BIOLOGICAL ASSESSMENT FOR
MOUNTAIN VALLEY PIPELINE, LLC
MOUNTAIN VALLEY PIPELINE PROJECT
FERC DOCKET NO. CP16-10-000

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Acronyms

AR	supporting access road
ATWS	additional temporary workspaces
BA	Biological Assessment
BLM	U.S. Bureau of Land Management
BMP	best management practices
BO	biological opinion
Certificate	Certificate of Public Convenience and Necessity
CFR	Code of Federal Regulations
COE	U.S. Army Corps of Engineers
Commission	Federal Energy Regulatory Commission
dB	decibel
dBA	decibels on the A-weighted decibel scale
dbh	diameter at breast height
DOT	Department of Transportation
Dth/day	dekatherms per day
E&S	erosion and sediment
E&SC	Erosion and Sediment Control
EIR	Environmental Information Request
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
FERC	Federal Energy Regulatory Commission
Plan	*FERC's Upland Erosion Control, Revegetation, and Maintenance Plan*
Procedures	*Mountain Valley's Wetland and Waterbody Construction and Mitigation Procedures*
FRA	Forest Resource Assessment
FS	U.S. Forest Service
FWS	U.S. Fish and Wildlife Service
HDD	Horizontal directional drilling
hp	horsepower
kHz	kilohertz
km	kilometer
LED	Light emitting diodes
M&R	Meter and regulation
MGD	million gallons per day
MLV	mainline valve

MMcf/d	million cubic feet per day
MOU	Memorandum of Understanding
Mountain Valley	Mountain Valley Pipeline, LLC
MVP	Mountain Valley Project
NEPA	National Environmental Policy Act
NHD	National Hydrography Dataset
NLCD	National Land Cover Database
NSA	noise sensitive area
OEP	Office of Energy Projects
PHMSA	Pipeline and Hazardous Materials Safety Administration
RUSLE	Revised Universal Soil Loss Equation
SPCC	Spill Prevention, Control, and Countermeasure
Transco	Transcontinental Gas Pipe Line Company, LLC
USGS	U.S. Geological Survey
VADCR	Virginia Department of Conservation and Recreation
VADCR-DNH	Virginia Department of Conservation and Recreation Division of Natural Heritage
VADEQ	Virginia Department of Environmental Quality
VADGIF	Virginia Department of Game and Inland Fisheries
VSS	Virginia Speleological Society
WNS	white nose syndrome
WVDEP	West Virginia Department of Environmental Protection
WVDNR	West Virginia Division of Natural Resources
WVMSP	West Virginia Mussel Survey Protocol
YOY	young-of-the-year

1.0 EXECUTIVE SUMMARY

The purpose of this Biological Assessment (BA) is to evaluate the effects of the proposed Mountain Valley Project (MVP; Project) on species listed as threatened or endangered under the Endangered Species Act (ESA). The MVP is a proposed 303.5-mile, 42-inch-diameter natural gas pipeline that would cross 17 counties in Virginia and West Virginia. In order for construction to begin, the Project would require a Certificate of Public Convenience and Necessity from the Federal Energy Regulatory Commission (FERC) pursuant to Section 7(c) of the Natural Gas Act, a right-of-way authorization from the Bureau of Land Management under the Mineral Leasing Act, and a right-of-way authorization from the National Park Service. These federal authorizations trigger the consultation requirements of Section 7 of the ESA. Other federal permitting requirements include the Clean Water Act, Clean Air Act, National Historic Preservation Act and various requirements associated with the crossing of U.S. Forest Service (FS) lands. Once the necessary permitting requirements are fulfilled (if they are fulfilled), the start of construction also would be subject to the FERC's separate issuance of a notice to proceed directive.

This BA is being submitted to the U.S. Fish and Wildlife Service (FWS) in compliance with requirements of ESA Section 7. It evaluates the effects of the Project on 15 species listed as threatened or endangered, including four mammals, one fish, three mussels, one insect, and six plants. Specifically, the BA evaluates effects on the Indiana bat (*Myotis sodalis*), northern long-eared bat (*Myotis septentrionalis*), gray bat (*Myotis grisescens*), Virginia big-eared bat (*Corynorhinus townsendii*), Roanoke logperch (*Percina rex*), James spinymussel (*Pleurobema collina*), clubshell (*Pleurobema clava*), snuffbox (*Epioblasma triquetra*), rusty patched bumble bee (*Bombus affinis*), northeastern bulrush (*Scirpus ancistrochaetus*), running buffalo clover (*Trifolium stoloniferum*), shale barren rock cress (*Arabis serotina*), small whorled pogonia (*Isotria medeoloides*), smooth coneflower (*Echinaceae laevigata*), and Virginia spiraea (*Spiraea virginiana*).

In addition to the species mentioned above, we determined that the Project would have no effect on the endangered Mitchell satyr butterfly (*Neonympha mitchellii*) because the FWS no longer considers this species present in the counties crossed by the MVP; therefore, this species is not discussed in this BA. Additionally, the southern population of the bog turtle (*Glyptemys muhlenbergii*), which is listed as threatened due to similarity of appearance to the federally threatened northern population, also is not discussed in this BA. The FWS states that species listed due to similarity of appearance with another listed species are not biologically endangered or threatened and are not subject to Section 7 consultation. Finally, the FWS recently proposed to list the yellow lance (*Elliptio lanceolata*) as a federally threatened species. We, in coordination with Mountain Valley as our non-federal representative, would address this species through future 7(a)(4) conferencing (if applicable) rather than Section 7 consultation; therefore, this species also is not discussed in this BA.

The MVP would 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. The Project is proposed to provide access to natural gas to local distribution companies, industrial users, and power generators in the Mid-Atlantic and southeastern markets, as well as potential markets in the Appalachian region. This BA includes information regarding the construction, operation, and maintenance of the Project.

Impacts on Federally Listed Bat Species. The Project would be located within the range of the federally endangered Indiana, gray, and Virginia big-eared bats and federally threatened northern long-eared bat. Mountain Valley conducted mist-net, winter hibernacula, and detailed summer habitat assessment surveys for these species.

Indiana bats were not captured during mist-net surveys, but we are assuming that the species occupies potentially suitable summer habitat and winter hibernacula in the Action Area. Based on the results from the effects analysis, we expect that Indiana bat individuals would be harassed and harmed during construction and operation of the Project. Thus, the Project ***is Likely to Adversely Affect*** the Indiana bat.

Results of summer mist-net and harp trap surveys confirmed presence of northern long-eared bats within the Project Area (defined as the Project's construction right-of-way). Mountain Valley would avoid take of adults and non-volant young by suspending tree clearing activities during June 1 through July 31. However, individuals present during hibernation, spring staging, and autumn swarming may be harmed or harassed during Project construction. Results from the effects analysis demonstrate the potential to harass and harm northern long-eared bats during Project construction or operation. Thus, the Project ***is Likely to Adversely Affect*** the northern long-eared bat. Some of this take is exempt under the 4(d) rule for the species; some would require Project-specific authorization.

While the Project would occur within the ranges of the Virginia big-eared and gray bats, suitable, occupied cave habitat does not exist within the Action Area for either species and neither species was detected during summer or autumn field surveys. Thus, the Project ***is Not Likely to Adversely Affect*** the Virginia big-eared bat and gray bat.

Impacts on the Roanoke Logperch. The Project would traverse a large portion of the Roanoke River basin within the geographic distribution of the federally endangered Roanoke logperch. Within the basin, the Project would cross a total of 38 perennial streams with potential to support populations of Roanoke logperch. Of these, the FWS requested assumed presence of Roanoke logperch at the Project crossings of the North Fork Roanoke, Roanoke, and Pigg Rivers (five crossings total), as the streams are known to currently support populations of this species. Of the remaining 33 stream crossings, Mountain Valley determined, based on desktop assessments, agency correspondence, and in-situ habitat assessments, that nine crossings have the potential to host Roanoke logperch populations. Although Mountain Valley would adhere to time-of-year-restrictions for instream construction activities within suitable habitat for the species, harm and harassment of Roanoke logperch individuals are still likely to occur. Thus, the Project ***is Likely to Adversely Affect*** Roanoke logperch.

Impacts on Listed Mussel Species. The Project would also cross perennial streams potentially supporting populations of federally protected freshwater mussels. In West Virginia, the Project traverses Leading Creek, Little Kanawha River, and Elk River that could potentially support federally endangered clubshell and snuffbox mussels. In Virginia, the Project crosses Craig Creek, which supports known populations of the federally endangered James spinymussel.

Neither clubshell nor snuffbox were present during mussel survey efforts at the proposed crossing locations for the Elk River and Little Kanawha River. Mussel survey efforts were not warranted at Leading Creek because the crossing location has an upstream drainage area of a size that is unlikely to support freshwater mussels. The nearest known populations of clubshell and snuffbox in Elk River, Little Kanawha River, and Leading Creek in West Virginia occur outside of the Action Area. Therefore, the Project ***is Not Likely to Adversely Affect*** clubshell or snuffbox mussels.

James spinymussel were not present during mussel survey efforts for the proposed crossings of Craig Creek. [redacted] Based on the location of known and presumed populations of this species relative to the crossings at Craig Creek, the lack of mussels or suitable habitat within the Action Area, and MVP's commitment to not cross Craig Creek from May 15 to July 31, no individuals are expected to be directly or indirectly harmed or harassed and no James spinymussel designated critical habitat would be affected by the Project. Thus, the Project ***is Not Likely to Adversely Affect*** James spinymussel.

Impacts on the Rusty Patched Bumble Bee. The Project Area is also within the historic range of the rusty patched bumble bee, a species listed as federally endangered as of March 21, 2017. The Project traverses several habitat types and physiographic provinces that serve as habitat for the rusty patched bumble bee. Mountain Valley is committed to implementing voluntary conservation measures due to potential impacts on the habitat for this species.

Estimates of the potential number of colonies that the Project could affect are difficult to ascertain as the species has not been found within the Project boundaries for several decades, and many experts believe it is extirpated from most areas east of Indiana. Critical habitat has not been designated for the species, and the nearest known populations of rusty patched bumble bee occur outside of the Action Area. Therefore, the Project ***is Not Likely to Adversely Affect*** the rusty patched bumble bee.

Impacts on Listed Plant Species. The Project Area would also be located within the distribution range of six federally listed plant species. These include plants adapted to wetlands and streams (northeastern bulrush and Virginia spiraea), open forests (small whorled pogonia), upland open habitats (running buffalo clover and smooth coneflower), and shale barrens (shale barren rock cress). No critical habitat has been designated for these species.

Mountain Valley did not detect any individuals of federally endangered or threatened plants during surveys; however, Mountain Valley did find potential habitat in the Project Area for running buffalo clover, small whorled pogonia, smooth coneflower, and Virginia spiraea. The nearest population of smooth coneflower occurs outside of the Project Area therefore the Project ***is Not Likely to Adversely Affect*** smooth coneflower.

Small portions of the Project remain unsurveyed due to landowners denying Mountain Valley survey access. The extents of unsurveyed land include 0.14 mile/1.8 acres for running buffalo clover, 0.12 mile/29.5 acres for small whorled pogonia, 0.12 miles/29.5 acres for shale barren rock cress, and 0.09 mile/4.28 acres for Virginia spiraea. We are assuming presence of these species on the unsurveyed land and therefore conclude the Project ***is Likely to Adversely Affect*** these four species. Mountain Valley did not find potential habitat for northeastern bulrush throughout the Project Area; therefore, the Project would have ***No Effect*** on northeastern bulrush.

2.0 INTRODUCTION

The purpose of this Biological Assessment (BA) is to evaluate the effects of construction and operation of the proposed Mountain Valley Project (MVP or Project) on federally listed species protected under the Endangered Species Act (ESA). Mountain Valley Pipeline, LLC (Mountain Valley) is a joint venture between EQT Midstream Partners, LP, NextEra Energy, Inc., WGL Holdings, Inc., Con Edison Gas Midstream, LLC, and RGC Midstream, LLC. Mountain Valley is seeking a Certificate of Public Convenience and Necessity (Certificate) from the Federal Energy Regulatory Commission (FERC or Commission) authorizing the proposed MVP with facilities located in the State of West Virginia and the Commonwealth of Virginia.

The FERC is the lead federal agency responsible for implementation of the National Environmental Policy Act (NEPA) review. We prepared the final Environmental Impact Statement (EIS) for the MVP in cooperation with the U.S. Forest Service (FS); U.S. Environmental Protection Agency (EPA); the U.S. Army Corps of Engineers (COE); U.S. Bureau of Land Management (BLM); the U.S. Fish and Wildlife Service (FWS), West Virginia Field Office; Pipeline and Hazardous Materials Safety Administration (PHMSA); West Virginia Department of Environmental Protection (WVDEP); and the West Virginia Division of Natural Resources (WVDNR). The notice of availability of the final EIS was published on June 23, 2017[1]. The final EIS includes a general summary of this BA and presents our findings of effects for each federally listed species that may be affected by the Project.

Federal agencies are required by the ESA Section 7(a)(2) to ensure that any action authorized, funded, or carried out by the agency would not jeopardize the continued existence of a federally listed threatened or endangered species or species proposed for listing, or result in the destruction or adverse modification of designated critical habitat. As the lead federal agency responsible for consultation with FWS under Section 7 of the ESA, the FERC is responsible for determining whether any federally listed endangered or threatened species, or any of their designated critical habitats, are near the proposed action and to determine the proposed action's potential effects on those species or critical habitats.

If we authorize the Project, Mountain Valley would be required to complete all necessary remaining species surveys and file the survey reports with the FERC and FWS, followed by the completion of Section 7 ESA consultation between the FERC and the FWS, before construction would be allowed to begin. If it is determined that the action would adversely affect a federally listed species, the FERC must submit a request for formal consultation to comply with Section 7 of the ESA. In response, the FWS would issue a biological opinion (BO) as to whether or not the federal action would likely jeopardize the continued existence of a listed species, or result in the destruction or adverse modification of designated critical habitat. Only after a determination is made that the Project would not jeopardize the continued existence of a federally listed threatened or endangered species and would not adversely modify designated critical habitat in consideration of all efforts to avoid, minimize, and mitigate potential impacts, would the other federal or

1 See accession number 20170623-4000.

federally-delegated agencies be able to proceed with issuance of a permit or other authorization to allow the Project to proceed.

Due to the presence of federally listed species within the MVP area, Mountain Valley, as our non-federal representative, engaged in coordination and informal consultations with federal and state regulatory authorities during the development and assessment of proposed alternative routes and sites for the MVP. Mountain Valley also participated in the development of other impact avoidance, minimization, and mitigation measures as well as study plans. Consultation with FWS is required if an action is "likely to adversely affect" listed species or their designated critical habitat. For proposed species, further consultation is required if the action is "likely to jeopardize the continued existence" of the species or result in "destruction or adverse modification" of critical habitat.

Other federal or federally-delegated agencies issuing permits for the Project (as part of this consultation) include the EPA and the COE, through jurisdiction under Section 404 of the Clean Water Act (33 U.S.C. 1344), and the WVDEP and the Virginia Department of Environmental Quality (VADEQ), through jurisdiction under the Section 401 of the Clean Water Act (33 U.S.C. 1341)[2]. These permits would only be issued after ESA consultation is complete. Other federal permitting requirements include the Clean Water Act, Clean Air Act, National Historic Preservation Act and various requirements associated with the crossing of FS lands. Once the necessary permitting requirements are fulfilled (if they are fulfilled), the start of construction also would be subject to the FERC's separate issuance of a notice to proceed directive.

2.1 ESA SPECIES OF CONCERN

On June 23, 2016, we issued our final EIS for the MVP describing species protected under the ESA as occurring or potentially occurring in the Project Area. We determined that the Project would have no effect on the endangered Mitchell satyr butterfly (*Neonympha mitchellii*) because the FWS no longer considers this species present in the counties crossed by the MVP and notified Mountain Valley that surveys for this species would not be necessary; therefore, this species is not discussed further. Additionally, the southern population of the bog turtle (*Glyptemys muhlenbergii*), which is listed as threatened due to similarity of appearance to the federally threatened northern population (ranging from western Pennsylvania northward) is potentially found within the MVP area, but field studies have not indicated the presence of individuals or suitable habitat to date. The FWS states that species listed due to similarity of appearance with another listed species are not biologically endangered or threatened and are not subject to Section 7 consultation (FWS, 2016a). The bog turtle is not discussed further in this BA. Finally, on April 5, 2015, the FWS proposed to list the yellow lance (*Elliptio lanceolata*) as a federally threatened species, but a final determination has not yet been made. Federal agencies are required by the ESA Section 7(a)(4) to engage in a conference with the FWS if a proposed action is likely to jeopardize the continued existence of a species proposed for federal listing as a threatened or endangered species or adversely modify its critical habitat. The intent of conferencing is to provide a mechanism for identifying and resolving potential conflicts between a proposed action and

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[2] WVDEP-DWWM issued a Conditional WQC for MVP on March 23, 2017 depending upon the terms of the FERC Certificate which, as part of the Special Conditions of the Conditional WQC, MVP is to supply to WVDEP-DWWM no later than 10 days after the issuance of the FERC Certificate.

proposed species or proposed critical habitat at an early planning stage (FWS and NMFS, 1998). The FWS Species Status Assessment Report for the Yellow Lance (FWS, 2017a) notes the only occurrence of the yellow lance in the vicinity of the MVP area is the James River population, which consists of one management unit of the species that occurs only in very specific locations within Johns Creek. The MVP does not cross Johns Creek nor tributaries to Johns Creek. Mountain Valley's Biological Evaluation for the Jefferson National Forest states that the Virginia Department of Game and Inland Fisheries (VADGIF) Wildlife Environmental Review Mapping Service lists the yellow lance as occurring within Craig Creek about 36 miles downstream of where the MVP would cross Craig Creek. Even if the species is present at the location indicated by the VADGIF, we conclude that the MVP would not be likely to jeopardize the continued existence of the yellow lance based on the combination of Mountain Valley's commitment to implementing its Procedures, which would control sedimentation as described in the final EIS, and the distance downstream of the potential occurrence. Therefore, we further conclude that a conference with the FWS would not be necessary. If the FWS disagrees with this conclusion, we would address the species through section 7(4)(a) conferencing at a future date. The yellow lance is not discussed further in this BA. Based on Mountain Valley's field studies and filings, our own research and analysis, and correspondence and coordination with the FWS as described further below, this BA will evaluate the effects of construction and operation of the MVP on the following species:

- Indiana bat (*Myotis sodalis)* – federally endangered;
- Northern long-eared bat (*Myotis septentrionalis)* – federally threatened;
- Gray bat (*Myotis grisescens*) – federally endangered;
- Virginia big-eared bat (*Corynorhinus townsendii virginianus*) – federally endangered;
- Roanoke logperch (*Percina rex)* – federally endangered;
- James spinymussel (*Pleurobema collina)* – federally endangered;
- Clubshell (*Pleurobema clava)* – federally endangered;
- Snuffbox (*Epioblasma triquetra)* – federally endangered;
- Rusty patched bumble bee (*Bombus affinis*) – federally endangered;
- Northeastern bulrush (*Scirpus ancistrochaetus)* – federally endangered;
- Running buffalo clover (*Trifolium stoloniferum)* – federally endangered;
- Shale barren rock cress (*Arabis serotine)* – federally endangered;
- Small whorled pogonia (*Isotria medeoloides)* – federally endangered;
- Smooth coneflower (*Echinacea laevigata)* – federally endangered; and
- Virginia spiraea (*Spiraea virginiana)* – federally endangered.

The BA does not evaluate the effects of the MVP on species discussed in section 4.7 of the final EIS with designations other than endangered or threatened. These include species classified as potential candidate species, such as the candy darter (*Etheostoma osburni*) and orangefin madtom (*Noturus gilberti*), and species of concern, such as the Atlantic pigtoe (*Fusconaia masoni*), yellow lampmussel (*Lampsilis cariosa*), and the Ellett Valley millipede (*Pseudotremia cavernarum*). Nor does the BA discuss state special status species. Although Mountain Valley conducted surveys for state special status species as requested by VADGIF and Virginia Department of Conservation and Recreation's Division Natural Heritage (VADCR-DNH), and continued coordination with the state agencies regarding results of the surveys and associated summary reports, this BA focuses only on federal special status species.

2.2 CONSULTATION HISTORY

Due to the presence of federal-listed species within the MVP area, Mountain Valley, as our non-federal representative, engaged in coordination and informal consultations with federal and state regulatory authorities during the development and assessment of proposed alternative routes and sites for the MVP. A record of Mountain Valley's correspondence and coordination with the FWS and other agencies is included as appendix A[3]. Formal consultation is required if an action is "likely to adversely affect" listed species or their designated critical habitat. For proposed species, further consultation is required if the action is "likely to jeopardize the continued existence" of the species or result in "destruction or adverse modification" of critical habitat.

On October 13, 2014, Mountain Valley provided an introduction and description of the MVP to the Elkins, West Virginia and Gloucester, Virginia Field Offices of the FWS, the WVDNR, and VADGIF. Mountain Valley followed its initial outreach to the FWS with letters on October 30, 2014, and March 6, 2015, requesting FWS input regarding the proposed facilities associated with the MVP in West Virginia and Virginia and the potential presence of species of concern and their habitats listed under Section 7 of the ESA. Mountain Valley participated in a meeting/conference call with FWS staff from both FWS offices on November 11, 2014 to discuss the Project and federally listed species. Additionally, on March 4 and 6, 2015, Mountain Valley requested natural heritage data from the VADCR-DNH and WVDNR, respectively, to gather additional information from other sources and determine whether additional special status species not reported by the FWS might be present within the MVP area. Mountain Valley received return correspondence from the FWS Gloucester and Elkins Field Offices on April 3 and 23, 2015, respectively, identifying the potential impacts of the MVP on federally listed species. Mountain Valley coordinated with the FWS offices regarding field study plans for federally listed species through multiple electronic mail and telephone contacts beginning in 2014 and continuing through 2016. Mountain Valley received return correspondence from the VADCR-DNH and WVDNR on April 6, 2015, confirming that all federally listed species of concern had already been identified through contact with FWS.

Correspondence with the FWS Gloucester and Elkins Field Offices provided the following information regarding the effects of the MVP on federally listed species:

- The MVP would cross habitat ranges, generally, and capture, roost, and hibernacula buffers, specifically, of the federally endangered Indiana bat and federally threatened northern long-eared bat;
    - based on the known presence of Indiana bats in the MVP area, formal consultation under Section 7 of the ESA between the FWS and FERC would be required for clearing of any trees greater than or equal to 3 inches in diameter at breast height (dbh) between April 1 and November 15;
- The MVP would cross three rivers in Virginia (Roanoke, North Fork Roanoke, and Pigg Rivers) known to contain the federally endangered Roanoke logperch;

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[3] This appendix is redacted in the public version of the BA because correspondence between the agencies and Mountain Valley is considered privileged and confidential.

  - FWS and VADGIF recommended that Mountain Valley bypass species surveys and proceed under the assumption that Roanoke logperch are present in these rivers;
  - crossing the three identified rivers would require formal consultation under Section 7 of the ESA between the FWS and FERC unless the horizontal directional drilling (HDD) method is used; Mountain Valley is not proposing to use HDD at the Roanoke or North Fork Roanoke; in the final EIS, the FERC recommended that Mountain Valley use an HDD to cross the Pigg River;
- The MVP would cross multiple perennial waterbodies in West Virginia (Leading Creek and the Little Kanawha River) known to contain the federally endangered clubshell (*Pleurobema clava*) and snuffbox (*Epioblasma triquetra*) freshwater mussels;
  - FWS requested completion of mussel surveys and continued coordination regarding the crossing of these waterbodies, if HDD is not used; Mountain Valley is not proposing to use HDD at these waterbodies;
- The MVP would cross Craig Creek in Virginia, which is known to contain the federally endangered James spinymussel;
  - crossing Craig Creek would require formal consultation under Section 7 of the ESA between the FWS and FERC unless the HDD method is used; Mountain Valley is not proposing to use HDD at this waterbody;
- The MVP would cross potentially suitable habitat for six federally endangered plant species (northeastern bulrush, running buffalo clover, shale barren rock cress, small whorled pogonia, smooth coneflower, and Virginia spiraea);
  - FWS requested completion of presence/absence surveys for these plants; and
- The MVP would cross potentially suitable habitat in Franklin and Montgomery counties in Virginia for the federally endangered Mitchell's satyr butterfly;
  - FWS initially requested completion of surveys to document the presence of suitable habitat (FWS revised their request on October 2, 2015 to state surveys were not necessary for the counties through which the MVP would pass).

Mountain Valley, through its contractor ESI, submitted a working draft of its BA to the FWS for preliminary review and comment on February 8, 2016 and filed a draft version with the FERC on June 24, 2016. The FERC issued a draft EIS on September 16, 2016 and a copy was sent to the FWS Gloucester and Elkins Field Offices. The draft EIS included a preliminary summary of our findings for federally threatened and endangered species. The FERC staff also facilitated a conference call to discuss listed species and BA requirements with FWS staff of the two offices on October 7, 2016. Mountain Valley filed a revised working draft of its BA to the FWS Gloucester and Elkins Field Offices in October 2016.

The FWS Elkins Field Office issued a letter on September 29, 2016 detailing the capture of a gray bat (*Myotis grisescens*) in Logan County, West Virginia. This capture represented a range expansion for the species. As such, the FWS requested additional consultation for projects located in select areas of West Virginia, including the counties of Fayette, Monroe, and Summers, which would be crossed by the MVP. Project-specific correspondence with the FWS resulted in a request for Mountain Valley to include the gray bat in its draft BA.

On January 10, 2017, the FWS Gloucester Field Office requested that the Virginia big-eared bat (*Corynorhinus townsendii*) be included in the BA due to the presence of caves and karst areas along the MVP corridor to which landowners have not granted survey access to Mountain Valley. These caves and karst areas could potentially provide suitable habitat for the Virginia big-eared bat.

On January 18, 2017, the FWS Gloucester Field Office requested that the rusty patched bumble bee (*Bombus affinis*) be included in the BA. The rusty patched bumble bee was subsequently listed as federally endangered by FWS on March 21, 2017. The MVP would intersect the distributional range and occurrence records for the species in West Virginia and Virginia.

Mountain Valley filed a final version of its Applicant-Prepared BA with the FERC on March 14, 2017. Based on supplemental comments received from the FWS on May 3, 2017, the FERC issued an Environmental Information Request (EIR) to Mountain Valley on May 10, 2017. Mountain Valley filed a response to the EIR on May 18, 2017.

3.0 DESCRIPTION OF THE PROPOSED ACTION

3.1 CONSTRUCTION

3.1.1 Pipeline

The proposed MVP pipeline consists of about 303.5 miles of 42-inch-diameter pipe located in the counties listed on table 3.1.1-1 and as depicted in figure 3.1.1-1. The pipeline route begins at an interconnection with Equitrans' existing H-302 pipeline at the Mobley Interconnect and Tap in Wetzel County, West Virginia and proceeds in a general southeasterly direction to Transco's existing compressor station 165 in Pittsylvania County, Virginia.

Mountain Valley would generally use a 125-foot-wide construction right-of-way to install the pipeline in uplands and a 75-foot-wide construction right-of-way through wetlands. Additional workspace would be needed in selected areas such as at steep slopes. Following construction, Mountain Valley would retain a 50-foot-wide permanent right-of-way to operate the pipeline.

TABLE 3.1.1-1

Pipeline Facilities for the Mountain Valley Project

State/County	MP Range	Length (miles)
West Virginia		
Wetzel County	0.0 – 9.5	9.5
Harrison County	9.5 – 31.5 32.6 – 33.7 37.4 – 38.0	23.7
Doddridge County	31.5 – 32.6 33.7 – 37.4	4.8
Lewis County	38.0 – 65.5	27.5
Braxton County	65.5 – 80.2	14.7
Webster County	80.2 – 110.8	30.4
Nicholas County	110.8 – 135.3	24.8
Greenbrier County	135.3 – 154.2 154.7 – 157.1	21.3
Fayette County	154.2 – 154.7	0.5
Summers County	157.1 – 174.3	17.1
Monroe County	174.3 – 196.3	22.1
	West Virginia (subtotal)	*196.3*
Virginia		
Giles County	196.3 – 216.8	20.4
Craig County	216.8 – 218.5	1.7
Montgomery County	218.5 – 238.1	19.6
Roanoke County	238.1 – 246.5	8.4
Franklin County	246.5 – 283.9	37.4
Pittsylvania County	283.9 – 303.4	19.5
	Virginia (subtotal)	*107.1*
	Mountain Valley Project Total	**303.5**

Note: Totals may not sum correctly due to rounding.

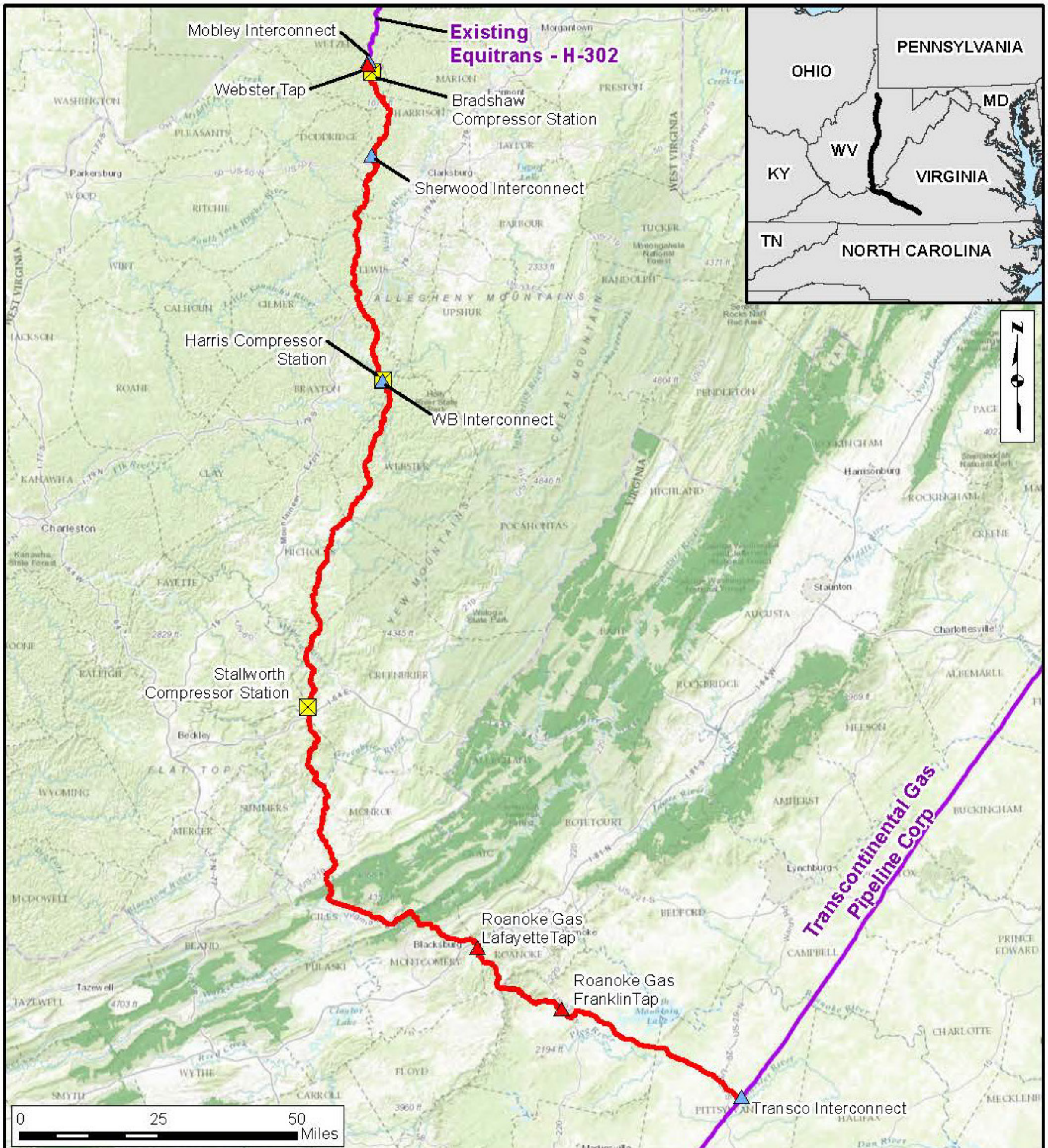

Figure 3.1.1-1

Mountain Valley Project

Mountain Valley Pipeline Overview Map

3.1.2 Aboveground Facilities

Construction of the MVP would include the construction of 3 new compressor stations; 4 meter and regulation (M&R) stations (i.e., interconnects); 3 taps; 8 pig (i.e., an internal pipeline inspection tool) launchers and receivers at 5 locations; 36 mainline valves (MLVs) (as listed on table 3.1.2-1); and 31 cathodic protection beds (as listed on table 3.1.2-2).

TABLE 3.1.2-1

Aboveground Facilities for the Mountain Valley Project

Facility	MP	County	State
Compressor Stations			
Bradshaw Compressor Station (with MLV 2 and pig launcher and receiver)	2.7	Wetzel	West Virginia
Harris Compressor Station (with MLV 9 and pig launcher and receiver)	77.4	Braxton	West Virginia
Stallworth Compressor Station (with MLV 19 and pig launcher and receiver)	154.5	Fayette	West Virginia
M&R Stations, Interconnections, and Taps			
Mobley Interconnect (receipt with MLV 1 and pig launcher)	0.0	Wetzel	West Virginia
Webster Tap	0.8	Wetzel	West Virginia
Sherwood Interconnect (receipt)	23.6	Harrison	West Virginia
WB Interconnect (delivery)	77.6	Braxton	West Virginia
Roanoke Gas Lafayette Tap	235.7	Montgomery	Virginia
Roanoke Gas Franklin Tap	261.4	Franklin	Virginia
Transco Interconnect (delivery with pig receiver) and MLV 36	303.5	Pittsylvania	Virginia
Mainline Valves			
MLV 3	15.3	Harrison	West Virginia
MLV 4	15.4	Harrison	West Virginia
MLV 5	34.8	Doddridge	West Virginia
MLV 6	53.0	Lewis	West Virginia
MLV 7	64.5	Lewis	West Virginia
MLV 8	65.4	Lewis	West Virginia
MLV 9 (co-located within Harris Compressor Station)	77.3	Braxton	West Virginia
MLV 10	93.1	Webster	West Virginia
MLV 11	98.6	Webster	West Virginia
MLV 12	102.2	Webster	West Virginia
MLV 13	111.3	Nicholas	West Virginia
MLV 14	120.2	Nicholas	West Virginia
MLV 15	138.7	Greenbrier	West Virginia
MLV 16	140.9	Greenbrier	West Virginia
MLV 17	143.9	Greenbrier	West Virginia
MLV 18	144.2	Greenbrier	West Virginia

TABLE 3.1.2-1(continued)

Aboveground Facilities for the Mountain Valley Project

Facility	MP	County	State
MLV 19 (collocated within Stallworth Compressor Station)	154.4	Fayette	West Virginia
MLV 20	170.0	Summers	West Virginia
MLV 21	171.9	Summers	West Virginia
MLV 22	186.1	Monroe	West Virginia
MLV 23	199.4	Giles	Virginia
MLV 24	201.5	Giles	Virginia
MLV 25	212.4	Giles	Virginia
MLV 26	222.8	Montgomery	Virginia
MLV 27	235.0	Montgomery	Virginia
MLV 28	236.4	Montgomery	Virginia
MLV 29	249.8	Franklin	Virginia
MLV 30	259.2	Franklin	Virginia
MLV 31	265.4	Franklin	Virginia
MLV 32	269.5	Franklin	Virginia
MLV 33	283.6	Franklin	Virginia
MLV 34	296.3	Pittsylvania	Virginia
MLV 35	299.7	Pittsylvania	Virginia

TABLE 3.1.2-2

Cathodic Protection Units
Along the Route of the Mountain Valley Project

Facility	MP	County	State
01A	2.3	Wetzel	West Virginia
01B	6.5	Wetzel	West Virginia
2	15.4	Harrison	West Virginia
3	23.0	Harrison	West Virginia
4	34.8	Harrison	West Virginia
5	45.8	Lewis	West Virginia
6	55.1	Lewis	West Virginia
7	62.2	Lewis	West Virginia
8	73.7	Braxton	West Virginia
9	84.1	Webster	West Virginia
10	93.1	Webster	West Virginia
11	98.6	Webster	West Virginia
12	107.0	Webster	West Virginia
13	122.4	Nicholas	West Virginia
14	128.2	Nicholas	West Virginia
15	138.3	Greenbrier	West Virginia
16	149.5	Greenbrier	West Virginia
17	159.5	Summers	West Virginia
18	171.9	Summers	West Virginia
19	182.3	Monroe	West Virginia
20	191.4	Monroe	Virginia
21	200.5	Giles	Virginia
22	211.1	Giles	Virginia
23	227.4	Montgomery	Virginia
24	235.6	Montgomery	Virginia
25	246.1	Roanoke	Virginia
26	255.5	Franklin	Virginia
27	264.2	Franklin	Virginia
28	275.0	Franklin	Virginia
29	285.5	Pittsylvania	Virginia
30	297.1	Pittsylvania	Virginia

The Bradshaw Compressor Station would be located at MP 2.7 along the MVP pipeline in Wetzel County, West Virginia. The four gas-driven turbine units at the station combined would generate about 89,600 horsepower (hp) of compression. The station has been designed to raise pipeline pressure from 765 psig to 1,450 psig. The station would contain five structures (compressor building, air compressor building, two electrical control buildings, and an office), with a gravel yard surrounded by a chain link fence. Other equipment at the station would include gas filter/separators, gas coolers, inlet air filters, exhaust silencers, tanks, blowdown silencers, heaters, auxiliary micro-turbines, and a pig receiver. Dual 42-inch-diameter, 550-foot-long suction and discharge pipelines would connect the MVP pipeline with the Bradshaw pig receiver and launcher.

The Harris Compressor Station would be located at MP 77.4 along the MVP pipeline in Braxton County, West Virginia. The two gas-driven turbine units at the station combined would be capable of generating about 41,000 hp of compression. The station has been designed to raise the natural gas pressure in the pipeline from 1,100 psig to 1,450 psig. The Harris Compressor Station would contain similar buildings and equipment to the Bradshaw Compressor Station. Dual 42-inch-diameter, 100-foot-long suction and discharge pipelines would connect the MVP pipeline with the Harris pig receiver and launcher.

The Stallworth Compressor Station would be located at MP 154.5 along the MVP pipeline in Fayette County, West Virginia. The two gas-driven turbine units at the station combined would be capable of generating about 41,000 hp of compression. The station has been designed to raise the natural gas pressure in the pipeline from 1,060 psig to 1,450 psig. The Stallworth Compressor Station would contain similar buildings and equipment to the Bradshaw and Harris Compressor Stations. Dual 42-inch-diameter, 100-foot-long suction and discharge pipelines would connect the MVP pipeline with the Stallworth pig receiver and launcher.

The Mobley Interconnect and receipt M&R station would be located at MP 0.0 at the beginning of the MVP pipeline, in Wetzel County, West Virginia. The site would include a gravel yard surrounded by a chain link fence. At the Mobley Interconnect, Mountain Valley would receive natural gas from Equitrans through its existing 24-inch-diameter H-302 pipeline, and via a new 36-inch-pipeline installed by Equitrans to discharge into the new 42-inch-diameter MVP pipeline. The new station would contain an electronics building (used to house gas chromatographs, flow computers, and communication equipment). Other components of the interconnection would be four gas filter separators, three 20-inch ultrasonic gas meters runs, two 20-inch flow control valve runs, and a pig launcher.

The Sherwood Interconnect and receipt M&R station would be located at MP 23.6 along the MVP pipeline in Harrison County, West Virginia. The site would include a gravel yard surrounded by a chain link fence. The Sherwood Interconnect would receive natural gas from a third-party upstream pipeline and discharge at the Sherwood Gas Processing Plant into the MVP pipeline. Components of the interconnection would include two gas filter separators, one 12-inch ultrasonic gas meter run, and one 10-inch overpressure protection/flow control valve run. The discharge from the M&R station into the 42-inch-diameter MVP pipeline would be through a 16-inch-diameter pipeline, 50 feet long. This station would also contain two electronics buildings.

The WB Interconnect and delivery M&R station would be located at MP 77.6 along the MVP pipeline in Braxton County, West Virginia. The site would include a gravel yard surrounded by a chain link fence. The WB Interconnect would be located directly adjacent to the Harris Compressor Station. The WB Interconnect would deliver gas from the MVP pipeline into Columbia Lines WB and WB-5. In order to access Columbia's approved tap location, about 1,000 feet of 24-inch-diameter pipeline would be installed from the MVP pipeline. Components of the interconnection and M&R station would include two gas filter separators, two 16-inch gas ultrasonic meter runs, and three 12-inch overpressure protection/flow control values runs. There would be a canopy installed over the meter runs, and another over the control value runs. There would be one electronics building for Columbia and one for Mountain Valley at the site.

The Transco Interconnect and delivery M&R station would be located at MP 303.5 at the terminus of the MVP pipeline in Pittsylvania County, Virginia. The site would include a gravel yard enclosed by a chain link fence. Mountain Valley proposes to interconnect with four existing Transco pipelines at existing station 165 (Pipelines A and B are 30 inches in diameter; Pipeline C is 36 inches in diameter; and Pipeline D is 42 inches in diameter). Components of the Transco Interconnect and M&R station would include five gas filter separators, six 16-inch ultrasonic gas meter runs, four 16-inch overpressure protection/flow control meter runs, two 26-inch overpressure protection security valve runs, and a pig receiver. The pig receiver would attach directly to the MVP pipeline. A meter building would enclose the meter runs and a control valve building would enclose the control valve runs. One electronics building would be erected for Transco's equipment, and another for Mountain Valley's equipment.

Mountain Valley would install three taps as part of the Project: the Webster, Roanoke Gas Lafayette, and Roanoke Gas Franklin taps. The Webster Tap would be located at about MP 0.8 along the MVP pipeline, in Wetzel County, West Virginia, and would be adjacent to the Webster Interconnect planned by Equitrans for its proposed Equitrans Expansion Project. It would have a delivery capacity of about 630,000 dekatherms per day (Dth/day) [630 million cubic feet per day (MMcf/d)]. The Roanoke Gas Lafayette Tap would be located MP 235.7 in Montgomery County, Virginia and the Roanoke Gas Franklin Tap would be located at MP 261.4 in Franklin County, Virginia. Mountain Valley currently estimates that both Roanoke Gas taps would have a delivery capacity of about 10,000 Dth/day (10 MMcf/d).

Mountain Valley proposes to use remotely controlled MLVs along the pipeline route at 36 locations. One MLV would be within each of the three compressor stations; one would be installed at the Mobley Interconnect; and one would be installed at the Transco Interconnect. The remainder would be constructed along the new pipeline. The MLVs would be continuously monitored at Mountain Valley's gas control center and could be controlled both locally and remotely. In the event of an incident, an electronic command for valve closure can be sent, with the MLV closing within 2 minutes following issuance of a remote signal.

Pig launchers and receivers would be installed at all three of the new compressor stations along with an additional launcher at MP 0.0 (Mobley Interconnect) and an additional receiver at the Project terminus at MP 303.5 (Transco Interconnect). Pig launchers would be installed on the discharge side of each compressor station. Pig receivers would be installed on the suction side of each compressor station.

Mountain Valley would install cathodic protection to prevent long-term corrosion of the pipeline at 31 locations along the MVP pipeline route (table 3.1.2-2).

According to Mountain Valley, the permanent footprint of cathodic surface groundbeds would be perpendicular to the right-of-way and vary from about 25 feet wide and 377 feet long to 25 feet wide and 972 feet long. Most surface groundbeds would also require a temporary workspace adjacent to the permanent footprint; this workspace would be 25 feet wide and run the length of the groundbed. The permanent footprint of deep well groundbeds would be within the permanent right-of-way or adjacent to the right-of-way in a workspace of 25 feet by 25 feet (0.014 acre each). A temporary workspace for deep well groundbeds would not be needed. Mountain Valley would affect about 18 acres during construction of cathodic groundbeds and about 10 acres during operation.

3.1.3 Yards

Mountain Valley would use 20 yards in West Virginia and 2 yards in Virginia during construction (see table 3.1.3-1). Temporary yards are used during construction to store pipe, materials, and equipment; set-up offices, and mobilize workers. Mountain Valley would grade, modify drainage, import gravel or crushed rock, install buildings (usually prefabricated mobile offices), and construct internal roadways within some of the yards. After pipeline installation, all yards would be restored to their pre-construction conditions and use, unless the landowner requests otherwise. The land use classifications of most of the yards are described as having an open land use. However, some of the yards contain limited forested areas. Yard MVP-LY-002 is an existing yard and Mountain Valley would not alter the landscape of this yard. In the case of open, agricultural, grasslands-rangelands, or developed land use at yards, impacts would be short-term, with vegetation re-established in a few years after construction is finished. In the cases where forest would be cleared at a yard, trees would not be replanted after construction; therefore, impacts would be long-term while trees recruit naturally and grow.

3.1.4 Access Roads

In addition to the use of public roads, Mountain Valley would use a combination of both temporary and permanent private roads to access the construction right-of-way. Of the 393 access roads that would be used during construction, 355 (totaling 203.3 miles) would be existing roads. Virtually all of the existing access roads (353) would require improvements for pipeline construction traffic. Mountain Valley would build 37 new roads for construction access. Mountain Valley would use 161 roads for permanent access to the right-of-way and aboveground facilities, including 131 existing roads, 27 new roads, and 1 road that currently exist in part and would require an additional new part as well. Improvements to existing roads, or new access roads built for this Project, would affect a total of about 906 acres during construction. Permanent use of access roads would utilize about 237 acres.

TABLE 3.1.3-1

Yards for the Mountain Valley Project

State/Yard Name	Type	MP	County, State	Land Use a/	Size (acres)
West Virginia					
MVP-LY-024	Laydown Yard	0.1	Wetzel	Forest	0.9
MVP-LY-001	Laydown Yard	2.0	Wetzel	Forest; developed, open space; and agricultural	4.8
MVP-RD-001	Laydown Yard	2.3	Wetzel	Forest; developed, open space	9.2
MVP-LY-003	Laydown Yard	25.8	Harrison	Forest; developed, open space	7.3
MVP-LY-013	Laydown Yard	31.5	Doddridge	Developed; developed, open; forest	5.7
MVP-LY-016	Laydown Yard	45.7	Lewis	Developed; emergent herbaceous wetland; developed, open	9.5
MVP-LY-017	Laydown Yard	46.4	Lewis	Developed, open; agriculture; developed	5.7
MVP-LY-018	Laydown Yard	46.5	Lewis	Developed, open; agriculture	3.3
MVP-AP-001	Truck Turn Radius	52.3	Lewis	Forest	0.7
MVP-LOG-001	Truck Turn Radius	54.2	Lewis	Forest; developed, open	0.2
MVP-SA-001	Truck Turn Radius	58.7	Lewis	Forest; developed, open	0.2
MVP-AP-002	Truck Turn Radius	59.6	Lewis	Open	0.2
MVP-LY-002	Laydown Yard	59.6	Lewis	Forest; developed, open; agriculture	17.8
MVP-LY-001A	Laydown Yard	75.3	Braxton	Agriculture	19.4
MVP-LY-021	Laydown Yard	76.2	Braxton	Developed	3.2
MVP-LY-004	Laydown Yard	93.3	Braxton	Developed; developed, open space	8.9
MVP-LY-023	Laydown Yard	109.4	Braxton	Agriculture; developed, open; forest	6.5
MVP-LY-022	Laydown Yard	114.5	Nicholas	Agriculture; forest; developed, open; developed	7.4
MVP-LY-007	Laydown Yard	118.8	Nicholas	Developed, open; developed; forest	17.8
MVP-LY-025	Laydown Yard	154.7	Greenbrier	Agriculture, developed, open	4.1
				West Virginia Subtotal	*132.6*
Virginia					
MVP-PY-006	Pipe Yard	234.2	Montgomery	Agriculture; developed, open; developed; forest	22.8
MVP-PY-005	Pipe Yard	264.3	Franklin	Agriculture; developed; forest	15.0
				Virginia Subtotal	*37.9*
				Mountain Valley Project Total	***170.5***

Note: The totals shown in this table may not equal the sum of addends due to rounding.

a/ Land use data from the National Land Cover Database. However, land cover data has changed for several areas since the dataset was last updated. Land cover data presented has been verified, to the extent possible, with recent aerial imagery.

3.1.5 Additional Temporary Workspaces

Mountain Valley would use additional temporary workspaces (ATWS) along its pipeline route totaling about 658 acres. Mountain Valley would require ATWS in areas such as the following:

- adjacent to crossings of roadways, railroads, waterbodies, wetlands, or other utilities;
- construction constraints that require special construction techniques such as steep slopes;
- areas requiring extra trench depth;
- certain pipe bends;
- areas for extra spoil storage;
- areas for temporary storage of segregated topsoil;
- locations with soil stability concerns;
- truck turnarounds;
- equipment passing lanes;
- hydrostatic test water withdrawal and discharge locations; and
- staging and fabrication areas.

ATWS would be used only during construction of the Project. After pipeline installation, all of the ATWS would be restored to their pre-construction contours. In open, agricultural, and developed and residential land use areas, construction impacts from use of ATWS would be short-term, as these areas would be revegetated in a few years. However, in previously forested areas, impacts from use of ATWS would be long-term, as it would take many years for trees to re-establish and mature.

3.1.6 Hydrostatic Pressure Testing

Prior to placement of the pipeline facilities into service, Mountain Valley would hydrostatically test the pipeline to ensure the system is capable of withstanding the operating pressure for which it was designed. Hydrostatic testing involves filling the pipeline with water to a designated test pressure and maintaining that pressure for about 8 hours. Actual test pressures and durations would be consistent with the requirements of 49 Code of Federal Regulation (CFR) 192. Any identified leaks would be repaired and the section of pipe retested until the required specifications were met.

Mountain Valley would primarily obtain water for hydrostatic testing from municipal water sources, though some surface waterbodies would also be used (table 3.1.6-1). When obtaining hydrostatic test water from surface waterbodies, Mountain Valley would collect baseline water samples prior to withdrawal and discharge of the water. In West Virginia, Mountain Valley would analyze baseline sampling data for oil and grease, total suspended solids, and pH. In Virginia, baseline sampling data would be obtained for total petroleum hydrocarbons, total organic carbon, total suspended solids, pH, and total residual chlorine. The samples would also be tested for chloroform if the discharge is to be released to a waterbody. Mountain Valley would add a biocide to surface waters used for hydrostatic testing. Prior to discharge, a biocide deactivating agent would be added so the test water could be discharge to a vegetated upland area.

TABLE 3.1.6-1

Hydrostatic Test Water Sources and Discharge Locations for the Mountain Valley Project

Segment/ Facility Name	Start MP	End MP	Required Water (gallons)	Proposed Water Source			Proposed Test Water Discharge Location			
				MP	Proposed Water	Watershed	MP	Watershed	Volume (gallons)	Proposed Discharge Month
01A	0.0	12.1	4,331,561	N/A	Reuse from Test Section 1B	N/A	0.0	Fishing Creek	4,331,561	Oct/Nov 2018
01B	12.1	25.8	4,904,330	25.8	Municipal Water	N/A	12.1	Tenmile Creek	572,768	Oct/Nov 2018
02A	25.8	41.2	5,512,896	25.8	Municipal Water	N/A	25.8	Tenmile Creek	3,078,630	Oct/Nov 2018
02B	41.2	48.0	2,434,266	N/A	Reuse from Test Section 2A	N/A	41.2	Middle West Fork River	2,434,266	Oct/Nov 2018
03A	48.0	60.3	4,403,157	N/A	Reuse from Test Section 3B	N/A	48.0	Leading Creek	4,403,157	Oct/Nov 2018
03B	60.3	73.7	4,796,936	N/A	Reuse from Test Section 4A	N/A	60.3	Upper Little Kanawha	393,778	Oct/Nov 2018
04A	73.7	87.3	4,868,532	N/A	Reuse from Test Section 4B	N/A	73.7	Upper Little Kanawha	71,596	Oct/Nov 2018
04B	87.3	104.9	6,300,453	104.9	Municipal Water	N/A	104.9	Birch River	1,431,921	Oct/Nov 2018
05A	104.9	118.8	4,975,926	104.9	Municipal Water	N/A	104.9	Outlet Gauley River	1,610,911	Oct/Nov 2018
05B	118.8	128.2	3,365,015	N/A	Reuse from Test Section 5A	N/A	128.2	Hominy Creek	3,365,015	Oct/Nov 2018
06A	128.2	144.0	5,656,088	144.0	Meadow River	Upper Little Kanawha	144.0	Upper Little Kanawha	1,897,295	Oct/Nov 2018
06B	144.0	154.5	3,758,793	N/A	Reuse from Test Section 6A	N/A	144.0	Upper Little Kanawha	3,758,793	Oct/Nov 2018
07A	154.5	171.6	6,121,463	171.6	Greenbrier River	Wolf Creek-Greenbrier River	171.6	Wolf Creek-Greenbrier	2,147,882	Oct/Nov 2018
07B	171.6	182.7	3,973,581	N/A	Reuse from Test Section 7A	N/A	171.6	Wolf Creek-Greenbrier River	3,973,581	Oct/Nov 2018
08A	182.7	191.4	3,114,428	N/A	Reuse from Test Section 8B	N/A	191.4	Bluestone River	3,114,428	Oct/Nov 2018
08B	191.4	204.3	4,617,946	191.4	Municipal Water	N/A	191.4	Bluestone River	1,503,517	Oct/Nov 2018
09A	204.3	211.4	2,541,660	211.4	Municipal	N/A	204.3	New River-Sinking Creek	2,541,660	Oct/Nov 2018
09B	211.4	227.3	5,691,886	211.4	Municipal	N/A	227.3	North Fork Roanoke River	2,649,054	Oct/Nov 2018

TABLE 3.1.6-1(continued)

Hydrostatic Test Water Sources and Discharge Locations for the Mountain Valley Project

Segment/ Facility Name	Start MP	End MP	Required Water (gallons)	Proposed Water Source			Proposed Test Water Discharge Location			
				MP	Proposed Water	Watershed	MP	Watershed	Volume (gallons)	Proposed Discharge Month
09C	227.3	235.8	3,042,832	N/A	Reuse from Test Section 9B	N/A	235.8	Roanoke River-Mason Creek	3,042,832	Oct/Nov 2018
10A	235.8	245.7	3,544,005	N/A	Reuse from Test Section 10B	N/A	235.8	Roanoke River-Mason Creek	3,544,005	Oct/Nov 2018
10B	245.7	258.3	4,510,552	258.3	Municipal	N/A	258.3	Walker Creek-Little Walker Creek	966,547	Oct/Nov 2018
10C	258.3	264.3	2,147,882	258.3	Municipal	N/A	264.3	Upper Blackwater River	2,147,882	Oct/Nov 2018
11A	264.3	275	3,830,389	N/A	Reuse from Test Section 11B	N/A	264.3	Upper Blackwater River	3,830,389	Oct/Nov 2018
11B	275.0	288.3	4,761,138	N/A	Reuse from Test Section 11C	N/A	275.0	Lower Blackwater River	930,749	Oct/Nov 2018
11C	288.3	303.5	5,441,300	303.5	Municipal	N/A	288.3	Lower Pigg River	680,163	Oct/Nov 2018

The pipeline would be tested in segments, with the water re-used and moved to each sequential segment along the route. The hydrostatic test water would be discharged through sediment filters in vegetated uplands away from waterbodies and wetlands.

3.2 OPERATIONS AND MAINTENANCE

Mountain Valley would maintain and operate the pipeline and aboveground facilities in accordance with the Department of Transportation (DOT)/PHMSA regulations at 49 CFR 192, the FERC regulations at 18 CFR 380.15, and the maintenance provisions found in the FERC's Upland Erosion Control, Revegetation, and Maintenance Plan (Plan) and Mountain Valley's Wetland and Waterbody Construction and Mitigation Procedures (Procedures).

3.2.1 Pipeline and Right-of-Way

Mountain Valley would maintain a 50-foot-wide permanent operational easement for the MVP pipeline. In accordance with the Plan, full-width vegetation maintenance/removal (e.g., mowing) within the operational easement would not be done more frequently than every 3 years. To facilitate periodic corrosion and leak surveys, a corridor not exceeding 10 feet in width centered on the pipeline may be maintained annually in an herbaceous state. Mountain Valley would also selectively cut trees within 15 feet of the centerline in wetlands. To reduce the effects of forest fragmentation on FS lands and expedite the re-establishment of wildlife habitat after construction, the FS has indicated that it will require, as part of its separate FS permitting process, Mountain Valley to maintain the permanent right-of-way through all of the Jefferson National Forest consistent with Mountain Valley's Procedures. In no case would routine vegetation maintenance occur between April 15 and August 1 of any year. Mountain Valley does not propose the wide-scale use of herbicides to maintain the right-of-way, but would consider their use on a local scale only after a request from the landowner or land management agencies. The FS may require the use of herbicides to maintain the right-of-way on National Forest System managed lands.

Besides vegetation maintenance, other operational activities on the pipeline right-of-way would include inspections and repairs. Periodic aerial and ground inspections may identify pipeline leaks, erosion or loss of vegetation cover on the right-of-way, and unauthorized encroachment. Mountain Valley would conduct pipeline inspections at varying frequencies as required by the DOT requirements. During the process, inspectors would look for any sign of encroachment or downed trees along the right-of-way and any abnormal ground conditions, physical damage in the area, or missing or damaged line markers. Inspectors would conduct a leak inspection and ensure required emergency contact information is posted and accurate on all line markers and fenced enclosures. Mountain Valley would also inspect the cathodic protection system periodically to ensure that it is functioning properly and send pigs through the pipeline to check for corrosion and irregularities in the pipe in accordance with DOT requirements.

3.2.2 Aboveground Facilities

Mountain Valley would perform routine inspections of and maintain all equipment at aboveground facilities, including compressor stations, M&R stations, taps and interconnects, MLVs, pig launchers and receivers, and cathodic protection beds. Routine maintenance checks would include calibration of equipment and instrumentation. Safety equipment, such as pressure relief devices and fire and gas detection systems, would be tested for proper operation. Corrective actions would be taken if problems were noted. Mountain Valley would maintain permanent access roads and would install appropriate erosion and sediment controls as necessary, including water breaks, sumps, and filter socks.

The aboveground facilities would be unmanned, with start/stop capabilities controlled from corporate headquarters. A telemetry system would notify operational personal at local offices and the gas control headquarters of the activation of safety systems or alarms. Maintenance personnel would be dispatched to investigate issues and take corrective actions as needed.

3.2.3 Land Requirements

Construction of the MVP pipeline would affect about 6,363 acres, including ATWS, yards, aboveground facilities, and access roads; of which about 4,248 acres would be in West Virginia, and about 2,115 acres would be in Virginia. Operation of the pipeline would affect a total of about 2,118 acres, including 1,393 acres in West Virginia, and 725 acres in Virginia. Land use types and acreages affected by Project component are reported in table 3.2.3-1.

TABLE 3.2.3-1

Land Use Types Affected by Construction and Operation of the Mountain Valley Project (in acres)

Project/State/ Component	Open Land		Agricultural		Forested/ Woodland		Industrial/ Commercial		Residential		Open Water		Total	
	Constr	**Oper**	**Constr**	**Oper**	**Constr**	**Oper**	**Constr**	**Oper**	**Constr**	**Oper**	**Constr**	**Oper**	**Constr**	**Oper**
West Virginia														
Pipeline Right-of-Way	140.5	62.1	146.8	63.4	2,592.9	1,060.2	3.4	1.8	4.1	1.7	2.1	1.2	2,889.7	1,190.4
Additional Temporary Workspace	71.2	0.0	85.0	0.0	297.4	0.0	1.7	0.0	3.0	0.0	0.6	0.0	458.8	0.0
Aboveground Facilities	16.5	2.5	3.3	0.0	88.2	19.9	0.0	0.0	0.0	0.0	0.0	0.0	108.0	22.4
Access Roads	99.3	34.9	39.6	10.7	504.6	126.6	0.6	0.2	3.3	1.4	0.3	0.0	647.6	173.7
Yards	35.3	0.0	50.4	0.0	26.7	0.0	9.9	0.0	10.5	0.0	0.0	0.0	132.6	0.0
Cathodic Protection	3.6	2.1	1.8	0.9	5.5	3.0	0.0	0.0	0.3	0.2	0.0	0.0	11.3	6.2
West Virginia Subtotal	*366.3*	*101.6*	*326.9*	*74.9*	*3,515.3*	*1,209.7*	*15.5*	*2.0*	*21.2*	*3.2*	*2.9*	*1.2*	*4,248.1*	*1,392.7*
Virginia														
Pipeline Right-of-Way	70.2	29.5	405.9	169.6	1,085.4	451.5	2.0	0.7	8.5	4.2	0.2	0.1	1,572.1	655.7
Additional Temporary Workspace	28.7	0.0	106.0	0.0	58.7	0.0	0.5	0.0	5.1	0.0	0.0	0.0	199.0	0.0
Aboveground Facilities	0.6	0.0	0.0	0.1	40.4	2.6	0.0	0.0	0.0	0.0	0.0	0.0	41.0	2.7
Access Roads	19.2	4.0	61.7	11.1	171.2	46.1	0.9	0.4	5.8	1.6	0.0	0.0	258.8	63.3
Yards	4.0	0.0	27.9	0.0	2.3	0.0	0.5	0.0	3.1	0.0	0.0	0.0	37.8	0.0
Cathodic Protection	1.6	0.9	3.7	1.8	0.4	0.2	0.3	0.1	0.5	0.3	0.0	0.0	6.4	3.4
Virginia Subtotal	*124.3*	*34.5*	*605.2*	*182.7*	*1,358.5*	*500.4*	*4.1*	*1.2*	*23.1*	*6.1*	*0.2*	*0.1*	*2,115.3*	*725.1*
MOUNTAIN VALLEY PROJECT TOTAL	***490.6***	***136.1***	***932.0***	***257.6***	***4,873.8***	***1,710.2***	***19.7***	***3.2***	***44.3***	***9.4***	***3.1***	***1.3***	***6,363.4***	***2,117.8***

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4.0 ACTION AREA

The Action Area is the area that may be affected directly or indirectly by a federal action and not merely the immediate area involved in the action (50 CFR 402.02). Direct effects are immediate effects of the Project on a species or its habitat, including effects resulting from interdependent or interrelated actions. Indirect effects are caused by or would result from the proposed action at a later time, but are still reasonably certain to occur. Interdependent actions have no independent utility apart from the proposed action. Interdependent actions are typically direct consequences of the proposed action. Interrelated actions are part of a larger action and depend on the larger action for their justification. Interrelated actions typically only occur in association with the proposed action. Cumulative effects for the ESA are defined in 50 CFR 402.02 as the effects of future state, local, or private activities that are reasonably certain to occur within the Action Area of the Federal action subject to consultation. Future federal actions that are unrelated to the proposed action are not considered as cumulative effects because they require separate consultation pursuant to Section 7 of the ESA (FWS and NMFS, 1998).

4.1 PROJECT ACTION AREA

The Action Area is not necessarily limited to the construction right-of-way or "footprint" of on-the-ground impacts due to the action within the Project Area. The Action Area includes the geographic extent of environmental changes (i.e., physical, chemical, and biotic effects) that result directly and indirectly from the action (50 CFR 402.02). The Action Area is defined by measurable or detectable changes in land, air, and water quantity or other measurable factors that may elicit a response in a species or critical habitat. As such, in addition to the immediate area of disturbance, the Action Area encompasses any distance beyond the Project Area in which impacts may occur that impair essential behavior patterns or the health and survival of an individual.

The primary, direct "footprint" of the MVP involves ground disturbance and tree clearing associated with construction of the Project for pipeline right-of-way (125-feet-wide for construction and 50-feet-wide for operation), ATWS (individual sizes vary), aboveground facilities (site-specific footprints), access roads (individual lengths and widths vary), cathodic protection beds (individual sizes vary), and yards (individual sizes vary) as discussed and enumerated above in section 2 and as discussed for habitat types below. An extension of the Action Area beyond the primary "footprint" may be caused by the following components:

- light pollution;
- noise pollution;
- water quality degradation; and
- dust pollution.

Maps of the Action Area are included as appendix B. The long-term operation of the pipeline facilities would be limited to the permanent easement and aboveground facilities

4.1.1 Light Pollution

Artificial lighting used during construction and at the aboveground facilities of the MVP during operation would generate light pollution. Ecological light pollution refers to artificial lighting that affects natural patterns of light and dark in ecosystems, which in turn may affect wildlife (Longcore and Rich, 2004). The effects of ecological light pollution may include causing disorientation in nocturnal animals, disrupting migratory patterns of birds, and altering seasonal day-length cues, which some wildlife may rely on as a trigger for critical behavior (e.g., migration). Mountain Valley would only use artificial lighting as necessary during construction between the hours of 7:00 am and 7:00 pm, except during emergencies or limited instances of 24-hour construction activities. During operation, Mountain Valley would generally orient lighting fixtures inward along the perimeters of aboveground facilities and would use full cut-off style fixtures. Full cut-off lighting fixtures are directed downward and possess shielding around the fixture that prevents light from shining above 90 degrees from the lamp (i.e., light only shines directly downward from the fixture).

The impacts of artificial lighting would vary by the type, quantity, and intensity of the light, and the habitat in which it occurs. Additionally, light pollution associated with a specific project must be assessed relative to the existing environmental baseline, which is not commonly addressed in studies of artificial lighting and bats or other wildlife. Few studies have assessed specific impacts and particularly the distance to which impacts occur.

4.1.1.1 Effects of Artificial Light on Bats

Lighting can affect the behavior and biology of bats, including roosting and emergence, foraging and commuting, and hibernation. It is likely that any impact from artificial lighting is species specific.

4.1.1.2 Effects on Roosting and Emergence

Artificial lighting at a roost could cause roost abandonment. Bats considered a nuisance to humans (e.g., at a home) are sometimes driven from roosts by lighting the roost. Artificial lighting could also cause bats to use alternate roosts or exits with greater exposure to predators. A powerful predictor of when many species of bats emerge from day roosts is ambient light level. Thus, artificial lighting may delay the timing and prolong the duration of emergence of bats from their roost. Given that insect densities decline rapidly at sundown (Speakman et al., 2000), bats may miss their most important foraging time. Delayed emergence could therefore negatively affect the fitness of individuals.

4.1.1.3 Effects on Foraging and Commuting

Artificial lighting may affect foraging behavior by affecting insect prey. Some insects are drawn to lights, depending in large part upon the species of insect and the wavelengths of light. An abundance of insects can attract some species of bats that may benefit from the concentrated food resource. For example, moths are often attracted to lights and both the Indiana and northern long-eared bats often eat moths (Brack and LaVal, 1985; Brack and Whitaker, 2001; Sparks et al., 2004; Whitaker, 2004; and Tuttle et al., 2006). However, neither species typically concentrates foraging in lighted areas, nor are myotid bats generally considered as bats that forage in lighted areas. Species adapted to foraging in open areas (e.g., bats of the genera *Eptesicus* and *Perimyotis*), may benefit from such situations.

Artificial lighting within foraging areas can potentially prevent or reduce foraging activity, effectively causing a loss of foraging areas. Lighting can change the composition and abundance of insect prey, which is potentially harmful if bats harvest fewer or less nutritious prey or prey that require a higher energy cost to catch and consume. Insects may be attracted away from dark areas, negatively affecting bats by reducing prey availability for bats that do not forage in lighted areas.

When bats are active in the light, it may make them more susceptible to predation. Although bats are not generally heavily preyed upon by most types of nocturnal predators (e.g., owls) lights may make them more susceptible to predation, especially when they become, in effect, a reliable, concentrated resource, such as at roost entrances. Predators known to exploit such situations include house cats, snakes, and many species of birds.

Artificial lighting may change the ways bats move through a landscape by causing commuting bats to take indirect routes among roosting and foraging sites and by making some sites inaccessible. Such barriers to movement disrupt the ecological functionality of the landscape. Bats using sub-optimal routes may fly farther, increasing energy costs and flight time, which could increase exposure to predators and the elements. If alternative routes are not available, colonies may be isolated from their foraging areas, potentially forcing them to abandon their roosts.

4.1.1.4 Effects of Artificial Light on Rusty Patched Bumble Bee

Very little research has been done on the effects of light pollution on bumble bees (Harrison and Winfree, 2015). The rusty patched bumble bee is diurnal and not likely to emerge at night unless disturbed.

Artificial light may affect bumble bee habitat and food sources however. Light pollution at night has been shown to reduce densities of flowers, negatively impacting food availability. Amber light similar to mercury-vapor street lighting and, to a lesser extent, white light emitting diodes (LED) suppressed flowering in a legume (Bennie et al., 2015). Flowering in woody plants often depends on day length, with severity of impact increasing the more the plant relies on photoperiods for growth cues. Incandescent and high pressure sodium night lights impact woody species the most, while metal halide, mercury vapor, and fluorescent lights have relatively low effect (Chaney, 2002).

4.1.1.5 Effects of Artificial Light on Aquatic Species

Artificial lighting has been shown to alter the behavior of some oceanic midwater and benthic fish species, causing individuals to either be attracted to or repelled from artificial light in a typically low light environment (Clarke et al., 1986; Marchesan et al., 2005). The impact of artificial light on freshwater stream and riparian ecosystems is not as well studied. Prenda et al. (2000) found that foraging behaviors of three small, nocturnal bottom fish species changed as artificial light was introduced, where greater intensities of light correlated with more changes to behavior. However, the effects of lights on darters such as Roanoke logperch have not been the subject of such research. While Roanoke logperch are bottom fish, they forage during the daytime, and are therefore unlikely to be affected by artificial lighting.

Few studies have been conducted to determine the effects of artificial lighting on freshwater mussel species in their natural habitat. In a controlled laboratory experiment, Coons et al. (2004) demonstrated zebra mussels moved away from strobe lights. However, when the experiment was repeated in the field (Lake Champlain), neither the settlement nor migration of zebra mussels was affected by the illumination of strobe lights or strobe light backscatter.

4.1.1.6 Effects of Artificial Light on Plant Species

Research on the effects of artificial lights on plants suggest most plants can benefit from added light as it can increase photosynthesis and thus enhance growth (Darko et al., 2014). In fact, most research suggests that in order to feed the growing human population, artificial lighting will be needed for increased and enhanced food production (Darko et al., 2014). Although none of the federally listed plants have been studied directly in regard to artificial light, some of these species do well in greenhouses. This, combined with research on other species, suggests that artificial light may have a neutral to beneficial impact on plants.

4.1.1.7 Distance of the Effects of Artificial Light

According to Gaston et al. (2015), there is little empirical evidence on the impacts of light type, quantity, intensity, and distance and direction because the impact mechanisms are not understood well enough to be quantified. Light follows a line-of-sight transmission pattern and reduces over distance or an object can block or diminish it. Light is most visible in open areas and is often blocked by trees and woodlands. Thus, light may have its greatest impact in open areas, where impacts from clearing and development are already greatest, but have much less impact in areas that remain forested.

4.1.1.8 Action Area for the Effects of Artificial Light

For purposes of impact assessment and a determination of the Action Area associated with Project lighting, we assume, based on the specifications of typical lighting equipment used for pipeline construction, that the light sources would be less than the height of typical woodland trees. In keeping with line-of-sight transmission, lighting associated with the Project is expected to be partly obscured by the surrounding woody vegetation, with the distance in which lighting would be visible influenced by the density of vegetation in the canopy and the understory of the surrounding forest. Pocock and Lawrence (2005) found that car lights penetrate a forest to a distance of about 1,181 feet in flat terrain, 1,476 feet down gullies, and 854 feet across ridges. The overall average distance for light penetration was about 1,170 feet. We rounded this value to 1,200 feet to serve as the Action Area for light in the current analysis.

4.1.2 Noise Pollution

Sounds that are intrusive, annoying, disruptive, or harmful are often referred to as noise pollution. Noise can originate from natural or anthropogenic sources and is often associated with impacts on humans and wildlife. The impact of anthropogenic noise associated with roads, airports, railroads, construction activities in many sectors, and military actions and facilities, is the basis for understanding noise impacts on wildlife (Barber et al., 2010). However, there are few large-scale, detailed studies with solid experimental design that quantify the effects of noise on wildlife. Therefore, extrapolation from small-scale studies and anecdotal reports, often across multiple taxa, is often necessary.

Wildlife relies on hearing for courtship and mating, prey location, predator detection, and/or homing. These behaviors and interactions could be affected by noise resulting from construction and operation of the MVP. Specifically, construction noise could lead to nest abandonment, egg failure, reduced juvenile growth and survival, or malnutrition or starvation of the young. However, studies note that separating the effects of acute increases in noise levels from the optical stimulus that often accompany such noises (e.g., the loud noise of a low-flying aircraft and the observation of the approaching aircraft) can be difficult (Kempf and Hüppop, 1996). Thus, during construction, the effects of noise would likely be related to areas immediately adjacent and/or within the viewshed of the construction right-of-way, but could extend to greater distances.

Effects on wildlife from chronic noise may vary by species (e.g., Barber et al., 2010; Francis et al., 2011a, b; Francis et al., 2012; Blickley et al., 2012). The number of individual birds present near oil and gas infrastructure has been shown to decline with proximity to the facility, but reproductive success was higher than expected, seemingly due to a proportionate decline in the presence of nest predators (Francis et al., 2011a). In another instance, increased noise levels from oil and gas infrastructure appeared to reduce reproductive success, potentially due to an inability of the females of the species to adequately hear male courtship songs (Habib et al., 2007). Another study concluded that species may be able to adjust to chronic noise by changing their vocalizations in ways that would allow them to be better heard (Francis et al., 2011b).

4.1.2.1 Sources of Noise

The MVP would generate noise during both construction and operation. Noise would be generated by heavy equipment, machinery, and potentially blasting, during construction. Most construction activities would be limited to daytime hours, with the exception of a limited number of 24-hour activities, such as water pump operations, HDD, and road bores. Construction is anticipated to occur throughout the year and would generally last 6 to 12 weeks at any given location. Noise levels along the construction right-of-way would vary depending on the phase of work, equipment in use, distance from noise receptors, and intervening topography. We estimate that at a distance of 50 feet from the work areas, general construction would generate noise levels of about 85 decibels on the A-weighted decibel scale (dBA), which is the typical noise level of heavy equipment operating at full capacity.

Mountain Valley has not determined where or whether blasting would be necessary during construction. Mountain Valley would attempt to minimize blasting as a means for grading or trench excavation; however, some amount could be necessary where shallow bedrock cannot be broken using other methods. Generally, noise levels produced during blasting are instantaneous and vary based on a number of factors, including the type and amount of explosives used, the depth below ground of the explosives, and whether noise attenuation methods are applied. Most of the energy released by the explosives used for blasting is directed at the bedrock being broken; however, a portion of the energy may travel beyond the work zone in the form of ground vibrations or air pressure waves. Higher frequency pressure waves may be audible to humans and wildlife as sound. Lower frequency pressure waves are often manifested as gusts of air (referred to as airblast) but are inaudible to humans. Unconfined or poorly confined blasting typically causes higher frequency, or loud, noise. Typical construction blasting operation noise levels have been documented at about 94 dBA at a distance of 50 feet (FHWA, 2006). Mountain Valley would use confined blasts, which typically generate lower-frequency effects that are often inaudible to humans.

While pipelines have no operational noise associated with them, compressor stations would generate noise on a continuous basis once in operation. Continuous noise impacts associated with the compressor stations would be limited to the general vicinity of the facilities. Noise levels at 50 feet from the MVP compressor stations could range from 68 dBA to 80 dBA[4]. Noise levels for maintenance blowdowns and emergency shutdown blowdowns could range from 75 dBA to 85 dBA at 50 feet, respectively, but would occur infrequently and would be short-term in duration.

4.1.2.2 Effects of Noise on Bats

Few studies exist regarding the effects of noise on bats compared to other wildlife species. This is largely because bats hear at a frequency range outside that of human hearing and measurement of sound at these frequencies is difficult. Furthermore, attenuation occurs at different rates over different frequencies, habitats, temperatures, and weather conditions, and sound varies over time, thus making extrapolation to bats difficult. Examples of available data for bats include the following studies.

Based on laboratory studies, Schaub et al. (2008) concluded that areas of intense broadband noise, including highways, are less suitable foraging areas for bats. The greatest impact is on species that rely on prey-generated sounds (like insects walking on the ground) rather than echo-locating bats, such as Indiana and northern long-eared bats. Greater mouse-eared bat, a “passive listening” bat, foraged 10 percent less in a chamber with 80-decibel (dB) noise, consistent with vehicle traffic noise at about 33 to 50 feet. Schaub et al. (2008) also found that vegetation noise (i.e., the sound produced by moving vegetation such as caused by wind), even when 12 dB lower than traffic noise, had a larger repellant effect than did traffic noise, presumably because of its similarity to prey-generated sounds. In a sister study, Siemers and Schaub (2010) concluded that prey search time increased fivefold at noise levels consistent with vehicle noise about 25 feet from the center of the right lane of the Autobahn A8 highway.

Bunkley et al. (2015) evaluated activity levels of bats located 50 meters (164 feet) from the center of natural gas compressor stations in New Mexico. Compressor station noise ranged from about 65 dBA to 80 dBA at a frequency of 24 kilohertz (kHz). The authors found that bats using a call frequency below 35 kHz altered activity levels, but bats using a call frequency above 35 kHz did not alter activity levels. Both Indiana and northern long-eared bats have calls above 35 kHz.

Snyder et al. (2015) reported that a captive outdoor colony of big brown bats reduced food consumption, and one bat died, concurrent with noise and vibration associated with a nearby

[4] Predicted noise levels at 50 feet are based on extrapolations of the noise model programs used to assess noise levels at Noise Sensitive Areas as described in section 4.11.2.3 of the MVP final Environmental Impact Statement. Extrapolations were calculated using the following equation: dBA2 = dBA1 + 20Log10(D1/D2); where dBA1 = noise level at a distance D1 from the point source and dBA2 = noise level at distance D2 from the same point source.

construction project. When the colony was moved away from the noise, individuals resumed eating. Despite the move, seven additional bats died within three weeks and another became moribund; necropsies showed hepatic lipidosis (fatty liver disease—often associated with starvation). Additional episodes of animal deaths (21 in all) associated with hepatic lipidosis occurred concurrent with other construction activities over a 10-year period. No quantification of construction noise or level of disturbance was provided.

Conversely, multiple bat species at the Indianapolis International Airport made regular use of a woodland within the approach zone about 3.5 miles from the end of the runways and within about 0.25 mile of Interstate 70 (Whitaker et al., 2004; Whitaker and Sparks, 2008). Bats used this woodlot for multiple years despite the Federal Aviation Administration purchasing adjacent properties that sustained noise levels above that allowed for human health and safety.

As noted in the previous subsection, noise levels produced during blasting are instantaneous and vary based on a number of factors, including the type and amount of explosives used, the depth below ground of the explosives, and whether noise attenuation methods are applied. Mountain Valley would use confined blasts, which typically generate lower-frequency effects that are often inaudible to humans (often less than 0.01 kHz). Bunkley et al. (2015) documented that noises at frequencies well below those used by Indiana, northern long-eared, and gray bats to echolocate and communicate did not cause them to alter their behavior. Likewise, while Virginia big-eared bats echolocate and communicate using lower frequencies than the other three bats, the frequency of noise resulting from blasting is still much lower. Blasting would primarily occur during daylight hours, when bats are least active, and the increased noise levels would be short-lived, infrequent, and likely would not contribute to disturbance of bats beyond that caused by general construction noise.

4.1.2.3 Effects of Noise on the Rusty Patched Bumble Bee

Noise pollution is similarly poorly studied in bees and in particular, the rusty patched bumble bee (FHWA, 2004; Harrison and Winfree, 2015). Although bees do not have ears, reactions to low frequency vibrations are documented in family Apidae (the family of bees of which bumble bees are members). Honeybees will become immobilized for up to 20 minutes when exposed to continuous sound frequencies between 3 and 1.0 kHz with intensities between 107 and 120 dB, without habituation (Frings and Little, 1957). Reactions less severe were documented at frequencies as low as 0.1 kHz at 106 dB and as high as 2.0 kHz at 128dB (Frings and Little, 1957). Unlike honey bees, rusty patched bumble bees generally nest in the ground and thus sounds and vibrations may attenuate more quickly depending on the soil substrate, which would have the effect of reducing impacts. Additional studies would be needed to evaluate the compounding effects of noise pollution on invertebrates over a long period (FHWA, 2004) or the acute effects of infrequent blasting in the vicinity of ground nesting bees.

4.1.2.4 Effects of Noise on Aquatic Species

Major effects of noise on aquatic species would primarily occur if blasting activities were to be necessary during waterbody crossings. The effects of blasting on aquatic biota varies by species (Yelverton et al., 1975), but generally relatively small organisms and those close to the blast or near the sediment surface experience higher mortality (Yelverton et al., 1975; Munday, 1986). Non-lethal effects may include eye distension, hemorrhage, hematuria, and damage to bodily systems (Hastings and Popper, 2005; Godard et al., 2008; Carlson et al., 2011; Martinez et al., 2011). If blasting is deemed necessary, Mountain Valley would implement its *General Blasting Plan*[5], in coordination with federal and state agencies, to minimize impacts on aquatic species.

4.1.2.5 Noise Attenuation

Sound decreases exponentially with distance from the source, and this decrease is accelerated within forested areas relative to the type of forest and the extent of understory present (Huisman and Attenborough, 1991). Sound also attenuates more rapidly in humid air. At 50 percent humidity, attenuation of sound at 31.5 kHz (below the level of focus by northern long-eared and Indiana bats) is nearly twice as rapid as at 20 kHz (the upper range of human hearing). At higher humidity levels typical of the Project Area, sound attenuation would be even greater. The average humidity near Blacksburg, Virginia (considered representative of the Project Area) during the summer months of the bat season of reproduction, the humidity exceeds 93 percent 3 days out of 4 (Weatherspark, 2017).

The MVP compressor stations are primarily surrounded by forested land. Mountain Valley would also employ noise mitigation measures at the compressor stations, such as compressor building walls, roof, doors, and ventilation systems designed to reduce noise emissions (potentially affecting nearby homes and other similar noise sensitive areas); turbine exhaust and intake silencers and breakouts; blowdown silencers; underground suction and discharge piping; and acoustically lagged aboveground main gas piping. The noise levels that wildlife would be exposed to beyond the compressor station property boundaries would vary based on the distance from the facility, but would be lower than the maximum noise levels provided above.

Mountain Valley has not determined whether blasting would be necessary during construction. However, if Mountain Valley determines blasting is necessary it would develop site-specific blasting plans, as noted in Mountain Valley's *General Blasting Plan*, which would specify mitigation measures it would use to prevent damage to hibernacula or other underground features. For example, Mountain Valley would use blasting mats or padding, restricted charge sizes, and/or charge delays to minimize airblast, peak sound pressure levels, and ground vibration.

4.1.2.6 Action Area for Noise Pollution

Based on the information provided above, the 85 dBA sounds produced by typical construction equipment at the site under typical (80 percent humidity) weather conditions would attenuate to a level of 49 dBA within about 0.6 mile of the source. This attenuation would be even greater for sounds within the 40+ kHz range where bats are most sensitive. Sound from the Project would have measurable impact no farther than about 0.6 mile from the Project Area. We assumed that minimal construction would occur in areas designated for use as temporary contractor, pipe storage, or laydown yards. Furthermore, these temporary facilities would be located adjacent to

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[5] See accession number 20170209-5249.

heavily trafficked areas where activity associated with the Project would not be likely to rise above existing sound levels. Therefore, the Action Area for noise in the current analysis is 0.6 mile.

4.1.3 Water Quality Degradation

The introduction of excess sediment into waterways may result in temporary changes to water quality. While conservation measures enacted for the Project would limit impacts on waterways, these measures are unlikely to prevent all excess sediment inputs. Although sedimentation of streams by erosion is a natural event, land development and disturbance may accelerate this process. Increased erodibility, due to loosening and exposure of fine particles, would increase the likelihood of sediment-laden runoff in the Project Area. Exposure of bare soils during land development increases the potential for detachment of soil particles, thus increasing the likelihood of deposition within adjacent and nearby waters. The biological effects of sediment and methods to quantify sedimentation created by the Project are discussed below; however, effects and biological thresholds are likely species specific.

4.1.3.1 Impact of Sedimentation on Aquatic Communities

Increased sedimentation and turbidity resulting from instream and adjacent construction activities would displace and impact fisheries and aquatic resources. Sedimentation could smother fish eggs, mussels, and other benthic biota and alter stream bottom characteristics, such as converting sand, gravel, or rock substrate to silt or mud. These habitat alterations could reduce juvenile fish survival, spawning habitat, mussel habitat, and benthic community diversity and health. Increased turbidity could also temporarily reduce dissolved oxygen levels in the water column and reduce respiratory functions in stream biota. Turbid conditions could also reduce the ability for biota to find food sources or avoid prey. The extent of impacts from sedimentation and turbidity would depend on sediment loads, stream flows, stream bank and stream bed composition, sediment particle size, and the duration of the disturbances.

4.1.3.2 Impact of Sedimentation on Bats

Over time, increases in sediment loads within streams could negatively impact habitat of aquatic insects. This, in turn, could indirectly affect bats, since aquatic insects (flies and caddisflies) make up a portion of the diets of bats, especially during the spring at the peak of aquatic insect emergence is highest (Brack, 1983; Brack and LaVal, 1985; Fukui et al., 2006; Hagen and Sabo; 2014).

4.1.3.3 Modeling Assessment of Sedimentation

To identify the extent of sedimentation effects from the Project, Mountain Valley conducted a hydrological analysis of sedimentation using the Revised Universal Soil Loss Equation (RUSLE) (Renard et al., 1997). This equation calculates annual estimates of erosion rates and sediment loads based on climate, soil, topography, and land use and management factors. The results provide an estimate of sediment load in streams within the vicinity of the Project. Specific details regarding the RUSLE and its application to construction activities are available in Renard et al. (1997), Galetovic (1998), and appendix C.

Mountain Valley used the RUSLE to estimate sediment loads and yields for all stream catchments within the 1:24,000 National Hydrography Dataset (NHD) within the vicinity of the MVP (see appendix C). Mountain Valley defined baseline, or reference, sediment conditions using the following datasets: current land uses available within the 2011 National Land Cover Database (NLCD) (Homer et al., 2015); expected soil erodibility based on the Natural Resources Conservation Service's SSURGO database (Soil Survey Staff, 2015a) or STATSGO soil database (Soil Survey Staff, 2015b); expected erosion potential based on rainfall estimates from climate data (NACSE, 2016); slopes and flow lengths derived from the National Elevation Dataset; and hydrologic flow paths based on the NHD. Mountain Valley then used the baseline sediment conditions to assess potential increases of soil loss expected during construction, restoration, and operation.

In order to estimate potential sediment introduced into nearby streams from the MVP, Mountain Valley divided construction, restoration, and operational impacts into the following three primary activities: access road improvements and construction; tree clearing; and pipeline construction and restoration. Mountain Valley projected these activities on a two-week interval using a sequential, assembly line construction schedule for each construction segment or spread in a north-to-south direction (appendix C contains a more detailed description of construction activities and their associated treatments within the RUSLE).

Mountain Valley estimated soil losses at two-week intervals and summed the estimated losses to estimate expected yearly loads and yields for a five-year period. Mountain Valley then compared the results to the derived baseline conditions to assess potential impacts from the MVP. Mountain Valley estimated maximum loads as the maximum cumulative sum of any consecutive 52-week period to estimate the full spatial extent of MVP impacts.

4.1.3.4 Action Area for Water Quality

A national standard for the permissible amount of sediment to enter waterways has not been established. A common threshold identified is one that increases sedimentation metrics (or surrogate metrics for sedimentation such as turbidity measurements) by 10 percent or more above baseline (EPA, 2003). Given that the mechanisms behind impacts of sediment can be due to either deposition or suspension (or both), total sediment load provides a reasonable metric, because it addresses both suspended and deposited sediments within a stream channel.

Mountain Valley used results of the RUSLE to identify boundaries associated with a 10 percent increase in sediment load to serve as the Action Area for water quality in this analysis. In total, over 705 miles of stream reaches would be expected to experience a 10 percent increase or more, at least temporarily; although only a small proportion of the reaches have the possibility of containing special status species. Although the majority of these stream reaches are closely associated with the boundaries of the Project Area, there are several exceptions in which the affected stream reaches would extend beyond the 0.6 mile and the farthest extent observed would be almost 8 miles away from the Project in Oil Creek, a tributary to the Little Kanawha River in West Virginia. The maps of appendix B illustrate which waterbodies along the MVP route extend beyond the Project Area.

4.1.4 Dust Pollution

Dust from construction sites can coat natural and anthropogenic surfaces and high levels of dust deposition can damage plants and affect the diversity of ecosystems. As such, dust produced during construction and operation of the MVP and estimates of distances dust can travel from a site are considered in the determination of the Project Action Area.

Crystalline silica is one of the most abundant naturally-occurring compounds on earth and is a common component of dust at construction sites. Quartz is the most common form of crystalline silica and it is the second most common surface material, accounting for almost 12 percent by volume of the earth's crust. Crystalline silica is a common component of sand, rock/stone, clay, concrete, masonry, and is found in soils. Activities that involve the cutting, breaking, crushing, drilling, grinding or blasting of these materials may produce fine silica dust.

4.1.4.1 Dust Production and Presence

Dust pollution is greatest during land preparation (e.g., demolition, land clearing, grubbing, earth moving, and grading) and construction. Emissions can vary substantially from day to day depending on the type and level of activity and weather. Dust emissions most often come from vehicle activity on site but dust can also travel off site if mud gets onto paved roads. Emissions from heavy construction machinery are positively correlated with the silt content of the soil, and the speed and weight of vehicles; emissions are negatively correlated with soil moisture. Ultimately, the scale of impacts often depends on dust suppression and other mitigation implemented in concert with or response to construction. Mountain Valley would attempt to suppress dust emissions generated by motorized equipment and miscellaneous vehicle traffic through use of wet suppression, as necessary. Mountain Valley would use a combination of water trucks, power washers, sweeping, and/or vacuuming.

4.1.4.2 Movement of Dust Offsite

The appearance of a dust cloud is the most common indication that dust is moving off a work site. Evidence on the distance over which dust impacts may occur is limited. Risk associated with dust from earth moving activities is an interaction between the proximity of the sensor and the intensity of work conducted at the site. The extent of dust emissions can be generally categorized by the following three classes:

- Large: Total site area greater than 2.5 acres; potentially dusty soil type (e.g., clay, prone to suspension when dry due to small particle size); more than 10 heavy earth moving vehicles active at any one time; formation of bunds greater than 26.2 feet in height; total material moved greater than 100,000 tons;
- Medium: Total site area between 0.6 and 2.5 acres; moderately dusty soil type (e.g., silt); between 5 and 10 heavy earth moving vehicles active at any one time; formation of bunds 13.1 to 26.2 feet in height; total material moved between 20,000 and 100,000 tons; and
- Small: Total site area less 0.6 acres; soil type with large grain size (e.g., sand); fewer than 5 heavy earth moving vehicles active at any one time; formation of bunds less than 13.1 feet in height.

4.1.4.3 Action Area for Dust Pollution

Based on the criteria identified above, the MVP would be categorized as a "Large" dust emission class based simply on its footprint. However, even for a project in the large dust emissions class, the ecological risk declines to low within approximately 131 to 328 feet of the Project Area, as shown in table 4.1.4.3-1. To provide a conservative assessment, we defined the Action Area for dust impacts as 350 feet beyond the Project Area.

TABLE 4.1.4.3-1

Risk Categories of Earth Moving Activities Estimated by the Institute of Air Quality Management

Distance to Nearest Receptor (ft) a/		**Dust Emission Class**		
Dust Soiling and PM_{10}	**Ecological**	**Large**	**Medium**	**Small**
< 66	-	High Risk Site	High Risk Site	Medium Risk Site
66 – 164	-	High Risk Site	Medium Risk Site	Low Risk Site
164 – 328	< 66	Medium Risk Site	Medium Risk Site	Low Risk Site
328 – 656	66 – 131	Medium Risk Site	Low Risk Site	Negligible
656 – 1,148	131 – 328	Low Risk Site	Low Risk Site	Negligible

a/ Distances are from the dust emission source. Where this is not known then the distance should be from the site boundary. The risk is based on the distance to the nearest receptor.

4.1.5 Summary of Action Area

The Action Area for the MVP is defined as the Project construction right-of-way plus the following spatial effects:

- the range at which light pollution might stimulate a response by active bats; estimated in section 4.1.1 as 1,200 feet;
- the distance noise pollution would likely travel; estimated in section 4.1.2 as about 0.6 mile;
- the distance water could carry deleterious concentrations of sediments downstream of the Project Area; estimated in section 4.1.3 as a cumulative total of about 705 miles of stream reach; and
- the distance meaningful concentrations of dust and airborne vehicle emissions would travel outside the Project Area; estimated in section 4.1.4 as about 350 feet.

When combined, the majority of these metrics lie within the 0.6-mile buffer associated with the distance that noise pollution from the Project Area would remain noticeable. The exception for this distance is where a 10 percent increase in sediment load would be detectable in streams beyond the 0.6-mile noise buffer. About 184 miles of the noted 705 miles of stream reach would occur beyond the 0.6-mile noise buffer. As such, the cumulative Action Area for this Project consists of all lands within 0.6 mile of the boundaries of the Project Area and approximately 705 miles of potentially affected streams (appendix B).

4.2 HABITAT IN THE ACTION AREA

4.2.1 Physical Geography

The MVP would be located in four physiographic provinces, including: 1) the Appalachian Plateau; 2) Valley and Ridge; 3) Blue Ridge; and 4) Piedmont (Fenneman and Johnson, 1946). The proposed pipeline would cross the Appalachian Plateau province throughout all of the counties that would be crossed within West Virginia except for about the last 10 miles of right-of-way in southern Monroe County. The Appalachian Plateau province consists mainly of steep sloped ridges and level valleys considered to be deeply dissected, rugged terrain. Bedrock underling this province generally consists of sandstone, siltstone, shale, coal, and some limestone from the Carboniferous (Pennsylvanian) period (WVGES, 2017; USGS, 1997).

The Valley and Ridge province would be crossed within southern Monroe County in West Virginia and Giles, Craig, Montgomery, and Roanoke counties in Virginia. The Valley and Ridge province consists of folded sedimentary bedrock that comprise linear mountain ridges and valleys that trend to the northeast. The underlying bedrock geology includes sandstone, shale, and carbonate bedrock. Karst features such as sinkholes, swallets, caves, and springs can be found in the carbonate formations in this province. The hazards of constructing a pipeline near karst features are discussed in section 4.1.1.5 of the final EIS and in Mountain Valley's *Revised Karst Hazard Assessment*.[6]

The Blue Ridge province would be crossed within Roanoke and Franklin Counties in Virginia. The Blue Ridge province consists of the Blue Ridge Mountains, which climb to a higher elevation than the ridges of the Valley and Ridge province. The bedrock geology of the Blue Ridge Mountains consists of crystalline bedrock from the Mesoproterozoic to Early Paleozoic eras comprised of granitic gneiss, granite, biotite gneiss, and schist.

Lastly, the Piedmont province would be crossed Franklin and Pittsylvania Counties in Virginia. Within the Piedmont province, the terrain transitions to gently sloping rounded hills that are underlain by deeply weathered bedrock. Ridges are rare in the Piedmont province. Partially weathered to competent bedrock is typically found at depths of 6 to 65 feet below ground surface and consists of igneous and metamorphic rocks including schists, gneiss, and granite ranging in age from the Proterozoic to Paleozoic eras.

4.2.2 Land Cover Types

Land cover usage with the Action Area may be divided into 15 types based on the NLCD (Homer et al; 2015). The NLCD is a large-scale, public domain collection of satellite imagery and supplementary datasets used for a variety of environmental, land management and modeling applications in the United States. Due to the approximately 100-feet by 100-feet resolution of the NLCD, it is best used for large-scale analyses of relatively homogenous habitat. The 15 land cover types that would be crossed by the Project are listed and described below:

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6 Revised *Karst Hazards Assessment Report* filed with the FERC on October 14, 2016 as Attachment RR2-4a.

- **Deciduous Forest** – Areas dominated by trees that are generally greater than 16.4 feet tall and comprise greater than 20 percent of total vegetation cover. More than 75 percent of the tree species shed foliage simultaneously in response to seasonal change;
- **Evergreen Forest** – Areas dominated by trees that are generally greater than 16.4 feet tall and comprise greater than 20 percent of total vegetative cover. More than 75 percent of the tree species maintain their leaves all year. Canopy is never without green foliage;
- **Mixed Forest** – Areas dominated by trees that are generally greater than 16.4 feet tall and comprise greater than 20 percent of total vegetation cover. Neither deciduous nor evergreen species are greater than 75 percent of total tree cover;
- **Woody Wetlands** – Areas where forest or scrubland vegetation accounts for greater than 20 percent of vegetative cover and the soil or substrate is periodically saturated with, or covered by, water. This habitat is documented remotely on the basis of vegetation and will differ from wetland boundaries identified during a field evaluation;
- **Developed Open Space** – Areas containing a mixture of some constructed materials but that are mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than 20 percent of total cover. These areas most commonly include large-lot single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes;
- **Developed, Low Intensity** – Areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 20 to 49 percent of total cover. These areas most commonly include single-family housing units;
- **Developed, Medium Intensity** – Areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 50 to 79 percent of the total cover. These areas most commonly include single-family housing units;
- **Developed, High Intensity** – Areas that are highly developed and are where people reside or work in high numbers. Apartment complexes, row houses, and commercial/industrial represent examples of developed, high intensity land use. Impervious surfaces account for 80 to 100 percent of the total cover;
- **Scrub-Shrub** – Areas dominated by shrubs that are less than 16.4 feet tall and which have a shrub canopy typically greater than 20 percent of total vegetation. This class includes true shrubs, young trees in an early successional stage, or trees stunted from environmental conditions;
- **Emergent Herbaceous Wetlands** – Areas where perennial herbaceous vegetation accounts for greater than 80 percent of vegetative cover and the soil or substrate is periodically saturated with or covered by water. This habitat is documented remotely on the basis of vegetation and will differ from wetland boundaries identified during a field evaluation;
- **Cultivated Crops** – Areas used to produce annual crops, such as corn, soybeans, vegetables, tobacco, and cotton, and perennial woody crops such as orchards and vineyards. Crop vegetation accounts for greater than 20 percent of total vegetation. This class also includes all land being actively tilled;

- **Pasture/Hay –** Areas containing grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops, typically on a perennial cycle. Pasture/hay vegetation accounts for greater than 20 percent of total vegetation;
- **Grassland/Herbaceous –** Areas dominated by graminoid or herbaceous vegetation, generally greater than 80 percent of total vegetation. These areas are not subject to intensive management such as tilling, but can be used for grazing;
- **Open Water –** Includes all areas of open water, generally with less than 25 percent cover of vegetation or soil; and
- **Barren Land –** Areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits, and other accumulations of earthen material. Generally, vegetation accounts for less than 15 percent of total cover.

Mountain Valley used the 2011 NLCD (Jin et al., 2013; Homer et al., 2015) to generate a desktop habitat evaluation to determine the general community types and suitability of habitat available for federally listed species within the Action Area and Project Area (table 4.2.2-1). Mountain Valley completed habitat assessments for listed bat species along portions of the Project Area within protective bat buffers. Mountain Valley also field delineated wetlands and waterbodies for many areas of the Project workspace based on having approved access. Land cover types collected in the field and later georeferenced in these areas were used in place of the corresponding NLCD cover types, as the field-collected data are presumed to be more accurate.

Analysis of the NLCD and field data identified 11 distinct land cover types within the Project Action Area totaling about 279,077 acres (table 4.2.2-1). The largest land cover type in area is deciduous forest (210,362 acres, 75.4 percent), followed by pasture/hay fields (30,489 acres, 10.9 percent). Although not reported in table 4.2.2-1, the Action Area also includes about 705 miles of stream habitat, of which about 184 miles extend beyond the 0.6-mile buffer for noise.

TABLE 4.2.2-1

Land Cover Types and Acreages Within the Project Area and Action Area as Indicated by NLCD and Field Assessments

Land Cover Type a/	Action Area (acres)	Project Area	
		Construction (acres)	Operation (acres)
Deciduous Forest	210,361.7	3,918.4	1,410.1
Evergreen Forest	6,537.7	118.9	44.2
Mixed Forest	4,342.2	415.8	144.1
Wetlands b/	559.56	41.4	12.3
Scrub-Shrub	1,421.2	71.4	21.5
Grassland/Herbaceous	4,402. 6	182.8	54.7
Pasture/Hay	30,489.1	1,003.7	279.9
Cultivated Crops	3,479.1	57.7	14.1
Developed c/	15,787.1	503.9	119.3
Open Water	710.5	19.9	9.8
Barren Land	986.7	30.5	6.7
Total d/	**279,077.2**	**6,364.3**	**2,117.1**

a/ Land cover types determined by field data collected when available and the 2011 NLCD otherwise.
b/ Wetlands include woody, scrub-shrub, and emergent herbaceous wetlands.
c/ Developed includes Open Space, Low, Medium, and High Intensity.
d/ Totals do not match table 2.2.3-1 due to slight geographic overlaps of spatial data.

5.0 MITIGATION MEASURES

Mountain Valley designed the Project to avoid and minimize impacts on the natural environment by selecting a route that avoids or minimizes impacts on critical or sensitive habitats, national wildlife refuges, sensitive soils, environmental hazards, and geologic/topographic hazards to the extent possible. Mountain Valley also adopted numerous modifications to the route throughout the environmental review process in an effort to minimize impacts as detailed below. In addition to route selection, Mountain Valley would implement best management practices (BMPs) for construction, operation, and maintenance of the Project to minimize impacts on uplands, wetlands, waterbodies, and associated riparian habitats.

Mountain Valley would implement a number of Project-specific plans to minimize construction and operation impacts that would generally be protective of natural resources and by extension, habitats or potential habitats for federally listed species. These plans are available for review on the FERC docket (CP16-10-000). Table 2.4-2 in the final EIS details where on the docket they are located. The plans include the following:

- *Upland Erosion Control, Revegetation, and Maintenance Plan;*
- *Wetland and Waterbody Construction and Mitigation Procedures;*
- *Erosion and Sediment Control Plan;*
- *Karst Mitigation Plan;*
- *Karst-specific Erosion and Sediment Control Plan;*
- *Water Resources Identification and Testing Plan;*
- *Spill Prevention, Control and Countermeasures Plan;*
- *General Blasting Plan;*
- *Compensatory Wetland Mitigation Plan;*
- *Revised Migratory Bird Conservation Plan;*
- *Exotic and Invasive Species Control Plan;*
- *Fire Prevention and Suppression Plan;*
- *Fugitive Dust Control Plan;*
- *Winter Construction Plan; and*
- *Plan of Development for Crossing of U.S. Forest Service (FS) and U.S. Army Corps of Engineer (COE) Managed Lands*.

Mountain Valley would implement both Project-wide and site-specific mitigation measures intended to further minimize construction and operation impacts on terrestrial and aquatic habitats. These measures are summarized below. Mountain Valley's proposed voluntary conservation measures intended as mitigation are discussed below in section 10 of this document.

5.1 WETLANDS AND WATERBODIES

Mountain Valley would use a variety of mitigation measures to minimize potential adverse impacts on waterbodies, wetlands, and riparian habitats resulting from construction of the MVP. Wetlands and open waters are important foraging and roosting habitats for bats (Carter, 2006). They offer mobility corridors, an abundance of nocturnal insects providing food and water during the spring, summer and autumn months, and important roosting resources (Fulton et al. 2014).

More importantly, waterbodies are the sole habitat for freshwater mussels and fish. Since impacts on wetlands and waterbodies could affect the overall foraging and roosting activity of bats and the habitat for fish and mussels in these areas, BMPs implemented for the Project to protect and minimize potential impacts on the environment during construction also would serve to minimize adverse effects on these species.

Measures that Mountain Valley would implement to avoid or minimize potential impacts on wetlands and waterbodies include:

- reducing the construction right-of-way width from 125 to 75 feet at most stream and wetland crossings;
- expediting construction within any waterbody effectively reducing disturbance to the streambed and adjacent soils and the quantity of suspended sediments;
- clearly marking wetland boundaries and buffers to be avoided in the field with signs and/or highly visible flagging until construction-related ground disturbing activities are complete;
- avoiding removal of riparian canopy or stabilizing vegetation, if possible;
- stabilizing waterbody banks and installing permanent sediment barriers (i.e., silt fence, silt logs) within 24 hours of completing instream construction activities and leaving the barriers in place until the site is stabilized with perennial vegetation (typically one full growing season after construction);
- aligning waterbody crossings as close to perpendicular to the axis of the waterbody channel as engineering and routing conditions allow;
- attempting to maintain, at minimum, a 15-foot section of undisturbed vegetation between the waterbody and construction right-of-way where the pipeline parallels a waterbody;
- conducting construction at stream crossings during low flow conditions, to the maximum extent possible;
- crossing streams using dry-ditch crossing methods by pumping or fluming water around if water is flowing at the time of construction, thereby minimizing sedimentation and turbidity downstream;
- conducting pipeline assembly in upland areas unless the wetland is dry enough to adequately support skids and pipe with timber mats used to cross wetlands;
- minimizing the length of time that the trench is open, to the maximum extent practicable, especially within wetlands;
- minimizing the amount of necessary construction equipment traffic to that which is needed to clear and grade the right-of-way, excavate the trench, install the pipeline, backfill the trench, and restore the construction right-of-way;
- prohibiting construction equipment, vehicles, hazardous materials, chemicals, fuels, lubricating oils, and petroleum products from being parked, stored, or serviced within a 100-foot radius of any wetland or waterbody;
- locating as many ATWS as possible at least 50 feet away from the water's edge;
- storing trench spoil excavated from within a stream at least 10 feet from the top of the bank to minimize turbidity caused by erosion;

- avoiding the use of herbicides and pesticides to maintain any portion of the Project right-of-way or aboveground facilities unless requested by a land management agency or landowner;
- installing temporary equipment bridges within the right-of-way to reduce turbidity and sedimentation caused by construction and vehicular traffic;
- minimizing crossing of the pipeline through forested wetlands to the maximum extent practicable. When forested wetlands are crossed, Mountain Valley would maintain no more than a 10-feet wide, herbaceous strip centered over the pipeline and only selectively remove woody vegetation within a 30-feet wide strip centered over the pipeline;
- allowing vegetation in wetlands to recover more rapidly by only removing tree stumps located directly over the trench line or where safety is a concern;
- restoring each waterbody to its original configuration and contour to the maximum extent possible. Permanent stabilization of the banks of the waterbody and adjacent areas using erosion control measures and vegetative cover as soon as possible after construction;
- using native stone to the extent possible during stream bed restoration and stabilization;
- promptly removing construction materials and related crossing structures from each waterbody after construction;
- using only municipal source waters for hydrostatic testing in Virginia;
- using only waterbodies that do not contain federally listed species as surface water sources for hydrostatic testing to avoid potential impacts on federally listed aquatic species;
- implementing sustainable water use practices to ensure water resources and environmentally responsible stream flows are maintained (All water withdrawals would be performed in accordance with local, state and/or federal regulations to prevent the localized and downstream dewatering of streams). Mountain Valley would use floating intakes with appropriately sized screens on the intake ends to prevent crushing, entrainment, or entrapment of mussels and fishes; Mountain Valley would also reduce withdrawal rates); and
- discharging hydrostatic test water through energy dissipating devices and sediment barriers in upland, well-vegetated areas and not directly into surface waters.

5.2 FEDERALLY LISTED TERRESTRIAL SPECIES

5.2.1 Bats

Mountain Valley would implement specific conservation measures to avoid, minimize, and mitigate potential adverse effects on Indiana and northern long-eared bats from construction, operation, and maintenance of the Project as follows:

- avoid felling of known roosts to the maximum extent practicable;
- a juvenile female northern long-eared bat was tracked to a roost in Lewis Count, West Virginia near MP 48.4. The work area has been reduced to 50 feet in this area to avoid impacts on the identified roost tree;

- a post-lactating adult female northern long-eared bat was tracked to a roost in Lewis County, West Virginia near milepost 51.0. The work area was shifted 141 feet east to avoid impacts on the identified roost tree;
- a juvenile male northern long-eared bat was tracked to a roost in Greenbrier County, West Virginia near MP 150.6. Access road MVP-GB-190 in Greenbrier County was shifted to avoid impacts on the identified roost tree;
- a juvenile male northern long-eared bat was tracked to a roost in Braxton County, West Virginia near milepost 74.6. The construction right-of-way was shifted 20 feet to the west to avoid impacts on the identified roost;
- avoid impacts on potentially suitable hibernacula in the Project vicinity to the maximum extent practicable;
- access road MVP-MN-264 in Montgomery County, Virginia was abandoned to avoid impacts on Old Mill Cave;
- access road MVP-WB-120 in Webster County, West Virginia was abandoned to avoid impacts on portal CRA-PO-00001;
- the pipeline route was moved to the east to avoid impacts on portal SJTB-PO-00002 in Greenbrier County, West Virginia;
- the pipeline route was moved 0.25-mile to the north of Canoe Cave in Giles County, Virginia to avoid impacting this feature and removing forested habitat within 0.25 mile of the entrance to Canoe Cave;
- suspend tree clearing operations from April 1 to November 15 within 5 miles of entrances to known Indiana bat hibernacula and within 0.25 mile of entrances to known northern long-eared bat hibernacula to prevent mortality to individuals engaging in autumn swarming or spring staging activities;
- suspend tree clearing operations from June 1 through July 31 to prevent mortality to non-volant young;
- clearly mark the Project construction right-of-way to help ensure that contractors do not accidentally remove more trees than anticipated to maintain the maximum amount of suitable summer maternity habitat;
- prepare and distribute information for the training of construction personnel that provides information about biology of Indiana and northern long-eared bats, activities that may affect bat behavior, ways to avoid and minimize these effects, and appropriate procedures to follow as they relate to Project-specific conservation measures;
- implement sediment and erosion control measures, ensure restoration of pre-existing topographic contours after any ground disturbance, and restore native vegetation (where possible);
- control erosion and sediment by using appropriate BMPs (as described previously). Environmental Inspectors would be present onsite during construction, and until stabilization after construction. Any erosion and sedimentation issues would be addressed immediately;
- minimize lighting impacts on bats by instituting a 7:00 a.m. to 7:00 p.m. work day, except as mandated by safety standards. The directional luminous intensity of lighting structures used during construction would be proportional to work area required to complete the task. Permanent outdoor lighting would be photocell controlled at compressor stations to only be on at night. Mountain Valley would

utilize fully shielded, "full cut-off" type lighting fixtures to minimize objectionable light from each station. "Full cut-off" means no direct upward lighting is emitted above the horizontal plane and, therefore, provides the maximum possible shielding to prevent unintentional lighting of surrounding areas. Further, outdoor lighting would be located on each station perimeter and pointed inward toward the station;

- allow natural woodland regeneration of temporary and additional work spaces;
- use water trucks to dampen the area and control fugitive dust when construction causes dust that affects wooded lands when roosting bats may be present (most frequently in summer, but also in spring and autumn);
- conduct future maintenance activities that involve tree removal, limb trimming, or pruning between November 15 and March 31 to avoid disturbance to bats, except in cases of human safety-related issues. If the seasonal restriction cannot be met, a qualified bat biologist would investigate trees for the presence of bats to avoid a take. Prior to conducting these investigations, coordination would be undertaken with FWS and other agencies as necessary to ensure the suitability of such a survey; and
- maintain areas that must be kept open for pipeline operation and safety by mowing at the maximum time interval required to prevent woody encroachment (e.g., every 3 years) and late in the growing season of any year (preferably August).

5.2.2 Rusty Patched Bumble Bee

Mountain Valley would implement conservation measures to avoid, minimize, and mitigate potential adverse effects on the rusty patched bumble bee from construction, operation, and maintenance of the MVP in Braxton, Fayette, Lewis, and Nicholas Counties in West Virginia and Montgomery and Giles Counties in Virginia. The conservation measures would include the following:

- use appropriate restoration seed mixes targeted for the rusty patched bumble bee, including native plant species known to be visited by the rusty patched bumble bee and containing a mix of flowering plant species with continual floral availability through the entire active season of the rusty patched bumble bee (March to October);
- consider foraging needs of pollinators when creating sub-canopy, shrub, and riparian mixes;
- restrict use of pesticides and herbicides;
- prohibit use of insecticides, including systemic insecticides;
- use herbicides only for invasive plant species control and only as requested by the landowner or land managing agency;
- attempt to only apply herbicides when flowers are not open;
- control invasive species on edges to encourage ephemeral spring wildflowers; and
- minimize disturbances to vegetation and create a dispersal corridor for insects by mowing open right-of-way on a rotating schedule with multiple-year cycles.

Long-term maintenance of the MVP corridor may be beneficial to the rusty patched bumble bee and many other species after initial impacts.

5.3 FEDERALLY LISTED PLANTS

In addition to the conservation measures listed above for bats and the rusty patched bumble bee, Mountain Valley would implement conservation measures to avoid, minimize, and mitigate potential adverse effects on federally listed plants from construction, operation, and maintenance of the Project as follows:

- avoid introducing exotic/invasive species in organic materials brought onsite during construction by thoroughly cleaning equipment prior to mobilization to Project Area;
- establish equipment cleaning stations to thoroughly wash all equipment before transporting it to the next construction spread;
- implement selective spot treatment or eradication of exotic/invasive plant species encountered during construction and operation of the Project;
- strip topsoil from full width of the construction right-of-way in wetlands, agricultural tracts, Jefferson National Forest lands, and residential areas and store it separately from other soils in areas identified as containing higher than usual concentrations of exotic/invasive plant species;
- commit to using native seed mixes, as developed by the Wildlife Habitat Council and Mountain Valley's local seed supplier, Ernst Conservation Seeds, Inc., during restoration efforts; and
- minimize the amount of time bare soil is exposed during construction to reduce opportunity for exotic/invasive plants to become established.

If federally listed plant species are located prior to construction, Mountain Valley would surround the area with fencing and require that construction activities avoid the area. If the plants are located within the construction area and cannot be avoided, Mountain Valley would transplant the specimens to an appropriate location outside of the Project Area.

5.4 FEDERALLY LISTED AQUATIC SPECIES

Mountain Valley would also implement additional conservation measures to avoid, minimize, and mitigate potential adverse effects on freshwater mussels and fish from construction, operation, and maintenance of the MVP by avoiding impacts on waterbodies where possible. Specific conservations measures are listed below.

- The Little Kanawha River in Braxton County, West Virginia is listed as a Group 2 stream; Mountain Valley has implemented avoidance and minimization measures in this river including the following:
  - o the pipeline crossing location avoids known occurrences of federally endangered mussels in the Little Kanawha River by traversing upstream of Burnsville Lake, therefore upstream of known populations of federally endangered mussels,
    - (1) Mountain Valley is no longer proposing to use the Little Kanawha River as a water source for hydrostatic testing; and
    - (2) Mountain Valley proposes to use two existing public-use roads (Gregory Road, Gregory Lake Lane) that currently traverse the Little Kanawha River via ford crossings. Mountain Valley

would improve the existing ford crossings by installing bridges across the river.

- The pipeline route would avoid known occurrences of federally endangered mussels in the Elk River by traversing the Elk River upstream of Sutton Lake in Webster County, West Virginia where the river is listed as a Group 1 waterbody and federally endangered mussels are not expected;
- The surface water sources for hydrostatic testing in West Virginia exclude any streams potentially supporting federally listed species; only municipal water sources would be used in Virginia;
- Mountain Valley would cross Craig Creek in Montgomery County, Virginia using the open-cut dry-ditch method, which Mountain Valley determined is most preferable due to the controlled visible work site, short crossing duration; the conventional bore and HDD methods are considered infeasible due to the following logistical and safety reasons:
  (1) additional workspace necessary for site drill support and bore pit spoil is not available at the crossing on the east side of Craig Creek;
  (2) the proximity of the west bore pit to Craig Creek and its depth below the creek could create a construction safety issue due to the presence of groundwater that could weaken the pit walls and the volume of groundwater that must be continually pumped out during boring; and
  (3) the HDD method risks an inadvertent release and horizontal break in the pipeline alignment.
- Mountain Valley would implement the following avoidance and minimization measures for crossing Craig Creek:
  - the MVP pipeline would cross Craig Creek once and an access road would cross Craig Creek via a bridge; previously proposed Project routes included four crossings of Craig Creek, including three pipeline crossings and use of an existing access road ford crossing; the access road crossing was modified to entail improvement of the access road and construction of a bridge to span the stream and thereby minimizing instream disturbances;
  - Mountain Valley would adhere to standards established in VADEQ Virginia Erosion & Sediment Control Field Manual (1995) and implement enhanced erosion and sediment (E&S) control BMPs in sensitive areas and/or high water-energy areas (yet to be determined);
  - most of the Craig Creek valley traversed by the Project is owned by Jefferson National Forest; Mountain Valley is coordinating with the FS to minimize potential impacts of sedimentation on Craig Creek; an alternatives analysis was completed to assess various alignments near the Craig Creek crossing that produces the least amount of potential sedimentation impacts (see section 3.0 of the final EIS);
  - Mountain Valley is committed to minimizing the duration of bare soil exposure during construction and restoration; Mountain Valley would minimize the time elapsed between vegetation clearing and grubbing/ grading/ trenching in the Craig Creek Valley; the construction timeline would immediately follow tree clearance within the Craig Creek watershed;

    - Mountain Valley would apply temporary seed/mulch to topsoil piles at the end of the day they are created;
    - Mountain Valley would temporarily mulch/seed disturbed right-of-way if the areas would remain inactive for more than 4 days at any point during construction and through installation of the pipeline and backfill to rough grade; if the right-of-way would remain inactive for more than 4 days once returned to rough grade, Mountain Valley would apply temporary seed/mulch to stabilize the area until full restoration is complete (Mountain Valley construction can accommodate an eight-week timeframe between right-of-way stabilization (e.g., backfill, mulching) and restoration);
    - Mountain Valley would mulch back-filled areas of the trench within 4 days;
    - Mountain Valley would leave temporary sediment control measures in place for one year after seeding;
    - Mountain Valley would reduce the right-of-way width at the Craig Creek crossing to less than 75 feet;
    - Mountain Valley would keep riparian timber and vegetation intact within 50 feet of each streambank and clearing activities would only occur immediately prior to instream construction; and
    - Mountain Valley would not conduct instream construction activities during time-of-year-restrictions for the James spinymussel (May 15 to July 31) in Craig Creek because of known populations downstream of the Action Area.
- Mountain Valley adjusted the MVP route to the north to eliminate two crossings of the Blackwater River in Franklin County, Virginia and thereby avoid suitable habitats for Roanoke logperch;
- Mountain Valley would locate the right-of-way and as many ATWS as possible at least 100 feet away from waterbodies that potentially support federally listed aquatic species;
- Mountain Valley would avoid instream construction activities in the North Fork Roanoke River by using Reese Mountain Road (MN-276.03) as an access road during construction efforts; Reese Mountain Road traverses the North Fork Roanoke River via an existing, paved bridge; therefore no instream construction impacts would be anticipated;
- Mountain Valley would use E&S control methods during construction of the MVP including (but not be limited to) the following: compost filter sock (e.g., single and triple stack); silt fence; super silt fence; belted silt fence; waterbars; temporary diversion berms; cross-culverts; broad based dips; rock checkdams; rock construction entrances; cofferdams; timbermats; seeding/mulching; erosion control blanketing; hydro-seed; hydro-mulch; dewatering structures; and sediment filter bags; Mountain Valley would minimize construction during rainy conditions, perform frequent inspections of the E&S control devices, and ensure appropriate grading;
- Mountain Valley would adhere to applicable state or federal required time-of-year-restrictions for instream construction including:
    - Snuffbox (mussel) – April 1 to June 30;
    - Clubshell (mussel) – April 1 to June 30;
    - Roanoke logperch – March 15 to June 30; and
    - James spinymussel – May 15 to July 31.

- Mountain Valley would remove non-federally listed freshwater mussels (by qualified and approved surveyors) from the stream bed and relocating them upstream outside of the impact area prior to construction; and
- Mountain Valley would remove all fish from work areas within waterbodies crossed within Virginia, per the VADGIF request.

5.5 FERC REQUIREMENTS

We included 41 environmental recommendations in our final EIS issued on June 23, 2017. These recommendations may be accepted or fulfilled by Mountain Valley prior to certificate issuance (if the Project is authorized by the Commission), or prior to construction, or alternately may be required by the Commission as part of a certificate order. Several of these recommendations are pertinent to avoidance, minimization, or mitigation of effects for wildlife and aquatic habitats, including those containing or potentially containing federally listed species. These recommendations include:

- **No. 14 –** Prior to construction, Mountain Valley shall file with the Secretary, for review and written approval by the Director of Office of Energy Projects (OEP), revised erosion control plans that contain only native species.
- **No. 21 –** Prior to construction, Mountain Valley shall file with the Secretary, for review and written approval of the Director of OEP, source, location, and quantities of water which would be used for dust control.
- **No. 22 –** Prior to construction, Mountain Valley shall adopt into its proposed pipeline route the alternative alignment for the crossing of the Pigg River and adopt an HDD as the crossing method. As part of its Implementation Plan, Mountain Valley shall file with the Secretary a revised alignment sheet, a summary comparison of impacts between the HDD alignment and the original alignment, and an HDD Contingency Plan, for the review and approval of the Director of OEP.
- **No. 24 –** Prior to construction, Mountain Valley shall file with the Secretary, for review and approval by the Director of OEP, either a plan to maintain a 15-foot buffer from the tributary to Foul Ground Creek or proposed mitigation measures to minimize impacts on the waterbody.
- **No. 26 –** Prior to construction, Mountain Valley shall file with the Secretary its final *Migratory Bird Conservation Plan*. The plan shall include impact avoidance, minimization, restoration, and/or mitigation measures for the impacts on migratory birds and it shall be prepared in coordination with the FWS, WVDNR, and VADGIF.
- **No. 28 –** Prior to construction, Mountain Valley shall file with the Secretary the results of all remaining environmental surveys (water resources, wetlands, cultural resources, and threatened and endangered species) for all cathodic protection groundbeds.
- **No. 34 –** Prior to construction of the Pig River HDD crossing, Mountain Valley shall file with the Secretary an HDD noise analysis identifying the existing and projected noise levels at each noise sensitive area (NSA) within 0.5 mile of the HDD entry and exit site. If noise attributable to the HDD is projected to exceed a day-night L_{dn} of 55 dBA at any NSA, Mountain Valley shall file with the noise analysis a mitigation plan to reduce the projected noise levels for the review and written approval by the

Director of OEP. During drilling operations, Mountain Valley shall implement the approved plan, monitor noise levels, and make all reasonable efforts to restrict the noise attributable to the drilling operations to no more than an L_{dn} of 55 dBA at the NSAs.

- **No. 40 –** Mountain Valley shall file noise surveys with the Secretary no later than 60 days after placing the equipment at the Bradshaw, Harris (including the WB Interconnect), and Stallworth Compressor Stations into service. If full load condition noise surveys are not possible, Mountain Valley shall provide interim surveys at the maximum possible horsepower load within 60 days of placing the equipment into service and provide the full load survey within 6 months. If the noise attributable to the operation of all of the equipment at each station under interim or full horsepower load exceeds an L_{dn} of 55 dBA at the nearest NSA, Mountain Valley shall file a report on what changes are needed and shall install the additional noise controls to meet the level within 1 year of the in-service date. Mountain Valley shall confirm compliance with the above requirement by filing a second noise survey with the Secretary for each station no later than 60 days after it installs the additional noise controls.

Finally, we included a recommendation that would prevent Mountain Valley from initiating construction prior to the completion of the consultation process for Section 7 of the ESA:

- **No. 27 –** Mountain Valley shall not begin construction of the proposed facilities until:
  - all outstanding and required biological surveys for federally listed species are completed and filed with the Secretary;
  - the FERC staff completes any necessary ESA Section 7 informal and formal consultation with the FWS; and
  - Mountain Valley has received written notification from the Director of OEP that construction and/or use of mitigation (including implementation of conservation measures) may begin.

6.0 STUDIES COMPLETED IN SUPPORT OF THE BIOLOGICAL ASSESSEMENT

6.1 BATS

6.1.1 Mist-Net Surveys

Mountain Valley sampled 338 mist-net sites (1,953 complete and 426 partial net nights) along the Project route from May 15 to August 15, 2015 and 3 mist-net sites (6 complete and 6 partial net nights) from May 15 to May 26, 2016.

Mountain Valley conducted mist-net surveys following the FWS 2015 Range-wide Indiana bat Summer Survey Guidelines, which are also applicable to northern long-eared bats for summer surveys. Mountain Valley implemented one exception to the protocols following discussions with the FWS Elkins Field Office and the WVDNR. The exception entailed increasing the distance between sampling locations beyond the recommended one sampling site per 0.6 mile (1 kilometer). At the time of the 2015 mist-net surveys, the interim 4(d) rule for the northern long-eared bat was in place. Based on the FWS Northern Long-Eared Bat Interim Conference and Planning Guidance (FWS, 2014), all lands within 1.5 miles (2.4 kilometers) of a northern long-eared bat roost location and within 2.5 miles (4 kilometers) of a capture with no associated roost location were considered "known, occupied" habitat for the threatened bat species. Thus, when northern long-eared bats were captured during mist-net surveys for the Project, further mist-net surveys were suspended within the appropriate radius. As a result, mist-net surveys were not conducted along approximately 42.4 percent (128.9 miles) of the proposed route and 50 percent (102.3 miles) of access roads because these Project features fall within the designated buffers surrounding northern long-eared bat captures and/or roost locations. Northern long-eared and Indiana bats are assumed present within all unsurveyed areas for the purposes of this document.

Throughout surveys, Mountain Valley captured 1,476 bats representing nine species: 763 big brown bats (*Eptesicus fuscus*), 538 eastern red bats (*Lasiurus borealis*), 74 northern long-eared bats, 38 silver-haired bats (*Lasionycteris noctivagans*), 24 eastern small-footed bats (*Myotis leibii*), 16 tri-colored bats (*Perimyotis subflavus*), 10 eastern hoary bats (*Lasiurus cinereus*), 10 evening bats (*Nycticeius humeralis*), and 3 little brown bats (*Myotis lucifugus*). No Indiana, gray, or Virginia big-eared bats were captured. The northern long-eared bat captures included 29 adult males, 21 juveniles, 19 reproductive adult females, and 5 non-reproductive adult females.

6.1.2 Telemetry Surveys and Emergence Counts

Following the capture of the northern long-eared bats, Mountain Valley attached radio transmitters to the bats and tracked the bats to their diurnal (i.e., daytime) roosts. Each identified roost tree was observed for a minimum of 2 nights, beginning one half hour before sunset, and lasting until bats finish emerging, or darkness precluded accurate counting. The findings of the surveys and counts are summarized in section 7.1.2 below.

6.1.3 Hibernacula Searches and Harp Trapping Surveys

From November 2014 to January 2017, Mountain Valley searched (within the bounds of access permission) for any voids and underground features within the 300-foot-wide environmental survey corridor centered on the pipeline and access road centerlines, and within all ATWSs and aboveground facilities. Mountain Valley used harp traps to sample select potentially suitable portals in West Virginia and Virginia between September 2015 and October 2016. The results of the searches and surveys are summarized in sections 7.1.2 and 7.2.2 below.

6.1.4 Habitat Assessment Surveys

Mountain Valley completed detailed habitat assessments for portions of the Project that would intersect protective buffers associated with Indiana and northern long-eared bat captures, roosts, and hibernacula from February 2015 through November 2015. Mountain Valley ranked (i.e., high, moderate, low) the potential suitability of trees to serve as roosts and the suitability of the habitat in general for foraging. The stated goal of the surveys was to assess habitat suitability for Indiana and northern long-eared bats in order to quantify potential impacts on the species that could be caused by year-round timber removal during construction of the Project.

Experienced and permitted bat biologists surveyed the environmental survey corridor, centered on the pipeline (300 feet wide) and access road (50 feet wide) centerlines, and all additional temporary workspace and aboveground facilities. Mountain Valley identified trees and "habitat patches" that were biologically similar and suitable for use by roosting and foraging bats based on available literature, habitat models (3D/Environmental, 1995), and experience with the species. The biologists noted the overall suitability of each habitat patch, mapped the location of each potential roost tree, and ranked the overall suitability (i.e., roosting potential) of each tree as high, moderate, or low. The results of the searches and surveys are summarized in sections 7.1 and 7.2 below.

6.2 ROANOKE LOGPERCH

6.2.1 Stream Habitat Assessments

In 2015, Mountain Valley completed qualitative habitat assessments at the proposed crossings of waterbodies with the potential to support populations of Roanoke logperch. Mountain Valley assessed reaches about 328 feet upstream and downstream of the proposed MVP footprint at the crossings to determine whether the habitat would be suitable for the presence of Roanoke logperch. In 2016, the VADGIF and FWS requested that remaining habitat assessments increase the distance surveyed upstream and downstream by about 1,640 feet to 3,281 feet, depending on the size of the drainage basin surrounding the site. The results of the searches and surveys are summarized in section 7.5 below.

6.3 FRESHWATER MUSSELS

6.3.1 West Virginia

Mountain Valley surveyed streams that would be crossed by the MVP in West Virginia with upstream drainages greater than 10 square miles for the presence of freshwater mussels from July 2015 to September 2015 and June 2016 to September 2016. Mussel surveys were successfully completed at nine Group 1 stream crossings and at three Group 2 stream crossings[7]. One stream crossing, the Gauley River (Group 1 stream), was not fully assessed because of high stream velocities (i.e., whitewater rapids) and unsafe diving conditions, and as a result the WVDNR waived the need for surveys via email correspondence on September 29, 2015. Mountain Valley proposes to withdrawal water from the Little Kanawha River (Group 2 stream) via temporary, floating surface water pumps. Direct instream impacts are not anticipated; however, because a mussel assessment was completed in September 2016 and no evidence of mussels was noted in the vicinity of the withdrawal site. A site-specific water withdrawal monitoring plan would be coordinated, developed, and submitted to WVDNR and FWS for approval to ensure surface water withdrawal operations do not adversely affect the nearest freshwater mussel population.

6.3.2 Virginia

Mountain Valley conducted freshwater mussel surveys and freshwater mussel habitat suitability assessments in streams that would be crossed by the MVP in Virginia with drainages greater than 5 square miles. Mountain Valley conducted the surveys and assessments from April 2015 to October 2015 and April 2016 to September 2016.

6.4 PLANTS

Mountain Valley conducted surveys for federally listed plant species between May 2015 and September 2016. A study plan outlining methods for plant surveys was submitted to the FWS (West Virginia and Virginia field offices), VADCR-DNH, and WVDNR on June 3, 2015, and concurrence was provided by the VADCR-DNH on June 10, 2015, the FWS in Virginia on June 17, 2015, and by the FWS in West Virginia on June 29, 2015. The WVDNR deferred to the FWS in West Virginia on June 16, 2015. Surveys were conducted during the optimal survey time frames for each species as set forth by the respective agencies.

Mountain Valley completed a desktop habitat analysis to identify potentially suitable habitat and to determine the specific survey areas. Field surveys were completed by a FWS Certified Plant Surveyor. Field surveys were completed using a pedestrian meander search technique across the 150 foot-wide right-of-way. Table 6.4-1 provides the number of acres and miles searched for federally listed species within the Project Area. In areas where habitat conditions were designated as highly suitable for any of the listed species, more intensive searches were employed.

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7 Group 1 streams are small to mid-sized streams not suspected of containing endangered species; Group 2 streams are small to mid-sized streams expected to contain endangered species (Clayton et al., 2015).

TABLE 6.4-1

Acres and Miles of Project Area Searched for Federally Threatened and Endangered Plant Species Along the Proposed Mountain Valley Pipeline Route in Virginia and West Virginia

Plant Species	Total Acres Surveyed	Acres Surveyed within the Construction Workspaces	Total Miles Surveyed	Miles Remaining to Survey	Acres Remaining to Survey
Northeastern bulrush	35.9	14.8	0.2	0.0	0.0
Running buffalo clover	438.5	217.3	24.4	0.1	1.8
Shale barren rock cress	272.8	129.6	10.6	0.1	29.5
Small whorled pogonia	335.3	158.4	12.8	0.1	29.5
Smooth coneflower	524.7	154.7	24.5	0.0	0.0
Virginia spiraea	3.6	2.7	0.1	0.1	4.3

7.0 TARGET SPECIES WTIHIN THE ACTION AREA

This section of the BA presents biological and ecological information relevant to the potential effects of the Project on federally threatened and endangered species. Other background information related to the biogeography, biology, and ecology of the species can be found in the respective species profiles provided by the FWS and the references listed in section 11.0 of this BA.

7.1 INDIANA BAT

Indiana bats are medium-sized bats in the genus *Myoti*s closely resembling little brown bats (*Myotis lucifugus*) but differing in coloration. The fur of Indiana bats is a dull grayish chestnut color rather than the bronze of little brown bats. The basal portion of the hairs on the back of Indiana bats is a dull-lead color. The underparts of the Indiana bat are pinkish to cinnamon, and their hind feet are smaller and more delicate than those of little brown bats. The calcar (heel of the foot) of Indiana bats is strongly keeled unlike that of little brown bats. The average body length of Indiana bats ranges from 1.6 to 1.9 inches.

7.1.1 Distribution

The geographic range of Indiana bats includes much of the eastern, southeastern, and north central United States (figure 7.1.1-1). They migrate seasonally between caves (hibernacula), where they hibernate during winter months, and their summer range where they roost in dead, dying, or live trees with cracks, crevices, or exfoliating bark. The FWS has records of winter populations of Indiana bats within 19 states: Alabama, Arkansas, Connecticut, Illinois, Indiana, Kentucky, Maryland, Michigan, Missouri, New Jersey, New York, North Carolina, Ohio, Oklahoma, Pennsylvania, Tennessee, Vermont, Virginia, and West Virginia. Of these, seven states contain Priority 1 hibernacula[8] (P1) and 11 states (including the seven states containing Priority 1 hibernacula) contain Priority 2 (P2) hibernacula. Greater than 90 percent of the estimated population of Indiana bats hibernated in just five states in 2005 (the most recent year of data provided in the FWS, 2007 publication): Indiana, Missouri, Kentucky, Illinois, and New York. About 96 percent of the total population hibernated in P1 and P2 hibernacula.

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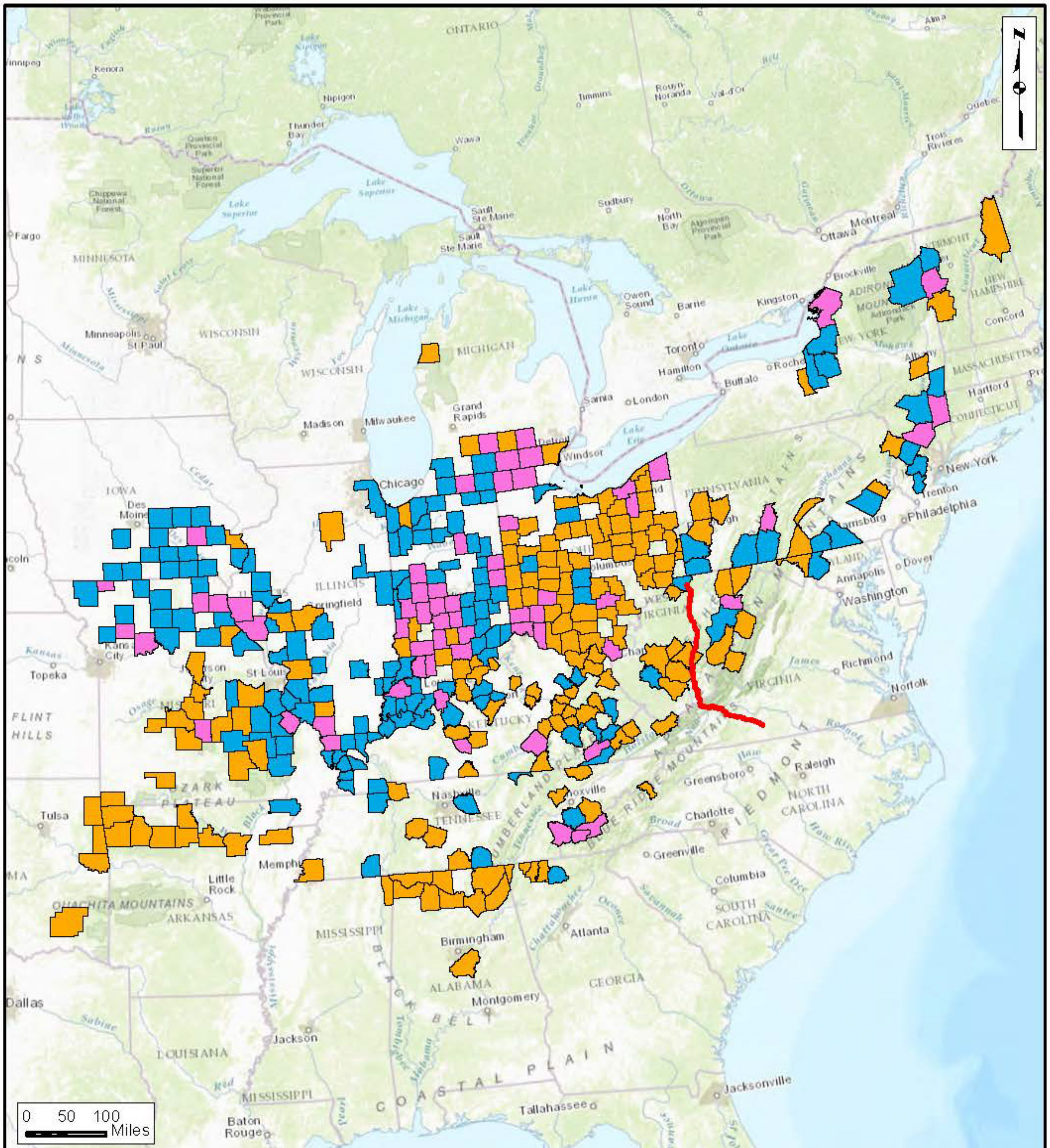
[8] Hibernacula are assigned priority numbers based on the current and/or historically observed winter population sizes they contain; Priority 1 (P1) hibernacula contain greater than or equal to 10,000 bats and are considered essential to recovery and long-term conservation of the species; Priority 2 (P2) hibernacula contain greater than 1,000 but fewer than 10,000 bats and are considered to contribute to recovery and long-term conservation of the species; Priority 3 (P3) hibernacula contain 50 to 1,000 bats and are considered to contribute less to recovery and long-term conservation of the species; Priority 4 (P4) hibernacula contain fewer than 50 bats and are considered least important to recovery and long-term conservation of the species.



Proposed Mountain Valley Project Route

County with Record of Indiana Bat Reproductive Occurrence

County with Record of Indiana Bat Summer Non-Reproductive Occurrence

County with Record of Indiana Bat Reproductive and Summer Non-Reproductive Occurrence

Figure 7.1.1-1

Mountain Valley Project

Distribution of Indiana Bats

The summer range of Indiana bats includes much of the eastern deciduous forestlands between the Appalachian Mountains and Midwest prairies of the U.S. However, distribution throughout the range is not uniform. Indiana bats are most common in southern Iowa and Michigan, northern Missouri, Illinois, and Indiana, and are considered rare throughout Appalachia. This is likely due to the geographic distribution of important hibernacula and the typically cooler and more variable temperatures and generally wetter climate of the higher elevations and latitudes in the Appalachia region, which may significantly increase the cost of reproduction (Brack et al., 2002).

7.1.2 Habitat

Indiana bats are "cave bats" in the winter during hibernation, and "tree bats" in the summer during their reproductive season. When female Indiana bats emerge from hibernation, they migrate to maternity colonies that may be located up to several hundred miles away (Kurta and Murray, 2002). Indiana bats exhibit strong site fidelity to summer roosting and foraging areas (Kurta and Murray, 2002; Kurta et al., 2002). Females form nursery colonies under exfoliating bark of dead, dying, and living trees in a variety of habitat types, including uplands and riparian habitats. A wide variety of tree species, including occasional pines (Britzke et al., 2003), are used as nursery colonies, indicating that it is tree form, not species that is important for roosts. Individual roost trees may be habitable for one to several years, depending on the species and condition of the tree (Callahan et al., 1997). Roost trees are typically located in canopy gaps in a forest, along fence lines, or within 50 feet of a forest edge and receive direct sunlight for more than half of the day. The amount of direct sunlight needed per day may vary with latitude.

Roosts that contain more than 20 bats are generally referred to as primary roosts, while secondary roosts hold fewer bats. Primary roost trees are often greater than 18 inches in dbh while secondary roost trees may be as small as 9 inches dbh (Gardner et al., 1991; Callahan et al., 1997; Kurta et al., 2002; Miller et al., 2002; Carter, 2003). As many as 20 suitable roost trees per acre may be required to support a single nursery colony (Gardner et al,. 1991; Miller et al., 2002; Carter 2003).

Although male bats are somewhat nomadic and may migrate varied distances, most males remain near hibernacula throughout summer (Whitaker and Brack, 2002). Males can be caught at hibernacula on most nights during summer (Brack, 1983; Brack and LaVal, 1985), although there may be a large turnover of individuals between nights (Brack, 1983). The woodland roosts of male bats appear similar to maternity roosts (Kiser and Elliott, 1996; Schultes and Elliott, 2002; Brack and Whitaker, 2004; Brack et al., 2004), although smaller diameter trees may be used. Less space is required for a single bat than a colony of bats and thermal requirements differ.

Indiana bats often use open flyways as travel corridors, such as streams, woodland trails, small infrequently used roads, and possibly utility corridors, regardless of suitability for foraging or roosting (Brown and Brack, 2003). Members of maternity colonies forage in a variety of woodland settings, including upland and floodplain forest (Humphrey et al., 1977; Brack, 1983; Gardner et al., 1991). Foraging activity is concentrated above and around foliage surfaces, such as over the canopy in upland and riparian woods, around crowns of individual or widely spaced trees, and along forest edges. They forage less frequently over old fields, and occasionally over bushes in open pastures. Forest edges, small openings, and woodlands with patchy trees provide a better supply of insects for foraging on than do dense wooded areas (Tibbels and Kurta, 2003).

7.1.2.1 Summer Occurrence

In West Virginia, maternity colonies are known from Boone, Tucker, and Caroline Counties (FWS, 2007a; St. Germain et al., 2017) and summer captures are documented near the proposed route of the Project in Tyler and Wetzel Counties. A pregnant female, was captured in Wetzel County on June 10, 2010 (FWS, 2013a), indicative of the potential existence of maternity colonies in the area. Summer non-reproductive records are also known from Bath, Bland, Dickenson, Highland, Lee, Tazewell and Wise Counties, Virginia. No Indiana bats were captured on this Project during the 2015 and 2016 mist-net surveys.

To estimate abundance of Indiana bats in unsampled areas of the Action Area during the summer season of reproduction, average densities of the species were calculated for both Virginia and West Virginia. According to the FWS (2015a), there are 2,373 Indiana bats in West Virginia's estimated 11,749,842 acres of forest and 597 within Virginia's 15,765,700 acres of forest. For West Virginia, where the species is distributed across most of the state, density estimates were made by dividing the number of bats by the number of forested acres (i.e., 2,373 bats/11,749,842 forested acres), which gives the number of bats expected per forested acre (0.000202 bats/forested acre). In Virginia, the species does not occur throughout the entire state. Based on a georeferenced version of the Indiana bat distribution taken from the *Bats of Illinois*, just over half (51.9 percent) of the state of Virginia is within the distributional range of the species. Summer density was calculated by dividing the number of bats by the number of forested acres times the proportion of the state within the range (i.e., 597/[15,767,700 × 0.519]). Based on this calculation, Indiana bat density within areas of known occupancy in Virginia was estimated as 0.000073 bats/forested acre.

7.1.2.2 Summer Habitat

Given that no Indiana bats were captured by Mountain Valley during mist-net surveys in 2015 and 2016, no occupied Indiana bat roosts were documented within the Project Area. However, potentially suitable summer habitat for Indiana bats is present along the entire length of the MVP. The Project intersects an area of known, occupied summer habitat from MPs 0.0 to 10.3 in Wetzel County, West Virginia associated with the capture of the above-mentioned pregnant female in 2010 (FWS, 2013a).

Mountain Valley completed detailed habitat assessments for portions of the Project that would intersect protective buffers associated with Indiana and northern long-eared bat captures, roosts, and hibernacula. The associated buffers entail the following distances: 1.5 miles from a northern long-eared bat roost; 2.5 miles from an Indiana bat roost; 3 miles from a northern long-eared bat capture site with no roost; and 5 miles from a hibernacula or Indiana bat capture site without a roost located. As part of the assessments, Mountain Valley assessed the potential suitability of trees to serve as roosts for Indiana bats. Mountain Valley concluded 986 trees have high potential suitability to serve as roosts, 4,346 trees have moderate potential, and 5,084 trees have low potential. Mountain Valley also assessed the foraging potential of the habitat. Mountain Valley concluded 649.5 acres have high foraging potential, 2,730.5 acres have moderate foraging potential, and 3,131.8 acres have low foraging potential. Of these areas, Mountain Valley judged that 10.9 percent of the acreage has high roosting potential, 29.4 percent has moderate roosting potential, 41.6 percent has low roosting potential, and 18.1 percent has no roosting potential for the Indiana bat.

7.1.2.3 Winter Hibernation, Autumn Swarming, and Spring Staging

Known and Potential Hibernacula Occurrence

Indiana bats are known to hibernate in 18 caves in Greenbrier, Mercer, Monroe, Pendleton, Preston, Randolph, and Tucker Counties, West Virginia. Greenbrier and Monroe Counties would be crossed by the Project. There are two Priority 3/4 winter hibernacula within 5 miles of the Project: Greenville Saltpeter Cave in Monroe County, West Virginia and Tawney's Cave in Giles County, Virginia. All features of the MVP are 2 miles or farther from the entrance to the Greenville Saltpeter Cave, which is outside the Action Area for the Project (see section 4.0). The construction right-of-way for the MVP would be less than 197 feet from the closest Tawny's Cave entrance.

Mountain Valley conducted field searches for portals to possible Indiana bat hibernacula from November 2014 through January 2017. Forty-four previously undocumented underground features and 8 known caves were identified during these searches, including Tawney's and Canoe Caves, with 24 determined to be potentially suitable for hibernating bats. Three of the suitable features would be located within the construction right-of-way (Crooks Crevice, PS-WV5-B-P2, and PS-WV5-B-P3). Mountain Valley surveyed all three features using harp traps and did not capture any bats. Mountain Valley surveyed 10 additional features that would fall within the Action Area but not within the Project footprint using harp traps in the fall 2015 and 2016. Appendix D provides a summary of the potential hibernacula within the Project Action Area as determined by Mountain Valley field searches or desktop analyses.

Canoe Cave is located about 0.25 mile from the Project and would therefore be within the Action Area. Mountain Valley did not survey Canoe Cave for the MVP; however, VADCR-DNH recently surveyed Canoe Cave and no Indiana bats were observed (personal communication between Mountain Valley and bat biologist Karen Powers on April 1, 2016). Therefore, Canoe Cave is considered unoccupied by Indiana bats for the purposes of this BA.

Four of the potentially suitable portals (BJD-PO-00001 through BJD-PO-00004) occur on an active surface mining site. These features were destroyed prior to Mountain Valley being able to conduct surveys for the MVP. One potentially suitable portal (CRA-PO-00001) discovered during Project surveys is no longer within the Action Area; the proposed access road that would have potentially affected the portal was abandoned. In addition to these features, Mountain Valley identified Fred Bull's Cave as potentially suitable during surveys. Fred Bull's Cave would be outside of the Project Area but within the Action Area; however, Mountain Valley was not able to obtain land access to conduct field surveys beyond the initial assessment of the opening. Therefore, we are assuming the presence of Indiana bats within Fred Bulls Cave for the purposes of this BA.

In addition to the 52 features documented during field surveys, desktop analysis of geospatial data provided by the Virginia Speleological Society (VSS), Draper Aden Associates, and public comments submitted to FERC, indicate an additional 124 features exist outside of the survey corridor but within the vicinity of the MVP (i.e., within 5 miles). Fifty-seven of these features occur within the Project's Action Area. However, the suitability of these remaining features to provide habitat for bats during winter hibernation is unknown because Mountain Valley has not been granted land access. Publically available data (e.g., the Indiana bat recovery plan) suggest these caves are unlikely to host wintering populations of Indiana bats. These features are not included within the spatial data layer containing known occurrences supplied to Mountain Valley by the FWS, Elkins Field Office. Given that these 124 features outside the survey corridor have the potential to host Indiana bats and may be affected by Project activities, they are treated as occupied for the purposes of this BA. Table 7.1.2.3-1 lists the 124 features, their distance from the construction right-of-way.

Given the potential for impacts from tree removal and noise from construction of the MVP on these 124 unsurveyed features, Mountain Valley has committed to the following impact avoidance and minimization measures:

- If burning brush piles within 0.25 mile of known or presumed occupied hibernacula from August 15 to May 15, the brush piles would be no more than 25 feet by 25 feet, spaced at least 100 feet apart, and located at least 100 feet from known hibernacula entrances and associated sinkholes, fissures, or other karst features;
- No woody vegetation or spoil (e.g., soil, rock, etc.) disposal would occur within 100 feet of known or presumed occupied hibernacula entrances and associated sinkholes, fissures, or other karst features;
- Potential recharge areas of cave streams and other karst features that are hydrologically connected to known or presumed occupied hibernacula would be protected by employing relevant erosion control standards for stream and wetland crossings, as well as spill prevention, containment and control;
- Blasting within 0.5 mile of known or presumed occupied hibernacula would be conducted in a manner that would not compromise the structural integrity or alter the karst hydrology of the hibernacula (e.g., maximum charge of 2 inches per second ground acceleration would avoid impact to nearby structures);
- Equipment servicing and maintenance areas would be sited at least 100 feet away from streambeds, sinkholes, fissures, or other karst features;
- Operators, employees, and contractors working in areas of known or presumed Indiana bat habitat would be educated on the biology of the Indiana bat, activities that may affect bat behavior, and ways to avoid and minimize these effects;
- Herbicides would not be used for vegetation management to maintain any portion of the MVP right-of-way or aboveground facilities, except as requested by a landowner and in the Jefferson National Forest as requested by the FS; and
- Sediment and erosion control measures would be strictly implemented, any ground disturbance would be restored to pre-existing topographic contours, and restoration would use native vegetation (where possible), as specified in the Mountain Valley's Restoration and Rehabilitation Plan[9], upon completion of work within and known or presumed occupied spring staging and fall swarming habitat.

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[9] See accession No. 20170511-5018a

TABLE 7.1.2.3-1

124 Hibernacula Features of Unknown Suitability Within 5 Miles of the Mountain Valley Project

Feature Name	County	State	Distance From Construction Right-of-Way (feet)
Echols Cave	Giles	VA	4
Hog Hole	Giles	VA	73
High Voltage Cave	Giles	VA	103
Jones Cave	Giles	VA	126
Mill Creek Pit	Montgomery	VA	175
Unknown	Giles	VA	200
Williams Contact Shaft	Giles	VA	242
Lhoist Cave	Giles	VA	336
Johnsons Cave	Montgomery	VA	404
Newport Cave	Giles	VA	454
Conklin Sink Cave	Giles	VA	457
Slussers Chapel Cave	Montgomery	VA	541
Mahaffey Trash Cave	Giles	VA	625
Plumb Bob Pit	Giles	VA	632
Hoges Farm Cave	Giles	VA	824
Unnamed	Montgomery	VA	845
Missing Link Cave	Giles	VA	950
Big Stony Canyon Cave	Giles	VA	967
Jimzuther Cave	Giles	VA	996
Links Cave	Giles	VA	1,104
Kimbalton Cave	Giles	VA	1,145
Smokehole Cave	Giles	VA	1,331
Conklin Air Hole	Giles	VA	1,443
Kanodes Pit	Giles	VA	1,555
Terrible Tortoise Cave	Giles	VA	1,577
Pighole Cave	Giles	VA	1,638
Bob Henderson Pit	Montgomery	VA	1,715
Freeman Pit	Giles	VA	1,811
Hancock Blowhole	Montgomery	VA	1,827
Maroon Canyon Cave	Giles	VA	1,835
Pedlar Hills Cave	Montgomery	VA	1,921
Small Room Cave	Giles	VA	1,946
Knipling Slot Cave	Giles	VA	1,971
Just a Little Farther Cave	Giles	VA	2,096
Thompsons Cave	Montgomery	VA	2,108
Gardners Little Cave	Montgomery	VA	2,161
Porterfields Cave	Giles	VA	2,349
Spruce Run Mountain Cave	Giles	VA	2,363
Longs Cave No.2	Montgomery	VA	2,408

TABLE 7.1.2.3-1 (continued)

124 Hibernacula Features of Unknown Suitability Within 5 Miles of the Mountain Valley Project

Feature Name	County	State	Distance From Construction Right-of-Way (feet)
Freeman Treestand Cave	Giles	VA	2,485
Andrews Cave	Giles	VA	2,549
Mill Creek Cave	Montgomery	VA	2,578
Chockstone Pit	Giles	VA	2,674
McDonalds Cave	Giles	VA	2,752
Key Ridge Cave	Giles	VA	2,759
Doe Mountain Cave	Giles	VA	2,767
Freeman Hole	Giles	VA	2,830
Trap Door Cave	Giles	VA	2,849
Barkers Cave	Montgomery	VA	2,915
Corkscrew Cave	Giles	VA	2,967
Unnamed	Montgomery	VA	2,973
Bob Henderson Cave	Montgomery	VA	3,072
Windsor Pit	Giles	VA	3,087
Klotz Quarry Cave	Giles	VA	3,224
Spider Cave	Montgomery	VA	3,252
Calamity Chasm Cave	Giles	VA	3,304
Red Hawk Cave	Montgomery	VA	3,461
Virginian Cliff Cave	Giles	VA	3,549
Elliston Cliff Cave	Montgomery	VA	3,566
Williams Cave	Giles	VA	3,611
Devils Den Cave	Giles	VA	3,658
Phlegars Cave	Giles	VA	3,677
Big Stony Fissure Cave	Giles	VA	4,079
Salem Quarry Cave	Roanoke	VA	4,103
Isaac Williams Cave	Giles	VA	4,312
Thorn Tree Pot	Giles	VA	4,338
Hoot Owl Cave	Giles	VA	4,407
John Smith Cave	Giles	VA	4,458
Arthur Dowdys Cave	Giles	VA	4,480
Almosta Cave	Giles	VA	4,515
Johnnys Cave	Giles	VA	4,515
Smith Cave	Giles	VA	4,591
Gardners Cave	Montgomery	VA	4,689
Frankies Cave	Giles	VA	4,693
Glacial Leaf Cave	Giles	VA	4,777
Niagara Hole	Giles	VA	4,793
Jake Williams Cave	Giles	VA	5,110
Sams Cave	Giles	VA	5,143

TABLE 7.1.2.3-1 (continued)

124 Hibernacula Features of Unknown Suitability Within 5 Miles of the Mountain Valley Project

Feature Name	County	State	Distance From Construction Right-of-Way (feet)
Underwoods Cave No.1	Montgomery	VA	5,330
Claude Links Cave	Giles	VA	5,758
Pyrtles Cave	Giles	VA	5,810
Garrisons Cave	Roanoke	VA	5,919
Bear Hole	Roanoke	VA	6,053
Will Johnsons Cave	Giles	VA	6,115
New Dixie Cave	Roanoke	VA	6,211
Pseudo-Garrisons Cave	Roanoke	VA	6,253
Maybrook Sinkhole Cave	Giles	VA	6,278
Rocky Sink School Cave	Giles	VA	6,490
Givens Cave	Roanoke	VA	6,567
Pembroke Railroad Cave	Giles	VA	6,581
Dixie Caverns	Roanoke	VA	6,821
Jan 1 2000 Cave	Giles	VA	7,106
Reads Cave	Giles	VA	7,116
Hoge Brothers Cave	Giles	VA	7,237
Kays Cave	Roanoke	VA	7,242
Dixie Annex Cave	Roanoke	VA	7,340
Cliff Cave	Giles	VA	7,395
Dead Cat Cave	Giles	VA	7,480
Blankenship Cave	Roanoke	VA	7,614
Mike Breens Cave	Giles	VA	7,807
Jim Millers Cave	Giles	VA	8,207
Sniders Cave	Giles	VA	8,352
Kings Cave	Giles	VA	8,352
460 Pit	Giles	VA	8,437
460 Cave	Giles	VA	8,470
Claypools Cave	Giles	VA	8,487
Lucas Cave	Giles	VA	8,743
Ripplemead Cliff Cave	Giles	VA	8,985
Rebel Yelp Cave	Roanoke	VA	9,086
Caldwell Cave	Giles	VA	10,522
Agnews Cave	Montgomery	VA	13,486
Thornhill Cave	Montgomery	VA	13,901
Poor Mountain Cave	Roanoke	VA	14,163
Greenville Glenray Cave	Monroe	WV	827
Bobcat Cave	Monroe	WV	1,053
Rich Creek Cave	Monroe	WV	1,486
Wolf Cave	Monroe	WV	2,937

TABLE 7.1.2.3-1 (continued)

124 Hibernacula Features of Unknown Suitability Within 5 Miles of the Mountain Valley Project

Feature Name	County	State	Distance From Construction Right-of-Way (feet)
Hans Creek Cave	Monroe	WV	5,652
Scampering Simmons Pit	Monroe	WV	9,698
Post Puke Pit	Monroe	WV	10,076
Lost Skier Pit	Monroe	WV	10,249
Coburn Cave	Monroe	WV	10,592
Ogdens Hole	Monroe	WV	12,236
Big Mother Sink	Monroe	WV	13,150

Estimates of Winter Abundance

As discussed above, there are two known Indiana bat hibernacula within 5 miles of the MVP: Greenville Saltpeter Cave and Tawney's Cave. Mountain Valley estimated abundance for these features using available survey data from the VADCR-DNH and WVDNR, where available.

The maximum population estimate for Indiana bats within the Greenville Saltpeter Cave is 300 (FWS, 2007a), but unpublished data maintained by the WVDNR suggest the current winter population to be less than 10 individuals, most likely due to white nose syndrome (WNS). Recent in-cave surveys for Indiana bats conducted by the WVDNR found six individuals in 2012 and four individuals in 2016. For the purposes of this BA, Mountain Valley used an estimate of six individuals for this feature.

The maximum population estimate of Indiana bats in Tawney's Cave is 14 (FWS, 2007a). In-cave winter surveys conducted in 2009, 2011, and 2013 yielded zero hibernating Indiana bats (Powers et al., 2015), suggesting this cave may no longer be occupied by this species during winter. To account for the potential for the species to occur within the cave, Mountain Valley treated Tawney's Cave similarly to the other suitable, surveyed portals within the Action Area (see below).

To account for the potential occurrence and abundance of Indiana bats within suitable but unsurveyed portals (including Tawney's, Fred Bulls, and Kimballton Mine caves) as well as the 124 features with unknown suitability, Mountain Valley estimated abundance using the best available information of the occurrence and abundance of Indiana bats in non-Priority 1/2 caves. Mountain Valley derived abundance from surveys conducted by Dalton (1987), Gates and Johnson (2006), and Powers et al. (2015), along with previous portal surveys conducted by Mountain Valley's bat survey contractor. Because many of these sources only documented bats captured via portal-trapping (e.g., harp traps), an effort was undertaken to correct for the general under-sampling of the population (i.e., the entire population is not exposed to portal traps). This effort is described fully in appendix C, but methods and results are outlined below.

Data Description and Model Development

Information from available studies (e.g., Whitaker and Rissler, 1992; Brack et al., 2005) as well as other projects conducted by Mountain Valley's bat survey contractor were compiled to create a dataset to estimate the relationship between portal-trap counts and in-cave counts. Counts were compiled for 6 different bat species (big brown, little brown, eastern small-footed, northern long-eared, Indiana, and tri-colored) at 41 separate localities (34 from Indiana, 6 from Virginia, and 1 from West Virginia). At each of these localities, at least one in-cave count and one portal-trap sample was available that were conducted within one year of each other.

In examination of this dataset, Mountain Valley found that portal-trap results may provide a reasonable index of winter population size if both the occurrence and expected abundance of wintering bats are correlated with the number of bats observed/captured during portal-trapping events. In order to quantify this relationship, a specific class of regression models known as hurdle models (Zuur et al., 2009) was used to model both the occurrence and abundance of bats (appendix C). Hurdle models jointly estimate abundance and occurrence of organisms as the product of two regression models: a logistic (or probit) regression model for occurrence and a count-based model for abundance when occupied.

Specifically, a multispecies hurdle model was deemed most appropriate for the analysis for this Project. The multispecies approach (DeWan and Zipkin, 2010; Ovaskainen and Soininen, 2010) was taken due to the small sample size of the Indiana bat presences and counts within the dataset, as well as the difficulty of getting accurate winter population size estimates for the northern long-eared bat, which is hypothesized to hibernate in small crevices within caves, making detection difficult. In the multispecies approach, both the occurrence and abundance components of the hurdle model are expanded to estimate parameters for all species studied jointly using a mixed effect formulation (appendix C). However, the northern long-eared bat was removed from this model due to the difficulty of detecting the species within in-cave counts. This multispecies approach recognizes that the species-specific relationship between portal-trap counts and winter counts may be different for each species studied but likely shares a common pattern among species. The advantage of this approach is two-fold:

- estimates are made for each species, even when data was limited, due to the ability to jointly utilize information across species; and
- the mean relationship can be used to create relationships for species not contained within the model training process; this is useful due to the difficulty of getting a winter estimate for northern long-eared bats.

Application to Portal-Trapping Dataset

The application of the hurdle model results to portals within the vicinity of the MVP involved multiple steps. First, data from surveys conducted by Dalton (1987), Gates and Johnson (2006), and Powers et al. (2015), and surveys conducted by Mountain Valley's bat survey contractor, were compiled into a database representing 527 unique features from six states: 290 from Pennsylvania, 172 from Virginia, 23 from West Virginia, 20 from Ohio, 20 from Kentucky, and 2 from New Jersey. Of these, 408 only had counts from portal-trapping, and the remaining features had results from in-feature counts.

For portals within the dataset where in-feature counts were available (e.g., Dalton 1987), no adjustment was made to correct winter abundance estimates. However, for surveys that had counts from portal-trapping but not in-feature counts, an estimate of the winter abundance was made using the multispecies hurdle model described above (detailed in appendix C). Using these counts, the expected number of Indiana bats was estimated as the mean winter abundance estimate. Thus, the expected number of Indiana bats in an unsampled but suitable feature is 2.007 bats. This estimate was also used as an estimate of the number of Indiana bats present within Tawney's Cave.

Information regarding the suitability of 124 features in the vicinity of the MVP is unknown, and thus the abundance estimate above is not applicable. For these features, the abundance estimate was multiplied by the proportion of features that are expected to be suitable within the region. This proportion was estimated using survey information performed for the MVP, because it represents the best available information within the vicinity of the Project. In total, 52 features were discovered within the survey corridor for the MVP. Of these 52 features, 24 were deemed suitable. Therefore, 46.2 percent of features with unknown suitability are likely to be suitable for hibernating bats. Multiplying the abundance estimate for suitable features by 46.2 percent provides an estimate of 0.9262 Indiana bats in features with unknown suitability within the vicinity of the Project.

7.2 NORTHERN LONG-EARED BAT

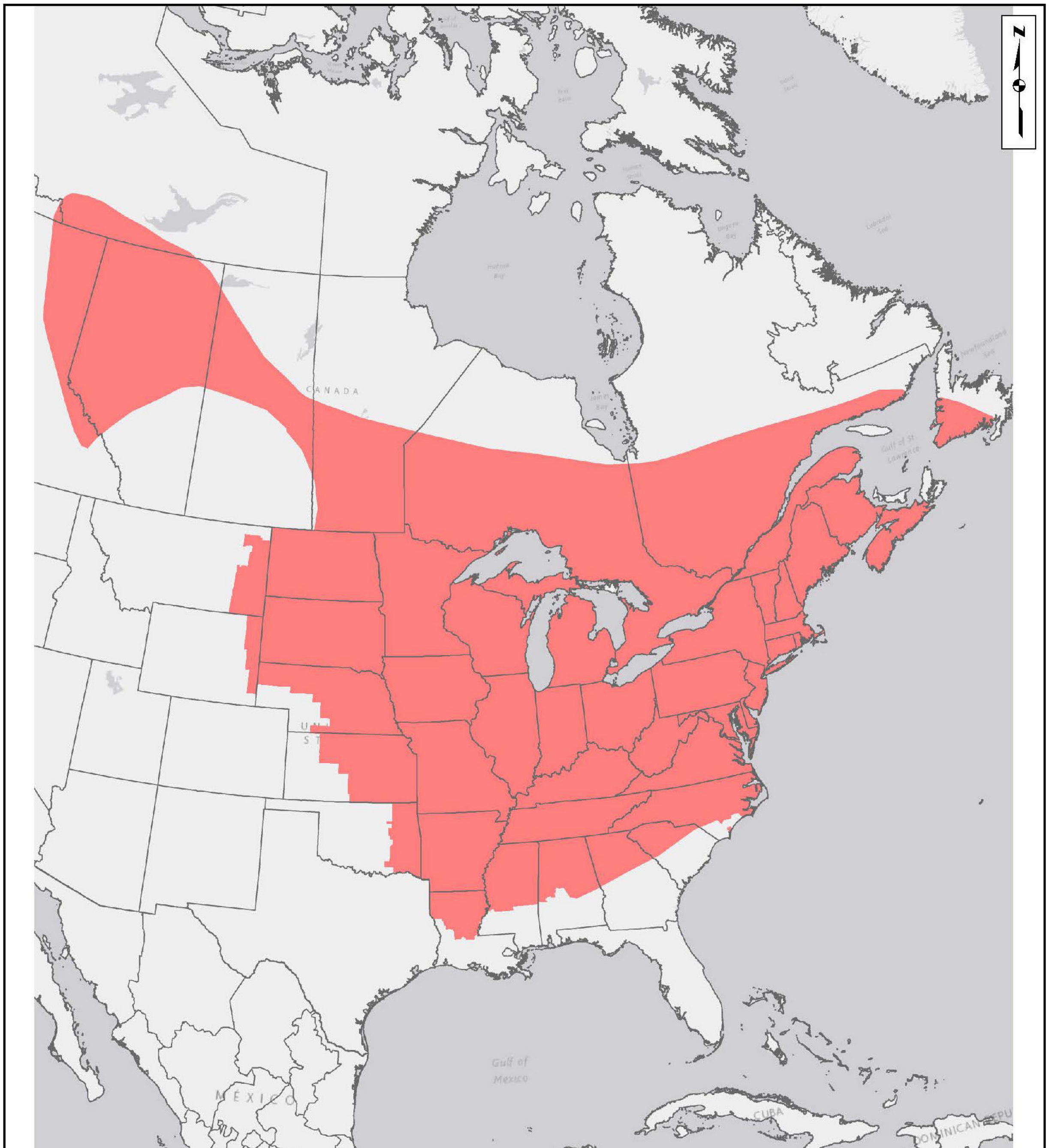
Northern long-eared bats are medium-sized bats in the genus *Myotis,* characterized by their long ears relative to other bats in the genus. They weigh about 0.17 to 0.28 ounces at maturity with average body lengths of about 3.0 to 3.7 inches. Females average slightly larger than males. The wing membrane connects to the foot at the base of the first toe. The fur of the northern long-eared bat is typically colored a light to dark brown on the dorsal side and a light brown on the ventral side (Caceres and Barclay, 2000; Whitaker and Mumford, 2009). Ears and wing membranes are usually a dark brown.

7.2.1 Distribution

The geographic range of northern long-eared bats includes much of the eastern and north central United States, and all Canadian provinces from the Atlantic Ocean west to the southern Yukon Territory and eastern British Columbia. Their general summer and winter ranges appear to be identical (Barbour and Davis, 1969).

Within the United States, northern long-eared bats are found in the District of Columbia and 37 States: Alabama, Arkansas, Connecticut, Delaware, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, New Hampshire, New Jersey, New York, North Carolina, North Dakota, Ohio, Oklahoma, Pennsylvania, Rhode Island, South Carolina, South Dakota, Tennessee, Vermont, Virginia, West Virginia, Wisconsin, and Wyoming (figure 7.2.1-1).

Northern long-eared bats are more common in the northern part of this range than in the southern part (Harvey, 1992) and they are rare in the northwestern portions (Nagorsen and Brigham, 1993; Caceres and Barclay, 2000).



Northern Long-Eared Bat Range

Figure 7.2.1-1

Mountain Valley Project

Distribution of Northern Long-Eared Bat in Summer

7.2.2 Habitat

Northern long-eared bats are “cave bats” in the winter, during hibernation, and “tree bats” in the summer during their reproductive season. During hibernation, they require areas in various sized caves or mines with constant temperatures, high humidity, and no air currents. Within the hibernacula, the bats are most often located in small crevices or cracks, often with only the nose and ears protruding (FWS, 2015b).

During the summer, northern long-eared bats typically roost underneath bark or in cavities or crevices of both live and dead trees (Sasse and Pekins, 1996; Foster and Kurta, 1999; Owen et al., 2002; Carter and Feldhamer, 2005; Perry and Thill, 2007; Timpone et al., 2010). Northern long-eared bats may also roost in colonies in human-made structures, such as buildings, barns, sheds, cabins, under eaves of buildings, behind window shutters, and in bat houses (Mumford and Cope, 1964; Barbour and Davis, 1969; Cope and Humphrey, 1972; Menzel et al., 2003; Amelon and Burhans, 2006; Whitaker and Mumford, 2009; Timpone et al., 2010). Male and non-breeding females typically roost in cooler locations, including caves and mines (Barbour and Davis, 1969; Amelon and Burhans, 2006).

Northern long-eared bats use multiple types of trees for roosts throughout their range, including different species of oak, maple, and even pine trees. The many different species used as roosts suggest that tree form, not species, is most important for choosing roost locations (Foster and Kurta, 1999). Northern long-eared bats often form social groups nested within networks of roost trees that contain a central, primary roost tree (Johnson et al., 2012). The bats may roost singly, or in groups of up to five among networks of 1 to 16 roost trees spread over areas ranging from less than 1 acre to upwards of 85 acres (Henderson and Broders, 2008; Johnson et al., 2012).

The primary roost trees are often in the early stages of decay and surrounded by greater basal area than other roost trees in the networks (Sasse and Pekins, 1996). Maternity colonies of northern long-eared bats are also generally located in large cavity trees in the early stages of decay (Johnson et al., 2012). Within roost networks, trees that are not central roost trees are typically cavity trees, while the central roost trees may be cavity trees or have exfoliating bark. The tendency of northern long-eared bats to select central roost trees in the early stages of decay indicates the bats are able to locate newly dead trees and establish those trees as hubs within roost networks.

Canopy coverage surrounding northern long-eared bat roosts can range from about 50 percent to more than 80 percent (Sasse and Pekins, 1996; Lacki and Schwierjohann, 2001; Perry and Thill, 2007; Timpone et al., 2010). The canopy coverage surrounding northern long-eared bat roosts may be in sections of forest with less canopy cover than the surrounding areas (Caceres, 1998; Sasse and Pekins, 1996), however this is not always the case (Carter and Feldhamer, 2005). Maternal colonies are typically located large diameter trees in relatively open areas and more often on upper and middle slopes than lower slopes. The open areas and higher elevations are likely to increase sun exposure, which aids in the development of young bats (Perry and Thill, 2007). Fewer trees surrounding maternity roosts may also benefit juvenile bats that are starting to learn to fly (Perry and Thill, 2007).

Northern long-eared bats typically change roosts every few days (Foster and Kurta, 1999; Sasse and Perkins, 1996; Owen et al., 2002; Carter and Feldhamer, 2005; Timpone et al., 2010). Bats switch roosts for a variety of reasons, including, temperature, precipitation, predation, parasitism, and the roost trees becoming uninhabitable (e.g., the tree falls over; Carter and Feldhamer, 2005). The need to investigate new potential roost trees prior to the current roost tree becoming uninhabitable may be the most likely reason for changing roosts frequently (Kurta et al., 2002; Carter and Feldhamer, 2005; Timpone et al., 2010).

7.2.2.1 Summer Occurrence

Prior to the arrival of WNS, the northern long-eared bat was widespread and common in forested landscapes of the eastern United States and Canada. There are hundreds of capture records within 50 miles of the Project, and the species remains relatively common throughout the region.

Mountain Valley sampled 338 net sites (1,953 complete and 426 partial net nights) within the Project Area from May 15 to August 15, 2015 and 3 net sites (6 complete and 6 partial net nights) from May 15 to May 26, 2016. Mountain Valley captured 74 northern long-eared bats during the 2015 survey efforts with all but one individual captured in West Virginia. No northern long-eared bats were captured in 2016. Radio transmitters were attached to 56 northern long-eared bats and 43 of those bats were tracked to daytime roosts for a minimum of 4 consecutive days. The locations of 70 roosts were identified and emergence counts were conducted on each roost tree for a minimum of 2 nights. These counts yielded a total of 267 bats over 145 observation nights with the greatest number of bats emerging from a single roost on a single night (July 9, 2015) consisting of 40 individuals.

7.2.2.2 Summer Habitat

In addition to the 70 documented northern long-eared bat roosts, Mountain Valley completed detailed habitat assessments for portions of the Project intersecting protective buffers associated with historic Indiana and northern long-eared bat captures, roosts, and hibernacula. Mountain Valley identified potentially suitable roost trees for northern long-eared bats and concluded 3,203 trees have high potential suitability to serve as roosts, 5,342 trees have moderate potential, and 2,433 trees have low potential. Mountain Valley also assessed the foraging potential of the habitat. Mountain Valley concluded 1,250.9 acres have high foraging potential, 3,417.5 acres have moderate foraging potential, 1,848.5 acres have low foraging potential, and 29.6 acres have no foraging potential. Of these areas, Mountain Valley judged that 25.2 percent of the acreage has high roosting potential, 33.0 percent has moderate roosting potential, 25.8 percent has low roosting potential, and 16.0 percent has no roosting potential for northern long-eared bats.

7.2.2.3 Winter Hibernation, Autumn Swarming, and Spring Staging

Known and Potential Hibernacula Occurrence

The northern long-eared bat is rarely found in large numbers during winter cave surveys in Virginia; however, it is frequently captured during the fall swarming period at cave entrances. There are three known winter hibernacula within 5 miles of the Project: Greenville Saltpeter Cave in Monroe County, West Virginia; Canoe Cave in Giles County, Virginia; and Tawney's Cave in Giles County, Virginia.

Mountain Valley conducted field searches for portals from November 2014 through January 2017. Forty-four previously undocumented underground features and eight known caves were identified during these searches, with 24 determined to be potentially suitable for hibernating bats (table 7.1.2.3-1). As described in section 7.1.2.3, 13 suitable portals were sampled using harp traps: 6 within West Virginia and 7 within Virginia. One northern long-eared bat was captured at a portal (PS-WV3-Y-P1) in Braxton County, West Virginia during these efforts. Additionally, a single tri-colored bat was observed flying in the vicinity of the Overlooked Cave entrance; however, no bats were captured in harp traps at other sites. A report detailing portal searches and harp trapping efforts was submitted to the FWS in December 2016; however, three additional features were discovered in January 2017. Five features remain unsampled for bats using harp traps: three known caves (Tawney's, Fred Bulls, and Kimbalton Mine caves) and two features discovered during Project surveys.

As noted in section 7.1.2.3 for the Indiana bat, Mountain Valley documented 124 known cave entrances within 5 miles of the MVP. These same caves could be potential northern long-eared hibernacula, but access to survey these caves was either not granted or the caves occur well outside the Project's designated 300-foot survey corridor. On January 11 and 19, 2016, Mountain Valley contacted the VADGIF and VADCR-DNH, respectively, and requested numbers of bats counted during any winter surveys conducted at these caves. The VADGIF responded on January 26, 2016 stating that Canoe and Tawney's caves are the only features of those queried with confirmed records for northern long-eared bat. Because these features have the potential to host northern long-eared bats and may be affected by Project activities, for the purposes of this BA, Mountain Valley assumed that all features, unless determined unsuitable or unoccupied during harp trapping or through agency correspondence, have potential to host the northern long-eared bat for winter hibernation.

Estimates of Winter Abundance

As discussed above, there are three known winter hibernacula within 5 miles of the Project: Greenville Saltpeter Cave, Canoe Cave, and Tawney's Cave. Estimates of abundance for these features are made using available survey data from the VDCR-DNH and WVDNR, where available. Although no northern long-eared bats were observed in recent surveys of Canoe Cave conducted by the VADCR-DNH, comments received from the VADCR-DNH on January 4, 2016 indicate an historic record of a single northern long-eared bat hibernating in Canoe Cave in February 1982. This record is used as an estimate of winter abundance. Recent surveys conducted by the WVDNR suggest the current winter population of northern long-eared bats in Greenville Saltpeter Cave is less than 10 individuals, with only 2 northern long-eared bats observed during an in-cave survey during March 2012. However, because all Project features are 2 miles or farther from the cave's entrance and outside the Action Area, any impacts on individuals staging/swarming around the feature, however unlikely, are exempt under the final 4(d) ruling. Thus, no abundance estimate is made for the Greenville Saltpeter Cave.

The current and historic population of the northern long-eared bat within Tawney's Cave is uncertain; however, based on correspondence with the VADGIF, the cave is considered occupied by the species. In-cave winter surveys conducted at Tawney's Cave in 2009, 2011, and 2013 yielded zero hibernating northern long-eared bats (Powers et al., 2015). To account for the potential for the species to occur within the cave, Tawney's Cave was treated similarly to the other suitable but unsurveyed portals within the Action Area (see below).

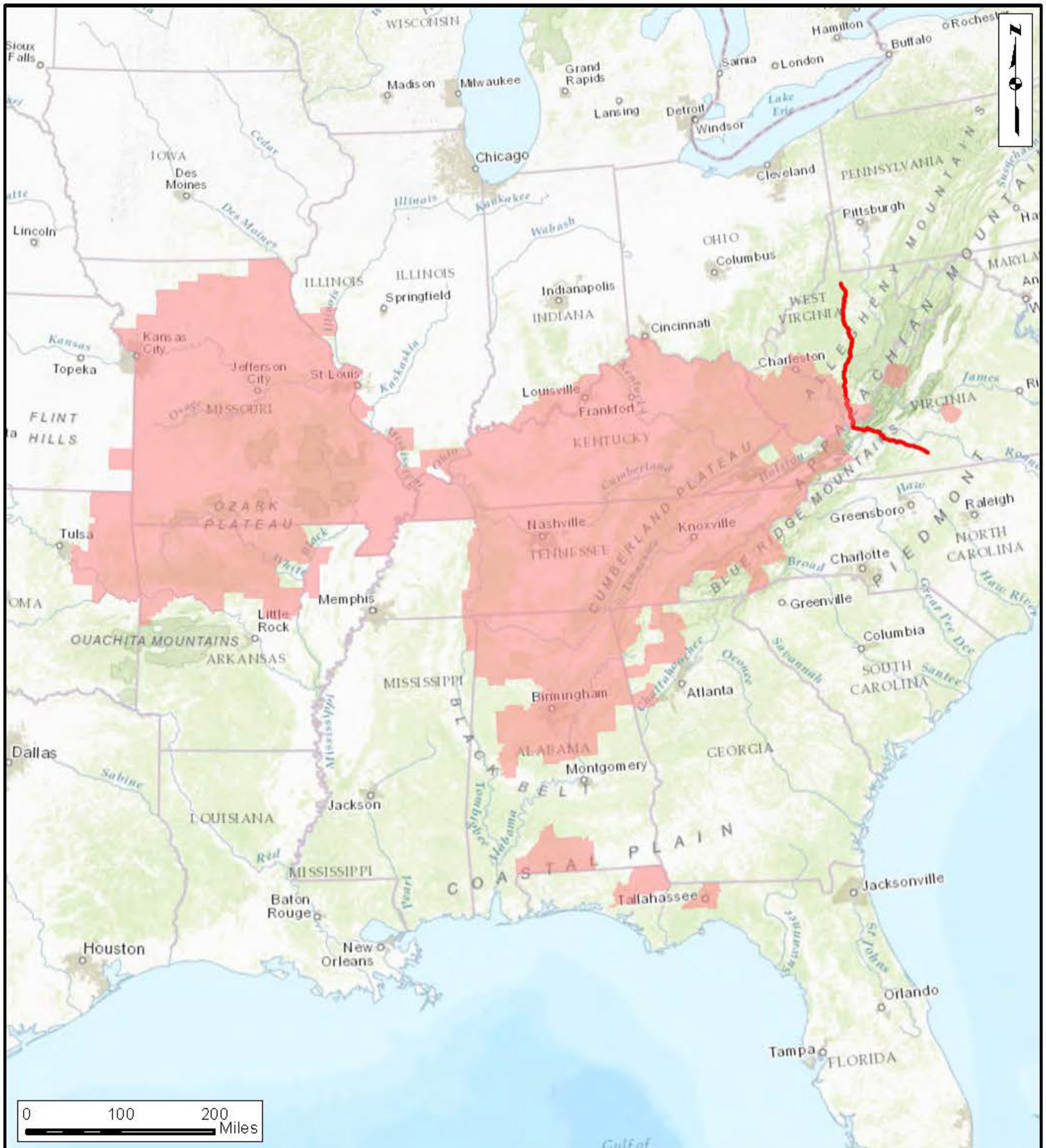
At the 5 suitable but unsurveyed portals and the 124 features with unknown suitability, estimates of abundance were made using the modeling approach described in section 7.1.2.3 (and detailed in appendix C). Similar to the approach taken with Indiana bats, expected abundance was derived from surveys conducted by Dalton (1987), Gates and Johnson (2006), and Powers et al. (2015) as well as previous surveys conducted by Mountain Valley's bat survey contractor. Using this dataset in conjunction with the hurdle model described in section 7.1.2.3 (detailed in appendix C), the expected number of northern long-eared bats in an unsampled but suitable feature is 7.017 bats. This estimate was also used as an estimate of the number of northern long-eared bats within Tawney's Cave (modeled as an unsampled feature that is considered suitable). The hurdle model was also used to estimate the number of bats within PS-WV3-Y-P1 (a sampled feature considered suitable). According to parameter estimates, an estimate of 1.293 individuals was made (see appendix C). As described in section 7.1.2.3, information regarding the suitability of the 124 features is unknown, and thus, the above estimate of 7.017 is not applicable. Similar to the approach taken for Indiana bats, estimates of abundance were made for these features by multiplying the proportion of features that are expected to be suitable within the region by the abundance estimate above. This proportion was estimated using survey information performed for the MVP. Of the 52 features surveyed, 24 were deemed suitable, and thus, 46.2 percent of features with unknown suitability are likely to be suitable for hibernating bats. Multiplying the population estimate for suitable features by 46.2 percent provides an estimate of 3.2384 northern long-eared bats in features with unknown suitability within the vicinity of the Project.

7.3 GRAY BAT

Gray bats are one of the largest species in the genus *Myotis* in eastern North America with a wingspan of about 10 to 12 inches. Gray bats are also distinguished from other *Myotis* species by their uniformly dark gray dorsal fur, their wing membrane, which attaches at the ankle as opposed to the base of the toes in other species, and by a notch in the claws of their hind feet. The body length of gray bats ranges from 3.1 to 4.1 inches (FWS, 2009).

7.3.1 Distribution

The primary range of gray bats is concentrated in the cave regions of Alabama, Arkansas, Kentucky, Missouri, and Tennessee, with smaller populations found in adjacent states, including a growing population in a quarry in Clark County, Indiana (figure 7.3.1-1; FWS, 2009).



Proposed Mountain Valley Project Route

Gray Bat Occurrence

Figure 7.3.1-1

Mountain Valley Project

Distribution of Gray Bat

7.3.2 Habitat

Gray bats are true "cave bats" requiring caves for winter hibernation and summer roosting. Gray bats migrate seasonally and hibernacula may be hundreds of miles from summer roosts. Hibernacula used by gray bats typically have a pronounced vertical component with domed sections that trap cold air. During the reproductive season, adult males roost in different caves (or in different sections of maternity caves) than adult females and usually begin roosting together again after young become volant (Brady et al., 1982). Maternity colonies are formed in caves with domed sections that trap warm air. These caves often contain underground streams and are usually located within 0.6 to 2.5 miles of rivers or other bodies of water (FWS, 1997). Occasionally, summer roosts have been found in storm sewers, mines, railroad tunnels, dams, buildings, and bridges (Brack et al., 1984; Decher and Choate, 1995; NatureServe, 2016). Gray bats use a wide variety of caves during spring and fall transient periods.

7.3.2.1 Summer Occurrence

On August 9, 2016, a gray bat was captured during a summer mist-net survey for a nearby but unrelated project in Logan County, West Virginia. At its easternmost point, Logan County is about 47 miles west of the closest point on the MVP pipeline route. This was the first summer record of the species in West Virginia. As this would represent a range expansion of the gray bat within West Virginia, the FWS West Virginia Field Office issued a statement on September 29, 2016 regarding the potential presence of the species within Boone, Fayette, Kanawha, Lincoln, Logan, McDowell, Mercer, Mingo, Monroe, Raleigh, Summers, Wayne, and Wyoming Counties in West Virginia. The Project Area occurs within three of these counties: Fayette, Monroe, and Summers. In Virginia, the species is known from Appomattox, Bath, Bland, Bristol, Buchanan, Lee, Norton, Russell, Scott, Smyth, Washington, Wise, and Wythe Counties, none of which are crossed by the Project.

Mountain Valley sampled 338 net sites (1,953 complete and 426 partial net nights) within the Project Area from May 15 to August 15, 2015 and 3 net sites (6 complete and 6 partial net nights) from May 15 to May 26, 2016. No gray bats were captured.

7.3.2.2 Summer Habitat

Gray bats roost in caves, mines, and other structures during the summer. No gray bat summer roosts are known from the Project vicinity and none were found during field searches for potential caves and portals conducted from November 2014 through January 2017. These surveys are discussed in further detail in sections 7.1.2 and 7.2.2.

7.3.2.3 Winter Hibernation, Autumn Swarming, and Spring Staging

Observations of gray bats are rare in West Virginia with only a single hibernating record of two individuals from Hellhole Cave in Pendleton County in 1991 when a winter survey found a total of over 61,000 bats in the cave (personal communication between Mountain Valley and WVDNR Biologist Craig Stihler, February 2017). Fossil records exist from three caves in Greenbrier and Monroe counties (Decher and Choate, 1995). Eleven of the 124 hibernacula features with unknown suitability (see section 7.1.2.3) are located in Monroe County. Table

7.3.2.3-1 lists these features and their distance from the construction right-of-way. Coordination between Mountain Valley and WVDNR indicates that no known gray bat hibernacula occur within the Project Area or anywhere within West Virginia.

Results of survey efforts to locate potential hibernacula within the Project Area are discussed in previous sections (7.1.2 and 7.2.2). Subsequent harp trap survey efforts of suitable portals did not yield any gray bat captures.

TABLE 7.3.2.3-1

Hibernacula Features of Unknown Suitability Within Counties Potentially Occupied by Gray Bats

Feature Name	Distance From Construction Right-of-Way (miles)
Greenville Glenray Cave	0.2
Bobcat Cave	0.2
Rich Creek Cave	0.3
Wolf Cave	0.6
Hans Creek Cave	1.1
Scampering Simmons Pit	1.8
Post Puke Pit	1.9
Lost Skier Pit	1.9
Coburn Cave	2.0
Ogdens Hole	2.3
Big Mother Sink	2.5

7.4 VIRGINIA BIG-EARED BAT

Virginia big-eared bats are medium-sized bats, averaging 3.9 inches in length. They are one of five subspecies of the Townsend's big-eared bat (*Corynorhinus townsendii*) and the only subspecies known to occur east of the Mississippi River. They are distinguished by their long ears, greater than 1 inch in length, and two mitten-shaped glandular masses on each side of its nose (FWS, 2011a).

7.4.1 Distribution

Virginia big-eared bats are distributed in isolated populations in the Appalachian Mountains in Kentucky, North Carolina, Virginia, and West Virginia (figure 7.4.1-1). They fly relatively short distances of up to 20 miles between their winter hibernacula and summer maternity colonies. Virginia big-eared bats have been documented in only 15 caves, with the majority of the population occurring in just a few of these caves (FWS, 2013b).

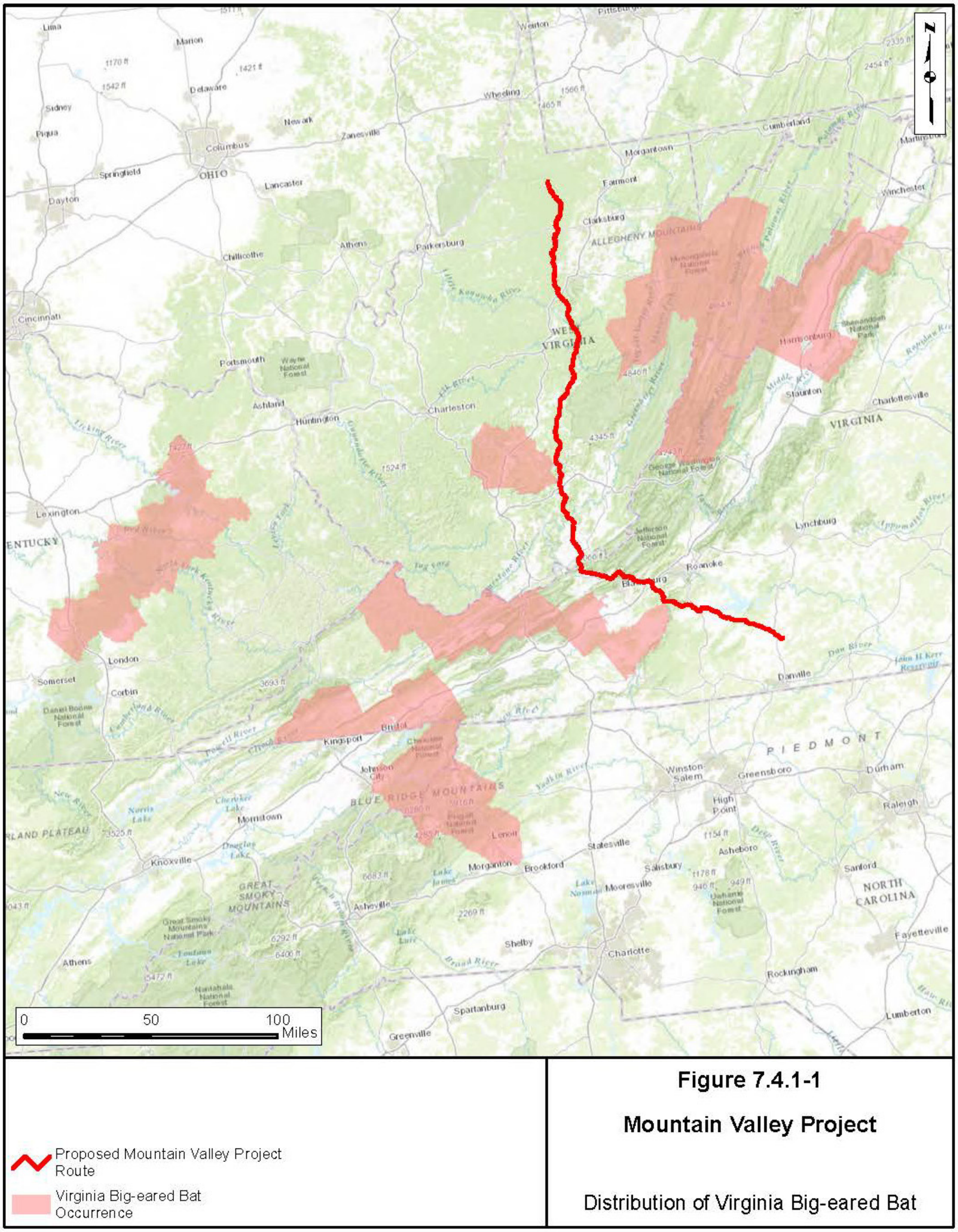


Figure 7.4.1-1

Mountain Valley Project

Distribution of Virginia Big-eared Bat

West Virginia supports the largest number of Virginia big-eared bats of any state. Virginia supports a smaller population. Most bats occur in Pendleton County, West Virginia, with additional large populations occurring in Grant, Tucker, and Fayette counties, West Virginia (Bagley, 1984; Gates and Johnson, 2006). Four caves in Pendleton County (Cave Mountain, Hellhole, Hoffman School, and Sinnit-Thorne Cave) and one in Tucker County (Cave Hollow Cave) were designated as critical habitat for the species.

7.4.2 Habitat

Virginia big-eared bats are true "cave bats" using caves for winter hibernation and summer roosting. They use cooler, better ventilated portions of caves during the winter while maternity colonies typically occur in warmer portions of caves where females give birth to young in early spring. Although they do not roost in trees, some have been documented roosting in exposed rock cliffs during the summer. They forage in open areas such as pastures and old fields, along forest edges, and in small openings in forests, but are not known to use clear-cuts. .

7.4.3 Summer Occurrence

Virginia big-eared bats occur in both West Virginia and Virginia in the summer. Ten caves in Grant, Pendleton, and Tucker Counties, West Virginia are currently known-occupied maternity or bachelor colonies in summer, totaling around 7,245 bats (FS, 2011). An estimated 1,150 bats use three caves in Tazewell County, Virginia during the maternity season (FWS, 2008a).

Mountain Valley sampled 338 net sites (1,953 complete and 426 partial net nights) within the Project Area from May 15 to August 15, 2015 and 3 net sites (6 complete and 6 partial net nights) from May 15 to May 26, 2016. No Virginia big-eared bats were captured during survey efforts.

7.4.3.1 Summer Habitat

Virginia big-eared bats are known to form maternity and bachelor colonies in limestone caves. No Virginia big-eared bat summer roosts are known from the Project vicinity and none were found during field searches for potential caves and portals conducted from November 2014 through January 2017 for the Project. These surveys are discussed in further detail in sections 7.1.2 and 7.2.2. Communication between Mountain Valley and the WVDNR indicated that the nearest known records of any kind are in Randolph and Pendleton counties (personal communication between Mountain Valley and WVDNR Biologist Craig Stihler, February 2017).

7.4.3.2 Winter Hibernation, Autumn Swarming, and Spring Staging

Virginia big-eared bat hibernate in caves and abandoned mines during the winter in both Virginia and West Virginia. As they migrate from summer to winter locations, they also use transitional "stop-over" caves between points.

Thirteen caves in Pendleton, Grant, Tucker, Fayette, and Randolph Counties presently serve as hibernacula in West Virginia, two of which are listed as critical habitat (Bagley, 1984; FWS, 2008a; FS, 2011). Hellhole Cave, a designated critical habitat in Pendleton County, houses

83 percent of the population. In 2010, 12,059 hibernating Virginia big-eared bats were estimated to occur in West Virginia (FS, 2011).

Communication with the WVDNR indicates that although the species may use mines in counties adjacent to Fayette, the closest known records are in Randolph and Pendleton counties (personal communication between Mountain Valley and WVDNR Biologist Craig Stihler, February 2017). Autumn trapping surveys in Fayette County in 2002 and 2005 revealed eight occupied mine portals between 14.2 and 18.9 miles from the Project Area (personal communication between Mountain Valley and WVDNR Biologist Barbara Sargent, February 2017; Gates and Johnson, 2006).

Limestone caves in Rockingham, Highland, Bland, and Tazewell counties, Virginia are also utilized as hibernacula. Other than Tazewell County, all other counties are limited to occasional winter use (FWS, 2008a).

No known Virginia big-eared bat hibernacula occur within the Action Area. Results of survey efforts to locate potential hibernacula within the Project Area are discussed in previous sections (7.1.2 and 7.2.2). Subsequent harp trap survey efforts of suitable portals did not yield any Virginia big-eared bat captures.

7.5 ROANOKE LOGPERCH

Roanoke logperch are relatively large darters within the genus and subgenus, *Percina*. Members of the subgenus *Percina* are referred to as 'logperch' and are known for their distinctive behavior of overturning substrates during foraging (Jenkins and Burkhead, 1994). Roanoke logperch have a long, conical snout, inferior mouth, and a moderate to robust body form (Rosenberger, 2007) and grow to an adult length of approximately 6 inches (Page and Burr, 1991). Their dorsal surface is dark green and their sides are greenish to yellowish, both with dark, blotched markings; the ventral side is white to yellowish (FWS, 2003). Their fins are patterned with dark pigment and their caudal fin is emarginate or truncate (Jenkins and Burkhead, 1994).

7.5.1 Distribution

Roanoke logperch are endemic to the upper Roanoke, upper Dan, and Nottoway River drainages of Virginia and North Carolina (figure 7.5.1-1). The population structure of the species is divided into several small, genetically distinct populations that are separated by dams or large segments of river presumed to be unsuitable for the species (FWS, 2003; Roberts et al., 2013). In addition to the known populations, the FWS have identified suitable habitat locations in the Blackwater, Dan, Falling, Mayo, and Meherrin river drainages (FWS, 2007b); however, no individuals have been observed in these systems. The MVP would traverse both the upper Roanoke River and the Pigg River (a tributary of the Roanoke) watersheds. Each of these watersheds contains a distinct population of Roanoke logperch (Roberts et al., 2013)

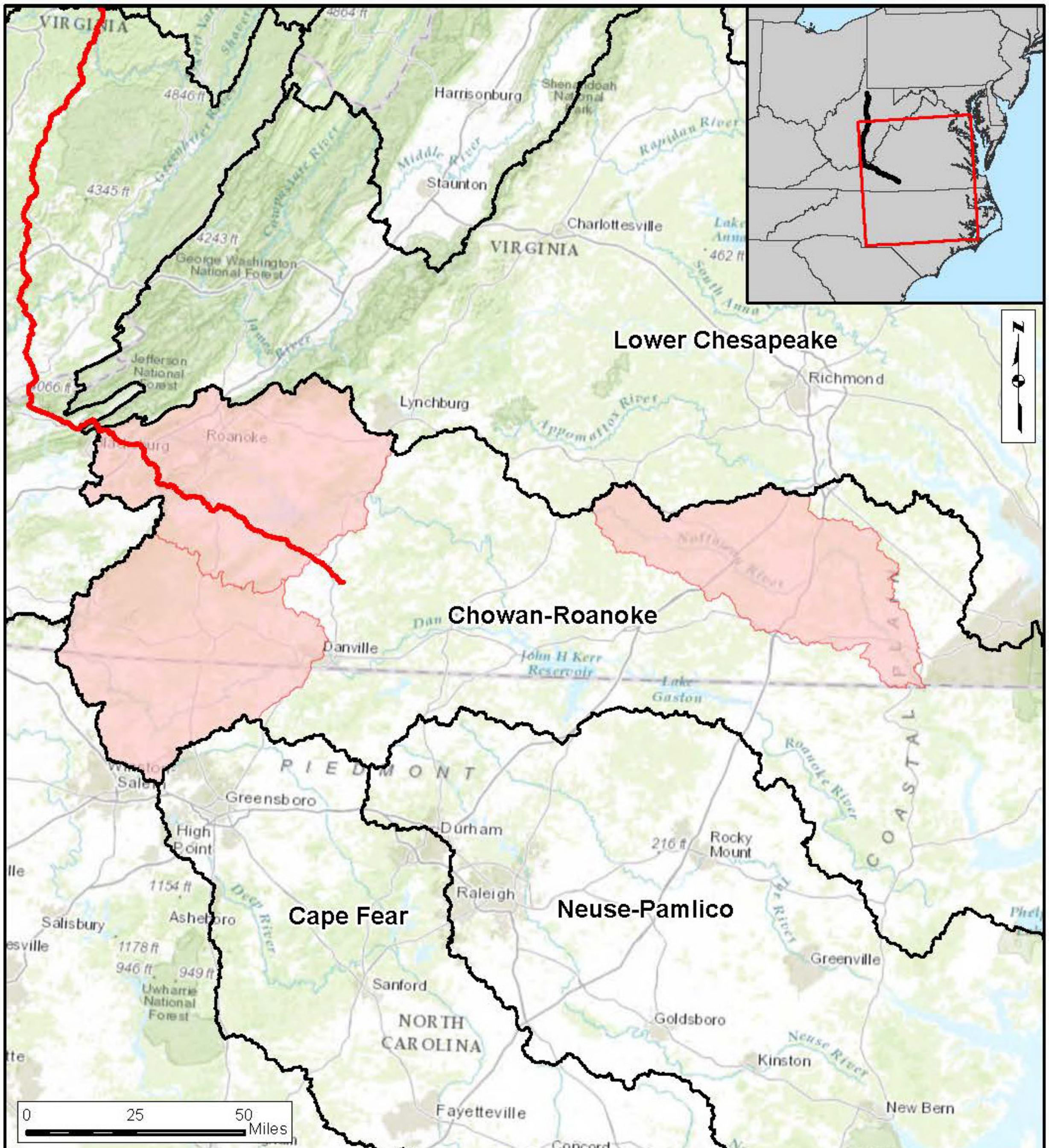


Figure 7.5.1-1

Mountain Valley Project

Distribution of Roanoke Logperch

7.5.2 Habitat

Roanoke logperch are benthic, or bottom dwelling, riverine species that use all available moving water habitats at some stage of life and development. Shifts in habitat use occur by age classes (i.e., ontogenetically), season, and reproductive cycle. Roanoke logperch are daytime feeders and consume bottom dwelling invertebrates (McCormick et al., 2001). They actively feed during the warmer months by using their elongated snout to flip over stones and then eating the exposed prey (FWS, 2003).

Juvenile logperch are likely to use pool and run habitats and backwater areas adjacent to riffle habitats in groups with other similar species of fish (Burkhead, 1983; Jenkins and Burkhead, 1994). Adults are generally found in riffle and run habitats over coarse bottoms (Burkhead, 1983).

During warmer months, adult Roanoke logperch are typically found in deep (greater than about 1 foot), high velocity riffle and run habitats over coarse bottoms (often preferring cobble) with little (less than 25 percent) to no silt coverage (Ensign et al., 2000). Young-of-the-year Roanoke logperch are present in slow runs and pools, frequently over clean, sandy bottoms (Ensign et al., 2000) or are present in low-velocity habitat adjacent to riffle-run complexes. Small individuals are present in shallow backwaters and river edges feeding over small patches of loosely embedded, silt-free gravel bottoms. Subadults in the Roanoke River are present in habitats of intermediate depth and with lower velocities than those occupied by adults.

In winter months, when water temperatures are less than about 45 degrees F, individuals enter a general state of inactivity and typically seek refuge in habitats with reduced water velocities, such as runs and pools. Roanoke logperch sometimes seek shelter in the spaces between and under rocks (Burkhead, 1983). As waters warm in the spring months, adults move to swifter currents and males and females segregate. Females are typically present in deep runs whereas males occupy shallower riffles (Burkhead, 1983). Logperch typically spawn in April or May in scoured, deep riffles and runs (Rosenberger and Angermeier, 2002; FWS, 2003).

7.5.3 Habitat Assessment Results

Mountain Valley assessed historic and recent fish collections and MVP-specific field observations to assess the potential occurrence of Roanoke logperch in waterbodies within the watersheds potentially affected by the MVP. According to desktop analyses, the MVP would traverse 38 stream crossings within the Roanoke River basin that are either known or have potential (i.e., within the Roanoke River basin) to support populations of Roanoke logperch (table 7.5.3-1). During initial Project correspondence, FWS recommended that Mountain Valley assume Roanoke logperch are present at the proposed stream crossing locations of the North Fork Roanoke, Roanoke River, and Pigg Rivers. The MVP would cross the North Fork Roanoke River three times (two access roads and one pipeline crossing) and the Roanoke and Pigg Rivers once each. These are the only streams with known occupancy within the Project Area. Given that Roanoke logperch were assumed present, Mountain Valley did not conduct habitat assessments at the respective proposed waterbody crossings.

TABLE 7.5.3-1

Stream Crossings Warranting Assessments for Roanoke Logperch Habitat Along the Proposed Mountain Valley Pipeline Project within the Roanoke River Watershed in Virginia

County	Stream Name a/	MP	Crossing Type b/	HA Completed c/	Strahler Stream Order d/	Drainage Area (mi^2)	Suitable Habitat
Montgomery	North Fork Roanoke River1	227.4	Pipeline	AP	3	23.8	Yes
Montgomery	North Fork Roanoke River AR1	227.4	AR (MN-268.01)	AP	3	23.7	Yes
Montgomery	Flatwoods Branch	229.8	Pipeline	Yes	1	0.2	No
Montgomery	Bradshaw Creek1	230.9	Pipeline	Yes	2	17.5	Yes
Montgomery	Bradshaw Creek AR	231.6	AR (MN-276)	Yes	2	13.5	Yes
Montgomery	North Fork Roanoke River AR2 e/	231.7	AR (MN-276.03)	AP	4	109.85	Yes
Roanoke	Roanoke River	235.6	Pipeline	AP	5	256.5	Yes
Roanoke	Bottom Creek f/	242.4	Pipeline	No	1	2.8	No
Roanoke	Mill Creek2 f/	245.1	Pipeline	No	2	5.8	No
Franklin	UNT1 North Fork Blackwater River	249.1	Pipeline	Yes	1	0.6	No
Franklin	North Fork Blackwater River	249.8	Pipeline	Yes	2	5.9	Yes
Franklin	UNT2 North Fork Blackwater River	251.0	Pipeline	Yes	1	2.1	No
Franklin	UNT3 North Fork Blackwater River	251.9	Pipeline	Yes	1	1.8	No
Franklin	UNT to Little Creek	256.4	Pipeline	Yes	2	0.971	No
Franklin	Teels Creek0.1	258.3	Pipeline	Yes	2	2.2	No
Franklin	Teels Creek0.2	259.2	Pipeline	Yes	2	3.1	No
Franklin	Teels Creek0.3	259.4	Pipeline	Yes	2	3.5	No
Franklin	Teels Creek0.6	260.4	Pipeline	Yes	2	4.5	No
Franklin	Teels Creek2	261.0	Pipeline	Yes	2	5.1	No
Franklin	Teels Creek3	261.9	Pipeline	Yes	2	5.5	No
Franklin	Teels Creek4	262.4	Pipeline	Yes	2	22.6	Yes
Franklin	Little Creek1.5	262.7	Pipeline	Yes	3	22.6	Yes
Franklin	Little Creek2	263.4	Pipeline	Yes	3	25.1	Yes
Franklin	UNT1 Maggodee Creek1	269.0	Pipeline	Yes	1	0.8	No
Franklin	Maggodee Creek1	269.4	Pipeline	Yes	3	45.4	Yes
Franklin	Blackwater River3	269.8	Pipeline	Yes	4	165.4	Yes
Franklin	Foul Ground Creek	272.4	Pipeline	Yes	2	1.9	No
Franklin	Poplar Camp Creek	274.4	Pipeline	Yes	1	1.9	No
Franklin	UNT1 Smith Mountain Lake	276.1	Pipeline	Yes	2	2.0	No
Franklin	Owens Creek	282.2	Pipeline	Yes	1	0.6	No

TABLE 7.5.3-1 (continued)

Stream Crossings Warranting Assessments for Roanoke Logperch Habitat Along the Proposed Mountain Valley Pipeline Project within the Roanoke River Watershed in Virginia

County	Stream Name a/	MP	Crossing Type b/	HA Completed c/	Strahler Stream Order d/	Drainage Area (mi^2)	Suitable Habitat
Franklin	Strawfield Creek	282.4	Pipeline	Yes	1	0.8	No
Franklin	Parrot Branch	283.0	Pipeline	Yes	1	0.5	No
Pittsylvania	UNT1 Jonnikin Creek	284.5	Pipeline	Yes	1	1.2	No
Pittsylvania	Jonnikin Creek	284.8	Pipeline	Yes	2	1.0	No
Pittsylvania	Pigg River	289.2	Pipeline	AP	5	340.1	Yes
Pittsylvania	Harpen Creek1	290.0	Pipeline	Yes	3	7.8	Yes
Pittsylvania	Harpen Creek2	290.6	Pipeline	Yes	2	3.1	No
Pittsylvania	Harpen Creek3	292.1	Pipeline	Yes	1	1.6	No

a/ UNT = Unnamed tributary
b AR = supporting access road
c/ HA = Roanoke Logperch Habitat Assessment; AP = Assumed presence of Roanoke logperch.
d/ Strahler stream order was calculated using the 1:100,000 NHD.
e/ Access road crosses existing, paved bridge. (Reese Mountain Road). No instream impacts are anticipated.
f/ Desktop analysis only completed; geologic features located downstream prevent species occurrence

Mountain Valley completed Roanoke logperch habitat assessments at 23 of the proposed stream crossings between April 2015 and November 2015. Based on field observations and correspondence with the FWS (letter dated March 8, 2016), Mountain Valley determined that suitable Roanoke logperch habitat occurs at five stream crossings (Bradshaw Creek1, North Fork Blackwater River, Maggodee Creek1, Blackwater River3, and Harpen Creek1) and unsuitable habitats occur at the remaining 18 locations.

In 2016, Mountain Valley identified 10 stream crossings for assessment. Mountain Valley subsequently eliminated two of these crossings based on correspondence with the FWS and VADGIF in March 2016 regarding the presence of an upstream natural geological barrier (Bottom Creek Gorge) that would prohibit colonization of habitat surrounding the proposed stream crossing. Based on qualitative habitat assessments, four of the remaining eight stream crossings visited in 2016 exhibited potentially suitable habitats for Roanoke logperch, including Bradshaw Creek AR, Teels Creek 4, Little Creek 1.5, and Little Creek 2.

Based on habitat assessments in 2015 and 2016, suitable habitat for Roanoke logperch is present at nine locations in addition to the five streams in which Roanoke logperch would be assumed to be present. Roanoke logperch have not been documented in any of the additional nine stream locations. Although some of these stream reaches are relatively small or only adjacent to a known, occupied stream (e.g., Bradshaw Creek is adjacent North Fork Roanoke River, Harpen Creek1 is adjacent to Pigg River), it is possible that Roanoke logperch may use the streams during specific times of the year.

Past survey efforts have been conducted within the Blackwater River drainage, which includes the North Fork Blackwater River and Maggodee, Teels, and Little Creeks; however, no populations of Roanoke logperch have been documented in the drainage. Nonetheless, the Blackwater River mainstem is a waterbody large enough to potentially support populations of Roanoke logperch.

To date, all stream crossings along the proposed alignment have been assessed using a desktop analysis or in-situ habitat assessment, and Roanoke logperch habitat suitability has been determined. Occurrence of Roanoke logperch is known at the crossings of North Fork Roanoke River, Roanoke River, and Pigg River. Suitable habitat also occurs in Bradshaw Creek, North Fork Blackwater River, Teels Creek, Little Creek, Blackwater River, Maggodee Creek, and Harpen Creek; however, many of these streams would likely represent supplementary (i.e., non-essential for life history processes) or opportunistically-available habitat in the vicinity of occupied habitats (e.g., North Fork Roanoke River, Pigg River).

7.5.4 Occurrence Modeling

Mountain Valley used a modeling approach to estimate Roanoke logperch presence and abundance within the upper Roanoke, Pigg, and Blackwater River drainages.

7.5.4.1 Site Occupancy Modeling

Estimates of abundance have been previously developed for Roanoke logperch in both the upper Roanoke and Pigg River drainages (Roberts, 2012). However, these estimates were limited to reaches within the documented extent of the species (i.e., known occurrences), and thus, may not incorporate all areas where the species may occur. Recognizing that the species may occur in other smaller, less-sampled waterbodies, Lahey and Angermeier (2007) developed a screening model to determine the potential for Roanoke logperch occurrence in these waterbodies. The Lahey and Angermeier model consists of four metrics that are thought to determine logperch occurrence within the Roanoke drainage: Strahler order (range=2-6), Shreve link (range=3-372), gradient (range=0-10.2 m/km), and elevation (range=181-488 m). Strahler order and Shreve link are to methods used to classify the size of a stream based on its number of tributaries. As streams join or tributaries enter a stream the order or link increases. For example, a stream with no tributaries is assigned an order of 1; as it gains tributaries its order increases. The Strahler order method increases in a stepwise fashion (Strahler, 1957). The Shreve link method increases in an additive fashion (Shreve, 1966). Note that both Strahler order and Shreve link are based on the 1:100,000 NHD within this model. For the purposes of this BA, all areas that meet these conditions are considered potentially occupied by the species, unless site-specific field assessments suggest otherwise.

Mountain Valley used a site occupancy modeling approach (N-mixture modeling; Royle, 2004) to obtain an estimate of Roanoke logperch abundance within occupied or assumed occupied stream reaches. In short, Mountain Valley used this approach to estimate the abundance of Roanoke logperch while accounting for imperfect capture of the species during fish surveys. Similar to the approach taken by Roberts (2012), a capture probability of 0.1 (10 percent) is assumed, but using the N-mixture model, abundance is modeled to vary by the U.S. Geological Survey watershed level hydrologic units and by the catchment area upstream of each stream segment within the watershed. Abundance in areas of assumed occupancy is always estimated to be 1 or greater. The advantage of this model-based approach to estimate abundance is two-fold.

First, heterogeneity in abundance among populations and within populations can be accounted for using linear regression. Second, adjustments for imperfect capture can be accounted for even when 0 individuals have been observed in nearby locations (e.g., the Blackwater River drainage). Therefore, this approach can also be used to model abundance in watersheds and waterbodies where no captures of Roanoke logperch have been made, but the species is assumed to be present. The output of this model-based approach is abundance within a suitable patch; therefore, estimates are adjusted to derive fish densities (e.g., fish per mile) by multiplying abundance times the patch density estimates derived in Roberts (2012).

In order to model abundance, Mountain Valley compiled fish collections within the upper Roanoke drainage, including: surveys reported in James (1979), Simonson and Neves (1986), Ferguson et al. (1994), Stancil (2000), Lahey and Angermeier (2007), Roberts and Anderson (2013), VADEQ (2015b), and Anderson and Angermeier (2015). In total, these collections provide 159 unique stream segments (i.e., reaches of stream between confluences of other streams) that have at least one sample event for fish. However, using the Lahey and Angermeier (2007) screening model, only 118 are within the possible distribution of the species. Mountain Valley used these samples in conjunction with prior information on estimates of capture rates from Roberts and Anderson (2013) to estimate abundance in areas of assumed occupancy while accounting for heterogeneity among and within populations. Similar to the estimates of Roberts (2012), these estimates are largely based on Age-1+ captures from electrofishing surveys and do not include young-of-the-year (YOY), which are individuals born within the past year and do not get recruited into the same habitats until Age 1.

Using this approach, densities within the five streams where the FWS suggest assumed presence are:

- 37.4 fish per mile for both the North Fork Roanoke1 and North Fork Roanoke River AR1;
- 108.4 fish per mile for the North Fork Roanoke River AR2;
- 262.9 fish per mile for the Roanoke River; and
- 159.4 fish per mile for the Pigg River.

In addition to these estimates, Mountain Valley derived densities for all waterbodies potentially affected by the MVP that are occupied or presumed occupied by Roanoke logperch. Estimated densities vary by both catchment area and the different U.S. Geological Survey (USGS) watershed level hydrologic units. Density estimates range from 2.5 fish per mile within Jonnikin Creek of the Lower Pigg River Watershed to 274.9 fish per mile within the Roanoke River of the Mason Creek-Roanoke River Watershed.

7.5.4.2 Young-of-Year Estimates

To get an estimate of the number of YOY logperch within occupied and potentially occupied reaches, Mountain Valley compiled information on population growth rates of the species from literature. Traditional approaches for estimating YOY population sizes require vital life history attributes of the species (e.g., egg fecundity, hatching success, natural mortality), which are unknown for Roanoke logperch. Therefore, Mountain Valley could not make YOY estimates using these approaches. Using population growth rates to estimate YOY population sizes provides a potentially biased estimate of population size, but capitalizes on the best currently available information. For Roanoke logperch, the growth rate is a "realized" growth rate because it is derived using live individuals collected during sampling. The realized population growth rate includes naturally selective factors and includes individuals that might be recruited from other populations. One major constraint of this approach to estimating YOY population size is the inability to account for these additional temporal dynamics of the Age-1+ Roanoke logperch population. To estimate the number of YOY for any given year, Mountain Valley used information from the aforementioned Age-1+ estimate and an estimated maximum population growth rate (λ) estimate of 1.7205 from Roberts et al. (2016). In this approach, the density of YOY is calculated as:

$$\mathbf{D\_YOY=D\_Adult\times(\lambda\text{-}1).}$$

In this model, D_YOY is the estimated YOY density and D_Adult is the estimated Age-1+ population density. Based on the data presented, the following are the density estimates for the five stream locations where the FWS suggested assumed presence:

- 30.0 fish per mile for both the North Fork Roanoke1 and North Fork Roanoke River AR1;
- 78.0 fish per mile for the North Fork Roanoke River AR2;
- 189.4 fish per mile for the Roanoke River; and
- 114.8 fish per mile for the Pigg River.

The YOY density estimates are also made for all waterbodies potentially affected by the Project where Roanoke logperch occur or are presumed to occur. Similar to the estimates made for Age-1+ individuals, densities of YOY vary by both catchment area and the different USGS watershed level hydrologic units. Density estimates range from 1.8 YOY per mile within Jonnikin Creek of the Lower Pigg River Watershed to 198.1 YOY per mile within the Roanoke River of the Mason Creek-Roanoke River Watershed.

7.6 JAMES SPINYMUSSEL

The James spinymussel is a small freshwater mussel (relative to other spinymussels) with a shell averaging approximately 2 inches in length and a maximum length typically not exceeding 3 inches. The shell is solid and somewhat rhomboid-shaped. The shells of juvenile James spinymussels have three short spines present on each valve. Spines are typically absent on adult shells. The periostracum is shiny and straw-colored with widely spaced concentric striations. Internally, James spineymussels have medium-sized lateral teeth and a whitish nacre with sometimes pink or bluish suffusions (FWS, 1990).

7.6.1 Distribution

James spinymussels are restricted to the James River drainage basin across Virginia, including Giles, Craig, Montgomery, Roanoke, Franklin, Floyd, and Pittsylvania Counties, Monroe County in eastern West Virginia, and the Dan and Mayo river systems within the Roanoke River drainage basin along the Virginia – North Carolina border (figure 7.6.1-1); (FWS ECOS, 2016). They are present in more than 20 waterbodies across central Virginia, including Craig Creek and its tributaries in Craig County (Terwilliger, 1991; Petty and Neves, 2005).

7.6.2 Habitat

James spinymussels are found in substrates consisting of sand and cobble with or without boulders, pebbles, or silt (FWS, 1990). Waterbodies that contain James spinymussles are of varied widths and depths, but with slow to moderate water velocities. The widths of the waterbodies range from 10 to 75 feet and depths range from 0.5 to 3 feet.

The habitat supporting James spinymussels must also support specific fishes that are a vital component of the reproductive cycle of James spinymussels and facilitate the dispersal of the sessile species. James spinymussels are short-term brooders. Female mussels release developing larvae (glochidia) into the water column, which must attach to an appropriate host fish for further development. After attachment, the glochidia continue development before dropping from the fish as free-living juvenile mussels. The specific fish hosts required for James spinymussel glochidia include bluehead club (*Nocomis leptocephalus*), rosyside dace (*Clinostomus funduloides*), blacknose dace (*Rhinichthys atratulus*), mountain redbelly dace (*Phoxinus oreas*), rosefin shiner (*Notropis ardens*), satinfin shiner (*Notropis analostanus*), stoneroller (*Campostoma anomalum*).

7.6.3 Occurrence

The MVP would traverse one stream known to support populations of James spinymussel: Craig Creek. James spinymussel occur within Craig Creek in Botetourt and Craig Counties, Virginia, which are downstream of the proposed MVP crossings. The MVP would traverse the upper portion of Craig Creek in Montgomery County, Virginia. No occurrence records of James spinymussel in Montgomery County have been documented. At the time of mussel surveys in 2015, the MVP route traversed the mainstem of Craig Creek four times within approximately 2,624 feet of stream reach. Three crossings were proposed for the installation of the pipeline and the fourth was a ford crossing at an existing, private access road. The access road traversed the stream between proposed pipeline crossing locations. A subsequent route modification in the vicinity of the Craig Creek crossings eliminated two of the formerly-proposed pipeline crossings. The MVP route now entails a single pipeline crossing of Craig Creek and a temporary access road crossing that would span the creek.

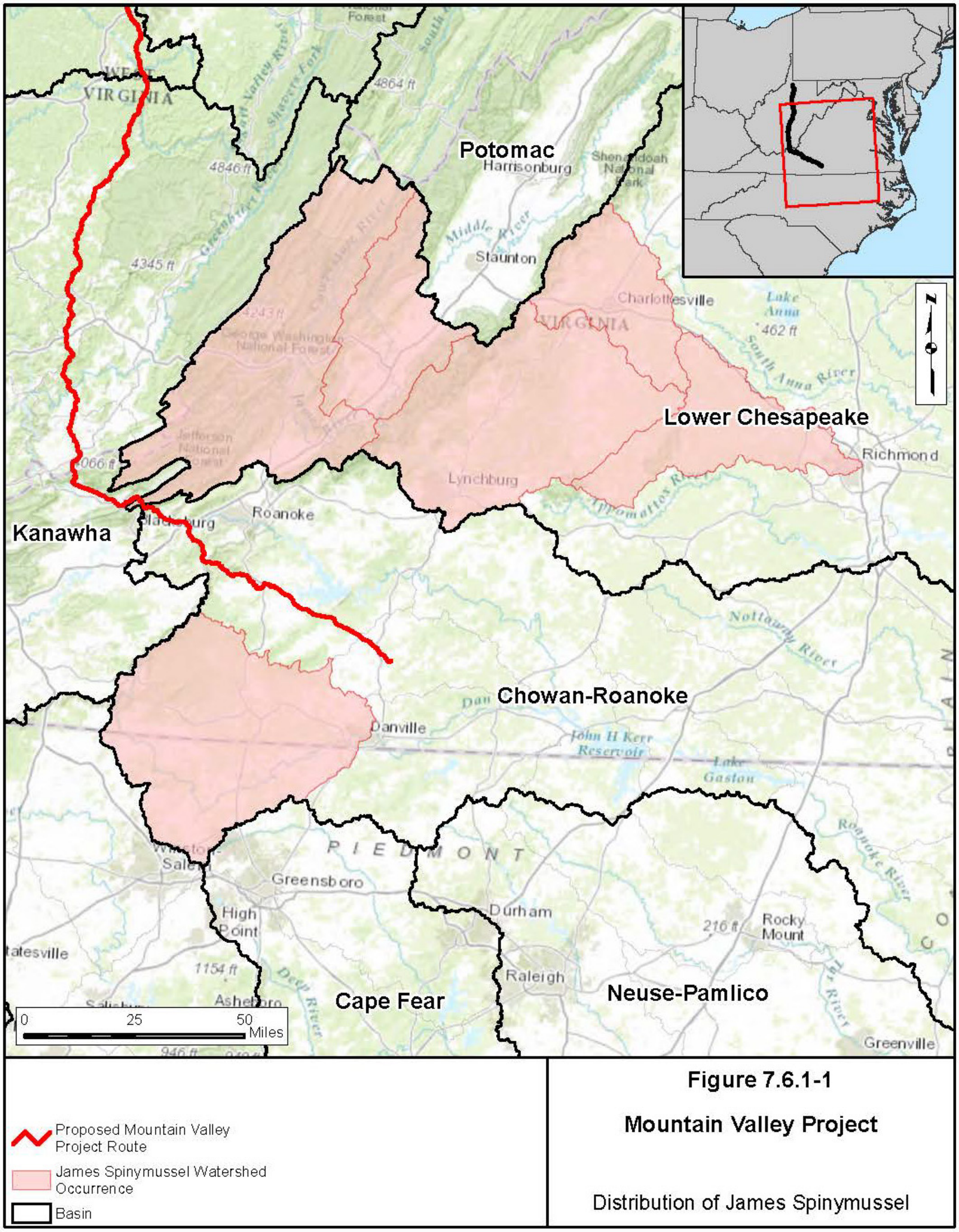


Figure 7.6.1-1

Mountain Valley Project

Distribution of James Spinymussel

Mountain Valley conducted a mussel survey in October 2015 of the Craig Creek pipeline crossing that extended 0.85 mile downstream and 0.14 mile upstream. The survey yielded no sign of James spinymussel or any other freshwater mussel species within the survey extent. The nearest known occurrence of James spinymussel in Craig Creek is approximately 15.8 stream miles downstream of the pipeline crossing and 15.0 miles downstream of the Action Area. The known occurrence record is a single live individual collected in March 1987 near the confluence of Craig Creek and Trout Creek. Known occurrences and abundances of James spinymussel increase from the confluence with Trout Creek downstream beyond the mouth of Johns Creek. Although there have not been many recent mussel surveys in Montgomery County based on an assessment of VADGIF survey records[10], numerous surveys were completed in Craig Creek in Montgomery County in the 1980s and 1990s. None of these surveys documented live James spinymussels or records of deadshell. The nearest known mussel occurrence, which included non-listed species such as *Villosa constricta, Strophitus undulatus,* and *Elliptio complanata*, was in 1991 in Craig County and approximately 12.6 miles downstream of the Project crossing.

7.7 CLUBSHELL

Clubshell (*Pleurobema clava*) is a small to medium-sized mussel with an average length of 1 to 1.5 inches and a maximum length of almost 3 inches (FWS, 1994; Watters et al., 2009). Their shell is thick, elongate, triangular, and moderately inflated. Its color is straw-yellow or light brown with distinct green rays. The rays may be thick blotches or thin lines and are often interrupted at growth lines. The rays may not be present in older individuals (FWS, 1994; Watters et al., 2009). Specimens from large rivers typically have prominent umbos, often projecting past the anterior margin (Watters et al., 2009).

7.7.1 Distribution

Clubshell were historically widespread throughout the Ohio River basin and tributaries of western Lake Erie. They are now thought to be restricted to 13 populations distributed across 21 streams in the Ohio River and Lake Erie Basins, including the Elk River, Hackers Creek, South Fork Hughes River, and Meathouse Fork of Middle Island Creek in West Virginia (FWS, 2008b); (figure 7.7.1-1). The other states that contain populations of clubshell include Illinois, Indiana, Kentucky, Michigan, New York, Ohio, Pennsylvania, and Tennessee.

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[10] VADGIF WERMS Database http://www.dgif.virginia.gov/gis/werms.asp; Accessed January 24, 2017

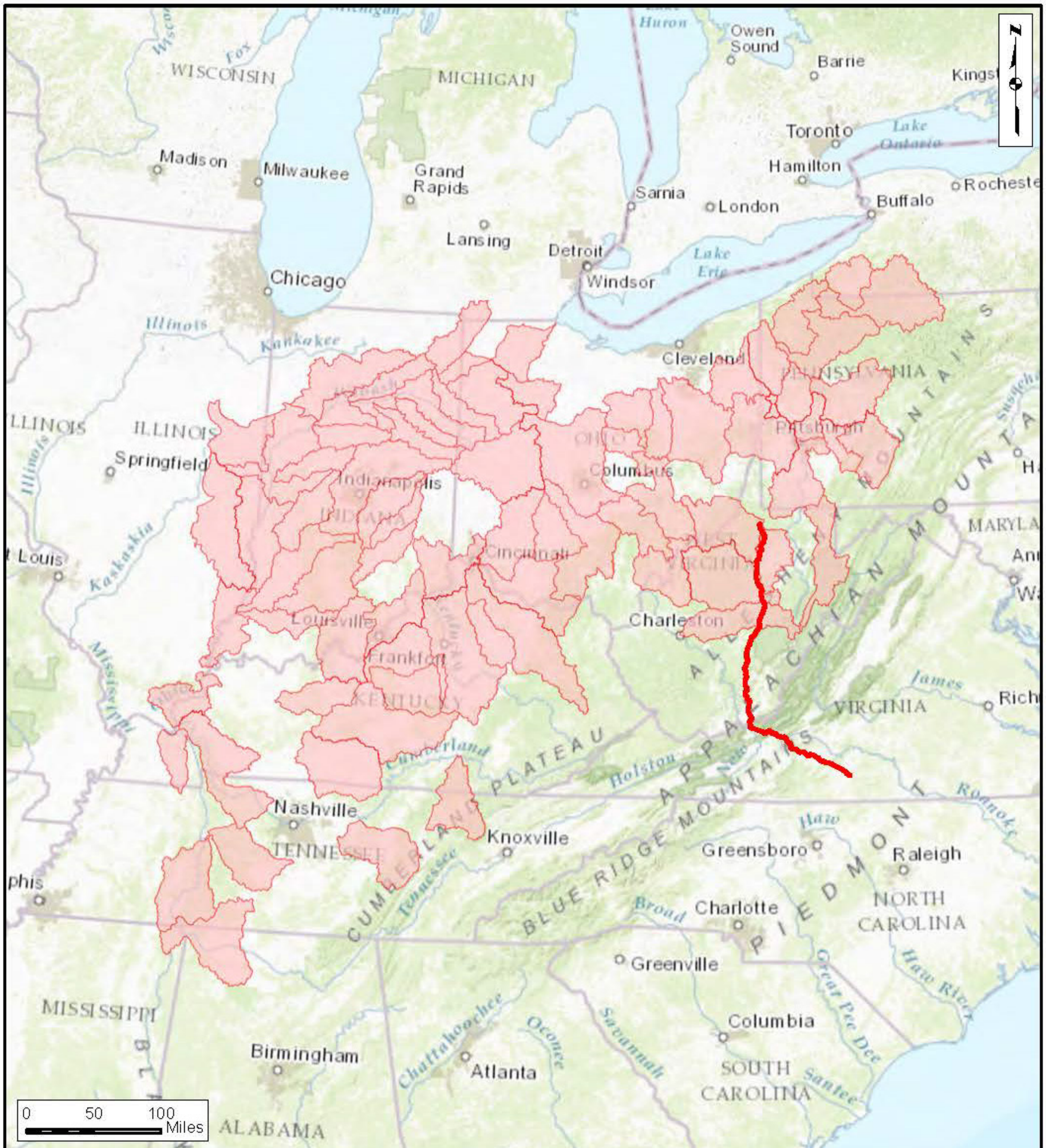


Figure 7.7.1-1

Mountain Valley Project

Distribution of Clubshell

7.7.2 Habitat

Clubshell are most often found in medium-to-small rivers and streams in clean, stable, coarse sand and gravel substrates, often immediately downstream of riffle areas. They typically burrow beneath the substrate to depths of 2 to 4 inches and rely on water to seep down between the sediment particles to obtain oxygen and food. Clubshell are able to tolerate a wide range of water velocities but are generally averse to areas with little to no water flow (FWS, 2008b).

The habitat supporting clubshell must also support specific fishes that are a vital component of the reproductive cycle of clubshell and facilitate the dispersal of a sessile species. Clubshell are short-term brooders. Female mussels release developing larvae (glochidia) into the water column, which must attach to an appropriate host fish for further development. After attachment, the glochidia continue development before dropping from the fish as free-living juvenile mussels. The specific fish hosts required for clubshell glochidia include striped shiner (*Notropis chrysocephalus*), central stoneroller (*Campostoma anomalum*), blackside darter (*Percina maculata*), and common logperch (*Percina caprodes*).

7.7.3 Occurrence

Clubshell were historically widespread in the Ohio River drainage, including many streams in West Virginia, but are not known to occur in Virginia. Potentially suitable habitats for clubshell may occur in select watersheds traversed by the MVP in West Virginia. The MVP intersects three watersheds with potential to support populations of clubshell, including the Elk River, Little Kanawha River, and Leading Creek. Mountain Valley did not observe clubshell during any of the mussel surveys for the MVP.

7.7.3.1 Elk River

A known population of clubshell occurs in the Elk River downstream of Sutton Lake in Braxton and Clay counties, West Virginia. Sutton Lake is a 1,520-acre reservoir on the Elk River. The MVP would cross the Elk River in Webster County, upstream of Sutton Lake and Braxton and Clay counties. The West Virginia Mussel Survey Protocol (WVMSP; Clayton et al., 2015) characterizes the Elk River as a Group 1 stream in Webster County; indicating freshwater mussels are likely present. However, federally listed mussels (e.g., clubshell) are not known to be present. A known population of clubshell occurs in the Elk River between Sutton Lake Dam and Sycamore Creek in Braxton and Clay counties, West Virginia (FWS, 1993b). Sutton Lake Dam is approximately 19.0 stream miles downstream of the proposed MVP crossing. Clubshell populations have been extirpated from areas upstream of the reservoir.

Mountain Valley completed a Phase I mussel survey in accordance with the WVMSP in July 2015 at the proposed crossing of the Elk River in Webster County and no live mussels were found. Surveys indicated no evidence of federally endangered mussels at the Elk River crossing.

7.7.3.2 Little Kanawha River

Sections of the Little Kanawha River provide habitat suitable for the clubshell and the river historically contained a clubshell population. The Project would cross upstream of Burnsville

Lake in Braxton County. Populations of clubshell are known or expected to occur in the Little Kanawha River downstream of Burnsville Lake in Braxton, Gilmer, Calhoun, Wirt, and Wood Counties. The WVMSP designates the Little Kanawha River as a Group 2 stream in Braxton County, indicating that freshwater mussels, including federally listed mussels (i.e., clubshell), may potentially occur. However, installation of Burnsville Lake (a 978-acre reservoir) may have isolated populations of clubshell in the Little Kanawha River and extirpated upstream populations. Three proposed crossings of the Little Kanawha River are anticipated approximately 14.0, 15.2, and 15.9 miles, respectively, upstream of the reservoir and would thus be isolated from the historic population. Clubshell populations have been extirpated from areas upstream of the reservoir. Phase I mussel surveys were completed in accordance with the WVMSP at all three proposed Project crossings and no evidence of federally endangered mussels was encountered at the Little Kanawha River crossings.

7.7.3.3 Leading Creek

Leading Creek is a direct tributary to Little Kanawha River and populations of clubshell are expected to occur in Lewis and Gilmer Counties, West Virginia. The WVMSP designates Leading Creek as a Group 2 stream in Lewis County, indicating freshwater mussels, including federally listed mussels (i.e., clubshell), may occur in stream sections where the upland drainage area is greater than 10 square miles. A mussel survey was not performed at the proposed crossing of Leading Creek because the stream, at the point of crossing, drains less than 10 square miles. The nearest known population of clubshell in Leading Creek is inferred based on streams listed in the WVMSP. Fink Creek is a relatively large tributary that empties into Leading Creek in Gilmer County and is listed as a Group 1, 2 (1/2) stream. This indicates that the downstream-most 0.5 mile of Fink Creek (leading to the confluence with Leading Creek) could potentially harbor federally endangered mussels, including clubshell. Stream reaches of Fink Creek upstream of the half-mile designation are not likely to support federally endangered mussels. Based on the WVMSP stream designations, it is assumed that the nearest clubshell population to the Project likely occurs in Leading Creek, downstream of its confluence with Fink Creek in Gilmer County, West Virginia. Populations of clubshell are not likely to occur in stream reaches with less than 10 square miles of upstream drainage area because of the lack of sufficient aquatic resources to support a population. The 10 square-mile threshold for Leading Creek occurs at the confluence of Leading Creek and Alum Fork. The Action Area in Leading Creek extends to the confluence of Alum Fork; therefore, any potential population of clubshell occurs beyond the limits of the Action Area.

7.8 SNUFFBOX

Snuffbox (*Epioblasma triquetra*) are medium-sized freshwater mussels that average about 2.5 inches in length and reach a maximum length of about 2.8 inches. Females are generally smaller than males, only reaching a length of about 1.7 inches. Snuffbox shells are thick and inflated. Their beaks are located in the middle of the shell and turn inward over a distinct lunule (i.e., hinge cover). Their left valve has two pseudocardinal teeth where the front tooth is smaller than the large triangular inner tooth. Their posterior ridge is well defined and their posterior slope is steep, flat, and adorned with radial striations. Periostracum of the shell is usually pale/greenish yellow with patterns of dark green areas and broken radiating rays composed of dots and dashes (NatureServe, 2016; FWS ECOS, 2016).

7.8.1 Distribution

Snuffbox were historically widespread among the upper Mississippi and Ohio River drainages, including many streams in West Virginia. The range of snuffbox has decreased substantially, but they are still believed to occur in Alabama, Arkansas, Illinois, Indiana, Kentucky, Michigan, Minnesota, Mississippi, Missouri, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia, and Wisconsin (figure 7.8.1-1). Where found, the populations are mostly small and geographically isolated from each other (NatureServe, 2016).

7.8.2 Habitat

Snuffbox are most often found in shoal habitat in small- to medium-sized streams within stable sand and cobble substrates. They primarily prefer swift moving water, but have also been documented within wave-washed shallows of large lakes, such as Lake Erie. Snuffbox typically remain deeply burrowed into substrate except during spawning. Mussels typically abandon the substrate during spawning periods and when gravid females attempt to attract a fish host (FWS, 2012)

Mussel biologists know relatively little about the specific life history requirements of snuffbox (FWS, 2012). Snuffbox are thought to be long-term brooders and host fish are a vital component of the reproductive cycle. After brooding, female mussels release developing larvae (glochidia) into the water column, which must attach to an appropriate host fish for further development. After attachment, the glochidia continue development before dropping from the fish as free-living juvenile mussels. Fish species that snuffbox have successfully used as hosts include common logperch, blackside darters, rainbow darters (*Etheostoma caeruleum),* Iowa darter (*Etheostoma exile*), blackspotted topminnow (*Fundulus olivaceous*), mottled sculpin (*Cottus bairdii*), banded sculpin (*Cottus carolinae*), Ozark sculpin (*Cottus hypselurus*), largemouth bass (*Micropterus salmoides*), and brook stickleback (*Culaea inconstans*) (FWS, 2012).

7.8.3 Occurrence

Potentially suitable habitats for snuffbox may occur in select watersheds traversed by the Project in West Virginia. The Project would intersect three watersheds with potential to support populations of snuffbox including the Elk River, Little Kanawha River, and Leading Creek. Snuffbox specimens were not encountered on this Project during mussel surveys, nor was suitable habitat documented in the Project Area.

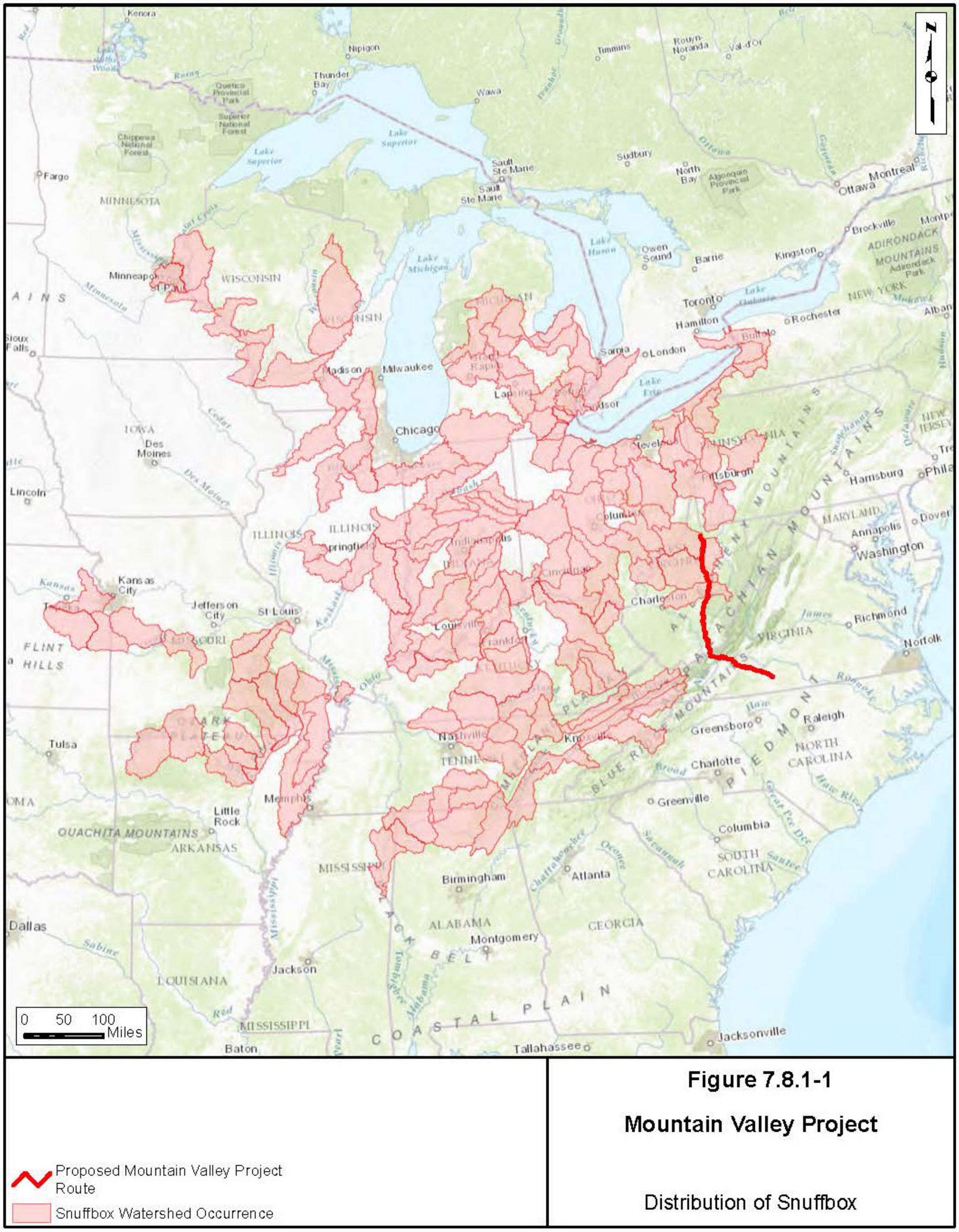


Figure 7.8.1-1

Mountain Valley Project

Distribution of Snuffbox

7.8.3.1 Elk River

A known population of snuffbox occurs in the Elk River downstream of Sutton Lake, a 1,520-acre reservoir on the Elk River in Braxton and Clay Counties, West Virginia. The Project crossing would be upstream of Sutton Lake in Webster County. The WVMSP designates the Elk River as a Group 1 stream in Webster County, indicating freshwater mussels are likely present, but federally listed mussels (e.g., snuffbox) are not known. The known population of snuffbox occurs in the Elk River between Sutton Lake Dam and Sycamore Creek in Braxton and Clay counties, West Virginia (FWS, 1993b). Sutton Lake Dam is approximately 19 miles downstream of the Project crossing. Snuffbox populations have been extirpated from areas upstream of the reservoir. A Phase I mussel survey was completed on July 26, 2015 at the proposed crossing of the Elk River in Webster County and no live mussels were found.

7.8.3.2 Little Kanawha River

The Little Kanawha River provides suitable habitat for the snuffbox, and historically contained a snuffbox population. The Project crossing would be upstream of Burnsville Lake in Braxton County. Populations of snuffbox are known or expected to occur in the Little Kanawha River downstream of Burnsville Lake in Braxton, Gilmer, Calhoun, Wirt, and Wood Counties. The WVMSP designates the Little Kanawha River as a Group 2 stream in Braxton County indicating freshwater mussels, including federally listed mussels (e.g., snuffbox), are expected to occur. However, installation of Burnsville Lake (a 978-acre reservoir) may have isolated populations of snuffbox in the Little Kanawha River and extirpated upstream populations. Three proposed crossings of the Little Kanawha River would occur approximately 14.0, 15.2, and 15.9 miles, respectively, upstream of the reservoir and would thus be isolated from the historic population. Snuffbox populations have been extirpated from areas upstream of the reservoir. Phase I mussel surveys were completed at the three proposed Project crossings of the Little Kanawha River, but no snuffbox mussels were found.

7.8.3.3 Leading Creek

Leading Creek is a direct tributary to Little Kanawha River and populations of snuffbox are expected to occur in Lewis and Gilmer Counties, West Virginia. The WVMSP designates Leading Creek as a Group 2 stream in Lewis County, indicating freshwater mussels, including federally listed mussels (e.g., snuffbox), may occur in stream sections where the upland drainage area is greater than 10 square miles. A mussel survey was not performed at this Project crossing because the stream at the point of crossing drains less than 10 square miles. The nearest known population of snuffbox in Leading Creek is inferred based on streams listed in the WVMSP. Fink Creek is a relatively large tributary that empties into Leading Creek in Gilmer County and is listed as a Group 1, 2 (1/2) stream indicating the downstream-most one half-mile of Fink Creek (from the confluence with Leading Creek) could potentially harbor federally endangered mussels, including snuffbox. Stream reaches of Fink Creek upstream of the half-mile designation are not likely to support federally endangered mussels. Based on the WVMSP stream designations, Mountain Valley assumes that the nearest snuffbox population to the Project likely occurs in Leading Creek downstream of its confluence with Fink Creek in Gilmer County, West Virginia. Populations of snuffbox are not likely to occur in stream reaches with less than 10 square miles of upstream drainage area because of the lack of sufficient aquatic resources to support the species.

The 10 square-mile threshold occurs at the confluence of Leading Creek and Alum Fork. The Action Area in Leading Creek extends about 3.4 miles downstream of the Project crossing, upstream of the confluence with Alum Fork. Therefore, any potential populations occur beyond the limits of the Action Area.

7.9 RUSTY PATCHED BUMBLE BEE

The rusty patched bumble bee was listed as federally endangered on March 21, 2017. Rusty patched bumble bees appear similar to other bumble bees, having large, round bodies with black and yellow coloration. All rusty patched bumble bees have entirely black heads and the workers and males have a rusty reddish patch centrally located on the abdomen (FWS, 2017b).

7.9.1 Distribution

Prior to the 1990s, the rusty patched bumble bee was present in 28 states throughout the eastern and Midwest U.S (Connecticut, Delaware, Georgia, Illinois, Indiana, Iowa, Kentucky, Maine, Maryland, Massachusetts, Michigan, Minnesota, Missouri, New Hampshire, New Jersey, New York, North Carolina, North Dakota, Ohio, Pennsylvania, Rhode Island, South Carolina, South Dakota, Tennessee, Vermont, Virginia, West Virginia, and Wisconsin) and in the District of Columbia. Since 2000, the rusty patched bumble bee has been documented in just 13 states in the eastern and Midwest U.S., including Virginia, Illinois, Indiana, Iowa, Maine, Maryland, Massachusetts, Minnesota, North Carolina, Ohio, Pennsylvania, Tennessee, and Wisconsin (figure 7.9.1-1).

7.9.2 Habitat

The rusty patched bumble bee has been documented inhabiting woodlands, marshes, agricultural landscapes, and residential parks and gardens. The species requires areas that support sufficient food (nectar and pollen from diverse and abundant flowers), undisturbed nesting sites in proximity to floral resources, and overwintering sites for hibernating queens. Nests are typically in abandoned rodent nests or other similar cavities and colonies may consist of up to 1,000 individual workers in a season.

7.9.3 Occurrence

Historical data indicate populations of the rusty patched bumble bee were present in Giles and Montgomery Counties Virginia and potentially Braxton, Fayette, Lewis, and Nicholas Counties in West Virginia. However, the closest known extant population of the rusty patched bumble bee appears to have been more than 3 miles from the MVP vicinity within Lewis County, West Virginia. The last known population within Virginia was in Fauquier County, which is in northern Virginia about 140 miles from the MVP.

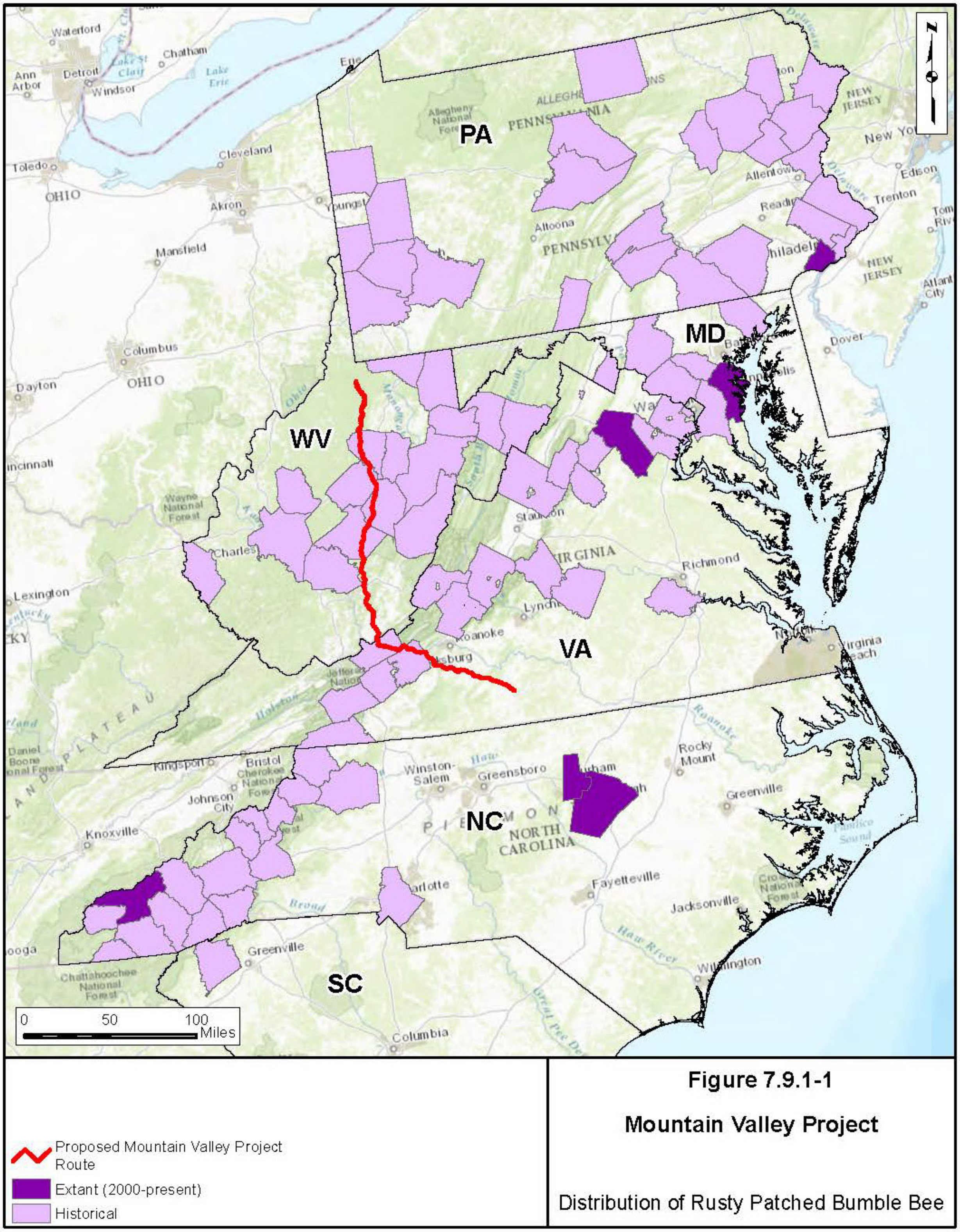


Figure 7.9.1-1

Mountain Valley Project

Distribution of Rusty Patched Bumble Bee

7.10 NORTHEASTERN BULRUSH

The northeastern bulrush is a member of the sedge family (*Cyperaceae*) and is native to the northeastern United States. It is a leafy, perennial herb that grows to approximately 31.5 to 47.2 inches in height. The lowermost leaves are up to 0.3 inch wide and 40 to 60 times as long as wide, while the uppermost leaves are 0.1 to 0.2 inch wide and 30 to 50 times as long as wide. Its flowering culms (stems) are produced from short, woody, underground rhizomes. The umbellate inflorescence has distinctly arching rays, which bear clusters of brown spikelets (small, elongated flower clusters). Each of the minute flowers has six small (0.04 to 0.08 inch long), rigid perianth bristles, and each bristle is armed with thick walled, sharply pointed barbs projecting downward. Its flowers have 0 to 3 stamens and a 3-parted style. The yellow brown achenes are 0.04 to 0.05 inches long, obovate, and tough and thickened above the seed. Flowering occurs mid-June to July, and fruit sets between July and September (FWS, 1993a).

7.10.1 Distribution

The northeastern bulrush has 113 existing populations range-wide. Populations of northeastern bulrush are present in Maryland, Massachusetts, New Hampshire, Pennsylvania, Vermont, Virginia, and West Virginia (figure 7.10.1-1). New York is known to have had an historical population, but is not known to have an existing population. The majority (92) of these populations occur in Pennsylvania and Vermont. New Hampshire contains nine populations and Virginia and West Virginia contain seven and three populations, respectively. Maryland and Massachusetts each contain one population (FWS, 2008c).

7.10.2 Habitat

The northeastern bulrush often grows in ponds, wet depressions, or shallow sinkholes within small (generally less than one acre) wetland complexes. These wetlands are characterized by seasonally variable water levels (FWS, 1993a). In the north, the species grows most commonly on the edge of shallow beaver ponds where water levels vary depending on animal activity. One population occurs on an inland sand plain in Massachusetts, in a depression that periodically fills with groundwater. In the south, the species often grows in sinkhole ponds that form in sandstone bedrock at intermediate elevations around 656 to 1,640 feet (somewhat higher elevations in the Virginias). Plants at all sites grow around the margins of ponds in about 3.1 to 15.7 inches of standing water (in wet years). In Pennsylvania, the northeastern bulrush grows almost exclusively in vernal pools where the water level fluctuates seasonally. A study comparing Pennsylvania wetlands that supported northeastern bulrush with nearby ponds that did not, showed that ponds with northeastern bulrush were typically larger (greater than 4,305 square feet), more free of forest canopy cover, higher in exchangeable sodium (> 7 ppm), and higher in pH (Lentz and Dunson, 1999). Critical habitat has not been designated for this species.

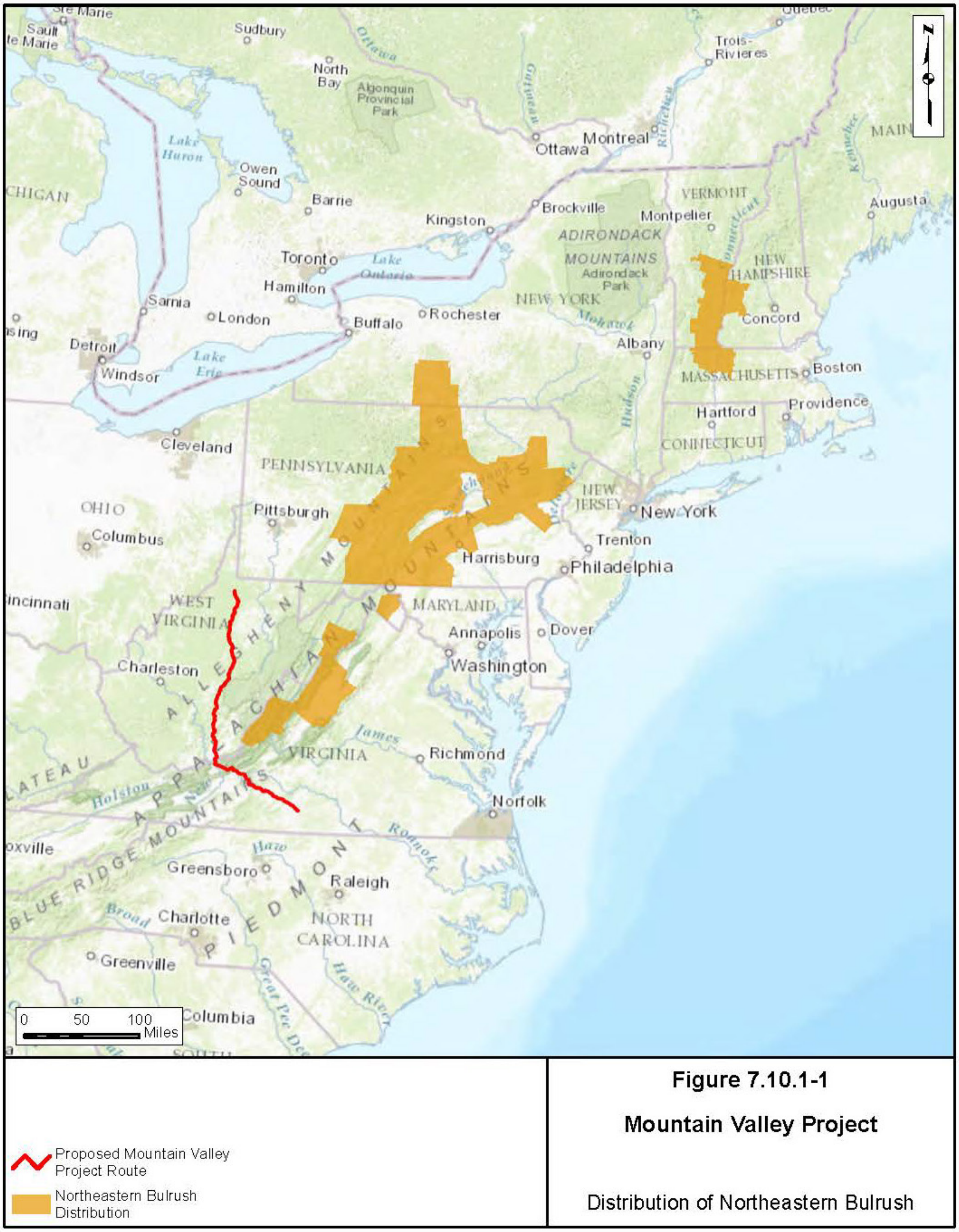


Figure 7.10.1-1

Mountain Valley Project

Distribution of Northeastern Bulrush

7.10.3 Occurrence

Potential habitat examined in the Project Area is shown in figure 7.10.3-1. The northeastern bulrush species is known from Alleghany, Augusta, Bath, and Rockingham Counties, Virginia and Berkeley and Hardy Counties, West Virginia. Potential habitat locations for the species in the Project Area in Giles County, Virginia and Monroe County, West Virginia were initially determined based on consultation with FWS and desktop analyses by Mountain Valley. Mountain Valley then conducted field surveys at the locations from August 5 through August 12, 2015. No potential habitat or individuals of northeastern bulrush were observed within the Project Area. No 2016 surveys were needed for this species.

7.11 RUNNING BUFFALO CLOVER

Running buffalo clover (*Trifolium stoloniferum*) is a stoloniferous, perennial herb. It is characterized by and differentiated from white clover (*Trifolium repens*) by having erect peduncles (flowering stalks) that have two large trifoliate leaves at their summit. White clover lacks these leaves on the peduncle. Running buffalo clover's erect flowering stems are typically 3.0 to 6.0 inches tall. The round flowering heads occur in mid-April to June with wilted flowering heads persisting for a short time thereafter. It reproduces by both seeds and stolons (FWS, 2007c)

7.11.1 Distribution

Running buffalo clover currently grows in limited portions of Arkansas, Indiana, Kentucky, Missouri, Ohio, and West Virginia (figure 7.11.1-1). In Ohio, Kentucky, and Indiana, populations are distributed around the limestone-underlain area in the Bluegrass region. In West Virginia, most populations grow in regions of limestone-underlain substrate of the east-central part of the state. Some of Missouri's populations are also underlain with limestone (Ozark Dome) (FWS, 2007c).

7.11.2 Habitat

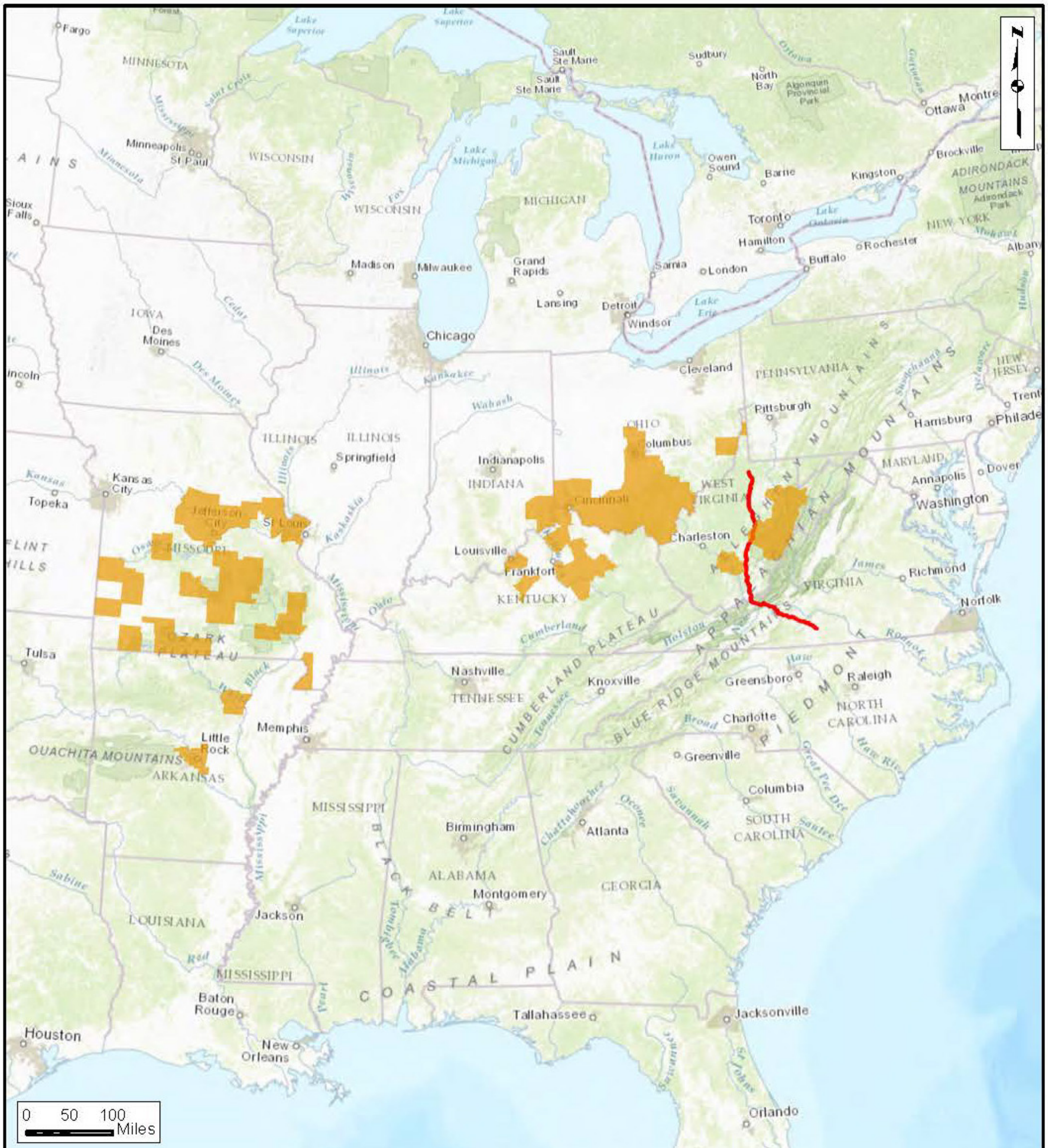
Running buffalo clover grows in relatively moist, fertile soils in regions with limestone or other calcareous bedrock. It is often found in semi-shaded, moist openings, and edge habitats maintained by some form of long-term disturbance. There is no apparent correlation between running buffalo clover and any particular soil type. It has been documented in semi-shaded conditions along footpaths, logging trails, lawns of older homes and cemeteries, and grazed, semi-wooded terraces along stream corridors. In Ohio, it grows in open to semi-open, moist ground with grazing, trampling, or mowing and it is generally near streams or rivers. Critical habitat has not been designated for running buffalo clover.

Proposed Mountain Valley Project Route
RTE Plant Species Concern Survey Area
Access Road

Figure 7.10.3-1

Mountain Valley Project

Potential Occurrence of
Northeastern Bulrush



Proposed Mountain Valley Project Route

Running Buffalo Clover Distribution

Figure 7.11.1-1

Mountain Valley Project

Distribution of Running Buffalo Clover

7.11.3 Occurrence

Running buffalo clover is known to occur or has occurred in Barbour, Brooke, Fayette, Greenbrier, Monongalia, Pendleton, Pocahontas, Preston, Randolph, Tucker and Webster Counties, West Virginia. [redacted] Greenbrier and Webster Counties, West Virginia have the closest known populations to the Project Area. The location of potential running buffalo clover habitat in the Project Area in Greenbrier and Webster Counties was initially identified through consultation with FWS and desktop analyses by Mountain Valley.

Mountain Valley conducted field surveys for running buffalo clover from July 16 through July 23, 2015. Individual running buffalo clover specimens were not observed, but potential habitat for the species was determined to be present within the Project Area. Due to route realignments, Mountain Valley performed additional surveys in Greenbrier and Webster Counties in 2016 from May 2 through May 3, August 5 through August 7, August 23 through August 26, and September 16 through September 17. Again, no individuals were identified. Due to land access issues, about 1.8 acres, consisting of a portion of an access road and a land parcel 0.4 mile west of the proposed construction right-of-way in Webster County, remains to be surveyed (see table 6.4-1).

Figure 7.11.3-1 Potential Locations of Running Buffalo Clover in the Project Area (redacted)

7.12 SHALE BARREN ROCK CRESS

The shale barren rock cress is a biennial plant species within the mustard family. Young, non-reproductive individuals have leaves in a basal rosette that range in size from 0.6 to 1.4 inches in diameter. Potentially reproductive individuals are erect (16.1 to 38.2 inches) and are flowering plants that lack the basal rosette. The flowering stalks are highly branched with three to 41 branches measuring 7.9 to 15.7 inches wide with many flowers. The flowers are small and white with calyxes (0.08 to 0.13 inches long) that bear silique fruits ranging from 1.7 to 3.1 inches long (FWS 1991). It flowers from mid-July to September (Wieboldt, 1987).

A similar species (*Arabis laevigata* var. *burkii*) is often confused with shale barren rock cress as it is also found on shale barrens. However, it occupies a variety of habitats, flowers in April and May, has broader leaves that are auricled at the base, less branched inflorescences and larger flowers than shale barren rock cress (Wieboldt, 1987).

7.12.1 Distribution

The shale barren rock cress has a very limited distribution (figure 7.12.1-1). It is only known to occur in West Virginia and Virginia at low densities on mid-Appalachian shale barrens of the Ridge and Valley Province of the Appalachian Mountains. (Catrow et al., 2009; FWS ECOS, 2016).

7.12.2 Habitat

The shale barren rock cress is very habitat restricted. It is only known to occur at low densities among scattered mid-Appalachian shale barrens in West Virginia and Virginia (Catrow et al., 2009). Mid-Appalachian shale barrens are characterized by an open, scrubby growth of pine, oak, red cedar, and other woody species adapted to dry conditions and are found most frequently on eroding slopes undercut by a stream. Shale barrens are isolated islands of habitat with steep southern exposures with elevations of 1,099 to 2,494 feet, dry, relatively sparse vegetative cover, high temperatures, and low moisture in the summer (FWS ECOS, 2016).

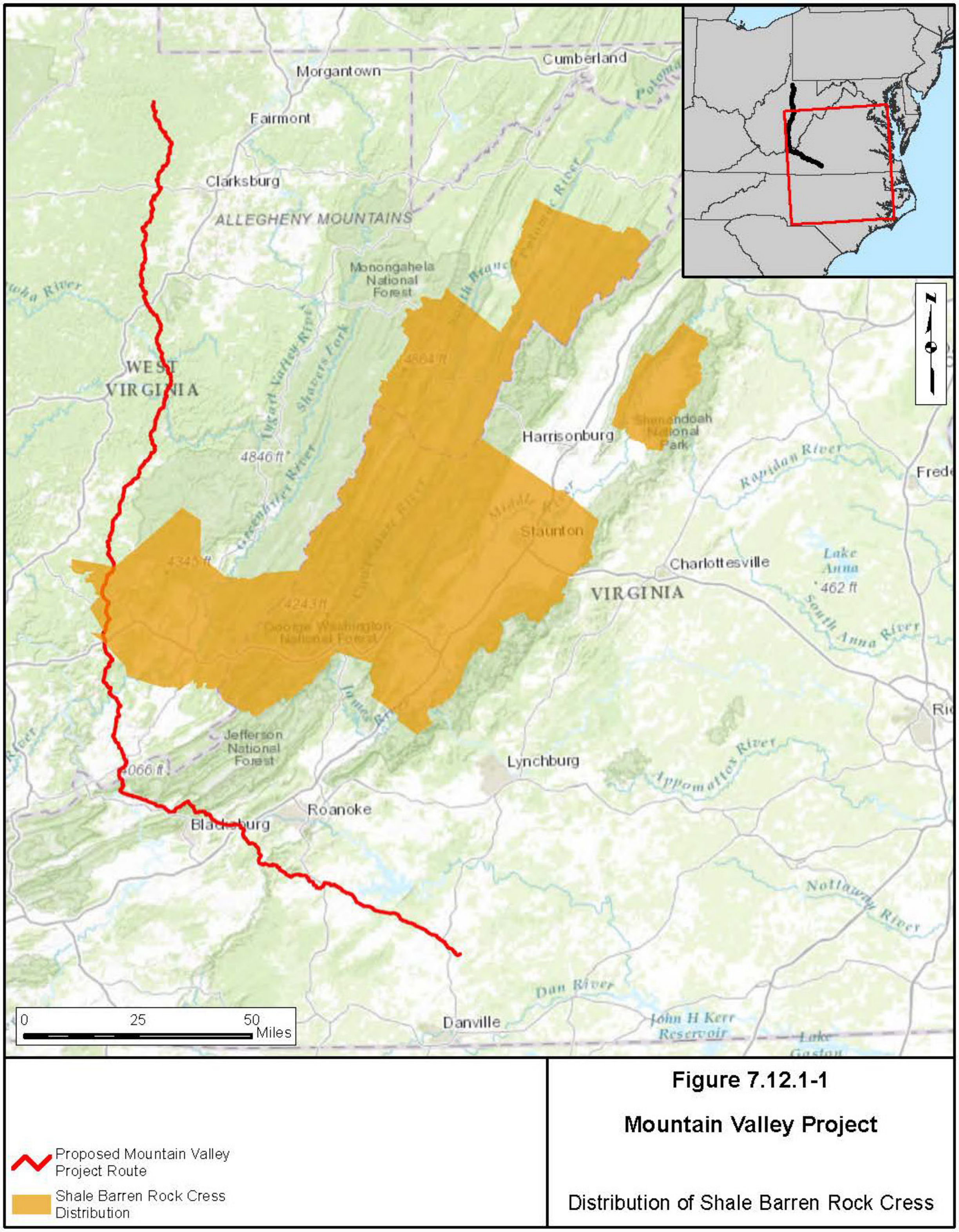


Figure 7.12.1-1

Mountain Valley Project

Distribution of Shale Barren Rock Cress

7.12.3 Occurrence

Shale barren rock cress has been documented in six Virginia counties (Bath, Alleghany, Augusta, Highland, Page, and Rockbridge) and three West Virginia counties (Pendleton, Greenbrier, and Hardy). The closest known populations to the Project Area occur in Greenbrier County, West Virginia; therefore, initial surveys by Mountain Valley for suitable habitat and individuals were concentrated in Greenbrier County and the bordering Fayette County. [redacted]

The locations of potential habitat for shale barren rock cress in the Project Area in Greenbrier and Fayette Counties were initially identified based on consultation with FWS and desktop analyses by Mountain Valley. Mountain Valley conducted plant surveys within these areas from August 5 through August 12, 2015. The surveys documented no potential habitat or individuals of shale barren rock cress within the Project Area. Due to route realignments, Mountain Valley conducted additional surveys in Greenbrier and Webster Counties in 2016 from August 5 through August 7, August 23 through August 26, and September 16 through September 17. Again, no potential habitat nor individual specimens were identified. Due to land access issues, about 29.5 acres of the construction right-of-way remains to be surveyed (see table 6.4-1).

Figure 7.12.3-1 Potential Occurrence of Shale Barren Rock Cress (redacted)

7.13 SMALL WHORLED POGONIA

The small whorled pogonia is a member of the orchid family and is characterized by a single gray-green stem up to 11.8 inches tall and the whorl of five to six leaves at the top of the stem. The leaves are gray-green, oblong, and reach 1.6 to 3.1 inches in length. A single or pair of green-yellow flowers appears in May or June. Pollinators are unknown. Fruits are capsules, which mature in the autumn.

Large whorled pogonia (*Isotria verticillata*) is a similar species and can be differentiated by its reddish stem, differently colored flowers and sepal characteristics. Small whorled pogonia also resembles young plants of Indian cucumber-root (*Medeola virginiana*) and is distinguished from it because it has a hollow stout stem, whereas Indian cucumber-root has a solid, more slender stem (FWS, 2008d).

7.13.1 Distribution

The small whorled pogonia is a widely distributed, but rare species (figure 7.13.1-1). It is found in 18 eastern states and Ontario, Canada. Populations are typically small with less than 20 plants. It has been extirpated from Missouri, Vermont, and Maryland.

7.13.2 Habitat

The small whorled pogonia occurs on upland sites in mixed-deciduous or mixed-deciduous/coniferous forests that are generally in second- or third-growth successional stages. Characteristics common to most small whorled pogonia sites include sparse to moderate ground cover in the species' microhabitat, a relatively open understory below the canopy, and proximity to features that create long persisting breaks in the forest canopy. It prefers acidic soils with a thick layer of dead leaves, often on slopes near small streams. Light availability could be a limiting factor for this species (FWS, 1992b; FWS, 2016b). Critical habitat has not been designated for the small whorled pogonia.

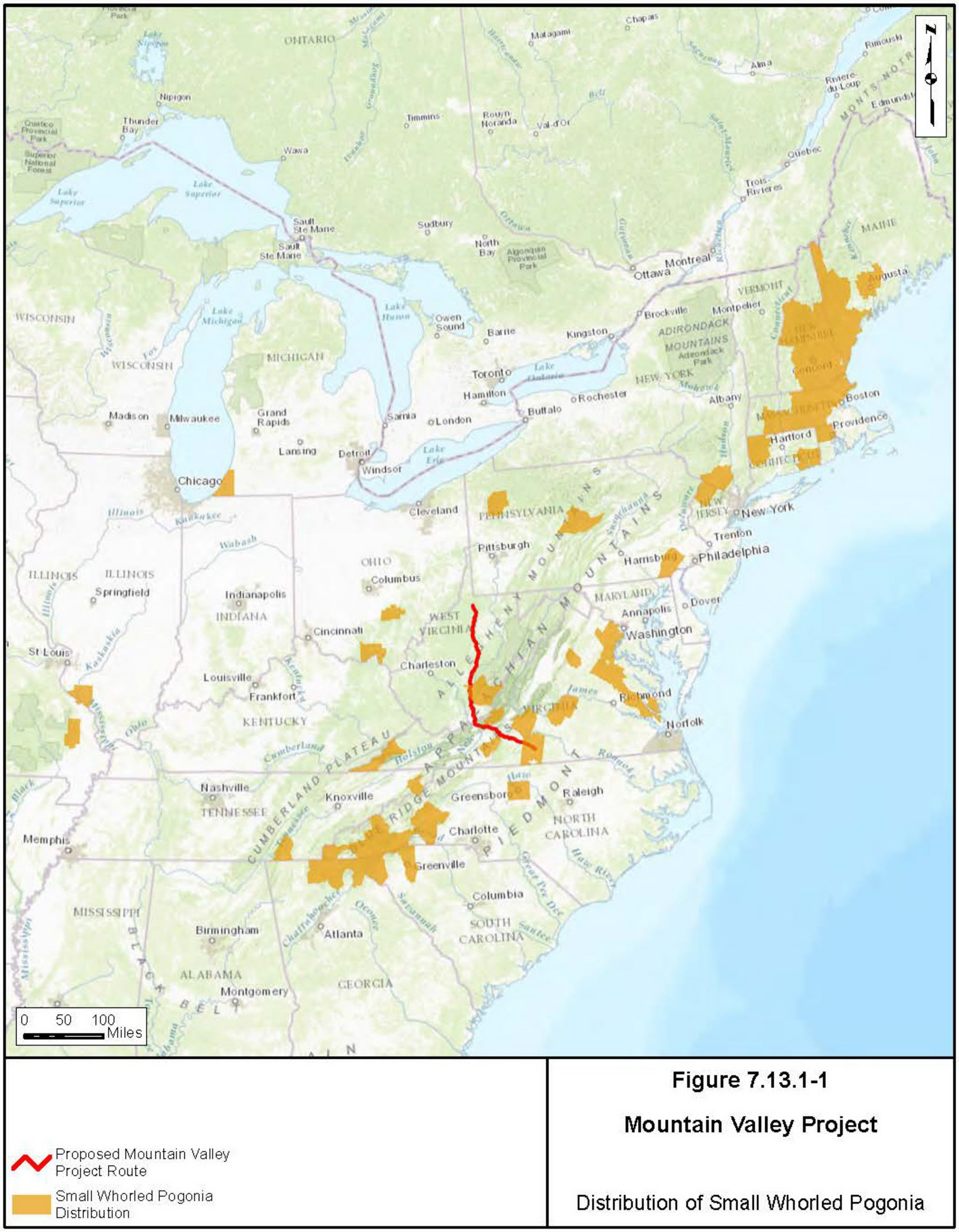


Figure 7.13.1-1

Mountain Valley Project

Distribution of Small Whorled Pogonia

7.13.3 Occurrence

Small whorled pogonia is known or believed to occur in 20 counties and 2 cities (Petersburg and Williamsburg) in Virginia and in Greenbrier and Randolph Counties in West Virginia. The closest known populations to the Project Area are in Greenbrier County, West Virginia; therefore, initial searches for suitable habitat and individuals were concentrated in Greenbrier County and bordering Fayette County. [redacted]

The locations of potential habitat for small whorled pogonia in the Project Area in Greenbrier and Fayette Counties were initially identified based on consultation with the FWS and desktop analyses by Mountain Valley. Mountain Valley conducted field surveys for small whorled pogonia from August 5 through August 12, 2015 in Greenbrier and Fayette Counties. Individual small whorled pogonia were not observed, but potential habitat for the species was determined to be present within the Project Area in Greenbrier and Fayette Counties.

Due to route realignments, Mountain Valley conducted additional surveys in Greenbrier and Fayette Counties in 2016 from May 2 through May 3, August 5 through August 7, August 23 through August 26, and September 16 through September 17. Again, no individuals were observed. Due to land access issues, about 29.5 acres of the construction right-of-way remains to be surveyed (see table 6.4-1).

Figure 7.13.3-1 Potential Locations of Small Whorled Pogonia in the Project Area (redacted)

7.14 SMOOTH CONEFLOWER

The smooth coneflower grows up to 59 inches tall from a vertical root stock; stems are smooth, with few leaves. The largest leaves are the basal leaves, which reach 7.8 inches in length and 2.9 inches in width, have long petioles, and are elliptical to broadly lanceolate, taper to the base, and are smooth to slightly rough. The midstem leaves have shorter petioles, if petioles are present, and are smaller than the basal leaves. Flower heads are usually solitary. The ray flowers (petal-like structures on the composite flower heads) are light pink to purplish, usually drooping, and 1.9 to 3.1 inches long. It has disk flowers that are about 0.2 inch long with tubular purple corollas and mostly erect short triangular teeth.

The smooth coneflower can be distinguished from its most similar relative, the purple coneflower (*E. purpurea*), by its leaves, which in the smooth coneflower are never cordate (heart-shaped) like those of the purple coneflower. In addition, the awn of the pale (chaffy scales at the base of the fruit) in the smooth coneflower is incurved, while that of the purple coneflower is straight. The vertical rootstock of the smooth coneflower also distinguishes it from the purple coneflower, which has a horizontal rootstock (FWS, 1995).

7.14.1 Distribution

Smooth coneflower historically occurred from Pennsylvania to Georgia (figure 7.14.1-1). It is thought to be extirpated from Pennsylvania and is currently only known from Georgia, North Carolina, South Carolina, and Virginia. In Virginia, it is known or believed to occur in the following counties: Alleghany, Amherst, Botetourt, Campbell, Covington, Franklin, Halifax, Montgomery, Nottoway, Pulaski, Roanoke, Salem, and Wythe. It is thought to be extirpated in Nottoway, Roanoke, and Wythe Counties, Virginia. There is also a historical record in Lynchburg, Virginia, but the species in that location is now thought to be extirpated.

7.14.2 Habitat

Smooth coneflower occurs preferentially in open areas over amphibolite, dolomite, or limestone. In Virginia, smooth coneflower occurs in dolomite woodlands or glades that are generally open and dry. It has also been found in open woods, cedar barrens, roadsides, clear-cuts, utility line rights-of-way, and dry limestone bluffs. It is believed that periodic disturbance, common to these habitats, is needed to maintain high light conditions and low level of herbaceous competition required for the species to thrive (FWS, 1995). Critical habitat has not been designated for smooth coneflower.

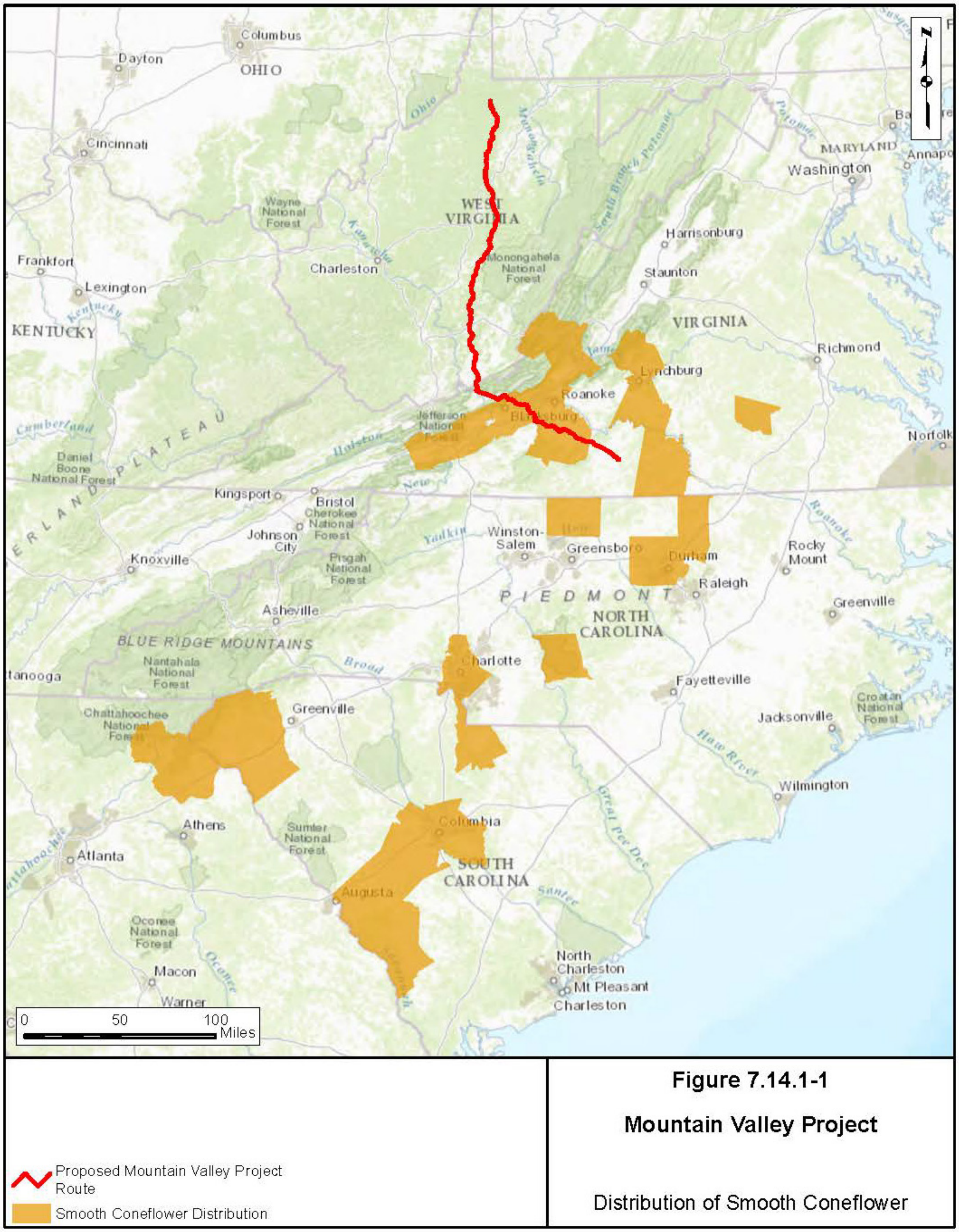


Figure 7.14.1-1

Mountain Valley Project

Distribution of Smooth Coneflower

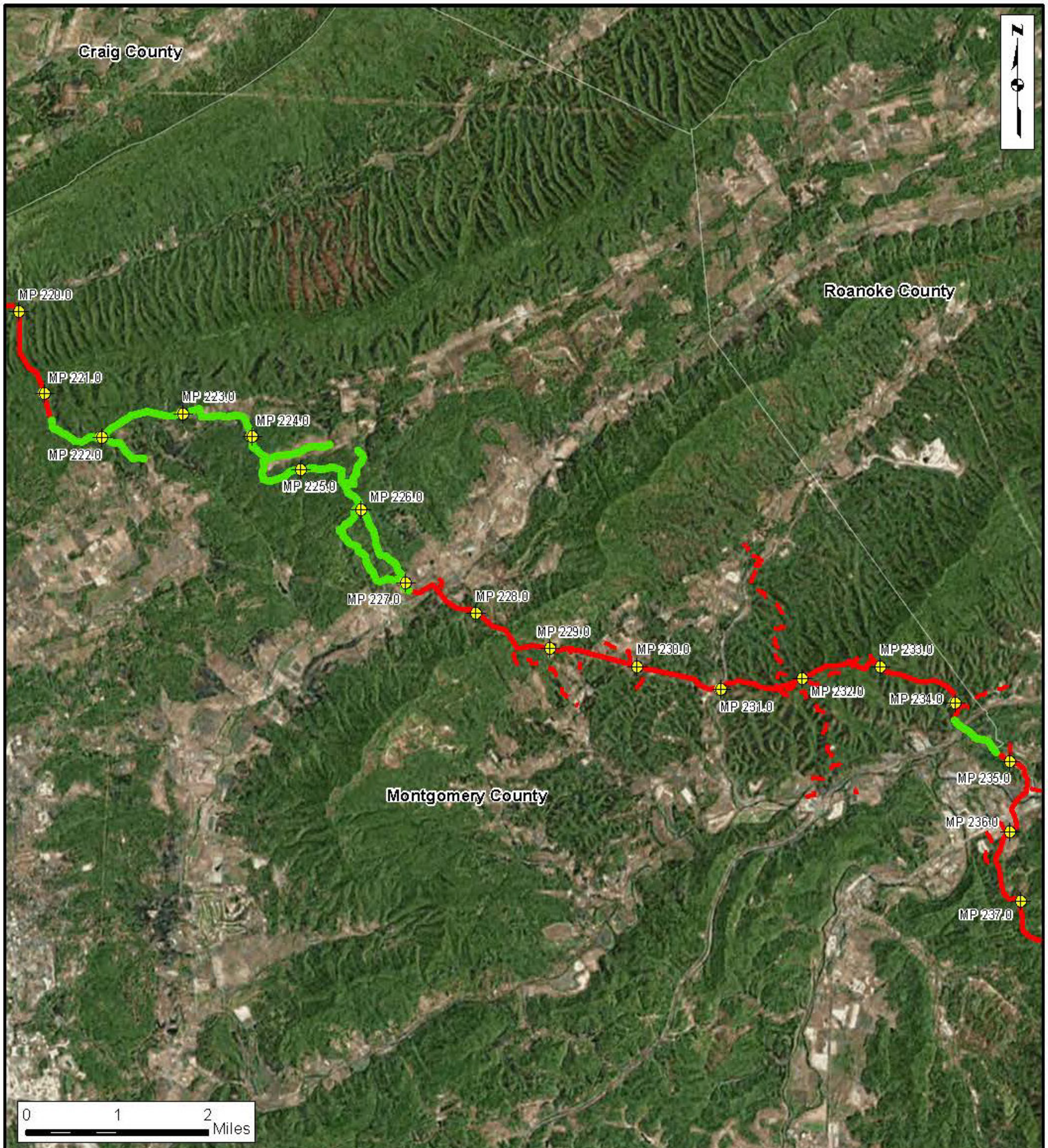
7.14.3 Occurrence

Smooth coneflower is known or believed to occur in 14 counties in Virginia. It does not occur in West Virginia. The closest known populations of smooth coneflower to the Project Area are in Montgomery County, Virginia; therefore, initial searches for suitable habitat and individuals were concentrated in Montgomery County. The locations of potential habitats searched for smooth coneflower are provided on figure 7.14.3-1.

The locations of potential habitat for smooth coneflower in the Project Area in Montgomery County were initially identified based on consultation with FWS and desktop analyses by Mountain Valley. Mountain Valley conducted a field survey for smooth coneflower on August 24, 2015 in Montgomery County. Individual smooth coneflower were not observed, but potential habitat for the species was determined to be present within the Project Area in Montgomery County.

Due to route realignments and land access issues in 2015, Mountain Valley conducted additional surveys in Montgomery County in 2016 from June 22 through July 3, August 8 through August 12, and September 19 through September 20. Again, no individuals were observed.

Mountain Valley was granted land access to previously unsurveyed parcels in 2016 after the survey window for smooth coneflower had closed. Mountain Valley conducted assessments for smooth coneflower habitat on these parcels on October 7 and October 25, 2016. Mountain Valley did not identify suitable habitat for smooth coneflower on these parcels; therefore, no additional surveys are needed for this species.



Proposed Mountain Valley Project Route
Access Road
RTE Plant Species Concern Survey Area

Appendix 7.14.3-1

Mountain Valley Project

Potential Occurrence of
Smooth coneflower

7.15 VIRGINIA SPIRAEA

Virginia spiraea is a perennial shrub with many branches. It grows 3 to 10 feet tall. Its alternate leaves are single-tooth serrated and grow to 1 to 6 inches long and 1 to 2 inches wide. The leaves are darker green above than below, occasionally curved, and have a narrow, moderately tapered base. The plant produces flowers that are yellowish green to pale white, with stamens twice the length of the sepal. It blooms from late May to late July, but flower production is sparse and does not begin until after the first year of establishment. Virginia spiraea has a clonal root system that can fragment and produce more plants. This form of vegetative reproduction is more common than flower pollination and seed dispersal in this species (FWS, 2011b)

7.15.1 Distribution

The Virginia spiraea is a Southern Appalachian species found in the Appalachian Plateaus or the southern Blue Ridge Mountains in Alabama, Ohio, West Virginia, Virginia, Tennessee, North Carolina, Kentucky, and Georgia (figure 7.15.1-1). It no longer occurs in Pennsylvania. Most of the existing populations consist of only a few clumps (FWS ECOS, 2016).

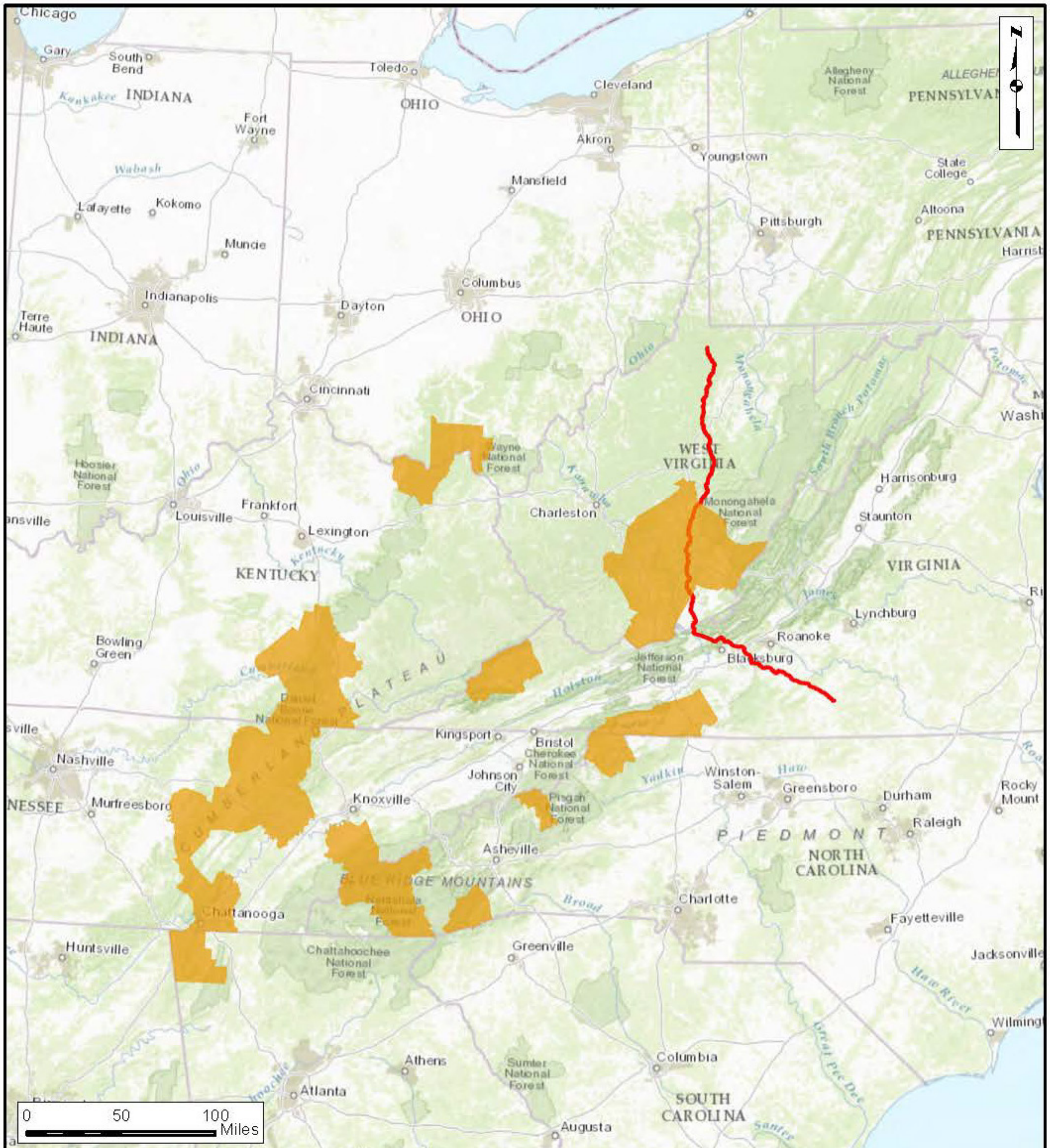
7.15.2 Habitat

Virginia spiraea occurs along scoured banks of second and third order streams, or on meander scrolls, point bars, natural levees, and other braided features of lower reaches of streams. Virginia spiraea is somewhat different in that its life history requirements are strongly tied to high gradient streams on larger creeks and rivers. In Virginia, Virginia spiraea plants are often located along flood scour zones in crevices of sandstone cobbles, boulders, and massive rock outcrop, and quartzite/feldspar boulders. It occurs in soils that are sandy, silty, or clay at elevations ranging between 1,000 and 2,400 feet. In West Virginia, it occurs among large boulders, flatrock, and flood debris along scoured streamsides. It occurs in silty and sandy soils at elevations ranging between 1,000 and 1,800 feet. Critical habitat has not been designated for Virginia spiraea.

7.15.3 Occurrence

Virginia spiraea is known or believed to occur in Carroll, Dickenson, Grayson, Norton, and Wise Counties in Virginia and Fayette, Greenbrier, Mercer, Nicholas, Raleigh, and Summers Counties in West Virginia. The closest known populations of Virginia spiraea to the Project Area are in Summers and Nicholas Counties; therefore, therefore, initial searches for suitable habitat and individuals were concentrated in these counties. [redacted]

The locations of potential habitat for Virginia spiraea in the Project Area in Summers and Nicholas Counties were initially identified based on consultation with FWS and desktop analyses by Mountain Valley. Mountain Valley conducted field surveys for Virginia spiraea from August 5 through August 12, 2015, in Summers and Nicholas Counties. Individual Virginia spiraea were not observed, but potential habitat for the species was determined to be present along the Gauley River within the Project Area in Nicholas County. Due to land access issues, about 4.3 acres of the construction right-of-way in Summers County remains to be surveyed (see table 6.4-1).



Proposed Mountain Valley Project Route

Virginia Spiraea Distribution

Figure 7.15.1-1

Mountain Valley Project

Distribution of Virginia Spiraea

Figure 7.15.3-1 Potential Locations of Virginia Spiraea in the Project Area (redacted)

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8.0 EFFECTS OF THE ACTION

A ***No Effect*** determination is appropriate when the action would not affect the species (FWS and NMFS, 1998). A ***May Affect*** determination is the appropriate conclusion when a proposed action may have any effects on the species. An ***Is Not Likely to Adversely Affect*** determination is appropriate when effects on the species are expected to be insignificant or discountable. Insignificant effects relate to the size of the impact and never reach the scale of a take. Discountable effects are those extremely unlikely to occur. ***Beneficial Effects*** are contemporaneous positive effects without any adverse effects. An ***Is Likely to Adversely Affect*** determination is appropriate if any adverse effect may occur to the listed species as a direct or indirect result of the proposed action or its interrelated or interdependent actions.

8.1 INDIANA BATS

Analysis of effects to Indiana bats as a result of Project construction and operation is based on the various seasonal life cycles, known occurrence data (table 8.1-1), and areas where survey data do not exist (and thus presence is assumed).

Within these areas, timber clearing and destruction of hibernacula pose the greatest potential threats to individuals. Clearing of forested habitat within the Project would be anticipated to primarily occur from January through May of 2018; however, several areas of the Project would likely need to be cleared between August and November of 2018 (figure 8.1-1 [Maps 1-3]). Mountain Valley would adhere to the time of year restriction for tree removal (April 1 – November 15) within 5 miles of known Indiana bat hibernacula and 5 miles of the summer capture of an Indiana bat in Wetzel County, West Virginia (table 8.1-1)

8.1.1 Direct Effects on Individuals

Indiana bats may be subjected to direct and indirect effects during construction and operation of the Project. Effects by season are addressed in the sections below. Mountain Valley determined the methods and calculated the results of the predictive models used to estimate occurrence and abundance of Indiana bats in coordination with the FWS. We have reviewed the methods, calculations, and results and concur with the findings. Mountain Valley's base report formulating estimates of take for federally listed species is included as appendix C. Effects determinations are provided in section 8.1.5.

8.1.1.1 Winter Season of Hibernation

As detailed in section 7.1.2.3, there are 131 potential winter hibernacula features within the Project vicinity. These include 124 features with assumed presence, two Priority 3/4 winter hibernacula (Greenville Saltpeter Cave and Tawney's Cave) and 5 additional portals determined to be suitable by field searches or desktop analysis (CRA-PO-00001, Kimbalton Mine, Fred Bulls, MKM-PO-002, and MKM-PO-003). The proposed route does not intersect any of these known or potential hibernacula; therefore, harm to individuals is unlikely. However, harassment in the form of disturbance from construction noise is possible.

TABLE 8.1-1

Known Indiana Bat Occurrences within the Action Area

Known or Potentially Occupied Indiana Bat Habitat	County, State	Area (acres) a/	Forested Habitat (acres)	% Total	Project Milepost		Impacts on Forested Habitat			
					Enter	Exit	Construction (acres)	Occupied Forested Habitat (%)	Operation (acres)	Occupied Forested Habitat (%)
Summer; 2010 capture of pregnant female; 5-mile buffer	Wetzel, WV	50,265.7	47,490.8	94.5	[redacted]	[redacted]	227.8	0.48	76.9	0.16
Winter; Greenville Saltpeter Cave; known hibernaculum; 5-mile buffer	Monroe, WV	50,265.7	37,276.7	74.2	[redacted]	[redacted]	171.3	0.46	63.3	0.17
Winter; Tawney's Cave; known hibernaculum; 5-mile buffer b/	Giles, VA	51,621.0	41,069.5	79.6	[redacted]	[redacted]	138.8	0.34	47.9	0.12
Total c/		**152,152.4**	**125,837.0**	**-**	**-**	**-**	**537.9**	**0.43**	**188.1**	**0.15**

a/ Area within 5 miles of the feature.
b/ 5-mile buffer was established around the three known entrances of the cave.
c/ Percent occupied forested habitat total presented as average of the three values

Figure 8.1-1 Planned Locations and Timing of Tree Clearing Activities near Potential Indiana Bat Habitat – Sheet 1 of 3 (redacted)

Figure 8.1-1 Planned Locations and Timing of Tree Clearing Activities near Potential Indiana Bat Habitat – Sheet 2 of 3 (redacted)

Figure 8.1-1 Planned Locations and Timing of Tree Clearing Activities near Potential Indiana Bat Habitat – Sheet 3 of 3 (redacted)

8.1.1.2 Impacts from Noise on Hibernating Bats

The Action Area for the Project is defined as extending about 0.6 mile from the edge of the Project Area (see section 4.1.2). Of 131 potential features within 5 miles of the Project, 62 occur within the Action Area. One of these, Tawney's Cave, was previously identified as occupied by Indiana bats; four features were deemed suitable but remain unsampled for bats (Kimbalton Mine, Fred Bulls, MKM-PO-002, and MKM-PO-003); and 57 features have not been assessed for suitability or occurrence of Indiana bats. In order to quantify the level of take from Project activities, an abundance estimate of 2.007 bats was used for Tawney's Cave and the four suitable portals, but for features with unknown suitability, an estimate of 0.9262 bats was used (see section 7.1.2.3 and appendix C). Individuals, if present, within these portals have the potential to be harassed during hibernation, and Mountain Valley expects that 62.8 bats may be harassed. Since take is measured as whole individuals, this is rounded up to 63 individuals.

Eq. 1		2.007	Individuals from Tawney's Cave
		2.007×4	Individuals from suitable features (n=4)
	+	0.9262×57	Individuals from features with unknown suitability (n=57)
		62.8	**Total individuals harassed**

Because bats also have potential to be harassed from noise during operation of the compressor stations, the effects analysis also included an assessment of hibernacula surrounding potential locations of permanent aboveground facilities (i.e., compressor stations); however, there are no documented hibernacula (known or potentially occupied) within 0.6 mile of a compressor station location. Based on these data, the risk of harassing hibernating Indiana bats by operational noise is insignificant and discountable.

8.1.1.3 Spring Staging and Autumn Swarming

After emerging from hibernation, Indiana bats participate in spring staging, where bats remain near the hibernacula for a short time (about 2 to 3 days) before migrating. A similar process occurs in autumn but over a longer time period, with most bats roosting in forested habitat within 5 miles of the cave entrances. As identified above, the Project is within 5 miles of 131 potential hibernacula features, 2 of which are known Indiana bat hibernacula; however, few hibernating Indiana bats have been observed within these caves since 2000.

Project construction could directly harm or harass individuals during spring staging and autumn swarming by removing forested habitat and creating the potential for both injury and mortality. Individuals also may be forced to expend additional energy to locate replacement roosts due to construction sound or active clearing of a tree where a bat is roosting.

Bat Activity during Spring Staging

To estimate impacts on individuals during spring staging, Mountain Valley derived information on the temporal and spatial attributes of bat activity during spring from available literature on the species. Based on information provided in Cope and Humphrey (1977), nearly all individuals remain in hibernation before March 14; however, a few individuals may remain active throughout the winter. The study also demonstrated that beginning in late March to early April individuals begin to emerge. By mid-April, 95 percent of individuals captured within the spring had emerged, with the remainder emerging by April 23. Based on this information, the majority of bats within a winter habitat likely emerge and participate in staging during April. In addition to the temporal aspects of staging, Mountain Valley derived the spatial configuration of roost tree use during spring and autumn from Gumbert et al. (2002) and created concentric bins surrounding known or potentially occupied portal features. Based on this information, Mountain Valley estimates that 50 percent of the population is found within 0.42 mile of the hibernacula, 25 percent between 0.42 mile and 0.83 mile, 20 percent between 0.83 mile and 1.47 miles, and 5 percent between 1.47 miles and 4.35 miles, respectively (figure 8.1.1.3-1).

Using both the temporal and spatial aspects of staging derived from Cope and Humphrey (1977) and Gumbert et al. (2002), respectively. Mountain Valley calculated the number of staging bats in a bin surrounding a potential hibernaculum as the product of the number of individuals expected in the feature during the winter months (column 1 in table 8.1.1.3-1; as derived in section 7.1.2 and detailed in appendix C) and the proportion of the population expected to be found within the distance bin based on (Gumbert et al., 2002; see example calculation in column 3 of table 8.1.1.3-1). Mountain Valley then used this estimate to calculate the potential harm and harassment from tree felling and construction disturbance.

Impacts from Tree Clearing during Spring Staging

Mountain Valley calculated expected harm to staging bats within each bin surrounding a potential hibernacula (figure 8.1.1.3-1) as the product of the number of bats expected in the bin (e.g., column 3 of table 8.1.1.3-1), the proportion of the bin within the construction workspaces cleared during April (e.g., column 4 of table 8.1.1.3-1), and the expected harm rate (25 percent) explained in the following text. Previous studies have observed mortalities of 10, 16, and 9 percent (Mumford and Cope, 1964; Cope et al., 1974; Belwood, 2002) when trees are felled with bats roosting within them. However, Mountain Valley considered the sample sizes in these studies to be low and the estimates only include mortality. To offset this low sample size and to include the potential for additional injury, Mountain Valley used a conservative harm rate of 25 percent. All bats present within the portion of the bin within the construction workspaces but not harmed are assumed to be harassed (i.e., harassment rate =75 percent).

Based on the Mountain Valley's estimated tree clearing schedule, harm and harassment from tree clearing is possible surrounding 70 different features within the month of April. However, these 70 features only include areas without confirmed occupancy. Four features discovered during searches for portals remain unsurveyed for the presence of bats and 66 features are of unknown suitability (table 8.1.1.3-2). No tree clearing would occur in April near [redacted] In the area around these 70 features, the probability of a staging Indiana bat being harmed or harassed due to tree clearing is low, but possible. Mountain Valley estimated harm as 0.0689 bats, and harassment as 0.2066 bats (table 8.1.1.3-2).

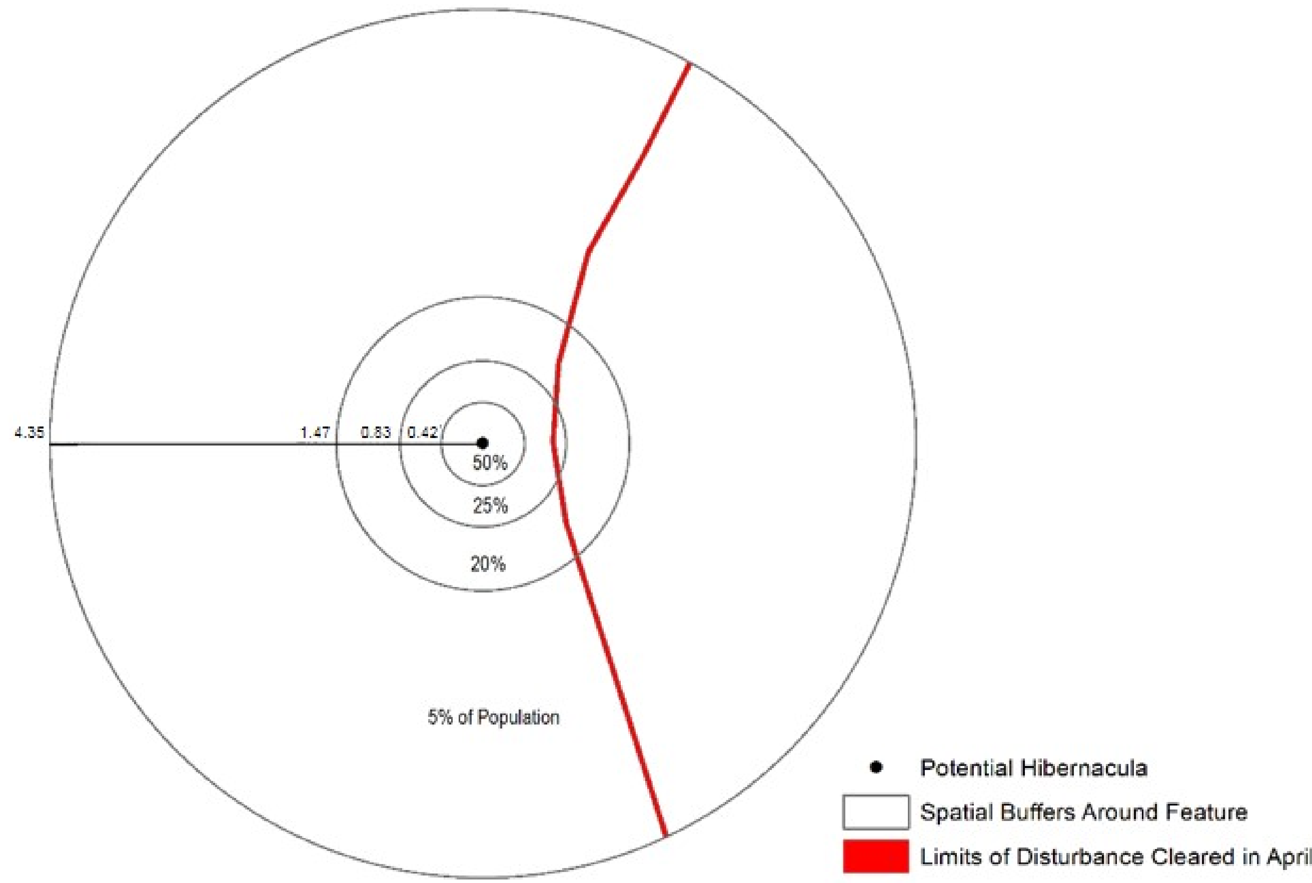

Figure 8.1.1.3-1 Example diagram of take calculation for staging Indiana bats due to tree clearing surrounding a potential hibernacula

TABLE 8.1.1.3-1

Example Take Calculation for Staging Indiana Bats Due to Tree Clearing Surrounding a Potential Hibernacula

Example Total Winter Abundance	Proximity Bin (miles)	Expected Individuals Staging in Bin	Proportion of Bin within the Construction Workspaces Cleared in April	Expected Individuals Staging within Construction Workspaces within Bin	Expected Harm	Expected Harassment
10	0.42-0.83	10×0.25=2.5	0.021	2.5×0.021=0.0525	0.0525×0.25=0.013125	0.0525×0.75=0.039375
	0.83-1.47	10×0.20=2	0.017	2×0.017=0.034	0.034×0.25=0.0085	0.034×0.75=0.0255
	1.47-4.35	10×0.05=0.5	0.005	0.5×0.005=0.0025	0.0025×0.25=0.000625	0.0025×0.75=0.001875
			Totals	**0.089**	**0.02225**	**0.06675**

TABLE 8.1.1.3-2

Potential Areas for Harm and Harassment of Spring Staging Indiana Bats from Tree Felling

Feature Type a/	Winter Abundance Estimate	Freq b/	Proximity Bin (miles) c/	Proportion of Ind. within Bin c/	Proportion of Forest in Bin Cleared in April	Expected Individuals Present in Cleared Forest in April	Expected Harassment d/	Expected Harm d/
Suitability Unknown	0.9262	66	0-0.42	0.50	0.0028	0.9262×66 ×0.50 ×0.0028=0.0856	0.0642	0.0214
			0.42-0.83	0.25	0.0032	0.9262×66 ×0.25 ×0.0032=0.0489	0.0367	0.0122
			0.83-1.47	0.20	0.0035	0.9262×66 ×0.20 ×0.0035=0.0428	0.0321	0.0107
			1.47-4.35	0.05	0.0023	0.9262×66 ×0.05 ×0.0023=0.0070	0.0053	0.0018
Suitable, Unsurveyed	2.007	4	0-0.42	0.50	0.0058	2.007×4 ×0.50 ×0.0058=0.0233	0.0175	0.0058
			0.42-0.83	0.25	0.0272	2.007×4 ×0.25 ×0.0272=0.0546	0.0410	0.0137
			0.83-1.47	0.20	0.0072	2.007×4 ×0.20 ×0.0072=0.0116	0.0087	0.0029
			1.47-4.35	0.05	0.0038	2.007×4 ×0.05 ×0.0038=0.0015	0.0011	0.0004
					Total	**0.2753**	**0.2066**	**0.0689**

a/ In addition to the two known hibernacula ([redacted]) there are 4 features that are suitable for Indiana bats but remain unsurveyed (i.e., Suitable, Unsurveyed) and 66 features that have unknown suitability and remain unsurveyed (i.e., Suitability Unknown).

b/ Frequency (Freq) refers to the number of features where impacts may occur from the activity.

c/ Proximity bins refer to concentric rings surrounding known and potential hibernacula and the expected proportion of individuals (Ind.) present was derived from Gumbert et al. (2002) (see Figure 8.1.1.3-1 for an example).

d/ Harassment and harm were calculated by multiplying the individuals present by 0.75 and 0.25, respectively.

Impacts from Construction during Spring Staging

Although the estimates of harm and harassment of staging bats from tree clearing are low, there is a much greater potential for disturbance from noise, sound, or dust from Project construction. Mountain Valley calculated such harassment for each feature as the product of three values. The first is the winter abundance estimate (see section 7.1.2 and example in column 1 of table 8.1.1.3-3); the second is the proportion of staging bats within each concentric bin as derived from Gumbert et al. (2002) (see calculation in column 3 of table 8.1.1.3-3 and figure 8.1.1.3-2); and the third is the proportion of the bin within the Action Area (column 4 of table 8.1.1.3-3 and figure 8.1.1.3-2). Note that no timeframe is incorporated within this estimate because it was assumed that all bats that participate in staging within 0.6 mile of the Project (as defined by the Action Area) would be harassed. No take from harm is anticipated as a result of noise, sound, or dust from Project construction. Using this approach, Mountain Valley estimated that, cumulatively, 55.25 staging bats may be harassed by construction disturbances during the spring (table 8.1.1.3-4).

Cumulatively, 55.46 and 0.07 staging bats may be harassed or harmed, respectively, during spring staging. This harassment estimate combines harassment due to the clearing of a tree with a bat occupying it, but the bat escaping unharmed (0.2066; table 8.1.1.3-2) with the potential harassment due to clearing and construction noises within 0.6-mile of the Project (55.2544; table 8.1.1.3-4). As with the estimates for winter take, these estimates are rounded up to 56 individuals harassed and 1 individual harmed.

Bat Activity during Autumn Swarming

In addition to the estimates for spring staging, harm and harassment during autumn swarming is also possible via the same mechanisms listed for staging individuals. However, the temporal dynamics of swarming are not as well documented. Based on information provided in Cope and Humphrey (1977) and Humphrey et al. (1977), female Indiana bats begin migrations from summer ranges around early- to mid-August and begin to arrive at caves around August 20. Several studies suggest that female Indiana bats enter torpor soon after arriving at the hibernacula (Cope and Humphrey, 1977; Humphrey et al., 1977; LaVal and LaVal, 1980; Richter et al., 1993; Johnson et al., 1998), and based on the information provided in Humphrey et al. (1977), females are likely to begin hibernation around September 10. Patterns of male Indiana bats are not as well documented, but males are thought to arrive prior to female individuals, and some males remain active as late as mid-November (Cope and Humphrey, 1977; Richter et al., 1993).

In addition to these arrival and hibernating timelines, several studies have documented that swarming may occur during several peak periods in the fall. LaVal and LaVal (1980) documented two peaks, one in mid- to late August with both males and females and one in late September or early October dominated by males. Cope and Humphrey (1977) also documented two peaks, one in early September and one in early October, with the second dominated by males.

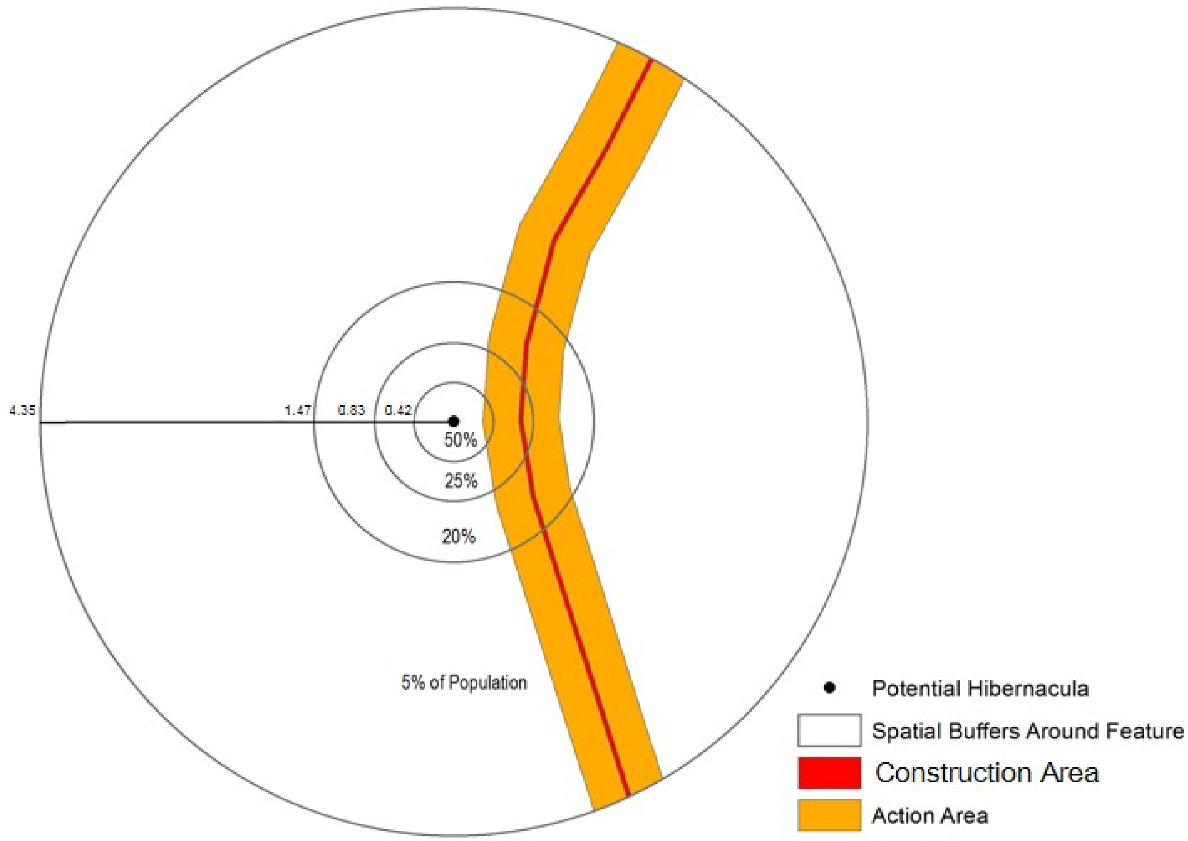

Figure 8.1.1.3-2 **Example diagram of take calculation for staging Indiana bats due to construction disturbance surrounding a potential hibernacula.**

TABLE 8.1.1.3-3

Example Take Calculation for Staging Indiana Bats due to Construction Disturbance Surrounding a Potential Hibernacula

Total Winter Abundance	Proximity Bin (miles)	Expected Individuals Staging in Bin	Proportion of Bin within Action Area	Expected Harassment
10	0-0.42	10×0.50=5	0.06	5×0.06=0.3
	0.42-0.83	10×0.25=2.5	0.28	2.5×0.28=0.7
	0.83-1.47	10×0.20=2	0.27	2×0.27=0.54
	1.47-4.35	10×0.05=0.5	0.08	0.5×0.08=0.04
			Total	**1.58**

TABLE 8.1.1.3-4

Potential harassment of staging Indiana bats within the Action Area.

Feature Type a/	Winter Abundance Estimate	Freq. b/	Proximity Bin (miles) c/	Proportion of Abundance within Bin c/	Cumulative Prop of Bin in Action Area	Expected Harassment
Suitability Unknown	0.9262	124	0-0.42	0.5	0.4149	(0.9262×124)×0.5× 0.4149=23.8254
			0.42-0.83	0.25	0.3961	(0.9262×124)×0.25× 0.3961=11.3729
			0.83-1.47	0.20	0.3962	(0.9262×124)×0.2× 0.3962=9.1006
			1.47-4.35	0.05	0.2283	(0.9262×124)×0.05× 0.2283 =1.311
Suitable, Unsurveyed	2.007	5	0-0.42	0.5	0.8699	(2.007×5)×0.5× 0.8699=4.3647
			0.42-0.83	0.25	0.8635	(2.007×5)×0.25× 0.8635=2.1663
			0.83-1.47	0.20	0.6378	(2.007×5)×0.2× 0.6378=1.2801
			1.47-4.35	0.05	0.2563	(2.007×5)×0.05× 0.2563 =0.1286
Tawney's Cave	2.007	1	0-0.42	0.5	0.9953	2.007×0.5× 0.9953=0.9988
			0.42-0.83	0.25	0.7502	2.007×0.25× 0.7502=0.3764
			0.83-1.47	0.20	0.5096	2.007×0.2× 0.5096=0.2046
			1.47-4.35	0.05	0.2099	2.007×0.05× 0.2099 =0.0211
Greenville Saltpeter Cave	6	1	0-0.42	0.5	0.0000	6×0.5× 0.0000=0.0000
			0.42-0.83	0.25	0.0000	6×0.25× 0.0000 =0.0000
			0.83-1.47	0.20	0.0227	6×0.2× 0.0227=0.0272
			1.47-4.35	0.05	0.2556	6×0.05× 0.2556 =0.0767
					Total	**55.2544**

a/ In addition to the two known hibernacula (Tawney's Cave and Greenville Saltpeter Cave) there are 5 features that are suitable for bat but remain unsurveyed (i.e., Suitable, Unsurveyed) and 124 features that have unknown suitability and remain unsurveyed (i.e., Suitability Unknown).

b/ Frequency (Freq) refers to the number of features where impacts may occur.

c/ Proximity bins refer to concentric rings surrounding known and potential hibernacula and the expected proportion of individuals (Ind.) present was derived from Gumbert et al. (2002) (see Figure 8.1.1.3-1 for an example).

Impacts from Tree Clearing During Autumn Swarming

Similar to the approach taken for staging, Mountain Valley assumed that swarming individuals are distributed among different distance bins derived from Gumbert et al. (2002) (figures 8.1.1.3-1 and 8.1.1.3-2). Thus, Mountain Valley calculated the number of swarming bats in a bin surrounding a potential hibernacula as the product of the number of individuals expected in the feature during winter (see section 7.1.2) and the proportion expected to be found within the distance bin derived from information in Gumbert et al. (2002). Mountain Valley then used this estimate to calculate the potential harm and harassment from tree felling and construction disturbance.

Based on these arrival and departure times and the projected Mountain Valley tree clearing schedule, harm and harassment from tree clearing to swarming individuals is possible within areas cleared in August through November. Projected tree clearing during this time (i.e., fall) would intersect the buffers surrounding 26 separate features: 3 features that are suitable, but remain unsurveyed (Kimbalton Mine Cave, MKM-PO-002, and MKM-PO-003) and 23 features with unknown suitability. Tree clearing in fall within these areas, however, is projected to be relatively limited, representing about 107.5 acres, and much of that area is a long distance from the potential hibernacula (table 8.1.1.3-5). Given this information, harm and harassment from tree clearing to swarming individuals is possible but the chance is low. In total, the expected individuals harassed and harmed is 0.0063 and 0.0021 individuals, respectively. As with the previous estimates, these estimates are rounded up to 1 individual harassed and 1 individual harmed.

Impacts from Construction during Autumn Swarming

Similar to the approach taken for spring staging individuals, harassment in the form of construction disturbance to swarming individuals is possible to all individuals within 0.6 mile of the Project (as defined by the Action Area). No timeframe is incorporated within this estimate because Mountain Valley assumed that all bats that participate in swarming would be harassed. Mountain Valley calculated such harassment for each feature as the product of the winter abundance estimate (see section 7.1.2), the proportion of swarming bats expected within each concentric bin surrounding a hibernaculum as derived from Gumbert et al. (2002), and the proportion of the bin within the Action Area (figure 8.1.1.3-2). Note that this is the same calculation as performed in table 8.1.1.3-3. Using this approach, it is expected that 55.25 swarming bats would be harassed from construction disturbances (e.g., noise). Rounding up, the cumulative expected number of swarming Indiana bats harassed or harmed by the Project is 56 and 1, respectively.

TABLE 8.1.1.3-5

Potential Areas for Harm and Harassment of Autumn Swarming Indiana Bats from Tree Felling

Feature Type a/	Winter Abundance Estimate	Freq b/	Proximity Bin miles) c/	Proportion of Ind. within Bin c/	Proportion of Forest in Bin Cleared in Fall	Expected Individuals Present in Cleared Forest	Expected Harassment d/	Expected Harm d/
Suitability Unknown	0.9262	23	0-0.42	0.50	0.0000	0.9262×23 ×0.50 ×0.0000=0.0000	0.0000	0.0000
			0.42-0.83	0.25	0.0006	0.9262×23 ×0.25 ×0.0006=0.0032	0.0024	0.0008
			0.83-1.47	0.20	0.0010	0.9262×23 ×0.20 ×0.0010=0.0043	0.0032	0.0011
			1.47-4.35	0.05	0.0008	0.9262×23 ×0.05 ×0.0008=0.0009	0.0007	0.0002
Suitable, Unsurveye d	2.007	3	0-0.42	0.50	0.0000	2.007×3 ×0.50 ×0.0000=0.0000	0.0000	0.0000
			0.42-0.83	0.25	0.0000	2.007×3 ×0.25 ×0.0000=0.0000	0.0000	0.0000
			0.83-1.47	0.20	0.0000	2.007×3 ×0.20 ×0.0000=0.0000	0.0000	0.0000
			1.47-4.35	0.05	<0.0001	2.007×3 ×0.05 ×0.0000=0.0000	<0.0001	<0.0001
					Total	**0.0084**	**0.0063**	**0.0021**

a/ In addition to the two known hibernacula (Tawney's Cave and Greenville Saltpeter Cave) there are 3 features that are suitable for Indiana bats but remain unsurveyed (i.e., Suitable, Unsurveyed) and 23 features that have unknown suitability and remain unsurveyed (i.e., Suitability Unknown).

b/ Frequency (Freq) refers to the number of features where impacts may occur from the activity.

c/ Proximity bins refer to concentric rings surrounding known and potential hibernacula and the expected proportion of individuals (Ind.) present was derived from Gumbert et al. (2002) (see Figure 8.1.1.3-1 for an example).

d/ Harassment and harm were calculated by multiplying the individuals present by 0.75 and 0.25, respectively.

Impacts from Operation on Staging and Swarming Bats

Operational harassment to swarming and staging individuals via noise is also possible surrounding 0.6 mile of each compressor station for the Project. However, there are no known or assumed occupied hibernacula within 5.6 miles (i.e., the sum of the 5-mile buffer where staging and swarming is thought to occur and the 0.6-mile noise buffer) of these compressor stations. Therefore, no harassment from sound disturbance from compressor stations to swarming/staging individuals is expected.

8.1.1.4 Summer Season of Reproduction

Although field surveys did not capture any Indiana bats during the summer season of reproduction (section 6.1.1), the Project intersects an area of known, occupied summer habitat from Project MPs 0.0 to 10.3. Harm and harassment are still possible in this area, in other areas of assumed presence, including near previously known hibernacula (i.e., Greenville Saltpeter and Tawney's Cave), and in areas where Mountain Valley was not granted land access. Harm is only possible within forested areas cleared during the summer months when bats are expected to be present.

Bat Activity during Summer

Available data from sites in Indiana (Humphrey et al., 1977; Brack, 1983; Sparks et al., 2008; Whitaker and Sparks, 2008) suggest that Indiana bats begin to arrive on the summer grounds in April, and the majority of individuals arrive by May 15, although a few stragglers continue to arrive into early June. Note that this is a pattern observed in female individuals, but adult males are thought to follow a similar pattern, though they are not as well studied. It is also important to note that males are thought to occupy different habitat than females during summer, often centered on hibernacula. Without knowledge of the location and number of individuals present within each hibernaculum within West Virginia, Virginia, and surrounding states, Mountain Valley assumed that all forested areas have an equal chance to host a male or female individual.

Departures of Indiana bats from summer habitats are not as well documented, but several aspects have been studied. According to Humphrey et al. (1977), females begin migrations from summer ranges around early- to mid-August and begin to arrive at hibernacula around August 20. Males, conversely, likely begin congregating at hibernacula prior to the arrival of females.

Impacts from Tree Clearing During Summer

Given that no Indiana bats were captured by Mountain Valley during mist-net surveys and therefore no occupied roost trees were documented in the Project Area, no known Indiana bat roost trees would be removed by Mountain Valley during tree clearing. However, based on the documented arrival and departure times of migrating Indiana bats and the projected Mountain Valley tree clearing schedule, harm and harassment from tree clearing is possible within areas cleared in April and May and in the fall (August through November) where the areas intersect locations of assumed presence. Harm and harassment from tree clearing is also possible for individuals around hibernacula during the same timeframe and at other times of the year (see section 8.1.1.3). Tree clearing has the potential to harm and harass both staging/swarming and summering individuals within areas cleared in April and the fall (particularly August) that intersect the 5-mile buffers surrounding known and potential Indiana bat hibernacula. Therefore, these areas are assessed independently and accounted for within each analysis; however, because summering individuals may arrive from hibernacula outside of the Action Area, these overlapping areas do not represent a double counting of individuals, but rather separate potential populations that may be affected.

In total, areas expected to be cleared in April, May, and in the fall represent approximately 522.3 acres in Virginia and 1,399.9 acres in West Virginia. However, much of this clearing would take place within areas sampled sufficiently to suggest probable absence of the species during the summer months. Only 60.2 forested acres within Virginia and 836.7 forested acres in West Virginia occur within areas of assumed presence for the species. Within these areas, harm and harassment are possible due to tree clearing (other forms of harassment are addressed below).

To assess the potential for harm and harassment from tree clearing, Mountain Valley used the summer densities derived in section 7.1.2 (detailed in appendix C). In short, the number of bats expected per forested acre is 0.000202 bats in West Virginia and 0.000073 in Virginia. However, during the transitional months of April and May and in the fall (August through November), densities of individuals are likely lower than those during June and July. Similar to the approach taken in 7.1.1.2, harm and harassment rates from tree felling were estimated at 0.25 and 0.75, respectively. Using these rates, there is a low, but present chance of harm and harassment to summering individuals from tree clearing by the Project. Expected harm and harassment (not including sound, light, or dust disturbance) were estimated to be less than one individual each (table 8.1.1.4-1), which was rounded up to 1 individual harassed and 1 individual harmed.

Impacts from Construction during Summer

In addition to this harm and harassment from tree clearing, harassment due to construction noises, light, and dust may also be possible. For the assessment of take, Mountain Valley assumed that an individual can only be harassed once; thus, harassment was estimated by the mechanism that has the largest area of impact, which is noise. Potential effects of changes in the soundscape as a result of construction are addressed in section 4.1.2.

To calculate the number of individuals potentially harassed during summer roosting, the density estimates from section 7.1.2 (also provided in table 8.1.1.4-1) were multiplied by the number of forest acres expected to be disturbed during active construction within each state (i.e., areas within 0.6 miles of the construction workspaces). Note that these acres were adjusted to remove areas where sufficient sampling was performed to claim probable absence of Indiana bat. Using the NLCD, it is expected that 131,787.7 and 40,830.8 acres of forest within the Action Area of West Virginia and Virginia, respectively, that remain unsampled for Indiana bat would be within the range of potential disturbance from Project construction.

Eq. 2

$$\begin{array}{rl} & 0.000202 \text{ bats/acre in West Virginia} \times 131{,}787.71 \text{ acres} \\ + & 0.000073 \text{ bats/acre in Virginia} \times 40{,}830.79 \text{ acres} \\ \hline & \mathbf{29.60177 \text{ bats}} \end{array}$$

TABLE 8.1.1.4-1

Potential Areas for Harm and Harassment of Summer Roosting Indiana Bats from Tree Felling

State	Summer Density	Month a/	Forested Acres Cleared with Assumed Presence b/	Expected Individuals Present	Expected Harm	Expected Harassment
Virginia	0.000073	April	34.5645	34.5645 × 0.000073=0.0025	0.0025×0.25=0.0006	0.0025×0.75=0.0019
		May	0.0000	0.0000 × 0.000073=0.0000	0.0000×0.25=0.0000	0.0000×0.75=0.0000
		Fall	25.6792	25.6792 × 0.000073=0.0019	0.0019×0.25=0.0005	0.0019×0.75=0.0014
West Virginia	0.000202	April	665.8926	665.8926 × 0.000202=0.1345	0.1345×0.25=0.0336	0.1345×0.75=0.1009
		May	5.9424	5.9424 × 0.000202=0.0012	0.0012×0.25=0.0003	0.0012×0.75=0.0009
		Fall	164.8484	164.8484 × 0.000202=0.0333	0.0333×0.25=0.0083	0.0333×0.75=0.025
		Totals	**896.9271**	**0.1734**	**0.0433**	**0.1301**

a/ Fall refers to clearing that may occur from August to November.

b/ Note that these acres were adjusted to remove areas where sufficient sampling was performed to claim probable absence.

Based on these density and acreage estimates, 29.602 bats, rounded to 30 bats, during the summer season of reproduction may be harassed during Project construction.

In addition to changes in the soundscape, the Project may also alter air quality. The primary issue affecting air quality is the creation of dust; however, Mountain Valley would use water trucks to control dust during summer construction, which would limit dust emissions to the immediate vicinity of the Project Area. Furthermore, the potential impacts on air quality that could affect bats would be temporary, occurring only during the overlap in time when construction would be on-going and bats are present in the Action Area during summer or migration. Impacts on bats from creation of dust are included in the estimate of bats harassed as a result of construction noise because, in theory, construction noise and dust production would occur simultaneously during Project construction, and the impact area for noise effects exceeds that created for dust.

Impacts from Operation during Summer

Potential effects of changes in the soundscape as a result of operation by permanent aboveground facilities (i.e., compressor stations) is addressed in section 4.1.2. Noise from compressor stations would occur, in effect, in perpetuity. However, noise associated with permanent facilities would be transmitted through a forested environment resulting in a "shading effect" as sound waves (similar to light waves) are absorbed by areas of increased elevation. Operational harassment is also possible surrounding 0.6 mile of each compressor station, where sampling was not sufficient to claim probable absence of the Indiana bat. Such harassment was calculated similarly to Eq. 2, in which the estimated density of bats (0.000202 bats per acre) was multiplied by the expected acres of forest, based on the NLCD, present within a 0.6 mile radius of the compressor stations (about 1,883.2 acres). Density and acreage estimates were only calculated for West Virginia because no compressor stations would be located in Virginia. The calculation resulted in an estimate of 0.3804 bats, which is rounded up to 1 bat harassed during operations of the Project.

Eq. 3 0.000202 bats/acre in West Virginia × 1,883.16 acres=**0.3804 bats**

8.1.1.5 Spring and Autumn Migration/Transient Period

Bat Activity during Migration

After staging and before swarming, Indiana bats make migrations of varying distances to summer roosts. However, relatively little is known about the timing or use of habitat during this migratory/transient period. Available data suggests that habitat use is similar to that in summer months (Caceres and Barclay, 2000). One aspect of migration that has been relatively well studied is the timing of bats' arrival from and departure to both the summer and winter ranges (e.g., Cope and Humphrey, 1977; Humphrey et al., 1977). Based on information from available studies, the first bats are thought to arrive on the summer grounds in April with most bats present by May 15, although a few stragglers continue to arrive into early June. After the summer season, individuals begin migrations back to hibernacula in August (Cope and Humphrey, 1977; Humphrey et al., 1977) but some migrants may not arrive at hibernacula until sometime in September.

Impacts from Tree Clearing during Migration

Because potential for removal of forested habitat occurs during portions of April, May, and the fall (i.e., August through November), a direct take of migrant individuals by harm (killing or injury) or harassment is possible via active tree clearing. Note that harm and harassment of staging/swarming individuals may occur through November. Such take is assessed in section 8.1.1.3.

Because no information is available regarding the paths or densities of migrants during the spring and autumn, summer densities of bats may provide the most reasonable surrogate to estimate take of migrants and is the best available information. As discussed above (and derived in appendix C), estimates for summering individuals within Virginia and West Virginia are 0.000202 and 0.000073 bats per forested acre, respectively. These densities were also specified for migrants in order to provide a conservative estimate of the potential for take of migrants. In reality, the densities are likely smaller and more variable across time during the migrant/transient months. Similar to the approach taken for summering individuals, harassment and harm was calculated by multiplying respective densities of migrant individuals by the acres being cleared within the month of April and May and the fall (i.e., August through November) to get a total number of expected bats. The total number of expected bats was then multiplied by 0.25 to get an estimate of harmed individuals from tree clearing (see section 8.1.1.3). All other individuals are assumed to be harassed.

In West Virginia, it is expected that 1,399.9 forested acres would be cleared in the months of April, May, and August. Likewise, 522.3 forested acres would be cleared within Virginia during the same time frame. Given the respective densities the areas that would be cleared, it is unlikely but possible that migrant Indiana bats would be harmed or harassed from tree clearing for the Project. Expected harm and harassment was estimated to be less than one individual (table 8.1.1.5-1), but because it is impossible to harass or harm a portion of an individual, each of these estimates is rounded up to 1. Thus, 1 migrant individual is expected to be harmed, and 1 individual is expected to be harassed from Project construction.

Construction and Operation Impacts during Migration

Given that migrants are expected to occur for only a brief amount of time within the Action Area (e.g., 1 day), it is assumed that disruptions from construction via noise, light, or dust would not significantly increase the stress or energetic costs of the species during this short time period. Likewise, noise from compressor stations would not significantly alter stress or energetic costs. Under these assumptions, harassment and harm from the Project to migrant individuals would only be possible within the construction workspaces in forested areas where trees are actively being cleared.

TABLE 8.1.1.5-1

Potential Areas for Harm and Harassment of Migrant Indiana Bats from Tree Felling

State	Density	Month a/	Forested Acres Cleared	Expected Individuals Present	Expected Harm	Expected Harassment
Virginia	0.000073	April	374.8191	(374.8191× 0.000073)=0.0274	0.0274×0.25=0.0069	0.0274×0.75=0.0206
		May	16.7222	(16.7222× 0.000073)=0.0012	0.0012×0.25=0.0003	0.0012×0.75=0.0009
		Fall	130.7284	(130.7284× 0.000073)=0.0095	0.0095×0.25=0.0024	.0095×0.75=0.0071
West Virginia	0.000202	April	1,082.2411	(1,082.2411× 0.000202)=0.2186	0.2186×0.25=0.0547	0.2186×0.75=0.164
		May	5.9424	(5.9424× 0.000202)=0.0012	0.0012×0.25=0.0003	0.0012×0.75=0.0009
		Fall	311.7235	(311.7235×0.000202)=0.063	0.063×0.25=0.0158	0.063×0.75=0.0473
			Totals	**0.3209**	**0.0804**	**0.2408**

*Fall refers to clearing that may occur from August to November.

8.1.2 Direct Effects on Habitat

8.1.2.1 Winter Season of Hibernation

The Project would not directly impact any currently known Indiana bat hibernacula. Field searches for cave or mine openings identified 52 features, 13 of which would be within the construction right-of-way. Three of these 13 features were determined potentially suitable for hibernating bats. Sampling (harp trapping) was completed at all three features determined to be potentially suitable, and no bats were captured. Thus, the three features sampled are considered unoccupied by the species and the Project is not likely to result in take in the form of habitat modification to winter habitat.

As noted in section 4.1.2.5, Mountain Valley has not determined whether blasting would be necessary during construction. However, if Mountain Valley determines blasting is necessary within 0.5 mile of known or potential Indiana bat hibernacula, it would develop site-specific blasting plans, as noted in the Mountain Valley's *General Blasting Plan*[11], which would specify mitigation measures Mountain Valley would use to prevent damage to hibernacula or other underground features. For example, Mountain Valley would use blasting mats or padding, restricted charge sizes, and/or charge delays to minimize airblast, peak sound pressure levels, and ground vibration.

Due to the proximity of the Project to Tawney's Cave, Mountain Valley conducted a hydrologic and geologic analysis to assess risk to the karst features, hydrology, and biological resources of Tawney's Cave. The analysis demonstrated that the risk of affecting these components of Tawney's Cave is negligible. This conclusion is based on several mitigating factors, including the nature and scale of construction, the separation between each cave and the proposed construction right-of-way, and importantly the relative position of the proposed alignment compared to the cave and upland catchment (i.e., karst watershed). [redacted] no impacts on the cave system are anticipated. Mountain Valley would employ stringent erosion and sedimentation controls, and implement karst inspection and mitigation to minimize potential impacts on karst features. Mountain Valley would be adequately prepared for and would reduce the probability and risk of a potential spill or release of oil or hazardous material during construction by adhering to measures specified in the Project-specific *Spill Prevention, Control, and Countermeasure (SPCC) Plan*, the *Karst-Specific E&S Control Plan* for Virginia, and the *Karst Mitigation Plan*. Specific measures are described in these documents and summarized in section 3.0.

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[11] See accession number 20170209-5249

8.1.2.2 Autumn Swarming and Spring Staging

Approximately 389,826.2 acres of forested habitat occur within 5 miles of the 131 features considered as known or potentially occupied winter habitat within the vicinity of the Project. Within these areas of winter habitat, construction of the Project would reduce forested (swarming and staging) habitat by 0.21 percent (804.3 acres). About 339 acres would be allowed to regenerate following construction. Regeneration of the forest to become suitable roosting habitat again could take upwards of 25 years. The Project would permanently reduce forested habitat by 0.12 percent (464.8 acres). This loss is a small fraction of the available fall swarming/spring staging habitat.

8.1.2.3 Summer Season of Reproduction

As a whole, the Project would convert 4,459.4 acres and 1,600.9 acres of forest (including woody wetlands) into largely herbaceous habitat during construction and operation, respectively, within a 6,363.0-acre Project Area and a 279,077.2-acre Action Area (table 4.2.2-1). These lands are assumed to provide viable habitat for foraging and roosting bats before construction and unsuitable roosting habitat after construction. No forested acres would be retained within the Project Area, but 216,951.0 acres of forest would remain within the Action Area following construction. This represents a forest loss of 2.01 percent from construction and a permanent loss of 0.72 percent of forest within the Action Area.

Habitat loss alone is unlikely to result in take of Indiana bat individuals. In Illinois, Gardner et al. (1991) found 90 percent of Indiana bat capture sites had 33 percent forest coverage within a 0.6-mile radius of capture sites (assumes the capture site was the center of the area used). A habitat model by Rommé et al. (1995) indicated that sites with woodland cover of at least 30 percent, within a 0.6-mile area support maternity colonies (i.e., they have a suitability index of 1 or 100 percent). A colony at Indianapolis airport has shown two periods of apparent growth (Sparks et al., 2008; Sparks et al., 2009) on a landscape that is only 13 percent forested within 5.3 miles of all known roosts, but this number rises to 28 percent when all habitat within 95 percent of the home ranges of these bats is included (Sparks et al., 2005). In the northeast, landscapes surrounding roosts used by Indiana bats ranged from 26 to 47 percent forest coverage (Watrous et al., 2006). Currently, the Action Area for the Project contains a heavily forest landscape with over 79 percent forest. As currently designed, the Project proposes to remove 4,459.4 acres of forest for construction, which would result in an Action Area with 77.7 percent forest cover. This forest cover would be much higher than those reported in the studies above, and thus, habitat for the species would likely not be limited.

Confirmed summer habitat exists from MPs 0.0 to 10.3 surrounding the capture of an Indiana bat individual in Wetzel County, West Virginia for a separate Project (FWS, 2013a). Within the 5-mile buffer surrounding the capture location, the landscape is mostly forested (94.5 percent) with about 47,490.7 acres of forest (table 8.1-1). Within this area, the Project would be expected to remove 227.8 acres of forest. The majority of this forest (150.9 acres) would be allowed to regenerate, but 76.9 acres would be maintained as an herbaceous state once construction is completed. After trees are removed for the Project, the 5-mile buffer would remain largely forested (94 percent) with higher forest cover than those reported by Gardner et al. (1991) and Watrous et al. (2006).

In total, about 3,066 acres of roosting, foraging, and travel habitat are present within the portions of the construction right-of-way that are within 5 miles of confirmed Indiana bat hibernacula, the above-mentioned summer habitat within Wetzel County, and the unsurveyed portions of the construction right-of-way for which Mountain Valley is assuming the presence of Indiana bat individuals. Table 8.1.2.3-1 lists the proportions of this total that Mountain Valley's detailed habitat assessments, described in sections 7.1.2 and 7.2.2, classify as low, moderate, or high quality habitat. A total of 579 acres of foraging and travel habitat ranked as high or moderate would be cleared during construction. A total of 1,268 acres of roosting habitat ranked as high or moderate would be cleared during construction. The latter equates to about 4,426 trees classified as having high or moderate roosting potential.

TABLE 8.1.2.3-1

Classification of Potential Roosting, Foraging, and Travel Habitat in Proximity of Confirmed and Assumed Indiana Bat Locations

Habitat Quality Rank a/	Roosting Habitat (acres)	Foraging and Travel Habitat (acres)
None	539	16
Low	1,259	1,471
Moderate	910	1,199
High	358	380
Total	**3,066**	**3,066**

a/ Habitat Quality Rank is described in sections 7.1.2 and 7.2.2.

Cumulatively, forest loss from the proposed Project represents a small fraction of the summer habitat available on the landscape that can sustain roosting bats, and is thus unlikely to result in take.

8.1.2.4 Spring and Autumn Migration/Transient Period

Relatively little is known about timing or use of habitat by Indiana bats during the migratory/transient period, but available data suggest that habitat use is similar to that in summer months (Caceres and Barclay, 2000). As such, it is assumed that areas suitable for use during summer are also suitable during migration. NLCD data indicate that 4,459.4 acres of forested habitat exist and would be lost within the construction right-of-way and 1,600.9 acres of forested habitat exist within the permanent right-of-way. Nearly 2,859 acres would be allowed to regenerate following construction. Regeneration of the forest to become suitable habitat again could take upwards of 25 years. The Project would permanently reduce forested habitat by 0.72 percent within the Action Area.

This forest loss is a small fraction of the migration/transient habitat available on the landscape that sustains bats as they traverse between summer and winter habitats. This habitat loss is insignificant and discountable and would not rise to the level of harm or result in a take of individuals.

8.1.3 Indirect Effects

Indirect effects are those effects that are caused by or would result from the proposed action and are later in time, but still reasonably certain to occur. Indirect effects on individual bats would occur if the Project causes chemical, biological, or physical changes that can affect bats.

8.1.3.1 Negative Effects

Clearing of Roost Trees during Winter

Trees in the Project Area would be removed from January through May 2018 and August 2018 through November 15, 2018, if needed. However, Mountain Valley would follow time-of-year-restrictions, within 5 miles of all known hibernacula for the species and surrounding the capture of an Indiana bat in Wetzel County, West Virginia for a separate project. Bats returning to the area in spring 2018 would encounter a cleared area that would be an active construction site. Within this area, direct effects of the Project include removal of 4,459.4 acres of forested land. However, this equates to a loss of only 2.01 percent of forested land within the Action Area, which contains suitable alternative roosting/foraging habitat.

Kurta (2004) hypothesized that removal of all or most of summer habitat of a colony of Indiana bats could force bats to locate new roosting and foraging areas, which may have detrimental effects to individuals within the colony (discussed further below). It is important to note, however, that Kurta's arguments were generated in response to a very large project that would remove all or most of the available habitat at a landscape scale containing a known maternity colony. Construction of the MVP would require clearing a linear corridor and not a large-scale areal clearing of the landscape focused on one specific location. Several recent publications (Silvis et al., 2014a; Silvis et al., 2014b; Silvis et al., 2015) address potential impacts of removing smaller batches of roost trees from the landscape in association with forest management activities. These studies used telemetry data to identify relationships among bats and roost trees on landscapes. Models employing analytical techniques to analyze the stability of community systems found that roosts connected to multiple other roosts are "nodal", and both Indiana (Silvis et al., 2014b) and northern long-eared bats (Silvis et al., 2014a; Silvis et al., 2015) can sustain the loss of multiple roosts including several nodal roosts. If some nodal roosts remain, bats can reconnect with roost mates and locate new roosts.

Clearing of a known maternity roost tree during the winter could result in adverse effects to the colony upon returning the following spring and finding the roost tree and surrounding foraging habitat gone. Although loss of a roost is a natural phenomenon that bats encounter regularly, the possible loss of multiple roosts due to forest clearing may stress individual bats, as well as the social structure of the colony. Kurta (2004) suggested that reduced reproductive success may be related to stress, poor microclimate in new roosts, a reduced ability to thermoregulate through clustering, or reduced ability to communicate and thus locate quality foraging areas. Kurta (2004) further suggested that the magnitude of impacts would vary greatly depending on the scale of roost loss (i.e., how many roosts are lost and how much alternative habitat is left for the bats in the immediate vicinity of the traditional roost sites). Recovery from the stress of hibernation and migration may be slower as a result of the added energy demands of searching for new roosting/foraging habitat, especially in fragmented landscapes where forested habitat is limited. The proposed Project, however, occurs within a heavily forested landscape where habitat is generally not limited. Nonetheless, pregnant females displaced from preferred roosting/foraging areas would have to expend additional energy to search for alternative roosts, which could result in reduced reproductive success for some females. If affected, females may have pups with lower birth weights given the increased energy demands associated with finding new roosting habitat, and their pups may experience delayed development. Overall, the effect of the loss of roosting/foraging habitat on individual bats from the maternity colonies may range from no effect to death of juveniles, and the effect on the colonies may result in a reduced rate of reproduction for that year.

Evidence from detailed habitat assessments performed for the Project suggest that roosting habitat within the Action Area is not a limiting factor for Indiana or northern long-eared bats (see sections 7.1.2 and 7.2.2). Although individuals returning to the Project Area would have to find new roosts, many potential roost trees are available within the vicinity of the Project, and thus individuals would not have to travel long distances or expend additional energy that would likely result in adverse effects. Furthermore, given the availability of potential roosts in areas surveyed for the Project, it is likely that these new roosts could be joined as new nodes within any network of roosts currently existing on the landscape.

Light Pollution

In addition to the effects of tree clearing, potential impacts from the Project include light pollution and changes to water quality near the Project. Potential effects of light pollution associated with the Project are assessed in section 4.1.1. Though limited, artificial lighting would be used during construction when completion of tasks warrant continued work outside normal daylight operating hours due to schedule concerns or agency requirements that limit the time allowed for such tasks. This practice would be most common when completing stream crossings and during the hydrostatic testing phase. Permanent lighting structures would be installed at all three compressor stations to allow for the station surveillance systems to operate and enable a safer working environment for Mountain Valley staff conducting any necessary operational activities after daylight. As noted in section 4.1.1, the most significant potential effect from lighting is on bat prey. However, it is difficult to assess impacts on insect behaviors from construction activities. Nonetheless, the probability that Indiana bats are harassed by lighting during construction is insignificant and discountable. However, to minimize any potential effects, Mountain Valley has committed to using downward-facing, full cut-off lens lights. Full cut-off lighting fixtures direct light downward and possess shielding around the fixture that prevents light from shining above 90 degrees from the lamp (i.e., light only shines directly downward from the fixture). Such fixtures provide the maximum possible shielding to prevent unintentional lighting of surrounding areas.

Water Quality Impacts

Potential effects of changes in water quality near the Project are assessed in section 4.1.3. Analysis using the RUSLE identified the boundaries associated with a 10 percent increase in sediment load. In total, 765.3 stream miles are expected to have a 10 percent increase or more, at least temporarily. Over a period of time, increases in sediment loads within streams could negatively impact habitat of aquatic insects, which in turn could indirectly affect Indiana bats, as aquatic insects (flies and caddisflies) make up a portion of their diet (Brack, 1983; Brack and

LaVal, 1985). However, the Indiana bat's diet is somewhat flexible across its range, and the species is not likely to rely solely on one taxonomic group of insect prey. Based on these data, the risk that Indiana bats are harassed by sedimentation and siltation is insignificant and discountable.

8.1.3.2 Beneficial Effects

Some trees along the edges of the Project Area would likely be damaged during clearing activities, potentially increasing the number of roost sites. Most damaged trees would survive, but would be more prone to insect infestations and diseases that result in senescence. This, in turn, would produce potential roosts for Indiana bats. Over time, some of the damaged trees would likely die and, combined with significant solar exposure along the forest edge, provide high quality roosts.

Restoration includes planting native seed mixes within temporary work areas and subsequently allowing forest regeneration. Initially these areas would provide foraging habitat and over time would provide roosting habitat. Woodland edges provide high quality foraging and commuting habitat for bats. Restoration using native herbaceous species in the permanent right-of-way and continuous maintenance would provide suitable foraging and commuting habitat for Indiana bats.

8.1.4 Determination of Effects and Rationale

Table 8.1.4-1 summarizes the effects determinations that are explained more fully in sections that follow.

TABLE 8.1.4-1

Summary of Effects and Effects Determinations for Indiana Bats

Description	Expected Harassed	Expected Harmed	Construction Impacts (acres) a/	Permanent Impacts (acres) a/	Effect Determination
Direct Effects					
Winter Season of Hibernation	63	0	-	-	Likely to Adversely Affect
Autumn Swarming and Spring Staging	112	2	804.3	464.8	Likely to Adversely Affect
Summer Resident Indiana Bats	32	1	4,459.4	1,600.9	Likely to Adversely Affect
Spring and Autumn Migration	1	1	4,459.4	1,600.9	Likely to Adversely Affect
Indirect Effects	**-**	**-**	**-**	**-**	**Not Likely to Adversely Affect**
Collective Impact/Determination	**208**	**4**			**Likely to Adversely Affect**

a/ Areas overlap and represent all forested habitat removed regardless of occupancy state.

8.1.4.1 Direct Effects to Individuals

Winter Season of Hibernation

The Project would not directly impact any Indiana bat proposed or designated critical habitat or potentially suitable or occupied hibernacula. Based on the expected number of Indiana bats in known or potentially occupied hibernacula within the Project's Action Area, an estimated 63 Indiana bats have potential to be disturbed. Thus, a determination of ***is Likely to Adversely Affect*** is appropriate.

Autumn Swarming and Spring Staging

Within 5 miles of known or potentially occupied winter habitat, Project development would temporarily reduce forested habitat used by swarming or staging Indiana bats by 0.21 percent 804.3 acres and permanently reduce it by 0.12 percent (464.8 acres). An estimated 56 Indiana bats have potential to be disturbed and 1 Indiana bat has potential to be killed during spring staging. The same level of potential harassment and harm may also be applicable to bats during autumn swarming, thus resulting in the potential harassment and harm of an additional 56 and 1 Indiana bats, respectively (i.e., a total of 112 harassed and 2 harmed for spring staging and autumn swarming). Given the potential for take, a determination of ***Likely to Adversely Affect*** staging Indiana bats is appropriate.

Summer Resident Indiana Bats

As a whole, the Project would permanently decrease forest within the Action Area by 0.72 percent and by 0.16 percent within the known, occupied Indiana bat summer habitat. This loss is a small fraction of the summer habitat available on the landscape that can sustain roosting bats. The Project crosses an area of occupied Indiana bat summer habitat from milepost 0.0 to 10.3. In addition, Indiana bat presence is assumed along the length of the right-of-way and access roads where summer mist-net surveys were not completed. Because timber would be removed during April, (except for near Greenville Salt Peter and Tawney's Cave) a portion of the Indiana bat population may be present within the Project Area during habitat removal, resulting in approximately 1 individual being harmed. Construction would occur during summer months, and the number of individuals estimated to be harassed by noise and dust as well as tree clearing along the Project is 31. Likewise, the number of bats expected to be harassed during the first year of operations at the compressor station facilities is 1. Thus, a determination of ***Likely to Adversely Affect*** is appropriate.

Spring and Autumn Migration/Transient Period

Approximately 0.72 percent 1,600.9 acres of the available forest within the Action Area would be permanently lost following Project development. This loss is a small fraction of the migration/transient habitat available on the landscape that sustains bats as they traverse between summer and winter habitats. Because there is the potential to remove forested habitat during portions of April and September (except around Tawney's Cave and Greenville Salt Peter), the expected number of migrating Indiana bats killed or disturbed due to tree clearing is 1 and 1, respectively. Given the potential for take, a determination of ***Likely to Adversely Affect*** migrating Indiana bats is appropriate.

8.1.4.2 Indirect Effects to Individuals

Based on the size, significance, and probability of occurrence of detrimental and beneficial effects to Indiana bats from roosting habitat removal, foraging habitat creation, and water channel sedimentation, a determination of ***Not Likely to Adversely Affect*** is appropriate.

8.1.4.3 Indiana Bat Determination Summary

Collectively, an ***Is Likely to Adversely Affect*** determination is appropriate for the Indiana bat, as tree clearing, noise, dust and lighting associated with clearing and construction activities, and lighting at compressor stations would affect bats during multiple stages of the annual reproductive cycle. The cumulative total of take of Indiana bats, as outlined above due to harassment is 208 individuals. The estimated number of Indiana bats to be harmed is 4 individuals.

This determination constitutes a take under the ESA. As such, we request formal Section 7 consultation with the FWS for the Indiana bat.

8.2 NORTHERN LONG-EARED BATS

In January 2016, FWS issued a special rule under Section 4(d) of the ESA that identifies the prohibitions applicable to the northern long-eared bat (codified at 50 CFR 17.40(o)). For areas within the WNS zone, which includes all of Virginia and West Virginia, the following actions are prohibited:

- Actions that result in the incidental take of northern long-eared bats in known hibernacula;
- Actions that result in the incidental take of northern long-eared bats by altering a known hibernaculum's entrance or interior environment if it impairs an essential behavioral pattern, including sheltering northern long-eared bats;
- Tree removal activities that result in the incidental take of northern long-eared bats when the activity:
  - Occurs within 0.25 mile (0.4 kilometer) of a known hibernaculum; or
  - Cuts or destroys known-occupied maternity roost trees, or any other trees within a 150-foot (45-meter) radius from the maternity roost tree, during the pup season (June 1 through July 31).

Any other form of incidental take of the northern long-eared bat is not prohibited. Accordingly, this analysis of effects to northern long-eared bats as a result of Project construction and operation is restricted to maternity roosts and trees within 150 feet of each roost as well as areas within 0.25 mile surrounding known or potentially occupied hibernacula. Clearing of forested habitat within the Project Area would be anticipated to occur from January through May 2018 and August 2018 through November 15, 2018, if needed (figure 8.2-1 (maps 1-3)). Given this schedule, analysis of effects to individuals only considers impacts on this species where take is not exempt under the final 4(d) rule (i.e., within the 0.25-mile buffers surrounding hibernacula where individuals may be affected during hibernation, spring staging, or autumn swarming). Within these areas, timber clearing, construction disturbance, and possible destruction of hibernacula pose the greatest threats to individuals and habitat; however, no entrances of known or potential hibernacula would be altered.

The analysis of direct and indirect effects of the Project on the northern long-eared bat and its habitat (provided below in sections 8.2.1 to 8.2.3) demonstrates that the Project is likely to result in take, beyond that exempted under the 4(d) rule, of 224 individuals through harassment and 3 individuals through harm.

8.2.1 Direct Effects on Individuals

Northern long-eared bats may be subjected to direct and indirect effects during construction, operation, and maintenance of the Project. Effects by season are addressed in the sections below. Mountain Valley determined the methods and calculated the results of predictive models used to estimate occurrence and abundance of northern long-eared bats in coordination with the FWS. We have reviewed the methods, calculations, and results and concur with the findings. Effects determinations are provided in section 8.2.4.

8.2.1.1 Winter Season of Hibernation

No historic or currently occupied northern long-eared bat hibernacula occurs within the MVP construction workspaces. However, noise produced during Project construction has potential to disturb hibernating bats within hibernacula. Based on field searches and desktop analyses, seven potentially suitable, currently occupied, or historically occupied northern long-eared bat portals occur within the Project's Action Area. These include three known hibernacula: Canoe Cave, Tawney's Cave, and a feature determined occupied by Mountain Valley's bat contractor, PS-WV3-Y-P1 (table 8.2.1.1-1), as well as four other potentially occupied hibernacula that lack occurrence and abundance information. In addition to these features, there are also 57 features with unknown suitability within the Action Area of the Project. These features were identified using data obtained from the Virginia Speleological Survey, West Virginia Speleological Survey, Draper Aden Associates, and FERC comments. Although features with unknown suitability are unlikely to be occupied by northern long-eared bat, they are treated as potentially occupied for the purposes of this analysis because they remain unsurveyed.

Figure 8.2-1 Planned Locations and Timing of Tree Clearing Activities Near Potential Northern Long-Eared Bat Habitat – Sheet 1 of 3 (redacted)

Figure 8.2-1 Planned Locations and Timing of Tree Clearing Activities Near Potential Northern Long-Eared Bat Habitat – Sheet 2 of 3 (redacted)

Figure 8.2-1 **Planned Locations and Timing of Tree Clearing Activities Near Potential Northern Long-Eared Bat Habitat – Sheet 3 of 3 (redacted)**

TABLE 8.2.1.1-1

Known Northern Long-Eared Bat Occurrences within the Action Area

Known or Potentially Occupied Northern Long-eared Bat Habitat	County, State	Area (acres) a/	Forested Habitat (acres)	% Total	Project Milepost		Impacts on Forested Habitat			
					Enter	Exit	Construction (acres)	Occupied Forested Habitat (%)	Operation (acres)	Occupied Forested Habitat (%)
Winter; PS-WV3-Y-P1; bat capture; 0.25-mile buffer	Braxton, WV	125.7	112.7	89.7	[redacted]	[redacted]	13.3	11.8	3.0	2.7
Winter; Tawney's Cave; known hibernaculum; 0.25-mile buffer b/	Giles, VA	193.3	92.8	48.0	[redacted]	[redacted]	2.7	2.9	1.2	1.3
Winter; Canoe Cave; known hibernaculum; 0.25-mile buffer	Giles, VA	125.7	115.3	91.7	[redacted]	[redacted]	0.0	0.00	0.00	0.0
Total c/		445	321	72.1			16.0	4.9	4.2	1.3

a/ Area within 0.25 mile of the feature.
b/ 0.25-mile buffer was established around the three known entrances of the cave.
c/ Percent occupied forested habitat total presented as average of the three values.

Because the proposed route does not intersect any known or potential hibernacula, no direct harm from impacting winter habitat is likely. The current proposed Project construction right-of-way is [redacted]; however, cave entrances and underground voids are unlikely to be altered by construction.

In addition, Mountain Valley performed a hydrologic and geologic analysis that demonstrated that there is negligible risk to karst features, hydrology and biological resources of Canoe Cave and Tawney's Cave. This conclusion is based on several mitigating factors, including the nature and scale of construction, the separation between each cave and the proposed construction right-of-way, and importantly the relative position of the proposed alignment compared to each cave and upland catchments (i.e., karst watershed). [redacted] Based on the nature of construction, and the relative location of the alignment being topographically and hydrologically removed from Tawney's Cave, no impacts on the cave system are anticipated.

Similarly, the Project is located about [redacted] Mountain Valley adjusted the proposed Project alignment by shifting approximately 1,300 feet to the north to avoid the cave and known karst features. This adjustment also moved the route into a cleared agricultural area, which eliminated the need for tree removal within the 0.25-mile buffer of the entrance to Canoe Cave. In addition, the proposed alignment would be located topographically lower and downgradient of the spring associated with Canoe Cave within the VADCR Conservation Site, thereby eliminating the potential for impacts.

Within the potential catchment basin for the Canoe Cave, the proposed trench would be approximately 100 to 200 feet above base flow levels leading to Sinking Creek. Mountain Valley would employ stringent erosion and sedimentation controls and implement karst inspection and mitigation measures to minimize potential impacts on karst features. Mountain Valley would be adequately prepared for and would reduce the probability and risk of a potential spill or release of oil or hazardous material during construction by adhering to measures specified in the Project-specific SPCC Plan, the Karst-Specific E&S Control Plan for Virginia, and the Karst Mitigation Plan.

8.2.1.2 Impacts from Noise on Hibernating Bats

Although harm from destruction of winter habitat is unlikely to result from Project actions, potential effects from changes in the soundscape near the Project are possible (see assessment in section 4.1.2). The Action Area for the Project is defined as extending 0.6 mile from the edge of the Project Area. There are 64 features with the potential to host northern long-eared bat within this area: two previously confirmed hibernacula (Tawney's Cave and Canoe Cave); one feature where a northern long-eared bat was captured for the Project (PS-WV3-Y-P1 in Braxton County, West Virginia); four features that have been deemed suitable but remain unsampled for bats; and 57 features that have not been field-surveyed for suitability or occurrence of northern long-eared bats.

In order to quantify the level of take from Project activities, an abundance estimate of 7.017 bats was used for Tawney's Cave and the four suitable portals (see section 7.2.2.3 and appendix C). As described in section 7.2.5, Canoe Cave was not surveyed for the Project but was recently surveyed by the VADCR-DNH. No northern long-eared bats were observed by VADCR-DNH, but historic records indicate the observation of a single hibernating northern long-eared bat from 1982. This record was used for the effects analysis. Given the results of harp trapping at PS-WV3-Y-P1, an estimate of 1.293 bats was used for impact assessment at this feature, which was derived from the hurdle model described in appendix C. For features with unknown suitability, an estimate of 3.2384 bats was used (see section 7.2.2.3 and appendix C). Individuals, if present, within these features have the potential to be harassed during hibernation, and Mountain Valley estimates that 221.96 bats would be harassed. This estimate is rounded up to 222 individuals.

Eq. 4		7.017	Individuals from Tawney's Cave
		7.017×4	Individuals from suitable features (n=4)
		1	Individual from Canoe Cave
		1.293	Individuals from PS-WV3-Y-P1
	+	3.2384×57	Individuals from features with unknown suitability (n=57)
		221.9668	**Total individuals harassed**

There are no known or potentially occupied hibernacula within 0.6 mile of a proposed compressor station; therefore, no impacts on hibernating northern long-eared bats from noise during operations is expected.

8.2.1.3 Autumn Swarming and Spring Staging

After emerging from hibernation, northern long-eared bats are thought to participate in spring staging, where bats remain near the hibernacula for a short time (i.e., 2 to 3 days) before migrating to summer maternity areas. A similar process, although longer, occurs in autumn with large numbers of bats roosting in nearby forested habitat. As described in section 8.2.1.1, the Project Action Area includes two previously document northern long-eared bat hibernacula. Although few hibernating northern long-eared bats have been observed within these caves during recent surveys, this species is inherently difficult to detect within hibernacula, as the bats wedge themselves into cracks and crevices, thus making identification difficult and bat counts inaccurate. The Action Area also contains one feature (PS-WV3-Y-P1) documented by ESI to host northern long-eared bats.

Along with the three known hibernacula, there are an additional four field documented, suitable and potentially occupied features within the Action Area of the Project and 57 features with unknown suitability that may also be occupied. For the purposes of this BA, all of these features are treated as potentially occupied by the species.

Project construction could directly impact individuals during spring staging in two primary ways. First, removal of wooded habitat associated with Project construction has potential for both injury and mortality; however, take from tree clearing outside of June or July is only prohibited within a 0.25-mile radius of a hibernacula. Second, individuals may be forced to expend additional energy to locate replacement roosts due to construction sound or active clearing of a tree in which a bat is roosting. However, noise disturbances other than those in relation to hibernacula are not prohibited under the final 4(d) rule published January 14, 2016, and therefore, are not covered within the effects analysis.

Combined, approximately 72.6 acres of forested habitat within the protective 0.25-mile buffers surrounding the known or potentially occupied portals would be cleared during Project construction, which could potentially harm or harass individuals participating in spring staging or autumn swarming.

8.2.1.4 Impacts from Tree Clearing During Spring Staging

To estimate impacts on individuals during spring staging, Mountain Valley derived information on the activity levels of bats in different months during spring from the available literature on the species. Whitaker and Rissler (1992) documented that northern long-eared bats emerge from hibernation early in the spring season. At Copperhead Cave in Indiana, large numbers of bats were observed exiting the cave when the temperature approached 50 degrees Fahrenheit, which typically occurred between the second week of March and April each year. During May and early June few northern long-eared bats were active at the cave. Based on this information, the chance of harm and harassment of spring staging bats is greatest within the months of March and April.

Since no information is available regarding the distribution and abundance of individuals around hibernacula during staging, Mountain Valley assumed that northern long-eared bats demonstrate a similar pattern as the Indiana bat (see section 8.1.1.3 and figure 8.1.1.3-1) with the majority of individuals present within 0.42 miles of the feature. For northern long-eared bats, Mountain Valley calculated the number of staging bats within 0.25 mile surrounding a potential hibernacula as the product of the number of individuals expected in the feature during the winter months (i.e., total winter abundance) as derived in section 8.2.1.2 (see example in column 1 from table 8.2.1.4-1); the proportion expected to be found within the distance of 0.42 mile (based on Gumbert et al., 2002); and the proportion of the 0.42 mile that is within the 0.25-mile buffer where take is prohibited (i.e., 0.360602; see column 2 of table 8.2.1.4-1). Mountain Valley then used this estimate to calculate the potential harm and harassment from tree felling (figure 8.2.1.4-1; table 8.2.1.4-1).

Expected harm of staging bats within 0.25 mile of a potential or known hibernaculum is calculated as the product of the number of bats expected within the buffer (column 2 of table 8.2.1.4-1); the proportion of the bin within the construction workspaces cleared during March and April when staging bats are present (column 3 of table 8.2.1.4-1); and the expected harm rate (0.25). A harm rate of 25 percent was developed for Indiana bats (section 8.1.1.3) but is assumed to be applicable for northern long-eared bats as well. All bats present within the proportion of the bin within the construction workspaces that are not expected to be harmed are assumed to be harassed.

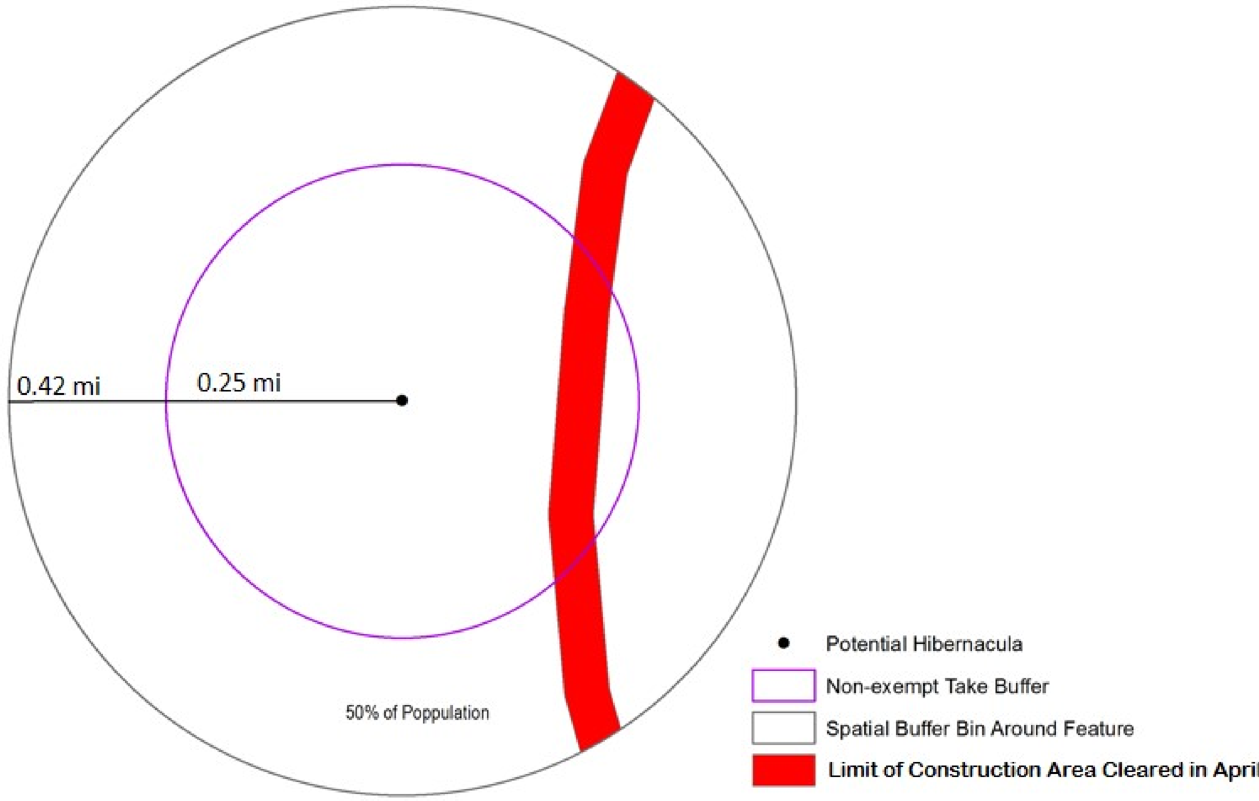

Figure 8.2.1.4-1 Example diagram for harm and harassment of staging northern long-eared bats due to tree clearing surrounding a potential hibernacula.

TABLE 8.2.1.4-1

Example Harm and Harassment Calculation for Staging Northern Long-Eared Bats due to Tree Clearing Surrounding a Potential Hibernacula

Total Winter Abundance	Expected Individuals Staging within 0.25 mile	Proportion of Take Buffer Cleared in April or March	Expected Individuals within Cleared Area	Expected Harm	Expected Harassment
10	10×0.5×0.360602=1.803 a/	0.077	1.803×0.077= 0.1388	0.1388×0.25= 0.0347	0.1388×0.75= 0.1041

a/ 0.5 is the proportion of the population within 0.42 mile based off of Gumbert et al. (2002) and 0.360602 is the proportion of 0.25 mile bin that represents the non-exempt take buffer (i.e., [$\pi \times 0.25^2$]/[$\pi \times 0.42^2$]).

Based on the tree clearing schedule, harm and harassment from tree clearing would be possible surrounding 14 features within the months of March and April; no tree clearing would be planned in the vicinity of Tawney's Cave or Canoe Cave during these months. Thirteen of these features are not known hibernacula but presence has been assumed for purposes of this analysis. Clearing would also be expected in the month of March surrounding PS-WV3-Y-P1, where a single northern long-eared bat was captured during harp trap surveys for the Project. Approximately, 13.3 acres of forest would be expected to be cleared during March within the 0.25-mile buffer surrounding the feature, and thus, there is the potential for harm and harassment. Within this area and other areas surrounding potential hibernacula, cumulatively it is expected that 0.0772 staging individuals could be harmed (table 8.2.1.4-1), and 0.2315 individuals could be harassed from tree clearing. These values were was rounded up to one individual harassed and one individual harmed.

8.2.1.5 Impacts from Tree Clearing During Autumn Swarming

In addition to spring staging, harm and harassment during autumn swarming is also possible via the same mechanisms listed for staging individuals. Based on information from Whitaker and Rissler (1992), male individuals begin to arrive at hibernacula in late July, and females arrive soon after. The majority of individuals likely swarm within August and September, but individuals may be active until mid-November. Therefore, harassment and harm to swarming bats from tree clearing may occur from late July to mid-November. Although several areas of the Project are proposed to be cleared within the fall (i.e., August through November), none of these areas are within 0.25 mile of a known or potential hibernacula. Thus, no prohibited harm or harassment under the final 4(d) rule is expected to swarming individuals.

8.2.1.6 Summer Season of Reproduction

Studies conducted in support of this BA provided evidence of occupation of the Project Area by the northern long-eared bat during the summer season of reproduction (section 6.1). The final 4(d) rule published January 14, 2016 prohibits incidental take of northern long-eared bats through removal of known maternity roosts and any trees within 150 feet from June 1 through July 31, when non-volant young are present within the roosts. Forested habitat would not be removed during June or July, and therefore a direct take via harm of individuals is exempt.

Potential effects of changes in the soundscape as a result of construction and operation of the Project are addressed in section 4.1.2. The final 4(d) rule does not prohibit incidental take of northern long-eared bats via harassment as a result of changes in sound levels or air quality in their summer range.

TABLE 8.2.1.4-1

Potential Areas for Harm and Harassment of Spring Staging Northern Long-eared Bats from Tree Felling

Feature Type a/	Winter Abundance Estimate	Freq b/	Proximity Bin (miles) c/	Proportion of Ind. within Bin‡	Proportion of Forest in Bin Cleared in March or April	Expected Individuals Present in Cleared Forest	Expected Harassment§	Expected Harm d/
Suitability Unknown	3.2384	10	0.25	0.1803	0.0454	$3.2384 \times 10 \times 0.1803 \times 0.0454 = 0.2651$	0.1988	0.0663
Suitable, Unsurveyed	7.017	3	0.25	0.1803	0.0059	$7.017 \times 3 \times 0.1803 \times 0.0059 = 0.0224$	0.0168	0.0056
PS-WV3-Y-P1	1.293	1	0.25	0.1803	0.1177	$1.293 \times 0.1803 \times 0.1177 = 0.0212$	0.0159	0.0053
					Total	**0.3087**	**0.2315**	**0.0772**

a/ In addition to the three known hibernacula (Tawney's Cave, Canoe Cave, and PS-WV3-Y-P1) there are 3 features that are suitable for bats but remain unsurveyed (i.e., Suitable, Unsurveyed) and 10 features that have unknown suitability and remain unsurveyed (i.e., Suitability Unknown).

b/ Frequency (Freq) refers to the number of features that have an intersecting buffer with proposed tree clearing in April and March.

c/ Proximity bins refer to area surrounding a known or potential hibernacula and the expected proportion of individuals (Ind.) present (i.e., 0.1803) was derived using the product of the 1) proportion (i.e., 0.5) of the population expected to occur within 0.42 mile as derived from Gumbert et al. (2002) and 2) the proportion of that the 0.42 mile buffer that represents the non-exempt take buffer (i.e., $0.3606 = [\pi \times 0.252] / [\pi \times 0.422]$).

d/ Harassment and harm was calculated by multiplying the individuals present by 0.75 and 0.25, respectively.

8.2.1.7 Spring and Autumn Migration/Transient Period

After staging and before swarming, northern long-eared bats make migrations of varying distances to summer roosts; however, relatively little is known about the timing or use of habitat during the migratory/transient period. For northern long-eared bats, the spring migration period likely occurs from mid-March to mid-May, and the fall migration period from mid-August to mid-October (FWS, 2016c). Given that the final 4(d) rule does not clearly define or prohibit take of migrating individuals on the summer landscape (e.g., no migrant roosts are known in the Project Area), any prohibited take would be restricted to 0.25 mile buffers surrounding known hibernacula (i.e., Canoe Cave, Tawney's Cave, and PS-WV3-Y-P1) and potentially occupied portal features (i.e., the 4 field documented suitable portals and 57 features with unknown suitability within the Action Area). Migrants occurring within this radius could potentially be harassed if tree clearing were to occur March through May or August through October.

Given that migrants are expected to occur for only a brief amount of time within the Project Area (i.e., about 1 day), it is assumed that disruptions from construction via noise, light, or dust would not significantly increase the stress or energetic costs of the species during this short time period. Under these assumptions, harassment and harm are only possible within the construction workspaces in forested areas where trees are actively being cleared. Because information regarding the flight paths and densities of migrants during the spring and autumn is lacking, a quantification of take from tree felling is not feasible. However, given that harm and harassment estimates from tree felling were less than one for both Indiana bat and northern long-eared bat for each respective life stage, it is likely that take of migrants from tree felling would be equally as small. Thus, it is assumed that one migrant individual may be harmed and one individual may be harassed from Project construction.

8.2.2 Direct Effects on Habitat

8.2.2.1 Winter Season of Hibernation

The Project would not directly impact any currently known or potential northern long-eared bat hibernacula. There are no known hibernacula within the Project Area; however, field searches for undocumented cave or mine openings resulted in identification of three potentially suitable features occurring within the Project's construction right-of-way. Harp trapping was completed at all three potentially suitable portals, but no bats were captured during these efforts. Therefore, these features are assumed to be unoccupied.

In addition, Mountain Valley conducted a hydrologic and geologic analysis that demonstrated negligible risk to karst features, hydrology, and biological resources of Canoe Cave and Tawney's Cave, the two known northern long-eared bat hibernacula in the Action Area. This conclusion is based on multiple mitigating factors, including the nature and scale of construction, the separation between each cave and the proposed construction right-of-way, and the relative position of the proposed alignment compared to each cave and upland catchments (i.e., karst watershed). Specifically, in relation to [redacted]. The MVP is not located within the VADCR Clover Hollow Conservation Site that encompasses Tawney's Cave. Based on the nature of construction, and the relative location of the alignment being topographically and hydrologically removed from Tawney's Cave, no impacts on the cave system are anticipated.

Similarly, the MVP would be located [redacted]. Mountain Valley adjusted the proposed Project alignment by shifting approximately 1,300 feet to the north to avoid the cave and known karst features. In addition, the proposed alignment would be located topographically lower and downgradient of the spring associated with Canoe Cave within the VADCR Conservation Site, which would reduce the potential for impacts to the cave system.

Within the potential catchment for the Canoe Cave, the proposed trench would be approximately 100 to 200 feet above base flow levels leading to Sinking Creek. Mountain Valley would employ stringent erosion and sedimentation controls, as well as implement karst inspection and mitigation to minimize potential impacts on karst features. Mountain Valley would also prepare for and thereby attempt to lessen the probability and effects of a potential spill or release of oil or hazardous material during construction by adhering to measures specified in the Project-specific SPCC Plan, the Karst-Specific E&S Control Plan for Virginia, and the Karst Mitigation Plan. Specific measures are described in these documents and summarized in section 3.0.

As noted in section 4.1.2.5, Mountain Valley has not determined whether blasting would be necessary during construction. However, if Mountain Valley determines blasting is necessary within 0.5 mile of known or potential northern long-eared bat hibernacula, it would develop site-specific blasting plans that would specify mitigation measures it would use to prevent damage to hibernacula or other underground features. For example, Mountain Valley would use blasting mats or padding, restricted charge sizes, and/or charge delays to minimize airblast, peak sound pressure levels, and ground vibration.

8.2.2.2 Autumn Swarming and Spring Staging

Approximately 1,705 acres of forested habitat occur within the 0.25-mile buffers of known or assumed occupied winter habitat that intersects the Project Area. Within these areas of winter habitat, Project development would reduce forested habitat by 3.6 percent (60.7 acres) from construction and permanently reduce forested habitat by 1.3 percent (21.3 acres), including 0.5 acre in the buffer for Canoe Cave, 1.4 acres in the buffer for Tawney's Cave, and 12 acres in the buffer for PS-WV3-Y-P1 cave.

The FWS requested that Mountain Valley respond to its recommendation to revise the MVP route so that it would pass no closer than 5 miles from the entrance to Tawney's Cave in order to minimize impacts on northern long-eared and Indiana bat swarming habitat. Mountain Valley assessed six alternative routes, five of which are addressed by the FERC in section 3.0 of the final EIS, that would increase the distance from the entrance to Tawney's Cave. However, each of the alternatives possessed significant environmental and/or construction disadvantages relative to the proposed route including increased crossings of karst terrain, increased crossings of steep and severe side slope terrain, increased major waterbody crossings, and increased crossings of FS and other conservation lands.

8.2.2.3 Summer Season of Reproduction

As a whole, the Project is expected to convert 4,459.4 acres and 1,600.9 acres of forest (including forested wetlands) during construction and operation, respectively, into developed, medium intensity habitat within a 6,363.0-acre Project Area and a 279,077.2-acre Action Area. These lands are assumed to provide viable habitat for foraging and roosting northern long-eared bats before construction and unsuitable habitat for roosting after construction. No forested lands would remain within the Project Area following construction, but 216,951.0 acres of forest would remain within the Action Area following construction and 2,858.5 acres of forested area would be allowed to regenerate following construction. Regenerated forest would likely take upwards of 25 years to become suitable roosting habitat again. This represents a loss of 2.01 percent of the forest following construction and a permanent loss of 0.72 percent of forest within the Action Area.

Two known, occupied maternity roosts and 7,329 potential roost trees occur within the Project's construction workspace. Note that potential roost trees were only marked in areas considered occupied by either Indiana or northern long-eared bats. One of the occupied maternity roosts (Roost 499-1) occurs on private land and has since been removed during logging activities by the landowner. MVP has agreed to avoid the remaining occupied maternity roost (Roost 423-1) by shifting an access road and fencing off the tree to avoid any direct impacts. However, the 7,329 identified potential roost trees would be lost during MVP construction. Because these trees would be removed outside June 1 to July 31, any incidental take caused by such removal would be exempt under the 4(d) rule.

8.2.2.4 Spring and Autumn Migration/Transient Period

Relatively little is known about the timing or use of habitat during the migratory/transient period, but available data suggest that habitat use is similar to summer months (Caceres and Barclay, 2000). As such, Mountain Valley assumes that areas suitable for use during summer are also suitable during migration. NLCD data indicate 4,459.4 acres of forested habitat exist within the construction workspaces, and 1,600.9 acres exist within the permanent easement. In total, this would be a loss 2.01 percent of the forested habitat available within the Action Area following construction; however, 2,858.5 acres would be allowed to regenerate once the Project is operational. Regenerated forest would likely take upwards of 25 years to become suitable roosting habitat again.

This loss is a small fraction of the migration/transient habitat available on the landscape that sustains bats as they traverse between summer and winter habitats. This habitat loss is insignificant and discountable and would not rise to the level of harm or result in a take of individuals. Even if take were to occur, it would be exempt under the 4(d) rule.

8.2.3 Indirect Effects

Indirect effects are those effects that are caused by or would result from the proposed action and are later in time but still reasonably certain to occur. Indirect effects on individual bats would occur if the Project causes chemical, biological, or physical changes that can affect bats.

8.2.3.1 Negative Effects

Mountain Valley would remove trees in the Project Area January through May of 2018 and in August through November of 2018, if needed. Bats returning to the area in spring 2018 would encounter a cleared area that is an active construction site. Direct effects of the Project include removal of 459.4 acres of forested land.

Impacts resulting from forest removal, changes in water quality, and light pollution on northern long-eared bats are expected to be similar to those described for Indiana bats (see section 8.1.3.1) because the two species are ecologically similar. In short, both species are believed to be able to sustain the loss of multiple roosts including several nodal roosts due to forest removal (Silvis et al., 2014a; Silvis et al., 2015). If some nodal roosts remain, bats can reconnect with roost mates and locate new roosts. Additionally, impacts on bats from increased sedimentation within adjacent waterbodies are insignificant and discountable. This is largely based on the fact that northern long-eared bats primarily feed on Lepidoptera (moths), Coleoptera (beetles), and Diptera (flies) (Brack and Whitaker, 2004; Lee and McCracken, 2004), and their diet is somewhat flexible across its range and it is not likely to rely solely on one taxonomic group of insect prey. Mountain Valley would minimize light pollution by using downward-facing, full cut-off lens lights where lighting is necessary at permanent facilities.

8.2.3.2 Beneficial Effects

Some trees along the edges of the Project are likely to be damaged during clearing activities, potentially increasing the number of roost sites. Most damaged trees would survive, but would be more prone to insect infestations and diseases that result in senescence, which in turn produces potential roosts for northern long-eared bats. Over time, some damaged trees would die and with significant solar exposure along the forest edge provide high quality roosts.

Restoration includes planting of native seed mixes within temporary work areas and then subsequently allowing forest regeneration. Initially these areas would provide foraging habitat and over time roosting habitat. Forest edges, as would be created by the new MVP corridor, provide high quality foraging and commuting habitat. Restoration using native herbaceous species in the permanent right-of-way and continuous maintenance would provide suitable foraging and commuting habitat for northern long-eared bats.

8.2.4 Determination of Effects and Rationale

Table 8.2.4-1 summarizes the effects determinations that are explained more fully in sections that follow. Rows in the table are referenced to the appropriate text section.

TABLE 8.2.4-1

Summary of Effects and Effects Determinations for Northern Long-eared Bats

Description	Expected Harassed	Expected Harmed	Construction Impacts (acres) a/	Operational Impacts (acres) a/	Effect Determination
Direct Effects					
Winter Season of Hibernation	222	0	-	-	Likely to Adversely Affect
Autumn Swarming and Spring Staging	1	1	60.7	21.3	Likely to Adversely Affect
Summer Resident Bats	0	0	4,459.4	1,600.9	Likely to Adversely Affect
Spring and Autumn Migration	1	1	4,459.4	1,600.9	Likely to Adversely Affect
Indirect Effects	**-**	**-**	**-**	**-**	**Not Likely to Adversely Affect**
Collective Impact/ Determination	**224**	**2**			**Likely to Adversely Affect**

a/ Areas overlap and represent all forested habitat removed regardless of occupancy state.

8.2.4.1 Direct Effects to Individuals

Winter Season of Hibernation

The Project would not directly impact any potentially suitable or occupied northern long-eared bat hibernacula. Based on the expected number of northern long-eared bats in known or potentially occupied hibernacula within the Project's Action Area and the Project's proposed tree clearing schedule, an estimated 222 individuals have potential to be harassed due to clearing and construction noise. Given the potential for harassment, a determination of ***Likely to Adversely Affect*** is appropriate.

Autumn Swarming and Spring Staging

Within 0.25 mile of known or potentially occupied northern long-eared bat winter habitat, Project development would temporarily reduce forested habitat by 3.56 percent (60.7 acres) and permanently reduce forested habitat by 1.25 percent (21.3 acres). Based on the location of known and potentially occupied hibernacula, the proposed MVP tree clearing schedule, and estimated number of bats in each hibernacula, it is estimated that 1 bat would be harassed and 1 bat would be harmed during spring staging and no bats would be harmed during autumn swarming. Given the potential for harm and harassment, a determination of ***Likely to Adversely Affec***t is appropriate.

Summer Resident Northern Long-eared Bats

Approximately 0.7 percent (1,600.9 acres) of the available forest within the Action Area, including four documented maternity roosts, would be permanently lost following Project development. This loss is a small fraction of the forested habitat available on the landscape that supports summer roosting and foraging bats. No forest habitat would be removed during June or July, and therefore a direct take via harm to individuals would not occur when maternity colonies are most vulnerable. A determination of ***Likely to Adversely Affect*** is appropriate based on removal of known, occupied habitat; however, this take is exempt under the final 4(d) rule.

Spring and Autumn Migration/Transient Period

Approximately 0.7 percent (1,600.9 acres) of the available forest within the Action Area would be permanently lost following Project development. It is estimated that one migrant individual would be harmed and one individual would be harassed from Project construction. Thus, a determination of ***Likely to Adversely Affect*** migrating northern long-eared bats is appropriate.

8.2.4.2 Indirect Effects

Based on the size, significance, and probability of occurrence of detrimental and beneficial effects to northern long-eared bats from roosting habitat removal, foraging habitat creation, and water channel sedimentation, a determination of ***Not Likely to Adversely Affect*** is appropriate.

8.2.4.3 Northern Long-eared Bat Determination Summary

Collectively, an ***is Likely to Adversely Affect*** determination is appropriate for the northern long-eared bat. The effects analysis projected that 224 northern long-eared bats would be harassed and 2 harmed during Project construction and operation.

8.3 GRAY BATS

Analyses of effects on gray bats as a result of Project construction and operation are restricted to areas of known or potentially occupied habitat. There are no records of occupied summer roosting or winter hibernating habitat within the Action Area. As described in section 8.3.1 to 8.3.6 below, no take of the gray bat would be anticipated as a result of the Project.

8.3.1 Direct Effects on Individuals

Gray bats may be subjected to direct and indirect effects during construction, operation, and maintenance of the Project. Effects by season are addressed in the sections below.

8.3.1.1 Winter Season of Hibernation and Summer Season of Reproduction

There are four caves within the Project's Action Area within the county-level occurrence of the species: [redacted] These caves were not field assessed for the MVP. However, gray bats are highly selective with few available caves actually used as roosts (Brady, 1982), and correspondence with WVDNR indicates that these four caves are not known to be occupied by gray bats in any season (Craig Stihler, pers. communication with Mountain Valley, February 2017). Summer mist-net surveys for bats (section 6.1.1) did not result any gray bat captures. Based on these data, gray bats are not present within the Project Area and thus would not be harmed or harassed during summer or winter.

8.3.1.2 Autumn Swarming and Spring Staging

Because no occupied summer or winter habitat occur within the Action Area, and autumn swarming and spring staging activities are associated with these features, gray bats would not be harmed or harassed during these seasons.

8.3.1.3 Spring and Autumn Migration/Transient Period

Depending upon colony size and available habitat, individuals may travel distances of 12 to 21 miles from a summer roost to foraging areas (LaVal and LaVal, 1980). The nearest, confirmed summer colonies of gray bats are located in Scott, Lee, and Washington Counties, Virginia, which are located over 70 miles away from the Project. There are four caves in Fayette, Monroe, and Summers Counties, West Virginia that bats may use as over-night stops during their migration activities. Based on these data, it is possible that gray bats could be present in the Action Area for very short periods of time and thus be harassed via noise impacts associated with clearing or construction activities. However, the presence of grays bats during migration is unlikely, and any impacts on migrating individuals are insignificant and discountable.

8.3.2 Direct Effects on Habitat

The Project would not directly impact any caves within Fayette, Monroe, or Summers Counties; therefore, there would be no effects on potential winter hibernating, summer roosting, autumn swarming, spring staging, or migration habitat for the gray bat.

8.3.3 Indirect Effects

Indirect effects are those effects that are caused by or would result from the proposed action and are later in time, but still reasonably certain to occur. Indirect effects on individual bats would occur if the Project causes chemical, biological, or physical changes that can affect bats.

8.3.3.1 Negative Effects

Gray bats are known to forage along water resources, including streams, rivers, lakes, and reservoirs (LaVal et al., 1977). Therefore, to the extent that sedimentation within adjacent water bodies reduces flying insects in these resources, the Project could have an effect on gray bats in the area. However, since gray bats do not occur within the Action Area except potentially during migration, this effect is insignificant and discountable.

8.3.3.2 Beneficial Effects

Project Area restoration includes planting of native seed mixes within temporary work areas and subsequently allowing forest regeneration. Woodland edges provide high quality foraging and commuting habitat. Restoration using native herbaceous species in the permanent right-of-way and continuous maintenance would provide suitable foraging and commuting habitat for gray bats.

8.3.4 Determination of Effects and Rationale

Based on the lack of summer captures during field surveys and complete absence of suitable, occupied roosting or hibernating habitat for the gray bat within the Action Area, no direct or indirect effects are expected on the species and a ***Not Likely to Adversely Affect*** determination is appropriate for gray bats.

8.4 VIRGINIA BIG-EARED BATS

As described in sections 8.4.1 to 8.4.3 below, based on the lack of summer captures during field surveys and complete absence of suitable, occupied roosting or hibernating habitat for the Virginia big-eared bat within the Action Area, no take of the species would be anticipated as a result of the Project.

8.4.1 Direct Effects on Individuals

8.4.1.1 Winter Season of Hibernation and Summer Season of Reproduction

Direct take of individual Virginia big-eared bats could occur in winter if occupied hibernacula are disturbed or destroyed during construction or maintenance. Except for Fayette County, the entire Project lies outside the known range of the Virginia big-eared bat. No suitable caves or portals were located within Fayette County during field surveys. Eleven portals were located during field surveys within counties adjacent to Fayette (Nicholas – 6, Greenbrier – 5, Summers – 0). Of those, six were deemed unsuitable. Of the five that were assessed to be potentially suitable in 2015, four had been destroyed by surface mining when biologists revisited them for survey in 2016, and the remaining portal was surveyed in autumn using harp traps with no bats detected. No individuals were captured during summer netting surveys across the length of the Project (section 6.1.1). Based on these data, it appears Virginia big-eared bats are not present within the Project Area and would not be harmed or harassed during summer or winter as a result of the Project.

8.4.1.2 Autumn Swarming and Spring Staging

Because there is no occupied summer or winter habitat within the Action Area, and autumn swarming and spring staging activities are associated with these features, gray bats would not be harmed or harassed during these seasons.

8.4.1.3 Spring and Autumn Migration/Transient Period

Virginia big-eared bats migrate relatively short distances (20 miles; Piaggio et al., 2008) but all eight known, occupied mine portals in Fayette County are within this distance. Therefore, there is potential for bats migrating through the Project Area during construction to be affected by noise. However, given that Project construction activities take place almost completely during daylight hours, and bats are generally active at night, the probability of bats being within the Action

Area while noise is occurring is relatively unlikely. Thus, the probability of Virginia big-eared bats being harmed or harassed during migration due to Project activities is insignificant and discountable.

8.4.2 Direct Effects on Habitat

The Project would not directly impact any suitable caves within counties adjacent to Fayette County. Therefore there would be no effects on potential winter hibernating, summer roosting, autumn swarming, spring staging or migration habitat for Virginia big-eared bat.

8.4.3 Indirect Effects

8.4.3.1 Detrimental Actions

To the extent that sedimentation resulting from construction of the MVP within Project-adjacent waterbodies reduces flying insects in these resources, the Project could have an effect on Virginia big-eared bats in the area. However, since Virginia big-eared bats do not occur within the Action Area except, potentially during migration, this effect is insignificant and discountable.

8.4.3.2 Beneficial Actions

Project Area restoration includes planting of native seed mixes within temporary work areas and subsequently allowing forest regeneration. Woodland edges provide high quality foraging and commuting habitat. Restoration using native herbaceous species in the permanent right-of-way and continuous maintenance would provide suitable foraging and commuting habitat for Virginia big-eared bats.

8.4.4 Determination of Effects and Rationale

Based on the lack of summer captures during field surveys and absence of occupied roosting or hibernating cave habitat for the species within the Action Area, no direct or indirect effects on the species would be expected. Therefore, a ***Not Likely to Adversely Affect*** determination is appropriate for Virginia big-eared bats.

8.5 ROANOKE LOGPERCH

Analyses of effects on Roanoke logperch as a result of Project construction and operation are restricted to areas of known, occupied habitat, where the species is presumed to be present, and areas of suitable habitat, where the species has the potential to be present. This includes 13 stream crossings where presence of the species is assumed present and impacts could occur. Known, occupied habitats include the North Fork Roanoke (three crossings), Roanoke (one crossing), and Pigg (one crossing) Rivers. Suitable habitats (and assumed occupation) occur in the North Fork Blackwater River (one crossing), Blackwater River (one crossing), Little Creek (two crossings), and portions of Bradshaw (two crossings), Teels (one crossing), Maggodee (one crossing), and Harpen (one crossing) Creeks. No instream construction activities would occur at one of the crossings of the North Fork Roanoke River due to the crossing being an access road across an existing bridge, thus only 13 crossings are relevant to impacts on the species. Potential effects of

Project activities on individuals and habitat are addressed in the sections below. Based on this analysis, the Project is expected to harass 3,618 Roanoke logperch and harm 29 Roanoke logperch. In the final EIS, we recommend that Mountain Valley use the HDD method to cross the Pigg River in Pittsylvania County, Virginia. A successful HDD crossing would eliminate instream disturbance and would likely reduce potential impacts on Roanoke logperch in the Pigg River and thereby reduce the number of Roanoke logperch expected to be harassed or harmed. However, the HDD method could result in an inadvertent release of drilling fluid into the river. An inadvertent release of drilling fluid would result in sedimentation and turbidity, the effects of which are described in section 4.1.3.1. If the HDD crossing were to be unsuccessful or deemed infeasible, Mountain Valley would revert to the originally planned dry open-cut crossing method. We are including the analysis of the dry open-cut crossing of the Pigg River to account for the worst-case scenario.

8.5.1 Direct Effects on Individuals

Project activities with potential to affect Roanoke logperch include (but are not limited to) instream, benthic disturbances (e.g., use or operation of machinery and equipment within a stream, trenching, blasting, etc.), upland disturbances (e.g., erosion, sedimentation), water-uses (e.g., hydrostatic testing, hydroseeding, dust control), noise, and artificial lighting. Effects on individuals by life stage are addressed in the sections below. Adults and subadults are individuals one year old or older. As defined in section 7.5.4.1, YOY are individuals born within the past year. The methods and results of predictive models used to estimate abundance of logperch are provided in appendix C and summarized in section 7.5.4.

8.5.1.1 Adults and Subadults

Effects on adults and subadults (i.e., Age-1+) can be broken up into three spatial scales: effects within the construction workspaces; effects downstream of the construction workspaces; and effects from sedimentation due to construction in upstream catchments. Each of these are addressed further below, beginning with effects within the construction workspaces.

Effects within the Construction Workspaces

The greatest potential for harm and harassment of individuals is due to instream construction activities. Although Roanoke logperch may demonstrate avoidance behaviors, individuals hiding under substrates may be susceptible to harm by being crushed by heavy equipment operations and construction in the stream. It is assumed that all individuals occupying a proposed stream crossing within the construction workspace could be subject to harm as a result of instream disturbance activities.

Effects from Removal and Translocation

Per recommendations from the VADGIF to minimize this risk of harm, Mountain Valley would remove fishes, including Roanoke logperch (where present), from instream disturbance areas (including, but not limited to, cofferdam, dewatered areas, and/or the pipeline construction footprint) immediately prior to instream construction activities (including blasting). Therefore, Roanoke logperch would be removed to the extent possible from the construction workspace and would not be susceptible to direct harm from construction and machinery. Depletion fish surveys would be performed by approved and permitted biologists via electrofishing techniques and seining within an isolated area between the upstream and downstream limits of construction. All collected fishes would be translocated downstream of the construction area.

Depletion fish survey efforts would be conducted within isolated areas until no fishes are collected for several consecutive passes. All collected fishes would be temporarily held in aerated containers until transported and released downstream (minimum of 50 feet) of the Project footprint (per VADGIF recommendation). Harm estimates assume proper fish handling techniques and careful vigilance by collectors of the ambient weather and water conditions that exist at the time of depletion fish surveys.

All Roanoke logperch encountered during depletion fish surveys are considered harassed per the definition of take under the ESA, and a fraction of individuals encountered could sustain harm (i.e., injury or mortality). Fishes are harassed by the physical act of collections, handling, temporary holding, translocating to alternative habitat(s), and subsequent isolation from previously occupied habitat. Harm rates caused by electrofishing surveys, a permitted activity under scientific collection permits, have been known to vary widely accordingly to species and the specific aquatic environment. Harm rates of electrofishing for Roanoke logperch are unknown; however, Cooke et al. (1998) documented an 8 percent harm rate (e.g., direct mortality or internal hemorrhaging) in benthic stream fishes as a result of standard electrofishing techniques.

Seining poses an inherent risk of crushing individuals by the collectors or the grinding movement of large substrates as a seine is hauled across the substrata; however, this harm rate is likely less than the electrofishing rate noted above. During fish collections, darters are often observed seeking shelter under larger substrates. Any physical disturbance of sheltering rocks could inadvertently harm individuals via crushing.

Roanoke logperch are mobile organisms and are expected to survive translocations without significant adverse effects. Roanoke logperch have exhibited movements greater than 1.9 miles, and individuals often make intra-site movements of 49.2 feet or more (Roberts et al., 2008). Translocated individuals would be returned to areas within the same waterbody in adjacent areas that demonstrate similar habitat qualities as where they were captured. All translocated individuals would be moved downstream of the Project crossing to prevent individuals washing via currents into the construction footprint.

To calculate harm and harassment due to the fish removal, Mountain Valley estimated abundances of Roanoke logperch within the 75-foot construction right-of-way at crossings of known-occupied habitats (i.e., North Fork Roanoke, Roanoke, and Pigg Rivers) and potentially occupied habitats that are proposed to be crossed by the Project (i.e., Bradshaw Creek1, Bradshaw Creek AR [MN-276], North Fork Blackwater River, Blackwater River3, Maggodee Creek1, Teels Creek4, Little Creek1.5, Little Creek2, and Harpen Creek1). Note the following pertinent information regarding four of the Project crossings:

- North Fork Roanoke River AR1 (MN-0268.01) occurs at an existing, private, access road traversing the river via a ford crossing. The existing access road ford crossing is located approximately 361 feet upstream of the Project crossing of the North Fork Roanoke River and is included as part of the Project construction workspace . MVP would make upgrades to the access road and would improve the stream crossing installing a temporary, single-span bridge thereby eliminating instream construction activities at the crossing location beyond installation of the bridge. A 40-foot construction right-of-way is applied at this stream crossing.

- The Project Area includes Reese Mountain Road as an access road during construction efforts. Reese Mountain Road traverses North Fork Roanoke River (AR2, MN-276.03) via an existing bridge that spans the river. No instream construction activities are proposed, and consequently, no site-specific impacts on Roanoke logperch would be anticipated.
- Bradshaw Creek AR (MN-0276) is composed of two existing stream crossings within a 92-foot stream reach. A single access road approaches Bradshaw Creek, splits near the stream crossing, and then rejoins after the crossing. The upstream crossing is composed of a multi-box, concrete culvert. The downstream crossing of Bradshaw Creek occurs downstream of the scour pool from the culvert (where the streambed aggrades) and is an existing ford crossing that would be upgraded to a single-span bridge.
- Based on in-situ habitat delineations conducted for mussel surveys for the Project, the proposed crossing of the Roanoke River is completely contained within a suitable patch for adult and subadult Roanoke logperch.

Because the proposed crossing of the Roanoke River is completely contained within a suitable patch for adult and subadult Roanoke logperch, an estimate of the expected abundance is used for take estimates rather than the expected density estimate. According to the site occupancy model (see appendix C), 181.57 individuals are expected in the suitable patch which is 3,692 square feet (0.32 acre) in size. The construction right-of-way for the crossing is estimated at 14,111 square feet (0.09 ac). Thus, an estimate of the number of adult and subadult individuals within the Action Area is made by multiplying the expected abundance by the proportion of the area of the patch that intersects the Action Area (i.e., 181.57 × [3,692/14,111] = 47.51).

For all other crossings, estimates of the number of adult or subadult Roanoke logperch within the Action Area are calculated as follows:

$$\textbf{\textit{Eq. 6}} \qquad N\_{_{Adult}} = D\_{_{Adult}} \times 0.0142$$

In this equation $D\_{_{Adult}}$ is the density estimate for the specific waterbody (table 8.5.1.1-1) and 0.0142 is the width (75 feet), in miles,) of the Action Area at stream crossings.

Individuals may be harassed by the physical act of collections, handling, temporary holding, translocating to alternative habitat(s), and subsequent isolation from previously occupied habitat. Individuals may be harmed by sustaining injury (e.g., internal hemorrhaging) or direct mortality as a result of electrofishing during depletion surveys. It is assumed that 8 percent of individuals occupying the construction right-of-way are harmed (Cooke et al. 1998), and the remaining number of individuals are harassed. Because it is impossible to harm a portion of an individual, all estimates were rounded up to the nearest integer. Thus, total harm and harassment for the 13 stream crossings where logperch are assumed present and instream activities are proposed to occur is estimated at 16 and 55 adult individuals, respectively (table 8.5.1.1-1).

Other potential effects within the construction workspace include blasting, noise, water use, artificial lights, water use, and leaks and spills. The potential effects for each mechanism are discussed further below.

TABLE 8.5.1.1-1

Estimated Densities, Expected Number of Individuals, and Respective Harassment and Harm Estimates Within the Action Area at Stream Crossings for Adult and Young-Of-The-Year (YOY) Roanoke Logperch

Stream Name	County a/	Adult Density (fish /mile) b/	YOY Density (fish /mile) b/	Expected Adults in Construction Right-of-Way c/	Expected YOY in Construction Right-of-Way c/	Adult Harassment c/	Adult Harm c/	YOY Harassment c/	YOY Harm c/
North Fork Roanoke River	Montgomery	96.8	69.8	1.4	1.0	1	1	0	1
North Fork Roanoke River AR1 (MN-268.01) d/	Montgomery	96.8	69.8	0.7	0.5	0	1	0	1
Bradshaw Creek AR (MN-276) e/	Montgomery	85.6	61.6	1.5	1.1	1	1	1	1
Bradshaw Creek1	Montgomery	89.9	64.8	1.3	0.9	1	1	0	1
Roanoke River	Montgomery	680.7	490.4	47.5	7.0	44	4	6	1
North Fork Blackwater River	Franklin	31.3	22.5	0.4	0.3	0	1	0	1
Teels Creek4	Franklin	31.6	22.8	0.5	0.3	0	1	0	1
Little Creek1.5	Franklin	38.5	27.7	0.6	0.4	0	1	0	1
Little Creek2	Franklin	39.6	28.6	0.6	0.4	0	1	0	1
Maggodee Creek1	Franklin	50.9	36.7	0.7	0.5	0	1	0	1
Blackwater River3	Franklin	240.2	173.1	3.4	2.5	3	1	2	1
Pigg River	Pittsylvania	412.7	297.3	5.9	4.2	5	1	4	1
Harpen Creek1	Pittsylvania	6.9	5.0	0.1	0.1	0	1	0	1
					Total	**55**	**16**	**13**	**13**

a/ All counties listed are within Virginia.

b/ Density estimates were derived using the methods summarized in section 7.5.4 and detailed in appendix C.

c/ Expected number of adults and YOY within the construction right-of-way were calculated using Eq. 2, except for the Roanoke River and access roads. Harassment and harm estimates were rounded up to the next integer for each crossing.

d/ The construction right-of-way of North Fork Roanoke River AR1 (MN-268.01) is 40 feet).

e/ The construction right-of-way of Bradshaw Creek AR (MN-276) is 92 feet).

Effects from Blasting

Although Mountain Valley has yet to determine whether blasting would be necessary at any of the occupied or assumed occupied streams (blasting would be a last resort after mechanical attempts to dislodge rock prove to be unsuccessful), impacts from its use are possible if the proper preventative measures are not employed. Impacts on fisheries from blasting vary by species (Yelverton et al., 1975), and documented injuries incurred by fish exposed to blasting include eye distension, multiple hemorrhages, hematuria (blood in the urine), and damage to a variety of systems (Hastings and Popper, 2005; Godard et al., 2008; Carlson et al., 2011; Martinez et al., 2011). Higher mortality has been found in fish that are smaller, closer to the blast, and at increased water depths (Yelverton et al., 1975; Munday et al., 1986). Should blasting be necessary, it would be conducted according to an approved Project blasting plan and would only be conducted at waterbody crossings once the trench corridor has been isolated from the waterbody and all Roanoke logperch have been translocated from the Project footprint. Thus, there is no potential for direct impacts on individuals within the construction right-of-way from blasting.

Noise Impacts

Noise may have potential impacts on individuals as well. A comprehensive review of studies performed on the effects of anthropogenic noises on fishes was completed by Popper and Hastings (2009) and concluded that the effects of anthropogenic sound on fishes cannot be extrapolated between species, specific conditions, or sound emissions. The majority of research performed on the effects of submerged anthropogenic noise includes explosions, airguns, and pile driving. The former is addressed in the context of blasting activities, and the latter two noise emissions are not applicable to the Project activities. Existing data do not provide adequate evidence to show that noise associated with Project activities would adversely affect Roanoke logperch.

Impacts from Artificial Lighting

In addition to noise, artificial light could also be a disturbing factor for individuals. However, the use of artificial lighting would be localized at the Project crossing and temporarily used at the time of instream construction. Although the Roanoke logperch is a benthic riverine species, it is a diurnal forager, and therefore is not likely subject to significant impacts from the temporary presence of artificial lighting.

Impacts from Leaks and Spills

Equipment and vehicles would be transporting or operating with diesel fuel and oil, thereby posing risks of an accidental spill of compounds that could inadvertently enter nearby waterways. These risks are minimal, but omnipresent, within the limits of Project activities and beyond. Mountain Valley has developed a Project-specific SPCC Plan and Unanticipated Discovery of Contamination Plan for Construction Activities to minimize the risk of spills and would implement procedures to minimize any adverse effect, in the event a spill occurs. Potential impacts associated with spills and leaks would be insignificant and discountable.

Effects Downstream of the Construction Workspaces from Instream Construction Activities

Anthropogenic sedimentation can be introduced to streams via upland land disturbances that enter waterways as well as direct instream construction activities. Although upland disturbances can be accounted for by a hydrological analysis of sedimentation (discussed in the following section), such an approach is designed to estimate sedimentation from water runoff across a landscape and thus cannot be used in isolation to accurately understand sedimentation and hydrological impacts from instream construction activities. Sedimentation would likely increase in the immediate vicinity of each pipeline crossing as a direct result of instream substrate disturbances (e.g., trenching), primarily once the water is returned to the construction right-of-way The spatial extent of the sedimentation from stream crossings is currently unknown and is likely dependent on the geological composition and river velocities. To account for sedimentation and hydrologic alteration at each stream crossing as a result of direct instream construction, it is assumed that a 2,625-foot downstream buffer would receive elevated levels of sedimentation that could result in harassment of individuals. This spatial extent is derived from preliminary informal consultation between Mountain Valley and the FWS in Virginia.

To calculate the number of individuals present within this area, the same approach used to calculate effects within the construction right-of-way is applied. Density estimates specific to the each stream length within the drainage based on the 1:24,000 NHD are used to calculate the number of individuals present within each 2,625-foot reach downstream of the construction right-of-way. A 2,625-foot downstream buffer was added to all stream crossings regardless of the suitability for Roanoke logperch at the crossing. However, harassment was only calculated in areas of known or assumed occupancy. If a buffer of a crossing with unsuitable habitat extended downstream into suitable habitat, harassment estimates were made for the portion of the buffer that was suitable. When information was lacking from in-situ field assessments of habitat suitability, the screening model developed by Lahey and Angermeier (2007) was used to remotely assess the potential for Roanoke logperch occurrence (see section 7.5.4 and appendix C). An existing access road ford crossing (i.e., North Fork Roanoke River AR) is located approximately 361 feet upstream of the MVP crossing of the North Fork Roanoke River and included in the Project Area disturbed. Consequently, the downstream effects of the construction right-of-way at the access road overlap the proposed pipeline and are therefore truncated accordingly (i.e., 285.8 feet).

In total, 1,177 Age-1+ individuals would be expected to be harassed directly downstream of the Project stream crossings (table 8.5.1.1-2). This estimate includes individuals from 11 separate waterbodies with varying densities and a total stream length of 8.07 miles. Note that only 11 streams are listed because harassment estimates at multiple crossings of streams (i.e., North Fork Roanoke River, Bradshaw Creek) and buffers that extend into these streams are aggregated.

TABLE 8.5.1.1-2

Estimated Harassment for Adult and Young-Of-The-Year (YOY) Roanoke Logperch From Impacts Immediately Downstream of Pipeline and Access Road Crossings

Stream Name	Counties a/	Stream Length (mi)	Expected Adult Harassment	Expected YOY Harassment
North Fork Roanoke River	Montgomery	1.15	69.60	50.14
Bradshaw Creek	Montgomery	1.99	109.02	78.55
Roanoke River	Montgomery and Roanoke	1.00	431.54	310.93
North Fork Blackwater River	Franklin	0.80	15.79	11.38
Teels Creek	Franklin	0.35	6.96	5.02
Little Creek	Franklin	1.38	33.07	23.83
Blackwater River	Franklin	2.76	263.54	189.88
Maggodee Creek	Franklin	1.07	34.01	24.51
Jonnikin Creek	Pittsylvania	0.35	1.43	1.03
Pigg River	Pittsylvania	0.80	205.86	148.32
Harpen Creek	Pittsylvania	1.32	5.64	4.06
	Total	**12.98**	**1,177 b/**	**848 b/**

a/ All counties listed are within Virginia.
b/ Cumulative harassment estimates were rounded up to the next integer.

Effects of Sedimentation from Catchments (Upland Disturbance)

Sedimentation caused by anthropogenic activities can settle and become deposited within streams or remain suspended in the water column, increasing turbidity within the water. Increased and sustained levels of sediment load can alter fish community structure, diversity, density, biomass, growth; decrease reproduction; and cause mortality of individuals. Although most fish species can tolerate a moderate amount of variation in turbidity, higher levels of turbidity can adversely affect fish swimming abilities, reduce growth, promote disease intolerance, reduce the quality of spawning habitats, reduce food availability, and increase the rate of mortality (Robertson et al., 2006). Likewise, increased water turbidity also inhibits the amount of sunlight that penetrates the water column, which can interfere with trophic interactions (e.g., increase susceptibility to predation) and behaviors (e.g., feeding and reproduction; Henley et al., 2000).

Lower dissolved oxygen levels brought on by sedimentation have been documented to negatively affect some species of darters and other stream fish, interfering with fishes' respiratory functions and causing them to decrease in abundance or causing fish extirpation. Although some species are able to tolerate moderate fluctuation in dissolved oxygen levels, fish in small streams and tributaries often have difficulty acclimating to lower levels of oxygen and thrive in rapidly flowing, silt-free streams (Dowling and Wiley, 1986).

Siltation and sedimentation are hypothesized to be contributing factors to the reduction of the Roanoke logperch distributional range and respective population sizes (Moser, 1992). Logperch, of all age classes, are particularly susceptible to siltation impacts due to their specialized feeding strategy, unique to species within the subgenus *Percina*, which requires ample interstitial spaces between small substrates such as gravel and pebbles. Roanoke logperch are invertivorous feeders that search for invertebrates residing beneath and on the undersides of small rounded stones. Roanoke logperch have conical snouts that allow them to grab a pebble or gravel stone with their mouths, dislodge it from the stream bottom, and flip it to search for any exposed invertebrate that may be attached to the underside of the stone or substrate beneath the stone (Rosenberger and Angermeier, 2002). This specialized feeding strategy requires that stones are available to be dislodged and flipped, exposed, unembedded, and free of silt. Roanoke logperch are typically found in mesohabitats with loose, silt-free substrates (Rosenberger and Angermeier, 2003). Siltation and sedimentation reduce the availability of interstitial spaces between substrate, compact substrates, and reduce the ability to dislodge stones, the frequency of encountering stones capable of dislodging, the exposed surface area of stones, the available foraging area within a stream, and/or space available for invertebrates to occupy. Due to this smothering of the foraging areas on the stream bottom, deposited sediment interferes with the Roanoke logperch's ability to forage (Robertson et al., 2006).

As a result of the aforementioned potential effects to normal feeding behaviors and an individual's reduced ability to find food, sedimentation and siltation from actions within the Project Area are likely to have an adverse effect on Roanoke logperch, in the form of reduced feeding efficiency and increased energy expenditures (i.e., harassment). To identify the extent of sedimentation effects, a hydrologic analysis of sedimentation was performed using the RUSLE (Renard et al., 1997). Results from the RUSLE yield generalized annual estimates of erosion rates and sediment loads based on climate, topography, and land use/management factors (section 3.2). These estimates are used to identify streams that are likely to have higher construction and post-construction sediment loads as compared to baseline, pre-construction levels.

Unfortunately, a national standard for the permissible amount of sediment to enter waterways is not available or established. Although the metrics used to assess impacts vary widely among states, tribes, and organizations, a common threshold identified is one that increases sedimentation metrics by 10 percent or more above baseline (EPA, 2003). Given that the mechanisms behind impacts of sediment can be due to either deposition or suspension (or both), total sediment load provides a reasonable metric because it addresses both suspended and deposited sediments within a stream channel. Thus, for the purposes of this analysis, stream areas with potential for impacts due to sedimentation were defined as any stream reach that increases existing total sediment load by more than 10 percent.

After accounting for sediment and erosion controls, it is expected that 22.6 stream miles with potential to support Roanoke logperch would be temporarily affected from increased sedimentation from upland Project construction. The majority (74.7 percent) of these impacts are within tributaries to the North Fork Roanoke, Roanoke, Blackwater, and Pigg Rivers; however, 5.7 miles of the North Fork Blackwater River are predicted to be affected directly. Beyond those established within the 2,625-foot buffer immediately downstream of Project crossings, no sedimentation increases in excess of 10 percent are expected within waterbodies with documented occurrences of Roanoke logperch (i.e., North Fork Roanoke, Roanoke, and Pigg Rivers). All impact reaches are areas where suitable habitat exists for the species and therefore have the potential to host the species. Using the density estimates from section 7.5.4 (see appendix C for derivation), expected harassment of adult and subadult Roanoke logperch from upland Project construction is 886 individuals (table 8.5.1.1-3).

TABLE 8.5.1.1-3

Estimated Harassment for Adult and Young-Of-The-Year (YOY) Roanoke Logperch From Impacts From Increased Sediment Loads From Upland Construction

Stream Name	Counties a/	Stream Length (mi)	Expected Adult Harassment	Expected YOY Harassment
Flatwoods Branch	Montgomery	1.44	68.78	49.55
North Fork Blackwater River	Franklin	9.21	202.06	145.59
Little Creek	Franklin	11.38	243.76	175.63
Foul Ground Creek	Franklin	5.33	109.44	78.85
Unnamed Tributary to Blackwater River	Franklin	0.68	13.77	9.92
Jacks Creek	Franklin	0.16	19.03	13.71
Parrot Branch	Franklin	1.74	201.84	145.43
Jonnikin Creek	Pittsylvania	3.65	15.01	10.81
Harpen Creek	Pittsylvania	2.77	11.96	8.62
	Total	**36.36**	**886 b/**	**639 b/**

a/ All counties listed are within Virginia.
b/ Cumulative harassment estimates were rounded up to the next integer.

8.5.1.2 Young-of-the-Year

Potential impacts are divided up by effects within the construction right-of-way, effects downstream of the construction right-of-way, and effects from sedimentation within upstream catchments just as for adults and subadults. However, because many of the mechanisms are the same as those discussed for the adults and subadults above (section 8.5.1.1); this section will focus on any differences within the types of impacts as well as calculations for estimating harm and harassment to YOY.

Effects within the Construction Workspaces

Installation of the proposed pipeline across waterbodies is limited to an instream construction footprint not to exceed 75 feet in stream length (unless specifically identified). YOY individuals would be removed from the construction right-of-way to the extent possible prior to instream construction. Similar to the approach taken with adults, it is assumed that 8 percent of individuals have potential to be harmed during this process, and the remainder are considered to be harassed via the same mechanisms discussed in section 8.5.1.1. Thus, it estimated that 13 YOY would be harmed and 13 YOY would be harassed from fish translocation measures (table 8.5.1.1-1). As with adults and subadults, no harm or harassment of YOY would be expected as a result of blasting, noise, artificial lights, water use, or leaks and spills.

Effects Downstream of the Construction Workspaces

To calculate the number of YOY present within the 2,625-foot downstream buffer of Project crossings, the same approach used to calculate effects within the construction right-of-way was employed. Density estimates of YOY were used that were specific to a stream segment based on the 1:24,000 NHD, and the number of individuals present within each 2,625 foot reach downstream of the pipeline crossing was calculated. Cumulatively, 848 YOY are expected to be harassed directly downstream of pipeline and access road crossings (see table 8.5.1.1-2).

Effects of Sedimentation from Catchments (Upland Disturbance)

As noted in section 8.5.1, impacts on known, occupied streams from sedimentation within catchments were predicted to be largely confined to tributaries to the mainstem of the North Fork Roanoke, Roanoke, Blackwater, and Pigg Rivers. Based on the output from the RUSLE and the respective density estimates from Mountain Valley (section 7.5.4), it is expected that 639 YOY would be harassed by increased sediment loads that occur as a result of upland construction (table 8.5.1.1-3).

8.5.2 Direct Effects on Habitat

Habitats may potentially be directly affected by construction activities at varying Roanoke logperch life stages. In addition to known-occupied habitats (i.e., North Fork Roanoke, Roanoke, and Pigg Rivers), potential habitat may occur at Bradshaw Creek, North Fork Blackwater River, Teels Creek 4, Little Creek 1.5, Little Creek 2, Maggodee Creek 1, Blackwater River 3, and Harpen Creek (see section 7.5.2).

Roanoke logperch exhibits ontogenetic habitat shifts (Rosenberger and Angermeier, 2003); therefore, all available mesohabitats (i.e., riffle, run, pools) are potentially suitable for occupation at one point of its life cycle. Any significant alteration to instream habitats could potentially impact the species. Because all available habitats are potentially used by Roanoke logperch, direct effects to adults and YOY habitats are addressed; however, MVP would restore all stream contours and substrates following installation of the pipeline.

Rosenberger and Angermeier (2002) completed reach-wide habitat assessments in the upper Roanoke River to estimate the availability of mesohabitats. It is estimated that riffles (19.3 percent) and run (22.0 percent) mesohabitats comprise approximately 41.3 percent of stream reaches and pool mesohabitats comprise 58.7 percent of stream reaches. Age-1+ Roanoke logperch are likely to occupy riffle and run habitats whereas YOY are likely to occupy areas of reduced water velocities such as pool mesohabitats. Reach-wide habitat assessments were not completed in the Pigg River and Blackwater River drainages; therefore, the aforementioned mesohabitat frequencies derived in the upper Roanoke River are applied.

8.5.2.1 Adults

Habitats within the construction right-of-way of each Project crossing would be significantly, but temporarily, altered by the direct removal of substrates for installation of the pipeline. Fishes would be temporarily isolated from the construction footprint (following translocation efforts) and free to recolonize the post-construction habitats. The construction footprint would be back-filled with native materials and is anticipated to recover over time and then approximate pre-construction conditions. Alternative backfill materials would not be used because these materials may provide inhospitable habitats for Roanoke logperch. It is not likely that habitats and substrates are a limiting resource in these waterbodies and such a limitation is not likely to result in harm as a result of direct impact to localized Project crossing locations.

Effects within the Construction Workspaces

Age-1+ Roanoke logperch are considered mesohabitat generalists and substrate specialists (Rosenberger and Angermeier, 2002). Significant alterations to habitats (i.e., substrate compositions and stability) would occur in the construction right-of-way as a result of instream construction activities (e.g., trenching, blasting, etc.). Known, occupied habitats would be significantly altered via instream construction activities at the proposed crossings of the North Fork Roanoke River, Roanoke River, and (for the purposes of this BA) Pigg River. Potential habitats would also be altered at the proposed crossings of Bradshaw Creek (right-of-way and access road), North Fork Blackwater River, Teels Creek4, Little Creek1.5, Little Creek2, Maggodee Creek1, Blackwater River3, and Harpen Creek (table 7.5.3-1). The extent of impacts would occur along 75 feet of stream reach at each of the 11 pipeline crossings, 40 feet at the North Fork Roanoke River access road, and 92 feet at the Bradshaw Creek access road. The total length of habitats occupied or potentially occupied by Roanoke logperch that would likely be affected is about 957.0 feet of stream reach. It is assumed that Age1+ suitable habitats (i.e., riffles and runs) occur at a frequency of 41.3 percent of stream reaches (Rosenberger and Angermeier, 2002); therefore, it is expected that 395.2 feet of Age-1+ habitat is projected to be affected. Habitat and substrates are likely not a limiting resource within these waterbodies; therefore, it is unlikely that the temporary disturbance of this amount of habitat would significantly alter any biological patterns of the species (e.g., feeding, sheltering, or reproduction) and therefore would not result in individuals harmed.

Effects Downstream of the Construction Workspaces

Adult Roanoke logperch require un-silted, exposed, and unembedded gravel and pebble substrates for feeding. The MVP has the potential to degrade habitat quality through increased sedimentation that could occur within 2,625 feet downstream of Project stream crossings. Affected stream reaches include North Fork Roanoke River, Bradshaw Creek, Roanoke River, North Fork Blackwater River, Teels Creek, Little Creek, Blackwater River, Maggodee Creek, Jonnikin Creek (crossing is proximal to mouth with Pigg River), Pigg River, and Harpen Creek. Sedimentation from stream crossings may affect a total of 8.1 miles of stream reaches occurring in occupied habitats or potentially suitable habitats. It is assumed that Age-1+ suitable habitats (i.e., riffles and runs) occur at a frequency of 41.3 percent of stream reaches (Rosenberger and Angermeier, 2002); therefore, 3.3 miles of Age-1+ habitat could potentially be affected. However, the sediment additions are unlikely to rise to a level where habitats would be significantly altered; therefore, we would not expect this to result in individuals harmed.

Effects of Sedimentation from Catchment

Increased sedimentation from upland disturbances may adversely affect stream reaches occurring in occupied habitats or potentially suitable habitats within the upper Roanoke, Blackwater, and Pigg River drainages. In total, it is expected that 36.4 stream miles with the potential to host Roanoke logperch would be temporarily affected (i.e., 10 percent increase in sediment load) from increased sedimentation from Project construction. Assuming the frequency of suitable habitat is 41.3 percent within stream reaches (Rosenberger and Angermeier, 2002), about 9.3 stream miles of suitable habitat may occur within the area where increased sediment loads would be expected. These elevated sediment loads in occupied and potentially occupied habitats would be only expected to occur during the construction phase of the Project. Sediment loads after restoration would be generally expected to be similar to pre-construction loads. The expected mean sediment load after restoration is 1.1 percent over baseline for those occupied and potentially occupied stream segments identified as having elevated sediment loads during construction. It is unlikely that habitat for the species would be significantly altered by this temporary sediment influx. It is therefore also unlikely the sediment influx would lead to harm of individuals.

8.5.2.2 Young-of-the-Year

Habitats within the construction right-of-way of each Project crossing may be significantly altered by the direct but temporary removal of substrates for installation of the pipeline. Fishes would be temporarily isolated from the construction footprint (following translocation efforts) and free to recolonize the post-construction habitats. The construction footprint would be back-filled with native materials and is anticipated to recover over time and then approximate pre-construction conditions. Alternative backfill materials would not be used because these materials would provide inhospitable habitats for Roanoke logperch. It is unlikely that habitats and substrates are a limiting resource in these waterbodies. The MVP is therefore unlikely to result in harm to Roanoke logperch YOY through direct impact at Project crossing locations.

Effects within the Construction Workspaces

YOY Roanoke logperch are likely to occupy pool mesohabitats with proximal access to riffle and run habitats (Rosenberger and Angermeier, 2002). Significant alterations to habitats (i.e., substrate compositions and stability) would occur in the construction right-of-way as a result of instream construction activities (e.g., trenching, blasting, ford crossings, etc.). Occupied (or presumed occupied) habitats would be significantly altered via instream construction activities at 13 proposed crossings (table 7.5.3-1). The extent of impacts at pipeline crossings would occur along 75 feet of stream reach at each of the crossings. Access roads would affect about 132.0 feet of habitat in the North Fork Roanoke River and Bradshaw Creek. The total length of habitats occupied or potentially occupied by Roanoke logperch that could be affected is 957.0 feet of stream reach. It is assumed that YOY suitable habitats (i.e., pools) occur at a frequency of 58.7 percent of stream reaches (Rosenberger and Angermeier, 2002) therefore, 561.8 feet of YOY habitat are projected to be affected. Habitats and substrates are not likely a limiting resource within these waterbodies; therefore, it is unlikely that the temporary disturbance of this habitat would significantly alter any biological patterns of YOY individuals (i.e., feeding and sheltering) and therefore would not result in individuals harmed.

Effects Downstream of the Disturbed Area

Research has identified that YOY are more vulnerable to anthropogenic sedimentation than adults (Rosenberger, 2002); however, physical harm to individuals as a result of habitat degradation has not been documented for the species. The degradation of YOY habitat quality could occur as a result of sediment that occurs within 2,625 feet downstream of Project stream crossings from instream construction activities. These areas include the North Fork Roanoke, Roanoke, and Pigg Rivers. These downstream impacts could adversely affect a total of 8.1 miles of stream reaches occurring in occupied habitats. It is assumed that YOY suitable habitats (i.e., pools) occur at a frequency of 58.7 percent of stream reaches (Rosenberger and Angermeier, 2002); therefore, 4.7 stream miles of YOY habitat are projected to occur within this area. However, the sediment additions are unlikely to rise to a level where habitats would be significantly altered; therefore, we would not expect this to result in individuals harmed.

Effects of Sedimentation from Catchment

Suitable habitats are potentially affected as a result of upland construction activities that introduce substantial sediment loading rates into affected stream reaches. Substantial sediment loading rates from upland disturbance are anticipated to extend into nine different waterbodies for a total of 22.6 stream miles with the potential to support YOY Roanoke logperch. It is assumed that YOY suitable habitats (i.e., pools) occur at a frequency of 58.7 percent of stream reaches (Rosenberger and Angermeier, 2002); therefore, 13.3 miles of YOY habitat could be affected. As discussed above, sediment loads after restoration are generally expected to be similar to pre-construction loads, and the mean sediment load after restoration is 1.1 percent over baseline for those occupied and potentially occupied stream segments identified as having elevated sediment loads during construction. It is unlikely that habitat for the species would be significantly altered by this temporary sediment influx. It is therefore also unlikely the sediment influx would lead to harm of individuals.

8.5.3 Indirect Effects on Individuals and Habitat

Roanoke logperch have the potential to experience lasting effects from sedimentation after construction of the Project is complete. Removal of riparian vegetation decreases bank stability, increases erosion rates, and subjects individuals to augmented turbidity and suspended sediments. Sedimentation can alter food web interactions for fishes, such as the Roanoke logperch, that rely on interstitial spaces for foraging (Henley et al., 2000). Allowing more sunlight to reach the stream may also expose fishes, including Roanoke logperch, to increased predation rates via predators such as birds. Additionally, increased sun exposure may alter the instream primary productivity. This, in combination with potential influx of nutrients via sediments, can encourage algal growth on substrates. These alterations can have cascading effects that modify food web dynamics, trophic interactions, and aquatic community structure. For example, the combined effects of an influx of nutrients via overland runoff and increase in direct sunlight can cause increased primary productivity, alteration of the aquatic species assemblage, which could increase natural competitive interactions and predation rates. Examples of this include alteration of the macroinvertebrate assemblage (i.e., prey availability), alteration of the fish assemblage (e.g., more silt-tolerant or generalist species), and facilitation of colonization and/or proliferation of aquatic invasive species (e.g., Asian clam, zebra mussels).

Sediments would primarily enter streams at a short temporal scale limited to the relatively short construction duration. High water events would likely flush out most sediments or transport them downstream. However, introduced sediment, and any associated contaminants or nutrients, can be sequestered in streams and impart a legacy effect to future generations in the form of altered aquatic community assemblages and/or reduced sheltering, feeding, or breeding habitats. All of these effects would likely occur at a localized scale and reducing the right-of-way width to 75 feet would minimize the spatial extent and overall potential of effects. To minimize the potential adverse effects along riparian corridors in perpetuity, Mountain Valley would allow revegetation along a 10-foot-wide strip of herbaceous cover centered on the pipeline (for potential maintenance purposes) and trees would be allowed to grow within 15 feet of the pipeline (although they may be selectively removed if root systems could affect the pipeline). Sedimentation modeling conducted for the Project demonstrates that sediment loads after restoration is complete would generally be expected to be similar to those during pre-construction. Furthermore, Project activities are not anticipated to introduce aquatic invasive species nor augment existing populations of aquatic invasive species within occupied streams, as Mountain Valley would implement its *Exotic and Invasive Species Control Plan*, including washing of equipment.

8.5.4 Determination of Effects and Rationale

Table 8.5.4-1 summarizes the effects determinations that are explained more fully in sections that follow.

TABLE 8.5.4-1

Summary of Effects and Effects Determinations for Roanoke Logperch

Description	Expected Harassed	Expected Harmed	Streams Affected (miles)	Effect Determination
Direct Effects on Individuals				
Adults	2,118	16	-	Likely to Adversely Affect
Young-of-the-Year	1,500	13	-	Likely to Adversely Affect
Direct Effects on Habitat				
Adults	-	-	12.7	Not Likely to Adversely Affect
Young-of-the-Year	-	-	18.1	Not Likely to Adversely Affect
Indirect Effects on Individuals	**-**	**-**	**-**	Likely to Adversely Affect
Indirect Effects on Habitat	**-**	**-**	**-**	Not Likely to Adversely Affect
Collective Take/Determination	**3,618**	**29**	**30.8**	**Likely to Adversely Affect**

8.5.4.1 Direct Effects on Individuals

Collectively throughout the Roanoke River basin, Project activities could potentially harass an estimated 3,618 individuals and harm an estimated 29 individuals of all age classes (YOY and Age 1+ individuals). Harm estimates are calculated at 13 crossings (see table 8.5.4-1), with expected harm rates for YOY and Age-1+ Roanoke logperch of 1 individual for each age class at each crossing with the exception of the Roanoke River where 4 adult individuals are expected to be harmed. Thus, the combined number of YOY and Age-1+ individuals that may be harmed is 29 Roanoke logperch. Based on these estimates, a determination of ***Likely to Adversely Affect*** is made, as further detailed in the two following subsections.

Adults

Based on the estimated number of Age-1+ Roanoke logperch in, occupied streams within the Project's Action Area, an estimated 2,118 Roanoke logperch could be disturbed by sedimentation and an additional 16 Age-1+ Roanoke logperch could be harmed during depletion fish surveys at 13 stream crossings with assumed presence. Thus, a determination of ***Likely to Adversely Affect*** is appropriate.

Young-of-the-Year

An estimated 1,500 YOY Roanoke logperch could be disturbed by sedimentation and an additional 13 YOY Roanoke logperch could be harmed during depletion fish surveys. A determination of ***Likely to Adversely Affect*** is appropriate.

8.5.4.2 Direct Effects on Habitat

Roanoke logperch occupy all available mesohabitats (i.e., riffle, run, pools; Rosenberger and Angermeier, 2003) at varying life stages. Instream and upland construction activities could temporarily and cumulatively affect 30.8 miles of occupied or suitable Roanoke logperch habitats. Critical habitat has not been designated for the species.

Adults

Direct, instream construction activities within the construction right-of-way could temporarily impact 395.3 feet of Age-1+ occupied or suitable habitats at 13 stream crossings. Construction and associated sedimentation would be likely to temporarily affect 12.7 miles of stream reaches occurring in Age-1+ occupied or suitable habitats. This estimate combines the 3.27 miles designated within 2,624.7-foot downstream buffers of the construction right-of-way with the 9.3 miles expected to be affected from upland disturbances. However, temporary destruction or degradation of habitats would not be likely to harm individuals. Further, given that no critical habitat has been designated, no impacts on critical habitat are possible. Based on this information, a determination of ***Not Likely to Adversely Affect*** is appropriate.

Young-of-the-Year

Direct, instream construction activities within the construction right-of-way could temporarily impact 561.7 feet of occupied or suitable YOY habitats at 13 stream crossings. Construction and associated sedimentation would be likely to temporarily affect 18.1 miles of stream reaches occurring in occupied habitats or suitable YOY habitats. This estimate combines the 4.7 miles designated within the 2,624.7-foot downstream buffers of the construction right-of-way with the 13.3 miles expected to be affected from upland disturbances. However, temporary habitat destruction or degradation is unlikely to harm individuals. Further, given that no critical habitat has been designated, no impacts on critical habitat are possible. A determination of ***May Affect—Not Likely to Adversely Affect*** based on impacts on habitat used by YOY is appropriate.

8.5.4.3 Indirect Effects on Individuals and Habitat

Various ecological processes (e.g., food web dynamics, trophic interactions, community structure) may be disrupted and perpetual effects to individuals are reasonably certain to occur as a result of Project completion. Additionally, occupied and suitable habitats may be degraded. However, effects from habitat degradation (if any were to occur) would likely occur on a small temporal scale and would be highly unlikely to rise to the level of take. In total, a ***Likely to Adversely Affect*** determination is appropriate.

8.5.4.4 Roanoke Logperch Determination Summary

Collectively, a ***Likely to Adversely Affect*** determination is appropriate for Roanoke logperch.

8.6 JAMES SPINYMUSSEL

Exposure to increased sedimentation can impact freshwater mussels by negatively affecting physiological energetics. Mussels open their aperture to feed. In heavily silted water, individuals are forced to close their valves up to 90 percent of the time, as opposed to 50 percent for individuals living in silt-free environments (Brim Box and Mossa, 1999). Extended aperture closure results in starvation or a state of semi-starvation. Extensive exposure to suspended sediments in the water column also affects individuals by clogging gill filaments, which significantly impacts feeding efficiency and filtering clearance rates, which can result in mortality (Brim Box and Mossa, 1999).

Project construction, operation, and maintenance activities could potentially cause direct and indirect effects to the James spinymussel. Mountain Valley surveyed the Project crossings at Craig Creek for mussels and did not document any sign of James spinymussel. As described in sections 8.6.1 to 8.6.4 below, based on the lack of individuals in the Action Area and location of known and presumed populations of this species relative to the crossings at Craig Creek, the Project is not expected to result in take of the James spinymussel.

Sedimentation is expected to increase in the Craig Creek watershed from instream construction activities and upland land disturbances. These actions could affect baseline water quality conditions by augmenting existing erosion rates and sedimentation, and by introducing contaminants into the streams via overland runoff, ditches, and swales, particularly in areas adjacent to streams. Mountain Valley investigated the necessity for two ATWS's (ATWS-1373 and ATWS-1057) that are proposed within 100 feet of Craig Creek and a brief portion of the right-of-way that parallels the stream. The temporary workspaces are proposed for placement between Craig Creek Road and Craig Creek and a 100-foot buffer cannot be maintained at either temporary workspace. Both workspaces are at the center of the valley with no access from the north for 1.5 miles and no access from the south for 1.9 miles. ATWS-1373 is currently a pasture and would be needed for boring of Craig Creek Road, additional material staging, spoil storage, and parking of construction vehicles. ATWS-1057 is a maintained field that would be needed for timber storage, construction vehicle parking, and material staging. Access roads border ATWS-1057 that would provide pipe trucks the ability to ingress and egress the right-of-way. In addition, a section of the right-of-way would parallel approximately 100 feet of Craig Creek (near MP 219.9) before the route would be directed southward and toward the top of Brush Mountain. Mountain Valley attempted to maintain the requested 100-foot buffer in this area, but side slope construction conditions would present safety concerns if the right-of-way were shifted further from Craig Creek.

Mountain Valley conducted a sedimentation analysis within the Craig Creek drainage to estimate baseline sediment loading rates and potential sediment loading rates anticipated as a result of MVP construction activities. The sedimentation model was used to analyze each stream reach of Craig Creek, assuming implementation of Mountain Valley's Erosion and Sediment Control (E&SC) Plan, the VADEQ Virginia Erosion & Sediment Control Field Manual (VADEQ, 1995), and Mountain Valley's avoidance and minimization measures outlined in section 5.0. By adherence to aforementioned standards, a 0.29-mile stream reach of Craig Creek would be anticipated to experience sediment load increases in excess of 10 percent above baseline.

Three small, unnamed tributaries of Craig Creek could experience sedimentation rates in excess of the 10-percent threshold. Two tributaries on the south-facing slope enter Craig Creek approximately 0.24 mile and 0.35 mile upstream of the Project crossing, respectively. The sedimentation rates in Craig Creek at the mouth of each tributary would be consequently elevated but would not exceed 10 percent above baseline. The third unnamed tributary is on the north-facing slope and empties into Craig Creek approximately 0.51 mile downstream of the pipeline crossing. Sedimentation rates in the third tributary would exceed the 10 percent threshold and contribute to increased sedimentation rates in Craig Creek proper for 0.29 mile downstream of the tributary mouth. Therefore, increased sedimentation rates over the 10-percent threshold would be to a stream segment that is located 0.51 mile to 0.80 mile downstream of the pipeline crossing. In summary, the Action Area would be contained within 0.80 mile downstream of the pipeline crossing of Craig Creek and within the negative mussel survey area.

8.6.1 Direct and Indirect Effects on Individuals

[redacted]. Live mussels have not been encountered (or documented) in Craig Creek in Montgomery County. The nearest known occurrence of live mussels in Craig Creek was documented in Craig County in 1991 and consisted of three non-listed mussel species. Nonetheless, presence of James spinymussel is assumed to occur at this historic survey location because conditions are suitable for the occupation of live mussels [redacted] Sedimentation rates above a 10-percent threshold in Craig Creek are predicted to extend only 0.80 miles downstream of the pipeline crossing. The Action Area occurs more than 11.8 stream miles upstream of the nearest presumed James spinymussel occurrence. Additionally, the mussel survey extent completed in 2015 encompassed the entirety of the Action Area in Craig Creek and was void of mussels and suitable habitats.

The absence of James spinymussel in the MVP Action Area within Craig Creek stream areas indicates Project activities would not directly or indirectly affect individuals of the species.

8.6.2 Direct and Indirect Effects on Habitat

Critical habitat has not been designated for James spinymussel anywhere within its range. The lack of occupied habitat in the Project or Action Area within the Craig Creek stream area indicates Project activities would not directly or indirectly affect suitable habitat for James spinymussel.

8.6.3 Determination of Effects and Rationale

Collectively, a ***Not Likely to Adversely Affect*** determination is appropriate for James spinymussel. The nearest known or potential population of James spinymussel occurs outside of the MVP Action Area in Craig Creek.

8.7 CLUBSHELL

Project construction, operation, and maintenance activities could potentially cause direct and indirect effects to clubshell. Mussel surveys at Elk River and Little Kanawha River crossings did not yield any indication of clubshell. Mussel surveys were not completed at the Leading Creek crossing because the location did not meet the minimum requisite upstream drainage area threshold to support the species per the WVMSP. The nearest known populations of clubshell in Elk River, Little Kanawha River, and Leading Creek in West Virginia occur outside of the MVP Action Area; therefore, the Project is not anticipated to result in take of clubshell.

Sedimentation is expected to temporarily increase in all three watersheds from instream construction activities and upland land disturbances. These actions could affect baseline water quality conditions by augmenting existing erosion rates and sedimentation, and by introducing contaminants into the streams via overland runoff, ditches, and swales. A sedimentation analysis was performed in these watersheds to estimate baseline sediment loading rates and potential sediment loading rates anticipated as a result of MVP construction activities. The sedimentation model was used to analyze each stream reach of the Elk River, Little Kanawha River, and Leading Creek, assuming implementation of Mountain Valley's E&SC plan. Areas where sedimentation rates substantially exceeded baseline conditions were identified as part of the Action Area.

The nearest known population of clubshell in the Elk River occurs downstream of Sutton Lake Dam, which is approximately 19.0 miles downstream of the MVP crossing. Based on the sedimentation analysis, substantial sedimentation rates in the Elk River extend approximately 2.4 miles downstream of the Project crossing, and terminate immediately upstream of the nearest downstream unnamed tributary; this is over 18.6 miles upstream of the nearest clubshell population.

The nearest known population of clubshell in the Little Kanawha River occurs downstream of Burnsville Lake Dam approximately 14.0, 15.2, and 15.9 miles, respectively, downstream of each Project crossing. Based on the sedimentation model, sediment loading rates in excess of 10 percent over baseline would not extend downstream; therefore, the Action Area is restricted to the MVP crossing location. Clubshell populations are not present at the Project crossings (or the Action Area) within the Little Kanawha River.

The nearest potential population of clubshell in Leading Creek occurs downstream of its confluence with Fink Creek, approximately 16.1 miles downstream of the Project's crossing. Substantial sediment loading rates extend approximately 3.44 miles downstream of the crossing, upstream of the confluence with Alum Fork. This is over 12.4 miles upstream of the nearest potential clubshell population. Additionally, the upstream drainage area of Leading Creek at the confluence with Alum Fork is 7.2 square miles. According to the WVMSP, mussel surveys in West Virginia are not required in streams if the upstream drainage area is less than 10 square miles.

8.7.1 Direct and Indirect Effects on Individuals

The absence of clubshell in the MVP Action Area at all three stream crossings indicates Project activities would not directly or indirectly affect individuals of the species.

8.7.2 Direct and Indirect Direct Effects on Habitat

The lack of occupied habitat in the Project and Action Area of the three stream crossings indicates Project activities would not directly or indirectly affect suitable habitat for clubshell.

8.7.3 Determination of Effects and Rationale

Collectively, a ***Not Likely to Adversely Affect*** determination is appropriate for clubshell. The nearest known or potential population of clubshell occurs outside of the MVP Action Area in Elk River, Little Kanawha River, and Leading Creek in West Virginia.

8.8 SNUFFBOX

Project construction, operation, and maintenance activities could potentially cause direct and indirect effects to snuffbox. Mussel surveys at Elk River and Little Kanawha River crossings did not yield any sign of snuffbox. Mussel surveys were not completed at the Leading Creek crossing because the location did not meet the minimum requisite upstream drainage area threshold to support the species. The nearest known populations of snuffbox in Elk River, Little Kanawha River, and Leading Creek in West Virginia occur outside of the MVP Action Area; therefore, the Project is not anticipated to result in take of snuffbox.

Sedimentation is expected to increase in all three watersheds from instream construction activities and upland land disturbances. These actions could affect baseline water quality conditions by augmenting existing erosion rates and sedimentation, and by introducing contaminants into the streams via overland runoff, ditches, and swales. A sedimentation analysis was performed in these watersheds to estimate baseline sediment loading rates and potential sediment loading rates anticipated as a result of Project construction activities. The sedimentation model was used to analyze each stream reach of the Elk River, Little Kanawha River, and Leading Creek, assuming implementation of MVP's E&SC plan.

The nearest known population of snuffbox in the Elk River occurs downstream of Sutton Lake Dam, which is approximately 19.0 miles downstream of the Project crossing. Substantial sedimentation rates in the Elk River are predicted to extend approximately 2.4 miles downstream of the MVP crossing, and terminate immediately upstream of the nearest downstream unnamed tributary; this is over 18.6 miles upstream of the nearest known snuffbox population. Snuffbox populations are not expected in Webster County based on the WVMSP Group 1 stream designation of the Elk River in Webster County.

The nearest known population of snuffbox in the Little Kanawha River occurs downstream of Burnsville Lake Dam approximately 14.0, 15.2, and 15.9 miles, respectively, downstream of the Project crossings. Based on the sedimentation model, substantial sediment loading rates do not exceed baseline loading rates downstream of the Project crossing location.

The nearest potential population of snuffbox in Leading Creek occurs downstream of its confluence with Fink Creek, approximately 16.1 miles downstream of the Project's crossing. Substantial sediment loading rates extend approximately 3.4 miles downstream of the crossing, terminating at the confluence with Alum Fork. This is over 12.4 miles upstream of the nearest potential snuffbox population. Additionally, the upstream drainage area of Leading Creek at the confluence with Alum Fork is 7.2 square miles. According to the WVMSP, mussel surveys in West Virginia are not required in streams if the upstream drainage area is less than square miles.

8.8.1 Direct and Indirect Effects on Individuals

The absence of snuffbox in the MVP Action Area at all three stream crossings indicates Project activities would not directly or indirectly affect individuals of the species.

8.8.2 Direct and Indirect Direct Effects on Habitat

Critical habitat has not been designated for snuffbox. The lack of occupied habitat in the MVP Action Area at the three stream crossings indicates Project activities would not directly or indirectly affect suitable habitat for snuffbox.

8.8.3 Determination of Effects and Rationale

Collectively, a ***Not Likely to Adversely Affect*** determination is appropriate for snuffbox. The nearest known or potential populations of snuffbox occur outside of the Action Area in Elk River, Little Kanawha River, and Leading Creek in West Virginia.

8.9 RUSTY PATCHED BUMBLE BEE

Analysis of the effects on the rusty patched bumble bee as a result of Project construction, operation, and maintenance is based on the distinct ecological divisions of its annual life cycle, known occurrence data (both extant and historical), and habitat needs. Project construction, operation, and maintenance activities could potentially cause direct and indirect effects to individuals of the species and habitats including, but not limited to, vegetation and timber clearing, digging, soil compaction, pesticide application, introduction of non-native plants, and augmentation of competitive interactions. The most recent rusty patched bumble bee occurrence record within a county crossed by the MVP occurred in Montgomery County in 1997. The nearest known extant populations of the rusty patched bumble bee are outside of the Action Area; therefore, no take of the species is anticipated as a result of the Project.

8.9.1 Direct and Indirect Effects on Individuals

As described in section 7.9.3, no rusty patched bumble bee populations have been identified in the Project Action Area. Therefore, Project activities would not directly or indirectly affect the rusty patched bumble bee.

8.9.2 Direct Effects on Habitat

Critical habitat has not been designated for the rusty patched bumble bee. Generally, the species requires suitable habitat for foraging, nesting, and overwintering. For foraging, the rusty patched bumble bee requires abundant floral resources. Crushing, mowing and clearing of vegetation or application of herbicides in the construction right-of-way could destroy potential bumble bee foraging habitat. However, the construction of a permanent right-of-way would provide open areas that could benefit bees by providing floral resources in summer and fall and by providing a dispersal corridor.

For nesting, the rusty patched bumble bee typically uses subterranean holes about 1 to 3 feet deep (e.g., abandoned rodent nests). Thus, digging and trenching activities could disturb or destroy nest sites, if present. Rusty patched bumble bees may also nest above ground in dead wood or clumps of grasses and thus vegetation clearing, heavy equipment, and mowing could destroy nest habitat. Little is known about the overwintering habitat of the rusty patched bumble bee; however, most bumble bees overwinter in loose soil a few centimeters below the ground (Jepsen et al., 2013; FWS, 2017b).

Although little is known about overwintering habitat, most bumble bees overwinter in loose soil a few centimeters below the ground (Hatfield et al., 2012; Jepsen et al., 2013). Thus, construction activities using heavy equipment, steady foot traffic, or digging may destroy potential overwinter habitat by compacting or removing soil. Some bumble bees use fallen dead wood for overwintering habitat and thus the removal of this material could reduce the availability of potential overwintering sites (Hatfield et al., 2012).

The MVP would transverse an area of suitable, but apparently unoccupied habitat for the rusty patched bumble bee. Because this species is not present, changes in habitat quality cannot cause harm and thus any impacts on habitat do not rise to the level of take.

8.9.3 Indirect Effects on Habitat

Indirect effects are those effects that are caused by or would result from the proposed action and are later in time but still reasonably certain to occur. Indirect effects on bee habitat could be detrimental or beneficial to the rusty patched bumble bee.

Negative Effects

Initial construction and maintenance of the right-of-way could have potential indirect detrimental effects to habitat. These include changes in soil hydrology that could affect overwintering habitat, nesting habitat, and foraging habitat. Changes in soil moisture level may impact the availability of loose soil and reduce densities or populations of rodents and their nests, consequently reducing rusty patched bumble bee nest availability (i.e., rusty patched bumble bees utilize rodent nests). Thus, while erosion control and sedimentation plans should minimize changes in soil hydrology, the displacement of rodents could have indirect effects, especially to the nesting habitat of this species (Environment and Climate Change Canada, 2016).

An increased likelihood of competitive interactions with non-native bee species is another potential indirect effect to the species (Environment and Climate Change Canada, 2016). The final right-of-way could be beneficial for many pollinators and could attract many other native bumble bee species, and non-native bees such as honey bees, *Osmia cornifrons*, and *O. taurus*, thereby increasing competition for resources. Many of these detrimental effects are omnipresent regardless of construction, operation, and maintenance of the Project.

However, the lack of known-occupied habitat in the Project and Action Area in Montgomery and Giles Counties in Virginia and Braxton, Fayette, Lewis, and Nicholas Counties, in West Virginia indicates indirect effects to suitable habitats would not result in a take of individuals.

Beneficial Effects

Although potential habitat for this species exists in places along the MVP route, converted habitat would add value for the rusty patched bumble bee. Furthermore, many old field type habitats would be improved and invasive species removed and replaced with native plants. In general, pollinating insects are known to benefit from the opening of habitat and the thinning of forests (Hanula et al., 2016). The MVP would produce hundreds of acres of permanent right-of-way, which would be managed and maintained in perpetuity, thus benefitting the rusty patched bumble bee and other pollinators. In addition to adding valuable summer and fall habitat and potential nesting habitat, the Project would provide the following:

- increased floral diversity based upon seed mix, shrub and tree selections;
- increased native plant species density based upon seed mixes;
- increased foraging acreage, particularly summer and fall foraging;
- limited or no pesticide and herbicide use;
- forest roads and thinned forests, shown to benefit most pollinators (Hanula et al., 2016); and
- a landscape-level connectivity corridor that would provide and connect all three habitat features (when including adjacent forested habitat) required for the lifecycle needs of the rusty patched bumble bee.

8.9.3.1 Determination of Effects and Rationale

Collectively, a ***Not Likely to Adversely Affect*** determination is appropriate for the rusty patched bumble bee. The nearest known or potential population of the species occurs well outside of the Project and Action Area in Fauquier County, Virginia.

8.10 NORTHEASTERN BULRUSH

A habitat analysis and survey in Monroe County, West Virginia and Giles County, Virginia did not yield any individuals of northeastern bulrush or potential habitat for this species. Because the species or its habitat does not occur in the Project Area, no direct or indirect impacts on individuals or existing habitat is expected.

8.10.1 Determination of Effects and Rationale

The MVP would not directly or indirectly impact known-occupied habitats of northeastern bulrush. Critical habitat has not been designated for the species and the nearest known populations of northeastern bulrush occur outside of the Action Area. Collectively, a ***No Effect*** determination is appropriate for northeastern bulrush. The nearest known or potential population of northeastern bulrush occurs outside of the Action Area in Alleghany County, Virginia.

8.11 RUNNING BUFFALO CLOVER

Field surveys in Greenbrier, Nicholas, and Webster Counties, West Virginia revealed suitable habitat for running buffalo clover within the Project Area; however no individuals were found.

Walking, trampling, traffic, heavy equipment, and habitat clearing could have effects on unoccupied, suitable habitat for running buffalo clover. These effects include removal of seed bank, canopy removal (which could cause light intensities to increase), and increased soil erosion from clearing and grading. All of these factors have potential to injure, stress, or destroy potential habitat. Use of BMPs would be expected to minimize these effects. Another effect of habitat clearing and grading is the potential spread of invasive species. Invasive species could potentially outcompete running buffalo clover for nutrients, space, and sunlight. Efforts to minimize these effects are addressed in the BMPs and Mountain Valley's E&SC Plan.

However, Project activities would be expected to have neutral to possibly beneficial effects on running buffalo clover habitat. Clearing could increase light regimes, which could benefit running buffalo clover habitat as long as light exposure is moderate. Running buffalo clover prefers open habitat with dappled shade.

8.11.1 Determination of Effects and Rationale

The MVP would not directly or indirectly impact known-occupied habitats of running buffalo clover. The nearest known populations of running buffalo clover occur outside of the Action Area in Greenbrier County, West Virginia and running buffalo clover individuals were not found in the Project Area during FWS-approved plant surveys. However, 1.8 acres of land potentially containing running buffalo clover remains unsurveyed.

The FWS requested that Mountain Valley provide information pertaining to the effect of Mountain Valley's proposed use of waterbars on the hydrology and microclimate on running buffalo clover within the unsurveyed area. The unsurveyed area consists of a proposed access road and a parcel of land in the vicinity of Project Area. The access road crosses a timber property that has recently been cleared. Although running buffalo clover is often found along consistently disturbed edge habitats, such as logging roads, the recent clearing of the adjacent property has likely disrupted the hydrology and microclimate needed for running buffalo clover to grow. The land parcel is located such that the watershed drainage from the MVP right-of-way enters the Elk River, Bear Run, or the unnamed tributary to Bear Run prior to reaching the parcel. Therefore, waterbars used for the MVP would not affect the hydrology or microclimate on the unsurveyed parcel.

Mountain Valley was unable to assess or estimate the extent of running buffalo clover that could be affected by the MVP without occurrence or abundance data from the unsurveyed properties. Mountain Valley would complete surveys along the access road and on the parcel as soon as possible if granted access by the landowners or if the Project is certificated by the FERC, through the use of eminent domain (if necessary). If granted access outside of the appropriate survey window for running buffalo clover, Mountain Valley would conduct field assessments to identify whether or how much suitable habitat is present. If Mountain Valley observed running buffalo clover during surveys, the plants would be fenced-off and avoided during construction, if feasible based on the location relative to the right-of-way. If it were not feasible, Mountain Valley would transplant the specimens prior to construction. We are conservatively assuming that running buffalo clover is present within the unsurveyed land; therefore, we conclude a ***Likely to Adversely Affect*** determination is appropriate for running buffalo clover.

8.12 SHALE BARREN ROCK CRESS

Field surveys in Greenbrier and Fayette Counties, West Virginia did not yield any individuals of shale barren rock cress or potential habitat for this species. However, 29.5 acres of the construction right-of-way potentially containing shale barren rock cress remain unsurveyed because the landowners have not granted Mountain Valley survey access.

8.12.1 Determination of Effects and Rationale

The MVP would not directly or indirectly impact known-occupied habitats of shale barren rock cress. The nearest known populations of shale barren rock cress occur outside of the Action Area in Greenbrier County, West Virginia and shale barren rock cress individuals were not found in the Project Area during FWS-approved plant surveys.

Mountain Valley was unable to assess or estimate the extent of shale barren rock cress that could be affected by the MVP without occurrence or abundance data from the unsurveyed portion of the right-of-way. Mountain Valley would complete surveys as soon as possible if granted access by the landowners or if the Project is certificated by the FERC, through the use of eminent domain (if necessary). If granted access outside of the appropriate survey window for shale barren rock cress, Mountain Valley would conduct field assessments to identify whether or how much suitable habitat is present. If Mountain Valley observed shale barren rock cress during surveys, the plants would be fenced-off and avoided during construction, if feasible. If it were not feasible, Mountain Valley would transplant the specimens prior to construction. We are conservatively assuming that shale barren rock cress is present within the unsurveyed land; therefore, we conclude a ***Likely to Adversely Affect*** determination is appropriate for the shale barren rock cress.

8.13 SMALL WHORLED POGONIA

Field surveys in Greenbrier and Fayette Counties, West Virginia did not yield any individuals of small whorled pogonia, but suitable habitat for this species was identified within the Project Area in open woodlands in Greenbrier County, West Virginia.

Walking, trampling, traffic, heavy equipment, habitat clearing, and habitat grading could have effects on small whorled pogonia. Habitat could be affected by disturbance of the seed bank. Use of BMPs would be expected to minimize these effects. Clearing and grading, especially canopy removal, could potentially degrade or destroy small whorled pogonia habitat and potentially spread invasive species, which in turn could cause increased competition for light, nutrients, and space. Conversely, clearing shrubs and dense understory (at least temporarily) would increase light regimes within the understory, potentially to the benefit of small whorled pogonia.

8.13.1 Determination of Effects and Rationale

The Project would not directly or indirectly impact known-occupied habitats of small whorled pogonia. The nearest known populations of small whorled pogonia occur outside of the Action Area in Greenbrier County, West Virginia and small whorled pogonia individuals were not found in the Project Area during FWS-approved plant surveys. However, 9.5 acres of the construction right-of-way potentially containing small whorled pogonia remains unsurveyed because the landowners have not granted Mountain Valley survey access.

The FWS requested that Mountain Valley provide information regarding whether the construction right-of-way would be within the upslope drainage of the unsurveyed area potentially containing small whorled pogonia and whether construction would thereby affect the species by altering light exposure or hydrology or by increasing sedimentation and runoff within the unsurveyed area. Since the unsurveyed land is part of the construction right-of-way, clearing and grading of the right-of-way could alter light exposure and generally degrade small whorled pogonia habitat as noted above. However, post-construction restoration of the right-of-way would restore the prior drainage patterns and general hydrology within the area and Project BMPs would minimize runoff and sedimentation in the vicinity of the right-of-way.

Mountain Valley was unable to assess or estimate the extent of small whorled pogonia that could be affected by the MVP without occurrence or abundance data from the unsurveyed portion of the construction right-of-way. Mountain Valley would complete surveys as soon as possible if granted access by the landowners or if the Project is certificated by the FERC, through the use of eminent domain (if necessary). If granted access outside of the appropriate survey window for small whorled pogonia, Mountain Valley would conduct field assessments to identify whether or how much suitable habitat is present. If Mountain Valley observed small whorled pogonia during surveys, the plants would be fenced-off and avoided during construction, if feasible. If it were not feasible, Mountain Valley would transplant the specimens prior to construction. We are conservatively assuming that small whorled pogonia is present within the unsurveyed land; therefore, we conclude a ***Likely to Adversely Affect*** determination is appropriate for small whorled pogonia.

8.14 SMOOTH CONEFLOWER

A field survey in Montgomery County, Virginia did not yield any individuals of smooth coneflower but suitable habitat was identified during the survey. Walking, trampling, traffic, heavy equipment, habitat clearing, and habitat grading could have effects on smooth coneflower habitat. Use of BMPs would be expected to minimize these effects. Another effect of habitat clearing and grading is the potential spread of invasive species. Invasive species could potentially alter habitat viability. Efforts to minimize these effects are addressed in the BMP's and Mountain Valley's *Exotic and Invasive Species Control Plan*.

Despite these potential adverse impacts, Project activities are expected to have neutral to possibly beneficial effect overall on smooth coneflower habitat. Clearing could increase light regimes, which may benefit smooth coneflower, as it prefers open habitats.

8.14.1 Determination of Effects and Rationale

The MVP would not directly or indirectly impact known-occupied habitats of smooth coneflower. The species and the nearest known populations of smooth coneflower occur outside of the Action Area in Montgomery County, Virginia and smooth coneflower individuals were not found in the Project Area during FWS-approved plant surveys. Therefore, we conclude that a ***Not Likely to Adversely Affect*** determination is appropriate for smooth coneflower.

8.15 VIRGINIA SPIRAEA

Field surveys in Summers and Nicholas Counties, West Virginia did not yield any individuals of Virginia spiraea, but potential habitat for this species was identified along the Gauley River in Summers County, West Virginia. Walking, trampling, traffic, heavy equipment, and habitat clearing could affect Virginia spiraea. Impacts from soil erosion and sedimentation resulting from clearing and grading could also be possible. However, since Virginia spiraea is a riparian species, impacts are expected to be minimized because Mountain Valley would implement construction BMPs to minimize impacts on riparian corridors and wetlands. Another effect of habitat clearing and grading is potential spread of invasive species, which could alter habitat viability. Conversely, clearings could increase light regimes, which could benefit Virginia spiraea habitat as long as hydrology patterns are maintained.

8.15.1 Virginia Spiraea Determination Summary

The Project would not directly or indirectly impact known-occupied habitats of Virginia spiraea. The nearest known populations of Virginia spiraea occur outside of the Action Area in Nicholas County, West Virginia and Virginia spiraea individuals were not found in the Project Area during FWS-approved plant surveys. However, 4.28 acres of the construction right-of-way potentially containing Virginia spiraea remains unsurveyed because the landowners have not granted Mountain Valley survey access.

Mountain Valley was unable to assess or estimate the extent of Virginia spiraea that could be affected by the MVP without occurrence or abundance data from the unsurveyed portion of the right-of-way. Mountain Valley would complete surveys as soon as possible if granted access by the landowners or if the Project is certificated by the FERC, through the use of eminent domain (if necessary). If granted access outside of the appropriate survey window for Virginia spiraea, Mountain Valley would conduct field assessments to identify whether or how much suitable habitat is present. If Mountain Valley observed Virginia spiraea during surveys, the plants would be fenced-off and avoided during construction, if feasible. If it were not feasible, Mountain Valley would transplant the specimens prior to construction. We are conservatively assuming that the species is present within the unsurveyed land; therefore, we conclude a ***Likely to Adversely Affect*** determination is appropriate for Virginia spiraea.

9.0 CUMULATIVE EFFECTS

In BOs, the FWS is required to consider "cumulative effects," which are defined as the effects of future state, tribal, local, or private actions that are reasonably certain to occur in the Action Area considered in a BO (50 CFR 402.02). Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to Section 7 of the ESA (FWS and NMFS, 1998).

Cumulative effects on federally listed species may occur where state, tribal, local, or private actions that are reasonably certain to occur are constructed in the Action Area and would affect federally listed species directly or indirectly through habitat alteration or loss. The Commission examined these actions within its final EIS for the Project issued to the public (and FWS) on June 23, 2017 and the cumulative impacts discussion in the final EIS is incorporated here by reference. These non-federal or potentially non-federal actions may include:

- oil and gas exploration and production (including non-jurisdictional natural gas gathering systems);
- FERC-jurisdictional natural gas interstate transportation projects;
- other energy projects, including power plants or electric transmission lines;
- mining operations;
- transportation or road projects; and
- commercial/residential/industrial and other development projects.

Appendix W of the final EIS provides a listing of other projects in the geographic scope of analysis considered for cumulative impacts. Cumulative effects can result from projects and continuing activities that incrementally contribute (increasing or decreasing) to overall changes in the quantity or quality of habitat in the Action Area. Activities that contribute to: 1) a loss of forest lands and/or 2) a reduction in water quality were considered to have potential to add cumulatively to the effects of MVP upon federally listed species. Forest loss and reduction in water quality can occur in many ways: tree removal associated with a timber harvest, land clearing for agriculture, housing and urban development, roads, and energy development, and use of pesticides or other chemicals in close proximity to water sources.

9.1 FOREST TRENDS AND FRAGMENTATION

9.1.1 State-wide Forest Trends

The 2008 Farm Bill required all states to work with the FS to develop a state-wide assessment of forest resources termed the Forest Resource Assessment (FRA). These documents provide a detailed review of forest trends in each state and represent the best available data.

Forest trends for West Virginia were obtained from the West Virginia FRA (WV Division of Forestry, 2010) and a summary publication (FS, 2010). West Virginia, at 78 percent forest cover, is the third most heavily forested state in the United States. The amount of forest cover increased between 1949 and 1989 and remained stable through 2007. Reductions in population have led to widespread abandonment of farm lands, many of which have and continue to revert to forest cover. In addition, tree size in West Virginia forests has also increased and there are now more large trees than at any point in the past century. The first decade of the 21st century saw a marked increase in the amount of timber cut in the state, but tree growth continued to exceed tree removal. FRA data pre-date extensive development in the Marcellus Shale, which has led to a wide variety of developments associated with some timber removal.

The Virginia FRA (Virginia Department of Forestry, 2010) indicates forest cover in the state increased markedly between the 1940s and 2007. This trend was evident across both evergreen and hardwood systems. In 2007, hardwood systems added 1.47 units of forest for every one unit removed, indicating that over time, both forest acreage and the size of trees increased. However, most of the current increase is driven by increasing size-classes of trees, as landscape conversion is a primary concern for foresters in Virginia. At present, forest reversion is outstripped by landscape conversion at a rate of 0.75 acre in regrowth compared to one acre of conversion. Conversion is least common in the mountains of western Virginia where the Project would be located.

9.1.2 Forest Fragmentation

Forest is the predominant land cover that would be affected by the Project with 4,453 acres affected by construction and 1,597 acres permanently converted to a grass/scrub-shrub right-of-way. Fragmentation occurs when large or contiguous areas of a habitat type, in this case forest, are subdivided into smaller areas. Forest fragmentation already exists in much of the Action Area in the form of roads, streams, developed areas, agriculture, and utility corridors.

Forest tract GIS data from the Natural Resource Analysis Center at West Virginia University in 2011 and Ecological Core Area data from the Virginia Natural Landscape Assessment (VADCR, 2007) were used to assess Project-specific fragmentation impacts on large, continuous tracts of forest, with emphasis on impacts on interior forest (referred to as core forest areas in West Virginia and Ecological Core Areas (ECA) in Virginia). These datasets define the forest interior as areas 328 feet (100 meters) from the forest edge [i.e., the outer 328 feet (100 meters) of each forest patch is considered “edge” habitat and not forest interior (Wickham et al., 2007; Riitters and Wickham, 2012)]. From an ecological perspective, loss of interior forest is different from the direct forest loss in the right-of-way in edge habitats. The MVP would pass through 24 core forest areas in West Virginia (see final EIS figure 4.4.1-2), which would result in temporary impacts from construction on about 2,428 acres of large core forest areas (greater than 500 acres) and permanent impacts from operations on about 872 acres of large core forest areas. Temporary impacts on medium (250 to 500 acres) and small core forest areas (less than 250 acres) combined would be about 59 acres and permanent impacts from operations on medium and small core forest areas combined would be about 20 acres (see final EIS table 4.4.2-2). In addition to these direct impacts, clearing of interior forest would also result in indirect effects to forest left standing along the edges of the new corridor. The result of these indirect effects would be the conversion of 17,194 acres of interior forest habitat to forest edge habitat in West Virginia based on the extension of forest edge an estimated 300 feet on either side of the MVP right-of-way. In Virginia, the MVP would pass through 17 ECA categorized as Outstanding, Very High, or High (see final EIS figure 4.4.1-3). Construction of the MVP in Virginia would result in temporary impacts on about 547 acres of ECA categorized as Outstanding to High and permanent impacts on about 209 acres of ECA categorized as Outstanding to High. Temporary impacts on ECA categorized as Moderate to General combined would be about 406 acres and permanent impacts on ECA categorized as Moderate to General combined would be about 142 acres (see final EIS table 4.4.2-3). In addition to these direct impacts, indirect impacts would involve the conversion of 4,579 acres of interior forest habitat to forest edge habitat in Virginia based on the extension of forest edge an estimated 300 feet on either side of the MVP right-of-way.

To reduce fragmentation to the maximum extent practical, the pipeline would be aligned parallel to existing rights-of-way where possible and feasible, including roads and utility corridors, along approximately 89.3 miles of the proposed route. Approximately 82.2 percent (138 acres) of land needed for ancillary sites, such as contractor or staging yards, and 53.8 percent (363 acres) of land needed for ATWS would occur in previously disturbed areas and thereby minimize forest fragmentation. Forest fragmentation resulting from construction of other unrelated projects that may occur during the same timeframe and broad geographic vicinity as the MVP is discussed in section 4.13.2.3 of the final EIS.

9.2 WATER RESOURCES

Construction and operation of the Project would likely result in only short-term impacts on water resources. These impacts, such as increased turbidity, would return to baseline levels over a period of days or weeks following construction.

Water availability, use and the regulations that are put in place to protect these resources varies from state to state. According to the WVDEP, there are an estimated 42 billion gallons of water available per day in its rivers and streams. Large quantity users (excluding hydro-electric) withdraw approximately 978 billion gallons per year of which only 59 billion gallons are consumed per year (WVDEP, 2015). In West Virginia, the Hydrostatic Testing General Permit, WV0113069, provides coverage for any establishment with discharges composed entirely of waters from hydrostatic testing of new pipeline and agreeing to be regulated under the terms of the General Permit. For the purpose of this General Permit, the term establishment means certain pipeline replacement and/or construction projects. The General Permit for Hydrostatic Testing became effective February 19, 2012 and was modified on October 31, 2014 to incorporate two new Other Requirements, B.13 and B.14. The current General Permit has been extended through June 2017.

According to the VADEQ, total 2014 water withdrawals were approximately 17 million gallons per day (MGD) (1.4 percent) greater than those reported for 2013, increasing from 1,202 MGD in 2013 to 1,219 MGD in 2014. This includes agricultural, commercial, irrigation, manufacturing, mining, public water supply, and other uses. The year-to-year changes in withdrawals represented by the two largest categories (Public Water Supply and Manufacturing) have been less than 3 percent of the previous year's total. As a result of these changes, the reported 2014 total withdrawals are within approximately 2 percent of the average for the 5-year period (VADEQ, 2015a).

In Virginia, General Permit VAG83 governs the discharge of wastewaters from sites contaminated by petroleum products, chlorinated hydrocarbon solvents, the hydrostatic testing of petroleum and natural gas storage tanks and pipelines, and the hydrostatic testing of water storage tanks and pipelines. These wastewaters may be discharged from the following activities: excavation dewatering, conducting aquifer tests to characterize site conditions, pumping contaminated groundwater to remove free product from the ground, discharges resulting from another petroleum product or chlorinated hydrocarbon solvent cleanup activity approved by the board, hydrostatic tests of natural gas and petroleum storage tanks or pipelines, hydrostatic tests of underground and aboveground storage tanks, and hydrostatic tests of water storage tanks and pipelines.

The VADEQ requires permits related to surface water and groundwater withdrawals and discharges including the Virginia Water Protection General Permit Number WP2 for facilities and activities of utilities regulated by the Commonwealth Corporation Commission. The permit program governs permanent and temporary impacts related to the construction and maintenance of utility lines.

The proposed MVP pipeline route would cross 389 perennially flowing waterbodies. Mountain Valley proposes to cross all waterbodies using dry-cut construction methods (flumes or dam-and-pump). However, in the final EIS, the FERC recommends that Mountain Valley use HDD to cross the Pigg River. The pipelines would be installed below scour depth. The use of dry construction methods in addition to the other protective measures in our Procedures such as fueling buffer restrictions, maintenance of flow rates, time requirements to complete instream waterbody crossings (typically 48 hours or less), and stream and riparian area restoration, would limit the potential for impacts on waterbodies and associated aquatic habitats.

Potential effects of changes in water quality near the Project for the MVP are assessed in sections 4.0 and 8.0 above. Analysis using the RUSLE identified the boundaries associated with a 10 percent increase in sediment load. In total, approximately 705 miles of waterbodies are expected to have a 10 percent increase or more, at least temporarily, although only a small proportion of the reaches have the possibility of containing special status species. Sedimentation impacts resulting from instream pipeline construction and access roads were estimated to be 13.0 miles of Roanoke logperch habitat; along with 36.4 miles of habitat affected by increased sedimentation from upland Project construction (i.e., upland runoff).

Construction of the Project and other unrelated projects would result in temporary or short-term impacts on surface water resources as well as some minor long-term impacts such as loss of forested cover in the watershed and partial loss of riparian vegetation. These impacts, such as increased turbidity levels, are expected to return to baseline levels over a period of days or weeks following construction given Mountain Valley's commitments to restore the waterbodies according to the required specifications, which are based on the FERC Procedures.

There is potential that cumulative impacts could result if the proposed Project was constructed at the same time as other projects listed in the final EIS (see section 4.13 and appendix W). However, the MVP would contribute little to the long-term cumulative impacts on waterbodies because the majority of the potential impacts are temporary and short-term. Impacts on surface waters resulting from construction of the MVP would end shortly after the pipeline is installed. The MVP pipeline would mostly cross waterbodies with open-cut dry methods following the Procedures including erosion controls to prevent sedimentation and elevated turbidity. Also, other energy projects, transportation projects, residential projects, FERC non-jurisdictional pipeline projects, etc. would likely be required to install and maintain BMPs similar to those proposed by the MVP as required by federal (including Section 7 of the ESA), state, and local permitting requirements so as to minimize impacts on waterbodies. Therefore, most of the impacts on waterbodies are expected to also be of short duration regardless of project type.

9.3 SPECIES-SPECIFIC CUMULATIVE EFFECT CONCLUSIONS

No cumulative impacts are anticipated for the clubshell, James spineymussel, snuffbox, rusty patched bumble bee, northeastern bulrush, and smooth coneflower because they do not exist within the Project Area.

9.3.1 Indiana Bat

Before the threat of WNS, declines in populations of Indiana bats were primarily attributed to loss of summer habitat and winter disturbances during hibernation. The Project would not destroy known, occupied Indiana bat hibernacula, but some individuals are likely to be harassed during construction. The amount of forest removed during Project construction is a fraction of what would remain available on the landscape. Approximately 221,463 acres of forest within the Project's Action Area currently provides suitable roosting and foraging habitat for Indiana bats. Project construction would reduce the amount of forest within the Action Area by approximately 2.0 percent (4,452.6 acres), and operation would permanently reduce the amount of forest by approximately 0.7 percent (1,602.1 acres). In consideration of potential cumulative effects from anticipated losses of suitable forested habitat from nearby energy projects, forestry practices, regional population growth, and increases in agriculture and pesticide use, we believe that our determination of likely to adversely affect is still appropriate. .

9.3.2 Northern Long-eared Bat

As with the Indiana bat, WNS is the primary threat to northern long-eared bats. In consideration of current, on-going, and future projects in addition to the MVP that may result in cumulative effects on the northern long-eared bat, we believe our effect determination (likely to adversely affect) is still appropriate.

9.3.3 Gray Bat

Gray bats congregate in larger numbers and in fewer caves than any other North American bat. Human disturbance, loss, and degradation of caves are currently the greatest threats to gray bats. Gray bats are extremely vulnerable to disturbances during hibernation; unnecessary arousal from hibernation lowers energy reserves that they are unable to replenish before the end of winter, resulting in premature deaths for many individuals. Many caves once inhabited by gray bats were flooded during the creation of reservoirs or were commercialized to the point where environmental conditions (e.g., air flow, temperature, humidity, and light) were no longer suitable for bats. Based on the lack of known gray bat winter hibernacula or summer roosts within the Project Area or Action Area, we conclude that land management and development actions of the MVP are not likely to adversely affect the gray bat, and thus would not result contribute to cumulative effects on the species.

9.3.4 Virginia Big-eared Bat

Disturbance of bats during hibernation and destruction of hibernacula and maternity colonies are the greatest threats to Virginia big-eared bats. Because the MVP is not likely to adversely affect the Virginia big-eared bat, it is not expected to contribute to cumulative impacts on the species.

9.3.5 Roanoke Logperch

Roanoke logperch populations in the upper Roanoke and Pigg River drainages are primarily threatened by road projects, urbanization, catastrophic spill events, and siltation from agricultural runoff (Rosenberger, 2007). These threats are continually present regardless of MVP construction and the Project is not expected to alter foreseeable trends in agricultural activities, urban development, or road projects. Because of the existing and persistent threats to the species, foreseeable increases in pesticide- and herbicide-applications, and augmented sediment loading rates (at a limited time scale) as a result of Project construction in the Roanoke River basin, the Project is likely to contribute to cumulative effects on Roanoke logperch. However, the cumulative effects to the species is likely to be limited (temporally and spatially) relative to the magnitude of aforementioned impacts and trends within the Roanoke River basin. As such, we conclude that the Project would not contribute to cumulative effects that would result in additional take of Roanoke logperch.

9.3.6 Federally Endangered Plant Species

The primary threats to the federally endangered plant species that may be adversely affected by the MVP (running buffalo clover, shale barren rock cress, small whorled pogonia, and Virginia spiraea) are destruction of species populations through habitat removal (e.g., construction of a road) or degradation and competition from invasive species. Construction of the MVP would not contribute to cumulative impacts to these species because to date none of the species have been documented as being present in the Project Area. A total of about 35.6 acres remain to be surveyed to determine whether the species are present; however, if any of the species are found during future surveys, they would be avoided during construction, if possible, or transplanted prior to construction. Consequently, while construction of the MVP may affect the species from the standpoint of Section 7 consultation, the actual populations would not be destroyed. Furthermore, Mountain Valley would minimize the spread of invasive species throughout the MVP route by following BMPs described in the Mountain Valley *Exotic and Invasive Species Control Plan.*

10.0 PROPOSED VOLUNTARY CONSERVATION MEASURES

Even with implementation of reasonable and prudent measures to avoid and minimize, the MVP would have impacts on federally listed species. As such, this section details voluntary conservation measures that Mountain Valley would employ to offset impacts on species caused by the Project, as identified under Section 7(a)(1) of the Act. Mountain Valley proposes to meet the objective of "carrying out programs for the conservation of endangered species" by funding compensatory mitigation to offset habitat losses associated with Project construction.

As identified in the Interim Guidance for Implementing the ESA Compensatory Mitigation Policy (FWS, 2017c), "mitigation projects may rely on a range of strategies including, but not limited to the following: preservation and management of existing functioning habitat, restoration of degraded habitat, connecting separated habitats, buffering protected areas, creating habitat, and other appropriate actions." A brief overview of Mountain Valley's proposed compensatory mitigation projects is provided below; a complete mitigation proposal will be submitted to the FWS by Mountain Valley.

10.1 BATS

Mountain Valley has acquired a 121-acre property crossed by the Project in Braxton County, West Virginia. There have been five northern long-eared bat captures documented about 4 miles north of this property and one northern long-eared bat capture documented about 3 miles south of the property. The parcel has a small stream on the southern end, is in proximity to Falls Mill, Millstone Run, Barbecue Run, and McChord Run, and is 1.75 miles east of Burnsville Lake. The parcel straddles three ridges. It contains mature, upland deciduous forest dominated by mostly oak (white, scarlet, and chestnut), hickory (pignut, shagbark, a few mockernut), and red maple. There are numerous ATV/hunting trails throughout the property that may provide travel/foraging corridors for bats. There are numerous existing snags throughout the property. The Project crosses the property about for about 860 feet on the eastern portion of the parcel. Post-construction, about 106 acres would remain as interior forest, as classified by the state of West Virginia, and would be maintained as such in perpetuity. There are a variety of options for habitat enhancement at this site, including but not limited to, erection of artificial roost structures and establishment of a permanent water source.

In addition, MVP would work with state agencies in West Virginia and Virginia to identify opportunities for enhancement to public lands including wildlife management areas or preserves.

10.2 LOGPERCH

The North Fork Roanoke River is crossed by the MVP and is known to support populations of a wide variety of native fish, including the Roanoke logperch. The FWS is engaged in a public-private partnership for restoration activities along the North Fork Roanoke River. Previous restoration efforts by the partnership have taken place both upstream and downstream of the Project's crossing of the river. These activities include the following: constructing instream features; planting riparian buffers with native vegetation to stabilize the streambank and floodplain; excluding cattle access to streams; grading streambanks; and reestablishing channel morphology. Mountain Valley would provide funds to continue and expand these restoration activities in the watershed, and expand on an existing, successful, landscape approach that tangibly benefits the federally listed Roanoke logperch within its known, occupied range.

Mountain Valley would also support proper stream restoration activities within the distributional range of Roanoke logperch and other sensitive riparian areas within the Project corridor. Proper stream restoration activities can provide a multitude of environmental and economic benefits including, but not limited to, the following: improved water quality; augmentation of habitat diversity; re-establish critical watershed functions; increases property and aesthetic values; reduction of flood damages; and riparian property loss. Targeted restoration activities in or near waterbodies would take place at 55 stream crossing locations along the Project.

10.3 FUNDING

10.3.1 Bats

As part of Mountain Valley's efforts to complete a project with "no net loss" to the environment, and in collaboration with the Virginia and West Virginia state environmental agencies, a mitigation model is being developed. This analysis utilizes interior forest as the benchmark to which habitat impacts are compared. Once complete, this analysis will identify the quantity of service acres required to fully offset forest impacts from the Project. Thus, funding for bat mitigation will be derived from the quantity of service acres translated into dollars, with inclusion of a typical land management multiplier.

10.3.2 Logperch

Funding for logperch mitigation would be derived directly from the number of linear stream feet of Roanoke logperch habitat impacts, as identified within the BA.

10.3.3 Financial Assurances

Prior to commencement of construction, Mountain Valley would place funding (the amount to be determined in coordination with the FWS and applicable state agencies) in an interest-bearing escrow account fund to be used as described above. Mountain Valley would identify an appropriate third-party, non-profit conservation organization(s) that would develop a Memorandum of Understanding (MOU) with the agencies that would establish criteria for ensuring that the funds from the conservation escrow account are disbursed in accordance with the final mitigation proposal. This third-party non-profit independent conservation organization would be responsible for documenting that Mountain Valley provides the funds as described above and for monitoring and reporting on the implementation and success of funded activities based on conservation standards established by Mountain Valley and the FWS in coordination with applicable state agencies. Mountain Valley would develop a separate agreement with the third-party organization to address how the third-party organization would disburse the funds.

11.0 REFERENCES

3D/Environmental. 1995. Literature summary and habitat suitability index model. Components of summer habitat for the Indiana bat, Myotis sodalis. Authors: R.C. Rommé, K. Tyrell, V. Brack, Jr. Report submitted to the Indiana Department of Natural Resources, Division of Wildlife, Bloomington, Indiana by 3D/Environmental, Cincinnati, Ohio. Federal Aid Project E-1-7, Study No. 8, 38 pp.

Amelon, S. and D. Burhans. 2006. Conservation assessment: *Myotis septentrionalis* (northern long-eared bat) in the Eastern United States. U.S. Department of Agriculture, Forest Service, General Technical Report NC-260: Conservation Assessments for Five Forest Bat Species in the Eastern United States.

Anderson, G. B., J. H. Roberts, and P. L. Angermeier. 2015. Assessing impacts of the Roanoke River Flood Reduction Project on the endangered Roanoke logperch. Annual report submitted to the U.S. Geological Survey, Reston, Virginia and U.S. Army Corps of Engineers, Wilmington, North Carolina. 47 pp.

Bagley, F. M. 1984. A recovery plan for the Ozark big-eared bat and the Virginia big-eared bat. U.S. Department of Interior, Fish and Wildlife Service, Region III. Twin Cities, Minnesota

Barbour, R. W. and W. H. Davis. 1969. Bats of America. University Press of Kentucky, Lexington, Kentucky.

Barber, J. R., K. R. Crooks, and K. M. Fristrup. 2010. The costs of chronic noise exposure for terrestrial organisms. Trends in Ecology and Evolution 25:547-618.

Belwood, J. J. 2002. Endangered bats in suburbia: observations and concerns for the future. *In* The Indiana Bat: Biology and Management of an Endangered Species (A. Kurta and J. Kennedy, eds.). Bat Conservation International, Austin, Texas.

Bennie, J., T. W. Davies, D. Cruse, R. Inger, and K. J. Gaston. 2015. Cascading effects of artificial light at night: resource-mediated control of herbivores in a grassland ecosystem. Philosophical Transactions of the Royal Society of London B: Biological Sciences 370:20140131.

Blickley, J. L., D. Blackwood, and G. L. Patricelli. 2012. Experimental evidence for the effects of chronic anthropogenic noise on abundance of greater sage-grouse at leks. Conservation Biology 26:461–471.

Brack, V., Jr. 1983. The nonhibernating ecology of bats in Indiana with emphasis on the endangered Indiana bat, Myotis sodalis. Unpublished Ph.D. dissertation, Purdue University, West Lafayette, Indiana.

Brack, V., Jr. and R. K. LaVal. 1985. Food habits of the Indiana bat in Missouri. Journal of Mammalogy 66:308-315.

Brack, V., Jr. and J. O. Whitaker, Jr. 2001. Foods of the northern myotis, *Myotis septentrionalis*, from Missouri and Indiana, with notes on foraging. Acta Chiropterologica 3:203-210.

Brack, V., Jr. and J. O. Whitaker, Jr. 2004. Bats of the Naval Surface Warfare Center at Crane, Indiana. Proceedings of the Indiana Academy of Science 113:66-75.

Brack, V., Jr., A. M. Wilkinson, and R. E. Mumford. 1984. Hibernacula of the endangered Indiana bat in Indiana. Proceedings of the Indiana Academy of Science 93:463-468.

Brack, V., Jr., C. W. Stihler, R. J. Reynolds, C. M. Butchkoski, and C. S. Hobson. 2002. Effect of climate and elevation on distribution and abundance in the mid-eastern United States. Pages 21-28 in The Indiana Bat: Biology and Management of an Endangered Species (A. Kurta and J. Kennedy, eds.). Bat Conservation International, Austin, Texas.

Brack, V., Jr., J. O. Whitaker, Jr., and S. E. Pruitt. 2004. Bats of Hoosier National Forest. Proceedings of the Indiana Academy of Science 113:78-86.

Brack, V., Jr., R. J. Reynolds, W. Orndorff, J. Zokaites, and C. Zokaites. 2005. Bats of Skydusky Hollow, Bland County, Virginia. Virginia Journal of Science 56:93-106.

Brady, J., T. Kunz, M. Tuttle, and D. Wilson. 1982. Gray bat recovery plan. U.S. Department of Interior, Fish and Wildlife Service in cooperation with the Gray Bat Recovery Team, Denver, Colorado. 143 pp.

Brim Box, J. and Mossa, J. 1999. Sediment, land use and freshwater mussels: prospects and problems. Journal of the North American Benthological Society 18(1): 99-117.

Britzke, E. R., M. J. Harvey, and S. C. Loeb. 2003. Indiana bat, Myotis sodalis, maternity roosts in the southern United States. Southeastern Naturalist 2:235-242.

Brown, R. J. and V. Brack, Jr. 2003. An unusually productive net site over an upland road used as a travel corridor. Bat Research News 44:187-188.

Bunkley, J. P., C. J. W. McClure, N. J. Kleist, C. D. Francis, and J. R. Barber. 2015. Anthropogenic noise alters bat activity levels and echolocation calls. Global Ecology and Conservation 3:62-71.

Burkhead, N. M. 1983. Ecological studies of two potentially threatened fishes (the orangefin madtom, *Noturus gilberti* and the Roanoke logperch, *Percina rex*) endemic to the Roanoke River drainage. Report to the Wilmington District of the Army Corps of Engineers, Wilmington, North Carolina.

Caceres, M. C. 1998. The summer ecology of Myotis species in the interior wet-belt of British Columbia. M.Sc. Thesis, University of Calgary.107 pp *in* U.S. Fish and Wildlife Service (FWS). 2013a. Endangered and Threatened Wildlife and Plants; 12-Month Finding on a Petition To List the Eastern Small-Footed Bat and the Northern Long-Eared Bat as Endangered or Threatened Species; Listing the Northern Long-Eared Bat as an Endangered Species. Federal Register [Docket No. FWS–R5–ES–2011–0024;4500030113]. Vol. 78, No. 191. Wednesday, October 2, 2013. Proposed Rules. pgs. 61,046-61,080.

Caceres, M. C. and R. M. R. Barclay. 2000. *Myotis septentrionalis*. Mammalian Species 634:1-4.

Callahan, E. V., R. D. Drobney, and R. L. Clawson. 1997. Selection of summer roosting sites by Indiana bats (*Myotis sodalis*) in Missouri. Journal of Mammalogy 78:818-825.

Carlson, T., G. Johnson, C. Woodley, J. Skalski, and A. Seaburg. 2011. Compliance monitoring of underwater blasting for rock removal at Warrior Point, Columbian River Channel Improvement Project 2009/2010. Prepared for the U.S. Army Corps of Engineers, Portland District By Pacific Northwest National Laboratory, Marine Sciences Laboratory, University of Washington, Columbia Basin Research, Richland, Washington. 110 pp.

Carter, T. C. 2003. Summer habitat use of roost trees by the endangered Indiana bat (*Myotis sodalis*) in the Shawnee National Forest of Southern Illinois. Ph.D.dissertation. Southern Illinois University, Carbondale, Illinois.

Carter, T. C. and G. A. Feldhamer. 2005. Roost tree use by maternity colonies of the Indiana bats and the northern long-eared bats in southern Illinois. Forest Ecology and Management 219:259-268.

Carter, T. C. 2006. Indiana bats in the midwest: the importance of hydric habitats. Journal of Wildlife Management 70:1185-1190.

Catrow, J. L., D. Wing, D. DiLella, and E. Volker. 2009. Gas chromatography and mass spectroscopy of cuticular and epicuticular waxes of *Arabis serotina*. The Shepard University Journal of Undergraduate Research (SUJUR) 1:27-35.

Chaney, W. R. 2002. Does night lighting harm trees? Department of Forestry and Natural Resources, Purdue University, West Lafayette. 4pp.

Clarke, M. R., P. L. Pascoe, and L. Maddock. 1986. Influence of 70 watt electric lights on the capture of fish by otter trawl off Plymouth. Journal of the Marine Biological Association of the United Kingdom 66:711-720.

Clayton, J., B. Douglas, and P. Morrison. 2015. West Virginia mussel survey protocols. West Virginia Division of Natural Resources.

Cooke, S. J., C. M. Bunt, and R. S. McKinley. 1998. Injury and short-term mortality of benthic stream fishes – a comparison of collection techniques. Hydrobiologia 379:207-211.

Coons, K., D. J. McCabe, and J. E. Marsden. 2004. The effects of strobe lights on zebra mussel settlement and movement patterns. Journal of Freshwater Ecology 19:1-8.

Cope, J. B., A. R. Richter, and R. S. Mills. 1974. A summer concentration of the Indiana bat, Myotis sodalis, in Wayne County, Indiana. Proceedings of the Indiana Academy of Science 83:482-484.

Cope, J. B. and S. R. Humphrey. 1977. Spring and autumn swarming behavior in the Indiana bat, Myotis sodalis. Journal of Mammalogy 58:93-95.

Dalton, V. M. 1987. Distribution, abundance, and status of bats hibernating in caves in Virginia. Virginia Journal of Science 38:369-379.

Darko, E., P. Heydarizadeh, B. Schoefs, and M. R. Sabzalian. 2014. Photosynthesis under artificial light: the shift in primary and secondary metabolism. Philosophical Transactions of the Royal Society of London B: Biological Sciences 369:1-7.

Decher, J. and J. R. Choate. 1995. *Myotis grisescens*. Mammalian Species 510:1-7.

DeWan, A. A. and E. F. Zipkin. 2010. An integrated sampling and analysis approach for improved biodiversity monitoring. Environmental Management 45:1223-1230.

Dowling, D. C. and M. J. Wiley. 1986. The effects of dissolved oxygen, temperature and low stream flow on fishes: a literature review. Springfield City Water, Light and Power Company.

Ensign, W. E., P. L. Angermeier, and B. W. Albanese. 2000. Final Report: Roanoke River flood reduction project pre-construction monitoring of the endangered Roanoke logperch (*Percina rex*). U.S. Army Corps of Engineers, Wilmington District, Wilmington, North Carolina.

Environment and Climate Change Canada. 2016. Recovery strategy for the rustypatched bumble bee (Bombus affinis) in Canada [Proposed]. Species at Risk Act, Environment and Climate Change Canada, Ottawa. 65 pp.

Federal Highway Administration (FHWA). 2004. Synthesis of Noise Effect on Wildlife Populations. Publication No. FHWA-HEP-06-016.

Federal Highway Administration (FHWA). 2006. Construction Noise Handbook. Final Report August 2006. Chapter 9 Construction Equipment Noise Levels and Ranges. Available at: http://www.fhwa.dot.gov/environment/noise/construction_noise/handbook/handbook09.cfm.

Fenneman, N.M., and D. W. Johnson. 1946. Physiographic divisions of the conterminous U.S. U.S. Geologic Survey. Available at: http://water.usgs.gov/GIS/metadata/usgswrd/XML/physio.xml. Accessed January 2016.

Ferguson, M. T., S. A. Bruenderman, and P. S. Lookabaugh. 1994. A survey of the Roanoke logperch (*Percina rex*) in the North Fork Roanoke River. Virginia Department of Game and Inland Fisheries, Nongame and Endangered Species Program Fisheries Division, Blacksburg, Virginia.

Foster, R. W. and A. Kurta. 1999. Roosting ecology of the northern bat (*Myotis septentrionalis*) and comparisons with the endangered Indiana bat (*Myotis sodalis*). Journal of Mammalogy 80:659-672.

Francis, C.D., C. P. Ortega, A. Cruz. 2011a. Different Behavioural Responses to Anthropogenic Noise by Two Closely Related Passerine Birds. Biological Letters. DOI: 10.1098/rsbl.2011.0359.

Francis, C.D., J. Paritsis, C. P. Ortega, A. Cruz. 2011b. Landscape patterns of avian habitat use and nest success are affected by chronic gas well compressor noise. Landscape Ecology. 26:9, 1269-1280.

Francis, C.D., N. J. Kleist, C. P. Ortega, A. Cruz. 2012. Noise pollution alters ecological services: enhanced pollination and disrupted seed dispersal. Proceedings of the Royal Society B. DOI: 10.1098/rspb.2012.0230.

Frick, W.F., J.F. Pollock, A.C. Hicks, K.E. Langwig, D.S. Reynolds, G.G. Turner, C.M. Butchkoski, and T. H. Kunz. 2010. An emerging disease causes regional population collapse of a common North American bat species. Science 329:679-682.

Frings, H. and F. Little. 1957. Reactions of honey bees in the hive to simple sounds. Science 125:122.

Fukui, D., M. Murakami, S. Nakano and T. Aoi. 2006. Effect of emergent aquatic insects on bat foraging in a riparian forest. Journal of Animal Ecology. 75: 1,252-1,258.

Fulton, S.A., L.E. Dodd and L.K. Rieske. 2014. Hydric Habitats are Important to Foraging Bats in the Bluegrass Region’s Urban Parks. Urban Naturalist 3: 1-13.

Gates, J. E. and J. B. Johnson. 2006. Bat-swarming inventory at abandoned mine portals at New River Gorge National River, West Virginia, technical report NPS/NER/NRTR--2006/046.

Galetovic, J. R. 1998. Guidelines for the use of the Revised Universal Soil Loss Equation (RUSLE) version 1.06 on mined lands, construction sites, and reclaimed lands. T. J. Toy and G. R. Foster, eds. The Office of Technology Transfer, Western Regional Coordinating Center, Office of Surface Mining, Denver, Colorado. 148 pp.

Gardner, J. E., J. D. Garner, and J. E. Hofmann. 1991. Summer roost selection and roosting behavior of *Myotis sodalis* (Indiana bat) in Illinois. Unpublished report. Illinois Natural History Survey, Illinois Department of Conservation, Section of Faunistic Surveys and Insect Identification. Champaign, Illinois. 56 pp.

Gaston, K. J., M. E. Visser, and F. Holker. 2015. The biological impacts of artificial light at night: the research challenge. Pages 1-7 in Proceedings of The Royal Society of London B: Biological Sciences. 370:1-7.

Godard, D. R., L. Peters, R. Evans, K. Wautier, P. A. Cott, B. Hanna, and V. Palace. 2008. Histopathological assessment of the sub-lethal effects of instantaneous pressure changes (IPC's) on rainbow trout (*Onchorhynchus mykiss*) early life stages following exposure to detonation under ice cover. Report No. 164, Environmental Studies Research Funds, Winnipeg. 93 pp.

Gumbert, M. W., J. M. O'Keefe, and J. R. MacGregor. 2002. Roost fidelity in Kentucky. Pages 143-152 *in* The Indiana Bat: Biology and Management of an Endangered Species (A. Kurta and J. Kennedy, eds.). Bat Conservation International, Austin, Texas.

Habib, L., E. M. Bayne, S. Boutin. 2007. Chronic Industrial Noise Affects Pairing Success and Age Structure of Ovenbirds Seiurus aurocapilla. Journal of Applied Ecology. 44, 176-184. doi: 10.1111/j.1365-2664.2006.01234.x.

Hagen, E. M. 2014. Temporal variability in insectivorous bat activity along two desert streams with contrasting patterns of prey availability. Journal of Arid Environments. 102: 104-112.

Hanula, J. L., M. D. Ulyshen, and S. Horn. 2016. Conserving Pollinators in North American Forest: A Review. Natural Areas Journal 36:427-439.

Harvey, M.J. 1992. Bats of the eastern United States. Arkansas Game & Fish Commission, 46pp.

Harrison, T. and R. Winfree. 2015. Urban drivers of plant-pollinator interactions. Functional Ecology 29:879-888.

Hastings, M. C. and A. N. Popper. 2005. Effects of sound on fish. Prepared for the California Department of Transportation By Jones & Stokes Associates, Inc. Sacramento, California. 82 pp.

Hatfield, R., S. Jepsen, E. Mader, S. H. Black, M. Shepard. 2012. Conserving Bumble Bees. Guidelines for Creating and Managing Habitat for America's Declining Pollinators. The Xerces Society for Invertebrate Conservation. Portland, Oregon. 32 pp.

Henderson, L.E., and H.G. Broders. 2008. Movement and resource selection of the Northern long-eared Myotis (*Myotis septentrionalis*) in a forest-agriculture landscape. Journal of Mammalogy 89: 952-963.

Henley, W. F., M. A. Patterson, R. J. Neves, and A. D. Lemly. 2000. Effects of sedimentation and turbidity on lotic food webs: a concise review for natural resource managers. Reviews in Fisheries Science 8:125-139.

Homer, C. G., J. A. Dewitz, L. Yang, S. Jin, P. Danielson, G. Xian, J. Coulston, N. D. Herold, J. D. Wickham, and K. Megown. 2015. Completion of the 2011 National Land Cover Database for the conterminous United States-representing a decade of land cover change information. Photogrammetric Engineering and Remote Sensing 81:345-354.

Huisman, W., Attenborough, K. 1991. Reverberation and attenuation in a pine forest. J. Acoust. Soc. Am. 90:2664–2677.

Humphrey, S. R., A. R. Richter, and J. B. Cope. 1977. Summer habitat and ecology of the endangered Indiana bat, *Myotis sodalis*. Journal of Mammalogy 58:334-346.

James, D. L., Jr. 1979. Ecological studies of the fishes of the Pigg River system, south-central Virginia, with special reference to threatened species. Master's Thesis, Virginia Commonwealth University, Richmond, Virginia. 71pp

Jin, S., L. Yang, P. Danielson, Homer, J. Fry, and G. Xian. 2013. A comprehensive change detection method for updating the National Land Cover Database to circa 2011. U.S. Geologic Survey, Published Research. Paper 711.

Jenkins, R. E. and N. M. Burkhead. 1994. The freshwater fishes of Virginia. American Fisheries Society, Bethesda, Maryland.

Jepsen, S., E. W. Evans, R. W. Thorp, R. Hatfield, and S. H. Black. 2013. Petition to list the rusty patched bumble bee Bombus affinis (Cresson), 1863 as an endangered species under the U.S. Endangered Species Act. Petition submitted to the U.S. Secretary of the Interior, acting through the U.S. Fish and Wildlife Service, Xerces Society for Invertebrate Conservation, Portland, Oregon. 42 pp.

Johnson, S. A., V. Brack, Jr., and R. E. Rolley. 1998. Overwinter weight loss of Indiana bats (*Myotis sodalis*) from hibernacula subject to human visitation. American Midland Naturalist 139:255-261

Johnson, J. B., W. M. Ford, and J. W. Edwards. 2012. Roost networks of northern myotis (*Myotis septentrionalis*) in a managed landscape. Forest Ecology and Management 266:223–231.

Kempf, N. and O. Hüppop. 1996. The Effects of Aircraft Noise on Wildlife; a Review and Comment. Journal of Ornithology 137:101-113.

Kiser, J. D. and C. L. Elliott. 1996. Foraging habitat, food habits, and roost tree characteristics of the Indiana Bat (*Myotis sodalis*) during autumn in Jackson County, Kentucky. Unpublished report to Kentucky Department of Fish and Wildlife Resources. Frankfort, Kentucky. 75 pp.

Kurta, A. 2004. Roosting ecology and behavior of Indiana bats (*Myotis sodalis*) in summer. Pages 29-42 in Indiana Bat and Coal Mining, A Technical Interactive Forum (K.C. Vories and A. Harrington, eds.). Office of Surface Mining, U. S. Department of the Interior, Alton, Illinois.

Kurta, A. and S. W. Murray. 2002. Philopatry and migration of banded Indiana bats (*Myotis sodalis*) and effects of radio transmitters. Journal of Mammalogy 83:585-589.

Kurta, A., S. W. Murray, and D. H. Miller. 2002. Roost selection and movements across the summer landscape. Pages 118-129 *in* The Indiana Bat: Biology and Management of an Endangered Species (A. Kurta and J. Kennedy, eds.). Bat Conservation International, Austin, Texas.

Lacki, M. J. and J. H. Schwierjohann. 2001. Day-roost characteristics of northern bats in mixed mesophytic forests. The Journal of Wildlife Management 65:482-488.

Lahey, A. M. and P. L. Angermeier. 2007. Range-wide assessment of habitat suitability for Roanoke logperch (*Percina rex*). Final report VTRC 07-CR8 prepared for Virginia Transportation Research Council, in Cooperation with the U.S. Department of Transportation, Federal Highway Administration, Charlottesville, Virginia. 58 pp.

LaVal, R. K., R. L. Clawson, M. L. LaVal, and W. Caire. 1977. Foraging behavior and nocturnal activity patterns of Missouri bats, with emphasis on the endangered species *Myotis grisescens* and *Myotis sodalis*. Journal of Mammalogy 58:592-599.

LaVal, R. K. and M. L. LaVal. 1980. Ecological studies and management of Missouri bats, with emphasis on cave-dwelling species. Missouri Department of Conservation: Terrestrial Series 8:1-53.

Lee, Y.-F. and G. F. McCracken. 2004. Flight activity and food habits of three species of Myotis bats (Chiroptera: Vespertilionidae) in sympatry. Zoological Studies 43:589-597.

Lentz, K. A. and W. A. Dunson. 1999. Distinguishing characteristics of temporary pond habitat of endangered northeastern bulrush, *Scirpus ancistrochaetus*. Wetlands 19:162-167.

Longcore, T., C. Rich. 2004. Ecological Light Pollution. Frontiers in Ecology and the Environment 2(4):191-198.

Marchesan, M., M. Spoto, L. Verginella, and E. A. Ferrero. 2005. Behavioural effects of artificial light on fish species of commercial interest. Fisheries Research 73:171-185.

Martinez, J. J., J. R. Myers, T. J. Carlson, Z. D. Deng, J. S. Rohrer, K. A. Caviggia, and M. A. Weiland. 2011. Design and implementation of an underwater sound recording device. Sensors 11:8519-8535.

McCormick, F. H., R. M. Hughes, P. R. Kaufmann, D. V. Peck, J. L. Stoddard, and A. T. Herlihy. 2001. Development of an index of biotic integrity for the Mid-Atlantic Highlands region. Transactions of the American Fisheries Society 130:857-877.

Miller, N. E., R. D. Drobney, R. L. Clawson, and E. V. Callahan. 2002. Summer habitat in northern Missouri. Pages 165-171 in The Indiana Bat: Biology and Management of an Endangered Species (A. Kurta and J. Kennedy, eds.). Bat Conservation International, Austin, Texas.

Moser, G. A. 1992. Roanoke logperch recovery plan. U.S. Department of Interior, Fish and Wildlife Service, Newton Corner, Massachusetts.

Mumford, R. E. and J. B. Cope. 1964. Distribution and status of the Chiroptera of Indiana. American Midland Naturalist 72:473-489.

Munday, D. R., G. L. Ennis, D. G. Wright, D. C. Jeffries, E. R. McGreer, and J. S. Mathers. 1986. Development and evaluation of a model to predict effects of buried underwater blasting charges on fish populations in shallow water areas. Canada Technical Report of Fisheries and Aquatic Sciences No. 1418. Department of Fisheries and Oceans, Habitat Management Division, Vancouver, BC.

Nagorsen, D.W. and R.M. Brigham. 1993. Bats of British Columbia. Royal British Columbia Museum, Victoria, and the University of British Columbia Press, Vancouver. 164 pp *in* U.S. Fish and Wildlife Service (FWS). 2013. Endangered and Threatened Wildlife and Plants; 12-Month Finding on a Petition To List the Eastern Small-Footed Bat and the Northern Long-Eared Bat as Endangered or Threatened Species; Listing the Northern Long-Eared Bat as an Endangered Species. Federal Register [Docket No. FWS–R5–ES–2011–0024;4500030113]. Vol. 78, No. 191. Wednesday, October 2, 2013. Proposed Rules. pgs. 61046-61080.

NatureServe. 2016. Ecological Communities and Systems. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available at: http://explorer.natureserve.org.

Northwest Alliance for computational Science and Engineering (NACSE). 2016. PRISM Climate Data. Available at: http://prism.oregonstate.edu. Accessed January 2016.

Ovaskainen, O. and J. Soininen. 2011. Making more out of sparse data: hierarchical modeling of species communities. Ecology 92:289-295.

Owen, S.F., M.A. Menzel, W.M. Ford, J.W. Edwards, B.R. Chapman, K.V. Miller, P.B. Wood. 2002. Roost tree selection by maternal colonies of northern long-eared myotis in an intensively managed forest. USDA Forest Service, General Technical Report NE-292, Northeastern Research Station, Newtown Square, PA, p.6.

Page, L. M. and B. M. Burr. 1991. A field guide to freshwater fishes: North America north of Mexico. Peterson Field Guide Series, Houghton Mifflin Company, Boston, Massachusetts. 432 pp.

Perry, R. W. and R. E. Thill. 2007. Roost selection by male and female northern long-eared bats in a pine-dominated landscape. Forest Ecology and Management 247:220-226.

Petty, M. and R.J. Neves. 2005. Species occurrence and habitat suitability survey for the endangered James spinymussel. Final Report to U.S. Fish and Wildlife Service, Gloucester, VA. 114 pp.

Piaggio, A. J., K. W. Navo, and C. W. Stihler. 2008. Intraspecific comparison of population structure, genetic diversity, and dispersal among three subspecies of Townsend's big-eared bats, *Corynorhinus townsendii townsendii, C. t. pallescens*, and the endangered *C. t. virginianus*. Conservation Genetics 10:143-159.

Pocock, Z. and R. E. Lawrence. 2005. How far into a forest does the effect of a road extend? Defining road edge effect in eucalypt forests of Southeastern Australia. Pages 397-405 *in* Proceedings of the 2005 International Conference on Ecology and Transportation (C. L. Irwin, P. Garrett, and K. P. McDermott). eds. Raleigh, North Carolina.

Popper, A. N. and M. C. Hastings. 2009. The effects of anthropogenic sources of sound on fishes. Journal of Fish Biology 75:455-489

Powers, K. E., R. J. Reynolds, W. Orndorff, W. M. Ford, and C. S. Hobson. 2015. Post –white nose syndrome trends in Virginia's cave bats, 2008-2013. Journal of Ecology and the Natural Environment 7:113-123.

Prenda, J., S. Rossomanno, and P. D. Armitage. 2000. Changes in depth distribution and activity in small benthic riverine fishes under gradually changing light intensities. Limnética 18:75-80.

Renard, K. G., G. R. Foster, G. A. Weesies, D. K. McCool, and S. C. Yoder. 1997. Predicting soil erosion by water: a guide to conservation planning with the Revised Universal Soil Loss Equation (RUSLE). U.S. Department of Agriculture, Agricultural Research Service, Agriculture Handbook No. 703, 404 pp.

Richter, A. R., S. T. Humphrey, J. B. Cope, and V. Brack, Jr. 1993. Modified cave entrances: Thermal effect on body mass and resulting decline of endangered Indiana bats (*Myotis sodalis*). Conservation Biology 7:407-415.

Riitters, K. H. and J. D. Wickham. 2012. Decline of forest interior conditions in the conterminous United States. Scientific Reports 2:1-4.

Roberts, J. H., A. E. Rosenberger, B. W. Albanese, and P. L. Angermeier. 2008. Movement patterns of endangered Roanoke logperch (*Percina rex*). Ecology of Freshwater Fish 17:374-381.

Roberts, J. H. 2012. Using genetic tools to understand the population ecology of stream fishes. Virginia Polytechnic Institute and State University.

Roberts, J. H., P. L. Angermeier, and E. M. Hallerman. 2013. Distance, dams and drift: what structures populations of an endangered, benthic stream fish? Freshwater Biology 58:2050-2064.

Roberts, J. H., P. L. Angermeier, and G. B. Anderson. 2016. Population viability analysis for endangered Roanoke logperch (*Percina rex*). Journal of Fish and Wildlife Management. 7:46-64.

Roberts, J. H. and G. B. Anderson. 2013. Assessing impacts of the Roanoke River Flood Reduction Project on the endangered Roanoke logperch (*Percina rex*): summary of construction-phase monitoring. Final report submitted to the Wilmington District, U.S. Army Corps of Engineers, Wilmington, North Carolina. 54 pp.

Robertson, M. J., D. A. Scruton, R. S. Gregory, and K. D. Clarke. 2006. Effect of suspended sediment on freshwater fish and fish habitat. Fisheries and Oceans Canada.

Rommé, R. C., K. Tyrell, and V. Brack, Jr. 1995. Literature summary and habitat suitability index model: components of summer habitat for the Indiana bat, *Myotis sodalis*. 3D/Environmental, E-1-7, Study No. 8. 174 pp.

Rosenberger, A. E. and P. L. Angermeier. 2002. Roanoke logperch (*Percina rex*) population structure and habitat use. Final report prepared by Virginia Cooperative Fish and Wildlife Research Unit, Department of Fisheries and Wildlife Sciences, Virginia Tech for Virginia Department of Game and Inland Fisheries, Blacksburg, Virginia.

Rosenberger, A. and P. L. Angermeier. 2003. Ontogenetic shifts in habitat use by the endangered Roanoke logperch (*Percina rex*). Freshwater Biology 48:1563– 1577.

Rosenberger, A. 2002. Multi-scale patterns of habitat use by Roanoke logperch (*Percina rex*) in Virginia rivers: a comparison among populations and life stages. Virginia Polytechnic Institute and State University.

Rosenberger, A. E. 2007. An update to the Roanoke logperch recovery plan. Prepared for U.S. Department of Interior, Fish and Wildlife Service, Virginia Field Office, Gloucester, Virginia.

Royle, J. A. 2004. N-Mixture models for estimating population size from spatially replicated counts. Biometrics 60:108-115.

Sasse, D. B. and P. J. Pekins. 1996. Summer roosting ecology of northern long-eared bats (*Myotis septentrionalis*) in the White Mountain National Forest. Pages 91-101 in Bats and Forests Symposium (R. M. R. Barclay and R. M. Brigham, eds.), October 19-21, 1995. Research Branch, British Columbia Minister of Forests Research Program. Victoria, British Columbia, Canada.

Schaub, A., J. Ostwald, and B. M. Siemers. 2008. Foraging bats avoid noise. Journal of Experimental Biology 211:3174-3180.

Schultes, K. L. and C. L. Elliott. 2002. Roost tree selection by Indiana bats and northern bats on the Wayne National Forest, Ohio. Unpublished report to U.S. Fish & Wildlife Service, Reynoldsburg, Ohio Field Office and U.S. Department of Agriculture, Forest Service, Wayne National Forest.

Shreve, R. L. 1966. Statistical Law of Stream Numbers. The Journal of Geology. Vol. 74, No. 1. pp. 17-37.

Siemers, B. M. and A. Schaub. 2010. Hunting at the highway: traffic noise reduces foraging efficiency in acoustic predators. Pages 1646-1652 in Proceedings of The Royal Society of London B: Biological Sciences 278:1646-1652.

Silvis, A., W. M. Ford, and E. R. Britzke. 2015. Effects of hierarchical roost removal on northern long-eared bat (*Myotis septentrionalis*) maternity colonies. PLoS ONE 10:e0116356.

Silvis, A., W. M. Ford, E. R. Britzke, and J. B. Johnson. 2014a. Association, roost use and simulated disruption of *Myotis septentrionalis* maternity colonies. Behavioural Processes 103:283–290.

Silvis, A., A. B. Kniowski, S. D. Gehrt, and W. M. Ford. 2014b. Roosting and foraging social structure of the endangered Indiana bat (*Myotis sodalis*). PLoS ONE 9:1- 12.

Simonson, T. D. and R. J. Neves. 1986. A status survey of the orangefin madtom (Noturus gilberti) and Roanoke logperch (Percina rex). Virginia Polytechnic Institute and State University. Blacksburg, Virginia. Virginia Commission of Game and Inland Fisheries, Richmond, Virginia. 60 pp.

Snyder, J. M., P. M. Treuting, T. Brabb, K. E. Miller, E. Covey, and K. L. Lencioni. 2015. Hepatic lipidosis in a research colony of big brown bats (Eptesicus fuscus). Comparative Medicine 65:133–139.

Soil Survey Staff. 2015a. Soil Survey Geographic (SSURGO) Database. U.S. Department of Agriculture, Natural Resources Conservation Service. Available online at http://sdmdataaccess.nrcs.usda.gov/.

Soil Survey Staff. 2015b. U.S. General Soil Map (STATSGO2). U.S. Department of Agriculture, Natural Resources Conservation Service. Available online at http://sdmdataaccess.nrcs.usda.gov/.

Sparks, D. W., J. O. Whitaker, Jr., and C. M. Ritzi. 2004. Foraging ecology of the endangered Indiana bat. in Indiana Bat and Coal Mining: A Technical Interactive Forum (K.C. Vories and A. Harrington, eds.). U.S. Department of the Interior, Office of Surface Mining. Alton, Illinois.

Sparks, D. W., C. M. Ritzi, J. E. Duchamp, and J. O. Whitaker, Jr. 2005. Foraging habitat of the Indiana bat (Myotis sodalis) at an urban-rural interface. Journal of Mammalogy 86:713-718.

Sparks, D. W., J. O. Whitaker, Jr., N. G. Gikas, and D. J. Judy. 2008. Final Report: Developing techniques for estimating populations of Indiana bats. U.S. Geological Survey, Fort Collins Science Center.

Sparks, D. W., V. Brack, Jr., J. O. Whitaker, Jr., and R. Lotspeich. 2009. Reconciliation ecology and the Indiana Bat at Indianapolis International Airport, Chapter 3. in Airports: Performance, Risks, and Problems, (P. B. Larauge and M. E. Castille, eds.) Nova Science Publishers, Inc., Hauppauge, New York.

St. Germain, M. J., A. B., Kniowski, A. Silvis, W. M. Ford. 2017. Who Knew? First *Myotis sodalist* (Indiana Bat) Maternity Colony in the Coastal Plain of Virginia. Notes of the Northeastern Naturalist. Vol. 24, No. 1. N5-N10.

Speakman, J. R., J. Rydell, P. I. Webb, G. C. Hayes, I. A. R. Hulbert, and R. M. McDevitt. 2000. Activity patterns of insectivorous bats and birds in northern Scadinavia (69 degrees N), during continuous midsummer daylight. OIKOS 88: 75-86.

Stancil, V. F. 2000. Effects of watershed and habitat conditions on stream fishes in the upper Roanoke River watershed. Unpublished Master's Thesis, Virginia Polytechnic Institute and State University, Blacksburg, Virginia

Strahler. A. N. 1957. Quantitative Analysis of Watershed Geomorphology. Transactions, American Geophysical Union Vol. 38, No. 6. pp 913-920.

Terwilliger, K. 1991. The 1989 Symposium. Pages 15-22 *in* Virginia's Endangered Species, Proceedings of a Symposium (K. Terwilliger, coord.), Virginia Department of Game and Inland Fisheries. The McDonald and Woodward Publishing Co., Blacksburg, Virginia. 672 pp.

Tibbels, A. E. and A. Kurta. 2003. Bat activity is low in thinned and unthinned stands of red pine. Canadian Journal of Forest Research 33 (12):2436-2442.

Timpone, J. C., J. G. Boyles, K. L. Murray, D. P. Aubrey, and L. W. Robbins. 2010. Overlap in roosting habits of Indiana bats (*Myotis sodalis*) and northern bats (*Myotis septentrionalis*). American Midland Naturalist 163:115-123.

Tuttle, N. M., D. P. Benson, and D. W. Sparks. 2006. Diet of *Myotis sodalis* (Indiana Bat) at an urban/rural interface. Northeastern Naturalist 13:435-442.

U.S Department of Agriculture (USDA). 2016. Rare Plant Profiles – *Arabis serotina*. Available at: http://www.fs.fed.us/wildflowers/Rare_Plants/profiles/TEP/arabis_serotina/index.shtml.

U.S. Environmental Protection Agency (EPA). 2003. Developing water quality criteria for suspended and bedded sediments (SABS). U.S. Environmental Protection Agency, Office of Water, Office of Science and Technology, Washington D.C. 58 pp.

U.S. Fish and Wildlife Service (FWS). 1990. James spinymussel (*Pleurobema collina*) recovery plan. U.S. Department of Interior, Fish and Wildlife Service, Annapolis, Maryland. 35 pp.

U.S. Fish and Wildlife Service (FWS). 1991. Shale Barren Rock Cress (*Arabis serotina*) Recovery Plan. Newton Corner, Massachusetts. 40 pp.

U.S. Fish and Wildlife Service (FWS). 1992a. Roanoke Logperch (*Percina rex*) Recovery Plan. Newton Corner, Massachusetts. 34 pp.

U.S. Fish and Wildlife Service. 1992b. Small Whorled Pogonia (*Isotria medeoloides*) Recovery Plan, First Revision. Newton Corner, Massachusetts. 75 pp.

U.S. Fish and Wildlife Service. 1992c. Virginia Spiraea (*Spiraea virginiana Britton*) Recovery Plan. Newton Corner, Massachusetts. 47 pp.

U.S. Fish and Wildlife Service (FWS). 1993a. Northeastern Bulrush (*Scbpus ancistrochaetus*) Recovery Plan. Hadley, Massachusetts. 68 pp.

U.S. Fish and Wildlife Service (FWS). 1993b. Endangered and threatened wildlife and plants; determination of endangered status for the northern riffleshell mussel (*Epioblasma torulosa rangiana*) and the clubshell mussel (*Pleurobema clava*). U.S. Department of Interior, Fish and Wildlife Service. Federal Register 58:5838-5842

U.S. Fish and Wildlife Service (FWS). 1994. Clubshell (*Pleurobema clava*) and northern riffleshell (*Epioblasma torulosa rangiana*) recovery plan. U.S. Department of Interior, Fish and Wildlife Service, Hadley, Massachusetts. 58 pp.

U.S. Fish and Wildlife Service (FWS). 1995. Smooth Coneflower (*Echinacea laevigata*) recovery plan. U.S. Department of Interior, Fish and Wildlife Service, Southeast Region, Atlanta, Georgia. 37 pp.

U.S. Fish and Wildlife Service (FWS). 1997. Endangered species – gray bat. U.S. Department of Interior, Fish and Wildlife Service, Fort Snelling, Minnesota.

U.S. Fish and Wildlife Service (FWS). 2003. Roanoke Logperch (*Percina rex*) fact sheet. U.S. Department of Interior, Fish and Wildlife Service, Virginia Field Office. Gloucester, Virginia.

U.S. Fish and Wildlife Service (FWS). 2007a. Indiana bat (*Myotis sodalis*) draft recovery plan: First revision. U.S. Department of Interior, Fish and Wildlife Service, Fort Snelling, Minnesota. 258 pp.

U.S. Fish and Wildlife Service (FWS). 2007b. Roanoke logperch (*Percina rex*) 5-year review: summary and evaluation. Prepared By W. Hester and K. Smith, U.S. Department of Interior, U.S. Fish and Wildlife Service, Virginia Field Office, Gloucester, Virginia. 24 pp.

U.S. Fish and Wildlife Service (FWS). 2007c. Running buffalo clover (*Trifolium stoloniferum*) Recovery Plan: First Revision. U.S. Fish and Wildlife Service, Fort Snelling, MN. 76 pp.

U.S. Fish and Wildlife Service (FWS). 2008a. Virginia big-eared bat, (*Corynorhinus townsendii virginianus*) 5-year review: summary and evaluation. U.S. Department of Interior, Fish and Wildlife Service, West Virginia Field Office, Elkins, West Virginia. 21 pp.

U.S. Fish and Wildlife Service (FWS). 2008b. Clubshell (*Pleurobema clava*) 5-Year Review: Summary and Evaluation. Pennsylvania Field Office. State College, Pennsylvania.

U.S. Fish and Wildlife Service (FWS). 2008c. Northeastern Bulrush (*Scirpus ancistrochaetus*) 5-Year Review: Summary and Evaluation. State College, Pennsylvania. 55 pp.

U.S. Fish and Wildlife Service (FWS). 2008d. Smooth Coneflower (*Echinacea laevigata*) 5-Year Review: Summary and Evaluation. Raleigh, North Carolina. 30 pp.

U.S. Fish and Wildlife Service (FWS). 2009. Gray Bat (*Myotis grisescens*) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service Midwest Region Columbia, Missouri Ecological Services Field Office. Columbia, Missouri. September 30, 2009.

U.S. Fish and Wildlife Service (FWS). 2011a. Virginia Big-eared Bat *Plecotus townsendii virginianus*. Fact Sheet. Prepared by U.S. Fish and Wildlife Service Asheville Field Office 160 Zillicoa Street Asheville, North Carolina 28801. November 2011.

U.S. Fish and Wildlife Service. 2011b. Virginia spiraea *Spiraea virginiana* Fact Sheet. Available at: https://www.fws.gov/asheville/htmls/listed_species/Virginia_spiraea.html. Accessed December 16, 2016.

U.S. Fish and Wildlife Service (FWS). 2012. Determination of Endangered Status for the Rayed Bean and Snuffbox Mussels Throughout Their Ranges; Final Rule. Federal Register. Volume 77, Number 30. February 14, 2012. Page 8632.

U.S. Fish and Wildlife Service (FWS). 2013a. Final Biological Opinion on the Effects of the Programmatic Forest Management Plan for Potential Indiana Bat Habitat Areas on Wildlife Management Areas for which the West Virginia Division of Natural Resources, Wildlife Resource Section Has Forest Management Authority. Available at: https://www.fws.gov/midwest/endangered/mammals/inba/bos/13_WV_WVDNRforestMgmntBO.pdf.

U.S. Fish and Wildlife Service (FWS). 2013b. Biological Opinion on an Application for an Incidental Take Permit Submitted by Beech Ridge Energy LLC for the Beech Ridge Wind Energy Project, in Greenbrier and Nicholas Counties, West Virginia. United States Department of the Interior Fish and Wildlife Service West Virginia Field Office 694 Beverly Pike Elkins, West Virginia 26241. December 3, 2013.

U.S. Fish and Wildlife Service (FWS). 2014. Northern long-eared bat interim conference and planning guidance: USFWS Regions 2, 3, 4, 5, & 6. U.S. Department of Interior, Fish and Wildlife Service. 67 pp.

U.S. Fish and Wildlife Service (FWS). 2015a. Range-wide population estimate for the Indiana bat (*Myotis sodalis*) by USFWS region. U.S. Department of Interior, Fish and Wildlife Service, Ecological Services Field Office, Bloomington, Indiana.

U.S. Fish and Wildlife Service (FWS). 2015b. Northern Long-Eared Bat Fact Sheet. Available at: https://www.fws.gov/Midwest/endangered/mammals/nleb/pdf/NLEBFactSheet01April2015.pdf.

U.S. Fish and Wildlife Service (FWS). 2016a. Endangered Species Program – About Us/Frequently Asked Questions/Species Status Codes. Available at: https://www.fws.gov/endangered/about/listing-status-codes.html.

U.S. Fish and Wildlife Service (FWS). 2016b. Small Whorled Pogonia *Isotia medeoloides* Fact Sheet. Available at: https://www.fws.gov/midwest/endangered/plants/pdf/smallwhorledpogoniafctsht.pdf. February 2016.

U.S. Fish and Wildlife Service (FWS). 2016c. Programmatic biological opinion on final 4(d) rule for the northern long-eared bat and activities excepted from take prohibitions. U.S. Department of the Interior, Fish and Wildlife Service, Midwest Regional Office, Bloomington, Minnesota. 103 pp.

U.S. Fish and Wildlife Service (FWS). 2017a. Species status assessment report for the Yellow Lance (Elliptio lanceolata). Version 1.2. March, 2017. Atlanta, GA.

U.S. Fish and Wildlife Service (FWS). 2017b. Endangered and Threatened Wildlife and Plants; Endangered Species Status for Rusty Patched Bumble Bee. Volume 82, Number 7 (Wednesday, January 11, 2017). Available at: https://www.gpo.gov/fdsys/pkg/FR-2017-01-11/pdf/2017-00195.pdf.

U.S. Fish and Wildlife Service (FWS). 2017c. Interim Guidance for Implementing the Endangered Species Act Compensatory Mitigation Policy. January 2017.

U.S. Fish and Wildlife Service (FWS) – Environmental Conservation Online System (ECOS). 2016. Available at: https://ecos.fws.gov/ecp/. Updated September 2, 2016.

U.S. Fish and Wildlife Service (FWS) and National Marine Fisheries Service (NMFS). 1998. Endangered species consultation handbook, procedures for conducting section 7 consultations and conferences. U.S. Department of Interior, Fish and Wildlife Service and National Marine Fisheries Service, 371pp.

U.S. Forest Service (FS). 2010. The Mountain State's Forests – Trends in the Resource - West Virginia Forest Resource Assessment. Available at: http://www.fs.fed.us/ne/newtown_square/publications/brochures/pdfs/state_forests/wv_forest.pdf.

U.S. Forest Service (FS). 2011. Conservation and management of eastern big-eared bats: a symposium (S.C. Loeb, M.J. Lacki, and D.A. Miller, eds.) U.S. Department of Agriculture, Forest Service, Southern Research Station General Technical Report SRS-145, Asheville, North Carolina. 168 pp.

U.S. Geological Survey (USGS). 1997. Ground Water Atlas of the United States: Segment 7- Delaware, Maryland, New Jersey, North Carolina, Pennsylvania, Virginia, West Virginia. HA 730-L.

Virginia Department of Environmental Quality (VADEQ). 1995. Virginia Erosion & Sediment Control Field Manual. Second Edition.

Virginia Department of Environmental Quality (VADEQ). 2015a. Digital information regarding public water supply locations. Available at: http://www.deq.virginia.gov/Programs/Water/WaterSupplyWaterQuantity.aspx.

Virginia Department of Environmental Quality (VADEQ). 2015b. Fish EDAS Database. Virginia Department of Environmental Quality Probabilistic Monitoring Program. Available at: http://www.deq.virginia.gov/Programs/Water/WaterQualityInformationTMDLs/WaterQualityMonitoring/ProbabilisticMonitoring/ProbMonDataSources.aspx.

Virginia Department of Forestry. 2010. Statewide Assessment of Forest resources. Accessed at http://www.dof.virginia.gov/infopubs/State-Assessment-2010_pub.pdf.

Virginia Department of Conservation and Recreation (VADCR). 2007. Virginia natural landscape assessment. Available at: http://www.dcr.virginia.gov/natural_heritage/vaconvisvnla.shtml.

Watrous, K. S., T. M. Donovan, R. M. Mickey, S. R. Darling, A. Hicks, and S. L. Von Oettingen. 2006. Predicting minimum habitat characteristics for the Indiana bat in the Champlain Valley. Journal of Wildlife Management 70:1228-1237.

Wickham, J. D., K. H. Riitters, T. G. Wade, M. Coan, and C. Homer. 2007. The effect of Appalachian mountaintop mining on interior forest. Landscape Ecology 22:179–187.

Watters, G. T., M. A. Hoggarth, and D. H. Stansbery. 2009. The freshwater mussels of Ohio. The Ohio State University Press, Columbus, Ohio. 421 pp.

Weatherspark. 2017. Average Weather in Blacksburg, Virginia. Available at: https://weatherspark.com/averages/29718/Blacksburg-Virginia-United-States.

West Virginia Department of Environmental Protection (WVDEP). 2015. Annual Progress Report to the WV Joint Legislative Oversight Commission on State Water Resources. Water Use Section. October 18, 2015. Available at: http://www.dep.wv.gov/WWE/wateruse/Documents/2015%20Annual%20Report.pdf.

West Virginia Division of Forestry. 2010. Statewide Forest Resource Assessment. http://www.wvforestry.com/DOF100Assessment_Revised_091310_Part1.pdf.

West Virginia Geological and Economic Survey (WVGES). 2017. Physiographic provinces of West Virginia. Available at: http://www.wvgs.wvnet.edu/www/geology/geolphyp.htm. West Virginia Geological & Economic Survey Website. Page last revised May 22, 2017.

Whitaker, J. O., Jr. and V. Brack, Jr. 2002. Distribution and summer ecology in Indiana. Pages 48-54 in The Indiana Bat: Biology and Management of an Endangered Species (A. Kurta and J. Kennedy, eds.). Bat Conservation International, Austin, Texas.

Whitaker, J. O., Jr. 2004. Prey selection in a temperate zone insectivorous bat community. Journal of Mammalogy 85:460–469.

Whitaker, J. O., Jr. and R. E. Mumford. 2009. Mammals of Indiana. Indiana University Press. Bloomington, Indiana, 661 pp.

Whitaker, J. O., Jr and L. J. Rissler. 1992. Seasonal activity of bats at Copperhead Cave. Proceedings of the Indiana Academy of Science 101:127-134.

Whitaker, J. O., Jr and D. W. Sparks. 2008. Roosts of Indiana bats (*Myotis sodalis*) near the Indianapolis International Airport (1997-2001). Proceedings of the Indiana Academy of Science 117:193-202.

Whitaker, J. O., Jr., D. W. Sparks, and V. Brack, Jr. 2004. Bats of the Indianapolis International airport area, 1991–2001. Proceedings of the Indiana Academy of Science 113:151-161.

Wieboldt, T. F. 1987. The shale barren endemic, *Arabis serotina* (Brassicaceae). Sida 12:381-389.

Yelverton, J. T., D. R. Richmond, W. Hicks, H. Saunders, and E. R. Fletcher. 1975. The relationship between fish size and their response to underwater blast. Prepared for the Defense Nuclear Agency. Lovelace Foundation for Medical Education and Research Topical Report, DNA 3677T, Albuquerque, NM.

Zuur, A., E. N. leno, N. Walker, A. A. Saveliev, and G. M. Smith. 2009. Mixed Effects Models and Extensions in Ecology with R. Springer-Verlag, New York, New York. 574 pp.

APPENDIX A

Agency Coorespondence

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APPENDIX B

Action Area Maps

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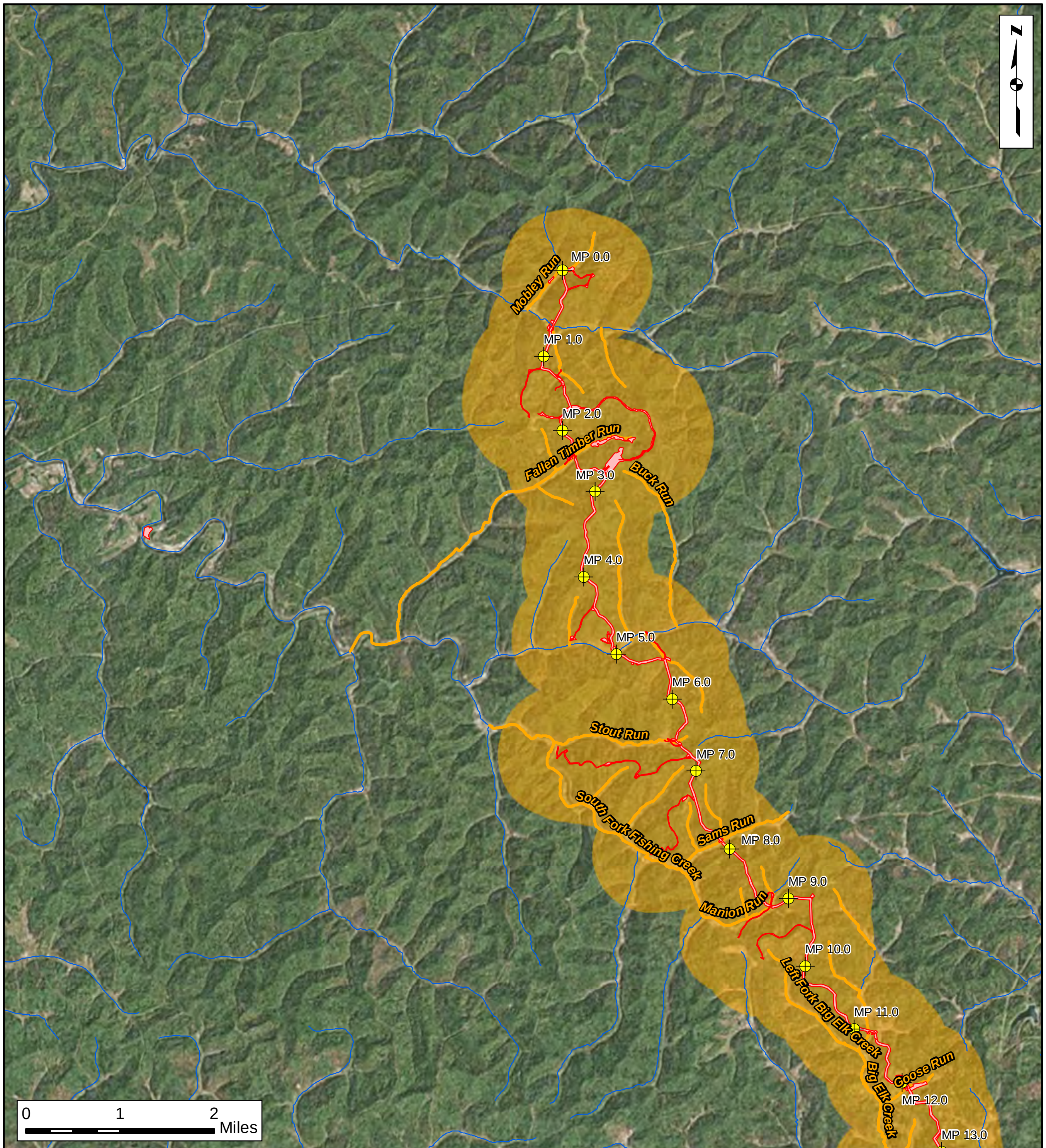
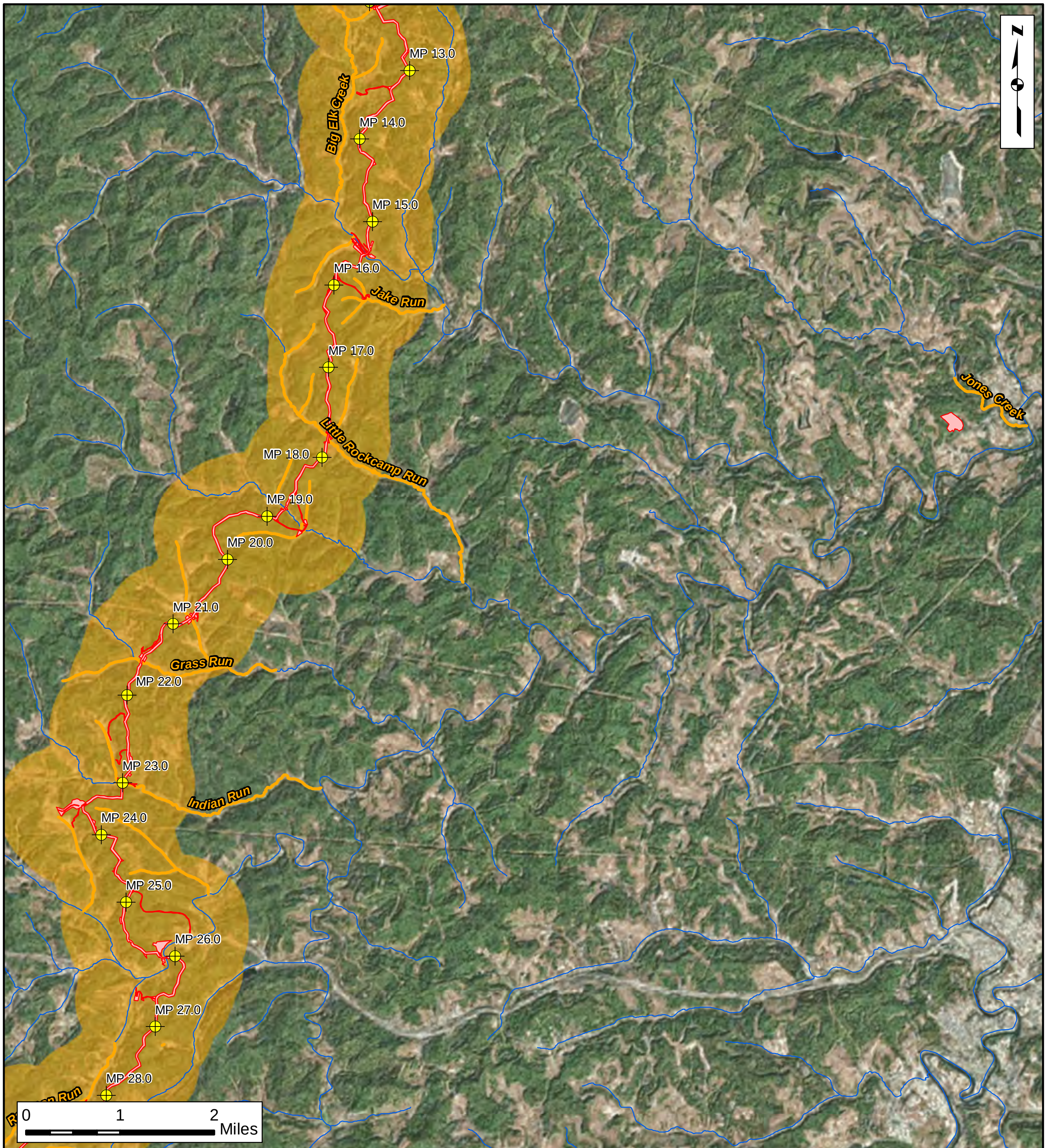


Proposed Limit of Disturbance
Action Area
Stream

Appendix B

Mountain Valley Project

Action Area Maps (Sheet 1 of 25)



Proposed Limit of Disturbance

Action Area

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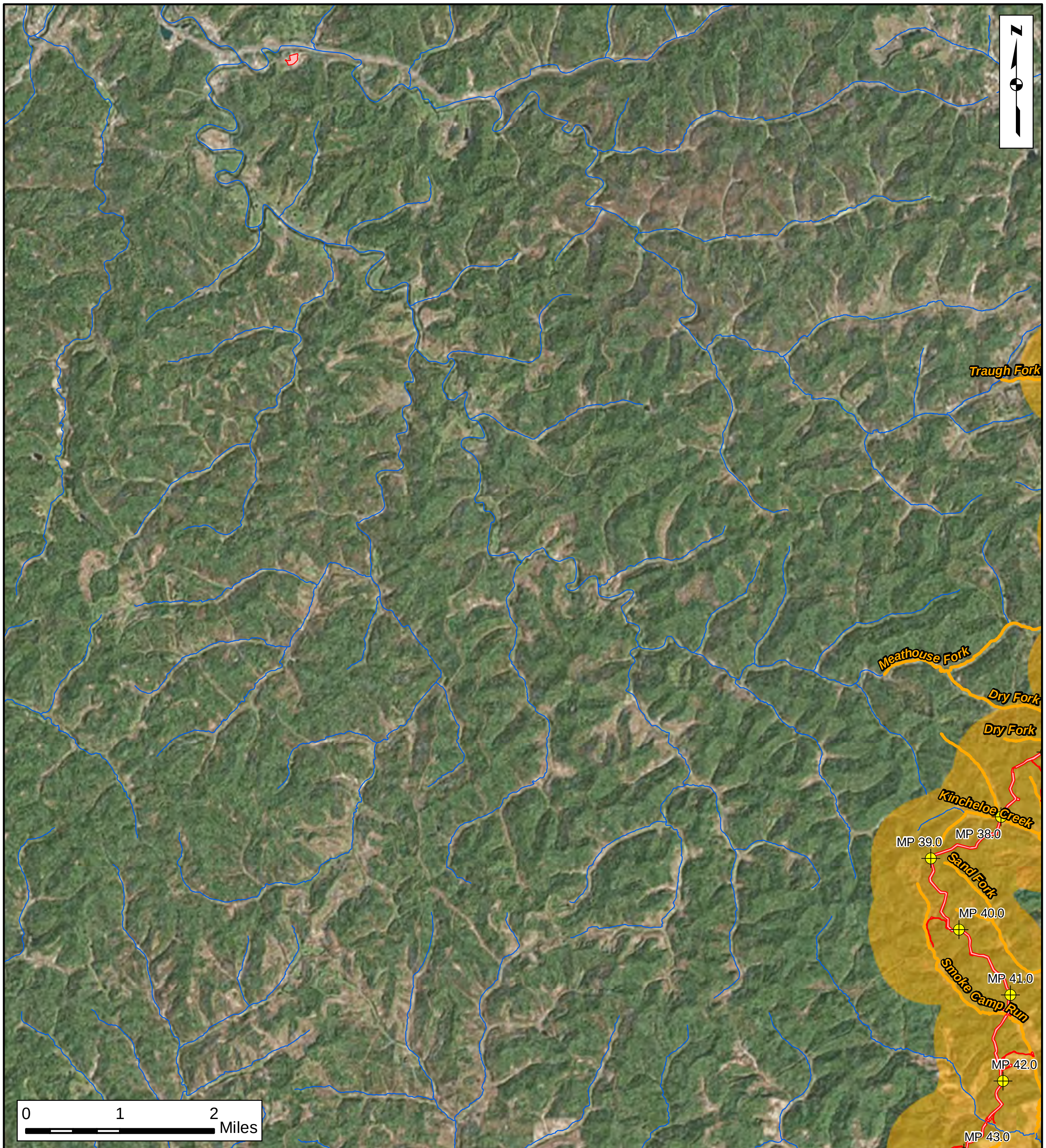
Appendix B

Mountain Valley Project

Action Area Maps (Sheet 2 of 25)



Proposed Limit of Disturbance

Action Area

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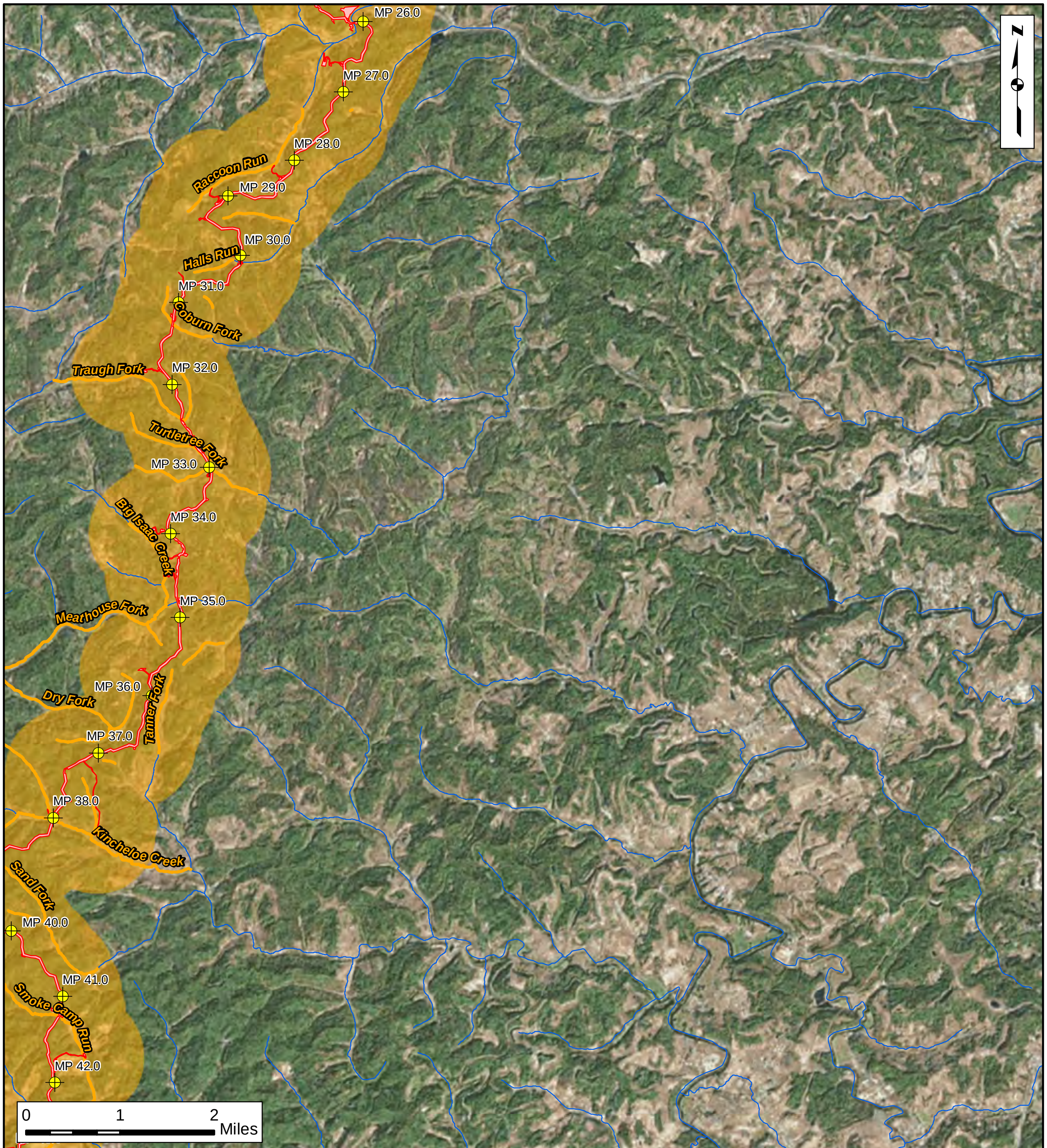
Appendix B

Mountain Valley Project

Action Area Maps (Sheet 3 of 25)



Proposed Limit of Disturbance
Action Area
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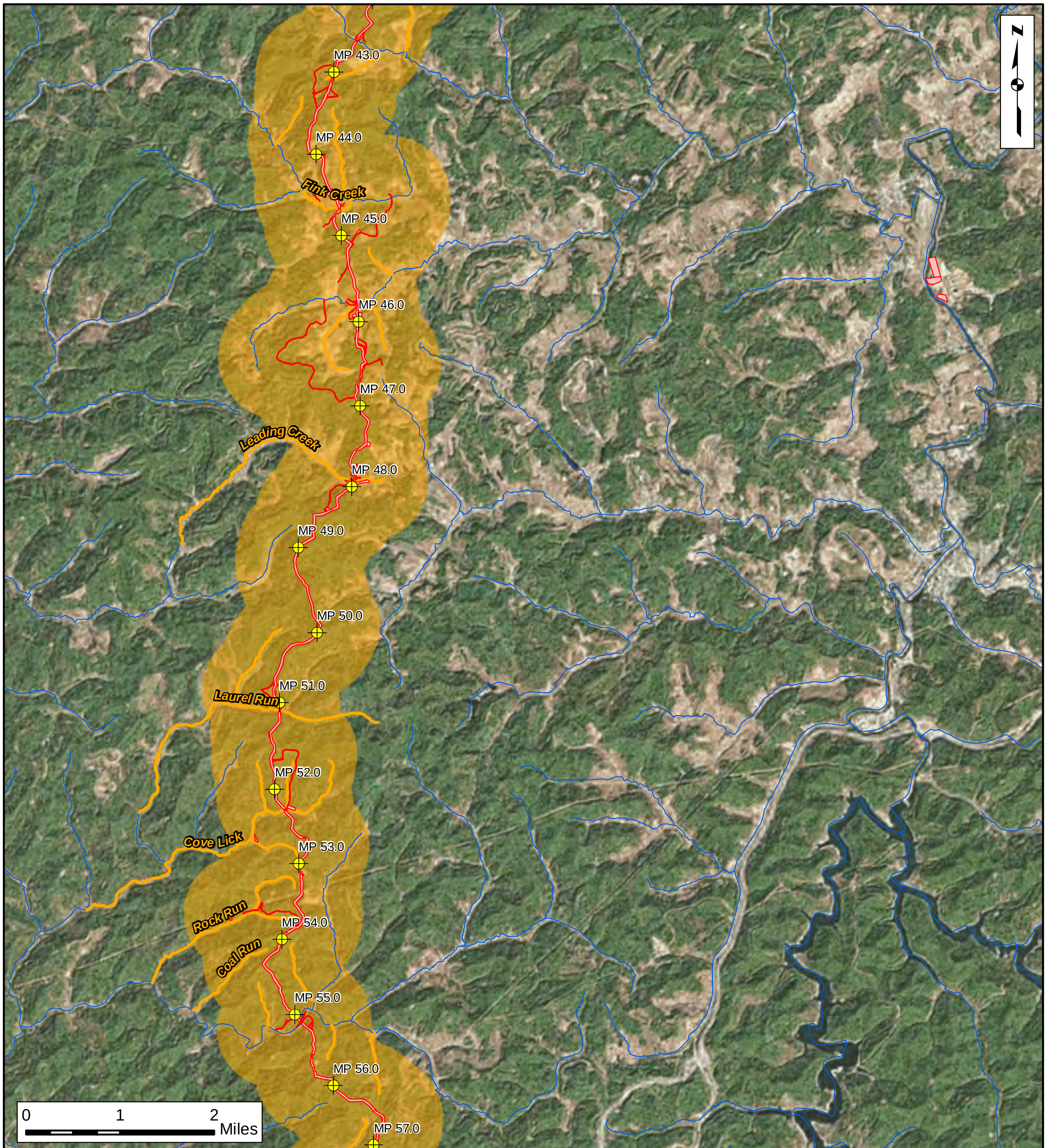
Appendix B

Mountain Valley Project

Action Area Maps (Sheet 4 of 25)

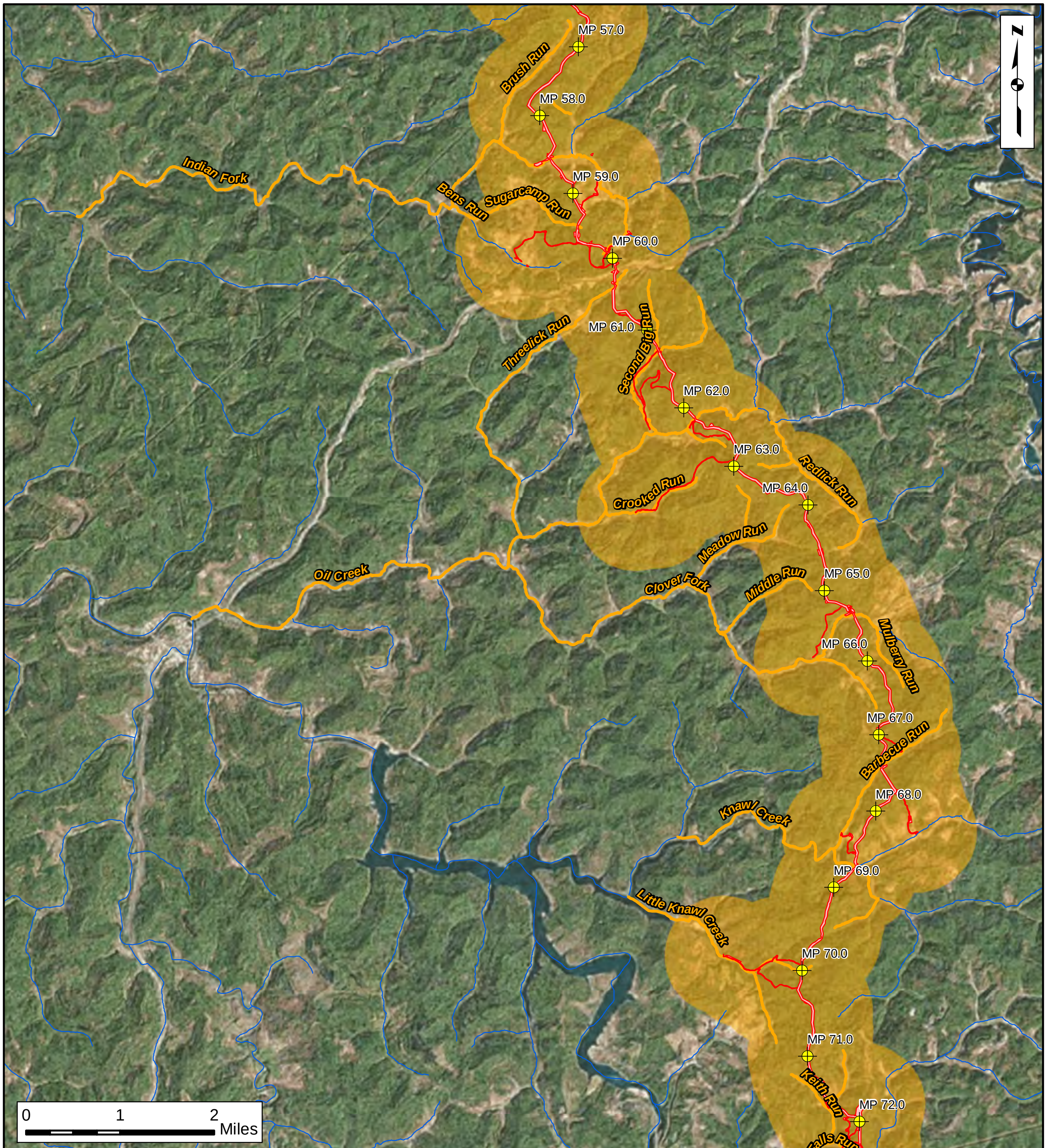


Proposed Limit of Disturbance
Action Area
Stream

Appendix B

Mountain Valley Project

Action Area Maps (Sheet 5 of 25)



Proposed Limit of Disturbance
Action Area
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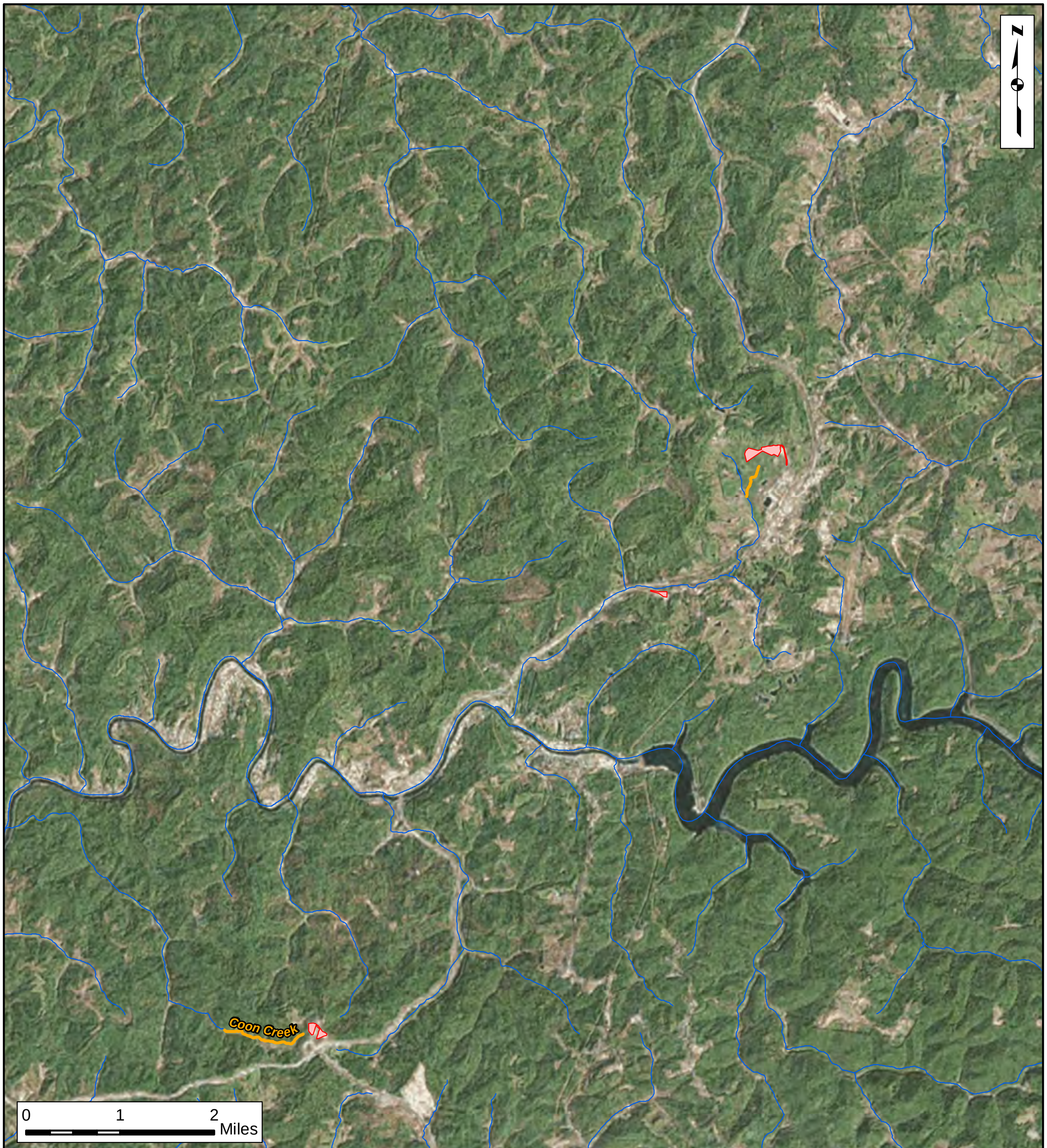
Appendix B

Mountain Valley Project

Action Area Maps (Sheet 6 of 25)

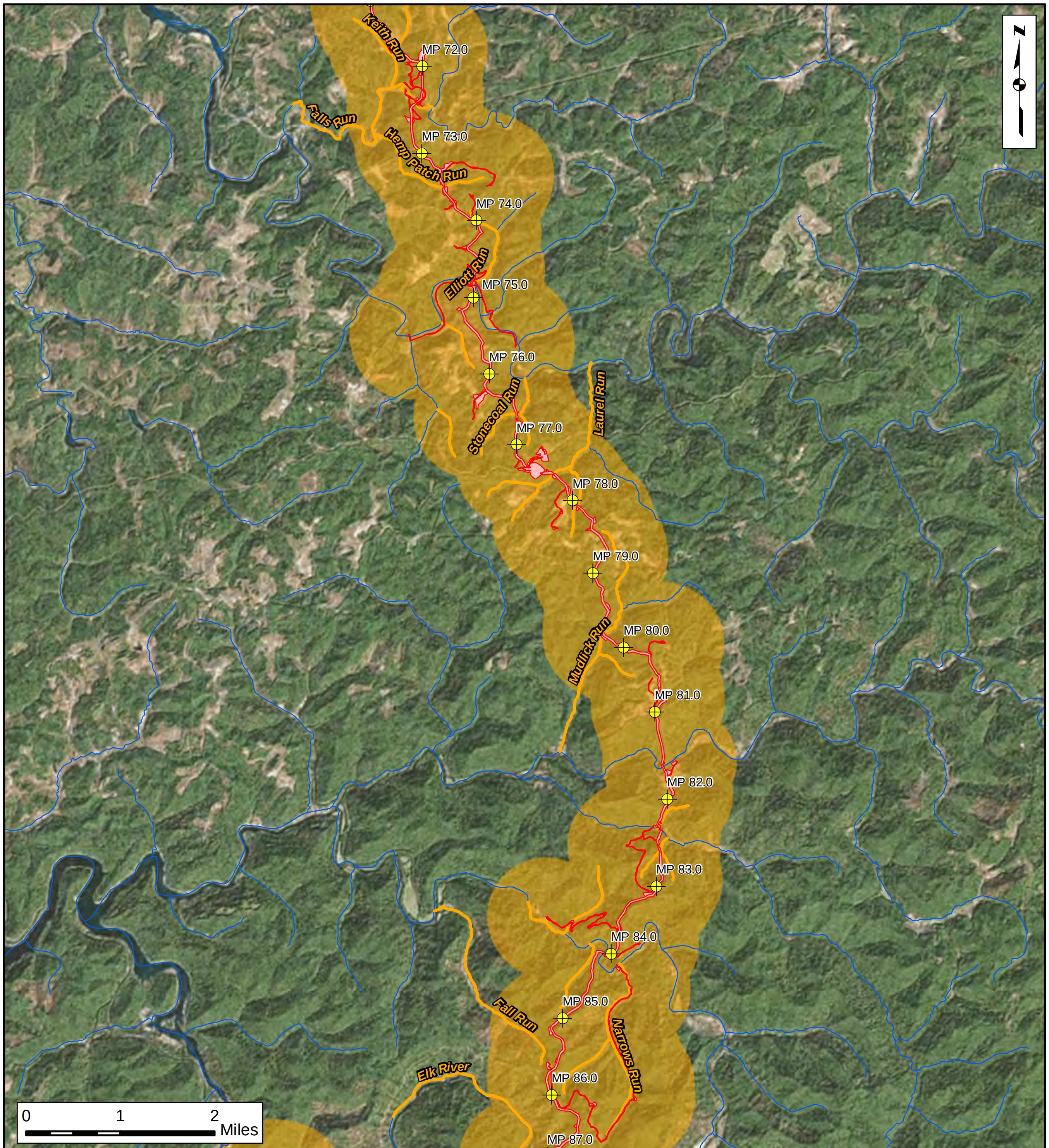


Proposed Limit of Disturbance
Action Area
Stream

Appendix B

Mountain Valley Project

Action Area Maps (Sheet 7 of 25)

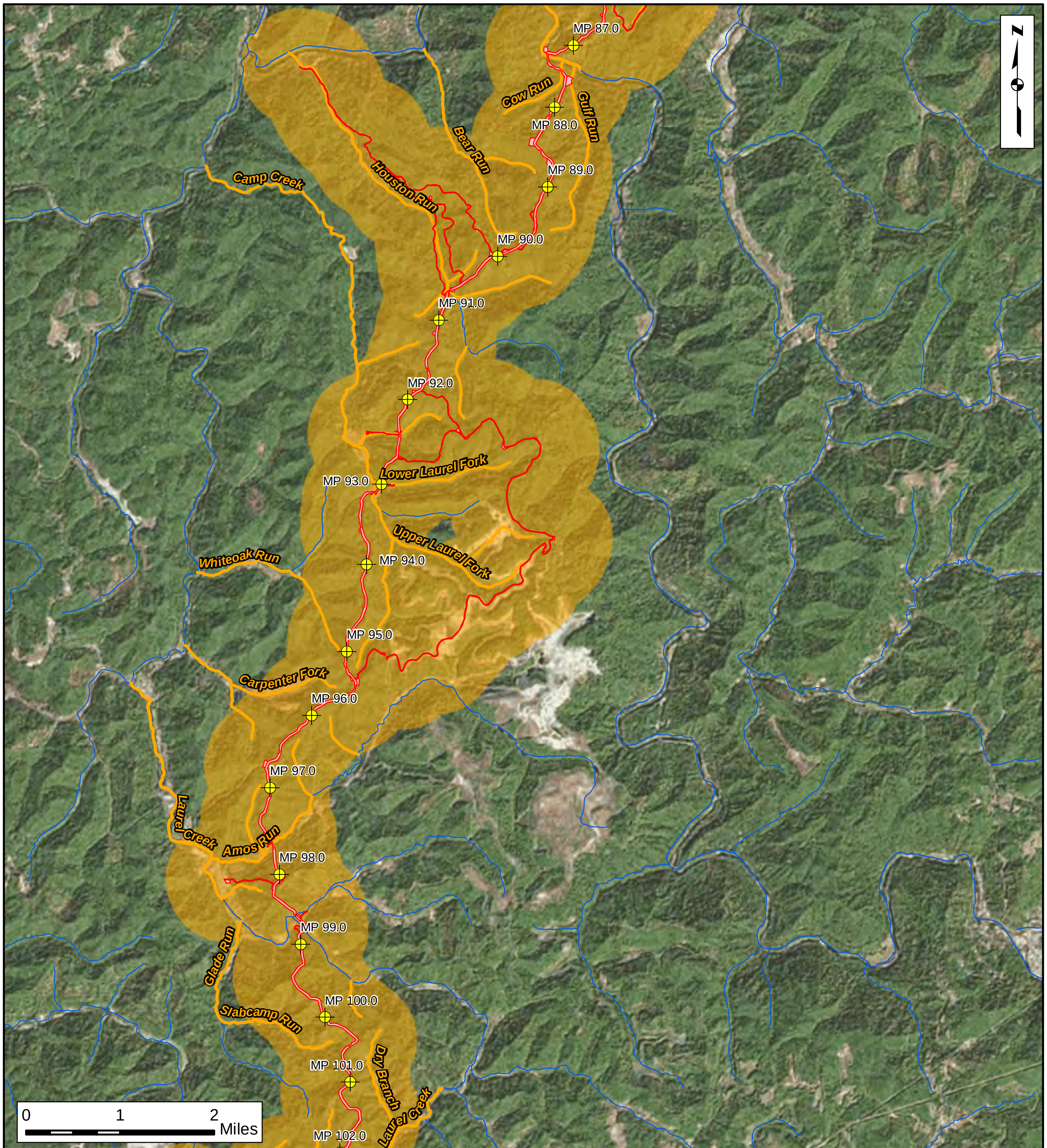


Proposed Limit of Disturbance
Action Area
Stream

Appendix B

Mountain Valley Project

Action Area Maps (Sheet 8 of 25)



Proposed Limit of Disturbance

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Mountain Valley Project

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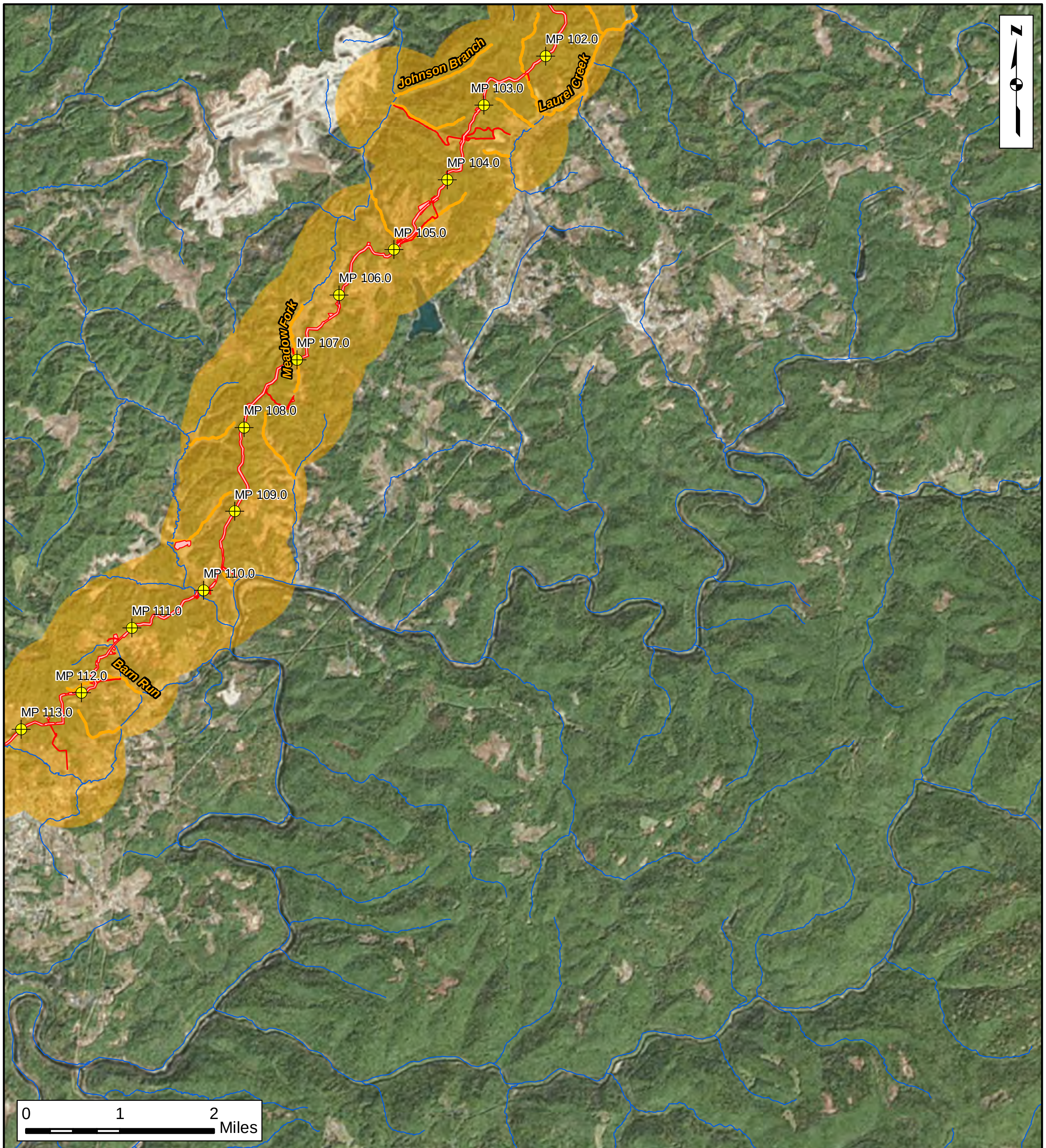

Proposed Limit of Disturbance
Action Area
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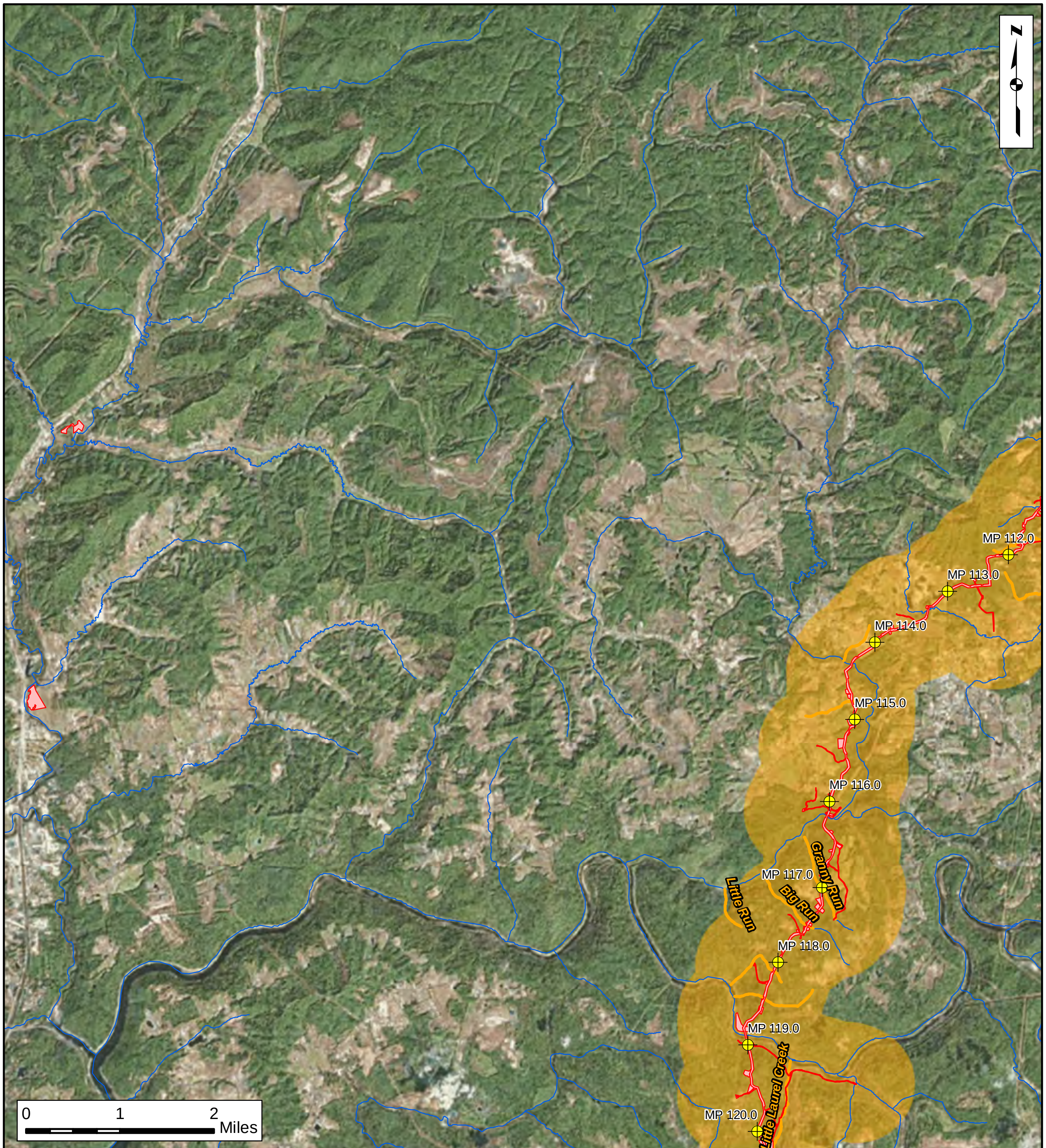
Appendix B

Mountain Valley Project

Action Area Maps (Sheet 10 of 25)



Proposed Limit of Disturbance
Action Area
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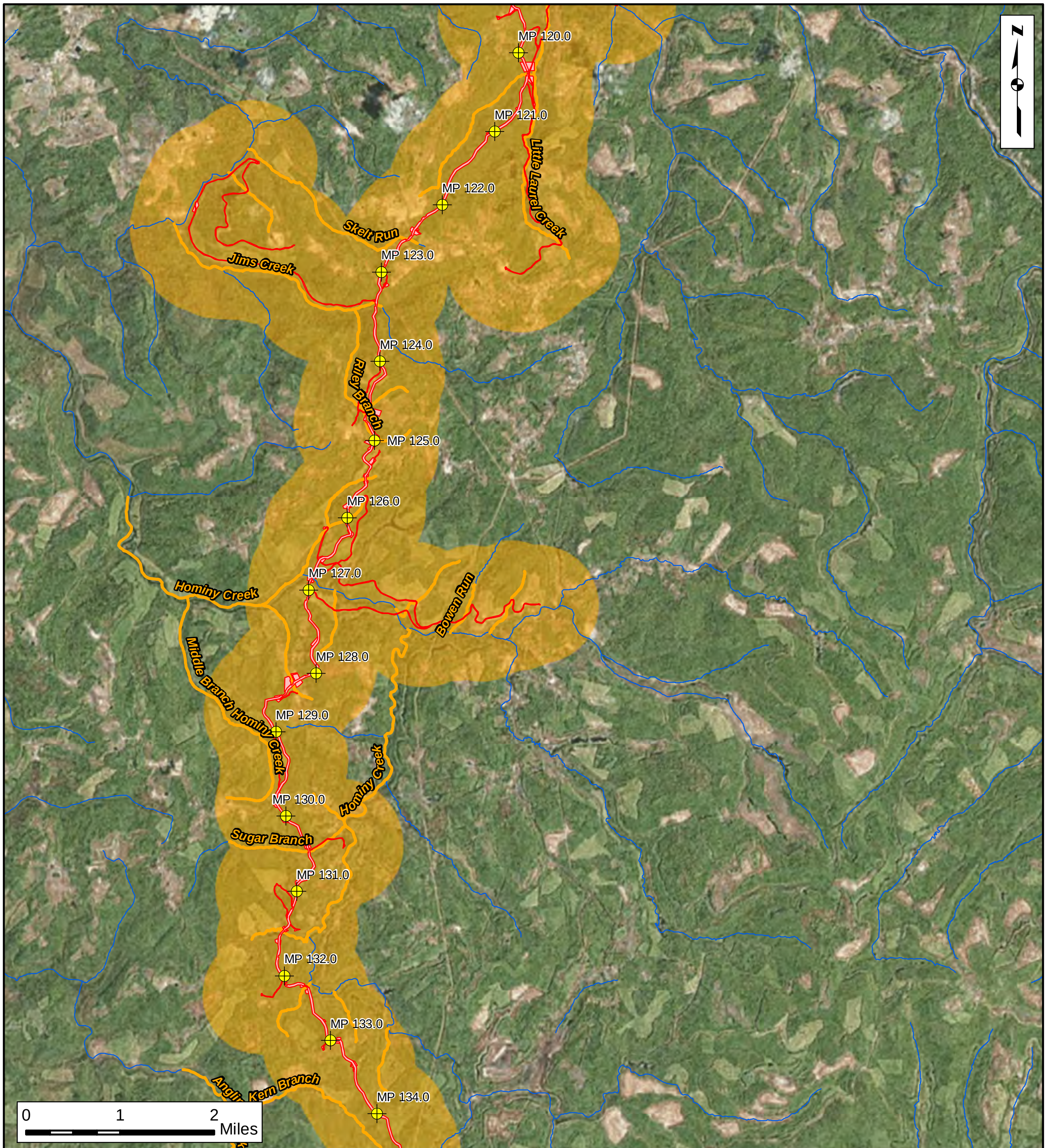
Appendix B

Mountain Valley Project

Action Area Maps (Sheet 11 of 25)



Proposed Limit of Disturbance

Action Area

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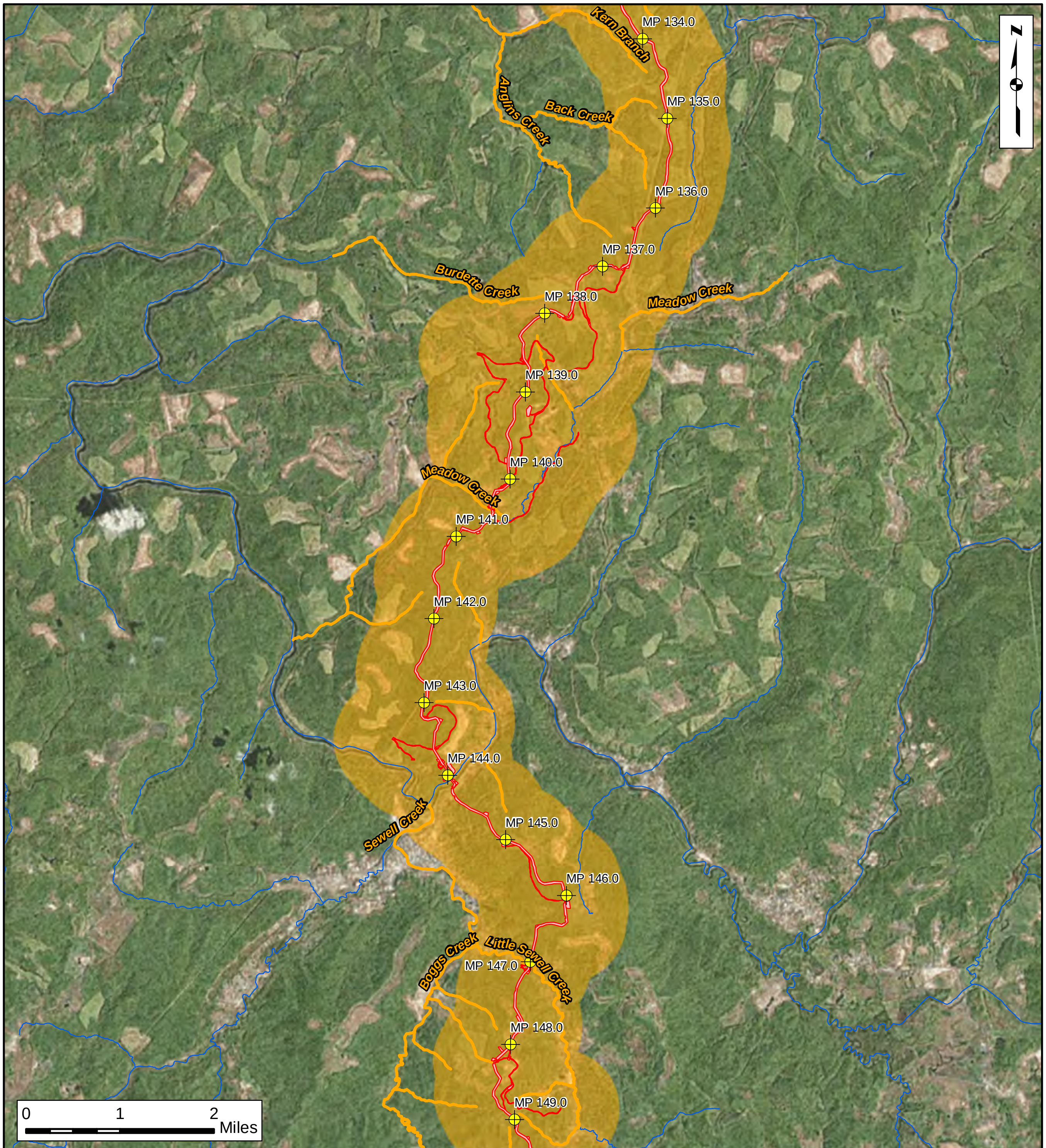
Appendix B

Mountain Valley Project

Action Area Maps (Sheet 12 of 25)



Proposed Limit of Disturbance
Action Area
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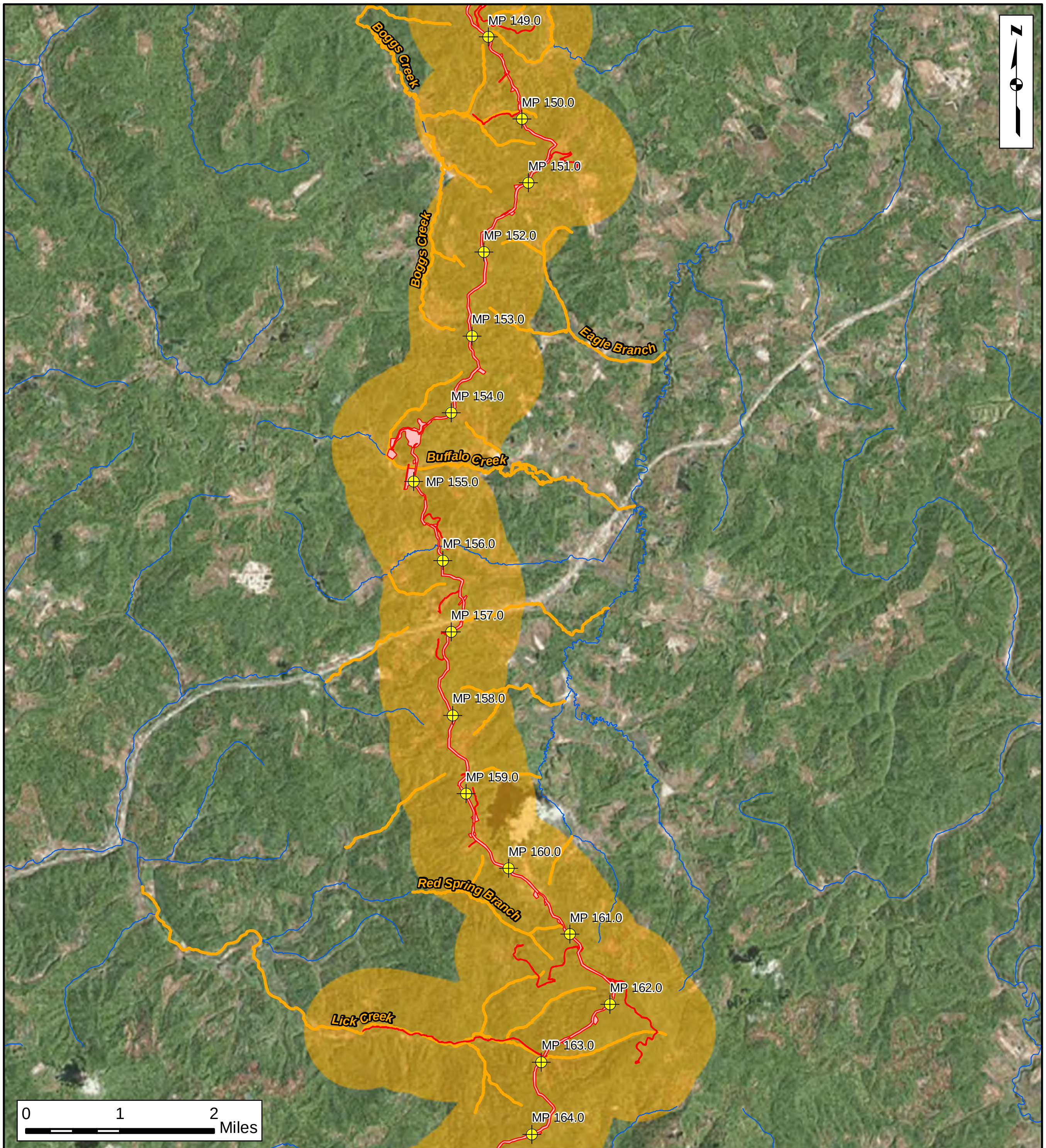
Mountain Valley Project

Action Area Maps (Sheet 13 of 25)



Proposed Limit of Disturbance
Action Area
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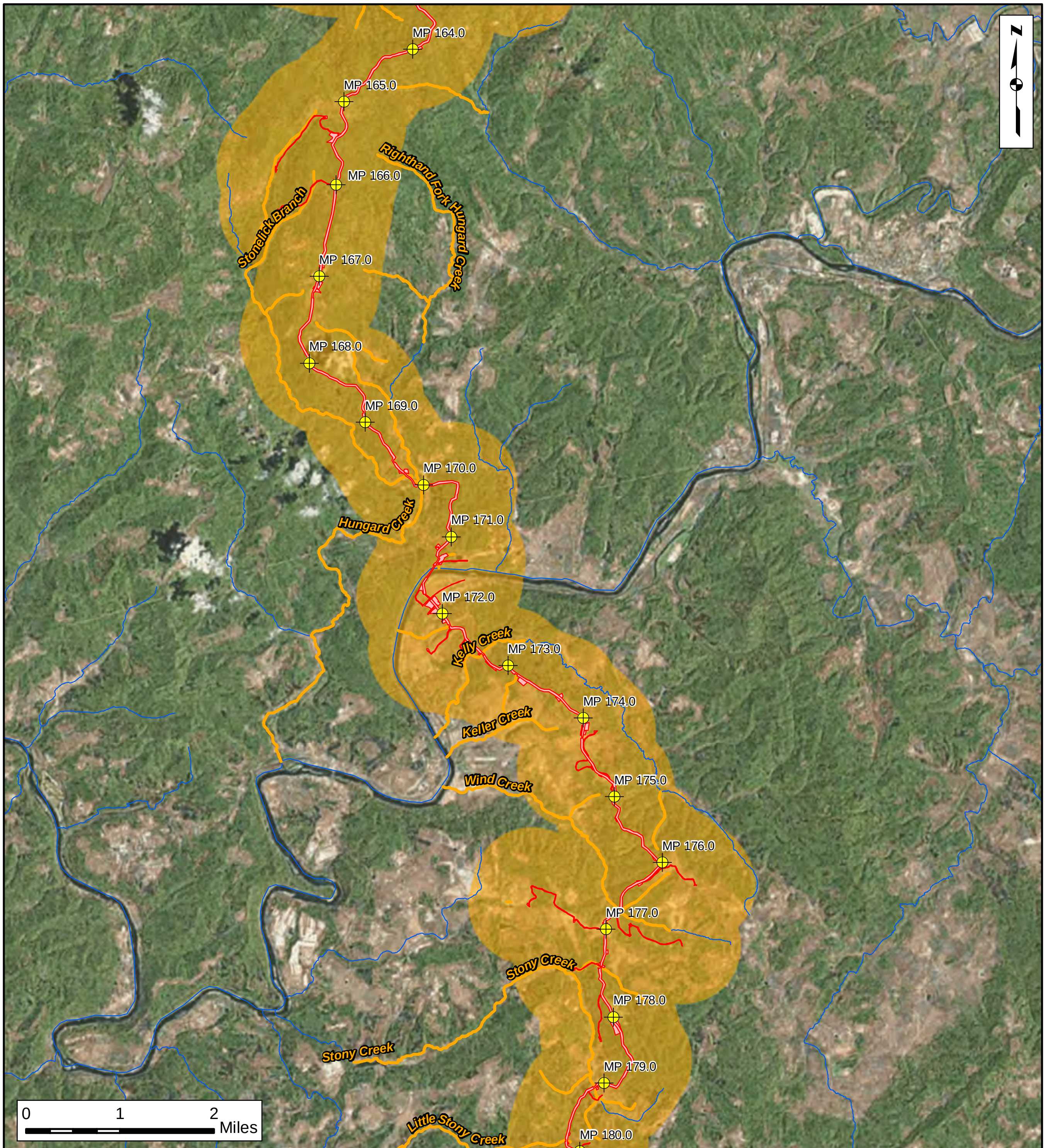
Appendix B

Mountain Valley Project

Action Area Maps (Sheet 14 of 25)



Proposed Limit of Disturbance

Action Area

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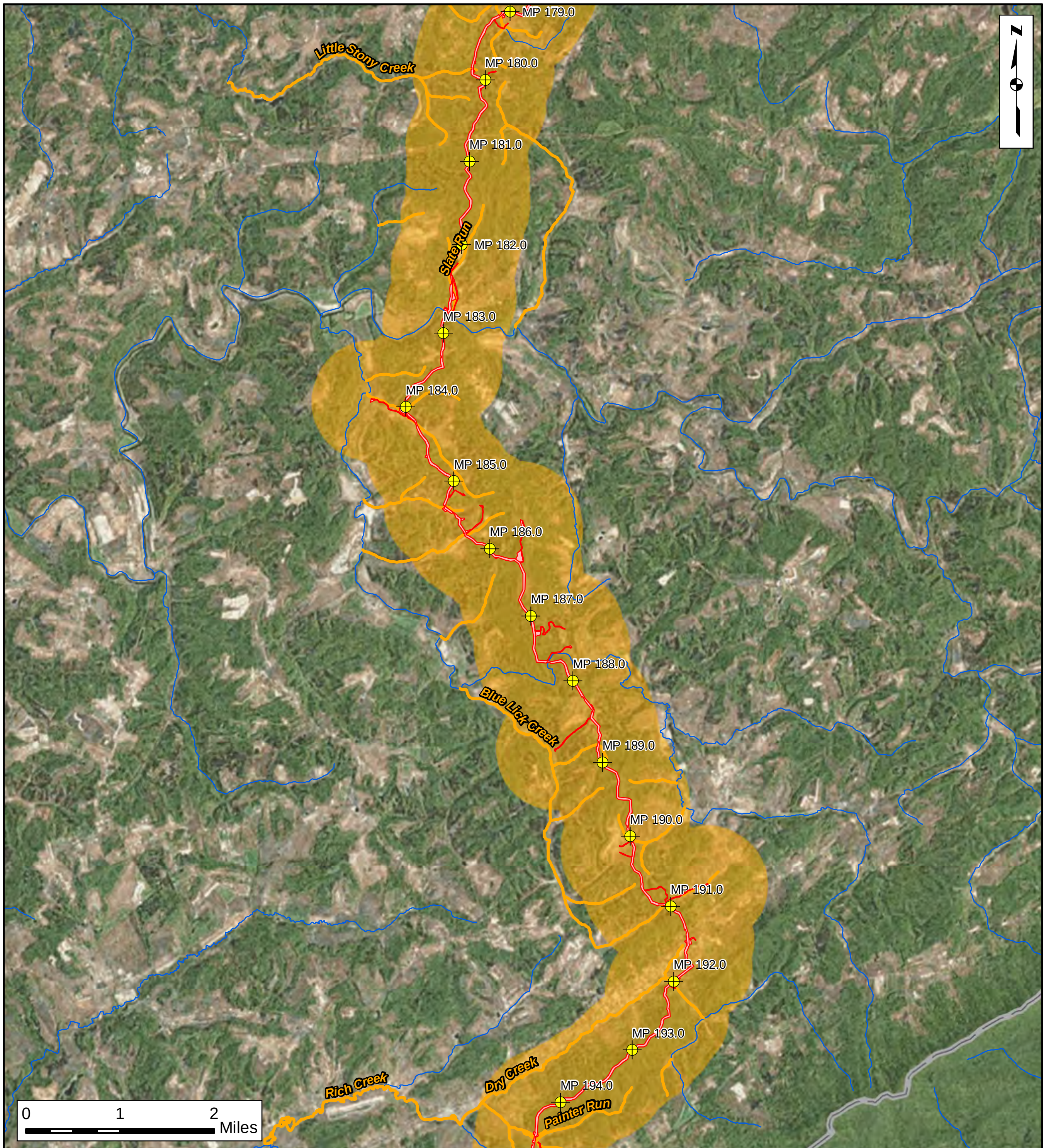
Appendix B

Mountain Valley Project

Action Area Maps (Sheet 15 of 25)



Proposed Limit of Disturbance

Action Area

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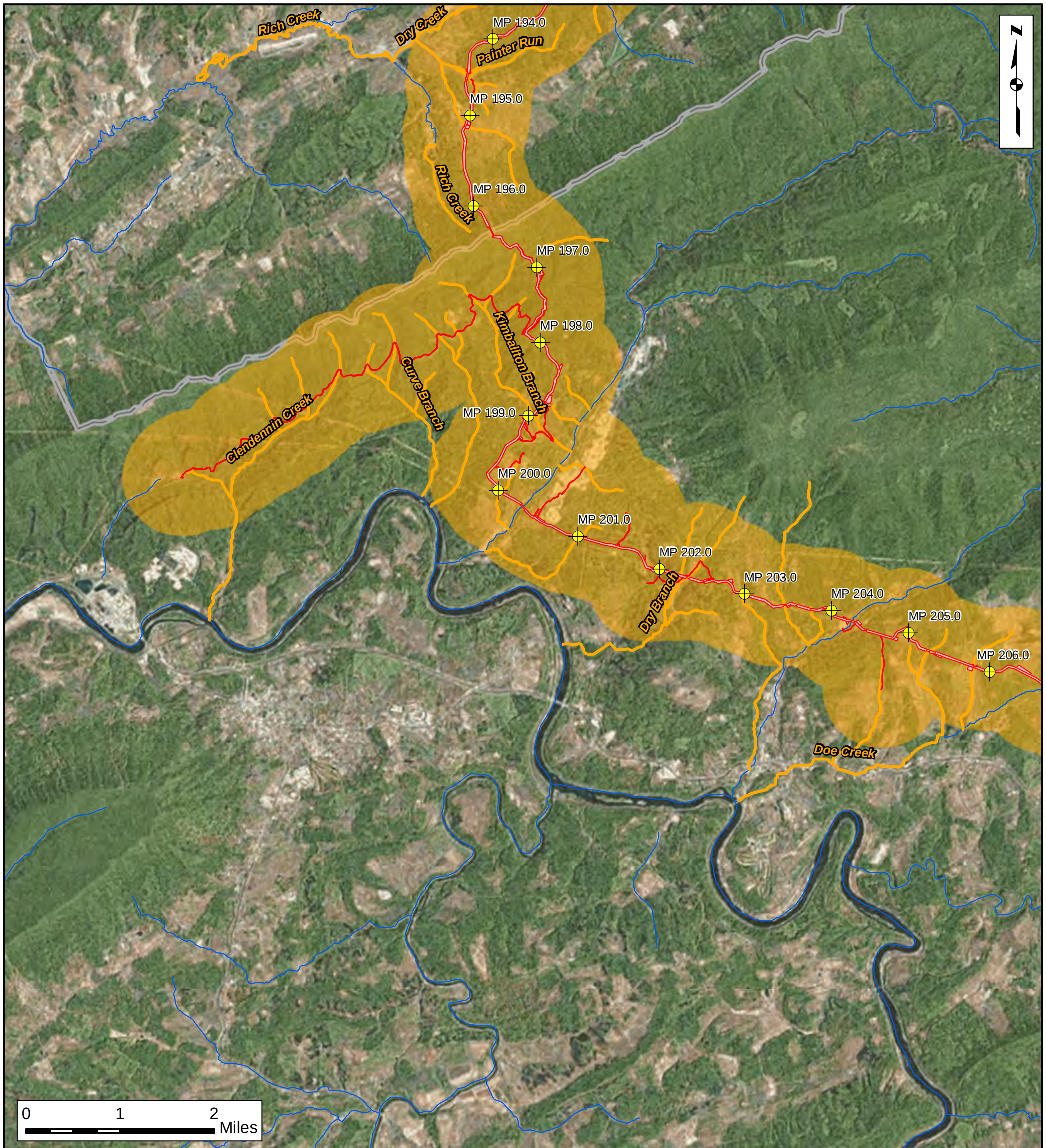
Appendix B

Mountain Valley Project

Action Area Maps (Sheet 16 of 25)



Proposed Limit of Disturbance
Action Area
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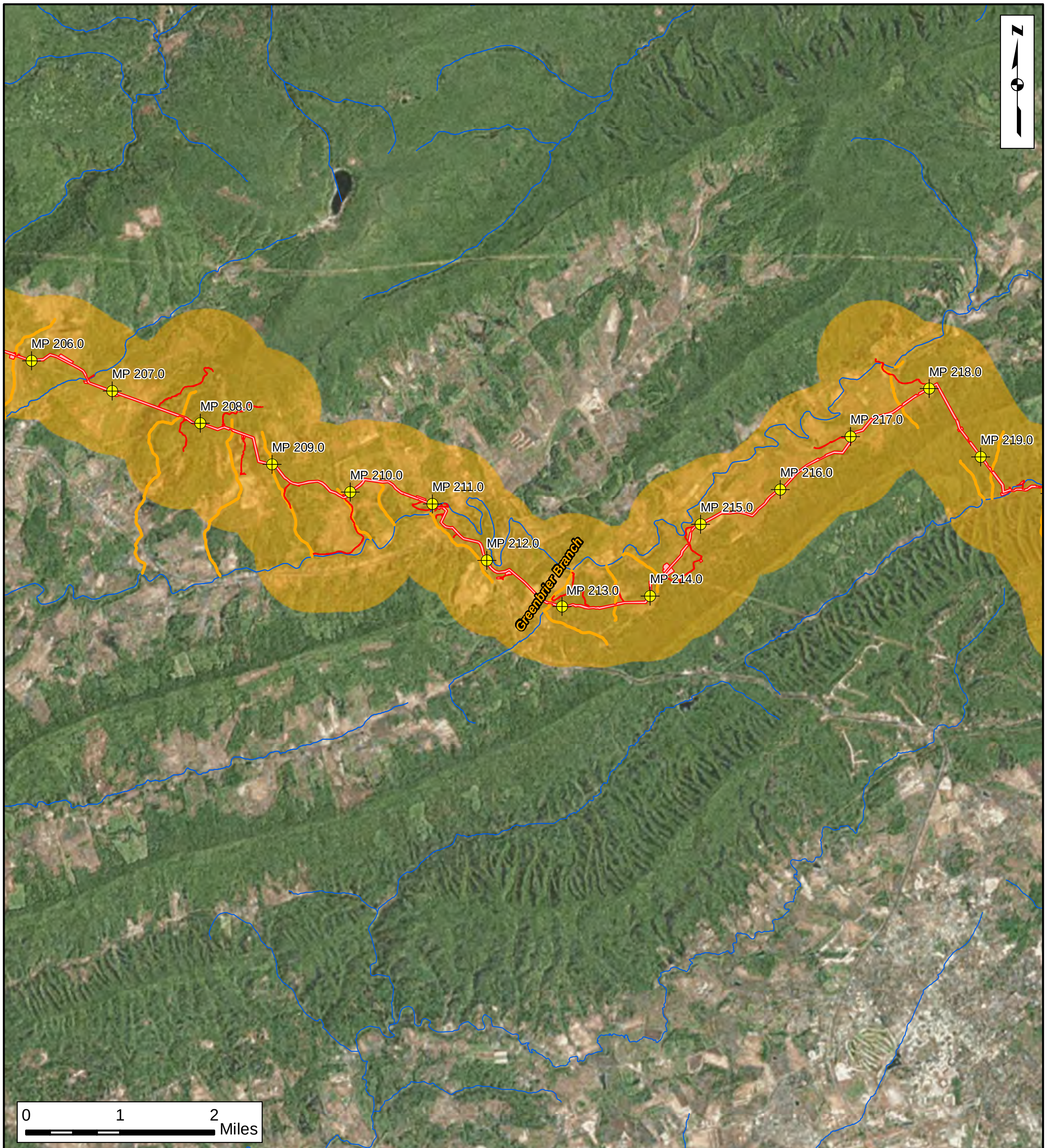
Appendix B

Mountain Valley Project

Action Area Maps (Sheet 17 of 25)



Proposed Limit of Disturbance

Action Area

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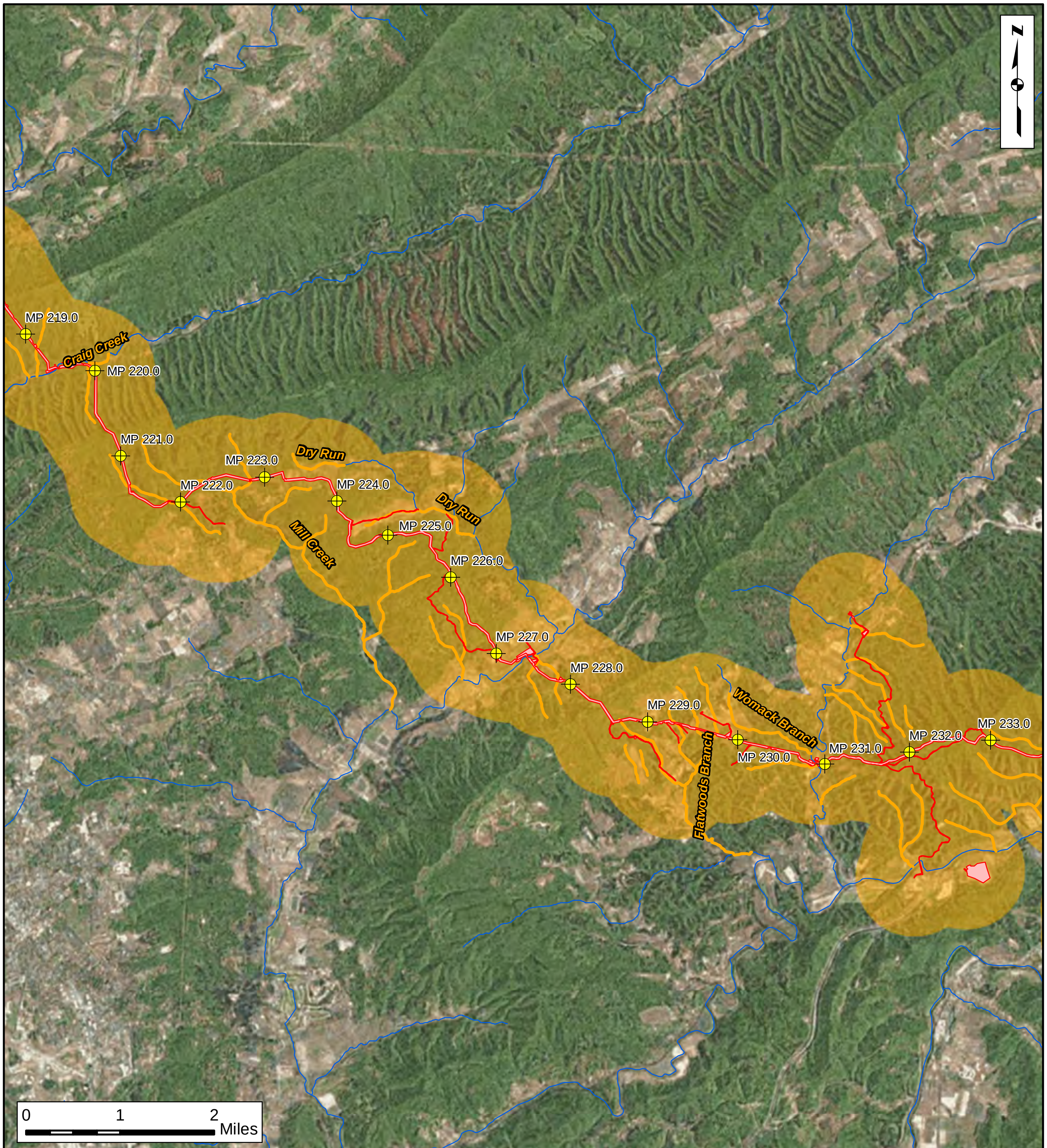
Appendix B

Mountain Valley Project

Action Area Maps (Sheet 18 of 25)



Proposed Limit of Disturbance

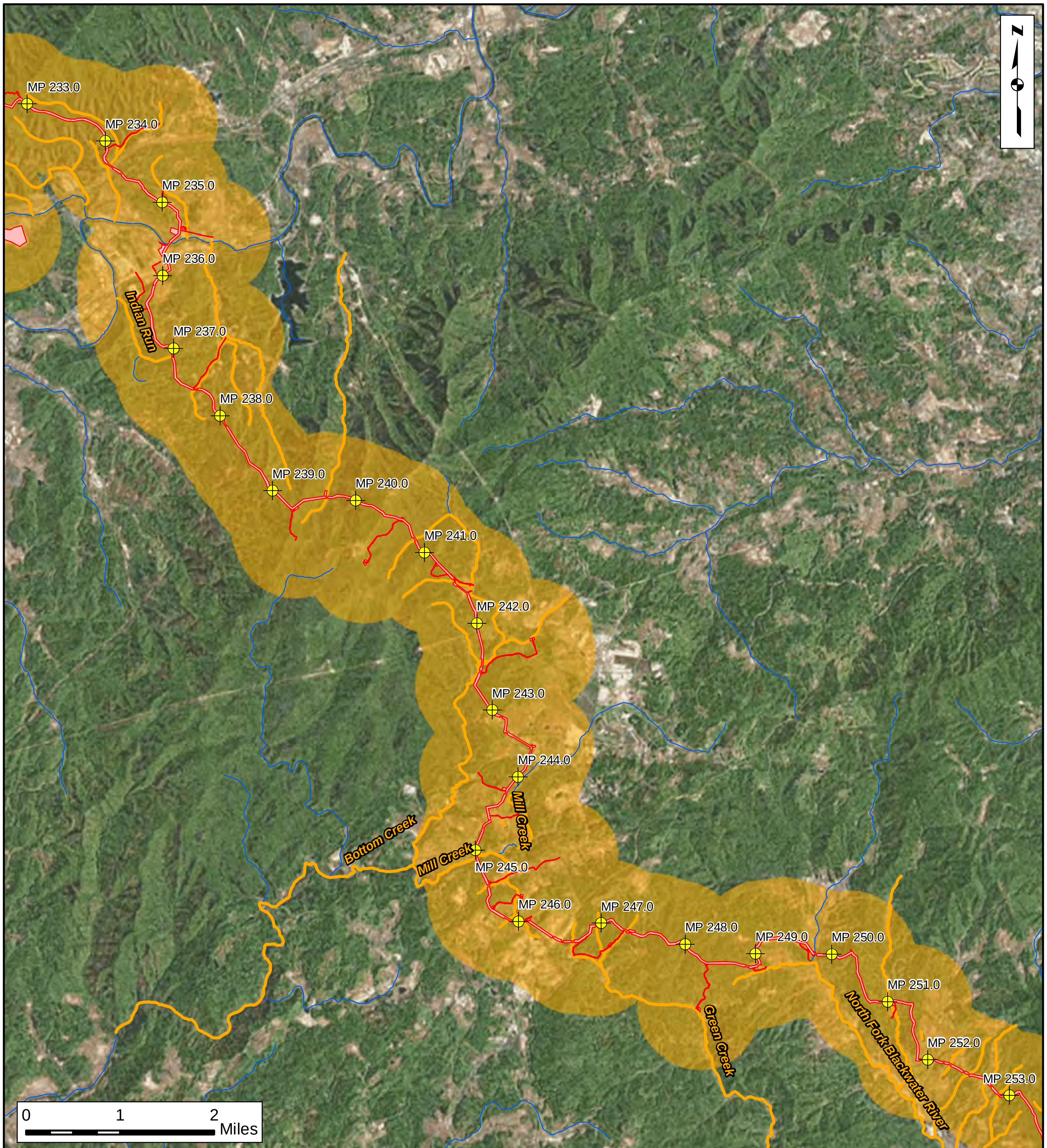
Action Area

Stream

Appendix B

Mountain Valley Project

Action Area Maps (Sheet 19 of 25)

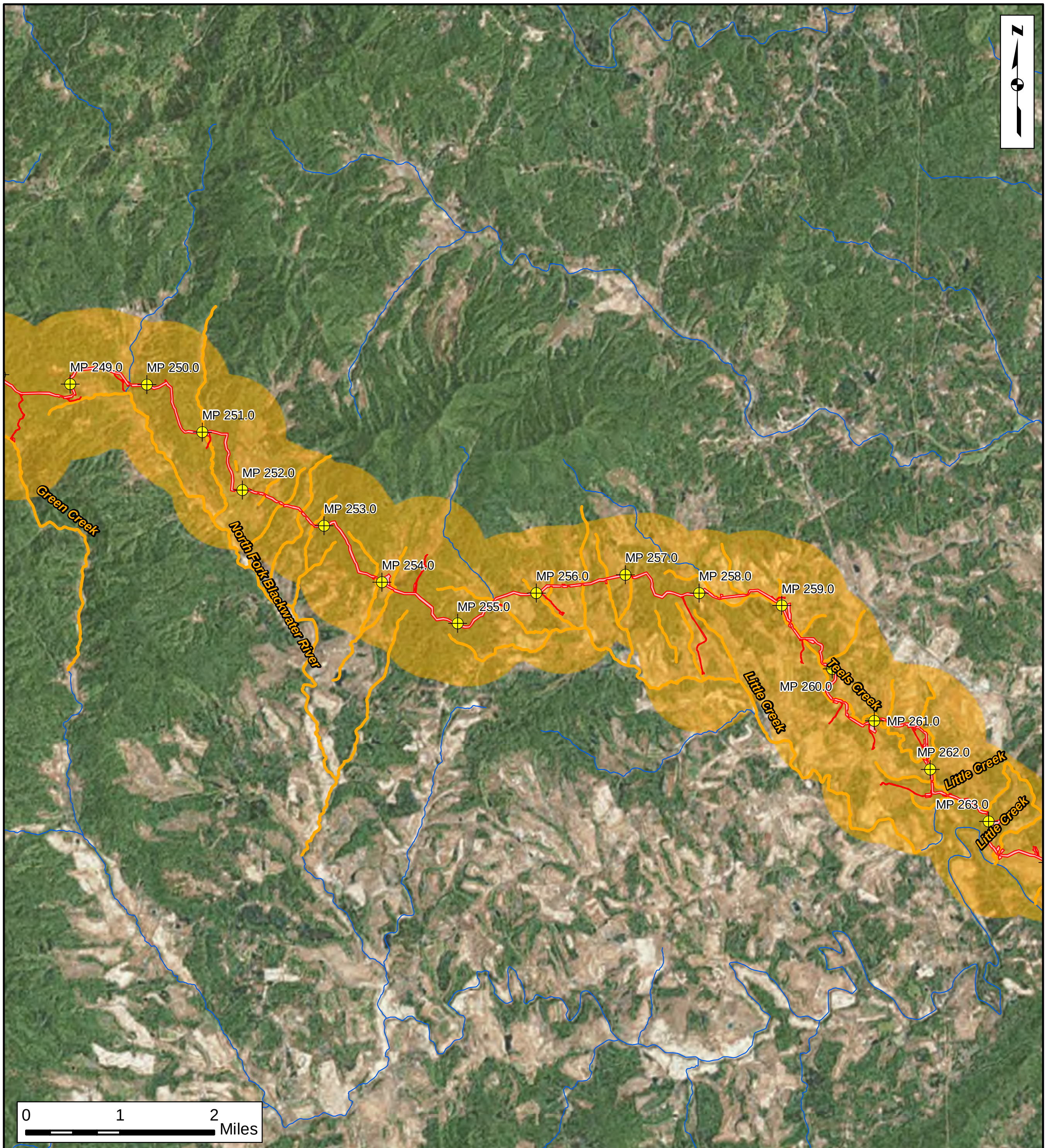


Proposed Limit of Disturbance
Action Area
Stream

Appendix B

Mountain Valley Project

Action Area Maps (Sheet 20 of 25)

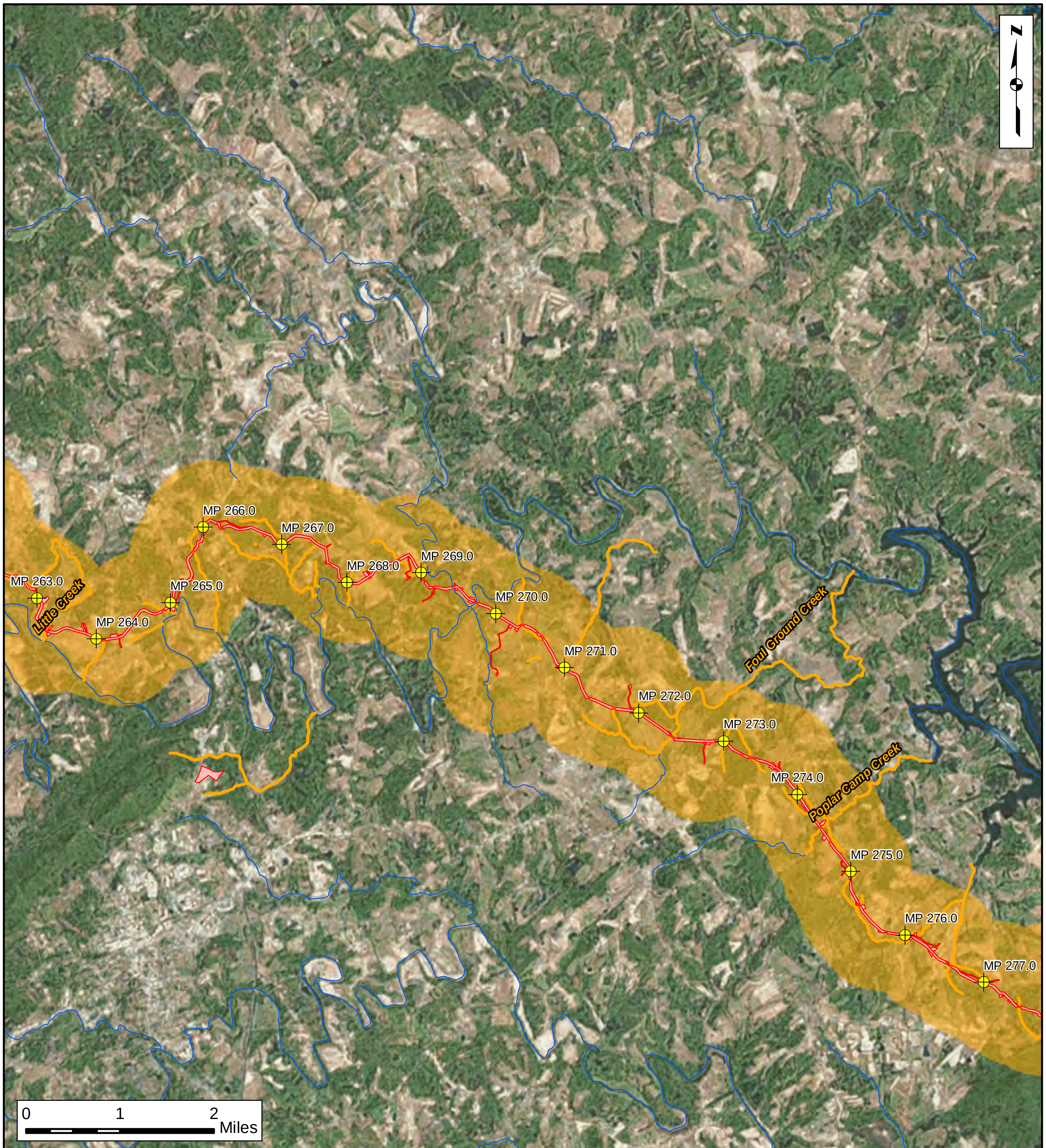


Proposed Limit of Disturbance
Action Area
Stream

Appendix B

Mountain Valley Project

Action Area Maps (Sheet 21 of 25)

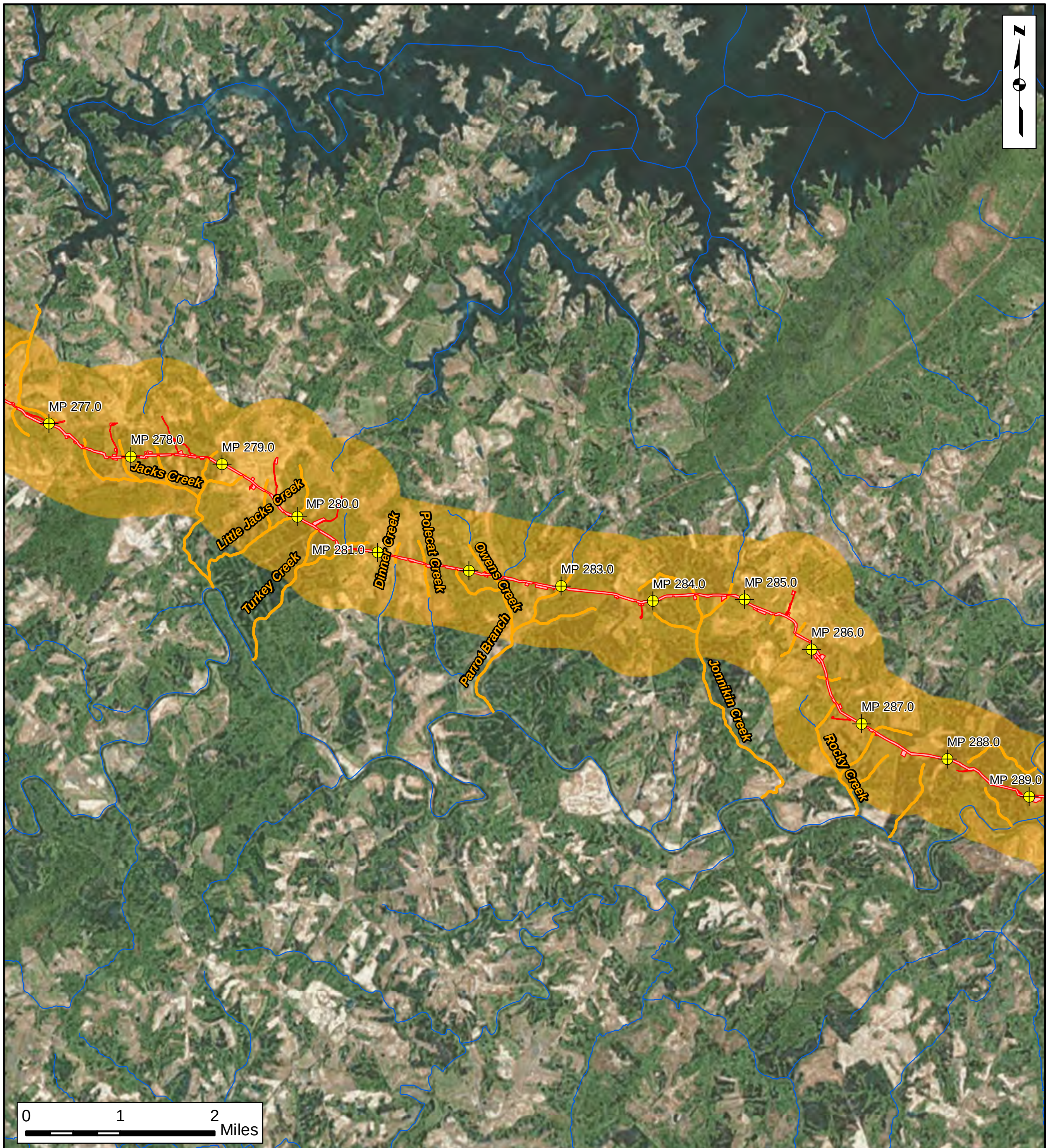


Proposed Limit of Disturbance
Action Area
Stream

Appendix B

Mountain Valley Project

Action Area Maps (Sheet 22 of 25)



Proposed Limit of Disturbance

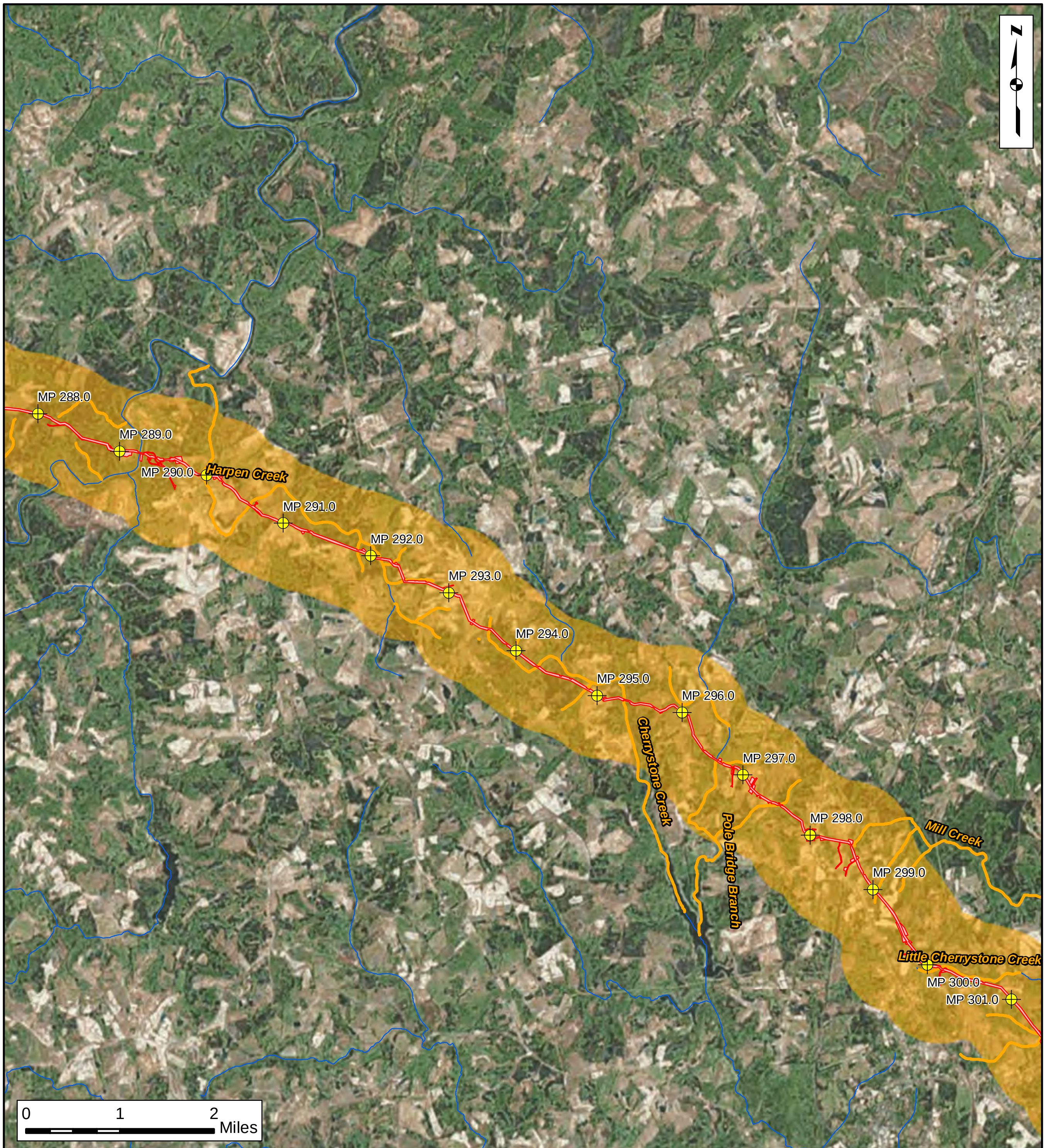
Action Area

Stream

Appendix B

Mountain Valley Project

Action Area Maps (Sheet 23 of 25)

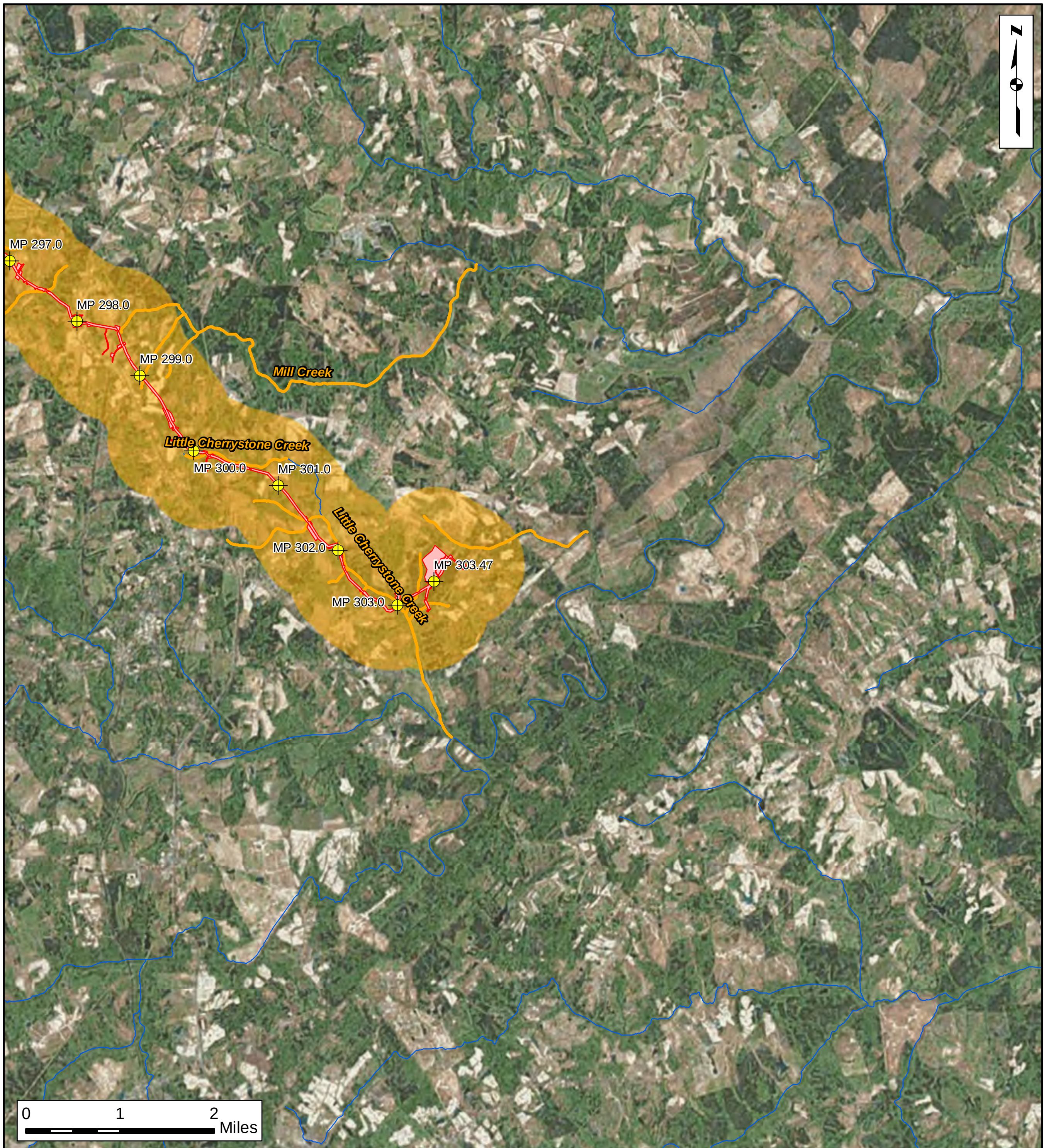


Proposed Limit of Disturbance
Action Area
Stream

Appendix B

Mountain Valley Project

Action Area Maps (Sheet 24 of 25)



Appendix B

Mountain Valley Project

Action Area Maps (Sheet 25 of 25)

Proposed Limit of Disturbance
Action Area
Stream

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APPENDIX C

Supplemental Models Regarding Effects Analyses for the Mountain Valley Pipeline Project

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APPENDIX C
SUPPLEMENTAL MODELS REGARDING EFFECTS ANALYSES
MOUNTAIN VALLEY PIPELINE PROJECT
WEST VIRGINIA AND VIRGINIA

BIOLOGICAL ASSESSMENT TO ADDRESS POTENTIAL EFFECTS ON FEDERALLY LISTED SPECIES FOR THE MOUNTAIN VALLEY PIPELINE PROJECT IN WEST VIRGINIA AND VIRGINIA

March 2017

CONTAINS PRIVILEGED INFORMATION – NOT FOR RELEASE

Prepared by:

ESI
Environmental Solutions & Innovations, Inc.
4525 Este Avenue
Cincinnati, OH 45232
Syracuse, NY • Stow, OH • Indianapolis, IN • Orlando, FL • Springfield, MO • Pittsburgh, PA • Teays Valley, WV
www.ENVSI.com

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1.0 Introduction

This appendix outlines several supplemental models used to aid in the assessment of direct effects of the Mountain Valley Pipeline, LLC (MVP; Project) on the Indiana bat (*Myotis sodalis*), northern long-eared bat (*Myotis septentrionalis*), and Roanoke logperch (*Percina rex*) and is intended to supplement the Biological Assessment (BA) for the Project. Where appropriate, references are made to the BA itself. In addition to methods to estimate the occurrence and abundance of species within the Action Area for the Project, this document presents the methods and results of the hydrologic analysis of sedimentation which was used to assess direct effects for aquatic species and indirect effects for terrestrial species within the Action Area.

2.0 Site-specific Estimates of Abundance

This section details the methods and results of predictive models used to estimate occurrence and abundance of Indiana bat, northern long-eared bat, and Roanoke logperch within the Action Area.

2.1 Indiana and Northern Long-eared Bats

2.1.1 Estimates of Winter Abundance

Based on information collected (i.e., portal surveys and harp trap surveys; see Section 1.4.1 of the BA) for the Project and data requests made to the Virginia Speleological Society, West Virginia Speleological Society, and Draper Aden Associates, there are 131 features within the vicinity of the Project (i.e., within 5-miles) that have the potential to host Indiana bats and 133 features with the potential to host northern long-eared bat (see Section 4.1.2.4 of the BA). These include two known winter hibernacula for Indiana bat (Greenville Saltpeter Cave and Tawney's Cave) and four known winter hibernacula for northern long-eared bat (Canoe Cave, Greenville Saltpeter Cave, PS-WV3-Y-P1, and Tawney's Cave). Although information regarding counts of bats at known hibernacula is available for many features (with the exception of Tawney's Cave and PS-WV3-Y-P1), information is lacking regarding the potential occurrence and abundance of northern long-eared bat and Indiana bat in five field documented, suitable features and 124 features with unknown suitability.

To account for the potential occurrence and abundance of Indiana and northern long-eared bats within suitable, un-surveyed portals (n=5) as well as the 124 features with unknown suitability, an abundance estimate that reflected the best available information of the occurrence and abundance of these bats in portals was derived from surveys conducted by Dalton (1987), Gates and Johnson (2006), and Powers et al.

(2015), along with previous portal surveys conducted by Environmental Solutions & Innovations, Inc. (ESI) for various previous projects. Because many of these sources only documented capture of bats using portal trapping (e.g., harp traps), an effort was undertaken to correct for the general undersampling of the population of these features (i.e., the entire population is not exposed to portal traps). The methods and results of this effort are outlined below.

2.1.1.1 Data Description and Model Development

Information from available ESI projects, as well as other studies (e.g., Whitaker and Rissler 1992, Brack et al. 2005), were compiled to create a dataset to estimate the relationship between portal-trap results and in-cave counts. Counts were compiled for six different bat species (*Eptesicus fuscus*, *Myotis lucifugus*, *M. leibii, M. septentrionalis*, *M. sodalis*, and *Perimyotis subflavus*) at 41 separate localities (34 from Indiana, 6 from Virginia, and 1 from West Virginia). At each of these localities, at least one in-cave count and one portal-trap sample was available that were close in temporal proximity (i.e., within 1 year). Although the majority of features only had a single winter in-cave count, the number of portal-trap samples varied dramatically among feature localities with a mean of 3.8 and a maximum of 29 samples.

Four general outcomes were observed in the compiled dataset:

- No winter population of the species existed at the locality based on in-feature counts, and no individuals of the species were caught in portal-traps (61%);
- No winter population of the species existed at the locality based on in-feature counts, but individuals were captured during portal-trap events (16.6%);
- A winter population existed and was greater than the maximum number of individuals caught in portal-traps (19.5%); and
- A winter population existed but was less than the maximum number of individuals caught in portal-traps (2.9%).

These findings suggest that the number of bats caught in a portal-trap does not represent an estimate of winter population size. In spite of this finding, portal-trap results may provide a reasonable index of winter population size if both occurrence and abundance are correlated with captures of bats during portal-trapping events.

A specific class of regression models known as hurdle models (Zuur et al. 2009) has been developed to account for such scenarios where occurrence and abundance are a function of different processes. Due to the large number of zero counts found in ecological data, hurdle models are often used to break up counts of organisms into a binary process of occupancy and a count-based process (e.g., Poisson) of abundance. In the case of wintering bats, the occurrence of wintering individuals (i.e., $\Pr[N > 0]$) is modeled using logistic (or probit) regression. Given that a portal is occupied (i.e., $N > 0$), winter abundance in the portal feature can be modeled using a variety of distributions suitable for counts (e.g., log-normal, Poisson, negative binomial). Using these two separate models, it can be shown that the expected value (i.e., number of expected bats; E) of winter abundance (N) given portal-trap results H (i.e., $\mathrm{E}[N|H]$) is:

$$\mathrm{E}[N_i|H] = \Pr(N_i > 0|H)\mathrm{E}[N_i|N > 0, H]. \qquad \text{Eq. 1}$$

Although hurdle models provide an estimate of winter abundance given portal-trap results, their use for some species of bats may not be applicable. This is particularly the case for northern long-eared bat (*M. septentrionalis*), which is hypothesized to hibernate in small crevices making it difficult to get accurate winter abundance estimates. Because of this problem, as well as the small sample size of Indiana bat presences and counts within the dataset, a multispecies hurdle model that omits data from northern long-eared bats may be most appropriate. In this approach, both the logistic regression component and the abundance component of the model are expanded to estimate parameters for all species studied ($n = 5$ [omitting northern long-eared bat]) simultaneously using a mixed effect formulation (Zuur et al. 2009). This approach recognizes that the species specific relationship between portal-trap counts and winter counts may be different for each species studied but likely share a common pattern among species. The advantage of this approach is two-fold:

- Estimates can be made for each species, even when data are limited (e.g., Indiana bat), due to the ability to jointly utilize information across species, and
- The mean relationship can be used to create relationships for species not contained within the model training process. This is useful because it is difficult to get a winter estimate for northern long-eared bats.

2.1.1.2 Data Analysis

Hurdle models are constructed using the R package glmmADMB which utilizes the Automatic Differentiation Model Builder (ADMB) to fit generalized linear mixed models (GLMMs). Occurrence models are fit using hierarchical logistic regression with the species treated as a random effect (DeWan and Zipkin 2010, Ovaskainen and Soininen 2011). Note that all harp trap counts are square-root transformed to improve model fit and optimization. Four separate models are fit:

- A random intercept model using the ***mean*** portal-trap count for each species at each portal. This approach recognizes that mean occurrence varies by species but the relationship between portal-trap counts and occurrence is common.
- A random intercept model using the ***max*** portal-trap count for each species at each portal. This is similar to the approach taken in the previous model.
- A random slope model using the ***mean*** portal-trap count for each species at each portal. This approach recognizes that mean occurrence and the relationship between portal-trap counts and occurrence varies by species.
- A random slope model using the ***max*** portal-trap count for each species at each portal. This is similar to the approach taken in the previous model.

Count models are fit using a similar approach, but three separate distributional assumptions are tested. Models are first fit using a zero-truncated Poisson distribution. Since count models only incorporate data where winter population size is greater than zero, the zero-truncated Poisson distribution eliminates zero from the probability density function. Note that given present overdispersion within the dataset (i.e., greater variability than expected by the statistical distribution), an overdispersed zero-truncated Poisson is fit by adding a random effect for each observation within the dataset. This approach essentially adds an additional variance component to the model to deal with overdispersion. In addition to the zero-truncated Poisson, a zero-truncated negative binomial is also fit. The negative binomial is less sensitive to overdispersion because it includes a scaling parameter for additional variance. Finally, abundance is also modeled using a log-normal distribution. For each distribution, four models are fit using the random intercept or random slope formulations described above for regressing against the mean or max portal-trap counts made at each feature.

The weight of evidence for each of the models is judged using Akaike's Information Criterion (AIC) (Akaike 1974) as corrected for small sample size (AICc) (Hurvich and Tsai 1989), and the models with the lowest AICc are used to predict the expected number of wintering bats given portal-trap results.

2.1.1.3 Application to Portal Trapping Dataset

Although the above analysis provides a relationship to link portal-trapping results to winter population sizes, it does not provide an estimate of the expected number of bats present in an unsampled portal or feature. The major issue with applying the estimated values from the model above is that they are biased by the fact that each feature was known to host at least one bat during winter, and these portals were trapped with the high expectation of finding bats. Ideally, an estimate of the expected number of bats in unsampled features would come from a designed study of randomly sampled features that demonstrate suitability for bats; however, no such study is available. Instead, results are available from several purposeful studies and reports involving either in-cave counts of bats or counts from portal–trapping. Although these results do not represent a true random sample, they are the best-available information regarding the presence and abundance of Indiana and northern long-eared bats in a random but suitable portal (excluding Priority 1 or 2 features).

In an attempt to estimate the expected number of bats in unsampled features, data from surveys conducted by Dalton (1987), Gates and Johnson (2006), and Powers et al. (2015) as well as surveys conducted for previous ESI projects were compiled into a database. In total, this database contained samples from 527 unique features (290 from Pennsylvania, 172 from Virginia, 23 from West Virginia, 20 from Ohio, 20 from Kentucky, and 2 from New Jersey) with 408 features containing only portal-trapping results and 119 features containing results from in-feature counts. For surveys that only had counts from portal-trapping, an estimate of the winter population size is made using the product of the expected probability of presence times the expected abundance given occupied (as in Eq. 1). For portals where in-feature counts were available (e.g., Dalton 1987), no adjustment is made. Using this approach, the expected number of bats in an unsampled feature is estimated as the mean winter abundance estimate from these sources.

2.1.1.4 Estimates of Winter Abundance

Models for presence of winter hibernating individuals given counts of bats in autumn or spring portal trapping events (i.e. $Pr[N > 0|H]$) showed strong support over the null hypothesis that no relationship existed (i.e., $Pr[N > 0]$). Based on AICc, the best supported model was one that related the presence of a winter population to the maximum observed number of individuals of the species during portal-trapping. Based on the estimated regression coefficients, for every one unit increase in bat captures on the square root scale (e.g., 0 to 2, 2 to 4, 4 to 9, etc.), the presence of a winter population is 1.78 times more likely.

Similar to the results for presence of wintering populations, count models for winter abundance showed strong support for the hypothesis that winter abundance was correlated to the maximum number of individuals captured during portal-trapping. Based on this relationship, for every one unit increase in bat captures on the square root scale (e.g., 0 to 2), we expect the size of the population to be 60% larger.

Using the best-supported models for presence and abundance when present, along with in-feature counts, the expected number of Indiana bats in an unsampled but suitable feature is 2.007 bats. For northern long-eared bats, this value is 7.017 bats. It is important to note that these estimates are based on ***suitable*** features. Thus, these estimates are applicable for the five suitable portals discovered during field surveys as well as an estimate of Indiana and northern long-eared bats present within Tawney's Cave. For one feature (PS-WV3-Y-P1) within the survey corridor, a northern long-eared bat was captured during harp trap surveys for this Project. Using the results of the hurdle model, a winter abundance estimate of 1.293 was made for this feature. In addition to features deemed suitable for hibernating bats, within the vicinity of Project there are an additional 124 features that lack information regarding the suitability for hibernating bats. For these features, the abundance estimate above made for suitable features (i.e., 2.007 for Indiana bats and 7.017 for northern long-eared bats) can be multiplied by the proportion of features that are expected to be suitable within the region. This proportion is estimated using survey information performed for the Project because it represents the best available information for the region. In total, 52 features were discovered within the 300-foot survey corridor for the Project. Of these 52 features, 24 were deemed suitable. Thus, it is expected that 46.15 percent ([24/52]*100) of portal features are likely to be suitable for hibernating bats, and thus a population estimate of 0.9262 Indiana bats and 3.2384 northern long-eared bats is made for each of the features with unknown suitability within the vicinity of the Project.

2.1.2 Summer Population Sizes

Field studies conducted in support of the BA failed to provide evidence of occupation by Indiana bats during the summer season of reproduction (see Section 1.4.1.1 of the BA). However, the Project intersects an area of known, occupied summer habitat from Project MP 0.0 to MP 10.3. In this area, and other areas of assumed presence, including near previously known hibernacula (i.e., Greenville Saltpeter and Tawney's cave) and areas not sampled by ESI (e.g., areas excluded due to captures of other endangered bat species), harm and harassment are possible.

In order to asses direct effects during the summer season of reproduction, average densities of Indiana bats are calculated for both Virginia and West Virginia. According to USFWS (2015), there are 2,373 Indiana bats in West Virginia's 11,749,842 estimated acres of forest and 597 within Virginia's 15,765,700 acres. For West Virginia, where the species is distributed across most of the state, density estimates can be made by dividing the number of bats by the number of forested acres (i.e., 2,373 bats /11,749,842 forested acres), which gives the number of bats expected per forested acre (0.000202 bats/forested acre). In Virginia, the species is not known throughout the entire state, making the calculation slightly more difficult. Based on a georeferenced version of the Indiana bat distribution taken from the *Bats of Illinois*, just over half (0.519) of the state of Virginia is within the distributional range of the species. Thus, density can be calculated by dividing the number of bats by the number of forested acres times the proportion of the state within the range (i.e., 597/[15,767,700*0.519]). Based on this calculation Indiana bat density within Virginia is 0.000073 per forested acre.

Note that no estimate of summer occurrence and abundance of northern long-eared bat was made for the Project.

2.2 Roanoke logperch

Roanoke logperch are known to occur in several disparate populations in widely separated segments within the Chowan and Roanoke river basins. All of the populations are geographically small, and limited to no genetic exchange occurs among them because they are separated by large impoundments and wide river gaps of apparently unsuitable habitat (USFWS 2003). The Project traverses four major drainages in the Roanoke basin including the upper Roanoke River, Blackwater River, Pigg River, and Banister River. Roanoke logperch are not known or recognized to occur in the Banister River Subbasin (HUC 03010105); therefore, the species is determined to be absent from waterbodies in this subbasin for the impact analysis. In contrast, Roanoke logperch have not been observed in the Blackwater River drainage; however, this drainage is nested within the currently-known range extent of the species and therefore has the potential to host the species. Thus, waterbodies within the Blackwater River drainage that exhibit potentially suitable habitats are included in the impact analysis within the BA.

2.2.1 Abundance Estimates and Occurrence

Population sizes have been previously estimated for Roanoke logperch in both the upper Roanoke and Pigg river drainages (Roberts 2012); however, these estimates were limited to reaches within the documented extent of the species (i.e., known occurrences), and thus, may not incorporate all areas where the species may occur. Recognizing that the species may occur in other smaller, less-sampled waterbodies, Lahey and Angermeier (2007) developed a screening model to determine the potential for Roanoke logperch occurrence in these waterbodies. The Lahey and Angermeier (2007) model consists of four metrics that are thought to determine logperch occurrence within the Roanoke drainage: Strahler order (range=2-6), Shreve link (range=3-372), gradient (range=0-10.2 m/km), and elevation (181-488 m). Note that both Strahler order and Shreve link are based on the 1:100,000 NHD within the Lahey and Angermeier (2007) model. For the purposes of the BA, all areas that meet these conditions are considered potentially occupied by the species, unless site specific field assessments suggest otherwise.

The effects analysis for Roanoke logperch is broken up into impacts to adults and subadults (hereafter adult or Age-1+) and young-of-the-year (hereafter YOY or Age-0). Although these different life stages may occupy different micro and mesohabitats, it is assumed that all stream reaches suitable for Age-1+ individuals are also suitable for YOY individuals. Site specific abundance estimates for both life stages are made below.

2.2.1.1 Occurrence and Abundance of Age-1+ Roanoke Logperch

To get an estimate of abundance within occupied or presumed occupied reaches within the upper Roanoke, Pigg, and Blackwater river drainages, a site-occupancy modeling approach is taken; namely, N-mixture modeling (Royle 2004). The standard N-mixture model utilizes replicated captures of a species at multiple sites in order to decompose per individual detection probability (p) and site abundance (N). Using this approach, abundance can be regressed against covariates to test hypotheses regarding variation in abundance using the Poisson distribution:

$$N_i \sim \text{Poisson}\big(\ln\left(\beta_0 + \beta_1 \times x_i\right)\big), \qquad \text{Eq. 2}$$

where β_0 and β_1 are regression coefficients and x_i is a variable hypothesized to be correlated with abundance (e.g., catchment area). Note that in this model N is not a known variable but is estimated in conjunction with a process component (i.e., per-individual detection). In most N-mixture models, detection and abundance are estimated simultaneously using replicated counts made at sample sites. In the absence of such replication, prior information regarding Roanoke logperch capture rates is used to fix per-individual detection at 10 percent (i.e., p=0.1) (Roberts and Anderson 2013). Using this estimate, rather than estimating detection directly in the model, allows for the application of the model without replicated counts at a site.

The advantage of this model-based approach to estimate site abundances is that heterogeneity in abundance among populations and within populations can be modeled. Additionally, this approach can also be used to model abundance in watersheds and waterbodies where no captures of Roanoke logperch have been made, but the species is assumed to be present (e.g., Blackwater River). This later advantage is accomplished by truncating the Poisson distribution to remove zero values. That is, abundance must always be greater than 0.

2.2.1.1.1 Data Description and Analysis

The approach described above is adapted to Roanoke logperch populations in the upper Roanoke subbasin. Within the upper Roanoke several fish collections are publically available from various reports, dissertations, theses, scientific papers, and databases, including: James (1979), Burkhead (1983), Simonson and Neves (1986), Ferguson et al. (1994), Stancil (2000), Lahey and Angermeier (2007), Roberts and Anderson (2013), VADEQ (2015), and Anderson and Angermeier (2015). In total, these collections provide 159 unique stream segments (i.e., reaches of stream between confluences of other streams) that have at least one sample event for fish. However, using the Lahey and Angermeier (2007) screening model, only 118 are within the possible distribution of the species.

Theses samples are used in conjunction with prior information on estimates of capture rates from Roberts and Anderson (2013) to estimate abundance in areas of assumed occupancy while accounting for heterogeneity among and within populations. More specifically, a few simplistic relationships using catchment area as a covariate of abundance are modeled. In addition to this covariate, a random effect is added to the model to account for differences in baseline abundance among the different watersheds (i.e., U.S. Geological Survey Hydrologic Unit Code 10) within the study area. In total, six different models are fit:

- A ***null model*** with no covariates or random effects for different watersheds. This model assumes that abundance is constant across all watersheds and all habitats within those watersheds (Figure 1a).
- A ***linear relationship*** with catchment area with no random effects for different watersheds. This model assumes that abundance increases with catchment area, and this relationship is the same for all watersheds within the study area (Figure 1b).
- A ***polynomial relationship*** with catchment area with no random effects for different watersheds. This model assumes that abundance increases with catchment area but decreases after some point (i.e., quadratic relationship), and this relationship is the same for all watersheds within the study area (Figure 1c).
- A ***random effect model*** with no covariates. This model recognizes that there might be variation in abundance among watersheds but abundance is constant within watersheds (Figure 1d).
- A ***linear relationship*** with catchment area with ***random effects*** for different watersheds. This model recognizes that there might be variation in abundance among and within watersheds and variation within watersheds is correlated with catchment area (Figure 1e).

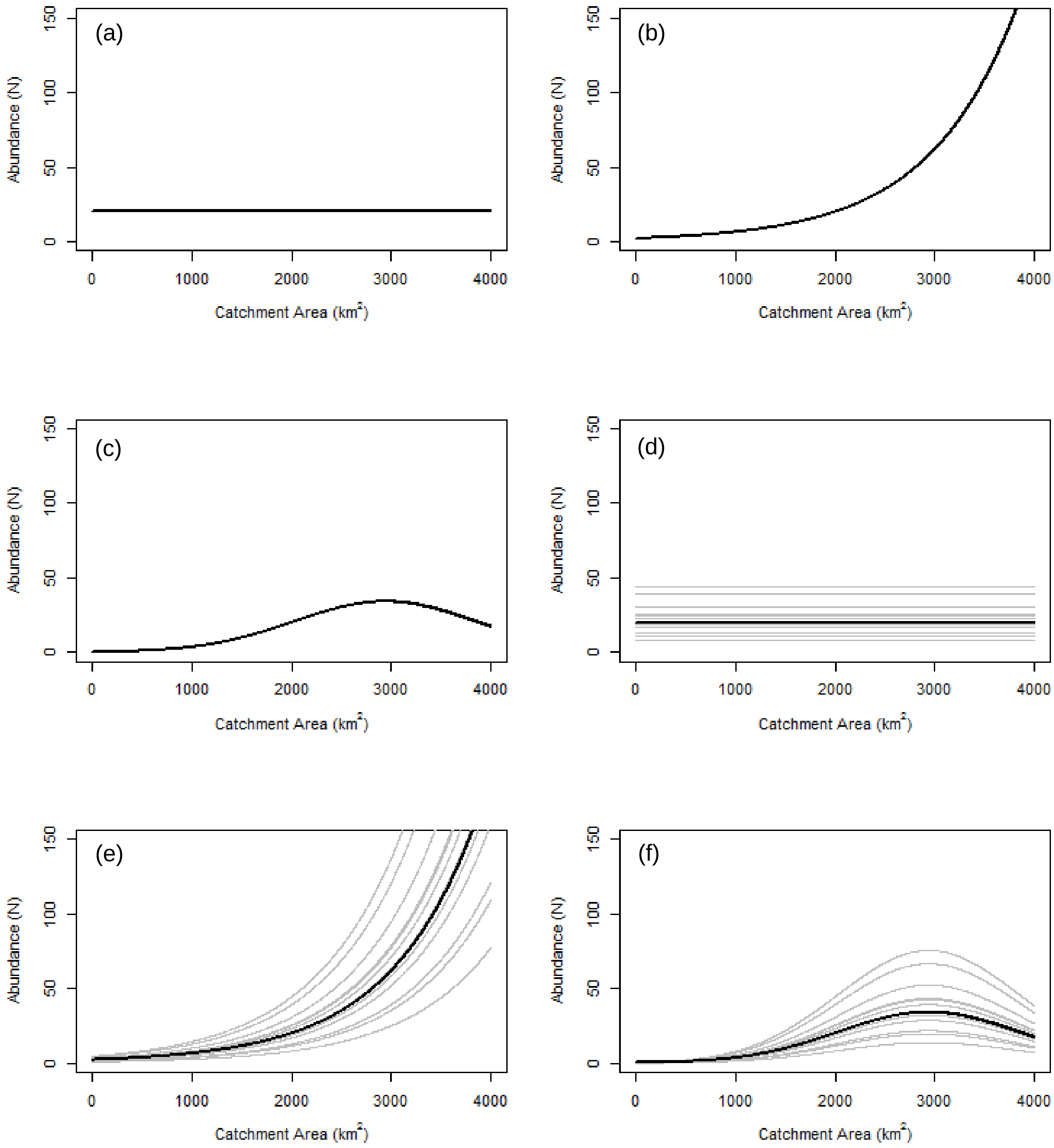

Figure 1. Six plausible models of Roanoke logperch abundance within the upper Roanoke River drainage. (a) A ***null*** model with no covariates or random effects for different watersheds; (b) a ***linear relationship*** with catchment area with no random effects for different watersheds; (c) a ***polynomial relationship*** with catchment area with no random effects for different watersheds; (d) a ***random effect model*** for different watersheds with no covariates; (e) a ***linear relationship*** with catchment area with ***random effects*** for different watersheds; and (f) a ***polynomial relationship*** with catchment area with ***random effects*** for different watersheds. Mean effects are shown as black lines, and watershed level effects are shown in gray. All relationships were simulated to demonstrate each model type.

- A ***polynomial relationship*** with catchment area with ***random effects*** for different watersheds. This model recognizes that there might be variation in abundance among and within watersheds and abundance increases with catchment area but decreases after some point (i.e., quadratic relationship; Figure 1f).

All models are fit using a Markov chain Monte Carlo approach to estimate parameters. This approach is chosen based on the presence of the random effects and prior information within the likelihood. The weight of evidence for each of these models is judged using the Watanabe-Akaike Information Criterion (WAIC) (Watanabe 2010). WAIC is a Bayesian analog to the Akaike Information Criterion (Akaike 1974) and is a penalized criterion of model performance that is based on model fit and the effective number of parameters in the model. Using this criterion, models that perform better are weighted higher but are penalized for their complexity. The model with the lowest WAIC is then used to predict the abundance of Roanoke logperch in suitable habitats within stream segments.

Note that the output of this model based approach is abundance within a suitable patch; thus, estimates are adjusted to derive fish densities (e.g., fish/km) by multiplying estimated abundance times the patch density estimates derived in Roberts (2012). Because no patch density was reported for the Blackwater drainage, the patch density estimate reported for the Pigg was used. This density is the highest of those reported in Roberts (2012).

2.2.1.1.2 Results and Application to Study Area

Out of the six different models for Roanoke logperch (Figure 1), the model containing a linear relationship with catchment area that included random effects for different watersheds showed the greatest support. Based on parameter estimates for this model, density estimates among the 14 crossings with suitable habitat (and thus assumed presence) vary from 4.29 to 423.05 Age-1+ Roanoke logperch per kilometer (0.621 mi). Note that Age-1+ density estimates are also made for all waterbodies potentially impacted by the Project where Roanoke logperch occur or are presumed to occur.

2.2.1.2 Occurrence and Abundance of YOY Roanoke Logperch

To get an estimate of the number of YOY Roanoke logperch within occupied and potentially occupied reaches, information on population growth rates of the species is compiled from the literature. Traditional approaches for estimating YOY abundance require vital life history attributes of species (e.g., egg fecundity, hatching success, natural mortality, etc.) that are unknown for Roanoke logperch, and therefore, estimates cannot be made using these approaches. Alternatively, using population growth rates to estimate YOY abundance provides a potentially biased estimate of abundance, but capitalizes on the best currently available information. For Roanoke logperch, the growth rate is a ‘realized’ growth rate because it is derived using live individuals collected during sampling. The realized population growth rate includes naturally selective factors and includes individuals that might be recruited from other populations. One major constraint of this approach to estimate YOY population size is the inability to account for these additional temporal dynamics of the Age-1+ Roanoke logperch population. To estimate the number of YOY for any given year, information from the aforementioned Age-1+ estimate and an estimated maximum population growth rate (λ) estimate of 1.7205 from Roberts et al. (2016) is used. In this approach the density of YOY is calculated as:

$$D_{YOY} = D_{Adult} \times (\lambda - 1), \quad \text{Eq. 3}$$

where D_{YOY} is the estimated YOY density and D_{Adult} is the estimated Age1+ population density. Based on the data presented, the density estimates among the 14 crossings with suitable habitat (and thus assumed presence) vary from 3.09 to 304.81 YOY Roanoke logperch per kilometer (0.621 mi). Note that YOY density estimates are also made for all waterbodies potentially impacted by the Project where Roanoke logperch occur or are presumed to occur.

3.0 Hydrologic Analysis of Sedimentation

Construction and operation of the Project has potential to introduce excess sediment into waterways within 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.

In order to estimate erosion due to disruption of land from construction, restoration, and operational activities for the Project, 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.

3.1 Hydrologic Study Area

To assess potential impacts of sedimentation within streams as a result of Project activities, a hydrologic analysis of sedimentation is performed. The spatial extent of this analysis is contained within the intersecting U.S. Geological Survey's (USGS) 4-digit subregional hydrologic unit codes (HUC) and includes the Roanoke-Chowan, Kanawha, Lower Chesapeake, Monongahela, and Upper Ohio subregions. Given this large extent, the analysis is further constrained to intersecting 8-digit, 10-digit, or 12-digit HUCs and is dependent on the spatial area within the HUC crossed by the Project and the location of the Project relative to upstream areas. More specifically, the study area for the hydrologic analysis of sedimentation is contained within: eight 8-digit HUC subbasins (West Fork [05020002], Little Kanawha [05030203], Upper New [05050001], Greenbrier [05050003], Gauley [05050005], Elk [05050007], Upper Roanoke [03010101], and Banister [03010105]), six 10-digit HUC watersheds (Headwaters Middle Island Creek [0503020104], Fishing Creek [0503020102], Indian Creek [050500027], Johns Creek [0208020111], Upper Craig Creek [0208020110], and Lower Craig Creek [0208020112]), one 12-digit HUC subwatershed (Lick Creek [050500040203]), and one modified version of the 8-digit HUC subbasin for the Middle New (05050002) that contained all areas upstream of the confluence of the New River with the East River (Figure 2). These areas and their various sizes are chosen with the intent to encompass all possible sediment effects downstream of the Project Area. Note that if results demonstrate possible sediment impacts outside of these areas, the study area is extended to include all downstream effects as well.

3.2 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 (see Figure 2 from the BA).

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}) 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 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 Limits of

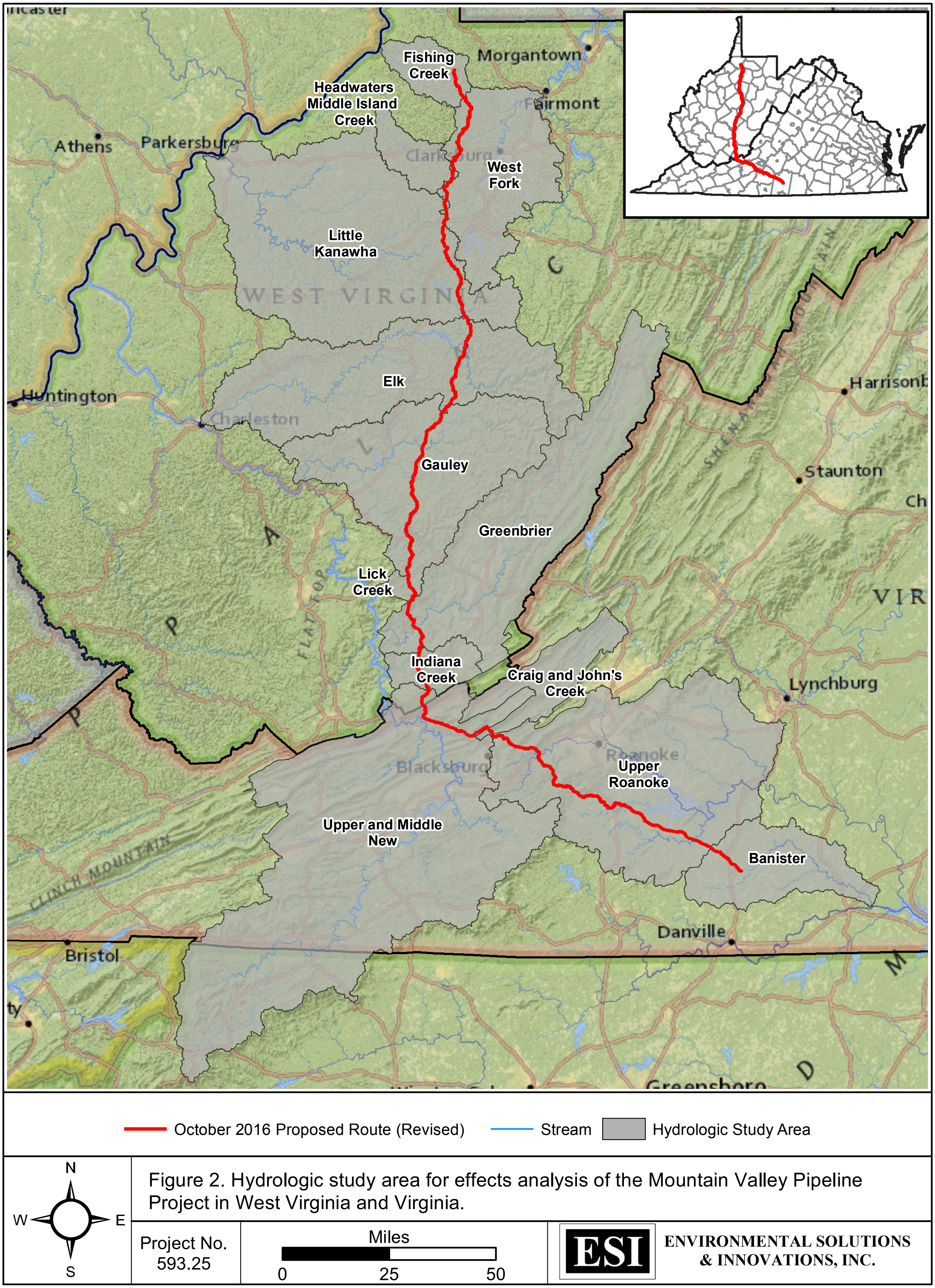

Figure 2. Hydrologic study area for effects analysis of the Mountain Valley Pipeline Project in West Virginia and Virginia.

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Disturbance (LOD), 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 3.3.4 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 many roads 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 3.3.4 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 (762 m) per day, and over a two-week period (six-day work week), approximately 30,000 linear feet (9,144 m) 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 3.3.4 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 (1,073 m) 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 3.3.4 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 1) 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 3.3.4 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 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.

3.3 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:

$$A = R \times K \times (L \times S) \times C \times P, \qquad \text{Eq. 4}$$

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.

3.3.1 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:

$$R = 0.059 \times 0.0483 \times P^{1.61}, \qquad \text{Eq. 5}$$

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.

3.3.2 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).

3.3.3 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:

$$LS_i = \left(\frac{A_{s_i}}{22.13}\right)^m \times \left(\frac{\sin\beta_i}{0.0896}\right)^n \times (m+1), \qquad \text{Eq. 6}$$

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).

3.3.4 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, 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 1, 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 3.2, 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 1). 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 specific C-factor and a mulch specific C-factor. For example, once construction is completed, areas may remain denuded for up to seven days following backfilling. Because this timeframe is less than two weeks, 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).

3.3.5 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 Project, 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 U.S. 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.

Table 1. 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

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 (six 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.

3.3.6 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:

- Construction immediately following tree clearance
- Restoration within 8 weeks of temporary stabilization
- Mulched areas remaining denuded for more than 4 days
- Mulched backfilled areas within 4 days
- Temporary sediment controls for 1 year after seeding

All of these factors are included within this analysis.

3.4 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:

$$SDR_w = 0.417762 \times A_w^{-0.134958} - 0.127097, \qquad \text{Eq. 7}$$

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:

$$L_w = \sum_{i=1}^{n} (A_i * a) * \ SDR_W \ , \qquad \text{Eq. 8}$$

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. 4, 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. 8. 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.

3.5 Data Analysis

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

Expected sediment loads within streams are estimated for all stream reaches within the study area intersecting and downstream of the Project Area. Impacts downstream represent cumulative impacts of construction. Because no sediment routing is performed within stream reaches, sediment delivery is assumed to be a function of drainage area (see Section 3.2).

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 Project, stream segments downstream with a 10 percent increase over baseline in maximum yearly load are delineated.

3.6 Results

Analysis using the RUSLE identified the boundaries associated with a 10 percent increase in sediment load. Detailed maps of streams with a 10 percent increase in sediment load can be found in Appendix B of the BA. Project-wide, 1,135.13 stream kilometers (705.03 mi) are expected to have a 10 percent increase or greater at a limited temporal scale. Although the majority of these stream reaches are closely associated with the boundaries of the Project Area, there are several exceptions (see Map 9 in Appendix B of the BA), and the farthest extent observed was over 7.79 kilometers (4.84 mi) away from the Project in Oil Creek, a tributary to the Little Kanawha River in West Virginia.

4.0 Literature Cited

Akaike, H. 1974. A new look at the statistical model identification. IEEE Transactions on Automatic Control 19:716-723.

Anderson, G. B. and P. L. Angermeier. 2015. Assessing impacts of the Roanoke River Flood Reduction Project on the endangered Roanoke logperch. Annual report submitted to the U.S. Geological Survey, Reston, Virginia and U.S. Army Corps of Engineers, Wilmington, North Carolina. 47 pp.

Banks, K. E. and D. J. Wachal. 2007. Final report for catalog of federal domestic assistance grant assistance number 66.463 water quality cooperative agreement for project entitled “Demonstrating the impacts of oil and gas exploration on water quality and how to minimize these impacts through targeted monitoring activities and local ordinances”. Prepared for U.S.

Environmental Protection Agency No. CP-83207101-1 by City of Denton, Denton, Texas. 216 pp.

Boyce, R. C. 1975. Sediment routing with sediment selievery ratios. Pages 61-65 *in* Present and Prospective Technology for Predicting Sediment Yields and Sources: Proceedings of the Sediment-Yield Workshop. U.S. Department of Agriculture, Agricultural Research Service, ARS-S-40, Oxford, MS.

Brack, V., Jr., R. J. Reynolds, W. Orndorff, J. Zokaites, and C. Zokaites. 2005. Bats of Skydusky Hollow, Bland County, Virginia. Virginia Journal of Science 56:93-106.

Breiby, T. 2006. Assessment of soil erosion risk within a subwatershed using GIS and RUSLE with a comparative analysis of the use of STATSGO and SSURGO soil databases. Volume 8, Papers in Resource Analysis. Saint Mary's University of Minnesota Central Services Press, Winona, MN.

Burkhead, N. M. 1983. Ecological studies of two potentially threatened fishes (the orangefin madtom, *Noturus gilberti* and the Roanoke logperch, *Percina rex*) endemic to the Roanoke River drainage. Report to the Wilmington District of the Army Corps of Engineers, Wilmington, North Carolina.

Dalton, V. M. 1987. Distribution, abundance, and status of bats hibernating in caves in Virginia. Virginia Journal of Science 38:369-379.

DeWan, A. A. and E. F. Zipkin. 2010. An integrated sampling and analysis approach for improved biodiversity monitoring. Environmental Management 45:1223-1230.

Dissmeyer, G. E. and G. E. Foster. 1980. A guide for predicting sheet and rill erosion on forest land. U.S. Department of Agriculture, U.S. Forest Service, Southeastern Area, Technical Publication SA-TP 11, Atlanta, GA. 40 pp.

Dubinsky, G. S. 2014. Performance evaluation of two silt fence geosynthetic fabrics during and after rainfall event. Master's thesis, University of Central Florida, Orlando, Florida. 157 pp.

Farias, R. J. C., E. M. Palmeira, and J. C. Carvalho. 2006. Performance of geotextile silt fences in large flume tests. Geosynthetics International 13:133-144.

Faucette, L. B., J. Governo, R. Tyler, G. Gigley, C. F. Jordan, and B. G. Lockaby. 2009. Performance of compost filter socks and conventional sediment control barriers used for perimeter control on construction sites. Journal of Soil and Water Conservation 64:81-88.

Faucette, L. B., K. A. Sefton, A. M. Sadeghi, and R. A. Rowland. 2008. Sediment and phosphorus removal from simulated storm runoff with compost filter socks and silt fence. Journal of Soil and Water Conservation 63:257-264.

Ferguson, M. T., S. A. Bruenderman, and P. S. Lookabaugh. 1994. A survey of the Roanoke logperch (*Percina rex*) in the North Fork Roanoke River. Virginia Department of Game and Inland Fisheries, Nongame and Endangered Species Program Fisheries Division, Blacksburg, Virginia.

Fernandez, C., J. Q. Wu, D. K. McCool, and C. O. Stockle. 2003. Estimating water erosion and seimdent yield with GIS, RULSE, and SEDD. Journal of Soil and Water Conservation 58:128-136.

Gaffer, R. L., D. C. Flanagan, M. L. Denight, and B. A. Engel. 2008. Geographical information system erosion assessment at a military training site. Journal of Soil and Water Conservation 63:1-10.

Galetovic, J. R. 1998. Guidelines for the use of the Revised Universal Soil Loss Equation (RUSLE) version 1.06 on mined lands, construction sites, and reclaimed lands. T. J. Toy and G. R. Foster, eds. The Office of Technology Transfer, Western Regional Coordinating Center, Office of Surface Mining, Denver, Colorado. 148 pp.

Gates, J. E. and J. B. Johnson. 2006. Bat-swarming inventory at abandoned mine portals at New River Gorge National River, West Virginia, technical report NPS/NER/NRTR--2006/046

U.S. Department of the Interior, National Park Service, Northeast Region, Philadelphia, Pennsylvania. 72 pp.

Homer, C. G., J. A. Dewitz, L. Yang, S. Jin, P. Danielson, G. Xian, J. Coulston, N. D. Herold, J. D. Wickham, and K. Megown. 2015. Completion of the 2011 National Land Cover Database for the conterminous United States-representing a decade of land cover change information. Photogrammetric Engineering and Remote Sensing 81:345-354.

Hurvich, C. M. and C.-L. Tsai. 1989. Regression and time series model selection in small samples. Biometrika 76:297-307.

James, D. L., Jr. 1979. Ecological studies of the fishes of the Pigg River system, south-central Virginia, with special reference to threatened species. Master's Thesis, Virginia Commonwealth University, Richmond, Virginia. 71pp.

Kemp, P., D. Sear, A. Collins, P. Naden, and I. Jones. 2011. The impacts of fine sediment on riverine fish. Hydrological Processes 25:1800-1821.

Lahey, A. M. and P. L. Angermeier. 2007. Range-wide assessment of habitat suitability for Roanoke logperch (*Percina rex*) Final report VTRC 07-CR8 prepared for Virginia Transportation Research Council, in Cooperation with the U.S. Department of Transportation, Federal Highway Administration, Charlottesville, Virginia. 58 pp.

Litschert, S. E., D. M. Theobald, and T. C. Brown. 2014. Effects of climate change and wildlife on soil loss in the Southern Rockies Ecoregion. Catena 118:206-219.

Maneux, E., J. L. Probst, E. Veyssy, and H. Etcheber. 2001. Assessment of dam trapping efficiency from water residence time: application to fluvial sediment transport in the Adour, Dordogne, and Garonne River basins (France). Water Resources Research 37:801-811.

Mitasova, H., W. M. Brown, M. Hohmann, and S. Warren. 2001. Using soil erosion modeling for improved conservation planning: a gis-based tutorial. University of

Illinois at Urban-Champaign, Geographic Modeling Systems Laboratory, Champaign, IL. Available online at http://www4.ncsu.edu/~hmitaso/gmslab/reports/CerlErosionTutorial/denix/denixstart.html.

Moore, I. D. and J. P. Wilson. 1992. Length-slope factors for the Revised Universal Soil Loss Equation: simplified method of estimation. Journal of Soil and Water Conservation 47:423-428.

MTDEQ. 2006. Ruby River watershed total maximum daily loads and framework for a water quality restoration plan. Montanta Department of Environmental Quality, Helena, MT. 658 pp.

NRCS. 1983. Sediment sources, yields, and delivery ratios. Section 3 Sedimentation, National Engineering Handbook. U.S. Department of Agriculture, Natural Resources Conservation Service. 18 pp.

Oliveria, A. H., M. A. da Silva, M. L. N. Silva, N. Curi, G. K. Neto, and D. A. F. de Freitas. 2013. Development of topographic factor modeling for application in soil erosion models. Pages 111-138 *in* Soil Processes and Current Trends in Quality Assessment (M. C. H. Soriano, ed.). InTech, Rijeka, Crotia. 433 pp.

Ovaskainen, O. and J. Soininen. 2011. Making more out of sparse data: hierarchical modeling of species communities. Ecology 92:289-295.

Powers, K. E., R. J. Reynolds, W. Orndorff, W. M. Ford, and C. S. Hobson. 2015. Post-white-nose syndrome trends in Virginia's cave bats, 2008-2013. Journal of Ecology and the Natural Environment 7:113-123.

PRISM Climate Group. 2012. Precipitation normals 1981-2010. Oregon State University, Corvallis, Oregon. Available online at http://www.prism.oregonstate.edu/normals/.

Renard, K. G., G. R. Foster, G. A. Weesies, D. K. McCool, and S. C. Yoder. 1997. Predicting soil erosion by water: a guide to conservation planning with the Revised Universal Soil Loss Equation (RUSLE). U.S. Department of Agriculture, Agricultural Research Service, Agriculture Handbook No. 703, 404 pp.

Renard, K. G. and J. R. Freimund. 1994. Using monthly precipitation data to estimate the R-factor in the revised USLE. Journal of Hydrology 157:287-306.

Risse, L. M., S. A. Thompson, J. Governo, and K. Harris. 2008. Testing of new silt fence materials: A case study of a belted strand retention fence. Journal of Soil and Water Conservation 63:265-273.

Roberts, J. H. 2012. Using genetic tools to understand the population ecology of stream fishes. Virginia Polytechnic Institute and State University, Blacksburg, Virginia.

Roberts, J. H. and G. B. Anderson. 2013. Assessing impacts of the Roanoke River Flood Reduction Project on the endangered Roanoke logperch (*Percina rex*): summary of construction-phase monitoring. Final report submitted to the

Wilmington District, U.S. Army Corps of Engineers, Wilmington, North Carolina. 54 pp.

Roberts, J. H., P. L. Angermeier, and G. B. Anderson. 2016. Population viability analysis for endangered Roanoke logperch (*Percina rex*). Journal of Fish and Wildlife Management. 7:46-64.

Royle, J. A. 2004. N-Mixture models for estimating population size from spatially replicated counts. Biometrics 60:108-115.

Simonson, T. D. and R. J. Neves. 1986. A status survey of the orangefin madtom *(Noturus gilberti)* and Roanoke logperch *(Percina rex)*. Virginia Polytechnic Institute and State University. Blacksburg, Virginia. Virginia Commission of Game and Inland Fisheries, Richmond, Virginia. 60 pp.

Soil Survey Staff. 2015a. Soil Survey Geographic (SSURGO) Database. U.S. Department of Agriculture, Natural Resources Conservation Service. Available online at http://sdmdataaccess.nrcs.usda.gov/.

Soil Survey Staff. 2015b. U.S. General Soil Map (STATSGO2). U.S. Department of Agriculture, Natural Resources Conservation Service. Available online at http://sdmdataaccess.nrcs.usda.gov/.

Stancil, V. F. 2000. Effects of watershed and habitat conditions on stream fishes in the upper Roanoke River watershed. Unpublished Master's Thesis, Virginia Polytechnic Institute and State University, Blacksburg, Virginia.

USEPA. 1993. Guidance specifying management measures for sources of nonpoint pollution in coastal waters. U.S. Environmental Protection Agency, Office of Water, Washington D.C. 822 pp.

USEPA. 2003. Developing water quality criteria for suspended and bedded sediments (SABS). U.S. Environmental Protection Agency, Office of Water, Office of Science and Technology, Washington D.C. 58 pp.

USEPA. 2009. Development document for final effluent guidelines and standards for the construction & development category. U.S. Environmental Protection Agency (EPA-821-R-09-010), Office of Water (4303T), Washington, DC. 266 pp.

USFWS. 2003. Roanoke Logperch (*Percina rex*) fact sheet. U.S. Department of Interior, Fish and Wildlife Service, Virginia Field Office. Gloucester, Virginia.

USFWS. 2015. 2015 Rangewide population estimate for the Indiana bat (*Myotis sodalis*) by USFWS region. U.S. Department of Interior, Fish and Wildlife Service, Ecological Services Field Office, Bloomington, Indiana.

VADEQ. 2015 Fish EDAS Database. Virginia Department of Environmental Quality Probablistic Monitoring Program. Available at: http://www.deq.virginia.gov/Programs/Water/WaterQualityInformationTMDLs/WaterQualityMonitoring/ProbabilisticMonitoring/ProbMonDataSources.aspx. Accessed

Watanabe, S. 2010. Asymptotic equivalence of Bayes cross validation and widely applicable information criterion in singular learning theory. Journal of Machine Learning Research 11:3571-3594.

Whitaker, J. O., Jr and L. J. Rissler. 1992. Seasonal activity of bats at Copperhead Cave. Proceedings of the Indiana Academy of Science 101:127-134.

Wischmeier, W. H. and D. D. Smith. 1978. Predicting rainfall erosion losses - a guide to conservation planning. Agriculture Handbook No. 537. U.S. Department of Agriculture, Science and Education Administration, Washington, District of Columbia. 67 pp.

Zech, W. C., X. Fang, and C. Logan. 2012. State-of-the-practice: Evaluation of sediment basin design, construction, maintenance, and inspection procedures. Prepared for Highway Research Center Project No. 930-791. Herbert Engineering Center, Auburn, Alabama. 67 pp.

Zuur, A., E. N. leno, N. Walker, A. A. Saveliev, and G. M. Smith. 2009. Mixed Effects Models and Extensions in Ecology with R. Springer-Verlag, New York, New York. 574 pp.

APPENDIX D

List of Potential Hibernacula within the Mountain Valley Project Area

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APPENDIX D

Summary of Potential Hibernacula within the Project Action Area as Determined by Mountain Valley Field Searches or Desktop Analysis

Portal ID	Number of Openings	County, State	Suitable?	Sampled?	Conclusions/Comments a/
JLV-PO-00001	1	Lewis County, WV	Yes	Yes	No bats captured during sampling; considered not occupied
JLV-PO-00002	1	Lewis County, WV	No	No	Determined not suitable for hibernating bats
PS-WV3-G1	1	Lewis County, WV	No	No	Determined not suitable for hibernating bats
JPD-PO-00001	1	Braxton County, WV	No	No	Determined not suitable for hibernating bats
P-DG-BR-001	1	Braxton County, WV	No	No	Determined not suitable for hibernating bats
PS-WV3-Y-P1	1	Braxton County, WV	Yes	Yes	One northern long-eared bat captured
CRA-PO-00001 b/	1	Webster County, WV	Yes	No	Suitable for hibernating bats; no longer in Action Area
SJTB-PO-00003	1	Webster County, WV	No	No	Determined not suitable for hibernating bats
SJTB-PO-00004	1	Webster County, WV	No	No	Determined not suitable for hibernating bats
PS-WV5-B-P1	1	Webster County, WV	Yes	Yes	No bats captured during sampling; considered not occupied
PS-WV5-B-P2	1	Webster County, WV	Yes	Yes	No bats captured during sampling; considered not occupied
PS-WV5-B-P3	1	Webster County, WV	Yes	Yes	No bats captured during sampling; considered not occupied
PS-WV2-J-P1	1	Webster County, WV	No	No	Determined not suitable for hibernating bats
PS-WV2-J-JD-P1	1	Webster County, WV	No	No	Determined not suitable for hibernating bats
PS-WV2-I-1	1	Webster County, WV	No	No	Determined not suitable for hibernating bats
PS-WV2-J-2	1	Webster County, WV	No	No	Determined not suitable for hibernating bats
PS-WV2-J-3	1	Webster County, WV	No	No	Determined not suitable for hibernating bats
PS-WV2-J-4	1	Webster County, WV	No	No	Determined not suitable for hibernating bats
PS-WV2-J-5	1	Webster County, WV	No	No	Determined not suitable for hibernating bats

APPENDIX D (continued)

Summary of Potential Hibernacula within the Project Action Area as Determined by Mountain Valley Field Searches or Desktop Analysis

Portal ID	Number of Openings	County, State	Suitable?	Sampled?	Conclusions/Comments a/
PS-WV3-K-P1	3	Webster County, WV	No	No	Determined not suitable for hibernating bats
PS-WV3-K-P2	1	Webster County, WV	No	n/a	Determined not suitable for hibernating bats
BJD-PO-00001	1	Nicholas County, WV	Yes	No	Portals destroyed before fall 2016 sampling could occur; considered not occupied
BJD-PO-00002	3	Nicholas County, WV	Yes	No	Portals destroyed before fall 2016 sampling could occur; considered not occupied
BJD-PO-00003	1	Nicholas County, WV	Yes	No	Portals destroyed before fall 2016 sampling could occur; considered not occupied
BJD-PO-00004	1	Nicholas County, WV	Yes	No	Portals destroyed before fall 2016 sampling could occur; considered not occupied
MLM-PO-00001	1	Nicholas County, WV	No	No	Determined not suitable for hibernating bats
DL-PO-00001	3	Nicholas County, WV	Yes	Yes	No bats captured during sampling; considered not occupied
MLM-NPO-001	1	Summer County, WV	No	No	Determined not suitable for hibernating bats
MLM-NPO-002	1	Summer County, WV	No	No	Determined not suitable for hibernating bats
MLM-NPO-003	1	Summer County, WV	No	No	Determined not suitable for hibernating bats
SJTB-PO-00001	2	Greenbrier County, WV	No	No	Determined not suitable for hibernating bats
SJTB-PO-00002	1	Greenbrier County, WV	No	No	Determined not suitable for hibernating bats
PS-WV1-E-P1	2	Greenbrier County, WV	No	No	Determined not suitable for hibernating bats
PS-WV1-K-P1	1	Greenbrier County, WV	No	No	Determined not suitable for hibernating bats
PS-WV1-K-P2	1	Greenbrier County, WV	No	No	Determined not suitable for hibernating bats
Bobcat Cave	1	Monroe County, WV	n/a	No	Not field reviewed; unable to determine suitability or occurrence of bats at this time
Rich Creek Cave	1	Monroe County, WV	n/a	No	Not field reviewed; unable to determine suitability or occurrence of bats at this time

APPENDIX D (continued)

Summary of Potential Hibernacula within the Project Action Area as Determined by Mountain Valley Field Searches or Desktop Analysis

Portal ID	Number of Openings	County, State	Suitable?	Sampled?	Conclusions/Comments a/
Wolf Cave	1	Monroe County, WV	n/a	No	Not field reviewed; unable to determine suitability or occurrence of bats at this time
Greenville Glenray Cave	1	Monroe County, WV	n/a	No	Not field reviewed; unable to determine suitability or occurrence of bats at this time
PS-VA7-M-P1	1	Craig County, VA	No	No	Determined not suitable for hibernating bats
Jones Cave	1	Craig County, VA	n/a	No	Not field reviewed; unable to determine suitability or occurrence of bats at this time
PS-VA2-A-P1	1	Giles County, VA	No	No	Determined not suitable for hibernating bats
Overlooked Cave	1	Giles County, VA	Yes	Yes	No bats captured during sampling; considered not occupied
Sinkhole	2	Giles County, VA	Yes	Yes	No bats captured during sampling; considered not occupied
Canoe Cave c/	1	Giles County, VA	Yes	No	Considered known northern long-eared bat hibernacula; not considered occupied by Indiana bats
MKM-PO-002	1	Giles County, VA	Yes	No	Suitable for hibernating bats but remains unsurveyed for bats
MKM-PO-003	1	Giles County, VA	Yes	No	Suitable for hibernating bats but remains unsurveyed for bats
MLM-PO-0004	1	Giles County, VA	Yes	Yes	No bats captured during sampling; considered not occupied
Andrews Cave	1	Giles County, VA	n/a	No	Not field reviewed; unable to determine suitability or occurrence of bats at this time
Big Stony Canyon Cave	1	Giles County, VA	n/a	No	Not field reviewed; unable to determine suitability or occurrence of bats at this time
Chockstone Pit	1	Giles County, VA	n/a	No	Not field reviewed; unable to determine suitability or occurrence of bats at this time
Conklin Air Hole	1	Giles County, VA	n/a	No	Not field reviewed; unable to determine suitability or occurrence of bats at this time
Conklin Sink Cave	1	Giles County, VA	n/a	No	Not field reviewed; unable to determine suitability or occurrence of bats at this time

APPENDIX D (continued)

Summary of Potential Hibernacula within the Project Action Area as Determined by Mountain Valley Field Searches or Desktop Analysis

Portal ID	Number of Openings	County, State	Suitable?	Sampled?	Conclusions/Comments a/
Corkscrew Cave	1	Giles County, VA	n/a	No	Not field reviewed; unable to determine suitability or occurrence of bats at this time
Doe Mountain Cave	1	Giles County, VA	n/a	No	Not field reviewed; unable to determine suitability or occurrence of bats at this time
Echols Cave	1	Giles County, VA	n/a	No	Not field reviewed; unable to determine suitability or occurrence of bats at this time
Freeman Hole	1	Giles County, VA	n/a	No	Not field reviewed; unable to determine suitability or occurrence of bats at this time
Freeman Pit	1	Giles County, VA	n/a	No	Not field reviewed; unable to determine suitability or occurrence of bats at this time
Freeman Treestand Cave	1	Giles County, VA	n/a	No	Not field reviewed; unable to determine suitability or occurrence of bats at this time
Hog Hole No. 2	1	Giles County, VA	n/a	No	Not field reviewed; unable to determine suitability or occurrence of bats at this time
Hoges Farm Cave	1	Giles County, VA	n/a	No	Not field reviewed; unable to determine suitability or occurrence of bats at this time
Homer Williams Cave	1	Giles County, VA	Yes	Yes	No bats captured during sampling; considered not occupied
Jimzuther Cave	1	Giles County, VA	n/a	No	Not field reviewed; unable to determine suitability or occurrence of bats at this time
Just a Little Farther Cave	1	Giles County, VA	n/a	No	Not field reviewed; unable to determine suitability or occurrence of bats at this time
Kanodes Pit	1	Giles County, VA	n/a	No	Not field reviewed; unable to determine suitability or occurrence of bats at this time
Key Ridge Cave	3	Giles County, VA	n/a	No	Not field reviewed; unable to determine suitability or occurrence of bats at this time
Kimballton Mine Cave	1	Giles County, VA	Yes	No	Suitable for hibernating bats but remains unsurveyed for bats
Kimballton Cave	1	Giles County, VA	n/a	No	Not field reviewed; unable to determine suitability or occurrence of bats at this time

APPENDIX D (continued)

Summary of Potential Hibernacula within the Project Action Area as Determined by Mountain Valley Field Searches or Desktop Analysis

Portal ID	Number of Openings	County, State	Suitable?	Sampled?	Conclusions/Comments a/
Links Cave	1	Giles County, VA	n/a	No	Not field reviewed; unable to determine suitability or occurrence of bats at this time
Maroon Canyon Cave	1	Giles County, VA	n/a	No	Not field reviewed; unable to determine suitability or occurrence of bats at this time
McDonalds Cave	1	Giles County, VA	n/a	No	Not field reviewed; unable to determine suitability or occurrence of bats at this time
Missing Link Cave	1	Giles County, VA	n/a	No	Not field reviewed; unable to determine suitability or occurrence of bats at this time
Newport Cave	1	Giles County, VA	n/a	No	Not field reviewed; unable to determine suitability or occurrence of bats at this time
Pig Hole	2	Giles County, VA	n/a	No	Not field reviewed; unable to determine suitability or occurrence of bats at this time
Plumb Bob Pit	1	Giles County, VA	n/a	No	Not field reviewed; unable to determine suitability or occurrence of bats at this time
Porterfields Cave	1	Giles County, VA	n/a	No	Not field reviewed; unable to determine suitability or occurrence of bats at this time
Small Room Cave	1	Giles County, VA	n/a	No	Not field reviewed; unable to determine suitability or occurrence of bats at this time
Smokehole Cave	2	Giles County, VA	n/a	No	Not field reviewed; unable to determine suitability or occurrence of bats at this time
Spruce Run Mountain Cave	1	Giles County, VA	n/a	No	Not field reviewed; unable to determine suitability or occurrence of bats at this time
Tawneys Cave	3	Giles County, VA	Yes	No	Determined suitable based on USFWS review; considered occupied by Indiana and northern long-eared bats
Terrible Tortoise Cave	1	Giles County, VA	n/a	No	Not field reviewed; unable to determine suitability or occurrence of bats at this time
Trap Door Cave	1	Giles County, VA	n/a	No	Not field reviewed; unable to determine suitability or occurrence of bats at this time
Williams Contact Shaft	1	Giles County, VA	n/a	No	Not field reviewed; unable to determine suitability or occurrence of bats at this time

APPENDIX D (continued)

Summary of Potential Hibernacula within the Project Action Area as Determined by Mountain Valley Field Searches or Desktop Analysis

Portal ID	Number of Openings	County, State	Suitable?	Sampled?	Conclusions/Comments a/
Crooks Crevice	2	Giles County, VA	Yes	Yes	No bats captured during sampling; considered not occupied
Unnamed Cave	1	Giles County, VA	n/a	No	Not field reviewed; unable to determine suitability or occurrence of bats at this time
Mahaffey Trash Cave	1	Giles County, VA	n/a	No	Not field reviewed; unable to determine suitability or occurrence of bats at this time
High Voltage Cave	1	Giles County, VA	n/a	No	Not field reviewed; unable to determine suitability or occurrence of bats at this time
Lhoist Cave	1	Giles County, VA	n/a	No	Not field reviewed; unable to determine suitability or occurrence of bats at this time
Knipling Slot Cave	1	Giles County, VA	n/a	No	Not field reviewed; unable to determine suitability or occurrence of bats at this time
Small Hole	1	Giles County, VA	No	No	Determined not suitable for hibernating bats
Windsor Pit	1	Giles County, VA	n/a	No	Not field reviewed; unable to determine suitability or occurrence of bats at this time
Barkers Cave	1	Montgomery, VA	n/a	No	Not field reviewed; unable to determine suitability or occurrence of bats at this time
Bob Henderson Cave	1	Montgomery County, VA	n/a	No	Not field reviewed; unable to determine suitability or occurrence of bats at this time
Bob Henderson Pit	1	Montgomery County, VA	n/a	No	Not field reviewed; unable to determine suitability or occurrence of bats at this time
Fred Bulls Cave	2	Montgomery County, VA	Yes	No	Suitable for hibernating bats; but remains unsurveyed for bats
Gardners Little Cave	1	Montgomery County, VA	n/a	No	Not field reviewed; unable to determine suitability or occurrence of bats at this time
Johnsons Cave	1	Montgomery County, VA	n/a	No	Not field reviewed; unable to determine suitability or occurrence of bats at this time
Longs Cave No. 2	1	Montgomery County, VA	n/a	No	Not field reviewed; unable to determine suitability or occurrence of bats at this time
Mill Creek Cave	1	Montgomery County, VA	n/a	No	Not field reviewed; unable to determine suitability or occurrence of bats at this time

APPENDIX D (continued)

Summary of Potential Hibernacula within the Project Action Area as Determined by Mountain Valley Field Searches or Desktop Analysis

Portal ID	Number of Openings	County, State	Suitable?	Sampled?	Conclusions/Comments a/
Mill Creek Pit	3	Montgomery County, VA	n/a	No	Not field reviewed; unable to determine suitability or occurrence of bats at this time
Old Mill Cave	1	Montgomery County, VA	Yes	Yes	Suitable for hibernating bats; proposed access road abandoned to avoid this feature; No bats captured during sampling; considered not occupied
Pedlar Hills Cave	1	Montgomery County, VA	n/a	No	Not field reviewed; unable to determine suitability or occurrence of bats at this time
P-DG-001	1	Montgomery County, VA	No	No	Determined not suitable for hibernating bats
P-DG-002	1	Montgomery County, VA	Yes	Yes	No bats captured during sampling; considered not occupied
Handcock Blowhole	2	Montgomery County, VA	n/a	No	Not field reviewed; unable to determine suitability or occurrence of bats at this time
Unnamed Cave	1	Montgomery County, VA	n/a	No	Not field reviewed; unable to determine suitability or occurrence of bats at this time
Unnamed Cave	1	Montgomery County, VA	n/a	No	Not field reviewed; unable to determine suitability or occurrence of bats at this time
Slussers Chapel Cave	1	Montgomery County, VA	n/a	No	Not field reviewed; unable to determine suitability or occurrence of bats at this time
Thompsons Cave	1	Montgomery County, VA	n/a	No	Not field reviewed; unable to determine suitability or occurrence of bats at this time

a/ Portals designated as “Not field reviewed; unable to determine suitability or occurrence of bats at this time” are assumed to be occupied and included in the Effects analysis

b/ CRA-PO-0001 is no longer part of the Action Area.

c/ Canoe Cave is considered as occupied by northern long-eared bats based on data maintained by VDCR-DNH.

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Document Content(s)

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