Indian Creek Watershed Association
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August 15, 2016

RE: Hydrogeological Assessment of Watershed Impacts Caused by Constructing the Mountain Valley Gas Pipeline Through Summers and Monroe Counties, West Virginia
Docket No. CP16-10-000

TO: Ms. Kimberly Bose, Secretary, Federal Energy Regulatory Commission (via e-filing)
U.S. Environmental Protection Agency, Region 3
Mr. Jon M. Capacasa, Director, Water Protection Division
Barbara Rudnick, NEPA Team Leader

U.S. Army Corps of Engineers, Huntington District
Mike Hatten, Regulatory Permits – Energy Resources
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WV Bureau for Public Health
William Toomey, Unit Manager, Source Water Assessment and Wellhead Protection Program
Environmental Engineering Division

Indian Creek Watershed Association hereby files the following report: “Hydrogeological Assessment of Watershed Impacts Caused by Constructing the Mountain Valley Gas Pipeline Through Summers and Monroe Counties, West Virginia,” by Pamela C. Dodds, Ph.D., Licensed Professional Geologist.

The conclusions of the report reinforce our request for detailed, on-the-ground hydrogeological studies in Monroe County and elsewhere before issuing a Draft Environmental Impact Statement for the MVP project.

Respectfully submitted,
Indian Creek Watershed Association Board of Directors
Judy Azulay, President; Scott Womack, Vice President;
Howdy Henritz, Treasurer; Nancy Bouldin, Secretary
Email: info@IndianCreekWatershedAssociation.org
HYDROGEOLOGICAL ASSESSMENT OF WATERSHED IMPACTS CAUSED BY CONSTRUCTING THE MOUNTAIN VALLEY GAS PIPELINE THROUGH SUMMERS AND MONROE COUNTIES, WEST VIRGINIA

By Pamela C. Dodds, Ph.D., Licensed Professional Geologist for Indian Creek Watershed Association

August 2016
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Cover: Waterfall in the headwater area of Lick Creek, MVP Milepost 162.6. Photo taken by Mr. Dwayne Milam, May 15, 2016.
EXECUTIVE SUMMARY

A gas pipeline constructed in Summers and Monroe Counties, as described in the Mountain Valley Pipeline, LLC (MVP) Application for a Certificate of Public Convenience and Necessity and Related Authorizations, submitted to the Federal Energy Regulatory Commission (FERC) October, 2015, will cause environmental degradation and destruction which will adversely impact landowners and communities:

1) The MVP gas pipeline construction will adversely impact headwater aquatic habitats which serve as the base of the food chain for the entire river continuum ecosystem.

The steep terrain in Summers and Monroe Counties provides the unique geomorphology for first order high gradient streams. First order streams consist of a single tributary which forms in the headwater areas of a watershed. The watersheds of first order high gradient streams in Summers and Monroe Counties provide the essential aquatic habitats for aquatic species and associated terrestrial fauna and fowls within the entire lengths of the river continuums in the overall major watersheds.

2) The MVP gas pipeline construction will adversely impact springs and wetlands by soil removal.

The composition of weathering products from the underlying bedrock determines characteristics of soils relating to water retention, pore space, and acidity. The organic fraction of the soils results from interactions between the available vegetation and soil organisms such as microbial communities, worms, and tree roots. Soil scientists estimate that a time period greater than 100 years is required for one inch of soil to form. For this reason, soil is considered a non-renewable resource. The MVP gas pipeline construction on forested ridges and slopes will destroy the soils which regulate the transport of surface water and also carbon, nitrogen, and oxygen to headwater areas of first order high gradient streams and to wetlands. The destruction will result from access road construction and from leveling the 125-foot wide work corridor, causing soil removal and compaction of the underlying subsoils and bedrock residuum.
3) The MVP gas pipeline construction will require deforestation and blasting, both of which will reduce groundwater recharge and cause significant changes to the amount of groundwater available as a drinking water source, as well as to groundwater flow routes.

The MVP gas pipeline construction will require deforestation, which will decrease groundwater recharge and increase stormwater runoff. Reduced groundwater recharge will reduce the amount of groundwater to springs and seeps to streams and wetlands. The MVP gas pipeline construction will also require blasting for more than approximately 80% of the work corridor in Summers and Monroe Counties because the soils surveys indicate that the depth to bedrock for more than approximately 80% of the work corridor is less than 4 feet. The trench depth required for installation of the 42-inch diameter is at least 8.5 feet. Blasting will destroy the flow of groundwater and change the route of groundwater flow to the abundant springs and wetlands that occur in the headwater areas of the first order high gradient streams.

4) The MVP gas pipeline construction will degrade karst environments.

Karst terrain is strongly developed in the limestone and dolostone underlying the surficial bedrock in Summers County and in the northern and eastern portions of Monroe County and also in the surficial limestone bedrock underlying the southeastern portion of Monroe County. This karst terrain contains a unique array of extensive cave systems, bedrock voids, and associated drainage basins. Blasting along the proposed MVP work corridor will degrade fragile cave systems by causing collapse as well as by causing changes in the groundwater flow and direction responsible for maintaining the moist cave conditions. There is a strong potential for collapse of the gas pipeline where construction occurs in karst terrain.

5) The MVP gas pipeline construction will cause increased stormwater discharge and also degrade stream functions at the numerous locations where stream crossings are proposed.

Streams will be degraded by increased stormwater discharge as well as disruption of streams at crossings and release of buried fertilizers and pesticides. Ground cover determines the amount of precipitation that will penetrate the ground as groundwater recharge or run off the surface. Forested areas intercept rainfall, allowing the rain to gently reach the ground surface. Therefore, in forested areas, the rain will penetrate the ground to recharge groundwater and will flow across the ground surface with less volume and velocity (discharge) than in non-forested areas. Even where sediment from stormwater discharge from construction areas is captured in erosion control structures, the increased discharge flowing into streams will result in stream bank erosion downstream and, consequently, increased sedimentation downstream. Where stream crossings are planned for the MVP gas pipeline construction, stream bedding
forms will be destroyed, aquatic habitats will be destroyed, and buried layers containing fertilizer and pesticides will be disturbed, with the consequence of releasing fertilizer and pesticides to the stream water. Areas along streams in Summers and Monroe Counties are commonly agricultural. Fertilizers and pesticides frequently enter the streams with the surface water runoff from agricultural fields. Through time, less toxic pesticides have been used, but the older, more toxic pesticides are now covered by sediment in the stream beds. When the stream bed sediments are disturbed, the older layers of fertilizer and pesticides will be released to the stream water. Algal blooms can result from the increased amount of fertilizer available. Algal blooms are known to cause death of aquatic organisms. Toxic pesticides are also known to cause death of aquatic organisms.

6) The MVP gas pipeline construction will create the potential for landslides.

Red shale and siltstone of the Mauch Chunk Group is the predominant bedrock in Summers and Monroe Counties. The West Virginia Geological and Economic Survey (WVGES) has determined that landslide-prone areas occur mostly on slopes of 15% to 45% on red shale bedrock. Such slopes are pervasive throughout the areas in Summers and Monroe Counties where the MVP gas pipeline route is proposed. Therefore, there is potential for significant landslide occurrences that would result from construction of the proposed MVP gas pipeline in Summers and Monroe Counties.

7) The MVP gas pipeline construction will create the potential for pipeline collapse in areas known to have experienced earthquakes.

The U.S. Geological Survey (USGS) 2014 Seismic Hazard Map depicts Summers and Monroe Counties in a zone of concern for earthquake events. The West Virginia Geological Survey 2014 earthquake map indicates several recent earthquakes in Summers and Monroe Counties. Although MVP discounts the seismic activity as insignificant, the combination of earthquakes in karst areas where the proposed MVP gas pipeline would be located presents definite concern because the karst areas are susceptible to collapse even without earthquakes.

8) Cumulative damage would result from the MVP gas pipeline construction.

The findings provided in this report are in contrast to the MVP statement on page 22 of its October, 2015 application that, “There Is Minimal Potential For Adverse Impacts To Landowners And Communities Affected By The Project“. The findings provided herein support the conclusion that there would be significant adverse impacts resulting from construction of the proposed pipeline through Summers and Monroe Counties. Cumulative adverse impacts will result from construction of a gas pipeline in the numerous watersheds of first order high gradient streams in Summers and Monroe Counties.
DESCRIPTION AND REQUIREMENTS FOR CONSTRUCTION OF THE MOUNTAIN VALLEY GAS PIPELINE IN SUMMERS AND MONROE COUNTIES, WV

Acreage Requirements for Work Activities

The route of the proposed MVP gas pipeline traverses ridgelines and intervening mountainsides as well as streams and rivers. The MVP reports include details of the requirements for placing their 42-inch diameter pipelines into trenches which are mostly located on mountain ridges. In the MVP General Project Description Resources Report 1 (RR1), dated October, 2015, the temporary construction easement for the pipeline installation work corridor is 125 feet. In RR1 Table 1.2-1, the work corridor is shown to extend 16.7 miles through Summers County, WV, and 22.0 miles through Monroe County, WV. Based on this information, there will be approximately 253 acres in the work corridor in Summers County and approximately 333 acres in the work corridor in Monroe County. RR1 provides that additional areas will be used for potential pipe storage and contractor staging yards. RR1 also provides that additional work space will be used in areas of slopes greater than 30%, rock, or other difficult terrain; road and railroad crossings; wetland and waterbody crossings; areas requiring full-width topsoil segregation; areas specifically requested of the landowner or land management agency; pipeline access and truck turnarounds; fabrication and staging areas; and hydrostatic test water withdrawal and discharge locations. Appendix 1-J of RR1 provides a list of vertical/lateral slopes with grades between 15% and 30% and also a list with grades greater than 30%. Based on this list, approximately 23% of the work corridor in Summers County has slopes between 15% and 45% and approximately 29% of the work corridor in Monroe County has slopes between 15% and 45%. In wetlands, the work corridor is proposed to be 75 feet in width, although it is stated that additional work space will be required at wetland and waterbody crossings. Appendix 1-D of RR1 provides the acreage of required additional work space. In Summers County, additional required work space is provided as 72.09 acres, with 21.35 acres (or 30%) forest land, and in Monroe County, additional required work space is provided as 33.54 acres, with 10.63 acres (or 32%) forest land. Using the access road lengths in Appendix 1-F of RR1 and the 40-foot width shown on the maps, there will be 43.8 acres of access roads in Summers County and 62.58 acres of access roads in Monroe County. The amount of additional workspace required in areas with slopes greater than 30% was not provided by MVP.
Table 1 – Acreage requirements for gas pipeline work corridor, additional work areas at wetlands, and access roads.

<table>
<thead>
<tr>
<th>County</th>
<th>Work Corridor (acres)</th>
<th>Slopes &gt; 30% Needing Additional Work Space (%)</th>
<th>Additional Work Space Required at Wetlands (acres)</th>
<th>Access Roads (acres)</th>
<th>TOTAL ACRES, Not Including Additional Work Space Needed Near Slopes &gt; 30%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summers</td>
<td>253</td>
<td>20%</td>
<td>72.09 (30% forested)</td>
<td>43.8</td>
<td>368.89</td>
</tr>
<tr>
<td>Monroe</td>
<td>333</td>
<td>30%</td>
<td>33.54 (32% forested)</td>
<td>62.58</td>
<td>429.12</td>
</tr>
</tbody>
</table>

**Pipeline Trench Description**

In the MVP General Project Description Resources Report 1 (RR1), dated October, 2015, provides: “Generally, the trench will be excavated at least 12 inches wider than the diameter of the pipe. The sides of the trench will be sloped with the top of the trench up to 12 feet across, or more, depending upon the stability of the native soils. The trench will be excavated to a sufficient depth to allow a minimum of three feet of soil cover between the top of the pipe and the final land surface after backfilling (minimum of 18 inches of cover will be provided in consolidated rock in Class 1 or greater locations or in ditches, where 24 inches of cover is required). Locations such as waterbodies, roads and railroads will include 36 inches of cover per applicable permits.”

Summarizing, the trench for the pipe itself is 5.5 feet wide. However, because the walls are sloped upward to the surface, the surface of the trenched area will be 12 feet wide. The Typical Drawings provided in RR1, Appendix 1-C1, do not indicate the trench depths. Trench descriptions in RR1 provide that the depth of excavation is 3 feet at the surface down to the pipe, plus 3.5 feet of pipe, plus up to 2 feet of cover at the base of the trench. The total depth is, then, approximately 8.5 feet.

**Work Corridor Leveling and Dewatering**

The work corridor of approximately 125 feet will be leveled by deforestation, excavation, and grading (Figure 1). RR1 describes trench dewatering procedures: “The storm water will be pumped from the trench to a location down-gradient of the trench. The trench will be dewatered in a manner that does not cause erosion and does not result in heavily silt-laden water flowing into any waterbody or wetland. The storm water will be discharged to an energy dissipation/filtration dewatering device, such as a hay bale structure.” On the left side of Figure 1, a hill has been excavated to its intersection with a ravine. Water can be observed in the trench by the ravine where the pipeline is to be placed. Groundwater from the hillside would also flow toward the ravine and the pipeline trench. However, MVP provides no discussion concerning the interception of groundwater on cut slopes/hillsides.
Figure 1 – Leveled work corridor for pipeline installation, showing cut hillsides and evident dewatering into the pipeline trench. Heavy equipment and pick-up trucks provide a scale.

GEOLOGY OF SUMMERS AND MONROE COUNTIES

Summers County and the Northwestern and Central Portions of Monroe County

Summers County and the northwestern and central portions of Monroe County, where the MVP gas pipeline route is proposed, are located in the Appalachian Plateau Physiographic Province. The surficial drainage displays a dendritic pattern, and erosional downcutting of the rock by streams has resulted in steep, mountainous terrain with typical relief between 200 feet and 1300 feet. The surficial bedrock underlying Summers County and the northwestern and central portions of Monroe County is significantly different from that underlying the southeastern portion of Monroe County. Where the MVP gas pipeline route is proposed in Summers County and the northwestern and central portions of Monroe County, the surficial bedrock is predominantly interbedded, mostly red shale, siltstone, and sandstone, assigned to the Mauch Chunk Group of Mississippian geologic age. The uppermost portion of the Mauch Chunk Group is the Hinton Formation, of which the Avis Limestone varies in thickness from 10 to 40 feet. The extent of the Avis Limestone is shown in Figure 2, “Limestones of the New River Drainage Basin” (in “The Karst of West Virginia”, by George Dasher, with Geological Maps by Greg Springer, in West Virginia Speleological Survey, Bulletin #14). Figure 3 is a portion of the geologic map, “Summers County Showing General and Economic Geology”, by David B. Reger and Paul H. Price, 1925, West Virginia Geological Survey. The Hinton Formation appears as light gray and is signified by “Chn”. The portion of the Hinton Formation shown in Figure 2 as the Avis Limestone is outlined in red on Figure 3.
Figure 2 – “Limestones of the New River Drainage Basin” depicts the Avis Limestone in northern Summers County. The Avis Limestone is part of the Hinton Formation (Mauch Chunk Group). The Greenbrier Limestone is the surficial bedrock in central Monroe County, extending to Lindside. The older carbonate bedrock units occur in the southeastern portion of Monroe County.

Figure 3 – The Avis Limestone is outlined in red to depict its location, shown in Figure 2, in the Hinton Formation in the northern portion of Summers County.
Sinkhole development in the Avis Limestone is uncommon because the limestone is calcium-pure and exhibits an interlocking crystalline texture; however, approximately ten caves have been reported in the Avis Limestone. The caves are several thousand feet long and occur along joints or fractures in the bedrock.

The Hinton Formation and the underlying Bluefield Formation are approximately 1000 feet thick and are underlain by the Mississippian-aged Greenbrier Limestone, which is approximately 1400 feet thick. These bedrock units underlying Summers County and the northwestern and central portions of Monroe County occur as relatively horizontal layers. However, with respect to geologic structure, there are several broad anticlines and synclines (broad, arched folds and broad, trough folds, respectively) within these bedrock units (Figure 4). In areas where anticlines occur, the older bedrock is closer to the ground surface. So, in areas where there are anticlines, the underlying Greenbrier Limestone occurs at the ground surface or closer to the ground surface than in other areas. The proposed MVP gas pipeline route crosses the Alderson Anticline in Summers County and the Creamery Syncline, Abes Valley Anticline, and Hurricane Ridge Syncline in Monroe County.

Figure 4 – Synclines have younger bedrock at the surface, whereas anticlines have older bedrock at the surface

The gently folded structural anticlines and synclines have been eroded and do not have a topographic anticlinal expression; however, different rock units are exposed at the surface along cross-sections of the folds as a result of the erosion. For example, the older Bluefield Group bedrock underlying the Hinton Group bedrock is exposed along the limbs of the Creamery Syncline, while the younger Hinton Group bedrock is exposed at locations along the axis of the syncline. The older Greenbrier Limestone (Cgr) is observed along the axis of the Alderson Anticline, whereas bedrock of the younger Bluefield Group (Cbf) occurs along the limbs of the anticline (Figure 5).
Figure 5 – Geologic Map of Summers County showing the Alderson Anticline (from Reger, et al, 1925). The older Greenbrier Limestone (Cgr) is outlined in orange and shown along the centerline of the Alderson Anticline and the younger Bluefield Group (Cbf) is shown to the northwest and southeast, flanking the anticline. The proposed MVP gas pipeline route is shown in red.

The Abes Valley Anticline, shown in Figure 6, traverses the Ellison Ridge area in Monroe County. This anticline trends southwest-northeast and plunges to the southwest. To the northeast of the proposed MVP gas pipeline location in the Ellison Ridge area, the older Greenbrier Limestone occurs at the surface. This is consistent with the observation of older bedrock units occurring along the axial line of any anticline (Figure 4). Because the anticline dips to the southwest, the younger Bluefield Formation of the Mauch Chunk Group is exposed along the axial line of the anticline to the southwest. Further southwest, the successively younger Hinton Formation of the Mauch Chunk Group is exposed along the axial line of the Abes Valley Anticline. Although the shale and sandstone of the younger Bluefield and Hinton formations occur at the surface along the Abes Valley Anticline in the Ellison Ridge area, the underlying Greenbrier Formation is observed in caves accessed through openings in the overlying shale and sandstone.
Figure 6 – Geologic Map of Monroe County in the Ellison Ridge area showing the Abes Valley Anticline (from Reger, et al, 1925). The older Greenbrier Limestone (Cgr) is outlined in deep red and shown along the centerline of the Abes Valley Anticline, and the younger Bluefield Formation (Cbf) is shown to the northwest and southeast, flanking the anticline. The proposed MVP gas pipeline route is shown in red.

Southeastern Portion of Monroe County

The Southeastern portion of Monroe County, where the MVP gas pipeline route is proposed, is located in the Valley and Ridge Physiographic Province, characterized by trellis stream drainage in closely spaced anticlines (arch-shaped bedrock folds) and synclines (trough-shaped bedrock folds). The combination of folded bedrock and downcutting by streams has created mountainous relief as much as 2,000 feet. It is in this southeastern portion of Monroe County that the proposed MVP gas pipeline route crosses the St. Clair overthrust fault. Older limestone and dolostone carbonate rock units occur to the southeast of the St. Clair overthrust fault. Figure 7 is a schematic geologic cross-section depicting the geologic bedrock units. At the St. Clair overthrust fault, the surficial rocks are shown as thrusted over the folded bedrock units at depth. Limestone of the Ordovician aged Beekmantown Group, Stones River Group, and Moccasin Formation occur at successive distances to the southeast, away from the St.
Clair fault. Further to the southeast are the Martinsburg Shale and then the Silurian Tuscarora Sandstone, which comprise the ridge-forming rocks of Peters Mountain. To the northwest of the St. Clair fault, a syncline occurs, indicating successively younger units in the middle of the syncline. The units include Devonian age Marcellus shale, Portage shale, Chemung siltstone, and Pocono sandstone and shale, overlain by the Greenbrier Limestone and the Bluefield shale and limestone formation of the Mauch Chunk Group. The Greenbrier Limestone is the predominant bedrock underlying the north central portion of Monroe County and a part of the southeastern portion. Although the proposed MVP gas pipeline route does not cross broad areas of the Greenbrier Limestone, it does cross surficial exposures near Lindside. As illustrated in the figure depicting the geologic units, the Greenbrier Limestone underlies the surficial Mauch Chunk interbedded sandstones, siltstones, and shales in all areas northwest of the St. Clair fault, except where the older units occur adjacent to the St. Clair fault. As noted, older limestone units are present adjacent to and southeast of the St. Clair Fault.

![Figure 7 – Geologic cross-section of bedrock units in southeastern Monroe County from northwest (D) to southeast (D’), taken from Reger, et al, 1925. The St. Clair Fault (near the right side of the diagram) separates the younger rock units to the northwest from the older rock units to the southeast.](image)

The structural features of the bedrock in the area, including the anticlines, synclines, and faults, have associated fracture sets which were caused by tectonic stress during the folding and thrust faulting of the overall area. The fracture sets formed parallel to the stress direction and also along planes at angles of 45 degrees or less to the stress direction. Springs and seeps occur where the bedding planes, faults, and fracture sets intersect the ground surface along the ridges throughout Summers and Monroe Counties (Figure 8). It is significant to note that blasting activities along the ridges can destroy the areas where the springs occur, changing the amount and direction of groundwater flow.
Figure 8 – Fractures within any rock provide conduits through which groundwater may flow downward or at angles to the ground surface. Where bedding planes of the rock or where fractures in the rock intercept the ground surface, it is common for springs or seeps to occur. Seeps and springs also provide water directly to streams.

Karst

In areas where the Greenbrier Limestone is the surficial bedrock unit and also where other overlying units are thinner, the topography is characterized as karst terrain containing numerous caves, crevices, cavities (voids), fractured rock, disappearing streams, sinkholes, and springs (Figure 9). Karst terrain is well developed in the Greenbrier Limestone because it is sandy and fossiliferous rather than having an interlocking crystalline texture (such as the Avis Limestone). Caves have also formed in the Greenbrier Limestone underlying the Mauch Chunk surficial bedrock in numerous portions of Monroe County.

Figure 9 – Features typical of karst terrain.
Draper Aden Associates prepared a “Karst Hazards Assessment (Desktop Review And Field Reconnaissance)” (dated April 16, 2016) for MVP to present as DR2 RR2-12 to FERC in response to FERC’s Environmental Information Request #2 (March 31, 2016). The report provides locations and descriptions of karst areas along the proposed MVP gas pipeline route. Information from tables and maps presented in the report is excerpted and summarized below for Summers and Monroe Counties; additional information provided on the Draper Aden maps is shown in red. An “open throat” refers to an opening in the sinkhole, such as an open fracture, into which water can flow into the rock or cavity below the sinkhole. In some cases, an “open throat” provides an opening into which an animal or people could traverse downward into a rock cavity (cave) below.

Table 2 – Summary of karst features in Summers County, excerpted from tables and maps (map information is shown in red) by Draper Aden Associates for the MVP DR2 RR2-12 response to FERC.

<table>
<thead>
<tr>
<th>MVP Milepost</th>
<th>Feature</th>
<th>Field Check</th>
<th>Description</th>
<th>Concerns</th>
</tr>
</thead>
<tbody>
<tr>
<td>172.02</td>
<td>Begin Limestone</td>
<td>Yes</td>
<td>Northern Extent of karst terrain. Little to no historic cave review performed in this area</td>
<td>None provided</td>
</tr>
<tr>
<td>172.40</td>
<td>Sinkhole</td>
<td>Yes</td>
<td>Sinkhole mapped approximately 300 feet to the southwest. Open throat shown on map.</td>
<td>Construction runoff and fluid discharge may impact sinkhole</td>
</tr>
<tr>
<td>172.47</td>
<td>Sinkhole</td>
<td>Yes</td>
<td>Sinkhole approximately 650 feet northeast. Proposed MVP crosses surface drainage leading to sinkhole. Open throat shown on map.</td>
<td>Construction runoff and fluid discharge may impact sinkhole, which may in turn lead to subsurface discharge to groundwater</td>
</tr>
<tr>
<td>172.75</td>
<td>Sinkhole</td>
<td>Yes</td>
<td>Sinkhole approximately 400 feet west. Proposed MVP crosses surface drainage leading to sinkhole. Open throat and swallet shown on map.</td>
<td>Construction runoff and fluid discharge may impact sinkhole, which may in turn lead to subsurface discharge to groundwater</td>
</tr>
<tr>
<td>172.84</td>
<td>Spring</td>
<td>Yes</td>
<td>Small spring approximately 260 feet west. Proposed MVP crosses surface drainage leading to [spring]</td>
<td>Construction runoff and fluid discharge may impact spring</td>
</tr>
<tr>
<td>172.92</td>
<td>Sinkhole</td>
<td>Yes</td>
<td>Compound sinkhole approximately 500 feet southwest of the proposed alignment. Two sinkholes shown on map, one with open throat, one with open throat and swallet and another nearby open throat.</td>
<td>Sinkhole is upstream of the proposed alignment</td>
</tr>
<tr>
<td>173.14</td>
<td>Sinkhole</td>
<td>Yes</td>
<td>Sinkhole mapped by desktop review approximately 100 feet east of proposed MVP alignment. Proposed alignment crosses watershed associated with the sinkhole, and crosses a topographic drainage leading to the south. Map shows sinkhole with open throat and another open throat nearby.</td>
<td>Construction across or in near vicinity of sinkhole may lead to long-term differential settlement and pipeline instability. Construction runoff and fluid discharge may impact sinkhole, which may in turn lead to subsurface discharge to groundwater.</td>
</tr>
<tr>
<td>173.35</td>
<td>End Limestone</td>
<td>Yes</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Table 3 – Summary of karst features in Monroe County, excerpted from tables and maps (map information shown in red) by Draper Aden Associates for the MVP DR2 RR2-12 response to FERC.

<table>
<thead>
<tr>
<th>MVP Milepost</th>
<th>Feature</th>
<th>Field Check</th>
<th>Description</th>
<th>Concerns</th>
</tr>
</thead>
<tbody>
<tr>
<td>190.90</td>
<td>Begin Limestone</td>
<td>Yes</td>
<td>Union Limestone (part of the Greenbrier Limestone Group)</td>
<td>-</td>
</tr>
<tr>
<td>190.93</td>
<td>Losing stream, Insurgence</td>
<td>Yes</td>
<td>Below the pond there is an area where a very small stream sinks into the ground. Elevation is about 30 feet above creek base level.</td>
<td>Construction runoff and fluid discharge may impact sinking stream and groundwater</td>
</tr>
<tr>
<td>191.10</td>
<td>Springs (2)</td>
<td>Yes</td>
<td>440 east and 105 feet southwest of access road MVP-MO-230 is a small wet weather seep. 705 feet east, and 370 feet southwest of access road MVP-MO-230, is a spring</td>
<td>None provided</td>
</tr>
<tr>
<td>193.90</td>
<td>Begin Dolomite</td>
<td>No</td>
<td>St. Clair thrust fault</td>
<td>This area historically known to have extensive and well documented cave and karst development. High karst potential with significant cave and karst feature development.</td>
</tr>
<tr>
<td>194.24</td>
<td>Sinkhole</td>
<td>No</td>
<td>Sinkhole mapped by desktop review approximately 100 feet to east of proposed alignment. Proposed alignment crosses watershed associated with the sinkhole. Other small sinkholes are located approximately 150 feet northeast. All these sinkholes are shown on the map as having open throats.</td>
<td>Construction across or in near vicinity of sinkhole may lead to long-term differential settlement and pipeline instability. Construction runoff and fluid discharge may impact sinkhole, which may in turn lead to subsurface discharge to groundwater. Sinkhole may have a hydraulic connection to nearby Bobcat Cave or Rich Creek Cave/Spring.</td>
</tr>
<tr>
<td>194.35</td>
<td>Sinkhole</td>
<td>No</td>
<td>Sinkholes mapped by desktop review more than approximately 800 feet west of alignment. These sinkholes are shown on the map as having open throats.</td>
<td>Construction runoff and fluid discharge may impact sinkhole</td>
</tr>
<tr>
<td>194.36</td>
<td>Begin Limestone</td>
<td>No</td>
<td>Begin Limestone area</td>
<td>This area historically known to have extensive and well documented cave and karst development. High karst potential with significant cave and karst feature development</td>
</tr>
<tr>
<td>194.40</td>
<td>Sinkhole and Cave</td>
<td>No</td>
<td>Bobcat Cave, described as a small room located in a large sinkhole, location uncertain, to west. Mapped by desktop review.</td>
<td>Construction across or in near vicinity of an open throat sinkhole may lead to long-term differential settlement and pipeline instability. Construction runoff and fluid discharge may impact sinkhole, which may in turn lead to subsurface discharge to groundwater. Sinkhole may have a hydraulic connection to nearby Bobcat cave or Rich Creek Cave Spring.</td>
</tr>
<tr>
<td>194.55</td>
<td>Spring and cave</td>
<td>No</td>
<td>Rich Creek Spring (headwaters of Rich Creek, water supply for Red Sulphur PSD and Town of Peterstown, WV). Rich Creek Cave and Rich Creek Fish Hatchery were mapped approximately 1,500 feet west of the proposed alignment, which is at a higher elevation than the spring which distances it from potential impact. However, the presence of sinking streams and open throat sinkholes could provide direct conduit to the subsurface flow. Rich Creek Spring is large, serves a fish hatchery, headwater of Rich Creek which is back up water supply for Peterstown.</td>
<td>The primary concern is potential impact to water resources. Construction and maintenance may impact Rich Creek Cave and Spring and the downstream surface water body Rich Creek.</td>
</tr>
<tr>
<td>194.48</td>
<td>Sinkhole</td>
<td>No</td>
<td>Open throat sinkhole located approximately 600 feet west of the proposed alignment. These sinkholes are upstream of the MVP alignment.</td>
<td></td>
</tr>
<tr>
<td>194.58</td>
<td>Sinkhole</td>
<td>No</td>
<td>Sinkhole located approximately 80 feet east of the proposed alignment. This sinkhole is shown on the map as having an open throat. Construction across sinkhole may lead to long-term differential settlement and pipeline instability. Construction runoff and fluid discharge may impact sinkhole, which may in turn lead to subsurface discharge to groundwater.</td>
<td></td>
</tr>
<tr>
<td>194.62</td>
<td>Sinkhole</td>
<td>No</td>
<td>Several sinkholes mapped by desktop review approximately 300 feet west of proposed alignment. These sinkholes are shown on the map as having open throats. These sinkholes are upstream of the MVP alignment.</td>
<td></td>
</tr>
<tr>
<td>194.78</td>
<td>End Limestone</td>
<td>Approximate end of limestone</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

In Summers County, the Avis Limestone member of the Hinton Formation has been identified (Dasher, 2000) in areas adjacent to the proposed MVP gas pipeline route from approximately MVP Milepost 157.0 to approximately MVP Milepost 163.0. At least 10 caves have been identified in the Avis Limestone in Summers County. MVP has identified wetlands along this section of the proposed gas pipeline route; however, there is no evidence that field work was conducted or reported in the Draper Aden report to provide the presence of karst features in the associated first order stream watersheds in this northern portion of Summers County.

In the letter dated November 13, 2015, submitted to FERC by the Indian Creek Watershed Association (ICWA letter), numerous locations of caves, springs, and sinking streams were provided in areas along the proposed MVP gas pipeline route that were not included in the Draper Aden report dated April 16, 2016. The Abes Valley Anticline traverses the area near Ellison Ridge, located between approximately MVP Milepost 181.6 and MVP Milepost 188.0. The Draper Aden report does not include any information about karst features in this area; however, there are numerous karst features associated with this southwest plunging anticline which trends northeast-southwest. The ICWA letter includes the location of an un-named cave in the area where the proposed MVP gas pipeline crosses Route 122 and Indian Creek, between approximately MVP Milepost 181.8 and 181.9. The ICWA letter also describes the location of Hans Creek Cave (Haala Cave), which is a shallow cave close to where Hans Creek discharges to Indian Creek. Sinking streams are also reported in the ICWA letter to occur within the area near Ellison Ridge. These features attest to the presence of karst terrain at this location.

The Draper Aden report includes the presence of numerous karst features between MVP Mileposts 172.02 and 173.35 in Summers County. The Alderson Anticline traverses this section of the proposed MVP gas pipeline. Sinkholes and caves typically occur near the axial strike of anticlines because of the fractures associated with the anticlinal fold. The Draper Aden report includes the presence of karst features between MVP Mileposts 190.90 and 191.10, near Lindside in
Monroe County where the Greenbrier Limestone occurs at the land surface. Also, the Draper Aden report includes the presence of karst features between MVP Milepost 193.90 and 194.78 in Monroe County, adjacent to the St. Clair Fault where older limestone bedrock units occur at the ground surface. There are abundant springs in this area, located in the Red Sulphur PSD, which have historically provided water to a fish hatchery as well as a large number of private residences.

**Seismic Hazards**

In the abstract, “West Virginia Earthquakes: Crustal Adjustments Along The Rome Trough Or Something Else?” (by Ronald R. McDowell, J. Eric Lewis, and Phillip A. Dinterman; West Virginia Geological and Economic Survey, 1 Mont Chateau Road, Morgantown, WV 26508; [http://www.wvgs.wvnet.edu/www/presentations/2014/WV-seismic_2014.pdf](http://www.wvgs.wvnet.edu/www/presentations/2014/WV-seismic_2014.pdf)), it is stated that there have been isolated earthquakes since 1966 which are associated with ancient faults. A map is provided (Figure 10) showing that most of these earthquakes have occurred in the western part of West Virginia within an area known as the Rome Trough. However, it is evident on the map that several earthquakes have occurred in Summers and Monroe Counties.

![Figure 10 – WVGES map showing the location of several earthquake epicenters in Summers and Monroe Counties.](image-url)
It is reported on the website [http://earthquaketrack.com/p/united-states/west-virginia/recent](http://earthquaketrack.com/p/united-states/west-virginia/recent) that as recently as October 19, 2013, an earthquake of magnitude 2.2 occurred 1.2 miles from Alderson, near the proposed MVP gas pipeline location. Additionally, an earthquake of magnitude 5.8 occurred in Mineral, Virginia in 2011, causing damage as far away as 85 miles in Washington, D.C. and also in West Virginia locations. Although the Lindside Fault Zone is identified in Monroe County, West Virginia in the MVP Resource Report 6, there is no mention of the earthquake which occurred near Alderson, WV, near the Alderson anticline. Alderson is located to the northeast of the proposed MVP gas pipeline route, but the Alderson anticline crosses the proposed MVP gas pipeline route. Bedrock underlying Lindside consists of Greenbrier Limestone which has been folded and trends southwest-northeast adjacent to the St. Clair Fault. Instead, it is stated in the MVP Resource Report 6 that “The Project alignment does not traverse known faults with recent (Quaternary) movement, such that risk to the pipeline by permanent ground deformation (PGD) from fault rupture is negligible. Therefore, avoidance of the PFZ [Pembroke Fault Zone in Giles County, Virginia] and Project-specific mitigation is not considered necessary.” The U.S. Geological Survey provides a map on its website [http://earthquake.usgs.gov/earthquakes/states/west_virginia/images/westvirginia_haz.jpg](http://earthquake.usgs.gov/earthquakes/states/west_virginia/images/westvirginia_haz.jpg) which shows areas of seismic hazard, with Summers and Monroe Counties being in a zone of concern (Figure 11).

![Figure 11 – USGS 2014 Seismic Hazard map showing Summers and Monroe Counties in a zone of concern.](image-url)
The Virginia Department of Mines, Minerals, and Energy developed an Earthquake Epicenter Density map (Figure 12) for areas in Virginia adjacent to Monroe County.

Figure 12 – Map showing the densities of earthquake epicenters, provided as a color scale indicating the relative densities in numbers per square mile. Three major earthquake zones are identified. Notice that the Giles County Seismic Zone extends into Monroe and Summers Counties, West Virginia. (Map from https://dmme.virginia.gov/DGMR/EQHazardMapping.shtml). The black line is the approximate location of the proposed MVP gas pipeline.

SOILS OF SUMMERS AND MONROE COUNTIES

Specific soils series develop based on the following factors: parent material, topography, climate, living organisms, and time. Soils scientists estimate that a time period greater than 100 years is required for one inch of soil to form (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/wa/soils/?cid=nrcs144p2_036333). Soil is therefore considered to be a non-renewable resource. The soils which would be traversed by the proposed MVP gas pipeline route in Summers and Monroe Counties formed primarily on interbedded shale, siltstone, and sandstone and, in some areas, on limestone. Soils which are described as “channery” contain “channer”, which are relatively flat rock fragments up to 6 inches in length. Along the proposed MVP gas pipeline route in Summers
County, approximately 59.5% of the soils are described as channery, stony, or as having rock ledges or outcrops. Along the proposed MVP gas pipeline route in Monroe County, approximately 51.5% of the soils are described as channery, stony, or as having rock ledges or outcrops. Such channery soils will not be suitable as bedding or backfill material around the pipeline because the channers could damage the pipeline.

All of the soils developed on the rocks that would be traversed by the proposed MVP gas pipeline route in Summers County are acidic to strongly acidic. Approximately 97% of the soils developed on the rocks that would be traversed by the proposed MVP gas pipeline route in Monroe County are acidic to strongly acidic. If the proposed MVP gas pipeline is installed in acidic to strongly acidic soil, or if the excavated acidic to strongly acidic soil is used as bedding or backfill material for the pipeline, corrosion of the pipeline could result if any of the protective coating on the pipeline is abraded during storage, moving, or installation procedures.

Soil permeability is a measure of how water can be transported through the soil. Soils with moderate to rapid permeability facilitate the downward flow of rainfall penetrating the ground surface to recharge the groundwater and to flow to and through rock fractures that form springs or seeps where the ground surface intercepts the rock fractures. If these essential soils are removed for pipeline construction and/or if blasting is conducted that will alter the system of fractures, the amount of groundwater flow and the direction of groundwater flow will change, such that flow of water to sustain springs and seeps will be destroyed.

Soil erosion is a major concern in the area proposed by MVP for gas pipeline construction. The Soil Survey of Mercer and Summers Counties, West Virginia, by the USDA Soil Conservation Service in cooperation with the WV University Agricultural and Forestry Experiment Station, with fieldwork conducted 1971-1979, published by the National Cooperative Soil, issued July, 1984, and the Soil Survey of Monroe County, West Virginia, by the USDA Soil Conservation Service in cooperation with the WV University Agricultural and Forestry Experiment Station, published by the U.S. Government Printing Office, 1965, provide the interpretations for the best use of land according to the specific soils that are present. The referenced Soil Surveys provide recommendations for the best use for land. The best use for land along the proposed MVP gas pipeline route in Summers County is 1) 24.5% wooded acreage, with the caution that erosion control is a major concern, especially on logging roads; and 2) 75.5% pastures, hay, or crops, with the caution that crops should be planted as contour strips with minimum tillage to control erosion and with diversion terraces to control erosion or divert runoff from gullies, or wooded acreage, with the caution that erosion control is a major concern, especially on logging roads. The best use for land along the proposed MVP gas pipeline route in Monroe County is 1) 49.5% wooded acreage, with the caution that erosion control is a major concern, especially on logging roads; and 2) 48.5% pastures, hay, or crops, with the
caution that crops should be planted as contour strips with minimum tillage to control erosion and with diversion terraces to control erosion or divert runoff from gullies, or wooded acreage, with the caution that erosion control is a major concern, especially on logging roads. Also, in Monroe County, 2% of the soils were for floodplain use.

An analysis of the detailed soil descriptions for Summers and Monroe Counties demonstrates that the depth to bedrock in Summers County along the length of the proposed pipeline route consists of 82% lineal feet less than 4 feet to bedrock, 16% lineal feet between 4 and 10 feet to bedrock, and 2% lineal feet greater than 10 feet to bedrock. The depth to bedrock in Monroe County along the length of the proposed pipeline route consists of 87.5% lineal feet less than 4 feet to bedrock, 8.5% lineal feet between 4 and 10 feet to bedrock, and 4% lineal feet greater than 10 feet to bedrock. Blasting will probably be required for all areas less than 10 feet to bedrock in order to provide space for the required pipe bedding below the pipe and cover material above the pipe. In the abstract, “19 Landslides in West Virginia” (by Peter Lessing and Robert B. Erwin; West Virginia Geological Survey, P.O. Box 879, Morgantown, West Virginia 26505; http://reg.gsapubs.org/content/3/245.abstract), it is stated that landslide-prone areas occur mostly on slopes of 15% to 45% on red shale bedrock. The Mauch Chunk Group consists of red shale, siltstone, and sandstone and underlies most of the area in Summers and Monroe Counties where the MVP gas pipeline route is proposed.

WATER RESOURCES OF SUMMERS AND MONROE COUNTIES

SURFACE WATER

Watersheds

“Watershed” refers to all of the land that drains to a certain point on a river (Figure 13). A watershed can refer to the overall system of streams that drain into a river, or can pertain to a smaller tributary. Stream order is a measure of the relative size of streams. The smallest tributary is a first order stream, which originates in the highest elevations. The headwater areas for these first order streams are environmentally sensitive and provide seeps, springs, and wetlands in shaded areas where light is filtered and temperatures are lower, sustaining the aquatic organisms at the very base of the food chain. The steep terrain in Summers and Monroe Counties provides the unique geomorphology for first order high gradient streams. In Figure 14, watersheds of first order high gradient streams are delineated along the proposed MVP gas pipeline between approximate mile post 166.3 and 168.5. Because the proposed MVP gas pipeline route is along the ridge, watersheds on both sides of the ridge are adversely impacted by construction activities.
Figure 13 – Headwaters of first order high gradient streams in Summers and Monroe Counties are located at the highest elevations on the watershed divides.

Figure 14 – Watersheds of 9 unnamed tributaries (UNTs) between approximate mile post 166.3 and 168.5 along the proposed MVP gas pipeline route (shown in red). Watersheds are outlined in blue. The black line outlines one of the affected property parcels. Delineations are shown on a topographic map from Terrain Navigator Pro software.
Forested ridges are our greatest defense against drought. The trees on the mountain ridges intercept rainfall so that it gently penetrates the ground as groundwater rather than flowing overland as runoff. This means that 1) the rain will gently fall to the ground and recharge groundwater and 2) the surface flow of rainwater on the ground will be slower than in cleared areas, thereby reducing the velocity and quantity of stormwater drainage. Conversely, where development occurs on forested ridges or where there are numerous roads constructed on forested ridges, the protective tree canopy is lost, the stormwater flow is greater in the cleared areas, groundwater is intercepted by road construction, and increased stormwater drainage results in habitat destruction within streams and the consequent death of aquatic organisms.

As depicted in Figure 15, when rainwater is intercepted by trees on forested ridges, the rainfall gently penetrates the ground surface and migrates downward through the soil to bedrock. The water then flows through bedrock fractures and along bedding planes to continue migrating downward or to form seeps and springs where the fractures or bedding planes intercept the ground surface. Seeps and springs can occur at various elevations on mountain slopes, depending on where the bedrock fractures or bedding planes intercept the ground surface, and can also occur along streams and rivers. As the quantity of groundwater accumulates beneath the ground surface, a hydraulic gradient forms, causing the groundwater to move downgradient to nearby streams and rivers or to lower areas where the water may reach streams and rivers that are farther away.

Figure 15 – Forests on ridges facilitate groundwater recharge and reduced stormwater runoff.
Public Water Supply in Summers and Monroe Counties

The Source Water Assessment and Protection Program (SWAPP) was established under the Safe Drinking Water Act. This Act requires every state to 1) delineate the area from which a public water supply system receives its water; 2) inventory land uses within the recharge areas of all public water supplies; 3) assess the susceptibility of drinking water sources to contamination from these land uses; and 4) publicize the results to provide support for improved protection of sources. Source Water Assessment Reports were prepared by the West Virginia Bureau for Public Health, Source Water Assessment and Protection Unit (WVBPH) to identify the most significant potential contaminant sources that could threaten the quality of the Public Supply District (PSD) public water supplies. In 2003, the WVBPH prepared the Source Water Assessment Report for the Big Bend PSD in Summers and Monroe Counties and in 2005, the WVBPH prepared the Source Water Assessment Report for the Red Sulphur PSD in Monroe County. Each report provides two maps: 1) a map showing the Watershed Delineation Area, which for the Big Bend PSD comprises 1,552 square miles of the Greenbrier River Watershed, and which for the Red Sulphur PSD comprises 26 square miles of the Upper New River Watershed; and 2) a map showing the Zone of Critical Concern, which delineates a corridor along all the streams within the Watershed Delineation Areas in order to define the susceptibility to potential surficial contaminants. The corridor width from each bank of a principal stream is 1,000 feet and the corridor width from each bank of a tributary draining to a principal stream is 500 feet.

In response to the FERC Environmental Information Request #2, dated March 31, 2016, the MVP Attachment DR2 RR2-6 (submitted April 15, 2016 by Draper Aden Associates), selected maps provided in the Source Water Assessment Reports that show the Zones of Critical Concern for water quality assessment, including the Big Bend Public Service District (PSD) for public water supply in Summers and Monroe Counties and the Red Sulphur PSD for public water supply in Monroe County. However, the Watershed Delineation Maps, also provided in the WVBPH reports, are not included. The Zones of Critical Concern address only water quality; they do not address water quantity. The focus of the WVBPH in preparing the Source Water Assessment Reports was primarily on water quality. In 2004, the West Virginia legislature enacted the West Virginia Water Resources Protection Act (WV Code §22-26-1), which requires consideration of the quantity of public water supplies, in addition to the quality of public water supplies. However, the West Virginia Department of Environmental Protection did not develop a plan for this legislation until 2008, after the WVBPH Source Water Assessment Reports were completed. The Watershed Delineation Area maps provided in the reports indicate that in Summers County, the proposed MVP gas pipeline route extending from approximately MVP milepost 163.3 to 164.3 in Summers County and from approximately MVP milepost 170.2 to 173.4 is located in the Big Bend PSD area of concern. In Monroe County, the proposed MVP gas pipeline route extending from approximately MVP milepost
173.4 to 176.0 is located in the big Bend PSD area of concern. Also, in Monroe County, the proposed MVP gas pipeline route extending from approximately MVP milepost 190.2 to 195.4 is located in the Red Sulphur PSD area of concern. Numerous headwater areas of first order high gradient stream tributaries are located in the delineated watersheds for the Big Bend PSD and the Red Sulphur PSD. These headwater areas are critically important to maintaining water quality, water quantities, groundwater recharge, and watershed functions in the river continuum for the Greenbrier River Watershed and for the Upper New River Watershed.

*Streams*

It is stated in the MVP Erosion and Sediment Control Plan, page 6, that “It is anticipated that all stream impacts within the pipeline limit-of-disturbance will be temporary, occurring during pipeline construction activities. These temporary waterbody impacts will not result in an adverse impact to water quality, physical or biological habitat, or aquatic species within the Project area due to the temporary stream crossing construction activities and implementing the Erosion and Sedimentation Control Plan’s Best Management Practices. The methods used include silt fence or compost filter sock along disturbed areas and permanent vegetative cover.” However the proposed method for the MVP gas pipeline installation is to excavate an open trench in the stream where the crossing is proposed. There is no indication from the proposed MVP work description or Best Management Practices (BMPs) that there is any comprehension or consideration of the in-stream aquatic habitats (Figure 16) that will be destroyed by open trenching. There is no mention of restoring the embeddedness required by aquatic organisms as adequate habitat.

![Figure 16](image_url)

Figure 16 – Cobbles and pebbles provide aquatic habitats and protection for aquatic organisms. Insect larvae, which constitute the base of the river continuum food chain, reside on the cobbles and pebbles. Minnows and juvenile fish hide in the spaces between cobbles and pebbles for protection. When sand and silt fill the spaces between the cobbles and pebbles, the aquatic habitats and protection areas are destroyed. When the aquatic habitats are removed for trenching and stream crossing work spaces, they cannot be restored.
In the MVP State of West Virginia Application for Individual 401 Water Quality Certification for Non Coal Related Activity, dated February 2016, MVP has provided the amount of linear feet of stream impacts to ephemeral streams, intermittent streams, and perennial streams, and also the amount of fill in Table 4.1 “Stream Impacts Summary Table” and in Table 7.1 “Desktop Evaluation Stream Impacts Summary Table”. A summary of the total linear feet, excerpted from the MVP tables, is provided below in Table 4.

Table 4 – Summary of total estimated stream impacts, excerpted from MVP Table 4.1 (Stream Impacts Summary Table) and from MVP Table 7.1 (Desktop Evaluation Stream Impacts Summary Table). NOTE: “feet” is abbreviated as “ft”; “cubic yards” is abbreviated as “yd$^3$”.

<table>
<thead>
<tr>
<th>County</th>
<th>Temporary Impacts</th>
<th>Permanent Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>SUMMERS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ephemeral</td>
<td>3792 ft; 2038 yd$^3$ of fill</td>
<td>335 ft; 13 yd$^3$ of fill</td>
</tr>
<tr>
<td>Intermittent</td>
<td>1194 ft; 1237 yd$^3$ of fill</td>
<td>50 ft; 15 yd$^3$ of fill</td>
</tr>
<tr>
<td>Perennial</td>
<td>3292 ft; 19,749 yd$^3$ of fill</td>
<td></td>
</tr>
<tr>
<td>MONROE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ephemeral</td>
<td>1500 ft; 780 yd$^3$ of fill</td>
<td>185 ft</td>
</tr>
<tr>
<td>Intermittent</td>
<td>1432 ft; 398 yd$^3$ of fill</td>
<td>53 ft</td>
</tr>
<tr>
<td>Perennial</td>
<td>2082 ft; 4349 yd$^3$ of fill</td>
<td>187 ft</td>
</tr>
</tbody>
</table>

**Wetlands**

In the MVP State of West Virginia Application for Individual 401 Water Quality Certification for Non Coal Related Activity (MVP 401 Certification Application), dated February 2016, tables are provided which list the impacted wetland areas. On page 11 of the MVP 401 Certification Application, the method of wetland “restoration” after trenching is described: “After pipeline installation, previously excavated material will be used to backfill the pipeline trench and restore the grade to pre-excavation conditions. The first 12 inches above the top of the pipe will be clean fill free of rocks from the excavation; where the previously excavated material contains large rocks or other materials that could damage the pipe or coating, clean fill will be used to protect the pipe. If additional fill is required, it will be either flowable fill or topsoil… Excavated material not required
for backfill will be removed and disposed of at an upland site.” It is further stated that after excavation in a wetland, the original surface hydrology will be re-established by backfilling and grading. There is no mention of preserving seeps and springs known to maintain the hydrology of numerous wetlands in the work corridor.

In the MVP Response Attachment RR2-37a, MVP provided Table 2.3-1 (Revised March 1, 2016), which lists the acreages for impacts from permanent “Access Roads”, permanent “Pipeline ROW” (right of way), temporary “Access Roads Temporary Work Space”, temporary “ATWS” (additional temporary work space), and temporary “ROW Temporary Work Space”. In its 401 Certification Application (dated February 2016), MVP has provided the amount of acres of wetlands impacts and also the amount of permanent fill material in Table 3.1 “Wetland Impacts Summary Table Mountain Valley Pipeline Project” and in Table 6.1 “Desktop Evaluation Wetland Impacts Summary Table Mountain Valley Pipeline Project”. The total acreage of wetlands impacted is slightly greater in Table 2.3-1 than in the 401 Certification Application tables. A summary of the total acreage of impacts from construction in the work corridor and in access road areas, excerpted from Table 2.3-1, and also of fill material, excerpted from the MVP tables, is provided below in Table 5.

<table>
<thead>
<tr>
<th>County</th>
<th>Permanent Impacts to Wetlands (acres)</th>
<th>Permanent Fill in Wetlands (cubic yards)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SUMMERS COUNTY</td>
<td>5.32</td>
<td>235,54643</td>
</tr>
<tr>
<td>MONROE COUNTY</td>
<td>4.43</td>
<td>1,445,6783</td>
</tr>
</tbody>
</table>

Culverts

On page 11 of the MVP 401 Certification Application, it is stated that permanent impacts to streams and wetlands are anticipated where culverts are installed in the streams along the new permanent access roads. Culvert installation will also
destroy seeps and springs and destroy aquatic habitats. The access roads and associated culverts are located in the same first order high gradient streams as the proposed pipeline ROW, causing cumulative adverse impacts.

**Mitigation Proposed for Wetlands and Streams**

The MVP mitigation approach for destroying wetlands and streams is to purchase credits in mitigation banks. For streams, MVP is proposing to purchase approximately 647 credits from the Davis Branch Mitigation Bank (1,500 credits available and 2,155 credits pending release in the first quarter of 2016), approximately 503 credits from the Hayes Run Mitigation Bank (1,593 credits available and 1,064 credits pending release in the first quarter of 2016), and approximately 530 credits from the Beverly Mitigation Bank Site #1 (1,088 credits available). For wetlands, MVP is proposing to purchase approximately 1.26 credits from the Beverly Mitigation Bank Site #1 (4.7 credits available) and approximately 0.18 credits from the Spanishburg Mitigation Bank (4.5 credits available). Additionally, MVP is proposing to purchase approximately 0.94 credits from the WV ILF Program to mitigate for anticipated wetland impacts occurring outside of the primary or secondary service areas of approved mitigation banks in the Project area.

No mention is provided to indicate that wetlands or streams within a specific watershed will be offset by creating wetlands banks or stream restoration areas. All wetlands and first order high gradient streams within a watershed serve to maintain the aquatic ecology within that specific watershed. Simply creating a wetland bank in another watershed will never offset the damage completed in the watershed where the wetland is destroyed. Where a first order high gradient stream is destroyed, the damage can never be offset by restoring a stream in an entirely different watershed.

**Hydrostatic Testing**

In response to the FERC Environmental Information Request #2, dated March 31, 2016, the MVP Attachment DR2 RR-18 provides a table listing the proposed water source locations and associated workspace areas for withdrawing water for hydrostatic testing. The Greenbrier River, located at mile post 170.6, is listed for segments 07A and 07B, with the explanation that 07B is a reuse of test section 07A. One 1,700,000-gallon tank and four 18,000-gallon tanks are required for test water storage, with the required temporary work space of 12.10 acres.
The West Virginia Department of Environmental Protection (DEP) has developed a water withdrawal guidance tool based on percentages of mean annual flow, based on a 10-year period that affords an appropriate flow to protect the aquatic habitat (http://www.dep.wv.gov/WWE/wateruse/Pages/WaterWithdrawal.aspx). There is no requirement for a stream gauge to be installed to determine annual mean flow for the specific stream or river where the test water will be withdrawn. There is no provision for DEP to conduct on-site monitoring when water withdrawals are made. Although some of the hydrostatic test water is used for testing more than one pipe section, there is no comprehensive explanation about the discharge to ground of the used hydrostatic test water. Locations provided on maps simply indicate a location on the ground surface. For example, in the MVP Response DR2 RR-18 to FERC’s Environmental Information Request #2 Dated March 31, 2016, a table is provided showing that at MVP Milepost 170.6 at the Greenbrier River in Summers County, an additional temporary work space of 12.10 acres will be constructed where the following testwater tanks will be placed: four 18,000 gallon tanks and one 1,700,000 gallon tank. At MVP Milepost 181.9 at Indian Creek in Monroe County, an additional temporary work space of 0.46 acres will be constructed where the following testwater tanks will be placed: four 18,000 gallon tanks and one 682,000 gallon tank.

In the MVP response to the U.S. Forest Service Request 4, it is stated that the test water will be discharged to an upland area within the watershed. Thousands of gallons of water in a small watershed for a first order high gradient watershed will result in erosion of the ground surface, destruction of the existing soil, and flooding of the first order stream that would result in destruction of aquatic habitats.

GROUNDWATER

The MVP response DR2 RR2-1 to the FERC Environmental Information Request #2, dated March 31, 2016, provides that the Appalachian Plateau regional aquifer system (USGS, 1997) flows through Mississippian bedrock (sandstone, shale, and limestone) in Summers County between proposed route mile post 156.7 and mile post 173.4. In Monroe County, the MVP response DR2 RR2-1 provides that the Appalachian Plateau regional aquifer system (USGS, 1997) flows through Mississippian, Devonian, and Silurian bedrock (sandstone, shale, siltstone, and limestone) and that the Valley and Ridge regional aquifer system (USGS, 1997) flows through Ordovician bedrock (sandstone, shale, limestone, and dolomite). Review of the geologic map indicates that the Appalachian Plateau regional aquifer system flows through the area in Monroe County from mile post 173.4 to approximately mile post 193.8 and that the Valley and Ridge regional aquifer system flows through the area in Monroe County from approximately mile post...
193.8 to 195.5. In “Aquifer-Characteristics Data for West Virginia”, by Mark D. Kozar and Melvin V. Mathes (U.S. Geological Survey, prepared in cooperation with the WV Bureau for Public Health, Office of Environmental Health Services, Water Resources Investigation Report 01-4036; 2001; http://pubs.usgs.gov/wri/wri01-4036/pdf/wri014036.pdf), the Mississippian bedrock aquifer system is reported to have relatively high transmissivity rates, meaning that fractures in the shales, siltstones, and sandstones of the Mauch Chunk Group are capable of transferring water from the land surface downward to recharge groundwater. The groundwater flow through rock fractures and bedding planes is described as diffuse flow (White, 1988). Groundwater flowing downward through the fractures and along the bedding planes of the Mauch Chunk Group is interconnected with the deeper Greenbrier Limestone.

Groundwater flow through karst areas (limestone and dolomite) exhibits both diffuse flow and conduit flow. Conduit flow consists of “integrated systems of openings ranging from solutionally widened joints and bedding plane partings to pipelike passages many meters in diameter” (White, 1988). Pipelike passages and larger solutionally widened joints and bedding plane partings can be observed in the caves throughout the area, and are also present, although inaccessible for observation, in limestone and dolomite throughout the area. The karst areas in Monroe County, including caves, sinking streams, sinkholes, and springs, indicate the presence of both diffuse flow and conduit flow in the Valley and Ridge regional aquifer which flows through the Ordovician and older bedrock. Dasher (2000) provides descriptions of groundwater in extensive karst sub-basins of caves within the Greenbrier Limestone. Dye traces provide evidence of the groundwater flow directions within the limestone. Springs attest to the flow of groundwater through fractures and along bedding planes within the limestone, in addition to flow through interconnected voids in the limestone. For example, Dickson Spring is the largest spring in Monroe County. Dickson Spring receives water from karst sub-basins in Greenbrier County, traveling toward Union along the axial strike of the Hurricane Syncline. Numerous caves occur in this area, as well, attesting to the interconnecting nature of the fractures, bedding planes, and voids within the Greenbrier Limestone.

Four major springs have been documented by the West Virginia Geological and Economic Survey (WVGES) in Summers County. The WVGES has documented 54 major springs in Monroe County. Numerous springs and seeps occur within Summers and Monroe Counties, undocumented by the WVGES. These smaller springs and seeps are critical to the ecosystems in the headwater areas of first order high gradient streams because they supply the water necessary for the headwater area aquatic species, which comprise the base of the river continuum food chain.

Although no known dye traces have been conducted in Summers County and only a few dye traces have been conducted in Monroe County, the dye traces confirm that the groundwater flow in the sub-karst basins travels in a northeast-
southwest trending direction along the axial planes of anticlines and synclines and also parallel to the St. Clair Fault. These dye trace routes provide evidence that supports the observation that groundwater flows through interconnecting fractures, bedding planes, and voids within the Greenbrier Limestone in Summers and Monroe Counties and within the older limestone bedrock adjacent to the St. Clair fault.

GROUNDWATER AND SURFACE WATER ARE ONE INTEGRAL UNIT

In its document, “Sustainability of Ground-Water Resources”, the USGS emphasizes that “Groundwater is not a renewable resource”. To understand this statement requires an understanding of the global water budget and also an understanding that groundwater and surface water are connected as one integral system. Firstly, the global water budget, or hydrological cycle, consists of precipitation, evaporation, and condensation. It is important to recognize, however, that the hydrological cycle over the ocean (covering approximately three-quarters of the earth) is essentially separate from the hydrological cycle over the continents. Dennis Hartmann, in his book “Global Physical Climatology”, provides an excellent summary diagram (Figure 17) showing the pathways of the hydrological cycle in terms of centimeters per year for the exchange of water. Through time, there has been a delicate balance of the amount of precipitation transferred to the continents from the hydrological cycle over the oceans and the amount of surface water flowing into the ocean. In this slide, the arrow representing the amount of water from the ocean’s hydrological cycle indicates that 11 centimeters per year transfers from the ocean to the continent. The arrow showing the runoff from the land surface indicates that 11 centimeters flows back to the ocean from the continent. It is obvious that when groundwater recharge is reduced and streamflow into the oceans is increased, a situation is created where there is no longer a balance: when streamflow to the oceans exceeds the amount of precipitation from the oceans back onto the continents, the water in the continental hydrological cycle is lost forever.
Figure 17 – Our water resources are finite on our continents. Calculations of the global water balance indicate that water transferred to land from the oceans is balanced by water drainage from land to the oceans. If water drainage to the oceans exceeds the amount of water transferred to land from the oceans, our water resources on land are lost. (Units are in centimeters per year. Diagram by Dennis L. Hartmann, Global Physical Climatology, 1994.)

When precipitation gently reaches the ground surface due to interception by forest trees, the water can penetrate the ground and travel through the bedrock fractures to form seeps and springs at lower elevations. These seeps and springs supply water to wetlands in the headwater areas of first order streams and also provide water directly to streams at lower elevations. During times of low stream water, it is the groundwater that continues the supply of water to the streams. Groundwater from seeps and springs enter the stream from stream banks to maintain aquatic habitats.

Deforestation for construction in the headwater areas of first order high gradient streams reduces the amount of precipitation to recharge groundwater. Compaction of soils for roads and work areas reduces and/or destroys the process of soils to be saturated and to serve as an avenue for groundwater recharge. Blasting for gas pipeline trenches and also for leveling of road and work corridor surfaces destroys or changes the bedrock fractures, compromising the amount of groundwater flow and the direction of groundwater flow to seeps and springs which provide water to wetlands and to streams and rivers.

ECOLOGICAL SYSTEMS IN SUMMERS AND MONROE COUNTIES

Headwater areas of first order streams provide the essential aquatic habitats for aquatic species and associated terrestrial fauna and fowl within the entire length of the river continuum in the overall watershed. The soils which have formed in the headwater areas regulate the transport of surface water and also carbon, nitrogen, and oxygen. The shade of the forest canopy provides the filtered light and lower temperatures critical to maintaining the headwater aquatic habitats.
The River Continuum Concept was developed by Vannote, R.L., G. W. Minshall, K.W. Cummins, J.R. Sedell, and C.E. Cushing in 1980 and presented in the Canadian Journal of Fisheries and Aquatic Sciences 37: 130-137. The U.S. Environmental Protection Agency and the U.S. Department of Agriculture have embraced the River Continuum Concept as illustrating the strong connection between headwater areas on mountain ridges and various downstream areas. The River Continuum Concept diagram (Figure 18) provides pie diagrams of predominant benthic aquatic organisms associated with various locations, starting at the headwaters, along the river continuum. Shredders, predominant in the forested headwaters, break down organic matter used downstream by collectors, predators, and filter-feeders. The filter-feeders are subsequently consumed by larger benthos and fish.

![Figure 18 – The River Continuum (Vannote, et al; 1980) illustrates the food chain connection between headwater areas of first order high gradient streams and the wider, larger downstream areas in the overall watershed.](image)

Ecological communities are typically classified with respect to the vegetation present because it is the most permanent, visible feature of a community. Biodiversity refers to the diversity within an ecological community, with emphasis on the inter-relationships and interdependence among the various species. Trees not only intercept rainfall so that it falls gently to the ground surface and is thus able to penetrate the ground as groundwater recharge, but also store nutrients in their trunks, branches, and roots (West Virginia Department of Natural Resources: [http://www.wvdnr.gov/Wildlife/Plants.shtm](http://www.wvdnr.gov/Wildlife/Plants.shtm)). Fungi in the soil facilitate transport of nutrients between trees and the soil. The soil stores
nutrients which are processed by soil microbes to regulate essential nutrient cycles involving oxygen, carbon dioxide, nitrogen. Roots of the trees and of herbal vegetation help to stabilize the soil so that the soil nutrients are not washed away by stormwater runoff. The ecological communities in the headwater areas of first order high gradient streams consist not only of the vegetation, but also the aquatic benthic macroinvertebrates, fungi, and soil microbes. Insect larvae, commonly grouped as shredders, constitute most of the aquatic benthic macroinvertebrates in the headwater areas because they shred organic material into components used by collectors and predators downstream.

In 2014, the West Virginia Division of Natural Resources (WVDNR) published the “Watershed Biodiversity Ranks in West Virginia” (ESRI shapefile). In the northern portion of Summers County where the proposed MVP gas pipeline route traverses along Red Spring Mountain, the Lick Creek watershed (HUC12 050500040204) to the west of Red Spring Mountain is ranked B5, designated as having “State Biodiversity” significance. To the east of Red Spring Mountain, the Otter Creek-Meadow River watershed (HUC12 050500050602) is ranked B1, designated as “Outstanding Global Biodiversity” significance. At MVP Milepost 161.30, the proposed MVP gas pipeline route traverses only the Lick Creek watershed until approximately MVP Milepost 163.20 at Keeney Mountain. Along this section, the Lick Creek watershed is located to the northwest of Keeney Mountain and the Griffith Creek-Greenbrier River watershed (HUC12 050500030905) is located to the southeast of Keeney Mountain. The Griffith Creek-Greenbrier River watershed is ranked B4, designated as having “Outstanding State Biodiversity” significance. At approximately MVP Milepost 164.60, the proposed MVP gas pipeline route traverses the Hungard Creek-Greenbrier River watershed (HUC12 050500030906), which is ranked B3, designated as having “Global Biodiversity” significance. The proposed MVP gas pipeline route continues to traverse within the Hungard Creek-Greenbrier River watershed where it enters Monroe County, until approximately MVP Milepost 179.10, at which point the Hungard Creek-Greenbrier River watershed is located to the northwest of the proposed MVP gas pipeline route and the Middle Indian Creek watershed (HUC12 050500020604) is located to the southeast of the proposed MVP gas pipeline route. At approximately MVP Milepost 180.30, the proposed MVP gas pipeline route is located entirely within the Middle Indian Creek watershed, which is ranked B2, designated as having “High Global Diversity” significance. From approximately MVP Milepost 190.20 to the border between Monroe County, WV, and Giles County, VA, the proposed MVP gas pipeline route traverses the Rich Creek watershed (HUC12 050500020404), which is ranked B3, designated as having “Global Biodiversity” significance.
CONCLUSIONS

The findings of this report provide evidence that construction of the proposed MVP gas pipeline will result in adverse impacts on the environment within specific watersheds of first order high gradient streams, within larger streams and rivers, within karst terrain, and within aquifer systems. The adverse impacts would be cumulative because of the expansive area of the proposed gas pipeline corridor, access roads, and additional work spaces. The adverse impacts would be cumulative also because of being in areas of existing or planned development.

1) Construction of the proposed MVP gas pipeline will adversely impact headwater aquatic habitats which serve as the base of the food chain for the entire river continuum ecosystem.

Where seeps, springs, and wetlands are adversely impacted in the headwater areas, the effects will continue along the entire length of rivers within the overall watershed system. Watersheds along the proposed MVP gas pipeline construction route are predominantly those of first order high gradient streams, which typically have stream profile slopes greater than 4%. Springs, seeps, and wetlands occur in the headwater areas of the first order streams.

2) Construction of the proposed MVP gas pipeline will remove soil and compact soil, causing adverse impacts to springs and wetlands and to the hydrologic function of transporting water from the watershed to wetlands and first order stream channels.

Soil microorganisms require soil moisture in order to function in their capacity to 1) fix nitrogen for uptake by plant roots; 2) transform iron and manganese to increase their solubility and availability to higher organisms in the food chain; 3) detoxify sulfur; 4) oxidize organic carbon; and 5) transform phosphorus into soluble reactive phosphorus for uptake by higher organisms in the food chain. Dewatering and compaction of the soil during construction activities for a 125-foot wide work corridor and during trenching activities will destroy the soil microorganisms. Simple replacement of surficial topsoil after construction cannot restore the function of microorganisms in their capacity to provide organic compounds to the higher organisms in the headwater area ecosystem.

Water transport includes surface water flow necessary to create channels, both ephemeral channels in ravines as well as stream channels. It is stated in the MVP Erosion and Sediment Control Plan (E&SCP) for West Virginia counties (February 2016) that the gas pipeline construction requires leveling a 125-foot wide corridor on ridge tops as well as the mountain slopes between the ridges: “Given the ruggedness of the terrain and steep slopes, the full 125-foot construction right-of-way will be necessary in forested areas for the safe construction of the Project. MVP will neck down to a 75-foot construction right-of-
way at streams and wetlands wherever possible.” When the land above the headwater areas is destroyed by leveling the ground surface, there is destruction of the slopes that would normally provide the sufficient amount of surface water to the ravines and stream channel. By leveling the ground surface, the existing soils which normally become saturated during precipitation events are removed and the remaining soils are compacted. This results in destroying the condition of saturated soils that allow surface water to flow slowly into the headwater areas. Additionally, the storage of water in soils facilitates the creation of hydric soils necessary to establish wetlands. The wetlands provide environments for chemical cycling of nutrients. With removal of soils in the headwater areas and compaction of the subsoil, the stormwater surface flow will increase in velocity, causing erosion within the stream bed and along the stream banks. The resulting erosion will cause deposition of silt and clay within the pebbles and cobbles, destroying the aquatic habitats of the microbes and insect larvae. Additionally, trenching for the gas pipeline installation provides conduits which remove and lower the groundwater. When the groundwater is diverted into ditches, it is transported away as surface water and the groundwater table is lowered. The depletion of groundwater removes the capacity for groundwater to supply water to the first order streams during drought conditions (baseflow), with the consequent death of aquatic organisms. The depletion and redirection of groundwater along the pipeline trench, as well as changes in the direction of groundwater movement caused by blasting, destroys springs, seeps, and wetlands in the headwater areas of first order streams.

3) Construction of the proposed MVP gas pipeline will adversely impact the hydraulic function of transporting water in ephemeral channels in ravines, in the channel, and through the sediments.

Water within an ephemeral channel or in a stream will determine the existence of aquatic habitats within the sediments and will interact with groundwater in the sediments of the stream bed and stream banks. The flow of water determines the size and amount of sediments that are deposited. Where the water velocity is great enough to move silt and sand away from areas of pebbles and cobbles, aquatic habitats are created for microbes and insect larvae which break down organic matter to provide food for larger aquatic species. Stream water velocities great enough to move pebbles and cobbles will obviously also result in the destruction of the aquatic habitats. Additionally, the velocity of the stream water controls the spacing and depth of stepped pools in the stream bed. The typical deep pools that form within the first order high gradient streams provide aquatic habitats for trout to live. In the MVP access road alignment maps submitted to FERC on April 22, 2016, the widths of access road easements are shown as 40 feet, with a wider study corridor of approximately 80 feet to 100 feet wide; however, the detailed construction plans are not provided. In order to construct a flat roadbed, fill material will be required for construction, indicating wide embankment areas associated with the roadbeds. The access roads are located not only in headwater areas, but also in the ravines associated with numerous
first order high gradient streams, as well as at specific stream crossings. Consequently, if the gas pipeline is installed, not only will the headwater areas be compromised by the gas pipeline construction activities, but also by the construction of substantial temporary and permanent access roads, which will cause additional destruction of riparian buffers and specific streams.

4) Deforestation for construction of the proposed MVP gas pipeline will adversely impact the geomorphologic function of conserving water in the ecosystem as well as transporting wood and sediment to create diverse bed forms and dynamic equilibrium.

Pipeline construction requires deforestation within an area at least 125 feet wide. The relatively dense tree canopy in the headwater areas intercepts rainfall so that it gently penetrates the ground as groundwater rather than flowing overland as runoff. This means that 1) the rain will gently fall to the ground and recharge groundwater and 2) the surface flow of rainwater on the ground will be slower than in cleared areas, thereby reducing the velocity and quantity of stormwater drainage. Woody debris in the forested headwater areas constitutes an important contribution to first order streams because the small woody debris provides particulate organic matter and the large woody debris, when transported to the stream bed, provides protected areas for aquatic organisms and also helps create the stepped pools needed by trout. MVP states in its E&SCP that the permanent ROW will be 50 feet wide and that “Future land use will be a maintained vegetated natural gas pipeline ROW.” (page 3, E&SCP). The disturbed ROW will, therefore, not provide the function of the original forested area. Also, the soil compaction in the remainder of the 125-foot will not facilitate growth of the original forested area. Therefore, the proposed MVP gas pipeline construction on forested ridge-tops will adversely impact the geomorphologic function of the forested ridges.

5) Construction of the proposed MVP gas pipeline will adversely impact the physicochemical functions of temperature oxygen regulation, and also the processing of organic matter and nutrients.

The deforestation required for pipeline construction will also adversely impact the function of the relatively dense tree canopy that provides filtered light and relatively cooler, regulated temperatures. Aquatic organisms in the headwater areas and upper reaches of the first order stream channels require the filtered light and cooler, regulated temperatures in order to survive. The deep, stepped pools of stream water must provide the cooler temperatures required for trout to survive.
6) Construction of the proposed MVP gas pipeline on ridge-tops will adversely impact biological functions of biodiversity and life cycles of aquatic and riparian life.

The ecology of the entire watershed is embraced in the river continuum concept, starting at the headwaters of first order high gradient streams and continuing downstream with changes of predominant benthic aquatic organisms along the river continuum. Shredders, predominant in the forested headwaters, break down organic matter used downstream by collectors and filter-feeders. The filter-feeders are subsequently consumed by larger benthos and fish farther downstream. The downstream healthy fish populations can only exist with specific water velocities, stream bed forms, temperature, and water chemistry.


7) The proposed MVP mitigation approach for wetlands and streams is deficient.

The MVP mitigation approach does not incorporate an understanding of the importance of headwater areas that supply surface and groundwater to the headwater streams and wetlands. Additionally, the MVP mitigation approach does not recognize the importance of headwater aquatic organisms as being the base of the food chain in the river continuum. Purchasing mitigation credits in areas outside of the actual watersheds for first order high gradient streams will not compensate for the cumulative damage to the specific watershed impacted or to the receiving water bodies downstream.

8) Construction of the proposed MVP gas pipeline will require deforestation and blasting, both of which will reduce groundwater recharge and cause significant changes to the amount of groundwater available as a drinking water source, as well as to groundwater flow routes.

Groundwater flows along bedrock bedding planes and fractures, forming seeps and springs where the bedding planes and fractures intercept the ground surface. The seeps and springs also occur within streams and along stream
banks, providing water to streams during drought conditions. Deforestation results in reduced groundwater recharge, with the consequent decreased availability of groundwater. Blasting causes changes in the bedrock fractures, resulting in changes in the direction of groundwater flow. Consequently, seeps and springs will not receive the groundwater that was available prior to construction.

9) **Construction of the proposed MVP gas pipeline will degrade karst environments by reducing and redirecting groundwater flow and by creating the potential for collapse.**

Where deforestation and blasting reduce and redirect groundwater flow, cave environments are impacted due to changes in moisture. Blasting causes collapse of fractures and voids in limestone, which results in degradation of karst terrain and cave environments.

10) **Construction of the proposed MVP gas pipeline will cause increased stormwater discharge and also degrade stream functions at the numerous locations where stream crossings are proposed.**

Increased stormwater discharge causes downstream stream bank erosion, introducing sediment into the streams. Increased amounts of silt and sand in the stream are deposited in openings between cobbles and pebbles, destroying the aquatic habitats and protective areas for minnows and juvenile fish.

11) **Construction of the proposed MVP gas pipeline will create the potential for pipeline collapse in areas known to have experienced earthquakes, especially in karst areas.**

Summers and Monroe Counties are located in earthquake hazard zones which have experienced significant numbers of earthquakes and which are considered to be at risk for future earthquakes. Construction of the proposed MVP gas pipeline in earthquake zones, especially in karst areas, creates the potential for pipeline collapse.

12) **Construction of the proposed MVP gas pipeline will result in landslides on the pervasive steep slopes underlain by the Mauch Chunk red shale bedrock.**

The West Virginia Geological and Economic Survey has provided documentation that landslides occur on steep slopes where the underlying bedrock is red shale. The Mauch Chunk red shale bedrock is the predominant unit in areas of Summers and Monroe Counties where the MVP gas pipeline construction is proposed. Regardless of best management practices, erosion and landslides will occur within these areas.
13) Construction of the Proposed MVP Gas Pipeline Will Cause Cumulative Damage.

The Council on Environmental Quality (CEQ) regulations that implement the National Environmental Policy Act define cumulative effects as “the impact on the environment which results from the incremental consequences of an action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency or person undertakes such other actions” (40 CFR § 1508.7). Cumulative effects include both direct and indirect, or induced, effects that would result from the Project, as well as the effects from other projects (past, present, and reasonably foreseeable future actions) not related to or caused by the Project. Cumulative impacts may result when the environmental effects associated with a Project are added to temporary (construction-related) or permanent (operations-related) impacts associated with other past, present, or reasonably foreseeable future projects. Although the individual impact of each separate project might not be significant, the additive or synergistic effects of multiple projects could be significant. The cumulative effects analysis evaluates the magnitude of cumulative effects on natural resources such as wetlands, water quality, floodplains, and threatened and endangered species, as well as cumulative effects on land use, socioeconomics, air quality, noise, and cultural resources. The CEQ regulations (40 CFR § 1508.8) also require that the cumulative effects analysis consider the indirect effects which are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable.

The cumulative damage that would result from construction of the proposed MVP gas pipeline is inconsistent with the protection of West Virginia water resources and is in violation of the West Virginia Water Resources Protection Act (WV Code §22-26-1 et seq., which was enacted to determine the quantity of water resources in West Virginia. By enacting this statute, the Legislature provided for claiming and protecting state waters for the use and benefit of its citizens; evaluating the nature and extent of its water resources; and identifying activities that impede the beneficial uses of the resource (“West Virginia Water Resources Management Plan”, Water Use Section, West Virginia Department of Environmental Protection, November 2013; http://www.dep.wv.gov/WWE/wateruse/WVWaterPlan/Documents/WV_WRMP.pdf).

It is stated in the MVP application that, “(1) the Mountain Valley Project is not expected to result in any significant adverse impact on the environment; (2) all impacts can be avoided or, where unavoidable, can be adequately mitigated; (3) the proposed route is the best of those evaluated; (4) the Mountain Valley Project’s short-term use of the environment will not conflict with the long-term productivity of the environment; and (5) resources will not be irreversibly or irrevocably lost due to the construction activities.” In Table 1.10-1 of MVP’s
RR1, only other gas pipeline projects and highway projects are considered in the cumulative impact analysis. MVP discounts cumulative impacts from nearby construction sites “because the construction periods would not overlap”.

The findings of this report support the conclusion that there would be significant environmental destruction and degradation in Summers and Monroe Counties if the MVP pipeline were to be constructed.

REFERENCES


Mitsch, William J. and James G. Gosselink; “Wetlands”; 1986; Van Nostrand Reinhold, NY.


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My education includes a bachelor’s degree in Geology and a doctoral degree in Marine Science (specializing in Marine Geology), both from the College of William and Mary in Williamsburg, VA. I have a Credential in Ground Water Science from Ohio State University and I am a Licensed Professional Geologist. I have held teaching positions at the high school level and at the college level, and have provided geology and hydrogeology presentations, workshops, and classes to state and federal environmental employees, to participants in the Regional Conference in Cumberland, MD for the American Planning Association, and to participants in the WV Master Naturalist classes. I have served as an expert witness in hydrogeology before West Virginia government agencies.

As a Hydrogeological Consultant (2000 – Present), I have conducted hydrogeological investigations, provided hydrogeological assessment reports, served as an expert witness in hydrogeology before the West Virginia Public Service Commission in three cases and before the West Virginia Environmental Quality Board in one case, and provided numerous presentations and workshops in hydrogeology to state and federal environmental employees (including USFWS and WV FEMA Managers), participants in the Regional Conference in Cumberland, MD for the American Planning Association, participants at civic and landowner meetings, and participants in the WV Master Naturalist classes.

As a Senior Geologist for the Virginia Department of Environmental Quality (1997-1999), I determined direction of groundwater flow and the pollution impacts to surface water and groundwater at petroleum release sites and evaluated corrective actions conducted where petroleum releases occurred. At sites where the Commonwealth of Virginia assumed responsibility for the pollution release investigation and corrective action implementation, I managed the site investigations for the Southwest Regional Office of the Virginia Department of Environmental Quality (DEQ). This included project oversight from contract initiation through closure.

As a Senior Geologist and Project Manager for the Environmental Department at S&ME, Inc. (Blountville, TN, 1992-1997), I conducted geology and groundwater investigations. I supervised technicians, drill crews, geologists, and subcontractors. The investigations were conducted in order to obtain permits for landfill sites and to satisfy regulatory requirements for corrective actions at petroleum release sites. My duties also included conducting geophysical investigations using seismic, electrical resistivity, and ground penetrating radar techniques. I conducted numerous environmental assessments for real estate transactions. I also conducted wetlands delineations and preparation of wetlands mitigation permits.

As the District Geologist for the Virginia Department of Transportation (1985-1992), my job duties included obtaining and interpreting geologic data from fieldwork and review of drilling information in order to provide foundation recommendations for bridge and road construction. My duties included supervision of the drill crew and design of asphalt and
concrete pavements for highway projects. Accomplishments included preliminary foundation investigations for interstate bridges and successful cleanup of leaking underground gasoline storage tanks and site closures at numerous VDOT facilities.

While earning my doctoral degree at the College of William and Mary, I worked as a graduate assistant on several grant-funded projects. My work duties included measuring tidal current velocities and tidal fluctuations at tidal inlets; land surveying to determine the geometry and morphology of numerous tidal inlets; determining pollution susceptibilities of drainage basins using data from surface water flow parameters, hydrographs, and chemical analyses; developing a predictive model for shoreline erosion during hurricanes based on calculations of wave bottom orbital velocities resulting from various wind velocities and directions; performing sediment size and water quality analyses on samples from the Chesapeake Bay and James River; conducting multivariate statistical analyses for validation of sediment laboratory quality control measures; reconnaissance mapping of surficial geologic materials in Virginia, North Carolina, and Utah for publication of USGS Quaternary geologic maps; teaching Introductory Geology laboratory classes at the College of William and Mary; and serving as a Sea Grant intern in the Department of Commerce and Resources, Virginia.

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1995: Safe Drinking Water Teleconference, sponsored by the American Water Works Association
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