE)	37.596	-81.985	51.80	Patton No. 11	S400401
WVDEP Mine Permit Database (provided by WVDOE)	37.590	-82.119	36.26	Remining No. 2 Surface Mine	S500403
WVDEP Mine Permit Database (provided by WVDOE)	37.883	-82.244	25.43	West Big Sang Kill Surface	S500700
WVDEP Mine Permit Database (provided by WVDOE)	37.894	-82.256	24.28	West Big Sang Kill Surface	S500700
WVDEP Mine Permit Database (provided by WVDOE)	37.909	-82.298	21.67	JENNIE CREEK NO. 3	S500801
WVDEP Mine Permit Database (provided by WVDOE)	37.892	-82.294	22.99	TAYWOOD WEST SURFACE MINE	S500802
WVDEP Mine Permit Database (provided by WVDOE)	37.758	-82.278	22.86	MT-500 SURFACE MINE	S500905
WVDEP Mine Permit Database (provided by WVDOE)	37.908	-82.230	25.40	JUDE BR SURFACE NO. 2	S500997
WVDEP Mine Permit Database (provided by WVDOE)	37.593	-82.013	47.73	HERNSHAW CUT THROUGH	S501294
WVDEP Mine Permit Database (provided by WVDOE)	37.594	-82.016	47.09	HERNSHAW CUT THROUGH	S501294
WVDEP Mine Permit Database (provided by WVDOE)	37.594	-82.017	46.59	HERNSHAW CUT THROUGH	S501294
WVDEP Mine Permit Database (provided by WVDOE)	37.712	-82.078	44.31	PHOENIX NO. 4 SURFACE MINE	S501301
WVDEP Mine Permit Database (provided by WVDOE)	37.725	-82.090	46.03	22 SHORT SURFACE MINE	S501401
WVDEP Mine Permit Database (provided by WVDOE)	37.779	-82.120	40.55	SCARLET	S501494
WVDEP Mine Permit Database (provided by WVDOE)	37.912	-82.304	21.35	JENNIE CREEK NO.2 SURFACE MINE	S501799
WVDEP Mine Permit Database (provided by WVDOE)	37.936	-82.245	23.44	TRI-COUNTY NO. 2 SURFACE	S501900
WVDEP Mine Permit Database (provided by WVDOE)	37.565	-82.092	40.06	GRAPEVINE SOUTH SURFACE MINE	S501901
WVDEP Mine Permit Database (provided by WVDOE)	37.676	-82.047	49.60	LITTLE MUNCY SURFACE MINE	S501994
WVDEP Mine Permit Database (provided by WVDOE)	37.672	-82.041	46.25	LITTLE MUNCY SURFACE MINE	S501994
WVDEP Mine Permit Database (provided by WVDOE)	37.672	-82.041	46.25	LITTLE MUNCY SURFACE MINE	S501994
WVDEP Mine Permit Database (provided by WVDOE)	37.690	-82.017	50.50	PHOENIX SURFACE MINE NO. 2	S501998

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WVDEP Mine Permit Database (provided by WVDOE)	37.679	-82.098	45.07	SURFACE MINE #9	S502097
WVDEP Mine Permit Database (provided by WVDOE)	37.684	-82.118	39.37	SURFACE MINE #9	S502097
WVDEP Mine Permit Database (provided by WVDOE)	37.620	-81.924	58.40	Surface Mine No. 2	S502099
WVDEP Mine Permit Database (provided by WVDOE)	37.884	-82.272	23.65	MARROWBONE TRACE SURFACE MINE	S502101
WVDEP Mine Permit Database (provided by WVDOE)	37.565	-81.902	56.88	SPRING FORK SURFACE MINE NO. 1	S502201
WVDEP Mine Permit Database (provided by WVDOE)	37.876	-82.247	25.73	BIG SANG KILL NO. 2 SURFACE MI	S502598
WVDEP Mine Permit Database (provided by WVDOE)	37.645	-82.090	41.32	CHAFIN BRANCH SURFACE MINE	S503198
WVDEP Mine Permit Database (provided by WVDOE)	37.747	-82.121	39.56	SURFACE	S503695
WVDEP Mine Permit Database (provided by WVDOE)	37.756	-82.299	21.50	MT-11	S503893
WVDEP Mine Permit Database (provided by WVDOE)	37.731	-82.295	20.68	MT-34	S504093
WVDEP Mine Permit Database (provided by WVDOE)	37.605	-82.104	42.37	REMINING NO. 3 SURFACE MINE	S501404
WVDEP Mine Permit Database (provided by WVDOE)	37.687	-82.154	35.02	SURFACE MINE #10	S501501
WVDEP Mine Permit Database (provided by WVDOE)	37.726	-82.100	40.41	LOGGY BRANCH SURFACE MINE	S502399
WVDEP Mine Permit Database (provided by WVDOE)	37.750	-82.285	21.95	MT-13	S503993
WVDEP Mine Permit Database (provided by WVDOE)	37.724	-82.083	42.72	PHOENIX NO. 5 SURFACE MINE	S502701
WVDEP Mine Permit Database (provided by WVDOE)	37.914	-82.312	21.05	JENNIE CREEK NO. 1 SURFACE MIN	S500999
WVDEP Mine Permit Database (provided by WVDOE)	39.571	-80.094	34.47	FORT GRAND SURFACE MINE	S201306
WVDEP Mine Permit Database (provided by WVDOE)	39.688	-80.049	22.03	GUSTON RUN NORTH SURFACE MINE	S100200
WVDEP Mine Permit Database (provided by WVDOE)	39.644	-80.019	24.69	PATRIOT /METZ	S100500
WVDEP Mine Permit Database (provided by WVDOE)	39.590	-80.100	33.46	CROWN EAST SURFACE MINE	S100797
WVDEP Mine Permit Database (provided by WVDOE)	39.598	-80.104	34.52	Crown No. 2 Surface Mine	S200801
WVDEP Mine Permit Database (provided by WVDOE)	39.590	-80.107	44.96	Crown No. 2 Surface Mine	S200801
WVDEP Mine Permit Database (provided by WVDOE)	39.670	-80.056	24.77	NEW HILL SURFACE MINE	S201001
WVDEP Mine Permit Database (provided by WVDOE)	39.671	-80.048	23.75	NEW HILL/EAST	S201004
WVDEP Mine Permit Database (provided by WVDOE)	39.676	-80.043	21.47	Guston Run South Surface Mine	S201006
WVDEP Mine Permit Database (provided by WVDOE)	38.364	-80.930	13.39	LILLY FORK SURFACE MINE	S302193
WVDEP Mine Permit Database (provided by WVDOE)	38.359	-80.941	13.97	LILLY FORK SURFACE MINE	S302193
WVDEP Mine Permit Database (provided by WVDOE)	38.342	-80.959	15.49	LILLY FORK SURFACE MINE	S302193
WVDEP Mine Permit Database (provided by WVDOE)	38.374	-80.947	14.17	LILLY FORK SURFACE MINE	S302193
WVDEP Mine Permit Database (provided by WVDOE)	38.366	-80.973	15.68	IKE FORK NO. 2 SURFACE MINE	S200599

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WVDEP Mine Permit Database (provided by WVDOE)	38.388	-81.003	16.98	WINOC NO. 2 SURFACE MINE	S200697
WVDEP Mine Permit Database (provided by WVDOE)	38.350	-81.010	17.99	SURFACE MINE NO. 6	S201199
WVDEP Mine Permit Database (provided by WVDOE)	38.364	-81.039	19.66	SURFACE MINE NO. 2A	S201496
WVDEP Mine Permit Database (provided by WVDOE)	38.360	-81.028	18.99	SURFACE MINE NO. 2A	S201496
WVDEP Mine Permit Database (provided by WVDOE)	38.308	-81.038	21.02	HARDWAY BRANCH SURFACE MINE	S300199
WVDEP Mine Permit Database (provided by WVDOE)	38.423	-80.683	6.02	Laurel No. 1 Mine	S300202
WVDEP Mine Permit Database (provided by WVDOE)	38.331	-80.984	17.36	ROBINSON NORTH SURFACE MINE	S300598
WVDEP Mine Permit Database (provided by WVDOE)	38.258	-81.129	39.81	Lilly Branch Surface Mine #2	S300699
WVDEP Mine Permit Database (provided by WVDOE)	38.271	-81.114	30.44	Lilly Branch Surface Mine #2	S300699
WVDEP Mine Permit Database (provided by WVDOE)	38.311	-81.021	20.62	Right Fork Surface Mine	S300702
WVDEP Mine Permit Database (provided by WVDOE)	38.358	-80.952	14.67	Hatchet Surface Mine	S300706
WVDEP Mine Permit Database (provided by WVDOE)	38.291	-81.040	23.63	PGM Surface Mine No. 1	S301405
WVDEP Mine Permit Database (provided by WVDOE)	38.290	-81.005	20.38	Tate Run Surface Mine	S302003
WVDEP Mine Permit Database (provided by WVDOE)	38.362	-80.996	16.96	MONOC 4 SURFACE MINE	S200396
WVDEP Mine Permit Database (provided by WVDOE)	37.604	-81.269	33.19	Tommy Crk Highwall Mine No. 2	S300106
WVDEP Mine Permit Database (provided by WVDOE)	37.611	-81.272	34.04	Tommy Crk Highwall Mine No. 2	S300106
WVDEP Mine Permit Database (provided by WVDOE)	37.916	-81.310	41.82	Ewing Fork No. 1 Surface Mine	S300703
WVDEP Mine Permit Database (provided by WVDOE)	37.920	-81.448	58.66	Bee Tree Surface Mine	S301004
WVDEP Mine Permit Database (provided by WVDOE)	37.866	-81.526	66.12	Shumate Powellton Surface Mine	S301100
WVDEP Mine Permit Database (provided by WVDOE)	37.856	-81.524	62.89	Edwight Surface Mine	S301299
WVDEP Mine Permit Database (provided by WVDOE)	37.933	-81.331	46.06	Horse Creek Surface Mine	S301599
WVDEP Mine Permit Database (provided by WVDOE)	37.920	-81.314	42.54	Ewing Fork No. 2 Surface Mine	S301803
WVDEP Mine Permit Database (provided by WVDOE)	37.611	-81.279	36.02	Tommy Creek Highwall Mine No.	S302203
WVDEP Mine Permit Database (provided by WVDOE)	37.899	-81.410	54.67		S302805
WVDEP Mine Permit Database (provided by WVDOE)	37.997	-81.450	72.76	STANLEY HERITAGE SURFACE MINE	S303593
WVDEP Mine Permit Database (provided by WVDOE)	37.994	-81.463	65.21	STANLEY HERITAGE SURFACE MINE	S303593
WVDEP Mine Permit Database (provided by WVDOE)	37.887	-81.296	38.59	MT-5B Surface Mine	S301006
WVDEP Mine Permit Database (provided by WVDOE)	37.965	-81.330	48.14	LICK KNOB SURFACE MINE	S301496
WVDEP Mine Permit Database (provided by WVDOE)	37.959	-81.383	53.67	EAGLE LAND NO. 1 SUR. MINE	S302195
WVDEP Mine Permit Database (provided by WVDOE)	37.969	-81.347	50.98	SKITTER CREEK NO. 1 MINE	S302794

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WVDEP Mine Permit Database (provided by WVDOE)	37.936	-81.285	39.39	PAX SURFACE MINE #3	S300295
WVDEP Mine Permit Database (provided by WVDOE)	37.929	-81.287	39.48	PAX SURFACE MINE #3	S300295
WVDEP Mine Permit Database (provided by WVDOE)	37.948	-81.289	40.74	PAX SURFACE MINE #3	S300295
WVDEP Mine Permit Database (provided by WVDOE)	37.930	-81.299	41.10	Pax Surface Mine No. 4	S300103
WVDEP Mine Permit Database (provided by WVDOE)	37.972	-81.468	64.16	Kayford South Surface Mine	S300800
WVDEP Mine Permit Database (provided by WVDOE)	37.972	-81.468	64.16	Kayford South Surface Mine	S300800
WVDEP Mine Permit Database (provided by WVDOE)	37.929	-81.297	40.76	Patience Surface Mine No. 4	S300105
WVDEP Mine Permit Database (provided by WVDOE)	37.923	-81.297	40.46	Patience Surface Mine No. 4	S300105
WVDEP Mine Permit Database (provided by WVDOE)	38.457	-80.629	4.29	O'BRIEN FORK #2 SURFACE MINE	S200603
WVDEP Mine Permit Database (provided by WVDOE)	38.457	-80.611	3.79	O'BRIEN FORK #2A SURFACE MINE	S200204
WVDEP Mine Permit Database (provided by WVDOE)	38.487	-80.642	5.27	Brandy Station Mine	S200205
WVDEP Mine Permit Database (provided by WVDOE)	39.143	-79.279	8.56	C-1 NORTH STRIP	S200303
WVDEP Mine Permit Database (provided by WVDOE)	38.439	-80.613	3.66	KNIGHT-INK NO. 2 SURFACE MINE	S200498
WVDEP Mine Permit Database (provided by WVDOE)	37.527	-81.523	48.98	Sewell Seam Surface Mine No. 2	S400900
WVDEP Mine Permit Database (provided by WVDOE)	37.511	-81.524	50.78	Sewell Seam Surface Mine No. 2	S400900
WVDEP Mine Permit Database (provided by WVDOE)	37.515	-81.537	57.30	Sewell Seam Surface Mine No. 2	S400900
WVDEP Mine Permit Database (provided by WVDOE)	37.506	-81.526	50.95	Sewell Seam Surface Mine No. 2	S400900
WVDEP Mine Permit Database (provided by WVDOE)	37.514	-81.523	50.85	Sewell Seam Surface Mine No. 2	S400900
WVDEP Mine Permit Database (provided by WVDOE)	37.517	-81.537	54.00	Sewell Seam Surface Mine No. 2	S400900
WVDEP Mine Permit Database (provided by WVDOE)	37.473	-81.399	38.49	Poca No. 11 Contour Auger No.2	S401301
WVDEP Mine Permit Database (provided by WVDOE)	37.641	-81.748	73.87	COAL MOUNTAIN NO. 1 SURFACE MI	S402096
WVDEP Mine Permit Database (provided by WVDOE)	37.646	-81.731	65.89	COAL MTN VALLEY FILL NO. 2	S402196
WVDEP Mine Permit Database (provided by WVDOE)	37.752	-81.750	66.37	Surface Mine No. 2	S400104
WVDEP Mine Permit Database (provided by WVDOE)	37.728	-81.675	66.60	Paynter Branch North Surface M	S400300
WVDEP Mine Permit Database (provided by WVDOE)	37.490	-81.443	41.32	Payne Branch Surface Mine	S400399
WVDEP Mine Permit Database (provided by WVDOE)	37.496	-81.443	40.90	Payne Branch Surface Mine	S400399
WVDEP Mine Permit Database (provided by WVDOE)	37.219	-81.613	14.61	Amonate Auger No. 2	S400403
WVDEP Mine Permit Database (provided by WVDOE)	37.695	-81.580	67.30	SIMMONS FORK MOUNTAINTOP REMOV	S400596
WVDEP Mine Permit Database (provided by WVDOE)	37.455	-81.374	36.01	Pinnacle Ridge Surface Mine	S400899
WVDEP Mine Permit Database (provided by WVDOE)	38.186	-81.116	29.45	Gauley Knob Surface Mine	S300207

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WVDEP Mine Permit Database (provided by WVDOE)	37.844	-82.146	33.46	WEST FORK SURFACE MINE #1	S501306
WVDEP Mine Permit Database (provided by WVDOE)	37.842	-81.906	50.44	REYLAS SURFACE MINE	S501506
WVDEP Mine Permit Database (provided by WVDOE)	38.347	-81.057	20.78	SURFACE MINE NO. 3	S200995
WVDEP Mine Permit Database (provided by WVDOE)	38.361	-81.057	20.49	SURFACE MINE NO. 3	S200995
WVDEP Mine Permit Database (provided by WVDOE)	38.337	-81.034	19.91	SURFACE MINE NO. 3	S200995
WVDEP Mine Permit Database (provided by WVDOE)	38.094	-81.982	27.35	Surface Mine No. 44	S500306
WVDEP Mine Permit Database (provided by WVDOE)	38.096	-81.987	27.02	Surface Mine No. 44	S500306
WVDEP Mine Permit Database (provided by WVDOE)	38.099	-81.979	27.34	Surface Mine No. 44	S500306
WVDEP Mine Permit Database (provided by WVDOE)	38.111	-81.965	27.91	Surface Mine No. 22	S500806
WVDEP Mine Permit Database (provided by WVDOE)	37.727	-82.264	23.36	PEG FORK SURFACE MINE	S501806
WVDEP Mine Permit Database (provided by WVDOE)	37.844	-82.146	33.46	WEST FORK SURFACE MINE #1	S501306
WVDEP Mine Permit Database (provided by WVDOE)	38.347	-80.968	15.91	Spruce Run Surface Mine	S301806
WVDEP Mine Permit Database (provided by WVDOE)	38.348	-80.962	15.51	Spruce Run Surface Mine	S301806
WVDEP Mine Permit Database (provided by WVDOE)	38.340	-80.984	16.93	Spruce Run Surface Mine	S301806
WVDEP Mine Permit Database (provided by WVDOE)	38.331	-80.967	16.56	Spruce Run Surface Mine	S301806
WVDEP Mine Permit Database (provided by WVDOE)	37.448	-81.801	61.87		S400707
WVDEP Mine Permit Database (provided by WVDOE)	37.262	-81.512	15.72	Paradise Surface Mine	S400906
WVDEP Mine Permit Database (provided by WVDOE)	37.561	-81.858	61.44	WHITE OAK SURFACE MINE #6	S501006
WVDEP Mine Permit Database (provided by WVDOE)	37.712	-81.694	67.37	Paynter Branch South Surface M	S400106
WVDEP Mine Permit Database (provided by WVDOE)	37.815	-81.724	63.93	TONEY FORK SURFACE #2	S503395
WVDEP Mine Permit Database (provided by WVDOE)	-81.087	38.381	21.95		S200307
WVDEP Mine Permit Database (provided by WVDOE)	-82.072	37.572	44.76		S500707
WVDEP Mine Permit Database (provided by WVDOE)	-82.003	37.644	50.32		S501307
WVDEP Mine Permit Database (provided by WVDOE)	-82.249	37.939	23.10		S501302
WVDEP Mine Permit Database (provided by WVDOE)	-81.250	37.612	31.82		S302007
WVDEP Mine Permit Database (provided by WVDOE)	-81.483	37.404	36.15		S400907
WVDEP Mine Permit Database (provided by WVDOE)	-81.496	37.376	36.24		S400705
WVDEP Mine Permit Database (provided by WVDOE)	-81.484	37.373	35.45		S401306
WVDEP Mine Permit Database (provided by WVDOE)	-81.635	37.273	21.81		S400307
WVDEP Mine Permit Database (provided by WVDOE)	-81.066	38.288	24.38		S301107

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WVDEP Mine Permit Database (provided by WVDOE)	-80.718	38.395	8.62		S302807
WVDEP Mine Permit Database (provided by WVDOE)	-80.701	38.444	5.75		S300507
WVDEP Mine Permit Database (provided by WVDOE)	-80.890	38.358	11.66		S301800
WVDEP Mine Permit Database (provided by WVDOE)	-81.796	37.855	57.62		S500907
WVDEP Mine Permit Database (provided by WVDOE)	-81.797	37.898	53.25		S500908
WVDEP Mine Permit Database (provided by WVDOE)	-81.091	38.186	26.44		S300206
WVDEP Mine Permit Database (provided by WVDOE)	-81.241	38.206	46.05		S302696
WVDEP Mine Permit Database (provided by WVDOE)	-80.595	38.490	4.78		S201202
WVDEP Mine Permit Database (provided by WVDOE)	-81.507	38.113	61.94		S302107
WVDEP Mine Permit Database (provided by WVDOE)	-81.536	38.063	62.05		S302607
WVDEP Mine Permit Database (provided by WVDOE)	-81.631	37.950	64.51		S401001
WVDEP Mine Permit Database (provided by WVDOE)	-81.981	38.339	30.16		S301806
WVDEP Mine Permit Database (provided by WVDOE)	-81.005	38.288	20.18		S302293
WVDEP Mine Permit Database (provided by WVDOE)	-81.485	38.061	68.74		S303107
WVDEP Mine Permit Database (provided by WVDOE)	-81.577	37.861	65.01		S400800
WVDEP Mine Permit Database (provided by WVDOE)	-81.625	37.896	77.33		S501707
WVDEP Mine Permit Database (provided by WVDOE)	-81.984	38.109	26.71		S500207
WVDEP Mine Permit Database (provided by WVDOE)	-81.781	38.200	41.14		S501007
WVDEP Mine Permit Database (provided by WVDOE)	-81.712	37.938	59.03		S501700