TO: West Virginia Department of Environmental Protection
601 57th Street SE
Charleston, WV 25304

FROM: Kirk A Bowers, PE
Mountain Valley Watch

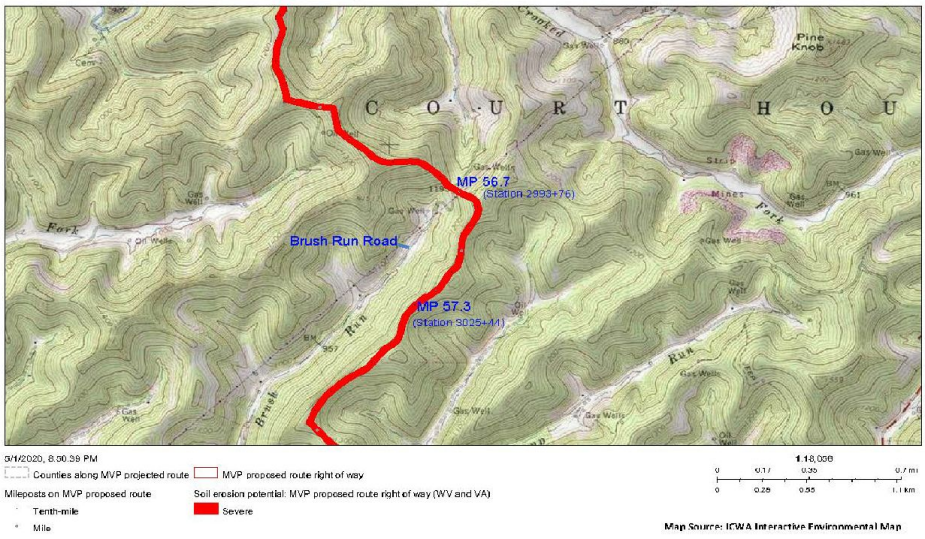
DATE: February 16, 2021

SUBJ: Mountain Valley Pipeline Slip report analysis, milepost 57.2-57.3

A slip at MP 57.2 requiring a variance request was reported in February 2019. One year later, new slips occurred, and by April 2020 MVP crews reported installed pipe had slipped at the same location. The pipeline was removed and reinstalled, and yet it has continued to be a problem. In December 2020, this section was completely bare and clearly under construction again.

The map below shows the location of the MVP in the area of continued land subsidence. The map shows that south of Brush Run Road (MP 56.7) the pipeline route makes a steep ascent, then runs southwest along or near the top of the ridge. MP 57.3, where the 200 ft-long slip occurred, appears to be about midway along the ridge. Exact locations of where the crew identified pipeline shifts was not reported.

Area of MVP Slips and Pipeline Movement in Lewis Co., WV



References in the Compliance Monitor Reports to Brush Run Road and "south of Brush Run Road" establish this as the location of installed pipe displacement.

Slip-related Variance Requests and Compliance Monitor Reports

The following section gives a brief history of landslide occurrences in the vicinity of mileposts 56.7, and 57.2 to 57.3 as documented in variance requests and excerpts from FERC Compliance Monitor Reports.

One of the earliest reports was a 2019 variance request that required nearly 1.5 acres for additional workspace and three quarters of an acre of tree clearing:

> **Variance Request B-17**
> **Location: MP 57.18**
> **Date requested by contractor: 2/15/2019**
> **Date filed with FERC: 5/13/2019**
>
> *This variance adds MVP-ATWS-SM-041, MVP-ATWS-SM-042 & MVP-ATWS-SM-065* ***for slip remediation****. No cultural resources, streams, or wetlands were found during surveys. This variance has a net increase of 1.40 acres of LOD from the original permit. There is a net tree clearing increase of 0.78 acres. Tree clearing was permitted to occur until June 1, 2019.*

Slips in this location have continued to be a problem since February 2019. A FERC Compliance Monitoring Report for February 16-22, 2020 noted the following:

> **2/18/2020: Spread B MP 57.3**
> *Compliance Monitor was notified of a new slip that occurred south of Brush Run Road. The new slip is at MP 57.3.* ***There are three total slips south of Brush Run Road****. … The Compliance Monitor conducted a follow-up inspection on February 21, 2020 … The slip at MP 57.3 appears to have moved since the previous inspection. These temporary barriers are acceptable but these areas will continue to be monitored for additional movement.*

Two additional Compliance Monitoring reports filed in April 2020 made references to slip problems "south of Brush Run Road", including the shifting of installed pipe. One report was for the period March 29 – April 4, 2020; the other was for April 5 – April 11, 2020. The reports by the FERC Compliance Monitor are shown below:

> **4/1/2020: Spread B MP 57.3**
> *The Lead Environmental Inspector notified the Compliance Monitor that there was movement outside of the limits of disturbance at the slip at MP 57.3*

(south of Brush Run Road). ***The bottom of the soil roll from this slip has now extended about 15 feet outside of the limits of disturbance for about 200 feet along the west side of the right-of-way****. The Lead Environmental inspector said crews will mobilize equipment to this location to start slip repair inside the limits of disturbance.*

4/8/2020: Spread B MP 56.7

The Lead Environmental Inspector notified the Compliance Monitor that ***crews verified that the installed pipe shifted due to the movement of the slips in at least three locations south of Brush Run Road****. The Lead Environmental Inspector said that survey crews marked where the pipe was installed and other crews used line locators and potholing to determine the current location of the pipe. Mountain Valley is still determining a course of action to correct the movement.*

December 2020 flight photo of milepost 56.7 slip location

Then, in October 2020, MVP's contractor initiated another variance request for additional slip remediation:

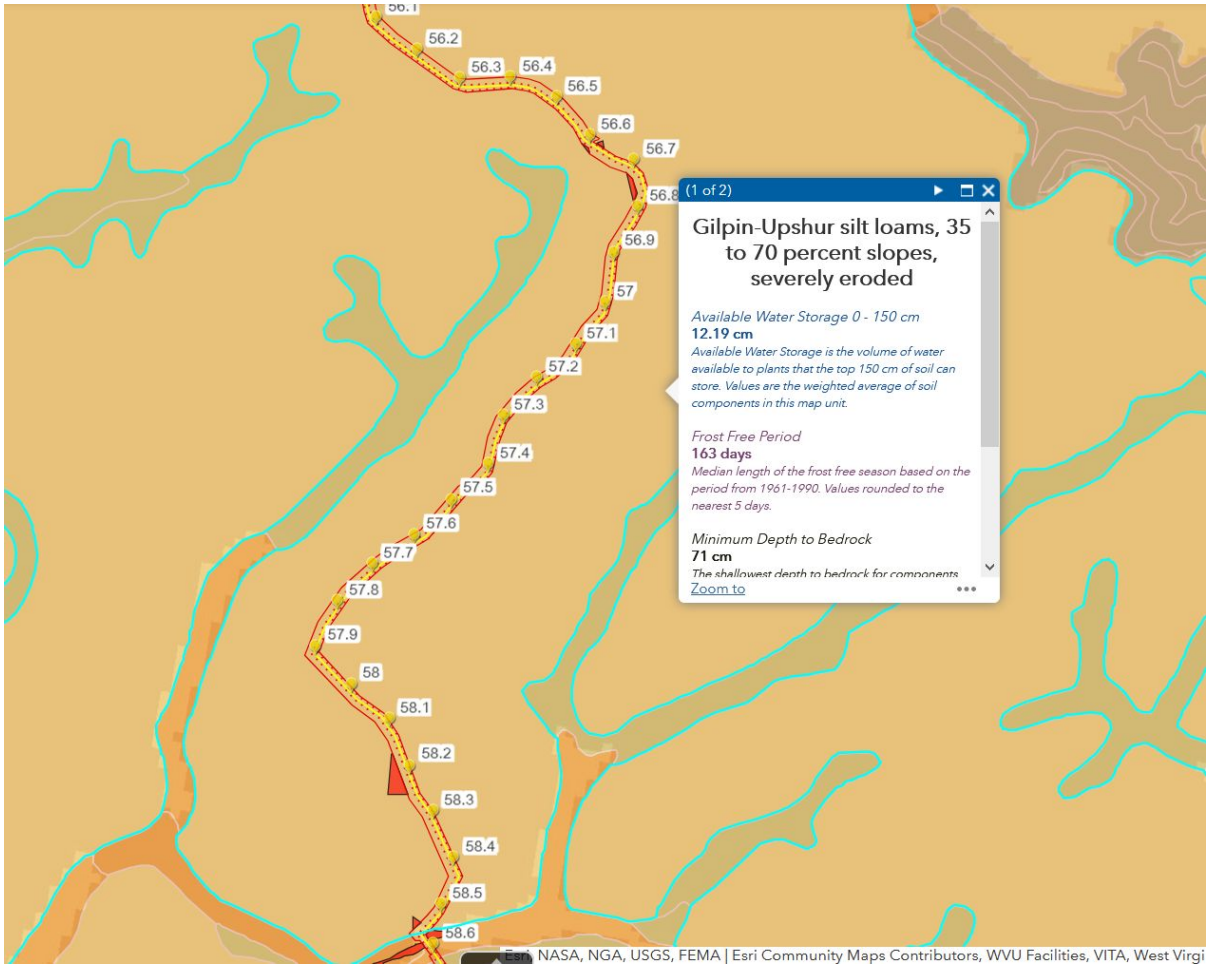
> **Variance Request B-59**
> **Location: MP 57.20**
> **Date requested by contractor: 10/8/2020**
> **Date filed with FERC: 12/7/2020**
>
> *Mountain Valley Pipeline LLC requests a variance to add MVP-ATWS-1676, MVP-ATWS-1677, and MVP-ATWS-1678 for slip remediation and the installation of rock drains (slip MBP-B-060). The rock drains will be permanent and above ground. This variance has a net increase of 0.07 acre of LOD from the original permit. The current vegetative cover of the variance area is deciduous forest and scrub-shrub. However, no tree clearing will be required as part of the slip remediation and drain installation.*

The photo below is from a December aerial flight over the MVP that records continued construction/remediation activity in the ROW at MP 57.2.

December 2020 flight photo of milepost 57.2 slip location

Soil Properties

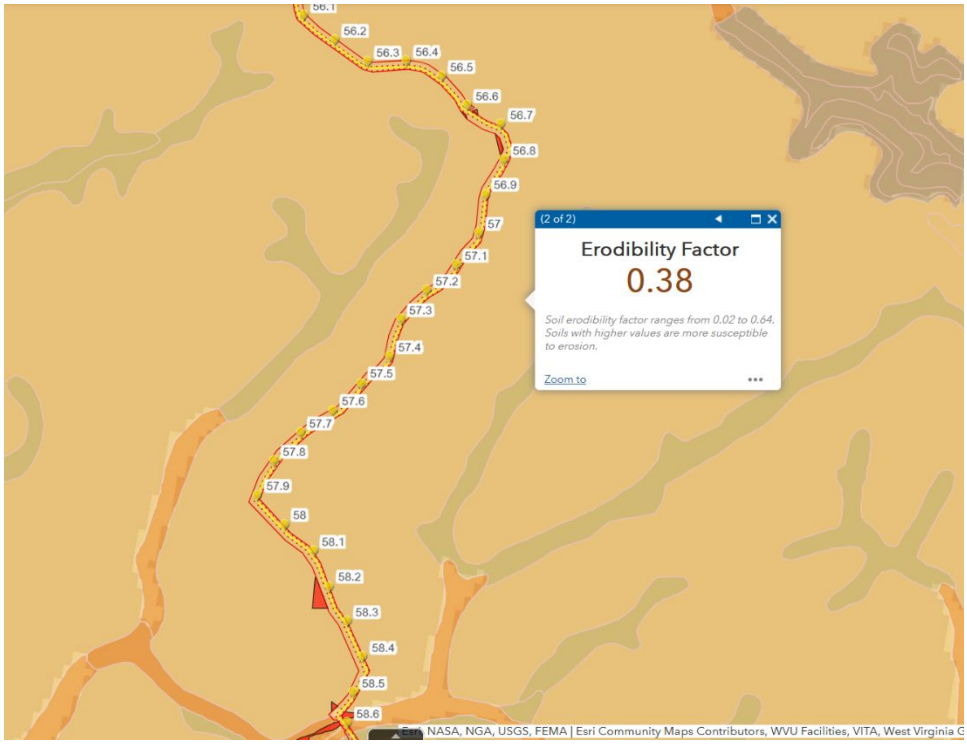
The physical characteristics of soils, especially on slopes resulting from cuts and fill activities, can create unstable conditions. High slip potential soils are a key factor for the majority of slips for construction projects in West Virginia. The dominant soil series in this area of Lewis County, WV is Gilpin-Upshur silt loams, 35 to 70 percent slopes, severely eroded. The Gilpin-Upshur complex, 35 to 70 percent slopes soil types have severe landslip potential.[1] The figures on the next pages show the pipeline in relation to the soils map for this area with the dominant soil classification and soil erodibility factor, K_f.



Soils map for section of MVP at Milepost 57.2

[1] Quote from Code Section. Marietta County, Ohio
https://codelibrary.amlegal.com/codes/marietta/latest/marietta_oh/0-0-0-16185

The Gilpin series consists of moderately deep, well drained soils formed in residuum derived from shale, siltstone, and sandstone. The Gilpin soils are on ridgetops, benches, and hillsides throughout the survey area. Slope ranges from 8 to 70 percent. The Upshur series consists of deep, well drained soils formed in material weathered from siltstone and shale. The Upshur soils are on ridgetops, benches, and side slopes throughout the survey area. Slopes range from 8 to 35 percent.



Dominant soil Erodibility Factor, K_f = 0.38

Soil erodibility (K_f) is the susceptibility of a soil to erosion by runoff and raindrop impact. Values of K range from the lowest erodibility, 0.02, to the highest, 0.69. All other factors being equal, the higher the K value, the greater the susceptibility of the soil to rill and sheet erosion by rainfall. K values are dependent upon the soil texture, structure, permeability, and organic matter content. In general, soils with greater permeability, higher levels of organic matter, and improved soil structure have a greater resistance to erosion and, therefore, a lower K value. The presence of silt, very fine sand, and clays with a high shrink-swell capacity tend to increase the K value[2].

[2] Soil Erodibility Evaluation for General Permit 3-9020 Stormwater Runoff from Construction Activities, Stormwater Technical guidance, Vermont Environmental Conservation.

Chapter 6, VA Erosion and Sediment Control Handbook, p. IV-44 (shown below) includes an explanation of the Erodibility factor and lists three groups of erosion hazard. **K_f factors above 0.36 are documented high risk No Build Zones.**

> Erodibility - The major soil consideration from an erosion and sediment control standpoint is its erodibility. An erodibility factor (K) indicates the susceptibility of different soils to the forces of erosion. A soil survey report includes the K factor for each soil found in the survey area. These K factors are used in the Universal Soil Loss Equation to determine soil loss from an area over a period of time due to splash, sheet, and rill erosion. K factors in Virginia range from about .10 (lowest erodibility) to about .50 (highest erodibility). K factors can be grouped into three general ranges:
>
> | | | |
> |---|---|---|
> | 0.23 and lower | - | low erodibility |
> | 0.23 to 0.36 | - | moderate erodibility |
> | 0.36 and up | - | high erodibility |

Rock fragments also can have a major effect on soil erosion. Rock fragments on the surface act as surface cover which reduces permeability and increases erosion. Blasting and excavation of underlying rock for the pipeline trench has introduced more rock fragments as surface cover. This is another factor that has exacerbated the situation in this area and increases the risk of landslides.

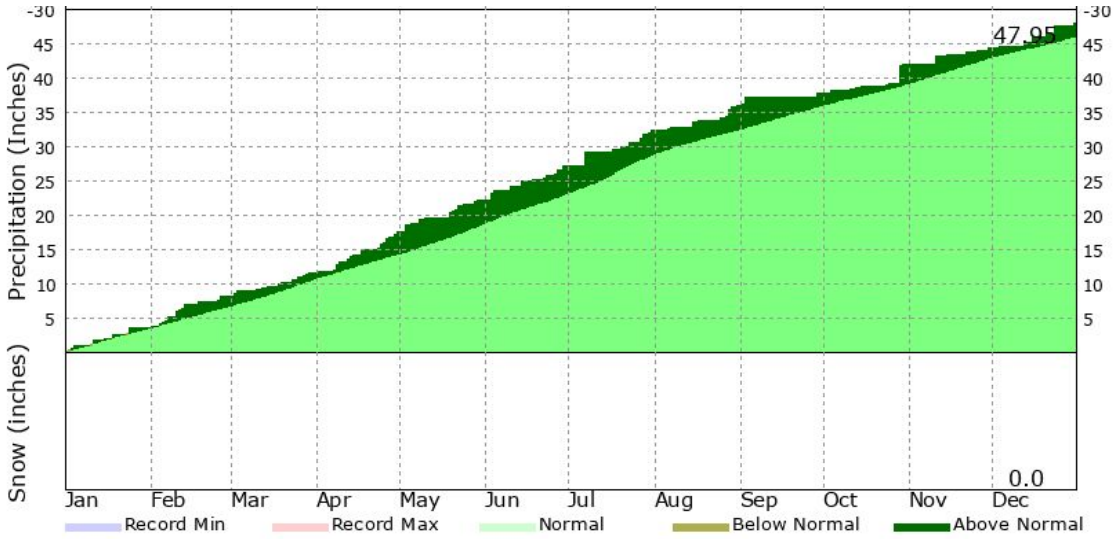
Topography also affects soil through its effect on the amount of water moving through the soil, the amount of runoff, and the rate of erosion. On steep and very steep hillsides, less water moves through the soils and more water runs off the soils. As a result, soil material is washed away rapidly resulting in soil displacement.

Soil moisture infiltration can cause slips by saturating existing soils resulting in lower resistance to movement while decreasing the angle of repose. Steep slopes in the headwaters of drainage basins also tend to generate more runoff than do lowland areas. On steep slopes erosion is caused primarily by water, especially by heavy rainfall. Rain that falls onto the exposed ground dislodges soil particles which are then carried away down the slope by the flowing water. The speed at which water flows downhill is directly affected by the slope, or steepness, of the land. The steeper the slope, the faster the water flows downhill, and the greater its power of erosion and landslides.

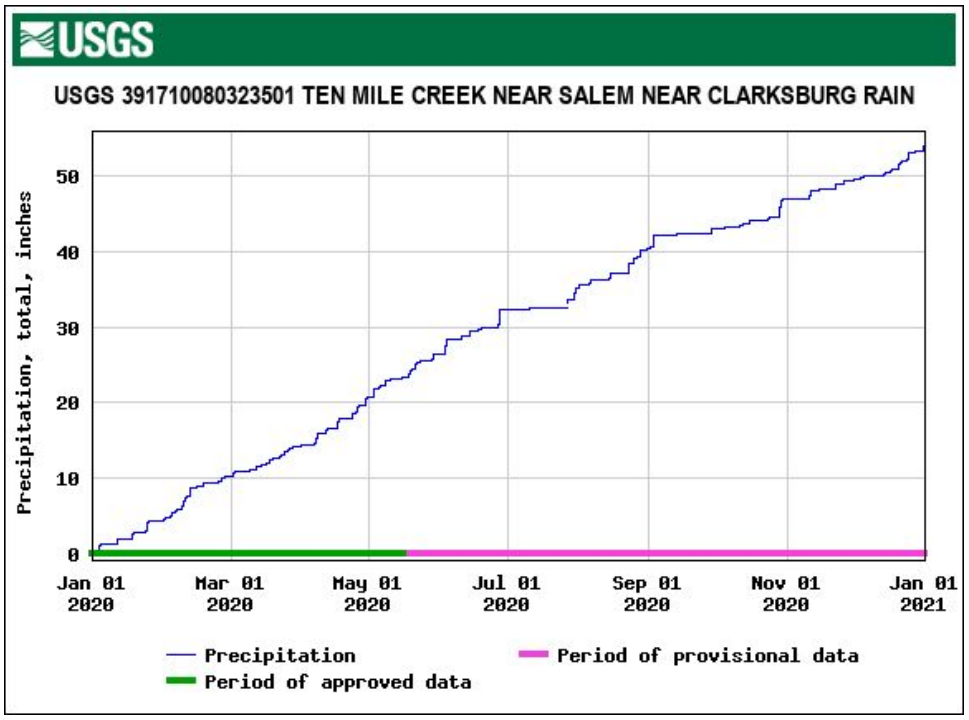
Shear strength is a very important property of soils. The property is used in estimating the bearing capacity of foundations and in assessing the stability of retaining walls, slopes, and embankments. Most failure patterns are based on shear stress development in soil mass due to induced loading or unloading caused by construction practices. If the induced shear stresses exceed the underneath soil shear strength, failure occurs.

When the soil was excavated for the pipeline trench, the surface of the excavation became a shear plane for the backfilled soil from the trench. The weight of the mass soil on the mountain slope above the pipeline pushing downward on the excavated soil can displace the excavated soil layer and create landslides. Large soil loading from upslope areas can exceed the strength of excavated soil materials to withstand movement downhill. The result is land slippage and displacement with possible rupture of the pipeline.

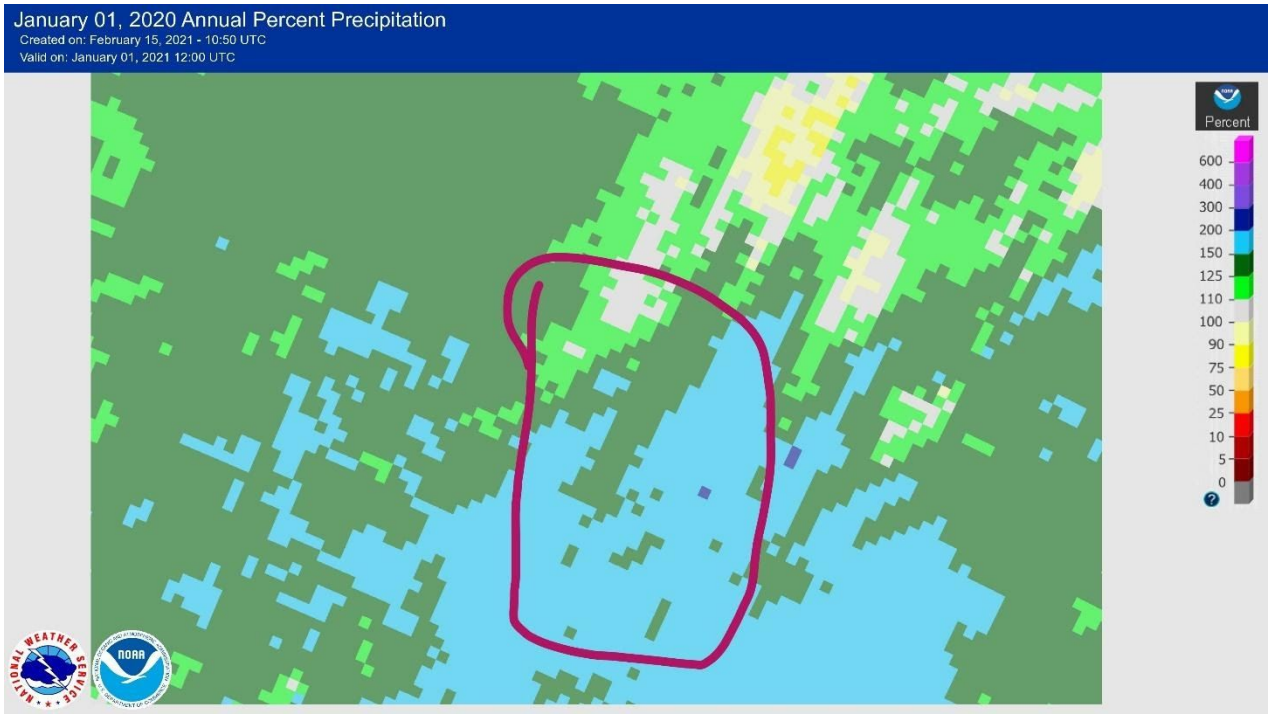
Mountain areas tend to receive more precipitation overall because they force air to be lifted and cooled. The totals shown in the graphs below indicate above average rainfall for this area of West Virginia during the year 2020.



Year 2020: Total Monthly Precipitation for Clarksburg, WV



2020 Annual Precipitation totals for Ten Mile Creek, WV near Clarksburg

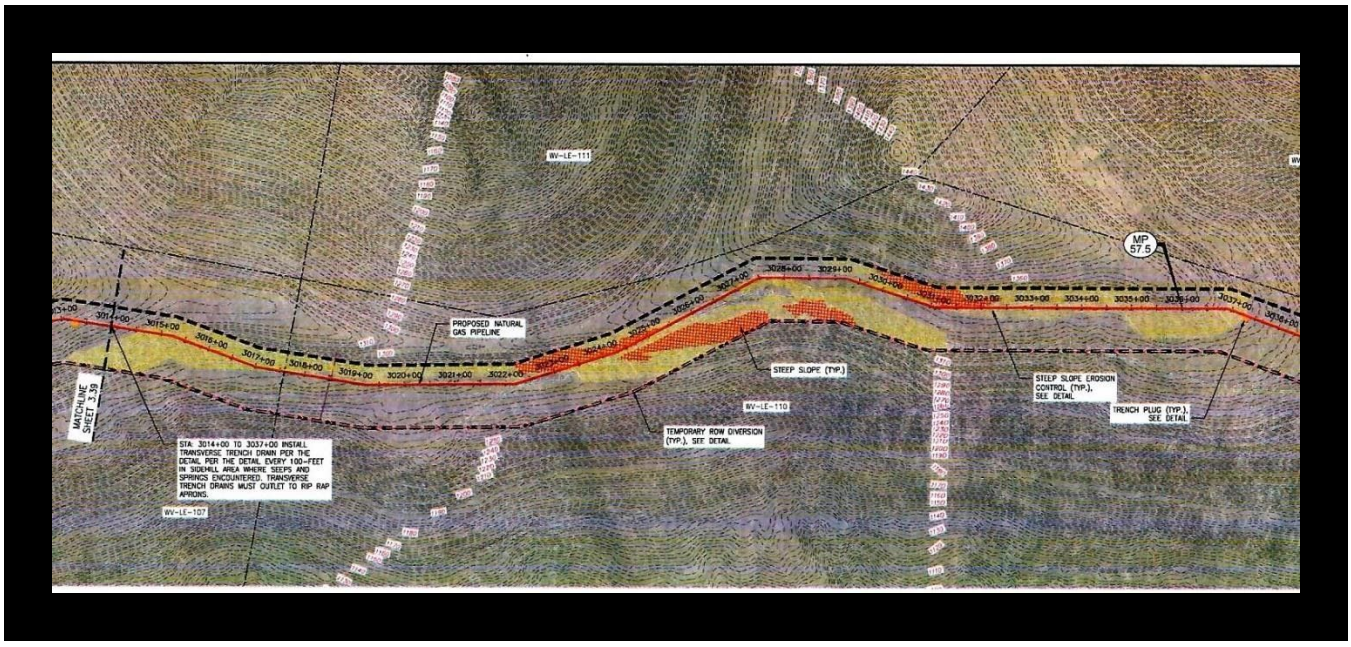


The MVP runs through the area circled in Red above which shows 125% to 150% increase in rainfall during 2020.

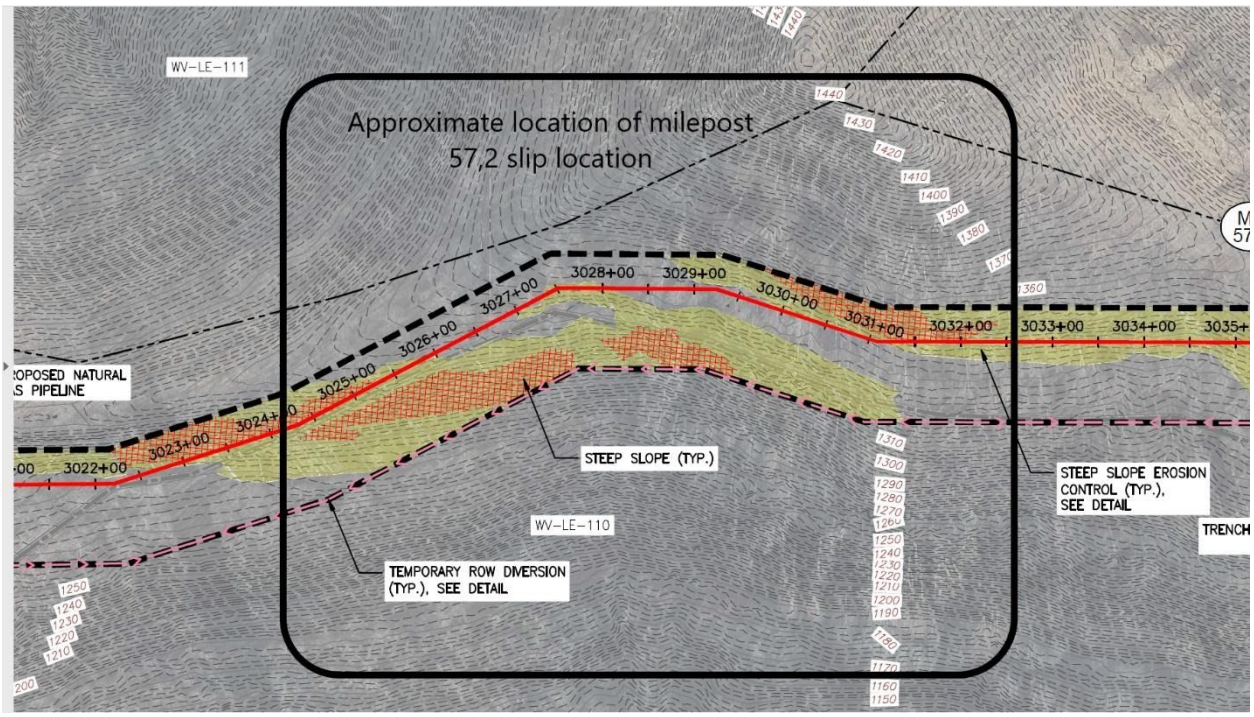
Findings and Conclusion

The photo below is from a recent aerial flight over the MVP that records construction in the ROW. The photo is in the area of recent landslides. What appears like a "construction site" in the photo below of MP 57.2 is a remediation effort for the location where the installed pipeline shifted early LAST year and was not adequately stabilized.

December 2020 Milepost 57.2



Construction plan sheet 3.40 showing location of landslide



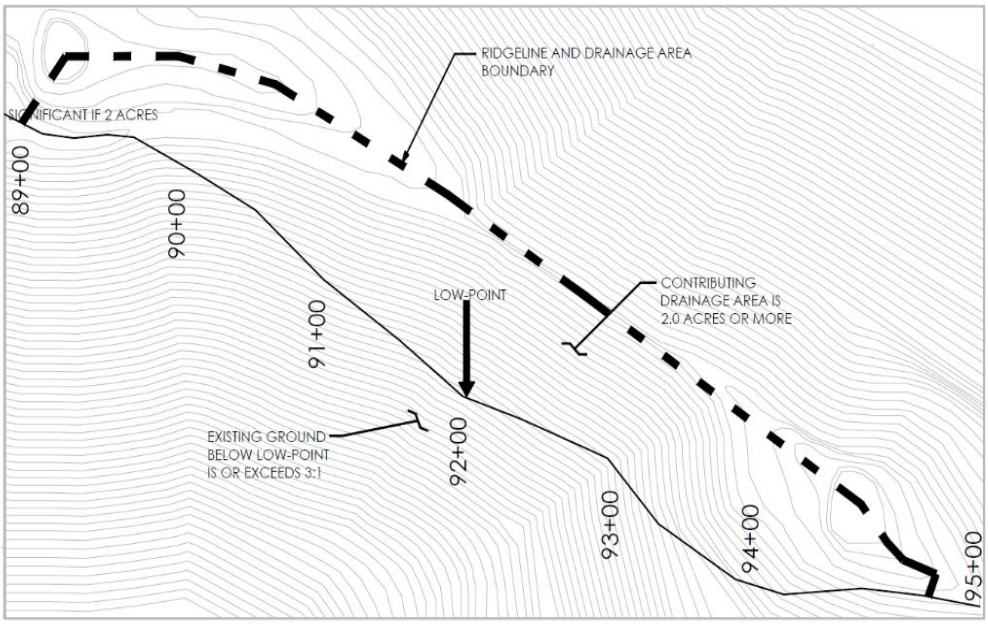
Enlarged view of plan sheet showing slope and elevation of existing ground.

The pipeline at milepost 57.2 is located on the side of a mountain. Elevation differences above the pipeline centerline are dependent on location. The lowest elevation difference is 8 feet at Station 3026+00. The highest elevation difference is 80 feet at Station 3030+00.

Higher elevation differentials on the slope of a mountainside creates a large mass of overburden which produces a downward force on the existing pipeline and displaced soils. The slopes below the pipeline are steep and provide little stability for sliding soils.

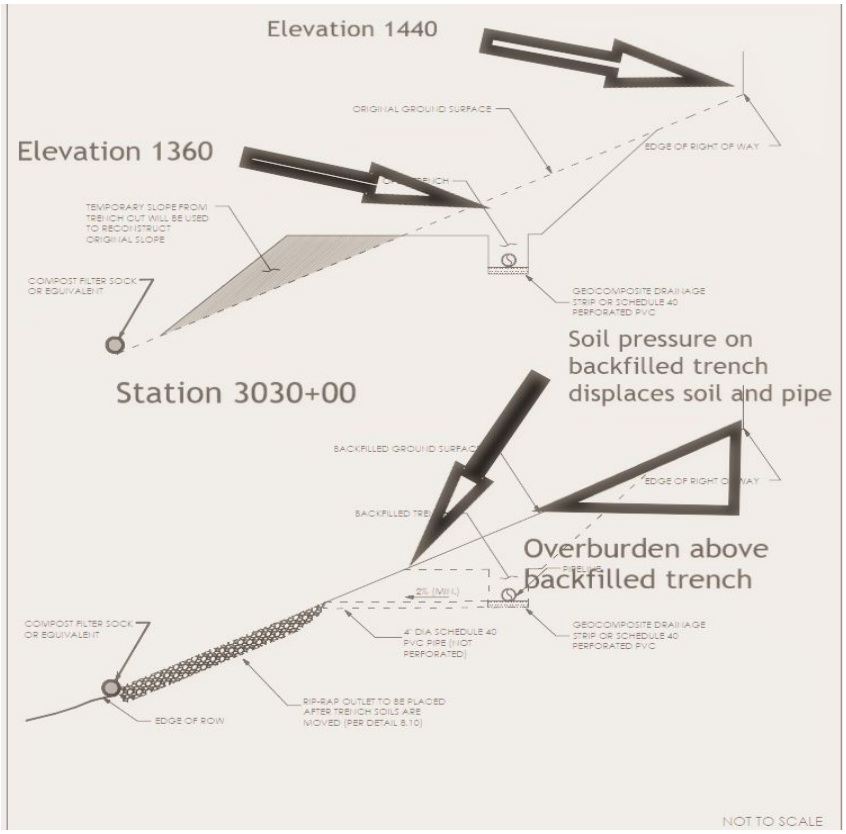
The illustration shown below[3] gives an example plan view of pipeline construction on the side of a mountain. The ridgeline shown in the sample plan is the drainage area boundary for the drainage area above the pipeline. The ridgeline also defines the boundary for soil overburden above the pipeline. Larger contributing drainage areas and greater differences in elevation increase the risk of landslides on steep mountain slopes.

[3] Chapter 8 Steep Slope Construction Guidelines in Areas Of High Slip Potential Soils, Erosion and Sediment Control Best Management Practice Manual, West Virginia Department of Environmental Protection, page 8-8.



PROPOSED PIPELINE PLANVIEW

Example of plan view for side hill construction



Trench construction profile at Station 3030+00

The ridgeline elevation shown on the MVP construction plan sheet 3.40 shows a large difference in elevation on the side of a steep mountain slope. There is up to 80 feet of elevation difference shown on the construction plan. The soils in this area are extremely sensitive to erodibility as indicated by a $K_{f,}$ erodibility factor, of 0.38. This is a high slip hazard area and construction was not recommended or suitable at this location.

What method was used to stabilize this area from further soil displacement? What guarantees are there that the pipeline in this area will not rupture during future landslides?

In Conclusion, a combination of highly erodible soils, above average annual precipitation rates, and steep mountain slopes produced an ideal situation for landslides to occur. Despite efforts to stabilize the slide areas, there is an increased risk of continuing slips at this location and others in Lewis County, WV. The dominant soil type combined with steep slopes on the sides of mountains creates unstable site conditions. The probability of slides occurring in the future in this area is high.

Lewis County, WV
Road damage caused by slippage in an area with Gilpin-Upshur silt loam, 35 to 70 percent slope[4]

[4] Soil Survey of Lewis County, WV, Cover page photo.