An Analysis of the Report Entitled
"An Expert Report on Geologic Hazards in the Karst Regions of Virginia and West Virginia"

Prepared for:

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December 2016

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DAA Project Number: B14188B-01

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1.0 INTRODUCTION AND PURPOSE

The Mountain Valley Pipeline Project (Project) entails construction and operation of a 42-inch diameter natural gas conveyance pipeline system spanning approximately 303 miles from Wetzel County, West Virginia, to Transcontinental Gas Pipeline Company's (Transco) Zone 5 compressor station 165 in Pittsylvania County, Virginia. The Project will be constructed and owned by Mountain Valley Pipeline, LLC (Mountain Valley). The Project is governed by the United States Natural Gas Act, which requires a Certificate of Convenience and Necessity from the Federal Energy Regulatory Commission (FERC) before construction can commence.

A July 2016 report entitled "*An Expert Report on Geologic Hazards in the Karst Regions of Virginia and West Virginia*" (herein referred to as the July 2016 Report), authored by Ernst H. Kastning, was submitted to FERC in Docket CP16-10-000, on behalf of *Protect Our Water, Heritage, Rights* to provide their perceptions of risk associated with constructing the Mountain Valley Pipeline Project in karst terrain of southern West Virginia and southwestern Virginia. In the Draft Environmental Impact Statement for the Project issued in September 2016, FERC referenced the July 2016 Report. The purpose for submitting the information contained herein is to rebut and clarify the contents and conclusions of the July 2016 Report. Overall, the July 2016 Report reaches an erroneous conclusion on the risk presented by the Project and does not account for the true nature of the karst hydrogeological systems in question. The July 2016 Report does not reflect the reality of construction practices in karst terrain; does not consider the volumes of technical information that Mountain Valley has provided to FERC that characterized karst features and risks; and does not consider Mountain Valley's plans for avoidance, assessment and mitigation of these risks. The July 2016 Report does not present any new information that MVP has not

previously considered, which further demonstrates the author's lack of understanding of modern construction processes and how such processes minimize impacts.

2.0 METHODS

The proposed Project route was carefully designed to utilize existing gas and electric transmission corridors when possible; to avoid sensitive or protected areas when feasible; and to limit surface disturbance and minimize the overall environmental footprint. As part of Mountain Valley's commitment to the environment, the Project team considered thousands of miles of alternatives and variations to the proposed route in an effort to alleviate concerns posed by interested and informed stakeholders along the route.

Evaluation of the proposed route and alternatives for the Project included civil surveying and evaluating various routes to help determine a proposed route with the least overall impact to landowners, cultural and historic resources, and the environment. Starting in 2014, the Project team conducted numerous environmental and civil surveys, hosted open houses, and participated in FERC scoping meetings, all in an effort to encourage open discussion with community members, landowners, local elected officials, and public agencies. These public meetings generated valuable feedback that helped shape the proposed route.

Draper Aden Associates was contracted by Mountain Valley to serve as the core of the Karst Specialist Team for identifying, assessing and mitigating karst hazards along the Project route and associated alternatives and variations. The Karst Specialist Team possesses more than 160 years combined experience in relevant hazards inherent to southern West Virginia and southwestern

Virginia. The lead scientist in the Karst Specialist team is a registered Professional Geologist with more than 44 years of experience in hydrogeology of West Virginia and Virginia, including direct experience in karst hydrogeology, who has published scientific studies of karst systems and served as directors of state and national speleological societies. The Karst Specialist Team also includes a karst specialist, surveyor and geospatial analyst with over 30 years of direct experience in karst assessments of southern West Virginia and southwestern Virginia. Other members of the Karst Specialist team include: a registered Professional Geologist with more than 26 years of experience in engineering geology, hydrogeology and geophysical and geotechnical analysis in karst terrain; a geologist with more than 18 years of experience in geophysical and geotechnical analysis of karst terrain; a registered Professional Geologist with 26 years of experience in hydrogeology and geochemistry in karst terrain; and a registered Professional Geologist with 16 years of experience in karst terrain geotechnical evaluation and hydrogeology. Each and every member of the Karst Specialist Team has direct experience with the specific karst terrain hydrogeology in southern West Virginia and southwestern Virginia. Furthermore, the Karst Specialist Team has over 45 years' experience in permitting, construction and installation of linear infrastructure projects including water lines, sewer lines, and natural gas pipelines in karst terrain of the Valley and Ridge and Appalachian Plateau geologic provinces.

With regard to the Project, the Karst Specialist Team has identified and assessed karst features and related risks starting with a detailed desktop analysis derived from public and proprietary data, then as land access was granted, direct and applied observations, utilizing their combined years of field experience. The Karst Specialist Team will be deployed to conduct inspections during

construction in karst terrain to ensure identification and protection of karst features, including avoidance and proper mitigation.

The Karst Specialist Team is concerned that the July 2016 Report neither documents nor demonstrates experience in the analysis of geologic hazards for natural gas pipeline construction in karst terrain, on steep slopes, or in the analysis of seismic hazards, materials and engineering controls. It is vital that infrastructure projects such as the Mountain Valley Pipeline Project be evaluated for efficacy by scientific and engineering analyses. In contrast to the July 2016 Report, the Mountain Valley Project team, including the Karst Specialist Team, developed numerous detailed analyses and documents on the topics of karst terrain, hydrogeology, foundation and slope analyses, water resources and seismic hazards analysis, and materials design. The resulting documents include the Karst Hazards Assessment, Karst Mitigation Plan, Seismic Hazards Assessment, Materials Engineering and Design, and the Water Supply Identification and Testing Plan. The July 2016 Report neither acknowledges nor considers this documented information, which was previously submitted to FERC and is available to the public.

The information presented below identifies various inaccurate and fundamentally flawed assumptions documented in the July 2016 Report's assertions. The information provided herein highlights examples where the July 2016 Report does not acknowledge Mountain Valley's route specific investigation and results. Importantly, as the planning and development stage of the Project progressed and environmental survey results were evaluated, numerous route adjustments were made in order to avoid karst features and geologic hazards. However, the July 2016 Report does not discuss, evaluate, or take into consideration any of this relevant information.

3.0 DISCUSSION

The following discussion highlights several examples where the July 2016 Report asserts claims that are unsupported, misdirected, or incorrect:

1. The July 2016 Report and the resume attached thereto do not document the author's experience or expertise with linear infrastructure (e.g., natural gas pipelines) construction techniques or with pipeline engineering and material design. The Report's reference to construction has no credibility as the author is not versed in construction designs, standards, quality controls, material engineering, and operational parameters especially within the pipeline industry.

2. The July 2016 Report implies that the active karst systems and their contributing watersheds comprise contiguous potable aquifer systems that are directly tapped for private and public consumption (July 2016 Report at 25, 39, 42, 43, 50, 52). The Karst Specialist Team disagrees with the July 2016 Report's implied assertions that groundwater under surface influence is typically used for human consumption. For example, the Red Sulphur Public Service District in Peterstown, West Virginia operates a treatment plant to remove ambient contaminants from Coburn Spring water, which is subject to surface influence. The point being that it is generally understood in the public service and scientific communities that even under ambient conditions (i.e., regardless of a pipeline or other construction) the subsurface water in shallow karst terrain, derived from topographic watersheds, is not a reliable source of pristine potable water because of its proximity to surface contamination sources (e.g., surface activities, septic fields, agricultural waste and stormwater run-off). Concern over the degree to which shallow subsurface water (in this case, water in karst that has a short residence time and limited natural filtration or conditioning to remove surface influences) can impact a drinking water source

(e.g., well intake or spring discharge) is the primary reason why West Virginia and Virginia regulatory agencies require a minimum amount of well casing to be installed and grouted in-place from the ground surface to depth for a drinking water well (i.e., the surface casing is designed to prevent direct influence from the surficial watershed to the underlying potable aquifer). Precipitation events inherently cause surface streams to have a high sediment content, and in karst terrain, the karst conduit, cave streams and springs receive sediment load from the surface water. This natural event is a common occurrence and these characteristics have been observed many times by the Karst Specialist Team during its karst evaluation and analysis of the Project. Because of these concerns about surface influences on shallow subsurface water in karst, even under ambient conditions, a properly drilled and constructed water supply well in this area will extend below the active surface influenced karst areas to avoid the direct effects of surface water.

3. The Karst Specialist Team disagrees with the July 2016 Report's assertion that karst terrain in folded and faulted mountainous areas of the Project (i.e., Appalachian karst) presents a higher degree of risk compared to that of low relief karst topography in flat-lying bedrock (July 2016 Report at 1, 8, 24, 36). In the karst terrain underlying the proposed Project, the bedrock tends to be steeply dipping and exposed to weathering at the surface in narrow bands. Most development of the karst system, associated conduits, voids, caves, and stream flow paths are often hundreds of feet below the surface. In contrast, the flat-lying karst plains of Kentucky or Florida, for example, are characterized by karst systems developed at shallow depths essentially parallel to the ground surface. While these terrains are different in terms of

construction and topographic stability, the risks are not necessarily higher in Appalachian karst due to the depth of features relative to surface construction.

4. The July 2016 Report states that "[o]ften karst is considered a 'no-build' zone for major construction projects" and that "[e]xisting large pipelines run over land to the west and east of [the Appalachian] mountains, but not across them" (July 2016 Report at 24). To the contrary, there are existing natural gas pipelines that traverse karst terrain, including the Appalachian Mountains of Virginia and West Virginia. Figure 1 attached hereto shows existing natural gas pipelines in the eastern United States, including numerous pipelines built and operating safely and efficiently in karst terrain. More to the point, Figure 2 attached hereto shows examples of existing natural gas pipelines in West Virginia and Virginia, including those in karst areas and crossing mountainous terrain. Specifically, as shown in Figure 2:

   - Columbia Gas Transmission's KA and VA pipeline systems include multiple pipelines up to 24-inch diameter traversing the Appalachian Mountains through karst areas.
   - Columbia Gas Transmission's WB and VB systems include multiple pipelines up to 36-inch diameter traversing the Appalachian Mountains through karst areas.
   - East Tennessee Natural Gas's pipeline system is located within Appalachian karst in the same region as the Mountain Valley Project.

   These and other natural gas pipelines were approved by FERC, constructed very similar to Mountain Valley Pipeline's planned implementation, and currently operate with no adverse effects in the same folded and faulted karst terrain as the Mountain Valley Pipeline Project. The July 2016 Report omits this successfully comparative information. Finally, the July 2016 Report's assertion that landforms and hazards "cannot be mitigated by engineering practice" disregards the numerous projects completed in karst terrain across Appalachia and other

regions by use of sound engineering and construction practices. In addition to natural gas pipelines, there are other linear infrastructure systems built in karst terrain, including water lines, sewer lines, roads and highways, and buried communication cables. The Report's assertion that the existence of karst leads to a "no-build" zone is blatantly incorrect.

5. The July 2016 Report mischaracterizes the seismic hazards analysis provided to FERC by Mountain Valley's Project team (July 2016 Report at 30, 42, 45). The July 2016 Report does not properly acknowledge the seismic hazard mitigation design provided by Mountain Valley for pipeline material specification and construction. Furthermore, the July 2016 Report alleges that mid-continent earthquakes in the area of southern West Virginia and southwestern Virginia could originate in the Giles County Seismic Zone (GCSZ); however, there is no consensus for this in the scientific community. As such, the July 2016 Report is specious in selectively presenting only certain opinions in order to propagate a worst-case hypothetical scenario that is based on supposition rather than science. The July 2016 Report is not an expert's critique on seismic risks, and also does not acknowledge that the Project's Seismic Hazards Assessment, which is based upon the work of the U.S. Geological Survey that provides a detailed assessment of seismic hazards in the region along the proposed Project route. The U.S. Geological Survey does not specifically define the GCSZ as a notable seismically active area in its earthquake hazards analysis work. In addition, in Resource Report 6, Mountain Valley provided to FERC a detailed analysis of engineering design for abating seismic hazards. Figure 3 attached hereto identifies numerous natural gas pipelines that are sited and safely operated in areas of the United States that are recognized by the U.S. Geological Survey as having more intense seismic activity than that identified in southern West

Virginia and southwestern Virginia. As noted in Figure 3, the GCSZ is not identified as a notable seismically active area by the U.S. Geological Survey. The July 2016 Report does not acknowledge this, nor does it provide an objective risk assessment. The July 2016 Report's assertion that no infrastructure can be sited in this region is incorrect.

6. The July 2016 Report asserts that specific karst features will be harmed during construction (July 2016 Report at 3, 47-52). However, the July 2016 Report fails to mention or consider important aspects of the Project:

   - Mountain Valley has already carefully identified and documented via desktop review and direct field observation karst features within 0.25-mile of the Project. This information is provided in the Karst Hazards Assessment, which the July 2016 Report does not fully or accurately acknowledge.
   - Mountain Valley has made hundreds of alignment adjustments to both avoid sensitive natural resources (in particular karst features including more than 40 caves, numerous springs, and hundreds of sinkholes), as well as to accommodate specific landowner requests. In particular, Mountain Valley's October 2016 Proposed Route incorporated a route change in the area of Canoe Cave. The Project does not cross over any known cave passage.
   - In fact, Mountain Valley conducted detailed studies within a wider survey corridor than is necessary for the actual pipeline installation in order to accommodate additional adjustments that may be necessary to avoid potential features or areas of concern that are discovered during construction.

- Mountain Valley developed a Karst Mitigation Plan and will construct the Project in accordance with a specific Erosion and Sediment Control Plan and a Spill Prevention Control and Countermeasures Plan.
- Mountain Valley will deploy inspectors during all phases of construction including karst specialists in karst terrain, to observe, evaluate, and mitigate any construction-related concerns. The role of the karst specialist is generally, but not limited to, a three-fold process: 1) to observe construction activities and ensure that Best Management Practices and control plans are implemented and adhered to; 2) surveille the construction limit of disturbance to monitor karst features; and 3) document newly discovered karst features (if any) and provide commensurate recommendations for avoidance and mitigation in conjunction with the appropriate state agency. Karst Specialist Team inspectors will be available to conduct multiple inspections in karst terrain where construction crews are working. A Level 1 Inspection of a karst feature will entail observation and documentation of soil subsidence; rock collapse; sediment filling; swallets or notable increased surface water infiltration; spring/seep/flooding; cave or void space; clogging; and/or other changes in morphology or functionality that might indicate potential impact to the epi-karst stratum caused by the work. The inspection results will be recorded and will include digital photographs, GPS coordinates and reference to the nearest pipeline milepost. If any of the representative changes listed above are observed at a karst feature, the inspector will then complete a Level 2 Inspection. The Level 2 Inspection will examine the suspected karst feature to identify potential connectivity to the subterranean environment and risk for impacting groundwater quality. The choice of characterization methods may include visual

assessment and physical inspection; geophysical survey; track drill probes; other techniques utilized to facilitate subsurface characterization of karst features; or combinations thereof. The karst specialist will provide recommendations on avoidance or stabilization measures for the feature. If it is determined that the feature has connectivity to the subterranean environment and the potential to impact groundwater, the karst inspectors will provide recommendations regarding appropriate mitigation in conjunction with the applicable state agency.

- Mountain Valley will conduct project construction activities in a manner that minimizes alteration of existing grade and hydrology of karst features. In linear excavations adjacent to karst features, spoils will be stockpiled and managed up-slope of the excavation, and runoff controlled according to the project-specific Erosion and Sediment Control Plan. Stormwater control measures will be utilized to prevent construction-influenced surface water from flowing into a karst feature. Karst features will not be utilized for the disposal of water; and during construction, vehicles will not park, idle, refuel, or be serviced within the vicinity of a karst feature. A construction inspector will conduct daily equipment inspections to check for leaks and to mitigate any identified concerns. In addition, Mountain Valley will restore the land surface to pre-construction grades after pipeline installation, and utilize in-trench features (e.g., breakers) to maintain the existing flow of local surface and subsurface water (if encountered). This is particularly important in karst terrain. In order to protect sensitive karst features, minimize erosion, and enhance revegetation, the Erosion and Sediment Control Plan and related Best Management Practices confine construction to a strictly defined disturbance area limit. Through these methods and plans and

monitoring, Mountain Valley's construction of the Project has negligible risk for impacting a karst feature or associated hydrologic system or ecosystem.

7. The July 2016 Report references dye test studies performed in the vicinity of the Project (July 2016 Report at 3, 4, 21, 22, 35, 39, 49, 51). These dye trace studies do not support the July 2016 Report's assertion that the shallow karst system is a potable aquifer, but instead demonstrate that major karst conduit flow patterns transmitting surface water occur hundreds of feet below the surface where there is very little risk of effects from the 10-foot excavation for the Project.

8. The July 2016 Report asserts that Mountain Valley will impact allogenic recharge (July 2016 Report at 1, 2, 32, 33, 48) and criticizes Mountain Valley for not addressing allogenic recharge because it "supplies drinking water for homes in karst areas." Mountain Valley has identified spring locations and will continue to evaluate potential route adjustments to avoid springs where possible, including the upper mountain springs. Under typical natural gas pipeline construction, water resources testing is not required except in areas where blasting is proposed, and only within 150 feet of the blast point. As specified in Mountain Valley's Water Supply Identification and Testing Plan, all water sources within 150 feet of the entire 303-mile alignment, and 500 feet in areas of karst terrain, will be tested for quality and yield prior to the start of construction. Mountain Valley is also contacting and working with all public water suppliers along the route to ensure that their concerns are addressed. Water insurgences and caves are also avoided to mitigate risks for construction stability, impact to the karst hydrologic network, and cave resources.

9. The July 2016 Report erroneously asserts that pipeline construction will disrupt natural surface water and groundwater flow paths (July 2016 Report at 2, 26, 27, 30, 38), and in a particularly irrelevant claim will partition the aquifer. These are not credible concerns in that the pipeline project comprises a 10-foot excavation that will be subsequently regraded to original topography. Water flow in the karst terrain of this region descends into the bedrock much deeper than the approximately 10-foot proposed excavation. For the majority of the karst areas along the proposed route it is known that the primary groundwater flow paths are hundreds of feet deep. Karst conduit water flow may be relatively shallow in the immediate vicinity of insurgences and resurgences. These locations were identified in the Karst Hazards Assessment and Mountain Valley has made alignment adjustments to avoid them. It is a particularly unsubstantiated mischaracterization that shallow construction such as the Mountain Valley Project will segregate and partition the subsurface aquifer. Given the actual Project characteristics, including construction methods to prevent preferential infiltration and flow along the backfilled trench and restoring the disturbed area to pre-construction conditions, Mountain Valley expects no effects on natural water flow patterns, and certainly will not be of the scale to partition an aquifer. In general, past and current agricultural practices such as sinkhole in-fill with rock or farm debris, livestock pasturing, timbering operations, septic fields, and manure spreading pose substantial, credible, and documented risks to karst systems. A 10-foot trench backfilled and graded to original topography is not reasonably anticipated to harm karst water flow patterns, or the aquifers.

10. The July 2016 Report asserts that there will be an increase in cover collapse sinkhole formation (July 2016 Report at 2, 37). However, no evidence for this concern is presented. Mountain Valley will regrade the disturbed area to pre-construction characteristics (i.e., restore existing topography) such that natural flow patterns will be restored. Mountain Valley will deploy a karst inspection team during all phases of construction in karst. If sinkholes are encountered, the Karst Mitigation Plan serves as a guide for evaluation and mitigation. In addition, Mountain Valley will install a minimum of Class II pipe in areas of karst terrain, which has a thicker wall and higher strain tolerance than standard Class I pipe. The Class II pipe is rated for a span distance of 145 feet for three feet of cover, which is significantly longer than any form of sinkhole development that could conceivably form in the Project area. Mountain Valley will incur substantial additional costs in using these materials in karst terrain through an abundance of caution and in an effort to address the public's concerns regarding karst.

11. The July 2016 Report asserts that compound hazards (e.g., soil type, seismic hazards and slope failure) make karst terrain a buffer zone in which no ground disturbance is acceptable (July 2016 Report at 34, 35, 48). If the July 2016 Report's conclusions regarding compound hazards were credible, there would be no infrastructure in large swaths of the United States, and especially in southern West Virginia and southwestern Virginia. Mountain Valley has prepared and submitted several detailed hazards analysis reports to support the Project. Mountain Valley will also deploy inspectors with expertise in karst, slope stability, and water resources during all phases of construction. The roles of these inspectors are to evaluate site conditions for their specific area of expertise and alert the construction teams regarding concerns or hazards. They will also ensure that construction practices are following the Erosion and Sediment Control Plan, Spill Prevention Control and Countermeasures Plan, Karst

Mitigation Plan, and other applicable plans and policies. The July 2016 Report again fails to acknowledge the Mountain Valley Project team's efforts in pre-construction engineering, design, and material planning; and more importantly, its commitment to safety before, during, and after construction

12. The July 2016 Report highlights certain areas of karst terrain and offers to the reader biased and technically unjustified descriptions of compounded risk. These karst locations and features are addressed below:

    - The July 2016 Report identifies the Mount Tabor Sinkhole Plain as a significant karst system (July 2016 Report at 51, 52). Mountain Valley had previously identified the Mount Tabor Sinkhole Plain as containing sensitive karst features, took preemptive measures by evaluating an alternate route, and subsequently incorporated the Mount Tabor Variation into the October 2016 Proposed Route. Mountain Valley updated the Karst Hazards Assessment (Attachment RR2-4a) to incorporate desktop review and field verification of karst features, and by performing a geophysical survey using electrical resistivity. Mountain Valley has conducted two-dimensional surface electrical resistivity (ER) surveys on the physically-accessible portions on all parcels of the October 2016 Proposed Route between mileposts 221.8 and 227.2 (previously referred to as the Mount Tabor Variation, which has been incorporated into the October 2016 Proposed Route). Certain portions of the alignment were impassable due to dense vegetation; thus ER data were not collected in these areas. In addition, ER data were not collected north of the Pulaski Fault because this area is underlain by clastic sedimentary bedrock that is not susceptible to karst formation processes. ER imaging

is a technique for geophysical analysis of sub-surface conditions using measurements made at the surface using electrodes. LiDAR is a valuable resource for desktop evaluation of karst topography and Mountain Valley utilized LiDAR to evaluate routing in karst areas. However, field evaluation by direct observation and geophysical methods, such as ER, provides a more comprehensive understanding of the sub-surface geology. ER imaging in the sub-surface operates by inducing an electric current into the ground between two electrodes and measuring the change in current at other electrodes. Between mileposts 221.8 and 227.2, Mountain Valley utilized a spacing of 3-5 meters between electrodes. Using a long line of electrodes connected to a cable on the surface, hundreds of resistivity measurements can be collected to create a data set for a two-dimensional cross-section of sub-surface ERs. Mountain Valley's geophysical experts collected the ER data and used computer software and expertise to analyze the data to determine whether a notable karst feature was present below the ground surface. The ER analysis demonstrated an irregular bedrock surface, which is common in karst terrain. The ER analysis also indicated a stable sub-surface within the design depth of the pipeline excavation and through a depth where the pipeline could affect, or be affected by, any karst features. For example, the ER analysis indicated that open, air-filled voids are not present within these areas. Based on this ER analysis, coupled with desktop analysis and other field reconnaissance, Mountain Valley does not expect any significant risk associated with karst terrain between mileposts 221.8 and 227.2 of the October 2016 Proposed Route. Any karst encountered during construction can be addressed through the processes detailed in the Karst Mitigation Plan, including minor route adjustments. As such, Mountain Valley

confirms that the referenced portion of the October 2016 Proposed Route is preferable to the originally proposed alignment in the vicinity of the Mount Tabor sinkhole plain.

- Mountain Valley addressed the Indian Creek Water Association concerns (see July 2016 Report at 20, 35, 47, 48) in its response to the December 25, 2015 FERC Environmental Information Request to Resource Report 6 – Request #27.
- In the Peters Mountain area of Monroe County, West Virginia (see July 2016 Report at 25, 35, 40, 43, 47, 48), the Red Sulphur Public Service District derives its water from Coburn Spring, which is 4.9 miles southwest and in a different watershed relative to the Project. The Red Sulphur PSD also has a backup surface water intake near Peterstown, West Virginia on Rich Creek, which is approximately 7.75 miles from the Rich Creek/Wilson Spring. The Mountain Valley Pipeline team is participating in on-going discussions and meetings with the Red Sulphur PSD to establish a water supply contingency plan to ensure no disruption to the quantity or quality of their water supply during pipeline construction. As related to the Project's construction, there is negligible risk to the water source for the Red Sulphur PSD due to the distance from the Project.
- The spring water source for the Sweet Springs Valley Water Bottling Company (see July 2016 Report at 48), a private commercial water bottling facility, is within a different watershed 19 miles to the northeast of the Project. As related to the Project's construction, there is negligible risk to the water source for the private facility due to the distance from the Project.
- The July 2016 Report asserts that the proposed crossing at Sinking Creek presents a significant risk for contaminating multiple karst aquifers and suggests that an

insurgence to a major karst aquifer is located at or very near the proposed crossing of Sinking Creek (July 2016 Report at 20, 21, 39, 49). Mountain Valley's Karst Specialist Team noted during preliminary studies that Sinking Creek insurges approximately three miles downstream of the proposed crossing. The waters of Clover Hollow resurge at the Smokehole Cave Spring, located approximately 1,900 feet upstream of the proposed crossing. The proposed crossing is outside of the Virginia Department of Conservation and Recreation's Clover Hollow Conservation Site, which was delineated based on the watershed. Crossing under Sinking Creek at this location bears negligible risk for interrupting the flow of the creek. In addition, the US-460 highway bridge abutments were built on the banks of Sinking Creek a few hundred feet upstream of the insurgence location, which is an example of infrastructure construction occurring with no observable impact to the karst hydrologic system.

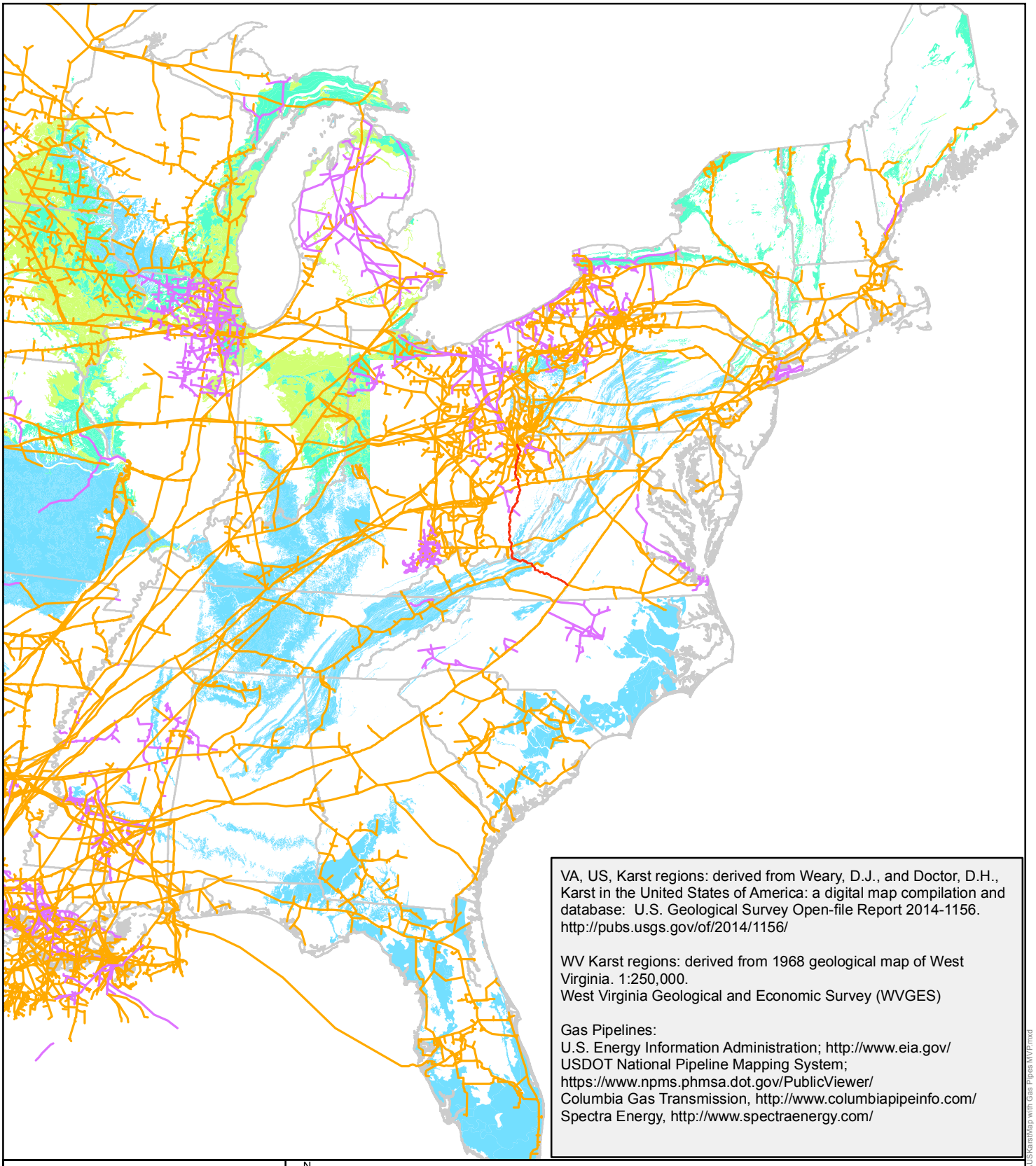
- The July 2016 Report notes a concern that pipeline construction will affect Indian Creek, Han Creek, Dixie Caverns, and Goodwins Cave. All of these resources are separated from the Project by a distance of one mile or more. Given the numerous planning, inspection, and construction safeguards that Mountain Valley has integrated into the Project to avoid affecting these types of resources, there are negligible risks to these resources as referenced in the July 2016 Report.
- Mountain Valley disagrees with the July 2016 Report's assertion that Project construction will impact Spring Hollow Reservoir. Mountain Valley adjusted its alignment early in the planning process to increase the distance between the pipeline right-of-way and the Spring Hollow Reservoir. The proposed alignment is now more

than a mile to the west of the Reservoir, on the west edge of Cove Hollow. Notably, an underground natural gas pipeline currently exists under the reservoir.

4.0 CONCLUSION

The information presented in this document refutes and clarifies the unsupported and erroneous assertions in the July 2016 Report regarding construction of the Mountain Valley Pipeline Project in karst areas of southern West Virginia and southwestern Virginia. Mountain Valley has submitted to FERC a rigorous assessment of environmental, engineering, and construction concerns related to karst terrain, along with detailed methods to mitigate risks. The July 2016 Report either omits or mischaracterizes this information. The July 2016 Report also presents claims of risks that are not commensurate with the nature of the Project and are not supported by the facts gathered by numerous environmental and engineering professionals.

The July 2016 Report demonstrates the author's lack of expertise in evaluating linear infrastructure projects, and more specifically a lack of expertise in evaluating natural gas pipeline construction. The July 2016 Report ascribes an unsupported and unreasonable level of risk for design and construction of a natural gas pipeline in Appalachian karst. Overall, the Project's Karst Specialist Team concludes that the July 2016 Report does not present a scientifically-robust analysis. There is no new or relevant information presented in the July 2016 Report that Mountain Valley has not already considered. The Karst Specialist Team concludes that the July 2016 Report presents a deeply flawed evaluation of the Mountain Valley Pipeline Project.



VA, US, Karst regions: derived from Weary, D.J., and Doctor, D.H., Karst in the United States of America: a digital map compilation and database: U.S. Geological Survey Open-file Report 2014-1156. http://pubs.usgs.gov/of/2014/1156/

WV Karst regions: derived from 1968 geological map of West Virginia. 1:250,000.
West Virginia Geological and Economic Survey (WVGES)

Gas Pipelines:
U.S. Energy Information Administration; http://www.eia.gov/
USDOT National Pipeline Mapping System;
https://www.npms.phmsa.dot.gov/PublicViewer/
Columbia Gas Transmission, http://www.columbiapipeinfo.com/
Spectra Energy, http://www.spectraenergy.com/

Mountain Valley Pipeline

N

NAD 1983 UTM 17N

1:11,335,000

0 100 200 300 Miles

Mountain Valley PIPELINE

Figure 1:
Gas Pipelines in Eastern US Karst

12-01-16

Draper Aden Associates
Engineering • Surveying • Environmental Services

All Locations Approximate

Legend

Karst (generalized, major near surface carbonates)

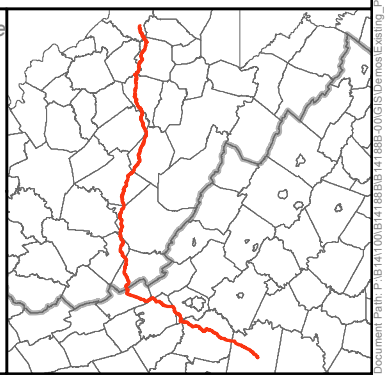
MVP October 2016 Proposed Route

Existing Natural Gas Pipelines

Interstate

Intrastate

Green: carbonate rocks buried under glacial sediments



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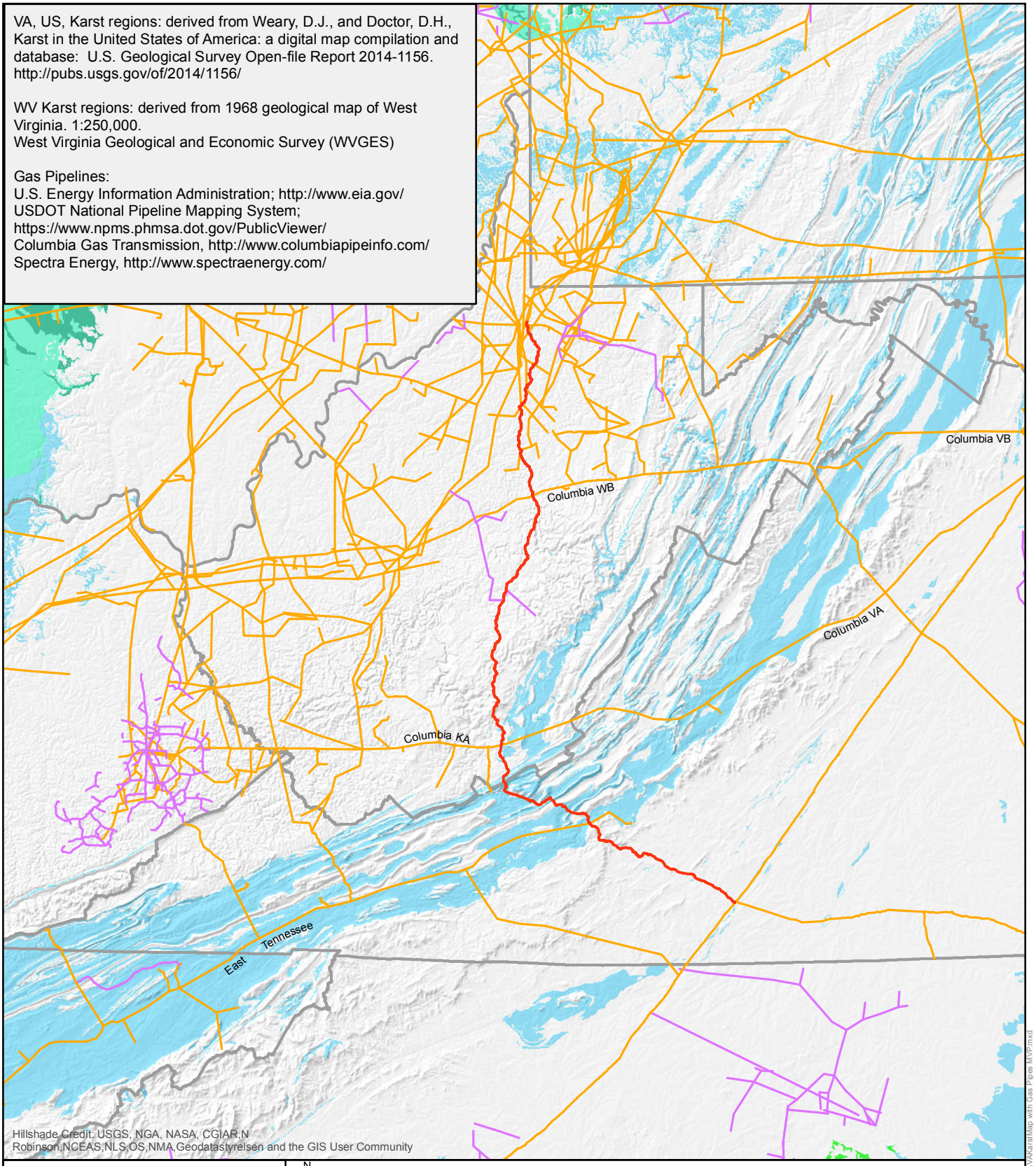
VA, US, Karst regions: derived from Weary, D.J., and Doctor, D.H., Karst in the United States of America: a digital map compilation and database: U.S. Geological Survey Open-file Report 2014-1156. http://pubs.usgs.gov/of/2014/1156/

WV Karst regions: derived from 1968 geological map of West Virginia. 1:250,000.
West Virginia Geological and Economic Survey (WVGES)

Gas Pipelines:
U.S. Energy Information Administration; http://www.eia.gov/
USDOT National Pipeline Mapping System;
https://www.npms.phmsa.dot.gov/PublicViewer/
Columbia Gas Transmission, http://www.columbiapipeinfo.com/
Spectra Energy, http://www.spectraenergy.com/



Mountain Valley Pipeline

N

NAD 1983 UTM 17N

1:2,750,000

0 25 50 75 Miles

Mountain Valley PIPELINE

Figure 2:
Gas Pipelines in
VA and WV Karst

12-01-16

Draper Aden Associates
Engineering • Surveying • Environmental Services

All Locations Approximate

Legend

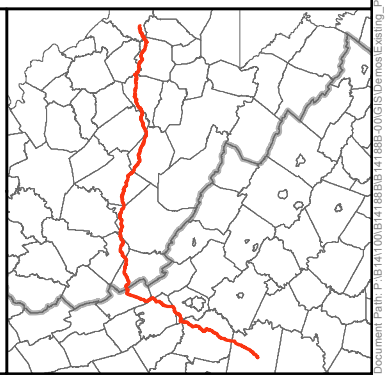
MVP October 2016 Proposed Route

Existing Natural Gas Pipelines

Interstate

Intrastate

Karst (generalized)



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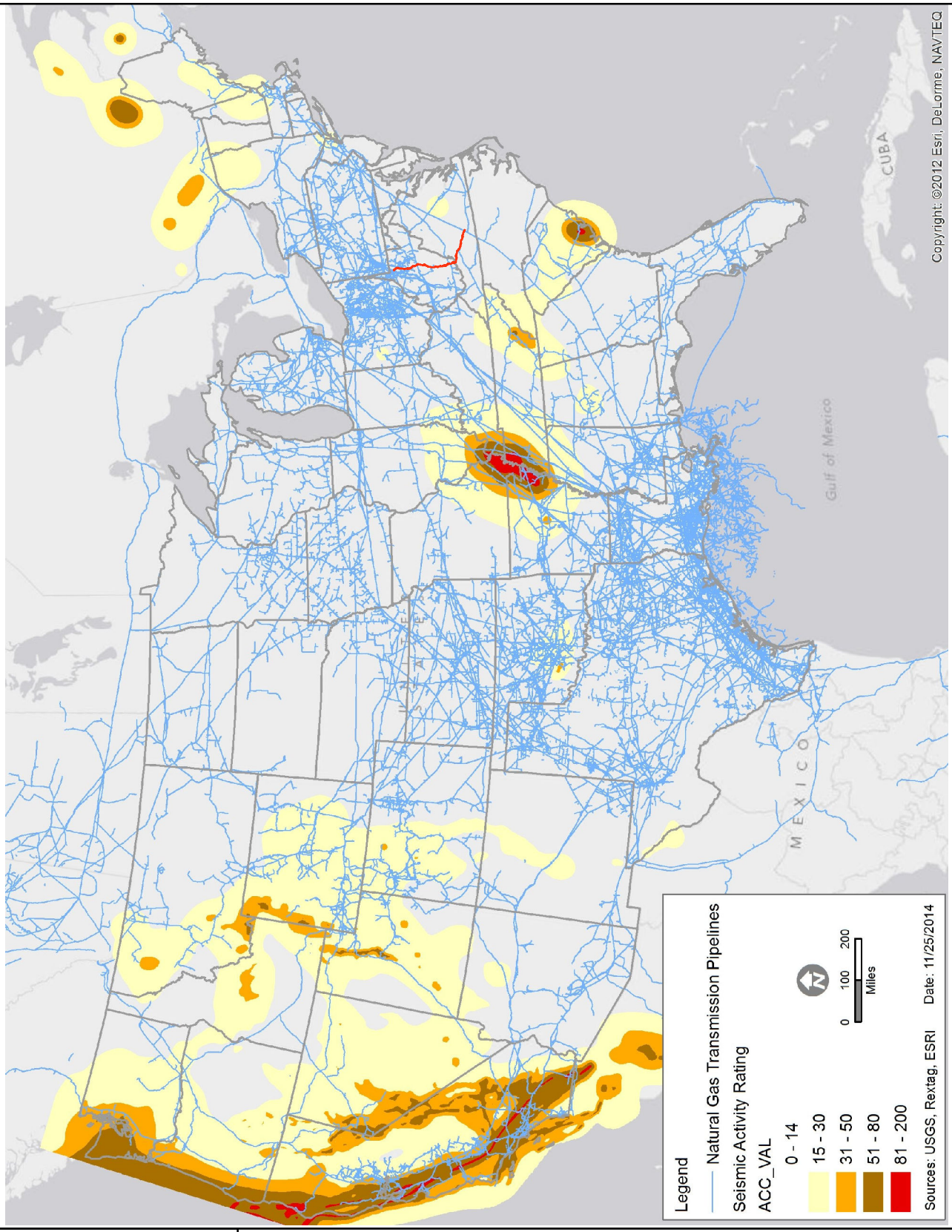


Mountain Valley Pipeline

Mountain Valley PIPELINE

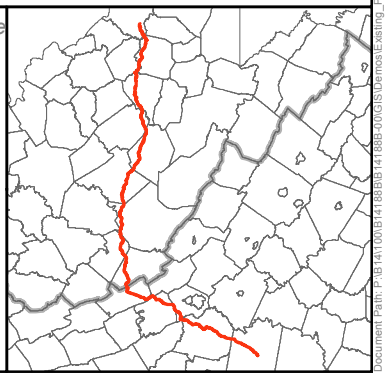
Figure 3:
Gas Pipelines Relative to Seismic Activity Ratings

12-01-16

Draper Aden Associates
Engineering • Surveying • Environmental Services

All Locations Approximate

MVP October 2016 Proposed Route



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