Sediment generation and impacts from dry-ditch open-cut stream crossings such as those proposed for the Mountain Valley Pipeline

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1. INTRODUCTION

As proposed, the Mountain Valley Pipeline (MVP) would extend for 304 miles from Wetzel County, West Virginia to Pittsylvania County, Virginia. Along this length, the pipeline itself, permanent and temporary access roads, and timber mats will cross hundreds of rivers and streams. (Tetra Tech 2021)

This report focuses on stream impacts from pipeline crossings using dry-ditch open-cut methods, as proposed for numerous MVP crossings. This method involves dewatering the construction site by diverting flow around the site while the ditch is dug and the pipe is laid. (Tetra Tech 2021)

Although the specific methods employed in dry-ditch crossings differ from those used in wet-ditch crossings, both methods have been documented to cause stream sedimentation and turbidity. Sediment inputs to the stream from either method may diminish if the stream successfully stabilizes over the buried pipe. However, as discussed below, stabilization of the original sediment source does not end the sediment impacts to the stream.

In addition to transporting water from the mountains downhill to the oceans, rivers and streams act as conveyor belts carrying suspended and dissolved loads of sediment, soil, and rock debris. Depending on the size of the river and other factors, loads of millions of tons per year can be transported. (Dunne and Leopold 1978)

Generally, the load is divided into size classes: clay, silt, sand, gravel, cobble, and boulder. When the flow is high enough, shears in the flow are created as faster water moves past slower water. Smaller sediment particles in the streambed, which can include clay, silt, and sand, are carried upward into the water column and become the suspended load.

Larger size classes require greater forces to move. Instead of being lifted into the water column, cobble and boulders are generally rolled or dragged along the river bed and constitute the bed load.

In this document, we focus on the suspended sediment load. Once sediment is suspended, or entrained, in a river, it will flow downstream. Along the way, the sediment will mix into the water column as it undergoes vertical, transverse, and longitudinal turbulent diffusion. The spatial extent of the exposure risk from suspended sediments—including, for example, the identification of the specific habitats affected by instream construction-induced suspended sediment—is not currently considered within many water quality management frameworks. (Courtice and Naser 2020)

Eventually, depending on the river conditions, the sediment will re-deposit on the streambed. This sediment will then be re-suspended in the water column at a later date, when conditions are right. In this manner, sediment that was originally generated from an upstream crossing will continue to impact downstream flora, fauna, and their habitats as the streams and rivers transport sediment loads downstream.

The amount of time it takes for this suspended sediment load to be flushed from a stream channel varies and depends on a number of factors, including the season of construction, droughts and floods, or other weather patterns.

2. PIPELINE CROSSINGS GENERATE SEDIMENT

The most common methods for crossing streams during construction of pipelines include:

- wet-ditch open-cut crossings, where the stream is allowed to run through the construction site;
- dry-ditch open-cut crossings, which isolate the streamflow from the construction site; and
- trenchless methods, including conventional boring and horizontal directional drilling, in which the pipe is installed in a tunnel drilled under the streambed.

This review focuses on open-cut methods. Once the pipe has been installed in the streambed and covered, long-term sedimentation impacts are similar for both wet-ditch and dry-ditch methods. MVP does not propose to use wet-ditch methods; however, these methods are included in this review due to similarities in long-term impacts generated by both open-cut methods. Because impacts from trenchless methods are quite different, these methods are not included in this review.

The goal in utilizing dry-ditch stream crossings to construct pipelines is to reduce the release of sediment into the aquatic environment. However, such reductions fall short of complete avoidance of sediment releases and are less than would be achieved through the use of trenchless technologies. Sediment releases in dry-ditch crossings often occur during the installation and removal of isolation structures. Sediment is also commonly released when installation and maintenance of isolation structures is flawed. Inadequate installation and maintenance of these structures allow sediment releases due to leakage around and/or underneath dams, dam or flume failures, and pump failures. (Pharris and Kopla 2007, Reid et al. 2002)

One example of a failed dry-ditch stream crossing that released significant amounts of sediment to the aquatic environment occurred during construction of the WB Express Pipeline's crossing of the North Fork of the South Branch of the Potomac River in West Virginia. A pump-around dam failed, and the pumps were overwhelmed. This resulted in a sediment release that violated West Virginia's water quality standards, and settleable solids were observed 19 miles downstream following this release. (West Virginia Department of Environmental Protection 2019)

In general, while the influx of sediment from an open-cut stream crossing may diminish when the disturbance ends, some residual increases may occur due to scour of the trench, erosion of exposed surfaces at the crossing site, and resuspension of settled materials. (Reid and Anderson 1999, Armitage and Gunn 1996, Courtice and Naser 2020, Pharris and Kopla 2007)

2.1 Impacts can last for years

While the short-term impacts of stream crossings by pipeline projects are well-defined in the literature, there is a paucity of current, data-driven documentation of the long-term impacts. Following pipeline construction, silt deposits and increased embeddedness due to sediment deposition may continue to impact downstream streambeds and aquatic life for years following crossing completion (Armitage and Gunn 1996, Reid and Anderson 1999). Long-term impacts of pipeline crossings must be evaluated at each individual stream due to stream-specific factors that influence the duration of stream channel and aquatic life impacts. Because of the potential for isolation methods to fail, stream crossing construction sites must receive adequate oversight to ensure that large-scale sedimentation events do not occur.

Armitage and Gunn (1996) analyzed anthropogenic impacts associated with construction of the United Kingdom terminal of the Channel Tunnel on benthic communities in three streams. One stream was crossed by a pipeline using the open-cut construction method and provided an opportunity to examine the impacts of this type of construction project on the aquatic community and sedimentation in the stream channel. Immediately following construction of the pipeline crossing, the proportion of silt in the substrate increased to 90 percent. This silt persisted in the streambed for more than four years until high spring flows washed away the silt, returning the streambed to a substrate dominated by pebbles and gravel. Macroinvertebrate communities shifted in correlation with the influx of silt: *Chironomidae* and *oligochaetes* became dominant following siltation, and the community returned to its pre-construction state dominated by crustaceans following silt flushing. (Armitage and Gunn 1996)

Reid and Anderson (1999) summarize 20 analyses of aquatic impacts following pipeline crossings. Of these, eight only assessed immediate impacts. Of the remaining twelve studies, ten found that sediment was flushed within one year and benthic communities had returned to their pre-construction status. The other two studies observed impacts two to four years after crossing construction. According to the authors, high stream flows, such as those produced during storms or spring melts, are required to flush sediment that has become embedded in stream bottoms (Reid and Anderson 1999).

Reid et al. (2002) found that fish populations were impacted up to one month following construction but returned to pre-construction numbers one year later. Notably, both studies (Reid and Anderson 1999, Reid et al. 2002) were funded and reviewed by the Interstate Natural Gas Association of America and the Gas Research Institute.

2.2 Impacts are site-specific

Pipeline stream crossings must be independently evaluated at each stream crossing to accurately assess impacts to the aquatic environment. The extent of sediment entrainment and deposition is highly dependent on flow conditions, construction activity and duration, and sediment particle size (Castro et al. 2014, Reid and Anderson 1999). “It is clear that the magnitude of change and recovery time is related not only to the type and intensity of the disturbance, but also to the intrinsic characteristics of the stream” (Armitage and Gunn 1996, p. 178). Stream morphology plays a role in determining the time required for sediment flushing to be complete. Sediment is maintained for longer periods of time in low-flow areas, such as behind boulders or in slow pools (Reid and Anderson 1999).

Stream responses to pipeline construction are highly dependent on characteristics of the stream system rather than the pipeline. These impacts occur not just at the project site, but may also propagate downstream, as discussed above. Impacts may also propagate upstream or laterally into the floodplain. (Castro et al. 2015)

In order to accurately predict the potential impacts of a proposed crossing on the aquatic environment, specific, detailed information would be required about individual site conditions, construction implementation, best management practices, site restoration, and monitoring and maintenance. (Castro et al. 2015)

3. EXCESS SEDIMENT HARMS AQUATIC LIFE

While sediment is a natural and important part of riverine ecosystems, it may be harmful to flora, fauna, and their habitats when it becomes suspended (Courtice and Naser 2020). Sediment that becomes entrained in the water column creates turbid conditions that negatively affect aquatic life. Once this suspended sediment is deposited, additional impacts are experienced by aquatic organisms as the streambed becomes embedded with fine sediment.

Suspended sediment leads to decreased aquatic biodiversity. Increased sediment loads impair breathing by clogging gills of fish and other aquatic species and by complicating feeding on suspended food sources. Increases in turbidity result in a relocation of aquatic organisms commonly utilized as a food source by fish species, which negatively affects fish populations.

Sediment already deposited, or embedded, in the stream channel often remains in the aquatic environment for extended periods of time. Embedded sediment harms habitat for many fish and other aquatic organisms. Fine sediment accumulation affects benthic macroinvertebrates in several ways: Sediment accumulation fills interstitial spaces used for refuge, decreases oxygen availability, and inhibits food sources (Harrison et al. 2007, Leitner et al. 2015). Some species are more susceptible to sediment impacts, which leads to a decrease in benthic biodiversity. Macroinvertebrates of the *Ephemeroptera*, *Plecoptera*, and *Trichoptera* orders are most impacted by sedimentation and are also important food sources for stream fish (Harrison et al. 2007). Also, many fish species require clean gravel substrate for reproduction, and regeneration rates suffer when streambeds are embedded. (Rabeni and Smale 1995, Berkman and Rabeni 1987)

Sediment inputs generated during construction of pipeline crossings have been documented to affect aquatic ecosystems and include direct effects such as physical alteration of channel morphology and habitat and indirect effects such as alteration of water quality and sediment dynamics. Castro et al. (2015) discuss impacts to aquatic species: “depending upon the crossing location, stream and catchment characteristics, timing, extent of activities, and application of Best Management Practices, impacts to aquatic species will vary but may include simplification of habitat, loss of aquatic species passage, removal of spawning gravel, increased suspended sediment and turbidity, loss of side channels, disconnection from the floodplain, or change in hyporheic flow patterns” (Castro et al. 2015, p. 769)

Sediment inputs in aquatic habitats result in decreases in benthic macroinvertebrate community diversity. Increases in silt and suspended solids in the water column and streambed sedimentation can cause invertebrate community drift where sensitive species relocate up- or downstream to unimpacted habitats. Reid and Anderson (1999) documented decreases in macroinvertebrate community biodiversity following construction of a pipeline crossing, and Armitage and Gunn (1996) observed a shift in benthic communities towards more tolerant species such as *Chironomidae* and *oligochaetes* after a pipeline crossing was constructed.

Similarly, fish communities are harmed by decreased water quality due to sediment entrainment in the water column and alteration of stream bottoms. Sediment in the water column decreases light penetration, which impacts primary production. This diminishes important food sources for fish communities, including macroinvertebrates and aquatic plants. Sediment deposition on gravel beds is harmful to fish and has been shown to decrease reproductive success rates. Many fish species rely on a gravel stream bottom for spawning; when a streambed becomes embedded due to sediment deposition, spawning success rates decrease. Additionally, silt reduces water flow through gravel, causing fish egg mortality. (Penkal and Phillips 1984, Castro et al. 2014, Lévesque and Dubé 2007, Reid et al. 2002)

4. MOUNTAIN VALLEY PIPELINE'S APPLICATION DOES NOT SUPPORT ITS ASSERTIONS

MVP's application addresses the generation of sediment from stream crossings, and its associated duration and impacts, with a sweeping statement:

> "Due to the dry-ditch open-cut construction practices discussed in Section 4.3.2, impacts to water quality will include minimal, short-term increases in sediment loads and turbidity level." (Tetra Tech 2021, p. 37)

The assertion that impacts will be minimal is not supported in the application.

The application does assert that the wet-ditch open-cut construction method "increases the potential for detrimental impacts to the aquatic environment" (Tetra Tech 2021, p. 50) and that the dry-ditch open-cut method is preferable: "With the use of diversion structures, the risk of increased levels of sediment and turbidity is largely reduced." (Tetra Tech 2021, p. 51)

But just because the dry-ditch method may reduce impacts compared with the wet-ditch method does not mean that the impacts will be minimal. As described above, the complete avoidance of sediment releases using the dry-ditch method is unlikely, and a variety of impacts to fish and other aquatic life can be expected once sediment leaves the site. The 19-mile sediment impact from a failed dry-ditch open-cut crossing during construction of the WB Express Pipeline, also described above, provides a vivid illustration of the scale of problems that can be caused.

MVP's assertion that impacts will be short-term is also not supported in the application. Nowhere in the application is data provided or summarized that supports this assertion.

As described above, while some studies document returns to pre-construction conditions within one year following the construction of pipeline crossings, one often-cited study found that sediment—and sediment-related impacts to aquatic life—persisted in the streambed for more than four years.

Detailed, site-specific and stream-specific information and modeling would be needed to predict the scale of impacts and the amount of time required to return to pre-construction conditions. This type of information and modeling is absent from MVP's application.

MVP's sweeping assurance about minimal, short-term water quality impacts must also be judged by taking into account its documented record of sediment-related violations. A review of agency inspection reports and violations received by MVP during its first 2.5 years of construction demonstrates that the company has a proven track record of carelessness in constructing erosion and sediment control devices. During an eight-month period in 2018, MVP was issued 25 notices of violation by the West Virginia Department of Environmental Protection. Each of these violations resulted in releases of sediment to the environment. Many of these releases occurred due to improper installation of commonly utilized sediment control measures such as water bars and perimeter fences. Other releases resulted from failures to adequately maintain and properly operate sediment control devices and incorrect calculations resulting in incorrectly sized controls. (Betcher et al. 2019)

Due to the importance of proper installation and maintenance of isolation structures while constructing dry-ditch crossings and MVP's record of violations, sediment impacts due to dry-ditch stream crossings are likely. Further, these violations demonstrate that MVP has been contributing sediment to streams along the pipeline's route during upland construction (Betcher et al. 2019). Construction of stream crossings would only compound the sediment inputs to streams along the pipeline's route.

5. CONCLUSIONS

While rivers and streams naturally carry suspended sediment from upstream to downstream, any type of construction performed in a river or stream—including open-cut stream crossings—disturb the streambed and generate additional sediment loads.

Once sediment is suspended in a river, it will begin to flow downstream. Eventually, it will re-deposit on the streambed, and this sediment will then be re-suspended when conditions are right.

Increased sediment loads harm aquatic life, whether suspended in the water column or embedded in the streambed.

Data on the long-term impacts of sediment generated from stream crossings is sparse. While some studies document returns to pre-construction conditions within one year following the construction of pipeline crossings, one often-cited study found that sediment—and sediment-related impacts to aquatic life—persisted in the streambed for more than four years.

Clearing of embedded sediment requires a flushing event. The amount of time it takes for sediment to be flushed from a stream channel varies and depends on the season of construction, droughts and floods, or other weather patterns.

Individual stream characteristics are important for predicting recovery; therefore, it is important to evaluate the potential for risk on a stream-by-stream basis. MVP's application does not include this type of detailed information.

MVP's application does not support its assertions that impacts will be minimal or short-term, nor does it include detailed, site-specific and stream-specific information and modeling to predict the scale of impacts and the amount of time required to return to pre-construction conditions.

Due to the importance of proper installation and maintenance of isolation structures while constructing dry-ditch crossings and MVP's record of sediment-related violations, sediment impacts due to dry-ditch stream crossings are likely.

REFERENCES

Anderson, Paul G. Christian Fraikin, G.J. Chandler, J. Trevor. 1998. Impacts and recovery in a coldwater stream following a natural gas pipeline crossing installation. ASME. International Pipeline Conference. Volume II. 1013-1022.

Armitage, P.D. and R.J.M. Gunn. 1996. Differential response of benthos to natural and anthropogenic disturbances in 3 lowland streams. *Int. Revue ges. Hydrobiol*: 81, 2, 161-181.

Berkman, Hilary E. and Charles F. Rabeni. 1987. Effect of siltation on stream fish communities. *Environmental Biology of Fishes*. 18: 285-294.

Betcher, Meghan, Alyssa Hanna, Evan Hansen, David Hirschman. 2019. Pipeline Impacts to Water Quality, Documented impacts and recommendations for improvements. August 21.

Castro, J.M., A. Macdonald, E. Lynch, and C.R. Thorne. 2015. Risk-based approach to designing and reviewing pipeline stream crossings to minimize impacts to aquatic habitats and species. *River Res. Applic*. 31: 767-783.

Courtice, Gregory and Gholamreza Naser. 2020. In-stream construction-induced suspended sediment in riverine ecosystems. *River Res Applic*. 36:327-337.

Dejiang, Long, Michael J. Bender, Les F. Sawatsky, Paul Anderson, Serge Metikosh. 1998. Sediment entrainment during construction of river pipeline crossings: Occurrence, prediction, and control. ASME. International Pipeline Conference. Volume II. 1045-1050.

Dunne, Thomas and Luna B. Leopold. 1978. Water in Environmental Planning. New York: W.H. Freeman and Company.

Harrison, Evan T. Richard H. Norris, and Scott N. Wilkinson. 2007. The impact of fine sediment accumulation on benthic macroinvertebrates: implications for river management. Proceedings of the 5th Australian Stream Management Conference.

Leitner, P. C. Hauer, T. Ofenbock, F. Pletterbauer, A. Schmidt-Kloiber, W. Graf. 2015. Fine sediment deposition affects biodiversity and density of benthic macroinvertebrates: A case study in the freshwater pearl mussel river Waldaist (Upper Austria). *Limnnologica*: 50, 54-57.

Levesque, Lucie M. and Monique G. Dube. 2007. Review of the effects of in-stream pipeline crossing construction on aquatic ecosystems and examination of Canadian Methodologies for impact assessment. *Environ Monit Asses*. 132:395-409.

Penkal, Russ F. and Glenn R. Phillips. 1984. Construction and operation of oil and gas pipelines. *American Fisheries Society*. Vol 9, No. 3; 6-8.

Pharris, T.C. and R.L. Kopla. 2007. Overview of the Design, Construction, and Operation of Interstate Liquid Petroleum Pipelines. Argonne National Laboratory. Environmental Sciences Division. November.

Rabeni, Charles F. and Martin A. Smale. 1995. Effects of siltation on stream fishes and the potential mitigating role of the buffering riparian zone. *Hydrobiologia*. 303: 211-219.

Reid, Scott M, Scott Stoklosar, Serge Metikosh, and Jim Evans. 2002. Effectiveness of isolated pipeline crossing techniques to mitigate sediment impacts on brook trout streams. Water *Qual Res. J. Canada*: 37; 2, 473-488.

Reid, Scott M. and Paul G. Anderson. 1999. Effects of sediment released during open-cut pipeline water crossings. *Canadian Water Resources Journal*, 24:3, 235-251.

Tetra Tech. 2021. Mountain Valley Pipeline Project Individual Permit Application. Prepared for: Mountain Valley Pipeline, LLC. Submitted to: United States Army Corps of Engineers – Pittsburgh District, United States Army Corps of Engineers – Huntington District, United States Army Corps of Engineers – Norfolk District, Virginia Department of Environmental Quality, Virginia Marine Resources Commission. February.

West Virginia Department of Environmental Protection. 2019. Consent Order Issued Under the Water Pollution Control Act, West Virginia Code, Chapter 22, Article 11. To Columbia Natural Gas. February 22.