APPENDIX O

Jefferson National Forest Biological Evaluation, Forest Service Locally Rare Species and Hydrologic Analysis of Sedimentation

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APPENDIX O-1

Jefferson National Forest Biological Evaluation

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BIOLOGICAL EVALUATION FOR THREATENED, ENDANGERED, AND SENSITIVE (TES) SPECIES

MOUNTAIN VALLEY PIPELINE

JEFFERSON NATIONAL FOREST
EASTERN DIVIDE RANGER DISTRICT

1 March 2017

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1.0 Introduction

1.1 Project Introduction

Mountain Valley Pipeline, LLC (MVP), a joint venture between EQT Midstream Partners, LP, NextEra Energy, Inc., WGL Holdings, Inc., Con Edison Gas Midstream, LLC, and RGC Midstream, LLC, is seeking a Certificate of Public Convenience and Necessity (Certificate) from the Federal Energy Regulatory Commission (FERC) pursuant to Section 7(c) of the Natural Gas Act authorizing it to construct and operate the proposed Mountain Valley Pipeline Project (Project) located in 17 counties in West Virginia and Virginia. MVP plans to construct an approximately 488.3-kilometer (303.4-mi), 106.7-centimeter (42-in) diameter natural gas pipeline to provide timely, cost-effective access to the growing demand for natural gas for use by local distribution companies (LDCs), industrial users and power generation in the Mid-Atlantic and southeastern markets, as well as potential markets in the Appalachian region.

The proposed pipeline will extend from the existing Equitrans, L.P. transmission system and other natural gas facilities in Wetzel County, West Virginia to the existing Transcontinental Gas Pipe Line Company, LLC's (Transco) Zone 5 compressor station 165 in Pittsylvania County, Virginia (Appendix A Figure 1). In addition to the pipeline, the Project will require approximately 171,600 horsepower (hp) of compression at three compressor stations currently planned along the route as well as measurement, regulation, and other ancillary facilities required for the safe operation of the pipeline. The pipeline is designed to transport up to 2.0 million dekatherms per day (MMDth/d) of natural gas.

1.2 Mountain Valley Pipeline and Jefferson National Forest

Approximately 3.4 miles of the proposed alignment cross Jefferson National Forest (JNF) lands in Monroe County, West Virginia and Giles and Montgomery counties, Virginia. The 6-mile Pocahontas Road (Forest Road 972) and 1-mile Mystery Ridge Road (Forest Road 11080) in Giles County, Virginia are currently proposed to provide access to portions of the alignment near Peters Mountain. Additionally, two additional temporary workspaces (ATWS) are currently proposed in Montgomery County. No ancillary facilities or new access roads are proposed to be constructed on JNF land.

Alternative pipeline alignments were considered and reviewed in the field on JNF. Alternatives 110, 110J, and 110R, identified in Permit BBW433301T issued on April 30, 2015, cross portions of Monroe County, West Virginia as well as Craig, Montgomery, and Roanoke counties, Virginia. Additionally, an extended survey area was requested to the west of the previously approved survey area near Craig Creek in Amendment #1 of Permit BBW433303T. These alternatives and extended survey area are not included as part of the proposed alignment. Alternative 200 (Montgomery

County, Virginia) is included in Amendment #1 of Permit BBW433301T issued on September 29, 2015. This alternative has been incorporated into the proposed alignment.

Tracts were created in order to reference individual crossings of the proposed alignment on JNF lands (Appendix A Figure 2, Maps 1-12). The Project crosses the JNF Eastern Divide Ranger District.

1.3 Biological Evaluation

A Biological Evaluation (BE) is required (Forest Service Manual, Section 2672.4) for all United State Forest Service (USFS) planned, funded, executed, or permitted programs and activities, to assess possible effects on endangered, threatened, proposed, or sensitive species. This differs from a Biological Assessment (BA; referenced in Section 5.0 of this BE) as it is prepared for major federal construction projects requiring an Environmental Impact Statement, in accordance with legal requirements under Section 7 of the Endangered Species Act (ESA).

The objectives of this BE are to:

- Ensure that USFS actions do not contribute to loss of viability of any native or desired non-native plants or animals or contribute to trends toward federal listing of any species;
- Comply with requirements of ESA to ensure that actions of federal agencies will not jeopardize or adversely modify the habitat of federally listed species; and,
- Provide a process and standard by which to ensure that all federal threatened, endangered, and proposed species, and USFS sensitive species receive full consideration in the decision-making process.

JNF has occurrences of and provides known suitable habitat for several threatened, endangered, and sensitive (TES) species, all of which are considered in this BE. A list of species addressed is provided in Appendix B. This BE documents the analysis of potential effects of the project to TES species and associated habitat. It also serves as biological input into the environmental analysis for project-level decision-making to ensure compliance with the ESA, National Environmental Policy Act (NEPA), and National Forest Management Act (NFMA).

2.0 Project Area

2.1 Proposed Alignment on JNF Land

Tracts were identified based on individual JNF crossings. In all, eight tracts were identified along the proposed alignment (Table 1; Appendix A Figure 2, Maps 1-11). Additional tracts for abandoned and alternate routes are referenced in this document but not included in Table 1. For terrestrial effects and impacts analysis, the Project area is considered to be the survey corridor on JNF land. The Project analysis area for aquatic species varies from the terrestrial area and is defined in Section 6.0.

Table 1. Tracts of Jefferson National Forest crossed by the proposed Mountain Valley Pipeline.

Tract	Alignment	Approximate Miles
001	Proposed	1.18
002	Proposed	0.11
003	Proposed	0.04
004	Proposed	0.02
005	Proposed	0.84
006	Proposed	0.96
008	Proposed	0.12
035	Proposed	0.19
Total		3.46

The Project crosses into Tract 001 of the JNF in Monroe County, West Virginia, southwest of the town of Lindside, and continues to the edge of JNF land at the border of Virginia. The proposed alignment continues through Virginia and into Tracts 002, 003, 004, 005, 006, 008, and 035 (Appendix A Figure 2, Maps 1-12).

The West Virginia portion of the Project lies in the Allegheny Plateau, Allegheny Mountains, and Valley and Ridge Physiographic regions. In Virginia, the Project lies in the Valley and Ridge, Blue Ridge, and Piedmont Physiographic regions. All JNF areas crossed by the Project are within the Valley and Ridge Province (Fenneman 1938).

The geologic strata of the Valley and Ridge mountains consist of several bedrock formations. Silurian sandstones underlie ridge tops and upper to middle slopes are underlain by shale and minor sandstone. The lower portion of the mountains is underlain by a layer of calcareous shale, shale, and minor limestone. Mountain bases are characterized by limestone and valleys are underlain by dolomite. The Valley and Ridge province is underlain by essentially the same strata as the Allegheny Plateau, which is located in western and central New York, northern and western Pennsylvania, northern and western West Virginia, and eastern Ohio. The Valley and Ridge province, however, contains older parts of the stratigraphic column. Structurally, the Valley and Ridge is much more severely deformed than the Allegheny Plateau. The ridges were formed where stronger rocks resisted erosion, and the valleys were formed by constant erosion and down-cutting over time. The Valley and Ridge contrasts the Allegheny Plateau with its longitudinal ridges and much deeper dips in the strata (Fenneman 1938). Elevations of the Project within the JNF range between approximately 518 and 1,097 meters (1,700 and 3,600 ft).

The West Virginia/Virginia border approximately forms the western edge of the Valley and Ridge province, which extends from southeast Tennessee northeast to eastern Pennsylvania in a fairly narrow band. The Valley and Ridge is part of the Oak-Chestnut forest described by Braun (1950). The region was traditionally dominated by oak and chestnut, but chestnut has been replaced in the canopy by oaks and hickories (Braun 1950). The portion of the JNF crossed by the Project is composed primarily of deciduous forest (Appendix C).

2.2 Streams and Wetlands

The Project, as proposed, crosses 10 waterbodies on JNF (Appendix A Figure 3, Maps 1-12). Of these, 6 are unnamed tributaries (UNT). Table 2 provides the names of each crossed waterbody and the stream to which it contributes.

The Project also includes two upstream crossings of Craig Creek. One crossing will be completed via open cut dry-ditch methods to install the pipeline. The second crossing will be done for access to the pipeline via timber mat bridge. No in-stream work or disturbance is proposed at this location.

Table 2. Waterbodies Crossed by the proposed Mountain Valley Pipeline on Jefferson National Forest.

Waterbody Crossed	HUC12 Subwatershed
Clendennin Creek	Clendennin Creek – Bluestone Lake
Curve Branch	Clendennin Creek – Bluestone Lake
Kimballton Branch	Stony Creek
UNT to Clendennin Creek	Clendennin Creek – Bluestone Lake
UNT to Clendennin Creek	Clendennin Creek – Bluestone Lake
UNT to Clendennin Creek	Clendennin Creek – Bluestone Lake
UNT to Clendennin Creek	Clendennin Creek – Bluestone Lake
UNT to Clendennin Creek	Clendennin Creek – Bluestone Lake
UNT to Craig Creek	Trout Creek – Craig Creek
UNT to Craig Creek	Trout Creek – Craig Creek
UNT to Craig Creek	Trout Creek – Craig Creek
UNT to Craig Creek	Trout Creek – Craig Creek
UNT to Curve Branch	Clendennin Creek – Bluestone Lake
UNT to Kimballton Branch	Stony Creek
UNT to New River	Clendennin Creek – Bluestone Lake

Waterbody Crossed	HUC12 Subwatershed
UNT to New River	Clendennin Creek – Bluestone Lake
Craig Creek 1 [a]	Trout Creek – Craig Creek
Craig Creek – Access Road [b]	Trout Creek – Craig Creek

[a]Not on JNF property (approximately 0.25 mile upstream)
[b]Not on JNF property (approximately 0.01 mile upstream)

Three palustrine emergent wetlands (Wetland IDs W-UU11, W-UU12, and W-HH15) were identified within the Limits of Disturbance (LOD) of Pocahontas Road on JNF. Wetland W-UU11 is approximately 0.008 hectare (0.02 ac; with an open boundary; therefore, size may be larger than reported). Dominant species observed included mountain-laurel (*Kalmia latifolia*), great laurel (*Rhododendron maximum*), polytrichum moss (*Polytrichum commune*), northern spicebush (*Lindera benzoin*), and woolgrass (*Scirpus cyperinus*). Wetland W-UU12 is approximately 0.001 hectare (0.003 ac) (closed boundary). Dominant species observed included mountain-laurel, woolgrass, and wild mint (*Mentha arvensis*). Wetland W-HH15 is approximately 0.01 hectare (0.03 ac; with an open boundary; therefore, size may be larger than reported). Dominant species observed included melic mannagrass (*Glyceria melicaria*) and jewelweed (*Impatiens capensis*).

2.3 Sedimentation Bounds for Effects Analysis

In order to quantify the amount of sediment expected within waterways and associated impacts to TES species within the JNF and in downstream areas, Environmental Solutions & Innovations, Inc. (ESI) contracted a hydrologist (Hydrogeology Inc.) to investigate the potential for downstream sedimentation impacts. The analysis was developed through consultation with Mr. Ken Landgraf, Natural Resources Group Staff Officer, and Ms. Dawn Kirk, Forest Service fisheries biologist. On June 7, 2016, ESI, on the behalf of MVP, submitted a Hydrologic Analysis of Sedimentation documenting potential sedimentation introduced during Project construction. Upon review, the USFS, ESI, and MVP discussed the analysis and how to best document the level of impacts of potential sedimentation introduced by the Project. Taking into account the USFS comments and recommendations, ESI re-conducted the analysis to include all aspects of the Project.

The Revised Universal Soil Loss Equation (RUSLE; Renard et al. 1997) was used to estimate erosion due to disruption of land from construction, restoration, and operational activities for the Project within the vicinity of the JNF. Specific details regarding the RUSLE and its application to construction activities are available in Renard et al. (1997) and Galetovic (1998) as well as the report submitted in support of this BE (ESI 2017). In brief, the RUSLE is used to estimate the sediment loads and sediment yields by multiplying a series of values representing erosivity (associated with rainfall and runoff), erodibility, slope length and steepness, land cover and management, and conservation practices and erosion and sediment control measures. The benefit of RUSLE is that it can be easily incorporated into a Geographic

Information Systems (GIS) environment, and sediment load can be estimated for a series of cells belonging to a watershed or catchment.

For the proposed Project, the RUSLE was used to estimate sediment loads and yields for all stream catchments within the 1:24,000 National Hydrography Dataset (NHD) within the vicinity of the Project. More specifically, a study area was established that included: (1) all subwatersheds from the U.S. Geological Survey's (USGS) Watershed Boundary Dataset that intersect the boundaries of the JNF and the Project area (Table 3), (2) all subwatersheds upstream of the intersecting subwatersheds (i.e., all upstream drainage areas), and (3) subwatersheds downstream of the intersecting subwatersheds that demonstrate substantial increases in cumulative sediment loads. Sediment loads within these catchments are estimated using current land use (based on the 2011 National Land Cover Database) and expected land use classes during construction, restoration, and operation of the Project within the LOD. Current sediment loads and yields are considered baseline conditions (i.e., baseline treatment) and provide a measure of the present sediment loads within streams in the vicinity of the Project. This baseline treatment is then used to assess potential increases of soil loss expected under Project construction, restoration, and operation (i.e., proposed action treatment).

Table 3. Subwatersheds in Virginia and West Virginia with Limits of Disturbance for the Mountain Valley Pipeline within the Jefferson National Forest.

Subwatershed Name	HUC12	State	Subwatershed Area (mi^2)*	Area within JNF (mi^2)*
Stony Creek	050500010902	VA,WV	48.9	39.6
Clendennin Creek-Bluestone Lake	050500020403	VA,WV	38.9	7.5
Rich Creek	050500020601	VA,WV	53.3	1.3
Trout Creek-Craig Creek	020802011001	VA	51.9	38.4
Dry Run-North Fork Roanoke River	030101010201	VA	51.3	3.3

* Subwatershed Area and Area within JNF are estimates of the total area of the subwatershed and the area of the subwatershed that is contained in the JNF, respectively.

In order to estimate potential sediment introduced into nearby streams from the Project, construction, restoration, and operational impacts were projected on a two-week interval using a sequential, assembly line construction schedule for each construction segment or spread in a north-to-south direction (see ESI [2017] for a more detailed description of construction activities and their associated treatments within the RUSLE). Soil losses were then summed to estimate yearly sediment loads and yields for a five-year period that includes Project construction, restoration, and operations. At year five, the landscape was assumed to enter into a new sediment equilibrium, and sediment produced during year five was used to forecast sediment produced for the life of the Project. Results were compared to baseline conditions to assess potential impacts, and the maximum load over any consecutive 52-week period was used to define the sedimentation bounds for effects. Unfortunately, no nationally-accepted sedimentation standard regarding the permissible amount of sediment allowed to enter into waterways is available (Kemp et al. 2011); however, a commonly used impact threshold is one in which the metric of impact is increased by 10 percent or more (USEPA 2003). This approach recognizes the biological reality that even a relatively small (in absolute terms) amount of sediment may degrade a pristine stream, while a larger amount might be needed to further degrade a historically impacted stream. Thus, streams with a 10 percent increase in sediment load over baseline were used to identify the extent of sedimentation effects from the proposed action on JNF and surrounding lands.

Analysis using the RUSLE identified the boundaries associated with a 10 percent increase in sediment load. In total, 45.56 stream kilometers (28.31 mi) downstream of the Project area within the JNF but within the study area are expected to have a 10 percent increase or more (Table 4). However, nearly 21 kilometers (13 mi) of stream impacts can be attributed to a pre-existing approximate 9.7-kilometer (6-mi) Forest Road (Pocahontas Road; Figure 1) that was not represented in the baseline assessment (i.e., using the 2011 NLCD). This road was treated as a construction component of the Project; however, the road will only need to be upgraded in sections and extended to the Project Rights-of-Way (ROW) in order to be used for the Project. Similarly, Mystery Ridge Road (Forest Development Road 11080 [approximately 1.6 kilometers [1 mi]) was also treated as a construction component of the Project; however, the road is already existing but was not represented by the 2011 NLCD.

Table 4. Waterbodies with an expected increase in sediment load of 10 percent or greater from the proposed Mountain Valley Pipeline within the vicinity of the Jefferson National Forest.

Waterbody	Subwatershed	Stream Kilometers Impacted*
Unnamed Tributaries to Craig Creek	Trout Creek-Craig Creek	3.09
Craig Creek	Trout Creek-Craig Creek	0.47
Unnamed Tributary to Mill Creek	Dry Run-North Fork Roanoke River	2.53
Mill Creek	Dry Run-North Fork Roanoke River	5.18
Unnamed Tributaries to Stony Creek	Stony Creek	1.87
Unnamed Tributaries to Kimbalton Branch	Stony Creek	1.87
Kimbalton Branch	Stony Creek	4.12
Unnamed Tributaries to Clendennin Creek	Clendennin Creek-Bluestone Lake	2.88
Clendennin Creek	Clendennin Creek-Bluestone Lake	6.15
Unnamed Tributaries to Curve Branch	Clendennin Creek-Bluestone Lake	1.69
Curve Branch	Clendennin Creek-Bluestone Lake	3.81
Unnamed Tributaries to New River	Clendennin Creek-Bluestone Lake	5.05

Waterbody	Subwatershed	Stream Kilometers Impacted*
Rich Creek	Rich Creek	6.86
Totals	-	45.56

* Assumes a 79 percent containment of sediment by sediment controls during the construction phase of the Project (ESI 2017).

Sediment yields in excess of 10 percent above baseline are expected within most unique catchments (i.e., the catchment area uniquely draining to an individual stream segment) crossed by the Project during the construction phase of the Project (i.e., year 1). Although many of these catchments are expected to have sediment yields that decrease after the construction phase of the Project, the majority of catchments (n=20) are expected to have a new sediment equilibrium in excess of 10 percent above baseline once restoration activities are complete. For 12 catchments, a new sediment equilibrium in excess of 50 percent over baseline is expected; however, these higher equilibriums are in relation to the pre-existing Pocahontas Road. As mentioned above, this road was not represented within the baseline treatment (likely due to a combination of cell resolution or forest canopy), and thus these increases are likely overestimated. The proposed actions of the Project include minor improvements to the road, and any modifications will be returned to original or better condition upon completion of the pipeline facilities as coordinated with the JNF.

To better examine the impacts of these increased sediment yields, expected sediment introduced by the proposed Project was also put into the context of actual stream segments with total sediment loads. In this context, loads above baseline originate from catchments crossed by the proposed action and are expected to be transported to streams downstream of the Project area outside the catchment of origin. Based on this approach, substantial increases (i.e., ≥ 10% over baseline) in sediment loads from the proposed Project are largely (>90%) confined to headwater streams (i.e., 1-3 Strahler order; Table 5); however, increased loads are expected in the larger ordered Rich Creek (Table 5).

Table 5. Maximum yearly sediment loads above baseline in downstream waterbodies and associated percent increases from the proposed Mountain Valley Pipeline in the Jefferson National Forest.

Subwatershed	Waterbody	Location	Drainage Area (km^2)	Strahler Order	Load Above Baseline ($ton\ yr^{-1}$)	Percent Inc.
Trout Creek-Craig Creek	Craig Creek	Above Confluence with Muddy Branch	59.52	4	30.68	2.66
		Above Confluence with Cabin Branch	78.79	4	28.56	1.93
		Above Confluence with Trout Creek	115.10	4	25.81	1.30
		Above Confluence with McAfee Run	150.74	5	23.94	0.94
		Above Confluence with Broad Run	199.46	5	22.06	0.72

Subwatershed	Waterbody	Location	Drainage Area (km²)	Strahler Order	Load Above Baseline (ton yr⁻¹)	Percent Inc.
		Above Confluence with Meadow Creek	252.24	5	20.54	0.53
		Above Confluence with Johns Creek	284.33	5	19.79	0.40
		Above Confluence with Barbours Creek	596.32	6	15.37	0.23
	Mill Creek	Above Confluence with North Fork Roanoke River	10.93	3	148.42	29.42
Dry Run-North Fork Roanoke River		Above Confluence with Indian Run	91.22	4	241.16	7.17
	North Fork Roanoke River	Above Confluence with Slate Lick Run	117.66	4	226.05	6.24
		Above Confluence with Wilson Creek	126.31	4	221.23	5.94
		Above Confluence with Laurel Branch	95.29	4	0.80	0.08
	Stony Creek	Above Confluence with Kimbalton Creek	112.74	4	24.41	1.81
Stony Creek		Above Confluence with New River	125.25	4	126.22	7.30
	Kimbalton Creek	Above Confluence with Stony Creek	4.45	2	89.02	69.75
	Curve Branch	Above Confluence with New River	3.11	2	58.85	48.76
	Clendennin Creek	Above Confluence with New River	9.43	2	64.40	29.15
		Above Confluence with Curve Branch	8862.27	6	174.43	1.00
Clendennin Creek-Bluestone Lake		Above Confluence with Clendennin Creek	8876.36	6	174.86	1.00
	New River	Above Confluence with Wolf Creek	8911.84	6	174.78	1.00
		Above Confluence with Rich Creek	9537.74	6	157.28	0.87
		Above Confluence with East River	9882.29	6	164.11	0.89
		Above Confluence with Mud Run	30.38	4	92.98	18.41
		Above Confluence with Crooked Creek	41.08	4	86.44	11.34
Rich Creek	Rich Creek	Above Confluence with Scott Branch	66.69	5	76.93	6.15
		Above Confluence with Brush Creek	85.57	5	72.16	5.12
		Above Confluence with New River	135.15	5	64.42	3.05

Note: A maximum sediment load is defined as the maximum yearly sediment load of any contiguous 52-week period.
* Assumes a 79 percent containment of sediment by sediment controls during the construction phase of the Project (ESI 2017).

It is important to recognize that these results are based on the assumption of adherence to the FERC 2013 Upland Erosion Control, Revegetation, and Maintenance Plan and the Project Erosion and Sedimentation Control Plan (E&SCP). Sedimentation is greatly influenced by the amount of bare soil exposed to erosive forces and the distance and method of transport of the eroded soil to the stream system. Adherence to these plans, as well as site-specific erosion and sedimentation control plans, will reduce the amount of sedimentation introduced into waterbodies. In general, MVP will place erosion and sedimentation control measures along the LOD prior to disturbance to the soil. These measures will be monitored and repaired or replaced as needed until revegetation is deemed complete by the appropriate agencies. MVP will revegetate the Project ROW as soon as possible following construction in an effort to reduce sediment run off resulting from exposed soils.

3.0 Proposed Actions

All activities associated with construction, operation, and maintenance of the pipeline and ancillary facilities will be conducted in a manner that complies with the conditions outlined in the FERC Certificate, Bureau of Land Management (BLM) Right-of-Way Grant, State Erosion and Sedimentation Control permits, and other permits, as applicable. Prior to initiating construction-related activities, secure ROW easements and other authorizations will be obtained. The proposed width of the permanent ROW is 15 meters (50 ft) and the proposed width of the construction ROW is 38 meters (125 ft). The following subsections detail construction procedures as they will occur on USFS and not a complete Project-wide construction sequence.

3.1 Typical Upland Construction Procedures

Construction in upland terrain uses conventional overland construction techniques for large-diameter pipelines. The following subsections outline typical steps for this type of construction.

3.1.1 Clearing and Grading

After the ROW has been surveyed and easements have been secured (for the permanent and temporary construction ROW), the permitted ROW will be cleared of obstructions (i.e., trees and stumps, brush, logs, and large rocks) according to the FERC Plan, as agreed upon with the USFS, and as outlined in an updated Annual Standards and Specifications which will be included as Appendix D upon completion. The ROW will be cleared to the width required for construction, but not more than specified on the pipeline alignment sheets. At no time will MVP or its contractor clear or alter any areas outside of the boundaries of the permitted pipeline ROW area.

The pipeline's 38-meter (125-ft) wide construction ROW and temporary workspaces will be cleared of vegetation (including timber) prior to the initiation of construction. All areas to be cleared during construction will be clearly marked by the USFS with paint and staked by the civil survey crew prior to the start of clearing operations. Also, in accordance with the invasive species plan, MVP will arrange a location in which a JNF designated employee will examine and certify that equipment is clean and permitted to be used on USFS property. Once removal has begun, timber will be cut into usable lengths and stacked adjacent to the ROW in accordance with the USFS requirements. Merchantable timber will be hauled away. Stumps will be cut as close to the ground as feasible and left in place except for in areas directly over the trench line. All non-merchantable brush and slash will be windrowed to the edge of the ROW, utilized in downslope areas of the ROW and access roads, or removed from the area in accordance with USFS requirements. The windrows will generally range from 10 to 20 feet in width and 6 to 8 feet in height. Breaks will be left in the windrows at approximately 100 feet intervals in order to provide fire breaks and wildlife crossings.

Where needed and as dictated by the E&SCPs, best management practices (BMPs) will be placed, maintained, and monitored throughout construction and will remain in place until permanent erosion controls are installed and restoration is deemed complete by the USFS and FERC.

3.1.2 Trenching

To bury the pipeline underground, it will be necessary to excavate a trench. The trench will be excavated with a track-mounted backhoe or similar equipment. Explosives will only be used when necessary in areas where rock substrates are found at depths that interfere with conventional excavation or rock-trenching methods. On JNF property, if requested, subsoil will be stockpiled separately from topsoil (or the upper 30.5 centimeters [12 in] of topsoil, if the topsoil is deeper).

Generally, the trench will be excavated at least 30.5 centimeters (12 in) wider than the diameter of the pipe. The sides of the trench will be sloped with the top of the trench up to 3.6 meters (12 ft) across, or more, depending upon the stability of the native soils. The trench will be excavated to a sufficient depth to allow a minimum of 0.9 meters (3 ft) of soil cover between the top of the pipe and the final land surface after backfilling (minimum of 45.7 centimeters [18 in] of cover will be provided in consolidated rock in Class 1 or greater locations or in ditches, where 61 centimeters [24 in] of cover is required). Locations such as waterbodies, roads and railroads will include 91.4 centimeters (36 in) of cover per applicable permits.

Excavated soils will typically be stockpiled along the ROW on the side of the trench (the “spoil” side) away from the construction traffic and pipe assembly area (the “working” side). Where the route is co-located adjacent an existing infrastructure, the spoil generally will be placed on the same side of the trench as the existing infrastructure.

3.1.3 Padding and Backfilling

After the pipe is lowered into the trench, the trench will be backfilled. Previously excavated materials will be pushed back into the trench using equipment or backhoes. Where the previously excavated material contains large rocks or other materials that could damage the pipe or coating, clean fill will be used to protect the pipe. However, limestone dust or sand, which is typically basic and will often aid in the cathodic protection of the pipeline, may be used as backfill material. The first 30.5 centimeters (12 in) above the top of the pipe will be clean fill free of rocks from the excavation. The remaining fill of the trench will be the aggregate of the excavation material removed at the time of the excavation. If additional fill is brought in, it will be either flowable fill or topsoil. Topsoil will be segregated and will be placed after backfilling the trench above the subsoil. In wetlands, hydrology will be restored to pre-existing conditions. Excess soil will be distributed evenly on the ROW, only in upland areas, while maintaining existing contours and will be in accordance with requirements.

3.1.4 Construction in Rugged Terrain

In mountainous areas where the pipeline will encounter steep slopes, MVP will employ special construction techniques where the slopes typically exceed 30 to 35 degrees. The elevation data were found using 3-meter digital elevation model (DEM) files generated from flown LiDAR. Average slopes were calculated for each 0.1-mile interval along the pipeline centerline, and every 0.25-mile interval along the access road. In each 0.1-miles interval, the steepest data point was taken as the maximum slope. The construction techniques will require expanded workspace areas. ATWS are located outside the 125-foot construction ROW for the pipeline. One acre of ATWS will be utilized within the JNF. These are located along the pipeline alignment on the south side of Sinking Creek Mountain, between MP 218.5 and 219.0. No additional ATWS are proposed on National Forest System lands. In rugged terrain, temporary sediment barriers, such as silt sock and reinforced silt fences will be installed during clearing to prevent movement of sediment off the ROW. In addition, temporary slope breakers will be installed during grading in accordance with the E&SCP to reduce water runoff or divert water to vegetated areas. Construction activities on rugged terrain will be similar to the typical construction; however, equipment will be tethered via winch lines to other equipment at the top of the slopes to ensure the safety of the construction personnel and surrounding areas.

Equipment used for the construction activity will be suspended from a series of winch tractors to maintain control of the equipment and provide an additional level of safety. All construction equipment and their winch lines will be inspected prior to operation to ensure the equipment is operable and sound. Spoil piles adjacent to the trench will be protected by temporary sediment barriers to keep excavated soils on the ROW. Pipe joints will be stockpiled at the top or bottom of each slope. A side-boom tractor will be suspended from a winch that will carry one joint at a time up or down the slope and place the joint along the trenchline. The joint will then be lowered into the ditch by a tractor. Welders will connect the joint to the previous joint within the trench to assemble the pipeline. Once welding is complete, the welds will be visually and radiographically inspected. The weld joints will be hand-coated with fusion-bonded epoxy coatings in accordance with required specifications. The coating on the pipe and at the weld will be inspected for defects and repaired, if necessary. Sand trench breakers will be installed in the trench along the pipeline to prevent or slow the movement of water along the trench. The pipeline will be padded and the trench will be backfilled by equipment tethered to the winch tractors. The surface of the ROW will be restored to original contours to the extent practical, and permanent slope breakers will be installed in accordance with the E&SCP. Erosion control blankets or hydroseed, in lieu of mulch, will be installed on steep slopes to provide stabilization for vegetation to help control sediment and water runoff.

In areas where the Project route crosses laterally across the face of a slope (side-hill construction), cut-and-fill grading may be required to establish a safe, flat work terrace which will be reclaimed as close as practical to original contours.

MVP will incorporate erosion and sediment control measures such as super silt fence, silt fence, sock filtration, erosion control socks, temporary and permanent water bars, ditch breakers, temporary mulch, and erosion control blankets as per Project design specifications based on slope.

On steep slopes, various measures will be taken in order to properly control erosion and sedimentation on the ROW. Spoil piles from trenching operations will be staged along the side of the ROW and will be compacted via rolling with dozers on site as additional material is added. Once a soil pile is completed, it will be temporarily mulched to control washouts. Additionally, spoil piles will be separated at intervals of 50 feet by temporary water bars, which will serve to slow the flow of runoff down the ROW and divert it into No. 3 aggregate. Silt fence and super silt fence will be used to stop rocks from rolling off the ROW. Other measures such as erosion control blankets, temporary mulching, hydroseed, and sock filtration may be used.

Within the trench, sand filled sacks will be stacked across the width of the trench as necessary based on field conditions. This will permit water to slowly filter through without carrying large amounts of soil with it. Similarly, permeable trench breakers constructed of sand or aggregate-filled sacks will be installed along the open ditch. Rock-fall protection measures such as rock fences, placement of concrete barriers, or creating catchment areas may be added where excavation is planned subjacent to steep slopes, as determined by the contractor. Once the area is stabilized, following construction, MVP will remove any temporary stabilization methods. Contours will be returned to pre-existing conditions to the extent practicable.

In addition to the measures taken on slopes to control erosion and sedimentation, trench drains will be installed on side slopes and steep slopes before the pipe is placed in order to channel water away from the ditch, and these drains will not be removed after construction is complete. These permanent drains will consist of perforated tile or pipe surrounded with rock (1-inch stone or similar, which may be taken from excavated spoils) that will terminate at a riprap pad near the edge of the ROW. Geotechnical inspectors will evaluate the need for additional engineering controls based on the subsurface conditions exposed in the pipeline excavation; such engineering controls could include regrading adjacent areas, embedding the pipeline in a bedrock trench, installing drains, buttressing unstable slopes, reinforcing fill slopes with geosynthetics, or other stabilization measures as appropriate.

On side-hill construction, tree stumps and other organic material will be removed from backfill material along the ROW, as decomposing organic materials and organic soils tend to exhibit low shear strengths and may accumulate water, increasing the likelihood of a landslide. Special attention will be paid to ensure that natural drains alongside slopes are properly restored after construction activities are complete. In order to accomplish this, additional French drains or rock-lined channels may be constructed to efficiently convey water across or around the ROW. Where seeps and springs are observed in the cut slope, cutoff drains and/or transverse trench drains will be installed to prevent saturation of the backfilled material. Where possible, compaction on side-cut sections should be completed in 12-inch lifts using a sheep's foot roller.

Specific slope stability considerations and construction measures are included in the December 20, 2016, *Site-Specific Design of Stabilization Measures in Selected High-Hazard Portions of the Route of the Proposed Mountain Valley Pipeline Project in the Jefferson National Forest* as well as the December 2016, *Landslide Mitigation Plan*. Additional landslide mitigation measures will be prescribed by geotechnical inspectors as subsurface conditions are revealed during construction.

Topsoils are not commonly found on slopes that are greater than 50 percent, as soils in these areas will naturally wash away; therefore, topsoil will not be placed on slopes that are greater than 50 percent during restoration activities. However, these areas will be treated as soon possible to minimize erosion potential. This may be accomplished by hydro-seeding the slope or covering the slope with jute erosion control matting.

3.1.5 Stove Pipe Construction

On slopes steeper than 30 degrees, the pipeline will be installed via a "stovepiping" method (see Figure 6-2). The stovepipe method entails excavating a trench long enough to install two joints of pipe (approximately 40 feet long), lowering the pipe into the trench, and then welding the pipe in the trench. Following welding, inspection, and coating, the welded joint of pipe is backfilled before moving on to the next two joints of pipe. This process is performed for each successive joint of pipe up the slope. This construction technique will reduce the length of pipe that will be handled at any one time and minimize the amount of open trench on steep slopes. The general construction and restoration methods that will be applied during stove pipe construction will be similar to those described above for rugged terrain.

3.1.6 Winter Construction

MVP has developed a Winter Construction Plan (Appendix S of the Plan of Development [POD]), which identifies BMPs for construction activities during snow accumulation. MVP will stop working in winter if weather conditions occur that are deemed unsafe to perform pipeline construction. Inspections will occur within 24 hours of each 0.5 inch of rainfall or snow melt. MVP will ensure the repair of all ineffective temporary erosion control measures within 24 hours of identification, or as soon as conditions allow if compliance with this time frame would result in the greater environmental impacts.

As necessary during snow accumulation, snow will be removed from construction work areas to expose soils for grading and excavation. Snow removal will be limited to active construction areas and areas needed to maintain access to the construction ROW. Snow will be bladed or pushed to the edges of the ROW with a motor-grader, snowplow, or bulldozer fitted with a “shoe” to minimize impacts on underlying soils and vegetation and stockpiled within the ROW or an approved ATWS areas. Snow will not be bladed off the ROW. Snow removal equipment will access the Project areas from approved access roads and will operate from within the construction ROW or approved ATWS areas. When snow accumulation is more than 1 foot, it will be removed from both the working and spoil sides of the construction ROW prior to topsoil segregation and grading to prevent mixing of snow with excavated spoil. Erosion and sediment control devices and diversion berms will be installed where needed to control snow and melting runoff.

3.1.7 Hydrostatic Test and Final Tie-In

Following backfilling of the trench, the pipeline will be hydrostatically tested to ensure that it is capable of safely operating at the design pressure. No water withdrawals or discharges will occur on JNF land.

3.1.8 Dust Control

Water withdrawal for dust abatement will not occur on JNF land. Water will be obtained through municipal sources. The locations and amount of disbursement of water will be decided by the lead environmental inspector for a specific construction spread.

3.1.9 Cleanup and Restoration

Post-construction restoration activities are undertaken in accordance with measures specified in FERC, USFS, and State restoration guidelines as applicable as well as the Restoration Plan appended to the POD. The ROW and other disturbed areas are finish-graded and construction debris is disposed of properly after a segment of pipe is installed, backfilled, and successfully tested. The surface of the ROW disturbed by construction activities is graded to match original contours and retain compatibility with surrounding drainage patterns. An exception is made at locations where permanent changes in drainage are required to prevent erosion, scour, and possible exposure of the pipeline. Unless otherwise requested by the agency, segregated topsoil is returned to its original horizon. At that time, temporary and permanent stabilization measures, including seed and mulch, are installed.

3.1.10 Typical Waterbody Crossings

Construction across waterbodies is performed to minimize the time that the trenches for the pipeline crossings of flowing streams and rivers are left open. The construction method used at a waterbody crossing depends on characteristics of the waterbody. Each method is performed in a manner consistent with regulatory permit conditions. All streams on JNF will be crossed by open-cut dry ditch dam and pump or flume crossing methods. Descriptions of these methods are provided below.

3.1.10.1 Dam and Pump Crossing Method

The dam and pump method involves installation of temporary dams upstream and downstream of the proposed waterbody crossing. The temporary dams will typically be constructed using sandbags and plastic sheeting. Following dam installation, appropriately sized pumps will be used to dewater and transport the stream flow around the construction work area and trench. Intake screens will be installed at the pump inlets to prevent entrainment of aquatic life, and energy dissipating devices will be installed at the pump discharge point to minimize erosion and stream bed scour. Trench excavation and pipeline installation will then commence through the dewatered portion of the waterbody channel. Following completion of pipeline installation, backfill of the trench, and restoration of stream banks, the temporary dams will be removed, and flow through the construction work area will be restored. This method is generally only appropriate for those waterbody crossings where pumps can adequately transfer the stream flow volume around the work area. This crossing method generally minimizes the duration of downstream turbidity by allowing excavation of the pipeline trench under relatively dry conditions.

3.1.10.2 Flume Crossing Method

The flume crossing method will consist of temporarily directing the flow of water through one or more flume pipes placed over the area to be excavated. This method will allow excavation of the pipe trench across the waterbody completely underneath the flume pipes without disruption of water flow in the stream. Stream flow will be diverted through the flumes by constructing two bulkheads and using sand bags or plastic dams to direct the stream flow through the flume pipes. Following completion of pipeline installation, backfill of the trench, and restoration of stream banks, the bulkheads and flume pipes will be removed. This crossing method generally minimizes the duration of downstream turbidity by allowing excavation of the pipeline trench under relatively dry conditions.

3.2 Access Roads and Ancillary Facilities

The 9.7-kilometer (6-mi) Pocahontas Road (Forest Road 972) in Giles County, Virginia is currently proposed to provide access to portions of the proposed alignment near Peters Mountain. This road will need to be upgraded in sections and extended to the Project ROW in order to be useable for the MVP Project. Mystery Ridge Road (Forest Development Road 11080 [approximately 1.6 kilometers [1 mi]]) in Giles County, Virginia will also be used to access portions of the alignment on JNF. Previously existing access roads that were modified and used during construction will be returned to original or better condition upon completion of the pipeline facilities as coordinated with the JNF. No ancillary facilities will be constructed on JNF land.

3.3 Appalachian National Scenic Trail Crossing

For the crossing of the Appalachian National Scenic Trail, pipe will be installed using the conventional bore method. The bore will be approximately 182.9 meters (600 ft). This method requires excavation of two pits, one on each side of the feature bored. A boring machine is lowered into the pit on one side and a horizontal hole is bored to the other bit at a diameter equal to the diameter of the pipe at the depth of the pipeline installation. The pipeline section is then pushed through the bore to the opposite pit. If additional pipeline sections are required to span the length of the bore, they are welded to the first section of the pipeline in the bore pit before being pushed through the bore.

3.4 Surface Disturbance, Erosion, and Downstream Sedimentation

MVP intends to implement the FERC Erosion Control, Revegetation, and Maintenance Plan and Wetland and Waterbody Construction and Mitigation Procedures as well as Virginia Department of Environmental Quality as a minimum standard during construction (unless noted otherwise). Additionally, MVP will also implement its Annual Standards and Specifications. These plans identify mitigation measures for minimizing erosion and enhancing revegetation, as well as minimizing the extent and duration of disturbance on wetlands and waterbodies. Environmental inspectors are present during on-site activities to ensure compliance with requirements for the Project and that proposed measures are implemented. Proposed measures are incorporated throughout the Project, including during preconstruction filing and planning, installation of the pipeline and associated facilities (e.g., access roads), restoration of the Project area, and post-construction. A brief overview of possible erosion and sediment control measures are provided in the following sections.

3.4.1 Environmental Inspection and Supervision

A minimum of four environmental inspectors with knowledge of wetland and waterbody conditions is assigned to each construction spread during construction and restoration based on the length of the construction spread and the number and significance of the resources affected. Some noted responsibilities of inspectors include ensuring sensitive resources (e.g., cultural; wetlands) are visibly marked, identifying erosion and sediment control and soil stabilization measures (as well as inspection of these controls), ensuring sensitive resources are not impacted by erosion or the deposition of sediment, and the preservation and maintenance of topsoil. The inspectors monitor all aspects of construction and restoration activities and have authority to stop activities that may violate conditions of the ROW Grant and Annual Standards and Specifications as well as all other applicable permits and approvals. The inspectors identify corrective actions and ensures an activity is brought back into compliance. The inspectors keep accurate and detailed records of compliance with environmental conditions and proposed mitigation measures that will be submitted regularly to the USFS and FERC.

3.4.2 Preconstruction Filing and Planning

Project sponsors coordinate with all appropriate local, state, and federal agencies regarding erosion control and revegetation. Construction is planned to limit the amount of open trench sections to the length necessary to safely construct the pipeline in an effort to avoid erosion and sediment deposition in and near sensitive resources. Beneficial reuse of materials will not result in adverse environmental impacts and will comply with all applicable surveys, landowner and agency approval, and permit requirements.

3.4.3 Installation of Pipeline and Associated Facilities

Measures are taken during construction to stabilize soils and to reduce erosion and sedimentation. Temporary erosion controls are installed immediately prior to disturbance of soil. The environmental inspector assigned to each construction spread maintains temporary controls throughout construction until permanent erosion controls are installed or restoration is deemed complete.

Temporary spoil will be placed, if possible, in the construction ROW at least 15.2 meters (50 ft) from the edge of a waterbody and necessary sediment barriers are installed to prevent the flow of spoil or silt-laden water into waterbodies and wetlands.

3.4.4 Restoration

Following the backfilling of a trench, final grading, topsoil replacement, and installation of permanent erosion control structures will be completed within 20 days. If weather conditions prevent compliance, temporary erosion controls will be maintained until weather improves and allows activities to be completed. Temporary erosion controls will be removed following the installation of permanent erosion controls or when revegetation is deemed successful.

Disturbed areas are planted with appropriate vegetation during the recommended seeding dates within six working days of final grading, weather and soil conditions permitting. If seeding cannot occur within these dates, temporary erosion controls will be maintained until the next recommended seeding dates. Areas are monitored until revegetation is deemed successful.

3.4.5 Post-construction

Inspections of all disturbed areas will be completed to determine the success of revegetation. A minimum of two inspections are completed: one after the first and one after the second growing seasons. Revegetation in non-agricultural areas is considered successful if upon visual inspection the density and cover of non-nuisance vegetation are similar in density and cover to adjacent undisturbed areas. Follow-up inspections and revegetation efforts are continued until revegetation is considered successful. Reporting regarding revegetation efforts is completed following standards in the POD.

3.5 Special Construction Procedures

3.5.1 Blasting

Blasting for grade or trench excavation will be considered only after all other reasonable means of excavation have been evaluated and determined to be unlikely to achieve the required results. MVP may specify locations (foreign line crossings, nearby structures, etc.) where consolidated rock will be removed by approved mechanical equipment, such as rock-trenching machines, rock saws, hydraulic rams, or jack hammers, instead of blasting. Areas where blasting may be required will be surveyed for features such as karst terrain, structures, utilities, and wells. The pre-construction condition of human-occupied buildings will be documented. Occupied buildings and their condition within 150 feet of the blasting area will be documented as to their pre-blast condition. In these areas, MVP is committed to taking measures to prevent damage to underground structures (e.g., cables, conduits, and pipelines) or to springs, water wells, or other water sources. Blasting mats or padding will be used as necessary to prevent the scattering of loose rock. All blasting will be conducted during daylight hours and will not begin until occupants of nearby buildings, stores, residences, places of business, and farms have been notified. Notifications to JNF will be made, placed on their website, and signage will also be posted when entering the Forest and other applicable locations. Where competent sandstone bedrock occurs in the stream bed, blasting may be used to reduce bedrock so that the trench can be excavated. Pre- and post-blasting structural surveys will be conducted of occupied structures, water supply wells, and water supply springs that will be specified in the site-specific Blasting Plan developed by the contractor conducting the blasting activities.

3.5.2 Karst Area

Based on consultation with MVP's karst experts, Draper Aden, following their local geologic expertise and a preliminary review of mapping from the United States Geological Survey, West Virginia Department of Environmental Protection, and Virginia Department of Mines, Minerals, and Energy, among other sources, it was determined that the pipeline will cross areas with the potential to contain karst features; however, no such features were identified on JNF. MVP will have a geotechnical contractor and Karst Specialists on site daily for construction in karst areas, which is further documented in the Karst Mitigation Plan. The contractor will be able to immediately identify potential problematic features and direct crews to employ mitigation measures as needed. A typical mitigation method for a sinkhole would be to excavate the feature to expose its throat, and then plug the throat using graded rock or sand fill to allow drainage and minimize alteration of flow patterns.

3.5.3 Trench Dewatering

In most cases, trench dewatering will be limited to the removal of storm water or perched groundwater seeping from the trench in the pipe trench excavated in upland locations. Storm water will typically be removed from the trench prior to lowering the pipe into place. The storm water will be pumped from the trench to a location down-gradient of the trench. The trench will be dewatered in a manner that does not cause erosion and does not result in heavily silt-laden water flowing into any waterbody or wetland. The storm water will be discharged to an energy dissipation/filtration dewatering device, such as a hay bale structure. Heavily-silt laden water may first be passed through a filter bag. The dewatering structure will be removed as soon as possible after completion of the dewatering activates. Trench breakers (ditch plugs) will be used where necessary to separate the upland trench from adjacent wetlands or waterbodies to prevent the inadvertent draining of the wetland or diversion of water from the waterbody in to the pipe trench.

3.6 Restoration

Post-construction restoration activities are undertaken in accordance with measures specified in FERC, USFS, and State restoration guidelines as applicable as well as the Restoration Plan appended to the POD. Areas disturbed by construction will be restored to their original grades, condition, and use, to the greatest extent practicable. Restoration will be considered successful if the disturbed surface condition is similar to adjacent undisturbed lands, construction debris is removed (unless requested otherwise by the land managing agency, revegetation is successful, proper drainage has been restored, and the appropriate federal and state agencies approve).

Herbaceous vegetative cover is re-established by spreading a grass seed and hydro/straw-mulch mixture over the disturbed surface. The type of seed is selected to match adjacent cover or as approved by JNF in order to avoid introduction of aggressive non-native vegetation. Depending upon the time of year, a temporary seed mix recommended by the USFS may be broadcast or drilled until a more permanent cover can be established. Steep slopes may require erosion control fabric, revetments, or sod. Vegetation success in these areas will be closely monitored and reseeding, fertilizing, and other measures will be employed until the density and cover of non-nuisance vegetation is similar in density and cover to adjacent lands undisturbed by the Project. An exception to this approach is the permanent ROW which must be maintained in herbaceous vegetative cover. No woody vegetation is allowed to grow in the permanent ROW.

MVP will use herbicides as necessary, through consultation with the USFS, to eliminate non-native invasive species within the Project area. An Herbicide Use Plan is included in the POD.

4.0 Species Evaluated

4.1 Desktop Assessment

Federally listed threatened and endangered species, species proposed for federal listing, and Region 8 Forest Sensitive Species that may potentially be affected by the proposed Project were examined using the following existing available information:

- The list of TES plant and animal species known or likely to occur on the JNF and their habitat preferences. This review included the U.S. Fish and Wildlife Service's (USFWS) current list of endangered, threatened, and proposed species for the JNF, dated January 1, 2002 and current Regional Forester's sensitive species list for Region 8 (list attached as Appendix B), dated July 28, 2016;
- Habitat classifications within the identified tracts on the JNF (Appendix C);
- Sources listed in the Literature Cited section of this BE.

Many TES species that occur on the JNF have unique habitat requirements, such as shale barrens, rock outcrops, bogs, caves, and natural ponds. Appendix B lists all 193 TES species currently known or expected to occur on or near the JNF; all were considered during analyses for this Project.

A "step down" process is followed to eliminate species from further analysis and increase focus on species that may be affected by Project activities. Species not eliminated in the "step down" process are analyzed in greater detail. Results of this "step down" analysis process are displayed in Appendix E. First, the range of a species is considered. Species' ranges on the JNF are based on county records contained in such documents as the Digital Atlas of Virginia Flora (DAVF), Biota of North American Plants (BONAP), NatureServe, the U.S. Department of Agriculture (USDA) PLANTS database and the Virginia Department of Game and Inland Fisheries (VDGIF) Wildlife Environmental Review Map Service (WERMS), but were refined further when additional information was made available, such as more recent occurrences documented in scientific literature or in Natural Heritage databases. Often, range information clearly indicates a species will not occur in the Project area due to a restricted geographic distribution. When the Project area is outside the known range of a species, that species is eliminated from further consideration and is coded as Occurrence Analysis Results (OAR) Code 1 in the Appendix B table. One hundred twenty-eight species were eliminated using this step of the method.

The remaining 65 species were analyzed based on habitat preferences using identified habitat classifications for the proposed Project (Appendix C). Habitat classifications were field verified. If the Project area lacked suitable habitat for a particular species, it was coded as Occurrence Analysis Results (OAR) Code 2. For this Project, 33 species were eliminated from further consideration because suitable habitat was lacking.

Some species could not be eliminated from further consideration based on range or habitat suitability; therefore, a field survey or additional USFS consultation was necessary to determine the presence or probable absence of TES species. Rare communities and rare habitats along the corridor are noted to aid in assessment of TES species.

4.2 Field Surveys

Field surveys are completed along the length of the proposed alignment. A 91-meter (300-ft) study corridor was used for field surveys unless a larger corridor was specified by applicable guidelines. Surveys are based on guidance provided by federal and state agencies, including the USFS for activities on JNF lands.

The survey method consisted of walking the study corridor searching for different habitat types and TES species occurrences. Plant surveys employ a meander search method (Goff et al. 1982) where new habitat variations or unique areas are constantly being searched for in order to maximize floristic variation. Wildlife surveys consist of searching for individuals and/or signs of their presence. Searching for individuals consists largely of visually scanning vegetation and looking under logs and rocks. Searching for signs of species consists of studying scat, tracks, calls, nests, and/or egg masses detected during the survey. Survey intensity is concentrated on potential sites where ground disturbance will be greatest.

Mist net surveys for listed bat species along the proposed alignment (Tracts 001-004, 008, and 035) and Pocahontas Road began in May 2015 and concluded in August 2015 (Appendix A Figure 2, Map 1). Tracts 005 and 006 were not completed in 2015 because Permit BBW433301T was not amended until after the USFWS survey window had closed. These tracts were surveyed in May 2016 (Appendix A Figure 2, Map 2). Mist net surveys were not completed for abandoned routes except in instances where survey buffers along the proposed alignment overlapped these routes.

Portal searches were completed along the proposed alignment and Pocahontas Road on JNF (Tracts 001 – 006, 008, and 035) as well as Tracts 007 – 014 and 032 - 037 (Appendix A Figure 2, Maps 1 – 3). This involves conducting pedestrian searches along the Project ROW and associated features for signs indicative of caves and/or mines which may provide suitable winter habitat for listed bat species. These searches began in July 2015 and concluded in November 2016. Portal searches were not conducted for the remaining alternative routes.

Detailed habitat assessments were completed for Tracts 012 – 014 because these previously proposed crossings were within the buffer, defined by USFWS, around a known bat occurrence (Appendix A, Figure 2, Map 3). These assessments were completed in July and August 2015. No other JNF alternatives cross buffers around known occurrences.

Plant surveys were completed on various tracts on JNF within the varying survey windows of the TES plant species (species listed in Appendix B). The specific survey dates are provided in Table 6.

Table 6. Plant Surveys on Tracts of Jefferson National Forest crossed by the proposed Mountain Valley Pipeline.

Survey	Date(s)	Survey Tracts
1	May 23 – June 3, 2015	009, 011 – 031
2	June 20 – July 1, 2015	009, 011 – 027
3	August 3 – 4, 2015	001 – 004, 007 – 014, 035
4	May 4 – 7, 2016	001 - 006, 008, 033 – 035
5	May 11, 2016	032
6	June 23 – 25, 2016	001 – 006, 008, 035
7	August 2 – 4, 2016	001 – 006, 008, 035

Avian habitat assessments and observations were completed on all tracts on JNF concurrently with other survey activities. These activities began in May 2015 and concluded in November 2016. An additional aerial nest survey is scheduled for early March 2017.

An abbreviated mussel survey was completed on October 20, 2015 for the current and abandoned Craig Creek crossings. Fourteen hours and 20 minutes of search time was expended along 1,553 meters (5,095 ft) of stream reach at the Project crossing. No signs of mussels (live or deadshell) were observed.

4.2.1 TES OAR Categorization

Based on results of field surveys, additional species are eliminated from further consideration because there is: a) a lack of suitable habitat in the Project area (OAR Code 2) or b) habitat is present and searches for the species were conducted but the species was not found (OAR Code 3).

4.2.2 Species Identified as In the Action Area or Potentially Affected by the Action

Species analyzed and discussed further in this document are those that: a) were in the Project area but outside the area where ground disturbance will occur (OAR Code 4); b) were found in the activity area (OAR Code 5); or c) were not seen during the survey, but possibly occur in the activity area based on habitat observed during the survey <u>or</u> field survey was not conducted when the species is recognizable (OAR Code 6).

In addition to species within the Action Area, aquatic species potentially occurring outside the Action Area are analyzed and classified as: a) aquatic species that occur outside the hydrological analysis area downstream from the Project area (OAR Code 7) or b) aquatic species that are known or suspected downstream of a project or activity area and are within identified geographic bounds of the water resource cumulative effects analysis area (OAR Code 8). If aquatic species are determined to occur in a 6th level watershed based on the USFWS/USFS T&E Mussel and Fish Conservation Plan, an OAR Code 9 is assigned and appropriate conservation measures apply.

5.0 Field Survey Results and Effects Determinations

Field surveys were completed to determine the presence or probable absence of the remaining 32 TES species that may occur within the proposed alignment. The locations of TES species identified during field surveys are provided in Appendix A, Figure 4. Additionally, observations and notes from the field surveys are provided in Appendix F.

Effects determinations for federally listed species are not included in this document. Those determinations, as well as analyses of direct, indirect, and cumulative effects, will be detailed in a BA. Based on coordination with the USFS, effects determinations for Forest Service Sensitive Species differ from federal determinations. These determinations are provided and defined as follows: A **No Impacts** determination is appropriate when the action will have no impacts on the species. A **Beneficial Impacts** determination is appropriate when positive effects occur without any adverse effects. Two types of **May Impact Individuals** determinations can be made: one is appropriate when the impact is not likely to cause a trend toward federal listing or loss of viability, and the other is appropriate when the impact is likely to cause a trend toward federal listing or loss of viability.

5.1 Federally Listed Species

Four federally listed species with potential to occur in the Project area were identified based on a desktop habitat assessment and coordination with the appropriate federal and state agencies. Field habitat assessments and surveys began in May 2015 and concluded in August 2016. Two of the four species were eliminated from further consideration because they were not found during field surveys (OAR Code 3). OAR Codes for the remaining federally listed species are provided in Table 7. The respective codes were assigned to the Roanoke logperch and James spinymussel due to the vicinity of the Project to sensitive habitat.

Additionally, a fifth federally listed species, the rusty patched bumblebee (*Bombus affinis*), is listed in Table 7. The final rule designating endangered species status for this species was published in the Federal Register on January 11, 2017. An OAR Code for the species has been provided below; however, it will be detailed in a BA.

Table 7. OAR Codes for federally listed species associated with Jefferson National Forest along the Mountain Valley Pipeline in Virginia and West Virginia.

Species	OAR Code(s)
Roanoke logperch (*Percina rex*)	7 and 9
James spinymussel (*Pleurobema collina*)	7 and 9
Indiana bat (*Myotis sodalis*)	3
Northern long-eared bat (*Myotis septentrionalis*)	3
Rusty patched bumblebee (*Bombus affinis*)	6

5.2 Forest Service Sensitive Species

Twenty-eight Forest Service Sensitive Species had potential to occur in the proposed Project area based on habitat suitability. Field habitat assessments and surveys began in May 2015 and concluded in November 2016. Twelve of the 28 species were eliminated from further consideration because they were not found during field surveys (OAR Code 3). One Forest Service Sensitive Species, rock skullcap (*Scutellaria saxatilis*), was identified [redacted] (OAR Code 5). An additional Forest Service Sensitive Species, eastern small-footed bat (*Myotis leibii*), was also found [redacted] however, suitable roosting habitat was not present (OAR Code 4). One additional species, American barberry (*Berberis canadensis*) was found on tracts no longer associated with the proposed alignment (OAR Code 4). A third species, Maureen's shale stream beetle (*Hydraena maureenae*), was assigned an OAR Code 4 based on previous surveys by USFS biologists. OAR Codes were assigned to the remaining 12 Forest Service Sensitive Species based on the results of these assessments and surveys. OAR Codes for the Forest Service Sensitive Species are provided in Table 8.

Table 8. OAR Codes for Forest Service Sensitive Species associated with Jefferson National Forest along the Mountain Valley Pipeline in Virginia and West Virginia.

Species	OAR Code(s)
Maureen's shale stream beetle (*Hydraena maureenae*)	4
Eastern small-footed bat (*Myotis leibii*)	4
American barberry (*Berberis canadensis*)	4
Rock skullcap (*Scutellaria saxatilis*)	5
Diana fritillary (*Speyeria diana*)	6
Regal fritillary (*Speyeria idalia*)	6
Sweet pinesap (*Monotropsis odorata*)	6
Yellow lance (*Elliptio lanceolata*)	7
Atlantic pigtoe (*Fusconaia masoni*)	7
Candy darter (*Etheostoma osburni*)	8

Species	OAR Code(s)
Roughhead shiner (*Notropis semperasper*)	8
Orangefin madtom (*Noturus gilberti*)	8
Kanawha minnow (*Phenacobius teretulus*)	8
Green floater (*Lasmigona subviridis*)	8
Green-faced clubtail (*Gomphus viridifrons*)	8
Allegheny snaketail (*Ophiogomphus incurvatus alleganiensis*)	8

5.2.1 Maureen's Shale Stream Beetle (*Hydraena maureenae*)

Maureen's shale stream beetle is a very small 1.2 – 1.5-millimeter (0.05-0.06-in) aquatic beetle (White 1983). It prefers the margins of very clear mountain streams, occurring mostly among fine shale gravels but sometimes on aquatic vegetation. Appalachian shale-bottom streams are considered habitat for this species. Sedimentation and subsequent loss of interstitial spaces in the shale gravels are a threat. This species has been collected from Alleghany, Bath, Bland, Botetourt, Craig, Highland, and Rockingham counties in Virginia (USFS, Dawn Kirk and Fred Huber, *personal communication*).

A **May Impact Individuals – Is Not Likely to Cause a Trend Toward Federal Listing or Loss of Viability** determination is made for the Maureen's shale stream beetle. Information from JNF consultation indicates surveys for this species were previously completed in the Project area (but not for this specific project) by JNF biologists. The species was located in Broad Run near the confluence with Craig Creek; however, it was not found in the immediate vicinity of the Project. The species is likely absent from the Project impact area; therefore, it is unlikely to be directly impacted by Project development and operation.

5.2.2 Eastern Small-footed Bat (*Myotis leibii*)

The eastern small-footed bat roosts in vertical cracks of cliff faces and horizontal cracks on talus slopes near deciduous or coniferous forest. It may also use man-made structures such as rip-rap and bridges. This bat hibernates in caves during the winter. The eastern small-footed bat forages widely in forested and open habitat types of mountainous habitat. Along the project ROW, it is specifically known from Giles County, Virginia and Monroe County, West Virginia (Best and Jennings 1997, Amelon and Burhans 2006).

A **May Impact Individuals – Is Not Likely to Cause a Trend Toward Federal Listing or Loss of Viability** determination is made for the eastern small-footed bat. Potential summer habitat for the eastern small-footed bat appeared limited along the proposed alignment and Pocahontas Road on JNF during field surveys (mist netting and portal searches). Four eastern small-footed bats (three adult males and one pregnant female) were captured during survey efforts [redacted] No suitable cave openings or portals were observed along the proposed alignment or Pocahontas Road on JNF. There are no known winter hibernacula along the proposed alignment; however, it is likely suitable winter habitat for the species is present on or within the vicinity of JNF as summer and winter habitats are often close together.

This species may be temporarily affected by construction of the proposed alignment and modifications to Pocahontas Road if it is using the Project impact area for summer roosting; however, this habitat is considered marginal. It is likely the bats are roosting outside of this area (a limestone quarry was observed south of the Project area) and only using Pocahontas Road as a travel and/or foraging corridor. This species may benefit from additional clearings associated with Project development and operation as this will increase the amount of foraging habitat and may also expose currently marginal rocky outcrops thus increasing their suitability for summer roosting. This is especially important for maternity colonies as roosts with greater solar exposure decrease required energy expenditures and provide more thermal stability for young thus increasing their probability of survival.

5.2.3 American Barberry (*Berberis canadensis*)

American barberry is a deciduous shrub with a range from southern Pennsylvania to northern Georgia and as far west as Missouri. Its habitat includes dry open woodlands, rocky slopes, cliffs, bluffs, exposed hillsides, mountains, and occasionally calcareous siltstone, shale, and sandstone (Hill 2003). Neutral well drained soils are preferred (Harvill et al. 1981).

A **No Impacts** determination is made for American barberry. This species was found at four locations during plant surveys on abandoned routes on JNF land [redacted] These locations are not along the proposed alignment. Although potentially suitable habitat is present within the Project development area, the species is likely absent from the Project impact area based on the negative survey results. It is unlikely to be directly impacted by Project development and operation; however, this species may benefit from an increase of potentially suitable habitat (woodland clearings and exposed hillsides) associated with the construction of the ROW.

5.2.4 Rock Skullcap (*Scutellaria saxatilis*)

Rock skullcap is a perennial herb that prefers mesic to dry, rocky forests and boulder fields. It frequently occurs in mountains and occasionally can be found on stream banks. This species is known from all counties crossed by the proposed alignment on JNF land (Strausbaugh and Core 1978, Gleason and Cronquist 1991).

A **May Impact Individuals – Is Not Likely to Cause a Trend Toward Federal Listing or Loss of Viability** determination is made for rock skullcap. A single population of approximately 10,000 individuals was identified [redacted] This population spans approximately 1.45 hectares (3.58 ac);

however, only an approximate 0.78 hectare (1.94 ac) are within the respective proposed construction ROWs (Appendix A Figure 4, Maps 1-4) as the proposed alignment was shifted in this area to avoid the majority of this population. Additionally, the construction footprint of the pipeline ROW in this area was reduced to 23 meters (75 ft) to minimize impacts to this species.

5.2.5 Diana Fritillary (*Speyeria diana*)

The Diana fritillary feeds on a variety of flowering plant species while occupying deciduous or mixed forests with moist rich soil (Wells and Smith 2013). The species may also occupy adjacent fields, pastures, shrublands, and grasslands during various stages of its life. The Diana fritillary is known from Monroe County, West Virginia and Giles and Montgomery counties, Virginia.

A **Beneficial Impacts** determination is made for the Diana fritillary. Potentially suitable habitat was identified during field habitat assessments; however, the species itself was not observed during surveys. The biggest threat to the Diana fritillary from Project development and operation would be removal of potentially suitable habitat from the Project area; however, this species is known to benefit from the presence of woodland clearings, including ROWs as it increases the amount of nectar forage available. Construction of the ROW will increase the amount of potentially suitable habitat for this species. Revegetation of the ROW will follow a two-step process as recommended by the USFS. This includes stabilization of soils immediately following tree removal and construction activities with appropriate seed mixes and techniques as well as revegetation of the ROW corridor as needed with native seed mixes recommended in consultation with the USFS.

5.2.6 Regal Fritillary (*Speyeria idalia*)

A petition to list the regal fritillary was submitted to the USFWS in April 2013 (Guardians 2013); listing status is currently under review. The regal fritillary is a relatively large butterfly that uses a variety of habitats such as herbaceous wetlands, riparian areas, grasslands, old fields, and savannas; however, it prefers high quality remnant tallgrass prairies. Nectar sources for the entire flight season are very important, and the regal fritillary prefers areas with wet patches or streams (Wagner et al. 1997, Wells and Smith 2013). The species primarily deposits eggs in close proximity to violets (especially birdfoot violet, *Viola pedata*, and prairie violet, *V. pedatifida*), which are the sole sources of food for larvae (Allen 1997). If the regal fritillary is still extant in Giles and Montgomery counties, Virginia and Monroe County, West Virginia, suitable habitat exists along the proposed alignment.

A **Beneficial Impacts** determination is made for the regal fritillary. This species was not observed during field habitat assessments and surveys; however, it possibly occurs along the proposed alignment based on the presence of potentially suitable habitat. The biggest threat to the regal fritillary from Project development and operation would be removal of potentially suitable habitat from the Project area; however, this species is only known from clearings in forested ecosystems and would potentially benefit from the presence of woodland clearings, including ROWs. Construction of the ROW will increase the amount of potentially suitable habitat for this species. This includes stabilization of soils immediately following tree removal and construction activities with appropriate seed mixes and techniques as well as revegetation of the ROW corridor as needed with native seed mixes recommended in consultation with the USFS.

5.2.7 Sweet Pinesap (*Monotropsis odorata*)

Sweet pinesap is a vascular plant found in mesic to dry upland forests, typically under oaks, pines, or shrubs (Kartesz 1994). In Virginia, it is known from Montgomery County (Kartesz 1994). This species is difficult to observe in the field due to its small size and propensity for blending in with and being covered by leaf litter

A **May Impact Individuals – Is Not Likely to Cause a Trend Toward Federal Listing or Loss of Viability** determination is made for sweet pinesap. Potentially suitable habitat for this species was identified in the field; however, this plant was not found during the plant survey. It may occur in the Project area based on the presence of potentially suitable habitat and its obscure nature. The biggest threat to this species from Project development and operation would be removal of potentially suitable habitat from the Project area; however, given the abundance of such habitat, coupled with this species' often concealed nature, it is likely sweet pinesap is more common than documented.

5.2.8 Yellow Lance (*Elliptio lanceolata*)

The yellow lance is an elongate freshwater mussel approximately 7.6 centimeters (3 in) long and is usually found in the main channels of streams, some as small as 0.9 meter (3 ft) in width (Johnson 1970). It is native to Atlantic slope drainages such as the James River basin. The species is typically found in clean, unimpounded areas of streams of varying sizes with substrates of smaller material (e.g., sand and fines).

A **May Impact Individuals – Is Not Likely to Cause a Trend Toward Federal Listing or Loss of Viability** determination is made for yellow lance. Populations of this species were not identified at any of the Project stream crossings, and the closest known population (according to the VDGIF WERMS database) occurs in Craig Creek downstream of the confluence with Barbours Creek approximately 58 stream kilometers (36.0 mi) downstream of the Project area. However, given the known presence of the species within the Upper Johns Creek Subwatershed (0208020011101), a similarly sized watershed adjacent to the Trout Creek-Craig Creek Subwatershed, suitable habitat for the species may exist closer to the Project area. The species is known to occupy the Upper James River (HUC Code 02080201) subbasin; however, it typically inhabits relatively large creeks and small rivers. The biggest threat to the yellow lance includes temporary sedimentation increases within potentially suitable habitat downstream of the Project area. Acute siltation events and chronic turbidity have been documented to reduce growth rates and survivability in other mussel species. According to the *Hydrologic Analysis of Sedimentation* conducted in support of this BE (ESI 2017), increased sedimentation rates in excess of 10 percent are not expected to occur outside the negative survey extent for the Project. More than 20 mussel survey records exist in the aforementioned subwatershed (including past records upstream and downstream of the Project crossing and mussel surveys associated with the Project); however, no yellow lance have been collected.

5.2.9 Atlantic Pigtoe (*Fusconaia masoni*)

The Atlantic pigtoe, a freshwater unionid mussel, is typically found in swift, clean, and well-oxygenated streams, larger in size (e.g., large creek to medium-sized river) with gravel and sand substrates (Terwilliger 1991). This species was designated as state threatened in Virginia in January 1987 and designated as a federal candidate species November 15, 1994 (USFWS 1994). This species is one of the Atlantic slope unionids that prefers to inhabit the upper parts of rivers, usually above the geological boundary, typically denoted by rapids or a waterfall, between an upland region and a plain (i.e., fall line).

A **May Impact Individuals – Is Not Likely to Cause a Trend Toward Federal Listing or Loss of Viability** determination is made for Atlantic pigtoe. Populations of this species were not identified at any of the Project stream crossings, and the closest known population (according to the VDGIF WERMS database) occurs in Craig Creek downstream of the confluence with Johns Creek approximately 48.6 stream kilometers (30.2 mi) downstream of the Project Area. However, given the known presence of the species within the Upper Johns Creek Subwatershed (0208020011101), a similarly sized watershed adjacent to the Trout Creek-Craig Creek Subwatershed, suitable habitat for the species may exist closer to the Project Area. The species is known to occupy the Upper James River (02080201) subbasin; however, it typically inhabits relatively large creeks and small rivers. The biggest threat to the Atlantic pigtoe includes temporary sedimentation increases within potentially suitable habitat downstream of the Project area. Acute siltation events and chronic turbidity have been documented to reduce growth rates and survivability in other mussel species. According to the *Hydrologic Analysis of Sedimentation* conducted in support of this BE (ESI 2017), increased sedimentation rates are not expected to occur outside of the Trout Creek-Craig Creek Subwatershed, and the cumulative impact area (i.e., areas with a 10 percent increase or more in sediment load) is confined to the negative survey area. According to the VDGIF WERMS database, more than 20 mussel survey events occurred in the Trout Creek-Craig Creek Subwatershed (including past records upstream and downstream of the Project crossing and mussel surveys associated with the Project); however, no Atlantic pigtoe have been collected.

5.2.10 Candy Darter (*Etheostoma osburni*)

The candy darter, a benthic fish species that is a candidate for federal listing as endangered or threatened, is considered rare in Virginia. Adults inhabit unsilted runs, riffles, and swift pockets of current in and around large rubble and boulders. Candy darters are threatened by degraded water quality resulting primarily from siltation, stocked trout, and habitat disturbance by recreationists (i.e., anglers walking through possible spawning site) (Leftwich et al. 1996). Their range includes the New River drainage, in the Ridge and Valley of Virginia, and the Appalachian Plateaus of West Virginia. In Virginia, they are commonly found in Big Stony Creek (also referred to as Stony Creek), perhaps solely above the gypsum plant at Kimbalton (Leftwich et al. 1996). They are extremely localized in Laurel Fork and Clear Creek of the Wolf Creek system and Dismal Creek. They are also known from Reed, Big Walker, Little Stony, and Sinking creeks, and Spruce and Pine runs (Jenkins and Burkhead 1994).

A **May Impact Individuals – Is Not Likely to Cause a Trend Toward Federal Listing or Loss of Viability** determination is made for the candy darter. Potentially suitable habitat and populations are likely at the Project crossings of Stony Creek near JNF as well as downstream of the Project area in the New River. Extensive surveys in 1995 in Stony Creek demonstrated that the species was distributed throughout the upper portion (i.e., upstream of the gypsum plant of Stony Creek) (Leftwich et al. 1996). The proposed Project crossing occurs downstream of the gypsum plant at Kimbalton and presumably downstream of the candy darter population. The Project crosses Stony Creek approximately 1.9 kilometers (1.2 mi) upstream of the confluence with the New River, thereby limiting the potential for sedimentation impacts only to fish populations in the lower portions of Stony Creek. The increased river discharge of the New River will help facilitate the dilution of potential sedimentation effects if they are to occur. The biggest threat to the candy darter from Project development and operation would be temporary destabilization or removal of localized substrates. Fish removal surveys are proposed to occur in Virginia at each perennial stream crossing immediately prior to construction. Therefore, all fishes will be removed from the instream construction footprint, limiting the potential for a direct take of individuals, if present. Downstream populations of candy darter may potentially experience minimal and temporary indirect effects in the form of sedimentation as a result of upland and instream construction activities; however, the implementation of erosion and sediment control measures is expected to limit such impacts. According to the Hydrologic Analysis of Sedimentation conducted in support of this BE (ESI 2017), sediment loads originating from the Project are expected to be less than 10 percent above baseline within this portion of Stony Creek. The Project crossing of Stony Creek is downstream of Kimbalton and therefore downstream of suitable habitats that occur on JNF. Due to avoidance of suitable habitats, implementation of erosion and sediment control measures during construction, and adherence to time-of-year restrictions (TOYR), the Project is not likely to cause a trend toward federal listing or a loss of viability for this species.

5.2.11 Roughhead Shiner (*Notropis semperasper*)

The roughhead shiner is a medium-sized minnow with an elongated body and pointed dorsal and anal fins with falcate margins. This species is endemic to the Ridge and Valley Province of the upper James River watershed (Stauffer et al. 1995). Habitat for the roughhead shiner includes clear rocky pools and backwaters of small to large rivers (Page et al. 2011) as well as cool to warm clear pristine streams with moderate gradient, hard bottom, and little siltation. This species prefers moderate currents of runs but can occasionally be found in swifter water (Jenkins and Burkhead 1994).

A **May Impact Individuals – Is Not Likely to Cause a Trend Toward Federal Listing or Loss of Viability** determination is made for the roughhead shiner. The Project traverses Craig Creek in the Trout Creek-Craig Creek subwatershed. Craig Creek is known to support populations of roughhead shiner; however, all known occurrence records (according to the VDGIF WERMS database) are approximately 27.1 kilometers (16.9 mi) downstream of the Project crossing and outside of the Trout Creek-Craig Creek subwatershed. Therefore, direct effects to the species are unlikely. Fish removal surveys are proposed to occur at each perennial stream crossing in Virginia immediately prior to construction. Therefore, all fishes will be removed from the instream construction footprint, limiting the potential for a direct take of individuals, in the unlikely event that roughhead shiner is present. The biggest threat to the roughhead shiner would involve temporary sedimentation increases within potentially suitable habitat downstream of the Project area. The implementation of erosion and sediment control measures is expected to reduce the sedimentation yields in the Trout Creek-Craig Creek subwatershed; however, elevated sedimentation rates are predicted to occur for approximately 0.47 kilometer (0.29 mi) within Craig Creek and 3.09 kilometers (1.92 mi) within unnamed tributaries (Table 4). Given that the closest known occurrence of the Roughhead shiner is approximately 27.1 kilometers (16.9 mi) downstream of the Project area, any potential impacts are expected to be minimal and temporary and not likely to cause a trend toward federal listing or a loss of viability for this species.

5.2.12 Orangefin Madtom (*Noturus gilberti*)

The orangefin madtom has a long, slender body and a flattened head ranging in length from 5 to 7.6 centimeters (2 to 3 in). It is olive to brown in color on the dorsal side, and yellow to white on the ventral side, with yellow to white edges on its fins. The species occurs in rocky riffles in small swift-moving rivers and streams. The species typically spawns in 10 to 20 degree Celsius water from April through May. Orangefin madtom is a federal species of concern and is considered a state-threatened species in Virginia.

A **May Impact Individuals – Is Not Likely to Cause a Trend Toward Federal Listing or Loss of Viability** determination is made for the orangefin madtom. Two distinct populations of this species occur in Virginia: a native population in the Roanoke River drainage and an introduced population in the James River drainage. The Project traverses both drainages and is therefore within the range of both populations. The species is known to occupy the Upper James River (HUC Code 02080201) and Upper Roanoke River (HUC Code 03010101) subbasins; however, there are no collections of the species within the Trout Creek-Craig Creek or Dry Run-North Fork Roanoke River subwatersheds. The native population in the Roanoke River subbasin is not likely to occur on JNF lands; however, the introduced population in Craig Creek is known to occur immediately downstream of the Trout Creek-Craig Creek subwatershed. Fish removal surveys are proposed to occur at each perennial stream crossing in Virginia immediately prior to construction. Therefore, all fishes will be removed from the instream construction footprint, limiting the potential for a direct take of individuals, if present. The biggest threat to the orangefin madtom would involve temporary sedimentation increases within potentially suitable habitat downstream of the Project area. The implementation of erosion and sediment control measures is expected to reduce the sedimentation yields in the Trout Creek-Craig Creek subwatershed; however, elevated sedimentation rates are predicted to occur for approximately 0.47 kilometer (0.29 mi) within Craig Creek and 3.09 kilometers (1.92 mi) within unnamed tributaries (Table 4). Project-related impacts may potentially affect individuals and potentially suitable habitats of the introduced population in the Trout Creek-Craig Creek subwatershed. Any impacts are expected to be minimal and temporary and not likely to cause a trend toward federal listing or a loss of viability for this species.

5.2.13 Kanawha Minnow (*Phenacobius teretulus*)

The Kanawha minnow is an elongate, slender minnow with a dark dorsal, greenish sides, a pale, silvery underside and orange-tinged fins and tail. This species is endemic to the New River system of North Carolina, Virginia, and West Virginia. This species prefers the riffles and runs over bedrock or boulder substrates in medium-sized rivers (Stauffer et al. 1995). The species is known to occupy the Middle New River (HUC 05050002) subbasin; however, according the VDGIF WERMS database, the species has only been captured in a few localities within the subbasin.

A **May Impact Individuals – Is Not Likely to Cause a Trend Toward Federal Listing or Loss of Viability** determination is made for the Kanawha minnow. According to the VDGIF WERMS database, the closest known population occurs within the Little River drainage, a tributary of the New River located upstream and outside of the Project Area; therefore, direct effects to the species are not expected. Fish removal surveys are proposed to occur at each perennial stream crossing in Virginia immediately prior to construction. Therefore, all fishes will be removed from the instream construction footprint, limiting the potential for a direct take of individuals, in the unlikely event the species is present. The biggest threat to the Kanawha minnow would involve temporary sedimentation increases within potentially suitable habitat downstream of the Project area; however, with the exception of Rich Creek, impacts to waterbodies within the New drainage are largely confined to smaller waterbodies where the Kanawha minnow is unlikely to occur (Stauffer et al. 1995). Due to avoidance of suitable habitats and implementation of erosion and sediment control measures during construction, the Project is not likely to cause a trend toward federal listing or a loss of viability for this species.

5.2.14 Green Floater (*Lasmigona subviridis*)

The green floater, state-threatened in Virginia, is a small freshwater mussel, typically less than 5.1 centimeters (2 in). It has a trapezoidal to subovate shape, and is yellow-green in color. This species mainly occurs in stagnant pools and other calm-water pockets in 0.3 to 1.2 meters (1 to 4 ft) in depth. It is native to many drainage basins in the United States, including the New and James River basins. The species is typically found in clear pool habitats of streams of varying sizes with substrates of gravel and sand. The species is known to occupy the Middle New River (HUC Code 05050002) and Upper James River (HUC Code 02080201) subbasins.

A May Impact Individuals – Is Not Likely to Cause a Trend Toward Federal Listing or Loss of Viability determination is made for green floater. Mussel surveys were performed at stream crossings, known or with potential to, support freshwater mussels in Virginia and West Virginia. Green floater mussels were not encountered during surveys; therefore, a direct take of individuals is unlikely. Green floater populations may occur both upstream and downstream of JNF land, particularly within Stony Creek. According to the VDGIF WERMS database, the closest known occurrence of green floater within the Upper James occurs outside of the Craig Creek drainage. However, within the Middle New, relic shells have been collected in relative proximity to the Project, but only within the New River between Little Stony Creek and Stony Creek (Pinder et al. 2002). Although no individuals have been collected within Stony Creek, the drainage area may be large enough to contain the species, and suitable habitat was available at the crossing when assessed for the Project. The proposed Project crosses Stony Creek approximately 1.9 kilometers (1.2 mi) upstream of the confluence with the New River thereby, limiting potential sedimentation impacts only to populations (if present) in the lower portions of Stony Creek. According to the Hydrologic Analysis of Sedimentation conducted in support of this BE (ESI 2017), sediment loads originating from the Project are expected to be less than 10 percent above baseline within this portion of Stony Creek. Acute siltation events and chronic turbidity have been documented to reduce growth rates and a lack of survivability in other mussel species. Any impacts are expected to be minimal and temporary and not contribute to reduced growth rates and a lack of survivability.

5.2.15 Green-faced Clubtail (*Gomphus viridifrons*)

The green-faced clubtail is a small, primarily black dragonfly with a clear gray-green face. It prefers clean, small to large highly oxygenated streams with a moderate current. The larval (i.e., nymph) stages of the species prefers substrates that consist of gravel-sand and lightly silted rocks. This species has an extremely local distribution, slightly under 50 counties across approximately 15 states (Dunkle 2000).

A **May Impact Individuals – Is Not Likely to Cause a Trend Toward Federal Listing or Loss of Viability** determination is made for green-faced clubtail. The proposed alignment traverses streams within the known range of the green-faced clubtail and some streams may support populations of the species. Populations of the species (nymph stages) may occur at Project stream crossing locations where a direct take of individuals could occur, and downstream of construction activities, nymphs (if present) may be subject to sedimentation issues. Adults are highly mobile and are likely able to avoid direct mortality by construction activities within the Project area. Green-faced clubtail exhibits a broad geographic distribution across numerous regions and states and any potential indirect effects due to temporary sedimentation are not likely to cause a trend toward federal listing or a loss of viability for this species.

5.2.16 Allegheny Snaketail (*Ophiogomphus incurvatus alleganiensis*)

The Allegheny snaketail is a dragonfly that requires riffle areas of spring-fed piedmont streams for nymph growth and seems to prefer shallow waters where gravel lies over soft mud. It has been found in Monroe County, West Virginia but is considered to be possibly extirpated from Giles County, Virginia along the proposed alignment (Schweitzer 1989, Needham et al. 2000).

A **May Impact Individuals – Is Not Likely to Cause a Trend Toward Federal Listing or Loss of Viability** determination is made for Allegheny snaketail. The proposed alignment traverses streams within the known range of the green-faced clubtail and some streams may support populations of the species. Populations of the species (nymph stages) may occur at Project stream crossing locations where a direct take of individuals could occur, and downstream of construction activities, nymphs (if present) may therefore be subject to sedimentation issues. Adults are highly mobile and are likely able to avoid direct mortality by construction activities. An overall lack of distribution and life history information for the species makes it difficult to provide an accurate effects determination for this species; however, any potential effects are not expected to cause a trend toward federal listing or a loss of viability of this species.

6.0 Recommendations for Removing, Avoiding, or Compensating for Adverse Effects and Impacts

Project-wide mitigation measures are included in Appendix G. Conservation measures to avoid and minimize the potential for adverse effects from construction, operation, and maintenance activities on federally listed species and their suitable habitat will be detailed in the BA whereas such measures for Forest Service Sensitive Species are provided below.

6.1 Eastern Small-footed Bat

Notifications will be made to JNF biologists and the appropriate federal and state agencies if undocumented caves, mine openings, or rock outcrops are observed during construction activities. These openings will be assessed for use by bats and conservation measures will be implemented based on coordination with JNF and the respective agencies.

6.2 Rock Skullcap

The construction footprint through the rock skullcap area will be reduced to 23 meters (75 ft) to minimize impact to the species. Additionally, seeds from existing rock skullcap plants will be collected prior to construction. These seeds will be planted during the appropriate time of year upon the completion of construction activities in locations determined in consultation with the USFS.

6.3 Forest Service Sensitive Fishes

The proposed alignment traverses streams within the known range of the candy darter, roughhead shiner, orangefin madtom, and Kanawha minnow. Avoidance and minimization measures will be implemented to prevent adverse effects to the species. In Virginia, fish removal surveys will occur prior to instream construction to prevent a direct take of individuals. Instream construction activities will be scheduled in accordance with the Virginia TOYR at streams potentially supporting sensitive fish populations. The TOYR for Roanoke logperch and roughhead shiner are March 15 to June 30, and March 15 to May 31 for orangefin madtom within its native range (Roanoke River drainage). The native population of orangefin madtom in the Roanoke River subbasin is not likely to occur on JNF lands or in subwatersheds immediately downstream. Adhering to TOYR guidelines will help avoid elevated turbidity and sedimentation in the streams during critical autecological time periods (e.g., spawning, egg development, larval development) and help facilitate survival and proliferation of populations. To further minimize potential adverse indirect effects of sedimentation to the species, strict erosion and sediment control measures will be implemented. The quality of these control measures will be instrumental in reducing sediment yields to all streams, particularly those watersheds expected to exceed baseline conditions (i.e., Stony Creek, Clendenin Creek – Bluestone Lake, and Trout Creek – Craig Creek).

6.4 Forest Service Sensitive Mussels

The proposed alignment traverses streams within the known range of the yellow lance, Atlantic pigtoe, and green floater. Avoidance and minimization measures will be implemented to prevent adverse effects to the species. Mussels were not located at stream crossings in the vicinity of JNF therefore occupied habitats are avoided, and there will not be a direct take of individuals. Instream construction activities will be scheduled in accordance with the Virginia TOYR in streams potentially supporting mussel populations of these species. Adhering to TOYR guidelines for short-term brooding mussels (e.g., yellow lance and Atlantic pigtoe) between May 15 and July 31 and long-term brooding mussels (e.g., green floater) between April 15 to July 15 and August 15 to September 30, will help avoid elevated turbidity and sedimentation in the streams during critical autecological time periods (e.g., spawning, glochidia liberation, juvenile development) and help facilitate survival and proliferation of populations. To further minimize potential adverse indirect effects of sedimentation to downstream mussel populations, strict erosion and sediment control measures will be implemented. The quality of these control measures will be instrumental in reducing sediment yields to all streams, particularly those watersheds expected to exceed baseline conditions (i.e., Stony Creek, Clendenin Creek – Bluestone Lake, and Trout Creek – Craig Creek).

6.5 Forest Service Sensitive Dragonflies

The proposed alignment traverses habitats (i.e., nymph and adult) within the known range of the green-faced clubtail and Allegheny snaketail. To minimize direct mortality to adults by vehicle, slow speed limits along constructed access roads will be established. To further minimize potential adverse indirect effects of sedimentation to nymphs, strict erosion and sediment control measures will be implemented. The quality of these control measures will be instrumental in reducing sediment yields to all streams, particularly those watersheds expected to exceed baseline conditions (i.e., Stony Creek, Clendenin Creek – Bluestone Lake, and Trout Creek – Craig Creek).

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APPENDIX A
FIGURES

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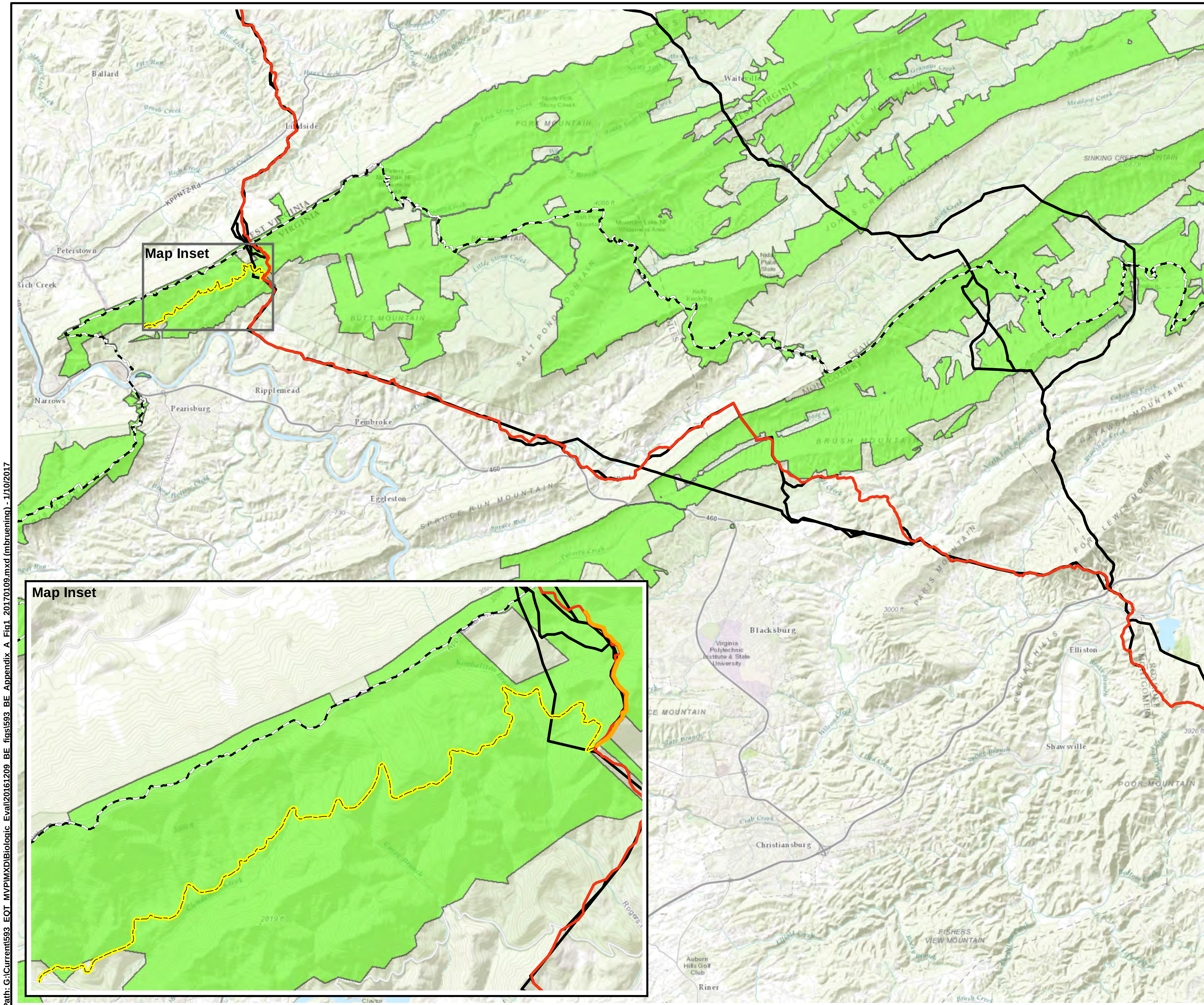

Figure 1. Potential routes for the Proposed Mountain Valley Pipeline within the Jefferson National Forest in Virginia and West Virginia.

- October 2016 Proposed Route (Revised)
- Appalachian National Scenic Trail
- Mystery Ridge Road
- Pocahontas Road
- MVP Abandoned/Alternate Route
- Jefferson National Forest Boundary

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Base Map: ESRI ArcGIS Web service - "US TOPO MAPS" accessed - 1/10/2017

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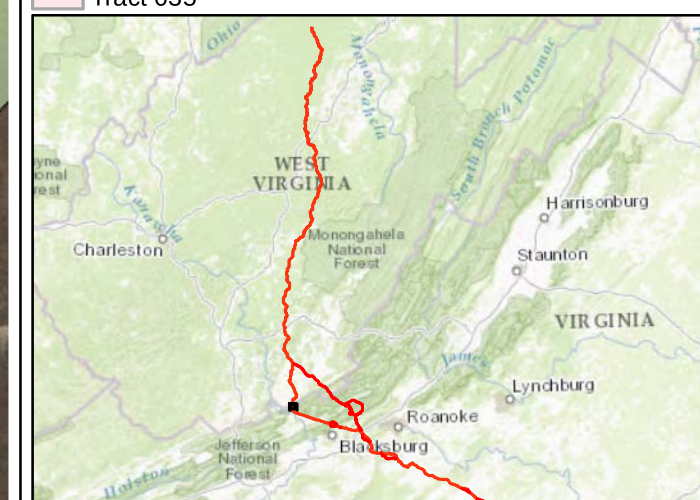
Figure 2. Tracts identified along MVP's proposed alignment and previous alternatives for the Mountain Valley Pipeline Project within the Jefferson National Forest in Virginia and West Virginia.

Map 1 of 12

- October 2016 Proposed Route (Revised)
- MVP Abandoned/Alternate Route
- Mystery Ridge Road
- Pocahontas Road
- Appalachian National Scenic Trail
- Jefferson National Forest Boundary

Tract Identified on Jefferson National Forest Land

- Tract 001
- Tract 002
- Tract 003
- Tract 004
- Tract 007
- Tract 008
- Tract 009
- Tract 010
- Tract 011
- Tract 032
- Tract 033
- Tract 035



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Base Map: ESRI ArcGIS Web service - "World_Imagery" accessed - 1/10/2017

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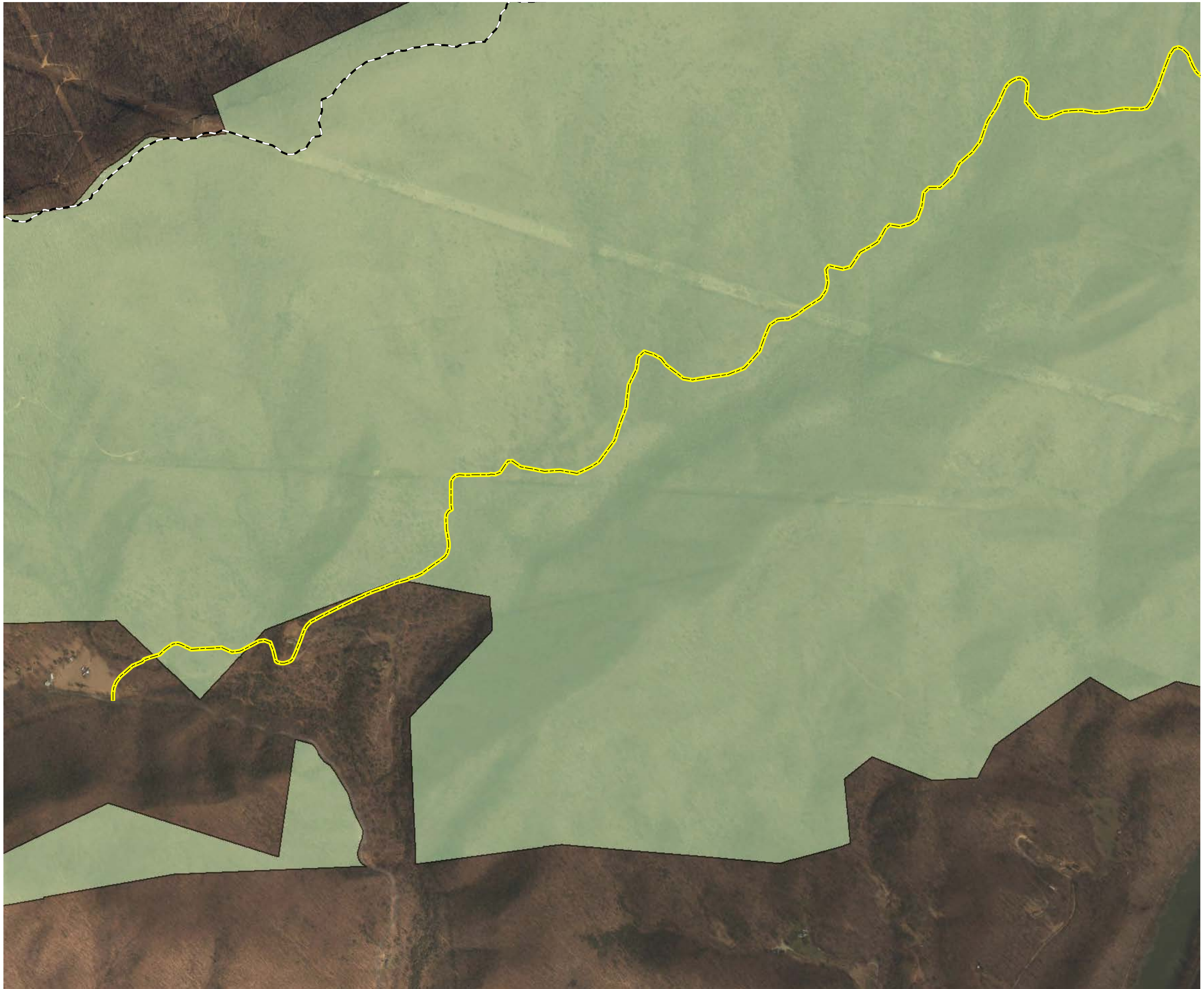
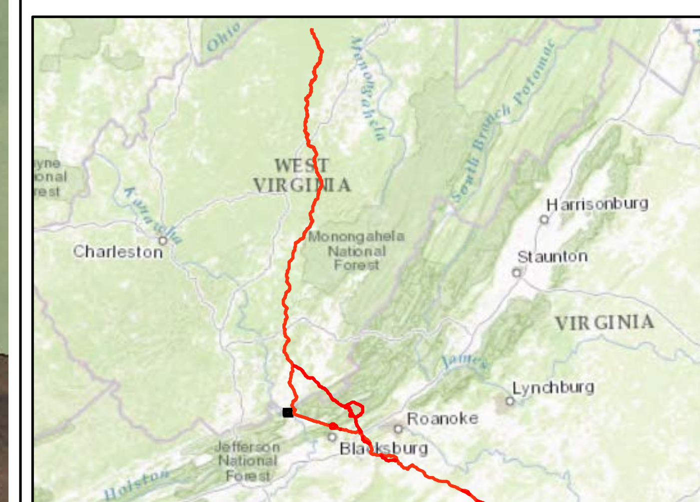
Figure 2. Tracts identified along MVP's proposed alignment and previous alternatives for the Mountain Valley Pipeline Project within the Jefferson National Forest in Virginia and West Virginia.

Map 2 of 12



Pocahontas Road
Appalachian National Scenic Trail
Jefferson National Forest Boundary



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Base Map: ESRI ArcGIS Web service - "World_Imagery" accessed - 1/10/2017

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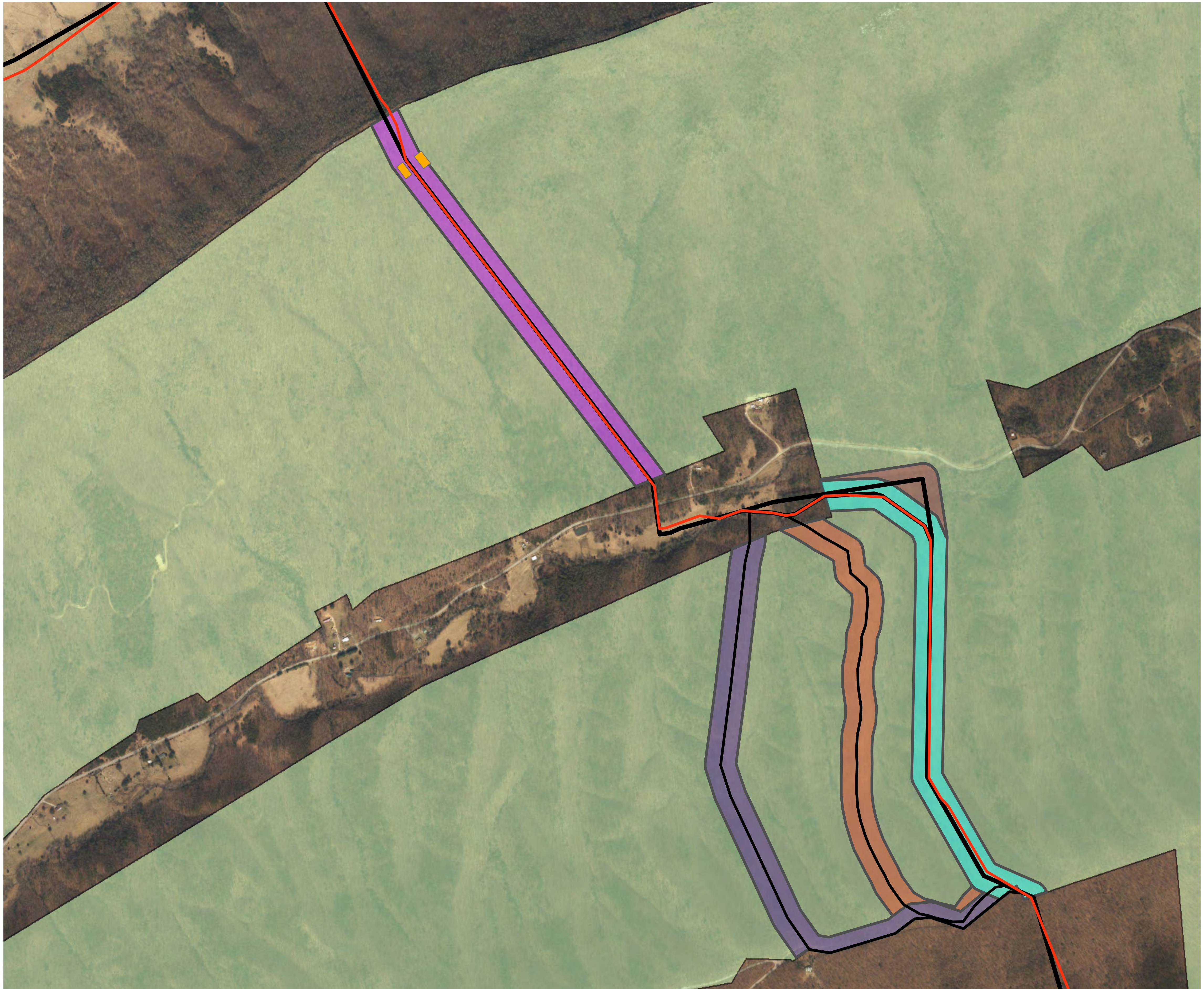
Figure 2. Tracts identified along MVP's proposed alignment and previous alternatives for the Mountain Valley Pipeline Project within the Jefferson National Forest in Virginia and West Virginia.

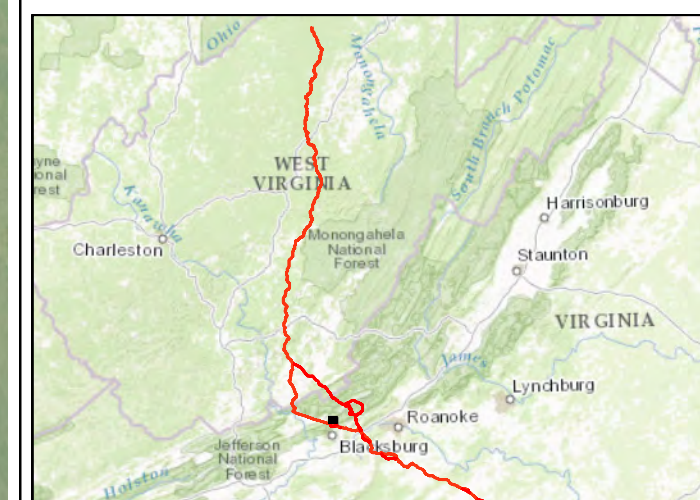
Map 3 of 12



- October 2016 Proposed Route (Revised)
- MVP Abandoned/Alternate Route
- Jefferson National Forest Boundary
- Proposed All Temporary Workspace

Tract Identified on Jefferson National Forest Land

- Tract 005
- Tract 006
- Tract 034
- Tract 036
- Tract 037



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Base Map: ESRI ArcGIS Web service - "World_Imagery" accessed - 1/10/2017

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Project No. 593.02

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Figure 2. Tracts identified along MVP's proposed alignment and previous alternatives for the Mountain Valley Pipeline Project within the Jefferson National Forest in Virginia and West Virginia.

Map 4 of 12

MVP Abandoned/Alternate Route

Jefferson National Forest Boundary

Tract Identified on Jefferson National Forest Land

Tract 012

Tract 013

Tract 014

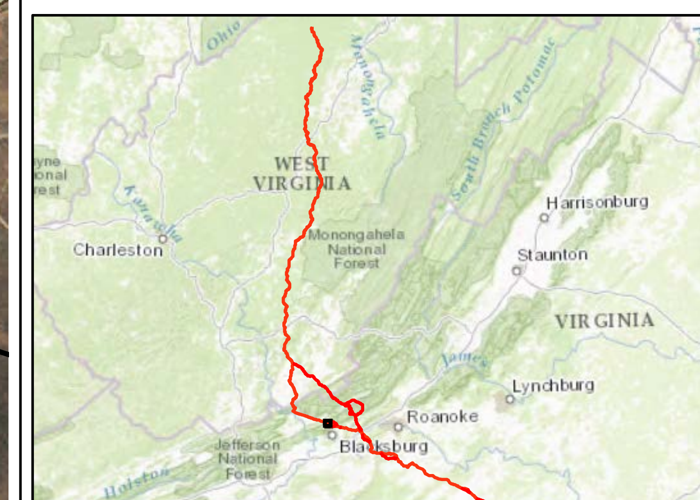

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Figure 2. Tracts identified along MVP's proposed alignment and previous alternatives for the Mountain Valley Pipeline Project within the Jefferson National Forest in Virginia and West Virginia.

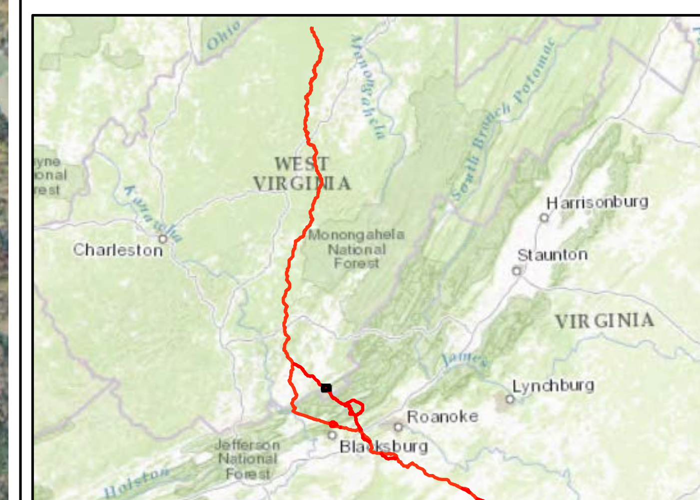
Map 5 of 12

MVP Abandoned/Alternate Route

Jefferson National Forest Boundary

Tract Identified on Jefferson National Forest Land

Tract 015



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Project No. 593.02

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Figure 2. Tracts identified along MVP's proposed alignment and previous alternatives for the Mountain Valley Pipeline Project within the Jefferson National Forest in Virginia and West Virginia.

Map 6 of 12

MVP Abandoned/Alternate Route
Jefferson National Forest Boundary
Tract Identified on Jefferson National Forest Land
Tract 016
Tract 017
Tract 018

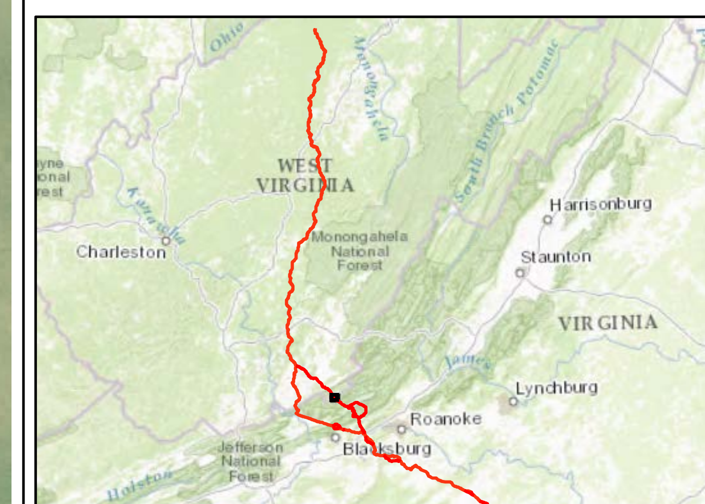

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Figure 2. Tracts identified along MVP's proposed alignment and previous alternatives for the Mountain Valley Pipeline Project within the Jefferson National Forest in Virginia and West Virginia.

Map 7 of 12

MVP Abandoned/Alternate Route

Jefferson National Forest Boundary

Tract Identified on Jefferson National Forest Land

Tract 019

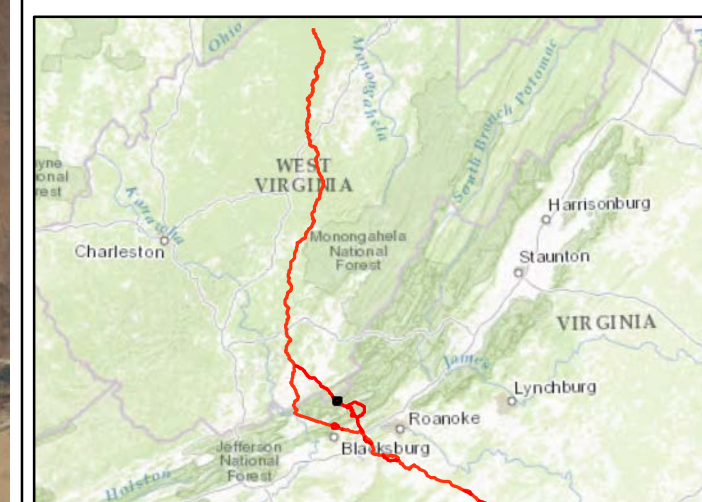

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Figure 2. Tracts identified along MVP's proposed alignment and previous alternatives for the Mountain Valley Pipeline Project within the Jefferson National Forest in Virginia and West Virginia.

Map 8 of 12

- MVP Abandoned/Alternate Route
- Jefferson National Forest Boundary

Tract Identified on Jefferson National Forest Land

- Tract 020

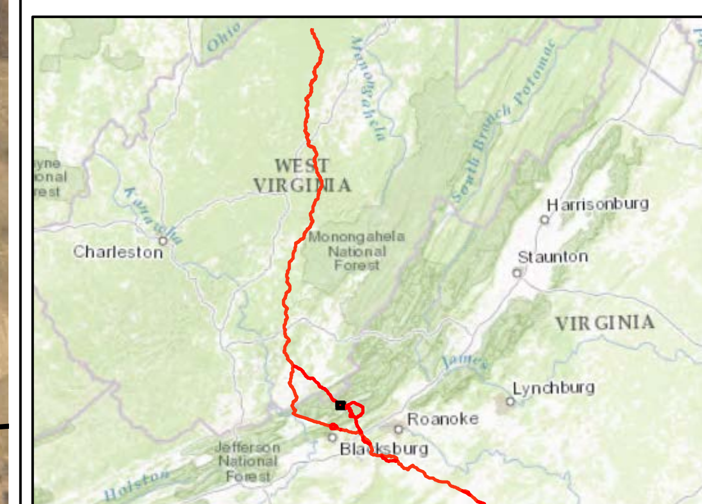

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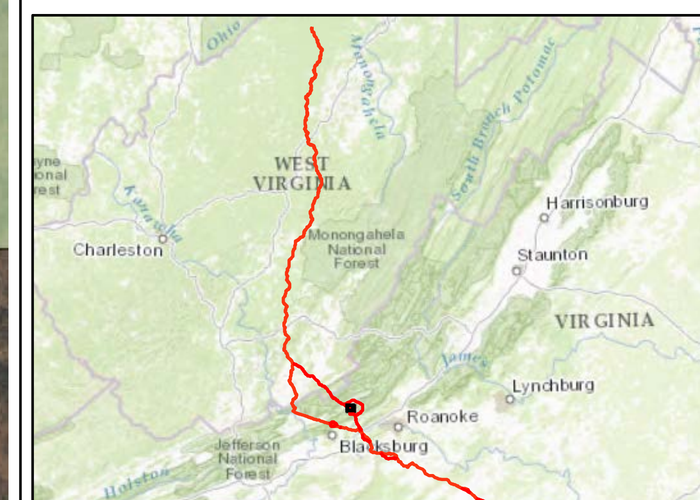
Figure 2. Tracts identified along MVP's proposed alignment and previous alternatives for the Mountain Valley Pipeline Project within the Jefferson National Forest in Virginia and West Virginia.

Map 9 of 12

- MVP Abandoned/Alternate Route
- Appalachian National Scenic Trail
- Jefferson National Forest Boundary

Tract Identified on Jefferson National Forest Land

- Tract 021
- Tract 022
- Tract 026



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Project No. 593.02

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Figure 2. Tracts identified along MVP's proposed alignment and previous alternatives for the Mountain Valley Pipeline Project within the Jefferson National Forest in Virginia and West Virginia.

Map 10 of 12

MVP Abandoned/Alternate Route

Jefferson National Forest Boundary

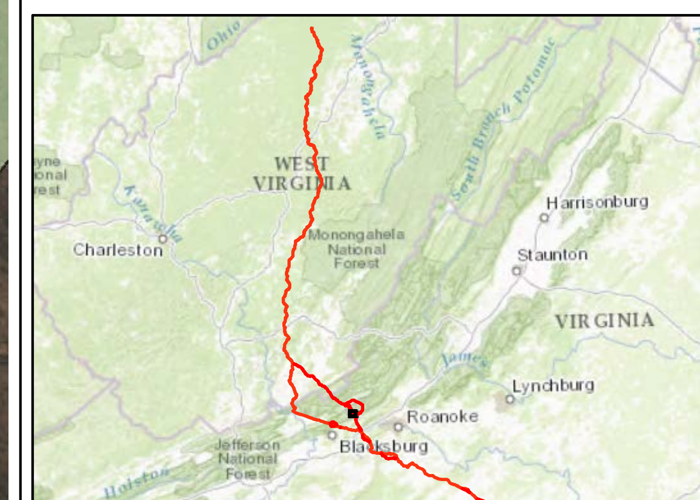
Tract Identified on Jefferson National Forest Land

Tract 023

Tract 024

Tract 025

Tract 027



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Project No. 593.02

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Figure 2. Tracts identified along MVP's proposed alignment and previous alternatives for the Mountain Valley Pipeline Project within the Jefferson National Forest in Virginia and West Virginia.

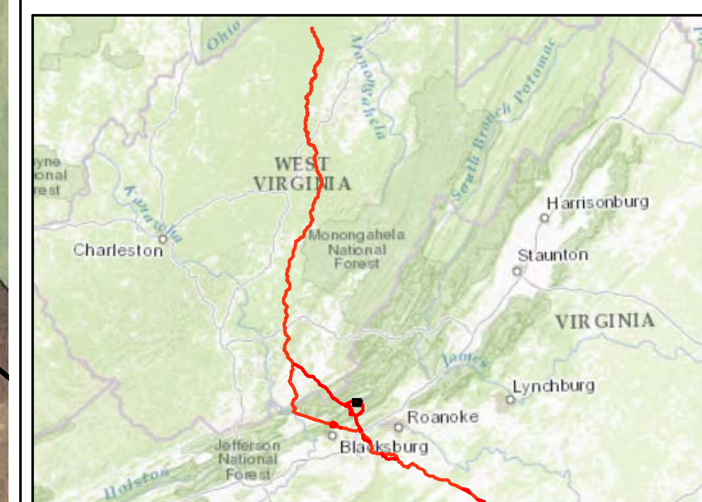
Map 11 of 12

MVP Abandoned/Alternate Route

Jefferson National Forest Boundary

Tract Identified on Jefferson National Forest Land

Tract 028



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Base Map: ESRI ArcGIS Web service - "World_Imagery" accessed - 1/10/2017

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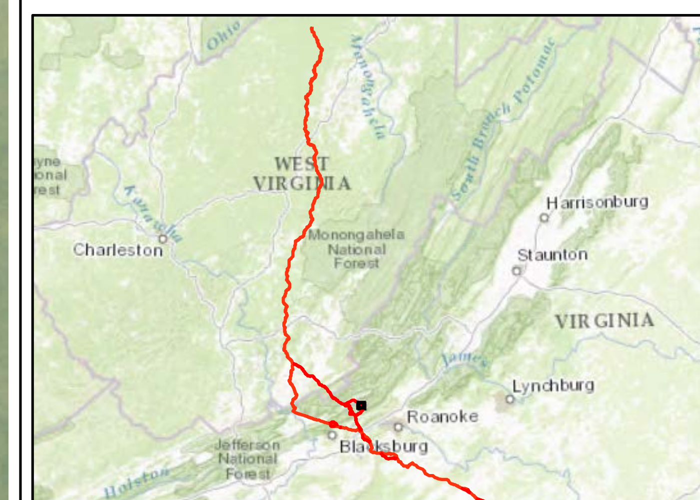
Figure 2. Tracts identified along MVP's proposed alignment and previous alternatives for the Mountain Valley Pipeline Project within the Jefferson National Forest in Virginia and West Virginia.

Map 12 of 12

- MVP Abandoned/Alternate Route
- Appalachian National Scenic Trail
- Jefferson National Forest Boundary

Tract Identified on Jefferson National Forest Land

- Tract 029
- Tract 030
- Tract 031



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Base Map: ESRI ArcGIS Web service - "World_Imagery" accessed - 1/10/2017

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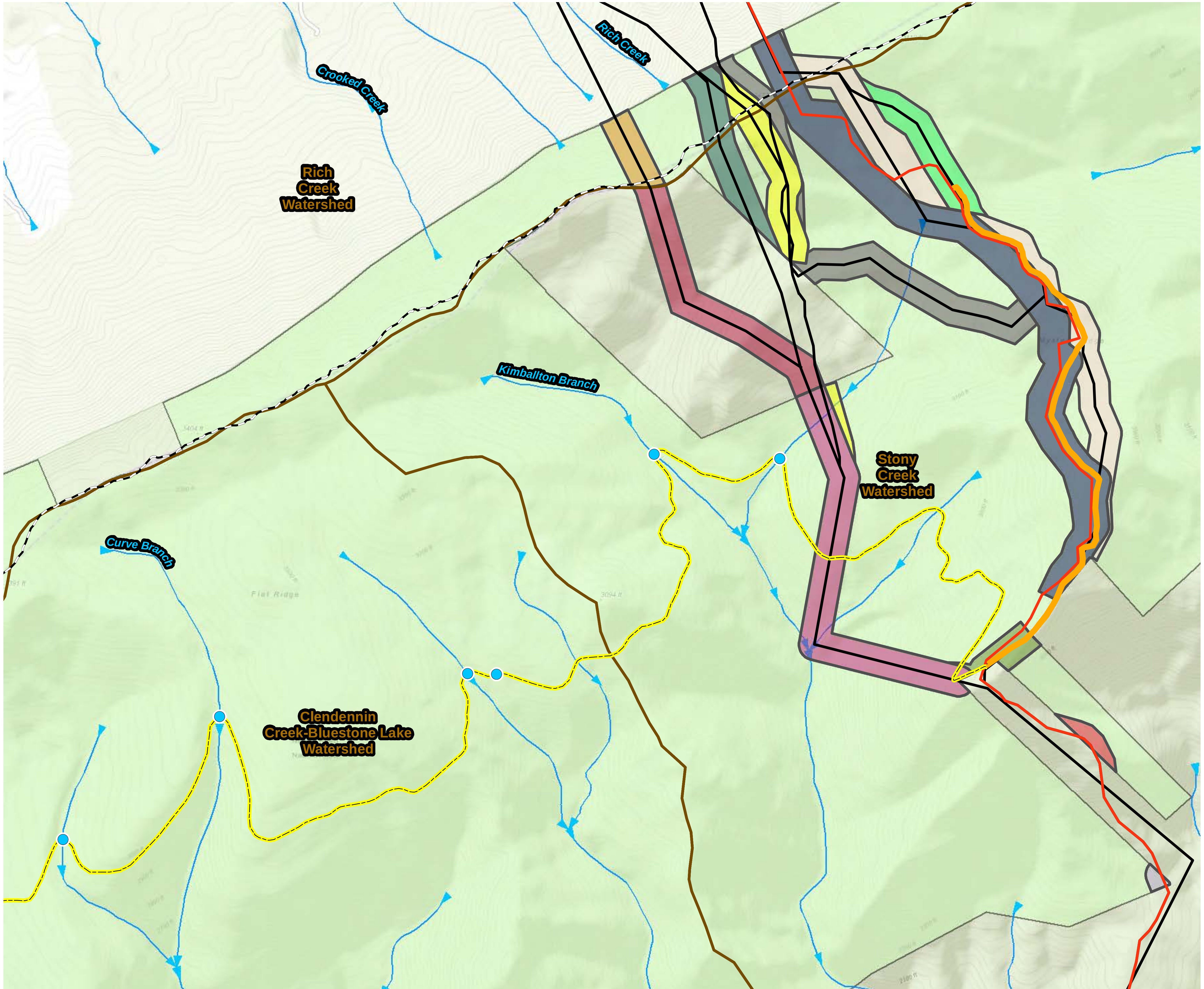


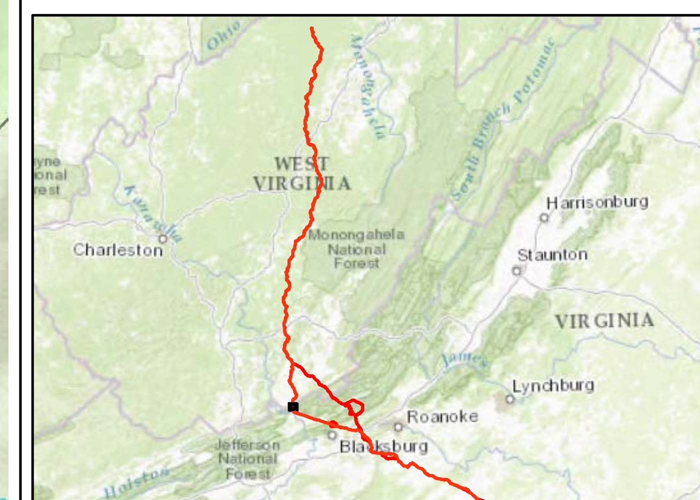
Figure 3. Stream and watershed boundaries for tracts identified along MVP's proposed alignment for the Mountain Valley Pipeline Project within the Jefferson National Forest in Virginia and West Virginia.

Map 1 of 12

- October 2016 Proposed Route (Revised)
- MVP Abandoned/Alternate Route
- Identified Stream Crossing on Jefferson National Forest Land
- Appalachian National Scenic Trail
- Mystery Ridge Road
- Pocahontas Road
- National Hydrography Dataset Flowline
- National Hydrography Dataset HUC12 Watershed Boundary
- Jefferson National Forest Boundary

Tract Identified on Jefferson National Forest Land

Tract 001	Tract 009
Tract 002	Tract 010
Tract 003	Tract 011
Tract 004	Tract 032
Tract 007	Tract 033
Tract 008	Tract 035



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Project No. 593.02

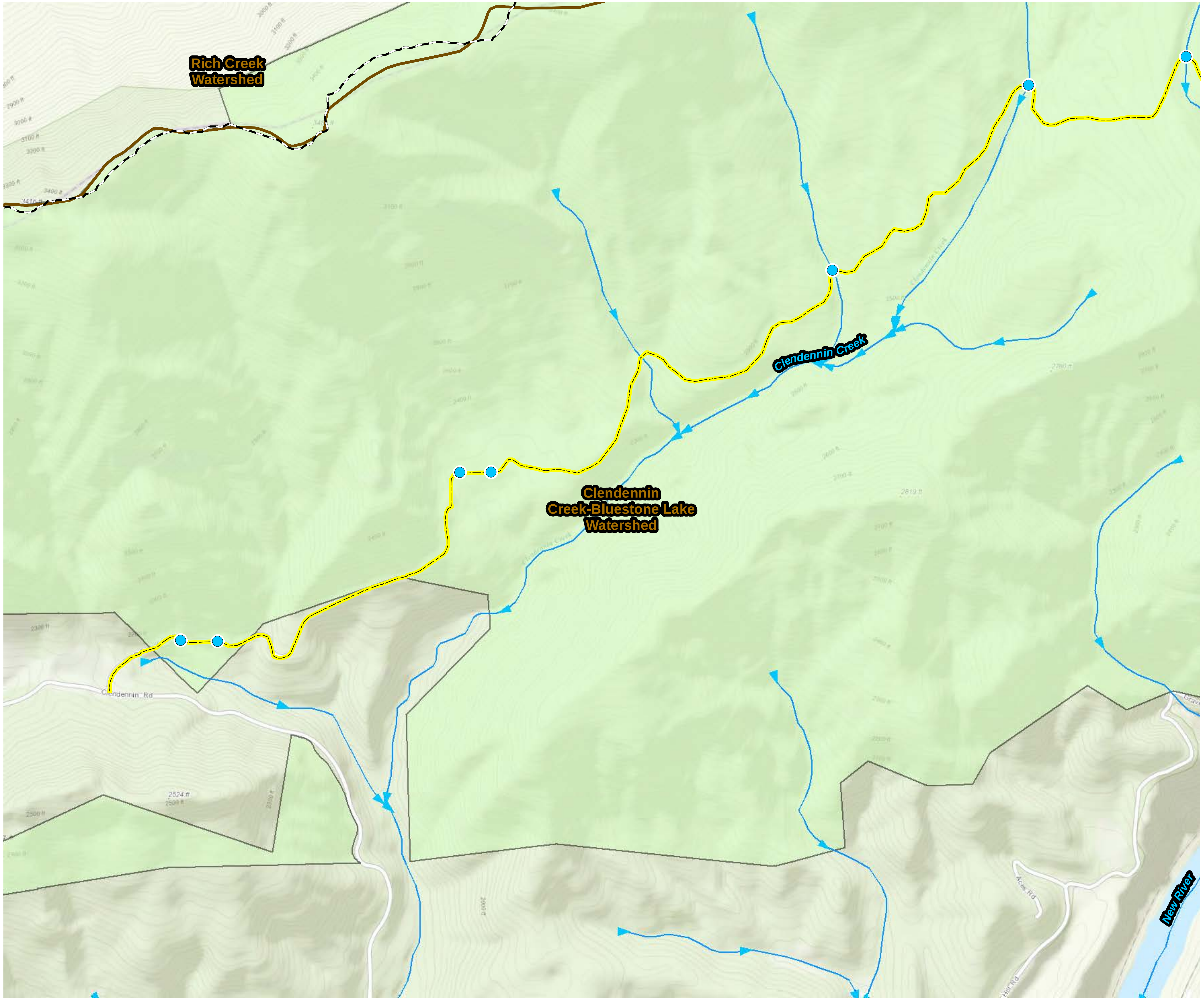
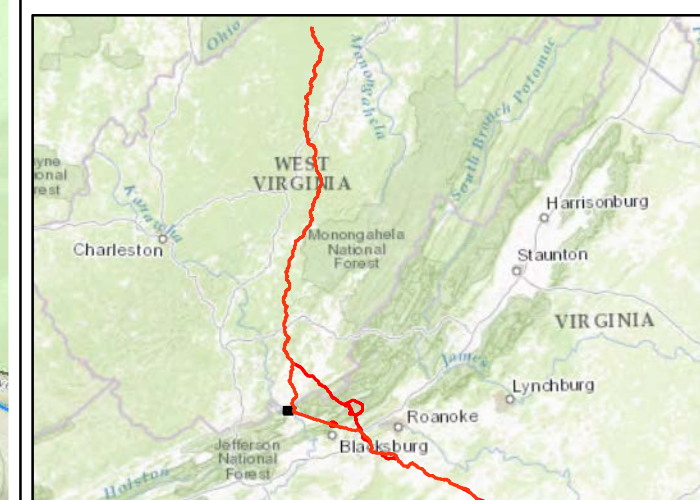


Figure 3. Stream and watershed boundaries for tracts identified along MVP's proposed alignment for the Mountain Valley Pipeline Project within the Jefferson National Forest in Virginia and West Virginia.

Map 2 of 12

- Identified Stream Crossing on Jefferson National Forest Land
- Appalachian National Scenic Trail
- Pocahontas Road
- National Hydrography Dataset Flowline
- National Hydrography Dataset HUC12 Watershed Boundary
- Jefferson National Forest Boundary



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Base Map: ESRI ArcGIS Web service - "US TOPO MAPS" accessed - 1/10/2017

ENVIRONMENTAL SOLUTIONS & INNOVATIONS, INC.

Project No. 593.02

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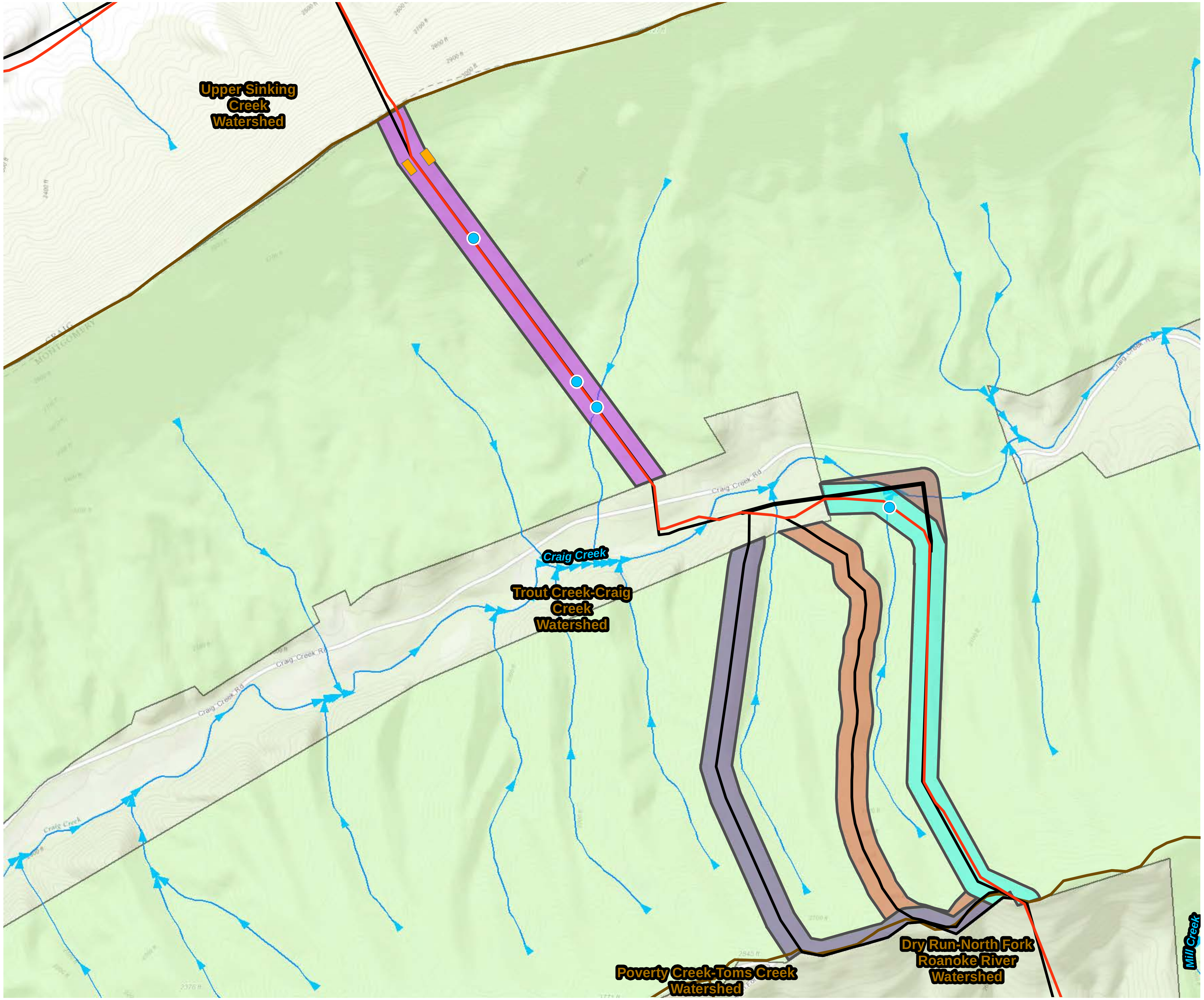
Figure 3. Stream and watershed boundaries for tracts identified along MVP's proposed alignment for the Mountain Valley Pipeline Project within the Jefferson National Forest in Virginia and West Virginia.

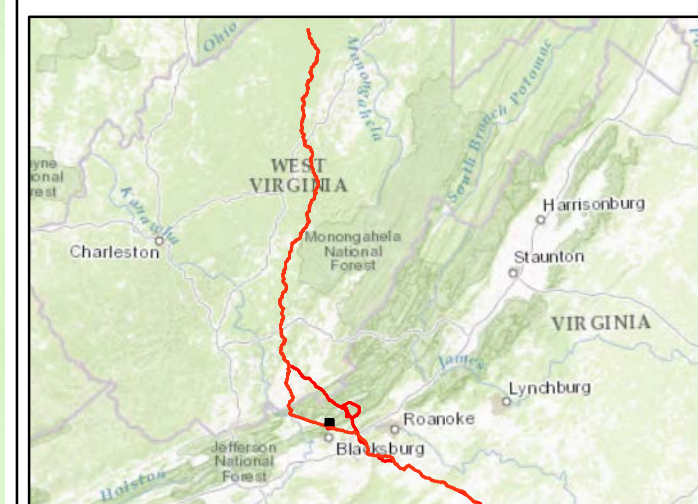
Map 3 of 12



- October 2016 Proposed Route (Revised)
- MVP Abandoned/Alternate Route
- Identified Stream Crossing on Jefferson National Forest Land
- National Hydrography Dataset Flowline
- National Hydrography Dataset HUC12 Watershed Boundary
- Jefferson National Forest Boundary
- Proposed ATWS

Tract Identified on Jefferson National Forest Land

- Tract 005
- Tract 006
- Tract 034
- Tract 036
- Tract 037



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Base Map: ESRI ArcGIS Web service - "US TOPO MAPS" accessed - 1/10/2017

ESI ENVIRONMENTAL SOLUTIONS & INNOVATIONS, INC.

Project No. 593.02

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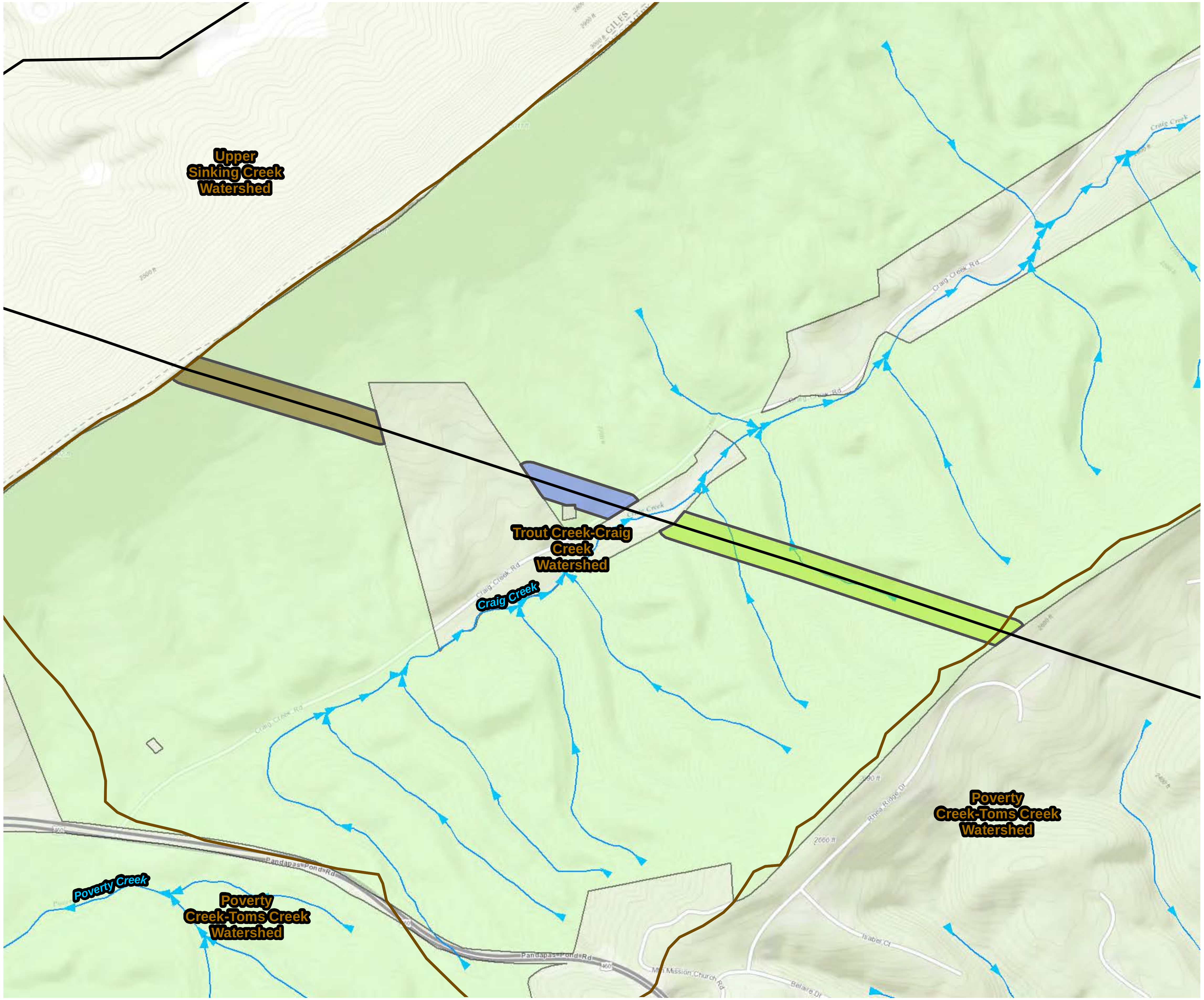
Figure 3. Stream and watershed boundaries for tracts identified along MVP's proposed alignment for the Mountain Valley Pipeline Project within the Jefferson National Forest in Virginia and West Virginia.

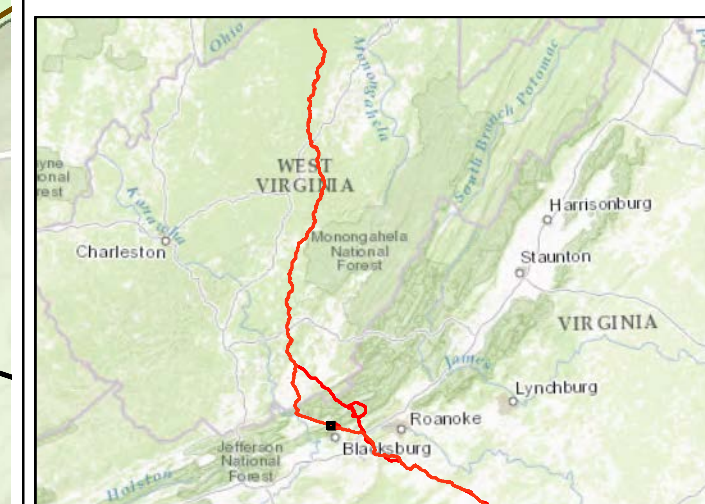
Map 4 of 12



- MVP Abandoned/Alternate Route
- National Hydrography Dataset Flowline
- National Hydrography Dataset HUC12 Watershed Boundary
- Jefferson National Forest Boundary

Tract Identified on Jefferson National Forest Land

- Tract 012
- Tract 013
- Tract 014



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Base Map: ESRI ArcGIS Web service - "US TOPO MAPS" accessed - 1/10/2017

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Project No. 593.02

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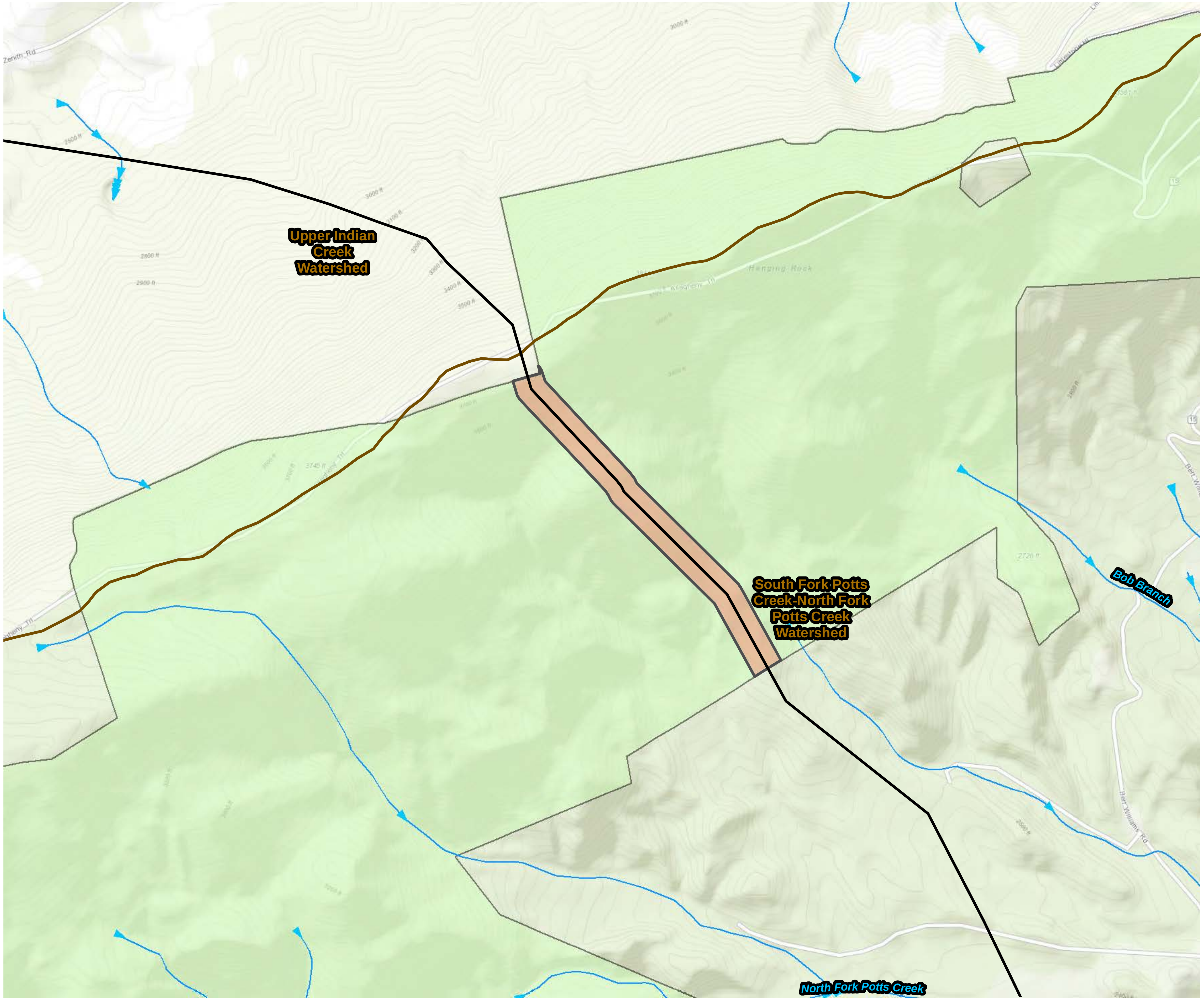

Figure 3. Stream and watershed boundaries for tracts identified along MVP's proposed alignment for the Mountain Valley Pipeline Project within the Jefferson National Forest in Virginia and West Virginia.

Map 5 of 12

MVP Abandoned/Alternate Route
National Hydrography Dataset Flowline
National Hydrography Dataset HUC12 Watershed Boundary
Jefferson National Forest Boundary
Tract Identified on Jefferson National Forest Land
Tract 015

N W E S

150 0 150 300 Meters

Base Map: ESRI ArcGIS Web service - "US TOPO MAPS" accessed - 1/10/2017

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Project No. 593.02

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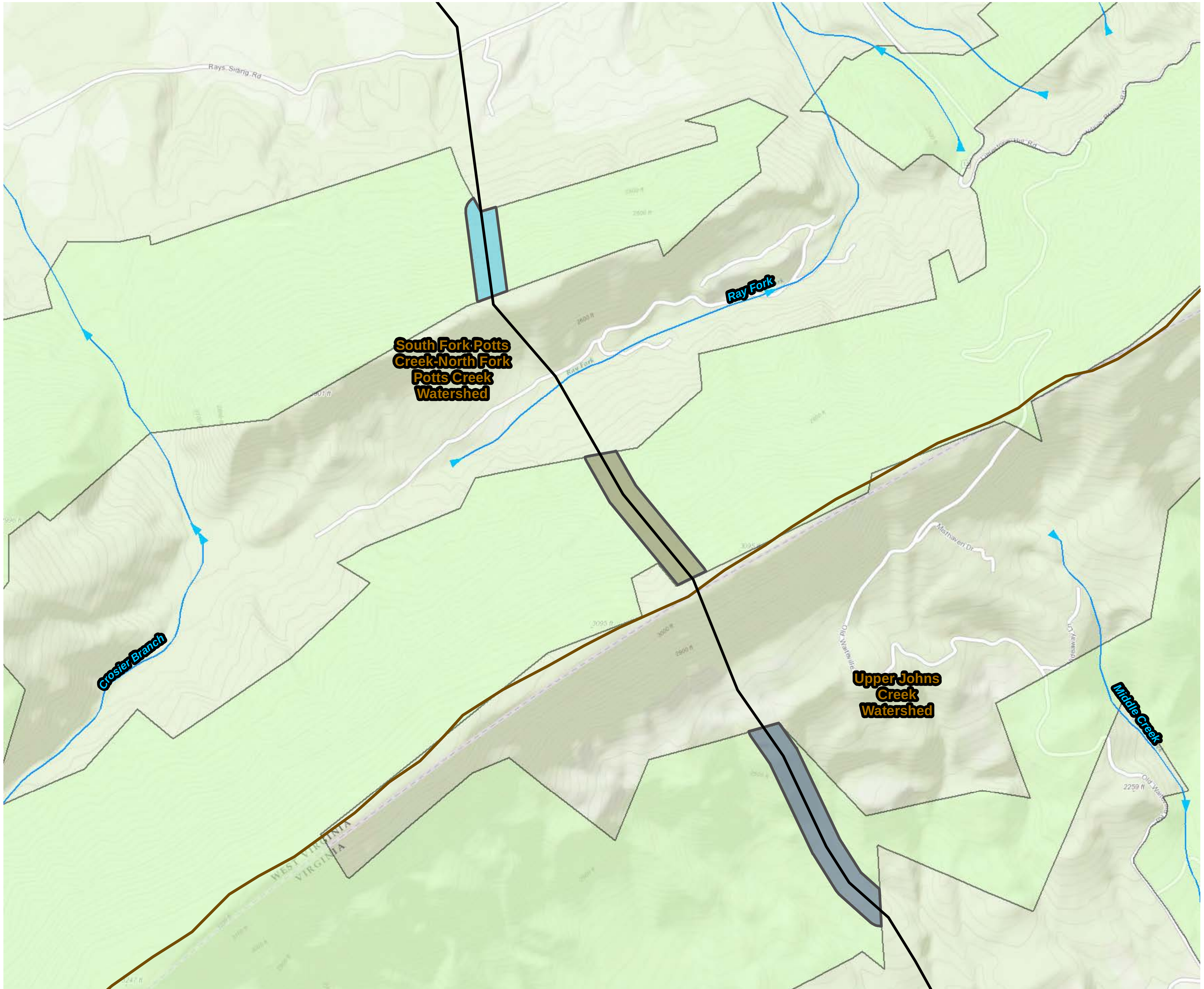


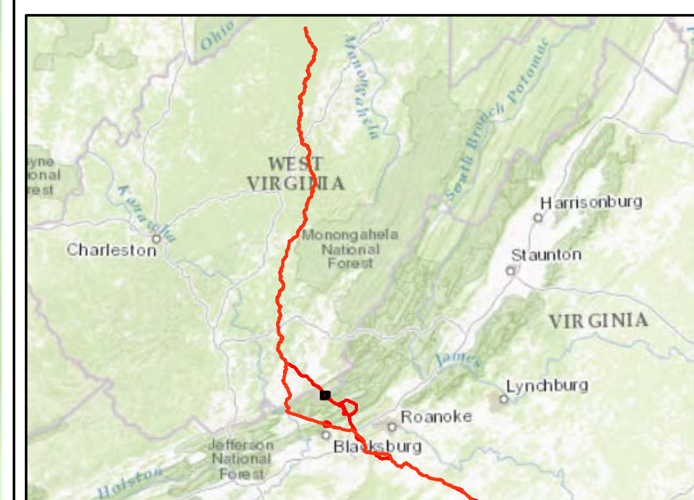
Figure 3. Stream and watershed boundaries for tracts identified along MVP's proposed alignment for the Mountain Valley Pipeline Project within the Jefferson National Forest in Virginia and West Virginia.

Map 6 of 12

- MVP Abandoned/Alternate Route
- National Hydrography Dataset Flowline
- National Hydrography Dataset HUC12 Watershed Boundary
- Jefferson National Forest Boundary

Tract Identified on Jefferson National Forest Land

- Tract 016
- Tract 017
- Tract 018



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Base Map: ESRI ArcGIS Web service - "US TOPO MAPS" accessed - 1/10/2017

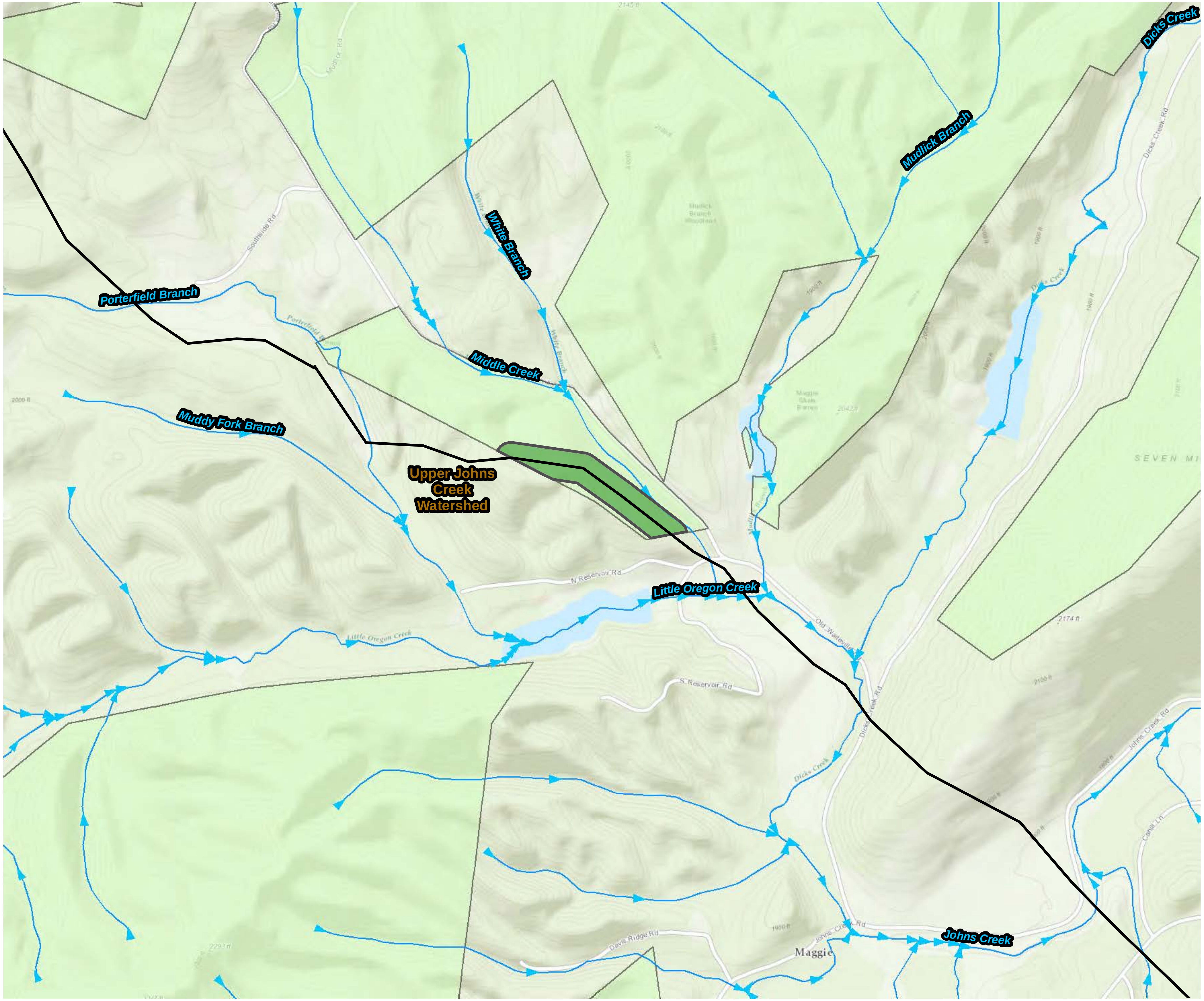
ESI ENVIRONMENTAL SOLUTIONS & INNOVATIONS, INC.

Project No. 593.02

Path: G:\Current\593_EQT_MVP\MXD\Biologic_Eval\20161209_BE_figs\593_BE_Appendix_A_Fig3_20170109.mxd (mbruening) - 1/10/2017

Figure 3. Stream and watershed boundaries for tracts identified along MVP's proposed alignment for the Mountain Valley Pipeline Project within the Jefferson National Forest in Virginia and West Virginia.

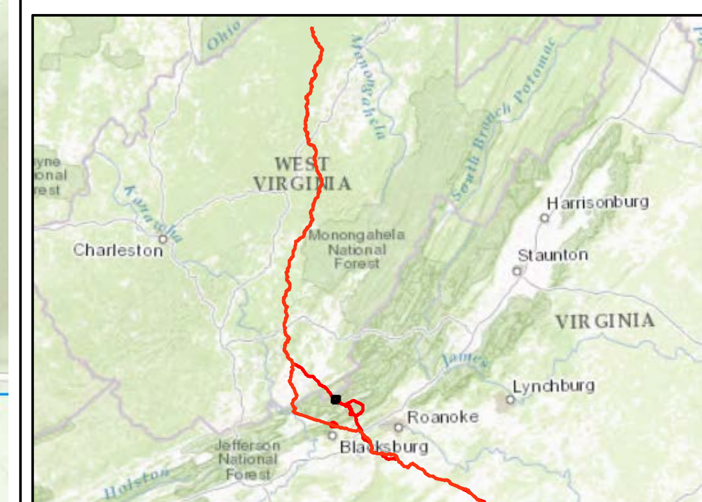
Map 7 of 12



- MVP Abandoned/Alternate Route
- National Hydrography Dataset Flowline
- National Hydrography Dataset HUC12 Watershed Boundary
- Jefferson National Forest Boundary

Tract Identified on Jefferson National Forest Land

- Tract 019



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Base Map: ESRI ArcGIS Web service - "US TOPO MAPS" accessed - 1/10/2017

ESI ENVIRONMENTAL SOLUTIONS & INNOVATIONS, INC.

Project No. 593.02

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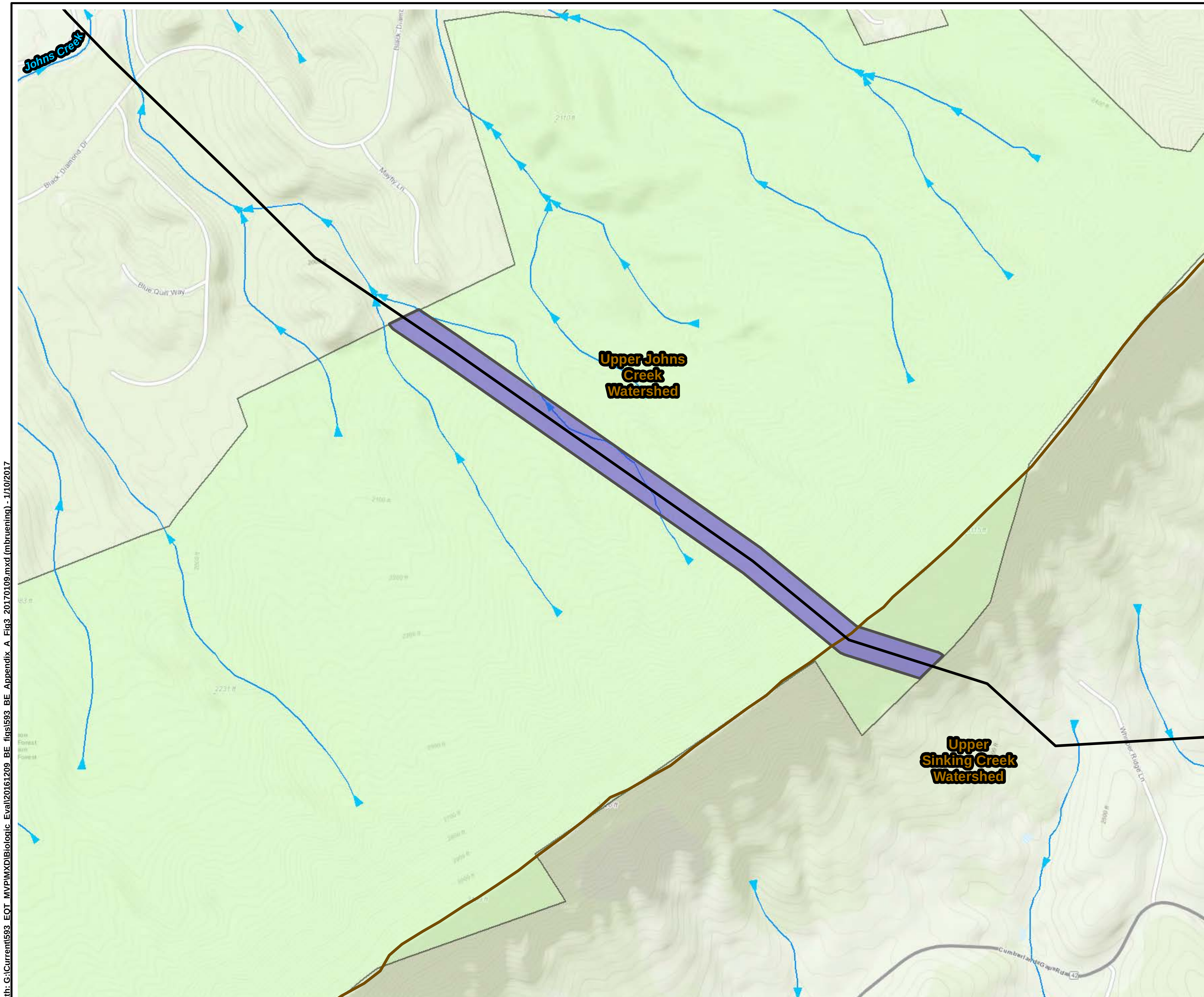
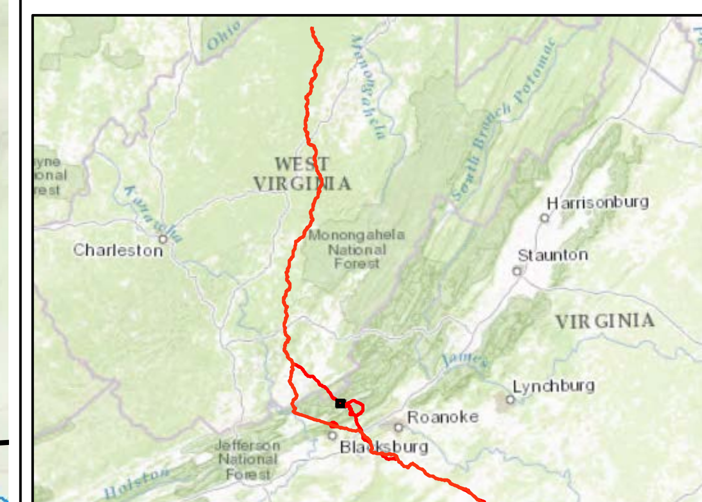


Figure 3. Stream and watershed boundaries for tracts identified along MVP's proposed alignment for the Mountain Valley Pipeline Project within the Jefferson National Forest in Virginia and West Virginia.

Map 8 of 12

MVP Abandoned/Alternate Route
National Hydrography Dataset Flowline
National Hydrography Dataset HUC12 Watershed Boundary
Jefferson National Forest Boundary
Tract Identified on Jefferson National Forest Land
Tract 020



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Base Map: ESRI ArcGIS Web service - "US TOPO MAPS" accessed - 1/10/2017

ESI ENVIRONMENTAL SOLUTIONS & INNOVATIONS, INC.
Project No. 593.02

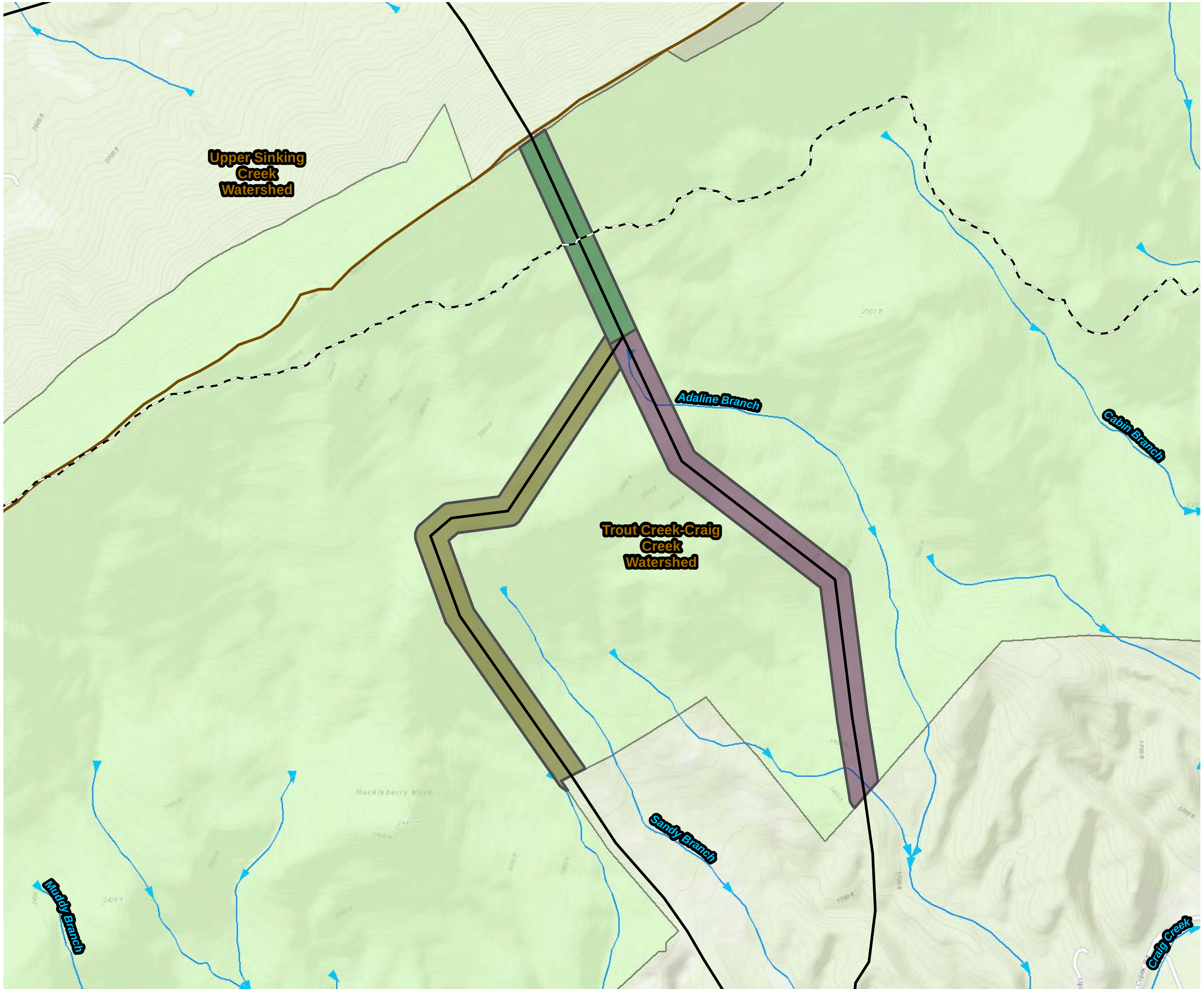


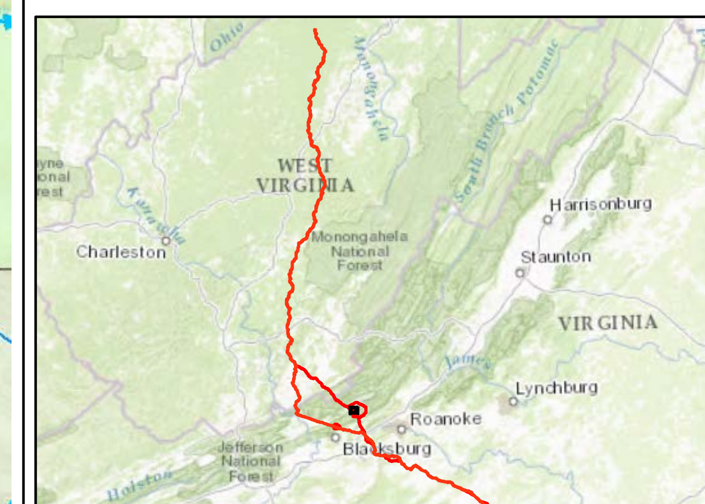
Figure 3. Stream and watershed boundaries for tracts identified along MVP's proposed alignment for the Mountain Valley Pipeline Project within the Jefferson National Forest in Virginia and West Virginia.

Map 9 of 12

- MVP Abandoned/Alternate Route
- Appalachian National Scenic Trail
- National Hydrography Dataset Flowline
- National Hydrography Dataset HUC12 Watershed Boundary
- Jefferson National Forest Boundary

Tract Identified on Jefferson National Forest Land

- Tract 021
- Tract 022
- Tract 026



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Base Map: ESRI ArcGIS Web service - "US TOPO MAPS" accessed - 1/10/2017

ESI ENVIRONMENTAL SOLUTIONS & INNOVATIONS, INC.

Project No. 593.02

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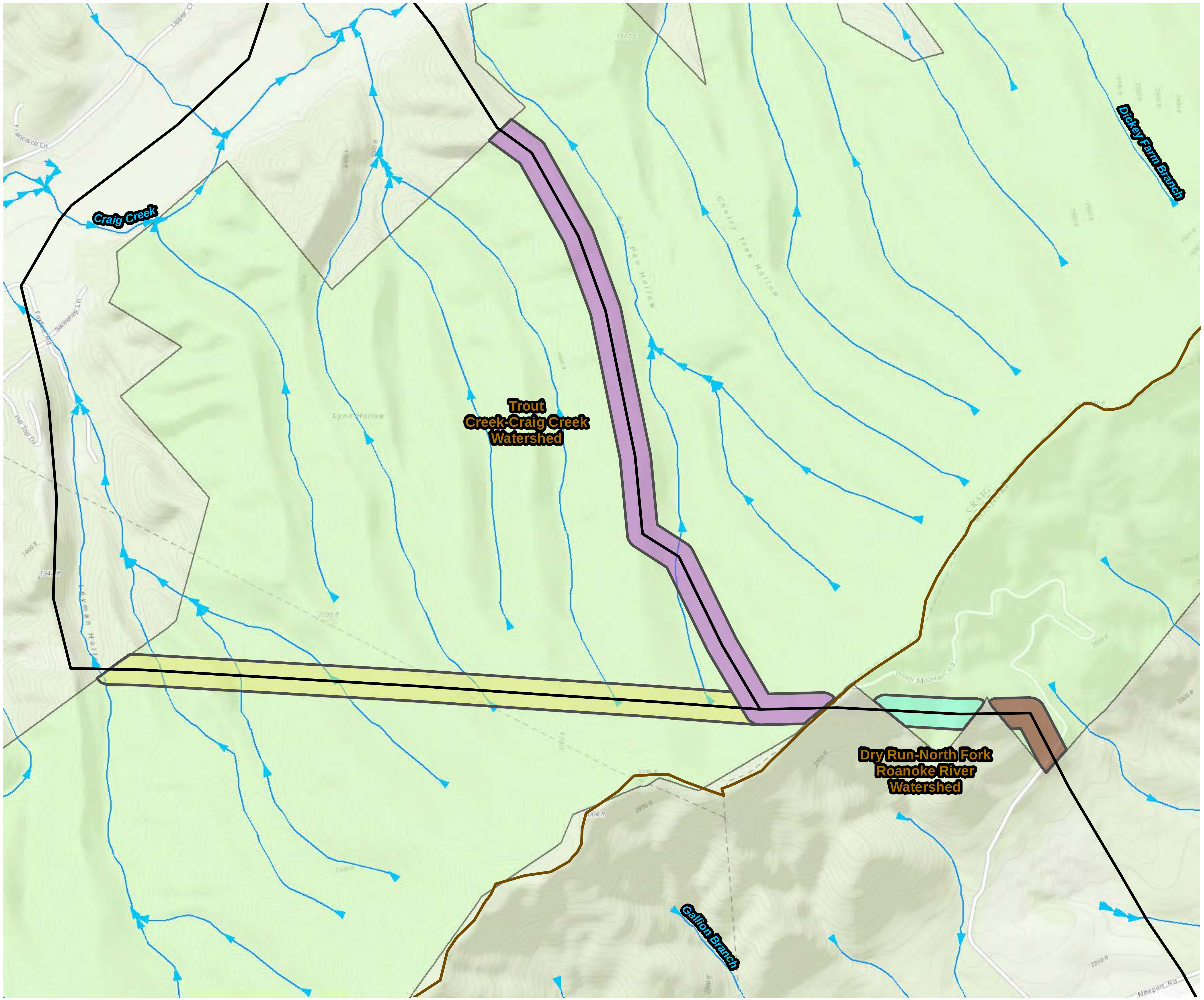
Figure 3. Stream and watershed boundaries for tracts identified along MVP's proposed alignment for the Mountain Valley Pipeline Project within the Jefferson National Forest in Virginia and West Virginia.

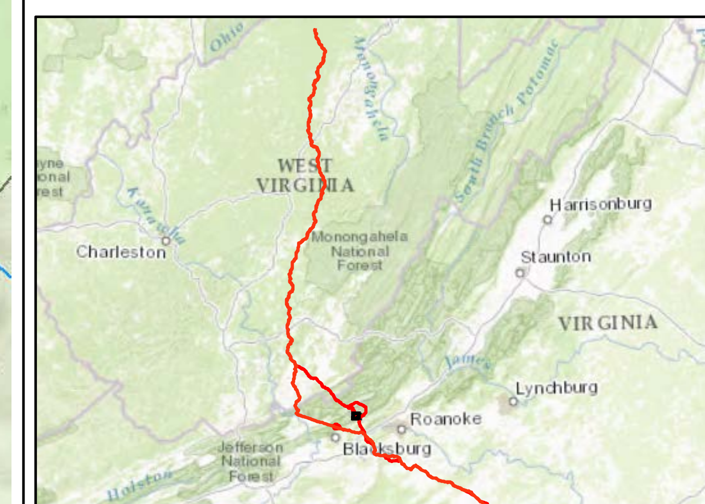
Map 10 of 12



- MVP Abandoned/Alternate Route
- National Hydrography Dataset Flowline
- National Hydrography Dataset HUC12 Watershed Boundary
- Jefferson National Forest Boundary

Tract Identified on Jefferson National Forest Land

- Tract 023
- Tract 024
- Tract 025
- Tract 027



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Base Map: ESRI ArcGIS Web service - "US TOPO MAPS" accessed - 1/10/2017

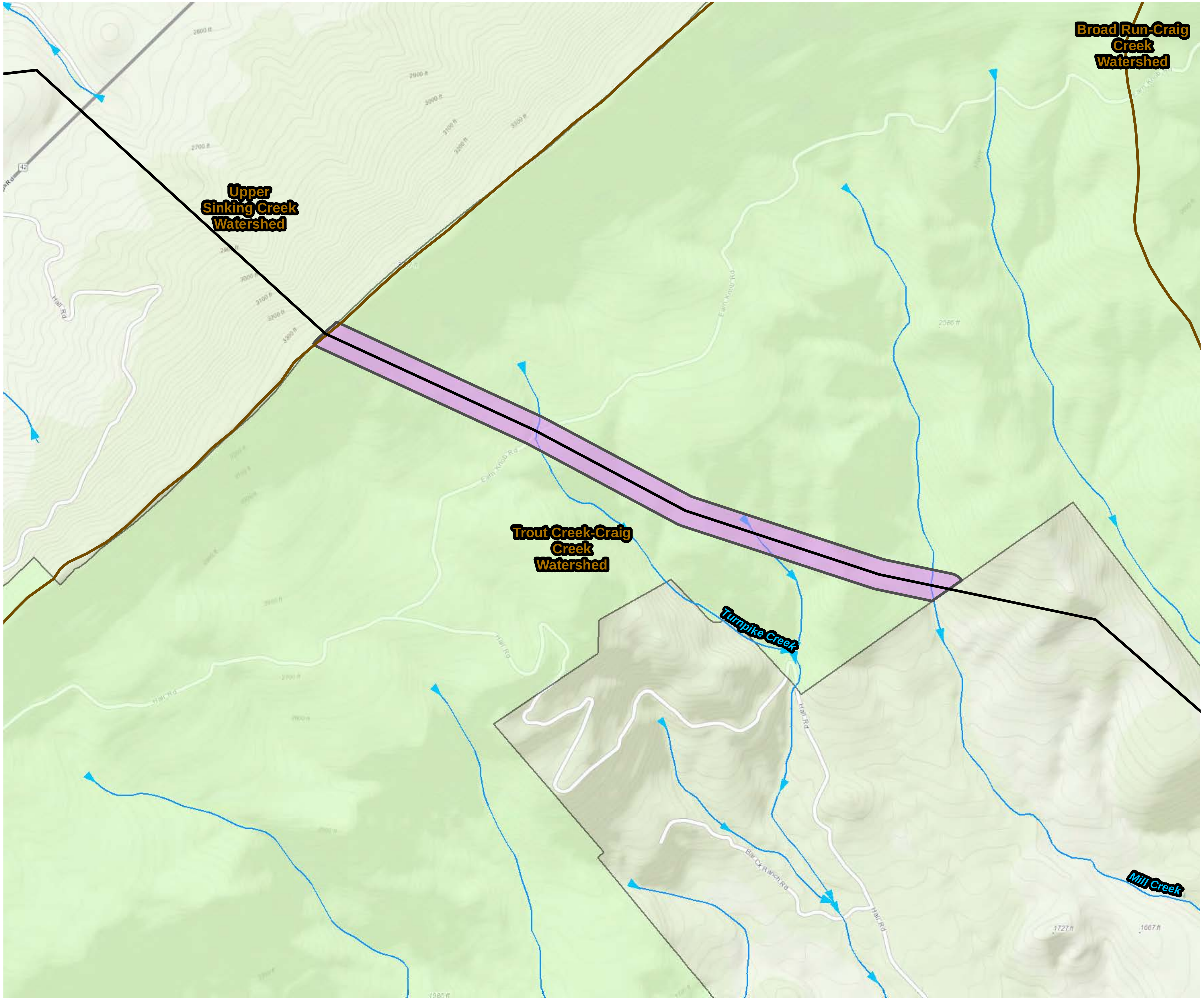
ENVIRONMENTAL SOLUTIONS & INNOVATIONS, INC.

Project No. 593.02

Path: G:\Current\593_EQT_MVP\MXD\Biologic_Eval\20161209_BE_figs\593_BE_Appendix_A_Fig3_20170109.mxd (mbruening) - 1/10/2017

Figure 3. Stream and watershed boundaries for tracts identified along MVP's proposed alignment for the Mountain Valley Pipeline Project within the Jefferson National Forest in Virginia and West Virginia.

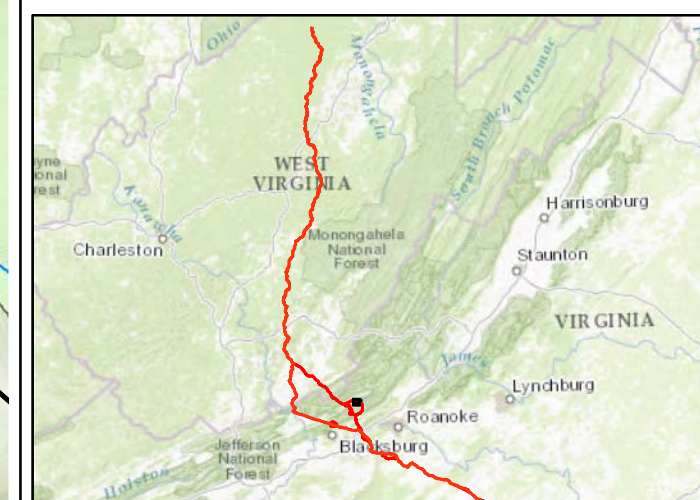
Map 11 of 12



- MVP Abandoned/Alternate Route
- National Hydrography Dataset Flowline
- National Hydrography Dataset HUC12 Watershed Boundary
- Jefferson National Forest Boundary

Tract Identified on Jefferson National Forest Land

- Tract 028



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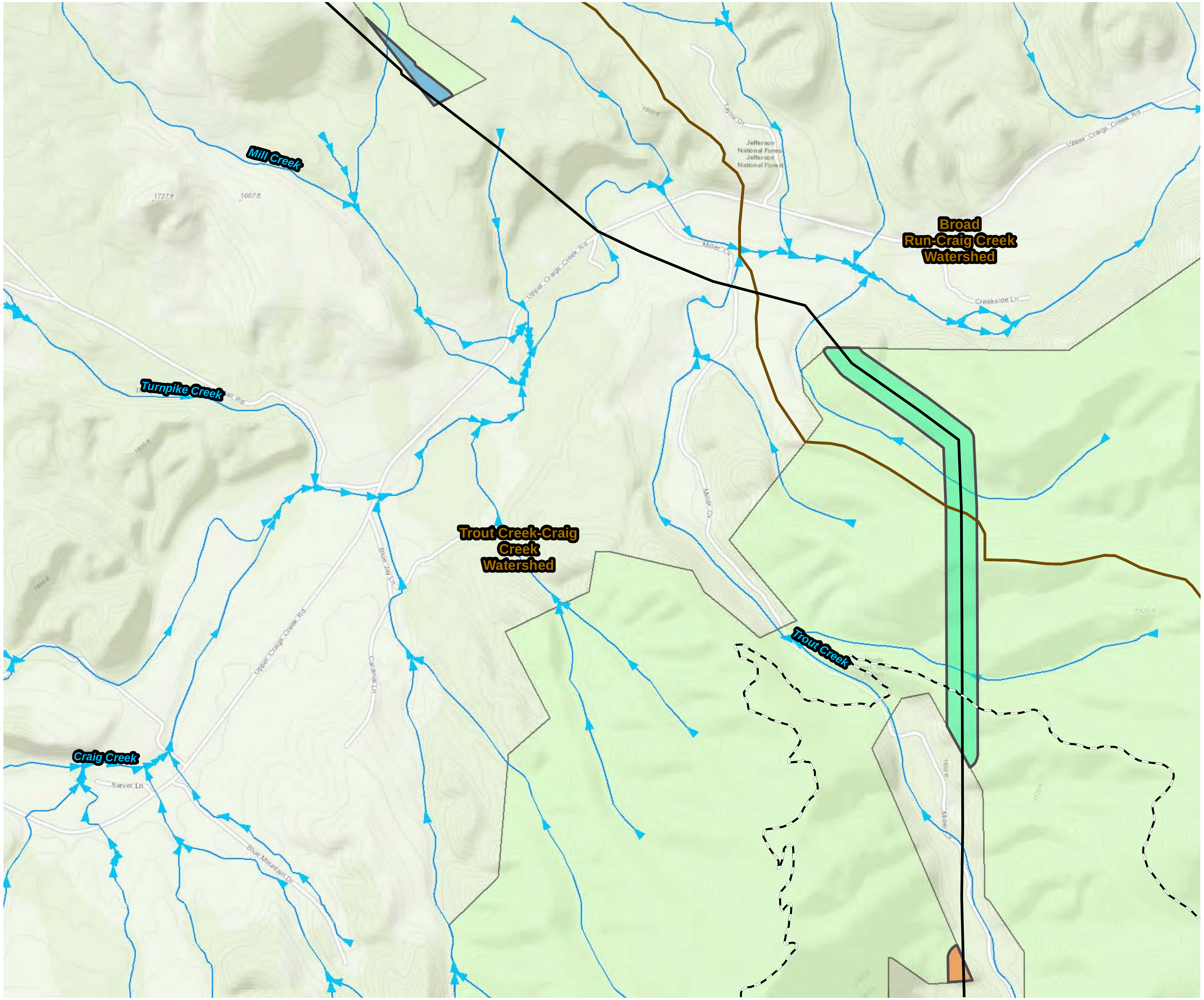
Base Map: ESRI ArcGIS Web service - "US TOPO MAPS" accessed - 1/10/2017

ESI ENVIRONMENTAL SOLUTIONS & INNOVATIONS, INC.

Project No. 593.02

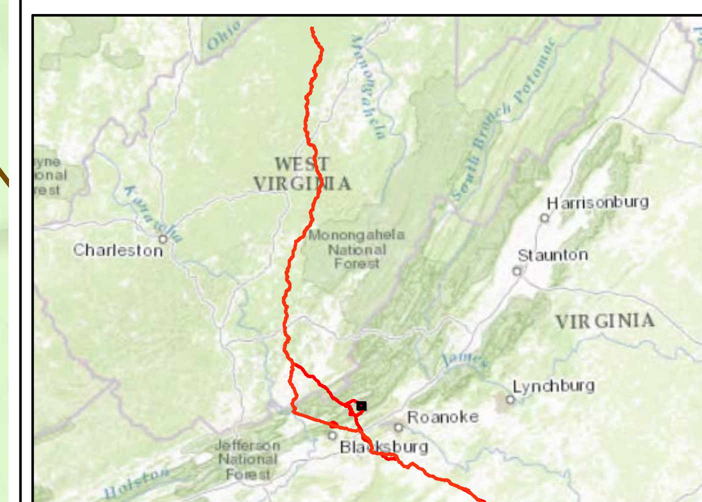
Figure 3. Stream and watershed boundaries for tracts identified along MVP's proposed alignment for the Mountain Valley Pipeline Project within the Jefferson National Forest in Virginia and West Virginia.

Map 12 of 12



- MVP Abandoned/Alternate Route
- Appalachian National Scenic Trail
- National Hydrography Dataset Flowline
- National Hydrography Dataset HUC12 Watershed Boundary
- Jefferson National Forest Boundary

Tract Identified on Jefferson National Forest Land
- Tract 029
- Tract 030
- Tract 031



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Base Map: ESRI ArcGIS Web service - "US TOPO MAPS" accessed - 1/10/2017

ENVIRONMENTAL SOLUTIONS & INNOVATIONS, INC.

Project No. 593.02

Path: G:\Current\593_EQT_MVP\MXD\Biologic_Eval\20161209_BE_figs\593_BE_Appendix_A_Fig3_20170109.mxd (mbruening) - 1/10/2017

APPENDIX B
DOCUMENTATION OF THREATENED, ENDANGERED, OR SENSITIVE SPECIES OCCURRENCES FOR THE JEFFERSON NATIONAL FOREST
(OCCURRENCE ANALYSIS RESULTS TABLE)

APPENDIX B
Documentation of Threatened, Endangered or Sensitive Species Occurrences for Jefferson National Forest
Coding for Occurrence Analysis Results (OAR) for 193 species

Forest updated July 28, 2016 (based on Region 8 sensitive species list effective January 1, 2002)

OAR	GW	J	Species Name	Common Name	Range on or near GWJNFs	Habitat - Detail	TES	GRank	VA SRank	WV SRank
VERTEBRATE										
Fish										
1	-	X	*Ammocrypta clara*	Western sand darter	Clinch R, Powell R	Aquatic-rivers	S	G3	S1	-
1	-	X	*Cottus baileyi*	Black sculpin	Little R, Upper Clinch R, S Fk Holston R	Aquatic-streams	S	G4Q	S2	-
1	-	X	*Chrosomus cumberlandensis*	Blackside dace	Upper Cumberland R, Upper Powell R, Poor Fk Cumberland R	Aquatic-streams	T	G2	S1	S3 (KY)
1	-	X	*Chrosomus tennesseensis*	Tennessee dace	Lick Ck, N Fk Holston R, Beaverdam Ck, M Fk Holston R	Aquatic-streams	S	G3	S1	-
1	-	X	*Erimonax monachus*	Spotfin chub	Lower N Fk Holston R	Aquatic-streams	T	G2	S1	-
1	-	X	*Erimystax cahni*	Slender chub	Two sites - Powell R, Lee Co	Aquatic-rivers	T	G1	S1	-
1	-	X	*Etheostoma acuticeps*	Sharphead darter	S and Middle Fk Holston R	Aquatic-rivers	S	G3	S1	-
8	-	X	*Etheostoma osburni*	Candy darter	Big Stony Ck, Laurel Fork in New R watershed	Aquatic-streams	S	G3	S1	S2
1	-	X	*Etheostoma percnurum*	Duskytail darter	Copper Ck, Clinch R	Aquatic-rivers	E	G1	S1	-
1	-	X	*Etheostoma tippecanoe*	Tippecanoe darter	Four sites Clinch R, lower Copper Ck	Aquatic-rivers	S	G2	S1	S2
1	-	X	*Icthyomyzon greeleyi*	Mountain brook lamprey	M, N Fk Holston R, Copper Ck, Indian Ck, Clinch R, Powell R	Aquatic-rivers	S	G3G4	S2	S1
1	-	X	*Notropis ariommus*	Popeye shiner	N Fk Holston R, Clinch R, Powell R	Aquatic-rivers	S	G3	S2S3	S2
8	X	X	*Notropis semperasper*	Roughhead shiner	Upper James R watershed above Buchanan	Aquatic-rivers	S	G2G3	S2S3	-
1	-	X	*Noturus flavipinnis*	Yellowfin madtom	Lower & Mid reaches of Copper Ck, Powell R	Aquatic-streams	T	G1	S1	-
8	X	X	*Noturus gilberti*	Orangefin madtom	S Fk Roanoke R watershed, Roanoke R above Salem, Craig Ck, Johns Ck, Cowpasture R	Aquatic-streams	S	G2	S2	-
1	-	X	*Percina burtoni*	Blotchside logperch	N Fk Holston R, Clinch R, Copper Ck, Little R	Aquatic-rivers	S	G2G3	S1	-
7/9	-	X	*Percina rex*	Roanoke logperch	Upper Roanoke R watershed	Aquatic-rivers	E	G1G2	S1S2	-
1	-	X	*Percina williamsi*	Sickle darter	N Fk Holston R above Saltville, lower Copper Ck	Aquatic-rivers	S	G2	S1S2	S2
1	-	X	*Phenacobius crassilabrum*	Fatlips minnow	Unimpounded lower S Fk Holston R, Whitetop Laurel Ck	Aquatic-rivers	S	G3G4	S2	-
8	-	X	*Phenacobius teretulus*	Kanawha minnow	Upper New R watershed	Aquatic-streams	S	G3G4	S2S3	S1
Amphibian										
1	-	X	*Plethodon hubrichti*	Peaks of Otter salamander	Peaks of Otter, Apple Orchard Mtn	Mixed oak, late successional with loose rocks and logs, >1800'.	S	G2	S2	-
1	X	-	*Plethodon punctatus*	Cow Knob salamander	Shenandoah Mtn, VA & WV	Mixed oak, late successional with loose rocks and logs, >2500'.	S	G3	S2	S1
1	-	-	*Plethodon shenandoah*	Shenandoah salamander	Three isolated populations in SNP: Hawksbill Mtn, The Pinnacles, Stony Man Mtn. GW occurrence questionable.	Talus slopes. Erroneous records from Three Ridges, The Priest, Pompeii on the Pedlar.	E	G1	S1	-

OAR	GW	J	Species Name	Common Name	Range on or near GWJNFs	Habitat - Detail	TES	GRank	VA SRank	WV SRank
1	-	X	*Plethodon welleri*	Weller's salamander	Mt Rogers & Whitetop Mtn	Spruce-fir forests and adjacent northern hardwoods.	S	G3	S2	-
Bird										
2	X	X	*Falco peregrinus*	Peregrine Falcon	Hack sites late 80s and early 90s – Mt Rogers, Grayson; Cole Mtn, Amherst; Big Schloss, Shenandoah; Elliot Knob, Augusta; High Knob, Rockingham Cos. No nests, current migrant.	Nests on ledges or cliffs, buildings, bridges, quarry walls. Non-breeding sites, farmland, open country, lakeshores, broad river valleys, airports, cities. Prefers pigeons, ducks.	S	G4	S1B/S2N	S1B/S2N
2	X	-	*Haliaeetus leucocephalus*	Bald Eagle	Potomac R, James R, New R, Upper Tennessee watersheds	Feeds and nests on or near large lakes and rivers.	S	G5	S3S4B/S3S4N	S2B/S3N
2	X	-	*Lanius ludovicianus migrans*	Migrant Loggerhead Shrike	Ridge & Valley (Shenandoah Valley)	Open grasslands with trees and shrubs, fencerows.	S	G4	S2B/S3N	S1B/S2N
2	X	X	*Thryomanes bewickii altus*	Appalachian Bewick's Wren	Historical records in Botetourt, Giles, Highland Washington Cos.	Thickets, old fields, fencerows, old home sites.	S	G5T2Q	SHB/S1N	S1B/S1N
Mammal										
2	X	X	*Corynorhinus townsendii virginianus*	Virginia big-eared bat	Summer: VA - Tazewell Co (3 caves), Highland Co (1 cave); WV - Pendleton Co (4 caves); Winter: Highland, Rockingham, Bland, and Tazewell Cos (6 caves); Pendleton Co (6 caves). Largest VA population in Tazewell Co and largest WV population in Pendleton Co. Small numbers of bats (usually <10) in a few other widely scattered caves during summer months. Bath & Pulaski Co records are historic. No occupied caves currently known on Forest.	Resides in caves winter and summer. Short distance migrant (<40 miles) between winter and summer caves. Forages primarily on moths and foraging habitat is common (fields, forests, meadows, etc.). Forages within 6 miles of summer caves. USFWS Critical Habitat is 5 caves in WV (4 Pendleton Co and 1 Tucker Co). Closest Critical Habitat cave to GWJNF is ~3 miles in Pendleton Co, WV. OAR code of "2" used when project further than 6 miles from summer or winter occupied cave.	E	G3G4T2	S1	S2
1	-	X	*Glaucomys sabrinus coloratus*	Carolina northern flying squirrel	Mt Rogers & Whitetop area	Spruce-fir forests and adjacent northern hardwoods.	E	G5T2	S1	-
1	X	-	*Glaucomys sabrinus fuscus*	Virginia northern flying squirrel	Laurel Fork area, Highland Co	Spruce forests and adjacent northern hardwoods.	S	G5T2	S1	S2
1	X	-	*Microtus chrotorrhinus carolinensis*	Southern rock vole	Alleghany Mtn, Bath Co	Cool, moist, mossy talus under oaks/northern hardwoods.	S	G4T3	S1	S2
1	-	X	*Myotis grisescens*	Gray bat	Ridge & Valley, Clinch R watershed	Caves winter and summer, forages widely.	E	G3	S1	-

OAR	GW	J	Species Name	Common Name	Range on or near GWJNFs	Habitat - Detail	TES	GRank	VA SRank	WV SRank
4	X	X	*Myotis leibii*	Eastern small-footed bat	Ridge & Valley	Hibernates in caves during winter, roosts in crevices of large rock outcrops, cliffs, and under large rocks in talus & boulder-fields during summer, plus similar man-made structures like rip-rap and bridges, forages widely in all forested and open habitat types over both ridges and valleys.	S	G1G3	S2	S1
3	X	X	*Myotis septentrionalis*	Northern long-eared bat	Blue Ridge, Ridge & Valley, Cumberland Mtns	Hibernates in crevices and cracks of cave walls during winter (sometimes mines & tunnels), difficult to find and rarely seen. During summer, forages widely and roosts singly or in colonies underneath bark, in cavities, or in crevices of both live and dead trees. Also may roost in structures like barns, sheds, & houses.	T	G1G2	S3	S3
3	X	X	*Myotis sodalis*	Indiana bat	Blue Ridge, Ridge & Valley, Cumberland Mtns	Caves winter, upland hardwoods summer, forages widely along riparian areas and open woodlands.	E	G2	S1	S1
1	X	-	*Sorex palustris punctulatus*	Southern water shrew	Alleghany Mtn, Bath Co; Laurel Fork, Highland Co	Riparian areas w/in spruce-fir forests and northern hardwoods.	S	G5T3	S1S2	S1
INVERTEBRATE										
Snail (Mollusk, Class Gastropoda)										
2	X	X	*Glyphyalinia raderi*	Maryland glyph	Alleghany, Montgomery Cos	Calciphile, edge of seeps within leaf litter. May burrow.	S	G2	S1S2	S2
1	X	-	*Helicodiscus diadema*	Shaggy coil	Alleghany Co	Calciphile; semi-open, calcium-rich environments, especially limestone rubble/ talus and thinly wooded limestone hills.	S	G1	S1	-
1	X	-	*Helicodiscus lirellus*	Rubble coil	Rockbridge Co	Calciphile, limestone rubble and rich fossiliferous shale talus. Found among leaf litter and limestone stones or talus, or rich shale scree, upon steep, forested slopes which are associated with certain rivers in the upper James River watershed, including Maury R & Kerr’s Ck.	S	G1	S1	-

OAR	GW	J	Species Name	Common Name	Range on or near GWJNFs	Habitat - Detail	TES	GRank	VA SRank	WV SRank
1	X	X	*Helicodiscus triodus*	Talus coil	Alleghany, Botetourt, Rockbridge Cos	Calciphile, limestone rubble on wooded hillsides and near cave entrances.	S	G2	S1S2	SH
1	-	X	*Io fluvialis*	Spiny riversnail	Clinch R, N Fk Holston R	Aquatic-rivers	S	G2	S2	-
2	-	X	*Paravitrea reesei*	Round supercoil	Monroe Co, WV; Grayson, Montgomery, Pulaski, Smyth Cos., VA	Calcareous woodlands and glades. Prefers moist environments.	S	G3	S2	S1
Mussel (Mollusk, Class Bivalvia)										
1	X	-	*Alasmidonta varicosa*	Brook floater	Potomac drainage	Aquatic-rivers	S	G3	S1	S1
1	-	X	*Cumberlandia monodonta*	Spectaclecase	2 sites Clinch R	Aquatic-rivers	E	G3	S1	-
1	-	X	*Cyprogenia stegaria*	Fanshell	Lower Clinch R, Scott Co	Aquatic-rivers	E	G1Q	S1	S1
1	-	X	*Dromus dromas*	Dromedary pearlymussel	Clinch R, Powell R, N Fk Holston R	Aquatic-rivers	E	G1	S1	-
7	X	X	*Elliptio lanceolata*	Yellow lance	Roanoke R, James R	Aquatic-rivers	S	G2G3	S2S3	-
1	-	X	*Epioblasma brevidens*	Cumberlandian combshell	Clinch R, Powell R, N Fk Holston R	Aquatic-rivers	E	G1	S1	-
1	-	X	*Epioblasma capsaeformis*	Oyster mussel	Clinch R, Powell R, N Fk Holston R	Aquatic-rivers	E	G1	S1	-
1	-	-	*Epioblasma florentina aureola*	Golden riffleshell	Restricted to lower 1.0 mile of Indian Ck to Clinch R. All other historical populations in M & Upper Tennessee R system now extirpated.	Aquatic-rivers	E	G1T1	S1	-
1	-	X	*Epioblasma torulosa gubernaculum*	Green-blossom pearlymussel	Clinch R, N Fk Holston R	Aquatic-rivers	E	G2TX	SX	-
1	-	X	*Epioblasma triquetra*	Snuffbox	Clinch R, Powell R, N Fk Holston R	Aquatic-rivers	E	G3	S1	S2
1	-	X	*Fusconaia cor*	Shiny pigtoe	Clinch R, Powell R, N Fk Holston R, Copper Ck	Aquatic-rivers	E	G1	S1	-
1	-	X	*Fusconaia cuneolus*	Fine-rayed pigtoe	Clinch R, Powell R, Copper Ck, Little R	Aquatic-rivers	E	G1	S1	-
7	-	X	*Fusconaia masoni*	Atlantic pigtoe	Roanoke R, Craig Ck drainage	Aquatic-rivers	S	G2	S2	-
1	-	X	*Hemistena lata*	Cracking pearlymussel	Clinch R, Powell R	Aquatic-rivers	E	G1	S1	-
1	-	X	*Lampsilis abrupta*	Pink mucket	Clinch R	Aquatic-rivers	E	G2	SX	S1
1	-	X	*Lasmigona holstonia*	Tennessee heelsplitter	Upper Clinch, N and M Fk Holston R drainages; Wolf Ck, Bland Co below Burkes Garden	Aquatic-streams	S	G3	S1	-
8	X	-	*Lasmigona subviridis*	Green floater	Widely distributed in N & S Fk Shenandoah R, Pedlar R, James R	Aquatic-rivers	S	G3	S2	S2
1	-	X	*Lemiox rimosus*	Birdwing pearlymussel	Clinch R, Powell R, Copper Ck, Little R	Aquatic-rivers	E	G1	S1	-
1	-	X	*Pegias fabula*	Little-winged pearlymussel	Clinch R, N Fk Holston R, S Fk Holston R, Little R	Aquatic-streams	E	G1	S1	-
1	-	X	*Plethobasus cyphyus*	Sheepnose	Clinch R, Powell R	Aquatic-rivers	E	G3	S1	S1
7/9	X	X	*Pleurobema collina*	James spinymussel	Potts Ck, Craig Ck, Johns Ck, Patterson Run, Pedlar R, Cowpasture R, Mill Ck (Deerfield)	Aquatic-rivers	E	G1	S1	S1
1	-	X	*Pleurobema cordatum*	Ohio pigtoe	Clinch R	Aquatic-rivers	S	G4	S1	S2
1	-	X	*Pleurobema oviforme*	Tennessee clubshell	Clinch R, Powell R, N, Middle, S Fk Holston R	Aquatic-streams	S	G2G3	S2S3	-
1	-	X	*Pleurobema plenum*	Rough pigtoe	Clinch R	Aquatic-rivers	E	G1	SH	SH

OAR	GW	J	Species Name	Common Name	Range on or near GWJNFs	Habitat - Detail	TES	GRank	VA SRank	WV SRank
1	-	X	*Pleurobema rubrum*	Pyramid pigtoe	Upper Clinch R	Aquatic-rivers	S	G2G3	SH	-
1	-	X	*Pleuronaia barnesiana*	Tennessee pigtoe	Clinch R, Powell R, N Middle, S Fk Holston R	Aquatic-rivers	S	G2G3	S2	-
1	-	X	*Pleuronaia dolabelloides*	Slabside pearlymussel	Clinch R, M Fk Holston, N Fk Holston R	Aquatic-rivers	E	G2	S2	-
1	-	X	*Ptychobranchus subtentum*	Fluted kidneyshell	Holston R., Powell R., Indian R., Clinch R., Little R., Copper Ck., Big Moccasin Ck. Critical Habitat: Indian Ck, VA: Middle Fk Holston R. VA: Big Moccasin Ck., VA: Copper Ck., VA; Clinch R, TN, VA: Powell R., TN, VA	Aquatic-rivers	E	G2	S2	-
1	-	X	*Quadrula cylindrica strigillata*	Rough rabbits foot	Clinch R, Powell R, N Fk Holston R, Copper Ck	Aquatic-streams	E	G3G4T2	S2	-
1	-	X	*Quadrula intermedia*	Cumberland monkeyface	Powell R	Aquatic-rivers	E	G1	S1	-
1	-	X	*Quadrula sparsa*	Appalachian monkeyface	Clinch R, Powell R	Aquatic-rivers	E	G1	S1	-
1	-	X	*Toxolasma lividum*	Purple lilliput	N Fk Holston R, Clinch R	Aquatic-rivers	S	G3Q	SH	-
1	-	X	*Villosa perpurpurea*	Purple bean	Clinch R, Copper Ck	Aquatic-rivers	E	G1	S1	-
1	-	X	*Villosa trabalis*	Cumberland bean	Clinch R	Aquatic-rivers	E	G1	SX	-
Spider (Arachnid)										
1	-	X	*Microhexura montivaga*	Spruce-fir moss spider	Whitetop Mtn	Damp, well-drained moss and liverwort mats on boulders in mature spruce-fir forests.	E	G1	S1	-
Pseudoscorpion (Arachnid, Order Pseudoscoriones)										
1	-	X	*Kleptochthonius orpheus*	Orpheus cave pseudoscorpion	Patton cave, Monroe Co, WV	Caves	S	G1	-	S1
Amphipod (Crustacean, Order Amphipoda)										
1	-	X	*Stygobromus abditus*	James Cave amphipod	James, Sam Bells caves, Pulaski Co; Watsons cave, Wythe Co; and other New River caves	Aquatic-caves, water well	S	G3	S3	-
1	-	X	*Stygobromus cumberlandus*	Cumberland cave amphipod	Lee, Scott, Wise Cos	Aquatic-caves	S	G3G4	S1S2	-
2	-	X	*Stygobromus estesi*	Craig County cave amphipod	Caves in Upper Sinking Ck Valley and Potts Ck, Poverty Hollow seeps, Captain seeps	Aquatic-caves, seeps	S	G4	S3	-
2	-	X	*Stygobromus fergusoni*	Montgomery County cave amphipod	Botetourt, Montgomery Cos	Aquatic-caves	S	G2G3	S1	-
1	X	-	*Stygobromus gracilipes*	Shenandoah Valley cave amphipod	Frederick, Rockingham, Shenandoah, Warren Cos	Aquatic-caves	S	G3G4	S3	S1
1	X	-	*Stygobromus hoffmani*	Alleghany County cave amphipod	Low Moor cave, Alleghany Co	Aquatic-caves, groundwater habitats including springs and seeps	S	G2	S2	-
1	X	-	*Stygobromus mundus*	Bath County cave amphipod	Alleghany, Bath Cos	Aquatic-caves	S	G2G3	S1S2	-
Isopod (Crustacean, Order Isopoda)										
1	-	-	*Antrolana lira*	Madison Cave isopod	Documented population centers in Waynesboro-Grottoes area, Augusta Co., Harrisonburg area Rockingham Co., and valley of main stem of Shenandoah R., Warren, Clarke Cos., VA; Jefferson Co. WV. Not known from the GWJNF	Aquatic-subterranean obligate in caves and karst groundwater	T	G2G4	S2	S1

OAR	GW	J	Species Name	Common Name	Range on or near GWJNFs	Habitat - Detail	TES	GRank	VA SRank	WV SRank
1	-	X	*Caecidotea incurva*	Incurved cave isopod	McCullin Cave, Smyth Co; Groseclose Cave No. 1, Wythe Co	Aquatic-caves	S	G2G4	S2	-
1	X	X	*Miktoniscus racovitzai*	Racovitza's terrestrial cave isopod	Allegheny, Botetourt, Page, Rockbridge, Shenandoah Cos	Aquatic-caves	S	G3G4	S2	-
Crayfish (Crustacean, Order Decapoda)										
1	-	X	*Cambarus callamus*	Big Sandy crayfish	In VA, Upper Russel Fk drainage Big Sand R	Aquatic-streams. Fast flowing streams of moderate width.	T	G2	S1S2	S1
Millipede (Class Diplopoda)										
1	-	X	*Brachoria dentata*	A millipede	Known only from Pennington Gap and Cave Spring Recreation Area, Lee Co.	Leaf litter, deciduous forests.	S	G1	S1	-
1	-	X	*Brachoria eutypa ethotela*	Hungry Mother millipede	Pine Mtn above Troutdale	Leaf litter, deciduous forests.	S	GNRT NR	S3	-
1	-	X	*Buotus carolinus*	A millipede	Brush Mtn, Whitetop Mtn, Apple Orchard Mtn, Tazewell Beartown	Beech leaf litter, deciduous forests.	S	G3	S3	-
1	-	X	*Cleidogona hoffmani*	Hoffman's cleidogonid millipede	Mt Rogers, Whitetop Mtn, Elk Garden; Hamilton cave (private) Bland Co	Mountaintop species, leaf litter, deciduous forests.	S	G3	S2S3	-
1	-	X	*Cleidogona lachesis*	A millipede	Mt Rogers & Whitetop Mtn	Beech leaf litter, deciduous forests.	S	G2	S1	-
1	-	X	*Dixioria fowleri*	Fowler's millipede	Walker Mtn; Comers Rock on Iron Mtn; Laurel Ck, Damascas; 1/2 mile west of NRA office; Tazewell Beartown	Leaf litter, deciduous forests.	S	G2	S2	-
1	-	X	*Dixioria pela coronata*	A millipede	Endemic to Mt Rogers	Leaf litter, northern hardwood and spruce-fir forests. Altitudinally restricted, >5000'.	S	G2T2	S2	-
1	X	-	*Nannaria shenandoah*	Shenandoah Mountain xystodesmid millipede	One site: along Long Run Road, Rockingham Co.	Leaf litter, mixed oak forest.	S	G1	S1	-
1	X	-	*Pseudotremia alecto*	A millipede	Griffith Knob, Alleghany Co; near Mountain Grove Saltpetre Cave, Bath Co	Leaf litter, deciduous forests.	S	GNR	SNR	-
1	X	X	*Semionellus placidus*	A millipede	Hawksbill Mtn, Apple Orchard Mtn, Tomahawk Mtn	Leaf litter, deciduous forests.	S	G3	S3 (old rank S2)	-
Centipede (Class Chilopoda)										
1	X	X	*Escaryus cryptorobius*	Montane centipede	The Priest, Nelson Co; Whitetop Mtn, near junction of Grayson, Washington, Smyth Cos	Upper soil horizon, spruce - birch forests.	S	G2	S2	-
1	-	X	*Escaryus orestes*	Whitetop Mountain centipede	Whitetop Mtn, near junction of Grayson, Washington, Smyth Cos	Dark moist soil and litter, spruce - birch forests.	S	G1G2	S1S2	-
1	X	-	*Nampabius turbator*	A cave centipede	One known site: Low Moor cave, Alleghany Co	Caves	S	G1G2	S1	-
Springtail (Insect, Order Collembola)										
1	X	X	*Pygmarrhopalites carolynae*	A cave springtail	Augusta, Bath, Highland, Lee, Wise Cos	Caves	S	G4	S3	-
2	-	X	*Pygmarrhopalites commorus*	A cave springtail	Giles, Lee, Wise Cos	Caves	S	G2G3	S2S3	-
1	X	-	*Pygmarrhopalites sacer*	A cave springtail	Bath Co	Caves	S	G2	S2	-
Mayfly (Insect, Order Ephemeroptera)										
1	-	X	*Leptophlebia johnsoni*	Johnson's pronggill mayfly	One location: Lewis Fk north slope Mt Rogers	Aquatic-streams	S	G4	S1	-
Dragonfly (Insect, Order Odonata)										
8	X	X	*Gomphus viridifrons*	Green-faced clubtail	New R, Craig Ck, Pound R, Locust Spring	Aquatic-rivers	S	G3G4	S2	S2

OAR	GW	J	Species Name	Common Name	Range on or near GWJNFs	Habitat - Detail	TES	GRank	VA SRank	WV SRank
8	-	X	*Ophiogomphus incurvatus alleghaniensis*	Allegheny snaketail	Rich Ck, Giles Co	Aquatic-streams	S	G3T2T3	S1	S1
Stonefly (Insect, Order Plecoptera)										
1	-	X	*Acroneuria kosztarabi*	Virginia stonefly	Station Spring Ck, Tazewell Co	Aquatic-streams	S	G1G2	S1S2	-
1	-	X	*Isoperla major*	Big stripetail stonefly	Burkes Garden, Tazewell Co	Aquatic-streams	S	G1	S1	-
1	-	X	*Megaleuctra williamsae*	Smokies needlefly	Mt Rogers & Whitetop Mtn	Aquatic-streams	S	G2	S1S2	-
1	-	X	*Taeniopteryx nelsoni*	Cryptic willowfly	Lewis Fk & Grindstone Branch N of Mt Rogers	Aquatic-streams	S	G1	S1	-
Beetle (Insect, Order Coleoptera)										
1	X	X	*Cicindela ancocisconensis*	Appalachian tiger beetle	Alleghany, Bath, Highland, Lee, Rockbridge, Washington, Wise Cos	Riparian - sandy/silty edges of streams and rivers.	S	G3	S2	S3
2	X	X	*Cicindela patruela*	Northern barrens tiger beetle	Blue Ridge, Ridge & Valley	Eroded slopes of exposed sandstone and conglomerate.	S	G3	S2	S2S3
1	-	X	*Cyclotrachelus incisus*	A ground beetle	Breaks Interstate Park, Dickenson Co	Dry, well drained site, red maple, magnolia, mountain laurel.	S	G4	S1	-
4	X	X	*Hydraena maureenae*	Maureen's Shale Stream Beetle	Alleghany, Bath, Botetourt, Bland, Craig, Cos	Interstitial water in riparian-shale substrate along stream edge.	S	G2?	S2?	-
Scorpionfly (Insect, Order Mecoptera)										
2	-	X	*Brachypanorpa jeffersoni*	Jefferson's short-nosed scorpionfly	Sugar Run Mountain, Giles Co; Whitetop Mtn, Smyth Co	Moist soil around seeps. Only known from high elevation. Larvae use short burrows in loose soil and moss.	S	G2	S1S2	-
Butterfly, Skipper, Moth (Insect, Order Lepidoptera)										
2	X	X	*Callophrys irus*	Frosted elfin	Frederick, Montgomery, Page, Roanoke Cos	Dry, open woods, clearings, and road/powerline ROWs with abundant wild indigo, *Baptisia tinctoria*.	S	G3	S2?	S1
6	X	X	*Speyeria diana*	Diana fritillary	Blue Ridge, Ridge & Valley	Grasslands-shrublands, near streams with thistles and milkweeds. Larval host plant, violets, *Viola* spp.	S	G3G4	S3	S2S3
6	X	X	*Speyeria idalia*	Regal fritillary	Blue Ridge, Ridge & Valley	Riparian, grasslands-shrublands. Larval host plant, violets, *Viola* spp.	S	G3	S1	S1
2	X	X	*Erynnis persius persius*	Persius duskywing	Blue Ridge, Ridge & Valley	Bogs, wet meadows, open seepages in boreal forests. Larval host plant, lupine, *Lupinus perennis*, wild indigo, *Baptisia tinctoria*.	S	G5T1T3	S1	-
2	X	-	*Pyrgus centaureae wyandot*	Appalachian grizzled skipper	Ridge & Valley	Shale barrens, open shaley oak woodlands. Larval host plant, cinquefoil, *Potentilla* spp, strawberry, *Fragaria virginina.*	S	G5T1T2	S1	S1
2	X	X	*Catocala herodias gerhardi*	Herodias underwing	Bald Knob, Bath Co; Poverty Hollow, Montgomery Co; Sand Mtn, Wythe Co (non FS property)	Pitch pine/bear oak scrub woodlands, >3000'. Larval host plant oak, *Quercus* spp.	S	G3T3	S2S3	SU

OAR	GW	J	Species Name	Common Name	Range on or near GWJNFs	Habitat - Detail	TES	GRank	VA SRank	WV SRank
1	X	-	*Euchlaena milnei*	Milne's euchlaena moth	Warm Springs Mtn, Catawba Creek Slopes, Sweet Spring Hollow, Salt Pond Mtn. (Doe Creek)	Moist, forested slopes of mixed pine hardwoods. Acidic oak woods.	S	G2G4	S2	S2
1	X	-	*Psectrotarsia hebardi*	Hebard's noctuid moth	Bath Co	Rich, mesic hardwood forest. Larvae host plant, Canada horse-balm, *Collinsonia canadensis*.	S	GU	SH	-
NON-VASCULAR PLANT										
Lichen										
1	-	X	*Gymnoderma lineare*	Rock gnome lichen	Whitetop Mtn	Spruce-fir forests	E	G2	S1	-
2	-	X	*Hypotrachyna virginica*	Virginia hypotrachyna lichen	Mt Rogers & Whitetop Mtn	Spruce-fir forest. Found on *Abies, Picea, Rhododendron* in spruce-fir and fire-cherry, *Prunus pensylvanica* communities in southern Appalachian Mountains. Typically at higher elevations, has been found at lower elevations.	S	G1G2	S1	SNR
1	X	X	*Hypotrachyna virginica*	Hydrothyria lichen	Augusta, Amherst, Alleghany, Bedford, Botetourt, Giles, Highland, Madison, Nelson, Rockbridge, Shenandoah, Smyth, Wyth Cos VA; Pendleton Co WV	Aquatic – in streams/springs/cascade. Grows at or below water level in cool, clear, partially-shaded streams.	S	G4	S1	-
Liverwort										
1	-	X	*Bazzania nudicaulis*	A liverwort	Mt Rogers & Whitetop Mtn	Bark and rock outcrops in spruce-fir forests.	S	G2G3	S?	-
1	-	X	*Frullania oakesiana*	A liverwort	Mt Rogers & Whitetop Mtn	Bark in spruce-fir forests.	S	G3?	S?	-
1	-	X	*Mertzgeria fruticulosa*	A liverwort	Whitetop Mtn	Bark in spruce-fir forests, >5000'.	S	G2Q	S?	-
2	-	X	*Nardia lescurii*	A liverwort	Blue Ridge, Ridge & Valley	Riparian - on peaty soil over rocks, usually in shade and associated w/ water, <3000'.	S	G3?	S1	-
1	-	X	*Plagiochila austinii*	A liverwort	Little Stony Ck – Cascades; Red Ck on Beartown Mtn	Rich, moist, densely forested ravines; shaded outcrops.	S	G3	S?	-
3	-	X	*Plagiochila sullivantii var. sullivantii*	A liverwort	Whitetop Mtn, Salt Pond Mtn	Moist shaded rock outcrops, under cliff ledges, in crevices.	S	G2T2	SNR	-
1	-	X	*Sphenolobopsis pearsonii*	A liverwort	Mt Rogers & Whitetop Mtn	Bark of Fraser fir, mountain ash, occasionally red spruce, >5000'.	S	G2	S?	-
Moss										
1	-	X	*Sphagnum flavicomans*	Northeastern peatmoss	Whitetop Mtn	Bogs, seeps	S	G3	SU	-
VASCULAR PLANT										
3	X	X	*Aconitum reclinatum*	Trailing white monkshood	Blue Ridge, Ridge & Valley	Rich cove sites, streambanks, seepages all with high pH.	S	G3	S3	S3
1	-	X	*Actaea rubifolia*	Appalachian black cohosh	Lower Clinch R watershed, Scott, Wise Cos	Moist, rich wooded bluffs over limestone.	S	G3	S1	-
2	X	X	*Allium oxyphilum*	Nodding onion	Monroe, Summers, Mercer, Greenbrier Cos, WV	Shale barrens, sandstone glades.	S	G2	S1	S2

OAR	GW	J	Species Name	Common Name	Range on or near GWJNFs	Habitat - Detail	TES	GRank	VA SRank	WV SRank
1	X	-	*Arabis patens*	Spreading rockcress	Frederick, Lee, Page, Shenandoah, Warren Cos, VA; Hampshire, Hardy, Pendleton, Cos, WV	Shaded, calcareous cliffs, bluffs, and talus slopes.	S	G3	S1	S2
4	X	X	*Berberis canadensis*	American barberry	Blue Ridge, Ridge & Valley	Calcareous open woods, bluffs, cliffs, and along fencerows.	S	G3	S3S4	S1
1	-	X	*Betula uber*	Virginia round-leaf birch	One location: Cressy Ck, Smyth Co	Riparian, mixed open forest, usually disturbed sites.	T	G1Q	S1	-
2	X	-	*Boechera serotina*	Shale barren rockcress	Ridge & Valley N of James R watershed	Shale barrens and adjacent open oak woods.	E	G2	S2	S2
3	X	X	*Buckleya distichophylla*	Piratebush	Blue Ridge S of Roanoke R, Ridge & Valley S of James R	Open oak and hemlock woods.	S	G3	S2	-
1	-	X	*Cardamine clematitis*	Mountain bittercress	Blue Ridge, Ridge & Valley, S of New R watershed	Riparian, spring seeps, rocky streamsides.	S	G3	S1	-
1	-	X	*Cardamine flagellifera*	Blue Ridge bittercress	Blue Ridge, Ridge & Valley, S of New R watershed	Riparian, spring seeps, rocky streamsides.	S	G3	SH	S2
1	X	X	*Carex polymorpha*	Variable sedge	Blue Ridge, Ridge & Valley, N of James R	Open acid soil, oak-heath woodlands, responds positively to fire.	S	G3	S2	S1
2	X	X	*Carex schweinitzii*	Schweinitz's sedge	Augusta, Bath, Highland, Montgomery, Pulaski, Washington Cos	Bogs, limestone fens, marl marshes.	S	G3G4	S1	-
1	-	X	*Chelone cuthbertii*	Cuthbert turtlehead	Blue Ridge Plateau, Grayson, Carroll Cos	Bogs, wet meadows, boggy woods and thickets.	S	G3	S2	-
3	-	X	*Cleistesiopsis bifaria*	Small spreading pogonia	Craig, Dickenson, Scott, Wise Cos	Well drained, rather open, scrubby hillsides, oak-pine-heath woodlands, acidic soils.	S	G4?	S2	S1
2	-	X	*Clematis addisonii*	Addison's leatherflower	Montgomery, Roanoke, Botetourt, Rockbridge Cos	Open glades & rich woods over limestone and dolostone.	S	G1?	S2	-
2	X	X	*Clematis coactilis*	Virginia white-haired leatherflower	Ridge & Valley, Rockbridge Co, S to Wythe Co	Shale barrens, rocky calcareous woodlands.	S	G3	S3	-
3	X	X	*Corallorhiza bentleyi*	Bentley's coralroot	Alleghany, Bath, Giles Cos VA; Monroe, Pocahontas Cos WV	Dry, acid woods, along roadsides, well-shaded trails.	S	G2	S2	S1
3	X	X	*Delphinium exaltatum*	Tall larkspur	Blue Ridge, Ridge & Valley	Dry calcareous soil in open grassy glades or thin woodlands.	S	G3	S3	S2
1	X	-	*Echinodorus tenellus*	Dwarf burhead	Pines Chapel Pond, Augusta Co	Pond margins, wet depressions in sandy soil.	S	G5?	S1	-
2	X	X	*Echinacea laevigata*	Smooth coneflower	Alleghany, Montgomery Cos	Open woodlands and glades over limestone or dolomite.	E	G2G3	S2	-
2	X	X	*Euphorbia purpurea*	Glade spurge	Blue Ridge, Ridge & Valley	Rich, swampy woods, seeps and thickets.	S	G3	S2	S2
1	-	X	*Gentiana austromontana*	Appalachian gentian	Mt Rogers, Whitetop Mtn, High Knob	High elevation forests and grassy balds. Southern Appalachian endemic.	S	G3	S3	S1
2	-	X	*Hasteola suaveolens*	Sweet-scented Indian-plantain	Giles, Montgomery, Pulaski Cos	Riverbanks, wet meadows.	S	G4	S2	S3
1	X	-	*Helenium virginicum*	Virginia sneezeweed	Endemic to Augusta, Rockingham Cos	Seasonally dry meadows and sinkhole depressions.	T	G3	S2	-

OAR	GW	J	Species Name	Common Name	Range on or near GWJNFs	Habitat - Detail	TES	GRank	VA SRank	WV SRank
1	X	-	*Helonias bullata*	Swamp-pink	Augusta, Nelson Cos	Sphagnum bogs, seeps, and streamsides.	T	G3	S2S3	-
1	X	-	*Heuchera alba*	White alumroot	Shenandoah Mtn	High elevation rocky woods and bluffs.	S	G2Q	S1	S2
2	X	X	*Hypericum mitchellianum*	Blue Ridge St. John's-wort	Blue Ridge, Ridge & Valley	Grassy balds, forest seepages, moderate to high elevations.	S	G3	S3	S1
2	X	X	*Ilex collina*	Long-stalked holly	Blue Ridge, Ridge & Valley	Bogs, seep, shrubby streamheads, >3100'.	S	G3	S1	S2
1	-	X	*Iliamna corei*	Peter's Mountain-mallow	One location: Narrows, Peters Mountain, Giles Co.	Rich, open woods along sandstone outcrops, soil pockets, fire maintained.	E	G1	S1	-
1	X	X	*Iliamna remota*	Kankakee globe-mallow	Alleghany, Botetourt, Rockbridge, Bedford Cos	Open, disturbed riverbanks and roadsides.	S	G1Q	S1	-
1	X	-	*Isoetes virginica*	Virginia quillwort	Augusta Co	Summer-dry sinkhole ponds, seasonally wet upland depressions, and small, wet-weather drains, especially in moss hummocks.	S	G1	S1	-
3	X	X	*Isotria medeoloides*	Small whorled pogonia	In mountains of VA known only from Bedford, Craig, and Lee Cos; other VA occurrences in Piedmont & Coastal Plain	Open, mixed hardwood forests on level to gently sloping terrain with north to east aspect.	T	G2?	S2	S1
3	X	X	*Juglans cinerea*	Butternut	Blue Ridge, Ridge & Valley	Well-drained bottomland and floodplain, rich mesophytic forests mostly along toeslopes.	S	G4	S3?	S3
2	X	X	*Liatris helleri*	Turgid gayfeather	Blue Ridge, Ridge & Valley	Shale barrens, mountain hillside openings.	S	GNR	S3	S2
1	-	X	*Lilium grayi*	Gray's lily	Blue Ridge, Mt Rogers & Whitetop Mtn (occurrences north of Floyd Co questionable)	Bogs, open seeps, wet meadows, grassy balds.	S	G3	S2	-
1	X	-	*Lycopodiella margueritae*	Marguerite's clubmoss	Bath Co	Seasonally moist soils, wet acidic ditches, borrow pits.	S	G2	NA	-
1	-	X	*Micranthes caroliniana*	Carolina saxifrage	Blue Ridge, Ridge & Valley, S of New R	Moist, shaded rocks and cliffs.	S	G3	S3	S1
6	X	X	*Monotropsis odorata*	Sweet pinesap	Blue Ridge, Ridge & Valley	Dry oak-pine-heath woodlands, soil usually sandy.	S	G3	S3	S1
1	-	X	*Packera millefolium*	Piedmont ragwort	Lee, Scott Cos	Open limestone outcrops and cedar barrens.	S	G2	S2	-
2	X	-	*Paxistima canbyi*	Canby's mountain lover	Ridge & Valley, Sarver Barrens SBA, Craig Co	Calcareous cliffs and bluffs, usually undercut by stream.	S	G2	S2	S2
3	X	X	*Phlox buckleyi*	Sword-leaf phlox	Blue Ridge, Ridge & Valley	Open, often dry oak woodlands and rocky slopes, usually over shale in humus rich soils, often along roadsides.	S	G2	S2	S2
3	X	X	*Poa paludigena*	Bog bluegrass	Blue Ridge, Ridge & Valley	Shrub swamps and seeps, usually under shade.	S	G3	S2	S1
1	X	-	*Potamogeton hillii*	Hill's pondweed	Bath Co	Clear, cold calcareous ponds.	S	G3	S1	-

OAR	GW	J	Species Name	Common Name	Range on or near GWJNFs	Habitat - Detail	TES	GRank	VA SRank	WV SRank
2	X	-	*Potamogeton tennesseensis*	Tennessee pondweed	Ridge & Valley	Ponds, back water of streams and rivers.	S	G2G3	S1	S2
1	-	X	*Prenanthes roanensis*	Roan Mountain rattlesnake-root	Mt Rogers & Whitetop Mtn	Grassy balds, open high elevation forests and outcrops.	S	G3	S3	-
3	X	X	*Pycnanthemum torrei*	Torrey's mountain-mint	Bland, Bath, Giles, Rockbridge, Wythe Cos	Open, dry rocky woods, roadsides, and thickets near streams, heavy clay soil over calcareous rock.	S	G2	S2	S1
2	-	X	*Rudbeckia triloba var. pinnatiloba*	Pinnate-lobed coneflower	Giles, Montgomery, Smyth, Wise Cos	Dry calcareous soil of open woods and roadsides.	S	G5T3	S1	-
1	-	X	*Sceptridium jenmanii*	Alabama grapefern	Scott, Russell, Wise Cos	Open woods, old fields, pastures.	S	G3G4	SH	-
1	X	X	*Scirpus ancistrochaetus*	Northeastern bulrush	Ridge & Valley	Mountain ponds, sinkhole ponds in Shenandoah Valley.	E	G3	S2	S1
5	X	X	*Scutellaria saxatilis*	Rock skullcap	Blue Ridge, Ridge & Valley	Rich, dry to mesic ridgetop woods, 32 counties in VA, likely G4/S4.	S	G3	S3	S2
1	X	X	*Sida hermaphrodita*	Virginia mallow	Ridge & Valley, James R watersheds	Riverbank glades with loose rock or sandy soil.	S	G3	S1	S3
1	-	X	*Silene ovata*	Mountain catchfly	Dickenson, Lee, Wise Cos	Rich woodlands and forests over limestone.	S	G3	S1	-
1	-	X	*Spiraea virginiana*	Virginia spiraea	Blue Ridge, Ridge & Valley, S of New R	Scoured banks of streams, riverside or island shrub thickets.	T	G2	S1	S1
1	X	-	*Trillium pusillum var. moniticulum*	Virginia least trillium	Great North Mtn & Shenandoah Mtn, VA and WV	Open oak woodlands in well drained soil and margins of thickets.	S	G3T2	S2	S1
3	-	X	*Tsuga caroliniana*	Carolina hemlock	Blue Ridge north to James R.	Rocky ridges and slopes, usually dry and well drained.	S	G3	S3	-
2	X	X	*Vitis rupestris*	Sand grape	Ridge & Valley	Scoured banks of rivers and streams over calcareous bedrock.	S	G3	S1	S2

LEGEND FOR TES SPECIES LIST IN OCCURRENCE ANALYSIS RESULTS:

OAR CODES:

1 = Project located out of known species range.
2 = Lack of suitable habitat for species in project area.
3 = Habitat present, species was searched for during field survey, but not found.
4 = Species occurs in project area, but outside of activity area.
5 = Field survey located species in activity area.
6 = Species not seen during field survey, but possibly occurs in activity area based on habitat observed. or Field survey not conducted when species is recognizable (time of year or time of day). Therefore assume presence and no additional surveys needed.
7 = Aquatic species or habitat known or suspected downstream of project/activity area, but outside identified geographic bounds of water resource cumulative effects analysis area (defined as point below which sediment amounts are immeasurable and insignificant).
8 = Aquatic species or habitat known or suspected downstream of project/activity area, but inside identified geographic bounds of water resource cumulative effects analysis area.
9 = Project occurs in a 6th level watershed included in the USFWS/FS T&E Mussel and Fish Conservation Plan (August 8, 2007 U.S. Fish & Wildlife Service concurrence on updated watersheds). Conservation measures from the USFWS/FS T&E Mussel and Fish Conservation Plan applied.

SPECIES: The term "species" includes any subspecies of fish, wildlife or plants, and any distinct population segment of any species or vertebrate fish or wildlife, which interbreeds when mature (Endangered Species Act of 1973, as amended through the 100th Congress).

RANGE: The geographical distribution of a species. For use here "range" is expressed as where a species is known or expected to occur on or near the George Washington and Jefferson National Forests in terms of landform (feature name, physiographic province), political boundary (county name), or watershed (river, or stream name).

HABITAT: A place where the physical and biological elements of ecosystems provide a suitable environment and the food, cover and space resources needed for plant and animal livelihood (FSM 2605-91-8, pg. 10 of 13).

TES CODES:

T = Federally listed as Threatened
E = Federally listed as Endangered
P = Federally Proposed as T or E
S = Southern Region (R8) Sensitive species

GLOBAL RANK: Global ranks are assigned by a consensus of the network of natural heritage programs, scientific experts, NatureServe and The Nature Conservancy to designate a rarity rank based on the range-wide status of a species or variety. This system was developed by The Nature Conservancy and is widely used by other agencies and organizations as the best available scientific and objective assessment of taxon rarity and level of threat to its existence. The ranks are assigned after considering a suite of factors including number of occurrences, numbers of individuals, and severity of threats.

G1 = Extremely rare and critically imperiled with 5 or fewer occurrences or very few remaining individuals; or because of some factor(s) making it especially vulnerable to extinction.
G2 = Very rare and imperiled with 6 to 20 occurrences or few remaining individuals; or because of some factor(s) making it especially vulnerable to extinction.
G3 = Either very rare and local throughout its range or found locally (even abundantly at some of its locations) in a restricted range; or vulnerable to extinction because of other factors. Usually fewer than 100 occurrences are documented.
G4 = Common and apparently secure globally, although it may be rare in parts of its range, especially at the periphery.
G5 = Very common and demonstrably secure globally, although it may be rare in parts of its range, especially at the periphery.
GH = Formally part of the world's biota with the exception that may be rediscovered.
GX = Believed extinct throughout its range with virtually no likelihood of rediscovery.
GU = Possibly rare, but status uncertain and more data needed.
G? = Unranked, or, if following a ranking, ranking uncertain (ex. G3?).
G_Q = Taxon has a questionable taxonomic assignment, such as G3Q.
G_T = Signifies the rank of a subspecies or variety. For example, a G5T1 would apply to a subspecies of a species that is demonstrably secure globally (G5) but the subspecies warrants a rank of T1, critically imperiled.

STATE RANK: The following ranks are used by the Virginia Department of Conservation and Recreation to set protection priorities for natural heritage resources. Natural Heritage Resources (NHRs) are rare plant and animal species, rare and exemplary natural communities, and significant geologic features. The criterion for ranking NHRs is the number of populations or occurrences, i.e. the number of known distinct localities; the number of individuals in existence at each locality or, if a highly mobile organism (e.g., sea turtles, many birds, and butterflies), the total number of individuals; the quality of the occurrences, the number of protected occurrences; and threats.

- **S1** - Extremely rare; usually 5 or fewer populations or occurrences in the state; or may be a few remaining individuals; often especially vulnerable to extirpation.
- **S2** - Very rare; usually between 6 and 20 populations or occurrences; or with many individuals in fewer occurrences; often susceptible to becoming extirpated.
- **S3** - Rare to uncommon; usually between 21 and 100 populations or occurrences; may have fewer occurrences, but with a large number of individuals in some populations; may be susceptible to large-scale disturbances.
- **S4** - Common; usually >100 populations or occurrences, but may be fewer with many large populations; may be restricted to only a portion of the state; usually not susceptible to immediate threats.
- **S5** - Very common; demonstrably secure under present conditions.
- **SA** - Accidental in the state.

- **S#B** - Breeding status of an organism within the state.
- **SH** - Historically known from the state, but not verified for an extended period, usually > 15 years; this rank is used primarily when inventory has been attempted recently.
- **S#N** - Non-breeding status within the state. Usually applied to winter resident species.
- **SR –** Reported for Virginia, but without persuasive documentation that would provide a basis for either accepting or rejecting the report.
- **SU** - Status uncertain, often because of low search effort or cryptic nature of the element.
- **SX** - Apparently extirpated from the state.
- **SZ** - Long distance migrant, whose occurrences during migration are too irregular, transitory and/or dispersed to be reliably identified, mapped and protected.
- **NA** – Not Applicable- A conservation status rank is not applicable because the species is not a suitable target for conservation activities.

These ranks should not be interpreted as legal designations.

APPENDIX C
HABITAT CLASSIFICATIONS WITHIN THE IDENTIFIED AREAS ALONG MVP'S POTENTIAL ROUTES FOR THE PROPOSED MOUNTAIN VALLEY PIPELINE PROJECT WITHIN THE JEFFERSON NATIONAL FOREST IN VIRGINIA AND WEST VIRGINIA

ESI

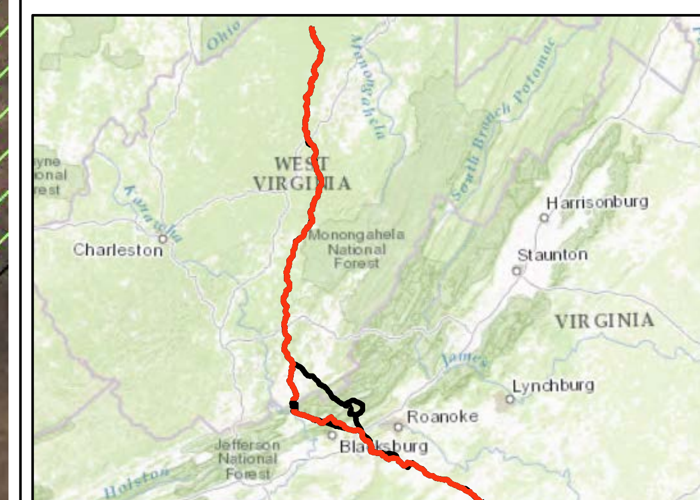
Appendix C. Habitat classifications along the proposed Mountain Valley Pipeline Project within the Jefferson National Forest.

Map 1 of 37

- October 2016 Proposed Route (Revised)
- MVP Abandoned/Alternate Route
- Tract Identified on Jefferson National Forest Land
- Jefferson National Forest Boundary
- Appalachian National Scenic Trail
- Mystery Ridge Road
- Pocahontas Road

Land Cover

- Deciduous Forest



N
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110 0 110 220 Meters

Base Map: ESRI ArcGIS Web service - "World_Imagery" accessed - 1/10/2017

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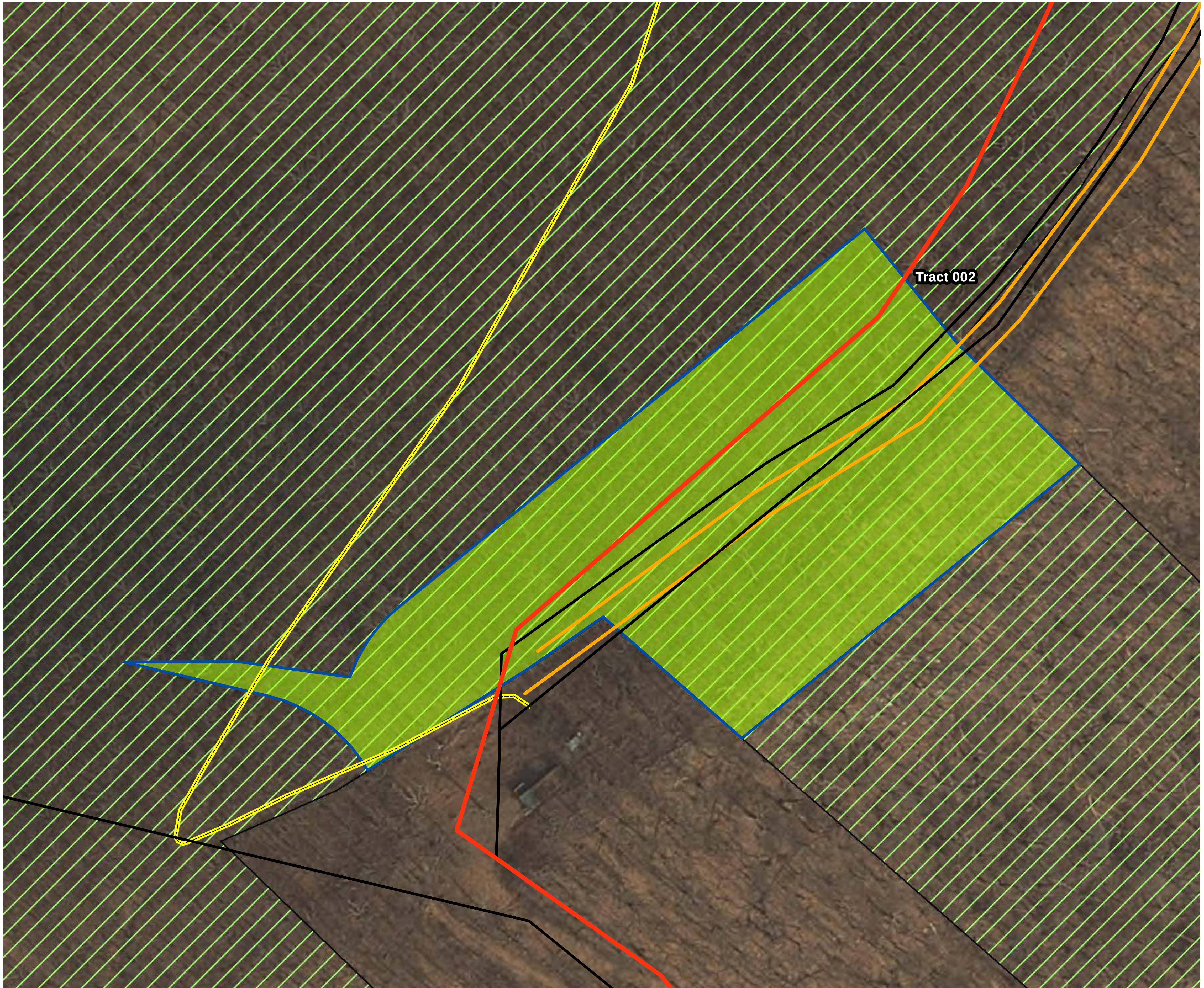
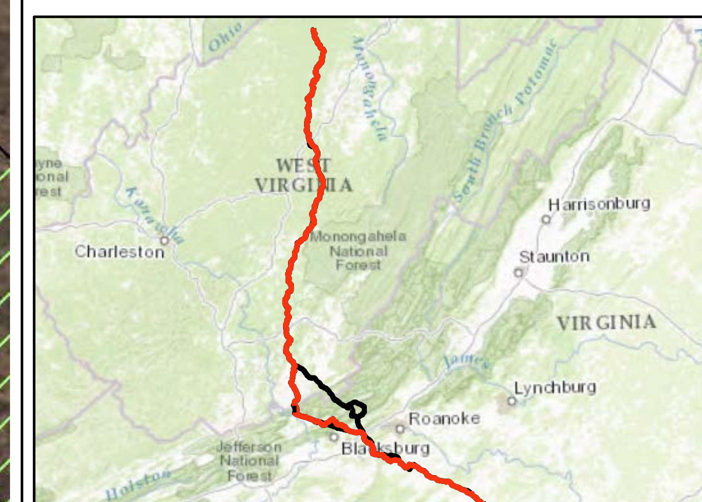
Appendix C. Habitat classifications along the proposed Mountain Valley Pipeline Project within the Jefferson National Forest.

Map 2 of 37



October 2016 Proposed Route (Revised)
MVP Abandoned/Alternate Route
Tract Identified on Jefferson National Forest Land
Jefferson National Forest Boundary
Mystery Ridge Road
Pocahontas Road
Land Cover
Deciduous Forest



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Base Map: ESRI ArcGIS Web service - "World_Imagery" accessed - 1/10/2017

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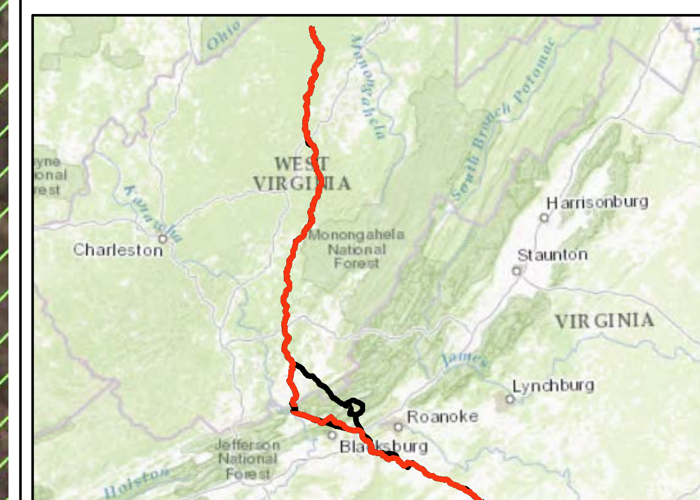
Appendix C. Habitat classifications along the proposed Mountain Valley Pipeline Project within the Jefferson National Forest.

Map 3 of 37

- October 2016 Proposed Route (Revised)
- MVP Abandoned/Alternate Route
- Tract Identified on Jefferson National Forest Land
- Jefferson National Forest Boundary

Land Cover

- Deciduous Forest
- Shrub/Scrub



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Base Map: ESRI ArcGIS Web service - "World_Imagery" accessed - 1/10/2017

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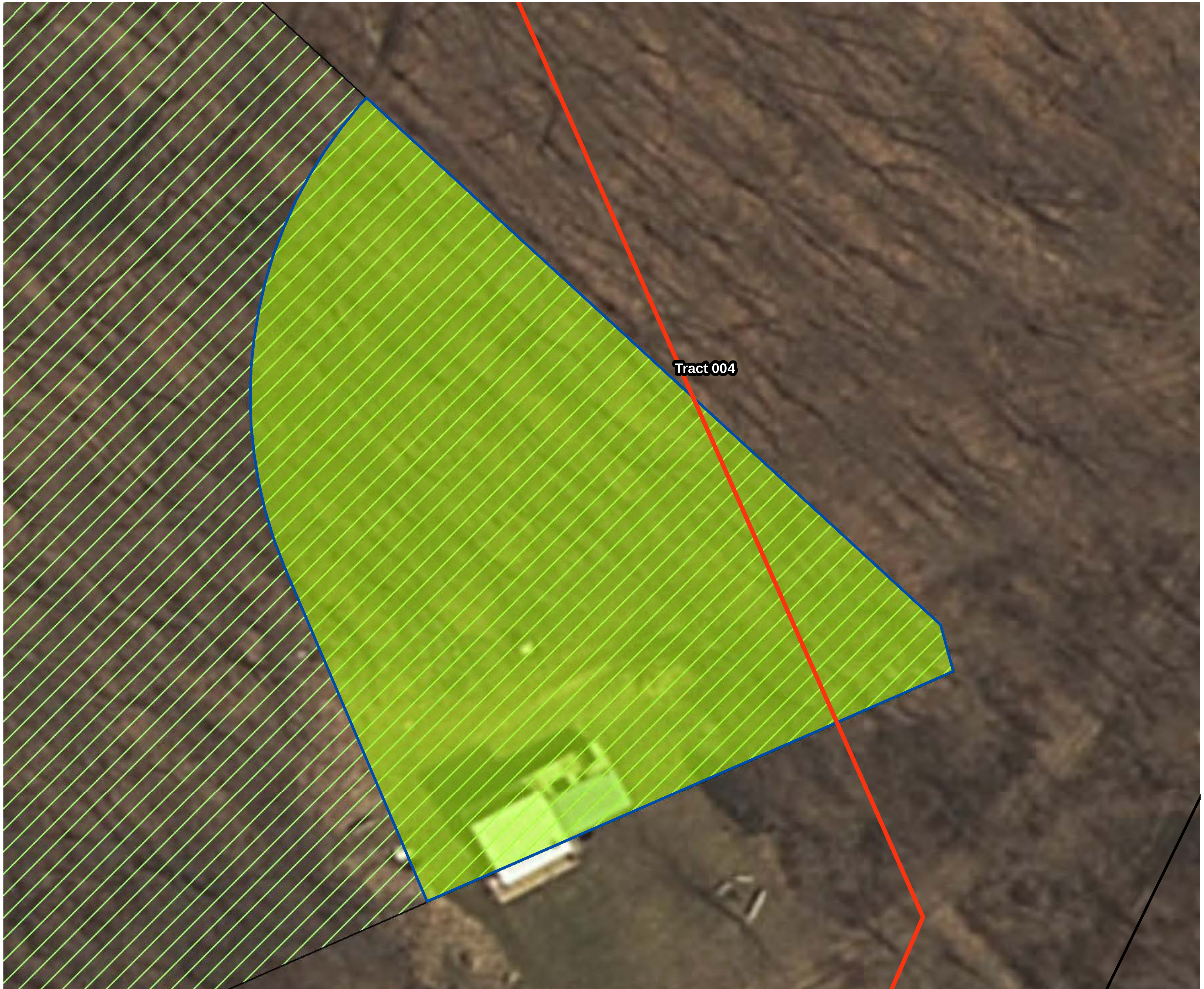
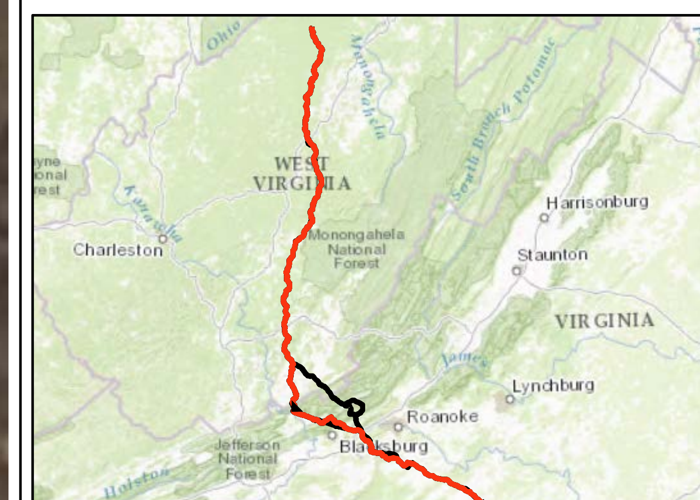


Appendix C. Habitat classifications along the proposed Mountain Valley Pipeline Project within the Jefferson National Forest.

Map 4 of 37

October 2016 Proposed Route (Revised)
MVP Abandoned/Alternate Route
Tract Identified on Jefferson National Forest Land
Jefferson National Forest Boundary
Land Cover
Deciduous Forest



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Base Map: ESRI ArcGIS Web service - "World_Imagery" accessed - 1/10/2017

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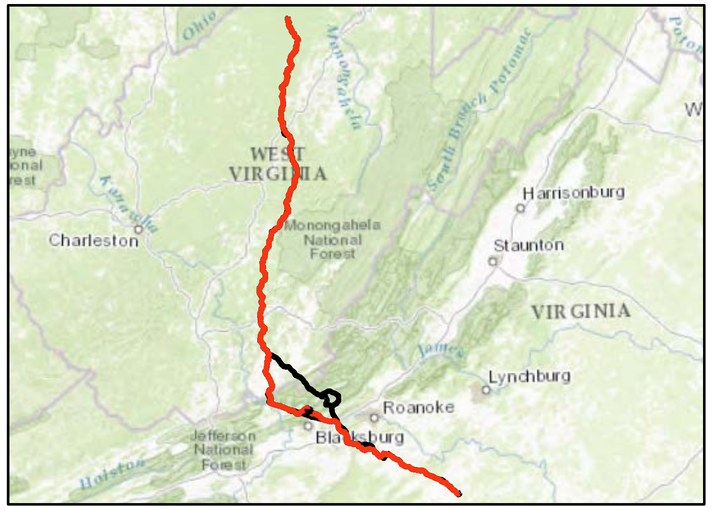
Appendix C. Habitat classifications along the proposed Mountain Valley Pipeline Project within the Jefferson National Forest.

- October 2016 Proposed Route (Revised)
- MVP Abandoned/Alternate Route
- Tract Identified on Jefferson National Forest Land
- Jefferson National Forest Boundary

Land Cover

- Deciduous Forest
- Evergreen Forest
- Proposed ATWS



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70 0 70 140 Meters

Base Map: ESRI ArcGIS Web service - "World_Imagery" accessed - 1/10/2017

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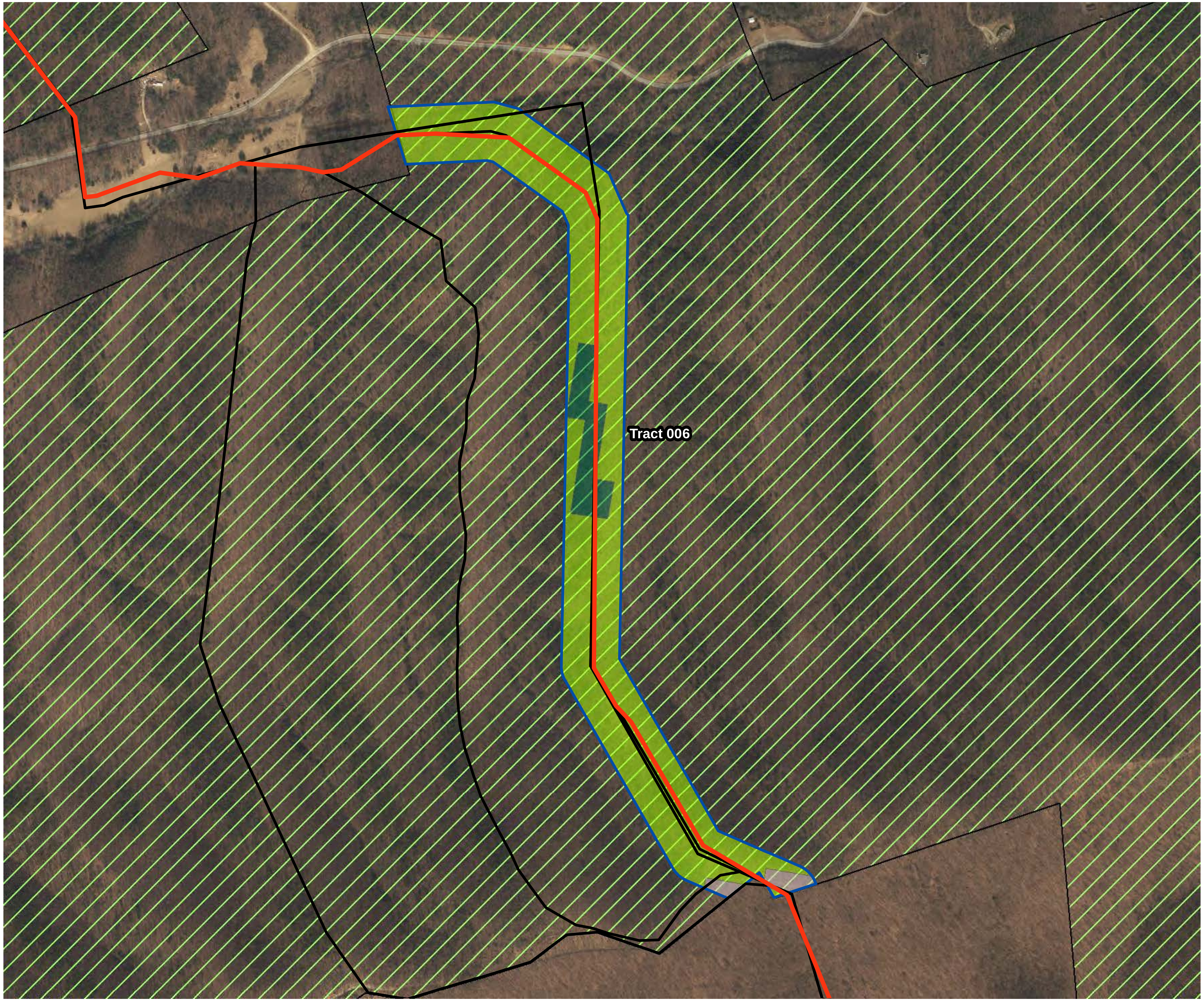
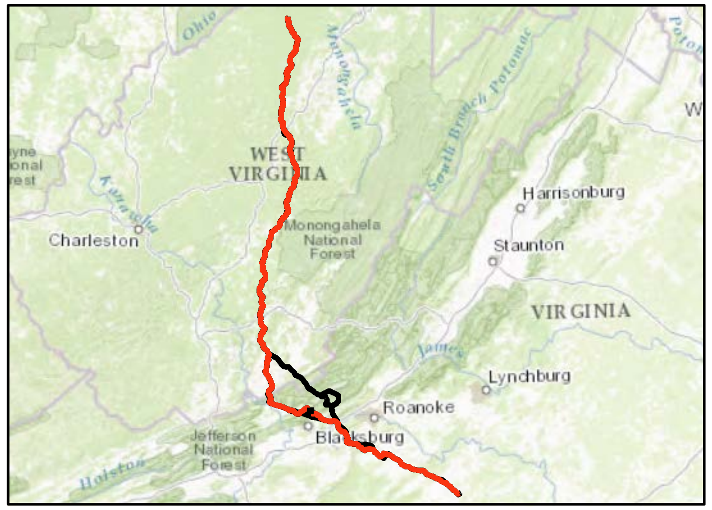


Appendix C. Habitat classifications along the proposed Mountain Valley Pipeline Project within the Jefferson National Forest.

Map 6 of 37

October 2016 Proposed Route (Revised)
MVP Abandoned/Alternate Route
Tract Identified on Jefferson National Forest Land
Jefferson National Forest Boundary
Land Cover
Deciduous Forest
Evergreen Forest
Developed, Open Space



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Meters

Base Map: ESRI ArcGIS Web service - "World_Imagery" accessed - 1/10/2017

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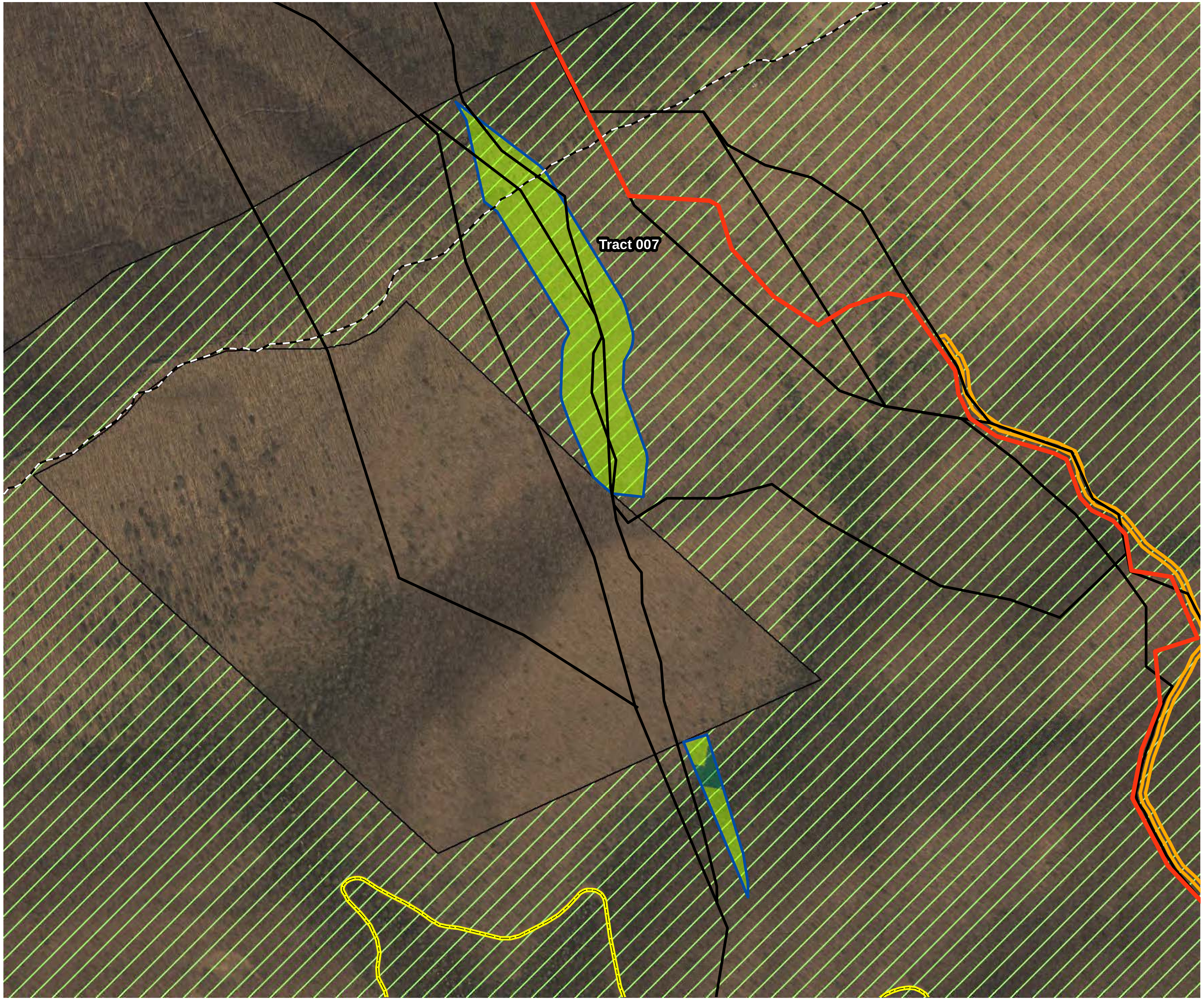
Appendix C. Habitat classifications along the proposed Mountain Valley Pipeline Project within the Jefferson National Forest.

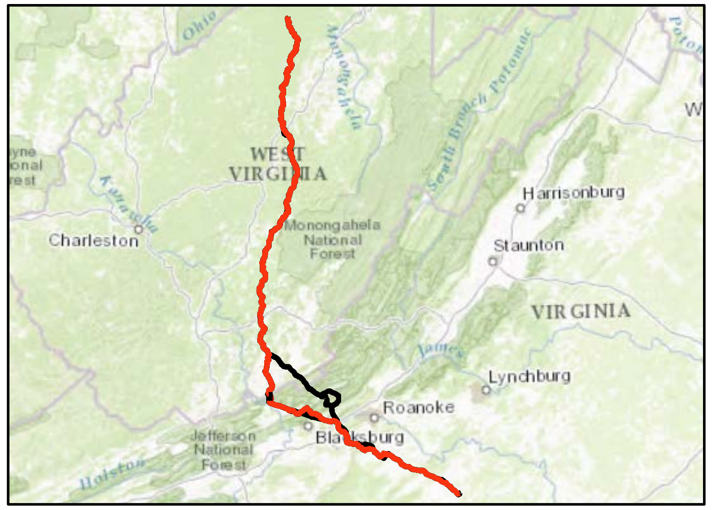
Map 7 of 37



- October 2016 Proposed Route (Revised)
- MVP Abandoned/Alternate Route
- Tract Identified on Jefferson National Forest Land
- Jefferson National Forest Boundary
- Appalachian National Scenic Trail
- Mystery Ridge Road
- Pocahontas Road

Land Cover

- Deciduous Forest
- Evergreen Forest



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Base Map: ESRI ArcGIS Web service - "World_Imagery" accessed - 1/10/2017

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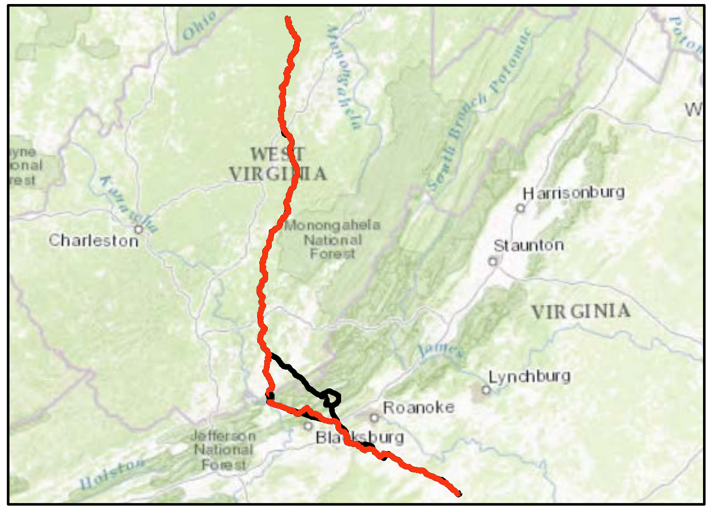
Appendix C. Habitat classifications along the proposed Mountain Valley Pipeline Project within the Jefferson National Forest.

Map 8 of 37

- October 2016 Proposed Route (Revised)
- MVP Abandoned/Alternate Route
- Tract Identified on Jefferson National Forest Land
- Jefferson National Forest Boundary
- Appalachian National Scenic Trail
- Mystery Ridge Road

Land Cover

- Deciduous Forest



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Base Map: ESRI ArcGIS Web service - "World_Imagery" accessed - 1/10/2017

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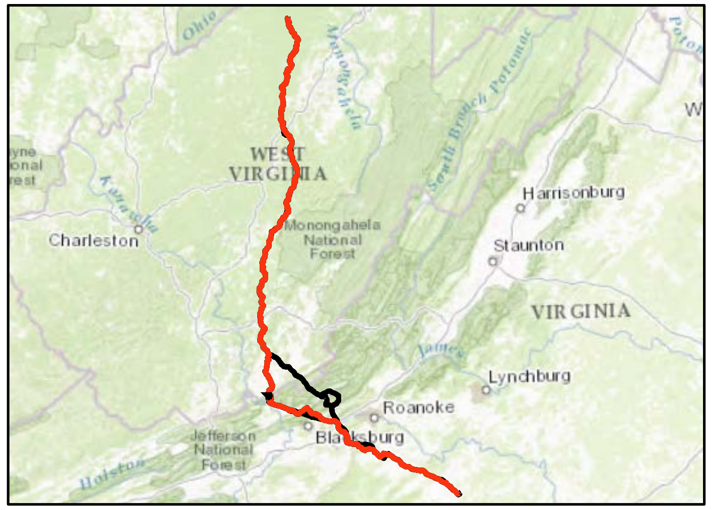
Appendix C. Habitat classifications along the proposed Mountain Valley Pipeline Project within the Jefferson National Forest.

Map 9 of 37

- MVP Abandoned/Alternate Route
- Tract Identified on Jefferson National Forest Land
- Jefferson National Forest Boundary
- Appalachian National Scenic Trail

Land Cover

- Deciduous Forest



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Base Map: ESRI ArcGIS Web service - "World_Imagery" accessed - 1/10/2017

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Project No. 593.02

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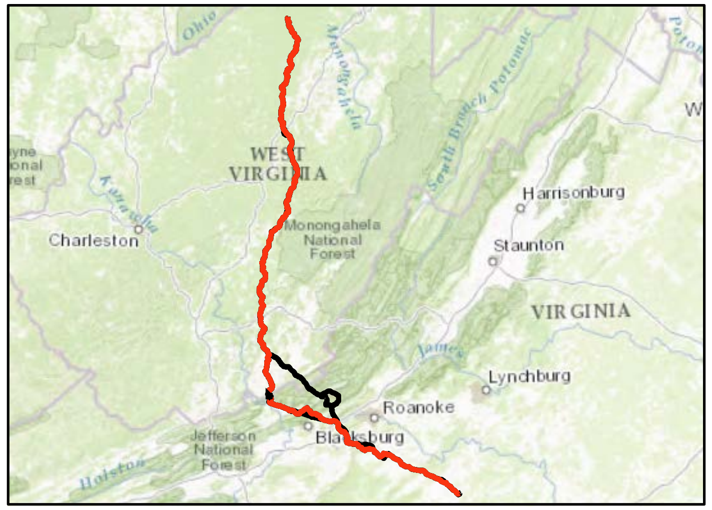
Appendix C. Habitat classifications along the proposed Mountain Valley Pipeline Project within the Jefferson National Forest.

Map 10 of 37

- October 2016 Proposed Route (Revised)
- MVP Abandoned/Alternate Route
- Tract Identified on Jefferson National Forest Land
- Jefferson National Forest Boundary
- Appalachian National Scenic Trail

Land Cover

- Deciduous Forest



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Base Map: ESRI ArcGIS Web service - "World_Imagery" accessed - 1/10/2017

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Project No. 593.02

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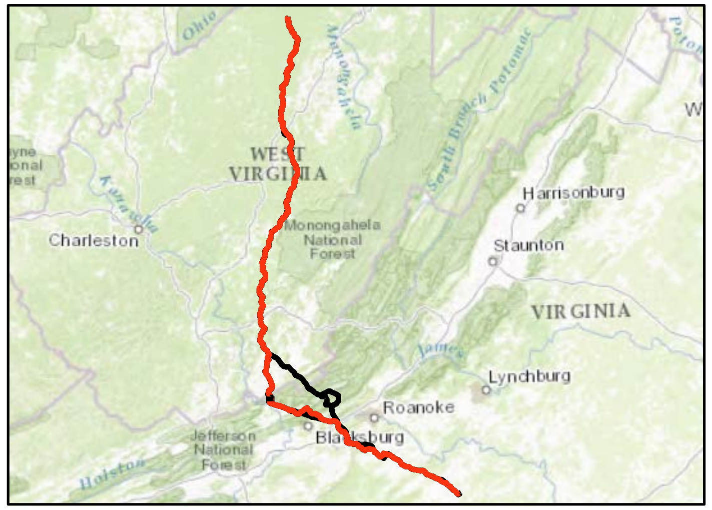
Appendix C. Habitat classifications along the proposed Mountain Valley Pipeline Project within the Jefferson National Forest.

Map 11 of 37

- October 2016 Proposed Route (Revised)
- MVP Abandoned/Alternate Route
- Tract Identified on Jefferson National Forest Land
- Jefferson National Forest Boundary
- Mystery Ridge Road
- Pocahontas Road

Land Cover

- Deciduous Forest
- Evergreen Forest



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Base Map: ESRI ArcGIS Web service - "World_Imagery" accessed - 1/10/2017

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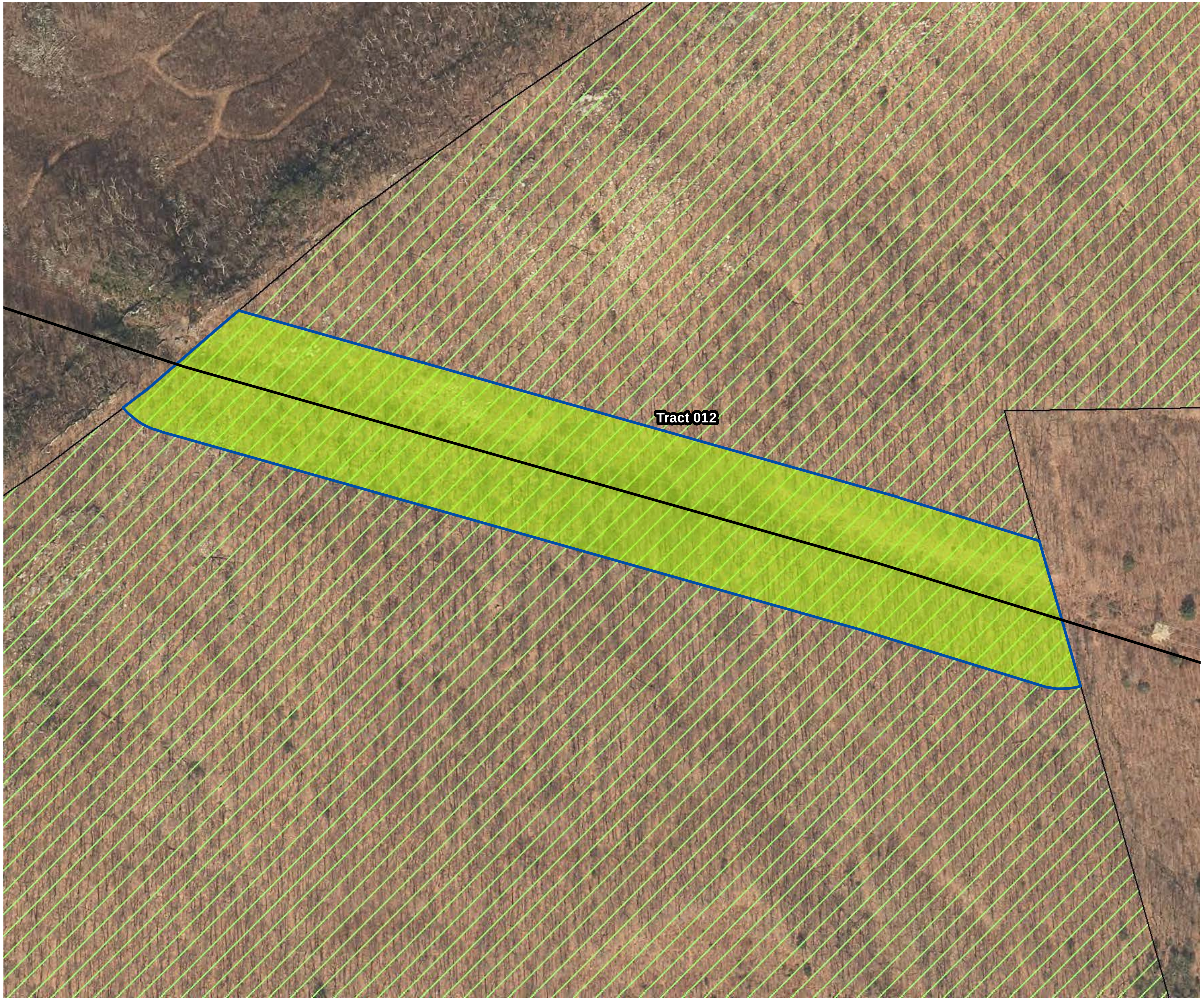
Project No. 593.02

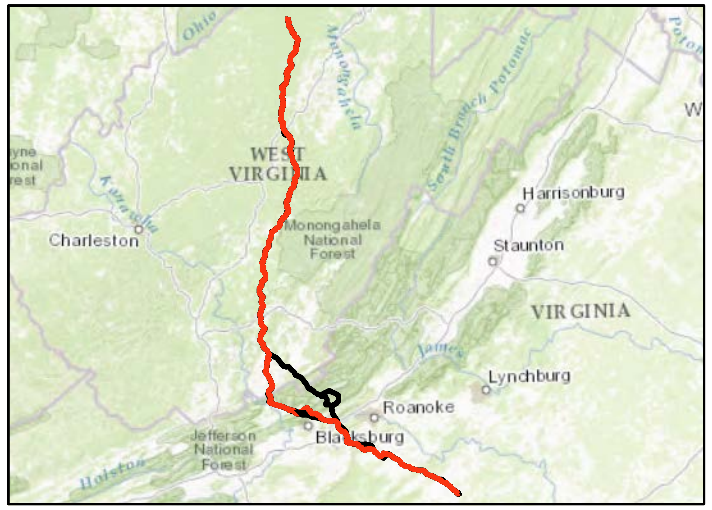
Appendix C. Habitat classifications along the proposed Mountain Valley Pipeline Project within the Jefferson National Forest.



- MVP Abandoned/Alternate Route
- Tract Identified on Jefferson National Forest Land
- Jefferson National Forest Boundary

Land Cover

- Deciduous Forest



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Base Map: ESRI ArcGIS Web service - "World_Imagery" accessed - 1/10/2017

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Project No. 593.02

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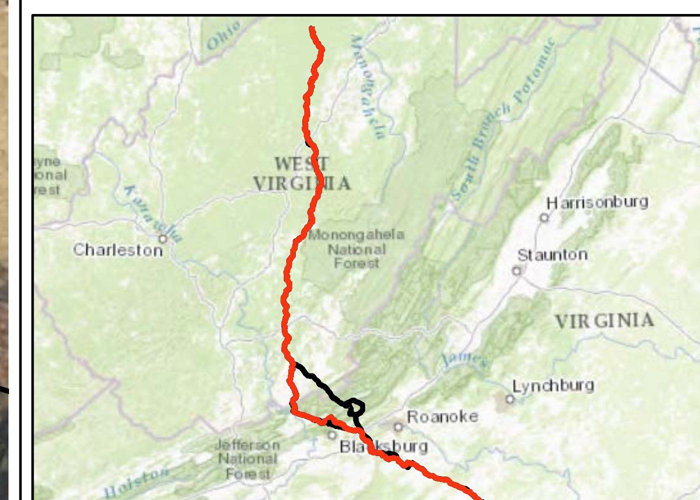
Appendix C. Habitat classifications along the proposed Mountain Valley Pipeline Project within the Jefferson National Forest.

Map 13 of 37

- MVP Abandoned/Alternate Route
- Tract Identified on Jefferson National Forest Land
- Jefferson National Forest Boundary

Land Cover

- Deciduous Forest
- Evergreen Forest
- Mixed Forest
- Developed, Low Intensity
- Developed, Open Space
- Hay/Pasture



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Meters

Base Map: ESRI ArcGIS Web service - "World_Imagery" accessed - 1/10/2017

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Project No. 593.02

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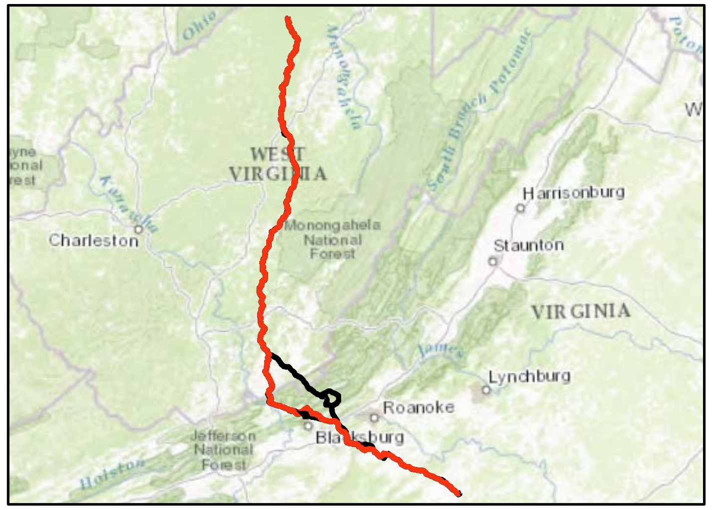
Appendix C. Habitat classifications along the proposed Mountain Valley Pipeline Project within the Jefferson National Forest.

Map 14 of 37

MVP Abandoned/Alternate Route
Tract Identified on Jefferson National Forest Land
Jefferson National Forest Boundary
Land Cover
Deciduous Forest
Evergreen Forest



N W E S

50 0 50 100 Meters

Base Map: ESRI ArcGIS Web service - "World_Imagery" accessed - 1/10/2017

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Project No. 593.02

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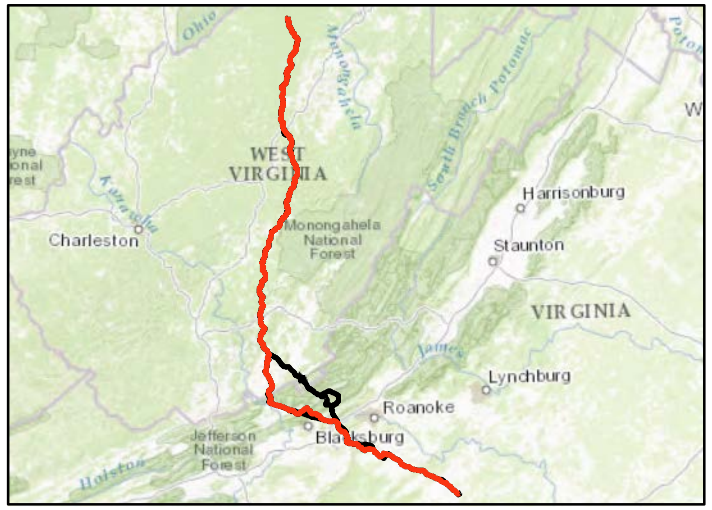
Appendix C. Habitat classifications along the proposed Mountain Valley Pipeline Project within the Jefferson National Forest.

Map 15 of 37

MVP Abandoned/Alternate Route
Tract Identified on Jefferson National Forest Land
Jefferson National Forest Boundary
Land Cover
Deciduous Forest
Developed, Open Space



N
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Base Map: ESRI ArcGIS Web service - "World_Imagery" accessed - 1/10/2017

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ENVIRONMENTAL SOLUTIONS & INNOVATIONS, INC.
Project No. 593.02

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Appendix C. Habitat classifications along the proposed Mountain Valley Pipeline Project within the Jefferson National Forest.

Map 16 of 37

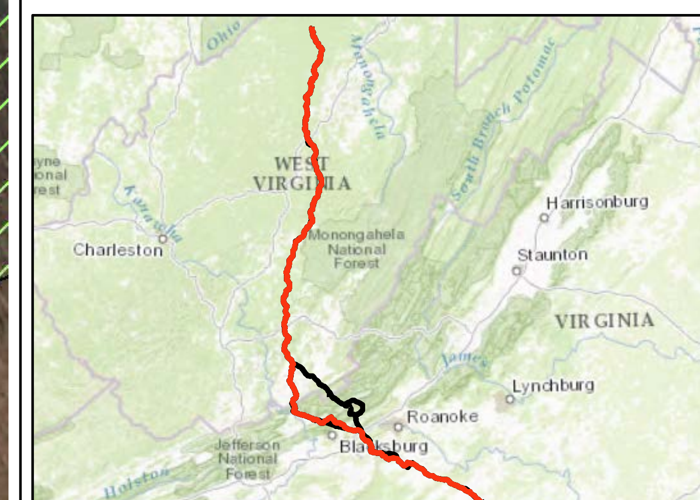
MVP Abandoned/Alternate Route

Tract Identified on Jefferson National Forest Land

Jefferson National Forest Boundary

Land Cover

Deciduous Forest



N W E S

20 0 20 40 Meters

Base Map: ESRI ArcGIS Web service - "World_Imagery" accessed - 1/10/2017

ESI ENVIRONMENTAL SOLUTIONS & INNOVATIONS, INC.

Project No. 593.02

Path: G:\Current\593_EQT_MVP\MXD\Biologic_Eval\20161209_BE_figs\593_BE_Appendix_C_20170109.mxd (mbruening) - 1/10/2017

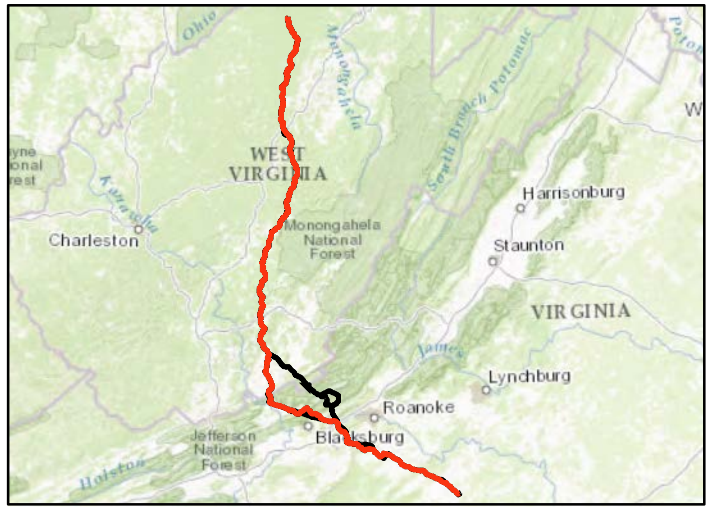
Appendix C. Habitat classifications along the proposed Mountain Valley Pipeline Project within the Jefferson National Forest.

Map 17 of 37

- MVP Abandoned/Alternate Route
- Tract Identified on Jefferson National Forest Land
- Jefferson National Forest Boundary

Land Cover

- Deciduous Forest



N W E S

25 0 25 50 Meters

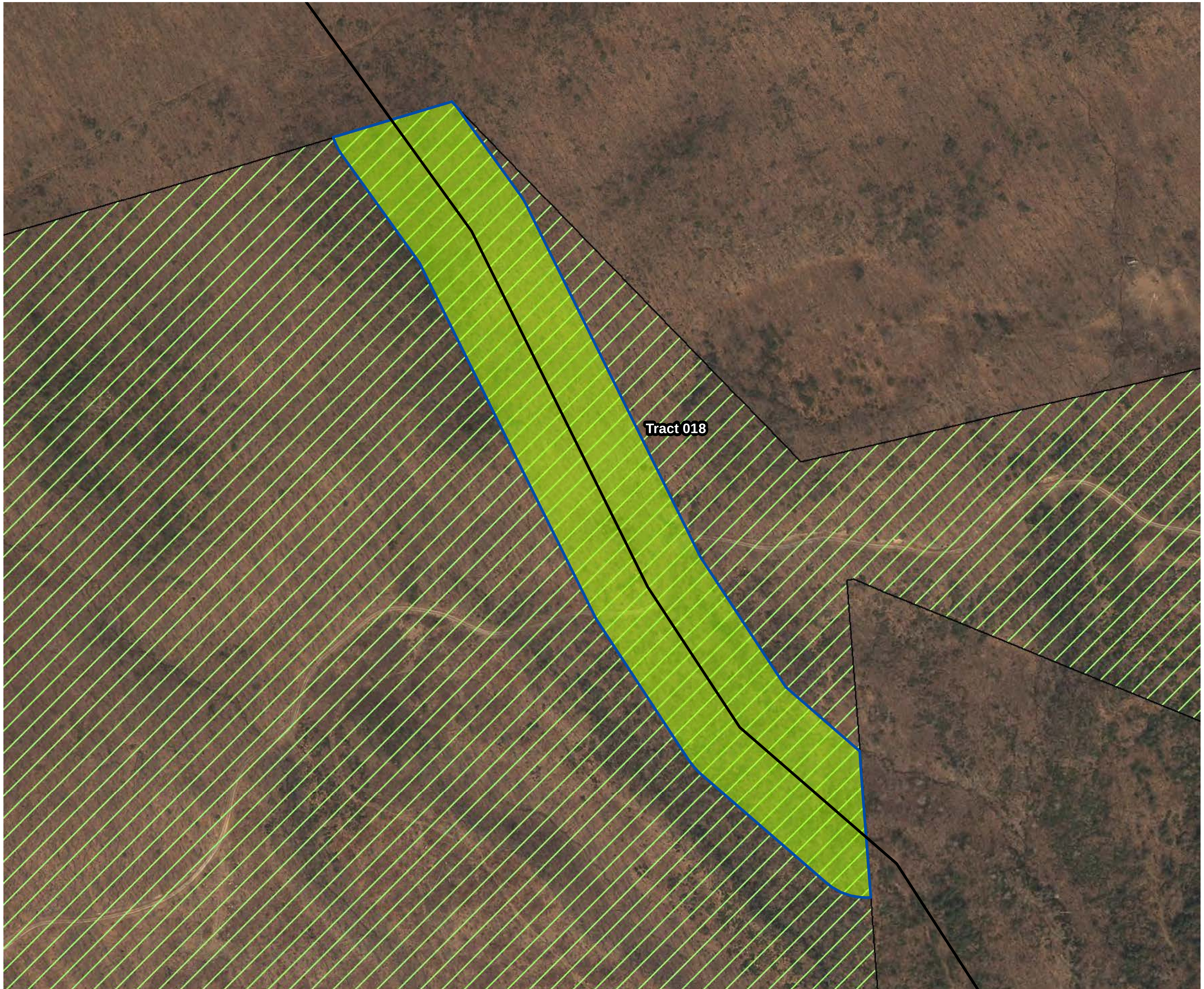
Base Map: ESRI ArcGIS Web service - "World_Imagery" accessed - 1/10/2017

ENVIRONMENTAL SOLUTIONS & INNOVATIONS, INC.

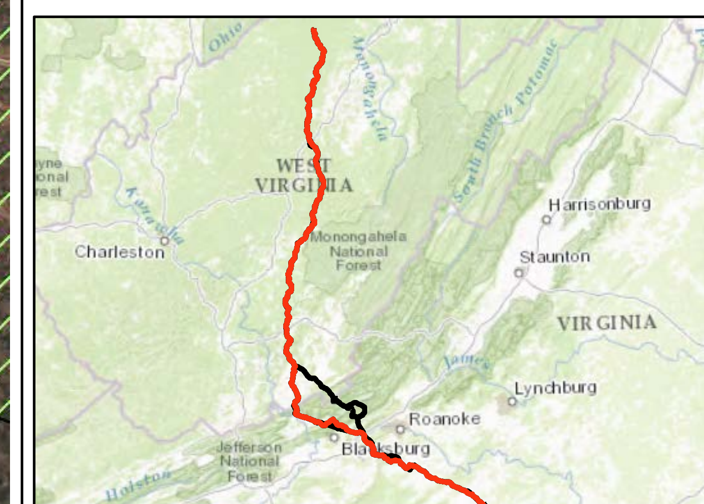
Project No. 593.02

Path: G:\Current\593_EQT_MVP\MXD\Biologic_Eval\20161209_BE_figs\593_BE_Appendix_C_20170109.mxd (mbruening) - 1/10/2017

Appendix C. Habitat classifications along the proposed Mountain Valley Pipeline Project within the Jefferson National Forest.



MVP Abandoned/Alternate Route
Tract Identified on Jefferson National Forest Land
Jefferson National Forest Boundary
Land Cover
Deciduous Forest



N S W E

30 0 30 60 Meters

Base Map: ESRI ArcGIS Web service - "World_Imagery" accessed - 1/10/2017

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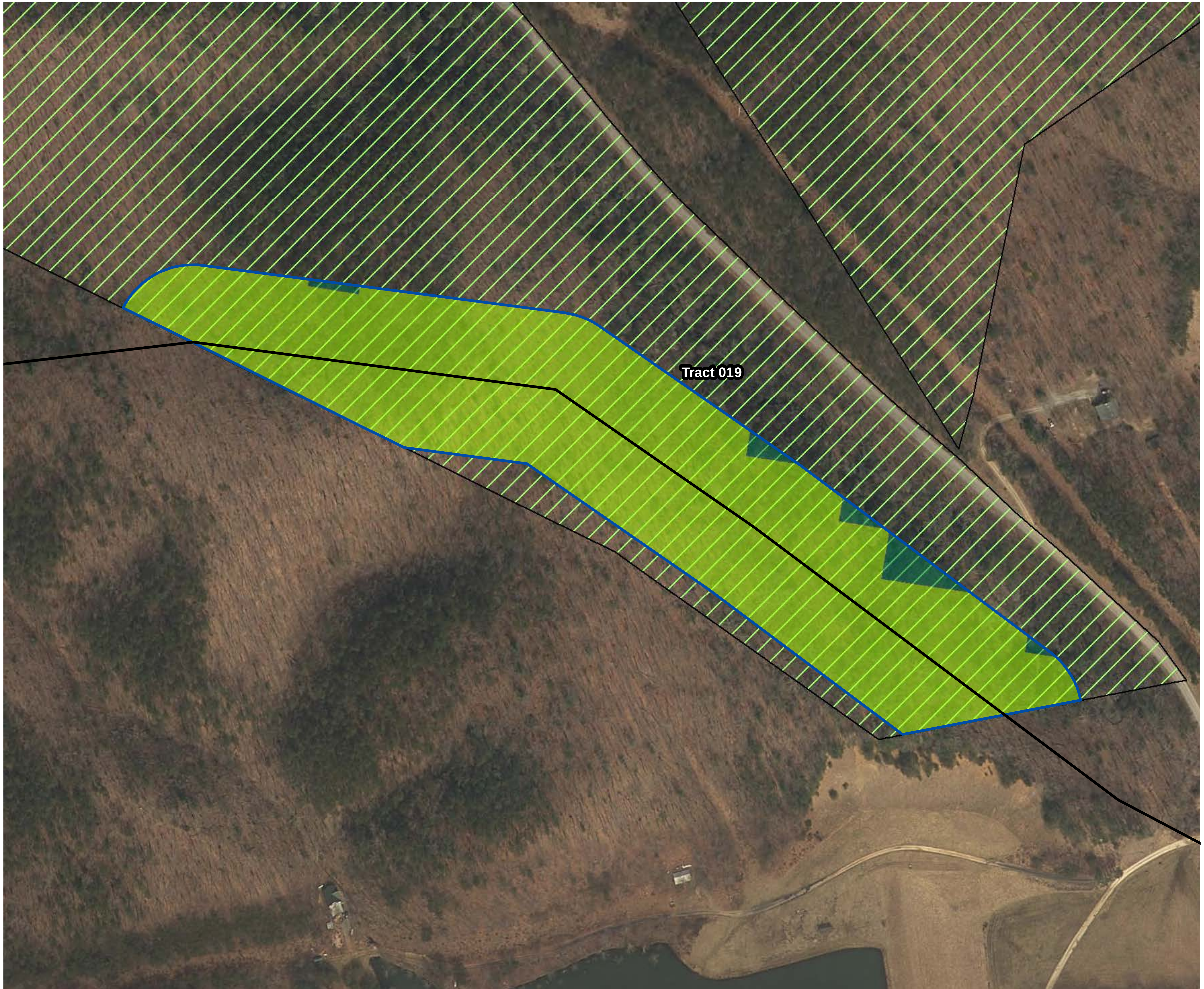
Appendix C. Habitat classifications along the proposed Mountain Valley Pipeline Project within the Jefferson National Forest.

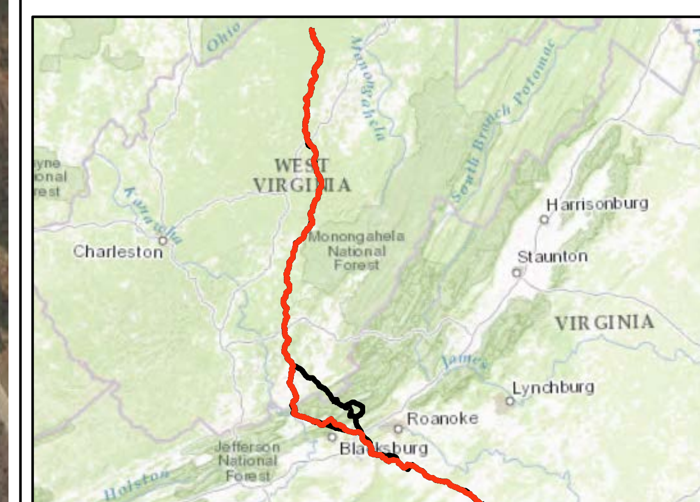
Map 19 of 37



- MVP Abandoned/Alternate Route
- Tract Identified on Jefferson National Forest Land
- Jefferson National Forest Boundary

Land Cover

- Deciduous Forest
- Evergreen Forest



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Base Map: ESRI ArcGIS Web service - "World_Imagery" accessed - 1/10/2017

ESI ENVIRONMENTAL SOLUTIONS & INNOVATIONS, INC.

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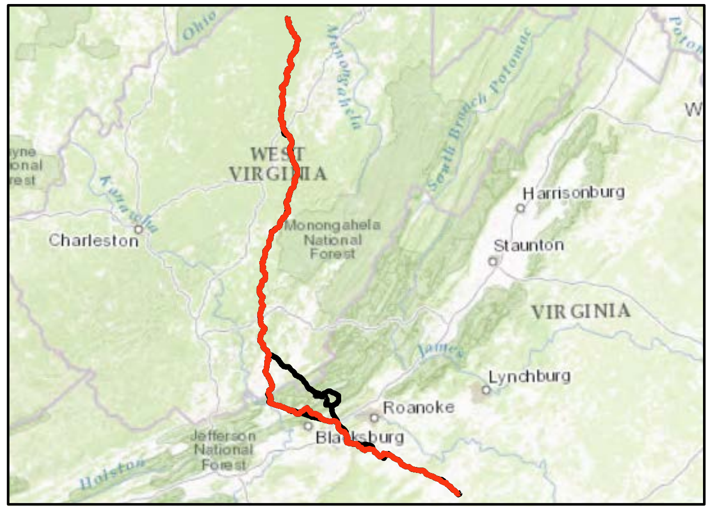
Appendix C. Habitat classifications along the proposed Mountain Valley Pipeline Project within the Jefferson National Forest.

MVP Abandoned/Alternate Route
Tract Identified on Jefferson National Forest Land
Jefferson National Forest Boundary
Land Cover
Deciduous Forest
Developed, Open Space



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Base Map: ESRI ArcGIS Web service - "World_Imagery" accessed - 1/10/2017

ENVIRONMENTAL SOLUTIONS & INNOVATIONS, INC.
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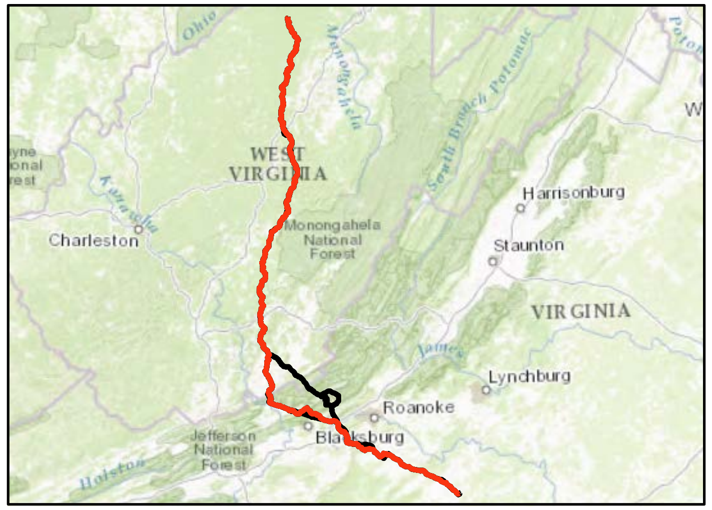
Appendix C. Habitat classifications along the proposed Mountain Valley Pipeline Project within the Jefferson National Forest.

Map 21 of 37

- MVP Abandoned/Alternate Route
- Tract Identified on Jefferson National Forest Land
- Jefferson National Forest Boundary
- Appalachian National Scenic Trail

Land Cover

- Deciduous Forest



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Base Map: ESRI ArcGIS Web service - "World_Imagery" accessed - 1/10/2017

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Project No. 593.02

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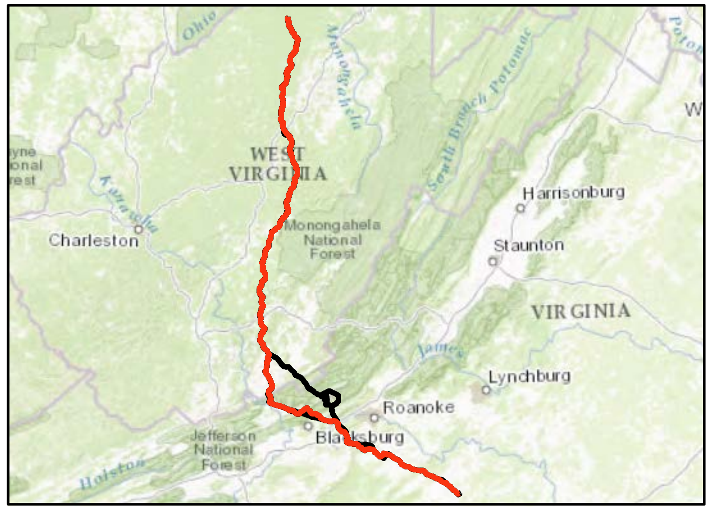
Appendix C. Habitat classifications along the proposed Mountain Valley Pipeline Project within the Jefferson National Forest.

Map 22 of 37

MVP Abandoned/Alternate Route
Tract Identified on Jefferson National Forest Land
Jefferson National Forest Boundary
Appalachian National Scenic Trail
Land Cover
Deciduous Forest
Evergreen Forest
Mixed Forest



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Base Map: ESRI ArcGIS Web service - "World_Imagery" accessed - 1/10/2017

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Project No. 593.02

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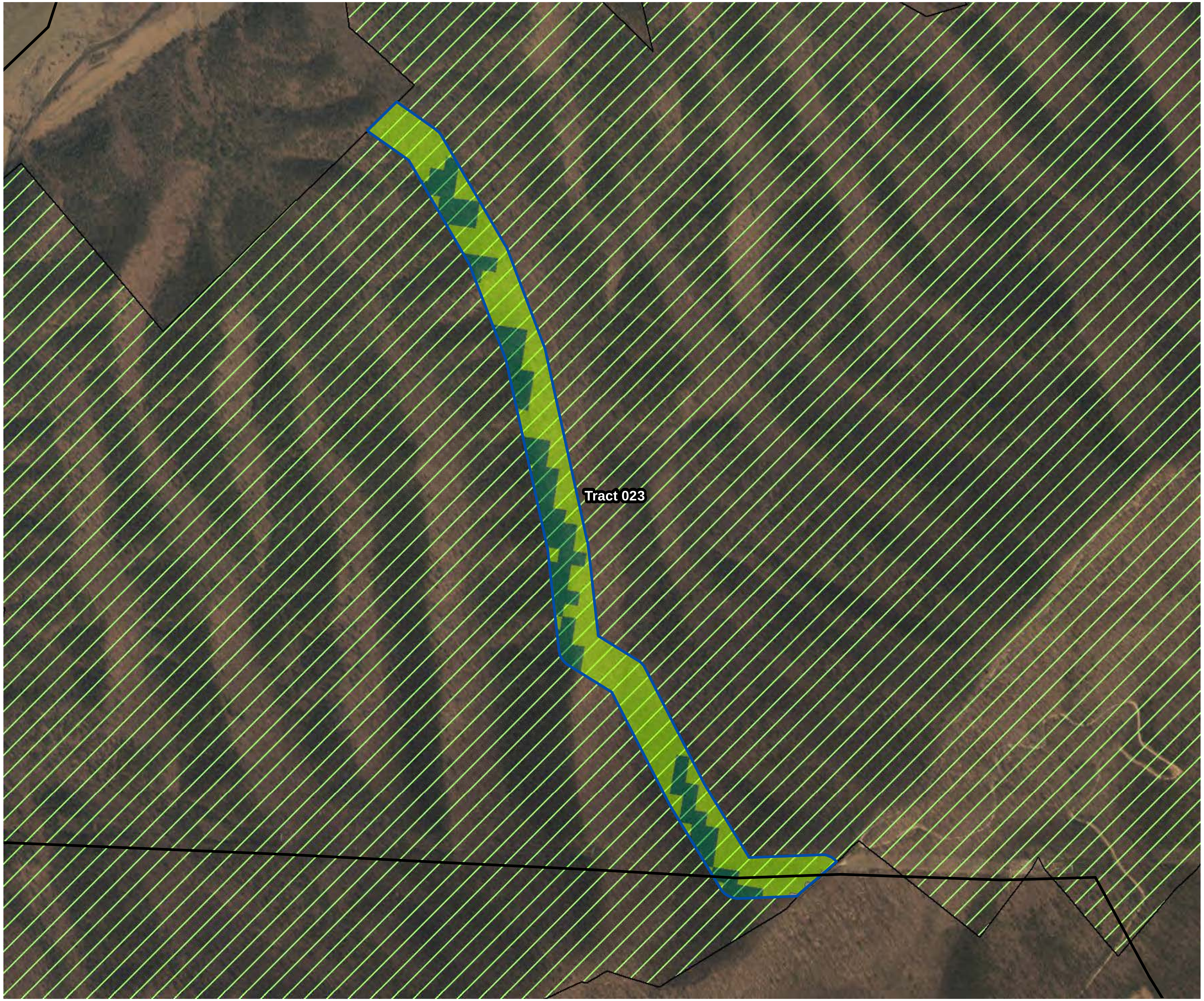


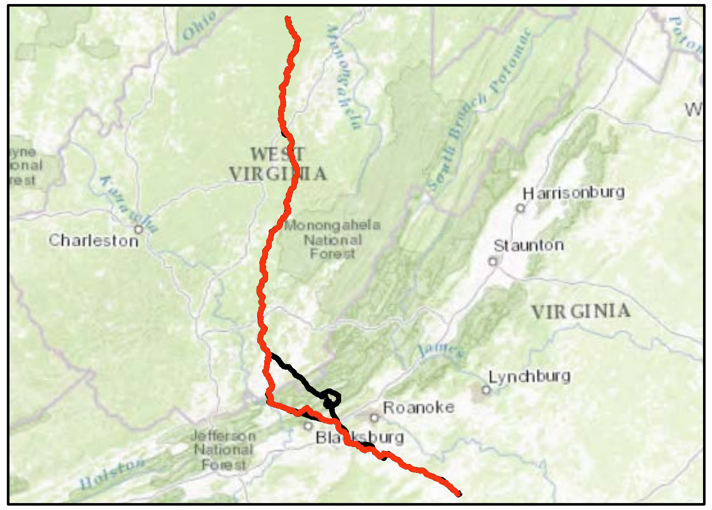
Appendix C. Habitat classifications along the proposed Mountain Valley Pipeline Project within the Jefferson National Forest.

Map 23 of 37

- MVP Abandoned/Alternate Route
- Tract Identified on Jefferson National Forest Land
- Jefferson National Forest Boundary

Land Cover

- Deciduous Forest
- Evergreen Forest
- Developed, Open Space



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110 0 110 220 Meters

Base Map: ESRI ArcGIS Web service - "World_Imagery" accessed - 1/10/2017

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Appendix C. Habitat classifications along the proposed Mountain Valley Pipeline Project within the Jefferson National Forest.

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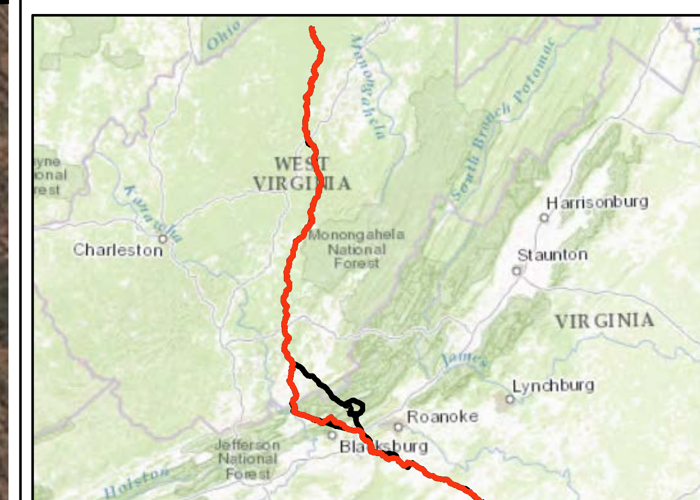
MVP Abandoned/Alternate Route

Tract Identified on Jefferson National Forest Land

Jefferson National Forest Boundary

Land Cover

Deciduous Forest



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Base Map: ESRI ArcGIS Web service - "World_Imagery" accessed - 1/10/2017

ENVIRONMENTAL SOLUTIONS & INNOVATIONS, INC.

Project No. 593.02

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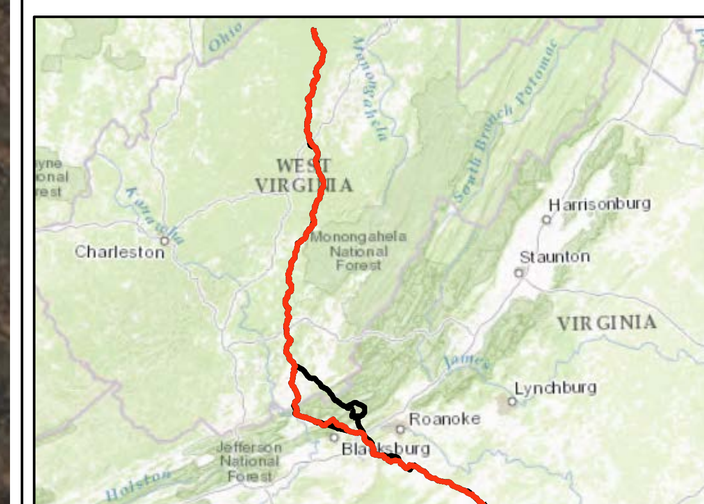
Appendix C. Habitat classifications along the proposed Mountain Valley Pipeline Project within the Jefferson National Forest.

Map 25 of 37

- MVP Abandoned/Alternate Route
- Tract Identified on Jefferson National Forest Land
- Jefferson National Forest Boundary

Land Cover

- Deciduous Forest
- Developed, Open Space



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Base Map: ESRI ArcGIS Web service - "World_Imagery" accessed - 1/10/2017

ENVIRONMENTAL SOLUTIONS & INNOVATIONS, INC.

Project No. 593.02

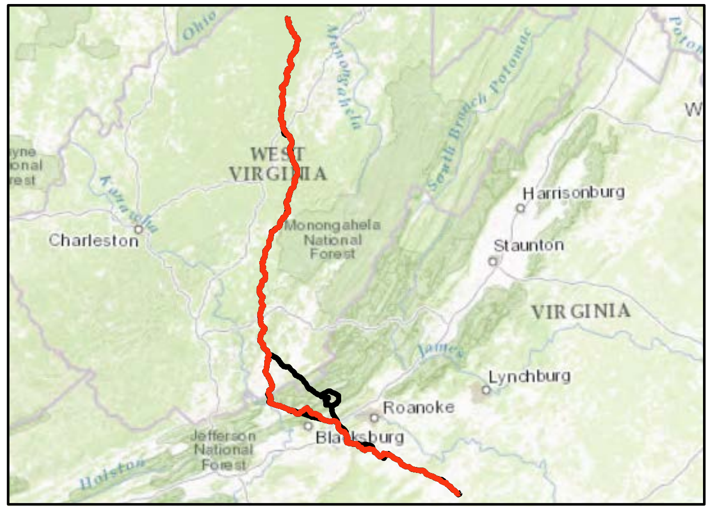
Path: G:\Current\593_EQT_MVP\MXD\Biologic_Eval\20161209_BE_figs\593_BE_Appendix_C_20170109.mxd (mbruening) - 1/10/2017

Appendix C. Habitat classifications along the proposed Mountain Valley Pipeline Project within the Jefferson National Forest.

- MVP Abandoned/Alternate Route
- Tract Identified on Jefferson National Forest Land
- Jefferson National Forest Boundary
- Appalachian National Scenic Trail

Land Cover

- Deciduous Forest
- Evergreen Forest
- Mixed Forest



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Base Map: ESRI ArcGIS Web service - "World_Imagery" accessed - 1/10/2017

ESI ENVIRONMENTAL SOLUTIONS & INNOVATIONS, INC.

Project No. 593.02

Path: G:\Current\593_EQT_MVP\MXD\Biologic_Eval\20161209_BE_figs\593_BE_Appendix_C_20170109.mxd (mbruening) - 1/10/2017

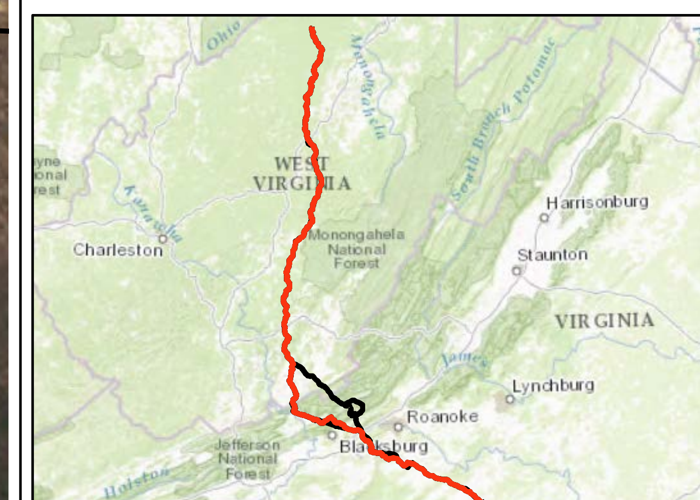
Appendix C. Habitat classifications along the proposed Mountain Valley Pipeline Project within the Jefferson National Forest.

Map 27 of 37

- MVP Abandoned/Alternate Route
- Tract Identified on Jefferson National Forest Land
- Jefferson National Forest Boundary

Land Cover

- Deciduous Forest
- Evergreen Forest



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Base Map: ESRI ArcGIS Web service - "World_Imagery" accessed - 1/10/2017

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Project No. 593.02

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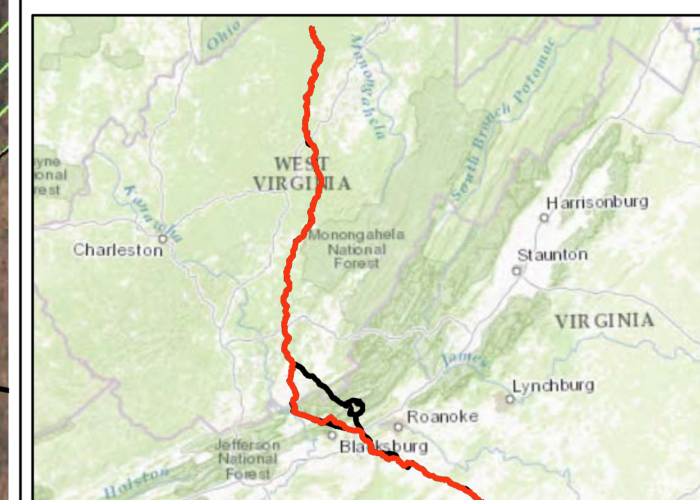
Appendix C. Habitat classifications along the proposed Mountain Valley Pipeline Project within the Jefferson National Forest.

Map 28 of 37

- MVP Abandoned/Alternate Route
- Tract Identified on Jefferson National Forest Land
- Jefferson National Forest Boundary

Land Cover
- Deciduous Forest
- Evergreen Forest
- Mixed Forest



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Base Map: ESRI ArcGIS Web service - "World_Imagery" accessed - 1/10/2017

ESI ENVIRONMENTAL SOLUTIONS & INNOVATIONS, INC.

Project No. 593.02

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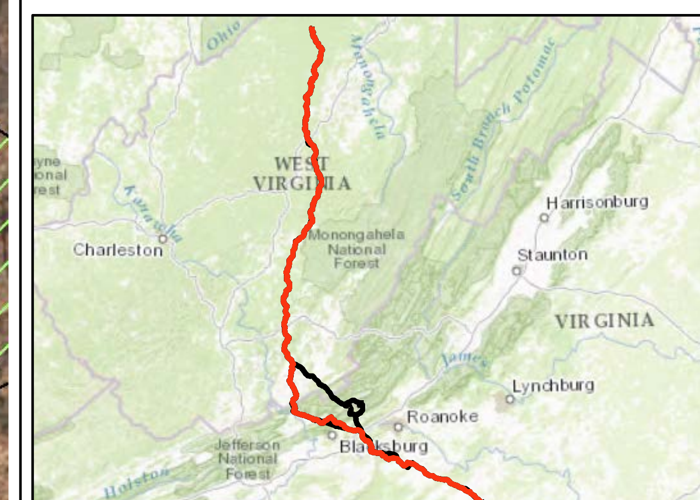
Appendix C. Habitat classifications along the proposed Mountain Valley Pipeline Project within the Jefferson National Forest.

Map 29 of 37

- MVP Abandoned/Alternate Route
- Tract Identified on Jefferson National Forest Land
- Jefferson National Forest Boundary

Land Cover

- Deciduous Forest
- Herbaceuous



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Base Map: ESRI ArcGIS Web service - "World_Imagery" accessed - 1/10/2017

ENVIRONMENTAL SOLUTIONS & INNOVATIONS, INC.

Project No. 593.02

Path: G:\Current\593_EQT_MVP\MXD\Biologic_Eval\20161209_BE_figs\593_BE_Appendix_C_20170109.mxd (mbruening) - 1/10/2017

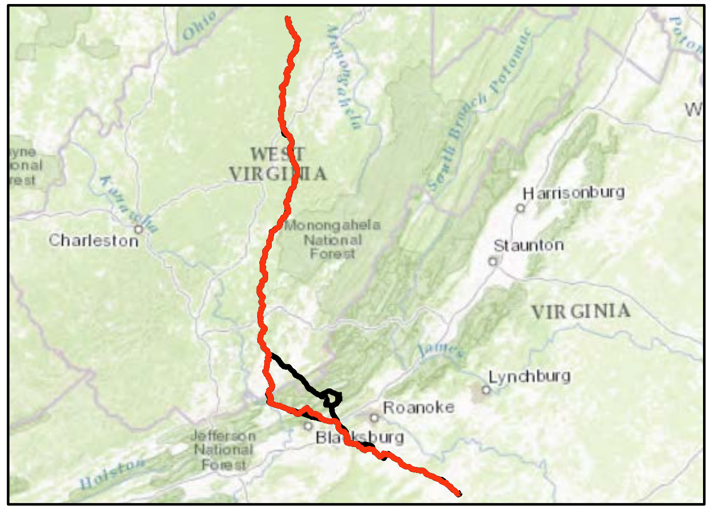
Appendix C. Habitat classifications along the proposed Mountain Valley Pipeline Project within the Jefferson National Forest.

Map 30 of 37

- MVP Abandoned/Alternate Route
- Tract Identified on Jefferson National Forest Land
- Jefferson National Forest Boundary
- Appalachian National Scenic Trail

Land Cover

- Deciduous Forest
- Evergreen Forest



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Base Map: ESRI ArcGIS Web service - "World_Imagery" accessed - 1/10/2017

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Project No. 593.02

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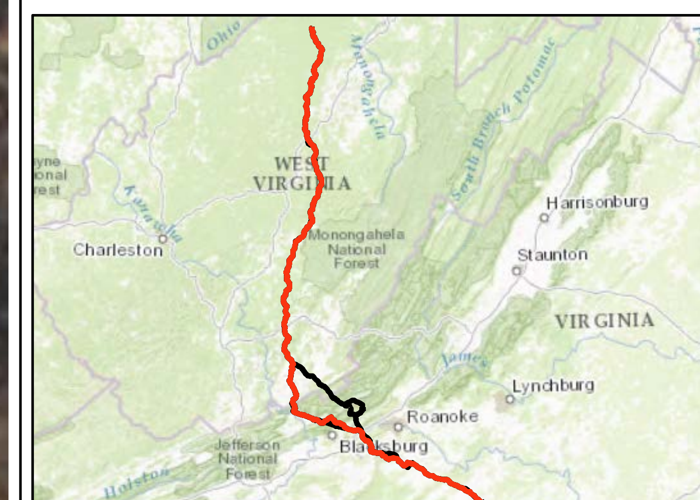
Appendix C. Habitat classifications along the proposed Mountain Valley Pipeline Project within the Jefferson National Forest.

Map 31 of 37

- MVP Abandoned/Alternate Route
- Tract Identified on Jefferson National Forest Land
- Jefferson National Forest Boundary

Land Cover

- Deciduous Forest



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Base Map: ESRI ArcGIS Web service - "World_Imagery" accessed - 1/10/2017

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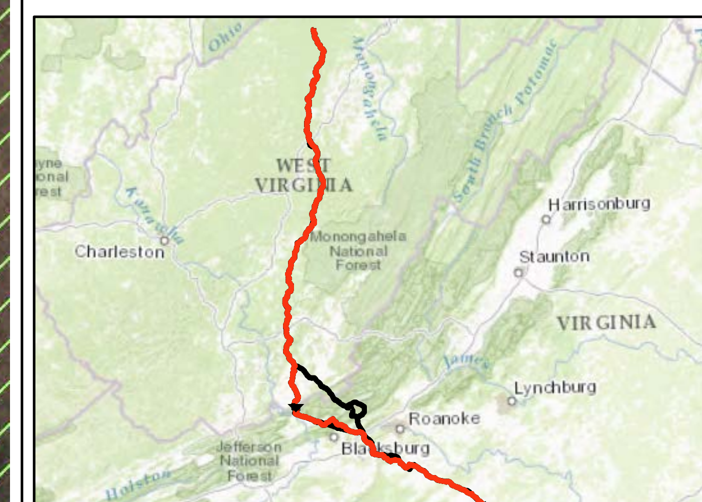
Appendix C. Habitat classifications along the proposed Mountain Valley Pipeline Project within the Jefferson National Forest.

Map 32 of 37

October 2016 Proposed Route (Revised)
MVP Abandoned/Alternate Route
Tract Identified on Jefferson National Forest Land
Jefferson National Forest Boundary
Appalachian National Scenic Trail
Mystery Ridge Road
Land Cover
Deciduous Forest



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Meters

Base Map: ESRI ArcGIS Web service - "World_Imagery" accessed - 1/10/2017

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Project No. 593.02

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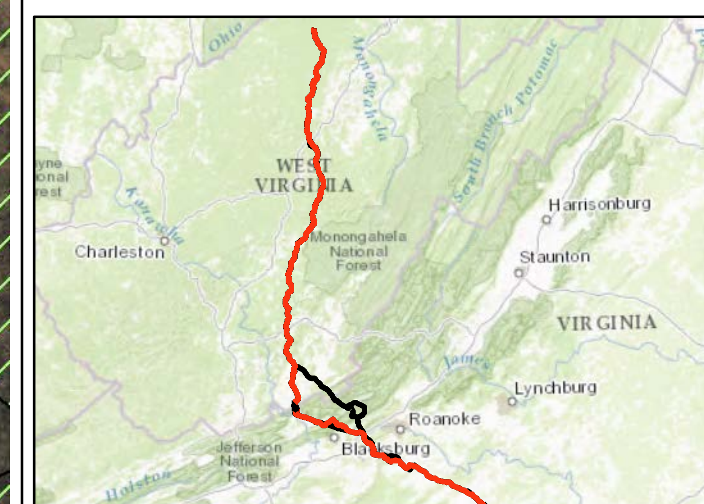
Appendix C. Habitat classifications along the proposed Mountain Valley Pipeline Project within the Jefferson National Forest.

Map 33 of 37

October 2016 Proposed Route (Revised)
MVP Abandoned/Alternate Route
Tract Identified on Jefferson National Forest Land
Jefferson National Forest Boundary
Appalachian National Scenic Trail
Land Cover
Deciduous Forest
Evergreen Forest



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Base Map: ESRI ArcGIS Web service - "World_Imagery" accessed - 1/10/2017

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Project No. 593.02

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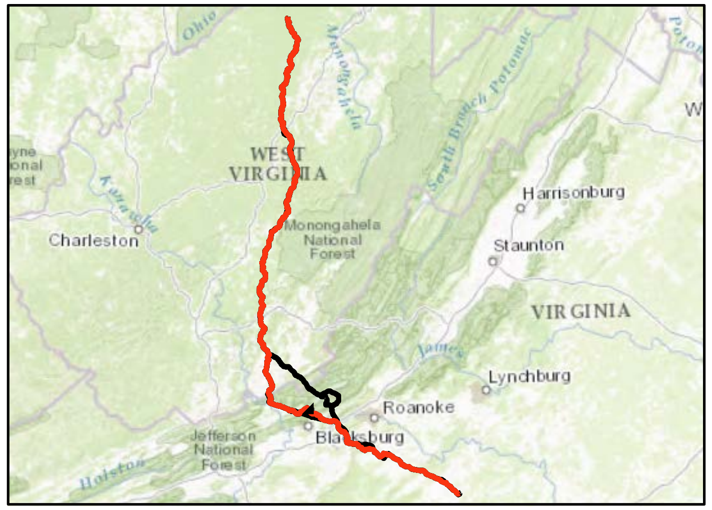
Appendix C. Habitat classifications along the proposed Mountain Valley Pipeline Project within the Jefferson National Forest.

Map 34 of 37

- October 2016 Proposed Route (Revised)
- MVP Abandoned/Alternate Route
- Tract Identified on Jefferson National Forest Land
- Jefferson National Forest Boundary

Land Cover

- Deciduous Forest
- Developed, Open Space



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Base Map: ESRI ArcGIS Web service - "World_Imagery" accessed - 1/10/2017

ESI ENVIRONMENTAL SOLUTIONS & INNOVATIONS, INC.

Project No. 593.02

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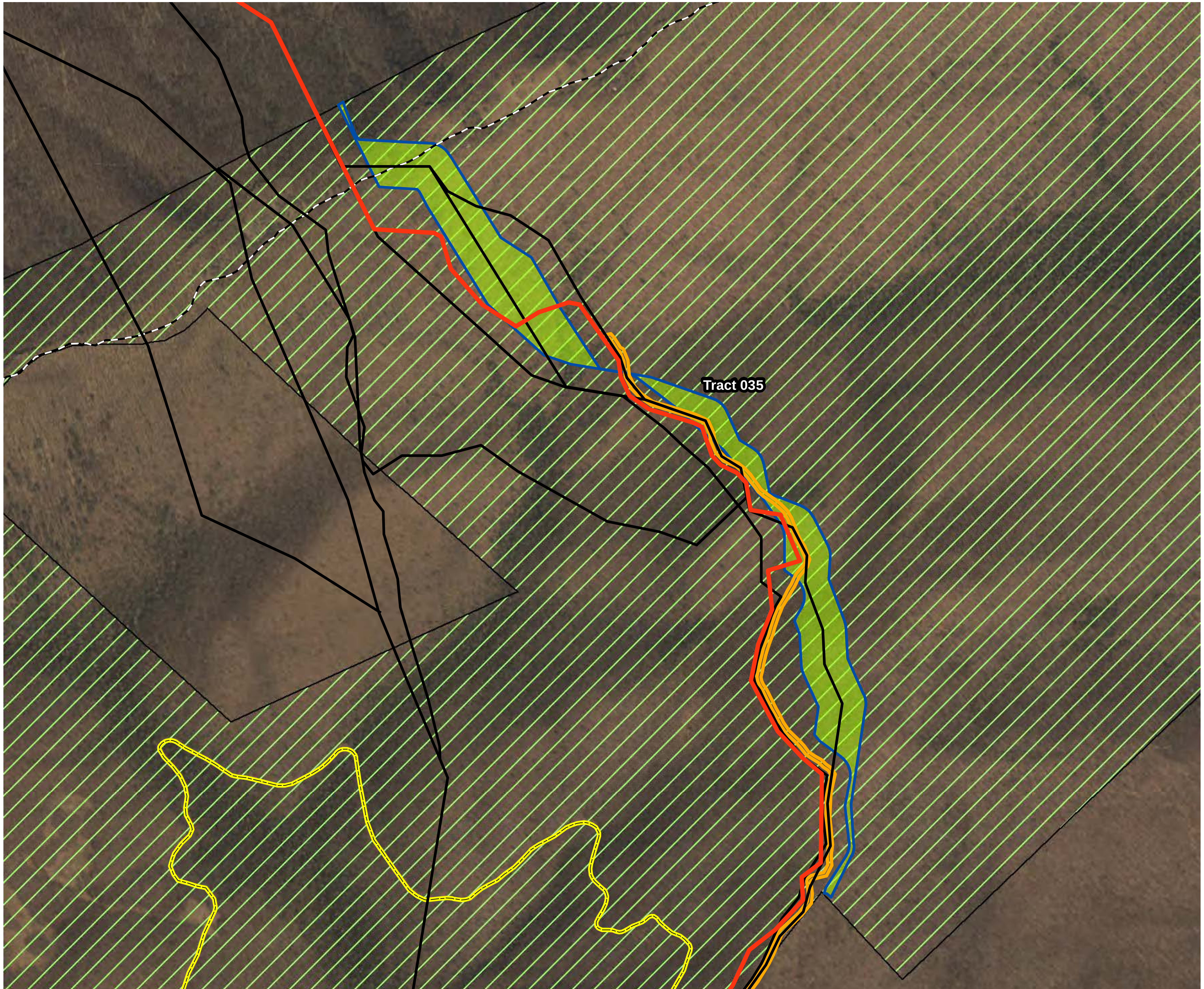


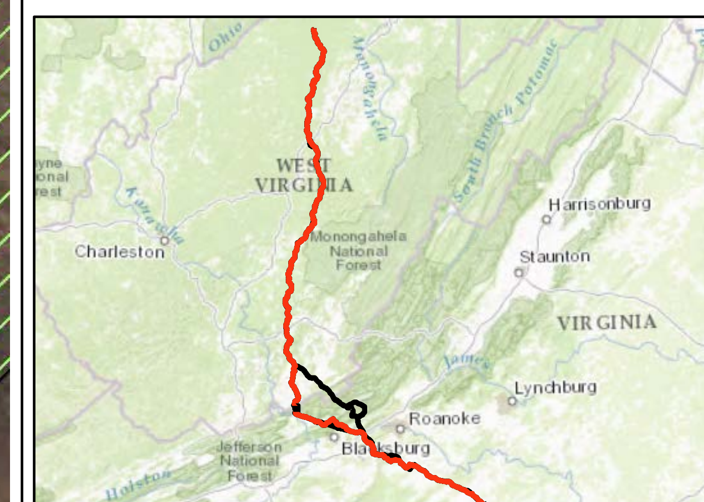
Appendix C. Habitat classifications along the proposed Mountain Valley Pipeline Project within the Jefferson National Forest.

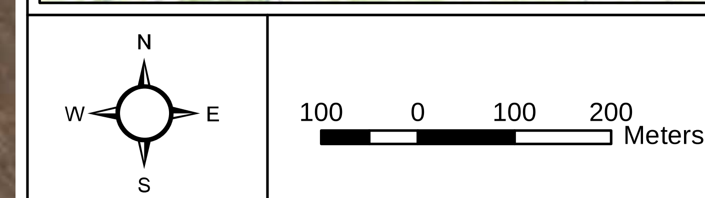
Map 35 of 37

- October 2016 Proposed Route (Revised)
- MVP Abandoned/Alternate Route
- Tract Identified on Jefferson National Forest Land
- Jefferson National Forest Boundary
- Appalachian National Scenic Trail
- Mystery Ridge Road
- Pocahontas Road

Land Cover

- Deciduous Forest





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ESI ENVIRONMENTAL SOLUTIONS & INNOVATIONS, INC.

Project No. 593.02

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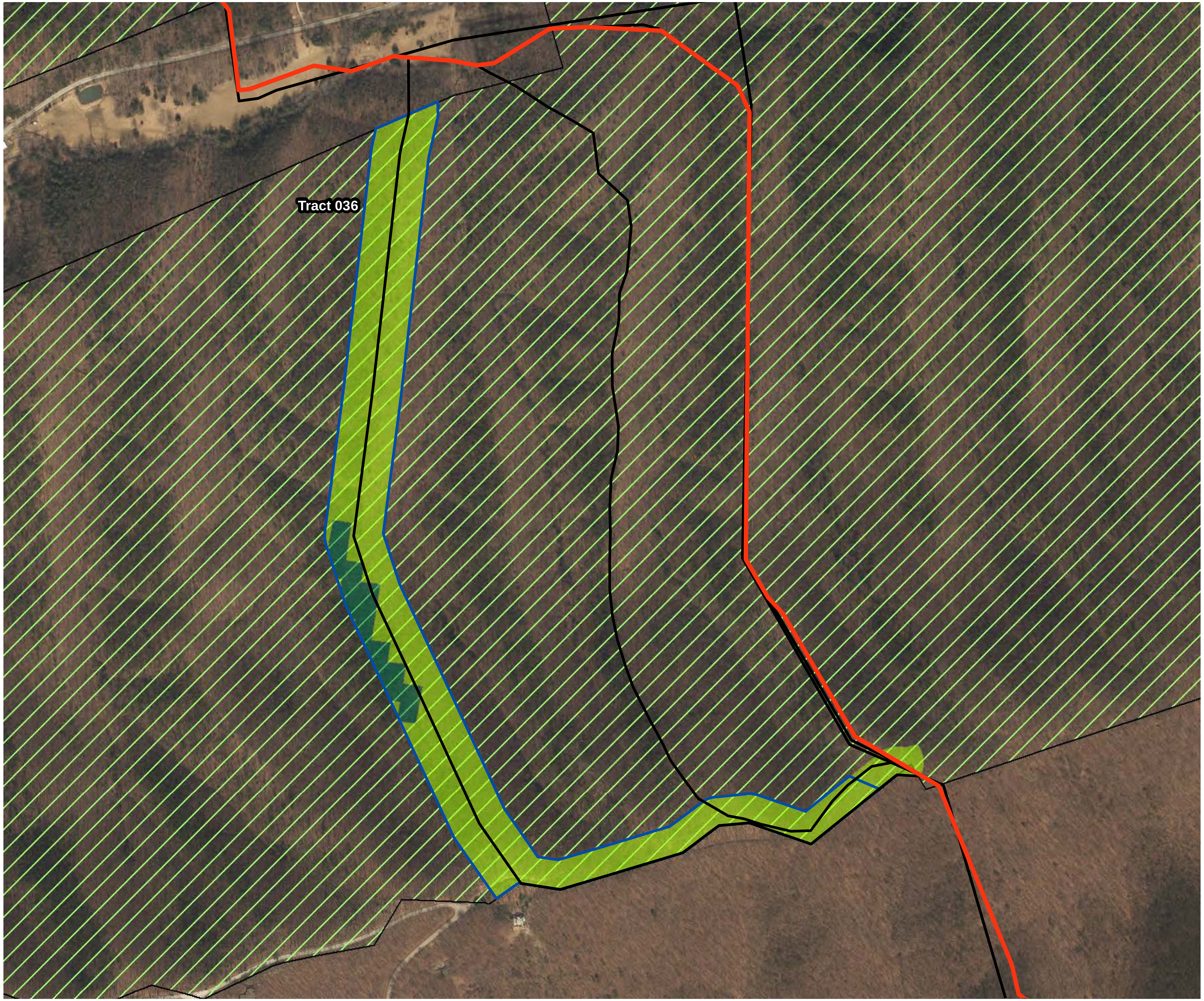
Appendix C. Habitat classifications along the proposed Mountain Valley Pipeline Project within the Jefferson National Forest.

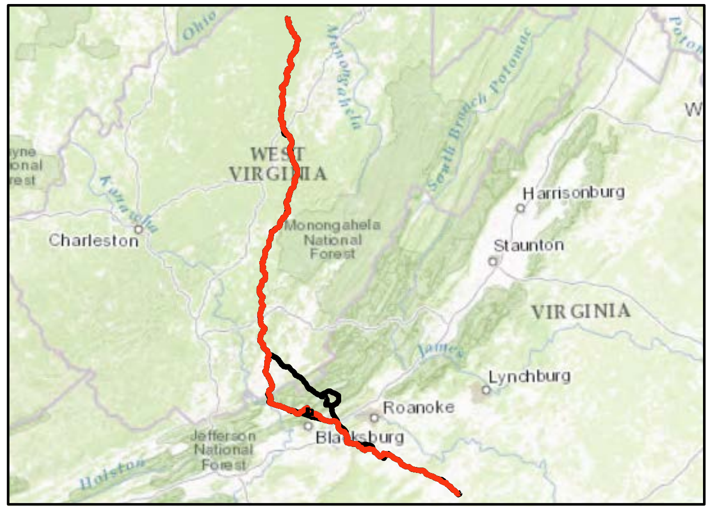
Map 36 of 37



- October 2016 Proposed Route (Revised)
- MVP Abandoned/Alternate Route
- Tract Identified on Jefferson National Forest Land
- Jefferson National Forest Boundary

Land Cover

- Deciduous Forest
- Evergreen Forest



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80 0 80 160 Meters

Base Map: ESRI ArcGIS Web service - "World_Imagery" accessed - 1/10/2017

ESI ENVIRONMENTAL SOLUTIONS & INNOVATIONS, INC.

Project No. 593.02

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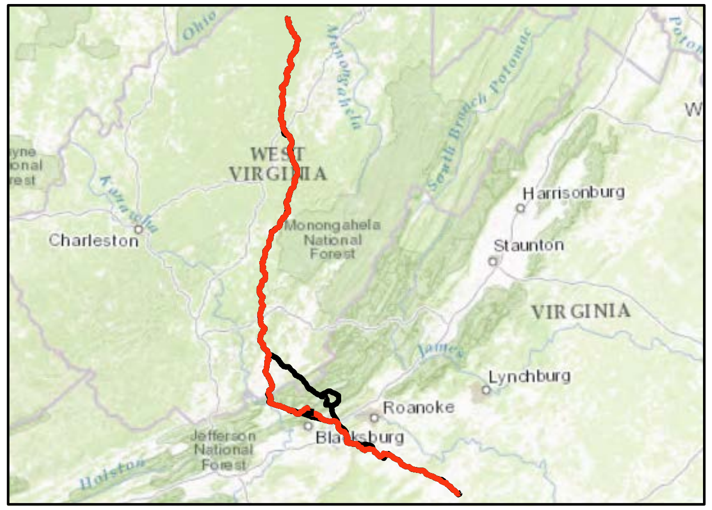
Appendix C. Habitat classifications along the proposed Mountain Valley Pipeline Project within the Jefferson National Forest.

Map 37 of 37

- October 2016 Proposed Route (Revised)
- MVP Abandoned/Alternate Route
- Tract Identified on Jefferson National Forest Land
- Jefferson National Forest Boundary

Land Cover

- Deciduous Forest



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75 0 75 150 Meters

Base Map: ESRI ArcGIS Web service - "World_Imagery" accessed - 1/10/2017

ENVIRONMENTAL SOLUTIONS & INNOVATIONS, INC.

Project No. 593.02

APPENDIX D
ANNUAL STANDARDS AND SPECIFICATIONS
(WILL BE INCLUDED UPON COMPLETION)

APPENDIX E
SPECIES ANALYSIS RESULTS

APPENDIX E
SPECIES ANALYSIS RESULTS

TES species eliminated due to known species range (OAR Code 1)

Species	Common Name
VERTEBRATE	
Fish	
Ammocrypta clara	Western sand darter
Cottus baileyi	Black sculpin
Chrosomus cumberlandensis	Blackside dace
Chrosomus tennesseensis	Tennessee dace
Erimonax monachus	Spotfin chub
Erimystax cahni	Slender chub
Etheostoma acuticeps	Sharphead darter
Etheostoma percnurum	Duskytail darter
Etheostoma tippecanoe	Tippecanoe darter
Icthyomyzon greeleyi	Mountain brook lamprey
Notropis ariommus	Popeye shiner
Noturus flavipinnis	Yellowfin madtom
Percina burtoni	Blotchside logperch
Percina williamsi	Sickle darter
Phenacobius crassilabrum	Fatlips minnow
Amphibian	
Plethodon hubrichti	Peaks of Otter salamander
Plethodon punctatus	Cow Knob salamander
Plethodon Shenandoah	Shenandoah salamander
Plethodon welleri	Weller's salamander
Mammal	
Glaucomys sabrinus coloratus	Carolina northern flying squirrel
Glaucomys sabrinus fuscus	Virginia northern flying squirrel
Microtus chrotorrhinus carolinensis	Southern rock vole
Myotis grisescens	Gray bat
Sorex palustris punctulatus	Southern water shrew
INVERTEBRATE	
Snail (Mollusk, Class Gastropoda)	
Helicodiscus diadema	Shaggy coil
Helicodiscus lirellus	Rubble coil
Helicodiscus triodus	Talus coil
Io fluvialis	Spiny riversnail
Mussel (Mollusk, Class Bivalvia)	
Alasmidonta varicosa	Brook floater
Cumberlandia monodonta	Spectaclecase
Cyprogenia stegaria	Fanshell
Dromus dromas	Dromedary pearlymussel
Epioblasma brevidens	Cumberlandian combshell

Species	Common Name
Epioblasma capsaeformis	Oyster mussel
Epioblasma florentina aureola	Golden riffleshell
Epioblasma torulosa gubernaculum	Green-blossom pearlymussel
Epioblasma triquetra	Snuffbox
Fusconaia cor	Shiny pigtoe
Fusconaia cuneolus	Fine-rayed pigtoe
Hemistena lata	Cracking pearlymussel
Lampsilis abrupta	Pink mucket
Lasmigona holstonia	Tennesse heelsplitter
Lemiox rimosus	Birdwing pearlymussel
Pegias fabula	Little-winged pearlymussel
Plethobasus cyphyus	Sheepnose
Pleurobema cordatum	Ohio pigtoe
Pleurobema oviforme	Tennessee clubshell
Pleurobema plenum	Rough pigtoe
Pleurobema rubrum	Pyramid pigtoe
Pleuronaia barnesiana	Tennessee pigtoe
Pleuronaia dolabelloides	Slabside pearlymussel
Ptychobranchus subtentum	Fluted kidneyshell
Quadrula cylindrical strigillata	Rough rabbits foot
Quadrula intermedia	Cumberland monkeyface
Quadrula sparsa	Appalachian monkeyface
Toxolasma lividum	Purple lilliput
Villosa perpurpurea	Purple bean
Villosa trobalis	Cumberland bean
Spider (Arachnid)	
Microhexura montiyaga	Spruce-fir moss spider
Pseudoscorpion (Arachnid, Order Pseudoscoriones)	
Kleptochthonius orpheus	Orpheus cave pseudoscorpion
Amphipod (Crustacean, Order Amphipoda)	
Stygobromus abditus	James Cave amphipod
Stygobromus cumberlandus	Cumberland cave amphipod
Stygobromus gracilipes	Shenandoah Valley cave amphipod
Stygobromus hoffmani	Alleghany County cave amphipod
Stygobromus mundus	Bath county cave amphipod
Isopod (Crustacean, Order Isopoda)	
Antrolana lira	Madison cave isopod
Caecidotea incurva	Incurved cave isopod
Miktoniscus racovitzai	Racovitza’s terrestrial cave isopod
Crayfish (Crustacean, Order Decapoda)	
Cambarus callamus	Big Sandy crayfish
Millipede (Class Diplopoda)	
Brachoria dentata	A millipede
Brachoria eutypa ethotela	Hungry Mother millipede
Buotus carolinus	A millipede

Species	Common Name
Cleidogona hoffmani	Hoffman's cleidogonid millipede
Cleidogona lachesis	A millipede
Dixioria fowleri	Fowler's millipede
Dixioria pela coronata	A millipede
Nannaria shenandoah	Shenandoah Mountain xystodesmid millipede
Pseudotremia alecto	A millipede
Semionellus placidus	A millipede
Centipede (Class Chilopoda)	
Escaryus cryptorobius	Montane centipede
Escaryus orestes	Whitetop Mountain centipede
Nampabius turbator	A cave centipede
Springtail (Insect, Order Collembola)	
Pygmarrhopalites carolynae	A cave springtail
Pymarrhopalites sacer	A cave springtail
Mayfly (Insect, Order Ephemeroptera)	
Leptophlebia johnsoni	Johnson's pronggill mayfly
Stonefly (Insect, Order Plecoptera)	
Acroneuria kosztarabi	Virginia stonefly
Isoperla major	Big stripetail stonefly
Megaleuctra williamsae	Smokies needlefly
Taeniopteryx nelsoni	Cryptic willowfly
Beetle (Insect, Order Coleoptera)	
Cicindela ancocisconensis	Appalachian tiger beetle
Cyclotrachelus incisus	A ground beetle
Butterfly, Skipper, Moth (Insect, Order Lepidoptera)	
Euchlaena milnei	Milne's euchlaena moth
Psectrotarsia hebardi	Hebard's noctuid moth
NON-VASCULAR PLANT	
Lichen	
Gymnoderma lineare	Rock gnome lichen
Hypotrachyna virginica	Hydrothyria lichen
Liverwort	
Bazzania nudicaulis	A liverwort
Frullania oakesiana	A liverwort
Mertzgeria fruticulosa	A liverwort
Plagiochila austinii	A liverwort
Sphenolobopsis pearsonii	A liverwort
Moss	
Sphagnum flavicomans	Northeastern peatmoss
VASCULAR PLANT	
Actaea rubifolia	Appalachian black cohosh
Arabis patens	Spreading rockcress
Betula uber	Virginia round-leaf birch
Cardamine clematitis	Mountain bittercress
Cardamine flagellifera	Blue ridge bittercress

Species	Common Name
Carex polymorpha	Variable sedge
Chelone cuthbertii	Cuthbert turtlehead
Echinodorus tenellus	Dwarf burhead
Gentiana austromontana	Appalachian gentian
Helenium virginicum	Virginia sneezeweed
Helonias bullata	Swamp-pink
Heuchera alba	White alumroot
Iliamna corei	Peter's Mountain mallow
Iliamna remota	Kankakee globe-mallow
Isoetes virginica	Virginia quillwort
Lilium grayi	Gray's lily
Lycopodiella margueritae	Marguerite's clubmoss
Micranthes caroliniana	Carolina saxifrage
Packera millefolium	Piedmont ragwort
Potamogeton hilii	Hill's pondweed
Prenanthes roanensis	Roan Mountain rattlesnake-root
Sceptridium jenmanii	Alabama grapefern
Scirpus ancistrochaetus	Northeastern bulrush
Sida hermaphrodita	Virginia mallow
Silene ovata	Mountain catchfly
Spiraea virginiana	Virginia spiraea
Trillium pusillum var. moniticulum	Virginia least trillium

TES species eliminated due to lack of suitable habitat in project area (OAR Code 2)

Species	Common Name
VERTEBRATE	
Bird	
Falco peregrinus	Peregrine Falcon
Haliaeetus leucocephalus	Bald Eagle
Lanius ludovicianus migrans	Migrant Loggerhead Shrike
Thryomanes bewickii altus	Appalachian Bewick's Wren
Mammal	
Corynorhinus townsendii virginianus	Virginia big-eared bat
INVERTEBRATE	
Snail (Mollusk, Class Gastropoda)	
Glyphyalinia raderi	Maryland glyph
Paravitrea reesei	Round supercoil
Amphipod (Crustacean, Order Amphipoda)	
Stygobromus estesi	Craig County cave amphipod
Stygobromus fergusoni	Montgomery County Cave amphipod
Springtail (Insect, Order Collembola)	
Pygmarrhopalites commorus	A cave springtail
Beetle (Insect, Order Coleoptera)	
Cicindela patruela	Northern barrens tiger beetle
Scorpionfly (Insect, Order Mecoptera)	
Brachypanorpa jeffersoni	Jefferon's short-nosed scorpionfly
Butterfly, Skipper, Moth (Insect, Order Lepidoptera)	
Callophrys irus	Frosted elfin
Erynnis persius persius	Persius duskywing
Pyrgus centaureae wyandot	Appalachian grizzled skipper
Cotocala herodias gerhardi	Herodias underwing
NON-VASCULAR PLANT	
Lichen	
Hypotrachyna virginica	Virginia hypotrachyna lichen
Liverwort	
Nardia lescurii	A liverwort
VASCULAR PLANT	
Allium oxyphilum	Nodding onion
Boechera serotina	Shale barren rockcress
Carex schweinitzii	Schweinitz's sedge
Clematis addisonii	Addison's leatherflower
Clematis coactilis	Virginia white-haired leatherflower
Echinacea laevigata	Smooth coneflower
Euphorbia purpurea	Glade spurge
Hasteola suaveolens	Sweet-scented Indian-plantain
Hypericum mitchellianum	Blue Ridge St. John's-wort
Ilex collina	Long-stalked holly
Liatris helleri	Turgid gayfeather

Species	Common Name
Paxistima canbyi	Canby's mountain lover
Potamogeton hillii	Hill's pondweed
Rudbeckia triloba var. pinnatiloba	Pinnate-lobed coneflower
Vitis rupestris	Sand grape

TES species eliminated due to negative survey results (OAR Code 3)

Species	Common Name
VERTEBRATE	
Mammal	
Myotis septentrionalis	Northern long-eared bat
Myotis sodalis	Indiana bat
NON-VASCULAR PLANT	
Liverwort	
Plagliochila sullivantii var. sullivantii	A liverwort
VASCULAR PLANT	
Acontinum reclinatum	Trailing white mokshood
Buckleya distichophylla	Piratebusch
Cleistesiopsis bifaria	Small spreading pogonia
Corallorhiza bentleyi	Bentley's coralroot
Delphinium exaltatum	Tall larkspur
Isotria medeoloides	Small whorled pogonia
Juglans cinerea	Butternut
Phlox buckleyi	Sword-leaf phlox
Poa paludigena	Bog bluegrass
Pycnanthemum torrei	Torrey's mountain-mint
Tsuga caroliniana	Carolina hemlock

TES species occurring within project area, but outside activity area (OAR Code 4)

Species	Common Name
VERTEBRATE	
Mammal	
Myotis leibii	Eastern small-footed bat
INVERTEBRATE	
Beetle (Insect, Coleoptera)	
Hydraena maureenae	Maureen’s shale stream beetle
VASCULAR PLANT	
Berberis canadensis	American barberry

TES species located during surveys within activity area (OAR Code 5)

Species	Common Name
VASCULAR PLANTS	
Scutellaria saxatilis	Rock skullcap

TES species not identified during surveys but may occur due to habitat (OAR Code 6)

Species	Common Name
INVERTEBRATE	
Butterfly, Skipper, Moth (Insect, Order Lepidoptera)	
Speyeria diana	Diana fritillary
Speyeria idalia	Regal fritillary
Bumblebee (Insect, Order Hymenoptera)	
Bombus affinis	Rusty patched bumblebee
VASCULAR PLANT	
Monotropsis odorata	Sweet pinesap

Aquatic TES species or habitat known or suspected downstream of Project, but outside of geographic bounds of water resource cumulative effects analysis area (OAR Code 7)

Species	Common Name
VERTEBRATE	
Fish	
*Percina rex**	Roanoke logperch
INVERTEBRATE	
Mussel (Mollusk, Class Bivalvia)	
Elliptio lanceolata	Yellow lance
Fusconaia masoni	Atlantic pigtoe
*Pleurobema collina**	James spinymussel

*Also OAR Code 9

Aquatic TES species or habitat known or suspected downstream of Project, but inside identified geographic bounds of water resource cumulative effects analysis area (OAR Code 8)

Species	Common Name
VERTEBRATE	
Fish	
Etheostoma osburni	Candy darter
Notropis semperasper	Roughhead shiner
Notrus gilberti	Orangefin madtom
Phenacobius teretulus	Kanawha minnow
INVERTEBRATE	
Mussel (Mollusk, Class Bivalvia)	
Lasmigona subviridis	Green floater
Dragonfly (Insect, order Odonata)	
Gomphus viridifrons	Green-faced clubtail
Ophiogomphus incurvatus alleghaniensis	Allegheny snaketail

Project occurs in a 6th level watershed included in the USFWS/FS T&E Mussel and Fish Conservation Plan (OAR Code 9)

Species	Common Name
VERTEBRATE	
Fish	
*Percina rex**	Roanoke logperch
INVERTEBRATE	
Mussel (Mollusk, Class Bivalvia)	
*Pleurobema collina**	James spinymussel

*Also OAR Code 7

APPENDIX F
FIELD SURVEY OBSERVATIONS AND NOTES
PRIVILEGED AND CONFIDENTIAL

APPENDIX G
PROJECT-WIDE MITIGATION MEASURES

APPENDIX G
PROJECT-WIDE MITIGATION MEASURES

Implement the Project's Migratory Bird Habitat Conservation Plan

- Routing Project facilities to avoid sensitive resources where possible
- Reduction of the ROW in sensitive stream and wetland habitats
- Co-locating Project facilities with existing pipeline or utility Rights-of-Way (ROWs) where feasible
- Minimization of habitat fragmentation to the maximum extent possible
- Environmental training of MVP personnel and inspection of construction and restoration activities
- Restrict maintenance activities to outside of the breeding/nesting season

Implement the Project's *Exotic and Invasive Species Control Plan* during construction, operation, and maintenance of the Project

- Avoid introducing exotic/invasive species in organic materials brought on- site during construction by thoroughly cleaning equipment prior to mobilization to Project area
- Clean equipment and arrange location where JNF designated employee will examine and certify equipment is clean and permitted for use on USFS property
- Selective spot treatment or eradication of exotic/invasive plant species encountered during construction and operation of the Project
- Topsoil from full width of the construction ROW will be stripped and stored separate from other soil in areas identified as containing higher than usual concentrations of exotic/invasive plant species
- Commit to using only native seed mixes, in coordination with the USFS, during all restoration efforts
- Minimize time bare soil is exposed during construction to minimize opportunity for exotic/invasive plants to become established

Contaminants

- Develop and implement a Project-specific Spill Prevention, Control, and Countermeasure Plan
- Institute preventive measures such as personnel training, equipment inspection, and refueling procedures to reduce likelihood of spills
- Construction equipment, vehicles, hazardous materials, fuels, chemicals, lubricating oils, and petroleum products will not be parked, stored, or serviced within a 100-foot radius of any waterbody

Sediment and Erosion Control

- Develop and implement a Project-specific Erosion and Sediment Control Plan
- Maintain surface and ground water quality using appropriate erosion control practices and best management practices
- Comply with FERC's Upland Erosion Control, Revegetation, and Maintenance Plan (May 2013)
- Erosion control measures to be installed immediately once construction begins

Sensitive Rare, Threatened, or Endangered Species Habitat

- Develop and implement a Project-specific Karst Management Plan to protect and minimize impacts to karst, karst-like features, and caves
- Commit to tree clearing activity outside of June-July to minimize impacts to non-volant, juvenile bats
- Abide by all time-of-year-restrictions for in-stream construction in waterbodies containing rare, threatened, or endangered aquatic species
- Co-locate pipeline with existing Mystery Ridge Road to the extent practicable to avoid further fragmenting wildlife habitat
- Use of existing Pocahontas Road and Mystery Ridge Road on JNF to avoid creation of new access roads
- Collect seeds from discovered rock skullcap plants for planting upon completion of construction activities

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APPENDIX O-2

Forest Service Locally Rare Species

APPENDIX O-2

US Forest Service Locally Rare Species Within or Near Portions of Jefferson National Forest Crossed by the Mountain Valley Project

Common Name	Scientific Name	Habitat
Amphibians		
Hellbender Salamander	*Cryptobranchus alleganiensis*	Aquatic-streams, rivers
Reptiles		
Coal Skink	*Plestiodon anthracinus (Eumeces anthracinus)*	Humid, wooded or rocky hillsides (mixed pine-hardwoods). Under logs, rocks, leaf litter on forest floor.
Pine Snake	*Pituophis melanoleucus*	Dry upland forests and ridges with shortleaf pine & scrub-oak
Smooth Greensnake	*Opheodrys vernalis (Liochlorophis vernalis)*	Mesic habitats; wet meadows; bog & marsh edges; open woodlands
Birds		
Alder Flycatcher	*Empidonax alnorum*	Alder swamps; near water in dense, low, damp thickets of alders, willows, sumacs, viburnum, elderberry, and red-osier dogwood.
Blackburnian Warbler	*Setophaga fusca (Dendroica fusca)*	Upper canopy of mature conifer forests with few deciduous trees w/ sparse understory; shrubs around forest edges
Brown Creeper	*Certhia americana*	Mature woods; dense coniferous, deciduous, mixed woodlands; wooded swamps w/ standing snags with loose bark
Cerulean Warbler	*Setophaga cerulea (Dendroica cerulea)*	Shady, mature upland woods. Prefers forests with tall deciduous trees & little undergrowth.
Cooper's Hawk	*Accipiter cooperii*	Woodlands, forest edges, river groves, deciduous woods, broken woodlands, along streams.
Golden Eagle	*Aquila chrysaetos*	Mostly forested ridgetops with scattered openings.
Golden-winged Warbler	*Vermivora chrysoptera*	Brushy edge habitats; openings w/ saplings, forbs, & grasses
Red Crossbill	*Loxia curvirostra*	Associated with, but not confined to conifers; northern hardwood hemlocks & red spruce; On Shenandoah Mt in pine-oak woods
Sharp-shinned Hawk	*Accipiter striatus*	Coniferous forests; woodland edges; mixed woodlands, especially coniferous-birch-aspen forests
Swainson's Thrush	*Catharus ustulatus*	Dense shaded woods, mixed coniferous woods
Yellow-bellied Sapsucker	*Sphyrapicus varius*	Deciduous, mixed deciduous-coniferous forests & woodlands w/ poplars: Usually > 3500-ft. Dead or live trees w/ heart rot for cavity nests.

APPENDIX O-2 (continued)

US Forest Service Locally Rare Species Within or Near Portions of Jefferson National Forest Crossed by the Mountain Valley Project

Common Name	Scientific Name	Habitat
Mammals		
Alleghany Woodrat	*Neotoma magister*	Rocky areas; caves; large boulder fields
Least Weasel	*Mustela nivalis*	Elevations 500 – 3,800 feet in pasturelands, brushy fence rows, weedy fence rows between hayfields, old fields
Northern River Otter	*Lontra canadensis*	Forested wetlands; herbaceous wetlands; riparian areas; scrub-shrub wetlands
Isopods		
Greenbrier Valley Cave Isopod	*Caecidotea holsingeri*	Caves and Springs
Millipedes		
A Millipede	*Rudiloria trimaculata tortua*	Leaf litter within mixed hardwoods.
Aeto Millipede	*Conotyla aeto*	Leaf litter within mixed mesic hardwoods.
Packards Blind Cave Millipede	*Zygonopus packardi (Trichopetalum packardi)*	Caves
Damselflies		
Appalachian Jewelwing	*Calopteryx angustipennis*	Aquatic-streams
Dragonflies		
Northern Pygmy Clubtail	*Lanthus parvulus*	Aquatic-streams
Spatterdock Darner	*Rhionaeschna mutata (Aeshna mutata)*	Aquatic-ponds
Butterflies		
Silver-Bordered Fritillary	*Boloria selene*	Herbaceous wetland, scrub-shrub wetland
Hoary Elfin	*Callophrys polios*	Rocky slopes & ridges; outcrops, dry rocky forests & forest edges; acid bogs
Early Hairstreak	*Erora laeta*	Deciduous woods with beech-maple forest
Olympia Marble	*Euchloe olympia*	Shale barrens and slopes; openings and rights-of-way
Tawny Crescent	*Phyciodes batesii*	Moist meadows and pastures in northern part of range; dry rocky sparsely wooded ridges or hillsides
Tawny Crescent	*Phyciodes batesii batesii*	Moist meadows and pastures in northern part of range; dry rocky sparsely wooded ridges or hillsides
Skippers		
Two-Spotted Skipper	*Euphyes bimacula*	Bogs/fens; herbaceous wetlands; shrub wetlands
Moths		
Brown-Lined Dart Moth	*Anaplectoides brunneomedia*	Mountains at high elevations
Marbled Underwing	*Catocala marmorata*	Breeding: mainly riparian forest areas; mostly mature, mesic hardwood forests
Precious Underwing	*Catocala pretiosa pretiosa*	Headwaters swamps; wet swales in pine barrens
Chestnut Clearwing Moth	*Synanthedon castaneae*	Mixed hardwoods: Prefers Quercus and Castanea (possibly chinkapin, Castanea pumila)

APPENDIX O-2 (continued)

US Forest Service Locally Rare Species Within or Near Portions of Jefferson National Forest Crossed by the Mountain Valley Project

Common Name	Scientific Name	Habitat
Liverworts (non-vascular plants)		
A Flapwort	*Plagiochasma rupestra*	Sandstone outcrops in a partially shaded xeric mixed oak-hickory forest
A Liverwort	*Radula tenax*	
Mosses (non-vascular plants)		
Narrowleaf Peatmoss	*Sphagnum angustifolium*	Above water level in open acid bogs; dry margins of open woodland fens.
Pom-Pom Peatmoss	*Sphagnum capillifolium*	On moist humus and rocks in Spruce Fir forests; uncommon at lower elevations on rock exposures; heath mires and spray waterfalls
Flexuose Peatmoss	*Sphagnum flexuosum*	Shrub and graminoid bogs; margins of vegetation mats; high elevation Spruce Fir forests.
Brown Peatmoss	*Sphagnum fuscum*	Short compact cushions along weak, poor fens.
Girgensohn'S Peatmoss	*Sphagnum girgensohnii*	High elevation Spruce Fir forests forming carpets on humus and large rocks; Waterfalls?
Five-Rowed Peatmoss	*Sphagnum quinquefarium*	Sheltered seepage areas; wet dripping cliffs; sloping banks in mountains; peaty soil in swamps
Red Peatmoss	*Sphagnum rubellum*	Hummocks and small carpets in Spruce Fir forests.
Russow'S Peatmoss	*Sphagnum russowii*	Cushions and small mats at edges of heath bogs.
Delicate Peatmoss	*Sphagnum subtile*	Small carpets in heath bogs and spruce fir forests.
Vascular Plants		
Great Indian-plantain	*Arnoglossum reniforme (Arnoglossum muehlenbergii)*	Sandy, semi-open alluvial streambanks, often flood-scoured. Edge of young mixed hardwoods.
Bradley's Spleenwort	*Asplenium bradleyi*	Crevices of dry, exposed or partly shaded cliffs and outcrops. Sandstone and felsic metasedimentary rocks.
Blue Wild Indigo	*Baptisia australis* var. *australis*	Moist, usually rocky or gravelly soil: Woodland borders, open woods
Triangle Grape Fern	*Botrychium lanceolatum* var. *angustisegmentum*	High elevation moist and shady forests, grassy balds, margins of swamps, meadows, bottoms, streambanks & sandy fields, Mostly subacid soils.
Dwarf Grape Fern	*Botrychium simplex var. simplex*	Mesic & dry-mesic forests.
Tuberous Grass-pink	*Calopogon tuberosus*	Bogs, fens, seeps. Basic and acidic substrates.
Wild Hyacinth	*Camassia scilloides*	Moist open woods, wet woods, thickets
Harebell	*Campanula rotundifolia*	Dry woods, barrens, cliffs, outcrops of calcareous substrates
Brown Bog Sedge	*Carex buxbaumii*	Calcareous & mafic fens, peat-bogs, marshes, wet meadows, seeps
Field Sedge	*Carex conoidea*	Calcareous and mafic fens, saturated meadows, old fields of calcareous substrates

APPENDIX O-2 (continued)

US Forest Service Locally Rare Species Within or Near Portions of Jefferson National Forest Crossed by the Mountain Valley Project

Common Name	Scientific Name	Habitat
Crested Sedge	*Carex cristatella*	Low, calcareous wet meadows, open swamp areas, seeps
Yellow Sedge	*Carex flava*	Wet places in calcareous areas
Inland Sedge	*Carex interior*	Calcareous seeps, fens, wet meadows
Sooner Sedge	*Carex oklahomensis*	Calcareous meadows, seeps
Limestone Purple Sedge	*Carex purpurifera*	Rich cove woods, dry calcareous woods
Roan Mountain Sedge	*Carex roanensis*	Dry-mesic, rocky, oak, oak-hickory and mixed hardwood forests. Middle to high elevations.
Rigid Sedge	*Carex tetanica*	Low woods, calcareous fens, spring marshes, meadows
Inflated Sedge	*Carex vesicaria*	Wet soil or shallow water in bogs, swamps, marshes, depression ponds, streams, seeps, springs
Fogg's Goosefoot	*Chenopodium foggii*	Dry, rocky open forests and woodlands. Shale or calcareous sandstones. Often amongst oak- hickory vegetation
Chestnut Lip Fern	*Cheilanthes castanea*	Dry exposed outcrops, shales: Calcareous sedimentary & metamorphic substrates
Chestnut Lip-Fern	*Cheilanthes eatonii*	Calcareous or metamorphic substrates: Cliffs, in crevices, on shale or talus slopes
Tall Thistle	*Cirsium altissimum*	Forests, rich thickets, river-banks, woods, fields, clearings
Satin-Curls	*Clematis catesbyana*	Woodlands, outcrops, clearings and roadsides. Calcareous substrates.
Purple Clematis	*Clematis occidentalis* var. *occidentalis*	High elevation forests, rock outcrops, clearings, roadsides
Roundleaf Dogwood	*Cornus rugosa*	Rocky forests, boulderfields
Pear Hawthorn	*Crataegus calpodendron*	Basic or calcareous substrates: Open woods, thickets, usually along small rocky streams
Downy Hawthorn	*Crataegus mollis* var. *mollis*	Mesic to dry upland forests, clearings and old fields.
Prunose Hawthorn	*Crataegus pruinosa*	M\iddle elevations: Thickets, fields, rocky ground
Fleshy Hawthorn	*Crataegus succulenta* var. *succulenta*	Old fields, pastures, clearings, forest edges. Ocasionally on forested slopes and ridges.
Hazel Dodder	*Cuscuta coryli*	On various shrubs and herbs: Dry open forests, rocky woodlands & barrens
Beaked Dodder	*Cuscuta rostrata*	Herbacious hosts: High elevation forests & clearings in the mountains
Showy Lady's-slipper	*Cypripedium reginae*	Calcareous soils: Bogs, seeps, swamps, wet woods
Tennessee Bladder Fern	*Cystopteris tennesseensis*	Mesic to xeric calcareous outcrops
Showy Tick-trefoil	*Desmodium canadense*	Calcareous substrates: Fens, wet meadows
Toothed Tick-Trefoil	*Desmodium cuspidatum*	Dry forests, woodlands, barrens. Calcareous substrates.

APPENDIX O-2 (continued)

US Forest Service Locally Rare Species Within or Near Portions of Jefferson National Forest Crossed by the Mountain Valley Project

Common Name	Scientific Name	Habitat
Ringed Panic Grass	*Dichanthelium annulum*	Dry open forests, woodlands, barrens, clearings. Rocky, sandy, hardpan soils. Usually over mafic or calcareous substrates.
Matted Spikerush	*Eleocharis intermedia*	Calcareous fens, seeps, pools, depressions, ruts, other disturbed areas
Nodding Wild Rye	*Elymus canadensis* var. *canadensis*	River banks, open ground, sandy soil
Slender Wheatgrass	*Elymus trachycaulus* ssp. *trachycaulus*	Limy soils, prairies, open soils
American Willow-Herb	*Epilobium ciliatum* ssp. *ciliatum*	High elevations. Bogs, seeps, wet meadows, wet clearings.
Bog Willow-Herb	*Epilobium leptophyllum*	Circumneutral soils: High elevation bogs, wet meadows, seeps, other moist soils
Pink Thoroughwort	*Fleischmannia incarnata = Eupatorium incarnatum*	Calcareous & mafic substrates: Mesic to dry open forests
Low Rough Aster	*Eurybia radula = Aster radula*	Bogs, streambanks, fens, seeps and other moist places of various soil types
Spotted Joe-Pye Weed	*Eutrochium maculatum* var. *maculatum (Eupatorium maculatum)*	Usually in rich or calcareous soils: Damp thickets, meadows, spring marshes
Box Huckleberry	*Gaylussacia brachycera*	Dry, acidic oak-pine woodlands
Narrow-leaf Gentian	*Gentiana linearis*	Open grassy areas, wet woods, & meadows
Greater Fringed Gentian	*Gentianopsis crinita*	Calcareous substrates: Low woods, wet meadows, brook banks
Low Cudweed	*Gnaphalium uliginosum*	High elevations: Ephemeral pools, depressions, ditches, damp clearings, waste places
Dwarf Rattlesnake-Plantain	*Goodyear repens*	Cove and hemlock forests: Usually in mossy substrates
Smooth Sunflower	*Helianthus laevigatus*	Dry open forests, rocky woodlands, barrens, clearings, road banks
Purple Alumroot	*Huchera hispida (Heuchera americana* var. *hispida)*	Rocky woods, outcrops, open woods over limestone
Long-Flowered Alumroot	*Heuchera longiflora*	Upland woods, hillsides, shales, rich woods on limestone substrate; open or shaded areas
Crested Coralroot	*Hexalectris spicata* var. *spicata*	Circumneutral, or calcareous soils: Rocky woods, woodland stream margins
Canada bluets	*Houstonia canadensis*	Woodlands, openings, rocky woods, hillsides of calcareous substrates
Northern St. John's-Wort	*Hypericum boreale*	Damp peat, sand, shallow water
Jointed Rush	*Juncus articulatus*	Wet meadows, seeps, gravel bars & shores
Small-Head Rush	*Juncus brachycephalus*	Calcareous fens & seeps
Narrow-Panicled Rush	*Juncus brevicaudatus*	High elevations: Muddy, or wet places such as bogs & seeps

APPENDIX O-2 (continued)

US Forest Service Locally Rare Species Within or Near Portions of Jefferson National Forest Crossed by the Mountain Valley Project

Common Name	Scientific Name	Habitat
Highland Dog-Hobble	*Leucothoe fontanesiana*	Gentle slopes in open deciduous hardwoods. Cove forests.
Grooved Yellow Flax	*Linum sulcatum*	Shale barrens, dry rocky woodlands, clearings
Bog Twayblade	*Liparis loeselii*	Damp or wet woods, bogs, fens, seeps, swamps, wet meadows of calcareous substrate
American Gromwell	*Lithospermum latifolium*	Mesic to dry forests of calcareous substrate
Northern Bog Clubmoss	*Lycopodiella inundata*	Damp peaty or sandy shores, bogs, seeps, swamps, pond edges
Winged Loosestrife	*Lythrum alatum*	Calcareous fens, swamps, meadows, prairies, ditches
Three-Flower Melic Grass	*Melica nitens*	Calcareous substrates: Rocky woods, bluffs, dry clearings
Swamp Saxifrage	*Micranthes pensylvanica (Saxifraga pensylvanica)*	Calcareous mafic substrates: Forested seeps, seepage swamps
Large-Leaved Grass-Of-Parnassus	*Parnassia grandifolia*	Neutral to basic thinly wooded gravely seeps, wet, calcareous soil, fens, bogs, meadows, bases of dripping cliffs.
Yellow Nailwort	*Paronychia virginia* var. *virginica*	Rocky places, crevices and ledges, shale barrensand cliffs of calcareous substrates.
Black-Seed Ricegrass	*Patis racemosa = Oryzopsis racemosa*	Rich cove forests.
Large-Leaf Phlox	*Phlox amplifolia*	Mesic woodlands, hardwood forests of calcareous substrates.
Large Purple Fringed Orchid	*Platanthera grandiflora*	Meadows, seeps, swamps, coves.
Fowl Bluegrass	*Poa palustris*	Meadows, rocky shores, marshes of calcareous substrate.
Canada Plum	*Prunus nigra*	Borders of woods, fencerows, old fields.
Shinleaf	*Pyrola elliptica*	Dry to moist woods, northern red oak and spruce forests.
Sweet Azalea	*Rhododendron arborescens*	Rocky forests, outcrops, banks of rivers, high gradient streams.
Cumberland Azalea	*Rhododendron cumberlandense*	Montane woodlands, balds, moist exposed slopes, rock outcrops.
Climbing Prairie Rose	*Rosa setigera*	Open woods, clearings, pastures, fields.
Red Raspberry	*Rubus idaeus* ssp. *strigosus*	Rocky woods, boulderfields, woodland edges, clearings.
Pursh'S Wild-Petunia	*Ruellia purshiana*	Dry forests, rocky woodlands, barrens. Calcareous and mafic substrates.
Sessile-Fruited Arrowhead	*Sagittaria rigida*	Natural montane ponds, meadows.
Large-Fruited Sanicle	*Sanicula trifoliata*	Rich cove and slope forests, northern hardwood forests, dry-mesic oak-hickory forests.

APPENDIX O-2 (continued)

US Forest Service Locally Rare Species
Within or Near Portions of Jefferson National Forest Crossed by the
Mountain Valley Project

Common Name	Scientific Name	Habitat
Heart-Leaf Skullcap	*Scutellaria ovata* ssp. *Rugosa (Scutellaria ovata* ssp. *Pseudoarguta)*	Calcareous woodlands, barrens. Shale, metabasalt substrates.
Small Skullcap	*Scutellaria leonardii (Scutellaria parvula)*	Mafic to felsic substrates. Barrens, outcrops, grass balds at high elevations.
Stiff Goldenrod	*Solidago rigida var. rigida (Oligoneuron rigidum)*	Dry rocky woods, barrens, outcrops, clearings, fields with prairie affinities.
Narrow-Leaf Burreed	*Sparganium emersum (Sparganium chlorocarpum)*	≥ 2,500 feet. Bogs, beaver wetlands, calcareous marshes .
Freshwater Cordgrass	*Spartina pectinata*	Rocky riverbanks, wet meadows, wet open streambanks, swamps, calcareous fens.
Shining Ladies'-Tresses	*Spiranthes lucida*	Calcareous fens and seeps, moist banks, damp meadows.
Yellow Nodding Ladies'-Tresses	*Spiranthes ochroleuca*	High elevations. Bogs, meadows, swamps, marshes, wet woods, edge of lakes and streams, peaty and gravelly soil in open barrens, on seepages slopes, forestsclearings, meadows.
Small Dropseed	*Sporobolus neglectus*	Dry, sterile or sandy soil, mostly open areas. Limestone barrens, cliffs and rocky fields.
Celandine Poppy	*Stylophorum diphyllum*	Rich woods, often calcareous, cove forests.
Common Snowberry	*Symphoricarpos albus*	Calcareous ledges, barrens and gravels. Rocky woods and fields.
Mountain Pimpernel	*Taenidia montana*	Dry woodlands, barrens, outcrops. Open rocky forests. Shale and calcareous sandstone.
Tower Mustard	*Turritis glabra (Arabis glabra)*	Dry soil. Woodland borders, disturbed habitats.
Fraser's Marsh St. John'S-Wort	*Hypericum fraseri (Triadenum fraseri)*	Bogs, seeps, swamps, depression ponds.
Narrow-leaf Blue Curls	*Trichostema setaceum*	Sandstone barrens and outcrops.
Kate's Mountain Clover	*Trifolium virginicum*	Shale barrens, dry open woodlands.
Nodding Pogonia	*Triphora trianthophora* ssp. *Trianthophora (Triphora trianthophora)*	Damp rich woods, often on rotten logs.
Cranberry	*Vaccinium macrocarpon*	Mostly high elevations. Open bogs and ponds.
Marsh Speedwell	*Veronica scutellata*	Calcareous substrates. Bogs, fens, seeps.
Nannyberry	*Viburnum lentago*	Banks of streams, seeps, old fields.
American Purple Vetch	*Vicia americana var. americana (Vicia americana)*	Dry shale woodlands, forest edges, clearings, prairies.
Prostrate Blue Violet	*Viola walteri*	Calcareous substrates. Dry woods, rocky ledges, slopes.

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APPENDIX O-3

Hydrologic Analysis of Sedimentation

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Pesi 593.02

HYDROLOGIC ANALYSIS OF SEDIMENTATION

MOUNTAIN VALLEY PIPELINE

JEFFERSON NATIONAL FOREST
EASTERN DIVIDE RANGER DISTRICT

1 March 2017

Prepared for:

U.S. Department of Agriculture, Forest Service
Jefferson National Forest
Eastern Divide Ranger District
110 South Park Avenue
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1.0 Introduction

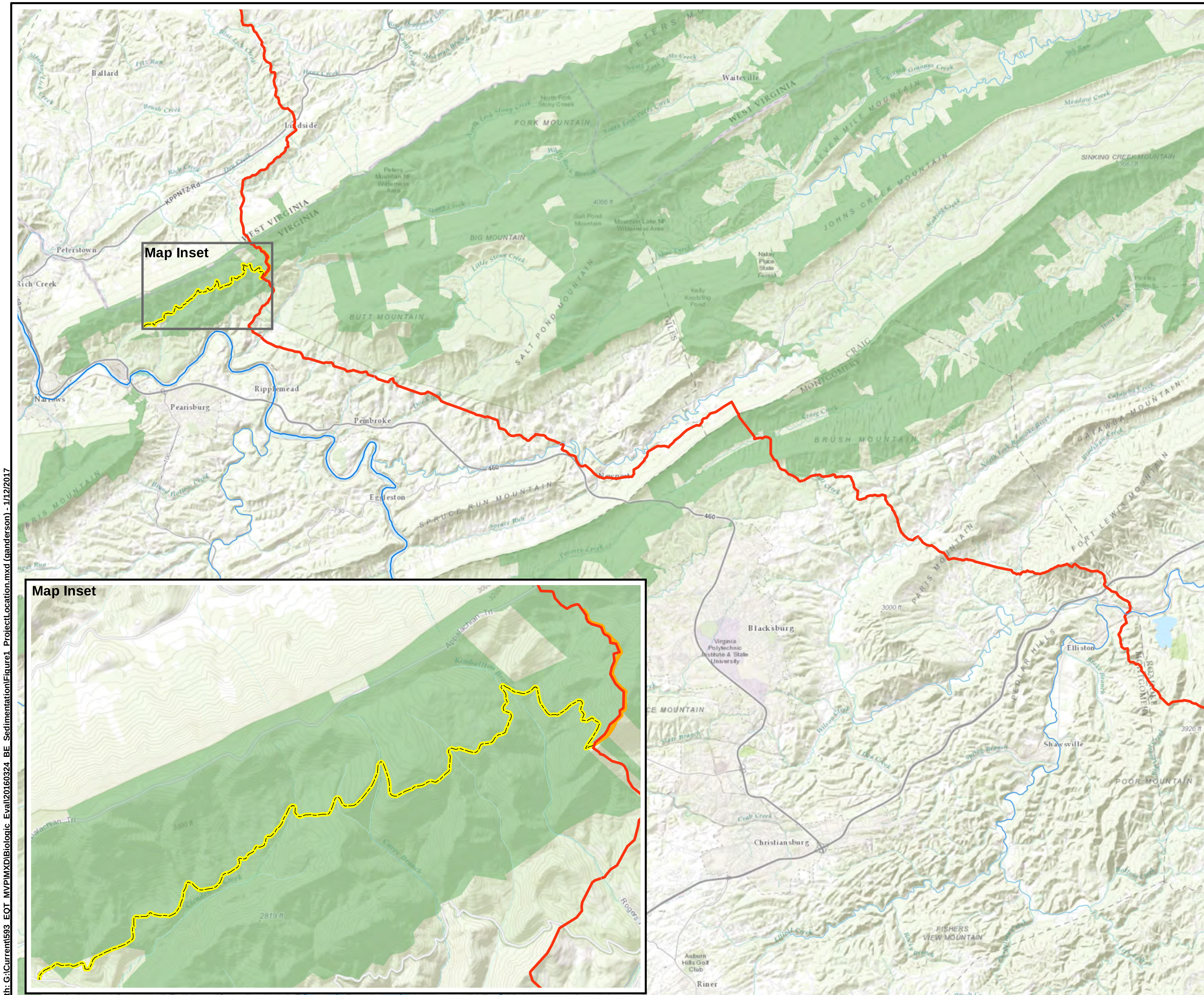
Mountain Valley Pipeline, LLC (MVP), a joint venture between EQT Midstream Partners, LP, NextEra Energy, Inc., WGL Holdings, Inc., Con Edison Gas Midstream, LLC, and RGC Midstream, LLC, is seeking a Certificate of Public Convenience and Necessity from the Federal Energy Regulatory Commission (FERC) pursuant to Section 7(c) of the Natural Gas Act (NGA) authorizing it to construct and operate the proposed Mountain Valley Pipeline Project (Project) located in 17 counties in West Virginia and Virginia. MVP plans to construct an approximately 303-mile, 42-inch-diameter natural gas pipeline to provide timely, cost-effective access to the growing demand for natural gas for use by local distribution companies (LDCs), industrial users and power generation in the Mid-Atlantic and southeastern markets, as well as potential markets in the Appalachian region.

The proposed pipeline will extend from the existing Equitrans, L.P. transmission system and other natural gas facilities in Wetzel County, West Virginia to Transcontinental Gas Pipe Line Company, LLC's (Transco) Zone 5 compressor station 165 in Pittsylvania County, Virginia (Figure 1). In addition to the pipeline, the Project will include approximately 171,600 horsepower of compression at three compressor stations currently planned along the route as well as measurement, regulation, and other ancillary facilities required for the safe and reliable operation of the pipeline. The pipeline is designed to transport up to two-million dekatherms per day of natural gas.

Approximately 3.4 miles of the proposed alignment cross Jefferson National Forest (JNF) lands in Monroe County, West Virginia and Giles and Montgomery counties, Virginia. Additionally, the approximate 6-mile Pocahontas Road (Forest Road 972) and 1-mile Mystery Ridge Road (Forest Road 11080) in Giles County, Virginia are currently proposed to provide access to portions of the alignment near Peters Mountain. No ancillary facilities or new access roads are proposed to be constructed on JNF lands; however, two additional temporary workspaces (ATWS) are currently proposed in Montgomery County.

Construction of MVP within the JNF and private lands has potential to introduce excess sediment into waterways within the JNF and downstream areas, which may result in changes to water quality and potentially impact aquatic biota. Although MVP will implement specific conservation measures (i.e., erosion and sediment controls) to minimize impacts to waterways, these measures are unlikely to prevent all sediment inputs. Sedimentation of streams by erosion is a natural process, but land development and disturbance may accelerate this process. Increased erodibility, due to the loosening and exposure of fine particles increases the likelihood of sediment-laden runoff from the Project into nearby waterways.

Figure 1. Location of the proposed Mountain Valley Pipeline within the vicinity of the Jefferson National Forest in Virginia and West Virginia.



- Stream
- Pocahontas Road
- Mystery Ridge Road
- October 2016 Proposed Route (Revised)
- Jefferson National Forest Boundary

N W E S

0 2.5 5 Miles

Base Map: ESRI ArcGIS Web service - "US TOPO MAPS" accessed - 1/12/2017

ESI ENVIRONMENTAL SOLUTIONS & INNOVATIONS, INC.

Project No. 593.02

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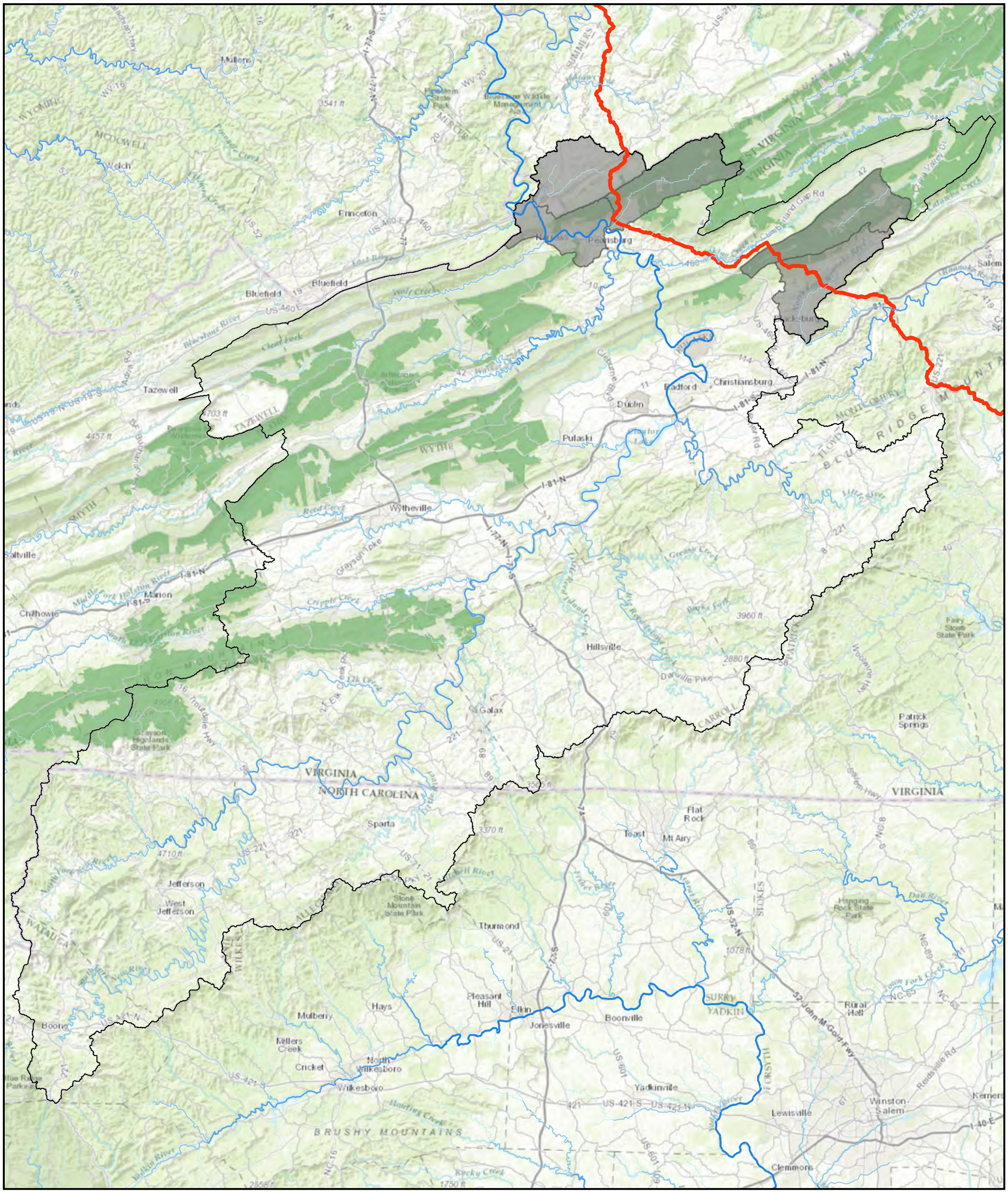
Environmental Solutions & Innovations, Inc. (ESI) was retained by MVP to provide protected species consultations, surveys, and analyses for the Project, including threatened, endangered, and sensitive (TES) species within the JNF. In order to quantify the amount of sediment expected within waterways and associated impacts to TES species within the JNF and in downstream areas, ESI contracted a hydrogeologist (Hydrogeology Inc.) to investigate the potential for downstream sedimentation impacts. On June 7, 2016, ESI, on the behalf of MVP, submitted a *Hydrologic Analysis of Sedimentation* documenting potential sedimentation introduced during Project construction. Upon review, the USFS, ESI, and MVP discussed the analysis and how to best document the level of impacts of potential sedimentation introduced by the Project. Taking into account the USFS comments and recommendations, ESI re-conducted the analysis to include all aspects of the Project. This updated analysis allows the USFS to review potential sediment impacts during construction as well as consider the cumulative effects of increased sediment as the Project transitions through post-construction phases.

2.0 Methods

In order to estimate erosion due to disruption of land from construction, restoration, and operational activities for the Project in the vicinity of the JNF, a hydrologic analysis of sedimentation is performed. This analysis uses the Revised Universal Soil Loss Equation (RUSLE; Renard et al. 1997) to estimate loss of soils due to Project activities. The RUSLE provides generalized annual estimates of erosion rates and sediment loads based on climate, soil, topography, and land use/management factors and can be used to determine sediment loads and yields for catchments within the vicinity of the Project.

2.1 Hydrologic Study Area

To assess the potential of impacts from the Project due to sedimentation within streams in and surrounding the JNF, a hydrologic study area is defined. This area is defined using subwatersheds (i.e., Hydrologic Unit Code [HUC] 12) from the U.S. Geological Survey's Watershed Boundary Dataset and is specified to contain: (1) all subwatersheds that intersect the JNF boundaries and the Project Area, (2) all subwatersheds upstream of the intersecting subwatersheds (i.e., all upstream catchment areas), and (3) subwatersheds downstream of the intersecting subwatersheds that demonstrate substantial increases in cumulative sediment loads (i.e., > 10 %; Figure 2).



Stream

October 2016 Proposed Route (Revised)

Subwatershed

Hydrologic Study Area

Jefferson National Forest (JNF) Boundary

Intersecting JNF and Project Subwatershed

N W E S

Figure 2. Hydrologic study area for the Mountain Valley Pipeline within the Jefferson National Forest in Virginia and West Virginia.

Project No. 593

0 10 20 Miles

Base Map: "US Topographic Maps"

ESI ENVIRONMENTAL SOLUTIONS & INNOVATIONS, INC.

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Within the vicinity of the JNF, the Project proposes to construct and operate in four subbasins belonging to three different hydrologic regions:

- Upper New (8-digit HUC 05050001) and Middle New (05050002) subbasins of the Ohio Region
- Upper James Subbasin (8-digit HUC 02080201) of the Mid-Atlantic Region
- Upper Roanoke Subbasin (8-digit HUC 03010101) of the South Atlantic-Gulf Region

Of the 243 subwatersheds within these three subbasins, 5 subwatersheds contain Limits of Disturbance (LOD) within the JNF (Table 1).

Table 1. Subwatersheds in Virginia and West Virginia with Limits of Disturbance for the Mountain Valley Pipeline within the Jefferson National Forest.

Subwatershed Name	HUC12	State	Subwatershed Area (mi^2)*	Area within JNF (mi^2)*
Stony Creek	050500010902	VA,WV	48.9	39.6
Clendennin Creek-Bluestone Lake	050500020403	VA,WV	38.9	7.5
Rich Creek	050500020601	VA,WV	53.3	1.3
Trout Creek-Craig Creek	020802011001	VA	51.9	38.4
Dry Run-North Fork Roanoke River	030101010201	VA	51.3	3.3

* Subwatershed Area and Area within JNF are estimates of the total area of the subwatershed and the area of the subwatershed that is contained in the JNF, respectively.

The Stony Creek Subwatershed is a headwater subwatershed that contains Laurel Branch, Iron Spring Branch, Dixon Branch, Pine Swamp Branch, Kimbalton Branch, North Fork Stony Creek, and Stony Creek. The outlet of the subwatershed is outside the JNF where Stony Creek flows into the New River.

The Clendennin Creek-Bluestone Lake Subwatershed is downstream of the Stony Creek Subwatershed and largely comprises an area draining directly to the mainstem of the New River but also contains several tributaries including Clendennin Creek, Curve Branch, Limestone Creek, and Piney Creek. The subwateshed predominantly drains private lands, but the headwaters of Clendennin Creek and Curve Branch originate within the JNF, and portions of the catchment of the mainstem New River are also within the JNF.

Near the outlet of the Clendennin Creek-Bluestone Lake Subwatershed, the Rich Creek Subwatershed meets the mainstem of the New River. This headwater subwatershed contains Brush Creek, Crooked Creek, Crooked Run, Dry Creek, Painter Run, Rich Creek, Scott Branch, and Tigger Run. Only a small proportion of the Rich Creek Subwatershed is contained within the JNF, and only streams within the southwestern portion of subwatershed drain JNF lands.

The Trout Creek-Craig Creek Subwatershed is a headwater system of the Upper James that contains Craig Creek, Trout Creek, Mill Creek, Turnpike Creek, Cabin Branch, Adaline Branch, Sandy Branch, Muddy Branch, Dickey Farm Branch, and Pickles Branch. The majority of the subwatershed is within the JNF; however, much of the Craig Creek mainstem and surrounding floodplain are not contained within the jurisdictional boundaries of the JNF.

A small portion (0.12 acre) of the Project is proposed to intersect the JNF and the Dry Run-North Fork Roanoke River Subwatershed. This subwatershed is a headwater system of the Upper Roanoke that drains to the North Fork Roanoke River and contains Wright Branch, Smith Run, Slate Lick Run, Sites Branch, Pepper Run, Mill Creek, Indian Run, Gallion Branch, and Dry Run.

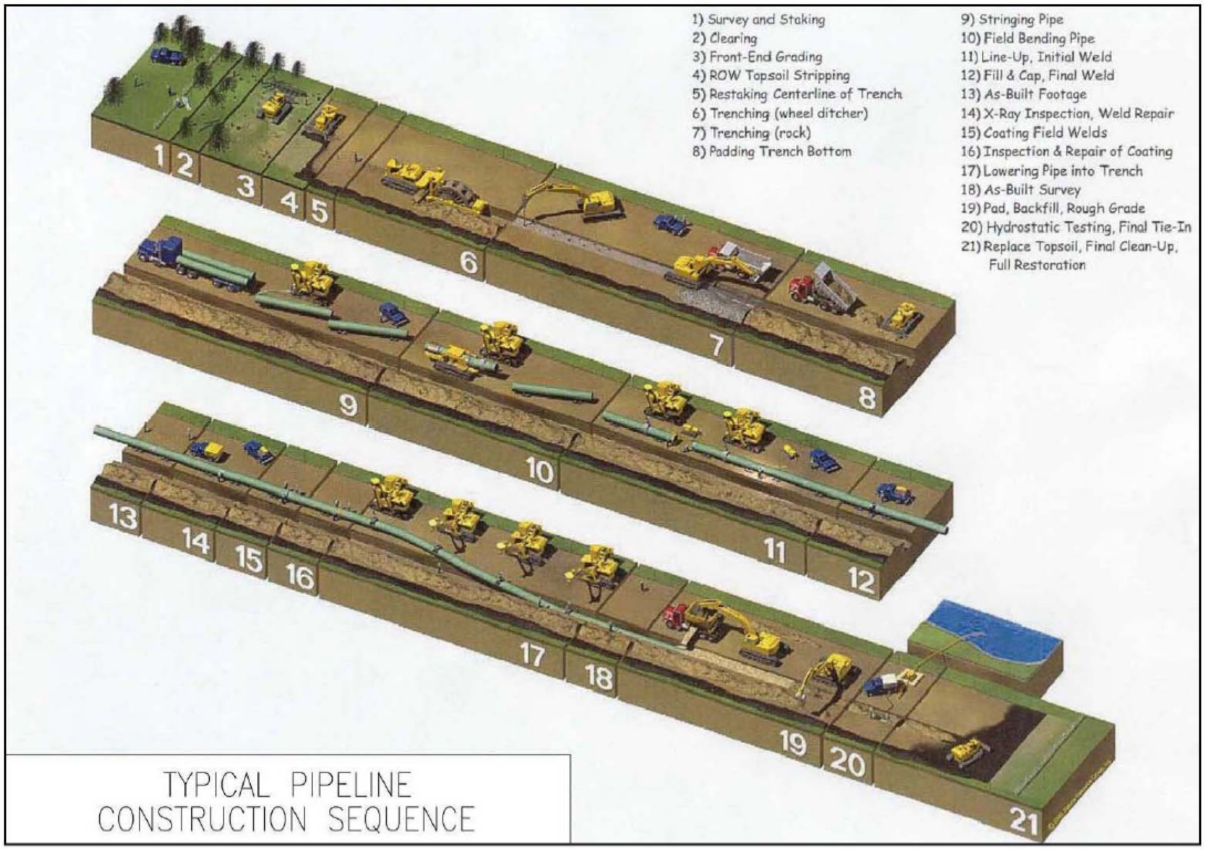
2.2 Impact Approach

Construction of the pipeline and associated facilities will be undertaken in 11 separate construction spreads using conventional open-cut methods during the majority of the process. A pipeline construction spread operates as a moving assembly line performing specialized procedures in an efficient, planned sequence. In the typical pipeline construction scenario, the construction contractor will construct the pipeline along the right-of-way (ROW) using sequential construction techniques, including surveying, staking, and fence crossing; clearing and grading; trenching; pipe stringing, bending, and welding; lowering-in and backfilling; hydrostatic testing; clean-up and restoration; and commissioning (Figure 3).

The following approach is taken to estimate soil loss rates from the Project. The RUSLE, as described below, is used to estimate sediment loads (tons yr^{-1}) and sediment yields (tons/mi^2 yr^{-1}) for the catchments of all streams within the 1:24,000 National Hydrography Dataset (NHD) within the study area (Figure 2). These calculations are made using current and expected land use classes during: construction, restoration, and operation of the Project. Current sediment loads and yields are considered baseline conditions (i.e., baseline treatment) and provide a measure of the present sediment loads within streams in the vicinity of the Project. This baseline treatment is then used to assess potential increases of soil loss expected under Project construction, restoration, and operation (i.e., proposed action treatment).

In order to estimate potential sediment introduced into nearby streams from the Project, construction, restoration, and operation impacts are divided into three primary activities: (1) access road improvements and construction, (2) tree clearing, and (3) pipeline construction and restoration. These activities are projected on a two-week interval using a sequential, assembly line construction schedule for each construction spread in a north-to-south direction. First, the northern most access road is constructed. Once the first access road is completed, construction of the next most northern access road begins, and tree clearance begins on the pipeline LOD,

Figure 3. Typical pipeline construction sequence.



associated workspaces, and ancillary sites. After trees are cleared, construction begins. The process for each one of these activities is further detailed below.

Access road improvements and construction are estimated to take two calendar weeks per access road. During this construction time, the entire LOD for the access road is treated as a bare soil land class (see Section 2.3.4 below) (Galetovic 1998), and temporary sediment erosion controls are employed. After two weeks, the road enters a recovery stage where the road will likely continue to contribute elevated sediment loads until it reaches a new equilibrium. Therefore, to be conservative, the LOD for the access road is treated as a bare soil land class during this phase; however, during this time the road will have gravel applied and final grading will be complete. After four weeks of recovery, herbaceous erosion controls are assumed to be established but not mature, and the road is considered to act as an improved road until the construction spread is restored and established (see Section 2.3.4 below) (Gaffer et al. 2008). Once the construction spread is restored and established, temporary access roads are treated similarly to the ROW with periods for grass establishment, development, and maturation (see below). Permanent access roads continue to act as an improved road for the life of the Project.

Tree clearance is estimated to occur at a rate of 2,500 linear feet per day, and over a two-week period (six-day work week), approximately 30,000 linear feet are estimated to be cleared. Because vegetation would generally be cut or scraped flush with the surface of the ground, the portion of the LOD cleared is treated as a bare soil land class scalped at the surface (see Section 2.3.4 below) (Galetovic 1998) until construction (e.g., grading) begins, and no erosion and sediment controls are assumed to be employed during this timeframe. This classification likely overestimates the sediment produced during this phase of the Project because the LOD will not be 100 percent bare soil.

Once trees are cleared, construction at any particular one-mile stretch along the pipeline route is estimated to take about three weeks to complete (19 work-days). Given this information, construction progress is estimated to occur at 3,520 linear feet every two-weeks (3,520 ft=5,200 ft × [2/3]), and the portion of LOD under active construction is treated as a bare soil land class (see Section 2.3.4 below) (Galetovic 1998). Note that as a conservation measure, piles of topsoil and subsoil are mulched each day to minimize erosion. These areas combined represent approximately 30 feet of the LOD width and are represented by buffering the spoil side of the LOD. This area is treated as a mulched land class (see Table 2) during active construction. Once construction is complete, all areas of the ROW are mulched within 7 days of backfilling and remain mulched until final grading.

Approximately 16-weeks after construction is completed, final grading takes place and areas are restored within 3-5 days of final grading. Seed areas are assumed to take approximately four-weeks to establish, six months to develop, and one-year to become a maturing crop. Until seeds are established, the LOD is classified as a mulched landscape with two tons of straw or hay applied per acre. Six months after seeding temporary erosion controls are assumed to be removed (however, permanent erosion controls remain in place) and the ROW is treated as a developed grassland. After one-year of seeding, grasses are assumed to act like a maturing crop, and the landscape is reclassified as a grassland or herbaceous landscape (see Section 2.3.4 below).

Using this schedule of events and associated land use classes, soil loss is estimated at two-week intervals and summed to estimate expected yearly loads and yields for a five-year period. Results are then compared to baseline conditions to assess potential impacts from the Project. To estimate the full spatial extent of Project impacts, maximum loads are estimated as the maximum cumulative sum of any consecutive 52-week period.

2.3 Estimating Erosion and Soil Loss

Soil loss is calculated for all subwatersheds within the hydrologic study area using the RUSLE. The RUSLE takes the product of several derived metrics in order to estimate expected soil loss under different land use, management, topographic, and climatic conditions. Sediment load (A) is estimated at a rate of tons per year using the following equation:

$$A = R \times K \times (L \times S) \times C \times P, \qquad \text{Eq. 1}$$

where R is the erositvity index, K is the soil erodibility factor, L is the slope length factor, S is the slope steepness factor, C is a cover-management or land use factor, and P is a support practice factor. These factors, along with their respective derivations are discussed further below.

2.3.1 Soil Erosivity Factor

Because the RUSLE does not directly model hydrology, runoff estimates are not available to simulate erosion; instead, a rainfall erosivity factor is calculated that characterizes the potential effect of runoff on soil erosion. To calculate R, average annual precipitation estimates (PRISM Climate Group 2012) from 1980 to 2010 are used within the following formula:

$$R = 0.059 \times 0.0483 \times P^{1.61}, \qquad \text{Eq. 2}$$

where P is precipitation expected within a raster cell (in millimeters), and R is the rainfall erosivity in hundreds of foot-ton-inch acre^{-1} hour^{-1} year^{-1} (Renard and Freimund 1994). In this equation, 1.61 and 0.0483 are estimated regression coefficients from Renard and Freimund (1994), and 0.059 is a conversion factor to U.S. customary units. Note that in this approach, annual estimates are used due to the complexity of integrating the RUSLE into the Geographical Information System (GIS) environment (see below); however, rainfall changes seasonally, thus sedimentation impacts may depend on the season in which construction takes place.

2.3.2 Soil Erodibility Factor

The soil erodibility factor (K) accounts for variability in the inherent erodibility of soils and is a function of integrated influences, including infiltration, rainfall, composition, and overland runoff. Fortunately, this metric is currently available within the National Resources Conservation Service's SSURGO (Soil Survey Staff 2015a) and STATSGO2 (Soil Survey Staff 2015b) soil databases. Note that although the K-factor is available in these datasets, it needs to be aggregated among soil components and horizons. To accomplish this, the kwfact parameter (K-factor, Whole Soil) from the dominant condition among components is used, and no aggregation is made among horizons but rather the surface layer is used instead.

In most areas within the hydrologic study area, the more detailed SSURGO dataset is used, but SSURGO K-factors are not readily available for all map-unit areas. Therefore, when SSURGO data are not available, the kwfact is calculated with STATSGO2 K-factors, which have lower resolution but sufficient correspondence with SSURGO factors (Breiby 2006).

2.3.3 Topographic Factor

The L and S factors within the RUSLE individually represent slope length and steepness, respectively, but combine to form what is known as a topographic factor. This topographic factor is a function of the landscape terrain. Following Moore and Wilson (1992), LS is calculated using upslope contributing area in order to account for the impact of flow convergence. For each raster cell i LS is calculated as:

$$LS_i = \left(\frac{A_{s_i}}{22.13}\right)^m \times \left(\frac{\sin\beta_i}{0.0896}\right)^n \times (m+1), \qquad \text{Eq. 3}$$

where A_{s_i} is the specific catchment area or the upslope contributing area per unit width of contour, β is the slope angle in radians, and m and n are constants. Both A_{s_i} and β_i are calculated using the standard Spatial Analyst functions within ArcGIS; however, to ensure alignment with the NHD, elevation data is adjusted to calculate A_{s_i}. In this process, elevation data (derived from the 1/3 arc-second seamless digital elevation model [DEM] available from the USGS 3D Elevation Program) are adjusted by burning in the NHD, and a flow direction and flow accumulation process is performed on this adjusted elevation data. The specific catchment area is then calculated as the product of the flow accumulation estimate and the cell resolution. As suggested by Galetovic (1998), the slope length component of this equation is truncated at 400 feet. Although the values of m and n can vary among different terrains, the parameters typically range from 0.4 to 0.6 and 1.0 to 1.4, respectively. For this analysis, m and n are set at 0.4 and 1.0, respectively. These values are chosen because of the high forest cover and complex topography (Oliveria et al. 2013).

2.3.4 Cover and Management Factor

The cover and management factor (C) accounts for the effects of vegetation, management, and erosion control practices. In the hydrologic sedimentation analysis for the JNF, baseline C-factors are generated by reclassifying: the 2011 National Land Cover Database (NLCD; Homer et al. 2015) and land use classifications made during bat habitat assessments and wetland and stream surveys. Reclassifications are conducted using the values from Table 2, which are taken from several literature sources, including Wischmeier and Smith (1978), Dissmeyer and Foster (1980), Galetovic (1998), Mitasova et al. (2001), MTDEQ (2006), Gaffer et al. (2008), and Litschert et al. (2014).

As described above in Section 2.2, soil loss from pipeline construction and practices is estimated by applying time and activity specific C factors to all areas of the pipeline ROW and other temporary and permanent work-spaces (Table 2). For most activities, C-factors are derived for a two-week period; however, for the periods immediately following backfilling and during restoration, construction activities span less than the two-week period. For these activities, where disturbance is a shorter time frame, two week cover management factors are derived by a weighted average of the construction

Table 2. Conservation and management factors applied for different land uses within the study area.

Vegetative Cover Type	Management Factor (C)
National Land Cover Classes	
Deciduous Forest	0.003
Evergreen Forest	0.003
Mixed Forest	0.003
Woody Wetlands	0.006
Developed Open Space	0.003
Developed, Low Intensity	0.001
Developed, Medium Intensity	0.001
Developed, High Intensity	0.001
Shrub/Scrub	0.010
Emergent Herbaceous Wetlands	0.003
Cultivated Crops	0.240
Pasture/Hay	0.010
Grassland/Herbaceous	0.010
Open Water	0.000
Barren Land	0.001
Proposed Activities	
Access Roads	
Improvements and Construction	0.450
Improved Road (Operations)	0.250
Tree Clearing	0.150
Project Construction	
Additional Temporary Work Space	0.450
Ancillary Site	0.450
Right-of-Way	1.000
Project Restoration	
Mulched, Slope ≤10 %	0.060
Mulched, Slope 11-15 %	0.070
Mulched, Slope 16-20 %	0.110
Mulched, Slope 21-25 %	0.140
Mulched, Slope 26-33 %	0.170
Mulched, Slope ≥ 34 %	0.200
Established Grasses and Forbs	0.150
Developed Grasses and Forbs (50-75% Crop Canopy)	0.042
Maturing Crop (≥ 75 % Crop Canopy; Operations)	0.010

specific C-factor and a mulch specific C-factor. For example, once construction is completed, areas may remain denuded for up to 7 days following backfilling. Because this timeframe is less than 2-tweeks, the C-factor is derived by multiplying the area specific construction C-factor by 7, adding 7 times a slope-specific mulching C-factor (i.e., 7 days of a mulched landscape), and dividing this sum by 14. A similar calculation is made for restoration; however, the construction C-factor is multiplied by 6 days (i.e., 1 day of grading, 4 days between grading and restoration, and 1 day of restoration), and the slope-specific mulching C-factor is multiplied by 8 (i.e., 14 days in two weeks minus 6 days of the activity=8 days of mulch).

2.3.5 Practice Factor

Reported estimates of the effectiveness of erosion and sediment controls vary widely among studies and have been reported to be between 10 and 90 percent (USEPA 2009). Performance of these controls is a function of design; frequency and duration of rainfall events; particle sizes; sediment accumulation; and the extent to which field maintenance has been performed. For the proposed MVP, a variety of erosion and sediment control practices will be used. Erosion control practices include, but are not limited to: trench breakers, permanent slope breakers, temporary seeding, mulching, soil stabilization mats and blankets, and surface roughing. According to a review conducted by the United States Environmental Protection Agency (USEPA 1993), erosion control on construction sites can average as high as 85 percent under proper application of erosion control best management practices. These erosion control practices are the first line of defense in preventing sedimentation into nearby waterways. In addition to erosion control practices, MVP will implement a variety of sediment containment practices, including, but not limited to: the establishment of construction entrances, creation of sedimentation barriers (e.g., silt fences [including j-hook fences], straw bales, compost filter socks), temporary ROW diversions, and sediment basins and traps.

As a first step in any land-disturbing activity, sediment basins and traps are constructed. Sediment basins are designed to promote settling of sediment by reducing flow velocities. As with most sediment containment practices, performance estimates vary widely among studies with some estimates as low as 55 percent (USEPA 1993); however, according to Zech et al. (2012), these features can remove approximately 85 percent of suspended solids within sediment laden runoff. Galetovic (1998) suggested that these basins can be thought of as closed-outlet terraces for the purpose of estimating soil containment, and containment is a direct function of particle or aggregate size with coarse particles having a containment as high as 99 percent and fines having a containment of 86 percent. According to a USEPA study on the impacts of oil and gas exploration on water quality, modeled annual average sediment reductions ranged from 77 to 93 percent (Banks and Wachal 2007); interestingly, the study also found that reductions did not decrease with increased slopes but rather decreased as a function of rainfall intensity.

In addition to sediment basins and traps, sediment barriers are installed to intercept and detain sediment from disturbed areas and to decrease the velocity of sheet flows. Silt fences are the current industry standard because of their long lifespan (6 month effectiveness), strong construction, and high removal efficiencies (Banks and Wachal 2007). However, their reported performance varies among numerous studies. Most laboratory studies conducted using flumes show relatively high rates of containment. For example, Farias et al. (2006) demonstrated sediment reduction between 93 and 96 percent, and Risse et al. (2008) evaluated containment at varying slopes (up to 59 percent) and found that containment remained upwards of 80 percent across all trials. Bench scale testing studies have also suggested high efficiencies, ranging from 72 to 89 percent containment (Faucette et al. 2008). Because of the uncontrollable nature of real storm and rain events on the landscape, containment studies involving field testing are difficult and have had mixed results. An alternative approach is field scale testing which involves using a tilted test bed with loose soil and a rainfall simulator. Essentially, the approach provides an approximation of field conditions but in a controlled experimental setting. A recent study conducted by Dubinsky (2014) evaluated containment at a variety of slopes and rainfall events and found that overall average projected performance efficiency ranged from 48 to 87 percent with a mean and median of 79 and 86 percent, respectively.

Newly emerging sediment perimeter controls, such as compost filter socks, are more often three-dimensional unlike the planar silt fence. With the three-dimensional design, these sediment containment devices allow runoff to flow through at higher rates; thus, there is less propensity for ponding, and the lower pressure reduces the chance of failure from overtopping and undermining (Faucette et al. 2009). For example, Faucette et al. (2008) and Faucette et al. (2009) found that removal efficiencies of compost filter socks ranged between 63.5 and 88.2 percent with a mean of approximately 80 percent.

Within the RUSLE, sediment containment is incorporated through the use of a support practice factor; however, many of the erosion control practices are likely to affect the cover and management factor as well. Using the review provided above, a support practice factor of 0.21 (i.e., 79% containment) is used to model the benefits of erosion and sediment control practices. This value is chosen because it is the mean reported value for both silt fences and compost filter socks, two predominant controls proposed to be used on the MVP ROW. Although in some areas, containment of these devices may be lower, additional erosion and sediment controls (e.g., sediment basins) will likely help to reach the chosen containment level. Furthermore, variability in sediment control performance is most likely a function of proper installation and maintenance. Given the increased requirements of inspection of all erosion and sediment controls and the increased presence of both federal and state environmental inspectors, attainment of 79 percent sediment containment is possible. However, most sediment controls are designed only to withstand runoff from a 2-year, 24-h storm event. If rainfall were to exceed this amount, sediment containment may be less.

2.3.6 Special Conservation Measures within the Craig Creek Drainage

During preliminary analyses, it was recognized that sediment produced by the Project may impact the Craig Creek mainstem up to several miles downstream of the Project footprint. In order to limit this potential, several conservation measures were developed for this basin that will help minimize sedimentation into this important waterbody. These measures include: 1) a construction timeline that immediately follows tree clearance with the Craig creek drainage, 2) a restoration timeline that follows within 8 weeks of temporary stabilization, 3) a regimen that includes mulching areas denuded for more than 4 days, 4) a schedule that involves mulching backfilled areas of the trench within 4 days, and 5) the continuation of temporary sediment controls for 1-year after seeding. All of these factors are included within this analysis.

2.4 Estimating Sediment Delivery

The RUSLE provides an estimate of the expected soil loss per unit of interest for the entire study area; however, not all sediment is expected to continue into downstream areas. The proportion that does continue downstream is expected to vary with catchment size, with the headwaters producing relatively more sediment than lower, flatter portions of the watershed. Based on this concept, sediment delivery ratios are used to predict the proportion of sediment expected to reach the outlet of each catchment. More specifically, the sediment delivery ratio is modeled using Boyce (1975) upland theory as:

$$SDR_w = 0.417762 \times A_w^{-0.134958} - 0.127097, \qquad \text{Eq. 4}$$

where A_w is the drainage area of the stream segment in square-miles and SDR_w is the estimated sediment delivery ratio (NRCS 1983). Thus, to calculate the expected sediment load for any given stream segment (L_w), the following equation based on Fernandez et al. (2003) is used:

$$L_w = \sum_{i=1}^{n} (A_i * a) * \ SDR_W \ , \qquad \text{Eq. 5}$$

where i indexes the n raster cells within the catchment, A_i is the expected sediment loss for cell i based on the RULSE from Eq. 1, and a is a conversion factor from square meters to acres. In this study 10-meter (32.8 ft) resolution rasters are used with a cell area of 100 square meters (1076.4 ft^2). Thus, to convert to standard units, a is equal to 0.0247105.

Calculating sediment loads in this manner assumes that sediments are continually transported downstream; however, most sediments will likely stop at the nearest dam. Although the ultimate fate of anthropogenic sediments are estuarine and/or marine environments (e.g., Gulf of Mexico), instream impoundments (e.g., mill, low-head, reservoir, etc.) can arrest the majority of these sediments (Maneux et al. 2001). To account for this phenomena, two types of upstream catchments are delineated: (1)

total catchment area and (2) catchment area below impoundment. Only cells that are members of the catchment area below impoundment can contribute to the sediment load calculation in Eq. 5. Both total catchment area and catchment area below impoundment are calculated using ArcHydro, which utilizes both raster information (e.g., flow direction grid) and vector networks (i.e., NHD) to delineate catchments and adjoining catchments. To account for impoundments within the stream network, the NHD waterbodies layer is used; however, only features with the FType of ‘Lake’, ‘Pond’ or ‘Reservoir’ are used as potential impoundments. Although this layer represents an underestimate of the number of impoundments present within a given stream network (compared to the National Inventory of Dams ([NID]); the NHD waterbodies are georeferenced to the NHD and provide common identifiers to join the two feature layers together.

Using the sediment load calculated in Eq. 5, a sediment yield is calculated by dividing the load by the catchment area.

2.5 Identifying Areas for Sediment Deposition

The RUSLE does not include a model for sediment transport or deposition. Instead, transport is included by applying a sediment delivery ratio, as in Eq. 4 and 5, to estimate the sediment loads within waterbodies using Boyce (1975) upland theory. Although quantifying the amount of sediment deposition requires a complex hydrological model, identifying the likely locations of deposition can be done remotely without extensive field measurements. Sediment transport is directly related to stream power (Ω), which can be approximated as the product of stream discharge (Q), energy gradient (S), the density of water (ρ), and gravity (g):

$$\Omega = \rho \times g \times Q \times S, \qquad \text{Eq. 6}$$

where S is equivalent to channel slope in uniform flow and ρ and g are constants of 62.3 lb/ft^3 at 68^{0}F and 32 ft/s, respectively (Bagnold 1977). Dividing stream power by the flow width (w) provides an estimate of the energy expenditure per unit bed area of channel (i.e., mean stream power; ω):

$$\omega = \Omega / w. \qquad \text{Eq. 7}$$

Stream power represents the functional forces available for sediment transport. Whereas Ω is related to river channel dimensions and channel mobility thresholds, ω is related to channel dynamics, bedload transport, and bed sediment entrainment (Lea and Legleiter 2016). Thus, the mean stream power gradient ($\partial\omega/\partial s$) may indicate areas where transport capacity increases (i.e., erosional areas) and decreases (i.e, depositional areas). Following Lea and Legleiter (2016), mean stream power gradient is estimated as:

$$\frac{\partial \omega}{\partial s} = \frac{\omega_i - \omega_{i-1}}{l} \qquad \text{Eq. 8}$$

where ω_{i-1} is the mean stream power at the outlet of the next upstream stream segment on the largest flow path, ω_i is the mean stream power at the outlet of the segment of interest, and l is the length of the stream segment.

Stream power is estimated using bankfull discharges and widths derived from regional curves for steams, and slopes based on the DEM. Areas of deposition are identified as stream segments with a negative stream power gradient within segments downstream of the LOD with a 10 percent increase in sediment load.

2.6 Data Analysis

Using the RUSLE, sediment loads and yields are compared for both baseline and proposed action treatments. All parameters are developed within a GIS environment using a 32.8-foot (10-meter) resolution. Given that the NLCD has a coarser resolution, nearest neighbor resampling is used to align the database with other datasets.

Using these methods, sediment loss is investigated at several scales. First, active sediment detachment within intersecting catchments is investigated by estimating sediment yields for both baseline and proposed action conditions. These sediment yields are restricted to the amount that is expected to be transported into the respective stream reach. Yields are reported on a yearly rate. Second, expected sediment loads within streams are estimated for all stream reaches within the study area intersecting and downstream of the Project area within the JNF. Note that the RUSLE analysis is performed using the entire MVP line and not just the construction corridor within the JNF. Thus, impacts downstream represent cumulative impacts of construction, restoration, and operation. Because no sediment routing is performed within stream reaches, sediment delivery is assumed to be a function of drainage area (see Section 2.4).

Unfortunately, a nationally-accepted sedimentation standard or exceedance threshold is not available. Attempts to establish such a standard have been stymied by five ecological realities (Kemp et al. 2011): 1) the amount of sediment inputs to streams exhibits substantial natural variation, 2) sedimentation regimes may differ in portions of the same stream based on highly localized factors such as riparian land cover, 3) sediments from different geological sources may have different physical properties and biological effects, 4) even closely related aquatic taxa may respond in markedly different ways to similar levels of sediment, and 5) different life stages of a single species may respond in markedly different ways to similar levels of sediment. Without a nation-wide standard, different regulatory entities use a wide variety of metrics, such as turbidity and total suspended solids, to assess potential changes associated with sedimentation. Threshold values may vary widely among state and tribal agencies (USEPA 2003), and metrics such as turbidity are sensitive to a variety of chemical and biological factors (such as algae and tannins) and may not clearly represent conditions related specifically to sediment inputs. Despite these inconsistencies, one commonly used impact threshold is one in which the metric of impact is increased by 10 percent or more (USEPA 2003). This approach recognizes the biological reality that even a relatively small (in absolute terms) amount of sediment may degrade a pristine stream, while a larger amount might be needed to further degrade a historically impacted stream. Therefore, to identify the extent of sedimentation effects from the proposed action on JNF (i.e., Cumulative Effect boundaries), stream segments downstream with a 10 percent increase over baseline in maximum yearly load are delineated.

3.0 Results

One hundred and seven subwatersheds are within the hydrologic study area for the proposed action. These subwatersheds contain a cumulative drainage area of 3,943.5 square miles spanning over the continental divide with 3,676.8 square miles draining to the New River, 111.7 square miles draining to the James River, and 51.3 square miles draining to the Roanoke River. The majority of the study area is forested (64%), but developed and planted/cultivated land uses account for 7 and 27 percent, respectively, according to the 2011 NLCD. Approximately 12.1 percent (478 mi^2) of the study area is within the JNF.

The proposed action within the JNF is largely confined to three subwatersheds within the study area: Stony Creek, Clendennin Creek-Bluestone Lake, and Trout Creek-Craig Creek. In addition to these subwatersheds, the proposed action also crosses the Rich Creek (050500020601) and Dry Run-North Fork Roanoke River (030101010201) subwatersheds; however, the proposed action only comprises a small portion of each of these catchments. In total, the proposed action within the JNF intersects the unique catchments of 29 stream segments (Table 3): 8 within the Stony Creek Subwatershed, 13 within the Clendennin Creek-Blueston Lake Subwatershed, 6 within the Trout Creek-Craig Creek Subwatershed, 1 within the Rich Creek Subwatershed, and 1 within the Dry Run-North Fork Roanoke River watershed.

3.1 Baseline Erosion and Soil Loss

Baseline soil yields vary substantially over the study area. Expected soil yields (calculated at the study area outlet) are greatest within the Upper Roanoke portion of the study area (84.805 tons/mi^2 yr^{-1}) and lowest within the New River portion of the study area (15.128 tons/mi^2 yr^{-1}). Within catchments crossed by the proposed Project, baseline sediment yields range from 29.7 to 194.5 tons per square mile per year (Table 3). Given the large hydrologic study area, sediment loads in streams downstream of the Project area vary greatly. As expected, total sediment loads (i.e., loads accounting for all upstream catchment areas) are smallest with the headwater systems and

Table 3. Predicted yearly sediment yields for baseline and proposed action conditions for the Mountain Valley Pipeline Project in intersecting catchments within the Jefferson National Forest.

						Proposed Action									
						Year 1		Year 2		Year 3		Year 4		Year 5	
Reach Code*	Permanent ID*	Stream Name*	Area† (ac)	LOD‡ (ac)	Baseline Yield§	Yield§	Percent Inc.	Yield§	Percent Inc.	Yield§	Percent Inc.	Yield§	Percent Inc.	Yield§	Percent Inc.
02080201000529	40757923	Craig Creek	204.03	10.43	148.77	212.80	43.04	156.51	5.20	157.06	5.58	157.06	5.58	157.06	5.58
02080201000529	40757927	Craig Creek	107.79	2.52	52.53	66.67	26.92	54.70	4.14	54.84	4.40	54.84	4.40	54.84	4.40
02080201000529	40757943	Craig Creek	70.5	7.14	45.89	77.97	69.90	50.87	10.85	51.21	11.58	51.21	11.58	51.21	11.58
02080201008435	40757955	UNT to Craig Creek	149.35	5.56	121.97	165.84	35.97	129.38	6.08	129.79	6.41	129.79	6.41	129.79	6.41
02080201008436	40757961	UNT to Craig Creek	194.52	5.72	97.31	141.30	45.21	104.86	7.76	105.27	8.18	105.27	8.18	105.27	8.18
02080201008439	40757993	UNT to Craig Creek	71.81	2.47	194.52	236.98	21.83	200.22	2.93	200.63	3.14	200.63	3.14	200.63	3.14
03010101005175	4432363	UNT to Mill Creek	82.83	1.43	130.01	231.48	78.05	157.21	20.91	143.28	10.20	135.53	4.24	135.53	4.24
05050002000818	43656529	Rich Creek	249.77	5.99	71.88	142.76	98.62	93.33	29.85	80.10	11.43	75.99	5.72	75.99	5.72
05050002000843	43657617	Curve Branch	128.77	0.16	139.45	140.02	0.40	140.54	0.78	143.69	3.04	144.85	3.87	144.85	3.87
05050002000844	43657525	Curve Branch	144.58	2.76	93.16	110.72	18.85	126.87	36.19	225.16	141.71	261.38	180.58	261.38	180.58
05050002000845	43657527	UNT to Curve Branch	89.65	1.1	106.67	118.92	11.48	130.18	22.03	198.70	86.27	223.95	109.94	223.95	109.94
05050002000846	43657299	UNT to New River	165.31	1.63	97.89	106.03	8.31	113.51	15.95	159.03	62.46	175.81	79.59	175.81	79.59
05050002000869	43656979	Kimbalton Branch	256.07	2.03	98.63	107.46	8.95	111.24	12.79	145.17	47.20	157.68	59.88	157.68	59.88
05050002000869	43657067	Kimbalton Branch	43.81	1.58	118.28	225.17	90.38	212.72	79.85	421.95	256.75	497.41	320.55	497.41	320.55
05050002000869	43657573	Kimbalton Branch	344.61	13.13	97.18	153.75	58.22	119.72	23.19	134.77	38.69	139.00	43.04	139.00	43.04
05050002003140	43656977	UNT to Kimbalton Branch	223.83	15.72	30.99	109.93	254.77	57.55	85.73	58.84	89.88	59.02	90.46	59.02	90.46
05050002003160	43657065	UNT to Kimbalton Branch	72.3	4.08	78.10	122.95	57.43	119.11	52.51	216.35	177.01	251.28	221.73	251.28	221.73
05050002003188	43657219	UNT to Stony Creek	270.18	2.07	66.98	72.14	7.70	68.59	2.41	67.95	1.44	67.58	0.89	67.58	0.89
05050002003200	43657297	UNT to New River	63.18	0.67	119.45	126.28	5.72	132.55	10.97	170.76	42.96	184.84	54.74	184.84	54.74
05050002003226	43657457	UNT to Stony Creek	99.71	9.45	77.40	356.98	361.24	158.73	105.08	116.02	49.90	92.35	19.32	92.35	19.32
05050002003250	43657611	UNT to Curve Branch	153.58	1.9	141.11	152.32	7.95	162.64	15.26	225.41	59.74	248.54	76.13	248.54	76.13
05050002003266	43657667	Clendennin Creek	306.51	3.75	82.68	90.50	9.46	97.69	18.17	141.49	71.13	157.62	90.65	157.62	90.65
05050002003270	43657709	UNT to Clendennin Creek	110.73	0.55	102.08	107.69	5.50	112.85	10.56	144.28	41.35	155.86	52.69	155.86	52.69
05050002003292	43657801	UNT to Clendennin Creek	177.25	1.03	106.19	108.47	2.14	110.56	4.11	123.29	16.10	127.98	20.51	127.98	20.51
05050002003339	43658059	UNT to Clendennin Creek	522.78	3.19	95.98	97.78	1.88	99.10	3.26	108.07	12.60	111.36	16.02	111.36	16.02
05050002007484	43658057	Clendennin Creek	365.27	3.28	94.55	96.61	2.18	98.51	4.19	110.07	16.42	114.33	20.93	114.33	20.93
05050002007485	43657799	Clendennin Creek	79.05	1.45	113.79	125.88	10.63	137.00	20.40	204.67	79.88	229.61	101.79	229.61	101.79
05050002007486	43657713	Clendennin Creek	67.43	0.3	96.51	98.59	2.16	100.50	4.14	112.14	16.20	116.43	20.64	116.43	20.64
05050002009526	-	UNT to Stony Creek	206.11	2.29	29.70	33.89	14.11	31.95	7.58	34.96	17.72	36.04	21.33	36.04	21.33

* Derived from National Hydrography Dataset; UNT=Unnamed Tributary.
† Unique area draining to stream segment.
‡ Area of Limits of Disturbance (LOD) within the unique catchment
§.Sediment Yields are reported in ton/mi^2/yr and only represent sediment produced within the respective unique catchment.

increase with catchment area (Table 4). At the three most downstream points within the study area in the New River, Craig Creek, and North Fork Roanoke River, expected baseline sediment loads are 18,463.99; 4924.27; and 3,723 tons per year, respectively. Note that these estimates do not include any sediment produced upstream of a lake or reservoir (e.g., Claytor Lake).

3.2 Proposed Action Erosion and Soil Loss

All catchments that intersect the proposed route and the JNF are expected to have increased sediment yields due to the proposed action (Table 3), and nearly all catchments are predicted to have an increase in sediment yield of 10 percent or greater within the first year (Table 3). During the first year, the highest expected percent increase in sediment yield will likely occur within an Unnamed Tributary to Stony Creek where yields increase from 77.4 tons/mi^2 yr^{-1} to 361.24 ton/mi^2 yr^{-1}. Increases in excess of 75 percent are also expected in unnamed tributaries to Mill Creek and Kimbalton Branch as well as directly in Kimbalton Branch, Craig Creek, and Rich Creek (Table 3).

Although for most catchments, sediment yields decrease with each consecutive year after construction, yields for several smaller order streams (n=12) continue to be in excess of 50 percent over baseline after the landscape has transitioned into a steady equilibrium (i.e., year 5; Table 3). With the exception of one catchment, these higher equilibriums are in relation to a pre-existing approximate 6-mile Forest Road (Pocahontas Road; Figure 1) that was not represented in the baseline assessment (i.e., using the 2011 NLCD). This road was treated as a construction component of the Project; however, the road will only need to be upgraded in sections and extended to the Project LOD in order to be used for the proposed action. Similarly, Mystery Ridge Road (Forest Development Road 11080 [approximately 1 mile]) was also treated as a construction component of the Project; however, the road is already existing but not represented by the 2011 NLCD. The proposed actions of the Project for these two features include minor improvements, and any modifications will be returned to original or better condition upon completion of the pipeline facilities as coordinated with the JNF.

To better examine potential impacts on aquatic biota downstream of construction activities, sediment loads were also put into the context of actual stream segments with total sediment loads (Table 4). In this context, loads above baseline originate from catchments crossed by the proposed action and are expected to be transported to streams downstream of the Project area outside the catchment of origin. Based on this approach, substantial increases in sediment loads from the proposed action are largely confined to headwater systems (i.e., 1-3 order streams; Table 5). The majority of sediment load increases are less than 10 percent; however, there are several notable exceptions, including Rich Creek (Table 4) and a portion of Craig Creek (Table 5 and Figure 4).

Table 4. Total expected sediment loads in downstream streams and associated percent increase in sediment loads expected from Mountain Valley Pipeline Project in the Jefferson National Forest.

				Proposed Action									
				Year 1		Year 2		Year 3		Year 4		Year 5	
Waterbody	Location	Drainage Area (mi^2)	Baseline Load*	Load Above Baseline*	Percent Inc.	Load Above Baseline	Percent Inc.	Load Above Baseline*	Percent Inc.	Load Above Baseline*	Percent Inc.	Load Above Baseline*	Percent Inc.
Craig Creek	Above Confluence with Muddy Branch	22.98	1152.87	30.54	2.65	4.34	0.38	4.62	0.40	4.62	0.40	4.62	0.40
	Above Confluence with Cabin Branch	30.42	1476.76	28.43	1.92	4.04	0.27	4.30	0.29	4.30	0.29	4.30	0.29
	Above Confluence with Trout Creek	44.44	1982.38	25.69	1.30	3.65	0.18	3.89	0.20	3.89	0.20	3.89	0.20
	Above Confluence with McAfee Run	58.20	2538.54	23.82	0.94	3.39	0.13	3.61	0.14	3.61	0.14	3.61	0.14
	Above Confluence with Broad Run	77.01	3083.91	21.95	0.71	3.12	0.10	3.32	0.11	3.32	0.11	3.32	0.11
	Above Confluence with Meadow Creek	97.39	3877.11	20.44	0.53	2.90	0.07	3.09	0.08	3.09	0.08	3.09	0.08
	Above Confluence with Johns Creek	109.78	4924.27	19.69	0.40	2.80	0.06	2.98	0.06	2.98	0.06	2.98	0.06
	Above Confluence with Barbours Creek	230.24	6694.06	15.29	0.23	2.17	0.03	2.31	0.03	2.31	0.03	2.31	0.03
Mill Creek	Above Confluence with North Fork Roanoke River	4.22	504.44	132.59	26.28	51.72	10.25	24.71	4.90	7.90	1.57	7.35	1.46
North Fork Roanoke River	Above Confluence with Indian Run	35.22	3362.58	207.24	6.16	104.21	3.10	38.93	1.16	2.26	0.07	0.53	0.02
	Above Confluence with Slate Lick Run	45.43	3625.28	194.26	5.36	97.68	2.69	36.49	1.01	2.12	0.06	0.50	0.01
	Above Confluence with Wilson Creek	48.77	3723.41	190.11	5.11	95.60	2.57	35.72	0.96	2.07	0.06	0.49	0.01
Stony Creek	Above Confluence with Laurel Branch	36.79	1057.46	0.53	0.05	0.28	0.03	0.66	0.06	0.80	0.08	0.80	0.08
	Above Confluence with Kimbalton Creek	43.53	1345.55	23.15	1.72	6.39	0.48	3.54	0.26	1.66	0.12	1.66	0.12
	Above Confluence with New River	48.36	1729.24	115.93	6.70	27.99	1.62	27.00	1.56	20.57	1.19	20.57	1.19
Kimbalton Creek	Above Confluence with Stony Creek	1.72	127.62	80.59	63.15	36.85	28.88	75.52	59.18	87.79	68.79	87.79	68.79
Curve Branch	Above Confluence with New River	1.20	120.69	6.14	5.09	11.79	9.77	46.18	38.27	58.85	48.76	58.85	48.76
Clendennin Creek	Above Confluence with New River	3.64	220.91	6.84	3.10	12.93	5.85	50.55	22.88	64.40	29.15	64.40	29.15
Rich Creek	Above Confluence with Mud Run	11.73	505.13	90.36	17.89	32.39	6.41	9.16	1.81	5.37	1.06	5.37	1.06
	Above Confluence with Crooked Creek	15.86	762.53	84.00	11.02	30.11	3.95	8.52	1.12	4.99	0.65	4.99	0.65
	Above Confluence with Scott Branch	25.75	1250.23	74.75	5.98	26.79	2.14	7.57	0.61	4.44	0.35	4.44	0.35
	Above Confluence with Brush Creek	33.04	1410.25	70.13	4.97	25.13	1.78	7.11	0.50	4.16	0.30	4.16	0.30
	Above Confluence with New River	52.18	2114.01	62.60	2.96	22.43	1.06	6.34	0.30	3.71	0.18	3.71	0.18
New River	Above Confluence with Curve Branch	3421.74	17525.65	164.98	0.94	68.53	0.39	29.10	0.17	21.13	0.12	20.72	0.12
	Above Confluence with Clendennin Creek	3427.18	17544.92	165.32	0.94	69.99	0.40	35.58	0.20	29.43	0.17	29.02	0.17
	Above Confluence with Wolf Creek	3440.88	17526.38	165.15	0.94	71.69	0.41	44.21	0.25	40.57	0.23	40.16	0.23
	Above Confluence with Rich Creek	3682.54	17974.92	148.59	0.83	64.39	0.36	39.72	0.22	36.38	0.20	36.01	0.20
	Above Confluence with East River	3815.57	18463.99	155.52	0.84	66.12	0.36	38.74	0.21	34.90	0.19	34.57	0.19

* Sediment loads are presented in tons yr^{-1}

Table 5. Stream lengths in miles for stream with an expected increase in sediment load of 10 percent or greater from the proposed Mountain Valley Pipeline within the vicinity of the Jefferson National Forest.

Waterbody	Subwatershed	Stream Miles Impacted
Unnamed Tributaries to Craig Creek	Trout Creek-Craig Creek	1.92
Craig Creek	Trout Creek-Craig Creek	0.29
Unnamed Tributary to Mill Creek	Dry Run-North Fork Roanoke River	1.57
Mill Creek	Dry Run-North Fork Roanoke River	3.22
Unnamed Tributaries to Stony Creek	Stony Creek	1.16
Unnamed Tributaries to Kimbalton Branch	Stony Creek	1.16
Kimbalton Branch	Stony Creek	2.56
Unnamed Tributaries to Clendennin Creek	Clendennin Creek-Bluestone Lake	1.79
Clendennin Creek	Clendennin Creek-Bluestone Lake	3.82
Unnamed Tributaries to Curve Branch	Clendennin Creek-Bluestone Lake	1.05
Curve Branch	Clendennin Creek-Bluestone Lake	2.37
Unnamed Tributaries to New River	Clendennin Creek-Bluestone Lake	3.14
Rich Creek	Rich Creek	4.26

To further investigate the spatial extent of increased sediment loads (i.e., Cumulative Effects boundaries), maximum yearly loads (i.e., maximum load of any consecutive 52-week period) were delineated (Table 5 and Figure 4). Using the approach, the Clendenin Creek-Bluestone Lake Subwatershed is expected to have the largest spatial extent (12.17 miles) of sediment load increases over 10 percent. Within the Dry Run-North Fork Roanoke River, Rich Creek, and Stony Creek subwatershed, the cumulative impact area is under 5 miles and, with the exception of Rich Creek and Kimbalton Branch, is restricted to unnamed tributaries. The smallest cumulative impact area is within the Trout Creek-Craig Creek Subwatershed, where sediment load increases in excess of 10 percent are restricted to approximately 2.21 stream miles; however, this includes a 0.29-mile stretch of the Craig Creek mainstem (Figure 4).

Cumulatively, approximately 29.31 miles of stream segments downstream of the Project Area within the JNF and within the study area are expected to have a 10 percent increase in sediment loads or more (Table 5). However, a large portion (nearly 13 miles) of stream impacts can be attributed to the pre-existing Pocahontas Road. As mentioned above, this road was not represented within the baseline treatment (likely due to a combination of cell resolution or forest canopy), and thus loads above baseline are likely overestimated.

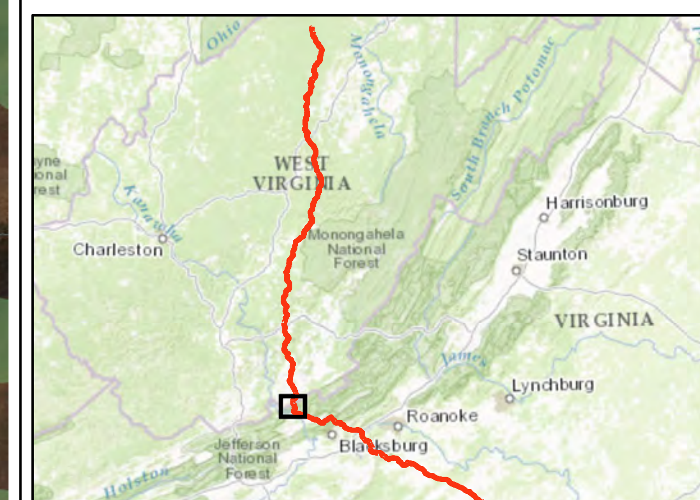
3.3 Potential Areas of Sediment Deposition

Using the mean stream power gradient ($\partial\omega/\partial s$) as an indicator of potential sediment deposition, several stream segments were identified within the Cumulative Impact boundaries as potential areas for sediment deposition (Table 6). The majority of these stream segments are within Craig, Mill, Rich, and Clendennin creeks and are third order or larger.

Figure 4. Cumulative Effects boundaries for sedimentation increases from the proposed Mountain Valley Pipeline within the vicinity of the Jefferson National Forest in Virginia and West Virginia.

Map 1 of 2

- Stream
- Cumulative Effect Boundaries
- October 2016 Proposed Route (Revised)
- Jefferson National Forest Boundary



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Base Map: ESRI ArcGIS Web service - "World Imagery" accessed - 2/14/2017

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Project No. 593.02

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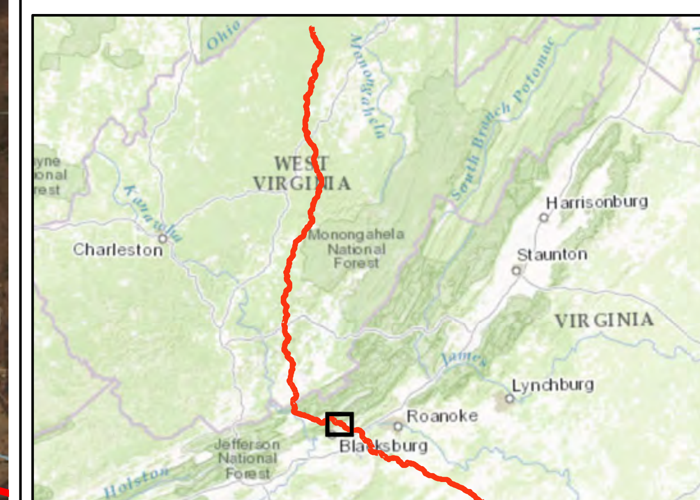
Figure 4. Cumulative Effects boundaries for sedimentation increases from the proposed Mountain Valley Pipeline within the vicinity of the Jefferson National Forest in Virginia and West Virginia.

Map 2 of 2

- Stream
- Cumulative Effect Boundaries
- October 2016 Proposed Route (Revised)
- Jefferson National Forest Boundary



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Base Map: ESRI ArcGIS Web service - "World Imagery" accessed - 2/14/2017

ENVIRONMENTAL SOLUTIONS & INNOVATIONS, INC.

Project No. 593.02

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Table 6. Expected sediment depositional areas in downstream waterbodies of the Mountain Valley Pipeline within the vicinity of the Jefferson National Forest with an expected sediment load of 10 percent or greater over baseline.

Reach Code*	Permanent ID*	Stream Name	Subwatershed	Stream Length (yards)
02080201000529	40757911	Craig Creek	Trout Creek-Craig Creek	33.18
02080201000529	40757923	Craig Creek	Trout Creek-Craig Creek	482.71
03010101000892	44325129	Mill Creek	Dry Run-North Fork Roanoke River	1526.56
03010101000893	44323513	Mill Creek	Dry Run-North Fork Roanoke River	896.60
05050002000374	43656237	Rich Creek	Rich Creek	2098.21
05050002000375	43655711	Rich Creek	Rich Creek	212.36
05050002000375	43655739	Rich Creek	Rich Creek	80.27
05050002000375	43655755	Rich Creek	Rich Creek	94.93
05050002000376	43655679	Rich Creek	Rich Creek	524.14
05050002000378	43655365	Rich Creek	Rich Creek	88.58
05050002000378	43655367	Rich Creek	Rich Creek	43.80
05050002000378	43655427	Rich Creek	Rich Creek	41.45
05050002000378	43655431	Rich Creek	Rich Creek	670.77
05050002000378	43655437	Rich Creek	Rich Creek	160.34
05050002000378	43655443	Rich Creek	Rich Creek	54.10
05050002000378	43655459	Rich Creek	Rich Creek	129.16
05050002000378	43655483	Rich Creek	Rich Creek	186.85
05050002000843	43657931	Curve Branch	Clendennin Creek-Bluestone Lake	1815.56
05050002003339	43658059	Unnamed Tributary to Clendennin Creek	Clendennin Creek-Bluestone Lake	1005.68
05050002007482	43658655	Clendennin Creek	Clendennin Creek-Bluestone Lake	635.87
05050002007483	43658523	Clendennin Creek	Clendennin Creek-Bluestone Lake	1848.34
05050002007484	43658057	Clendennin Creek	Clendennin Creek-Bluestone Lake	1680.84

4.0 Conclusions

The proposed MVP route traverses the JNF by crossing five separate subwatersheds belonging to the New River, James River, and Roanoke River drainages. Results from the hydrologic analysis of sedimentation show that catchments within these subwatersheds are expected to experience increases in sediment yield over baseline conditions during construction, restoration, and operation with the highest expected increases occurring during the construction timeframe for most waterbodies. Sediment loss from the proposed action will likely be transported into downstream waterbodies; however, predicted total sediment loads demonstrate that these impacts will largely be confined to tributary systems and not larger order rivers (e.g., New River, North Fork Roanoke River). Notable exceptions include Rich Creek where sediment impacts are expected to extend for greater than four miles downstream of the Project LOD.

For most waterbodies studied in this analysis, expected impacts to streams are greatest during the active construction phase of the Project. This pattern was also reflected in monitoring data for the Jewell Ridge Lateral natural gas pipeline in southwest Virginia (Moyer and Hyer 2009). As part of the Biological Opinion for the pipeline, East Tennessee Natural Gas was required to develop a real-time sediment input within the Indian Creek watershed of the Clinch River system. Over the 24-month monitoring period, significant increases in turbidity were observed during the construction phase; however, the magnitude of the increase was relatively small (less than 2 Formazin Nephelometric Units) and much less than the threshold (i.e., 15% increase) that was determined to be acceptable. Furthermore, patterns indicated that upland runoff was the primary source of the increased turbidity, but the increase did not adversely alter the long-term water-quality conditions of the creek (Moyer and Hyer 2009).

Based on this analysis, it is expected that sediment loads and yields will reach a new sediment equilibrium approximately four to five years from the start of the Project. For the majority of streams, this new sediment equilibrium represents a one percent or less increase in sediment load over baseline conditions; however, within both the Roanoke and New River drainages, new sediment equilibriums in excess of two percent over baseline are expected. For several streams within the New River drainage, sediment loads in excess of 10 percent over baseline are expected to represent a new sediment equilibrium. Most of these streams are in relation to the use of a pre-existing Forest road (Pocahontas Road) which was not represented within the baseline treatment for this analysis. Therefore, it is expected that these percentages over baseline are overestimated because the baseline treatment is underestimated. Only minor improvements and modifications are proposed for the majority of this feature, and any modifications will be returned to original or better condition upon completion of the pipeline facilities as coordinated with the JNF.

It is important to note that this analysis assumes strict adherence to the FERC 2013 Upland Erosion Control, Revegetation, and Maintenance Plan and the Project Erosion and Sediment Control Plan during construction. Sedimentation is greatly influenced by the amount of bare soil exposed to erosive forces and the distance and method of transport of the eroded soil to the stream system. Adherence to these plans, as well as site-specific erosion and sedimentation control plans, will reduce sedimentation into waterbodies. In general, temporary erosion controls (e.g., silt fences) will be installed prior to disturbance to the soil and will be maintained throughout construction and restoration phases of the Project until permanent erosion controls are installed, restoration is complete, and planted grasses and vegetation have matured enough to inhibit erosion. Environmental Inspectors will be present at each construction spread and will aid in determining if erosion controls are properly installed, maintained, or if additional measures are necessary.

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