Virginia Scientist-Community Interface
Public Comment
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# Geology, Hydrology, Ecology, and Soils may present challenges for construction of the Mountain Valley Pipeline near Bent Mountain, Virginia

**Executive Summary**

- We draw on scientific literature and publicly available data to describe challenges to MVP stream and wetland crossing construction in the Bent Mountain, Virginia area.
- The area assessed is underlaid by aquifers that are highly susceptible to contamination by human activities
- Headwater streams, like those found near Bent Mountain, are critical to overall river system health
- Analysis of soils data shows severe limitations for and sensitivity to construction activities
- We strongly recommend that MVP be required to conduct field-based geotechnical feasibility assessments for all stream and wetland crossings.

**About this substantive formal comment:** This independent review was conducted by the Virginia Scientist-Community Interface (V-SCI). V-SCI is a graduate student organization dedicated to reviewing and synthesizing science related to environmental issues. V-SCI analysts on this project include PhD students with formal training and expertise in hydrology, ecology & evolution, and environmental restoration. We are happy to discuss our findings in more detail if we can be of greater service.

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## Contents



## 1. Introduction

Mountain Valley Pipeline (MVP) crosses sensitive and rugged environments throughout its proposed route. This includes steep, rocky terrain in highly sensitive stream and wetland habitat. There is little or no precedent for major construction throughout many of these environments, so the construction challenges that MVP would likely face in stream and wetland crossing construction, and environmental impacts resulting from failures, are difficult to predict. **MVP's assumption that the same mitigation plan and general construction will work similarly across numerous sites, without thorough field-based feasibility and geotechnical assessments, is not grounded in the best available science or engineering practices.**

In this public comment, we use publicly available environmental data and scientific literature to elucidate the threats of MVP construction in just one of these sensitive and unique environments along its proposed route. Bent Mountain, Virginia is a headwater area for the Roanoke River watershed located southwest of Roanoke in the Blue Ridge Mountains. Like many areas crossed by MVP, it is an ecologically important area with highly interconnected hydrology. Within the vicinity of Bent Mountain, MVP has proposed to cross 40 wetlands and 26 streams.

In Section 2, we describe how Bent Mountain is underlain by aquifers that are susceptible to contamination by humans, and help provide drinking water to communities across Virginia (USGS, 2014). In section 3, we describe how small headwater streams, like those crossed by MVP on Bent Mountain, provide valuable aquatic habitat and ecosystem services and disturbance within their riparian zone represents a threat to these important ecosystems. In section 4, we summarize literature describing the considerable connectedness of groundwater and surface water, especially in the Blue Ridge EPA Level III ecoregion. In Section 5, we demonstrate that soils data from the U.S. Geological Survey show severe limitations construction of MVP stream and wetland crossings based on soil types and hydrologic characteristics of the Bent Mountain area.

In section 6, we discuss why increased sediment input to streams on Bent Mountain would represent a significant danger to aquatic habitat because every stream crossing is designated as one or more of the following: Orangefin madtom, Stockable Trout, Natural Trout, Coldwater Fishery, or Non-listed mussels habitat. The area is also within the federally protected range for the Roanoke Logperch, and historical pollutant spills indicate that stream degradation in these waters can have a devastating impact on the species.

In addition to construction on steep slopes, the Bent Mountain aquifer is shallow, with 22 of the crossings on Bent Mountain occurring where the water table is only 0.5 feet deep (See supplemental data in Excel sheet submitted with this comment). Because of the shallow aquifer, bore pits used for conventional bore crossings (on Bent Mountain, 11 wetland and 15 stream crossings use conventional bore methods) will be dug directly into Bent Mountain's shallow aquifer, which many residents use for drinking water (Dashiell, 2018). Because of the considerable hydrological connection between groundwater and surface water (described in sections 2 and 4), dewatering of these bore pits may impact groundwater sources and lead to alterations of the wetlands they sustain. **Because geological, terrain, and soil characteristics on Bent Mountain are highly heterogeneous, field-based site-specific planning and geotechnical analysis must take place before construction begins**.

## 2. Aquifers underlying Bent Mountain are sensitive to contamination

Roanoke County is an area of "unusual phyto-geographical interest" with at least 1025 species and varieties of vascular plants" (Wood 1944). Parts of Bent and Poor Mountains form a plateau with an elevation of approximately 3000 feet. Rainfall in this mountainous region is higher than other parts of the county and "conditions are more suitable for plants of northern affinity, which, indeed, seem to occur here more frequently than elsewhere in the county." The Blue Ridge portion of Roanoke County (including Bent Mountain) is "occupied by Pre-Cambrian crystalline rocks (gneisses and schists) which weather readily, producing a heavy, red soil", and the region is "abundantly supplied" with limestone springs (Wood 1944).

Aquifers in the Blue Ridge province are either crystalline-rock aquifers (under Bent Mountain) or carbonate-rock aquifers. In the Blue Ridge crystalline-rock aquifers, water is relatively young, which means it has not spent long within the aquifer and recharge rates are fast. Because of this fast recharge rate, **in aquifers such as those in the Bent Mountain area "human activities near a well are likely to have a substantial effect on the quality of water withdrawn from that well" (USGS 2014).**

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**"Some of these aquifers are among the most vulnerable in the Nation to contamination from chemicals with human-related or geologic sources" (USGS 2014)**

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In the Bent Mountain area, crystalline rock aquifers also have higher levels of phosphorus than other aquifers. Blue Ridge carbonate-rock aquifers are karst aquifers, found just north of Bent Mountain area within Roanoke County, and are "highly susceptible to contamination" compared to other types of aquifers in the area (USGS 2014). Some Blue Ridge carbonate-rock groundwater wells tested had water ages of just a few days, indicating rapid transport of water through the bedrock conduits.

Combined, these Blue Ridge aquifers underlie an area with 40 million people in 10 states. "The amount of water pumped from domestic (private) wells tapping these aquifers—more than 550 million gallons per day—is among the largest in the Nation (USGS 2014). Some of these aquifers are among the most vulnerable in the Nation to contamination from chemicals with human-related or geologic sources (USGS 2014)." Importantly, streamflow in Blue Ridge streams is "sustained by discharge of groundwater from the aquifer", but "these aquifers are a major source of water and contaminants to streams and estuaries such as the Chesapeake Bay and the Albemarle-Pamlico Sound (USGS 2014)". This highlights the tight connections between groundwater and surface water in the Blue Ridge province.

## 3. Degradation of Headwater Streams impacts the entire watershed

Streams and wetlands surrounding Bent Mountain are a part of the headwaters of the Roanoke River. Headwater streams are widely recognized as providing valuable aquatic habitat for a variety of aquatic species and it has been recognized that **"the biological integrity of entire river networks may be greatly dependent on the individual and cumulative impacts occurring in the many small streams that constitute their headwaters. (Meyers et al. 2007) "**. Put simply, the health of the entire river network can be compromised when headwaters are degraded. Headwater streams also provide important ecosystem services. For example, headwater streams disproportionately remove and transform large amounts of nitrogen inputs to their watershed, reducing nitrogen loads to downstream waters (Peterson et al. 2001).

**The health of the entire river network can be compromised when headwaters are degraded**

Forest cover in headwater streams is important to ecosystem health not only locally, but throughout the river system and headwater stream health is linked to the health of the terrestrial ecosystem. Headwater ecosystems in the Southern Appalachians are highly sensitive to deforestation, especially riparian deforestation (England and Rosemond 2004). This sensitivity to riparian deforestation is important, because maintaining intact riparian vegetation is crucial to ensuring stream channel stability, thereby reducing stream bank and gully erosion (Zaimes et al. 2019).

In addition to the loss of riparian zone vegetation, land use changes within headwater watersheds can lead to changes to stream morphology and sedimentation dynamics. A survey of 44 headwater streams in the southern Blue Ridge province found that forested headwater streams had greater channel width when compared to pasture/grassland streams, which resulted in increasedinstream habitat, and that bed particle size increased with watershed area (Leigh 2010). Finer bed particles in small streams suggests that disturbances to these headwater streams could result in increased transport of bed sediment downstream. **In a study of four Blue Ridge headwater streams, human disturbance has also been shown to increase the percentage of particles $\leq 2$ mm found in riffle habitat (Price and Leigh 2006)**. Price and Leigh (2006) also characterized riffle and pool habitat at each stream, finding riffle habitat among all streams ranged from 20-35%, and pool habitat among all streams ranged from 1.3-7.0%.

**An extensive review by Wallace and Eggerts (2015) highlights the fact that headwater streams in the south-central Appalachians are important habitats and are important to protecting major river systems, including the Roanoke River.** Wallace and Eggerts (2015) further highlight the tight linkage between changes to the terrestrial environment and headwater streams, stating that "the replacement of forested land and riparian habitats with impervious surfaces, such as roads and rooftops, alters stream hydrology and geomorphology (Elmore and Kaushal 2008, Finkenbine et al. 2000, Paul and Meyer 2001, Rose and Peters 2001)." Wallace and Eggerts (2015) also point to significant sediment inputs from logging roads and skid trails having negative effects on instream aquatic organisms, and that this effect was most pronounced following rainstorms during construction. A study of land use impacts on southern Appalachian streams found that "cumulative impacts due to landscape alteration under study conditions were much greater during storm events" and thus policy should not be based on baseflow conditions but instead consider the combined impacts of land use and storm flow (Bolstad and Swank 1997).

## 4. Groundwater and surface water are an interconnected hydrologic system

MVP has failed to adequately evaluate hydrologic connectivity when predicting the impacts of construction in the Bent Mountain area. Headwater streams, wetlands, and groundwater form a complex hydrologic network, and "hillslopes, headwater streams, and downstream waters are best described as individual elements of integrated hydrological systems" (Nadeau et al. 2007). Groundwater and surface water can be considered part of the same system. **Groundwater flows into surface water and sustains perennial streams, and surface water also frequently contributes to groundwater (Winter et al. 2007)**, highlighting the connected nature of ground and surface waters.

Even supposed "geographically isolated wetlands" occur on a gradient of hydrological connectedness and the notion that they are not connected is not scientifically supported (Calhoun et al. 2017). In a review of wetlands not located directly in a stream's floodplain (non-fluvial wetlands; NFW), Lane et al. (2018) describe how during wet conditions, **"wetlands were observed connecting to streams over long distances (up to 37 km; Vanderhoof and Alexander 2016)**.Ameli and Creed (2017) found that both surface water and groundwater inputs from NFWs contributed to river flows, with surface inputs affecting flows up to 8 km from the river system (and groundwater flows affecting the river system up to 30 km away)." Put simply, as these wetlands are lost, connectivity decreases.

Studies also suggest that there is connectivity among groundwater sources. A study of stream discharge in two small Appalachian watersheds found that as groundwater flow decreases in one stream, it simultaneously increases in the adjacent watershed, suggesting that groundwater between watersheds is connected in the southern Appalachian mountains (Huff et al. 1977).

## 5. Analysis of soil characteristics in the Bent Mountain area

We assessed soils data for the Bent Mountain area using National Cooperative Soil Survey (NCSS) data (Soil Survey Staff, 2021). NCSS is a service of the U.S. Department of Agriculture (USDA) and other federal agencies [1] , and provides publicly available data on soil properties that are widely used throughout environmental research and management applications. **Tables 1 and 2 demonstrate potential challenges for construction of MVP wetland and stream crossings, respectively, based on inherent soil properties. See tables on pages 7 and 8.** Descriptions of the soil characteristics in Tables 1 and 2 are taken directly from or summarized from the NCSS descriptions.

Scientists at NCSS developed these soil classification data to "help the land users identify and reduce the effects of soil limitations on various land uses." They are based on extensive soil surveys by scientists paired with models that allow scientists "to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape." However, these data are not intended to be a standalone tool, and "If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas" (Soil Survey Staff, 2021).

### 5.1 Specific concerns for Bent Mountain MVP stream and wetland crossings

Our analysis showed that inherent properties of the soil and terrain present challenges for MVP construction throughout the Bent Mountain area. It is important to note that the challenges themselves are highly heterogeneous, so extensive field-based site-by-site planning is important to overcoming these issues.

**76% of stream and wetland crossing sites assessed are defined by the National Cooperative Soil Survey to be "Very limited" for shallow excavation projects.**

For example, at 22 of the 66 stream and wetland crossing areas we assessed, NCSS estimates the water table to be only 0.5 feet deep, which indicates that considerable pumping will be required at those sites. A separate 50 of the 66 stream and wetland crossing sites assessed (76%) are defined by NCSS to be "Very limited" for shallow excavation projects.

This shallow excavation classification is defined by NCSS as follows:

> "The ratings are based on the soil properties that influence the ease of digging and the resistance to sloughing. Depth to bedrock or a cemented pan, hardness of bedrock or a cemented pan, the amount of large stones, and dense layers influence the ease of digging, filling, and compacting... 'Very limited' indicates that the soil has one or more features that are unfavorable for the specified use. **The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures.** Poor performance and high maintenance can be expected." (emphasis added, Soil Survey Staff, 2021; "specified use" refers to excavating in the top 0-6ft of depth)

**At all of the sites assessed, the soil rutting hazard assessed by NCSS was either "moderate" or "severe."** NCSS describes this soil rutting hazard classification as follows:

> "Ratings are based on depth to a water table, rock fragments on or below the surface, the Unified classification of the soil, depth to a restrictive layer, and slope. The hazard is described as slight, moderate, or severe. A rating of 'slight' indicates that the soil is subject to little or no rutting. **'Moderate' indicates that rutting is likely. 'Severe' indicates that ruts form readily.**" (emphasis added, Soil Survey Staff, 2021)

MVP has proposed to use the conventional bore crossing method at 26 of the 66 sites assessed. All except two of these proposed 26 boring crossings are "Very limited" for shallow excavations, indicating that "major soil reclamation, special design, or expensive installation procedures" will generally be called for to complete the bore pit excavation, and that "poor performance and high maintenance can be expected" (quote from Soil Survey Staff, 2021). They are also all ranked as having either "moderate" or "high" potential steel corrosion, which could become an additional complicating factor.

**Eighteen of the 26 boring sites near Bent Mountain have an estimated water table depth of 2.3 feet or shallower. The average boring pit depth at these sites is 23.6 feet**, which means that these sites would require extensive pumping. Soils at these sites range from "well-drained" to "poorly drained," which means that the pumping and dispersal rates for these sites is likely to vary widely. MVP's stated rationale for selecting the boring crossing method is to avoid impacts to the imperiled Orangefin Madtom and protected

[1] The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

trout that may be present in these streams, but field-based and site-specific planning and monitoring has not been conducted to describe the feasibility at each of these unique crossings.

**Numerous additional NCSS soil classifications in the Bent Mountain area suggest challenges for MVP that call for extensive field testing, planning, and additional alternate route assessment to avoid these challenges.** We have assembled these into a spreadsheet that can be reviewed in the attached Excel document. The issues mentioned in this report are only a few of the concerns raised by NCSS soil classifications for crossings in the Bent Mountain area. The challenges presented by this unique terrain should be met with field-based assessments, extensive and transparent planning, and in-stream monitoring.

### 5.2 Overall implications of soils analysis for MVP

This simple analysis of publicly available soil characteristics suggests considerable and variable challenges for construction of MVP in the Bent Mountain area. Every crossing in the area examined contained at least one site characteristic that could cause delays, failures, or other challenges. It is not possible to know the extent of these challenges without extensive field-based feasibility studies and site characterization, which MVP has not conducted. Our soils analysis also revealed considerable heterogeneity in soil and hydrological properties across stream and wetland crossings in the Bent Mountain area. **Due to the challenging and heterogeneous terrain, we draw the conclusion that, without sufficient site-by-site planning, feasibility studies, and in-stream monitoring, MVP cannot claim their potential impacts will be minor and temporary.**

## 6. Endangered species near Bent Mountain

Many of the streams near Bent Mountain are designated for imperiled or protected species. This region is central to the small range of the critically imperiled Orangefin Madtom, and there are also designated trout waters that would be impacted by MVP construction.

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**In 1992, a contaminant spill in a small stream near Bent Mountain killed an estimated 300 Roanoke Logperch (Moser, 1992)**

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This area also falls within the federally protected range for Roanoke logperch. Bottom Creek Watershed, including Bent Mountain, comprises headwaters for “probably the largest, most important population in this species’ range” in the upper Roanoke River (Hester and Smith, 2007). In 1991, a manure spill in a nearby Upper Roanoke River headwater stream, Elliott Creek, resulted in the death of an estimated 300 Roanoke logperch. This was “one of the most destructive” events for the species according to the USFWS recovery plan for species (Moser, 1992). From this incident it is clear that pollution in these headwater streams has an impact on the Roanoke logperch, but MVP has not explicitly considered their presence downstream in selecting crossing methods in this area.

Downstream from Bent Mountain, Bottom Creek is impaired for temperature. Riparian tree removal related to MVP stream and wetland crossing removal could feasibly exacerbate this impairment and present further threats to aquatic species.

Bent mountain also falls within the range of protected habitat for Bog turtles. These turtles are found in Virginia only in the southern Blue Ridge Plateau in wetlands above 610 meters elevation, such as Bent Mountain (elevation 796 meters). One of the primary threats to this species is draining of wet meadows and other wetlands (Mitchell et al., 1991).

## 7. Conclusion

Publicly available data and the best available science demonstrate the ecological importance, environmental heterogeneity, and sensitivity of Blue Ridge headwater streams and underlying aquifers. These areas are crossed repeatedly by MVP without site-specific field-based geotechnical feasibility assessments. The natural landscape, including steep slopes, sloughing soils, large boulders, and protected aquatic habitats, all present unique challenges at each crossing site. **Lack of individual field-based feasibility assessments at stream and wetland crossing sites demonstrates lack of appreciation for this natural heterogeneity, and lack of preparedness for the considerable challenges to MVP construction.**

In this comment we provided a preliminary assessment of inherent challenges in the Bent Mountain area to demonstrate the unique characteristics present in a relatively short stretch of MVP’s proposed route. **Across MVP’s proposed route, variable stream and wetland environments will present unique challenges that warrant individual field-based site assessments and individualized mitigation plans in MVP planning documents.**

## Conflicts of Interest

This report was prepared by members of Virginia Scientist-Community Interface. The analysis presented is entirely our own and does not represent the position of our respective affiliations. Affiliation is for identification purposes only. We have no conflicts of interest to declare.

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**Table 1.** Select Mountain Valley Pipeline (MVP) wetland crossings in Bent Mountain area with National Cooperative Soil Survey (NCSS) soil classifications.

| Wetland ID | Impact type | Crossing type | Rutting Hazard | Suitability: subsurface drainage | Suitability: shallow excavation | Seedling mortality |
|---|---|---|---|---|---|---|
| | | | Hazard of surface rut formation through the operation of equipment. Where “Severe,” ruts form readily. | Evaluates soils potential to allow contaminants into water. Indicates water quality during drainage activities. “Very limited” indicates that water quality is likely to be compromised. | Indicates limitations for excavations up to 6’ depth. Based on ease of digging and resistance to sloughing. Where “Very limited,” poor performance and high maintenance can be expected. | "High" indicates that mortality pf propagated seedlings is likely, and planting requires special design, extra maintenance, and costly alteration. |
| W-Q11 | Permanent Access Road | NA | Severe | Very limited | Very limited | High |
| W-IJ10 | Permanent Access Road | NA | Severe | Very limited | Very limited | High |
| W-KL17 | Pipeline ROW | Dry-Ditch Open-Cut | Severe | Very limited | Very limited | High |
| W-B25-PEM-1 | Pipeline ROW | Dry-Ditch Open-Cut | Severe | Very limited | Very limited | High |
| W-B24-PEM | Pipeline ROW | Dry-Ditch Open-Cut | Severe | Very limited | Very limited | High |
| W-AB6-PFO-1 | Pipeline ROW | Dry-Ditch Open-Cut | Severe | Very limited | Very limited | High |
| W-AB6-PEM-2 | Pipeline ROW | Dry-Ditch Open-Cut | Severe | Very limited | Very limited | High |
| W-Z7 | Temporary Access Road | NA | Severe | Very limited | Very limited | High |
| W-Z6 | Temporary Access Road | NA | Severe | Very limited | Very limited | High |
| W-B25-PSS-2 | Timber Mat Crossing | Conventional Bore (11ft dep) | Severe | Very limited | Very limited | High |
| W-EF46 | Timber Mat Crossing | Conventional Bore (21 ft dep) | Severe | Very limited | Very limited | High |
| W-IJ36 | Timber Mat Crossing | Conventional Bore (30 ft dep) | Severe | Very limited | Very limited | High |
| W-B25-PEM-1 | Timber Mat Crossing | Dry-Ditch Open-Cut | Severe | Very limited | Very limited | High |
| W-B25-PEM-4 | Timber Mat Crossing | NA | Severe | Very limited | Very limited | High |
| W-B25-PEM-2 | Timber Mat Crossing | NA | Severe | Very limited | Very limited | High |

**Table 2.** Select MVP stream crossings in the Bent Mountain area with underlying NCSS soil classifications.

| Stream ID | Impact type | Crossing type | Stream Designation | Suitability: subsurface drainage | Suitability: shallow excavation | Erosion hazard |
|---|---|---|---|---|---|---|
| | | | | Evaluates soils potential to allow contaminants into water. Indicates water quality during drainage activities. “Very limited” indicates that water quality is likely to be compromised. | Indicates limitations for excavations in the top 6’ depth. Based on ease of digging and resistance to sloughing. “Very limited” indicates that poor performance and high maintenance can be expected. | Hazard of soil loss after disturbance activities. “Very severe” indicates that erosion-control measures are costly and generally impractical. |
| S-Y13 | Pipeline ROW | Dry-Ditch Open-Cut | Natural Trout, Coldwater Fishery | Very limited | Very limited | Very Severe |
| S-Y14 | Pipeline ROW | Dry-Ditch Open-Cut | Orangefin madtom, Non-listed mussels, Natural Trout, Coldwater Fishery | Very limited | Very limited | Very Severe |
| S-EF44 | Timber Mat Crossing | Conventional Bore (21 ft dep) | Natural Trout, Coldwater Fishery | Very limited | Very limited | Severe |
| S-IJ89 | Timber Mat Crossing | Conventional Bore (22 ft dep) | Orangefin madtom, Natural Trout, Coldwater Fishery | Very limited | Very limited | Severe |
| S-IJ90 | Timber Mat Crossing | Conventional Bore (22 ft dep) | Natural Trout, Coldwater Fishery | Very limited | Very limited | Severe |
| S-KL55 | Timber Mat Crossing | Conventional Bore (22 ft dep) | Orangefin madtom, Natural Trout, Coldwater Fishery | Very limited | Very limited | Severe |
| S-Y7 | Timber Mat Crossing | Conventional Bore (25 ft dep) | Natural Trout, Coldwater Fishery | Very limited | Very limited | Severe |
| S-Y8 | Timber Mat Crossing | Conventional Bore (25 ft dep) | Orangefin madtom, Natural Trout, Coldwater Fishery | Very limited | Very limited | Severe |
| S-EF33 | Pipeline ROW | Dry-Ditch Open-Cut | Natural Trout, Coldwater Fishery | Very limited | Very limited | Severe |
| S-EF34b | Pipeline ROW | Dry-Ditch Open-Cut | Orangefin madtom, Natural Trout, Coldwater Fishery | Very limited | Very limited | Severe |
| S-EF55 | Pipeline ROW | Dry-Ditch Open-Cut | Natural Trout, Coldwater Fishery | Very limited | Very limited | Severe |