Mountain Valley Pipeline Project

Docket No. CP16-10-000

Attachment DR4 RTE 6a

March 2017

BIOLOGICAL ASSESSMENT TO ADDRESS POTENTIAL EFFECTS ON FEDERALLY LISTED SPECIES FOR THE MOUNTAIN VALLEY PIPELINE PROJECT IN WEST VIRGINIA AND VIRGINIA

March 2017

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Mountain Valley
PIPELINE

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Executive Summary

The purpose of this Biological Assessment (BA) is to evaluate the effects of the proposed Mountain Valley Pipeline Project (Project) on species listed as threatened or endangered under the Endangered Species Act (ESA). The Project is 303-mile, 42-inch-diameter natural gas pipeline in 17 counties in Virginia and West Virginia. The Project requires 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 from the Bureau of Land Management under the Mineral Leasing Act, and a right-of-way from the National Park Service. These federal authorizations trigger the consultation requirements of Section 7 of the ESA.

This BA has been prepared by Environmental Solutions & Innovations (ESI) on behalf of the Project proponent, Mountain Valley Pipeline, LLC (MVP), at the direction of FERC and will be submitted to the U.S. Fish and Wildlife Service (USFWS) 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. In particular, the BA evaluates effects to 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*).

The Project will extend from the existing Equitrans, L.P. transmission system and other natural gas facilities in Wetzel County, West Virginia to the existing Transcontinental Gas Pipe Line Company, LLC's (Transco) Zone 5 compressor station 165 in Pittsylvania County, Virginia. The Project is being proposed to provide timely, cost-effective access to the growing demand for natural gas for use by local distribution companies, industrial users, and power generation 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 to Federally Listed Bat Species. The Project will be located within the range of the federally endangered Indiana, gray, and Virginia big-eared bats and federally threatened northern long-eared bat. ESI conducted mist-net, winter hibernacula, and detailed summer habitat assessment surveys for these species.

Indiana bats were not captured during mist-net surveys, but it is assumed that the species occupies potentially suitable summer habitat and winter hibernacula in the Action Area. Based on the results from the effects analysis, it is expected that Indiana bat individuals will be harassed and harmed during construction and operation of the Project. Thus, the Project **May Affect** – **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 limit of disturbance). MVP will 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 development. Results from the effects analysis demonstrated the potential to harass and harm northern long-eared bats during Project construction or operation. Thus, the Project **May Affect – 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 will require Project-specific authorization.

While the Project will 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 they were not detected during summer or autumn field surveys. Thus, the Project **May Affect – Is Not Likely to Adversely Affect** these species.

Impacts to the Roanoke Logperch*.* The Project will traverse a large portion of the Roanoke River basin within the geographic distribution of the federally endangered Roanoke logperch. Within the basin, the Project will cross a total of 38 perennial streams with potential to support populations of Roanoke logperch. Of these, USFWS requested assumed presence of Roanoke logperch at the Project crossings of the [redacted] OF the remaining 33 stream crossings, ESI determined, based on desktop, agency correspondence, and in-situ habitat assessments, that nine crossings have thepotential to host Roanoke logperch populations. Although MVP will adhere to time of year restrictions for instream construction activities within suitable habitat for the species, harm and harassment of Roanoke logperch individuals is still likely to occur. Thus, the Project **May Affect – Is Likely to Adversely Affect** Roanoke logperch.

Impacts to Listed Mussel Species. The Project will also cross perennial streams potentially supporting populations of federally protected freshwater mussels. In West Virginia, the Project traverses [redacted]

In Virginia, the Project crosses [redacted]

Neither clubshell nor snuffbox were present during mussel survey efforts at the proposed crossing locations for the [redacted]. Mussel survey efforts were not warranted at [redacted] 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 [redacted] n West Virginia occur outside of the Action Area. Therefore, the Project **May Affect – Is Not Likely to Adversely Affect** clubshell or snuffbox mussels.

[redacted] Based on the location of known and presumed populations of this species relative to the crossings at [redacted] 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 will be impacted by the Project. Thus, the Project **May Affect– Is Not Likely to Adversely Affect** James spinymussel.

Impacts to the Rusty Patched Bumble Bee. The Project Area is also within the historic range of the rusty patched bumble bee, a species currently listed as federally endangered (anticipated effective date for final rule listing the species as endangered is March 21, 2017). The Project traverses several habitat types and physiographic provinces, many of which contain habitat for the rusty patched bumble bee. MVP is committed to implementation of voluntary conservation measures due to potential impacts to the habitat for this species.

Estimates of the potential number of colonies that the Project could impact 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 **May Affect – Is Not Likely to Adversely Affect** the rusty patched bumble bee.

Impacts to Listed Plant Species. In addition to these animal species, the Project Area is also 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.

No individuals of federally endangered or threatened plants were detected during surveys; however, potential habitat was found for running buffalo clover, small whorled pogonia, smooth coneflower, and Virginia spiraea in the Project Area. The nearest population of smooth coneflower occurs outside the Project Area therefore the Project **May Affect-Is Not Likely to Adversely Affect** smooth coneflower. Small

Portions of the project remain unsurveyed for running buffalo clover [0.23 kilometer / 0.74 hectares (0.14 mi / 1.8 ac)], small whorled pogonia [0.19 kilometer / 11.94 hectares (0.12 mi / 29.5 ac)], shale barren rock cress [0.19 kilometer / 11.94 hectares (0.12 mi / 29.5 ac)] and Virginia spiraea [0.14 kilometer / 1.73 hectares (0.09 mi / 4.28 acres)]and are presumed present therefore the project **May Affect – Is Likely to Adversely Affect** these species. No potential habitat was found for northeastern bulrush throughout the Project Area; therefore, the Project will have **No Effect** on running buffalo clover.

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°F	Fahrenheit
ACGIH	American Conference of Government Industrial Hygienists
ADI	Area of Direct Impact
AEP	Appalachian Power Company
API	American Petroleum Institute
AR	access road
ATON	Aid to Navigation
ATV	All-Terrain Vehicle
ATWS	additional temporary workspace
BA	Biological Assessment
BMPs	best management practices
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
cm	centimeter(s)
dB	decibel
dBA	A-weighted decibels
dbh	diameter at breast height
DCH	designated critical habitat
DS	downstream
E&SC	Erosion and Sediment Control
ESA	Endangered Species Act
ESI	Environmental Solutions & Innovations, Inc.
FAA	Federal Aviation Administration
FERC	Federal Energy Regulatory Commission
FHWA	Federal Highway Administration
FHWA	Federal Highway Administration
FR	Federal Register
FRRRP	Forest and Rangeland Renewable Resources Planning Act
ft	foot (feet)
HDD	horizontal directional drilling
hp	horsepower
HUC	hydrologic unit code
Hz	hertz
IAQM	Institute of Air Quality Management
in	inch(es)
ITS	Incidental Take Statement
kHz	kilohertz
KMP	Karst Mitigation Plan
KS	Karst Specialist
LDB	left descending bank
LDC	local distribution companies
Ldn	day/night average sound level

Leq	equivalent sound level
LOD	limits of disturbance
LRMP	Land and Resource Management Plan
m	meter(s)
m^2	square meter(s)
MarkWest	MarkWest Liberty Midstream & Resources, LLC
mg/m^3	micrograms per cubic meter
mi	mile(s)
mi^2	square mile(s)
MLV	mainline block valve
MMDth/d	million dekatherms per day
MP	milepost
MVP	Mountain Valley Pipeline, LLC
n	sample size
NEPA	National Environmental Policy Act
NFMA	National Forest Management Act
NGA	Natural Gas Act
NHD	National Hydrography Dataset
NHRP	National Register of Historic Places
NIOSH	National Institute for Occupational Safety and Health
NLAA	May affect, not likely to adversely affect
NLCD	National Land Cover Database
NMFS	National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NSAs	noise sensitive areas
OSHA	Occupational Safety & Health Administration
PM	particulate matter
PM10	particulate matter under 10 microns
Project	Mountain Valley Pipeline Project
Project Area	Project's Limits of Disturbance
psig	Pounds Per Square Inch Gage
RCNM	Federal Highway Administration's Roadway Construction Noise Model
RDB	right descending bank
ROW	right-of-way
RUSLE	Revised Universal Soil Loss Equation
SSURGO	Soil Survey Geographic
STATSGO	State Soil Geographic
Transco	Transcontinental Gas Pipe Line Company, LLC
TSS	total suspended solids
U.S.	United States
US	upstream
USACE	U.S. Army Corps of Engineers
USC	U.S. Code
USDA	U.S. Department of Agriculture

USEPA	U.S. Environmental Protection Agency
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UV	ultraviolet
VA	Virginia
VAC	Virginia Annotated Coded
VDCR-DNH	Virginia Department of Conservation and Recreation’s Division of Natural Heritage
VDGIF	Virginia Department of Game and Inland Fisheries
VDHR	Virginia Department of Historic Resources
VDMME	Virginia Department of Mines, Minerals, and Energy
VSS	Virginia Speleological Society
WERMS	Wildlife Environmental Review Map Service
WNS	White Nose Syndrome
WV	West Virginia
WVDEP	West Virginia Department of Environmental Protection
WVDNR	West Virginia Division of Natural Resources
WVDOT	West Virginia Department of Transportation
WVMSP	West Virginia Mussel Survey Protocol
WVNHP	West Virginia Natural Heritage Program
X-ray	radiography
YOY	Young of Year
µg/m3	micrograms per cubic meter

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1.0 Introduction

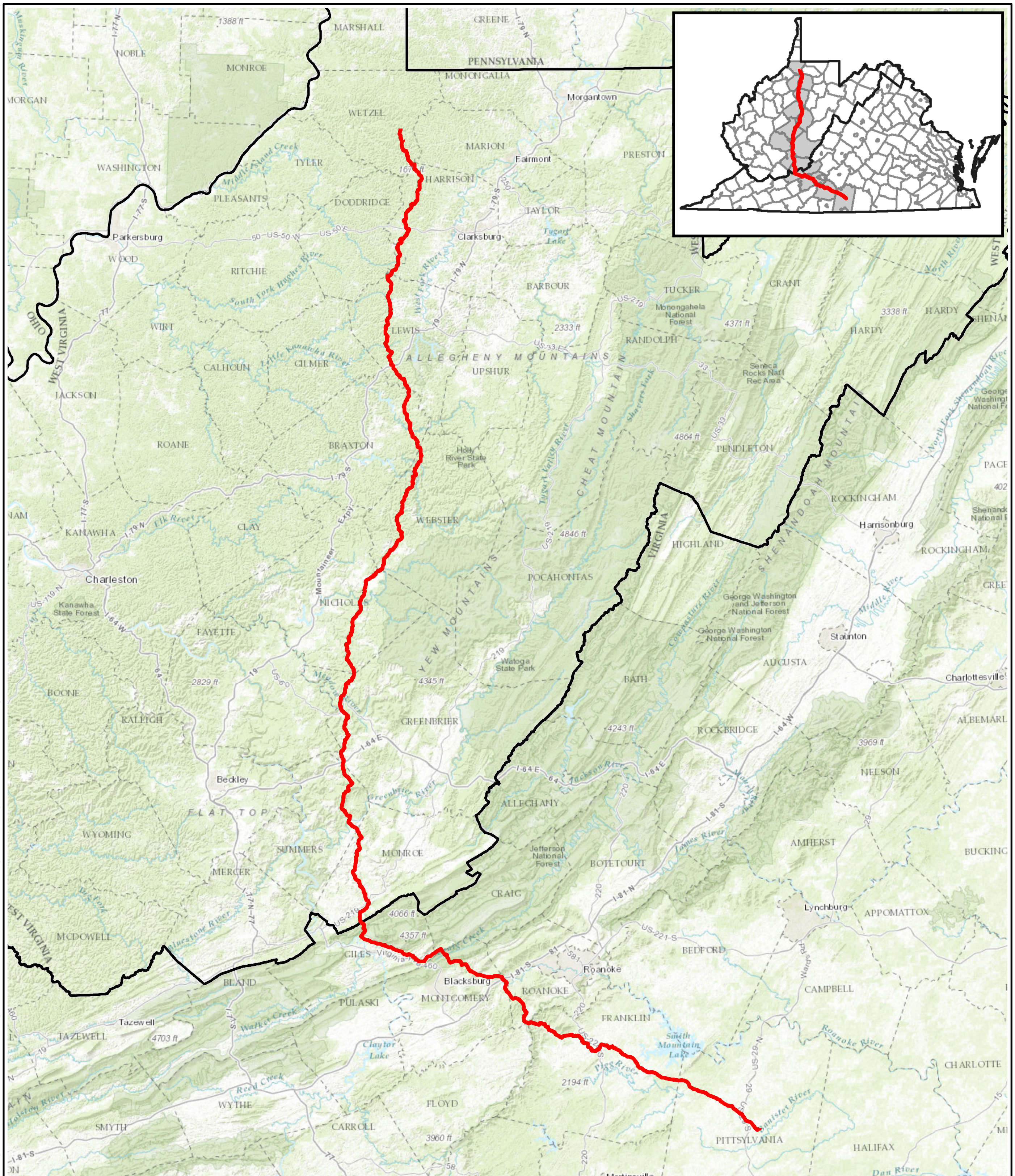
Mountain Valley Pipeline, LLC (MVP), a joint venture between EQT Midstream Partners, LP, NextEra Energy, Inc., WGL Holdings, Inc., Con Edison Gas Midstream, LLC, and RGC Midstream, LLC, is seeking a Certificate of Public Convenience and Necessity from the Federal Energy Regulatory Commission (FERC) pursuant to Section 7(c) of the Natural Gas Act (NGA) authorizing it to construct and operate the proposed Mountain Valley Pipeline Project (Project) located in 17 counties in West Virginia and Virginia. MVP plans to construct an approximately 488.3-kilometer (303.4-mi), 106.7-centimeter (42-in) diameter natural gas pipeline to provide timely, cost-effective access to the growing demand for natural gas for use by local distribution companies (LDCs), industrial users and power generation in the Mid-Atlantic and southeastern markets, as well as potential markets in the Appalachian region. Because the Project is proposed to cross the Jefferson National Forest, which is under the jurisdiction of the U.S. Forest Service (USFS), and the Weston and Gauley Bridge Turnpike Trail, which is under the jurisdiction of the U.S. Army Corps of Engineers (USACE), MVP is also seeking a right-of-way (ROW) grant from the Bureau of Land Management under the Mineral Leasing Act.

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

1.1 Regulatory Compliance

As described below, MVP is working with multiple entities to assure compliance with state and federal environmental regulations. Efforts to address the following statutes have influenced Project design as it relates to federally and state-listed species:

- Section 7 (c) of the Natural Gas Act
- The National Environmental Policy Act
- The Endangered Species Act (16 USC A-1535-1543, P.C. 93-205)
- The National Forest Management Act
- Virginia Annotated Code Title 29.1 Chapter 5, Article 6: Endangered Animal Species



October 2016 Proposed Route (Revised)

N

W E

S

Figure 1. Location of the Mountain Valley Pipeline Project in West Virginia and Virginia.

Project No.
593.25

Miles
0 20 40

ESI ENVIRONMENTAL SOLUTIONS & INNOVATIONS, INC.

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These laws and regulations are described in more detail in the following sections. MVP is also complying with additional state and local laws and regulations as required for the construction, operation, and maintenance of the Project, but these are not discussed in the BA.

1.2 Consultation

On October 13, 2014, MVP submitted letters introducing the Project to the U.S. Fish and Wildlife Service (USFWS) (Elkins and Gloucester Field Offices), West Virginia Division of Natural Resources (WVDNR), and the Virginia Department of Game and Inland Fisheries (VDGIF). Environmental Solutions & Innovations, Inc. (ESI), on behalf of MVP, submitted letters to USFWS on October 30, 2014 and March 6, 2015 requesting information on the potential for federally listed species to occur within the Project's limits of disturbance (LOD) (referred to hereafter as the Project Area). On April 3 and April 23, 2015, the USFWS Gloucester Field Office and Elkins Field Office, respectively, provided formal comments to ESI regarding the Project's potential to impact federally listed species within the Project Area.

The USFWS indicated the Project is within the range of the federally endangered Indiana bat (*Myotis sodalis*) and federally threatened northern long-eared bat (*Myotis septentrionalis).* Furthermore, the Project will traverse multiple protective capture, roost, and hibernacula buffers associated with both species. Consultation with the USFWS further specified that clearing of any trees ≥7.6 centimeters (3 in) in diameter at breast height (dbh) between April 1 and November 15 would require formal consultation under Section 7 of the ESA between the USFWS and FERC due to the known occurrences of Indiana bats.

The USFWS indicated the Project will cross three streams (Roanoke River, North Fork Roanoke River, and Pigg River) in Virginia currently inhabited by the federally endangered Roanoke logperch (*Percina rex*). The USFWS and VDGIF did not recommend surveys as species presence is assumed in these streams. The USFWS further stated that crossing the streams using any method other than horizontal directional drilling (HDD) would require formal consultation under ESA Section 7. As currently designed, the proposed crossing method for the Roanoke River, North Fork Roanoke River, and Pigg River is open cut, dry ditch.

The USFWS indicated the Project will cross several perennial streams that support populations of [redacted] If these streams could not be avoided or HDD could not be used, the USFWS requested additional coordination and completion of mussel surveys at the proposed crossing locations. In Virginia, the Project will cross [redacted] and other streams within the [redacted] watershed would require formal consultation under ESA Section 7. As currently designed, the proposed crossing method for [redacted]

The USFWS indicated that there is potentially suitable habitat for six federally protected plant species occurring within the Project Area and requested completion of presence/absence surveys. These species include northeastern bulrush (*Scirpus ancistrochaetus*), running buffalo clover (*Trifolium stoloniferum*), shale barren rock cress (*Arabis serotina*), small whorled pogonia (*Isotria medeoloides*), smooth coneflower (*Echinacea laevigata*), and Virginia spiraea (*Spiraea virginiana*). Additionally, in Virginia, the USFWS initially indicated that potentially suitable habitat for the federally endangered Mitchell's satyr butterfly (*Neonympha mitchellii mithcellii*) is present in [redacted], and requested completion of field surveys to document suitable habitat within the Project Area. On October 2, 2015, the USFWS revised its recommendations to require surveys for potentially suitable Mitchell's satyr butterfly habitat only in [redacted]. As currently designed, the Project Area does not include [redacted] so no surveys were conducted.

To confirm that no other protected species are known to occur in or near the Project Area, ESI requested natural heritage data from the WVDNR on March 6, 2015 and from the Virginia Department of Conservation and Recreation's Division Natural Heritage (VDCR-DNH) on March 4, 2015. In response to this request, WVDNR confirmed on April 6, 2015 that no other known records of rare, threatened, or endangered species or sensitive habitats are within the Project Area. On April 6, 2015, the VDCR-DNH provided information and recommendations for field surveys for several state protected plant and wildlife species with potential to occur within 3.2 kilometers (2 mi) of the Project Area. The VDCR-DNH did not provide information on federally protected species in addition to that previously conveyed by USFWS. Surveys for state protected species were completed following guidelines recommended by VDGIF and VDCR-DNH, and results were summarized in reports submitted to the state agencies for approval. State protected species are not discussed further within this Biological Assessment (BA).

The USFWS Elkins Field Office issued a letter on September 29, 2016 detailing the capture of a gray bat (*Myotis grisescens*) in [redacted]. This capture represented a range-expansion for the species. As such, USFWS requested additional consultation for projects located in select areas of West Virginia, including the counties of [redacted] which are crossed by the Project Area. Project-specific correspondence with the USFWS resulted in a request for MVP to include the gray bat in the BA.

On January 10, 2017, the USFWS Gloucester Field Office requested the inclusion of the Virginia big-eared bat (*Corynorhinus townsendii*) in the BA as a result of unassessed caves and karst areas that could potentially provide suitable habitat for this species.

On January 18, 2017, the USFWS Gloucester Field Office requested the inclusion of the rusty patched bumble bee (*Bombus affinis*) in the BA. Rusty patched bumble bee was recently listed as federally endangered by USFWS, with an anticipated effective date of March 21, 2017. The Project intersects the distributional range and occurrence records for the species in West Virginia and Virginia.

Copies of correspondence with the USFWS related to the Project are included in Appendix A.

1.3 Species Covered

This BA reviews potential effects of the Project on 15 federally listed or proposed species identified through consultation with the USFWS:

- Indiana bat
- Northern long-eared bat
- Gray bat
- Virginia big-eared bat
- Roanoke logperch
- James spinymussel
- Clubshell
- Snuffbox
- Rusty patched bumble bee
- Northeastern bulrush
- Running buffalo clover
- Shale barren rock cress
- Small whorled pogonia
- Smooth coneflower
- Virginia spiraea

These federally listed species are described in more detail in Section 4.0.

1.4 Studies Completed in Support of the Biological Assessment

ESI was contracted to complete presence/probable absence or qualitative habitat surveys for all federally listed species potentially present, as identified by the

USFWS, within the Project Area. The following sections summarize these field efforts.

1.4.1 Bats

1.4.1.1 Mist Net and Telemetry Surveys - Summary

ESI 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 three mist-net sites (6 complete and 6 partial net nights) from May 15 to May 26, 2016. Methods were generally consistent with the USFWS 2015 Range-wide Indiana bat Summer Survey Guidelines, which are also applicable to northern long-eared bats for summer surveys. The one exception to this protocol, as discussed with the USFWS Elkins Field Office and the WVDNR, is that if sampling had been conducted at a rate of 1 site per kilometer as recommended in the guidelines, surveys would have been conducted at 556 sites. The reason for this departure from the guidelines was that, at the time of the 2015 mist net survey, the interim 4(d) rule for the northern long-eared bat was in place. Based on the USFWS Northern Long Eared Bat Interim Conference and Planning Guidance (USFWS 2014), all lands within 2.4 kilometers (1.5 miles) of a northern long-eared bat roost location and within 4.0 kilometers (3.0 miles) 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 survey were not conducted along approximately 42.4 percent (207.47 kilometers [128.92 miles]) of the proposed route and 50 percent (164.67 kilometers [102.32 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.

A total of 1,476 bats representing nine species was captured: 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 federally endangered Indiana, gray, or Virginia big-eared bats were captured. Northern long-eared bat captures included 29 adult males, 21 juveniles, 19 reproductive adult females, and 5 non-reproductive adult females. Radio transmitters were attached to 56 of the northern long-eared bats. Two pregnant northern long-eared bats were not tagged due to West Virginia permit conditions, two bats were not tagged because they were too small to carry the transmitter, and the remaining 14 were not tagged because requirement of three tagged bats per net site was already fulfilled. Forty-three tagged bats were tracked to diurnal roosts for a minimum of four consecutive days. One tagged bat was never tracked due to transmitter failure on the first day, and 12 tagged bats were never located during telemetry studies. Sixty-nine roosts were found. The greatest number of tagged bats using the same roost was two which occurred on only one day. Eighteen tagged bats changed roosts at least once during the course of tracking.

ESI completed emergence counts concurrent with telemetry studies. Each identified roost tree was observed for a minimum of two nights, beginning 30 minutes before sunset, and lasting until bats finished emerging, or darkness precluded accurate counting. ESI observed 267 bats emerging from 69 roost trees over 145 observation nights. The greatest number of bats emerging from a single roost on a single night (July 9, 2015) consisted of 40 individuals.

A complete report detailing mist net and telemetry studies completed in support of this BA was submitted to the USFWS on November 13, 2015. An addendum to this report outlining the results of the three net sites completed in 2016 was submitted to the USFWS on June 13, 2016.

1.4.1.2 Hibernacula Search and Harp Trapping Surveys - Summary

Between November 2014 to January 2017, ESI biologists searched for any voids and underground features within the 91.4-meter (300-ft) wide environmental survey corridor centered on the pipeline and access road centerlines, and within all additional temporary workspace and aboveground facilities. ESI observed 44 previously undocumented voids or underground features and eight known caves during these searches, and 24 (11 in West Virginia and 13 in Virginia) were determined potentially suitable for hibernating bats. Four potentially suitable portals in West Virginia were sampled using harp traps between September 25 and October 22, 2015 and two were sampled in October 2016. One northern long-eared bat was captured at a portal in [redacted] during these efforts. No bats were captured at the other five portals sampled. One suitable portal in Virginia was sampled using a harp trap on September 29 and October 20, 2015, but no bats were captured during this effort. [redacted] was sampled using a harp trap on April 17-21, 2016 and on October 14-15, 2016. An additional five features in Virginia were sampled from September 27 to October 14, 2016. No bats were captured at these features.

A report detailing portal search and sampling efforts in support of this BA was submitted to the USFWS Elkins Field Office on January 11, 2016 and to the USFWS Gloucester Field Office on January 13, 2016. An addendum report summarizing portal searches and trapping efforts for the 2016 season were submitted to the USFWS Elkins Field Office and the USFWS Gloucester Field Office on December 2, 2016. Three additional suitable portals were discovered in January 2017 and are included within this BA; a survey report detailing these features has not yet been submitted. As a consequence of denied land access, approximately 33.44 kilometers / 208.35 hectares (20.78 mi / 514.85 ac) of the project in West Virginia and 0.04 kilometer / 0.04 hectares (0.023 mi / 0.11 ac) remains unsearched for portals.

1.4.1.3 On-Site Detailed Habitat Assessment - Summary

ESI undertook detailed assessments of bat habitat suitability within the Project Area between February 10, 2015 and November 22, 2015. Portions of the Project within listed bat capture (8 kilometer [5 mi] and 4.8 kilometer [3 mi]) and roost (4 kilometer [2.5 mi] and 2.4 kilometer [1.5 mi]) buffers were assessed for roosting and foraging habitat for the Indiana bat and the northern long-eared bat (respectively), and then ranked low, moderate, or high according to suitability for roosting and foraging. The goal of this survey was to assess habitat suitability for Indiana and northern long-eared bats in order to quantify potential impacts to the species as a result of year-round timber removal during construction of the Project.

Qualified bat biologists walked an environmental survey corridor centered on the pipeline (91.4 meters [300 ft] wide) and access road (15.2 meters [50 ft] wide) centerlines, and within all additional temporary workspace and aboveground facilities (94 miles of miles of proposed pipeline route, 17.5 miles of access roads, one proposed compressor station and four proposed laydown yards in the state of West Virginia) and 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. In addition to noting the overall suitability of each habitat patch, biologists also map the location of each potential roost and rate its overall quality on a scale from low to high. ESI identified 917 habitat patches and 10,978 potential roost trees were identified.

Of these 917 habitat patches, 343 had no roosting potential for Indiana bat and 314 had no roosting potential for the northern long-eared bat. Fifty-five habitat patches were ranked as high roosting potential for the Indiana bat and 137 patches were ranked as high roosting potential for the northern long-eared bat. Of the 10,978 potential roost trees, 5,084 (46.3%) were ranked as low, 4,908 (44.7%) were ranked as moderate, and 986 (9.0%) were ranked as high potential for the Indiana bat. For northern long-eared bat, 2,431 (22.1%) potential roost trees were ranked as low, 5,344 (48.7%) were ranked as moderate, and 3,203 (29.2%) were ranked as high potential.

With respect to foraging potential, 265 (28.9%) of the habitat patches identified had high foraging potential for the northern long-eared bats, and 200 (21.8%) of patches had high foraging for the Indiana bat.

A complete report detailing the detailed habitat assessment conducted in support of this BA was submitted to the USFWS on January 8, 2016.

1.4.2 Roanoke Logperch Stream Habitat Assessments - Summary

The Project will traverse a large portion of the Roanoke River basin within the geographic distribution of the federally endangered Roanoke logperch. Within the basin, the Project will cross a total of 38 perennial streams within the upper Roanoke subbasin that have potential to support populations of Roanoke logperch based on the initial desktop analysis. In a letter dated April 3, 2015, USFWS requested that the presence of Roanoke logperch be assumed at any crossing in three waterbodies [redacted] These waterbodies, which the Project will cross a total of five times, are known to currently support populations of this species. [redacted] The remaining 33 stream crossings warranted habitat assessments to determine habitat suitability or potential presence for Roanoke logperch populations.

Between April and November 2015, ESI completed qualitative habitat assessments for suitable Roanoke logperch habitat along a survey reach that extended approximately 100 meters (328 ft] extending upstream and approximately 100 meters (328 ft) downstream of the proposed Project footprint at 23 proposed stream crossings. In a letter dated March 8, 2016, USFWS identified five stream crossings that exhibited potentially suitable habitats for Roanoke logperch including [redacted] Correspondence with agencies involve stream crossings that have been eliminated because of route modifications and are not included in this BA [e.g., [redacted] are added to the end of stream names to differentiate between the different crossings.

In 2016, at the request of VDGIF and USFWS, the level of effort to complete remaining qualitative habitat assessments was increased to include a survey reach ranging between 500 and 1,000 meters (1,640 and 3,281 ft), depending on the catchment area of the site. Ten stream crossings were identified for assessment in 2016. Based on Project correspondence with USFWS (March 16, 2016) and VDGIF (March 11, 2016), two crossings were eliminated based on desktop analysis because of a natural geological feature prohibiting colonization of habitats (i.e., stream crossings upstream of [redacted]). Based on qualitative habitat assessments, four of the remaining eight stream crossings visited in 2016 exhibited potentially suitable habitats for Roanoke logperch, including [redacted]

In total, 14 stream crossings are known to support Roanoke logperch or harbor potentially suitable habitat for the species along the Project. The remaining 24 proposed stream crossings do not support habitat suitable for Roanoke logperch.

A complete report detailing the qualitative habitat assessments conducted in 2015 for Roanoke logperch in support of this BA was submitted to the USFWS on November

13, 2015. A report detailing 2016 Roanoke logperch habitat assessments in Virginia was submitted to the USFWS on October 17, 2016.

1.4.3 Freshwater Mussel Surveys – Summary

Complete reports detailing 2015 freshwater mussel surveys conducted in support of this BA were submitted to the USFWS on November 13, 2015. A report detailing 2016 freshwater mussel assessments and surveys in Virginia was submitted to the USFWS on October 14, 2016. A report detailing the 2016 freshwater mussel assessment at the access road crossing [redacted] was submitted to the WVDNR and USFWS Elkins Field Office on July 28, 2016, and a similar report for a second access road crossing [redacted] was submitted to the WVNDR and USFWS Elkins Field Office on October 28, 2016.

1.4.3.1 West Virginia

In accordance with the West Virginia Mussel Survey Protocol (WVMSP), streams crossed in West Virginia with upstream drainages greater than 25.9 square kilometers (10 mi^2) were surveyed for the presence of freshwater mussels from July to September 2015 and June to September 2016. Mussel surveys were successfully completed at nine Group 1 stream crossings and at three Group 2 stream crossings. One stream crossing, [redacted] was not fully assessed because of high stream velocities (i.e., whitewater rapids) and unsafe diving conditions. The WVDNR waived the need for formal surveys at the [redacted] crossing via email correspondence on September 29, 2015. No federally listed mussels were encountered during 2015 and 2016 mussel survey efforts. Future relocation efforts of non-listed mussels are warranted at two proposed crossings including [redacted].

MVP originally proposed to withdrawal water from the Little Kanawha River (Group 2 stream) via a temporary, floating surface water pump. Although a mussel site assessment completed in September 2016 yielded no sign of mussels, MVP was amenable to USFWS requests to forego water withdrawal activities in the Little Kanawha River. Water withdrawals are not proposed to occur in streams in West Virginia listed as Group 2 streams and potentially supporting federally endangered mussels.

1.4.3.2 Virginia

In accordance with the Freshwater Mussel Guidelines for Virginia, streams crossed in Virginia with drainages greater than 13 square kilometers (5 mi^2) were surveyed for the presence of freshwater mussels or assessed for potentially suitable habitat from April to October 2015 and April to September 2016. Of the 24 stream crossings identified during the desktop analyses and traversed by the Project, five crossings [redacted] yielded live mussels and two crossings ([redacted] yielded deadshell mussels only. Mussels are assumed present at one additional stream crossing [redacted] based on agency correspondence. Future relocation efforts of non-listed mussels are proposed at the eight aforementioned stream crossings. The remaining 16 stream crossings assessed or surveyed did not yield live mussels or exhibit suitable habitat; therefore, no additional mussel-related concerns are proposed at these 16 locations.

1.4.4 Rusty Patched Bumble Bee – Summary

Two counties in Virginia (Montgomery and Giles counties) and four counties in West Virginia (Braxton, Fayette, Lewis, and Nicholas Counties) have historical records and MVP is committed to implementation of voluntary conservation measures in these counties.

1.4.5 Plant Surveys – Summary

Surveys and field habitat assessments for federally-listed plant species were conducted across 37 deployments between May 22, 2015 and October 25, 2016. A study plan outlining methods for plant surveys was submitted to the USFWS (West Virginia and Virginia), VDCR-DNH, and WVDNR on June 3, 2015, and concurrence was provided by the VDCR-DNH on June 10, 2015, the USFWS in Virginia on June 17, 2015, and by the USFWS in West Virginia on June 29, 2015. The WVDNR deferred to the USFWS 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.

A desktop habitat analysis was completed to identify potentially suitable habitat and used to determine the specific survey areas. Field surveys were completed by a USFWS Certified Plant Surveyor. Field surveys were completed using a pedestrian meander search technique across the 91.4-meter (300 ft) wide environmental study corridor. Table 1 provides the number of acres and miles searched for federally listed species within the Project Area. The column regarding miles remaining to survey identifies areas that could not be surveyed due to land-access restrictions. In areas where habitat conditions were designated as highly suitable for any of the listed species, more intensive searches were employed.

Table 1. Acres and miles of Project Area searched for federally threatened and endangered plant species along the Mountain Valley Pipeline in Virginia and West Virginia.

Plant Species	Total Acres Surveyed	Acres Surveyed LOD	Total Miles Surveyed	Miles Remaining to Survey
Northeastern bulrush	35.93	14.82	0.22	0.00
Running buffalo clover	438.49	217.31	24.41	0.14
Shale barren rock cress	272.81	129.60	10.58	0.12

Plant Species	Total Acres Surveyed	Acres Surveyed LOD	Total Miles Surveyed	Miles Remaining to Survey
Small whorled pogonia	335.26	158.44	12.80	0.12
Smooth coneflower	524.69	154.65	24.51	0.00
Virginia spiraea	3.64	2.73	0.14	0.09

Complete reports detailing the 2015 plant surveys conducted in support of this BA were submitted to the USFWS, VDCR-DNH, and WVDNR on November 13, 2015. Due to route realignments, additional areas were surveyed in 2016 as new potential habitat was identified during the desktop analysis. No federally listed species were identified. The 2016 West Virginia plant survey report was submitted to the USFWS and WVDNR on November 9, 2016 and the 2016 Virginia plant survey report was submitted to the USFWS and VDCR-DNH on November 21, 2016.

1.5 Purpose of the Biological Assessment

The purpose of this BA is to evaluate the effects on federally listed species resulting from development of the Project in Wetzel, Doddridge, Harrison, Lewis, Braxton, Webster, Nicholas, Greenbrier, Fayette, Summers, and Monroe counties, West Virginia and Giles, Craig, Roanoke, Montgomery, Franklin, and Pittsylvania counties, Virginia. This BA has been prepared and submitted in compliance with requirements of Section 7 of the ESA (16 USC 1536[c], 50 CFR 402.12[f] and 402.14[c]), and in conjunction with requests for authorization from FERC to construct and operate the proposed pipeline under Section 7(c) of the NGA and for other federal authorizations, including a ROW grant from the Bureau of Land Management.

2.0 Project Description

2.1 Purpose and Location

The Project is a new pipeline designed to transport up to 2.0 MMDth/d of natural gas from the Appalachian Basin to growing markets in the Mid-Atlantic and southeastern United States. The purpose of the Project is to provide timely, cost-effective access to supplies to meet the growing demand for natural gas for use by local distribution companies (LDCs), industrial users, and power generation facilities in the Mid-Atlantic, southeastern, and Appalachian markets. The Project will also provide the opportunity for unserved and underserved markets along the route to access natural gas supplies.

The 488.3-kilometer (303.4-mi) pipeline will extend from an interconnection with Equitran's existing H-302 pipeline in Wetzel County, West Virginia and traverse south-southeast to the town of Chatham, Pittsylvania County, Virginia where the pipeline will terminate at Transco's compressor station 165. Mileposts (MPs) and length (miles) of the Project in each county crossed are summarized in Table 2.

The Project Area consists of the temporary and permanent ROW established for construction, operation, and maintenance of the pipeline, access roads, and aboveground facilities. The pipeline will require a 38.1-meter (125-ft) construction ROW and a 15.2-meter (50-ft) permanent, operational ROW. In mountainous areas

Table 2. Length of proposed pipeline by county.

County, State	Milepost Range	Length (miles)
Wetzel, West Virginia	0.0 – 9.5	9.5
Harrison, West Virginia	9.5 – 31.5 32.6 – 33.7 37.4 – 38.0	23.7
Doddridge, West Virginia	31.5 – 32.6 33.7 – 37.4	4.8
Lewis, West Virginia	38.0 – 65.5	27.5
Braxton, West Virginia	65.5 – 80.2	14.7
Webster, West Virginia	80.2 – 110.8	30.4
Nicholas, West Virginia	110.8 – 135.3	24.8
Greenbrier, West Virginia	135.3 – 154.2 154.7 – 157.1	21.3
Fayette, West Virginia	154.2 – 154.7	0.5
Summers, West Virginia	157.1 – 174.3	17.1
Monroe, West Virginia	174.3 – 196.3	22.1
Giles, Virginia	196.3 – 216.8	20.4
Craig, Virginia	216.8 – 218.5	1.7

County, State	Milepost Range	Length (miles)
Montgomery, Virginia	218.5 – 238.1	19.6
Roanoke, Virginia	238.1 – 246.5	8.4
Franklin, Virginia	246.5 – 283.9	37.4
Pittsylvania, Virginia	283.9 – 303.4	19.5
Total		303.4

where slopes typically exceed 30 to 35 percent, MVP will employ special techniques to allow safe construction of the Project which will require expanded work areas. Special techniques include the use of winch lines on the back end of bull dozers in order to secure pipe laying equipment on the steep slopes. The bull dozers will be placed securely at the top of the steep slopes and the winch cable line will be unreeled from the cable spool on the back of the bull dozer. The winch cable will then be securely attached to the pipe laying equipment and slowly be pulled up the hill from the bottom to the top of the hill. Once the equipment reaches a point that it can travel on its own power, the winch cable will be removed.

MVP will neck down to a 23-meter (75-ft) construction ROW in streams and wetlands. Land required for the construction of the pipeline ROW is approximately 1,804.2 hectares (4,458.3 ac), with 1,057.9 hectares (2,614.2 ac) being temporarily disturbed for construction and 746.3 hectares (1,844.1 ac) remaining permanently maintained for operation. Additional temporary workspace and contractor yards needed during construction of the Project total an additional 335.8 hectares (829.8 ac). Approximately 366.6 hectares (905.8 ac) are required for the construction of access roads, and 60.3 hectares (149.0 ac) are required to construct aboveground facilities. Mainline block valve sites will be entirely contained within the pipeline ROW and will therefore not require any additional land disturbance. Land required for the Project is summarized in Table 3.

Table 3. Land requirements for the Mountain Valley Pipeline Project.

	Land Affected During Construction	Land Affected During Operation
Project Component	Acres	
Pipeline Facilities		
Pipeline Right-of-Way	4,458.3	1,844.1
Additional Temporary Workspaces (ATWS)	659.4	0.00
Above Ground Facilities		
Mobley Interconnect	3.21	1.1
Bradshaw Compressor Station	36.5	6.3
Sherwood Interconnect	12.0	1.1
Harris Compressor Station	16.5	5.6
WB Interconnect	9.9	1.2
Stallworth Compressor Station	29.9	7.2
Transco Interconnect	41.0	2.7
Yards	170.4	0.0

Project Component	Land Affected During Construction	Land Affected During Operation
	Acres	
Access Roads	905.8	237.6
Cathodic Protection Beds	17.7	9.6
Total	6,360.6	2,116.5

2.2 Construction Timeline

The Project schedule is dependent upon obtaining all necessary authorizations, which will then dictate when Project tree-clearing activities can begin. MVP will begin tree-clearing activities as soon as allowed, which could be as early as November 2017. In that case, the majority of clearing will be completed by March 31, 2018. However, because of uncertainty associated with dependency on authorizations, and in order to estimate impacts as realistically as possible, the following clearing schedule is used in preparation of impact assessments within this document:

- January to March 2018 – 167 miles
- April to May 2018 – 101 miles
- August to November 2018 – 32 miles

This schedule is based on the following assumptions: a clearing rate of 762 linear meters (2,500 feet) per day and clearing crews working 6 days per week with no clearing on standard federal holidays. If clearing begins earlier than January, then a greater portion of the Project will be cleared during winter 2018, meaning that actual impacts to listed species will be less than predicted within this document. In addition, areas along the Project within 8 kilometers (5 miles) of Indiana bat hibernacula or within 0.4 kilometer (0.25 mile) of northern long-eared bat hibernacula will be cleared before March 31, 2018 or after November 15, 2018. No clearing of any areas along the Project will occur between June 1 and July 31. Maps depicting this schedule in relation to known and potentially occupied bat winter habitats are available in Figure 27 (Section 5.1.1.1).

Pipeline construction will be completed by December 2018 with a target full in-service date for the Project of December 2018. Restoration will begin immediately following pipeline installation throughout the construction process and continue through June 2019, or until vegetation is successfully established.

2.3 Life of the Project

MVP currently has no plans for either future expansion or abandonment of the facilities. Market forces will determine the timing and need for future expansions.

2.4 Route Selection

Several criteria were used to select the proposed pipeline route, including the following:

- Avoiding or minimizing potential impacts on sensitive biological and cultural resources, protected lands, wetlands and waterbodies, floodplains, sensitive soils, disruption to mineral resources, environmental hazards (e.g., hazardous landfills) and geologic/topographic hazards to the extent possible;
- Avoiding, when possible, residential or high density population areas;
- Existing ROWs; transportation features and utility crossings; land uses (i.e., both existing and planned); potential impacts (i.e., both positive and negative) to local communities and landowners (e.g., increase tax revenue, short-term disruptions due to construction activities); and
- Engineering, construction, and cost feasibility (i.e., including route length, topography implications, side slopes and trenchless crossing location(s).Facilities and Infrastructure

2.5 Facilities and Infrastructure

This section provides an overview of the typical and specialized construction methods that will be implemented on this Project. Note that, per USFS's request, some of these methodologies vary slightly on the Jefferson National Forest. The Plan of Development describes how the Project will be constructed on USFS-managed lands.

2.5.1 Pipeline Construction

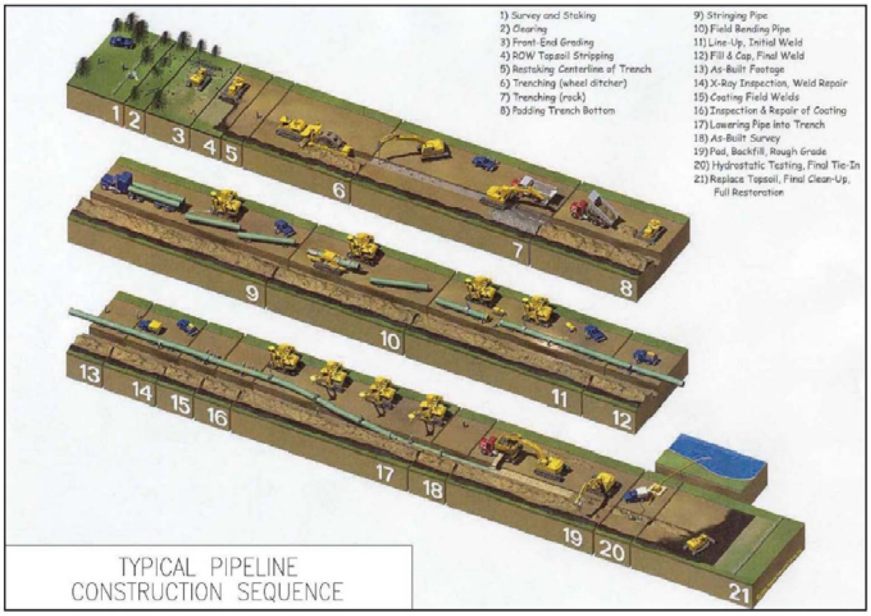
As proposed, the pipeline will be constructed of high strength carbon steel pipe and manufactured in accordance with the American Petroleum Institute's Specification for Line Pipe (API 5L PSL2). The pipe will be protected from corrosion by a fusion-bonded epoxy coating and an impressed current cathodic protection system during operations.

Construction of the pipeline and associated facilities will occur within one construction season and will be undertaken in 11 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. Elements of a construction spread vary depending on the selected contractor and execution plan. Depending on the Project schedule, more than one spread may be utilized concurrently.

Those portions of the Project primarily in upland terrain will employ conventional overland construction techniques for large-diameter pipelines. In the typical pipeline construction scenario, the construction contractor will construct the pipeline along the ROW using sequential construction techniques, including survey, staking and fence crossing; clearing and grading; trenching; pipe stringing, bending and welding;

lowering-in and backfilling; hydrostatic testing; clean-up and restoration; and commissioning (Figure 2).

Figure 2. Typical pipeline construction sequence.



2.5.1.1 Surveying and Staking

The initial step in preparing the ROW for construction is the civil survey. Engineers and land survey crews will stake the outside limits of the construction ROW, the centerline of the proposed trench, additional temporary workspace (ATWS), and other approved work areas. Approved access roads will be marked using temporary signs or flagging, as well as the limits of approved disturbance on any access road requiring widening. Any identified environmentally sensitive areas (e.g., waterbodies and wetlands, special status species habitat, and historic properties) will be fenced off to constrict the construction ROW as necessary to avoid these features. The "One Call" system of each state will be contacted, and underground utilities (e.g., cables, conduits, and pipelines) will be located and flagged. Affected landowners will be notified prior to surveying and staking of the proposed route, following applicable state/federal guidelines.

2.5.1.2 Clearing and Grading

After the ROW has been surveyed and easements secured, a combination of heavy equipment and sawyers will be used to clear the ROW of any obstructions (i.e., trees and stumps, brush, logs, and large rocks). Ground cover may remain until grading is required. All merchantable timber will be cut into lengths and stacked off the edge of the ROW. Timber ranging from 10.2 to 20.3 centimeters (4 to 8 in) in diameter at the butt end, suitable for fence posts or other uses, will be cut into usable lengths. If the landowner does not wish to use timber products or any other tree material it will be windrowed, no taller than 1.2 meters (4 ft) with wildlife breaks/openings every 61 meters (200 ft), except that on the Jefferson National Forest, openings will be every 30 meters (100 ft).

Brush and slash will be handled according to local permitting and landowner requests. MVP will dispose of brush and slash through burning, windrowing, or chipping, in this order. Open burning of brush will be conducted on a site-specific basis, in accordance with applicable state and local regulations, and meet Mountain Valley's *Fire Prevention and Suppression Plan*. No burning will be conducted within the Jefferson National Forest. Except in environmentally sensitive areas (i.e., waterbodies, wetlands, and habitat for special status species), chipped brush will be blown from the ROW with landowner approval.

Once the ROW is cleared of timber and brush, rough-grading will be conducted as necessary using bulldozers and backhoes to allow for a reasonably level work surface, the passage of equipment, and the preparation of a work area for pipeline installation activities. Displaced soils will be stockpiled along the construction ROW to minimize the need and potential impact of additional haul vehicles. In residential and agricultural areas, at minimum the top 30.5 centimeters (12 in) of topsoil will be segregated from subsoil. The entire topsoil layer will be segregated in soils with less than 30.5 centimeters (12 in) of topsoil.

The FERC 2013 Upland Erosion Control, Revegetation, and Maintenance Plan and Project Erosion and Sediment Control Plan as well as site-specific erosion and sedimentation control plans will be implemented along the construction ROW. Temporary erosion controls (e.g., mulching, silt fences, compost filter socks) will be installed prior to disturbance to the soil and will be maintained throughout construction phases of the Project until permanent erosion controls (e.g., waterbars, slope breakers) are installed or restoration is completed. Environmental Inspectors (EIs) will be present at each construction spread and will aid in determining if erosion controls are properly installed, maintained, or if additional measures are necessary.

2.5.1.3 Trenching

To bury the pipeline underground, it will be necessary to excavate a trench by removing all soil and bedrock using a track-mounted excavator/backhoe or similar equipment. Excavated soils will be stockpiled along the ROW on the side of the trench opposite construction traffic (commonly referred to as the "spoil side"). As previously discussed, subsoil will not be allowed to mix with stockpiled topsoil. Where the route is co-located adjacent to existing infrastructure, the spoil generally will be placed on the same side of the trench as the existing infrastructure. Bedrock will be fractured prior to excavation using tractor-mounted mechanical rippers or rock trenchers. Explosives will be used only when necessary in areas where rock substrates are found at depths that interfere with conventional excavation or rock-trenching methods. The amount of blasting will be minimized to the extent practical, but may be required in areas of shallow bedrock. Blasting is more fully discussed in Section 2.5.2.

Generally, the trench will be excavated at least 30.5 centimeters (12 in) wider than the pipe diameter. The sides of the trench will be sloped with the top of the trench up to 3.7 meters (12 ft) across, or more, depending upon the stability of native soils. The trench will be excavated to a depth of 1.7 to 2.7 meters (5.5 to 9.0 ft) to allow a minimum of 0.9 meter (3 ft) of soil cover between the top of the pipe and final land surface after backfilling. At waterbody crossings the pipe will be buried deeper with a minimum of 1.2 meters (4 ft) of cover at navigable waterways and a minimum of 0.6 meter (2 ft) of cover at waterbodies with consolidated rock. Under railroads, uncased pipeline will be installed with a minimum of 3.0 meters (10 ft) of cover and cased pipe with a minimum of 1.7 meters (5.5 ft) of cover.

2.5.1.4 Pipe Stringing, Bending, Welding, and Coating

Steel pipe will be procured in nominal double random and/or triple random lengths (also referred to as “joints”) typically between 12.2 and 18.3 meters (40 and 60 ft) long and protected with a fusion-bonded epoxy coating applied at the factory or at a coating yard. The coating inhibits corrosion by preventing moisture from coming into direct contact with the steel. These joints will be shipped to pre-determined and strategically located materials storage areas (“pipe yards”). The individual joints will be transported to the ROW by truck and placed along the excavated trench in a single, continuous line and easily accessible to the construction personnel on the working side of the trench. This allows subsequent lineup and welding operations to proceed efficiently. At stream crossings, the amount of pipe required to span the stream will be stockpiled in the ATWS on one or both sides of the stream.

The pipe will be delivered to the job site in straight joints. The use of field controlled internal diameter fittings, in addition to the bending of pipe, will be required to allow the pipeline to follow natural grade changes and directional changes of the ROW. Prior to welding, selected joints will be bent in the field by track-mounted hydraulic bending machines. After pipes are bent, they will be aligned, welded together into a long segment by qualified welders, and placed on temporary supports at the edge of the excavated trench. All welds will be inspected to determine quality using radiographic or other approved methods. Radiographic examination is a non-destructive method of inspecting the inner structure of welds and determining presence of defects. Defective welds not meeting regulatory standards will be repaired or removed.

The bare pipe around approved welds will be thoroughly cleaned with a power wire brush or sandblast machine to remove dirt, mill scale, and debris before a coating crew recoats the area around the weld. After the coat has dried, the pipeline will be inspected electronically for faults or voids in the coating and visually inspected for scratches or other defects. Any detected damage will be repaired before the assembled pipe is lowered into the trench.

2.5.1.5 Lowering-in and Backfilling

Prior to lowering the pipeline, the bottom and sides of the trench will be checked for sharp rocks that could damage the pipe and/or its coating during installation. Any questionable rocks will be removed prior to trench installation. In rocky areas where the bottom of the trench is not smooth, a layer of soil or sand may be placed on the bottom to protect the pipe by using a padding machine or excavator with a “shaker bucket,” which will separate rocks from satisfactory padding materials. Concrete-coated pipe or aggregate filled sacks will be used if required for negative buoyancy in areas of saturated soils. Excess water from the trench line may need to be removed during periods of heavy precipitation or due to high water table. Dewatering activities will be performed in well vegetated areas and in a manner that does not cause erosion.

The completed section of pipe will be lifted off the temporary supports and lowered into the trench by side-boom tractors or similar equipment. After the pipe is lowered into the trench, the trench will be backfilled. Previously excavated materials will be pushed back into the trench using backhoes or similar equipment. In areas where excavated material contains large rocks or other material that could cause damage to the pipe or coating, clean fill will be used instead. Clean fill will include limestone dust or sand, which is typically basic and will often aid in cathodic protection of the pipeline. Fly-ash will not be used due to concerns about the acidity of this material and the potential impacts on cathodic protection.

Clean fill free of rocks will be used in the first 30.5 centimeters (12 in) above the top of the pipe. The remainder of the trench will be filled using an aggregate of material removed during the time of excavation. Topsoil will be segregated and will be placed after backfilling the trench above the subsoil. In agricultural land, grassland, or open land, a small crown may be left to account for any future settling of the soil that may occur following backfilling of the trench. In wetlands, a crown will not be left in order to restore the hydrology to pre-construction conditions. Excess soils will be distributed evenly on the ROW, only in upland areas, while maintaining existing contours.

2.5.1.6 Hydrostatic Testing and Final Tie-In

Following backfilling of the trench, the pipeline will be hydrostatically tested to ensure it is capable of safe operation at the designated pressure. Hydrostatic testing involves filling the pipeline with water to a designated test pressure and maintaining that pressure for approximately 8 hours (Table 4). Water for hydrostatic testing will be obtained from surface waterbodies (except within the Jefferson National Forest and Virginia) and municipal water sources. Water will not be withdrawn or discharged into streams containing federally listed aquatic species. Baseline water samples will be taken at the withdrawal source prior to water-up and prior to discharge.

Water withdrawals for hydrostatic testing will follow established best management practices (BMPs) in West Virginia and will be implemented in coordination with the West Virginia Department of Environmental Protection (WVDEP). Intakes must be

Table 4. Hydrostatic test water sources and discharge locations for the Mountain Valley Pipeline Project.

October 2016 Proposed Route (Revised)					Proposed Water Source		Proposed Discharged Source[2]		
Segment/Facility Name	Start MP[1]	End MP[1]	Segment Length	Required Water (gallons)	MP[1]	Proposed Water	MP[1]	Volume	Reason
01A	0.0	12.1	12.1	4,331,561		Reuse from Test Section 1B	0.0	4,331,561	Discharge Segment 01A at MP 0.0.
01B	12.1	25.8	13.7	4,904,330	25.8	Municipal Water	12.1	572,768	Pump Segment 01B into 01A; discharge remainder at MP 12.1.
02A	25.8	41.2	15.4	5,512,896	25.8	Municipal Water	25.8	3,078,630	Pump Segment 02A into 02B; discharge remainder at MP 25.8.
02B	41.2	48.0	6.8	2,434,266		Reuse from Test Section 2A	41.2	2,434,266	Discharge Segment 02B at MP 41.2.
03A	48.0	60.3	12.3	4,403,157		Reuse from Test Section 3B	48.0	4,403,157	Discharge Segment 03A at MP 48.0.
03B	60.3	73.7	13.4	4,796,936		Reuse from Test Section 4A	60.3	393,778	Pump Segment 03B into 03A; discharge remainder at MP 60.3.
04A	73.7	87.3	13.6	4,868,532		Reuse from Test Section 4B	73.7	71,596	Pump Segment 04A into 03B; discharge remainder at MP 73.7.
04B	87.3	104.9	17.6	6,300,453	104.9	Municipal Water	104.9	1,431,921	Pump Segment 04B into 04A; discharge remainder at MP 104.9.
05A	104.9	118.8	13.9	4,975,926	104.9	Municipal Water	118.8	1,610,911	Pump Segment 05A into 05B; discharge remainder at MP 118.8.
05B	118.8	128.2	9.4	3,365,015		Reuse from Test Section 5A	128.2	3,365,015	Discharge Segment 05B at MP 128.2.
06A	128.2	144.0	15.8	5,656,088	144.0	Meadow River	144.0	1,897,295	Pump Segment 06A into 06B; discharge remainder at MP 144.0.
06B	144.0	154.5	10.5	3,758,793		Reuse from Section 6A	144.0	3,758,793	Discharge Segment 06B at MP 144.0.
07A	154.5	171.6	17.1	6,121,463	171.6	Greenbrier River	171.6	2,147,882	Pump Segment 07A into 07B; discharge remainder at MP 171.6.
07B	171.6	182.7	11.1	3,973,581		Reuse from Test Section 7A	171.6	3,973,581	Discharge Segment 07B at MP 171.6.
08A	182.7	191.4	8.7	3,114,428		Reuse from Test Section 8B	191.4	3,114,428	Discharge Segment 08A at MP 191.4.
08B	191.4	204.3	12.9	4,617,946	191.4	Municipal Water	191.4	1,503,517	Pump Segment 08B

October 2016 Proposed Route (Revised)					Proposed Water Source		Proposed Discharged Source[2]		
Segment/Facility Name	Start MP[1]	End MP[1]	Segment Length	Required Water (gallons)	MP[1]	Proposed Water	MP[1]	Volume	Reason
									into 08A; discharge remainder at MP 191.4.
7/09A	204.3	211.4	7.1	2,541,660	211.4	Municipal Water	204.3	2,541,660	Discharge Segment 09A at MP 204.3.
09B	211.4	227.3	15.9	5,691,886	211.4	Municipal Water	227.3	2,649,054	Pump Segment 09B into 09C; discharge remainder at MP 227.3.
09C	227.3	235.8	8.5	3,042,832		Reuse from Test Section 9B	235.8	3,042,832	Discharge Segment 09C at MP 235.8.
10A	235.8	245.7	9.9	3,544,005		Reuse from Test Section 10B	235.8	3,544,005	Discharge Segment 10A at MP 235.8.
10B	245.7	258.3	12.6	4,510,552	258.3	Municipal Water	258.3	966,547	Pump Segment 10B into 10A; discharge remainder at MP 258.3.
10C	258.3	264.3	6.0	2,147,882	258.3	Municipal Water	264.3	2,147,882	Discharge Segment 10C at MP 264.3.
11A	264.3	275.0	10.7	3,830,389		Reuse from Test Section 11B	264.3	3,830,389	Discharge Segment 11A at MP 264.3.
11B	275.0	288.3	13.3	4,761,138		Reuse from Test Section 11C	275.0	930,749	Pump Segment 11B into 11A; discharge remainder at MP 275.0.
11C	288.3	303.5	15.2	5,441,300	303.5	Municipal Water	288.3	680,163	Pump Segment 11C into 11B; discharge remainder at MP 288.3.

[1]Mileposts are approximate.
[2]Discharges will be filtered through a dewatering structure that is an upland, well vegetated area, released at a low flow rate and monitored to prevent flooding/erosion.

designed to meet the demand of the withdrawal, yet minimize the overall disturbance to aquatic plants and wildlife from installation. To minimize potential adverse impacts to aquatic plants and wildlife near water withdrawal areas, temporary, floating, screened intake pumps will be used with a screen size no larger than 4.7625 millimeters (0.1875 in) and preferably placed in water depths of 0.9 meter (3 ft) or greater. Intakes are designed to limit the through-screen approach velocity to 0.1524 meter per second (0.5 ft /sec) or less.

Test segments of the pipeline will be capped with test manifolds, filled with water, and pressurized to a minimum of 1.1 to 1.25 times the designed operating pressure for a minimum of eight hours. Loss of pressure that cannot be attributed to other factors, such as temperature changes, will be investigated. Leaks detected will be repaired and the segment will be retested.

Following completion of the test in a pipeline segment, the water may be pumped to the next segment for testing or discharged to upland areas, typically within the same watershed as the source from which it was obtained. The test water will be discharged to the ground (not directly to surface waters) in an upland, well-vegetated area through an energy-dissipating device in compliance with National Pollutant Discharge Elimination System (NPDES) permit conditions. No discharge of hydrostatic-test water will occur on USFS- or USACE-managed lands. Topography and availability of test water will influence the length of each test segment. Test water will contact only new pipe. If chlorinated water is used for testing, a de-chlorinating agent may be required before discharge. The discharge will be filtered, conducted at low release rate, and monitored to prevent erosion or off-site discharge.

Once a segment of pipe has been successfully tested and dried, the test manifold will be removed and the pipe will be connected to the remainder of the pipeline. Desiccant will not be used to dry the pipe.

2.5.1.7 Cleanup and Restoration

Construction debris, temporary construction structures, and equipment will be removed at the end of construction. The construction ROW and other areas disturbed by construction activities will be restored to pre-existing contours and hydraulic regimes. Exceptions may be made based on slope stability on unstable slopes in landslide-prone areas. In agricultural areas, the segregated topsoil will be returned to its original horizon. Final restoration typically occurs within five to seven days of rough backfilling, weather permitting.

Temporary and permanent erosion and sediment controls will be installed and the construction ROW will be re-seeded and/or mulched according to permit requirements and landowner agreements. Private and public property, such as fences, gates, driveways, and roads, that have been disturbed by the pipeline construction will be restored to their original or better condition.

2.5.2 Specialized Construction Methods and Crossings

Special construction methods and crossings are likely to occur throughout the construction phases. These special methods are in addition to the aforementioned standard construction practices for the pipeline. Aquatic resource crossings are evaluated to reduce the LOD and establish setbacks where feasible. ROW crossing widths are reduced from 38.1 meters (125 ft) to 22.9 meters (75 ft) at most stream and wetland crossings. Exceptions preventing the appropriate neck-down at resource crossings are discussed below and include the aquatic resource being completely contained within the LOD, of the need for adjacent temporary work spaces to accommodate construction equipment, and the need to complete a road crossing at the same location waterbody/wetland crossing.

2.5.2.1 Waterbody Crossings

The Project will require 1,269 waterbody crossings. Construction across waterbodies will be performed to minimize the time trenches for pipeline crossings are left open. The typical trenching operation, as described above, will skip the waterbody crossing, stopping on each side near the top of the bank. Where feasible, a 30.5-meter (100-ft) buffer will be maintained between the aquatic resource and LOD immediately prior to stream crossings. In general, waterbody and wetland crossings will be conducted by specialized construction crews separate from the mainline construction activity. Typically, pipe will be pre-assembled prior to initiating trench excavation of the waterbody. Waterbody crossings are conducted as a single and complete project, such that waterbody buffers are restored immediately following completion of the crossing. All ATWS necessary for waterbody crossings would be placed a minimum of 15.2 meters (50 ft) from the waterbody edge, and the setback will be maintained unless site-specific approval for a reduced setback is granted by FERC or other jurisdictional agencies. All appropriate staging, storage, and fueling setbacks will be maintained throughout the Project Area.

Temporary equipment bridges will be installed to prevent sedimentation caused by construction equipment traffic crossing the waterbodies. Bridges would be maintained throughout construction and types may include clean rock fill over culverts, equipment pads, wooden mats, and free-spanning bridges. Each bridge will be designed to accommodate normal to high streamflow (storm events), prevent soil from entering the waterbody, and prevent restriction of flow when in use.

Sediment barriers, such as silt fence and straw/hay bales, will be installed prior to initial disturbance to the waterbody and adjacent upland area. Sediment barriers will be properly maintained throughout construction until replaced with permanent erosion controls (e.g., waterbars, slope breakers) or restoration of adjacent upland areas is complete and revegetation has stabilized the disturbed areas. Trench plugs, consisting of compacted earth of similar low permeability material will be installed at the entry and exit points of the waterbodies to prevent water from the stream from moving along the trench. After backfilling, streambanks will be re-established to approximate pre-construction contours and stabilized.

Prior to installation of the pipeline across a wetland or waterbody, the pipeline will be welded, non-destructively tested, and coated in an upland area. Once the pipeline is fully prepared for installation, the contractor will excavate the trench in the wetland/waterbody and the pipeline section will be transported via sidebooms and installed in the excavated trench. The trench will then be backfilled to its original contour. If the wetland/waterbody can support the use of skids and pipe, the process would generally be the same; however, the pipeline will be welded, non-destructively tested, and coated in the wetland/waterbody area.

The pipeline will be installed below the scour depth with a minimum of 1.2 meters (4 ft) of cover over the pipe except in consolidated rock where there would be a minimum of 0.6 meter (2 ft) of cover. Trench spoil will be placed on the banks above the high water mark for use during backfilling. Construction of minor (less than 3 meters [10 ft] wide from water's edge) waterbody crossings will be completed within

24 hours, and construction at intermediate (between 3 and 30.5 meters [10 and 100 ft] wide from water's edge) waterbody crossings will be completed within 48 hours. Proposed waterbody construction methods include dry open-cut (flume or dam/pump) methods and each are discussed in more detail below. Table 5 provides a summary of crossing methods at streams considered fisheries of special concern. MVP will abide by all time of year restrictions for instream construction, as designated in Table 5.

Table 5. Fisheries of special concern crossed by the Project.

Facility	Waterbody	MP	County	Fishery Type/Issue a/	Species b/	Crossing Method	Restricted In-stream Construction Window c/
Pipeline	North Fork Fishing Creek	0.7	Wetzel, WV	WW, M	-	Open-Cut Dry	April 1 - June 30
Pipeline	Rockcamp Run	18.7	Harrison, WV	WW, M	-	Open-Cut Dry	April 1 - June 30
Access Road	Rockcamp Run	18.8	Harrison, WV	WW, M	-	Fill/Culvert	April 1 - June 30
Pipeline	Salem Fork	25.9	Harrison, WV	WW, M	-	Open-Cut Dry	April 1 - June 30
Pipeline	Right Fork Freemans Creek	42.5	Lewis, WV	WW, M	-	Open-Cut Dry	April 1 - June 30
Access Road	Fink Creek	44.6	Lewis, WV	WW, M	-	Temporary Fill	April 1 - June 30
Pipeline	Fink Creek	44.7	Lewis, WV	WW, M	-	Open-Cut Dry	April 1 - June 30
Pipeline	Leading Creek	47.9	Lewis, WV	WW, TE	Snuffbox	Open-Cut Dry	April 1 - June 30
Pipeline	Sand Fork	55.1	Lewis, WV	WW, M	-	Open-Cut Dry	April 1 - June 30
Pipeline	Knawl Creek	68.7	Braxton, WV	WW, M	-	Open-Cut Dry	April 1 - June 30
Pipeline	Little Kanawha River	74.8	Braxton, WV	WW, TE	Snuffbox	Open-Cut Dry	April 1 - June 30
Access Road	Little Kanahwa River	75.3	Braxton, WV	WW, TE	Snuffbox	Temporary Fill	April 1 - June 30
Access Road	Little Kanawha River	75.6	Braxton, WV	WW, TE	Snuffbox	Temporary Fill	April 1 - June 30
Pipeline	Left Fork Holly River	81.6	Webster, WV	CW, B2	-	Open-Cut Dry	September 15 - March 31
Pipeline	Elk River	87.3	Webster, WV	B2, CW, M, TE	Clubshell	Open-Cut Dry	September 15 - March 31
Pipeline	Laurel Creek	98.8	Webster, WV	CW, M	-	Open-Cut Dry	September 15 - March 31
Pipeline	Gauley River	118.9	Nicholas, WV	WW, M	-	Open-Cut Dry	April 1 - June 30
Pipeline	Hominy Creek	126.9	Nicholas, WV	CW, B2, M	-	Open-Cut Dry	September 15 - March 31
Access Road	Hominy Creek	127.5	Nicholas, WV	CW, B2, M	-	Fill/Culvert	September 15 - March 31
Access Road	Meadow Creek	140.5	Greenbrier, WV	B2	-	Temporary Fill	September 15 - March 31
Pipeline	Meadow River	144.0	Greenbrier, WV	WW, M	-	Open-Cut Dry	April 1 - June 30
Pipeline	Greenbrier River	171.6	Summers, WV	WW, M	-	Open-Cut Dry	April 1 - June 30
Pipeline	Indian Creek	182.8	Monroe, WV	WW, M	-	Open-Cut Dry	April 1 - June 30
Access Road	Kimballton Branch	196.7	Giles, VA	CW, WT	-	Fill/Culvert	October 1 - June 30

Facility	Waterbody	MP	County	Fishery Type/Issue a/	Species b/	Crossing Method	Restricted In-stream Construction Window c/
Pipeline	Kimballton Branch	198.9	Giles, VA	CW, WT	-	Open-Cut Dry	October 1 - June 30
Access Road	Kimballton Branch	198.9	Giles, VA	CW, WT	-	Fill/Culvert	October 1 - June 30
Pipeline	Stony Creek	200.3	Giles, VA	CW, WT, ST, TE	Green floater, Candy darter, pistolgrip	Open-Cut Dry	August 15 - July 31
Pipeline	UNT to Little Stony Creek	203.5	Giles, VA	CW, WT	-	Open-Cut Dry	October 1 - June 30
Pipeline	UNT to Little Stony Creek	203.8	Giles, VA	CW, WT	-	Open-Cut Dry	October 1 - June 30
Pipeline	UNT to Little Stony Creek	204.2	Giles, VA	CW, WT	-	Open-Cut Dry	October 1 - June 30
Pipeline	UNT to Little Stony Creek	204.3	Giles, VA	CW, WT, ST	-	Open-Cut Dry	October 1 - June 30
Pipeline	Little Stony Creek	204.3	Giles, VA	CW, WT, ST	-	Open-Cut Dry	October 1 - June 30
Pipeline	UNT to Sinking Creek	207.8	Giles, VA	CW, WT	-	Open-Cut Dry	October 1 - June 30
Pipeline	UNT to Sinking Creek	207.8	Giles, VA	CW, WT	-	Open-Cut Dry	October 1 - June 30
Pipeline	UNT to Sinking Creek	207.9	Giles, VA	CW, WT	-	Open-Cut Dry	October 1 - June 30
Access Road	UNT to Sinking Creek	208.3	Giles, VA	CW, WT	-	Temporary Fill	October 1 - June 30
Pipeline	UNT to Sinking Creek	208.3	Giles, VA	CW, WT	-	Open-Cut Dry	October 1 - June 30
Pipeline	Sinking Creek	211.0	Giles, VA	CW, WT	-	Open-Cut Dry	October 1 - June 30
Pipeline	UNT to Grass Run	212.9	Giles, VA	CW, WT	-	Open-Cut Dry	October 1 - June 30
Access Road	UNT to Sinking Creek	213.7	Giles, VA	CW, WT	-	Temporary Fill	October 1 - June 30
Access Road	UNT to Sinking Creek	214.8	Giles, VA	CW, WT	-	Fill/Culvert	October 1 - June 30
Pipeline	UNT to Sinking Creek	214.9	Giles, VA	CW, WT	-	Open-Cut Dry	October 1 - June 30
Pipeline	UNT to Sinking Creek	216.5	Giles, VA	CW, WT	-	Open-Cut Dry	October 1 - June 30
Pipeline	UNT to Sinking Creek	216.6	Giles, VA	CW, WT	-	Open-Cut Dry	October 1 - June 30
Pipeline	UNT to Sinking Creek	217.7	Craig, VA	CW, WT	-	Open-Cut Dry	October 1 - June 30
Access Road	Sinking Creek	217.7	Craig, VA	CW, WT	-	Temporary Fill	October 1 - June 30

Facility	Waterbody	MP	County	Fishery Type/Issue a/	Species b/	Crossing Method	Restricted In-stream Construction Window c/
Pipeline	Craig Creek	219.5	Montgomery, VA	CW, TE	James spinymussel, Atlantic pigtoe	Open-Cut Dry	March 1 - July 31
Access Road	Craig Creek	219.7	Montgomery, VA	CW, TE	James spinymussel, Atlantic pigtoe	Temporary Fill	March 1 - July 31
Pipeline	UNT to Craig Creek	219.9	Montgomery, VA	CW, TE	James spinymussel, Atlantic pigtoe	Open-Cut Dry	March 1 - July 31
Pipeline	Mill Creek	222.4	Montgomery, VA	CW, TE, WT	Orangefin madtom	Open-Cut Dry	October 1 - June 30
Access Road	North Fork Roanoke River	227.2	Montgomery, VA	CW, TE, WT	Roanoke logperch, Orangefin madtom	Fill/Culvert	October 1 - June 30
Pipeline	North Fork Roanoke River	227.2	Montgomery, VA	CW, TE, WT	Roanoke logperch, Orangefin madtom	Open-Cut Dry	October 1 - June 30
Pipeline	Bradshaw Creek	230.8	Montgomery, VA	CW, TE, WT	Roanoke logperch, Orangefin madtom	Open-Cut Dry	October 1 - June 30
Access Road	Bradshaw Creek	231.3	Montgomery, VA	CW, TE, WT	Roanoke logperch, Orangefin madtom	Temporary Fill	October 1 - June 30
Access Road	North Fork Roanoke River	231.8	Montgomery, VA	CW, TE, WT	Roanoke logperch, Orangefin madtom	Temporary Fill	October 1 - June 30
Pipeline	Roanoke River	235.6	Montgomery, VA	WW, TE	Roanoke logperch, Orangefin madtom	Open-Cut Dry	March 15 - July 15
Pipeline	UNT to Bottom Creek	240.8	Roanoke, VA	CW, WT, TE	Orangefin madtom	Open-Cut Dry	October 1 - June 30
Access Road	Bottom Creek	241.5	Roanoke, VA	CW, WT, TE	Orangefin madtom	Temporary Fill	October 1 - June 30
Pipeline	UNT to Bottom Creek	241.6	Roanoke, VA	CW, WT, TE	Orangefin madtom	Open-Cut Dry	October 1 - June 30
Access Road	Bottom Creek	241.7	Roanoke, VA	CW, WT, TE	Orangefin madtom	Temporary Fill	October 1 - June 30
Pipeline	Bottom Creek	242.4	Roanoke, VA	CW, WT, TE	Orangefin madtom	Open-Cut Dry	October 1 - June 30
Pipeline	Mill Creek	245.1	Roanoke, VA	CW, WT, TE	Orangefin madtom	Open-Cut Dry	October 1 - June 30
Pipeline	Green Creek	246.9	Franklin, VA	CW, WT, TE	Orangefin madtom	Open-Cut Dry	October 1 - June 30
Access Road	Green Creek	246.9	Franklin, VA	CW, WT, TE	Orangefin madtom	Fill/Culvert	October 1 - June 30
Pipeline	North Fork Blackwater River	249.8	Franklin, VA	CW, TE, WT	Roanoke logperch	Open-Cut Dry	October 1 - June 30
Pipeline	Teels Creek	258.3	Franklin, VA	TE	Roanoke logperch	Open-Cut Dry	March 15 - June 30

Facility	Waterbody	MP	County	Fishery Type/Issue a/	Species b/	Crossing Method	Restricted In-stream Construction Window c/
Pipeline	Teels Creek	259.2	Franklin, VA	TE	Roanoke logperch	Open-Cut Dry	March 15 - June 30
Pipeline	Teels Creek	259.4	Franklin, VA	TE	Roanoke logperch	Open-Cut Dry	March 15 - June 30
Pipeline	Teels Creek	260.3	Franklin, VA	TE	Roanoke logperch	Open-Cut Dry	March 15 - June 30
Pipeline	Teels Creek	261.1	Franklin, VA	TE	Roanoke logperch	Open-Cut Dry	March 15 - June 30
Pipeline	Teels Creek	262.0	Franklin, VA	TE	Roanoke logperch	Open-Cut Dry	March 15 - June 30
Pipeline	Teels Creek	262.4	Franklin, VA	TE	Roanoke logperch	Open-Cut Dry	March 15 - June 30
Pipeline	Little Creek	262.7	Franklin, VA	TE	Roanoke logperch	Open-Cut Dry	March 15 - June 30
Pipeline	Little Creek	263.4	Franklin, VA	TE	Roanoke logperch	Open-Cut Dry	March 15 - June 30
Pipeline	Maggodee Creek	269.5	Franklin, VA	TE	Roanoke logperch	Open-Cut Dry	March 15 - June 30
Pipeline	Blackwater River	269.8	Franklin, VA	TE	Roanoke logperch	Open-Cut Dry	March 15 - June 30
Pipeline	UNT to Jacks Creek	278.3	Franklin, VA	TE	Orangefin madtom	Open-Cut Dry	March 15 - May 31
Pipeline	UNT to Jacks Creek	278.8	Franklin, VA	TE	Orangefin madtom	Open-Cut Dry	March 15 - May 31
Pipeline	Turkey Creek	280.6	Franklin, VA	TE	Orangefin madtom	Open-Cut Dry	March 15 - May 31
Pipeline	Owens Creek	282.2	Franklin, VA	TE	Orangefin madtom	Open-Cut Dry	March 15 - May 31
Pipeline	Strawfield Creek	282.4	Franklin, VA	TE	Orangefin madtom	Open-Cut Dry	March 15 - May 31
Pipeline	Parrot Branch	283.0	Franklin, VA	TE	Orangefin madtom	Open-Cut Dry	March 15 - May 31
Pipeline	UNT to Jonnikin Creek	284.5	Pittsylvania, VA	TE	Orangefin madtom	Open-Cut Dry	March 15 - May 31
Pipeline	UNT to Rocky Creek	287.2	Pittsylvania, VA	TE	Orangefin madtom	Open-Cut Dry	March 15 - May 31
Pipeline	Pigg River	289.2	Pittsylvania, VA	TE	Roanoke logperch, Yellow lampmussel, Orangefin madtom	Open-Cut Dry	March 1 - June 30; August 15 - September 30
Pipeline	Harpen Creek	290.0	Pittsylvania, VA	TE	Roanoke logperch, Orangefin madtom	Open-Cut Dry	March 1 - June 30
Pipeline	Harpen Creek	290.6	Pittsylvania, VA	TE	Orangefin madtom	Open-Cut Dry	March 15 - May 31
Pipeline	Harpen Creek	292.1	Pittsylvania, VA	TE	Orangefin madtom	Open-Cut Dry	March 15 - May 31

Note: MP listed for access roads is nearest pipeline MP.

a/ M = Mussel Stream – Project crossing may or may not meet 10 mi^2 drainage area threshold per WVMSP
B2 = Trout Waters (WV only)
CW = Coldwater Stream; in-stream construction restriction from Sept. 15 – March 31 in WV and March 1 – June 30 in VA
WW = Warmwater Stream; in-stream construction restriction from April 1 – June 30 in WV and April 15 – July 15 in VA

TE = Threatened and Endangered Species Stream
WT = Wild Trout Stream (VA only); in-stream construction restriction from October 1 – March 31
ST = Stocked Trout Steam (VA only); in-stream construction restriction from March 15 – May 15

b/ Atlantic pigtoe mussel; VDGIF in-stream construction restriction from May 15 – July 31
Green floater mussel; VDGIF in-stream construction restriction from April 15 – June 15 and August 15 – September 30
James spinymussel; VDGIF in-stream construction restriction from May 15 – July 31
Orangefin madtom; VDGIF in-stream construction restriction from March 15 – May 31
Roanoke logperch; VDGIF in-stream construction restriction from March 15 – June 30
Yellow lampmussel; VDGIF in-stream construction restriction from April 15 – June 15 and August 15 – September 30

c/ Restricted In-stream Construction Windows = Any span of time within time-of-year restrictions set forth by U.S. Army Corps of Engineer's 401 Water Quality Certification for streams crossed in WV and by VDGIF time-of-year restrictions for warmwater streams, coldwater streams, or streams containing rare, threatened, or endangered species in VA.

Sources: VDGIF Wildlife Environmental Review Map Service. (*EnviroReview Listed SppObs*; accessed March 11, 2015).; VDGIF Wildlife Environmental Review Map Service. (*TroutWaters*; accessed March 10, 2015).; VDGIF Special Legal Status Faunal Species, 2015.; WVDNR *2016 West Virginia Mussel Survey Protocol*

http://www.dgif.virginia.gov/wildlife/virginiatescspecies.pdf

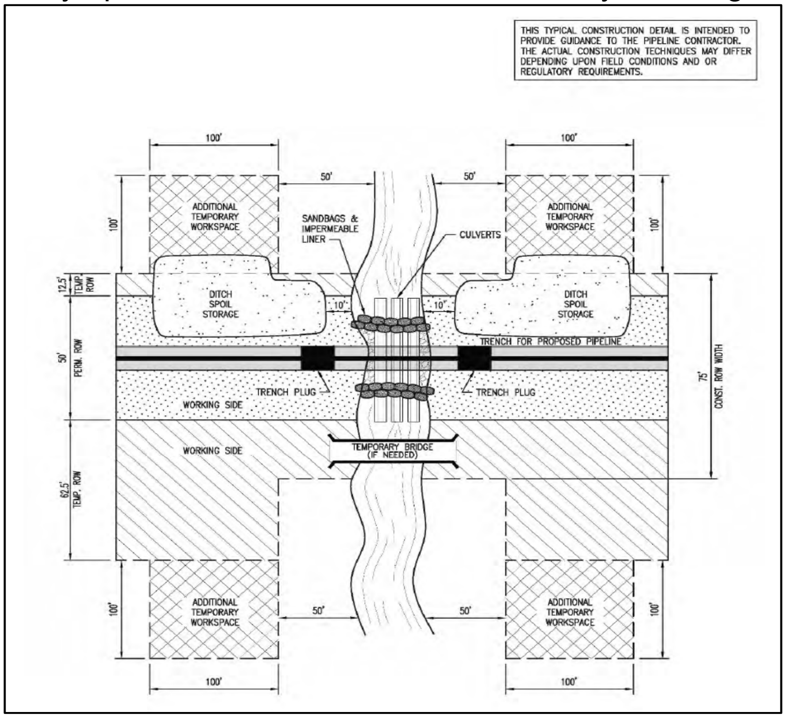
All stream crossings will involve dry-ditch crossing methods using flume pipe, dam and pump, or cofferdams with the exception of four streams in West Virginia including the Elk, Gauley, Greenbrier, and Meadow rivers. These four aforementioned river crossings are planned to be traversed via specialized dry-ditch crossing techniques using Portadam structures.

Dry-ditch stream crossings require the use of pumps to remove water from within an isolated, instream workspace and trench de-watering. De-watering operations within isolated, instream workspaces involve use of a screened, intake pump. The screen size is no larger than 4.7625 millimeters (0.1875 in) for floating intake structures and no larger than 2.54 millimeters (0.10 in) for submerged or buried intakes. Intakes are designed to limit the through-screen approach velocity to 0.1524 meter per second (0.5 ft /sec) or less. In Virginia, fish relocations are completed prior to the dewatering of workspaces.

2.5.2.1.1 Dry Open-Cut Crossing Methods

The flume method is a type of dry open-cut crossing method that involves diverting the flow of water across the construction work area through one or more flume pipes placed in the waterbody (Figure 3). First, a sufficient number of adequately sized flume pipes will be placed within the waterbody to accommodate the highest anticipated flow during construction. Secondly, sand bags or equivalent dam diversion structures will be placed in the waterbody upstream and downstream of the proposed trench area. These devices serve to dam the stream and divert the water flow through the flume pipes, thereby isolating the water flow from the construction area between the dams. Flume pipes will be left in place until trenching (under the flumes), pipeline installation, and final cleanup of the streambed is complete. Afterwards, the flume pipes will be removed and water flow will be allowed to return to pre-construction conditions.

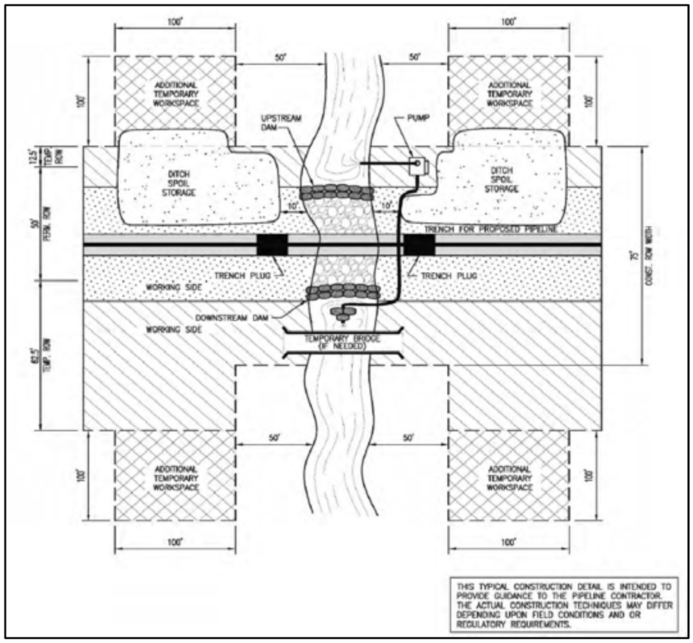
Figure 3. Typical dry open-cut flume method for waterbody crossings.



The dam-and-pump method is similar to the flume crossing methods except pumps and hoses are used instead of flume pipes to move water across the construction work area (Figure 4). Temporary dams using sandbags or plastic sheeting will be installed across the waterbody on both the upstream and downstream sides of the proposed trench. Pumps will then be set up at the upstream dam with the discharge line routed through the construction area to discharge water immediately downstream of the downstream dam. At the request of the VDGIF, fish and all other aquatic wildlife will be removed from the de-watered area between the dams at waterbodies crossed in Virginia. An energy dissipation device will be used to prevent scouring of the streambed at the discharge location. After the pipeline is installed and the trench backfilled, the water flow will be re-established to pre-construction conditions. The dams will be removed and the banks restored and stabilized.

For the Elk, Gauley, Greenbrier, and Meadow Rivers in West Virginia, MVP had originally explored the option of crossing these rivers using a wet, open-cut technique which would allow the water to flow over the active construction site while the trench was being excavated. Under this scenario, downstream BMP's, such as turbidity curtains, would be utilized to protect and reduce sediment migration. However, after further analysis, MVP has determined that a dry-ditch technique is a more viable option and will reduce the potential for downstream sedimentation and turbidity by

Figure 4. Typical dry open-cut dam and pump method for waterbody crossings.



creating a dry working site. Typically, the dry-ditch technique uses a sandbag or jersey barrier cofferdam to create a dry, workable area. The dry-ditch technique establishes a controlled, dry working site, while also maintaining sediment free water-flow downstream of the work area by using a pump around technique, fluming, or direct diversion method. However, because of the topography, crossing size, and hydrology of these four rivers, the standard sandbag/jersey barrier cofferdam approach would not provide a safe, reliable work area and could potentially increase downstream impacts. As an alternative to the cofferdam approach, MVP intends to use a Portadam structure (or equivalent structured system) that creates a dry-ditch work site for these stream crossings. The Portadam is an engineered, segmental or linked system that creates a dry workable area while minimizing instream and downstream impacts. When compared to open-cut/wet ditch or sandbag coffer dam techniques, the dry ditch/Portadam technique offers better environmental protection for the following reasons:

- The structure creates a more reliable, controlled, dry workable area;
- Downstream sedimentation is reduced by constructing inside a dry workable area, which keeps the trench spoils contained and provides better control over trenching depth;
- Potential impacts to aquatic life are reduced by conducting earth disturbance within a controlled structure, maintaining upstream and downstream connectivity, and removing instream construction activities;
- The structure maintains water flow during construction;

- The Portadam also allows for continued recreational uses during the construction process.

In addition to the erosion and sediment (E&S) BMPs that will be implemented during construction, a site-specific spill response plan will be developed and an Aid to Navigation (ATON) will be prepared to provide public information on construction, instream activities, and any potential user restrictions during construction. The installation process will include installing approximately one half of the crossing, completing required stream restoration in that area and then switching to the other side of the crossing to install the system and complete the crossing accordingly. All material, including spill kits, E&S BMPs (e.g., turbidity curtains, timber mats, compost filter socks, belted silt fences, etc.), pipes, water pumps, secondary containment units, and fittings shall be placed on site before starting the installation. All fueling equipment will be parked or located at least 30.5 meters (100 ft) from the waterbody; signs will be installed stating that fueling must occur at least 30.5 meters (100 ft) from the waterbody.

All topsoil will be removed on both sides of the crossing and all work areas as necessary. Topsoil will be stockpiled inside the approved LOD and protected by E&S BMPs identified in the approved Erosion and Sediment Control (E&SC) Plan. Equipment mats will be installed as necessary where all equipment will be used. E&S controls will be installed in all work areas of the crossing according to approved E&SC Plan. All necessary containment will be installed for ancillary equipment that is necessary for the river crossing. This includes full containment of cranes and pumps (including backup pumps). The containment is necessary to properly operate and fuel equipment that is positioned next to the river for the duration of the crossing. This practice will be duplicated on both sides of the crossing.

Silt booms/turbidity curtains will be installed downstream of the proposed Portadam location. The silt boom/turbidity curtain will be attached to the Portadam corner and the working side shoreline. All pumped out water will be discharged on the inside of this curtain structure through a filtration device (sediment bag) of required filter size. Filtering through a sediment bag and then the turbidity curtain will help reduce the potential for downstream sedimentation by creating a dual filtration procedure.

As necessary, the cofferdam location will be cleared of all large rocks, boulders, or other debris that would interfere with the Portadam footprint. These objects will be moved to the inside of the structure where they can be managed after pump down. The stockpiled material will be placed inside the Portadam in areas conducive to ensuring that necessary work is unobstructed.

The Portadam structure will be installed, starting on the upstream side and then working towards the center of the river. The structure will be extended to a point in the river to create a safe area of overlap when the opposite side is installed. The A-frame supports will be anchored by a U-bolt fastener and the fastener is installed by hand or pneumatic hammer. The center section will be installed parallel to stream flow. The downstream section that connects to the stream bank will then be installed. The flow will be maintained in the river section outside of the Portadam during this process. A waterproof membrane will be installed over the Portadam and anchored with sandbags to ensure a watertight seal. The working side of the Portadam will be dewatered by a floating dewatering structure. It will be dewatered into the silt boom/turbidity curtain area on the surface through the sediment filter bag to prevent impacts from occurring. A perimeter trench on the inside of the Portadam will then be installed to maintain dry conditions. A pump in a containment unit will be used for the entire construction sequence. Equipment mats will be installed over and adjacent to the ditch line for operating equipment.

The next step will be to string pipe (i.e. place pipe segments) in preparation of welding and installation. The pipe will then be welded and welding inspections performed to prepare for installation. Ditch/rock will be excavated and material inside the Portadam will be stockpiled in areas to ensure that the work area is unobstructed. The pipe will then be installed. The pipe trench, and perimeter trench will then be backfilled inside of the Portadam. The Portadam structure is then removed and large rocks and boulders will be returned to their approximate original location. The above installation sequence will then be conducted on the opposite side of the stream to complete the crossing (the process will be similar, except the final tie-in will be in a shored, excavated trench at the midpoint of the river). When the crossing is completed, all mats will be removed, topsoil will be replaced, and the area will be restored to pre-construction condition.

2.5.2.1.2 Waterbody Crossing Method Evaluation

MVP performed an alternatives analysis to demonstrate that crossings are designed and constructed to avoid and minimize temporary and permanent adverse effects to the maximum extent practicable. MVP focused the review on the most environmentally sensitive waterbodies. This evaluation included waterbodies meeting one or more of the following criteria: top of bank width greater than 10-feet, a listed flow regime of perennial, a FERC classification of intermediate or major and a fishery type of cold water, trout waters (West Virginia only), coldwater, threatened and endangered species stream, wild trout (Virginia only), or stocked trout (Virginia only). Waterbodies that were a subject of concerns expressed during the public comment period on the Project’s DEIS were also included. The crossing methods evaluated included horizontal directional drilling (HDD), conventional bore, and open cut:

- Horizontal directional drilling is a method that allows for trenchless construction across an area by pre-drilling a pilot (or guide) hole below the depth of a conventional pipeline lay and then pulling the pipeline through the pre-drilled borehole. The primary advantage of the HDD method is that there is minimal planned disturbance of the surface between the entry and exit points of the HDD. Although the HDD method is a proven technology for pipe installation, the potential exists for a HDD installation to fail.

Reasons for failure include: encountering soil conditions not conducive to boring, caving of the borehole, losing the drill string in the borehole, loss of drilling fluid return or inadvertent return (IR) to surface of drilling fluid, and pullback refusal. Specific geology, such as karst, fractures or fissures, and the presence of underground waterways can increase the potential of an inadvertent return. Proximity to public drinking water sources, private wells and mining activities (both active and abandoned), as well as the maximum bend radius of the pipe should be considered during the HDD feasibility analysis. Other considerations include: volume of drilling muds and fluids that must be managed onsite, increased volume of spoil that must be managed onsite, additional collected surface water from precipitation that must be managed, significantly more support area (1 to 3 acres), and possibility for an IR to occur.

- Conventional boring is a collection of techniques that allows for trenchless construction across an area. To complete a conventional bore, two pits will be excavated, one on each side of the feature to be bored. These pits are typically much closer to the feature being crossed than they would be for an HDD due to design length constraints for a conventional bore. A boring machine will be lowered into one pit, and a horizontal hole (or series of holes with increasing diameter) will be bored at the depth of the pipeline installation. The pipeline section and/or casing will then be pushed through the bore to the opposite pit. Like HDD, the primary advantage of the conventional bore method is that there is minimal planned disturbance of the surface between the entry and exit points. Potential issues which must be considered during evaluation of conventional bore include: increased volume of spoil that must be managed onsite, significantly more support (up to 1 acre), additional groundwater that must be managed, and geology may hinder or eliminate the potential use of conventional bore due to the hardness of rock encountered, the presence of varying different materials in the bore path (i.e. large boulders in sand and gravel) or changes in bedding thickness.
- Open cut crossings combine traditional trench construction techniques with erosion and sediment control best management practices (silt fence, compost filter socks, turbidity curtains, pumped water filter bags) and water management techniques (damming, pumping, etc.) to install pipeline across waterways. The open cut is recognized as the fastest method to cross a waterbody, thus minimizing the potential threats to the resource. Considerations for this method include: presence of sensitive species, initial direct disturbance to the feature being crossed due to the need to divert water from the work area, potential exists for a release, fastest method for crossing, and controlled construction environment. In general, impacts on sensitive species can be minimized through time-of-year

restrictions, relocation, specific mesh-size on pump intake screens to prevent entrainment of individuals, and other species-specific BMPs.

For crossings with federally-listed species, the open cut crossing method is the currently proposed method for crossings due to the controlled, visible work site and short duration of the crossing. However, MVP is continuing to finalize the alternatives analysis, in cooperation with jurisdictional agencies, and will adjust crossing methods where necessary.

2.5.2.2 Wetland Crossings

The crossings of jurisdictional wetlands will be completed in accordance with state and federal permits and the FERC *2013 Wetland and Waterbody Construction and Mitigation Procedures* (Procedures). However, specific site conditions may require MVP to request variances from the Procedures that will require approval by FERC (and USFS in the Jefferson National Forest) prior to construction in these areas. As proposed, the pipeline is expected to cross 300 wetlands and other Project components (e.g., access roads) would cross 265 wetlands.

A maximum construction ROW width of 22.9 meters (75 ft) in wetlands will be utilized, and operation of construction equipment will be limited to that which is needed to clear the ROW, dig the trench, fabricate the pipe, install the pipe, backfill the trench, and restore the ROW. Exceptions to the maximum construction ROW of 22.9 meters (75 ft) are required at seven wetlands (six occur in West Virginia and one in Virginia). Identification and justification for the increased ROW construction widths are provided in Table 6. Fuel will not be stored within 30.5 meters (100 ft) of wetlands or waterbodies. Topsoil will be segregated up to 0.3 meter (1 ft) in depth within wetlands where hydrologic conditions permit and placed into the trench following subsoil backfilling. The restoration and monitoring of wetland crossings will be conducted in accordance with FERC Procedures.

Site-specific weather conditions, inundation, soil saturation, and soil stability at the time of construction will dictate selection of the most appropriate crossing method for each wetland. The conventional open ditch lay method will be used most frequently when installing pipeline in wetlands, but the push/pull lay method will be used in inundated or saturated wetland areas when necessary. Construction methods for crossing saturated and unsaturated wetlands are briefly described in the sections below.

Table 6. Site-specific justification at wetland crossings by with Mountain Valley Pipeline anticipated right-of-way widths greater than 22.9 meters (75 ft).

State	Wetland ID	MP	County	Cowardin Class	Length of pipeline Crossing (ft)	Construction Impacts (acres)	Operational Impacts (acres)	Justification
West Virginia	W-A40	18.7	Harrison	PEM	78	0.2500	0.0697	ATWS required in this location to accommodate proposed open-cut method at crossing of County Route 5/Marshville-Rockcamp Rd. to the north and stream crossing to the south. Wetland cover type will not change following construction therefore impacts to this PEM wetland will be temporary.
West Virginia	W-A23	34.8	Doddridge	PEM	104	0.3900	0.1655	ATWS required at this location to accommodate proposed open-cut method at crossing of County Route 25. Wetland cover type will not change following construction therefore impacts to this PEM wetland will be temporary.
West Virginia	W-K33 PSS	44.6	Lewis	PSS	0[a]	0.0024	0.0000	Standard width of construction right-of-way (125 feet) required at this location due to PSS portion protruding into LOD by 10 feet on the western edge of temporary ROW and approved open cut crossing method of County Route 10 to the north and stream crossing to the south. Because of vegetation clearing, wetland cover type will be converted from PSS to PEM. Stumps will not be removed so stump sprout will occur. Impact will be mitigated as part of compensatory mitigation.
West Virginia	W-K33 PEM	44.6	Lewis	PEM	37	0.1113	0.0431	Standard width of construction right-of-way (125 feet) required at this location due to crossing of County Route 10 to the north and stream crossing to the south. Wetland cover type will not change following construction, therefore impacts to this PEM wetland will be temporary.

State	Wetland ID	MP	County	Cowardin Class	Length of pipeline Crossing (ft)	Construction Impacts (acres)	Operational Impacts (acres)	Justification
West Virginia	W-UV9	154.9	Greenbrier	PEM	0[a]	0.4291	0.0070	A small area of wetland is within an ATWS required for execution of a hydrostatic test, however no hydrostatic test equipment will be placed within the wetland itself. Mountain Valley will place timber mats in the area of the wetland to reduce impacts by construction equipment. This ATWS is confined by a stream on the north and south, road to the west, and pipeline to the east.
West Virginia	W-MM20	171.3	Summers	PFO	238	2.9913	0.2812	ATWS required at this location to accommodate boring equipment to complete the crossing of County Route 3. Wetland cover type will not change following construction therefore impacts to this PEM. Impacts will be mitigated as part of compensatory mitigation
Virginia	W-H2	302.1	Pittsylvania	PEM	560	0.2334	0.5653	Standard width of construction right-of-way (125 feet) required at this location to accommodate boring equipment to complete the crossing of County Route 685 to the north. Wetland cover type will not change following construction, therefore impacts to this PEM wetland will be temporary.

[a]Project centerline does not cross the wetland itself but the wetland is located within the construction workspace.
PEM = Palustrine emergent
PSS = Palustrine shrub/scrub
PFO = Palustrine forested

2.5.2.2.1 Unsaturated Wetland Crossings

In wetlands without standing water or saturated soils (i.e. unsaturated wetlands), construction will be similar to the typical upland construction described in Section 2.5.1., with some exceptions including restricting construction equipment to one traffic lane instead of two. If use of normal construction equipment leads to rutting or mixture of wetland topsoil and subsoil, crews will switch to low ground pressure equipment or temporary equipment mats will be installed to allow passage of equipment with minimal disturbance to the surface and vegetation.

Trees within the construction ROW will be cut to grade, but stumps will only be removed within 4.6 meters (15 ft) of the pipeline trench unless safety dictates otherwise. Topsoils over the trench will be segregated from the underlying subsoils, and a vegetation buffer zone will be retained between the wetland and adjacent upland construction areas outside of the pipe trench and travel lane. Erosion control measures such as silt fences and erosion control sock will be installed and maintained to minimize sedimentation within the wetland, and trench plugs will be installed where necessary to prevent unintentional draining of water out of the wetland. The construction ROW will be restored upon completion of pipe installation, and a 3.0-meter (10-ft) wide strip centered on the pipeline will be maintained in an herbaceous state.

2.5.2.2.2 Saturated Wetland Crossings

In wetlands where soils are saturated and/or inundated, the pipeline is installed using the push-pull technique. This method involves stringing and welding the pipeline outside of the wetland and excavating the trench using a backhoe supported by equipment mats. Topsoil segregation in saturated wetlands is not feasible due to the unconsolidated nature of the soils. Water that seeps into the trench is used to float the pre-assembled pipeline into place as it is aided by a winch and flotation devices. After being floated into place, the flotation devices will be removed from the pipe and it will be allowed to sink into place. Aggregate-filled sacks will be used to decrease buoyancy of the installed pipe. After the pipe sinks into position, trench breakers are installed where necessary to prevent subsurface drainage of water from the wetland. The wetland will then be backfilled, equipment mats and timber riprap will be removed, and cleanup will be completed.

2.5.2.3 gered is March

Construction techniques in mountainous areas where the pipeline will encounter slopes exceeding 30 to 35 percent will require expanded workspace areas. The dimensions of these ATWS will vary depending on the degree and length of the slope.

Construction activities on rugged terrain will be similar to the typical construction; however, equipment used for the construction activity will be suspended from a series of winch tractors to maintain control of the equipment and provide an additional level of safety. All construction equipment and their winch lines will be inspected prior to operation to ensure the equipment is operable and sound. Spoil piles adjacent to the trench will be protected by temporary sediment barriers and mulched to keep excavated soils on the ROW. Pipe joints will be stockpiled at the top or bottom of each slope. A side-boom tractor will be suspended from a winch that will carry one joint at a time up or down the slope and place the joint along the trench line. The joint will then be lowered into the ditch by a tractor. Welders will connect the joint to the previous joint within the trench to assemble the pipeline.

Once welding is complete, the welds will be visually and radiographically inspected. The weld joints will be hand coated with fusion bonded epoxy coatings in accordance with required specifications. The coating will be inspected for defects and repaired, if necessary. Sand trench breakers will be installed in the trench along the pipeline to prevent or slow the movement of water along the trench. The pipeline will be padded and the trench backfilled by equipment tethered to the winch tractors. The surface of the ROW will be restored to original contours, and permanent slope breakers will be installed in accordance with the E&SC plans. Erosion control blankets or hydroseed, in lieu of mulch, will be installed on steep slopes to provide stabilization for vegetation to help control sediment and water runoff.

In areas where the Project route laterally crosses the face of a slope or side slope, cut-and-fill grading may be required to establish a safe, flat work terrace; this may require ATWS along the construction ROW. MVP will incorporate erosion and sediment control measures such as super silt fence, silt fence, sock filtration, erosion control socks, temporary and permanent water bars, ditch breakers, temporary mulch, and erosion control blankets as per Project design specifications based on slope.

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

Within the trench, sand filled sacks will be stacked across the width of the trench as necessary based on field conditions. This will permit water to slowly filter through without carrying large amounts of soil with it. Similarly, permeable trench breakers constructed of sand or aggregate-filled sacks will be installed along the open ditch.

Rock fall protection measures such as installation of rock fences, placement of concrete barriers, or creation of catchment areas may be added where excavation is planned at the top of steep slopes, as determined by the contractor. Once the area is stabilized, following construction, MVP will remove any temporary stabilization methods. Contours will be returned to pre-existing conditions to the extent practicable.

In addition to the measures taken on slopes to control erosion and sedimentation, trench drains will be installed on side slopes and excessively steep slopes before the pipe is placed in order to channel water away from the ditch, and these drains will not be removed after construction is complete. These permanent drains will consist of perforated tile or pipe surrounded with rock (one-inch stone or similar, which may be taken from excavated spoils) that will terminate in one of the following locations: at the bottom of a very steep slope into a well vegetated area, near a roadway at the edge of the ROW, at the low point along a side cut onto a riprap pad near the edge of the ROW, or at a wooded area off the ROW. Geotechnical inspectors will evaluate the need for additional engineering controls based on the subsurface conditions exposed in the pipeline excavation in these areas; such engineering controls could include the use of select backfill, geosynthetic reinforcement, or a retaining structure.

On side hill construction, tree stumps and other organic material will be removed from backfill material along the ROW, as this can lead to soil saturation and eventual slippage. Special attention will be paid to ensure that natural drains alongside slopes are properly restored after construction activities are complete. In order to accomplish this, additional french drains or rock-lined channels may be constructed to efficiently convey water across or around the ROW. Where possible, compaction on side-cut sections should be completed in 30.5-centimeter (12-in) lifts using a sheep's foot roller.

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

2.5.2.4 Karst Areas

Portions of the Project will cross areas with potential to contain karst and karst-related features. After consultations with karst experts and numerous governmental agencies, MVP has made route adjustments to avoid areas containing dense concentrations of features, such as sinkholes, which are indicative of karst development; however, the route may encounter areas of karst geology not detectable until construction activity begins.

MVP developed a Karst Mitigation Plan (KMP) that addresses the assessment and mitigation of potential karst hazards associated with construction activities along the proposed route. Construction activities will be conducted in a manner to limit potential impact to karst features and related water resources. Per the KMP, MVP will implement the following measures:

- A geotechnical contractor will be on site daily during construction in karst areas in order to immediately identify potential problematic features and direct crews to employ mitigation measures as needed.
- In areas of karst, MVP will use special pipe (Class 2) able to withstand greater stress should a sinkhole develop under the pipeline.
- MVP will minimize alterations of existing grade and hydrology of karst features:
    - In linear excavations adjacent to karst features, spoils will be stockpiled and managed upslope of excavated area and runoff will be controlled according to Project-specific erosion control measures and stormwater management.
    - Surface water control measures (e.g., diversion; detention or collection) will be implemented to prevent construction-influenced surface water from free flowing into karst features.
    - Karst features will not be utilized for water disposal, including the discharge of hydrostatic test water. Karst areas may be flagged for identification. Discharge will not be directed into these areas or areas that flow towards them. Where possible, discharge will be down-gradient from karst features unless circumstances prevent such action. In that situation, water will be discharged into uplands greater than 500 feet from karst areas, where practicable. When this is not practicable, water will be discharged as far from karst areas as possible and sediment and water flow control devices will be utilized to minimize effects. Rate and volume of discharge will be controlled to prevent erosion, sediment mobilization, and ponding of water.
- MVP will conduct blasting in a manner that will not compromise the structural integrity or hydrology of karst structures. If rock is required to be blasted to achieve grade, then the following parameters will be adhered to:
    - MVP will prepare a Karst Blasting Plan in coordination with MVP's karst specialist and submit the plan to the appropriate federal, state, and local authorities with the requisite jurisdiction at least five working days prior to blasting in or near a karst area.
    - A qualified blasting contractor will operate in accordance with an approved blasting plan, including the Karst Blasting Plan in areas of karst terrain.

- Excavation, rock removal, and other activities related to blasting (e.g., using a track drill to prepare holes for explosive charge) will be carefully inspected by MVP's karst specialist for voids, openings, caves, or other signs of enhanced secondary porosity. If the rock removal intercepts an open void, channel, or cave, the work in that area will be stopped until a remedial assessment can be carried out by MVP's karst specialist.
- Use of explosives will be limited to low-force charges that are designed to transfer the explosive force only to the rock which is designated for removal (e.g., maximum charge of two inches per second ground acceleration).

- MVP will comply with requirements of the Project-specific *Spill Prevention, Control, and Countermeasure Plan and Unanticipated Discover of Contamination Plan for Construction Activities,* which include the following measures:
  - Idling vehicles/equipment will be limited to less than 12 hours within 30.5 meters (100 ft) of any karst feature.
  - Equipment and vehicle refueling (excluding by use of no more than 5 gallon capacity cans), maintenance, and servicing areas will be sited outside of flagged/marked streambeds, sinkholes, fissures, and areas draining into these or other karst features.
  - Hazardous materials, chemicals, fuels, lubricating oils, and petroleum products will be stored at least 30.5 meters (100 ft) away from any karst feature.
  - Equipment will be inspected daily for leaks prior to beginning work in karst areas. Any identified leaks will be addressed through containment measures (e.g., drip pans) and equipment will be removed from the site and repaired prior to being used again.
  - Any spill occurring within a karst area or water body will be addressed based on criteria provided in the Project-specific *Spill Prevention, Control, and Countermeasure Plan and Unanticipated Discover of Contamination Plan for Construction Activities*).
- MVP will adhere to the erosion and sediment control measures and BMPs it has adopted. Specific BMPs related to karst features will be identified by a karst specialist and discussed with the on-site EIs and other personnel.

2.5.2.5 Trench Dewatering

In most cases, trench dewatering will be limited to the removal of storm water in the pipe trench excavated in upland locations. In saturated wetlands, it will not be practical to attempt to dewater the trench, since the groundwater level is at or near the ground surface. In those locations, the pipe may be concrete-coated or weighted with aggregate filled sacks to overcome buoyancy in the flooded trench. In uplands, storm water will typically be removed from the trench prior to lowering the pipe into place. The storm water will be pumped from the trench to a location downgradient of the trench. The trench will be dewatered in a manner that does not cause erosion and does not result in heavily silt-laden water flowing into any waterbody or wetland. The storm water will be discharged to an energy dissipation/filtration dewatering device, such as a hay bale structure. Heavily silt-laden water may first be passed through a filter bag. The dewatering structure will be removed as soon as possible after completion of the dewatering activities. Trench breakers (ditch plugs) will be used where necessary to separate the upland trench from adjacent wetlands or waterbodies to prevent the inadvertent draining of the wetland or diversion of water from the waterbody into the pipe trench.

2.5.2.6 Blasting

All blasting will be conducted in accordance with the Project Blasting Plan. Pre- and post- blasting structural surveys will be conducted of occupied structures, water supply wells and water supply springs that will be specified in the prepared Blasting Plan. At this time, the extent of blasting for the Project is unknown. MVP will minimize the amount of blasting required to the extent practicable. Where unrippable subsurface rock is encountered, blasting for ditch excavation may be necessary. In these areas, MVP is committed to taking measures to prevent damage to underground structures (e.g., cables, conduits, and pipelines) or to springs, water wells, or other water sources. Blasting mats or padding will be used as necessary to prevent the scattering of loose rock. Pre-blast plans will be developed and submitted to all necessary state and federal agencies. All blasting will be conducted during daylight hours and will not begin until occupants of nearby buildings, stores, residences, places of business, and farms have been notified. Where competent sandstone bedrock occurs in the stream bed, blasting may be used to reduce bedrock so that the trench can be excavated.

2.5.3 Aboveground Facilities

Three compressor stations (Bradshaw, Harris, and Stallworth Stations) and four meter (interconnect) stations will be constructed for the receipt and delivery of natural gas with other pipelines. Additional ancillary aboveground facilities will include pig launcher and receiver sites at the compressor stations and the beginning and end of the pipeline and meter stations, along with mainline block valve (MLV) sites within the permanent pipeline ROW. Locations and descriptions of aboveground facilities are summarized in Table 7.

Table 7. Locations of proposed aboveground facilities for the Mountain Valley Pipeline.

Facility	Approximate Milepost	County	State
Compressor Stations			
Bradshaw Compressor Station (with MLV 2, pig launcher and receiver)	2.7	Wetzel	West Virginia
Harris Compresor Station (with pig launcher and receiver)	77.4	Braxton	West Virginia
Stallworth Compressor Station (with 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	303.47	Pittsylvania	Virginia
Mainline Valves (MLV)			
MVP-MLV-03	15.3	Harrison	West Virginia
MVP-MLV-04	15.4	Harrison	West Virginia
MVP-MLV-05	34.8	Doddridge	West Virginia
MVP-MLV-06	53.0	Lewis	West Virginia
MVP-MLV-07	64.5	Lewis	West Virginia
MVP-MLV-08	65.4	Lewis	West Virginia
MVP-MLV-09	77.3	Braxton	West Virginia
MVP-MLV-10	93.1	Webster	West Virginia
MVP-MLV-11	98.6	Webster	West Virginia
MVP-MLV-12	102.2	Webster	West Virginia
MVP-MLV-13	111.3	Nicholas	West Virginia
MVP-MLV-14	120.2	Nicholas	West Virginia
MVP-MLV-15	138.7	Greenbrier	West Virginia
MVP-MLV-16	140.9	Greenbrier	West Virginia
MVP-MLV-17	143.9	Greenbrier	West Virginia
MVP-MLV-18	144.2	Greenbrier	West Virginia
MVP-MLV-19	154.4	Fayette	West Virginia
MVP-MLV-20	170.0	Summers	West Virginia
MVP-MLV-21	171.9	Summers	West Virginia
MVP-MLV-22	186.1	Monroe	West Virginia
MVP-MLV-23	199.4	Giles	Virginia
MVP-MLV-24	201.5	Giles	Virginia
MVP-MLV-25	212.4	Giles	Virginia
MVP-MLV-26	222.8	Montgomery	Virginia
MVP-MLV-27	235.0	Montgomery	Virginia
MVP-MLV-28	236.4	Montgomery	Virginia

Facility	Approximate Milepost	County	State
MVP-MLV-29	249.8	Franklin	Virginia
MVP-MLV-30	259.2	Franklin	Virginia
MVP-MLV-31	265.4	Franklin	Virginia
MVP-MLV-32	269.5	Franklin	Virginia
MVP-MLV-33	283.6	Franklin	Virginia
MVP-MLV-34	296.3	Pittsylvania	Virginia
MVP-MLV-35	299.7	Pittsylvania	Virginia

2.5.4 Access Roads

The Project will use a combination of both temporary and permanent access roads to provide access to the pipeline facilities. Temporary access roads will be obtained for the purpose of constructing the pipeline facilities only and will be restored to pre-construction conditions upon completion. Permanent access roads will be secured to support both the initial construction as well as regular operational activities after the pipeline is placed in-service. To the extent practicable, the Project will use existing access roads and maintain and/or improve them as needed. The necessary upgrades and maintenance at existing access roads depend on the conditions of the road. Minor maintenance and upgrades to existing access roads include grading, tree trimming, environmental controls, and the installation of geotech fabric and gravel. If the road is not existing, MVP will build the road in a similar manner including potential grading, tree trimming and/or clearing, environmental controls, and the installation of geotech fabric and gravel. MVP will maintain permanent access roads throughout construction, and once the Project is completed, the permanent access roads will be used during typical operational activities. Temporary access roads will be restored to pre-construction conditions.

2.5.5 Additional Temporary Workspace

Areas of ATWS will be necessary for construction activities requiring space beyond the 38.1-meter (125-ft) construction ROW. Example construction activities or situations that may require ATWS include road and railroad crossings, winch hills, wetlands and waterbody crossings, foreign utility and pipeline crossings, interconnects, difficult terrain, truck turnarounds, fabrication and staging areas, and hydrostatic test water withdrawal and discharge locations.

2.5.6 Pipe Storage and Contractor Yards

Pipe storage and contractor staging yards for temporary use during construction have been selected and designed to avoid streams, wetlands, and other sensitive habitats. To the maximum extent practical, MVP avoided locating storage and contractor yards in forested tracts. Depending on the current condition and use of these yards, minor surface grading, drainage improvements, placement of surface material (e.g., gravel), and internal roadways may be required. Upon completion of construction, all facilities and equipment will be removed from the pipe storage and contractor yards. Unless otherwise requested by the landowner, each yard will be graded to original contours and restored to its original use.

Grading is not anticipated at pipe storage and contractor yards. If necessary, the topsoil may be segregated and stockpiled within pipe storage and contractor yards to provide a level base for gravel or matting. Impacts to aquatic resources are not anticipated at any yards. If existing resources are present, they will be avoided or spanned. The appropriate E&S BMP's will also be installed around yards to provide additional protection to potential resources.

2.5.7 Operation and Maintenance

Operational activity on the pipeline will be limited to maintenance of the permanent ROW and inspection, repair, and cleaning of the pipeline. Inspections at highway and railroad crossings will be conducted at least twice a year, with inspections occurring at least once a year at other pipeline locations. Pipeline inspections are completed at varying frequencies based on Department of Transportation requirements. During the process, inspectors will look for any sign of encroachment or downed trees on the ROW. Additionally, they will look for any abnormal ground conditions, physical damage in the area, and missing or damaged line markers. They also will conduct a leak inspection and ensure required emergency contact information is posted and accurate on all line markers and fenced enclosures.

Regular cleaning will be conducted at established pig launcher/receiver sites. Emergency spill kits will be on site and accessible during pigging operations. Temporary containment will be installed prior to pig removal. All contaminated material will be collected and disposed of by a qualified vendor and temporary containment will be removed when all work is complete.

The permanent ROW will be allowed to revegetate and will be maintained by periodic mechanical mowing, cutting, and trimming. Permanent mowing in the ROW will not occur more frequently than every three years (per standard FERC procedures) and not during the period of April 15 to August 1. Large brush and trees will not be permitted to grow within the permanent ROW. Vegetation maintenance is not expected to be required in agricultural areas or within wetlands.

Site personnel at aboveground facilities will perform routine checks of the facilities, including calibration of equipment and instrumentation, inspection of critical components, and scheduled and preventative maintenance of equipment. The surface of permanent access roads to these stations will be properly maintained, and appropriate erosion and sediment control will be employed. Permanent erosion and sedimentation controls will be installed including culverts, drainage ditches, water breaks, sumps, and filter socks if necessary. Also, the road surface will be maintained with placement of gravel when needed.

2.6 Project Design Features to Avoid and Minimize Impacts to Natural Resources

MVP designed the Project to avoid and minimize impacts to the natural environment by selecting a route that avoids critical or sensitive habitats, national wildlife refuges, sensitive soils, disruption to mineral resources, environmental hazards, and geologic/topographic hazards to the extent possible. In addition to route selection, MVP is implementing BMPs for construction, operation, and maintenance of the Project to minimize impacts to wetlands, waterbodies, and associated riparian habitats.

These practices serve to minimize adverse effects on both terrestrial and aquatic species associated with these habitats. BMPs and Project-wide conservation measures for the Project are listed in the following sections.

2.6.1 Wetlands and Waterbodies

MVP will use a variety of mitigation measures to minimize potential adverse impacts to waterbodies, wetlands, and riparian habitats as a result of Project construction. Notably, wetlands and open waters are important foraging and roosting habitats for bats (Carter 2006). They offer an abundance of nocturnal insects providing food and water during the spring, summer and autumn months, and flood-killed trees are an important roosting resource (Watrous et al. 2006). More importantly, waterbodies are the sole habitat for freshwater mussels and fish. Since impacts to wetlands and waterbodies could affect the overall foraging and roosting activity of bats and existence of fish and mussels in these areas, BMPs implemented for the Project to protect and minimize potential impacts to the environment during construction also serve to minimize adverse effects on these species.

Measures MVP will implement to avoid or minimize potential impacts to wetlands and waterbodies include:

- Reducing the construction ROW width from 38.1 to 23 meters (125 to 75 ft) at 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. Crushing or shearing streamside woody vegetation is preferable to complete removal.

- Stabilizing waterbody banks and installing sediment barriers (i.e., silt fence, silt logs) installed within 24 hours of completing in-stream construction activities. Sediment barriers will be left in place until the site has been stabilized with perennial vegetation (typically one full growing season after construction).
- Aligning crossings as close to perpendicular to the axis of the waterbody channel as engineering and routing conditions allow.
- Attempting to maintain, at minimum, a 4.6-meters (15-ft) section of undisturbed vegetation between the waterbody and construction ROW 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.
- Conducting pipeline assembly in upland areas unless the wetland is dry enough to adequately support skids and pipe. Timber mats are 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 ROW, excavate the trench, install the pipeline, backfill the trench, and restore the construction ROW.
- Prohibiting construction equipment, vehicles, hazardous materials, chemicals, fuels, lubricating oils, and petroleum products from being parked, stored, or serviced within a 30.5-meter (100-ft) radius of any wetland or waterbody. All equipment will be inspected for leaks by an inspector at the beginning of the day. Operation will not commence or will cease until the spill is contained, cleaned up, and collected before operations continue. Leaking equipment will be removed or repaired the same day.
- Locating as many ATWS as possible at least 15.2 meters (50 ft) away from the water's edge. Storing trench spoil excavated from within a stream at least 3 meters (10 ft) 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 ROW or aboveground facilities, unless requested by a land-management agency.
- Installing temporary equipment bridges within the ROW 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, MVP will maintain no more than a 3-meter (10-ft) wide, herbaceous strip centered over the pipeline and only remove woody vegetation within a 9.1-meter (30-ft) 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 will occur 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.
- Avoiding the use of surface water sources in Virginia for hydrostatic testing. Municipal source waters will be used instead.
- Avoiding the use of waterbodies supporting federally listed species as surface-water sources for hydrostatic testing to avoid potential impacts to federally listed aquatic species.
- Implementing sustainable water-use practices to ensure water resources and environmentally responsible stream-flows are maintained during water withdrawal activities. All water withdrawals will be performed in accordance with local, state and/or federal regulations to prevent the localized and downstream dewatering of streams. To prevent crushing, entrainment, or entrapment of mussels and fishes, floating, screened intakes will be used. The intake end of the pump will contain an appropriately sized screen (i.e., less than 4.7625 millimeters [0.1875 in] mesh size), and withdrawal rates will be reduced (i.e., screen approach velocity will be 0.1524 meter per second [0.5 ft /sec] or less).
- Discharging hydrostatic test water to the ground in an upland, well-vegetated area and not directly to surface waters.

2.6.2 Federally Listed Terrestrial Species

2.6.2.1 Bats

MVP will implement 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 roost 116-1. The work area has been reduced to 15 meters (50 ft) in this area to avoid impacts to the identified roost tree.
    - A post-lactating adult female northern long-eared bat was tracked to roost 084-2 in [redacted] The work area was shifted 43 meters (141 ft) east to avoid impacts to the identified roost tree.
    - A juvenile male northern long-eared bat was tracked to roost 044-1. [redacted] was shifted to avoid impacts to the identified roost tree.
    - A juvenile male northern long-eared bat was tracked to roost 791-1 in [redacted] The construction ROW was shifted 6 meters (19.7 ft) to the west to avoid impacts to the identified roost.
- Avoid impacts to 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 to [redacted]
    - Access road MVP-WB-120 in Webster County, West Virginia was abandoned to avoid impacts to [redacted].
    - The pipeline route was moved to the east to avoid impacts to [redacted] Greenbrier County, West Virginia.
    - The pipeline route was moved > 0.4 kilometer (0.25 mi) to the north of [redacted] to avoid impacting this feature and removing forested habitat within 0.4 kilometer (0.25 mile) of the cave's entrance (Figure 5).
- Suspend tree clearing operations from April 1 to November 15 within 8 kilometers (5 miles) of entrances to known Indiana bat hibernacula and within 0.4 kilometer (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 ROW to help ensure that contractors do not accidentally remove more trees than anticipated to maintain the maximum amount of suitable summer maternity habitat.

FIGURE 5
REMOVED: CONTAINS CONFIDENTIAL INFORMATION

- Prepare and distribute information to construction personnel that provides information about biology of Indiana and northern long-eared bat, 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 will be present onsite during construction, and until stabilization after construction. Erosion and sedimentation issues will 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 will be proportional to work area required to complete the task. Permanent outdoor lighting will be photocell controlled at compressor stations to only be on at night. MVP will utilize fully shielded, “full cut-off” type lighting fixtures to minimize objectionable light from each station. “Full cut-off” lighting means no direct upward lighting will be emitted above horizontal and therefore provides the maximum possible shielding to prevent unintentional lighting of surrounding areas. Further, outdoor lighting will 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. When the seasonal restriction cannot be met, a qualified bat biologist will investigate trees for the presence of bats to avoid a take. Prior to conducting these investigations, coordination will be undertaken with USFWS and other agencies as necessary to ensure the suitability of such a survey.
- 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 three years) and late in the growing season of any year (preferably August).

2.6.2.2 Rusty Patched Bumble Bee

MVP will implement conservation measures to avoid, minimize, and mitigate potential adverse effects on rusty patched bumble bees from construction, operation, and maintenance of the Project in Montgomery and Giles counties in Virginia and Braxton, Fayette, Lewis and Nicholas counties in West Virginia as follows:

- Use appropriate seed mixes targeted for rusty patched bumble bee
  - Use native plant species known to be visited
  - Use a mix of flowering plant species with continual floral availability through the entire active season (March-October).
  - Consider foraging needs of pollinators when creating subcanopy, 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. All attempts will be made to apply when flowers are not open.
- Control invasive species on edges to encourage ephemeral spring wildflowers.
- Minimize disturbances to vegetation and create a dispersal corridor for insects by mowing open ROW on a rotating schedule with multiple-year cycles.

Long term maintenance of this corridor may be greatly beneficial to this species and many other species after initial impacts.

2.6.2.3 Plants

In addition to the conservation measures above for bats and the rusty patched bumble bee, MVP will 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.
- In wetlands, agricultural, and residential areas, strip topsoil from the full width of the construction ROW 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 Ernst Conservation Seeds, Inc., during restoration efforts.
- Minimize amount of time bare soil is exposed during construction to reduce opportunity for exotic/invasive plants to become established.

2.6.3 Federally Listed Aquatic Species

In addition to the measures implemented to protect wetlands and waterbodies as described above, MVP will implement conservation measures to avoid, minimize, and mitigate potential adverse effects on freshwater mussels and fish from construction, operation, and maintenance of the Project as follows:

- Avoid impacts to potentially suitable waterbodies.
    - The Little Kanawha River in Braxton County, West Virginia is listed as a Group 2 stream. Avoidance and minimization measures have been implemented in this river including the following:
        - 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,
        - The Little Kanawha River was originally proposed as a water source for hydrostatic testing, but the temporary, water withdrawal location has been abandoned.
        - MVP proposes to use two existing public-use roads (i.e., Gregory Road, Gregory Lake Lane) that currently traverse the Little Kanawha River via ford crossings. MVP plans to improve the existing ford crossings by installing bridges across the river.
    - The pipeline route traverses the Elk River upstream of Sutton Lake and in Webster County, West Virginia where the river is listed as a Group 1 waterbody and federally endangered mussels are not expected. The pipeline crossing avoids known occurrences of federally endangered mussels in the Elk River.
    - The surface water sources for hydrostatic testing exclude any streams in West Virginia potentially supporting federally listed species. No surface water sources will be used in Virginia.
    - Craig Creek (Montgomery County, Virginia) avoidance and minimization measures include the following:
        - Former Project routes included the potential crossing of Craig Creek in Montgomery County, Virginia four times, including three pipeline

crossings and use of an existing access road ford crossing. The pipeline route was adjusted to eliminate two pipeline crossings. Use of the existing access road remains and the access road will be improved to include a bridge spanning the stream; thereby minimizing instream disturbances.

- MVP conducted an alternatives analysis of the proposed pipeline crossing of Craig Creek, which confirmed the open cut dry-ditch method is preferable due to the controlled, visible work site and short duration for the crossing. Conventional bore was eliminated due to the lack of additional work area currently available on the east side of Craig Creek to site drill support and bore pit spoil material storage areas. In addition, the proximity of the west bore pit to the creek and its depth below the stream 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. HDD was eliminated due to the risk of an IR and a horizontal break in the alignment near the proposed crossing.
- MVP will adhere to standards established in Virginia Department of Environmental Quality's (VDEQ) Virginia Erosion & Sediment Control Field Manual (1995) and implement enhanced 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. MVP is coordinating with USFS 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.
- MVP is committed to minimizing the duration of bare soil exposure during construction and restoration. The time elapsed between vegetation clearing and grubbing/ grading/ trenching in the Craig Creek Valley will be minimized. The construction timeline will immediately follow tree clearance within the Craig Creek watershed.
- MVP will apply temporary seed/mulch to topsoil piles at the end of each day.
- Disturbed ROW areas will be temporarily mulched/seeded if the areas are to remain undisturbed for more than four days. This includes following installation of the pipeline and backfill to rough grade. Once it is returned to rough grade, if the area is to remain undisturbed for more than four days, MVP will apply temporary seed/mulch to stabilize the area until full restoration is complete.

        - Backfilled areas of the trench will be mulched within four days.
        - Temporary sediment control measures will remain in place for one year after seeding.
        - MVP construction can accommodate an eight-week timeframe between ROW stabilization (e.g., backfill, mulching) and restoration.
        - MVP will reduce the ROW width at the Craig Creek crossing to less than 22.9 meters (75 ft).
        - Riparian timber and vegetation will remain within 15.2 meters (50 ft) from each streambank and clearing activities will occur immediately prior to instream construction.
        - Instream construction activities will not occur during time-of-year-restrictions for James spinymussel (i.e., May 15 to July 31) in Craig Creek because of known populations downstream of the Action Area.
    - The pipeline route was adjusted to the north to eliminate two crossings of the Blackwater River in Franklin County, Virginia; thereby avoiding suitable habitats to Roanoke logperch.
    - MVP has located the ROW and as many ATWS as possible at least 30.5 meters (100 ft) away from the water's edge potentially supporting federally listed aquatic species. Exceptions are provided in Table 8.
    - The Project Area includes using Reese Mountain Road (MN-276.03) as an access road during construction efforts. Reese Mountain Road traverses North Fork Roanoke River via an existing, paved bridge that spans the river, and because no instream construction activities are anticipated, instream impacts are avoided. The crossing of river by this access road is referred to as North Fork Roanoke River AR2.
    - BMPs that will be used along the Project include (and may not be limited to) 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. Construction will minimize work in rain conditions, perform frequent inspections, and ensure appropriate grading.
- Adhere to applicable state or federal required time-of-year-restrictions for in-stream construction including:
    - Snuffbox – April 1 to June 30
    - Clubshell – April 1 to June 30

    - Roanoke logperch – March 15 to June 30
    - James spinymussel – May 15 – July 31
- 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. These efforts are proposed to occur at two crossings in West Virginia (Sand Fork and Greenbrier River), and eight stream crossings in Virginia, (Sinking Creek2, North Fork Roanoke River1, North Fork Roanoke AR1 (MN-268.01), North Fork Roanoke River AR2 (MN-276.03), Roanoke River, Little Creek2, Blackwater River3, and Pigg River).
- Remove all fish from work areas within waterbodies crossed within Virginia per VDGIF's request.

Table 8. Project features less than 30.5 meters (100 ft) from a stream potentially supporting federally listed species (or suitable habitats) along the Mountain Valley Pipeline.

[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

[redacted]

3.0 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 direct or immediate effects of the Project on the species or its habitat, including those effects resulting from interdependent or interrelated actions. Indirect effects are those effects that are caused by or will result from the proposed action and are later in time, but still reasonably certain to occur. Interdependent actions are actions that have no independent utility apart from the proposed action. Interdependent actions are typically “because of” the proposed action. Interrelated actions are those actions that are part of a larger action and depend on the larger action for their justification. Interrelated actions are typically “associated with” the proposed action. Cumulative effects for the ESA are defined in 50 CFR 402.02 and include effects of future state, local, or private activities, not involving federal activities that are reasonably certain to occur within the Action Area.

3.1 Project Action Area

The Action Area is not limited to the “footprint” or on-the-ground impacts of 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 (Appendix B). 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 the species or critical habitat. As such, in addition to the immediate area of disturbance, the Action Area should include any location where impacts can occur, even outside of the Project Area, that impair essential behavior patterns or the health and survival of an individual, whether associated with:

- Movement of an element from within to outside the Project Area (e.g., construction dust).
- The visual spectrum (e.g., night-time lights or recognition/perception of distinctive changes or patterns in in habitat)
- Air or substrate-born sound or vibration (i.e., noise)
- Water (e.g., surface or subsurface water quality or in-stream habitat alteration)

3.1.1 Dust Effects

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 Project and estimates on 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.

3.1.1.1 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. Often, most dust emissions come from vehicle activity on site but if mud gets onto paved roads, dust can also travel off site. Emissions from heavy construction is positively correlated with the silt content of the soil, and the speed and weight of vehicles; it is negatively correlated with soil moisture. Ultimately, the scale of impacts often depends on dust suppression and other mitigation. For example, MVP will control dust emissions generated by motorized equipment and miscellaneous vehicle traffic through use of wet suppression, as necessary. On paved surfaces, dust emissions will be suppressed using a combination of water trucks, power washers, sweeping, and/or vacuuming.

3.1.1.2 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 being completed at the site, which can be categorized as:

- Large: Total site area >10,000 square meters (>1 hectare [2.5 ac]), potentially dusty soil type (e.g., clay, prone to suspension when dry due to small particle size), >10 heavy earth moving vehicles active at any one time, formation of bunds >8 meters (26.2 ft) in height, total material moved >100,000 tons
- Medium: Total site area 2,500 to 10,000 square meters (0.62 to 2.47ac), moderately dusty soil type (e.g., silt), 5-10 heavy earth moving vehicles active at any one time, formation of bunds 4 to 8 meters (13.1 to 26.2 ft) in height, total material moved 20,000 tons – 100,000 tons

- Small: Total site area <2,500 square kilometers (0.62 ac), soil type with large grain size (e.g., sand), <5 heavy earth moving vehicles active at any one time, formation of bunds <4 meters (13.1 ft).

The Project is largely based simply on its footprint. However, ecological effects for even a large project decline to low-risk after 100 meters (328.1 ft) (Table 9).

Table 9. Risk categories of earth moving activities estimated by the Institute of Air Quality Management.

Distance to Nearest Receptor (m)[1]		Dust Emission Class		
Dust Soiling and PM_{10}	Ecological	Large[2]	Medium[3]	Small[4]
<20	-	High Risk Site	High Risk Site	Medium Risk Site
20 – 50	-	High Risk Site	Medium Risk Site	Low Risk Site
50 – 100	<20	Medium Risk Site	Medium Risk Site	Low Risk Site
100 – 200	20 – 40	Medium Risk Site	Low Risk Site	Negligible
200 – 350	40 – 100	Low Risk Site	Low Risk Site	Negligible

[1] These 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.
[2] Large: Total site area >10,000m² (greater than 2.47 acres), potentially dusty soil type (e.g., clay, prone to suspension when dry due to small particle size), >10 heavy earth moving vehicles active at any one time, formation of bunds >8m in height, total material moved >100,000 tonne
[3] Medium: Total site area 2,500m² – 10,000m² (0.62 to 2.47) acres, moderately dusty soil type (e.g., silt), 5-10 heavy earth moving vehicles active at any one time, formation of bunds 4m – 8m in height, total material moved 20,000 tonne – 100,000 tonne
[4] Small: Total site area <2,500m² (0.62 acres), soil type with large grain size (e.g., sand), <5 heavy earth moving vehicles active at any one time, formation of bunds <4m

3.1.1.3 Action Area for Dust

Per the criteria identified above, the Project is 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 40 to 100 meters (131.2 to 328.1 ft) of the Project Area. As such, to be conservative, a distance of 106.7 meters (350 ft) beyond the Project Area was selected to define the Action Area for dust impacts.

3.1.2 Changes in Light Levels

Though limited, artificial lighting will be used during construction when completion of particular tasks warrant continued work outside normal daylight operating hours due to agency requirements that limit the time allowed for such tasks. This practice will be most common when completing stream crossings and during the hydrostatic testing phase. The directional luminous intensity will be proportional to work area required to complete the task.

3.1.2.1 Effects of Artificial Light on Bats

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

3.1.2.1.1 Effects on Roosting Bats

A powerful predictor when many species of bats emerge from day roosts is ambient light level (Brack 1983, Viele et al. 2002). 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. 1999), bats may miss their most important foraging time. Delayed emergence could therefore negatively affect the fitness of individuals.

Lighting at a roost might cause roost abandonment. Nuisance bats are sometimes driven from roosts by lighting the roost. Lighting might also cause bats to use alternate roosts or exits with greater exposure to predators. However, during studies of Interstate 69 highway in Indiana, ESI documented use of two artificial roosts by Indiana bats in areas of light pollution (ESI 2004; 2012). In one case, a male Indiana bat was tracked to an artificial roost (shared with multiple other bats) in a backyard with several white lights. More surprisingly, a maternity roost of Indiana bats was found under the conduit on a utility pole that also housed a security light that turned on each night at dusk.

3.1.2.1.2 Effects on Commuting and Foraging Bats

Light 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.

Light 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 them (Brack and LaVal 1985, Brack and Whitaker 2001, Sparks et al. 2004, Whitaker 2004, Tuttle et al. 2006). However, neither species is known to concentrate foraging efforts in lighted areas, and myotid bats are not commonly considered to be among the species so attracted. Species adapted to foraging in open areas (e.g., bats of the genera *Eptesicus* and *Perimyotis*), may benefit from such situations.

Light 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 lit 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.

3.1.2.1.3 Sensory Interference

Impacts of lighting will vary by the type (wavelength), quantity, and intensity of light, and the habitat in which it occurs. This is sometimes stated as concentration, emission, direction, and spectrum. In addition, light pollution associated with a specific project must be assessed as changes in environmental baseline--a concept that is not addressed in studies of night lights and bats or wildlife. Very little has been done to assess the specificity of impacts and particularly the distance to which impacts occur.

3.1.2.2 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). No studies on light pollution have been conducted on the rusty-patched bumble bee, but conclusions can be made by reviewing studies focused on other insects.

The rusty patched bumble bee is diurnal and not likely to emerge at night unless disturbed. However, if the bee emerges at night, it may be impacted by artificial night lighting. Most arthropods are phototaxic (attracted to light) and are known to congregate under artificial lighting. Moths are often attracted to street and house lights, consequently, moth populations may become depleted if the lighting they are attracted to is in an ecological sink (an area that ultimately cannot sustain a population) (Eisenbeis 2006). However, Conrad et al. (2002) did not find negative changes in moth abundance as urban light increased over an eight-year period. Spoelstra et al. (2015) suggests that yearly decrease in moth populations as a response to urban lighting are slight and may only be noticeable over a longer period.

Type and temperature (color) of lighting affects nocturnal insect attraction. Overall arthropod congregation numbers suggest light-emitting diodes (LED) attract fewer insects than compact fluorescent lamps (CFLs) and mercury vapor bulbs (van Grunsven et al. 2014, Longcore et al. 2015). Cooler blue-tinted 3500K LEDs are more attractive to arthropods than warmer red-tinted 2700K LEDs (Longcore et al. 2015). While type and temperature affect attraction, light intensity has no effect (Longcore et al. 2015).

Studies on the effects of lighting on bumble bees are limited to captive-raised buff-tailed bumble bees (*Bombus terrestris*) in laboratory settings. When exposed to only eight hours of fluorescent light, *B. terrestris* queens laid eggs an average of 33 days from colony creation. Constant light extended this period to 59 days, and because of the delay in colony creation, gyne eggs were laid less frequently. Neither success of colony creation nor worker bee larval development were affected by differing photoperiods (Tasei and Aupinel 1993). The distribution of bumble bees across many latitudes and into the Arctic also suggest they are adapted to varied day lengths and changes in light levels (Williams et al. 2014). Rusty patched bumble bee nests are usually subterranean; thus, the bees move from dark to light conditions many times within a single day as they forage for and store pollen and nectar.

Light also affects bumble bee habitat and food sources. 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 white LED (to a lesser extent) 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).

3.1.2.3 Effects of Artificial Light on Aquatic Species

Artificial lights may temporarily be used to extend workable hours during the construction phase. The introduction of artificial light sources has been known to alter the behavior of some oceanic midwater and benthic fish species, causing individuals to either be attracted to or repelled by the introduction of 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 has only more recently considered. Prenda et al. (2000) found that foraging behaviors of three small, nocturnal benthic 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 the Roanoke logperch have not been the subject of such research. While the Roanoke logperch is a benthic riverine species, it is a diurnal forager, and therefore not likely subject to impacts from the presence of 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 the migration of zebra mussels was affected by the illumination of strobe lights or strobe light backscatter.

3.1.2.4 Effects of Artificial Light on Plant Species

Research on the effects of artificial lights in plants suggest most plants benefit from added light as it presumably increases photosynthesis and thus enhances 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.

3.1.2.5 Distance of Light Pollution

According to Gaston et al. (2015), there is little empirical evidence on the impacts of light type, quantity, intensity, distance, and direction because the impact mechanisms are not understood well enough to be quantified. Like most other energy waves, light follows a line-of-sight transmission pattern and it degrades over distance or it can be blocked by an object. 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 have already been greatest, but have much less impact in areas that remain forested.

3.1.2.6 Action Area for Light Pollution

For purposes of impact assessment and a determination of the Action Area associated with Project lighting, it is assumed, based on the specifications of typical lighting equipment used for pipeline construction, that light sources will 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 level of signal loss influenced by the density of vegetation in both the canopy and subcanopy of the surrounding forest. Pocock and Lawrence (2005) found that car lights penetrate a forest a distance of 360 meters (1,181 ft) in flat terrain, 450 meters (1,476 ft) down gullies, and 260.3 meters (854 ft) across ridges. The overall mean distance for light penetration was 360 meters (1,181 ft), which has been rounded to 1,200 feet for the current analysis.

3.1.3 Changes in Noise

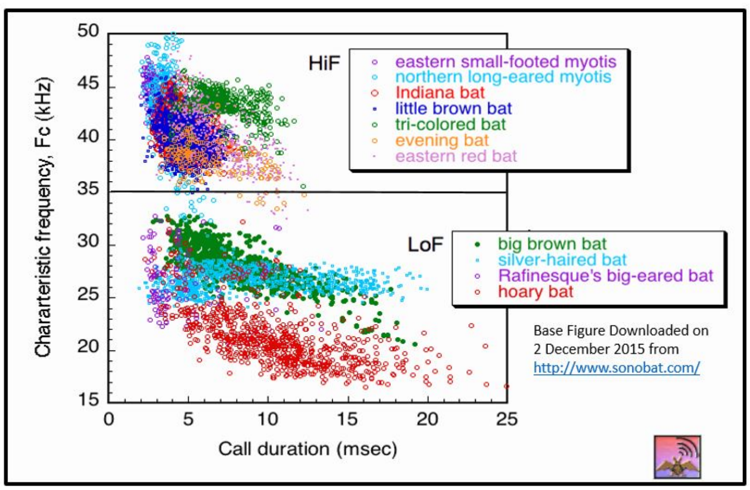
Sounds that are intrusive, annoying, disruptive, or harmful are often referred to as noise. Noise can originate from natural or anthropogenic sources, and is often associated with impacts to humans and wildlife. Studies regarding anthropogenic noise associated with roads, airports, railroads, construction activities in many sectors, and military actions/facilities provide abasis for understanding noise impacts on wildlife (Barber et al. 2010). Even so, few large-scale, detailed studies with solid experimental design have been undertaken to quantify noise stimuli. Thus, it is often necessary to extrapolate from small-scale studies and anecdotal reports, often across multiple taxa. Indeed, most of what we know is extrapolated from the impacts of noise on humans.

3.1.3.1 Measuring Noise Levels

Sound is a wave propagated in a gas (air), a liquid, or a solid. For bats and humans, sound is perceived as any vibration of the eardrum in the audible frequency range, and these result from an incremental variation in air pressure at the ear. Pressure variation above and below atmospheric pressure is called sound pressure and the number of pressure variations per second is called the frequency of sound, measured in cycles per second, called Hertz (Hz). High frequency sounds, such as those produced by bats, are often expressed as thousands of cycles per minute of kilohertz (kHz) (Figure 6). Broadband sound includes sound energy summed across the frequency spectrum.

The decibel is a measurement relative to a reference quantity. Sound levels decrease with distance from a sound source at a rate of 6 dB with every doubling of distance from a point source. While humans hear sounds ranging from 0.002 to about 20 kHz, little brown bats hear sounds in the .002 to 50 kHz range with a focus on sounds within the range of their echolocation (Henson 1970). Further, bats have the ability to reduce the diameter of the ear canal when faced with loud sounds, a mechanism that reduces their sensitivity to loud noises (Henson 1970).

Figure 6. Acoustic characteristics of eastern North American bats and the 35 kHz line where bats are most sensitive to noise associated with compressor stations.



3.1.3.2 Effects of Noise on Wildlife

Noise can affect wildlife in many ways: It can disrupt feeding by making prey difficult to find, driving prey away, or affecting the time of foraging. It can render habitats less suitable or disrupt individuals that hibernate. Noise can also affect an animal's physiology and behavior; if it is a chronic stress, noise can affect an animal's energy budget, reproductive success and long-term survival. Physiological responses to noise include (1) an increased heart rate, (2) altering of metabolism and hormone balance, and (3) behavioral reactions such as panic and escape reactions, decreased food intake, habitat avoidance and abandonment, and lowered reproductive fitness (Fletcher and Busnel 1978). Knight and Swaddle (2011) reviewed the effects of acoustic stimuli from numerous studies and concluded that detrimental effects of noise pollution on wildlife are linked to genetic and cellular responses to physiological and behavioral ecological mechanisms. Souther (2014) evaluated knowledge gaps related to impacts from shale development on plants and animals, and although noise was evaluated, it was not among the impacts with the greatest probabilistic threat.

Although impacts of noises on wildlife have been relatively well studied, the effect of noise on bats has been less researched. This is largely due to the fact that bats hear at a frequency range outside that of human hearing, and thus, the 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. Most sound is a combination of frequencies, and some animals may habituate to sound. Anthropogenic noise may also be masked by ambient natural sounds like the wind or preexisting ambient sounds. For example, noise from high-flying airplanes reaches nearly 100 percent of the continental United States and noise from trains and roads reaches 10 to 100 percent of land areas in the eastern United States (Barber et al. 2010). Nevertheless, the available data regarding noise impacts to bats include:

- Based on laboratory studies, Schaub et al. (2008) concluded that areas of intense broadband noise, including highways, are less suitable foraging areas. The greatest impact is on species that rely on prey generated sounds (like insects walking on the ground) rather than echo-locating bats. The greater mouse-eared bat (*Myotis myotis)*, a “passive listening” bat, foraged 10 percent less in a chamber with 80 decibel (dB) noise, consistent with vehicle traffic noise at 10 to 15 meters (32.8 to 49.2 ft). Schaub et al. (2008) also found that vegetation noise (i.e., the sound produced by moving vegetation), even when 12 dB lower that 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 consistent with vehicle noise at 7.5 meters (24.6 ft) from the center of the right lane of the Autobahn A8 highway. Bunkley and Barber (2015) found that the pallid bat (*Antrozous pallidus)*, also a listening bat, required more time to locate prey sounds when exposed to playback sounds of roads and a gas compressor, down to 35 dB.

- Bunkley et al. (2015) evaluated the activity levels of bats located 50 meters (164 ft) from the center of natural gas compressor stations in New Mexico. The study found that bats using a call frequency below 35 kHz alter 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 (Figure 6). However, the study did not quantify the frequency or the intensity (dB) of the compressor station noise.
- Snyder et al. (2015) reported that a captive outdoor colony of big brown bats (*Eptesicus fuscus)* reduced food consumption, and one animal died, concurrent with noise and vibration associated with a nearby construction project. When the colony was moved away from the noise, individuals resumed eating. Despite the move, seven additional animals 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 were concurrent with other construction activities over a 10-year period. No quantification of construction noise or level of disturbance was provided.
- Multiple bat species at the Indianapolis International Airport made regular use of a woodland within the approach zone 5.6 kilometers (3.5 mi) from the end of the runways and within 0.4 kilometer (0.25 mi) of Interstate 70 (Whitaker et al. 2004, Whitaker and Sparks 2008). Bats used this woodlot for multiple years despite the Federal Aviation Administration having purchased adjacent properties that sustained noise levels above that allowed for human health and safety.

Noise pollution is similarly poorly studied in bees and in particular rusty patched bumble bees (FHWA 2004, Harrison and Winfree 2015). Although bees do not have ears, reactions to low frequency vibrations are documented in family Apidae (family of bees of which bumble bees are members). Honey bees will become immobilized up to 20 minutes when exposed to continuous sound frequencies between 300 and 1,000 Hz with intensities between 107 and 120 dB, without habituation (Frings and Little 1957). Reactions less severe were documented at frequencies as low as 100 Hz at 106 dB and as high as 2,000 Hz at 128dB (Frings and Little 1957). Other invertebrates also react to sounds, suggesting that this is not exclusive to honeybees. Flies startle between 80 and 800 Hz at 80 dB and become agitated near 125 Hz at 13 dB and 250 Hz at 3-8 dB (Frings and Frings 1959). 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 are needed to evaluate the compounding effects of noise pollution on invertebrates over a long period (FHWA 2004).

3.1.3.3 Sources of Noise

The Project will generate noise during both construction and operation. Noise from during the construction phase will result from construction of the pipeline and from construction of the facilities. Noise associated with operation will be essentially limited to the three new compression facilities: Bradshaw, Harris, and Stallworth.

3.1.3.3.1 Ambient Noise

Ambient noise was determined at noise sensitive areas (NSAs) near the three proposed compressor stations: five NSAs at Bradshaw, four NSAs at Harris, and six NSAs at Stallworth. All three compressor stations will be located in rural and sparsely populated areas, and are likely representative of much of the Project Area.

- Bradshaw ambient sound level is 42.6 to 45.8 dBA L_{dn}
- Harris ambient sound level is 47.9 to 55.3 dBA L_{dn}
- Stallworth ambient sound level is 35.8 to 54.9 dBA L_{dn}

3.1.3.3.2 Construction Noise

Noise from construction will be temporary and usually will only occur in the daytime. During construction, the highest sound levels will be experienced early in the earthmoving phase. At the compressor construction sites, the sound impact was analyzed using the Federal Highway Administration's Roadway Construction Noise Model (version 1).

Based on noise modeling, predicted noise levels at the noisiest NSA at the three compressor sites, based on construction noises, are as follows:

- Bradshaw 46.4 dBA L_{dn} at 2,380 feet (NSA 5)
- Harris 48.7 dBA L_{dn} at 1,965feet (NSA 3)
- Stallworth 42.0 dBA L_{dn} at 1,340 feet (NSA 5)

Construction noise along the ROW is anticipated to be no greater than construction at the compressor sites.

3.1.3.3.3 Compressor Operational Noise

Modeling was used to assess the increase in noise during operations associated with each receptor site at the three compressor stations (Table 10). Additional information is provided in MVP's Resource Report 9, submitted to FERC Docket No. CP16-10-000, including Appendices 9-G through I. The sound model used (CadnaA, version 4.5.151, by DataKustik GmbH) employed U.S. Geological Survey (USGS) topographic resolution of 10 meters by 10 meters, a temperature of 20 degrees Celsius (68 Fahrenheit) and 70 percent relative humidity.

Table 10. Distance of each receptor from the associated compressor station, receptor ambient noise levels, and resulting increases over ambient.

Compressor Station/NSA	Distance (feet) to NSA	Measured Ambient dBA L_{dn}	dB Increase over Ambient
Bradshaw			
NSA 1	1,335	42.6	2.0
NSA 2	2,135	42.6	0.2
NSA 3	3,105	42.6	0.1
NSA 4	3,030	44.1	2.7
NSA 5	2,380	45.8	2.3
	2,397 feet (0.45 mi)	MEAN	1.46 dB
Estimated Mean dB increase in Ambient noise at 0.5 mile = 1.46 dB			
Harris			
NSA 1	1,445	47.9	0.6
NSA 2	1,825	48.5	2.3
NSA 3	1,965	48.5	3.0
NSA 4	3,340	55.3	0.2
	2,144 feet (0.41 mi)	MEAN	1.53 dB
Estimated Mean dB increase in Ambient at 0.5 mile = 1.20 dB			
Stallworth			
NSA 1	2,835	54.9	0.1
NSA 2	1,985	39.6	3.4
NSA 3	2,085	44.9	1.3
NSA 4	1,465	35.8	2.0
NSA 5	1,340	54.1	0.1
NSA 6	2,755	54.1	0.1
	2,076 feet (0.39 mi)	MEAN	1.17 dB
Estimated Mean dB increase in Ambient at 0.5 mile = 0.88 dB			
Compressor Station/NSA	Distance (feet) to NSA	Measured Ambient dBA L_{dn}	dB Increase over Ambient
Bradshaw			
NSA 1	1,335	42.6	2.0
NSA 2	2,135	42.6	0.2
NSA 3	3,105	42.6	0.1
NSA 4	3,030	44.1	2.7
NSA 5	2,380	45.8	2.3
	2,397 ft (0.45 mi)	MEAN	1.64 dB
Estimated Mean dB increase in Ambient at 0.5 mi = 1.46 dB			
Harris			
NSA 1	1,445	47.9	0.6
NSA 2	1,825	48.5	2.3
NSA 3	1,965	48.5	3.0
NSA 4	3,340	55.3	0.2
	2,144 ft (0.41 mi)	MEAN	1.53 dB
Estimated Mean dB increase in Ambient at 0.5 mi = 1.20 dB			
Stallworth			
NSA 1	2,835	54.9	0.1

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NSA 4	1,465	35.8	2.0
NSA 5	1,340	54.1	0.1
NSA 6	2,755	54.1	0.1
	2,076 ft (0.39 mi)	MEAN	1.17 dB
Estimated Mean dB increase in Ambient at 0.5 mi = 0.88 dB			

Based on mean distances of receptors at each station and mean dB increases, a straight-line extrapolation of the noise level was made for 0.8 kilometer (0.5 mi) from each compressor. These extrapolations are conservative based on the nonlinear nature of sound attenuations and a lack of consideration for the dampening effect of foliage. At all three locations, the noise increase is less than 1.5 dB at 0.4 kilometer (0.5 mi).

In addition, post-construction monitoring must be completed at each NSA to ensure that the FERC required maximum noise level of 55 dbA is not exceeded.

3.1.3.4 Sound Attenuation

Sounds are not evenly transmitted through the air, as high-frequency sounds attenuate more rapidly than low-frequency sounds and all sound 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, the difference is even greater. The average humidity in the Project Area is high. For example, near Blacksburg, Virginia (which is considered representative of the Project Area) the humidity exceeds 93 percent three days out of four during the summer months of the bat season of reproduction. Thus, sounds, especially high-frequency sounds most relevant to bats, attenuate more rapidly than modeled in that area

3.1.3.5 Action Area for Noise Pollution

Based on the information provided above, the 85 dB sounds produced by typical construction equipment at the site under typical (80 percent humidity) weather conditions will have attenuated to a level of 49 dB within 965.6 meters (3,168 ft) of the source. This attenuation is even greater for sounds within the 40+ kHz range where bats are most sensitive. Sound from the Project has a measurable impact no farther than 965.6 meters (3,168 ft) (0.97 kilometer [0.6 mi]) from the Project Area. It is assumed that minimal construction will occur in areas designated for use as temporary contractor, pipe storage, or laydown yards. Furthermore, these temporary facilities are located adjacent already heavily trafficked areas where activity associated with the Project is not likely to rise above existing sound levels. Thus, these areas are not buffered by 0.9 kilometer (0.6 mi).

3.1.4 Changes in Water Quality

The introduction of excess sediment into waterways may result in temporary changes to water quality. Although the specific conservation measures outlined in Section 2.6.1 will limit impacts to waterways, these measures are unlikely to prevent all excess sediment inputs. Although sedimentation of streams by erosion is a natural process, land development and disturbance may accelerate this process. Increased erodibility, due to loosening and exposure of fine particles, increases 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.

3.1.4.1 Impact of Sediment on Aquatic Communities

The impacts of sediment deposition and suspension in waterways include degradation of aquatic habitat, increased turbidity and decreased light attenuation, elevation of the streambed, and decreased storage capacity in downstream reservoirs. Aquatic community impacts may include abrasion and dislodgement by suspended particles, burial by sediment, mortality of fish eggs, and clogging of gills and respiratory systems (Wood and Armitage 1997, Burkhead and Jelks 2001, Jones et al. 2012). Additional impacts include alteration of physical habitat and changes in primary productivity, which can limit the suitability of stream habitats for aquatic biota, including fish, crayfish, mussels, snails, insects, and plants (Bogan 1993, Wood and Armitage 1997, Taylor et al. 2007).

3.1.4.2 Level of Impact Considered Significant

A biologically defensible method of assessing the potential impacts of sedimentation must account for a variety of factors and be:

- Transferable between regions (so projects may be consistently evaluated)
- Easily understood by a variety of stakeholders
- Able to account for site-specific variation within and between stream systems; and
- Scalable or adjustable to multiple taxonomic groups

However, attempts to establish a nation-wide standard have been stymied by five biological realities (Kemp et al. 2011):

- The amount of sediment inputs to streams exhibits substantial natural variation.
- Sedimentation regimes may differ in portions of the same stream based on highly localized factors like riparian land cover.

- Sediments from different geological sources may have different physical properties and biological effects.
- Even closely related taxa may respond in markedly different ways to similar levels of sediment.
- Different life stages of a single species may respond in markedly different ways to similar levels of sediments.

Despite 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. Given that the mechanisms of sediment impact are related to either deposition or suspension (or both), total sediment load provides a reasonable impact metric as it encompasses both suspended and deposited sediments within a stream channel. Using this method, a significant impact is defined as anything that raises current total sediment load by more than 10 percent. It should be noted, however, that the magnitude of impact is also related to both the duration and frequency of the elevated sediment load. Longer and more frequent periods of sedimentation are likely to prove more harmful to aquatic ecosystems.

3.1.4.3 Sedimentation Model

To identify the extent of sedimentation effects from the Project, a hydrological analysis of sedimentation is performed using the Revised Universal Soil Loss Equation (RUSLE) (Renard et al. 1997). Specific details regarding the RUSLE are its application to construction activities are available in Renard et al. (1997) and Galetovic (1998) as well as Appendix C. In brief, the RULSE is used to generate sediment loads and yields by multiplying a series of values representing erosivity (associated with rainfall and runoff), erodibility, slope length and steepness, land cover and management, and conservation practices and erosion and sediment control measures. The benefit of RUSLE is that it can be easily incorporated into a Geographic Information Systems (GIS) environment, and sediment load can be estimated for a series of cells belonging to a watershed or catchment.

For the proposed Project, the RUSLE is used to estimate sediment loads and yields for all stream catchments within the 1:24,000 National Hydrography Dataset (NHD) within the vicinity of the Project (see Appendix C). Baseline, or reference, sediment conditions are defined using (1) current land uses available within the 2011 National Land Cover Database (NLCD) (Homer et al. 2015), (2) 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), (3) expected erosivity based on rainfall estimates from climate data (http://prism.oregonstate.edu; accessed January 2016), (4) slopes and flow lengths derived from the National Elevation Dataset, and (5) hydrologic flow paths based on the NHD. Baseline sediment conditions are then used to assess potential increases of soil loss expected under Project construction, restoration, and operation.

In order to estimate potential sediment introduced into nearby streams from the Project, construction, restoration, and operational 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 segment or spread in a north-to-south direction (Figure 2; see Appendix C for a more detailed description of construction activities and their associated treatments within the RUSLE).

Soil losses are estimated at two-week intervals and summed to estimate expected yearly loads and yields for a five-year period. Results are then compared to baseline conditions to assess potential impacts from the Project. To estimate the full spatial extent of Project impacts, maximum loads are estimated as the maximum cumulative sum of any consecutive 52-week period.

Estimates from the RULSE are used to identify streams that are likely to have higher construction sediment loads as compared to baseline, pre-construction levels. A national standard for the permissible amount of sediment to enter waterways is not available or established. A common threshold identified is one that increases sedimentation metrics by 10 percent or more above baseline. 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 address both suspended and deposited sediments within a stream channel. Thus, any stream reach that is predicted to have a 10 percent or greater increase in sediment load is delineated and mapped (Appendix B).

3.1.4.4 Action Area For Water Quality

Analysis using the RUSLE identified the boundaries associated with a 10 percent increase in sediment load. In total, over 1,135.13 stream kilometers (705.03 mi) are expected to have a 10 percent increase or more, at least temporarily. Although the majority of these stream reaches are closely associated with the boundaries of the Project Area, there are several exceptions (see Map 9, Appendix B), 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.

3.1.5 Summary of Action Area

For this Project, the Action Area is defined as the Project construction ROW plus the distance where:

- meaningful concentrations of dust and airborne vehicle emissions will travel outside the Project Area, estimated in Section 3.1.1.3 at 106.7 meters (350 ft);
- night-time lights might stimulate a response by active bats, estimated in Section 3.1.2.5 at 365.8 meters (1,200 ft);
- air or substrate-borne sound or vibration travels, estimated in Section 3.1.3.5 at 0.967 kilometer (0.6 mi or 3,168 ft); and
- water carries deleterious concentrations of sediments downstream of the Project Area, estimated in Section 3.1.4.4 (varies by stream).

When combined, the majority of these metrics lie within the 0.967-kilometer (0.6-mi) buffer associated with the distance that sound from the Project Area will remain noticeable, with the exception of where a 10 percent increase in sediment loads is detectable in streams extending beyond the 0.97-kilometer (0.6-mi) noise buffer. As such, the Action Area for this Project consists of all lands within 0.9-kilometer (0.6-mi) of the boundaries of the Project Area and approximately 1,135.13 kilometers (705.34 mi) of potentially impacted streams (Figure 7). Detailed maps are provided in Appendix B.

3.2 Habitat in the Action Area

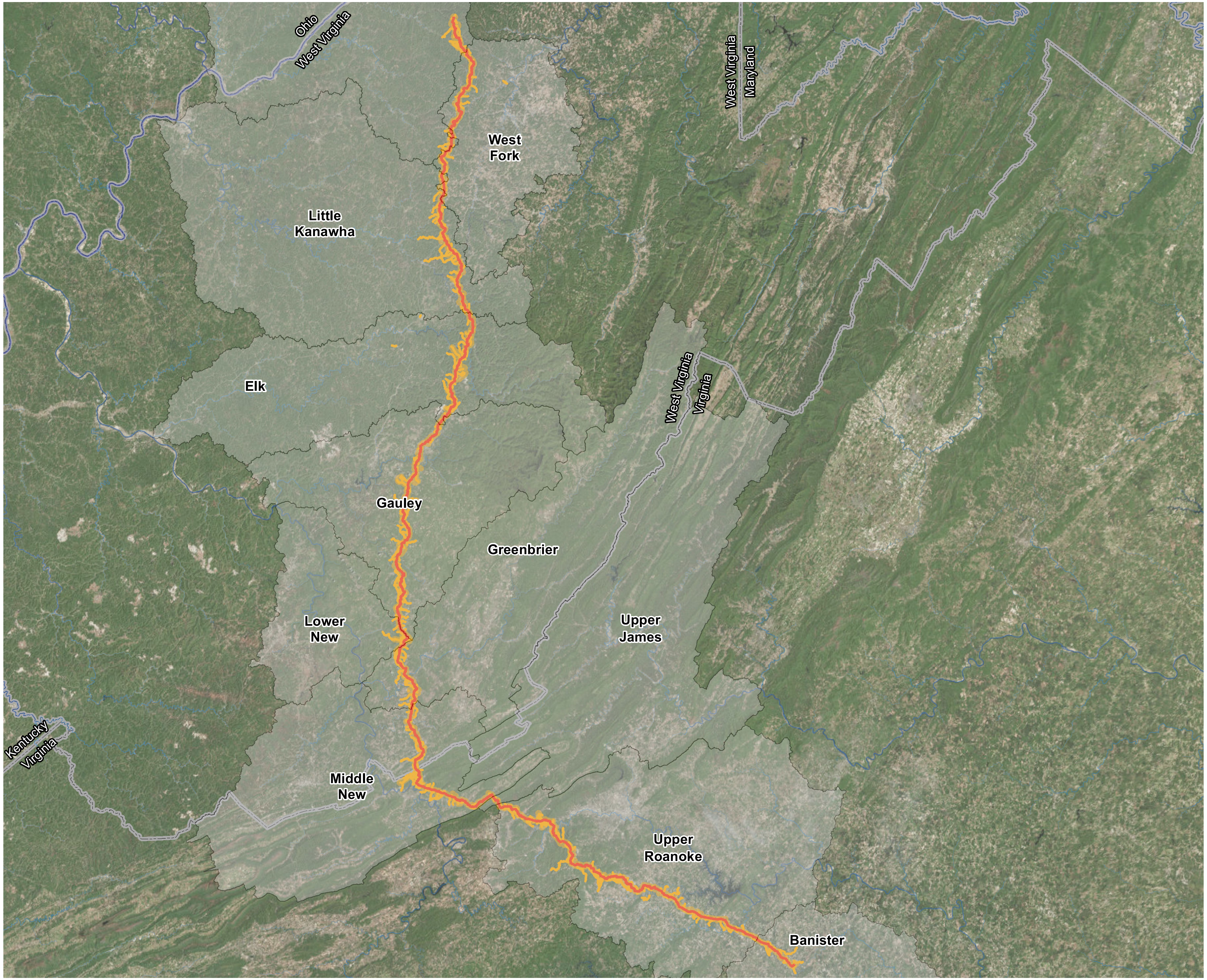
3.2.1 Physiography

The Project traverses four physiographic provinces including the Appalachian Plateau, Valley and Ridge, Blue Ridge, and Piedmont provinces. Except for less than 16 kilometers (10 mi) in Monroe County, the Project in West Virginia is entirely within the Appalachian Plateau province and is considered strongly dissected by stream erosion with rugged topography.

The Appalachian Plateau is underlain mainly by horizontally bedded sedimentary rock, including Pennsylvanian-age sandstone, siltstone, shale, coal, and some limestone (WVGES 2015). The area where the Appalachian Plateau meets the Valley and Ridge province, referred to as the Allegheny Front, is characterized as a complex and abrupt change in topography, stratigraphy where low-amplitude folds and flat-lying rocks in the Plateau give way to the tight folds of the Valley and Ridge province.

The Project traverses the Valley and Ridge province in southern Monroe County, West Virginia and Giles, Craig, Montgomery, and Roanoke counties, Virginia. This province is a long belt of parallel mountain ridges and valleys trending in a northeast direction, where geological forces squeezed the original flat-lying sedimentary layers and folded them into a series of arches (anticlines) and troughs (synclines). Over time, erosion of these folds has produced a distinctive repeating landscape of ridges and valleys. Resistant sandstone or conglomerate forms the top of strike ridges and the mid to upper area of the dip slopes. The lower flanks of ridges and the valleys are

Figure 7. Overview of the Action Area as defined by construction and operational impacts of the Mountain Valley Pipeline.*



Stream

October 2016 Proposed Route (Revised)

Action Area

State

Subbasin

*Detailed Action Area maps are available in Appendix B.

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Base Map: ESRI ArcGIS Web service - "World Imagery" accessed - 3/9/2017

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underlain by shale and, in some areas, carbonate bedrock (limestone and dolomite). Caves, sinkholes, and karst features are prevalent in some limestone areas (WVGES 2015).

The Project traverses the Blue Ridge province from Roanoke County to within Franklin County, Virginia and is characterized by the northeast-trending Blue Ridge Mountains that tower above the eastern border of the Valley and Ridge province (WVGES 2015). The Blue Ridge province is composed of Mesoproterozoic crystalline rock at its core and Late Neoproterozoic to Early Paleozoic cover rock on its flanks that were thrust to the northwest over the Paleozoic rock of the Valley and Ridge province. Specific rock types within this province include granitic gneiss, granite, biotite gneiss, and schist.

The Project traverses the Piedmont province in Franklin and Pittsylvania counties, Virginia. The Piedmont is characterized by low, rounded hills with gentle slopes and a few isolated ridges. Bedrock is composed of igneous and metamorphic rocks typically buried under a thick (1.8 to 19.8 meters [6 to 65 ft]) blanket of weathered rock responsible for the area's clay-rich soils. Outcrops are typically restricted to stream valleys where erosion has removed the soil layer. This province is bounded on the east by the Fall Zone, which separates the province from the Coastal Plain.

3.2.2 Land Cover Types

The National Land Cover Database (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 The NLCD, because of its 30-meter by 30-meter (98.4 x 98.4 ft) resolution, is best used for large-scale analyses of relatively homogenous habitat. Land cover usage is divided into fifteen types:

- Deciduous Forest - These are areas dominated by trees generally greater than 5 meters (16.4 ft) 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 - These are areas dominated by trees generally greater than 5 meters (16.4 ft) 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 - These are areas dominated by trees generally greater than 5 meters (16.4 ft) 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 - These are 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 - These are areas with a mixture of some constructed materials, but 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 - These are 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 - These include 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 - Developed, high intensity includes highly developed areas 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.

- Shrub/Scrub - Shrub/Scrub includes areas dominated by shrubs which are less than 5 meters (16.4 ft) tall with 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 - Emergent herbaceous wetlands are defined by 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 - Cultivated crops include areas used for the production of 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 - Pasture/Hay includes areas of 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 - Grassland/Herbaceous comprises 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 - Open water land use includes all areas of open water, generally with less than 25 percent cover of vegetation or soil.
- Barren Land - Barren Land includes 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.

The 2011 NLCD (Jin et al. 2013, Homer et al. 2015) was used 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 11). As described in Section 1.4.1.3, habitat assessments for listed bat species were completed along portions of the Project Area within protective bat buffers. Furthermore, wetlands and waterbodies were field delineated for many areas of the Project workspace. Land cover types collected in the field and later geo-referenced in these areas are 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 112,938.636 hectares (279,077.19 ac) (Table 11). The largest land cover type in area is deciduous forest (85,130.41 hectares [210,361.6 ac], 75.38 %) followed by pasture/hay fields (12,338.50 hectares [30,489.06 ac], 10.93%). Although not reported in Table 11, the Action Area also includes 1,135.13 kilometers (705.34 mi) of stream habitat, of which 296.22 kilometers (184.06 mi) extend beyond the 0.97-kilometer (0.6-mi) buffer for noise.

Table 11. Land cover types and acreages within the Project Area and Action Area as indicated by NLCD and field assessments.

		Project Area	
Vegetative Cover Type[1]	Action Area (acres)	Construction (acres)	Operation (acres)
Deciduous Forest	210,361.65	3,918.40	1,410.08
Evergreen Forest	6,537.70	118.92	44.66
Mixed Forest	4,342.19	415.80	144.07
Wetlands[2]	559.46	41.40	12.25
Shrub/Scrub	1,421.18	71.41	21.49
Grassland/Herbaceous	4,402.56	182.76	54.74

Vegetative Cover Type[1]	Action Area (acres)	Project Area Construction (acres)	Project Area Operation (acres)
Pasture/Hay	30,489.06	1,003.65	279.90
Cultivated Crops	3,479.06	57.66	14.09
Developed[3]	15,787.13	503.92	119.28
Open Water	710.53	19.85	9.84
Barren Land	986.68	30.49	6.72
Total[4]	279,077.20	6,364.26	2,117.12

[1] Vegetative cover types determined by field data collected when available and the 2011 NLCD otherwise.
[2] Wetlands include woody, scrub/shrub, and ermergent herbaceous wetlands.
[3] Developed includes Open Space, Low, Medium, and High Intensity.
[4] Totals do not match Table 3 due to slight geographic overlaps of spatial data.

4.0 Target Species within the Action Area

4.1 Indiana Bat

The Indiana bat is a medium-sized bat in the genus *Myotis*. The forearm length has a range of 3.6 to 4.1 centimeters (1.4 to 1.6 in). The head and body length range from 4.1 to 4.8 centimeters (1.6 to 1.9 in).

4.1.1 Activity Patterns

The Indiana bat is a "tree bat" in summer and a "cave bat" in winter. There are four ecologically distinct components of the annual life cycle: winter hibernation, spring staging and autumn swarming, spring and autumn migration, and the summer season of reproduction (Figure 8). The USFWS Recovery Plan (2007b) provides a description of the life history, and Figure 8 provides an annual chronology of seasonal activities. The summer range of the Indiana bat is large and includes much of the eastern deciduous forestlands between the Appalachian Mountains and Midwest prairies (Figure 9).

The distribution of Indiana bat is not uniform throughout its range, and summer occurrences are more frequent in southern Iowa and Michigan, northern Missouri, Illinois, and Indiana. Greater tree densities do not equate to more bats (Brack et al. 2002); however, cooler summer temperatures associated with latitude or altitude likely affect reproductive success and the summer distribution of the species (Brack et al. 2002).

Some males remain near hibernacula throughout summer while others migrate varying distances (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). Woodland roosts appear similar to maternity roosts (Kiser and Elliott 1996, Schultes and Elliott 2002, Brack 2004, Brack and Whitaker 2004), although smaller-diameter trees may be used for woodland roosts. Less space may be required for a single bat than a colony of bats, and thermal requirements may differ. Males appear somewhat nomadic; over time, the number of roosts and activity area used by an individual increases. Activity areas encompass roads of all sizes, from trails to interstate highways. Roosts have also been located near roads of all sizes (Kiser and Elliott 1996, Schultes and Elliott 2002, Brack 2004), including adjacent to an interstate highway (Brack 2004).

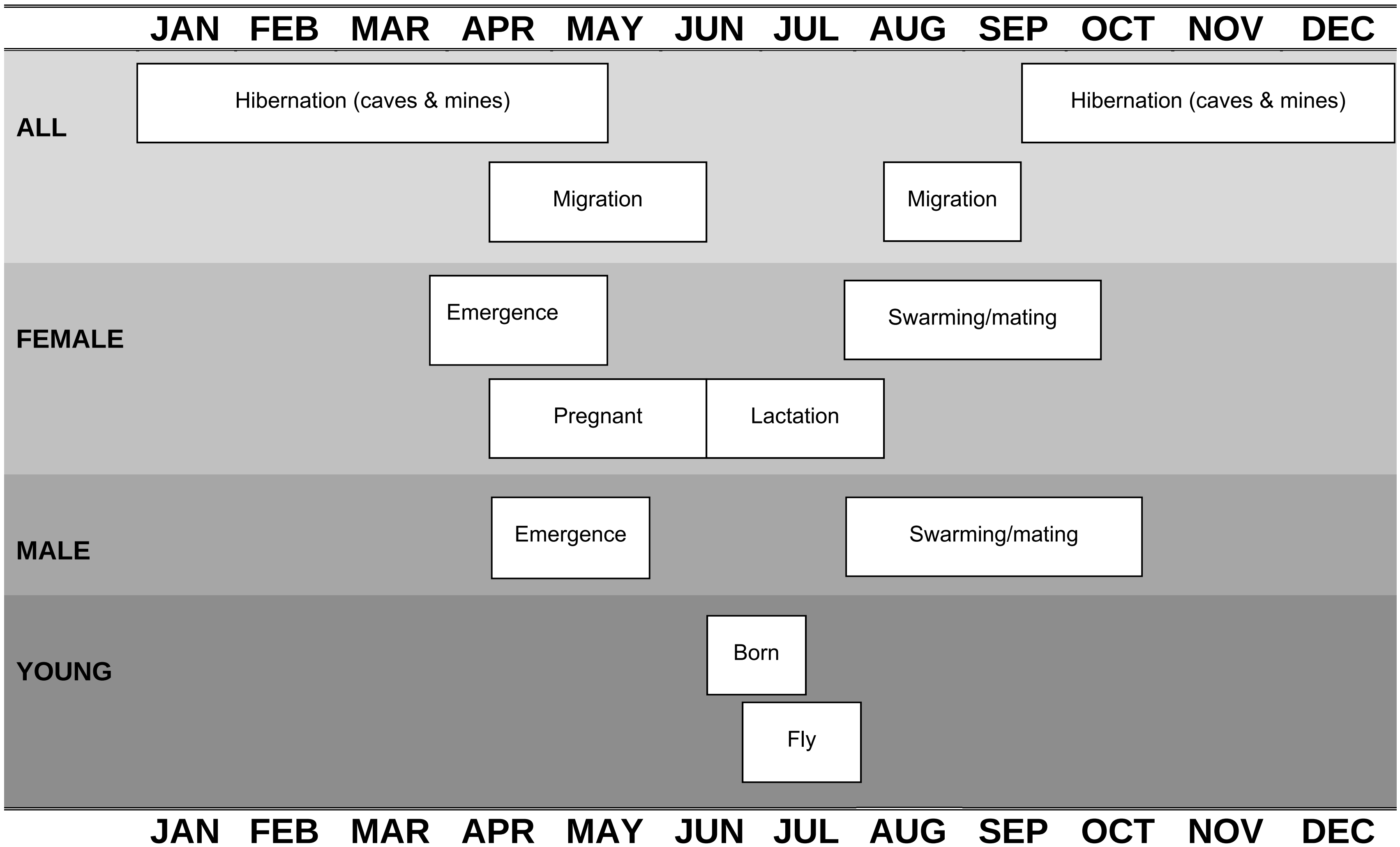
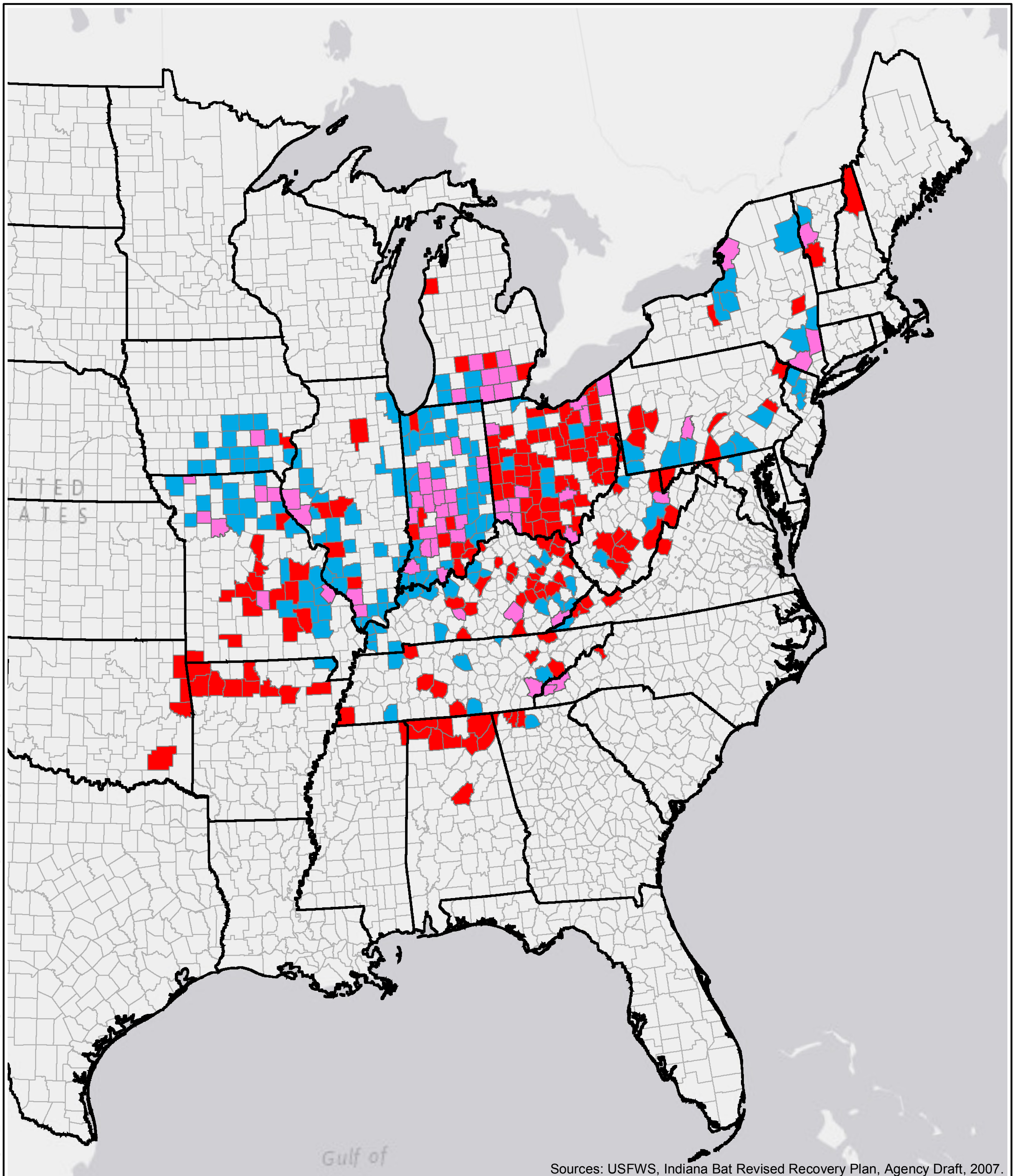


Figure 8. Seasonal chronology of Indiana bat activities.



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

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Figure 9. Range-wide distribution of the Indiana bat during summer, showing counties with reproductive (adult female and/or young-of the-year) and non-reproductive records.

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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). 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. Since many roosts are in dead or dying trees, they are often ephemeral.

Indiana bats exhibit strong site fidelity to summer roosting and foraging areas (Kurta and Murray 2002, Kurta et al. 2002), and roost trees may be habitable for one to several years, depending on the species and condition of the tree (Callahan et al. 1997). Females are pregnant when they arrive at maternity roosts, and parturition typically occurs between late June and early July. Most members of a colony coalesce into a single roost tree about the time of parturition, which begins to break up again as soon as young are volant.

Roosts that contain large numbers of bats (more than 20 bats) are often called primary roosts, while secondary roosts hold fewer bats. Primary roost trees are often greater than 46 centimeters (18 in) diameter at breast height (dbh), and secondary roost trees are often greater than 23 centimeters (9 in) dbh (Gardner et al. 1991, Callahan et al. 1997, Kurta et al. 2002, Miller et al. 2002, Carter 2003). Numerous suitable roosts may be required to support a single nursery colony, possibly about 45 stems per hectare (20/acre) (Gardner et al. 1991, Miller et al. 2002, Carter 2003).

Roost trees are often located where they have solar exposure, with 20 to 80 percent canopy closure (Humphrey et al. 1977, Gardner et al. 1991, Kurta et al. 1993, Kurta et al. 1996, Kurta et al. 2002, Carter 2003). They are often exposed to 10 or more hours of solar radiation per day (Kurta et al. 2002), but the need for solar exposure may vary with latitude.

Like many other species of microchiropterans, the Indiana bat often uses travel corridors that consist of open flyways 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 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 more foraging opportunities than dense woodlands. Most species of woodland bats forage prominently along edges, less in openings, and least within forests (Grindal 1996).

Openings also provide a better supply of insects than do wooded areas (Tibbels and Kurta 2003).

4.1.2 Site-specific Data

4.1.2.1 Summer Occurrence

In West Virginia, maternity colonies are known from Boone and Tucker counties (USFWS 2007c) and [redacted] Summer non-reproductive records are also known from Bath, Bland, Dickenson, Highland, Lee, Tazewell and Wise counties, Virginia. Surveys were conducted as described in Section 1.4. No Indiana bats were captured on this Project during the 2015 and 2016 mist net surveys.

4.1.2.2 Estimates of Summer Abundance

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 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 forested acres. 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 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 (51.9%) of the state of Virginia is within the distributional range of the species. Thus, 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 is 0.000073 bats/forested acre.

4.1.2.3 Summer Habitat

Potentially suitable summer habitat for the Indiana bat is present along the entire length of the proposed Project. The Project intersects an area of known, occupied summer habitat from [redacted] Wetzel County, West Virginia associated with the capture of a pregnant female in 2010.

Detailed habitat assessments were completed for portions of the Project falling within a set distance of a listed bat capture, roost or hibernacula. (These distances are 2.4 kilometers (1.5 mi) for a northern long eared bat roost, 4 kilometers (2.5 mi) for an Indiana bat roost, 4.8 kilometers (3 mi) of a northern long eared bat capture site with no roost, and 8 kilometers (5 mil) of a hibernacula or Indiana bat capture site without a roost located.) A total of 986 high; 4,346 moderate; and 5,084 low suitable roost trees was identified during these assessments. A total of 262.8 hectares (649.5 ac) of high; 1,105 hectares (2,730.5 ac) of moderate; and 1,267.4 hectares (3,131.8 ac) of low foraging potential were identified. Of these areas, 10.92 percent were considered to have high roosting potential, 29.37 percent as moderate roosting potential, 41.64 percent as low roosting potential, and 18.06 percent provided no roost potential for the Indiana bat.

No Indiana bats were captured during the 2015 and 2016 mist-net survey efforts for this Project. Therefore no occupied Indiana bat roosts were documented within the Project Area.

4.1.2.4 Winter Hibernation, Autumn Swarming, and Spring Staging

4.1.2.4.1 Known and Potential Hibernacula Occurrence

The Indiana bat is known to hibernate in 18 caves in Greenbrier, Mercer, Monroe, Pendleton, Preston, Randolph, and Tucker counties, West Virginia. [redacted]

The maximum all-time population estimate for Indiana bats within the [redacted] 300 (USFWS 2007c), 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). All features of the Project are 3.2 kilometers (2 mi) or farther from the cave's entrance, which is outside the Action Area for the Project (see Section 3.1).

The Project's construction ROW is currently less than 60 meters (197 ft) from the closest [redacted] suggesting this cave may be no longer occupied by this species during winter. However, given the potential for Tawney's cave to host the species, the feature was assumed occupied for this BA.

Field searches for portals that may be possible Indiana bat hibernacula were conducted from November 2014 through January 2017. Forty-four previously undocumented underground features and eight known caves were identified during these searches, including [redacted] ll three of these features were surveyed using harp traps, and no bats were captured. An additional ten features that are within the Action Area but not within the project footprint were harp trapped in fall 2015 and 2016, but no

Table 12. Summary of potential hibernacula within the Project Action Area as determined by field searches or desktop analysis.

Portal ID	Number of Openings	County, State	Suitable?	Sampled?	Conclusions/Comments[3]
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[1]	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
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

Portal ID	Number of Openings	County, State	Suitable?	Sampled?	Conclusions/Comments[3]
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
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[2]	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
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
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

Portal ID	Number of Openings	County, State	Suitable?	Sampled?	Conclusions/Comments[3]
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
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
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

Portal ID	Number of Openings	County, State	Suitable?	Sampled?	Conclusions/Comments[3]
Thompsons Cave	1	Montgomery County, VA	n/a	No	Not field reviewed; unable to determine suitability or occurrence of bats at this time

[1] CRA-PO-0001 is no longer part of the Action Area.
[2]Canoe Cave considieried occupied by northern long-eared bats based on data maintained by VDCR-DNH.
[3]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 (See Section 5.1.1)

Indiana bats were captured. [redacted] located approximately 0.4 kilometers (0.25 mi) from the Project and is thus within the Action Area. This feature was not surveyed for this Project but was recently surveyed by the VDCR-DNH, and no Indiana bats were observed (K. Powers, pers. comm. April 1, 2016). [redacted]

Four of the potentially suitable portals ([redacted] occur on an active surface mining site and were destroyed before harp trap surveys could occur for the Project. One potentially suitable portal ([redacted] discovered during Project surveys is no longer within the Action Area. In addition to these features, [redacted]

In addition to the 52 features documented during field surveys, geospatial data provided by the Virginia Speleological Society (VSS), Draper Aden Associates, and public comments submitted to FERC indicate an additional 124 features outside the survey corridor but within the vicinity of the Project (i.e., within 5-mi) based on desktop analyses. 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 land access has yet to be granted to MVP-contracted biologists. Publically available data (e.g., recovery plan) suggest these caves are unlikely to host wintering populations of Indiana bats, and these features are not included within the spatial data layer containing known occurrences supplied by the USFWS, Elkins Field Office. Because these features have the potential to host Indiana bats and may be impacted by Project activities, the 124 features outside the survey corridor are treated as potentially occupied for this BA.

4.1.2.4.2 Estimates of Winter Abundance

As discussed above, there are two known Indiana bat hibernacula within 8 kilometers (5 mi) of the Project: [redacted] Estimates of abundance for these features are made using available survey data from the VDCR DNH and WVDNR, where available.

The maximum population estimate of Indiana bats in [redacted] is 300 (USFWS 2007c), but unpublished data maintained by the WVDNR suggest the current winter population is less than ten individuals due to WNS. Recent in-cave surveys for Indiana bats conducted by the WVDNR found 6 individuals in 2012 and 4 individuals in 2016. For the purposes of this BA, an estimate of 6 individuals is made for the feature.

The maximum population estimate of Indiana bats in [redacted] (USFWS 2007c). 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, [redacted] treated similarly to the other suitable, surveyed portals within the Action Area (see below).

[redacted] 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 undersampling 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 ESI projects 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 (*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).

In examination of this dataset, it was found that portal-trap results may provide a reasonable index of winter population size if both 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 2011) was taken due to the small sample size of Indiana bat presences and counts within the dataset, as well as the difficulty to get accurate winter population size estimates for northern long-eared bat (*M. septentrionalis*), 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 (Zuur et al. 2009) (Appendix C). However, 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 share a common pattern among species. The advantage of this approach was two-fold:

- Estimates were 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 was useful because it is difficult to get 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 MVP involved multiple steps. First, data from surveys conducted by Dalton (1987), Gates and Johnson (2006b), and Powers et al. (2015) as well as surveys conducted from previous projects conducted by ESI 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. Four-hundred-and-eight of these features only had counts from portal-trapping, and the remaining features had results from in-feature counts.

For portals within this dataset where in-feature counts were available (e.g., Dalton 1987), no adjustment was made to correct winter abundance estimates. However, for surveys that only had counts from portal-trapping and 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 Project is unknown, and thus the abundance estimate above is not be 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 Project, 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 Project. Of these 52 features, 24 were deemed suitable, and thus, 46.15 percent of features with unknown suitability are likely to be suitable for hibernating bats. Multiplying the abundance estimate for suitable features by 46.15 percent provides an estimate of 0.9262 Indiana bats in features with unknown suitability within the vicinity of the Project.

4.2 Northern Long-eared Bat

The northern long-eared bat weighs about 5 to 8 grams (0.17 to 0.28 oz) at maturity, and its right forearm measures about 3.3 to 3.8 centimeters (1.3 to 1.5 in). The wing membrane connects to the foot at the base of the first toe. The northern long-eared bat is most easily characterized by the long ears (1.8 centimeters [0.7 in]), which extend past the muzzle when laid forward, as well as a long and thin tragus (1.02 centimeters [0.4 in]) (Whitaker and Mumford 2009). The northern long-eared bats' pelage 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.

4.2.1 Activity Patterns

The northern long-eared bat is a "tree bat" in summer and a "cave bat" in winter. During the summer, the species is forest dependent. As with the Indiana bat, there are four ecologically distinct components of the annual life cycle: winter hibernation, spring staging and autumn swarming, spring and autumn migration, and the summer season of reproduction (Figure 10).

The summer range of the northern long-eared bat is large and includes much of the eastern deciduous forestlands from the northern border of Florida north and west to Saskatchewan and east to Labrador (Caceres and Barclay 2000, Whitaker and Mumford 2009) (Figure 11). The distribution of the species throughout the range is not uniform, and summer occurrences are more common in the northern and northeastern portions of the species' range than in southern and western portions (Caceres and Barclay 2000, Amelon and Burhans 2006). Historically, these areas were primarily forested. Through the southern portions of its range, the northern long-eared bat appears to be less abundant and is thought of as rare in Alabama, South Carolina, and Georgia (Mumford and Cope 1964, Barbour and Davis 1969, Amelon and Burhans 2006, Whitaker and Mumford 2009, Timpone et al. 2010). Although occasionally captured/recorded in western portions of its range, it is uncommon when records are compared to eastern areas and may now occupy this area as a result of range expansion following settlement (Sparks et al. 2011).

A wide variety of deciduous tree species, as well as occasional coniferous species, are used as nursery colonies indicating that it is tree form, not species that is important for roosts (Caceres and Barclay 2000, Carter and Feldhamer 2005).

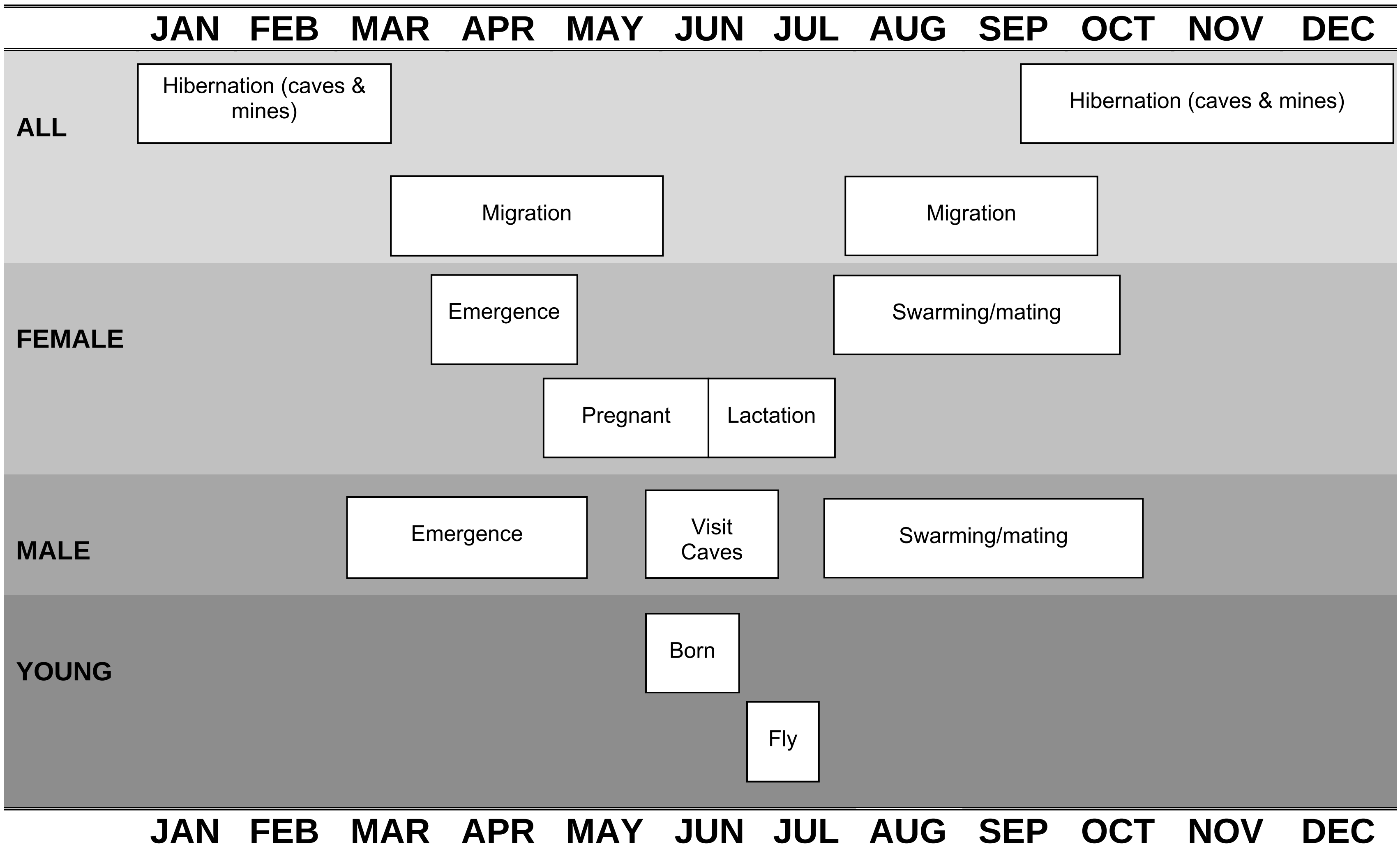
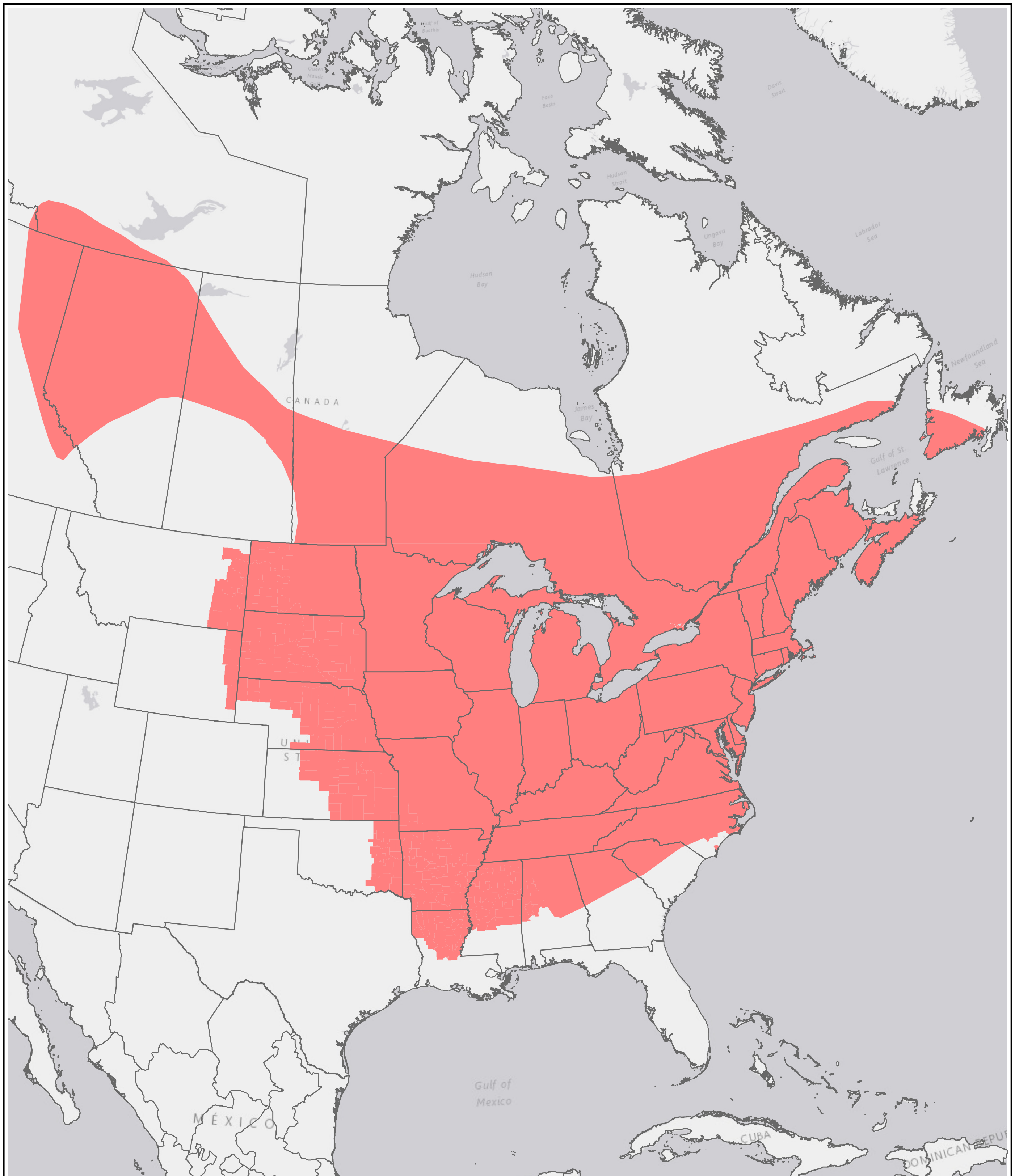


Figure 10. Seasonal chronology of northern long-eared bat activities.



Northern Long-Eared Bat Range

State or Province Boundary

Figure 11. Range-wide distribution of the northern long-eared bat during summer.

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This species regularly uses both live and dead trees (Sasse and Pekins 1996, Foster and Kurta 1999, Lacki and Schwierjohann 2001, Sparks 2003, Timpone 2004, Whitaker et al. 2004, Carter and Feldhamer 2005, Ford et al. 2006, Timpone et al. 2010, Johnson et al. 2012, Silvis et al. 2012, Johnson et al. 2013, Silvis et al. 2014a). The northern long-eared bat may choose either live or dead trees, depending on the presence or availability within an area, or possibly due to competition with or predation from other wildlife (Perry and Thill 2007, Perry et al. 2007). Roost trees may be habitable for one to several years, depending on the species and condition of the tree. The species may also use several other structures as summer roost sites. These can be natural or man-made (e.g. bridges, barns/homes, rocky cracks or crevices). Northern long-eared bats make extensive use of bat-houses when these structures are available (Whitaker et al. 2006).

Some males and non-reproductive females remain near their winter hibernacula throughout summer while others migrate varying distances. This may be due to a preference for cooler environments in the absence of pups (Barbour and Davis 1969, Amelon and Burhans 2006).

Structurally, summer roosts used by males are similar to those used by maternity colonies. Trees used by males are often smaller than those used by maternity colonies, perhaps because males are often solitary or form small groups and thus need less space or they may have different thermal requirements than females.

4.2.2 Site-specific Data

4.2.2.1 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 80.5 kilometers (50 mi) of the Project, and the species remains relatively common throughout the region.

ESI sampled 338 mist-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. A total of 74 northern long-eared bats was captured 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 diurnal roosts for a minimum of four consecutive days. Seventy roosts were found, 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.

4.2.2.2 Summer Habitat

In addition to the 70 northern long-eared bat roosts documented from telemetry, detailed habitat assessments were completed as described in Section 4.1.2.3. A total of 3,203 high; 5,342 moderate; and 2,433 low potentially suitable roost trees for northern long-eared bats was identified during these assessments. A total of 506.3 hectares (1,250.9 ac) of high; 1,383 hectares (3,417.5 ac) of moderate; 748.1 hectares (1,848.5 ac) of low foraging; and 12 hectares (29.6 ac) of no foraging potential were identified. Of these areas, 25.17 percent were considered to have high roosting potential, 33 percent as moderate roosting potential, 25.80 percent as low roosting potential, and 16.03 percent provided no roost potential for the northern long-eared bat.

4.2.2.3 Winter Hibernation, Autumn Swarming, and Spring Staging

4.2.2.3.1 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 [redacted]

Field searches for portals were conducted 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 12). As described in Section 4.1.2.4, 13 suitable portals were sampled using harp traps: 6 within West Virginia and 7 within Virginia. [redacted]

As described above in Section 4.1.2.4 for Indiana bats, numerous known cave entrances are in close proximity (i.e., within 5-miles) to the Project Area (n=124). 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 91.4-meter (300-ft) survey corridor. On January 11 and 19, 2016, MVP contacted VDGIF and VDCR-DNH, respectively, and requested numbers of bats counted during any winter surveys conducted at these caves. VDGIF responded on January 26, 2016 stating that [redacted] 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 impacted by Project activities, for the purposes of this BA, it was 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.

4.2.2.3.2 Estimates of Winter Abundance

As discussed above, there are three known winter hibernacula within 8 kilometers (5 mi) of the Project: [redacted] 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 3.2 kilometers (2 mi) or farther from the cave's entrance and outside the Action Area, any impacts to individuals staging/swarming around the feature, however unlikely, are exempt under the final 4(d) ruling. Thus, no abundance estimate is made for the [redacted]

The current and historic population of northern long eared bats within [redacted] is uncertain; however, based on correspondence with the VDGIF, the cave is considered occupied by the species. In-cave winter surveys conducted at [redacted]

At the 5 suitable, unsurveyed portals as well as the 124 features with unknown suability, estimates of abundance were made using the modeling approach described in Section 4.1.2.4.2 (and detailed in Appendix C). Similar to the approach taken with Indiana bat, expected abundance was derived from surveys conducted by Dalton (1987), Gates and Johnson (2006b), and Powers et al. (2015) as well as surveys conducted from previous projects conducted by ESI. Using this dataset in conjunction with the hurdle model described in Section 4.1.2.4.2 (detailed in Appendix C), the expected number of northern long-eared bats in an unsampled by suitable feature is 7.017 bats. This estimate is also used as an estimate of the number of northern long-eared bats within [redacted]. The hurdle model is also used to estimate the number of bats within P[redacted]. According to parameter estimates, an estimate of 1.293 individuals is made (see Appendix C). As described in Section 4.1.2.4.2, information regarding the suitability of 124 features is unknown, and thus, the above estimate of 7.017 is not applicable. Similar to the approach taken for Indiana bat, 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 Project. Of these 52 features surveyed, 24 were deemed suitable, and thus, 46.15 percent of features with unknown suitability are likely to be suitable for hibernating bats. Multiplying the population estimate for suitable features by 46.15 percent provides an estimate of 3.2384 northern long-eared bats in features with unknown suitability within the vicinity of the Project.

4.3 Gray Bat

The gray bat weighs approximately 10 grams (0.35 ounce) at maturity with a right forearm measurement of 40.5 – 45.5 millimeters (1.6 – 1.8 inches). The wing membrane connects to the foot at the ankle rather than at the base of the first toe, as in other species of *Myotis*. The gray bat is monochromatic (i.e., the fur is one color – gray). However, young and newly molted individuals are a bright silvery gray whereas just before molt, the fur may be anywhere between a darker gray to blondish or russet color. Color changes are due to environmental factors, with lighter colors the result of bleaching from the ammonia in urine, and thus may be most pronounced in reproductive females.

4.3.1 Activity Patterns

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 strong vertical component (e.g., the farther south, the steeper the vertical component) with domed rooms that trap cold air with temperatures ranging from 6° to 11.6° Celsius (43° - 52°F) (Tuttle 1976a; 1979). Mating begins soon after adults arrive at hibernacula in autumn, and females begin hibernating immediately thereafter. Females may begin hibernation by early September, but adult males and juveniles remain active for several weeks after but are usually hibernating by early November. Hibernation continues through April (Brady et al. 1982).

Females store sperm over the winter, become pregnant soon after emerging from hibernation and give birth to a single young by late May or early June (Brady et al. 1982). Colony members are loyal to their colony home range but tend to disperse in groups among several different caves within that area (Brady et al. 1982). Males form bachelor colonies in spring (late March to mid-May), although many remain with females until young are born. 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 ceilings that trap warm air with temperatures ranging from 14° to 26° Celsius (57° - 79°F) (Tuttle 1976a). These caves often contain underground streams and are usually located within 1 to 4 kilometers (0.6 - 2.5 mi) of rivers or other bodies of water (Tuttle 1976b, USFWS 1997). Occasionally, summer roosts have been found in storm sewers (Decher and Choate 1995), mines (Brack et al. 1984), railroad tunnels, dams, buildings (Evans and Drilling 1992), and bridges (Mumford and Cope 1958, Davis and Cockrum 1963, Kiser et al. 2002). Gray bats use a wide variety of caves during spring and fall transient periods.

4.3.2 Site-specific Data

4.3.2.1 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. This was the first summer record of the species in West Virginia and represents a range expansion. As a result of the capture, the USFWS 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 (

Figure 12). 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.

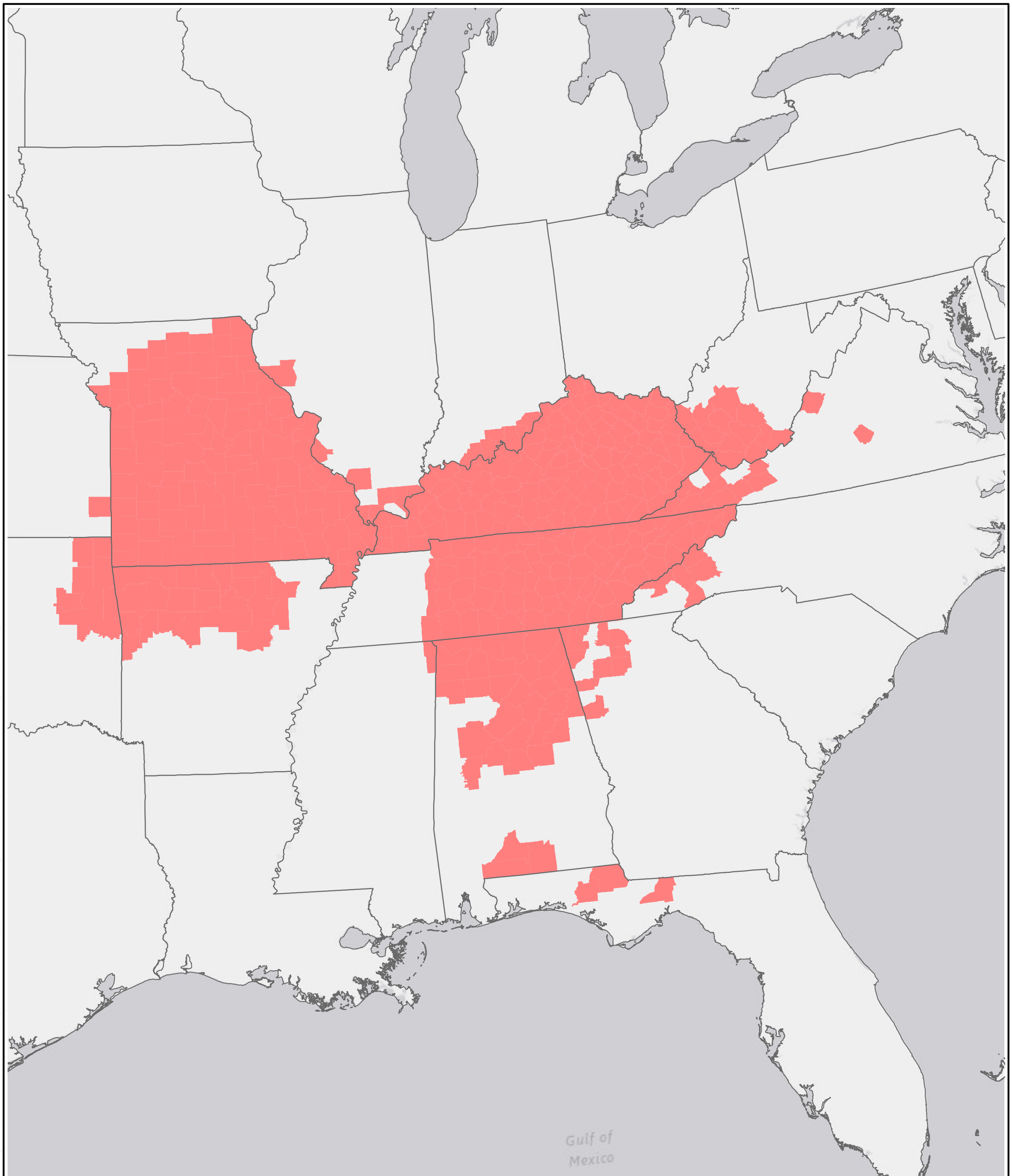
ESI sampled 338 net sites (1,953 complete and 426 partial net nights) within the Project Area from May 15 to August 15, 2015 and 3 net sites (6 complete and 6 partial net nights) from May 15 to May 26, 2016. No gray bats were captured during survey efforts.

4.3.2.2 Summer Habitat

Gray bats are known to 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 4.1.2.3 and 4.2.2.3.)

4.3.2.3 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 [redacted] in Pendleton County in 1991 when a winter survey found a total of over 61,000 bats in the cave (Craig Stihler pers. comm. February 2017). Fossil records exist from three caves in Greenbrier and Monroe counties (Decher and Choate 1995).



Gray Bat Occurrence | State or Province Boundary

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Figure 12. Potential county-level occurrence of gray bat (*Myotis grisescens*)

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Coordination with WVDNR indicates that no known gray bat hibernacula occur within the Project Area, or indeed currently within the entire state.

Results of survey efforts to locate potential hibernacula within the Project Area are discussed in previous sections (4.1.2.3 and 4.2.2.3). Subsequent harp trap survey efforts of suitable portals did not yield any gray bat captures.

4.4 Virginia Big-eared Bat

The Virginia big-eared bat is a federally endangered subspecies of the Townsend's big-eared bat (*Corynorhinus townsendii*), a species divided into five subspecies. Three subspecies are widely distributed in the western half of the U.S., but the Virginia big-eared bat subspecies is isolated to a small area in the eastern U.S. (Figure 13). Another surviving isolated subspecies population, the Ozark big-eared bat (*Corynorhinus t. ingens*), occurs in Missouri and Oklahoma. Virginia big-eared bats are present in West Virginia, Virginia, Kentucky, and North Carolina.

The Virginia big-eared bat is a medium-sized bat weighing 7 to 12 grams (0.24 – 0.42 ounces) with forearm measurements between 3.9 and 4.8 centimeters (1.5 – 1.9 inches). Its fur is light brown to buff, depending on the age of the individual. The ears are its most distinctive feature, measuring 2.5 centimeters (1 inch) long; however, it also has two conspicuous lumps on either side of its nose, earning an alternate common name of lump-nosed bat.

4.4.1 Activity Patterns

Virginia big-eared bats, similar to gray bats, are true "cave bats" requiring caves for winter hibernation and summer roosting.

Virginia big-eared bats often use colder or well-ventilated areas of the cave during hibernation (Barbour and Davis 1969, Humphrey and Kunz 1976), and hibernating individuals are often found in loose clusters, although some roost singly (Adam 1992). Clusters of hibernating big-eared bats are seemingly more easily aroused than are other species of bats (V. Brack pers. obs.). Age and sex segregation does not occur during hibernation (Whitaker and Hamilton 1998), but does during the summer reproductive season.

Copulation occurs in autumn, but ovulation, fertilization, and gestation do not occur until the following spring. Ovulation takes place around the time that females leave the hibernaculum (Pearson et al. 1952). Juvenile females typically mate during their first season while juvenile males do not (Adam 1992).

Virginia big-eared bats migrate a maximum distance of 32.2 kilometers (20 mi) from winter roosts (Pearson et al. 1952, Piaggio et al. 2008). Because this species migrates such short distances, most colonies are isolated and do not intermingle, resulting in small genetically differentiated populations, each with low genetic diversity (Piaggio et al. 2008).

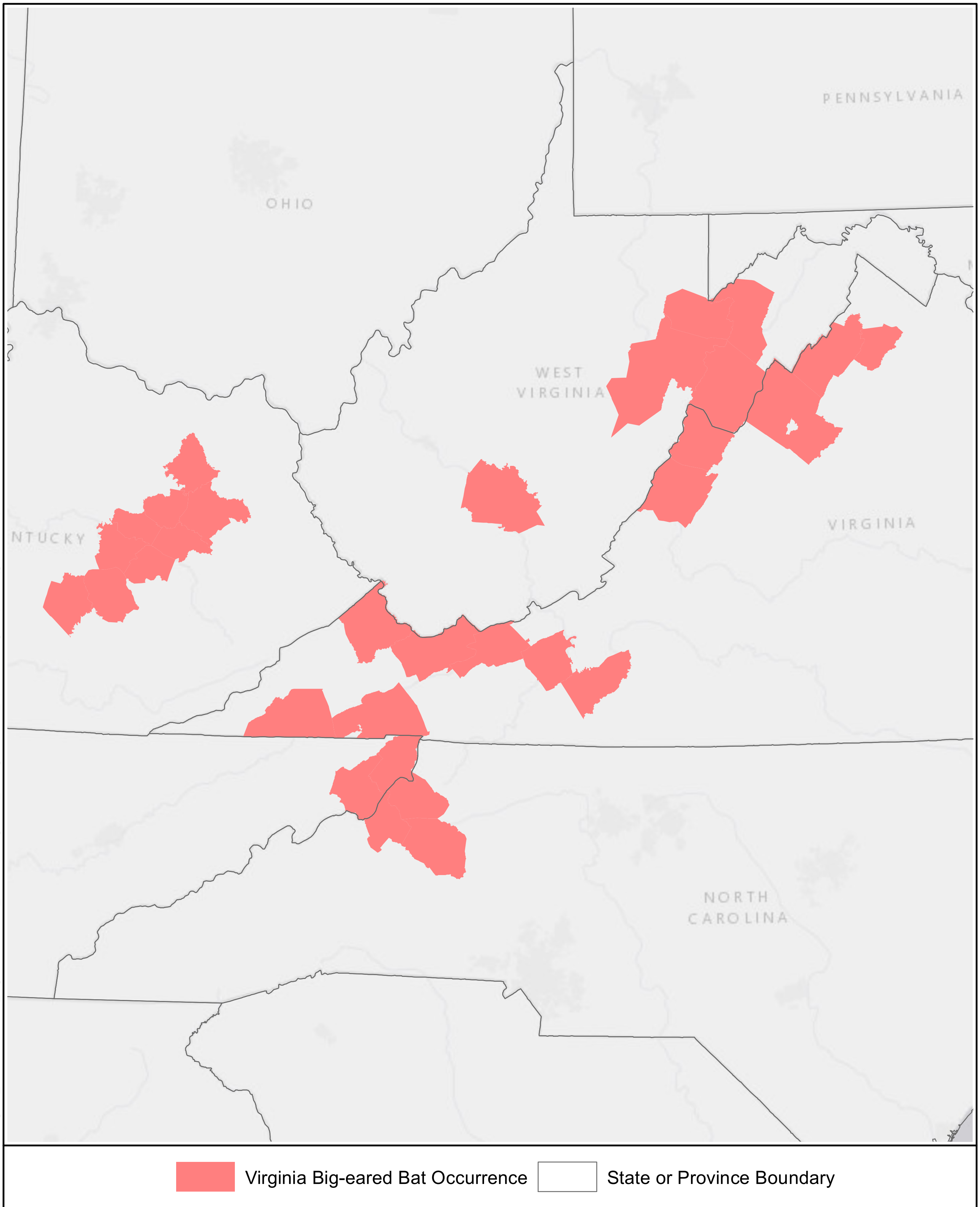

Figure 13. Potential county-level occurrence of Virginia big-eared bat (*Corynorhinus townsendii*)

Project No. 593.25

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In late March or early April, female Virginia big-eared bats form maternity colonies that may number from several to hundreds of individuals. Colonies are usually located in warm caves (or portions of caves), rock shelters, or abandoned mines (Pearson et al. 1952, Bagley 1984, Johnson et al. 2005). Females leave their young nightly to forage, but may return to the cave to nurse early in the season after parturition. As the season progresses, females typically remain gone all night and sometimes use an alternate day roost. During the maternity period, males are apparently solitary (Pearson et al. 1952, Barbour and Davis 1969, Humphrey and Kunz 1976), although bachelor colonies (e.g., loose aggregations of individuals) may be formed.

A wide range of habitat types is utilized for foraging by Virginia big-eared bats. Light tagging and telemetry studies in West Virginia (Stihler 1994; 1995) indicated that the species forages in woodlands, old fields, hay fields, and sometimes-grazed pastures; however, recent clear cuts were not used during the study. In West Virginia, forested habitats appear to be used with greater frequency in July than in May. In Kentucky, Virginia big-eared bats spent a large amount of time over grassy fields (Burford and Lacki 1995). Virginia big-eared bats may travel several miles to forage. Individuals from a maternity colony in West Virginia (Cave Mountain Cave, Pendleton County) often traveled 5 to 7 kilometers (3.1 to 4.3 mi) from the maternity cave to feed (Stihler 1994). These bats usually foraged in the same general area on consecutive nights, but some bats used more than one foraging area. In a similar study, Stihler (1995) documented a maximum foraging distance of 10.5 kilometers (6.5 mi) and noted that most bats appeared to utilize more than one foraging area. Bats often used anthropogenic structures (e.g., abandoned houses, barns, out buildings, and bridges) as night-roosts near the foraging area, and sometimes did not return to the main roost at dawn. In Tazewell County, Virginia, some bats returned to the cave to night roost, but some roosted in woodlands, and on two occasions, bats roosted in a shed (Brack and Dalton In preperation). In autumn, very little time was spent night roosting (0.2%), but in spring, 18.3 percent of time was spent night roosting. In Kentucky, big-eared bats night-roosted extensively in sandstone cliffs with a wide variety of physical features (Lacki et al. 1993).

4.4.2 Site-specific Data

West Virginia supports the largest number of Virginia big-eared bats out 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 (Barbour and Davis 1969, Bagley 1984, Gates and Johnson 2006b). 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.

4.4.2.1 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. (USFS 2011). An estimated 1,150 bats use three caves in Tazewell County, Virginia during the maternity season (USFWS 2008b).

ESI 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.

4.4.2.2 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 4.1.2.3 and 4.2.2.3.) Coordination with WVDNR indicated that the nearest known records of any kind are in Randolph and Pendleton counties (Craig Stihler pers. comm. February 2017).

4.4.2.3 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, USFWS 2008b, USFS 2011). Hellhole Cave, a designated critical habitat in Pendleton County, houses 83 percent of the population. Documentation in Fayette County is relatively new (Johnson et al. 2005), and provides the first example of this species using abandoned mines for roosts. In 2010, 12,059 hibernating Virginia big-eared bats were estimated to occur in West Virginia (USFS 2011).

Coordination with WVDNR indicates that although the species may use mines in counties adjacent to Fayette, the closest known records are in Randolph and Pendleton counties (Craig Stihler, pers. comm. February 2017). Autumn trapping surveys in Fayette County in 2002 and 2005 revealed eight occupied mine portals between 28.3 kilometers (14.2 mi) and 30.5 kilometers (18.9 mi) from the Project Area (Barb Sargent, pers. comm February 2017) (Gates and Johnson 2006a).

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 (USFWS 2008b).

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 (4.1.2.4.1 and 4.2.2.3.1). Subsequent harp trap survey efforts of suitable portals did not yield any Virginia big-eared bat captures.

4.5 Roanoke Logperch

The Roanoke logperch is a relatively large darter within the genus and subgenus, *Percina*. Members of the subgenus *Percina* are referred to as "logperches" and are known for their distinctive behavior of overturning substrates during foraging (Jenkins and Burkhead 1994). The Roanoke logperch has a long, conical snout, inferior mouth, and a moderate to robust body form (Rosenberger 2007) and grows to an adult length of approximately 15 centimeters (6 in) (Page and Burr 1991). Its dorsal is dark green; its sides are greenish to yellowish, both with dark, blotched markings; and the ventral side is white to yellowish (USFWS 2003). Fins are patterned with dark pigment and the caudal fin is emarginate or truncate (Jenkins and Burkhead 1994).

The Roanoke logperch is a benthic, riverine species that uses all available lotic (i.e., 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 categorized as benthic invertivores (McCormick et al. 2001) and predominantly feed diurnally. The species actively feeds during the warmer months by using its elongated snout to flip over stones and then eating the exposed prey, usually bottom-dwelling insects (USFWS 2003).

Based on the life history of the species, populations vary dynamically across years and are speculatively largest following the spawning season in April through July.
Juvenile logperch are likely to use pool and run habitats and backwater areas adjacent to riffle habitats and exhibit interspecific shoaling behaviors (Burkhead 1983, Jenkins and Burkhead 1994). Adults predominantly occupy riffle and run habitats over coarse substrates (Burkhead 1983).

4.5.1 Activity Patterns

Two forms of movements have been documented for Roanoke logperch at variant spatial scales; small-scale, site-fidelity movements and large-scale migration movements (Roberts et al. 2008). All available meso-habitats in the Roanoke River drainage are potentially utilized at some point during the life stages of the Roanoke logperch. Adults use riffle and run mesohabitats whereas young-of-the-year (YOY) have been observed in various mesohabitats but typically occupy pool habitats along stream margins and areas immediately upstream of riffles. YOY occupy shallower waters over smaller substrates (i.e., small gravel, sand, silt) and areas of reduced water velocities along the stream margins. YOY are likely more prone to predation and therefore seek shelter in shallower waters to minimize predation.

During warmer months, adult logperch are typically found in deep (>30 cm or 11.8 in), high velocity riffle and run habitats over coarse substrates (often preferring cobble) with little (<25% coverage) to no silt coverage (Ensign et al. 2000). YOY have been observed in slow runs and pools, where they are frequently observed over clean sand bottoms (Ensign et al. 2000). YOY logperch are also found in low-velocity habitat adjacent to riffle-run complexes, but are typically not observed in the thalweg (i.e., deepest, natural direction of watercourse in a stream). Instead, small individuals are found in shallow backwaters and river edges feeding over small patches of loosely embedded, silt-free gravel substrate. Subadults are found in habitats of intermediate depth and with lower velocities than those occupied by adults.

In winter months, when water temperatures are less than 8 degrees Celsius, individuals become ‘quiescent’ (i.e., not active) and typically seek refuge in mesohabitats with reduced water velocities such as runs and pools. The species can be found seeking shelter in interstitial spaces between and under rocks (Burkhead 1983). As waters warm in the spring months, adults move to swifter currents and segregate by sexes. Females can be found 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, USFWS 2003).

4.5.2 Site-specific Data

Roanoke logperch are endemic to the upper Roanoke, upper Dan, and Nottoway river drainages of Virginia and North Carolina (Figure 14). The population structure of the species is divided into several small, genetically disparate populations that are separated by dams or large segments of river presumed to be unsuitable for the species (USFWS 2003, Roberts et al. 2013). In addition to the known populations, suitable habitat locations have been identified in the Blackwater, Dan, Falling, Mayo, and Meherrin river drainages (USFWS 2007a); however, no individuals have been observed in these systems.

The Project will traverse both the upper Roanoke River and the Pigg River (a tributary of the Roanoke) watersheds, and each of these watersheds contain a distinct population of Roanoke logperch (Roberts et al. 2013). In order to assess the potential occurrence of the species in waterbodies within these watersheds, historic and recent fish collections were reviewed and supplemented with Project specific field observations.

The Project will traverse 38 stream crossings within the Roanoke River basin that were identified via desktop analyses that are either known or have potential (i.e., within the Roanoke River basin) to support populations of Roanoke logperch (Table 13). During initial Project correspondence, USFWS recommended assumed species presence at any stream crossing location of the North Fork Roanoke River (i.e., three Project crossings), Roanoke River (one crossing), and Pigg River (one crossing). These are the only streams with confirmed occupancy within the Project area.

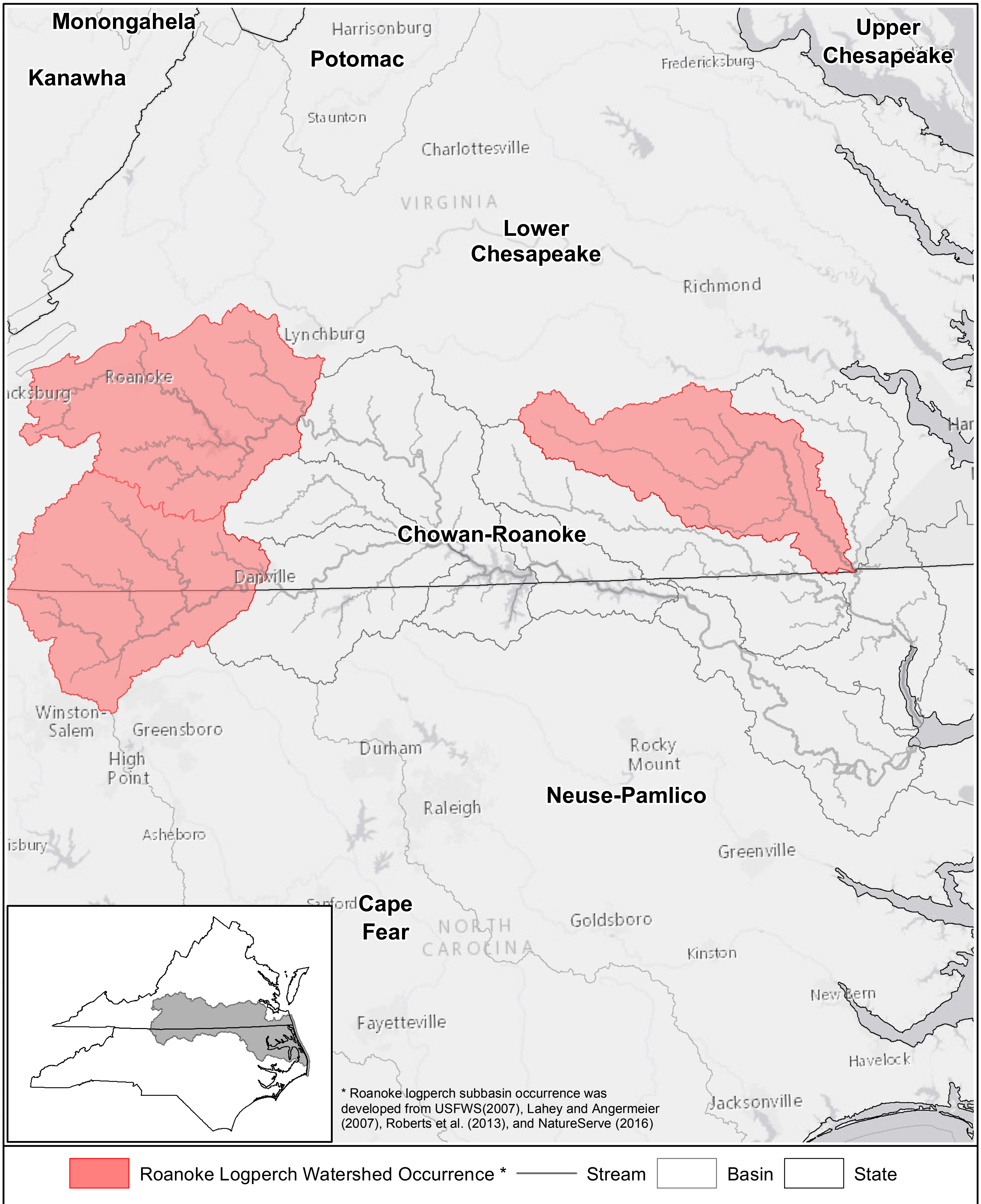

Figure 14. Potential watershed occurrence of Roanoke logperch (*Percina rex*).

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Table 13. 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[1]	Mile Post	Crossing Type[2]	HA Completed[3]	Strahler Stream Order[4]	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[4]
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[5]	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[6]	242.4	Pipeline	No	1	2.8	No
Roanoke	Mill Creek2[6]	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 UNT2 North Fork Blackwater River	251.0	Pipeline	Yes	1	2.1	No
Franklin	UNT3 UNT2 North Fork Blackwater River	251.9	Pipeline	Yes	1	1.8	No
Franklin	UNT to UNT to Little Creek	256.4	Pipeline	Yes	2	0.971	No
Franklin	Teels Creek 0.1	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
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

[1] UNT = Unnamed tributary
[2] AR = suppporting access road
[3] HA = Roanoke Logperch Habitat Assessment; AP = Assumed presence of Roanoke logperch.
[4] Strahler stream order was calculated using the 1:100,000 National Hydrography Dataset.
[5] Access road crosses existing, paved bridge (Reese Mountain Road). No instream impacts are anticipated.
[6] Desktop analysis only completed; geologic features located downstream prevent species occurrence

Because presence is assumed, neither Roanoke logperch habitat assessments nor fish surveys were performed for these five crossings (Table 13).

Field habitat assessments were proposed for the remaining 33 stream crossing locations to determine the presence of potentially suitable logperch habitat. In 2015, habitat assessments were completed at 23 of these stream crossings. (Additional assessments were completed; however, route modifications have eliminated stream crossings and are not discussed in this document). In 2016, ten stream crossings were assessed or eliminated through agency correspondence. Of the 38 stream crossings identified via desktop analyses along the current proposed route: 1) 24 were determined not to contain suitable habitat for Roanoke logperch, 2) nine exhibited potentially suitable habitat that could support the species, and 3) five streams have previously documented presence of Roanoke logperch. The 14 streams with suitable habitat or previously documented presence include two proposed access road crossings over the North Fork Roanoke River (i.e., North Fork Roanoke River AR1 and North Fork Roanoke River AR2). North Fork Roanoke River AR1 (MN-268.01) occurs at an existing, private, access road traversing the River via a ford crossing. MVP will make upgrades to the access road, and the stream crossing will be improved by installing a temporary, pre-constructed, portable (i.e. bailey bridge) single-span bridge, thereby minimizing instream activities at the crossing location. The other access road traversing North Fork Roanoke River (i.e., AR2, MN-276.03) is an existing, paved bridge that completely spans across the river (Reese Mountain Road). No instream disturbance activities are anticipated at this location. 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. Project-related presence/absence fish surveys have not been performed at any stream crossing.

4.5.2.1 Habitat

In 2015, the potential for suitable Roanoke logperch habitat was assessed at 23 stream crossings. Based on field observations and correspondence with USFWS (letter dated March 8, 2016), suitable Roanoke logperch habitat occurs at five stream crossings including Bradshaw Creek1, North Fork Blackwater River, Maggodee Creek1, Blackwater River3, and Harpen Creek1. (Correspondence with agencies involve stream crossings that have been eliminated because of route modifications and are not included in this biological assessment [e.g., Blackwater River2]). Unsuitable habitats occur at the remaining 18 locations.

In 2016, the potential for suitable Roanoke logperch habitat was assessed at ten proposed stream crossings. Based on Project correspondence with USFWS (March 16, 2016) and VDGIF (March 11, 2016), two crossings were eliminated based on desktop analysis because of a natural geological feature prohibiting colonization of habitats. Four stream crossings exhibited suitable Roanoke logperch habitat including Bradshaw Creek AR (MN-276), Teels Creek4, Little Creek1.5, and Little

Creek2. The remaining 4 stream crossings exhibited unsuitable habitats for Roanoke logperch.

Based on habitat assessments in 2015 and 2016, suitable habitat for Roanoke logperch is present at nine locations in addition to the five localities identified during Project correspondence with USFWS (April 3, 2015). Roanoke logperch occurrence records have not been documented in any of the nine aforementioned stream locations. Although some of these stream reaches are relatively small, because of their respective proximity to known, occupied streams (e.g., Bradshaw Creek adjacent North Fork Roanoke River, Harpen Creek1 adjacent to Pigg River), it is possible that Roanoke logperch may use the stream during specific times of the year.

Past survey efforts have occurred within the Blackwater River drainage; however, no individuals of Roanoke logperch have been encountered within the Blackwater drainage, which includes North Fork Blackwater River, Maggodee, Teels, and Little creeks (Burkhead 1983). Because of the presence of suitable habitat and waterbodies large enough to support populations of Roanoke logperch, Roanoke logperch are assumed present within stream segments deemed suitable within the drainage.

In summary, occurrence of Roanoke logperch is known at the crossings of North Fork Roanoke River (i.e., ROW and two access roads), Roanoke River, and Pigg River. Suitable habitat also occurs in sections of Bradshaw Creek (i.e., ROW and access road), 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).

4.5.2.2 Occurrence and Abundance

Roanoke logperch are endemic to the Roanoke-Chowan River Basin. The Project will traverse four major drainages in the 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 Roanoke logperch. Thus, waterbodies within the Blackwater River drainage that exhibit potentially suitable habitats are included in the impact analysis within this document.

Site Occupancy Modeling. Estimates of abundance 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 (range=181-488 m). 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.

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 was used; namely, N-mixture modeling (Royle 2004). Although fully detailed in Appendix C, in short, this approach was adopted to estimate abundance of Roanoke logperch while accounting for imperfect capture of the species. More specifically, biologically relevant hypotheses regarding abundance are tested using a regression based approach. Similar to the approach taken by Roberts (2012), a fixed capture probability of 0.1 (10%) was assumed (Roberts and Anderson 2013), and using the N-mixture model, abundance was modeled to vary by the USGS watershed level hydrologic units and by the catchment area upstream of each stream segment within the watershed. Note that abundance in areas of assumed occupancy was 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., Blackwater River drainage). Thus, 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. Note that the output of this model based approach was abundance within a suitable patch; thus, estimates were adjusted to derive fish densities (e.g., fish / km) by multiplying abundance times the patch density estimates derived in Roberts (2012).

In order to model abundance, fish collections within the upper Roanoke drainage were compiled, 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 (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. These samples were 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. Similar to the estimates of Roberts (2012), these estimates are largely based on Age-1+ captures from electrofishing surveys and do not include YOY, which do not get recruited into the same habitats until Age 1.

Using the above described approach, estimated densities within the five streams where the USFWS suggested assumed presence are:

- 60.19 fish / km for both North Fork Roanoke1 and North Fork Roanoke River AR1,
- 174.38 fish / km for North Fork Roanoke River AR2,
- 423.05 fish / km for Roanoke River, and
- 256.47 fish / km for Pigg River.

Note that in addition to these estimates, densities are derived for all waterbodies potentially impacted by the Project that are occupied or presumed occupied by Roanoke logperch. Estimated densities vary by both catchment area and the different USGS watershed level hydrologic units. Density estimates range from 4.02 fish per kilometer (2.5 per mi) within Jonnikin Creek of the Lower Pigg River Watershed to 442.4 fish per kilometer (274.89 per mi) within Roanoke River within the Mason Creek-Roanoke River Watershed.

Young-of-Year Estimates. To get an estimate of the number of YOY logperch within occupied and potentially occupied reaches, information on population growth rates of the species was compiled from the literature. Traditional approaches for estimating YOY population sizes require vital life-history attributes of the species (e.g., egg fecundity, hatching success, natural mortality, etc.), which are unknown for Roanoke logperch. Therefore, YOY estimates cannot be made using these approaches. Alternatively, using population growth rates to estimate YOY population sizes, while potentially biased, 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, information from the aforementioned Age-1+ estimate and an estimated maximum population growth rate (λ) estimate of 1.7205 from Roberts et al. (2016) was used. In this approach, the density of YOY is calculated as:

$$D_{YOY} = D_{Adult} \times (\lambda - 1), \quad \text{Eq. 1}$$

where D_{YOY} is the estimated YOY density and D_{Adult} is the estimated Age-1+ population density.

Based on the data presented, the YOY density estimates for the five stream localities where the USFWS suggested assumed presence are:

- 43.37 fish / km for both North Fork Roanoke1 and North Fork Roanoke River AR1,
- 125.64 fish / km for North Fork Roanoke River AR2,
- 304.81 fish / km for Roanoke River, and
- 184.79 fish / km for Pigg River.

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. 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 2.9 YOY per kilometer (1.8 per mile) within Jonnikin Creek of the Lower Pigg River Watershed to 318.75 YOY per kilometer (198.06 per mile) within Roanoke River within the Mason Creek-Roanoke River Watershed.

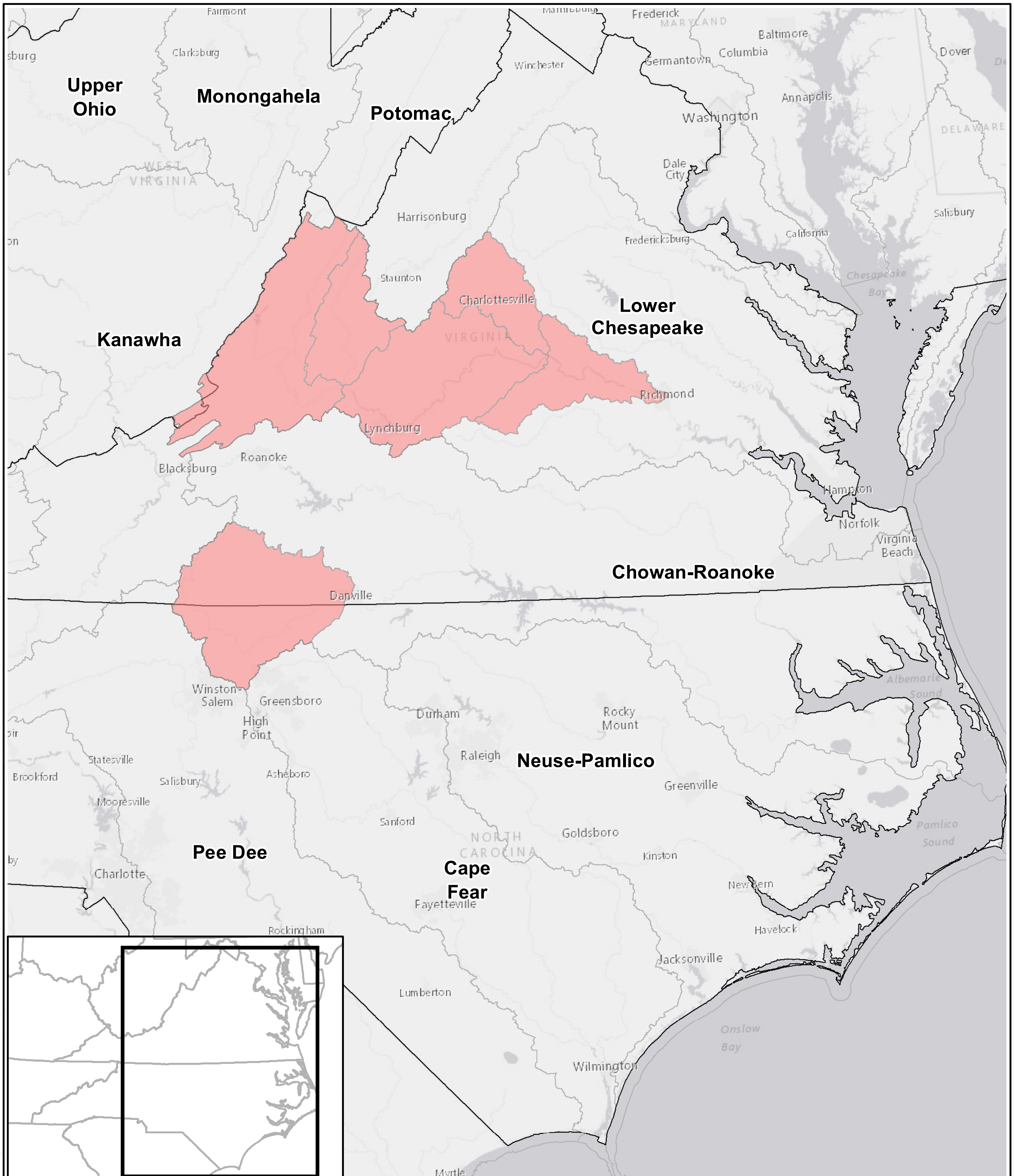
4.6 James Spinymussel

James spinymussel is a small freshwater mussel (relative to other spinymussels) with a shell averaging approximately 5.1 centimeters (2 in) in length and a maximum length typically not exceeding 7.6 centimeters (3.0 in). The shell is solid and subrhomboid, with three short spines on each valve, that are most conspicuous in young specimens. The presence of spines is more likely to be absent than present. Periostracum is shiny and straw-colored with widely spaced concentric striations. Internally, this species has medium sized lateral teeth and the nacre is whitish sometimes with pink or bluish suffusions (USFWS 1990).

4.6.1 Activity Patterns

The USFWS listed James spinymussel as endangered on July 22, 1988 across its entire range. James spinymussel is endemic to the James River drainage (Figure 15) and is known to occur in more than 20 waterbodies including (but not limited to) Craig Creek and tributaries (e.g., Johns, Dicks, and Little Oregon creeks in Craig and Botetourt counties, Virginia) (Terwilliger 1991, Petty and Neves 2005). The Project proposes to traverse Craig Creek once in Montgomery County, Virginia.

James spinymussel is considered a sedentary species and its spatial (i.e., horizontal and vertical) and temporal (i.e., diurnal and seasonal) benthic movements are



James Spinymussel Watershed Occurrence | State | Hydrologic Subregion

N W E S

Figure 15. Potential watershed occurrence of James spinymussel (*Pleurobema collina*).

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Path: G:\Current\593_EQT_MVP\MXD\Biological_Assessment\BA_Figures\Revision_20170221\Figure15_James_SpinyMussel_Watersheds.mxd (ganderson) - 3/9/2017 unknown. Inferences regarding general activity patterns can be drawn from studies completed on a sympatric species, eastern elliptio (*Elliptio complanata*) (Amyot and Downing 1997) and may pertain to tachytictic mussels.James spinymussel is tachytictic, or a short-term brooder. Spawning occurs during spring months when males broadcast sperm into the water column and females siphon in for egg fertilization. Females brood eggs until glochidial release in early June and late July and glochidia release peaks after mean daily water temperatures reach 23 degrees Celsius (USFWS 1990, Hove and Neves 1994).

Mussel behaviors (e.g., siphoning, reproductive displaying) have been documented to change in response to high levels of suspended solids (Aldridge et al. 1987, Corey et al. 2006a; b). During periods for elevated turbidity, mussels continue to actively filter and exhibit reproductive displays. Mussel displays have been documented to decrease in the frequency and duration or ceased altogether (Corey et al. 2006a; b). The effectiveness of mussel displays may be reduced due to the limited visibility of host organisms. In addition, turbid water conditions have been documented to reduce feeding rates and efficiency as well as alter physiological energetics in the form of reduced oxygen uptake and increased nitrogenous excretions (Aldridge et al. 1987). Prolonged periods of elevated suspended solids should be minimized or avoided, particularly in species known to occur in clear streams.

One of the largest biological threats to the species is the potential invasion of the invasive Asiatic clam (*Corbicula fluminea*). Other threats to the species include reduced water quality conditions as a result of sewage treatment plant releases, closures of dams altering downstream habitats, hypolimnetic discharges causing reduced water temperatures, and augmented sedimentation rates from agriculture and forestry practices (USFWS 1990).

4.6.2 Site-specific Data

The Project will traverse one stream known to support populations of James spinymussel; Craig Creek. James spinymussel is known to occur within Craig Creek in Botetourt and Craig counties, Virginia; downstream of the proposed Project crossings. The Project traverses the upper portion of Craig Creek in Montgomery County, Virginia. No occurrence of James spinymussel in Montgomery County has been documented.

At the time of mussel surveys in 2015, the proposed Project route traversed the mainstem of Craig Creek four times within approximately 800 meters (2,624 ft) of stream reach. Three crossings were proposed for the installation of the pipeline, and the remaining 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. Thus the Project now includes a single pipeline crossing of Craig Creek and a temporary access road crossing that will span the creek.

4.6.2.1 Occurrence

A mussel survey was completed on October 20, 2015 which encompassed 1.37 kilometers (0.85 mi) downstream and 0.23 kilometer (0.14 mi) upstream of the pipeline crossing. The survey yielded no sign of James spinymussel nor any other freshwater mussel species within the 1.5-kilometer (0.9-mi) length of survey extent.

The nearest known occurrence of James spinymussel in Craig Creek is approximately 25.4 stream kilometers (15.8 mi) downstream of the proposed pipeline crossing and 24.1 stream kilometers (15.0 mi) downstream of the Action Area. The known occurrence record is a single live individual collected in March 1987 in the vicinity of Trout Creek confluence. Known occurrences and abundances of James spinymussel increase from the confluence with Trout Creek downstream beyond the mouth of Johns Creek. Based on previous mussel survey records (VDGIF WERMS Database http://www.dgif.virginia.gov/gis/werms.asp, Accessed January 24, 2017), mussels in Craig Creek are under-surveyed, especially in Montgomery County. Numerous surveys were completed in Craig Creek in Montgomery County (mostly in the 1980’s and 1990’s) and all have yielded no live individuals or records of deadshell. The nearest known mussel occurrence includes non-listed species (e.g., *Villosa constricta*, *Strophitus undulatus*, *Elliptio complanata*) was in 1991 in Craig County and approximately 20.3 stream kilometers (12.6 miles) downstream of the Project crossing.

4.6.2.2 Habitat

Mussel habitat was evaluated during a mussel survey completed along 1.5 kilometers (0.9 mi) of stream reach and encompassed all four originally-proposed crossings (including applicable full survey buffers) and the Action Area in Craig Creek. Craig Creek is characterized as a small perennial, headwater stream with an average bankfull width ranging from 8 to 25 meters (26 - 82 ft) and wetted width ranging from 1 to 8 meters (3 - 26 ft) at the time of assessment. It is a moderately low gradient stream and substrates are a heterogeneous mix composed of 15 percent cobble, 25 percent gravel, 5 percent sand, and 55 percent bedrock. The majority of the stream bottom consists of underlying or uplifted bedrock. Coarse substrates are present on top of or in the seams of bedrock, but overall the stream provides impervious substrates and, consequently, limited habitat availability or potential for colonization of mussels.

Overall stream morphology is characterized as 60 percent riffle, 25 percent run, and 15 percent pool habitats. Average and maximum depths measure 15 centimeters (5.9 in) and 150 centimeters (59.1 in), respectively. Maximum depth occurs just upstream of a massive logjam that has created a dam. Two white pine trees have fallen across the stream and subsequent collection of foliage and woody debris have dammed the stream. The dam is approximately 1.2 meters (3.9 ft) tall and creates a pool habitat along 210 meters (689 ft) of stream reach. The stream exhibits little to no embeddedness or siltation; however, a very fine layer of detrital material is present on all substrates, particularly in areas of reduced water velocities. Because the species is a habitat generalist, although habitat within the Project Area is far from ideal, it is potentially suitable.

4.7 Clubshell

Clubshell (*Pleurobema clava*) is a small to medium-sized mussel averaging 2.5 to 3.8 centimeters (1 to 1.5 in) and a maximum length of nearly 7.6 centimeters (3 in) (USFWS 1994, Watters et al. 2009). The shell is rather thick, elongate, triangular, moderately inflated, and straw-yellow or light brown with distinct green rays. The rays may be thick blotches or thin lines, which may be obsolete on old individuals and are usually interrupted at growth lines (USFWS 1994, Watters et al. 2009). Specimens from large rivers typically have prominent umbos, often projecting past the anterior margin (Watters et al. 2009).

4.7.1 Activity Patterns

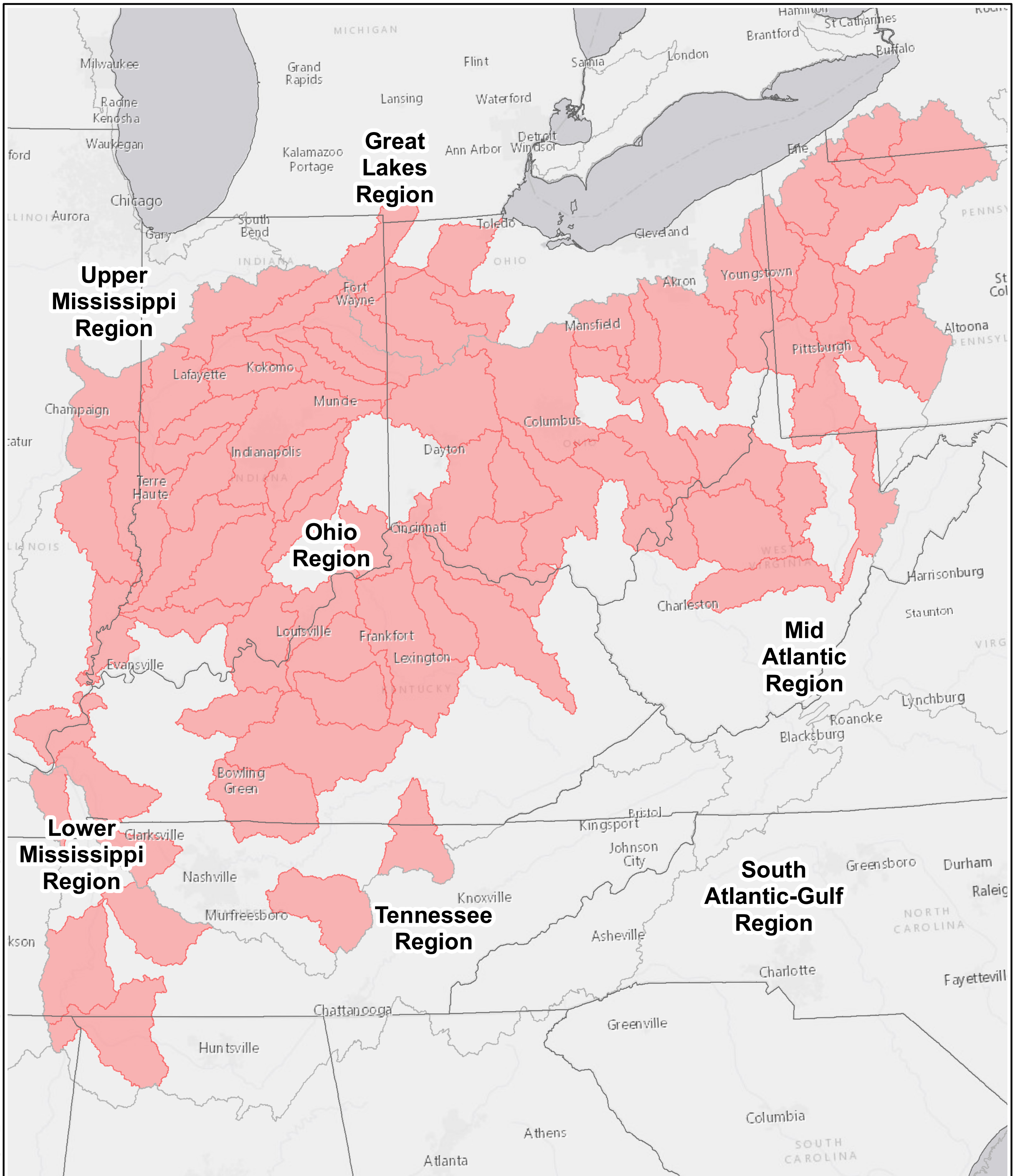
The USFWS listed clubshell as endangered across its entire range on January 22, 1993. The clubshell historically was widespread in the Ohio River basin and tributaries of western Lake Erie and is believed to occur in nine states (USFWS 1993a) (Figure 16).

Clubshell is found in clean, coarse sand and gravel runs where it may live several inches beneath the substrate. It is most common in downstream ends of riffles and islands. Adults caught and released will burrow out of sight within 24 hours (Watters et al. 2009). The species cannot tolerate mud or slackwater conditions, and is susceptible to siltation (USFWS 1994).

Clubshell reproduction requires an undisturbed habitat and a large population of hosts to complete larval development. Males discharge sperm into streams where it flows downstream to females, which siphon sperm to fertilize eggs. Females store eggs in their gill pouches until larvae hatch. Clubshell is tachytictic, or short-term brooder (USFWS 1994). Eggs appear in May, and glochidia develop in June and July (Watters et al. 2009).

4.7.2 Occurrence

Clubshell were historically widespread in the Ohio River drainage including many streams in West Virginia, but are not known from Virginia. Potentially suitable habitats for clubshell may occur in select watersheds traversed by the Project in West Virginia. The Project intersects three watersheds with potential to support populations



Clubshell Watershed Occurrence | State | Hydrologic Region

Figure 16. Potential watershed occurrence of clubshell (*Pleurobema clava*).

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Path: G:\Current\593_EQT_MVP\MXD\Biological_Assessment\BA_Figures\Revision_20170221\Figure16_Clubshell_Watersheds.mxd (ganderson) - 3/9/2017 of clubshell: Elk River, Little Kanawha River, and Leading Creek. Clubshell were not encountered on this Project during mussel surveys. Neither clubshell individuals nor occupied habitats were documented in the Project area during any mussel survey efforts.

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 615.1-hectare (1,520-ac) reservoir on the Elk River. The proposed Project crossing occurs in Webster County, upstream of Sutton Lake and Braxton and Clay counties. The WVMSP (Clayton et al. 2015) designates the Elk River as a Group 1 stream in Webster County, indicating freshwater mussels are likely present, but federally listed mussels (e.g., clubshell) are not known. A known population of clubshell occurs in the Elk River between Sutton Lake Dam and Sycamore Creek in Braxton and Clay counties, West Virginia (USFWS 1993a). Sutton Lake Dam is approximately 30.5 stream kilometers (19 mi) downstream of the Project crossing. Clubshell 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. Surveys were completed in accordance with corridor disturbances at a Group 1 stream as outlined in the WVMSP. No evidence of federally endangered mussels was encountered at the Elk River crossing.

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 crossing is 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 (Clayton et al. 2015) 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 395.8-hectare [978-ac] 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 22.5, 24.5, and 25.6 stream kilometers (14.0, 15.2, and 15.9 mi), respectively, upstream of the reservoir and thus isolated from the historic population. Clubshell populations have been extirpated from areas upstream of the reservoir. Phase I mussel surveys were completed at all three proposed Project crossings, and no evidence of federally endangered mussels was encountered at the Little Kanawha River crossings.

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 (Clayton et al. 2015) in stream sections where the upland drainage area is greater than 26 square kilometers (10 mi^2). A mussel survey was not performed at this Project crossing of Leading Creek because the stream at the point of crossing, drains less than 26 square kilometers (10 mi^2). The nearest known population of clubshell in Leading Creek is inferred based on WVMSP's list of streams in Appendix A (Clayton et al. 2015). Fink Creek is a relatively large tributary that empties into Leading Creek in Gilmer County and is listed as a Group 1, 2 (½) stream. This indicates that the downstream-most one half-mile of Fink Creek (from 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, [redacted] Populations of clubshell are not likely to occur in stream reaches with less than 26 square kilometers (10 mi^2) of upstream drainage area because of the lack of sufficient resources to support a population. The 26-square kilometer (10-mi^2) threshold 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 occurs beyond the limits of the Action Area.

4.8 Snuffbox

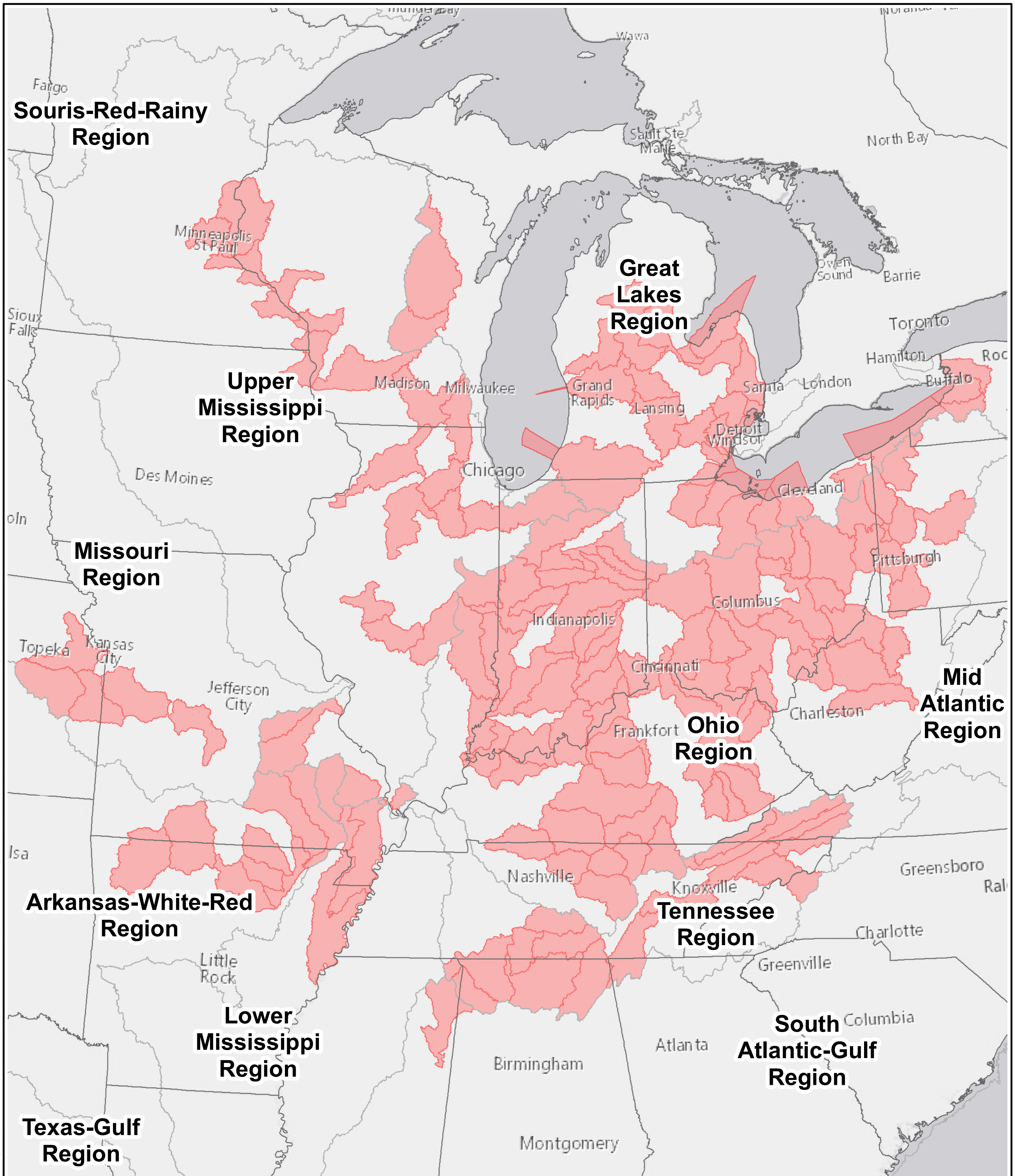
Snuffbox (*Epioblasma triquetra*) is a medium-sized freshwater mussel averaging 6.4 centimeters (2.5 in), with a maximum length of 7 centimeters (2.76 in). Females are generally smaller than males, only reaching about 4.3 centimeters (1.7 in). The shells are thick and inflated. Beaks are located in the middle of the shell and turn inward over a distinct lunule (i.e., hinge cover). The left valve has two pseudocardinal teeth where the front tooth is smaller than the large triangular inner tooth (Parmalee and Bogan 1998). The posterior ridge is well defined, and the posterior slope is steep and flat, adorned with radial striations (Williams et al. 2008). Periostracum of the shell is usually pale/greenish yellow with patterns of dark green areas and broken radiating rays composed of dots and dashes (Parmalee and Bogan 1998).

4.8.1 Activity Patterns

Snuffbox typically occur in shoal habitat with stable sand and cobble substrates. Habitat encompasses small to medium-sized streams with swift moving water, although populations have been recorded in Lake Erie and larger rivers. Snuffbox often are buried completely beneath substrate and collected in riffles 5 centimeters (2 in) to 61 centimeters (24 in) deep (Watters et al. 2009). Snuffbox remains 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.

4.8.2 Site-specific Data

Snuffbox were historically widespread in the Ohio River drainage including many streams in West Virginia (Figure 17). Potentially suitable habitats for snuffbox may occur in select watersheds traversed by the Project in West Virginia. The Project



Snuffbox Watershed Occurrence | State | Hydrologic Region

N W E S

Figure 17. Potential watershed occurrence of snuffbox (*Epioblasma triquetra*).

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intersects three watersheds with potential to support populations of snuffbox: Elk River, Little Kanawha River, and Leading Creek. Snuffbox were not encountered on this Project during mussel surveys. Neither snuffbox individuals nor occupied habitats were documented in the Project Area.

Elk River. A known population of snuffbox occurs downstream of Sutton Lake, a 615.1-hectare (1,520-ac) reservoir on the Elk River in Braxton and Clay counties, West Virginia. The proposed Project crossing occurs upstream of Sutton Lake in Webster County. The WVMSP (Clayton et al. 2015) designates the Elk River as a Group 1 stream in Webster County, indicating freshwater mussels are likely present but federally listed mussels (i.e., snuffbox) are not known. A known population of snuffbox occurs in the Elk River between Sutton Lake Dam and Sycamore Creek in Braxton and Clay counties, West Virginia (USFWS 1993a). Sutton Lake Dam is approximately 30.5 stream kilometers (19 mi) 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.

Little Kanawha River. Little Kanawha River provides suitable habitat for the snuffbox, and historically contained a snuffbox population. The Project crossing is 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 (Clayton et al. 2015) designates the Little Kanawha River as a Group 2 stream in Braxton County, indicating freshwater mussels including federally-listed mussels (i.e., snuffbox) are expected to occur. However, installation of Burnsville Lake (a 395.8-hectare [978-ac] reservoir) may have isolated populations of snuffbox in the Little Kanawha River and extirpated upstream populations. Three proposed crossings of the Little Kanawha River are anticipated approximately 22.5, 24.5, and 25.6 stream kilometers (14.0, 15.2, and 15.9 mi), respectively, upstream of the reservoir and thus 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.

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 (i.e., snuffbox), may occur (Clayton et al. 2015) in stream sections where the upland drainage area is greater than 26 square kilometers (10 mi^2). A mussel survey was not performed at this Project crossing because the stream at the point of crossing, drains less than 26 square kilometers (10 mi^2). The nearest known population of snuffbox in Leading Creek is inferred based on WVMSP's list of streams in Appendix A (Clayton et al. 2015). Fink Creek is a relatively large tributary that empties into Leading Creek in Gilmer County and is listed as a Group 1, 2 (½) 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, it is assumed 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 26 square kilometers (10 mi^2) of upstream drainage area because of the lack of sufficient resources to support the species. The 26 square kilometers (10 mi^2) threshold occurs at the confluence of Leading Creek and Alum Fork. The Action Area in Leading Creek extends 5.54 kilometers (3.44 mi) downstream of the Project crossing (and upstream of the confluence of Alum Fork). Therefore any potential snuffbox populations occur beyond the limits of the Action Area.

4.9 Rusty Patched Bumble Bee

Rusty patched bumble bees (*Bombus affinis*) are morphologically similar to other bumble bees with large, round bodies and contrasting black and light (usually yellow) hairs. By comparison, rusty patched bumble bees are considered one of the larger bumble bee species. These social bees form colonies that include several distinct castes (i.e., bees with different roles based on gender and reproductive ability) composed of a queen, males, and workers. Colonies begin as a single queen and increase in size during the year, in some cases comprising more than 1,000 individuals by autumn. Members of each caste are morphologically distinct (Mitchell 1962, Williams et al. 2014).

- A queen represents the singular reproductive female within a colony and all other colony members are her offspring. A queen is the largest member among the castes, measuring 0. 19-23 millimeters (0.75-0.92 in) long and 9.5-11 millimeters (0.37-0.42 in) in width. Black hairs occur on the face and head of the queen, as well as on lower portions of the thorax (i.e., the middle body segment of an insect), middle of the upper portion (scutum) of the thorax, legs, and the rear-most portions of the abdomen. Contrasting, yellow hairs cover the rest of the thorax as well as the first two segments of the abdomen. Unlike most of her offspring, the queen does not have the rusty patch.
- Males are intermediate in size with a typical length of 13-17.5 millimeters (0.51-0.69 in) and width of 5-7 millimeters (0.20-0.28 in). The rusty patch, for which the species is named, is an area of darker, rusty-colored hair on the abdomen that contrasts with the brighter yellow hairs. Males are produced in late summer/early fall and solely serve for purposes of mating.
- Workers vary in size with lengths of 0. 9-16 millimeters (0.37-0.64 in) and widths of 5-9 millimeters (0.28-0.35 in). The first workers hatched each year are large, whereas later broods tend to become

progressively smaller, depending on floral resource availability. Like males, workers also typically have the rusty patch. The uppermost portion of the thorax often has a small band of black hairs medially, in contrast to queens who exhibit only a spot of black hairs. Most individuals in a colony are in the worker caste.

All castes have a relatively short tongue (Laverty and Harder 1988) and malar space (i.e., area between eye and attachment of mandible). While the absence of a rusty patch is not a diagnostic identification feature, the combination of color patterns on the head and abdomen in combination with the short malar space distinguish this species from most co-occurring species throughout its range.

4.9.1 Activity Patterns

Rusty patched bumble bees have a complex life cycle comprising four components (Plath 1922, Macfarlane et al. 1994, Colla and Dumesh 2010) including; 1) spring emergence and colony formation, 2) worker foraging and colony growth, 3) late summer/fall gyne production, reproduction, and dispersal, and 4)winter diapause
These four annual components are described below and illustrated in Figure 18.

4.9.1.1 Spring Emergence and Colony Formation

Queens emerge from overwintering burrows in March to May (depending on weather conditions), and begin to search for a suitable nest. They forage at wildflowers for food for themselves and their offspring, the future workers within the colony.

4.9.1.2 Worker Foraging and Colony Growth

Once a few workers hatch, they begin to forage for food and become responsible for colony defense, and care of the young. The queen remains within the nest and continues to lay eggs. The workers are unmated females and hormones and dominance by the queen suppress reproductive potential of the workers. During this phase, access to sufficient floral resources is requisite to support continued growth of the colony.

The colony continues to grow throughout the summer until it has sufficient resources to produce males and unmated queens. Mature, autumn colonies of wild rusty patched bumble bees range in size from 100 – 1,000 individuals (Plath 1922, Macfarlane et al. 1994), but a single captive colony, containing 2,100 individuals (Macfarlane 1974) is the largest recorded colony for any North American species of bumble bee.

4.9.1.3 Late Summer/Fall Gyne Production, Reproduction, and Dispersal

In late summer/early fall (August-October), the colony begins to produce reproductive individuals (males and unmated queens called gynes). Gynes disperse to mate and find a suitable overwintering site, while the original founding queen, males, and workers die at the end of the season in September or October (Figure 18).Males

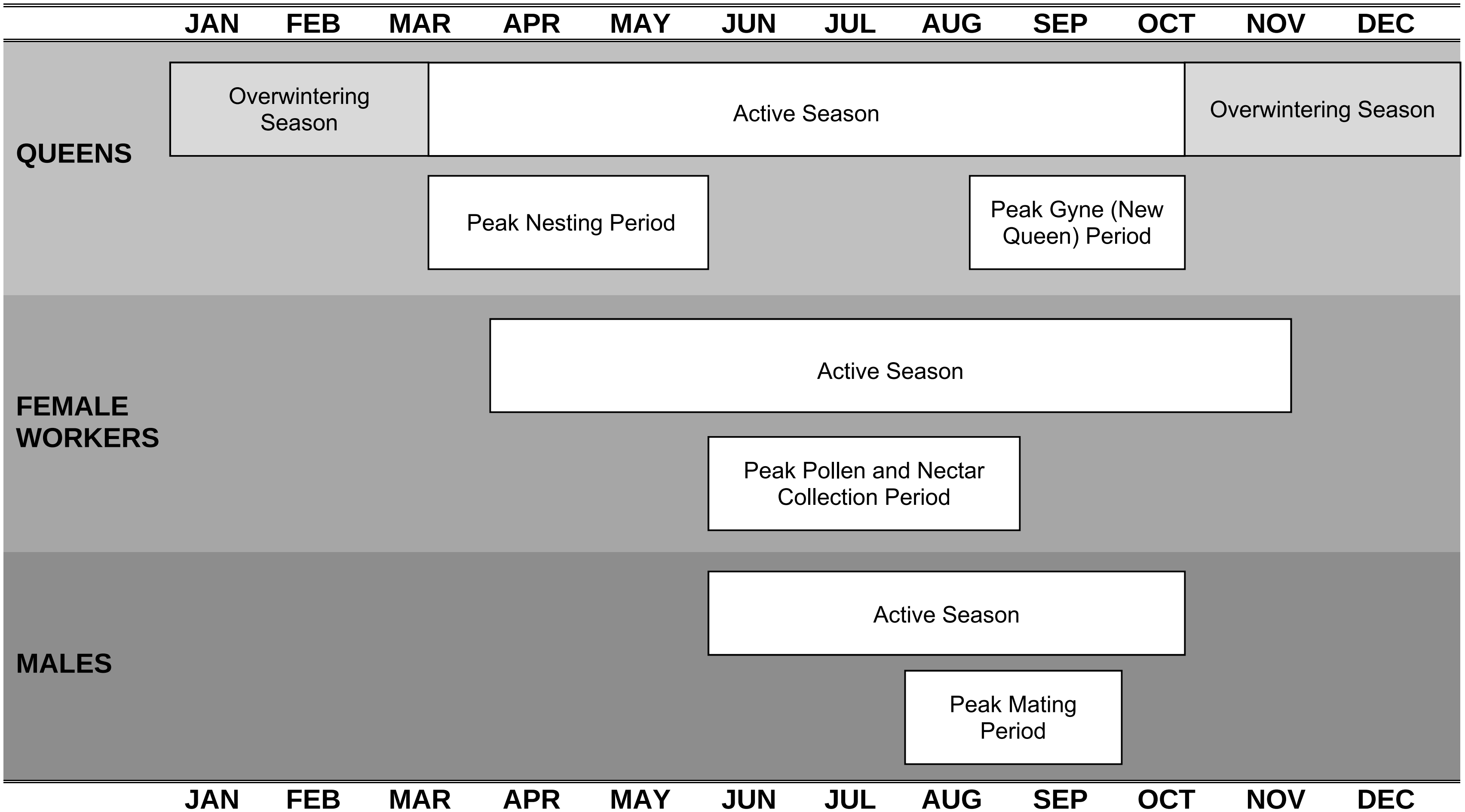

Figure 18. Seasonal chronology of rusty patched bumble bee.

produced in fall disperse to potentially mate and then die when temperatures and resources become too low in late September and October.

4.9.1.4 Winter Diapause

Once new queens find appropriate winter habitat (e.g., loose soil), they go into a diapause (hibernation). New queens emerge the following spring to start the cycle again (Figure 18).

4.9.2 Potential Causes of Decline

As noted above, rusty patched bumble bees were once abundant in the meadows and forests of the north-central U.S. The species has declined by more than 90 percent since 1990, and the reason for that decline is not well understood. It is likely the decline is attributable to multiple factors. In particular, the pathogens *Nosema bombi* and *Crithidia bombi* have been associated with rapid declines in other species of bumble bees (Goulson et al. 2008) and may have been introduced in captive colonies of bumble bees used in agriculture and greenhouses (Colla et al. 2006). These same imported bees also compete with native bees for limited food resources and may also harbor other diseases (Evans et al. 2008, Williams and Osborne 2009, COSEWIC 2010). Bees are also sensitive to nicotinoid and other insecticides (Tasei et al. 2000, Tasei et al. 2001, Scott-Dupree et al. 2009, Bernal et al. 2010), now widely used in agricultural systems. In addition to direct mortality, some researchers (Bortolotti et al. 2003, Decourtye et al. 2003, Morandin and Winston 2003, Franklin et al. 2004, Yang et al. 2008, Mommaerts et al. 2010) have suggested that sub-lethal exposures may cause other behavioral and physiological issues including reducing immune function (Alaux et al. 2010, Pettis et al. 2012).

All pollinators are reliant on nectar and pollen-producing plants for food. As such, declines in natural habitat, including a loss of floral diversity can substantially reduce local bee populations. Similarly, large-scale agriculture may produce crops that are outstanding producers of pollen and nectar, but clean farming techniques have removed much of the habitat requisite for nesting (Williams 1989, Evans et al. 2008, COSEWIC 2010).

There is also a clear bottleneck in the annual life cycle of this species. Each queen represents a potential colony, thus March to May and August to October, when queens are active, are among the most sensitive time periods. During these time periods, destruction of vegetation and excavation can disturb bumble bees, reduce available resources, disrupt nests or mating behaviors, and potentially kill individuals and colonies.

Finally, bees are extremely susceptible to extinction when population sizes become small (Zayed and Packer 2005). Bees have a haplodiploid genetic system where females are diploid and males are haploid. Females that are homozygous at the sex locus are functionally males and thus genetic diversity is crucial for maintaining populations. As the number of diploid males increases, this increases the rate at which the population declines (Zayed and Packer 2005, Hedrick et al. 2006).

4.9.3 Site-Specific Data

4.9.3.1 Occurrence

Prior to the 1990s, the rusty patched bumble bee was widely distributed across twenty-nine states: Connecticut, Delaware, District of Columbia, 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 two Canadian Provinces, Ontario and Quebec (USFWS 2017) (Figure 19). Since 2000, the rusty patched bumble bee has been reported from thirteen States and one Canadian Province: Illinois, Indiana, Iowa, Maine, Maryland, Massachusetts, Minnesota, North Carolina, Ontario, Ohio, Pennsylvania, Tennessee, Virginia, and Wisconsin (Figure 19).

Historical and extant records were gleaned from publicly available information and museum collections, databases and publications (Evans et al. 2008, USFWS 2017). These included the American Museum of Natural History, University of Kansas, Ohio State University, Smithsonian, Field Museum in Chicago, and Illinois Natural History Survey, Indiana State University, Global Biodiversity Information Facility (GBIF), discoverlife.org, and bumblebeewatch.org. Additional records were produced by overlaying county level state maps on the record map published in the federal register (Figure 20) (USFWS 2017).

Occurrence in Virginia. The USFWS final ruling published 11 January 2017 indicates records dating post-1999 are considered extant populations (USFWS 2017), which includes Faquier County. The extant record from Fauquier County, Virginia was collected in 2014 in Spring Meadows State Park. Repeated sampling of this site as well as seven nearby counties in Virginia and the northern Shenandoah Valley from 2014 to 2016 have revealed only negative surveys for rusty patched bumble bee (Thai Roulston, University of Virginia, Blandy Experimental Station, personal communication, December 2016).

In addition, historical records are noted for 17 counties and six cities in Virginia including Alleghany, Carroll, Chesterfield, Fairfax, Frederick, Giles, Grayson, Madison, Montgomery, Nelson, Northumberland, Prince William, Pulaski, Rappahannock, Rockbridge, and Wythe counties, and the cities of Arlington, Falls Church, Galax City, Radford City, Winchester, and Norfolk. Thus the Project crosses two counties with historic records in Virginia (Montgomery and Giles) (Figure 20). Based upon a query of available online museum records, 30 records of rusty patched bumble bee were found for these counties. Twenty-five records were found for Montgomery County ranging in dates from 5 April 1947 to 15 May 1997. Five records

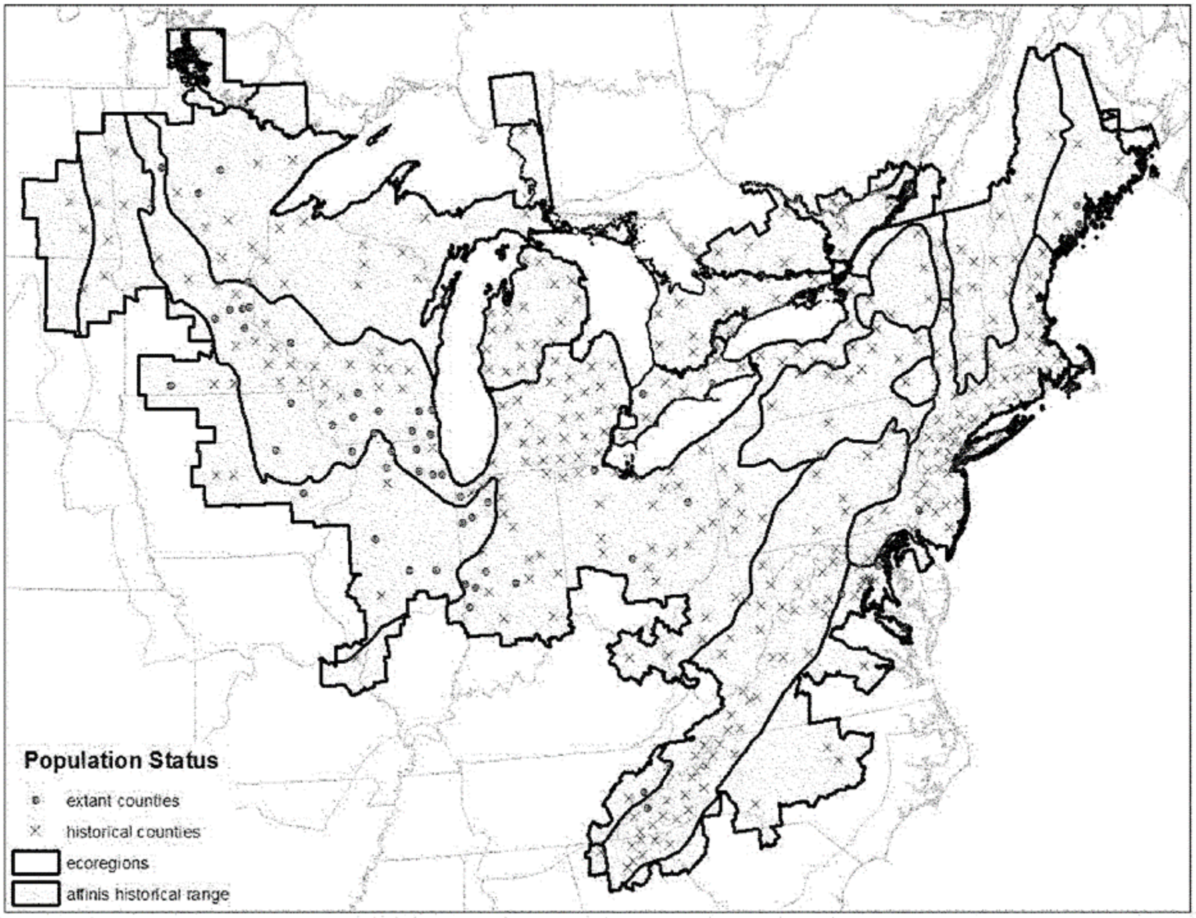

Figure 19. Map of range of rusty patched bumble bee throughout the United States and Canada. Figure adapted from USFWS (2017)

FIGURE 20
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were found for Giles County with the most recent collection from Mountain Lake University on 24 July 1987.

Occurrence in West Virginia. No extant populations of rusty patched bumble bee are known from West Virginia. Historic records for West Virginia gleaned from publicly available information, museum collections, databases and publications show 16 counties in West Virginia with historical records. These include: Braxton, Fayette, Hardy, Kanawha, Jefferson, Lewis, Monongalia, Nicholas, Pendleton, Pocahontas, Preston, Randolph, Roane, Tucker, Upshur and Wayne counties. The Monongalia County record is not shown on the federal map but the specimen is housed at the American Museum of Natural History. Dates of historic records in West Virginia range from 2 April to 10 October and years of capture range from 1921-1996. Thus potential impacts from the Project could occur in Braxton, Fayette, Lewis, and Nicholas counties because no recent surveys have been performed in these areas and the current status of rusty patched bumble bee is thus largely unknown in many areas of historical occurrence (Figure 20). [redacted]

4.9.3.2 Habitat

The rusty patched bumble bee is a habitat generalist and has been observed and documented in a variety of habitats including prairies, woodlands (especially open woodlands), marshes, meadows, old fields, agricultural landscapes, and residential parks (Colla and Packer 2008, Colla and Dumesh 2010). In early spring, emerging queens extensively use woodlands with abundant spring ephemeral wildflowers and potential nesting areas. Thus, rusty patched bumble bee is highly susceptible to disturbance as a successful colony requires three types of habitats (i.e., foraging, nesting, and wintering) in close proximity to one another (Colla and Packer 2008). Rusty patched bumble bees require habitat that supports sufficient food sources (nectar and pollen) from diverse and abundant flowers, undisturbed nesting sites near floral food sources, and overwintering sites for queens entering diapause.

4.9.3.2.1 Foraging Habitat

Rusty patched bumble bee is one of the first bumble bee species to emerge in the early spring (March – May) and one of the last species to go into diapause in September or October. Due to this long active period in temperate ecosystems, the rusty patched bumble bee is considered a generalist forager. Thus to meet its nutritional needs, the rusty patched bumble bee requires a constant and diverse supply of blooming flowers across the entire flight season. Basically any area with flowers is potential foraging habitat for this species. Forbs, spring ephemerals and flowering shrubs are among the most important foraging habitat for rusty patched bumble bee, but several species of flowering trees such as willows, redbuds, serviceberry, haws, hawthorns, and locusts may also provide excellent forage when few other species are available.

Floral collection records include at least 136 plant species (Evans et al. 2008, Jean 2010, Environment and Climate Change Canada 2016) (Table 14). Records with only

Table 14. Known food sources for the rusty patched bumble bee.

Common Name	Scientific Name	Plant Species Used by MVP to Revegetate ROW
glossy abelia*	*Abelia grandiflora**	
unknown buckeye	*Aesculus* spp.	
blue giant hyssop*	*Agastache foeniculum**	
unknown giant hyssop	*Agastache* sp.	
white snakeroot	*Ageratina altissima*	
unknown hollyhock*	*Alcea* sp.*	
unknown onion	*Allium* sp.	
leadplant*	*Amorpha canescens**	
red columbine	*Aquilegia canadensis*	
spikenard	*Aralia* spp.	
lesser burdock*	*Arctium minus**	
green milkweed	*Asclepias hirtella*	
swamp milkweed	*Asclepias incarnata*	
Mead's milkweed*	*Asclepias meadii**	
unknown milkweed	*Asclepias* sp.	X (*Asclepias tuberosa*)
common milkweed	*Asclepias syriaca*	X
whorled milkweed	*Asclepius verticillata*	
white panicle aster	*Aster paniculatus*	
unknown aster	*Aster* sp.	X (*Aster novae-angliae*)
fernleaf yellow false foxglove	*Aureolaria pedicularia*	
garden yellowrocket*	*Barbarea vulgaris**	
barberry	*Berberis* spp.	
Japanese barberry*	*Berberis thunbergii**	
unknown pagoda-plant	*Blephilia* sp.	
Atlantic camas	*Camassia scilloides*	
American bellflower	*Campanula americana*	
unknown bellflower	*Campanula* sp.	
nodding plumeless thistle*	*Carduus nutans**	
unknown plumeless thistle*	*Carduus* sp.*	
New Jersey tea	*Ceanothus americanus*	
garden cornflower*	*Centaurea cyanus**	
spotted knapweed*	*Centaurea stoebe* subsp. *micranthos**	
spotted knapweed*	*Centaurea stoebe**	

Common Name	Scientific Name	Plant Species Used by MVP to Revegetate ROW
eastern redbud	*Cercis canadensis*	
leatherleaf*	*Chamaedaphne calyculata**	
fireweed	*Chamerion angustifolium*	
tall thistle	*Cirsium altissimum*	
unknown thistle	*Cirsium* sp.	
unknown springbeauty	*Claytonia* sp.	
Virginia springbeauty	*Claytonia virginica*	
greater tickseed	*Coreopsis major*	
crownvetch*	*Coronilla* sp.*	
cotoneaster*	*Cotoneaster adpressa**	
unknown hawthorn	*Crataegus* spp.	
cantaloupe*	*Cucumis melo**	
purple prairie clover*	*Dalea purpurea**	
dwarf larkspur	*Delphinium tricorne*	
slender pride of Rochester*	*Deutzia gracilis**	
squirrel corn	*Dicentra canadensis*	
dutchman's breeches	*Dicentra cucullaria*	
eastern purple coneflower	*Echinacea purpurea*	X
unknown purple coneflower	*Echinacea* sp.	
common viper's bugloss*	*Echium vulgare**	
common boneset	*Eupatorium perfoliatum*	
lateflowering thoroughwort	*Eupatorium serotinum*	
unknown thoroughwort	*Eupatorium* sp.	X (*Eupatorium coelestinum*)
flat-top goldentop	*Euthamia graminifolia*	
spotted joe pye weed	*Eutrochium maculatum*	
thinleaf sunflower	*Helianthus decapetalus*	
woodland sunflower	*Helianthus divaricatus*	
unknown sunflower	*Helianthus* spp.	
unknown hydrangea	*Hydrangea* spp.	
unknown waterleaf	*Hydrophyllum* spp.	
eastern waterleaf	*Hydrophyllum virginianum*	
common St. Johnswort*	*Hypericum perforatum**	
jewelweed	*Impatiens capensis*	
unknown touch-me-not	*Impatiens* sp.	
mountain laurel	*Kalmia latifolia*	
unknown laurel	*Kalmia* sp.	
purple deadnettle*	*Lamium purpureum**	
unknown laportea	*Laportea* spp.	
unknown motherwort*	*Leonurus* sp.*	
tall blazing star	*Liatris aspera*	
prairie blazing star*	*Liatris pycnostachya**	
unknown blazing star	*Liatris* sp.	X (*Liatris spicata*)

Common Name	Scientific Name	Plant Species Used by MVP to Revegetate ROW
unknown toadflax*	*Linaria* sp.*	
butter and eggs*	*Linaria vulgaris**	
sweetberry honeysuckle*	*Lonicera caerulea**	
European honeysuckle*	*Lonicera periclymenum**	
unknown honeysuckle	*Lonicera* sp.	
Tatarian honeysuckle*	*Lonicera tatarica**	
bird's-foot trefoil*	*Lotus corniculatus**	
sundial lupine	*Lupinus perennis*	
prairie crab apple*	*Malus ioensis**	
paradise apple*	*Malus pumila**	
European crab apple*	*Malus sylvestris**	
alfalfa*	*Medicago sativa**	
sweetclover*	*Melilotus officinalis**	
unknown sweetclover*	*Melilotus* sp.*	
spearmint*	*Mentha spicata**	
Virginia bluebells	*Mertensia virginica*	
wild bergamot	*Monarda fistulosa*	X
unknown beebalm	*Monarda* sp.	
catnip*	*Nepeta cataria**	
unknown catnip*	*Nepeta* sp.*	
Scotch cottonthistle*	*Onopordum acanthium**	
unknown parsnip*	*Pastinaca* sp.*	
Canadian lousewort	*Pedicularis canadensis*	
swamp lousewort	*Pedicularis lanceolata*	
large beardtongue*	*Penstemon grandifloras**	
unknown beardtongue	*Penstemon* sp.	X (*Penstemon laevigatus*)
unknown mock orange	*Philadelphus* spp.	
lionsheart	*Physostegia* sp.	
unknown leafcup	*Polymnia* spp.	
common selfheal	*Prunella vulgaris*	
American plum	*Prunus americana*	
sour cherry*	*Prunus cerasus**	
unknown plum	*Prunus* sp.	
Nanking cherry*	*Prunus tomentosa**	
unknown mountainmint	*Pycnanthemum* sp.	X (*Pycanthemum incanum*)
pinnate prairie coneflower	*Ratibida pinnata*	
handsome Harry	*Rhexia virginica*	
unknown rhododendron	*Rhododendron* spp.	
unknown sumac	*Rhus* spp.	
European gooseberry*	*Ribes grossularia**	
European black currant*	*Ribes nigrum**	
unknown currant	*Ribes* spp.	

Common Name	Scientific Name	Plant Species Used by MVP to Revegetate ROW
bristly locust	*Robinia hispida* var. *fertilis*	
unknown locust	*Robinia* sp.	
Carolina rose	*Rosa carolina*	
unknown rose	*Rosa* spp.	
unknown blackberry	*Rubus* sp.	
unknown willow	*Salix* spp.	
purple pitcherplant	*Sarracenia purpurea*	
lanceleaf figwort	*Scrophularia lanceolata*	
forked catchfly*	*Silene dichotoma**	
cup plant	*Silphium perfoliatum*	
climbing nightshade*	*Solanum dulcamara**	
unknown nightshade	*Solanum* sp.	
Canada goldenrod	*Solidago canadensis*	
zigzag goldenrod	*Solidago flexicaulis*	
unknown goldenrod	*Solidago* sp.	X (*Solidago juncaei, S. nemoralis*)
common sowthistle*	*Sonchus oleraceus**	
unknown spiraea	*Spiraea* sp.	
Thunberg's meadowsweet*	*Spiraea thunbergii**	
marsh hedgenettle*	*Stachys palustris**	
white heath aster	*Symphyotrichum ericoides*	
calico aster	*Symphyotrichum lateriflorum*	
New England aster	*Symphyotrichum novae-angilae*	
common comfrey*	*Symphytum officinale**	
unknown lilac*	*Syringa* spp.*	
common lilac*	*Syringia vulgaris**	
common dandelion*	*Taraxacum officinale**	
unknown dandelion	*Taraxacum* spp.	
bluejacket	*Tradescantia ohiensis*	X
red clover*	*Trifolium pretense**	
white clover*	*Trifolium repens**	
unknown clover	*Trifolium* sp.	
lowbush blueberry	*Vaccinium angustifolium*	
cranberry	*Vaccinium macrocarpon*	
unknown blueberry	*Vaccinium* spp.	
mullein*	*Verbascum* spp.*	
yellow crownbeard	*Verbesina occidentalis*	
unknown ironweed	*Vernonia* sp.	
unknown veronicastrum	*Veronicastrum* sp.	
Culver's root	*Veronicastrum virginicum*	
bird vetch*	*Vicia cracca**	
unknown vetch	*Vicia* spp.	

Common Name	Scientific Name	Plant Species Used by MVP to Revegetate ROW
common periwinkle*	*Vinca minor**	
unknown chastetree*	*Vitex* sp.*	
weigela*	*Weigela florida**	
unknown cocklebur	*Xanthium* sp.	

*non-native plant to Virginia and West Virginia
Sources: Betz et al. (1994), Evans et al. (2008), Colla and Dumesh (2010), and personal communication with Dr. Leif Richardson and Dr. Rob Jean.

genera were interpreted as an additional floral record if no other species were listed in that genus, but were not counted as additional records if one or more species were already listed for the plant genus. For example, Virginia springbeauty (*Claytonia virginica*) and *Claytonia* sp. are both listed in the table but were counted as one species as the *Claytonia* sp. record could likely be Virginia springbeauty. Thus, this is a conservative list of floral records. Ten of these plant species are being used to revegetate portions of the ROW to benefit pollinators and potentially rusty patched bumble bees (Table 14). It should be noted that foraging habitat for spring queens and early workers may be and probably will be different than foraging areas used by the same colony later in the season (Colla 2016). For example, in early spring the vast majority of the floral resources available and used by the rusty patched bumble bee are spring ephemerals in woodlands. As the season progresses and the forest canopy closes, wildflower species diversity tends to decline in forests and thus foraging bees often switch to more open and unforested habitats where late spring, summer, and fall wildflowers dominate. Open forests have been shown to be highly valuable for pollinators and many current forest management practices such as thinning and invasive species control may benefit rusty patched bumble bees and other pollinators by increasing sunlight and creating favorable understory species composition (Hanula et al. 2016). Although foraging range of rusty patched bumble bees have not been studied directly, studies on other species in the genus suggest foraging ranges of 500 meters (1,640 ft) to 2.3 kilometers (1.4 mi) (Osborne et al. 1999, Walther-Hellwig and Frankl 2000, Darvill et al. 2004, Knight et al. 2005, Osborne et al. 2008, Wolf and Mortiz 2008, Kraus et al. 2009). Recent studies suggest foraging ranges could be more than 2.5 kilometers (1.6 mi) for some bumble bee species (Hagen et al. 2011, Rao and Strange 2012).

4.9.3.2.2 Nesting Habitat

Because bumble bee nests are very difficult to locate (Harder 1986), little information is available regarding nesting biology and nest site choice of rusty patched bumble bee.. Abandoned, subterranean rodent nests are the most common nest location, although nests have been reported in a variety of conditions (Plath 1922, Macfarlane et al. 1994, COSEWIC 2010, Environment and Climate Change Canada 2016). Plath (1922) reported above-ground nests in leaf litter in Massachusetts, but these had few individuals, were easy to find, and were likely low quality and highly susceptible to predation. These may have been nests that were made in subpar habitat due to interspecific and intraspecific competition for nest sites. Macfarlane (1974) reported a nest in an abandoned armchair. Others have reported subterranean nests 0.3 to 1.2 meters (1 to 4 ft) in the ground (Jepsen et al. 2013, Environment and Climate Change Canada 2016). Most of these nests are abandoned rodent nests and thus the abundance of rodent populations may directly and indirectly influence bumble bee populations.

4.9.3.2.3 Wintering Habitat

As little is known about the overwintering habits of rusty patched bumble bee gynes, it is an area of high research priority for this species. Near Madison, Wisconsin, an investigator taking soil samples accidentally unearthed one overwintering rusty patched bumble bee gyne (pers. comm., Bradley Herrick, University of Wisconsin, January 2017) from a (somewhat) poorly drained silt loam soil in a forested plot predominantly composed of sugar maples with some scattered oaks. The rusty patched bumble bee gyne was under leaf litter and a few centimeters (1-2 in) of loose soil. Soil in the immediate vicinity was looser than the immediate surrounding area indicating the gyne "worked" the soil. The gyne did not fly away and the investigator took several photographs before placing the gyne back in the original location (personal communication Bradley Herrick, University of Wisconsin, January 2017). Other congeneric species are reported to exhibit similar overwintering patterns, including forming a chamber in soft soil a few centimeters deep in woodlands or woodland edges where necessary floral resources are available when the species emerges. Occasionally compost or mole hills are used (Goulson 2010, USFWS 2017) (pers. comm. Susan Carpenter).

4.10 Northeastern Bulrush

The northeastern bulrush is a member of the sedge family (Cyperaceae) and is native to the northeastern United States. Northeastern bulrush, first described as a new species by A.E. Schuyler in 1962, is a leafy, perennial herb approximately 80 to 120 centimeters (31.5 to 47.2 in) in height (Schuyler 1962). The lowermost leaves are up to 0.8 centimeter (0.3 in) wide and 40 to 60 times as long as wide, while the uppermost leaves are 0.3 to 0.5 centimeter (0.1 to 0.2 in) wide and 30 to 50 times as long as wide (Schuyler 1962). 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 (0.1 to 0.2 centimeter [0.04 to 0.08 in] long), rigid perianth bristles, and each bristle is armed with thick walled, sharply pointed barbs projecting downward. Flowers have 0 to 3 stamens and a 3-parted style. The yellow brown achenes are 0.10 to 0.13 centimeter (0.04 to 0.05 in) long, obovate, and tough and thickened above the seed (Schuyler 1962). Flowering occurs mid-June to July, and fruit sets between July and September.

4.10.1 Habitat Requirements

Throughout its range, northeastern bulrush is found in open, tall herb-dominated wetlands. In the north, the species is most commonly found 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 taxon occurs often in sinkhole ponds that form in sandstone bedrock at intermediate elevations around 200 to 500 meters (656.1 to 1640.4 ft) (somewhat higher elevations in the Virginias). Plants at all sites occur around the margins of ponds in 8 to 40 centimeters (3.1 to 15.7 in) of standing water (in wet years). In Pennsylvania, the northeastern bulrush is found almost exclusively in vernal pools where the water level fluctuates seasonally. A study comparing Pennsylvania wetlands that supported northeastern bulrush wetlands with nearby ponds that did not, showed that ponds with northeastern bulrush were typically larger (> 400 square meters [>4305.5 ft^2]), freer of forest canopy cover, higher in exchangeable sodium (> 7 ppm), and higher in pH (Lentz and Dunson 1999). Northeastern bulrush is often found 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 (USFWS 1993b). Habitat of northeastern bulrush in Pennsylvania typically consists of small depressional palustrine wetlands (Lentz and Dunson 1999) that receive water primarily through precipitation (Lentz 1998).

Plants emerge from underground rhizomes in May (the new year's seedlings typically begin to germinate in March (USFWS 1993b). Flowering occurs from mid-June to mid-July across the range of the species. Hybridization has been observed between northeastern bulrush and mosquito bulrush (*S. hattorianus*) in the wild; in fact, Schuyler (1962, 1967) suggested that the intermediate, co-occurring species, green bulrush (*S. atrovirens*), might have arisen evolutionarily from a backcross hybridization of these taxa.

Examination of field reports indicates that there is considerable variety in associated species. A few species, however, are common to several of the sites. These are three way sedge (*Dulichium arundinaceum*), woolgrass (*Scirpus cyperinus*), rattlesnake manna grass (*Glyceria canadensis*), and Virginia marsh St. Johnswort (*Triadenum virginicum*) (USFWS 1993b).

4.10.2 Site-specific Data

The northeastern bulrush has 33 known populations range-wide. Twenty of these 33 populations occur on private land are identified as subject to habitat loss, modification, and degradation caused by residential and agricultural development (USFWS 1993b). Potential habitat examined in the Project Area is shown in Figure 21. The species is known from Alleghany, Augusta, Bath, and Rockingham counties, Virginia and Berkeley and Hardy counties, West Virginia but most occurrences are in Pennsylvania.

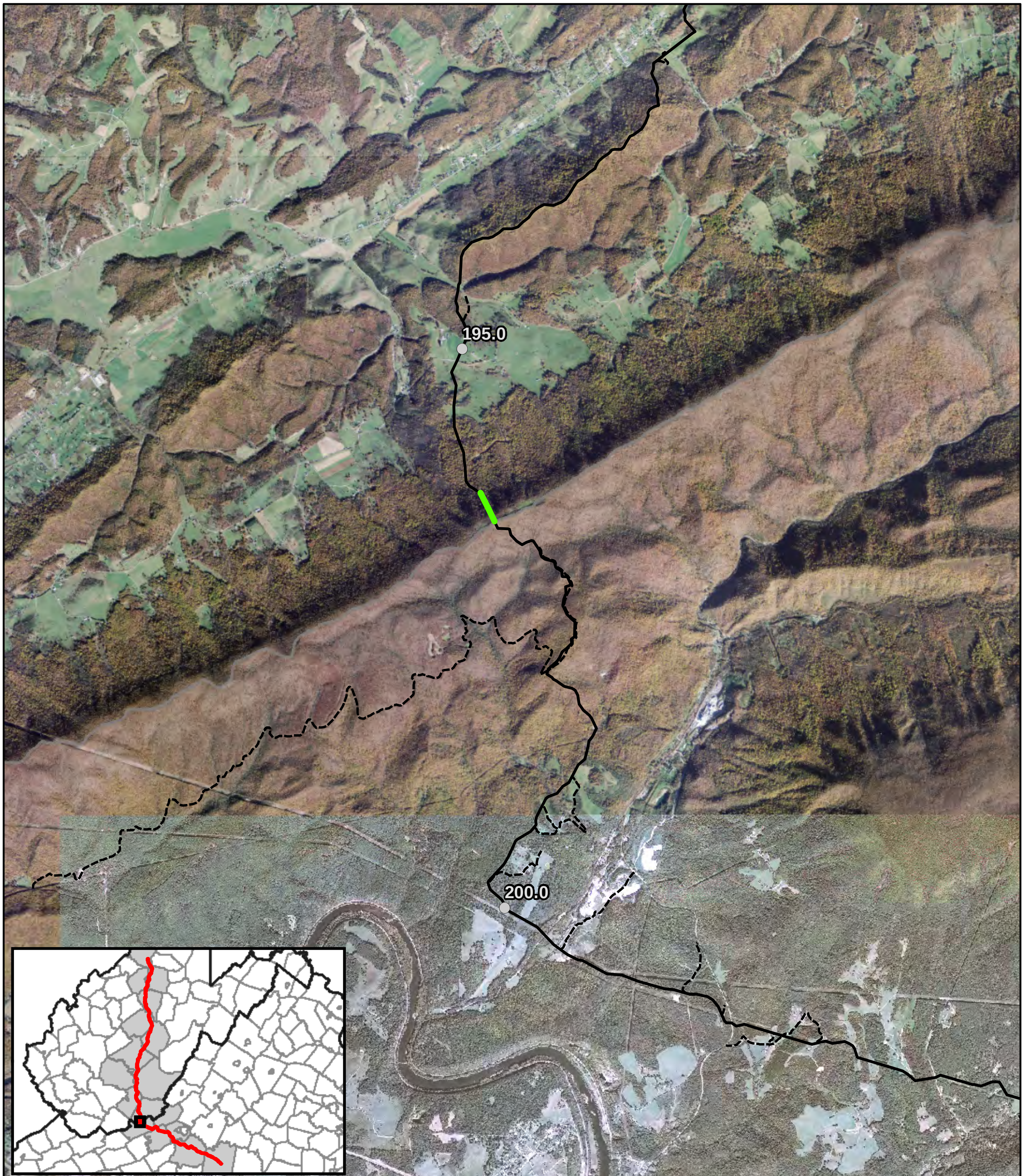

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Figure 21. Potential occurrence of northeastern bulrush (*Scirpus ancistrochaetus*) in the Project Area.

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4.10.2.1 Habitat

Northeastern bulrush habitat was initially determined based on consultation with USFWS and desktop analyses. These areas were then assessed during field surveys completed August 5 to 12, 2015. No potential habitat or individuals of northeastern bulrush were observed within the Project Area in Giles County, Virginia and Monroe County, West Virginia. No 2016 surveys were needed for this species.

4.11 Running Buffalo Clover

Running buffalo clover (*Trifolium stoloniferum*) is a stoloniferous, perennial herb. This species is characterized by and differentiated from white clover (*Trifolium repens* L.) 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 7.6 to 15.2 centimeters (3 to 6 in) 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.

4.11.1 Habitat Requirements

Running buffalo clover is known to occur in relatively moist, fertile soils in calcareous regions. There does not appear to be any correlation between running buffalo clover and any particular soil type. It has been encountered in semi-shaded conditions along footpaths, logging trails, lawns of older homes and cemeteries, and on grazed, semi-wooded terraces along stream corridors. In Ohio, it clearly inhabits open to semi-open, moist ground with grazing, trampling, or mowing and it is generally near streams or rivers. Running buffalo clover may be found in semi-shaded, moist openings and edge habitats maintained by some form of long-term disturbance. Disturbance must be moderate in intensity: minimal or excessive disturbance is detrimental. Disturbances that may be helpful when moderate (or detrimental when excessive) include grazing, trampling, and mowing. Moderate amounts of disturbance, at a level conducive for establishment and maintenance of healthy populations, are infrequently encountered.

4.11.2 Site-specific data

Historically, the range of this species was across the central eastern United States. Brooks (1983) included eight states within the range: Arkansas, Illinois, Indiana, Kansas, Kentucky, Missouri, Ohio, and West Virginia. The earliest dated collection of the species was in 1830 near St. Louis, Missouri, with scattered collections throughout its range during the latter part of the 1800s and early 1900s. In Ohio, running buffalo clover is known from Hamilton, Warren, and Clermont counties, and most recently from Lawrence County. It is known to occur or has occurred in Barbour, Brooke, Fayette, Greenbrier, Monongalia, Pendleton, Pocahontas, Preston, Randolph, Tucker and Webster counties, West Virginia. Potential habitat for running buffalo clover in the Project Area is depicted in Figure 22. Greenbrier and Webster counties, West Virginia have the closest populations to the Project Area.

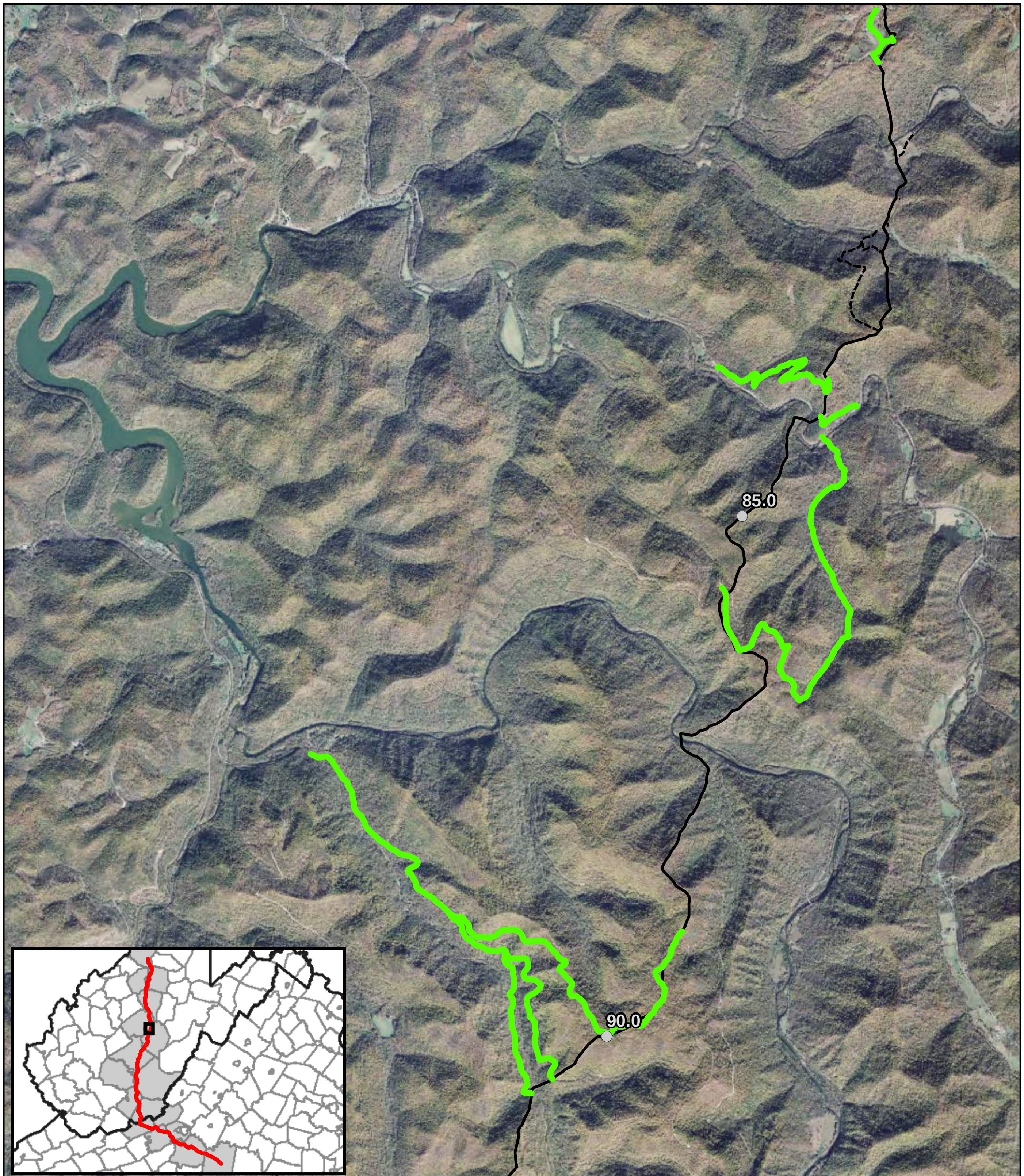

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Figure 22. Potential occurrence of running buffalo clover (*Trifolium stoloniferum*) in the Project Area.

Map 1 of 5

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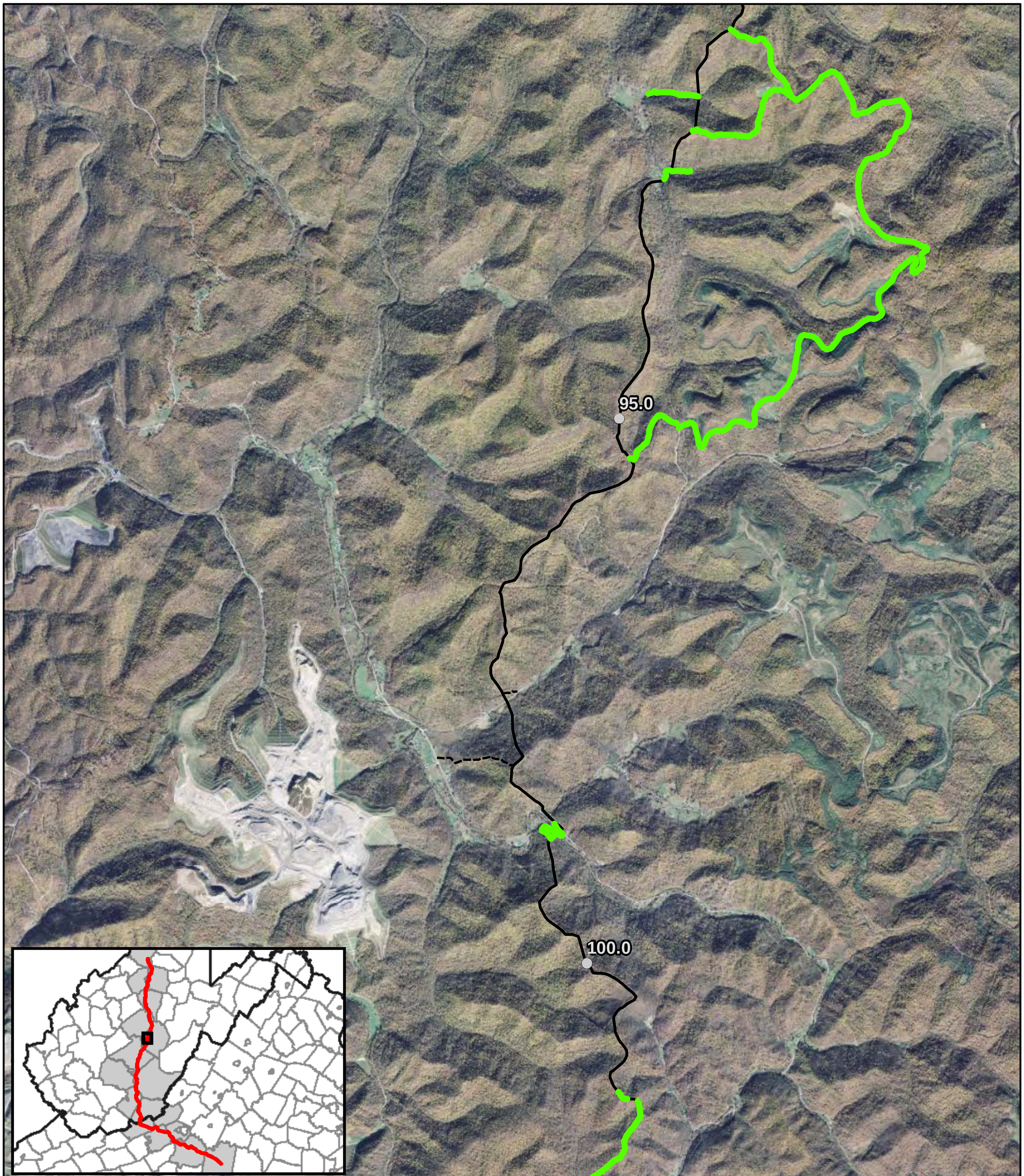

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Figure 22. Potential occurrence of running buffalo clover (*Trifolium stoloniferum*) in the Project Area.

Map 2 of 5

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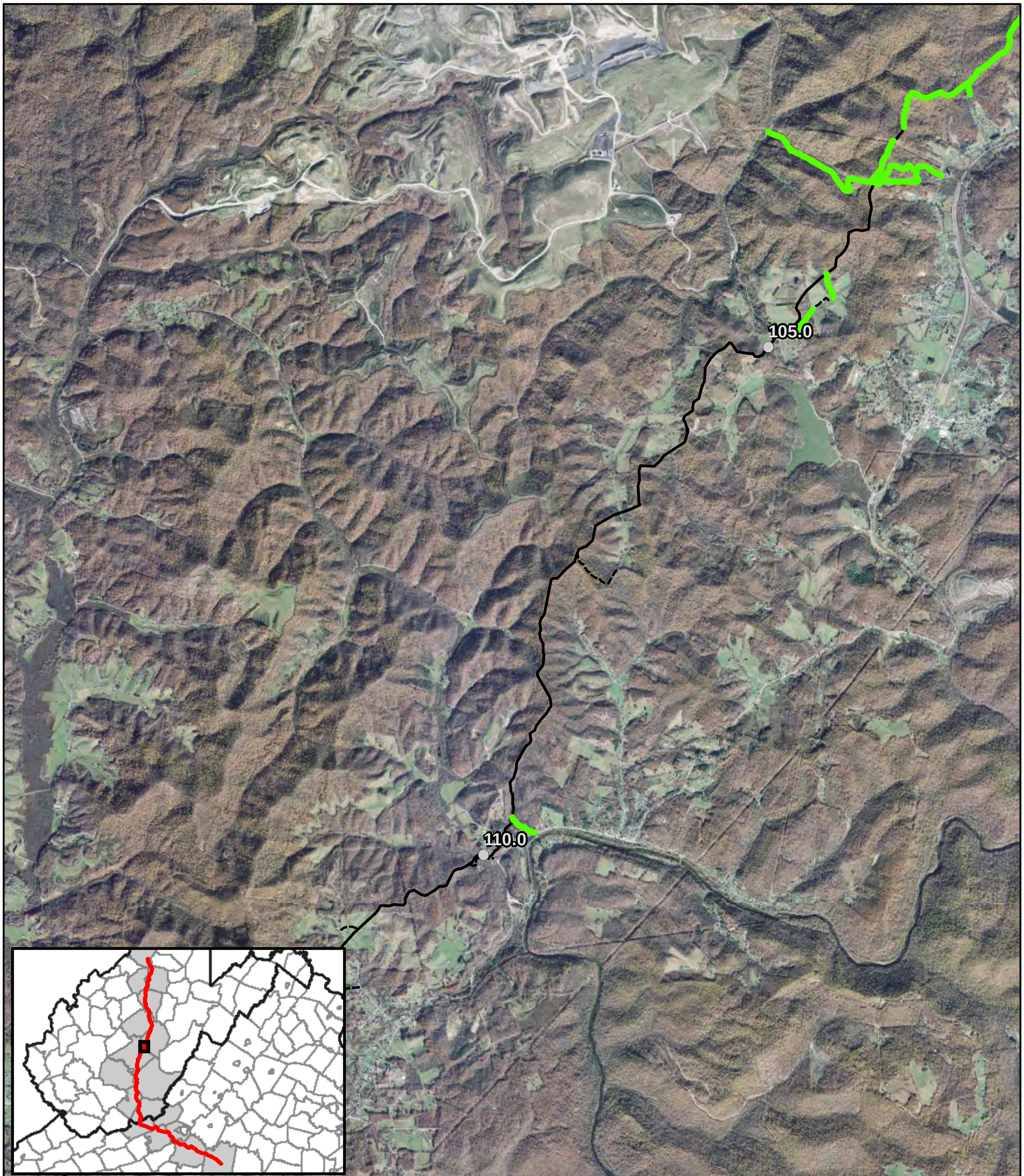

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October 2016 Proposed Route (Revised) Centerline

RTE Plant Species of Concern Survey Area

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Figure 22. Potential occurrence of running buffalo clover (*Trifolium stoloniferum*) in the Project Area.

Map 3 of 5

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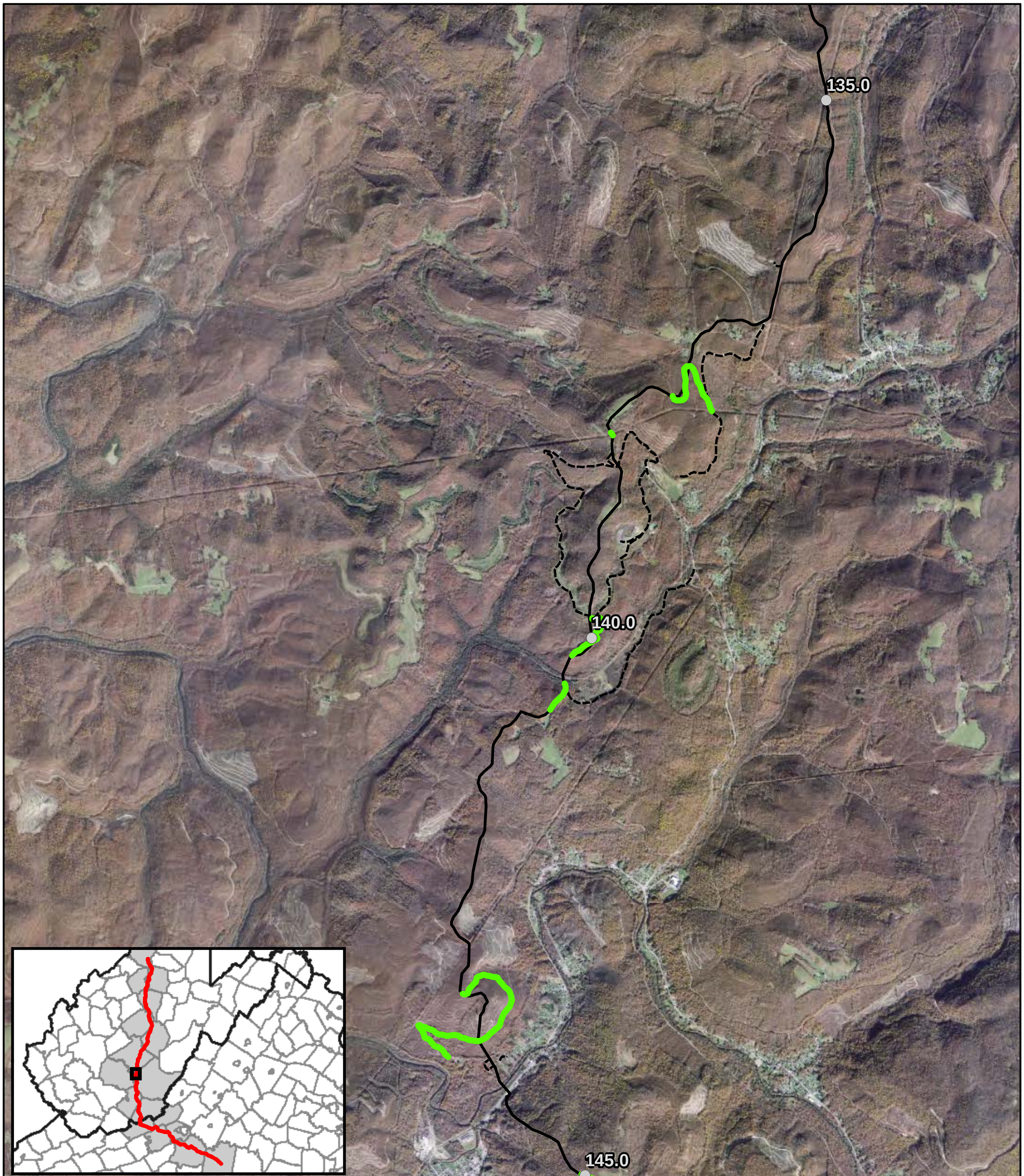

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Figure 22. Potential occurrence of running buffalo clover (*Trifolium stoloniferum*) in the Project Area.

Map 4 of 5

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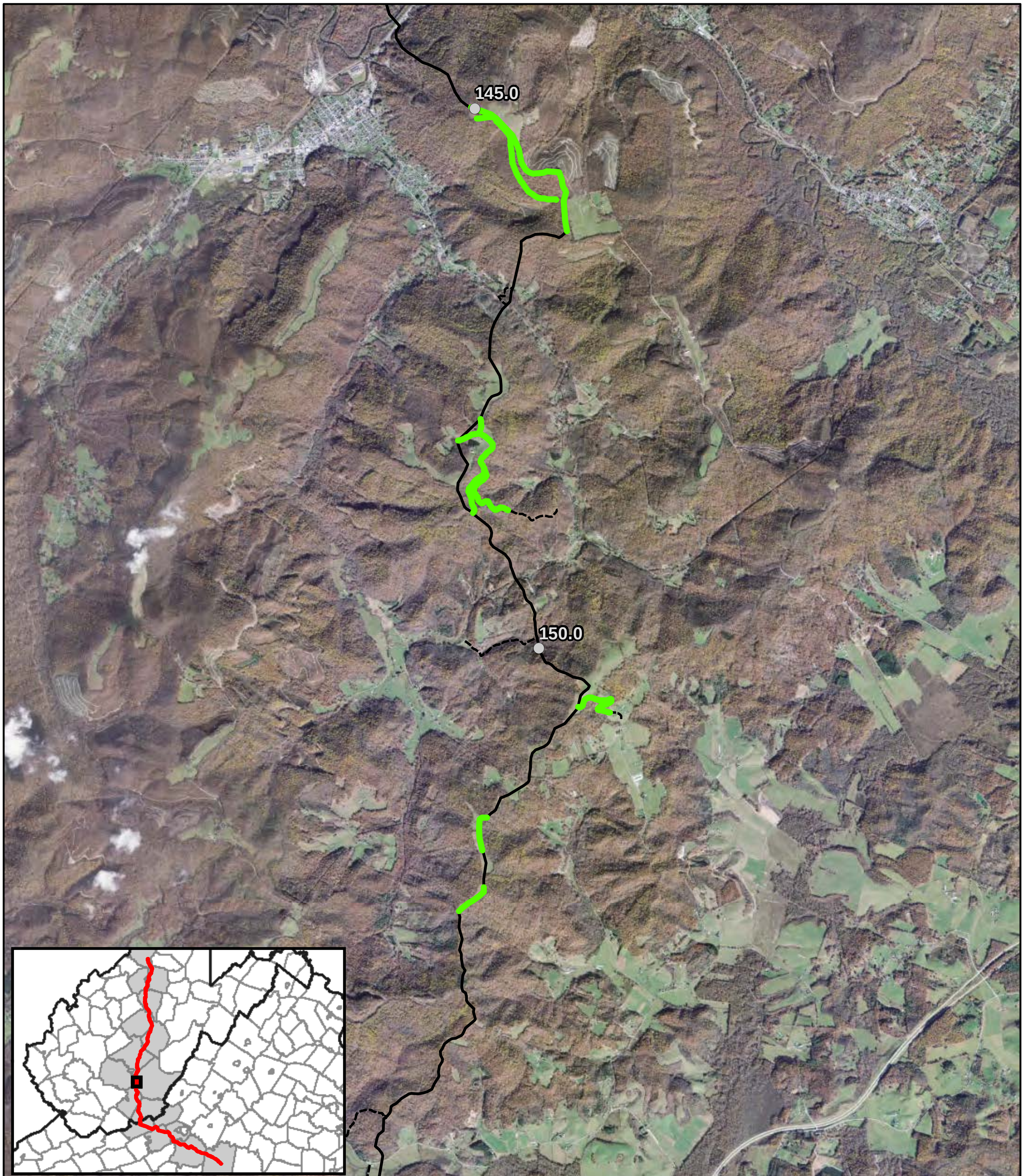

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October 2016 Proposed Route (Revised) Centerline
October 2016 Proposed Route (Revised) Access Road
RTE Plant Species of Concern Survey Area

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Figure 22. Potential occurrence of running buffalo clover (*Trifolium stoloniferum*) in the Project Area.

Map 5 of 5

Project No.
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4.11.2.1 Habitat

Running buffalo clover habitat was initially determined based on consultation with USFWS and desktop analyses. These areas were then assessed during field surveys which revealed potential habitat for running buffalo clover within the Project Area in Greenbrier and Webster counties, West Virginia.

4.11.2.2 Occurrence

A survey for running buffalo clover was performed July 16 to 23, 2015 in Webster and Nicholas counties, West Virginia which yielded no individuals. Due to route realignments, additional surveys were performed May 2 to 3, August 5 to 7, August 23 to 26, and September 16 to 17, 2016 in Greenbrier and Webster counties, West Virginia. Again, no individuals were identified. Due to land access issues, 0.23 kilometer (0.14 mi) in Webster County remains to be surveyed in 2017 (Table 1).

4.12 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 1.6 to 3.5 centimeters (0.6 to 1.4 in) in diameter. Potentially reproductive individuals are erect (41 to 97 centimeters [16.1 to 38.2 in]) and are flowering plants that lack the basal rosette. The flowering stalks are highly branched with 3 to 41 branches measuring 20 to 40 centimeters (7.9 to 15.7 in) wide with many flowers. The flowers are small and white with calyxes (0.2 to 0.3 centimeter [0.08 to 0.13 in] long) that bear silique fruits ranging from 4.3 to 7.9 centimeters (1.7 to 3.1 in) long (USFWS 1991). It flowers from mid-July to October.

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, and has broader leaves that are auricled at the base, less branched inflorescences and larger flowers than shale barren rock cress (Wieboldt 1987).

4.12.1 Habitat Requirements

The shale barren rock cress is very habitat restricted, and is only known to occur at low densities among scattered mid-Appalachian shale barrens in West Virginia and Virginia (Catrow et al. 2009). It is endemic to the shale barrens of these areas. It is believed there may be fewer than 4,000 individuals in existence. Of known populations, most have fewer than 50 individuals.

4.12.2 Site-specific Data

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). For this Project, the closest known populations occur in Greenbrier County, West Virginia and thus searches for suitable habitat and individuals were concentrated in that area. Figure 23 shows the potential habitat based upon desktop analyses that were searched for shale barren rock cress.

4.12.2.1 Habitat

Shale barren rock cress habitat was initially determined based on consultation with USFWS and desktop analyses. These areas were then assessed during botanical field surveys on August 5 to 12, 2015 which revealed no potential habitat or individuals of shale barren rock cress within the Project Area in Greenbrier and Fayette counties, West Virginia. Due to route realignments, additional surveys were performed August 5 to 7, August 23 to 26, and September 16 to 17, 2016 in Greenbrier and Fayette counties, West Virginia. Again, no potential habitat nor individuals were identified. Due to land access issues, 0.19 kilometer (0.12 mi) remains to be surveyed in 2017 (Table 1).

4.13 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 30 centimeters (11.8 in) tall and the whorl of five to six leaves at the top of the stem. The leaves are gray-green, oblong, and reach 4 to 8 centimeters (1.6 to 3.1 in) 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 (USFWS 2008a).

4.13.1 Habitat Requirements

The small whorled pogonia is found in mature or secondary hardwood or mixed stands composed of beech (*Fagus* spp.), birch (*Betula* spp.), maple (*Acer* spp.), oak (*Quercus* spp.), hickory (*Carya* spp.), and pine (*Pinus strobus*) that have an open understory. However, it has been found that vegetative cover does not necessarily limit this species as it has been found in up to sixty percent cover (Mehrhoff 1980). In fact, one indicator community used to find this species is paper birch (*Betula papyrifera*) on steep slopes with dense fern understory. Associated herbaceous cover includes Indian cucumber-root, club mosses (*Lycopodium* spp.), eastern teaberry (*Gaultheria procumbens*), trailing arbutus (*Epigaea repens*), striped prince's pine (*Chimaphila maculata*), partridgeberry (*Mitchella repens*), wintergreens (*Pyrola* spp.)

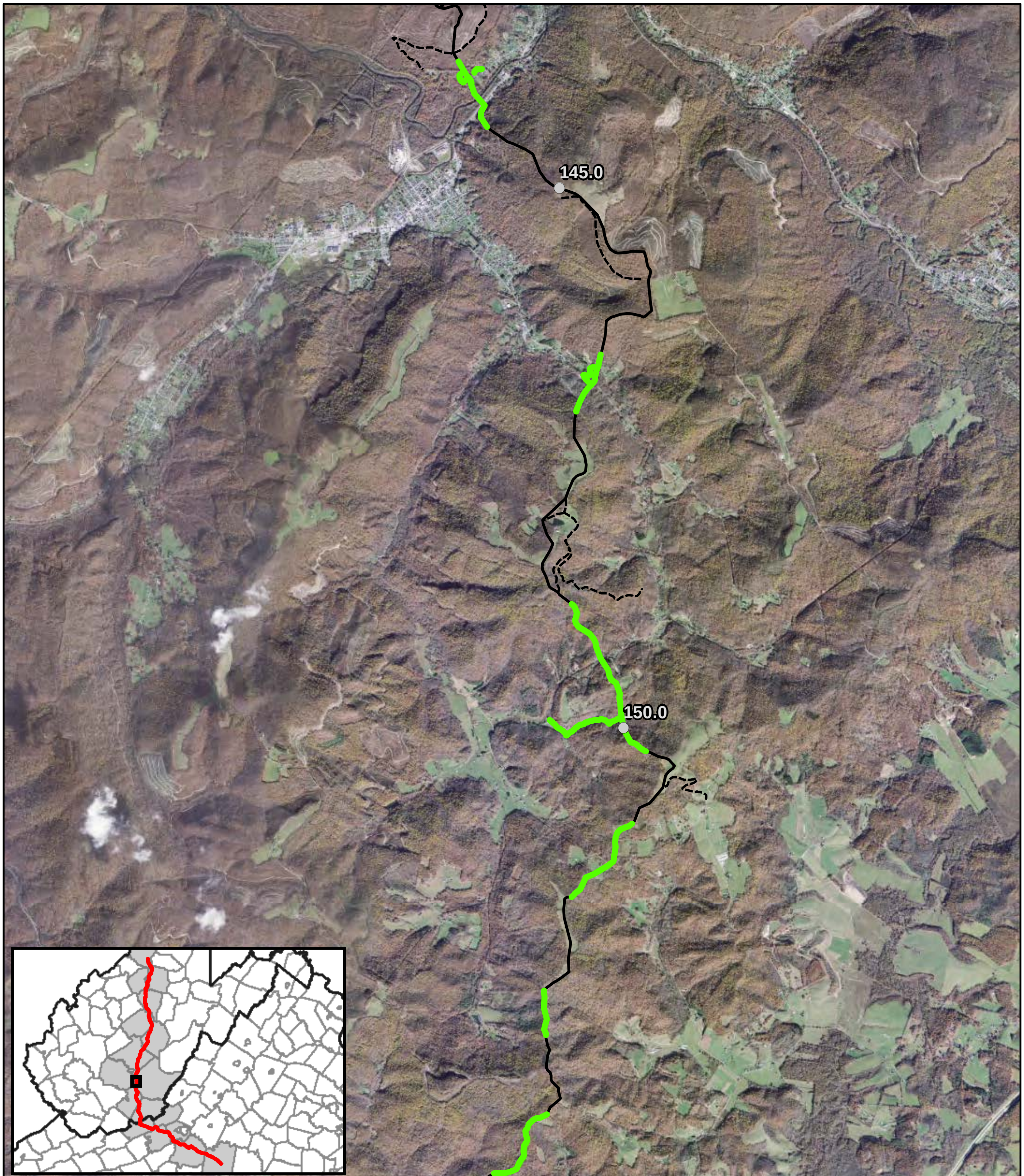

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Figure 23. Potential occurrence of shale barren rock cress (*Arabis serotina*) in the Project Area.

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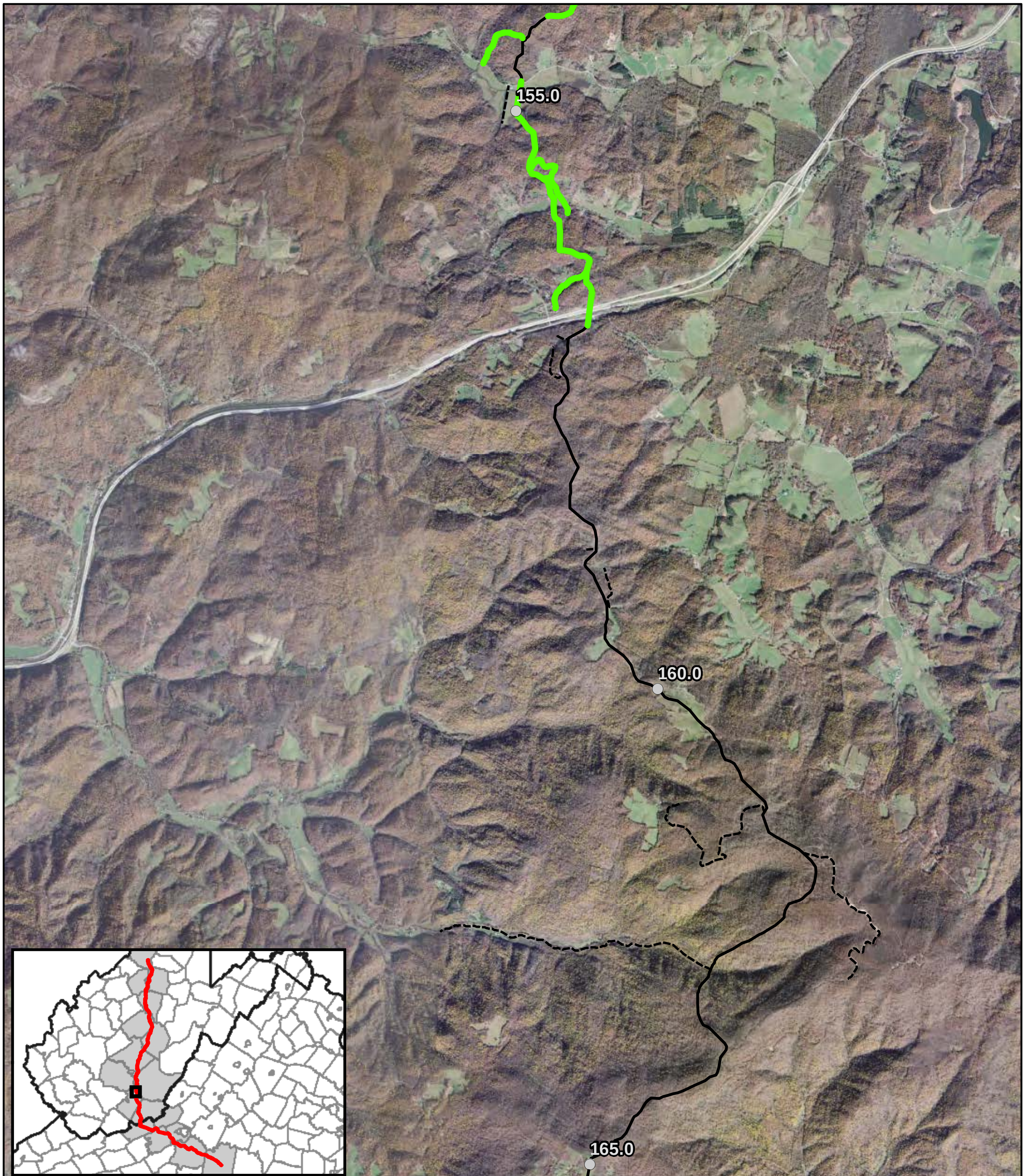

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Figure 23. Potential occurrence of shale barren rock cress (*Arabis serotina*) in the Project Area.

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Eight other orchids have been listed associated with a population in Ontario (Brownell and Bowman 1981). In Virginia, green adder's-mouth orchid (*Malaxis unifolia*) and brown widelip orchid (*Liparis liliifolia*) have been listed as associated orchids (Grimes 1921). The species typically occurs in acidic soils (Mehrhoff 1989).

4.13.2 Site-specific Data

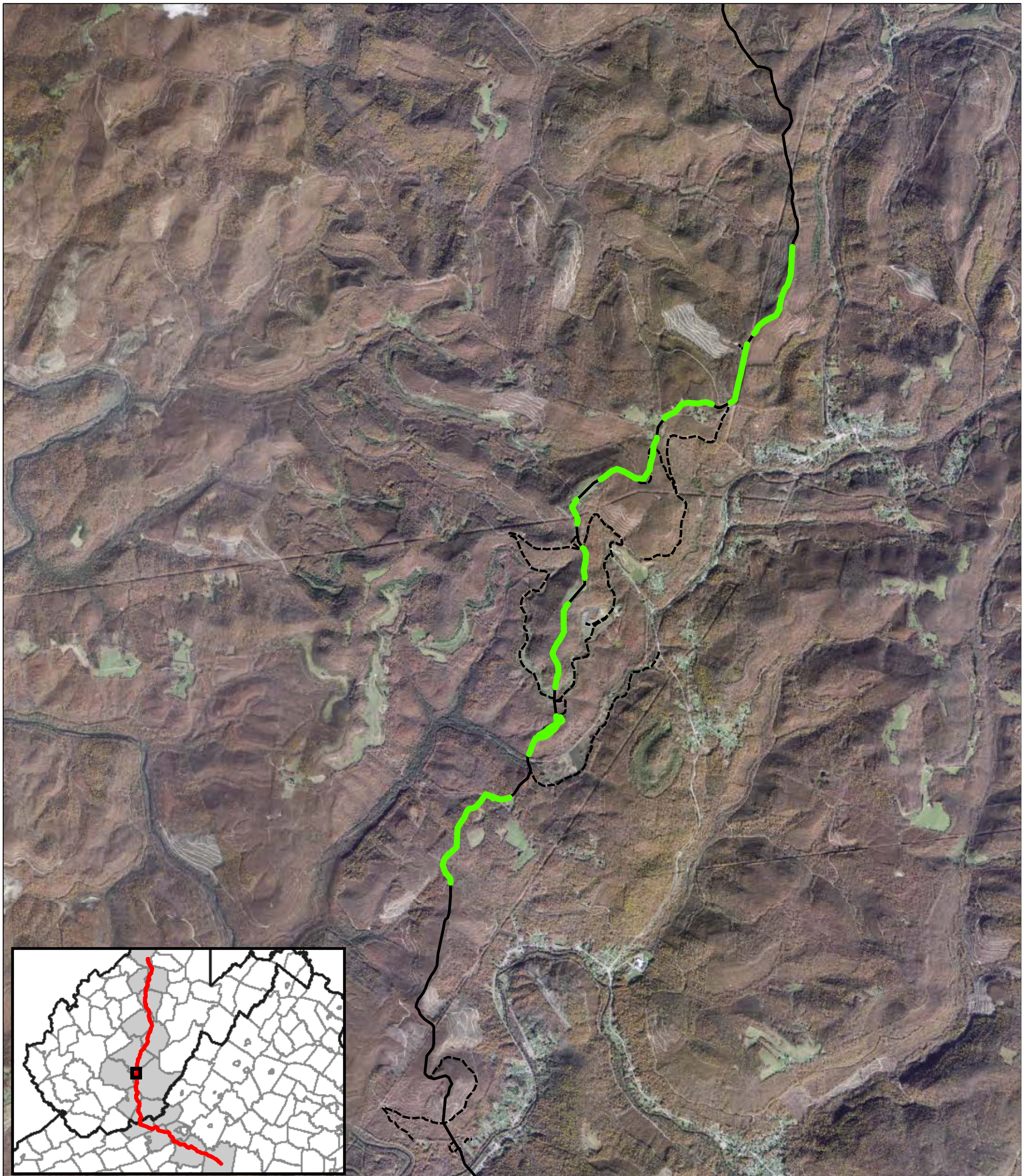
the range of the small whorled pogonia is from Ontario to Maine down the eastern United States coast to Georgia and possibly as far west as Missouri, although it is thought to be extirpated there. It is known from 20 counties in Virginia and two cities (Petersburg and Williamsburg) as well as Greenbrier and Randolph counties, West Virginia. It is thought to be extirpated in four of these counties (Appomattox, Buckingham, New Kent, and York) and the city of Petersburg. The closest known populations to the Project Area are in Greenbrier County, West Virginia and thus searches for potential habitat and individuals were concentrated in that area. Based on desktop analyses, potential habitats searched for small whorled pogonia are provided on Figure 24.

4.13.2.1 Habitat

Small whorled pogonia habitat was initially determined to be potentially present based on consultation with USFWS and desktop analyses. These areas were then assessed during plant surveys which revealed potential habitat for small whorled pogonia within the Project Area in Greenbrier and Fayette counties, West Virginia.

4.13.2.2 Occurrence

A survey for small whorled pogonia was performed August 5 to 12, 2015 in Greenbrier and Fayette counties, West Virginia which yielded no individuals. Due to route realignments, additional surveys were performed May 2 to 3, August 5 to 7, August 23 to 26, and September 16 to 17, 2016 in Greenbrier and Fayette counties, West Virginia, again yielding no individuals. Due to land access issues, 0.19 kilometer (0.12 mi) remains to be surveyed in 2017 (Table 1).



October 2016 Proposed Route (Revised) Centerline

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Figure 24. Potential occurrence of small whorled pogonia (*Isotria medeoloides*) in the Project Area.

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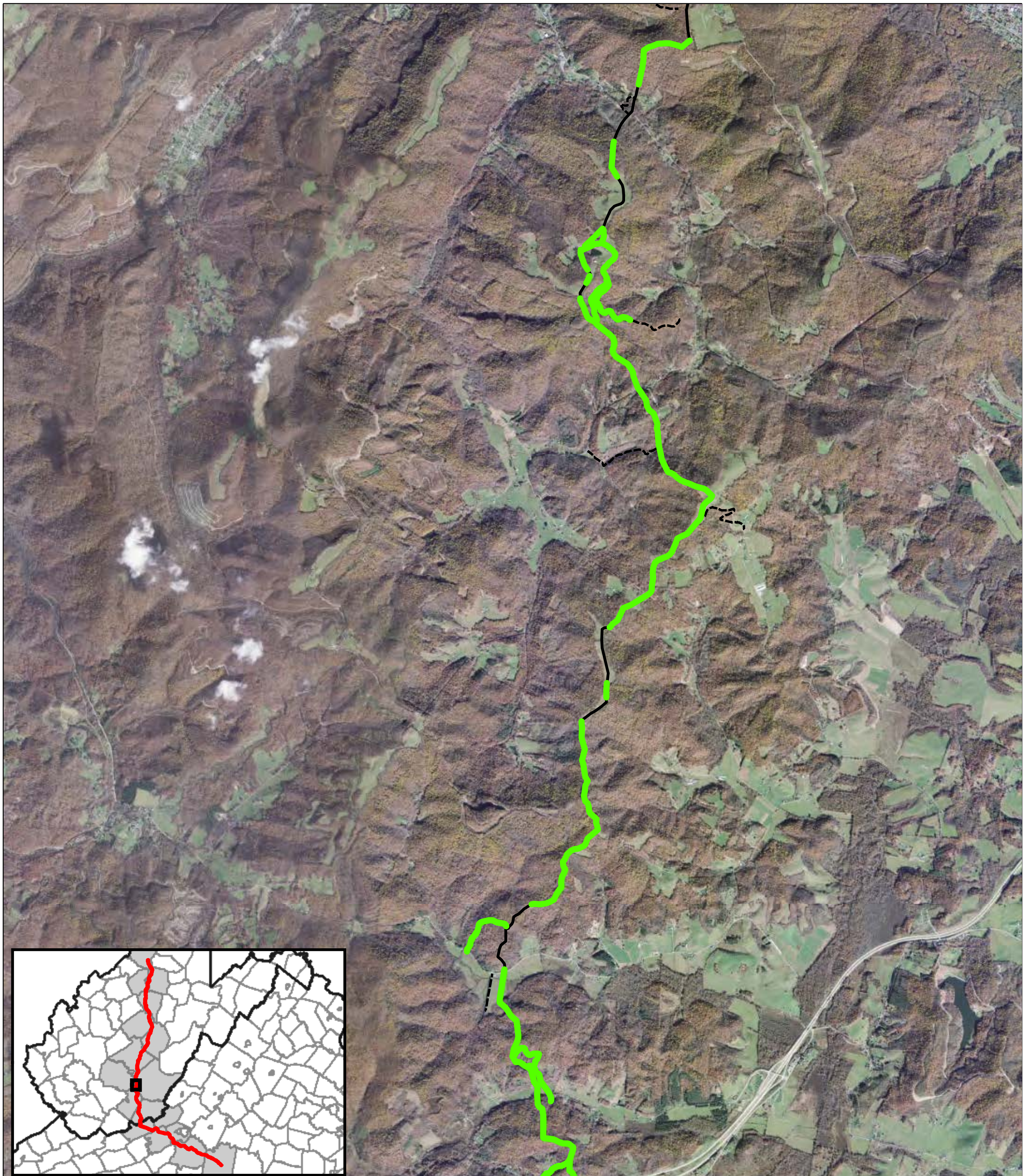

October 2016 Proposed Route (Revised) Centerline
October 2016 Proposed Route (Revised) Access Road
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Figure 24. Potential occurrence of small whorled pogonia (*Isotria medeoloides*) in the Project Area.

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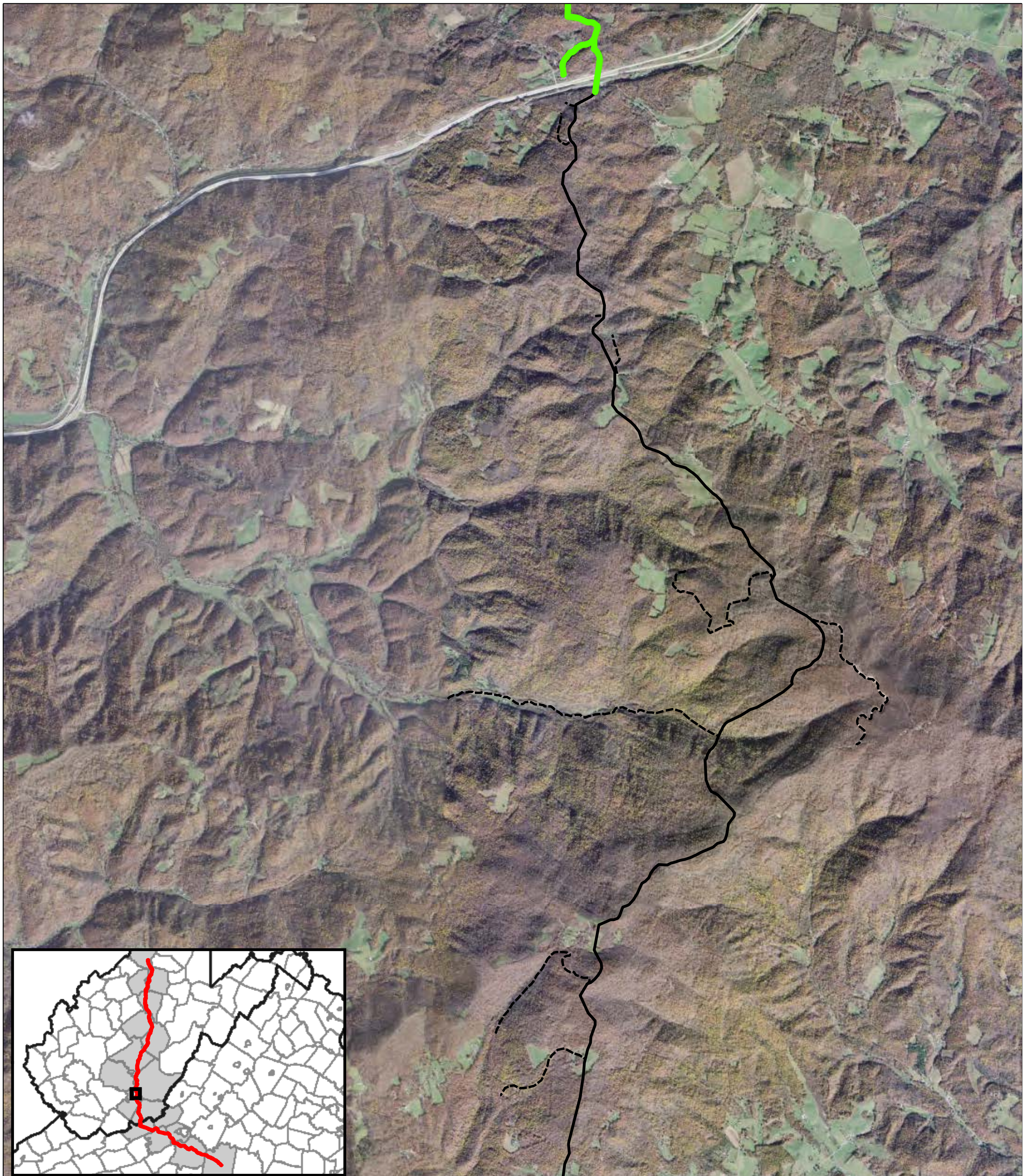

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Figure 24. Potential occurrence of small whorled pogonia (*Isotria medeoloides*) in the Project Area.

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4.14 Smooth Coneflower

Smooth coneflower grows in a single stem, becoming 35 to 110 centimeters (13.8 to 43.3 in) tall. It has broadly lanceolate to elliptic or broadly ovate leaves, which are 10 to 50 centimeters (3.9 to 19.7 in) long and 3 to 6.5 centimeters (1.2 to 2.6 in) wide with up to 26-centimeter-long (10.2-inch-long) petioles or stalks (Chafin 2007). They are contracted to subcordate to the petiole, and are usually glabrous and more-or-less glaucous. The flower disk is 1.5 to 3.5 centimeters (0.6 to 1.4 in) wide and the 3- to 8-centimeter (1.2- to 3.1-in) reddish purple to pale pink ray flowers droop away from the disk. The pollen is bright yellow. It is very similar to purple coneflower (*E. purpurea*), except for the hairier leaves and the sometimes multiple and slightly taller (to 18 centimeters [7.1 in]) stems of purple coneflower. Smooth coneflower also occurs in drier sites than purple coneflower. Another similar related species is pale purple coneflower (*Echinacea pallida*); however, it has a more westerly distribution and has smaller basal leaves (up to 33 centimeters [13 in] long and 4 centimeters [1.6 in] wide) and white pollen (Chafin 2007).

This species flowers from May through July (Gleason and Cronquist 1991, USFWS 1995). Coneflowers have open conspicuous flowering heads and are animal pollinated with the principle pollinators being bees, flies and butterflies (Krombein et al. 1979). Congener species have been found to be pollen limited probably because they occur in aggregations, are self-incompatible, and use generalist pollinators which may contribute to decline in populations (Kunin 1993, Wagenius 2004). In addition, agriculture contributes to these declines as populations often occur in areas that cannot be plowed or in which it is not economically feasible (Wagenius 2004). Plowing destroys the large single taproot. The fruits are achenes which are mainly gravity dispersed but may also be dispersed by birds or small mammals (Chafin 2007).

Associated plants include oak trees (*Quercus* spp.), shortleaf pine (*Pinus echinata*) and forbs such as rattlesnake master (*Eryngium yucciflium*), and sunflowers (*Helianthus* spp.). It grows and germinates in most soils but must have full sun and open habitat. Young plants do not compete well and can be easily dominated by other species. Historically, it probably occurred in prairies and savannas maintained by fire or animal grazing (Chafin 2007).

4.14.1 Habitat Requirements

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 xeric. It has also been found in open woods, cedar barrens, roadsides, clearcuts, utility line ROWs, and dry limestone bluffs. It is believed that periodic disturbance, common to these habitats, is needed to maintain high light conditions and low herbaceous competition required for the species to thrive (USFWS 1995).

4.14.2 Site-specific Data

Smooth coneflower historically occurred from Pennsylvania to Georgia. It is thought to be extirpated from Pennsylvania and is currently only known from Virginia, North Carolina, South Carolina, and Georgia. In Virginia it is known from the following counties: Alleghany, Amherst, Botetourt, Campbell, Franklin, Halifax, Montgomery, Nottoway, Pulaski, Roanoke, and Wythe. It is thought to be extirpated in Nottoway, Roanoke, and Wythe counties, Virginia. There is also a historical record in Lynchburg but that is now thought to be extirpated. The closest know populations of smooth coneflower to the Project Area are in Montgomery County, Virginia and thus search efforts were concentrated in that area. Based on desktop analyses, potential habitats searched for smooth coneflower are provided on Figure 25.

4.14.2.1 Habitat

Smooth coneflower habitat was initially determined based on consultation with USFWS and desktop analyses. These areas were then assessed during plant surveys which revealed potential habitat for smooth coneflower within the Project Area in Montgomery County, Virginia.

4.14.2.2 Occurrence

A survey for smooth coneflower was performed August 24, 2015 in Montgomery County, Virginia which yielded no individuals. Due to route realignments and land access issues in 2015, additional surveys were performed June 22 to July 3, August 8 to 12, and September 19 to 20, 2016 in Montgomery County, Virginia which also yielded no individuals. Additionally, habitat assessments were conducted for smooth coneflower on parcels granting land access after the survey window on October 7 and October 25, 2016. No suitable habitat was identified in the field for smooth coneflower on these parcels; therefore, no additional surveys are needed for this species in 2017.

4.15 Virginia Spiraea

Virginia spiraea is a clonal, often profusely branched shrub that grows 1 to 3 meters (3.3 to 9.8 ft) in height. Its leaves are oblong-lanceolate or oblanceolate, 3 to 6 centimeters (1.2 to 2.4 in) by 1.0 to 1.8 centimeters (0.4 to 0.7 in), acute and mucronate, entire or with a few low teeth near the tip, and somewhat glaucous beneath. The inflorescence is a short, broad, terminal corymb, 5 to 22 centimeters (2.0 to 8.7 in) wide, with glabrous or villous branches. The flowers are white and 0.5 to 0.6 centimeter (0.19 to 0.24 in) wide, with 0.08- to 0.11-centimeter (0.03- to 0.04-in) sepals. The fruits are small follicles, at 0.15 centimeter (0.06 in) long. This species flowers in late May to late July (Gleason and Cronquist 1991, USFWS 1992).

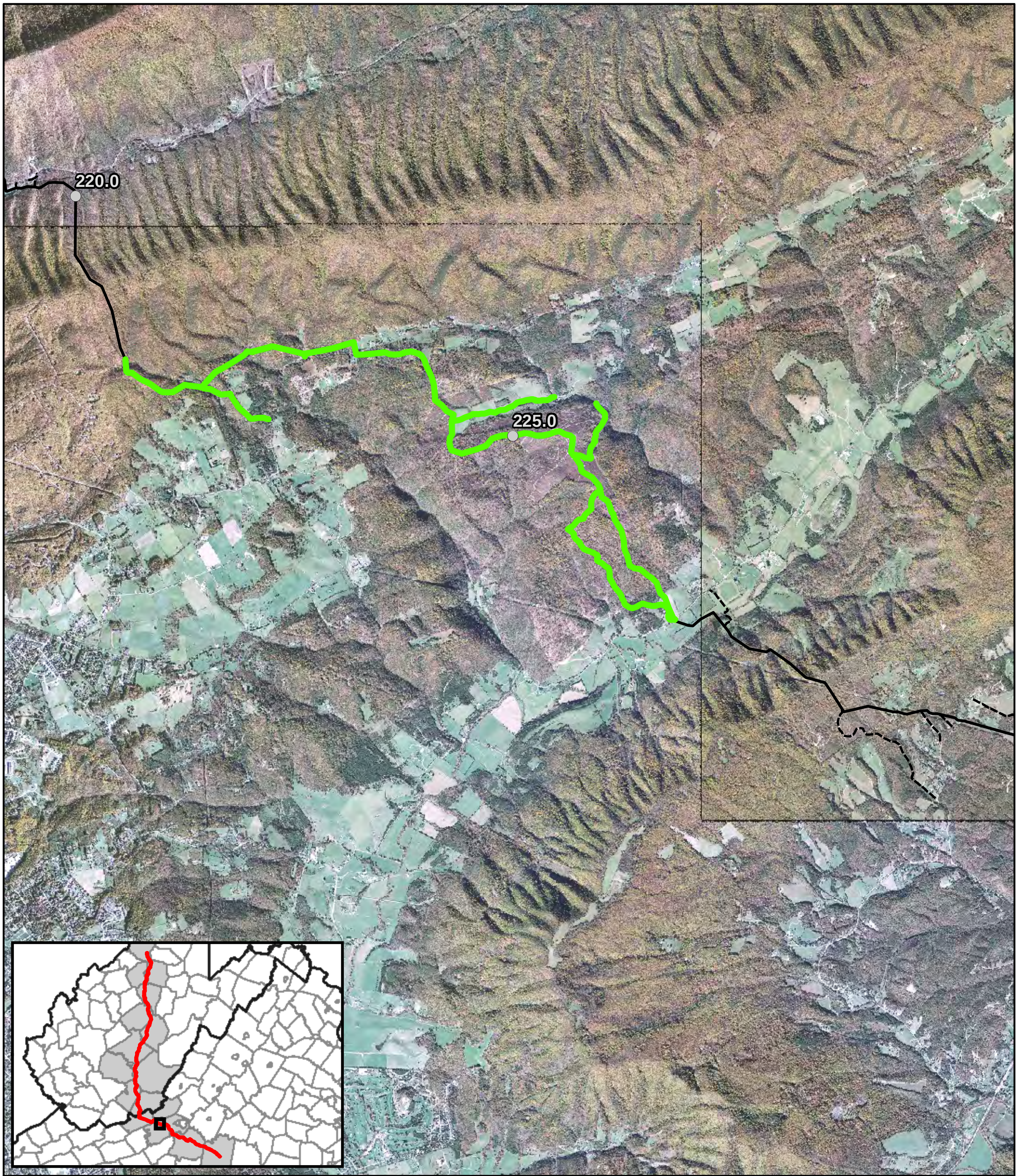

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Figure 25. Potential occurrence of smooth coneflower (*Echinacea laevigata*) in the Project Area.

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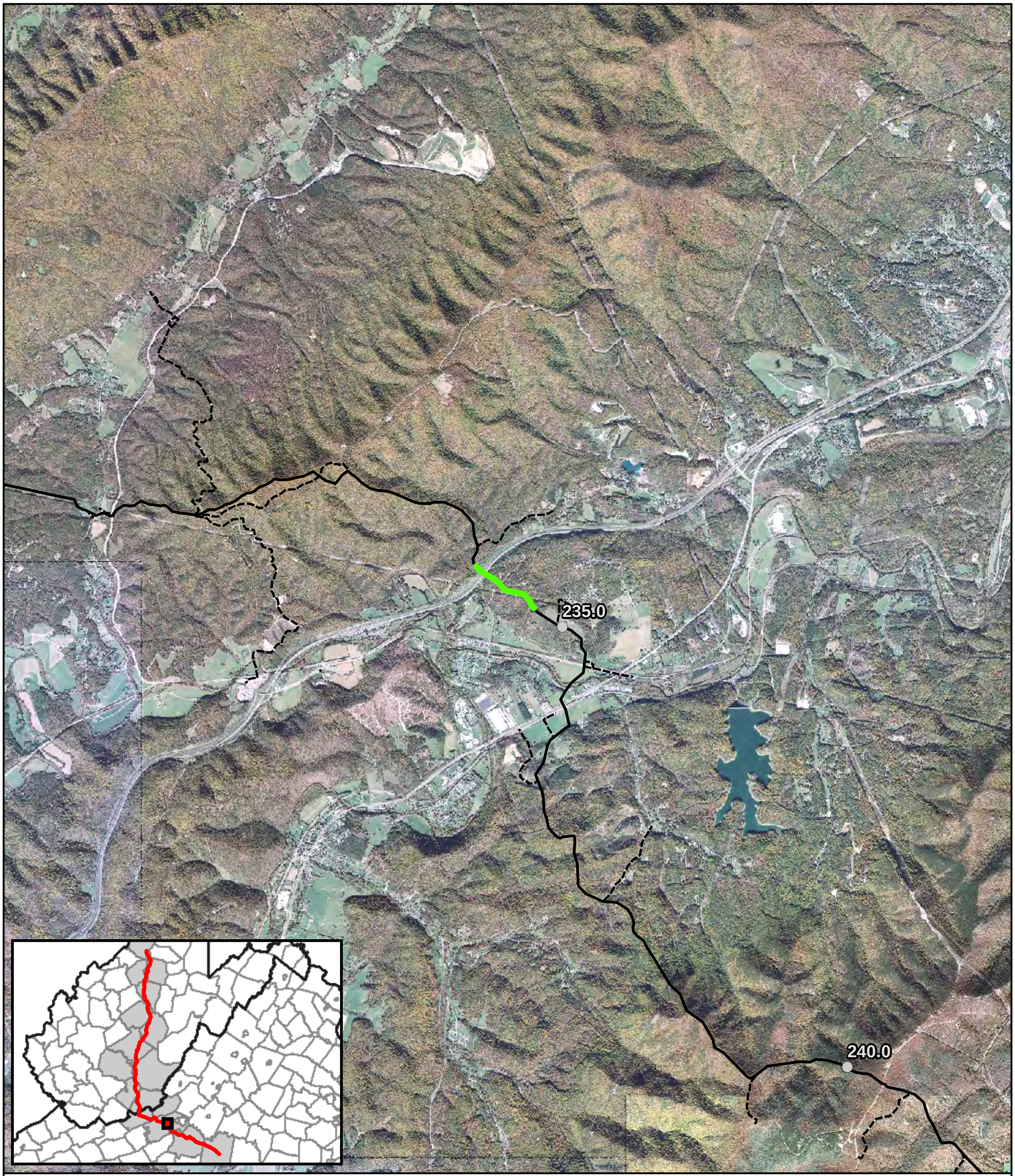

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Figure 25. Potential occurrence of smooth coneflower (*Echinacea laevigata*) in the Project Area.

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Virginia spiraea can be differentiated from other spiraeas mainly by its creamy white flower color and leaves which have an acute apex (Weakley 2015). It most closely resembles shinyleaf meadowsweet (*Spiraea betulifolia* var. *corymbosa*). Virginia spiraea is distinguished from shinyleaf meadowsweet by its leaves which are more than twice as long as wide and cuneate base (Weakley 2015). The introduced Japanese spiraea (*Spiraea japonica*) occurs in similar habitats but has pink flowers and leaves with long-acuminate tips (Patrick et al. 1995).

4.15.1 Habitat Requirements

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. 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 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. The elevation range is 304.8 to 731.5 meters (1000 to 2400 ft). In West Virginia, it occurs among large boulders, flatrock, and flood debris along scoured stream-sides. Soils are silt and sand and elevation for populations ranges from 304.8 to 548.6 meters (1000 to 1800 ft).

Associated plants in Virginia include trees, shrubs and forbs such as hazel alder (*Alnus serrulata*), American hogpeanut (*Amphicarpaea bracteata*), sweet birch (*Betula lenta*), river birch (*B. nigra*), trumpet creeper (*Campsis radicans*), American hornbeam (*Carpinus caroliniana*), common buttonbush (*Cephalanthus* sp.), silky dogwood (*Cornus amomum*), leatherwood (*Dirca* sp.), scouringrush horsetail (*Equisetum hyemale*), ash (*Fraxinus* sp.), common winterberry (*Ilex verticillata*), cardinalflower (*Lobelia cardinalis*), royal fern (*Osmunda regalis*), ninebark (*Physocarpus* sp.), American sycamore (*Platanus occidentalis*), dotted smartweed (*Polygonum punctatum*), Japanese meadowsweet (*Spiraea japonica*), steeplebush (*S. tomentosa*), eastern poison ivy (*Toxicodendron radicans*), bluejacket (*Tradescantia ohiensis*), hemlock (*Tsuga* sp.), wingstem (*Verbesina alternifolia*), and yellowroot (*Xanthorhiza simplicissima*). In West Virginia, associated plants are red maple (*Acer rubrum*), hazel alder (*Alnus serrulata*), river birch, common buttonbush, silky dogwood, leatherwood, common winterberry, royal fern, creeper

(*Parthenocissus* sp.), ninebark, American sycamore, Japanese meadowsweet, eastern poison ivy, bluejacket, hemlock, and yellowroot.

Many sites are threatened by changes in hydrology by impoundment and by impact from recreational use, hydroelectric facilities, and run-off debris. Small populations may be threatened by severe flooding that results in wash-outs of the streambank. Other threats include exotic species, such as multiflora rose (*Rosa multiflora*) and Japanese honeysuckle (*Lonicera japonica*), that compete with Virginia spiraea, roadside maintenance, damage by mammals, ATV use, and upslope timbering. One site in West Virginia is near a powerline ROW and may be threatened by herbicide overspray.

4.15.2 Site-specific Data

There are 31 known stream populations of Virginia spiraea across seven states (decreased from 39 populations in eight states) (USFWS 1992). The closest known populations to the Project Area are in Summers and Nicholas counties, West Virginia and thus search efforts were concentrated there. Based on desktop analyses, potential habitats searched for Virginia spiraea are provided on Figure 26.

4.15.2.1 Habitat

Virginia spiraea habitat was initially determined based on consultation with USFWS and desktop analyses. These areas were then assessed during plant surveys which revealed potential habitat for Virginia spiraea along the Gauley River within the Project Area in Nicholas County, West Virginia.

4.15.2.2 Occurrence

A survey for Virginia spiraea was performed August 5 – 12, 2015 in Summers and Nicholas counties, West Virginia yielding no individuals. Due to land access issues, 0.14 kilometer (0.09 mi) in Summers County remains to be surveyed in 2017 (Table 1).

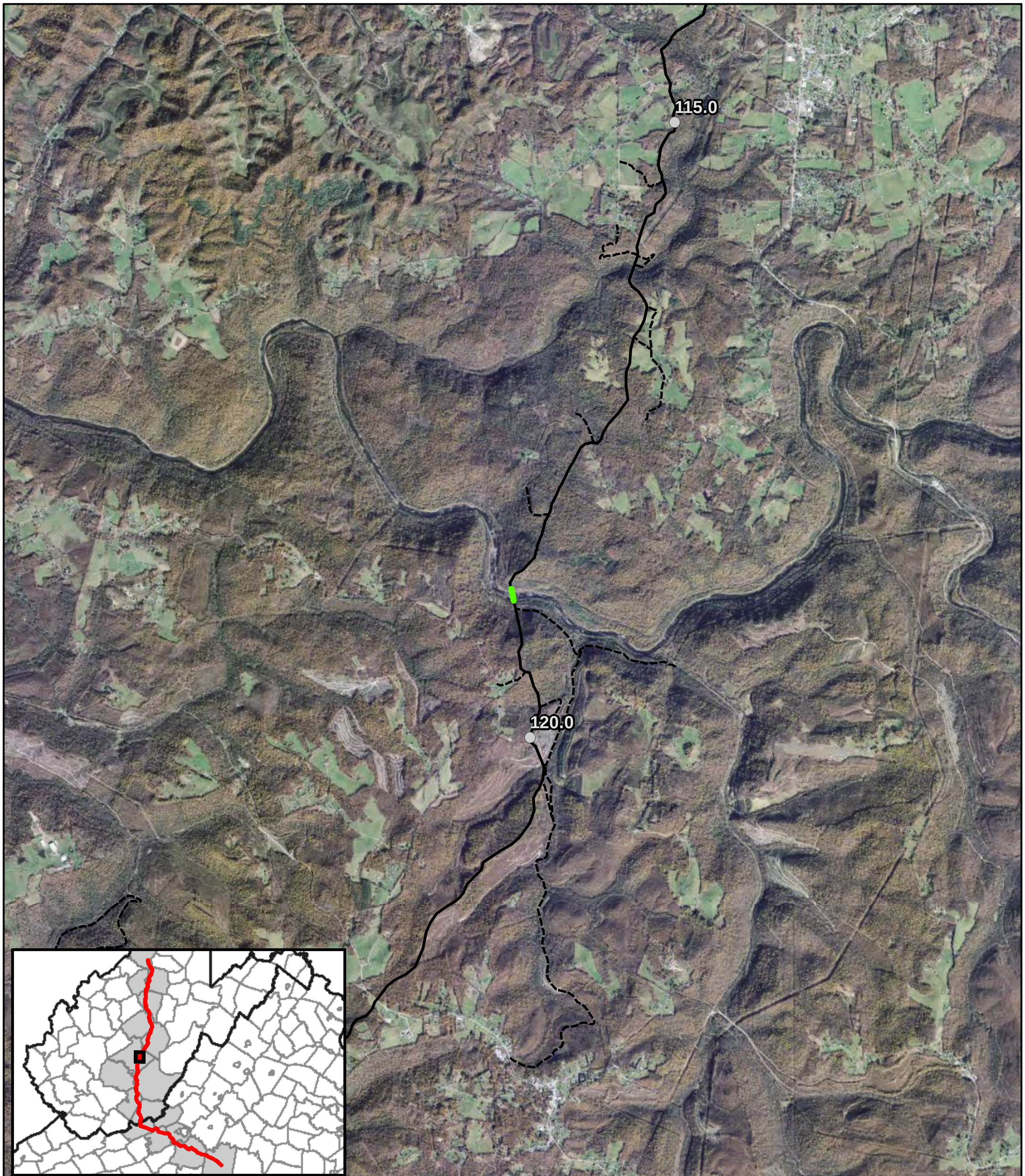

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Figure 26. Potential occurrence of Virginia spiraea (*Spiraea virginiana*) in the Project Area.

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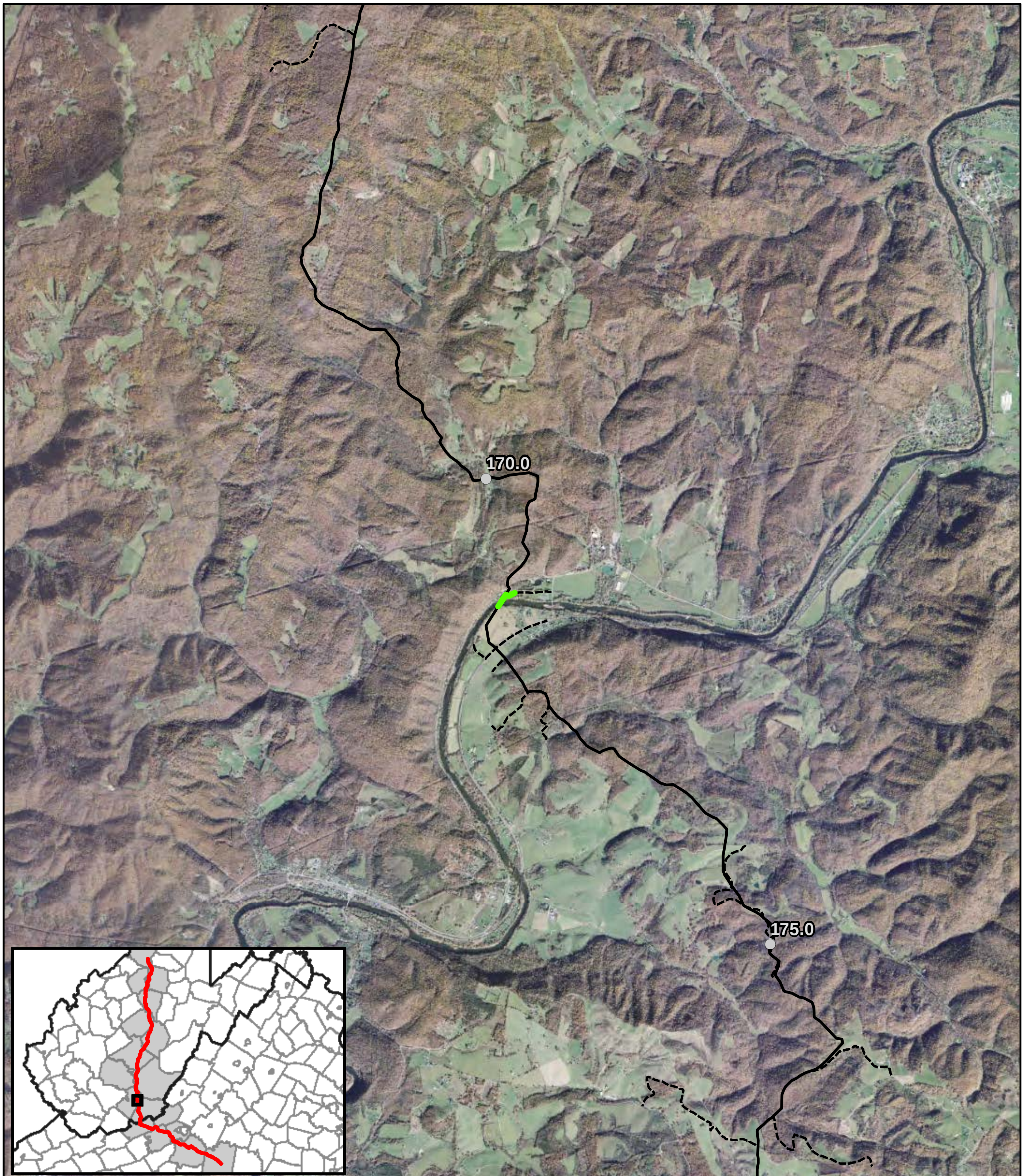

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Figure 26. Potential occurrence of Virginia spiraea (*Spiraea virginiana*) in the Project Area.

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5.0 Effects Analysis

5.1 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 15), and areas where survey data do not exist (and thus presence is assumed).

Table 15. Known Indiana bat occurrences within the Action Area.

[redacted]

*5-mile buffer was established around the three known entrances of the cave.
†Area within 8 kilometers (5 mi) of the feature.

Within these areas, timber clearing and destruction of hibernacula pose the greatest potential threats to individuals. Clearing of forested habitat within the Project Area is largely anticipated to occur from January through May of 2018; however, several areas of the Project will likely need to be cleared between August and November of 2018 (Figure 27). MVP will adhere to the time of year restriction for tree removal (April 1 – November 15) within 8 kilometers (5 mi) of known Indiana bat hibernacula and within 8 kilometers (5 mi) of the summer capture of an Indiana bat in Wetzel County, West Virginia (Table 15).

5.1.1 Direct Effects to 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. Methods and results of predictive models used to estimate occurrence and abundance of Indiana bat are described in Section 4.1 (with further details in Appendix C).

5.1.1.1 Winter Season of Hibernation

As detailed in Section 4.1.2.4, there are 131 potential winter hibernacula features within the Project vicinity. These include 124 features with assumed presence, two Priority 3/4 winter hibernacula (Table 15): [redacted]

FIGURE 27
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[redacted] 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 noises is possible.

Noise Impacts to Hibernating Bats. The Action Area for the Project is defined as extending 965.6 meters (3,168 ft) (0.97 kilometer [0.6 mi]) from the edge of the Project Area, based on the distance to which Project sounds during construction would be above an intensity rated as quiet for human hearing (see assessment in Section 3.1.3). Of 131 potential features within 5 miles of the project, 62 occur within the action area. One of these, Tawney's Cave, previously identified as occupied by the species [redacted]

In order to quantify the level of take from Project activities, an abundance estimate of 2.007 bats was used for [redacted] the four suitable portals, but for features with unknown suitability an estimate of 0.9262 bats was used (see Section 4.1.2.4 and Appendix C). Individuals, if present, within these portals have the potential to be harassed during hibernation, and it is expected that in total 62.828 bats may be harassed:

	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)	
	62.828	**Total individuals harassed**	Eq. 2

Since take is measured as whole individuals, this is rounded up to 63 individuals.

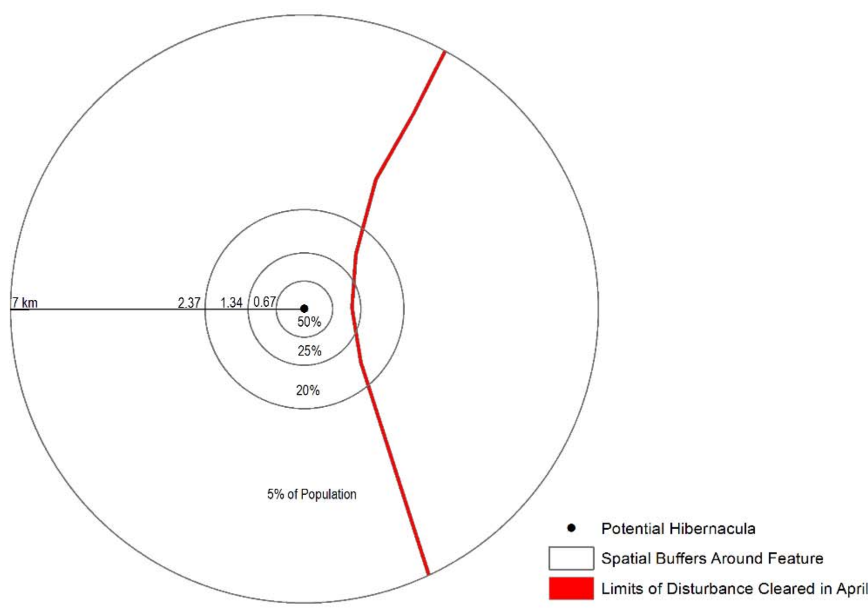
Because bats also have potential to be harassed from noise during operation of the compressor stations, the effects analysis also included an assessment of hibernacula surrounding potential locations of permanent aboveground facilities (i.e., compressor stations); however, there are no (0) documented hibernacula (known or potentially occupied) within 0.97 kilometer (0.6 mi) of a compressor station location. Based on these data, the risk of harassing hibernating Indiana bats by operational noise is insignificant and discountable.

5.1.1.2 Autumn Swarming and Spring Staging

As described in Section 4.1.1, after emerging from hibernation, Indiana bats participate in a spring staging, where bats remain near the hibernacula for a short time (e.g., couple of days) before migrating. A similar process occurs in autumn but over a longer time period, with most bats roosting in forested habitat within 8 kilometers (5 mi) of the cave entrances. As identified in Section 5.1.1.1 above, 131 potential hibernacula features exist within 8 kilometers (5 mi) of the Project Area, two 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 in two primary ways. First, removal of wooded habitat associated with Project construction creates the potential for both injury and mortality. Second, individuals 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 to individuals during spring staging, information on the temporal and spatial attributes of bat activity during spring was derived 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, and 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, the spatial configuration of roost tree use during spring and autumn was derived from Gumbert et al. (2002) and used to create concentric bins surrounding known or potentially occupied portal features. Based on this information, it is expected that 50 percent of the population is found within 0.67 kilometer (0.416 mi) of the hibernacula, 25 percent between 0.67 (0.416 mi) and 1.34 kilometers (0.833 mi), 20 percent between 1.34 (0.833 mi) and 2.37 kilometers (1.473 mi), and 5 percent between 2.37 and 7 kilometers (1.473 and 4.35 mi, respectively; Figure 28).



Example Total Winter Abundance	Proximity Bin	Expected Individuals Staging in Bin	Proportion of Bin within the LOD Cleared in April	Expected Individuals Staging within LOD within Bin	Expected Harm	Expected Harassment
	0.67-1.34 km	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
10	1.34 -2.37 km	10×0.20=2	0.017	2×0.017=0.034	0.034×0.25=0.0085	0.034×0.75=0.0255
	2.37–7 km	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

Figure 28. Example diagram (top) and respective example take calculation (bottom) for staging Indiana bats due to tree clearing surrounding a potential hibernacula.

Using both the temporal and spatial aspects of staging derived from Cope and Humphrey (1977) and Gumbert et al. (2002), respectively, the number of staging bats in a bin surrounding a potential hibernaculum was calculated as the product of 1) the number of individuals expected in the feature during the winter months (as derived in Section 4.1.2.3 and detailed in Appendix C; see column 1 in Figure 28) and 2) 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 Figure 28). This estimate was then used to calculate the potential harm and harassment from 1) tree felling and 2) construction disturbance.

Tree-Clearing Impacts During Spring Staging. Expected harm of staging bats within each bin surrounding a potential hibernacula (Figure 28) was calculated as the product of 1) the number of bats expected in the bin (e.g., column 3 of Figure 28), 2) the proportion of the bin within the LOD cleared during April (e.g., column 4 of Figure 28), and 3) the expected harm rate (25 percent), as explained in the following narrative. 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, the sample size in these studies was fairly low and estimates only include mortality. To offset this low sample size and to include the potential for additional injury, a conservative harm rate of 25 percent was used. All bats present within the portion of the bin within the LOD but not harmed are assumed to be harassed (i.e., harassment rate =75%).

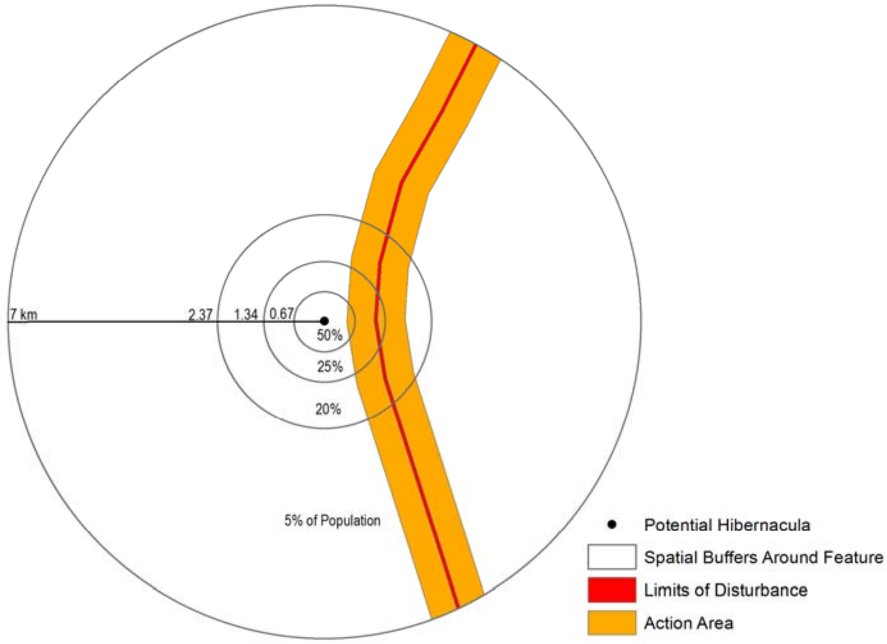
Based on the tree clearing schedule, harm and harassment from tree clearing is possible surrounding 70 different features within the month of April. However, these 70 features only include areas without confirmed occupancy: 4 features discovered during searches for portals that remain unsurveyed for the presence of bats and 66 features with unknown suitability (Table 16). No tree clearing will occur in April near Tawney's Cave or Greenville Saltpeter. 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. Estimated harm is 0.0689 bats, and estimated harassment is 0.2066 bats (Table 16).

Table 16. Potential areas for harm and harassment of spring staging Indiana bats from tree felling.

Feature Type*	Winter Abundance Estimate	Freq†	Proximity Bin (km)‡	Proportion of Ind. within Bin‡	Proportion of Forest in Bin Cleared in April	Expected Individuals Present in Cleared Forest in April	Expected Harassment§	Expected Harm§
Suitability Unknown	0.9262	66	0-0.67	0.50	0.0028	0.9262×66 ×0.50 ×0.0028=0.0856	0.0642	0.0214
			0.67-1.34	0.25	0.0032	0.9262×66 ×0.25 ×0.0032=0.0489	0.0367	0.0122
			1.34-2.37	0.20	0.0035	0.9262×66 ×0.20 ×0.0035=0.0428	0.0321	0.0107
			2.37-7	0.05	0.0023	0.9262×66 ×0.05 ×0.0023=0.0070	0.0053	0.0018
Suitable, Unsurveyed	2.007	4	0-0.6	0.50	0.0058	2.007×4 ×0.50 ×0.0058=0.0233	0.0175	0.0058
			0.67-1.34	0.25	0.0272	2.007×4 ×0.25 ×0.0272=0.0546	0.0410	0.0137
			1.34-2.37	0.20	0.0072	2.007×4 ×0.20 ×0.0072=0.0116	0.0087	0.0029
			2.37-7	0.05	0.0038	2.007×4 ×0.05 ×0.0038=0.0015	0.0011	0.0004
					Total	0.2753	0.2066	0.0689

*In addition to the two known hibernacula (Tawney's Cave and Greenville Saltpeter Cave) 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).
†Frequency (Freq) refers to the number of features where impacts may occur from the activity.
‡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 28 for an example).
§Harassment and harm was calculated by multiplying the individuals present by 0.75 and 0.25, respectively.

Construction Impacts 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. Such harassment can be calculated for each feature as the product of 1) winter abundance estimate (see Section 4.1.2.3) (see example in column 1 of Figure 29), 2) the proportion of staging bats within each concentric bin as derived from Gumbert et al. (2002) (see calculation in column 3 of Figure 29), and 3) the proportion of the bin within the Action Area (column 4 of Figure 29). Note that no timeframe is incorporated within this estimate because it was assumed that all bats that participate in staging within 0.97 kilometers (0.6 mi) of the Project (as defined by the Action Area) will be harassed. No take from harm is anticipated as a result of noise, sound, or dust from Project construction. Using this approach, it was estimated that, cumulatively, 55.2544 staging bats may be harassed by construction disturbances during the spring (Table 17).



Total Winter Abundance	Proximity Bin	Expected Individuals Staging in Bin	Proportion of Bin within Action Area	Expected Harassment
10	0-0.67 km	10×0.50=5	0.06	5×0.06=0.3
	0.67-1.34 km	10×0.25=2.5	0.28	2.5×0.28=0.7
	1.34 -2.37 km	10×0.20=2	0.27	2×0.27=0.54
	2.37–7 km	10×0.05=0.5	0.08	0.5×0.08=0.04
			Total	1.58

Figure 29. Example diagram (top) and respective take calculation (bottom) for staging Indiana bats due to construction disturbance surrounding a potential hibernacula.

Table 17. Potential harassment of staging Indiana bats within the Action Area.

Feature Type*	Winter Abundance Estimate	Freq. †	Proximity Bin‡	Proportion of Abundance within Bin‡	Cumulative Prop of Bin in Action Area	Expected Harassment
Suitability Unknown	0.9262	124	0-0.67 km	0.5	0.4149	(0.9262×124)×0.5× 0.4149=23.8254
			0.67-1.34 km	0.25	0.3961	(0.9262×124)×0.25× 0.3961=11.3729
			1.34-2.37 km	0.20	0.3962	(0.9262×124)×0.2× 0.3962=9.1006
			2.37-7km	0.05	0.2283	(0.9262×124)×0.05× 0.2283 =1.311
Suitable, Unsurveyed	2.007	5	0-0.67 km	0.5	0.8699	(2.007×5)×0.5× 0.8699=4.3647
			0.67-1.34 km	0.25	0.8635	(2.007×5)×0.25× 0.8635=2.1663
			1.34-2.37 km	0.20	0.6378	(2.007×5)×0.2× 0.6378=1.2801
			2.37-7km	0.05	0.2563	(2.007×5)×0.05× 0.2563 =0.1286
Tawney's Cave	2.007	1	0-0.67 km	0.5	0.9953	2.007×0.5× 0.9953=0.9988
			0.67-1.34 km	0.25	0.7502	2.007×0.25× 0.7502=0.3764
			1.34-2.37 km	0.20	0.5096	2.007×0.2× 0.5096=0.2046
			2.37-7km	0.05	0.2099	2.007×0.05× 0.2099 =0.0211
Greenville Saltpeter	6	1	0-0.67 km	0.5	0.0000	6×0.5× 0.0000=0.0000

Feature Type*	Winter Abundance Estimate	Freq. †	Proximity Bin‡	Proportion of Abundance within Bin‡	Cumulative Prop of Bin in Action Area	Expected Harassment
Cave			0.67-1.34 km	0.25	0.0000	6×0.25× 0.0000 =0.0000
			1.34-2.37 km	0.20	0.0227	6×0.2× 0.0227=0.0272
			2.37-7km	0.05	0.2556	6×0.05× 0.2556 =0.0767
					Total	55.2544

*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).
†Frequency (Freq) refers to the number of features where impacts may occur. .
‡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 28 for an example).

Cumulatively, 55.461 and 0.0689 staging bats may be harassed or harmed, respectively, during spring staging. This harassment estimate combines harassment due to 1) the clearing of a tree with a bat occupying it but the bat escaping unharmed (0.2066; Table 16) with 2) the potential harassment due to clearing and construction noises within a 0.9-kilometer (0.6-mi) radius of the Project (55.2544). 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 these 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.

Tree-Clearing Impacts During Autumn Swarming. Similar to the approach taken for staging, it was assumed that swarming individuals are distributed among different distance bins derived from Gumbert et al. (2002) (Figure 28 and Figure 29). Thus, the number of swarming bats in a bin surrounding a potential hibernacula is calculated as the product of 1) the number of individuals expected in the feature during winter (see Section 4.1.2.3) and 2) the proportion expected to be found within the distance bin derived from information in Gumbert et al. (2002). This estimate was then used to calculate the potential harm and harassment from tree felling and construction disturbance.

Based on these arrival and departure times and the projected MVP 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) intersects the buffers surrounding 26 separate features: 3 features that are suitable but remain unsurveyed [redacted] 23 features with unknown suitability. Tree clearing in fall within these areas, however, is fairly limited representing about 43.51 hectares (107.52 ac), and much of that area is a far distance from the potential hibernacula (Table 18). Given this information, harm and harassment from tree clearing to swarming individuals is possible but the chance is low (Table 18). In total, the expected individuals harassed and harmed is 0.0063 and 0.0021 individuals, respectively.

Table 18. Potential areas for harm and harassment of autumn swarming Indiana bats from tree felling.

Feature Type*	Winter Abundance Estimate	Freq†	Proximity Bin (km)‡	Proportion of Ind. within Bin‡	Proportion of Forest in Bin Cleared in Fall	Expected Individuals Present in Cleared Forest	Expected Harassment§	Expected Harm§
Suitability Unknown	0.9262	23	0-0.67	0.50	0.0000	0.9262×23 ×0.50 ×0.0000=0.0000	0.0000	0.0000
			0.67-1.34	0.25	0.0006	0.9262×23 ×0.25 ×0.0006=0.0032	0.0024	0.0008
			1.34-2.37	0.20	0.0010	0.9262×23 ×0.20 ×0.0010=0.0043	0.0032	0.0011
			2.37-7	0.05	0.0008	0.9262×23 ×0.05 ×0.0008=0.0009	0.0007	0.0002
Suitable, Unsurveyed	2.007	3	0-0.6	0.50	0.0000	2.007×3 ×0.50 ×0.0000=0.0000	0.0000	0.0000
			0.67-1.34	0.25	0.0000	2.007×3 ×0.25 ×0.0000=0.0000	0.0000	0.0000
			1.34-2.37	0.20	0.0000	2.007×3 ×0.20 ×0.0000=0.0000	0.0000	0.0000
			2.37-7	0.05	<0.0001	2.007×3 ×0.05 ×0.0000=0.0000	<0.0001	<0.0001
					Total	0.0084	0.0063	0.0021

*In addition to the two known hibernacula (Tawney's Cave and Greenville Saltpeter Cave) 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).
†Frequency (Freq) refers to the number of features where impacts may occur from the activity.
‡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 28 for an example).
§Harassment and harm were calculated by multiplying the individuals present by 0.75 and 0.25, respectively.

<u>Construction Impacts During Autumn Swarming</u>. 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 0.97 kilometers (0.6 mi) of the Project (as defined by the Action Area). No timeframe is incorporated within this estimate because it was assumed that all bats that participate in swarming will be harassed. Such harassment was calculated for each feature as the product of 1) the winter abundance estimate (see Section 4.1.2.3), 2) the proportion of swarming bats expected within each concentric bin surrounding a hibernaculum as derived from Gumbert et al. (2002), and 3) the proportion of the bin within the Action Area (Figure 29). Note that this is the same calculation as performed in Table 17. Using this approach, it is expected that 55.2544 swarming bats will be harassed from construction disturbances (e.g., noise). Rounding up, the cumulative expected number of swarming Indiana bats harmed or harassed by the Project is 1 and 56, respectively.

Operational Impacts to Staging and Swarming Bats. Operational harassment to swarming and staging individuals via noise is also possible surrounding 0.97 kilometers (0.6 mi) of each compressor station for the Project. However, there are no known or assumed occupied hibernacula within 9.02 kilometers (i.e., the sum of the 8.05-km buffer where staging and swarming is thought to occur and 0.97-km noise buffer) of these compressor stations. Therefore, no harassment from sound disturbance from compressor stations to swarming/staging individuals is expected.

5.1.1.3 Summer Season of Reproduction

Field studies conducted in support of this BA failed to provide evidence of occupation by Indiana bats during the summer season of reproduction (Section 1.4.1.1). However, the Project intersects an area of known, occupied summer habitat from Project MP 0.0 to MP 10.3 (Table 15). 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, harm and harassment are possible. Harm to summering individuals is only possible within forested areas cleared in the summer months when bats summering individuals 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 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, it was 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.

Tree-Clearing Impacts During Summer. Based on these arrival and departure times and the projected MVP tree clearing schedule, harm and harassment from tree clearing is possible within areas cleared in April, May, and the fall (August through November) that intersect these areas of assumed presence. Harm and harassment from tree clearing is also possible for individuals around hibernacula during this same timeframe and other times of the year which is addressed in Section 5.1.1.2. Within areas cleared in April and the fall (particularly August) that intersect the 8-kilometer (5-mi) buffers surrounding known and potential Indiana bat hibernacula, tree clearing has the potential to harm and harass both staging/swarming and summering individuals, and thus 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 impacted.

In total, areas expected to be cleared in April, May, and the fall represent approximately 211.36 hectares (522.27 ac) in Virginia and 566.52 hectares (1,399.91 ac) in West Virginia. However, much of this clearing takes place within areas sampled sufficiently to suggest probable absence of the species during the summer months. Only 24.38 forested hectares (60.24 ac) within Virginia and 338.59 forested hectares (836.68 ac) 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, the summer densities derived in Section 4.1.2.2 (detailed in Appendix C) were used. 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 5.1.1.2, 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 19), which was rounded up to 1 individual harassed and 1 individual harmed.

Table 19. Potential areas for harm and harassment of summer roosting Indiana bats from tree felling.

State	Summer Density	Month*	Forested Acres Cleared with Assumed Presence†	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

*Fall refers to clearing that may occur from August to November.
†Note that these acres were adjusted to remove areas where sufficient sampling was performed to claim probable absence.

Construction Impacts 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, it is 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 is addressed in Section 3.1.3. Noise from construction activities is short in duration, but the localized nature of the persistent noise and the fact that bats are able to restrict the size of their ear canal (Henson 1970), likely provides some protection from increased sounds.

To calculate the number of individuals potentially harassed during summer roosting, the density estimates from Section 4.1.2.2 (also provided in Table 19) were multiplied by the number of forest acres expected to be disturbed during active construction within each state (i.e., areas within 0.97 km [0.6 mi] of the LOD). 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 131,787.71 and 40,830.79 acres of forest within the Action Area of West Virginia and Virginia, respectively, that remain unsampled for Indiana bat will be within the range of potential disturbance from Project construction.

$$\begin{array}{rl} & 0.000202 \text{ bats/acre in West Virginia} \times 131{,}787.71 \text{ acres} \\ + & \underline{0.000073 \text{ bats/acre in Virginia} \times 40{,}830.79 \text{ acres}} \\ & 29.60177 \text{ bats,} \end{array} \quad \text{Eq. 3}$$

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, MVP will use water trucks to control dust during summer construction, which will limit dust emissions to the immediate vicinity of the Project Area. Further, these minimized potential impacts on air quality that could affect bats will be temporary, occurring only during the overlap in time when construction is on-going and bats are present in the Action Area during summer or migration. Impacts to 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 are occurring simultaneously during Project construction, and the impact area for noise effects exceeds that created for dust.

Operational Impacts 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 3.1.3. Noise from compressor stations is, in effect, in perpetuity. However, noise associated with permanent facilities are 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 0.97 kilometers of each compressor station where sampling was not sufficient to claim probable absence for Indiana bat. Such harassment was calculated similarly to Eq. 3:

$$0.000202 \text{ bats/acre in West Virginia} \times 1{,}883.16 \text{ acres} = 0.3804, \qquad \text{Eq. 4}$$

which is rounded up to 1 bat harassed during operations of the Project.

5.1.1.4 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.

Tree-Clearing Impacts 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, and this take is assessed in Section 5.1.1.2.

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. This total number was then multiplied by 0.25 to get an estimate of harmed individuals from tree clearing (see Section 5.1.1.2), and all other individuals are assumed to be harassed.

In West Virginia, it is expected that 566.52 forested hectares (1,399.91 ac) will be cleared in the months of April, May, and August. Likewise, 211.36 hectares (522.27 ac) will be cleared within Virginia within that same time frame. Given these clearing areas and the respective densities, it is unlikely but possible that migrant Indiana bats will be harmed or harassed from tree clearing from the Project. Expected harm and harassment was estimated to be less than one individual (Table 20), 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.

Table 20. Potential areas for harm and harassment of migrant Indiana bats from tree felling.

State	Density	Month*	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.

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 is only possible within the LOD in forested areas where trees are actively being cleared.

5.1.2 Direct Effects on Habitat

5.1.2.1 Winter Season of Hibernation

The Project will not directly impact any currently known Indiana bat hibernacula. Field searches for cave or mine openings identified 52 features; 13 of which are within the construction ROW. 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.

Because of the proximity of the Project to Tawney's Cave, a hydrologic and geologic analysis was performed that demonstrated that there is negligible risk to karst features, hydrology, and biological resources of the feature. This conclusion is based on several mitigating factors, including the nature and scale of construction, the separation between each cave and the proposed construction ROW, and importantly the relative position of the proposed alignment compared to the cave and upland catchment (i.e., karst watershed). [redacted] o impacts to the cave system are anticipated. MVP will employ stringent erosion and sedimentation controls, as well as implement karst inspection and mitigation to minimize potential impacts to karst features. MVP will be adequately prepared for and will 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 Erosion and Sediment Control Plan for Virginia, and the Karst Mitigation Plan. Specific measures are described in these documents and summarized in Section 2.0.

5.1.2.2 Autumn Swarming and Spring Staging

Approximately 157,757.06 hectares (389,826.18 ac) of forested habitat occur within 8 kilometers (5 mi) of the 131 features that are considered to be known or potentially occupied winter habitat within the vicinity of the Project (n=131). Within these areas of winter habitat, Project development will reduce forested (swarming and staging) habitat by 0.21 percent (325.49 hectares [804.31 ac]) from construction. One-hundred-thirty-seven hectares will be allowed to regenerate following construction (which may take upwards of 25 years to become suitable roosting habitat again), but the Project will permanently reduce forested habitat by 0.12 percent (188.1 hectares [464.8 ac]). This loss is a small fraction of the available fall swarming/spring staging habitat.

5.1.2.3 Summer Season of Reproduction

As a whole, the Project is expected to convert 1,804.65 hectares (4,459.37 ac) and 647.85 hectares (1,600.87 ac) of forest (including woody wetlands) during construction and operation, respectively, into a largely herbaceous habitat within a 2,575.01-hectare (6,362.98-ac) Project Area (Table 11) and a 112,938.63-hectare (279,077.19-ac) Action Area. These lands are assumed to provide viable habitat for foraging and roosting bats before construction and unsuitable roosting habitat after construction. No forested acres will be retained within the Project Area, but 87,797.04 hectares (216,951.01 ac) of forest will 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 take Indiana bat individuals. In a study conducted in southern Michigan, Kurta (2002) found a In southern Michigan, Kurta (2002) found Indiana bats prospering in areas of 36 percent forest cover in a 12,529.8-hectare (30,962-ac) study area. In Illinois, Gardner et al. (1991) found 90 percent of Indiana bat capture sites had 33 percent forest coverage within a 0.9-kilometer (0.6-mi) radius of capture sites (assumes the capture site was the center of the area used). Brack and Tyrell (1990) found forest cover at 33 Indiana bat capture sites in northern Indiana was 30 percent within 0.9 kilometer (0.6 mi). Finally, habitat models by Rommé et al. (1995) and Farmer et al. (2002) indicated that sites with 30 and 31 percent (respectively) woodland cover (or more) within a 0.9-kilometer (0.6-mi) area support maternity colonies (i.e., they have a suitability index of 1 or 100 %). 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 8.37 kilometers (5.3 mi) of all known roosts, but this number rises to 28 percent when all habitat within 95 percent 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). Finally, in glaciated portions of Ohio, Indiana bats have home ranges that were 21.7 percent forested, on a landscape that is 7 percent forested (Kniowski and Gehrt 2014). 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 1,804.646 hectares (4,459.373 ac) of forest for construction, which would result in an Action Area with 77.7 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 MP 0.0 to 10.3 surrounding the capture of an individual in Wetzel County, West Virginia for a separate Project. Within the 8-

kilometer (5-mi) buffer surrounding the capture location, the land scape is mostly forested (94.48 percent) with approximately 19,218.8 hectares (47,490.69 ac) of forest (Table 15). Within this area, the Project is expected to remove 92.18 hectares (227.78 ac) of forest. The majority of this forest (150.87 ac) will be allowed to regenerate, but 76.91 acres will be maintained as an herbaceous state once construction is completed. After trees are removed for the Project, the 8-kilometer (5-mi) buffer will remain largely forested (94 percent) with higher forest cover than those reported by Brack and Tyrell (1990), Gardner et al. (1991), Farmer et al. (2002), Kurta (2002), Watrous et al. (2006), and Kniowski and Gehrt (2014).

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

5.1.2.4 Spring and Autumn Migration/Transient Period

Relatively little is known about timing or use of habitat 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 1,804.646 hectares (4,459.373 ac) of forested habitat exist and will be lost within the construction ROW and 647.85 hectares (1,600.87 ac) of forested habitat exist within the permanent ROW. Nearly 1,157 hectares will be allowed to regenerate following construction (which may take upwards of 25 years to become suitable habitat again), but the Project will permanently reduce forested habitat by 0.72 percent within the Action Area.

This forest loss is a tiny 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 will not rise to the level of harm or result in a take of individuals.

5.1.3 Indirect Effects

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

5.1.3.1 Detrimental

Clearing of Roost Trees During Winter. Trees in the Project Area will be removed from January through May 2018 and August 2018 through November 15, 2018, if needed. Time-of-year restrictions, however, will be met within 8 kilometers (5 mi) 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 will encounter a cleared area that is an active construction site. Within this area, direct effects of the Project include removal of 1,804.65 hectares (4,459.37 ac) 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 (2004)'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. At this scale, removal of all or most available roosting and foraging areas may result in adverse effects to the colony. Individuals returning the following spring will no longer have the familiar roost tree(s) and surrounding foraging habitat available. Instead individuals will need to expend greater energy in locating alternative resources. However, construction of the MVP Project would require clearing a linear corridor and not a large-scale areal clearing of the landscape. 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 northern long-eared (Silvis et al. 2014a, Silvis et al. 2015) and Indiana (Silvis et al. 2014b) bats 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.

As stated above, clearing of a known maternity roost tree during the winter may 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 (2005) 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 (2005) 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 will have to expend additional energy to search for alternative roosts, which could result in reduced reproductive success for some females. If impacted, 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 Section 1.4.1.3). Although individuals returning to the Project Area will have to find new roosts, many potential roost trees are within the vicinity of the Project, and thus individuals will 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 can 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 3.1.2. Though limited, artificial lighting will 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 will be most common when completing stream crossings and during the hydrostatic testing phase. Permanent lighting structures will be installed at all three compressor stations to allow for the station surveillance systems to operate and enable a safer working environment for MVP staff conducting any necessary operational activities after daylight. As noted in Section 3.1.2 above, the most significant potential effect from lighting is on bat prey. However, it is difficult to assess impacts to 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, MVP has committed to using downward-facing, full cut-off lens lights. “Full cut-off” lighting means no direct uplight will be emitted above horizontal and therefore provides 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 3.1.4. Analysis using the RUSLE identified the boundaries associated with a 10 percent increase in sediment load. In total, 1,135.13 stream kilometers (765.34 mi) 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 indirectly affects Indiana bats as aquatic insects (flies and caddisflies) make up a portion of their diet (Brack

1983, Brack and LaVal 1985, Murray and Kurta 2002). However, terrestrial-based prey (moths and beetles) appear to be preferred by Indiana bats occurring in the species southern range, whereas aquatic-based prey is more commonly taken in the species northern range (Murray and Kurta 2002, USFWS 2007c). In general, 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.

5.1.3.2 Beneficial

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

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

5.2 Northern Long-eared Bats

In January 2016, USFWS 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:
    - o Occurs within 0.25 mile (0.4 kilometer) of a known hibernaculum; or
    - o 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 analyses 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 0.4 kilometer (0.25 mi) surrounding known or potentially occupied hibernacula. Clearing of forested habitat within the Project Area is anticipated to occur from January through May 2018 and August 2018 through November 15, 2018, if needed (Figure 30). Given this schedule, analysis of effects to individuals only considers impacts to this species where take is not exempt under the final 4(d) rule (i.e., within the 0.4-kilometer (0.25-mi) buffers surrounding hibernacula where individuals may be impacted 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 will 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 5.2.1 to 5.2.3) demonstrates that the Project is likely to result in take, beyond that exempted under the 4(d) rule, of 225 individuals through harassment and three individuals through harm.

5.2.1 Direct Effects to 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. Methods and results of predictive models used to estimate occurrence and abundance of northern long-eared bats are described in Section 4.2 and detailed in Appendix C. Effects determinations are provided in Section 7.2.

5.2.1.1 Winter Season of Hibernation

No historic or currently occupied northern long-eared bat hibernacula occurs within the Project's construction workspace. However, noise produced during Project construction has potential to disturb hibernating bats within hibernacula. Based on field searches and desktop analyses, seven suitable, currently occupied, or historically occupied northern long-eared bat portals occur within the Project's Action Area (Section 4.2.2.3).

FIGURE 30
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These include three known hibernacula: [redacted] (Table 21), 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 this analysis because they remain unsampled.

Table 21. Known northern long-eared bat occurrences within the Action Area.

[redacted]

*0.4-kilometer (0.25-mi) buffer was established around the three known enterances of the cave.
† Area within 0.4 kilometers (0.25 mi) of the feature.

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 ROW is less than 60 meters (200 ft) from the closest Tawney's Cave entrance; however, cave entrances and underground voids are unlikely to be altered by construction.

In addition, a hydrologic and geologic analysis was performed 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 ROW, 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 to the cave system are anticipated.

Similarly, the Project is located approximately [redacted] VP adjusted the proposed Project alignment by shifting approximately 396.2 meters (1,300 ft) 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 0.4-kilometer (0.25-mi) buffer of the entrance to Canoe Cave. In addition, the proposed alignment will be located topographically lower and downgradient of the spring associated with Canoe Cave within the DCR Conservation Site thereby eliminating the potential for impacts.

Within the potential catchment for the Canoe Cave, the proposed trench will be approximately 30.5 to 70 meters (100 to 200 ft) above base flow levels leading to Sinking Creek. MVP will employ stringent erosion and sedimentation controls, as well as implement karst inspection and mitigation to minimize potential impacts to karst features. MVP will be adequately prepared for and will 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 Erosion and Sediment Control Plan for Virginia, and the Karst Mitigation Plan.

Noise Impacts to 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 3.1.3). The Action Area for the Project is defined as extending 965.6 meters (0.6 mi) from the edge of the Project Area, based on the distance to which Project sounds during construction would be above an intensity rated as quiet for human hearing. 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 Count, West Virginia), four features that have been deemed suitable but remain unsampled for bats; and 57 features that have not been assessed 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 4.2.2.3 and Appendix C). As described in Section 4.2.2.3, Canoe Cave was not surveyed for the Project but was recently surveyed by the VDCR-DNH. No northern long-eared bats were observed by VDCR-DNH, but historic records indicate the observation of a single hibernating northern long-eared bat from 1982, and this record was used for the effects analysis. Given the results of harp trapping at [redacted] 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

4.2.2.3.2 and Appendix C). Individuals, if present, within these features have the potential to be harassed during hibernation, and it is estimated that in total 221.967 bats will be harassed:

	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	Eq. 5

This estimate is rounded up to 222 individuals.

No known or potentially occupied hibernacula were discovered during field surveys for the Project within 0.97 kilometer (0.6 mi) of a proposed compressor station; therefore, no impacts to hibernating northern long-eared bats from noise during operations is expected.

5.2.1.2 Autumn Swarming and Spring Staging

After emerging from hibernation, northern long-eared bats are thought to participate in a process known as spring staging, where bats remain near the hibernacula for a short time (e.g., couple of 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 5.2.1.1, the Project Action Area includes two previously document northern long-eared bat hibernacula; however, few hibernating northern long-eared bats have been observed within these caves during recent surveys. In addition to the well-documented reduction in population sizes within caves due to WNS, 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 ([redacted] documented by ESI to host northern long-eared bats.

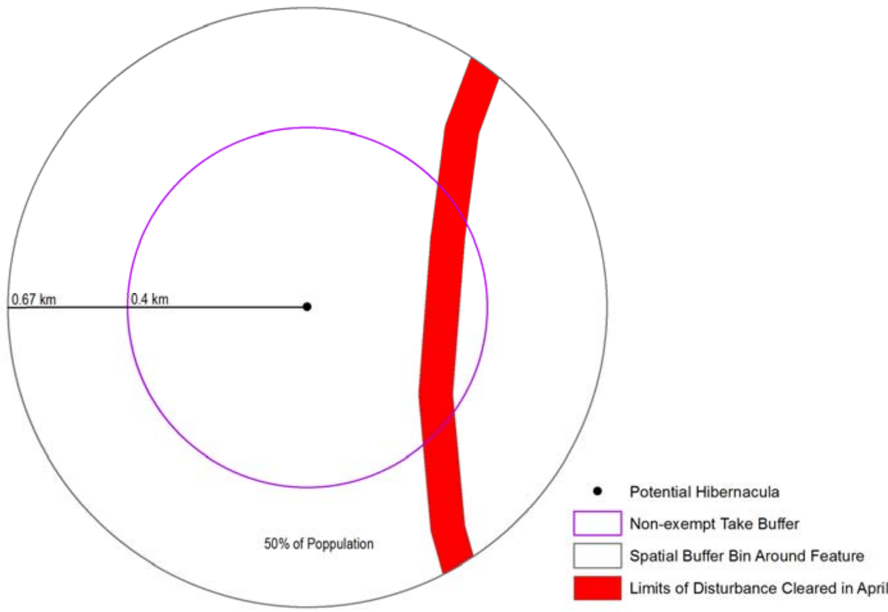
Along with these three known hibernacula, there are an additional four field documented, suitable and potentially occupied features within the Action Area of the Project and 57 features with unknown suitability that may also be occupied. For the purposes of this BA, all of these features are treated 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 0.4-kilometer (0.25-mi) 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 outside of the 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 29.39 hectares (72.63 ac) of forested habitat within the protective buffers (0.4-kilometer [0.25-mi] radius) surrounding the known or potentially occupied portals will be cleared during Project construction, which could potentially harm or harass individuals participating in spring staging or autumn swarming.

Impacts from Tree-Clearing During Spring Staging. To estimate impacts to individuals during spring staging, information on the activity levels of bats in different months during spring was derived 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 10 degrees Celsius, which typically occurred between the second week of March and April each year, and 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, it is assumed that northern long-eared bats demonstrate a similar pattern as the Indiana bat (see Section 4.1.1.2 and Figure 28) with the majority of individuals present within 0.67 kilometers of the feature. For northern long-eared bats, the number of staging bats within 0.4 kilometers (0.25 mi) surrounding a potential hibernacula was calculated as the product of 1) the number of individuals expected in the feature during the winter months (i.e., total winter abundance) as derived in Section 4.2.2.3.2 (column 1 from Figure 31), 2) the proportion expected to be found within the distance of 0.67 kilometer (0.416 mi; based on Gumbert et al. (2002)), and 3) the proportion of the 0.67 kilometer that is within the 0.4-kilometer (0.25-mile) buffer where take is prohibited (i.e., 0.360602; see column 2 of Figure 31). This estimate was then used to calculate the potential harm and harassment from tree felling.



Total Winter Abundance	Expected Individuals Staging within 0.4 km	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*	0.077	1.803×0.077=0.1388	0.1388×0.25=0.0347	0.1388×0.75=0.1041

*0.5 is the proportion of the population within 0.67 km based off of Gumbert et al. (2002) and 0.360602 is the proportion of 0.67 km bin that represents the non-exempt take buffer (i.e., [$\pi \times 0.402336^2$]/[$\pi \times 0.67^2$]).

Figure 31. Example diagram (top) and respective example harm and harassment calculation (bottom) for staging northern long-eared bats due to tree clearing surrounding a potential hibernacula.

Expected harm of staging bats within 0.4 km (0.25 mi) of a potential or known hibernaculum is calculated as the product of 1) the number of bats expected within the buffer (column 2 of Figure 31), 2) the proportion of the bin within the LOD cleared during March and April when staging bats are present (column 3 of Figure 31), and 3) the expected harm rate (0.25). A harm rate of 25 percent was developed for Indiana bats (Section 5.1.1.2) but is assumed to be applicable for northern long-eared bats as well. All bats present within the proportion of the bin within the LOD that are not expected to be harmed are assumed to be harassed.

Based on the tree-clearing schedule, harm and harassment from tree clearing is possible surrounding 14 features within the months of March and April; no tree clearing is 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 is also 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, 5.37 hectares (13.27 ac) of forest are expected to be cleared during March within the 0.4-kilometer 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 may be harmed (Table 22), and 0.2315 individuals will be harassed from tree clearing, which was rounded up to one individual harassed and one individual harmed.

Table 22. Potential areas for harm and harassment of spring staging northern long-eared bats from tree felling.

Feature Type*	Winter Abundance Estimate	Freq†	Proximity Bin (km)‡	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§
Suitability Unknown	3.2384	10	0.4023	0.1803	0.0454	3.2384×10 ×0.1803 ×0.0454=0.2651	0.1988	0.0663
Suitable, Unsurveyed	7.017	3	0.4023	0.1803	0.0059	7.017×3 ×0.1803 ×0.0059=0.0224	0.0168	0.0056
PS-WV3-Y-P1	1.293	1	0.4023	0.1803	0.1177	1.293 ×0.1803 ×0.1177=0.0212	0.0159	0.0053
					Total	0.3087	0.2315	0.0772

*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).

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

‡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 0.67 km as derived from Gumbert et al. (2002) and 2) the proportion of that the 0.67 kilometer buffer that represent the non-exempt take buffer (i.e., 0.3606=.[$\pi \times 0.402336^2$]/[$\pi \times 0.67^2$]).

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

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 come soon after. The majority of individuals likely swarm within August and September, but individuals may be active until mid-November. Thus, 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 0.4 kilometers (0.25 mi) of a known or potential hibernacula. Thus, no prohibited harm or harassment under the final 4(d) rule is expected to swarming individuals.

5.2.1.3 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 1.4.1.1). 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 45.7 meters (150 ft) from June 1 through July 31, when non-volant young are present within the roosts. Woodland habitat will 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 3.1.3. 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.

5.2.1.4 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 (USFWS 2016). 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 0.4-kilometer (0.25-mi) 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 (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. Under these assumptions, harassment and harm are only possible within the LOD 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 will be equally as small. Thus, it is assumed that one migrant individual may be harmed and one individual may be harassed from Project construction.

5.2.2 Direct Effects on Habitat

5.2.2.1 Winter Season of Hibernation

The Project will not directly impact any currently known or potential northern long-eared bat hibernacula. There are no known hibernacula within the Project Area; however, as stated in Section 5.1.2.1, field searches for undocumented cave or mine openings resulted in identification of three potentially suitable features occurring within the Project's construction ROW. 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, a hydrologic and geologic analysis was performed that demonstrated that there is 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 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). Specifically, in relation to Tawney's Cave, the proposed Project is located on an opposite ridge west of the cave and approximately 550 feet from and topographically below the known cave passages at the crossing of Zells Mill Road and Sinking Creek. The project is not located within the Virginia DCR 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 to the cave system are anticipated.

Similarly, the Project is located [redacted] MVP 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 to clear trees near Canoe Cave. No trees will be cleared within 0.4-kilometer (0.25-mi) buffer of the entrance to Canoe Cave. In addition, the proposed alignment will be located topographically lower and downgradient of the spring associated with Canoe Cave within the DCR Conservation Site thereby eliminating the potential for impacts.

Within the potential catchment for the Canoe Cave the proposed trench will be approximately 100 to 200 feet above base flow levels leading to Sinking Creek. MVP will employ stringent erosion and sedimentation controls, as well as implement karst inspection and mitigation to minimize potential impacts to karst features. MVP will be adequately prepared for and will 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 Erosion and Sediment Control Plan for Virginia, and the Karst Mitigation Plan. Specific measures are described in these documents and summarized in Section 2.0.

5.2.2.2 Autumn Swarming and Spring Staging

Approximately 690.15 hectares (1,705.39 ac) of forested habitat occur within 0.4 kilometer (0.25 mi) buffers of known or assumed, occupied winter habitat that intersect the Project Area. Within these areas of winter habitat, Project development will reduce forested habitat by 3.56 percent (24.57 hectares [60.71 ac]) from construction and permanently reduce forested habitat by 1.25 percent (8.62 hectares [21.3 ac]). This loss is a small fraction of the available fall swarming/spring staging habitat, and thus impacts from this habitat modification will be minimal.

5.2.2.3 Summer Season of Reproduction

As a whole, the Project is expected to convert 1,804.646 hectares (4,459.373 ac) and 647.85 hectares (1,600.87 ac) of forest (including woody wetlands) during construction and operation, respectively, into developed, medium intensity habitat within a 2,575.01-hectare (6,362.98-ac) Project Area (Table 11) and a 112,938.63-hectare (279,077.19-ac) 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 acres will be retained within the Project Area immediately following construction, but 87,797.04 hectares (216,951.01 ac) of forest will remain within the Action Area following construction, and 1,156.79 hectares of forest (2,858.5 ac) will be allowed to regenerate following construction which may 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. This loss is a tiny fraction of the summer habitat available on the landscape that sustains roosting bats.

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 due to logging events 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 will be lost during Project development. Because these trees will be removed outside June 1 to July 31, any incidental take caused by such removal would be exempt under the 4(d) rule.

5.2.2.4 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, it is assumed that areas suitable for use during summer are also suitable during migration. NLCD data indicate 1,804.646 hectares (4,459.373 ac) of forested habitat exists within the LOD, and 647.85 hectares (1,600.87 ac) exists within the permanent easement. In total, this is a loss 2.01 percent of the forested habitat available within the Action Area following construction; however, 1,156.80 hectares (2,858.5 ac) will be allowed to regenerate once the Project is operational which may take upwards of 25 years to become suitable roosting habitat again.

This loss is a tiny 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 will 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.

5.2.3 Indirect Effects

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

5.2.3.1 Detrimental

Trees in the Project Area will be removed from January through May 2018 and August through November, if needed. Bats returning to the area in spring 2018 will encounter a cleared area that is an active construction site. Direct effects of the Project include removal of 1,804.646 hectares (4,459.373 ac) of forested land.

Impacts of this forest removal and changes in water quality on northern long-eared bats are expected to be similar to those described for Indiana bats (see Section 5.1.3.1) 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 increases in 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 2001, Lee and McCracken 2004), and their diet is somewhat flexible across its range, and the species is not likely to rely solely on one taxonomic group of insect prey.

5.2.3.2 Beneficial

Some trees along the edges of the Project Area are likely to be damaged during clearing activities, potentially increasing the number of roost sites. Most damaged trees will survive but will 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 will 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 will provide foraging habitat and over time roosting habitat. Woodland edges provide high quality foraging and commuting habitat. Restoration using native herbaceous species in the permanent ROW and continuous maintenance will provide suitable foraging and commuting habitat for northern long-eared bats.

5.3 Gray Bats

Analyses of effects to 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 5.3.1 to 5.3.3 below, no take of the gray bat is anticipated as a result of the Project. As described in Sections 5.3.1 to 5.3.3 below, no take of the gray bat is anticipated as a result of the Project.

5.3.1 Direct Effects to 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.

5.3.1.1 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: Rich Creek Cave, Bobcat Cave, Wolf Cave, and Greenville Glenray Cave. These caves were not field assessed for the MVP Project. However, gray bats are highly selective with few available caves actually used as roosts (Tuttle 1979), and correspondence with WVDNR indicates that these four caves are not known to be occupied by gray bats in any season (Craig Stihler, pers. comm. February 2017). Summer mist net surveys for bats (Section 1.4.1.1) did not result any gray bat captures. Based on these data, gray bats are not present within the Project Area and thus will not be harmed or harassed during summer or winter.

5.3.1.2 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 will not be harmed or harassed during these seasons.

5.3.1.3 Spring and Autumn Migration/Transient Period

Depending upon colony size and available habitat, individuals may travel distances of 19 to 34 kilometers (12 to 21 mi) 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 112.6 kilometers (70 mi) away from the Project. There are 4 caves in the 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 to migrating individuals are insignificant and discountable.

5.3.2 Direct Effects on Habitat

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

5.3.3 Indirect Effects

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

5.3.3.1 Detrimental

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, that 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.

5.3.3.2 Beneficial

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

5.4 Virginia Big-Eared Bats

As described in Sections 5.4.1 to 5.4.3 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 is anticipated.

5.4.1 Direct Effects to Individuals

5.4.1.1 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 5 that were assessed to be potentially suitable in 2015, 4 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 1.4.1.1). Based on these data, it appears Virginia big-eared bats are not present within the Project Area and will not be harmed or harassed during summer or winter as a result of the Project.

5.4.1.2 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 will not be harmed or harassed during these seasons.

5.4.1.3 Spring and Autumn Migration/Transient Period

Virginia big-eared bats migrate relatively short distances [32.2 kilometers (20 miles)] (Pearson et al. 1952, Piaggio et al. 2008) but all 8 known, occupied abandoned mine portals in Fayette County are within this distance. Therefore there is a potential for bats migrating through the Project Area during construction could 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.

5.4.2 Direct Effects on Habitat

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

5.4.3 Indirect Effects

5.4.3.1 Detrimental

To the extent that sedimentation within Project-adjacent water bodies reduces flying insects in these resources, that could have an effect on Virginia big-eared 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.

5.4.3.2 Beneficial

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

5.5 Roanoke Logperch

Analyses of effects to 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 as well as areas of suitable habitat (and thus potential occurrence). This includes 14 stream crossings where presence of the species is assumed present. 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. Note, however, that no instream construction activities will occur at one of the crossings of the North Fork Roanoke River, so only 13 crossings are relevant to impacts to 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 and harm 29 Roanoke logperch.

5.5.1 Direct Effects to 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 to individuals by life stage are addressed in the sections below. Adults and subadults are those individuals one year old or older. Young-of-the-year (YOY) are those individuals born within the past year. Methods and results of predictive models used to estimate abundance of logperch are provided in Appendix C and summarized in Section 4.5.2.

5.5.1.1 Adults and Subadults

Effects to adults and subadults (i.e., Age-1+) can be broken up into three spatial scales: 1) effects within the LOD, 2) effects downstream of the LOD, and 3) effects from sedimentation due to construction in upstream catchments. Each of these are addressed further below, beginning with effects within the LOD itself.

5.5.1.1.1 Effects within the LOD

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 LOD could be subject to harm as a result of instream disturbance activities.

Effects from Removal and Translocation. Per recommendations from the VDGIF, to minimize this risk of harm, MVP will remove all fishes, including Roanoke logperch (where present), from instream disturbance areas (including [but not limited to] coffer dam, dewatered areas, and/or pipeline construction footprint) immediately prior to instream construction activities (including blasting). Therefore, all Roanoke logperch will be removed from the LOD and will not be susceptible to direct harm from construction and machinery. Depletion fish surveys will 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 will be translocated downstream of the construction area.

Depletion fish survey efforts will be conducted within isolated areas until no fishes are collected for several consecutive passes. All collected fishes are temporarily held in aerated containers until transported and released downstream (minimum of 15 meters [50 ft]) of the Project footprint (per VDGIF 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 3.2 stream kilometers (1.9 mi), and individuals often make intra-site movements of 15 meters (49.2 ft) or more (Roberts et al. 2008). Translocated individuals will be returned to areas within the same waterbody in adjacent areas that demonstrate similar habitat qualities as where they were captured. All translocated individuals will be moved downstream of the Project crossing to prevent individuals washing into the construction footprint.

To calculate harm and harassment due to the fish removal, abundances of Roanoke logperch within the 22.86-meter (75-ft) LOD are estimated at crossings of known-occupied habitats (i.e., North Fork Roanoke, Roanoke, and Pigg rivers) as well as 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 pertinent information regarding four 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 110 meters (361 ft) upstream of the Project crossing of the North Fork Roanoke River and included in the Project LOD. MVP will make upgrades to the access road and will 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 12.2-meter (40-ft) LOD is applied at this stream crossing.
- The Project LOD 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 to Roanoke logperch are anticipated.
- Bradshaw Creek AR (MN-0276) is composed of two existing stream crossings within a 28-meter (92-ft) 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 stream bed aggrades) and is an existing ford crossing that will 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 with 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 1,311 square meters (0.32 ac) in size. The LOD for the crossing is estimated at 343 square meters (0.09 ac). Thus, an estimate of the number of adult and subadult individuals within the LOD is made by multiplying the expected abundance by the proportion of area of the patch that intersects the LOD (i.e., 181.57 × [343/1,311] = 47.51).

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

$$N_{Adult} = D_{Adult} \times 0.02286 \qquad \text{Eq. 6}$$

where D_{Adult} is the density estimate for the specific waterbody (Table 23) and 0.02286 is the width (in kilometers) of the LOD at stream crossings.

Table 23. Estimated densities, expected number of individuals, and respective harassment and harm estimates within the LOD at stream crossings for adult and young-of-the-year (YOY) Roanoke logperch.

Stream Name	County*	Adult Density (fish / km)†	YOY Density (fish / km) †	Expected Adults in LOD‡	Expected YOY in LOD‡	Adult Harassment‡	Adult Harm‡	YOY Harassment‡	YOY Harm‡
North Fork Roanoke River	Montgomery	60.19	43.37	1.38	0.99	1	1	0	1
North Fork Roanoke River AR1 (MN-268.01)§	Montgomery	60.19	43.37	0.73	0.53	0	1	0	1
Bradshaw Creek AR (MN-276)**	Montgomery	53.17	38.31	1.49	1.07	1	1	1	1
Bradshaw Creek1	Montgomery	55.89	40.27	1.28	0.92	1	1	0	1
Roanoke River	Montgomery	423.05	304.81	47.51	6.97	44	4	6	1
North Fork Blackwater River	Franklin	19.45	14.01	0.44	0.32	0	1	0	1
Teels Creek4	Franklin	19.62	14.14	0.45	0.32	0	1	0	1
Little Creek1.5	Franklin	23.90	17.22	0.55	0.39	0	1	0	1
Little Creek2	Franklin	24.64	17.75	0.56	0.41	0	1	0	1
Maggodee Creek1	Franklin	31.65	22.80	0.72	0.52	0	1	0	1
Blackwater River3	Franklin	149.30	107.57	3.41	2.46	3	1	2	1
Pigg River	Pittsylvania	256.47	184.79	5.86	4.22	5	1	4	1
Harpen Creek1	Pittsylvania	4.29	3.09	0.10	0.07	0	1	0	1
					Total	55	16	13	13

* All counties listed are within Virginia.

† Densitiy estiamtes were derived using the methods summarized in Seciton 4.5.2.2 and detailed in Appendix C.

‡Expected number of adults and YOY within the LOD 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.

§ The LOD of North Fork Roanoke River AR1 (MN-268.01) is 12.2 meters (40 ft).

** The LOD of Bradshaw Creek AR (MN-276) is 28 meters (92 ft).

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 LOD 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 23).

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

Effects from Blasting. Although it has yet to be determined if blasting will be necessary at any of the occupied or assumed occupied streams, impacts from its use are possible if the proper preventative measures are not employed. Impacts to 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 by 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 to individuals within the LOD.

Noise Impacts. Noise may have potential impacts to 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, nor 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 will adversely affect Roanoke logperch.

Impacts from Artificial Lighting. In addition to noise, artificial light might also be a disturbing factor for individuals. However, the use of artificial lighting will 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 Water Use. Water may be used for various parts of the construction phase including (but not limited to) hydrostatic testing, dust control, and hydro-seeding, and water withdrawals could therefore pose a risk to entrainment or entrapment of fishes (particularly larval fish) at the point of intake. MVP plans to avoid potential impacts to Roanoke logperch resulting from water-use activities. Water will not be withdrawn from streams potentially supporting federally listed aquatic species, and surface water sources in Virginia are not being used for hydrostatic testing; rather municipal sources will be used. Thus, no impacts from water use are anticipated.

Impacts from Leaks and Spills. Equipment and vehicles will 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. MVP has developed a Project-specific SPCC Plan and Unanticipated Discover of Contamination Plan for Construction Activities to minimize the risk of spills and will implement procedures to minimize any adverse effect, in the event a spill occurs. Potential impacts associated with spills and leaks is insignificant and discountable.

5.5.1.1.2 Effects Downstream of the LOD 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 Section 5.5.1.1.3), 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 will 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 LOD. 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 an 800-meter (2,625-ft) downstream buffer will receive elevated levels of sedimentation that could result in harassment of individuals. This spatial extent is derived from preliminary formal consultation with the USFWS in Virginia.

To calculate the number of individuals present within this area, the same approach used to calculate effects within the LOD 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 800-meter (2,625 ft) reach downstream of the LOD. Note that an 800-meter (2,625-ft) 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 4.5.2 and Appendix C). An existing access road ford crossing (i.e., North Fork Roanoke River AR [MN-268.01]) is located approximately 110 meters (361 ft) upstream of the MVP crossing of the North Fork Roanoke River and included in the Project LOD. Consequently, the downstream effects of the LOD at the access road overlap the proposed pipeline and are therefore truncated accordingly (i.e., 87.1 meters [285.8]).

In total, 1,177 Age-1+ individuals are expected to be harassed directly downstream of the Project stream crossings (Table 24). This estimate includes individuals from 11 separate waterbodies with varying densities and a total stream length of 12.98 kilometers (8.07 mi). Note that only eleven 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 24. 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*	Stream Length (km)	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†	848†

* All counties listed are within Virginia.

† Cumulative harassment estimates were rounded up to the next integer.

5.5.1.1.3 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 RUSLE yield generalized annual estimates of erosion rates and sediment loads based on climate, topography, and land use/management factors (Section 3.0). 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 (USEPA 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 36.36 stream kilometers (22.59 mi) with potential to support Roanoke logperch will be temporarily impacted from increased sedimentation from upland Project construction. The majority (74.7%) of these impacts are within tributaries to the North Fork Roanoke, Roanoke, Blackwater, and Pigg rivers; however, 9.21 kilometers (5.72 mi) of the North Fork Blackwater River are predicted to be impacted directly . Beyond those established within the 800-meter (2,625-ft) 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 4 (see Appendix C for derivation), expected harassment of adult and subadult Roanoke logperch from upland Project construction is 886 individuals (Table 25).

Table 25. Estimated harassment for adult and young-of-the-year (YOY) Roanoke logperch from impacts from increased sediment loads from upland construction.

Stream Name	Counties*	Stream Length (km)	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†	639†

* All counties listed are within Virginia.

† Cumulative harassment estimates were rounded up to the next integer.

5.5.1.2 Young-of-the-Year

Potential impacts are divided up by effects within the LOD, effects downstream of the LOD, 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 5.5.1.1), this section will focus on any *differences* within the types of impacts as well as calculations for estimating harm and harassment to YOY.

5.5.1.2.1 Effects within the LOD

Installation of the proposed pipeline across waterbodies is limited to an instream construction footprint not to exceed 22.9 meters (75 ft) in stream length (unless specifically identified). YOY individuals will be removed from the LOD prior to in-stream 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 5.5.1.1.1. Thus, it is estimated that 13 YOY will be harmed and 13 YOY will be harassed from fish translocation measures (Table 23). As with adults and subadults, no harm or harassment of YOY is expected as a result of blasting, noise, artificial lights, water use, or leaks and spills.

5.5.1.2.2 Effects Downstream of the LOD

To calculate the number of YOY present within the 800-meter (2,625-ft) downstream buffer of Project crossings, the same approach used to calculate effects within the LOD 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 800-meter (2,625-ft) reach downstream of the pipeline crossing was calculated. Cumulatively, 848 YOY are expected to be harassed directly downstream of pipeline and access road crossings (Table 24).

5.5.1.2.3 Effects of Sedimentation from Catchments (Upland Disturbance)

As mentioned in Section 5.5.1.1.3, impacts to known, occupied streams from sedimentation within catchments was 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 RULSE and the respective density estimates (see Section 4.5.2 and Appendix C), it is expected that 639 YOY will be harassed by increased sediment loads that occur as a result of upland construction (Table 25).

5.5.2 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 in 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 4.5.2.2).

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 will restore all stream contours and substrates.

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%) and run (22.0%) 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 Rosenberger and Angermeier (2002) in the Pigg and Blackwater river drainages; therefore, the aforementioned mesohabitat frequencies derived in the upper Roanoke River were applied.

5.5.2.1 Adults

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

5.5.2.1.1 Effects within the LOD

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) will occur in the LOD as a result of instream construction activities (e.g., trenching, blasting, etc.). Known, occupied habitats will be significantly altered via instream construction activities at the proposed crossings of the North Fork Roanoke River, Roanoke River, and Pigg River. Potential habitats will also be altered at the proposed crossings of Bradshaw Creek (ROW and access road), North Fork Blackwater River, Teels Creek4, Little Creek1.5, Little Creek2, Maggodee Creek1, Blackwater River3, and Harpen Creek (Table 23). The extent of impacts will occur along 22.9 meters (75 ft) of stream reach at each of the 11 pipeline crossings and 12.2 (40 ft) and 28 meters (92 ft) at the North Fork Roanoke River and Bradshaw Creek access roads, respectively. The total length of habitats occupied or potentially occupied by Roanoke logperch that will likely be affected is 291.69 meters (956.99 ft) of stream reach (Table 23). 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 120.47 meters (395.24 ft) of Age-1+ habitat are projected to be impacted. Because habitats and substrates are not likely a limiting resource within these waterbodies, it is unlikely that the removal of this habitat will significantly alter any biological patterns of the species (i.e., feeding, sheltering, or reproduction) and therefore will not result in individuals harmed.

5.5.2.1.2 Effects Downstream of the LOD

Adult Roanoke logperch require un-silted, exposed, and unembedded gravel and pebble substrates for feeding. Effects from the Project have the potential to degrade the habitat quality due to the increase in sediment that may occur within 800 meters (2,625 ft) 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 (i.e., crossing is proximal to mouth with Pigg River), Pigg River, and Harpen Creek. Sedimentation from stream crossings may affect a total of 12.98 kilometers (8.07 mi) of stream reaches occurring in occupied habitats or potentially suitable habitats (Table 24). 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, 5.36 stream kilometers (3.33 mi) of Age-1+ have the potential to be impacted. Because sediment from instream activities is an acute effect, sediment additions are unlikely to arise to a level where habitats would be significantly altered and therefore will not result in individuals harmed.

5.5.2.1.3 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 36.36 stream kilometers (22.59 mi) with the potential to host Roanoke logperch will be temporarily impacted (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), approximately 15.02 stream kilometers (9.33 mi) of suitable habitat may be within the area where increased sediment loads are expected. These elevated sediment loads in occupied and potential occupied habitats are only expected to occur during the construction phase of the Project. 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. Thus, it is unlikely that habitat for the species will be significantly altered by this temporary sediment influx, and therefore will not lead to harm of individuals.

5.5.2.2 Young-of-the-Year

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

5.5.2.2.1 Effects within the LOD

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) will occur in the LOD as a result of instream construction activities (e.g., trenching, blasting, ford crossings, etc.). Occupied (or presumed occupied) habitats will be significantly altered via instream construction activities at 13 proposed crossings (Table 23). The extent of impacts at pipeline crossings will occur along 22.9 meters (75 ft) of stream reach at each of the crossings. Access roads will also impact approximately 40.23 meters (131.99 ft) of habitat in the North Fork Roanoke River and Bradshaw Creek (Table 23). The total length of habitats occupied or potentially occupied by Roanoke logperch that could be affected is 291.69 meters (956.99 ft) 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, 171.22 meters (561.75 ft) of YOY habitat are projected to be affected. Because habitats and substrates are not likely a limiting resource within these waterbodies, it is unlikely that the removal of this habitat will significantly alter any biological patterns of YOY individuals (i.e., feeding and sheltering) and therefore will not result in individuals harmed.

5.5.2.2.2 Effects Downstream of the LOD

Research 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 may occur as a result of sediment that occurs within 800 meters (2,625 ft) downstream of Project stream crossings from instream construction activities. These areas included North Fork Roanoke River, Roanoke River, and Pigg River. These downstream impacts may adversely impact a total of 12.98 kilometers (8.07 mi) of stream reaches occurring in occupied habitats (Table 24). 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, 7.62 stream kilometers (4.73 mi) of YOY habitat are projected to be within this area. Because sediment from instream activities is an acute effect, sediment additions are unlikely to arise to a level where habitats would be significantly altered and therefore will not result in individuals harmed.

5.5.2.2.3 Effects of Sedimentation from Catchment

Suitable habitats are potentially affected as a result of upland construction activities that introduce substantial sediment loading rates into impacted stream reaches. Substantial sediment loading rates from upland disturbance are anticipated to extend into 9 different waterbodies for a total of 36.36 stream kilometers (22.59 mi) with the potential to support YOY Roanoke logperch (Table 25). 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, 21.34 stream kilometers (13.26 mi) of YOY habitat may 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. Thus, it is unlikely that habitat for the species will be significantly altered by this temporary sediment influx and therefore will not lead to harm of individuals.

5.5.3 Indirect Effects on Individuals

Roanoke logperch have the potential to experience lasting effects from sedimentation after the Project is completed. Removal of riparian vegetation decreases bank stability, increases erosion rates, and subjects individuals to augmented turbidity and suspended sediments. Allowing more sunlight to reach the stream may also expose fishes, including Roanoke logperch, to increased predation rates via aerial predators. 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 combinatorial effects of an influx of nutrients via overland runoff and increase in direct sunlight can cause increased primary productivity, alteration of the macroinvertebrate assemblage (i.e., prey availability), and alteration of the fish assemblage (e.g., more silt-tolerant or generalist species) that may augment natural competitive interactions and predation rates. To minimize the potential adverse effects along riparian corridors in perpetuity, MVP plans to allow revegetation along a 3.3-meter-wide (10-foot-wide) strip of herbaceous cover centered on the pipeline (for potential maintenance purposes) and trees will be allowed to grow within 4.6 meters (15 ft) of the pipeline. Furthermore, sedimentation modeling conducted for the Project demonstrates that sediment loads after restoration is complete are generally expected to be similar to those during pre-construction.

5.5.4 Indirect Effects on Habitat

Roanoke logperch heavily relies on interstitial space availability for foraging, and sedimentation can alter food web interactions for fishes, particularly those that rely on interstitial spaces for foraging (Henley et al. 2000). Sediments that enter streams are anticipated to occur at a relatively short temporal scale and are primarily limited to a short construction duration. It is anticipated that sediments will be flushed out or transported downstream during high-water events. 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 fish assemblages or macroinvertebrate (i.e., prey) communities or a reduction in sheltering, feeding, or breeding habitats.

Removal of riparian vegetation at the reduced ROW could potentially affect Roanoke logperch. Reductions in canopy cover can increase natural light, increase primary productivity and autotrophic organisms, increase water temperatures, etc., and these effects can lead to an increase in predation via aerial predators, alter trophic structure, increase growth rates (particularly for YOY), etc. All of these effects are likely to occur at a localized scale, and the reduction of the ROW width to 22.9 meters (75 ft) may minimize the spatial extent and overall potential of effects.

Any potential reduction in water or habitat quality could invite the potential colonization and/or proliferation of aquatic invasive species (e.g., Asian clam, zebra mussels) because these species are opportunistic in nature and are habitat generalists. The presence of aquatic invasive species increases the potential for competitive or predatory interactions. However, Project activities are not anticipated to introduce aquatic invasive species nor augment existing populations of aquatic invasive species within occupied streams.

5.6 James Spinymussel

Project construction, operation, and maintenance activities could potentially cause direct and indirect effects to the species. A mussel survey encompassing Project crossings at Craig Creek in Montgomery County, Virginia did not yield any sign of James spinymussel. As described in Sections 5.6.1 to 5.6.4 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 the 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; especially areas adjacent to streams. MVP investigated the necessity for two ATWS's (ATWS-1373 and ATWS-1057) that are proposed within 30.5 meters (100 ft) of Craig Creek and a brief portion of the ROW that parallels the stream. The temporary workspaces are proposed for placement between Craig Creek Road and Craig Creek and a 30.5-meter (100-ft) buffer cannot be maintained at either temporary workspace. Both workspaces are at the center of the valley with no access from the North for 2.4 kilometers (1.5 mi) and no access from the south for 3.1 kilometers (1.9 mi). ATWS-1373 is currently a pasture and needed for boring of Craig Creek road, additional material staging, spoil storage, and parking of construction vehicles (Figure 32; Map 1). ATWS-1057 is a maintained field needed for timber storage, construction vehicle parking, and material staging (Figure 32; Map 2). Access roads (MN-258.04 and MN-258.05) border ATWS-1057 and together provide pipe trucks the ability to safely ingress and egress the ROW. In addition, a brief section of the ROW parallels Craig Creek (near milepost 219.9) approximately 30.5 meters (100 ft) of the stream before the route is directed southward and toward the top of Brush Mountain (Figure 32; Map 2). MVP attempted to maintain the requested 30.5-meter (100-ft) buffer in this area but side slope construction

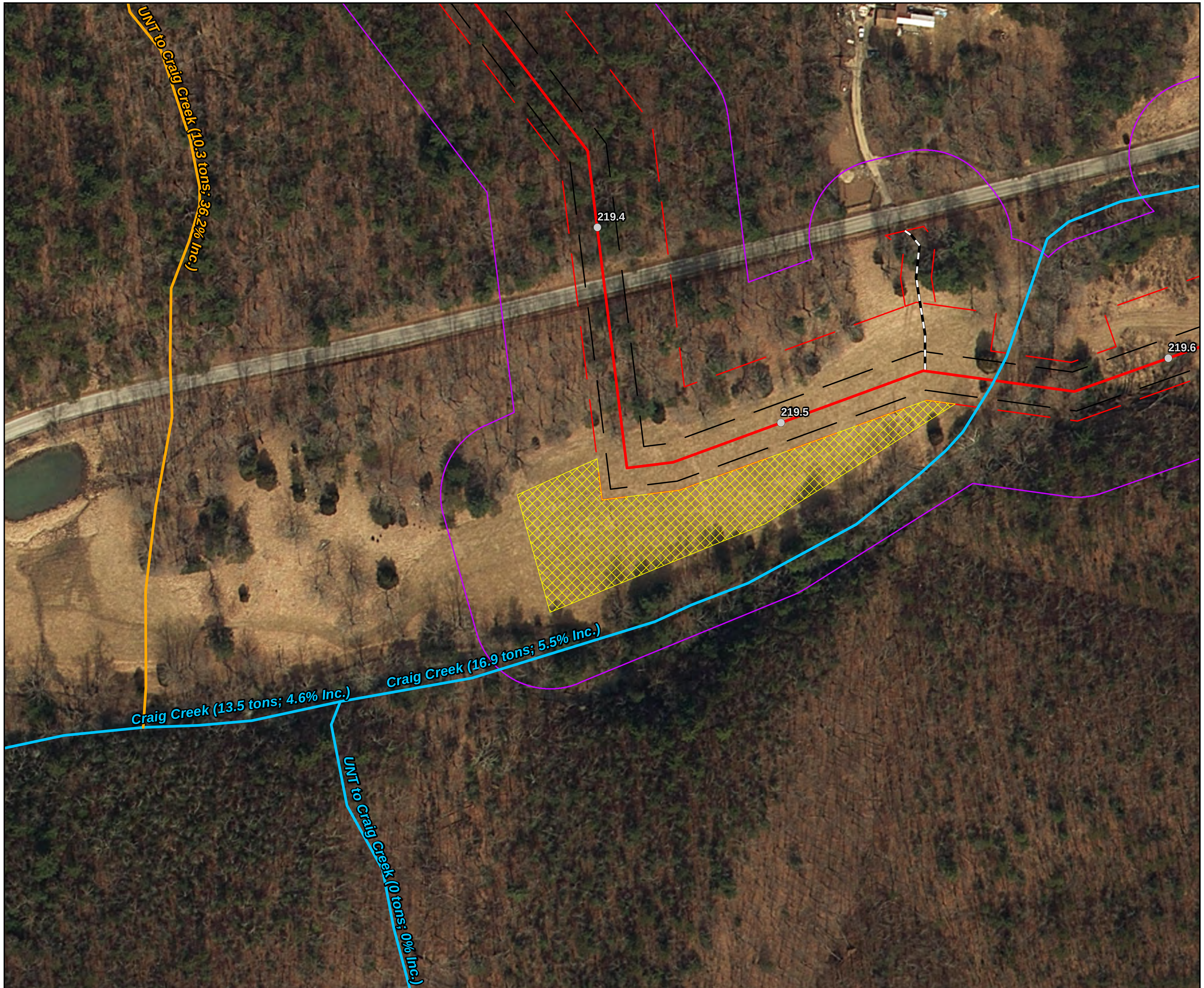
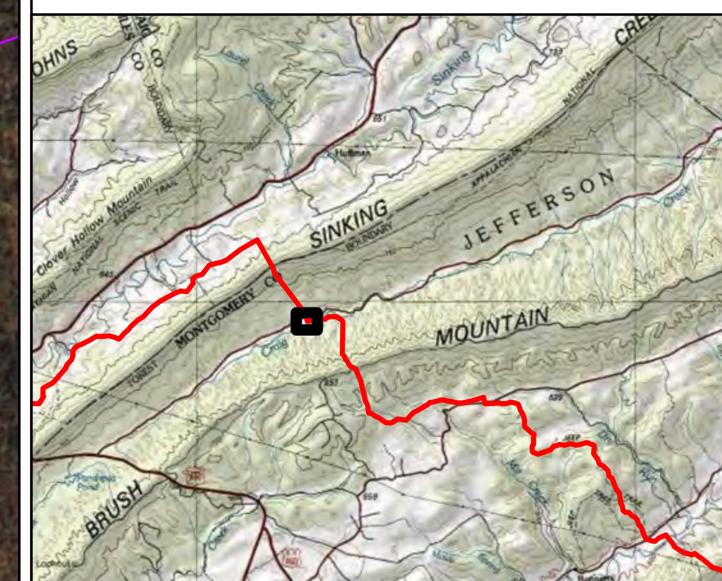
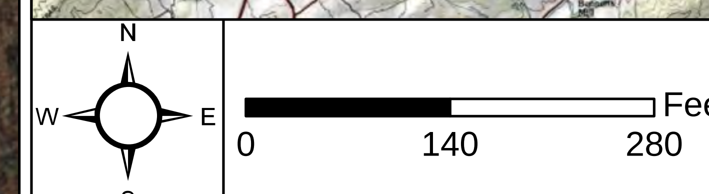


Figure 32. Detailed Action Area for sedimentation increases from the proposed Mountain Valley Pipeline in the vicinity of Craig Creek in Montgomery County, Virginia.

Map 1 of 3

- Milepost
- October 2016 Proposed Route (Revised)
- Access Road
- Stream
- Sediment Impact >10 Percent
- Permanent Easement Limits
- Workspace Limits
- Additional Temporary Workspace
- 100-foot (30.48-m) Limits of Disturbance Buffer





Base Map: ESRI ArcGIS Web service - "World Imagery" accessed - 3/10/2017

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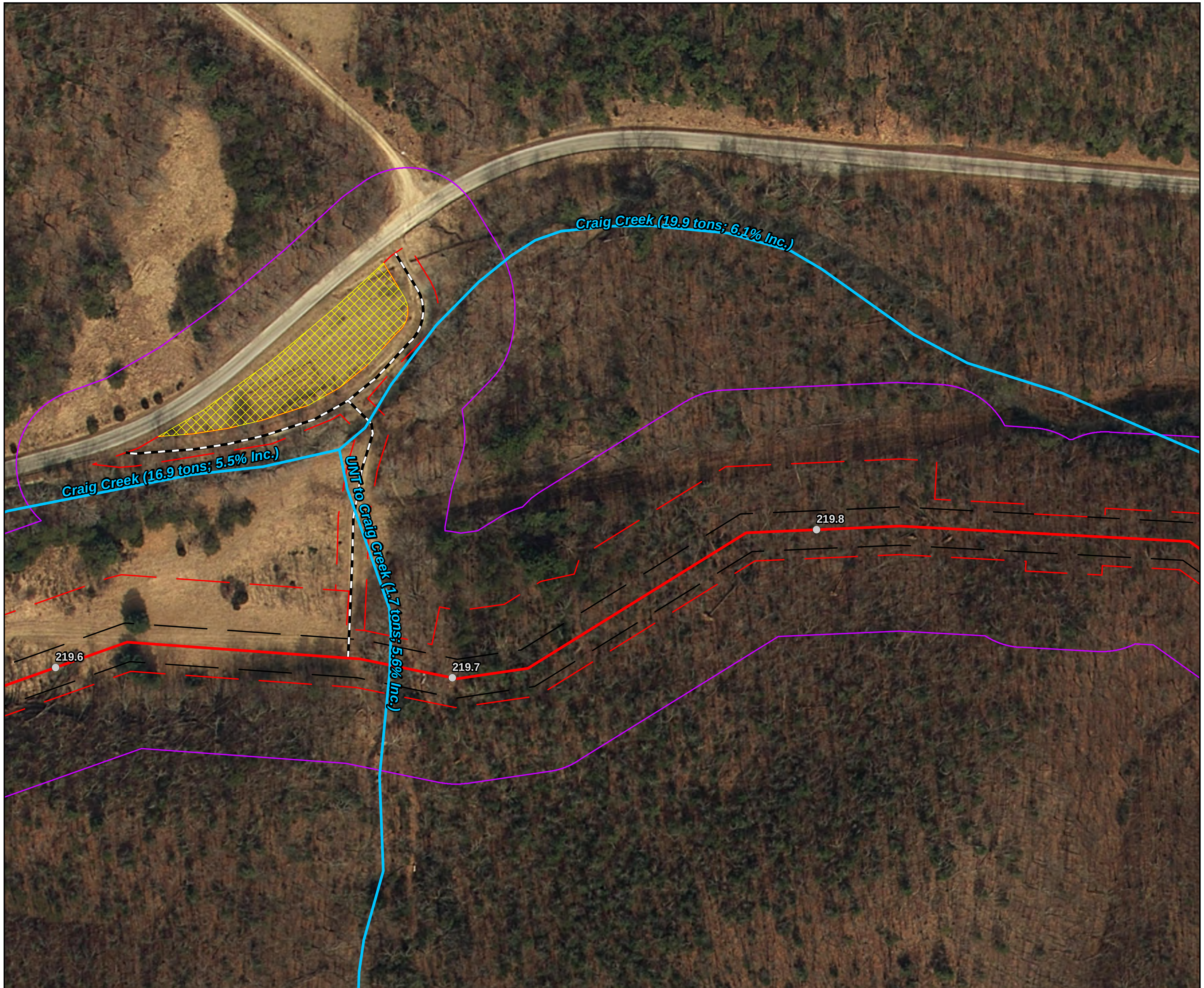
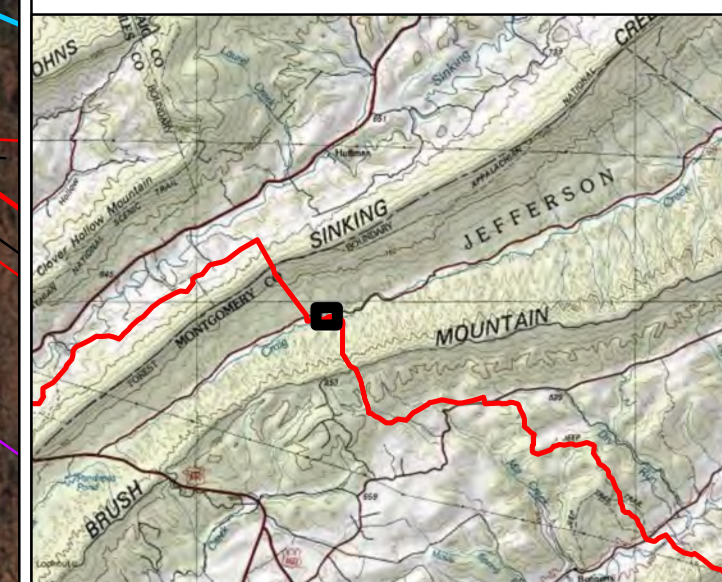
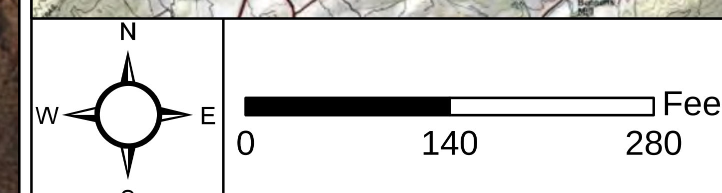


Figure 32. Detailed Action Area for sedimentation increases from the proposed Mountain Valley Pipeline in the vicinity of Craig Creek in Montgomery County, Virginia.

Map 2 of 3

- Milepost
- October 2016 Proposed Route (Revised)
- Access Road
- Stream
- Sediment Impact >10 Percent
- Permanent Easement Limits
- Workspace Limits
- Additional Temporary Workspace
- 100-foot (30.48-m) Limits of Disturbance Buffer





Base Map: ESRI ArcGIS Web service - "World Imagery" accessed - 3/10/2017

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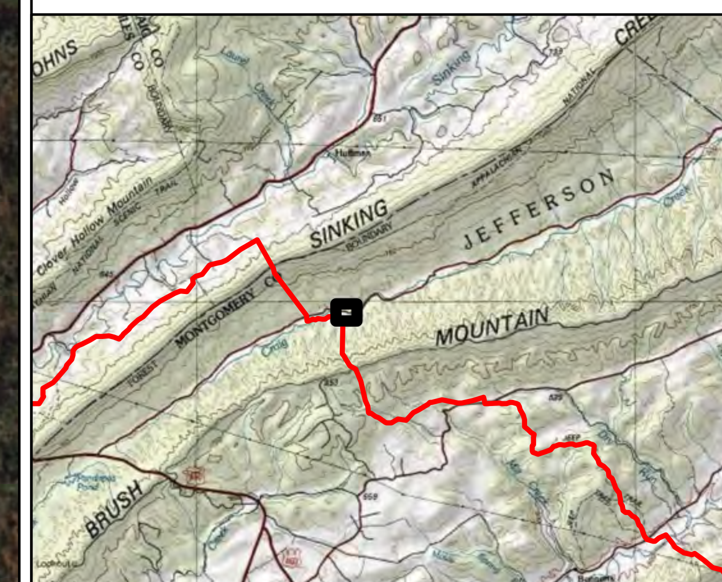
Figure 32. Detailed Action Area for sedimentation increases from the proposed Mountain Valley Pipeline in the vicinity of Craig Creek in Montgomery County, Virginia.

Map 3 of 3

- Milepost
- October 2016 Proposed Route (Revised)
- Access Road
- Stream
- Sediment Impact >10 Percent
- Permanent Easement Limits
- Workspace Limits
- Additional Temporary Workspace
- 100-foot (30.48-m) Limits of Disturbance Buffer



N S W E

Feet
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Base Map: ESRI ArcGIS Web service - "World Imagery" accessed - 3/10/2017

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conditions would present safety concerns if the ROW were shifted further from Craig Creek.

A sedimentation analysis was performed in the Craig Creek drainage 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 Craig Creek, assuming implementation of MVP's E&SC plan, the VDEQ Virginia Erosion & Sediment Control Field Manual (1995), and MVP's avoidance and minimization measures outlined in Section 2.6. By adherence to aforementioned standards, a 0.47-kilometer (0.29-mile) stream reach of Craig Creek is anticipated to experience sediment load increases in excess of 10 percent above baseline.

Three small, unnamed tributaries of Craig Creek may experience sedimentation rates in excess of the 10-percent threshold. Two tributaries on the south-facing slope enter Craig Creek approximately 0.39 kilometer (0.24 mi) and 0.56 kilometer (0.35 mi) upstream of the Project crossing. The sedimentation rates in Craig Creek at the mouth of each tributary are consequently elevated but do not exceed 10 percent above baseline. The third unnamed tributary is on the north-facing slope and empties into Craig Creek approximately 0.82 kilometer (0.51 mile) downstream of the pipeline crossing. Sedimentation rates in the third tributary exceed the 10 percent threshold and contributes to increased sedimentation rates in Craig Creek proper for 0.47 kilometer (0.29 mi) downstream of the tributary mouth. Therefore, increased sedimentation rates over the 10-percent threshold are confined to a stream segment that is located 0.82 kilometer (0.51 mile) to 1.3 kilometers (0.80 mi) downstream of the pipeline crossing (Figure 32). In summary, the Action Area is contained within 1.3 kilometers (0.80 mi) downstream of the pipeline crossing of Craig Creek and within the negative mussel survey area.

The nearest known population of James spinymussel in Craig Creek occurs approximately 25.4 stream kilometers (15.8 mi) downstream of the proposed pipeline crossing. Live mussels have not been encountered (or documented) in Craig Creek in Montgomery County. The nearest known occurrence of live mussels in Craig Creek occurs in Craig County, dates back to 1991, and relates to three non-listed mussel species. Presence of James spinymussel is assumed to occur at this location because conditions are suitable for the occupation of live mussels. Therefore, the nearest known presumed presence of James spinymussel is located in Craig County, 20.3 stream kilometers (12.6 mi) downstream of the Project crossing. Sedimentation rates above a 10-percent threshold in Craig Creek are predicted to extend only 1.3 stream kilometers (0.80 mi) downstream of the pipeline crossing. The Action Area occurs more than 19.0 stream kilometers (11.8 mi) 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.

5.6.1 Direct Effects on Individuals

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).

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

5.6.2 Direct Effects on Habitat

James spinymussel require clean, silt-free gravel substrate and a water column free of suspended material (Brim Box and Mossa 1999). Elevated levels of sedimentation can harass or harm individuals by reducing water quality and benthic substrate conditions. Critical habitats has not been designated for James spinymussel anywhere within its range. The lack of occupied habitat in the Project or Action Area in the Craig Creek stream area indicates direct effects to James spinymussel habitat will not occur.

5.6.3 Indirect Effects on Individuals

The Action Area includes the Project Area and the geographic extent of environmental changes that result indirectly (i.e., later in time) from the action. Implementation of E&SC BMPs during and after construction and post-construction restoration activities (e.g., vegetative and stream bank restorations) will prevent latent, indirect effects within the Action Area. There will be no indirect effects on individuals because there are no individuals in the Action Area.

5.6.4 Indirect Effects on Habitat

The Action Area includes the Project Area and the geographic extent of environmental changes that result indirectly (i.e., later in time) from the action. Implementation of E&SC BMPs during and after construction and post-construction restoration activities (e.g., vegetative and stream bank restorations) will prevent latent, indirect effects within the Action Area. The lack of occupied habitat in the Project and Action Area of the stream crossings indicates indirect effects to suitable habitats will not result in a Take of individuals.

5.7 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 sign 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 WVMSP. Because, as described in Sections 5.7.1 to 5.7.7 below, the nearest known populations of clubshell in Elk River, Little Kanawha River, and Leading Creek in West Virginia occur outside of the Action Area, the Project is not anticipated to result in the take of the 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 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. Areas where sedimentation rates substantially exceeded baseline conditions were identified as part of the Action Area.

5.7.1 Elk River

The nearest known population of clubshell in the Elk River occurs downstream of Sutton Lake Dam approximately 30.5 kilometers (19.0 mi) downstream of the Project crossing. Substantial sedimentation rates in the Elk River extend approximately 3.88 kilometers (2.4 mi) downstream of the Project crossing, and terminate immediately upstream of the nearest downstream unnamed tributary; this is over 30 kilometers (18.6 mi) upstream of the nearest clubshell population.

5.7.2 Little Kanawha River

The nearest known population of clubshell in the Little Kanawha River occurs downstream of Burnsville Lake Dam approximately 22.5, 24.5, and 25.6 kilometers (14.0, 15.2, and 15.9 mi), respectively, downstream of each crossing. Based on the sedimentation model, sediment loading in excess of 10 percent over baseline does not extend downstream; therefore the Action Area is restricted to the Project crossing locations. Clubshell populations are not present at the Project crossings (or the Action Area) within the Little Kanawha River.

5.7.3 Leading Creek

The nearest potential population of clubshell in Leading Creek occurs downstream of its confluence with Fink Creek, approximately 25.88 kilometers (16.1 mi) downstream of the Project’s crossing. Substantial sediment loading rates extend approximately 5.54 kilometers (3.44 mi) downstream of the crossing, terminating upstream of the confluence with Alum Fork. This is over 20 kilometers (12.4 mi) upstream of the nearest potential clubshell population. Additionally, the upstream drainage area of Leading Creek at the confluence with Alum Fork is 18.7 square kilometers (7.2 mi^2). According to the WVMSP (Clayton et al. 2016), mussel surveys in West Virginia are not required in streams if the upstream drainage area is less than 25.9 square kilometers (10 mi^2); presumably because federally listed mussels are not known to occur in waterbodies less than the aforementioned drainage threshold.

5.7.4 Direct Effects on Individuals

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

5.7.5 Direct Effects on Habitat

The lack of occupied habitat in the Project and Action Area of the three stream crossings indicates direct effects to clubshell habitat will not occur.

5.7.6 Indirect Effects on Individuals

The Action Area includes the Project Area and the geographic extent of environmental changes that result indirectly (i.e., later in time) from the action. Implementation of E&SC BMPs during and after construction and post-construction restoration activities (e.g., vegetative and stream bank restorations) will prevent latent, indirect effects within the Action Area. There will be no indirect effects on clubshell individuals because there are no individuals in the Action Area.

5.7.7 Indirect Effects on Habitats

The Action Area includes the Project Area and the geographic extent of environmental changes that result indirectly (i.e., later in time) from the action. Implementation of E&SC BMPs during and after construction and post-construction restoration activities (e.g., vegetative and stream bank restorations) will prevent latent, indirect effects within the Action Area. The lack of occupied habitat in the Project and Action Area of the three stream crossings indicates indirect effects to suitable habitats will not result in a take of individuals.

5.8 Snuffbox

Project construction, operation, and maintenance activities could potentially cause direct and indirect effects to the species. 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. Because, as described in Sections 5.8.1 to 5.8.7 below, the nearest known populations of snuffbox in Elk River, Little Kanawha River, and Leading Creek in

West Virginia occur outside of the Action Area, the Project is not anticipated to result in the take of the 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.

5.8.1 Elk River

The nearest known population of snuffbox in the Elk River occurs downstream of Sutton Lake Dam approximately 30.5 kilometers (19.0 mi) downstream of the Project crossing, which is upstream of Sutton Lake in Webster County. Substantial sedimentation rates in the Elk River extend approximately 3.88 kilometers (2.4 mi) downstream of the Project crossing, and terminate immediately upstream of the nearest downstream unnamed tributary, which is more than 30 kilometers (18.6 mi) upstream of the nearest known snuffbox population. Snuffbox populations are not expected in Webster County (i.e., WVMSP Group 1 stream designation).

5.8.2 Little Kanawha River

The nearest known population of snuffbox in the Little Kanawha River occurs downstream of Burnsville Lake Dam approximately 22.5, 24.5, and 25.6 kilometers (14.0, 15.2, and 15.9 mi), respectively, downstream of each crossing. Based on the sedimentation model, sediment loading in excess of 10 percent over baseline does not extend downstream; therefore the Action Area is restricted to the Project crossing locations. Snuffbox populations are not present at the Project crossings (or the Action Area) within the Little Kanawha River.

5.8.3 Leading Creek

The nearest potential population of snuffbox in Leading Creek occurs downstream of its confluence with Fink Creek, approximately 25.88 kilometers (16.1 mi) downstream of the Project's crossing. Substantial sediment loading rates extend approximately 5.54 kilometers (3.44 mi) downstream of the crossing, terminating at the confluence with Alum Fork. This is over 20 kilometers (12.4 mi) upstream of the nearest potential snuffbox population. Additionally, the upstream drainage area of Leading Creek at the confluence with Alum Fork is 18.7 square kilometers (7.2 mi^2). According to the WVMSP (Clayton et al. 2016), mussel surveys in West Virginia are not required in streams if the upstream drainage area is less than 25.9 square kilometers (10 mi^2);

presumably because federally listed mussels are not known to occur in waterbodies less than the aforementioned drainage threshold.

5.8.4 Direct Effects on Individuals

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

5.8.5 Direct Effects on Habitat

The lack of occupied habitat in the Project and Action Area of the three stream crossings indicates direct effects to snuffbox habitat will not occur.

5.8.6 Indirect Effects on Individuals

The Action Area includes the Project Area and the geographic extent of environmental changes that result indirectly (i.e., later in time) from the action. Implementation of E&SC BMPs during and after construction and post-construction restoration activities (e.g., vegetative and stream bank restorations) will prevent latent, indirect effects within the Action Area. There will be no indirect effects on snuffbox individuals because there are no individuals in the Action Area.

5.8.7 Indirect Effects on Habitats

The Action Area includes the Project Area and the geographic extent of environmental changes that result indirectly (i.e., later in time) from the action. Implementation of E&SC BMPs during and after construction and post-construction restoration activities (e.g., vegetative and stream bank restorations) will prevent latent, indirect effects within the Action Area. The lack of occupied habitat in the Project and Action Area of the three stream crossings indicate indirect effects to suitable habitats will not result in a take of individuals.

5.9 Rusty Patched Bumble Bee

Analysis of the effects to rusty patched bumble bees 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, and is detailed in Table 26. 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 nonnative plants, and augmentation of competitive interactions. The most recent rusty patched bumble bee occurrence record bisecting a county of the Project occurred in Montgomery County in 1997. Because, as discussed in Sections 5.9.1 to 5.9.3 below, the nearest known populations of the rusty patched bumble bee are outside the Action Area, no take of the species is anticipated as a result of the Project.

Table 26. Effects analysis on rusty patched bumble bee (*Bombus affinis*).

Pipeline Activity	Environmental Impact or Threat	Stressor	Stressor Pathway	Exposure (Resource Affected)	Range of Response	Conservation Need Affected	Demographic Consequences	Individuals or Habitat Present?	Comments
Surveying and Staking	Physical impacts to individuals and habitat	Trampling, crushing, soil compaction	Vehicle and foot traffic	Individuals, Habitat	Injury, death	Reproduction, growth, habitat	Numbers, reproduction	Individuals-No; Habitat-Yes	
Clearing and Grading	Physical impacts to individuals, habitat degradation, habitat alteration	Crushing, burying, soil compaction, tree removal, brush clearing, spread of invasive species	Heavy equipment, erosion	Individuals, habitat	Injury, death	Reproduction, growth, nutrition, habitat	Numbers, reproduction	Individuals-No; Habitat-Yes	Habitat destruction in all capacities and potential crushing of foraging individuals
Trenching	Physical impacts to individuals, habitat degradation and destruction	Crushing, soil removal	Not applicable	Individuals, habitat	Not applicable	Not applicable	Not applicable	Individuals-No; Habitat-Yes	Nests could be disturbed or destroyed, overwintering habitat altered or destroyed
Pipe Stringing and Bending	Neutral	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Individuals-No; Habitat-Yes	No impacts expected from this action
Assembly and Welding	Neutral	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Individuals-No; Habitat-Yes	No impacts expected from this action
Lowering in and Backfilling	Physical impacts to habitat	Soil compaction	Heavy equipment	Habitat	Not applicable	Not applicable	Not applicable	Individuals-No; Habitat-Yes	BMP and erosion control plans should minimize soil compaction
Hydrostatic testing	Physical impacts to individuals, habitat degradation	flooding	Heavy equipment, discharge of water into uplands	Individuals, habitat	Injury, death	Reproduction, growth, nutrition, habitat	Numbers, reproduction	Individuals-No; Habitat-Yes	Use of best management practices should avoid upland flooding
Cleanup and Restoration	Neutral to beneficial	Soil compaction, burning of brush, dragging and moving logs	Heavy equipment, fire	Individuals, habitat	Injury, death	Reproduction, growth, nutrition, habitat	Numbers, reproduction	Individuals-No; Habitat-Yes	Removal of brush and opening of edges may increase habitat for rusty patched bumble bee
Use of artificial light	Physical Impacts to individuals and habitat	Artificial light	Artificial light	Individuals, habitat	Neutral, beneficial	Growth, reproduction	Numbers, reproduction	Individuals-No; Habitat-Yes	Artificial light likely has neutral effects on bumble bees. Artificial light has been shown to benefit many species of plants which may in turn benefit bees; flower density can be reduced with certain lights.
Noise	Physical impacts to individuals	Noise	Heavy equipment, machinery, compressor stations	Individuals	Neutral, harassment	Use of habitat	Dispersal	Individuals-No; Habitat-Yes	No impacts anticipated from noise, but some insects flee from loud noises or are paralyzed; bumble bees have been known to respond aggressively to noise and vibrations which could injure workers on site and reduce foraging time for colony success

5.9.1 Direct Effects on Individuals

As described in Section 4.9.3, no individuals rusty patched bumble bees have been identified in the Project Action Area. Thus, so direct effects to individuals are not expected.

5.9.2 Direct Effects on Habitats

5.9.2.1 Foraging Habitat

Rusty patched bumble bees need abundant floral resources. Crushing, mowing and clearing of flowers destroys potential bumble bee foraging habitat. In addition, herbicide applications can destroy bumble bee foraging habitats. However, the construction of a permanent ROW provides open areas which can benefit bees by providing floral resources in summer and fall and by providing a dispersal corridor. The project transverses an area of suitable, but apparently unoccupied habitat for the rusty patched bumble bee. Because no bees are present, changes in habitat quality cannot cause harm and thus any impacts to habitat do not rise to the level of take.

5.9.2.2 Nesting Habitat

Rusty patched bumble bees mainly nest in subterranean holes 0.3 to 0.9 meter (1-3 ft) deep with entrance tunnels 0.15 to 0.91 meter (0.5 – 3 ft) wide (Plath 1927, Macfarlane 1974, Laverty and Harder 1988, Jepsen et al. 2013). Thus, digging and trenching activities may disturb or destroy nest sites – if present. In addition, rusty patched bumble bees may nest above ground in dead wood or clumps of grasses and thus vegetation clearing, heavy equipment, and mowing could destroy nest habitat. It should be noted that brush piles and stacking of non-salvageable wood along ROW edges could provide increased nesting opportunities for rodents which could in turn provide nesting sources for rusty patched bumble bees, therefore increasing nesting habitat. The project transverses an area of suitable, but apparently unoccupied habitat for the rusty patched bumble bee. Because no bees are present, changes in habitat quality cannot cause harm and thus any impacts to habitat do not rise to the level of take.

5.9.2.3 Winter Habitat

Although little is known about overwintering habitat, most bumble bees overwinter in loose soil a few centimeters below the ground (Macfarlane 1974, 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(Macfarlane 1974). The project transverses an area of suitable, but apparently unoccupied habitat for the rusty patched bumble bee. Because no bees are present, changes in habitat quality cannot cause harm and thus any impacts to habitat do not rise to the level of take.

5.9.2.4 Foraging Habitat

Rusty patched bumble bees need abundant floral resources. Crushing, mowing and clearing of flowers destroys potential bumble bee foraging habitat. In addition, herbicide applications can destroy bumble bee foraging habitats. The project transverses an area of suitable, but apparently unoccupied habitat for the rusty patched bumble bee. Because no bees are present, changes in habitat quality cannot cause harm and thus any impacts to habitat do not rise to the level of take.

5.9.3 Indirect Effects

Indirect effects are those effects that are caused by or will result from the proposed action and are later in time, but still reasonably certain to occur. Indirect effects on individual bees occur when the Project causes chemical, biological, or physical changes that can affect bees by altering foraging or homing abilities, altering immune responses or spread of pathogens, or increase competition with other pollinators.

5.9.3.1 Indirect Effects on Individuals

There will be no indirect effects on individuals because individuals are not known to occur in the Project or Action Area.

5.9.3.2 Indirect Effects on Habitats

5.9.3.2.1 Detrimental

Initial construction and maintenance of the ROW 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. Thus, the displacement of rodents could have indirect effects, especially to the nesting habitat of this species (Environment and Climate Change Canada 2016). However, erosion control and sedimentation plans should minimize changes in soil hydrology.

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 ROW will be beneficial for many pollinators and is likely to attract many other native bumble bee species, and non-native bees such as honey bees, *Osmia cornifrons,* and *O. taurus*, thus 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 will not result in a take of individuals.

5.9.3.2.2 Beneficial

Although potential habitat for this species exists along much of the proposed project areas, converted habitat will add value for rusty patched bumble bees. Furthermore, many old field type habitats will be improved and invasive species will be 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). Proposed activities will produce hundreds of acres of permanent ROW, which will be managed and maintained in perpetuity, thus benefitting rusty patched bumble bee and other pollinators. In addition to adding valuable summer and fall habitat as well as potential nesting habitat, the Project will provide:

- 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, requisite for production of males and new queens in the fall as well as colony growth.
- Proximity to overwintering sites within two kilometers of most ROW.
- Limited pesticide and herbicide use and monitoring.
- Maintained (or replaced) land contours and implementation of erosion control and sedimentation plans to facilitate soil hydrology maintenance for overwintering and nest sites.
- Maintained roads and utility corridors, shown to be of value for pollinator foraging (Hopwood 2008) .
- Forest roads and thinning of forests, shown to benefit most pollinators (Hanula et al. 2016).
- Suitable species habitat based on operations and maintenance plans to roads and other disturbances. Benefits include little traffic, fairly protected areas, invasive species control, open habitat conditions, native species and floral resources, and limited mowing (often on longer rotations).

5.10 Northeastern Bulrush

A field 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 to individuals or existing habitat is expected.

5.11 Running Buffalo Clover

Field surveys in Greenbrier, Nicholas, and Webster counties, West Virginia revealed suitable habitat within the Project Area; however no individuals were found. Analysis of potential effects to running buffalo clover and associated habitat as a result of Project construction and operation is detailed in Table 27.

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 soil erosion from clearing and grading could also be possible. All of these factors have potential to injure, stress, or destroy potential habitat. Use of BMPs is 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 MVP's erosion plan.

However, project activities are expected to have neutral to possibly beneficial effect on running buffalo clover habitat. Clearing could increase light regimes which may actually benefit running buffalo clover habitat as long as light patterns are not too intense. Running buffalo clover prefers open habitats with dappled shade.

Critical habitat has not been designated for running buffalo clover. The lack of occupied habitat in the Project and Action Area in indicates direct and indirect effects to suitable habitats will not result in a loss of individuals. No individuals were identified in the Project Area, so direct or indirect effects to a known population is not expected. However, as of the writing of this document, 0.23 kilometer / 0.74 hectares (0.14 mi / 1.8 ac) of the project remains unsurveyed and the species is presumed present there, so loss of individuals may occur if this area is indeed occupied.

Table 27. Effects analysis on running buffalo clover (*Trifolium stoloniferum*).

Pipeline Activity	Environmental Impact or Threat	Stressor	Stressor Pathway	Exposure (Resource Affected)	Range of Response	Conservation Need Affected	Demographic Consequences	Individuals or Habitat Present?	Comments
Surveying and Staking	Physical impacts to individuals	Walking and trampling of individuals, compaction of soil	Foot and vehicle traffic	Individuals	Injury, death	Reproduction, Nutrition, habitat	Numbers, reproduction	Individuals – No; Habitat - Yes	All known populations will be avoided
Clearing and Grading	Physical impacts to individuals and habitat	Crushing, changes in microclimate/sunlight, erosion, introduction and spread of invasive species, cutting of roots	Removal of vegetation	Individuals and habitat	Beneficial to neutral (Clearing may benefit from increased light)	Not applicable	Numbers, reproduction	Individuals – No; Habitat - Yes	Amount of clearing and erosion BMPs should reduce so little to no impact on plants; clearing may actually create more habitat
Trenching	Physical impacts to individuals and habitat	Removal of soil	Removal of soil	Individuals and habitat	Injury, death	Reproduction, habitat	Numbers, reproduction	Individuals – No; Habitat - Yes	No additional impacts expected after clearing and grading
Pipe Stringing and Bending	Physical impacts to individuals	Walking or trampling of individuals	Foot and vehicle traffic	Individuals	Injury, death	Numbers, reproduction	Numbers, reproduction	Individuals – No; Habitat - Yes	No additional impacts after clearing and grading
Assembly and Welding	Physical impacts to individuals	Walking or trampling of individuals	Foot and vehicle traffic	Individuals	Injury, death	Numbers, reproduction	Numbers, reproduction	Individuals – No; Habitat - Yes	No additional impacts after clearing and grading
Lowering in and Backfilling	Physical impacts to individuals	Walking or trampling of individuals, spread of invasive species	Foot and vehicle traffic	Individuals	Injury, death	Numbers, reproduction	Numbers, reproduction	Individuals – No; Habitat - Yes	No additional impacts after clearing and grading
Hydrostatic testing	Physical impacts to individuals and habitat	Trampling, water draw down, flooding	Heavy equipment, water use and discharge	Individuals and habitat	Injury, death	Reproduction, nutrition, habitat	Numbers, reproduction	Individuals – No; Habitat - Yes	Avoidance of water withdrawal and discharge into habitats will minimize affects.
Cleanup and Restoration	Physical impacts to individuals and habitat	Crushing, burying, soil compaction, introduction and spread of invasive species	Heavy equipment and machinery	Individuals and habitat	Injury, death	Reproduction, nutrition, habitat	Numbers, reproduction	Individuals – No; Habitat - Yes	BMPs should reduce the impact of these activities
Use of artificial light	Physical Impacts to individuals	Artificial light	Artificial light	Individuals	Beneficial	Not applicable	Numbers, growth	Individuals – No; Habitat - Yes	Artificial light has been shown to benefit many species of plants
Noise	Neutral	Noise	Heavy equipment, machinery, compressor stations	Individuals and habitat	Neutral	Not applicable	Not applicable	Individuals – No; Habitat - Yes	No impacts anticipated from noise

5.12 Shale Barren Rock Cress

A field survey in Greenbrier and Fayette counties, West Virginia did not yield any individuals of shale barren rock cress or potential habitat for this species. Because the species or its habitat does not occur in the Project Area, no direct or indirect impacts to known individuals or existing habitat is expected. However, as of the writing of this document, 0.19 kilometer / 11.94 hectares (0.12 mi / 29.5 ac) of the project remains unsurveyed and the species is presumed present there, so loss of individuals may occur if this area is indeed occupied. No critical habitat has been designated for the shale barren rock cress.

5.13 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. An analysis of effects to small whorled pogonia as a result of Project construction and operation is detailed in Table 28.

Walking, trampling, traffic, heavy equipment, habitat clearing, and habitat grading could have effects on small whorled pogonia. Habitat could be impacted by the seed bank being disturbed. Use of BMPs is 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 could cause increased competition for light, nutrients, and space.

On the other hand, clearing remove shrub and understory density (at least temporarily) which would create open under stories and increase light regimes and benefit small whorled pogonia.

Critical habitat has not been designated for small whorled pogonia. The lack of occupied habitat in the Project and Action Area indicates direct and indirect effects to suitable habitats will not result in loss of individuals. No individuals were identified in the Project Area, so direct or indirect effects to a known population is not expected. However, as of the writing of this document, 0.19 kilometer / 11.94 hectares (0.12 mi / 29.5 ac) of the Project Area remains unsurveyed and the species is presumed present there, so loss of individuals may occur if this area is indeed occupied.

Table 28. Effects analysis on small whorled pogonia (*Isotria medeolodoides*).

Pipeline Activity	Environmental Impact or Threat	Stressor	Stressor Pathway	Exposure (Resource Affected)	Range of Response	Conservation Need Affected	Demographic Consequences	Individuals or Habitat Present?	Comments
Surveying and Staking	Physical impacts to individuals	Trampling, crushing, soil compaction	Vehicle and foot traffic	Individuals	Injury, death	Reproduction, growth, habitat	Numbers, reproduction	Individuals-No; Habitat-Yes	
Clearing and Grading	Physical impacts to individuals, habitat degradation, habitat alteration	Crushing, burying, soil compaction, tree removal, brush clearing, spread of invasive species	Heavy equipment, erosion,	Individuals, habitat	Injury, death	Reproduction, growth, nutrition, habitat	Numbers, reproduction	Individuals-No; Habitat-Yes	Removal of brush may increase habitat for small whorled pogonia
Trenching	Neutral	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Individuals-No; Habitat-Yes	No impacts expected from this action
Pipe Stringing and Bending	Neutral	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Individuals-No; Habitat-Yes	No impacts expected from this action
Assembly and Welding	Neutral	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Individuals-No; Habitat-Yes	No impacts expected from this action
Lowering in and Backfilling	Physical impacts to individuals	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Individuals-No; Habitat-Yes	No impacts expected from this action
Hydrostatic testing	Physical impacts to individuals, habitat degradation	flooding	Heavy equipment, discharge of water into uplands	Individuals, habitat	Injury, death	Reproduction, growth, nutrition, habitat	Numbers, reproduction	Individuals-No; Habitat-Yes	Use of best management practices should avoid upland flooding
Cleanup and Restoration	Neutral to beneficial	Soil compaction, burning of brush, dragging and moving logs	Heavy equipment, fire	Individuals, habitat	Injury, death	Reproduction, growth, nutrition, habitat	Numbers, reproduction	Individuals-No; Habitat-Yes	Removal of brush and opening of edges may increase habitat for small whorled pogonia
Use of artificial light	Physical Impacts to individuals	Artificial light	Artificial light	Individuals	Beneficial	Growth, reproduction	Numbers, reproduction	Individuals-No; Habitat-Yes	Artificial light has been shown to benefit many species of plants
Noise	Neutral	Noise	Heavy equipment, machinery, compressor stations	Individuals, habitat	Neutral	Not applicable	Not applicable	Individuals-No; Habitat-Yes	No impacts anticipated from noise

5.14 Smooth Coneflower

A field survey in Montgomery County, Virginia did not yield any individuals of smooth coneflower, but suitable habitat was identified. Analysis of potential effects to smooth coneflower and it's habitat, as a result of Project construction and operation is detailed in Table 29.

Walking, trampling, traffic, heavy equipment, habitat clearing, and habitat grading could have effects on smooth coneflower habitat. Use of BMPs is 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 BMPs and MVP's erosion 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 actually benefit smooth coneflower as it prefers open habitats.

Critical habitats have not been designated for smooth coneflower. The lack of occupied habitat in the Project and Action Area indicates direct and indirect effects to suitable habitats will not result in a loss of individuals. No individuals were identified in the Project Area, so direct or indirect effects to a known population is not expected.

Table 29. Effects analysis on smooth coneflower (*Echinaceae laevigata*).

Pipeline Activity	Environmental Impact or Threat	Stressor	Stressor Pathway	Exposure (Resource Affected)	Range of Response	Conservation Need Affected	Demographic Consequences	Individuals or Habitat Present?	Comments
Surveying and Staking	Physical impacts to individuals	Trampling, crushing, soil compaction	Vehicle and foot traffic	Individuals	Injury, death	Reproduction, growth, habitat	Numbers, reproduction	Individuals-No; Habitat-Yes	None
Clearing and Grading	Physical impacts to individuals, habitat degradation, habitat alteration	Crushing, burying, soil compaction, tree removal, brush clearing, spread of invasive species	Heavy equipment, erosion,	Individuals, habitat	Injury, death	Reproduction, growth, nutrition, habitat	Numbers, reproduction	Individuals-No; Habitat-Yes	Removal of canopy trees will likely increase habitat for smooth coneflower
Trenching	Neutral	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Individuals-No; Habitat-Yes	No impacts expected from this action
Pipe Stringing and Bending	Neutral	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Individuals-No; Habitat-Yes	No impacts expected from this action
Assembly and Welding	Neutral	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Individuals-No; Habitat-Yes	No impacts expected from this action
Lowering in and Backfilling	Neutral	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Individuals-No; Habitat-Yes	No impacts expected from this action
Hydrostatic testing	Physical impacts to individuals, habitat degradation	flooding	Heavy equipment, discharge of water into uplands	Individuals, habitat	Injury, death	Reproduction, growth, nutrition, habitat	Numbers, reproduction	Individuals-No; Habitat-Yes	Use of best management practices should avoid upland flooding
Cleanup and Restoration	Neutral to beneficial	Soil compaction, burning of brush, dragging and moving logs	Heavy equipment, fire	Individuals, habitat	Injury, death	Reproduction, growth, nutrition, habitat	Numbers, reproduction	Individuals-No; Habitat-Yes	Removal of brush and opening of edges may increase habitat smooth coneflower
Use of artificial light	Physical Impacts to individuals	Artificial light	Artificial light	Individuals	Beneficial	Growth, reproduction	Numbers, reproduction	Individuals-No; Habitat-Yes	Artificial light has been shown to benefit many species of plants
Noise	Neutral	Noise	Heavy equipment, machinery, compressor stations	Individuals, habitat	Neutral	Not applicable	Not applicable	Individuals-No; Habitat-Yes	No impacts anticipated from noise

5.15 Virginia Spiraea

A field survey 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. Analysis of potential effects to Virginia spiraea and its habitat as a result of Project construction and operation is detailed in Table 30.

Walking, trampling, traffic, heavy equipment, and habitat clearing could have effects on Virginia spiraea. Impacts from soil erosion and sedimentation as a result of clearing and grading could also be possible. However, since Virginia spiraea is a riparian species, impacts are expected to be minimized using BMPs and avoidance of riparian corridors and wetlands. Water withdrawals for hydrostatic testing have potential to modify stream and river flow patterns. Virginia spiraea prefers scoured banks and thus changes in hydrology could negatively affect the species' habitat. Another effect of habitat clearing and grading is potential spread of invasive species, which could alter habitat viability.

On the other hand, clearing could increase light regimes which may actually benefit Virginia spiraea habitat as long as hydrology patterns are maintained.

Critical habitat has not been designated for Virginia spiraea. The lack of occupied habitat in the Project and Action Area indicates direct and indirect effects to suitable habitats will not result in loss of individuals. No individuals were identified in the Project Area, so direct or indirect effects to a known population is not expected. However, as of the writing of this document, 0.14 kilometer / 1.73 hectares (0.09 mi / 4.28 acres) of the Project Area remains unsurveyed and the species is presumed present there so loss of individuals may occur if this area is indeed occupied.

Table 30. Effects analysis on Virginia spiraea (*Spiraea virginiana*).

Pipeline Activity	Environmental Impact or Threat	Stressor	Stressor Pathway	Exposure (Resource Affected)	Range of Response	Conservation Need Affected	Demographic Consequences	Individuals or Habitat Present?	Comments
Surveying and Staking	Physical impacts to individuals, habitat degradation	Trampling, crushing	Vehicles, walking	Individuals, habitat	Injury, death	Growth, reproduction, habitat	Numbers, reproduction	Individuals-No; Habitat-Yes	No effects to riparian habitat from this activity.
Clearing and Grading	Physical impacts to individuals, habitat degradation l	Trampling, crushing, soil compaction	Vegetation removal, heavy equipment	Individuals, Habitat	Injury, death	Growth, reproduction, habitat	Numbers, reproduction	Individuals-No; Habitat-Yes	No impacts to riparian habitat are expected from this activity.
Trenching	Neutral	None	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Individuals-No; Habitat-Yes	Streams will be bored under.
Pipe Stringing and Bending	Neutral	None	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Individuals-No; Habitat-Yes	No additional impacts after clearing and grading
Assembly and Welding	Neutral	None	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Individuals-No; Habitat-Yes	No additional impacts after clearing and grading
Lowering in and Backfilling	Neutral	None	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Individuals-No; Habitat-Yes	No additional impacts after clearing and grading
Hydrostatic testing	Physical impacts to individuals and habitat	Altered hydrology, contaminants	Water removal, flooding	Habitat, individuals	Injury, death	Reproduction, nutrition, habitat	Numbers, reproduction	Individuals-No; Habitat-Yes	
Cleanup and Restoration	Neutral	None	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Individuals-No; Habitat-Yes	No impacts to riparian habitat are expected from this activity
Use of artificial light	Physical Impacts to individuals	Artificial light	Artificial light	Individuals	Beneficial	Growth, reproduction	Numbers, reproduction	Individuals-No; Habitat-Yes	Artificial light has been shown to benefit many species of plants
Noise	Neutral	Noise	Heavy equipment, machinery, compressor stations	Individuals, habitat	Neutral	Not applicable	Not applicable	Individuals-No; Habitat-Yes	No impacts anticipated from noise

6.0 Cumulative Effects

For section 7 consultation, cumulative effects are defined as those effects of future state or private activities, not involving federal activities, that are reasonably certain to occur within the action area of the federal action subject to consultation (50 CFR § 402.02). For section 7 consultation, "cumulative effects involve only future non-Federal actions: past and present impacts of non-Federal actions are part of the environmental baseline" (emphasis in original, USFWS and NMFS 1998).

Cumulative effects can result from specific, usually large-scale, developments and from subsequent stages of existing 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 a loss of forest lands and/or a reduction in water quality were considered likely to add cumulatively to the effects of this Project. 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. These activities are described in detail in the following sections.

6.1 Large-Scale Construction

The first step in this process was to identify large construction projects that when combined with the Project may have a significantly detrimental impact on the Indiana bat, northern long-eared bat, gray bat, Virginia big-eared bat, Roanoke logperch, James spinymussel, clubshell, snuffbox, rusty patched bumble bee, northeastern bulrush, running buffalo clover, shale barren rock cress, small whorled pogonia, smooth coneflower, or Virginia spiraea. These projects meet the following criteria:

- Impact a resource potentially affected by the Project
- Cause an impact within the Project's Action Area
- Are of significant magnitude to meet the threshold of a major project
- Cause potential impact within a generally consistent time span associated with the Project

6.1.1 Natural Gas and Oil Transmission Projects

The Project is associated with exploitation of the Marcellus and Utica shales. These shales contain marketable quantities of gaseous and liquid petroleum products. Once oil or gas is obtained from a well site it is typically shipped to market via transmission pipelines, although liquid products are also shipped by rail and sometimes in trucks. Midstream and transmission lines are treated as major projects, and 11 natural gas development or improvement projects are expected to occur in the vicinity of the Project (Table 31).

Notably, all major construction projects listed in Table 31 have either already undergone a review by USFWS or have commenced the application process with FERC. As such these all represent Federal Actions with no cumulative effects under ESA. Any cumulative effects from these projects or others will be addressed by FERC in the Final Environmental Impact Statement.

6.1.2 Transportation

Four transportation construction or improvement projects are within the vicinity of the Project area in Virginia (Table 31). Two projects are under construction, so they are not considered in the cumulative impact analysis because they are not future actions, and two are in planning stages.

6.1.3 Coal and Mineral Extraction

The Project traverses the Appalachian coal-producing region, where coal mining has been ongoing since the 1800s. In this region, coal is extracted through surface strip mining (e.g., mountaintop removal) and underground (e.g., longwall mining) operations. Coal mining causes disturbances to land, and can cause soil erosion, dust, noise, and water pollution. Numerous coal mining operations are present near the Project, and future mining projects are expected. According to the WVDEP and the VDMME, there are 59 active mines within counties traversed by the Project. Approximately 3,508.04 and 840.56 hectares (8,668.57 and 2,077.06 ac) are permitted in association with the active mines in West Virginia and Virginia, respectively.

6.2 Forest Trends and Fragmentation

6.2.1 State-wide Forest Trends

The 2008 Farm Bill required all states to work with the USFS 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.

Table 31. Energy and transportation projects in the vicinity of the Mountain Valley Pipeline Project.

Project	Description	County/State	Distance from MVP (mi)	Direction from MVP	Status	Shared Watershed (5th Level)	Shared Air Quality Control Region
Equitrans Expansion Project	Equitrans Expansion Project consists of the installation of approximately 7.9 miles of various diameter pipelines and approximately 31,300 HP of compression at a new site in Franklin Township, Greene County, Pennsylvania.	Allegheny, Washington & Greene counties, PA & Wetzel County, WV	0 – 33	NE	Application filed with FERC	Fishing Creek	81.70 – Parkersburg (WV) – Marietta (OH)
Columbia WB Express Project	Columbia is proposing to modify and construct various facilities along its existing WB natural gas pipeline system in West Virginia and Virginia.	Various	5 28	E W	Pre-filing stage	N/A	N/A
Access South Pipeline	Texas Eastern is planning a natural gas pipeline project that cuts east-west across Marshall County, WV before heading south to Mississippi.	Marshall County, WV	11	N	Application filed with FERC	N/A	N/A
Appalachian Connector Pipeline	Williams is planning the Appalachian Connector pipeline project that would connect Western Marcellus and Utica natural gas supply areas in northern West Virginia with Williams's existing Transco natural gas pipeline, which stretches about 850 miles in Virginia.	N/A	Various	E	Preliminary planning stages	N/A	N/A
Atlantic Coast Pipeline Project	An approximately 550-mile, 42-inch natural gas pipeline is proposed by four energy companies that have entered into a joint venture: Dominion, Duke Energy, Piedmont Natural Gas, and AGL Resources. The capacity of the pipeline is projected to be 1.5 billion cubic feet/day.	Harrison & Lewis counties, WV	10 – 15	E	Application filed with FERC	Middle West Fork River, Upper West Fork River	81.231 Central West Virginia, 81.234 North Central West Virginia
Stonewall Gas Gathering Pipeline	The 55-mile gathering line, consisting of both 24 and 30 inch pipe, will connect to the Momentum Midstream's Appalachian Gathering System.	Doddridge, Harrison, Lewis, & Braxton counties, WV	Varies	Varies	Construction complete	Headwaters Middle Island Creek, Middle West Fork River, Upper West Fork River, Sand Fork, Upper Little Kanawha River	81.231 Central West Virginia, 81.234 North Central West Virginia
Supply Header Project	This proposed project would include approximately 39 miles of new 36-inch natural gas pipeline and would modify existing compression facilities on Dominion's system in West Virginia. The compressor station in Mockingbird Hill is approximately 7 miles west of MVP MP 1.0.	Wetzel & Harrison counties, WV	4 – 7	W	Application filed with FERC	Fishing Creek, Ten Mile Creek	81.231 Central West Virginia, 81.70 Parkersburg (WV) – Marietta (OH)
Rover Pipeline Project	Rover Pipeline LLC, a subsidiary of Energy Transfer, has proposed to construct the Rover Pipeline Project, which would carry 3.25 billion cubic feet of natural gas per day through 710 miles of pipeline. The last few miles of the project cuts southeast through Marshall, Wetzel, and Tyler counties before terminating in Doddridge County, WV.	Marshall, Wetzel, Tyler, & Doddridge counties, WV	5	W	Application filed with FERC	Ten Mile Creek, Headwaters Middle Island Creek, Fishing Creek	81.231 Central West Virginia, 81.70 Parkersburg (WV) – Marietta (OH)
Ohio Valley Connector	The proposed project includes approximately 36 miles of 30-inch diameter pipeline, two compressor stations, and associated facilities. The project is designed to transport natural gas from northern West Virginia to southeastern Ohio for subsequent delivery to mid-continent and Gulf Coast markets.	Wetzel County, WV	< 1	W	Construction is underway	Upper Ohio South and Dunkard Creek	81.231 Central West Virginia

Project	Description	County/State	Distance from MVP (mi)	Direction from MVP	Status	Shared Watershed (5th Level)	Shared Air Quality Control Region
Leach Xpress	The Leach Xpress project, proposed by Columbia Pipeline Group, would involve construction of approximately 160 miles of natural gas pipeline and compression facilities in West Virginia's northern panhandle.	Marshall County, WV	20	N	Application filed with FERC	N/A	N/A
Mountaineer Xpress Transmission Line	Columbia Gas Transmission LLC plans to construct a 165-mile pipeline from Marshall County to Wayne County, West Virginia. This project includes upgrades to three existing Columbia compressor stations in Kanawha, Wayne, and Marshall counties, as well as the construction of three new stations in Doddridge, Jackson, and Calhoun (or Ritchie) counties.	Marshall, Wetzel, Tyler, Doddridge, Ritchie, Calhoun, Wirt, Roane, Jackson, Mason, Putnam,& Cabell counties, WV	Unknown	Various	Pre-filing stage	N/A	81.143 Central Virginia
I-81 Bridge Replacement	This project will replace the I-81 bridges over the New River and Route 232 bridge over I-81.	Montgomery County, VA	7 – 8	S	Planning stage	N/A	81.146 Valley of Virginia
Elliston/Ironto Connector	Resurfacing of route 603	Montgomery County, VA	1	W	Under construction	North Fork Roanoke River	81.146 Valley of Virginia
U.S. Route 29 South	Replacement of structurally deficient bridge.	Pittsylvania County, VA	0.5	NW	Planning stage	Stinking River-Banister River	81.413 Central Virginia
Southgate Connector	Replacement of signalized intersection at Route 460 and Southgate Drive with a diverging diamond interchange.	Montgomery County, VA	5	S	Under construction	Back Creek-New River	81.146 Valley of Virginia

Forest trends for West Virginia were obtained from the West Virginia FRA: (http://www.fs.fed.us/ne/newtown_square/publications/brochures/pdfs/state_forests/wv_forest.pdf) and a summary publication: (http://www.wvforestry.com/DOF100Assessment_Revised_091310_Part1.pdf). 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 wide-spread 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 explosive development in the Marcellus Shale, which has led to a wide variety of developments associated with some timber removal. The Virginia FRA (http://www.dof.virginia.gov/infopubs/State-Assessment-2010_pub.pdf) indicates forest cover in the state increased markedly between the 1940s and 2007. This trend was evident across both soft- 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 0.3 hectare (0.75 ac) in regrowth compared to one acre of conversion. Conversion is least common in the mountains of western Virginia where the Project is located.

6.2.2 Forest Fragmentation

Forest is the predominant land cover impacted by the Project with 1,802.12 hectares (4,453.12 ac) impacted by construction and 647.02 hectares (1,598.82 ac) permanently converted to a grass/scrub shrub ROW. Fragmentation occurs when large or contiguous areas of a habitat type, in this case forest, are subdivided into smaller areas. Forest fragmentation exists in much of the Action Area in the form of roads, streams, developed areas, agriculture, and utility corridors.

As such, 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 (VDCR 2007) are used to assess Project-specific fragmentation impacts to large, continuous tracts of forest, with emphasis on impacts to interior forest. These datasets define the forest interior as areas 100 meters (328 ft) from the forest edge [i.e., the outer 100 meters (328.1 ft) 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 than the direct forest loss in the ROW.

Based on the forest core value assessment, the Project crosses 92 high value (in terms of wildlife) forest tracts (38 in West Virginia and 54 in Virginia) and, following construction, creates 447 fragments (255 in West Virginia; 192 in Virginia) greater than 0.04 hectare (>0.10 ac). GIS analysis estimates the net loss of forest interior at 5,140.93 hectares (12,703.52 ac), a 0.45 percent decrease from pre-impact conditions in West Virginia. The net loss of forest interior in Virginia is estimated at 1,265.06 hectares (3,126.02 ac), a 2.78 percent decrease from pre-impact conditions. Conversely, forest edge increases following construction by 6,615.05 hectares (16,346.15 ac), or 2.55 percent, in West Virginia, and by 1,575.32 hectares (3,892.70 ac), or 10.14 percent, in Virginia.

To reduce fragmentation to the maximum extent practical, the pipeline is aligned parallel to existing ROWs, including roads and utility corridors, along approximately 143.71 kilometers (89.30 mi) of the proposed route. Approximately 82.2 percent (55.87 hectares [138.07 ac]) of land needed for ancillary sites, such as contractor or staging yards, and 53.8 percent (146.68 hectares [362.46 ac]) of land needed for ATWS occurs in previously disturbed areas and thereby minimizes forest fragmentation.

6.3 Other Land Use Changes

6.3.1 Agricultural Lands

Data were compiled on agricultural practices and operations within counties traversed by the Project using the USDA's 2012 Census of Agriculture in Virginia (USDA 2014a) and West Virginia (USDA 2014b). The Agricultural census is updated every 5 years and trends were compared using census data from 2007 and 2012. County-wide data were compiled for select chemical applications (i.e., pesticides, herbicides, and fertilizers) and general farm information (e.g., number and size of farms). For various counties, publicly-available census data are missing or unreported regarding pesticide, herbicide, and fertilizer uses; however, general trends were interpolated using available information.

In both West Virginia and Virginia, the use of pesticides and herbicides steadily increased from 2007 to 2012 in the majority of counties impacted by the Project (USDA 2014a; b). In general, the net acreage of pesticide and herbicide use increased in counties in the northern part of West Virginia, although a few experienced a decrease. The trend of increasing pesticide and herbicide uses continued for counties in southern West Virginia and throughout counties along the Project in Virginia (Table 32).

The number of farms in West Virginia decreased between 2007 and 2012. In general, this trend existed for both southern and northern counties although a few experienced an increase (Table 32). In Virginia, numbers of farms increased, and this too was the trend for counties in the southern part of the state and counties along the Project alignment. Between 2007 and 2012, farm acreage decreased in the northern part of West Virginia, but increased in southern West Virginia. In Virginia, total farmland acres increased in all counties along the alignment.

Table 32. Agricultural census data reflecting changes in agricultural land uses and practices between 2007 and 2012 in counties traversed by the Project in West Virginia and Virginia.

	% Change from 2007 to 2012		Net Acreage Change from 2007 to 2012[a]		
County, State	Number of Farms	Average Size of Farms	Pesticide	Herbicide	Fertilizer
Braxton, WV	1	11	-109	-1210	-1291
Doddridge, WV	-28	12	101	143	-450
Fayette, WV	-12	-1	64	185	-32
Gilmer, WV	-11	23	-23	7106	2730
Greenbrier, WV	-7	15	-874	1205	-1820
Harrison, WV	1	4	-18	1290	-4117
Lewis, WV	-7	-15	203	11	-2830
Marion, WV	1	-9	-92	49	-908
Monroe, WV	13	-3	1475	3972	5378
Nicholas, WV	-9	25	-13	94	262
Summers, WV	-10	8	50	-418	-907
Webster, WV	-43	20	86	-10	[b]
Wetzel, WV	-29	4	161	250	153
Craig, VA	7	4	-107	842	279
Floyd, VA	0	13	209	4151	-13291
Franklin, VA	-2	1	136	4545	-4465
Giles, VA	10	-9	-569	235	-467
Montgomery, VA	-4	25	2064	4768	859
Pittsylvania, VA	-28	12	5201	19890	5619
Roanoke, VA	-19	32	-164	-483	-2221

[a] 2007 and/or 2012 county-wide census data may be missing or unreported
[b] 2012 Census data not reported to avoid disclosing data for individual farms in the county

In addition, agricultural land values in counties traversed by the Project were compiled from the USDA 2015 Land Values Summary report for West Virginia and Virginia (USDA 2015). The census is compiled annually, so usage trends are compared to the previous year. Between 2014 and 2015 agricultural land values steadily increased in both West Virginia and Virginia.

Based on the county-wide Agricultural reports, future increases in agricultural practices are foreseeable. Trends indicate further increase in harvested cropland and farmland values and a consequent increase in use of pesticides and herbicides (Table 32). Exceptions to these trends may occur along the northern portion of the Project in West Virginia (e.g., Doddridge, Wetzel, and Webster counties) where the number of farms has decreased. Concomitant with a reduction in the number of farms in these counties, the average farm size remains relatively similar or slightly increased, indicating a consolidation and/or expansion of existing farms. Because farm values will likely remain steady or continue to increase, farmland is not likely to be reverted back to forested habitats. Despite the occurrences of small fluctuations, no major changes are expected from changes in agricultural practices.

6.4 Protected Lands

This section identifies protected lands in and near the Action Area that provide long-term habitat for endangered species addressed by this BA. These forested areas may help protect listed species against landscape-scale deforestation and protected waters may provide refuge for aquatic animals. Various resources were used, including the following websites:

- www.nature.org
- www.dcr.virginia.gov/
- www.usace.army.mil/
- www.dgif.virginia.gov/
- www.wvdnr.gov/

Much of the surrounding forested landscape is permanently protected as West Virginia alone provides 19,072 hectares (47,128 ac) of Wilderness Area and 104,015.5 hectares (257,028 ac) of reserved area. In addition, the Commonwealth of Virginia protects approximately 1.58 million hectares (3.9 million ac). Table 33 lists protected areas comprising 404.7 hectares (1,000 ac) or more that occur in counties bisected by the Project Action Area. Project impacts to protected lands during construction and operation will be approximately 41.7 hectares (103.1 ac) and 18.6 hectares (46.0 ac), respectively.

Table 33. Protected lands crossed or within the vicinity of the Project.

Protected Land	County, State	Owner/Manager	Area (acres)	Project Impacts (acres)		Protected Water
				Cons.[1]	Oper.[2]	
Cecil H. Underwood Wildlife Management Area	Wetzel, WV	WVDNR	2,215	0.0	0.0	~2.75 miles West Virginia Fork of Fish Creek[3]
Lewis Wetzel Wildlife Management Area	Wetzel, WV	WVDNR	13,590	0.0	0.0	
Ohio River Islands National Wildlife Refuge	Wetzel, WV	USFWS	3,354	0.0	0.0	
Cedar Creek State Park	Gilmer, WV	WVDNR	2,588	0.0	0.0	~3.5 miles of Cedar Creek[3]
Stumptown Wildlife Management Area	Gilmer, WV	WVDNR	1,675	0.0	0.0	
Stonecoal Lake Wildlife Management Area	Lewis, WV	WVDNR	2,985	0.0	0.0	550 acres of Stonecoal Lake
Stonewall Jackson Lake State Park	Lewis, WV	WVDNR	1,736	0.0	0.0	
Dents Run Wildlife Management Area	Marion, WV	CONSOL/WVDNR	1,226	0.0	0.0	30 acres
Center Branch Wildlife Management Area	Harrison, WV	WVDNR	975	0.0	0.0	Center Branch Wildlife Management Area
Burnsville Lake Wildlife Management Area	Braxton, WV	WVDNR	12,579	0.0	0.0	968 acres of Burnsville Lake
Elk River Wildlife Management Area	Braxton, WV	WVDNR	18,225	0.0	0.0	1,440 acres of Sutton Lake
Babcock State Park	Fayette, WV	WVDNR	4,127	0.0	0.0	19 acres of Boley Lake
Beury Mountain Wildlife Management Area	Fayette, WV	WVDNR	9,232	0.0	0.0	
Gauley River National Recreation Area	Nicholas, Fayette, WV	NPS	11,507	0.0	0.0	25 miles of Gauley River, 6 miles of Meadow River
Monongahela National Forest	Greenbrier, Nicholas, Webster, WV	USFS	921,150	0.0	0.0	
Greenbrier State Forest	Greenbrier, WV	WVDNR	5,133	0.0	0.0	
Meadow River Wildlife Management Area	Greenbrier, WV	WVDNR	2,385	0.0	0.0	~4 miles of Meadow River[3]

Protected Land	County, State	Owner/Manager	Area (acres)	Project Impacts (acres)		Protected Water
				Cons.[1]	Oper.[2]	
Holly River State Park	Webster, WV	WVDNR	8,101	0.0	0.0	~7 miles of Laurel Fork of Holly River[3]
Big Ditch Wildlife Management Area	Webster, WV	WVDNR	388	0.0	0.0	55 acres of Big Ditch Lake
Valley Falls State Park	Monroe, WV	WVDNR	1,145	0.0	0.0	~3 miles of Tygart River[3]
Bluestone Wildlife Management Area	Monroe, Summers, WV	USACE/WVDNR	18,029	0.0	0.0	1,970 acres of Bluestone Lake
Bluestone State Park	Summers, WV	WVDNR	2,154	0.0	0.0	
New River Gorge National River	Fayette, Summers, WV	NPS	72,808	0.0	0.0	53 miles of New River
Pipestem Resort State Park	Summers, WV	WVDNR	4,050	0.0	0.0	~5 miles of Bluestone River and Montain Creek[3]
Peters Mountain Wilderness (within the Jefferson National Forest)	Giles, VA	USFS	3,328	0.0	0.0	
New River Conservancy Easement	Giles, VA	New River Conservancy	157	6.49	2.47	~ 0.3 miles of Little Stony Creek[3]
GIL-VOF-2250	Giles, VA	Virginia Outdoors Foundation	46	0.0	0.0	
Bottom Creek Gorge Preserve	Montgomery, VA	Nature Conservancy	1,657	0.0	0.0	~10 miles of Bottom Creek[3]
Brush Mountain Wilderness (within the Jefferson National Forest)	Montgomery, VA	USFS	4,794	0.0	0.0	
MON-VOF-844	Montgomery, VA	Virginia Outdoors Foundation	173	0.0	0.0	
MON-VOF-3333	Montgomery, VA	Virginia Outdoors Foundation	63	0.0	0.0	
Mill Creek Springs Natural Area Preserve (North Fork Roanoke River)	Montgomery, VA	VDCT; Nature Conservancy	222	0.0	0.0	
MON-VOF-2606	Montgomery, VA	Virginia Outdoors Foundation	64	0.0	0.0	
MON-VOF-1871	Montgomery, VA	Virginia Outdoors Foundation	269	0.93	0.36	
Elliston Park	Montgomery, VA	Montgomery County Parks and Recreation	10.3	0.0	0.0	
Grassy Hill Natural Area Preserve	Franklin, VA	VDCR	1,440	0.0	0.0	
Philpott Lake	Franklin, VA	USACE	2,880	0.0	0.0	2,880-acre Philpott Lake
Turkeycock Wildlife Management Area	Franklin, VA	VDGIF	2,679	0.0	0.0	
FRN-VOF-2766	Franklin, VA	Virginia Outdoors Foundation	160	0.0	0.0	
FRN-VOF-1549	Franklin, VA	Virginia Outdoors Foundation	124	0.0	0.0	
Buffalo Mountain Natural Area Preserve	Floyd, VA	VDCR	1,140	0.0	0.0	
MON-VOF-2563	Roanoke, VA	Virginia Outdoors Foundation	590	0.38	0.0	
The Nature Conservancy Easement	Roanoke, VA	The Nature Conservancy	870	23.92	8.06	
ROA-VOF-2931	Roanoke, VA	Virginia Outdoors Foundation	n/a	0.0	0.0	
Blue Ridge Land Conservancy Easement	Roanoke, VA	Blue Ridge Land Conservancy	201.5	0.0	0.0	
Blue Ridge Parkway Property	Roanoke and Franklin, VA	NPS	93,376	7.57	2.55	
Blue Ridge Parkway	Roanoke and Franklin, VA	NPS	93,376	0.0	0.0	
Havens Wildlife Management Area	Roanoke, VA	VDGIF	7,190	0.0	0.0	
Poor Mountain Natural Area Preserve	Roanoke, VA	VDCR	933	0.0	0.0	

Protected Land	County, State	Owner/Manager	Area (acres)	Project Impacts (acres)		Protected Water
				Cons.[1]	Oper.[2]	
White Oak Mountain Wildlife Management Area	Pittsylvania, VA	VDGIF	2,748	0.0	0.0	
George Washington and Jefferson National Forest	Craig, Giles, Montgomery, Roanoke, VA; Monroe, WV	USFS	1,646,328 VA, 123,384 WV	81.16	40.69	2,530 acres of Lake Moomaw, 2,340 miles perennial streams + additional reservoirs

[1]Cons. = Construction
[2]Oper = Operation
[3]Estimated using protected lands maps

6.5 Cumulative Effects Analysis

6.5.1 Indiana Bats

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 will 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 will remain available on the landscape. Approximately 89,623.13 hectares (221,463 ac) of forest within the Project's Action Area currently provides suitable roosting and foraging habitat for Indiana bats. Project construction will reduce the amount of forest within the Action Area by approximately 2.01 percent (1,801.9 hectares [4,452.6 ac]), and operation will permanently reduce the amount of forest by approximately 0.72 percent (648.3 hectares [1,602.1 ac]). Anticipated losses of suitable forested habitat from nearby energy projects, forestry practices, regional population growth, and increases in agriculture and pesticide use in the immediate area are minimal. As such, there is no reason to believe the Project will contribute to cumulative effects that will result in Jeopardy to Indiana bats.

6.5.2 Northern Long-eared Bats

As with the Indiana bat, WNS is the primary threat to northern long-eared bats. The northern long-eared bat is not habitat limited and the level of take associated with on-going land management and development actions do not individually or cumulatively affect the bat. As such, there is no reason to believe the Project will contribute to cumulative effects that will result in additional take of northern long-eared bats.

6.5.3 Gray Bats

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, and unnecessary arousal from hibernation lowers energy reserves which cannot be replenished before the end of winter, resulting in a premature death 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, it is not expected that land management and development actions of the MVP Project the Project is not likely to adversely affect the gray bat, and thus will not result in cumulative effects on the species.

6.5.4 Virginia Big-Eared Bats

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

6.5.5 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 Basin.

6.5.6 James Spinymussel

No cumulative impacts are anticipated for this species since it does not exist within the Action Area.

6.5.7 Clubshell

No cumulative impacts are anticipated for this species since it does not exist within the Action Area.

6.5.8 Snuffbox

No cumulative impacts are anticipated for this species since it does not exist within the Action Area.

6.5.9 Rusty Patched Bumble Bee

Rusty patched bumble bees are mainly threatened by pathogens, pesticide use, habitat loss, competition with non-native species, and climate change. These threats are continuously 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 and foreseeable increases in herbicide-applications, as a result of Project construction, the Project is likely to contribute to cumulative effects on the rusty patched bumble bee. 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 Project Area. Long-term effects based on management of the Project will likely be beneficial to rusty patched bumble bees due to the management of invasive species, the addition of floral resources preferred by this species, and maintenance of a dispersal corridor for this species. The Project increases openness of habitats and this has been shown highly beneficial to bees, especially in forested habitats (Hanula et al. 2016). These corridors generally have minimal disturbance and thus they may have equal or greater value to pollinators than powerline corridors (Russell et al. 2005, Hanula et al. 2016) and roads (Hopwood 2008).

6.5.10 Northeastern Bulrush

No cumulative impacts are anticipated for this species since it does not exist within the Action Area.

6.5.11 Running Buffalo Clover

No cumulative impacts are anticipated for this species since it does not exist within the Action Area.

6.5.12 Shale Barren Rock Cress

No cumulative impacts are anticipated for this species since it does not exist within the Action Area.

6.5.13 Small Whorled Pogonia

No cumulative impacts are anticipated for this species since it does not exist within the Action Area.

6.5.14 Smooth Coneflower

No cumulative impacts are anticipated for this species since it does not exist within the Action Area.

6.5.15 Virginia Spiraea

No cumulative impacts are anticipated for this species since it does not exist within the Action Area.

7.0 Determination of Effects and Rationale

A "**No Effect"** determination is appropriate when the action will not affect the species (USFWS and NMFS 1998). A "**May Affect"** determination is the appropriate conclusion when a proposed action may have any effects on the species. A **"May Affect – 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. A **"May Affect – 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.

7.1 Indiana Bats

Table 34 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 34. Summary of effects and effects determinations for Indiana Bats.

Description	Expected Harassed	Expected Harmed	Construction Impacts (ha)*	Operational Impacts (ha)*	Effect Determination	Section
Direct Effects						7.1.1
Winter Season of Hibernation	63	0	-	-	May Affect – Likely to Adversely Affect	7.1.1.1
Autumn Swarming and Spring Staging	112	2	325.49	188.1	May Affect – Likely to Adversely Affect	7.1.1.2
Summer Resident Indiana Bats	32	1	1,804.65	647.85	May Affect – Likely to Adversely Affect	7.1.1.3
Spring and Autumn Migration	1	1	1,804.65	647.85	May Affect – Likely to Adversely Affect	7.1.1.4
Indirect Effects	-	-	-	-	May Affect – Not Likely to Adversely Affect	7.1.2
Collective Impact/Determination	208	4			May Affect – Likely to Adversely Affect	7.1.3

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

7.1.1 Direct Effects

7.1.1.1 Winter Season of Hibernation

The Project will 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 **May Affect– Is Likely to Adversely Affect** is appropriate.

7.1.1.2 Autumn Swarming and Spring Staging

Within 8 kilometers (5 mi) of known or potentially occupied winter habitat, Project development will temporarily reduce forested habitat used by swarming or staging

Indiana bats by 0.21 percent (325.49 hectares [804.31 ac]) and permanently reduce it by 0.12 percent (188.1 hectares [464.8 ac]). 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 56 and 1 Indiana bats, respectively. Given the potential for take, a determination of **May Affect–Likely to Adversely Affect** staging Indiana bats is appropriate.

7.1.1.3 Summer Resident Indiana Bats

As a whole, the Project will permanently decrease forest within the Action Area by 0.72 percent and by 0.162 percent within the known, occupied Indiana bat summer habitat. This loss is a tiny 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 ROW and access roads where summer mist net surveys were not completed. Because timber will 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 will 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 **May Affect—Likely to Adversely Affect** is appropriate.

7.1.1.4 Spring and Autumn Migration/Transient Period

Approximately 0.72 percent (647.85 hectares [1,600.87 ac]) of the available forest within the Action Area will be permanently lost following Project development. This loss is a tiny 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 migrant Indiana bats killed or disturbed due to tree clearing is 1 and 1, respectively. Given the potential for take, a determination of **May Affect–Likely to Adversely Affect** migrating Indiana bats is appropriate.

7.1.2 Indirect Effects

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 **May Affect—Not Likely to Adversely Affect** is appropriate.

7.1.3 Indiana Bat Determination Summary

Collectively, a **May Affect – 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 will 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 ESA, thus FERC will require an Incidental Take Statement (ITS) from USFWS.

7.2 Northern Long-eared Bats

Table 35 summarizes the effects determinations that are explained more fully in sections that follow. Rows in the table are referenced to the appropriate text section.

7.2.1 Direct Effects

7.2.1.1 Winter Season of Hibernation

The Project will 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 **May Affect–Likely to Adversely Affect** is appropriate. This take is exempted under the final 4(d) rule.

Table 35. Summary of effects and effects determinations for northern long-eared bats, where take is not exempted.

Description	Expected Harassed	Expected Harmed	Construction Impacts (ha)*	Operational Impacts (ha)*	Effect Determination	Section
Direct Effects						7.2.1
Winter Season of Hibernation	222	0	-	-	May Affect – Likely to Adversely Affect	7.2.1.1
Autumn Swarming and Spring Staging	1	1	24.57	8.62	May Affect – Likely to Adversely Affect	7.2.1.2
Summer Resident Bats	0	0	1,804.65	647.85	May Affect – Likely to Adversely Affect	7.2.1.3
Spring and Autumn Migration	1	1	1,804.65	647.85	May Affect – Likely to Adversely Affect	7.2.1.4
Indirect Effects	-	-	-	-	May Affect – Not Likely to Adversely Affect	7.2.2
Collective Impact/Determination	224	2			May Affect – Likely to Adversely Affect	7.2.3

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

7.2.1.2 Autumn Swarming and Spring Staging

Within 0.4 kilometer (0.25 mi) of known or potentially occupied northern long-eared bat winter habitat, Project development will temporarily reduce forested habitat by 3.56 percent (24.57 hectares [60.71 ac]) and permanently reduce forested habitat by 1.25 percent (8.62 hectares [21.3 ac]). 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 and 1 bats will be harassed or harmed, respectively, during spring staging. No individuals are expected to be harmed or harassed during autumn swarming. Given the potential for harm and harassment, a determination of **May Affect–Likely to Adversely Affect** is appropriate. This take is exempted under the final 4(d) rule.

7.2.1.3 Summer Resident Northern Long-eared Bats

Approximately 0.72 percent (647.85 hectares [1,600.87 ac]) of the available forest within the Action Area, including four documented maternity roosts, will be permanently lost following Project development. This loss is a tiny fraction of the forested habitat available on the landscape that supports summer roosting and foraging bats. No forest habitat will be removed during June or July, and therefore a direct take via harm to individuals will not occur when maternity colonies are most vulnerable. A determination of **May Affect–Likely to Adversely Affect** is appropriate based on removal of known, occupied habitat. This take is exempted under the final 4(d) rule.

7.2.1.4 Spring and Autumn Migration/Transient Period

Approximately 0.72 percent (647.85 hectares [1,600.87 ac]) of the available forest within the Action Area will be permanently lost following Project development. It is estimated that 1 migrant individual may be harmed and 1 individual may be harassed from Project construction. Thus, a determination of **May Affect–Likely to Adversely Affect** migrating northern long-eared bats is appropriate. This take is exempted under the final 4(d) rule.

7.2.2 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 **May Affect—Not Likely to Adversely Affect** is appropriate.

7.2.3 Northern Long-eared Bat Determination Summary

Collectively, a **May Affect – 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.

7.3 Gray Bat

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 **May Affect–Not Likely to Adversely Affect** determination is appropriate for gray bats (Table 36).

Table 36. Summary of effects determinations for Gray Bat.

Description	Effect Determination
Direct Effects	May Affect – Not Likely to Adversely Affect
Indirect Effects	May Affect – Not Likely to Adversely Affect
Collective Determination	May Affect – Not Likely to Adversely Affect

7.4 Virginia Big-Eared Bat

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 are expected on the species and a **May Affect–Not Likely to Adversely Affect** determination is appropriate for Virginia big eared bats (Table 37).

Table 37. Summary of effects determinations for Virginia Big-Eared Bat.

Description	Effect Determination
Direct Effects	May Affect – Not Likely to Adversely Affect
Indirect Effects	May Affect – Not Likely to Adversely Affect
Collective Determination	May Affect – Not Likely to Adversely Affect

7.5 Roanoke Logperch

Table 38 summarizes the effects determinations that are explained more fully in sections that follow.

Table 38. Summary of effects and effects determinations for Roanoke Logperch.

Description	Expected Harassed	Expected Harmed	Streams Impacted (km)	Effect Determination	Section
Direct Effects on Individuals					7.5.1
Adults	2,118	16	-	May Affect–Likely to Adversely Affect	7.5.1.1
Young-of-the-Year	1,500	13	-	May Affect–Likely to Adversely Affect	7.5.1.2
Direct Effects on Habitat					7.5.2
Adults	-	-	20.50	May Affect–Not Likely to Adversely Affect	7.5.2.1
Young-of-the-Year	-	-	29.13	May Affect–Not Likely to Adversely Affect	7.5.2.2
Indirect Effects on Individuals	-	-	-	May Affect–Likely to Adversely Affect	7.5.3
Indirect Effects on Habitat	-	-	-	May Affect–Not Likely to Adversely Affect	7.5.4
Collective Take/Determination	3,618	29	49.63	May Affect – Likely to Adversely Affect	-

7.5.1 Direct Effects on Individuals

Collectively throughout the Roanoke River basin, it is estimated that Project activities could potentially harass 3,618 individuals and harm 29 individuals of all age classes (YOY and Age 1+ individuals). Harm estimates are calculated at 13 crossings (Table 23), 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 **May Affect–Likely to Adversely Affect** is made, as further detailed in the two following subsections.

7.5.1.1 Adults

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

7.5.1.2 Young-of-the-Year

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

7.5.2 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 may temporarily and cumulatively affect 49.63 stream kilometers (30.84 mi) of occupied or suitable Roanoke logperch habitats. Critical habitat has not been designated for the species.

7.5.2.1 Adults

Direct, instream construction activities within the LOD may temporarily impact 120.5 meters (395.3 ft) of Age-1+ occupied or suitable habitats at 13 stream crossings. Construction and associated sedimentation is likely to temporarily affect 20.50 kilometers (12.74 mi) of stream reaches occurring in Age-1+ occupied or suitable habitats. This estimate combines the 5.36 stream kilometers (3.33 mi) designated within 800-meter (2,624.7-ft) downstream buffers of the LOD with the 15.02 stream kilometers (9.33 mi) expected to be impacted from upland disturbances. However, temporary destruction or degradation of habitats is not likely to harm individuals. Further, given that no critical habitat has been designated, no impacts to critical habitat are possible. Based on this information, a determination of **May Affect—Not Likely to Adversely Affect** is appropriate.

7.5.2.2 Young-of-the-Year

Direct, instream construction activities within the LOD may temporarily impact 171.2 meters (561.7 ft) of occupied or suitable YOY habitats at 13 stream crossings. Construction and associated sedimentation is likely to temporarily affect 29.13 kilometers (18.10 mi) of stream reaches occurring in occupied habitats or suitable YOY habitats. This estimate combines the 7.62 stream kilometers (4.73 mi) designated within 800-meter (2,624.7-ft) downstream buffers of the LOD with the 21.34 stream kilometers (13.26 mi) expected to be impacted 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 to critical habitat are possible. A determination of **May Affect—Not Likely to Adversely Affect** based on impacts to habitat used by YOY is appropriate.

7.5.3 Indirect Effects on Individuals

Because various ecological processes (e.g., food web dynamics, trophic interactions, community structure) may be disrupted and perpetual effects to individuals is reasonably certain to occur as a result of Project completion, a **May Affect—Likely to Adversely Affect** determination is appropriate.

7.5.4 Indirect Effects on Habitat

Occupied and suitable habitats may be degraded; however, effects (if any) are likely to occur at a small scale and are highly unlikely to rise to the level of take, so a **May Affect—Not Likely to Adversely Affect** determination is appropriate.

7.5.5 Roanoke Logperch Determination Summary

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

7.6 James Spinymussel

Table 39 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 39. Summary of effects determinations for James spinymussel.

Description	Effect Determination	Section
Direct Effects on Individuals	May Affect – Not Likely to Adversely Affect	7.6.1
Direct Effects on Habitat	May Affect – Not Likely to Adversely Affect	7.6.2
Indirect Effects on Individuals	May Affect – Not Likely to Adversely Affect	7.6.3
Indirect Effects on Habitat	May Affect – Not Likely to Adversely Affect	7.6.4
Collective Determination	May Affect – Not Likely to Adversely Affect	7.6.5

7.6.1 Direct Effects to Individuals

James spinymussel were not present during mussel survey efforts that encompassed the proposed crossings and Action Area of Craig Creek in Montgomery County, Virginia. [redacted] extends approximately 1.3 stream kilometers (0.8 mi) downstream of the proposed pipeline crossing. The limits of the Action Area are more than 19.0 kilometers (11.8 mi) upstream of the nearest potential James spinymussel occurrence. 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 **May Affect–Not Likely to Adversely Affect** James spinymussel individuals.

7.6.2 Direct Effects to Habitat

No critical habitat has been designated for the James spinymussel, and the nearest known populations of James spinymussel occur outside of the Action Area; therefore the Project **May Affect–Not Likely to Adversely Affect** James spinymussel habitats.

7.6.3 Indirect Effects to Individuals

There will be no indirect effects on individuals because there are no individuals in the Action Area; therefore the Project **May Affect–Not Likely to Adversely Affect** James spinymussel individuals.

7.6.4 Indirect Effects to Habitats

The Project will not directly impact critical or known-occupied habitats of James spinymussel. Critical habitats have not been designated for the species and the nearest known populations of James spinymussel occur outside of the Action Area; therefore the Project **May Affect–Not Likely to Adversely Affect** James spinymussel habitats.

7.6.5 James Spinymussel Determination Summary

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

7.7 Clubshell

Table 40 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 40. Summary of effects determinations for clubshell.

Description	Effect Determination	Section
Direct Effects on Individuals	May Affect – Not Likely to Adversely Affect	7.7.1
Direct Effects on Habitat	May Affect – Not Likely to Adversely Affect	7.7.2
Indirect Effects on Individuals	May Affect – Not Likely to Adversely Affect	7.7.3
Indirect Effects on Habitat	May Affect – Not Likely to Adversely Affect	7.7.4
Collective Determination	May Affect – Not Likely to Adversely Affect	7.7.5

7.7.1 Direct Effects to Individuals

Clubshell were not present during USFWS approved mussel survey efforts at crossings of 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 less than 25.9 square kilometers (10 mi^2) and is consequently unlikely to support freshwater mussels. The nearest known populations of clubshell in Elk River, Little Kanawha River, and Leading Creek in West Virginia occur outside of the Action

Area therefore Project activities **May Affect–Not Likely to Adversely Affect** clubshell individuals.

7.7.2 Direct Effects to Habitat

The Project will not directly impact critical or known-occupied habitats of clubshell. Critical habitats have not been designated for the species and the nearest known populations of clubshell occur outside of the Action Area; therefore the Project **May Affect–Not Likely to Adversely Affect** clubshell habitats.

7.7.3 Indirect Effects to Individuals

There will be no indirect effects on individuals because there are no individuals in the Action Area; therefore the Project **May Affect–Not Likely to Adversely Affect** clubshell individuals.

7.7.4 Indirect Effects to Habitats

No critical habitat has been designated for the clubshell, and the nearest known populations of clubshell occur outside of the Action Area; therefore the Project **May Affect–Not Likely to Adversely Affect** clubshell habitats.

7.7.5 Clubshell Determination Summary

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

7.8 Snuffbox

Table 41 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 41. Summary of effects determinations for snuffbox.

Description	Effect Determination	Section
Direct Effects on Individuals	May Affect – Not Likely to Adversely Affect	7.8.1
Direct Effects on Habitat	May Affect – Not Likely to Adversely Affect	7.8.2
Indirect Effects on Individuals	May Affect – Not Likely to Adversely Affect	7.8.3
Indirect Effects on Habitat	May Affect – Not Likely to Adversely Affect	7.8.4
Collective Determination	May Affect – Not Likely to Adversely Affect	7.8.5

7.8.1 Direct Effects to Individuals

Snuffbox were not present during USFWS approved mussel survey efforts at crossings of 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 less than 25.9 square kilometers (10 mi^2) and is consequently unlikely to support freshwater mussels. The nearest known populations of snuffbox in Elk River, Little Kanawha River, and Leading Creek in West Virginia occur outside of the Action Area therefore Project activities **May Affect–Not Likely to Adversely Affect** snuffbox individuals.

7.8.2 Direct Effects to Habitat

No critical habitat has been designated for the snuffbox, and the nearest known populations of snuffbox occur outside of the Action Area; therefore the Project **May Affect–Not Likely to Adversely Affect** snuffbox habitats.

7.8.3 Indirect Effects to Individuals

There will be no indirect effects on individuals because there are no individuals in the Action Area; therefore the Project **May Affect–Not Likely to Adversely Affect** snuffbox individuals.

7.8.4 Indirect Effects on Habitats

The Project will not directly impact critical or known-occupied habitats of snuffbox. Critical habitats have not been designated for the species and the nearest known populations of snuffbox occur outside of the Action Area; therefore the Project **May Affect–Not Likely to Adversely Affect** snuffbox habitats.

7.8.5 Snuffbox Determination Summary

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

7.9 Rusty Patched Bumble Bee

Table 42 summarizes the effects determinations that are explained more fully in sections that follow. Rows in the table are referenced to the appropriate section.

Table 42. Summary of effects determinations for rusty patched bumble bee.

Description	Effect Determination	Section
Direct Effects on Individuals	May Affect – Not Likely to Adversely Affect	7.9.1
Direct Effects on Habitat	May Affect – Not Likely to Adversely Affect	7.9.2
Indirect Effects on Individuals	May Affect – Not Likely to Adversely Affect	7.9.3
Indirect Effects on Habitat	May Affect – Not Likely to Adversely Affect	7.9.4
Collective Determination	May Affect – Not Likely to Adversely Affect	7.9.5

7.9.1 Direct Effects to Individuals

The last known population of RPBB near the project area was in Fauquier (2014) Countiy, Virginia. Fauquier County is over 100 miles from the project. Historical records from Montgomery county are about 3.7 miles from the Action Area and from

Giles county are approximately four and seven miles from the Action Area. Historical records in Braxton, Fayette, Lewis, and Nicholas Counties, West Virginia are difficult to ascertain as specific data was often not collected; however, the closest record to the Action area appears to be over three miles away in Lewis County. Thus, project activities **May Affect–Not Likely to Adversely Affect** rusty patched bumble bee individuals.

7.9.2 Direct Effects to Habitat

The Project will not directly impact critical or known-occupied habitats of rusty patched bumble bee. Critical habitats have 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 **May Affect–Not Likely to Adversely Affect** rusty patched bumble bee habitat.

7.9.3 Indirect Effects to individuals

There will be no indirect effects on individuals because there are no individuals known to occur in the Action Area; therefore, the Project **May Affect–Not Likely to Adversely Affect** rusty patched bumble bee individuals.

7.9.4 Indirect Effect to Habitat

The Project will not directly impact critical or known-occupied habitats of rusty patched bumble bee. Critical habitats have 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 **May Affect–Not Likely to Adversely Affect** rusty patched bumble bee habitat.

7.9.5 Rusty Patched Bumble Bee Determination Summary

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

7.10 Northeastern Bulrush

The Project will not directly or indirectly impact known-occupied habitats of northeastern bulrush. Critical habitats have not been designated for the species and the nearest known populations of northeastern bulrush occur outside of the Action Area. Northeastern bulrush individuals were not found in the Project Area during USFWS approved plant surveys. The nearest known population of northeastern bulrush is in Alleghany County, Virginia outside of the Action and Project Area. Thus, Project activities have **No Effect** on northeastern bulrush (Table 43).

Table 43. Summary of effects determinations for northeastern bulrush.

Description	Effect Determination

Description	Effect Determination
Direct Effects	No Effect
Indirect Effects	No Effect
Collective Determination	No Effect

7.11 Running Buffalo Clover

The Project will not directly or indirectly impact known-occupied habitats of running buffalo clover. Critical habitats have not been designated for the species and the nearest known populations of running buffalo clover occur outside of the Action Area in Greenbrier County, West Virginia. Running buffalo clover individuals were not found in the Project Area during USFWS approved plant surveys. As of the writing of this document, 0.23 kilometer / 0.74 hectares (0.14 mi / 1.8 ac) of the project remains unsurveyed and the species is presumed present there; thus, project activities **May Affect– Likely to Adversely Affect** running buffalo clover (Table 44).

Table 44. Summary of effects determinations for running buffalo clover.

Description	Effect Determination
Direct Effects	May Affect – Likely to Adversely Affect
Indirect Effects	May Affect – Likely to Adversely Affect
Collective Determination	May Affect – Likely to Adversely Affect

7.12 Shale Barren Rock Cress

The Project will not directly or indirectly impact known-occupied habitats of running buffalo clover. Critical habitats have not been designated for the species and the nearest known populations of shale barren rock cress occur outside of the Action Area in Greenbrier County, West Virginia. Shale barren rock cress individuals were not found in the Project Area during USFWS approved plant surveys. As of the writing of this document, 0.19 kilometer / 11.94 hectares (0.12 mi / 29.5 ac) of the project remains unsurveyed and the species is presumed present there; thus, project activities **May Affect– Likely to Adversely Affect** running shale barren rock cress (Table 45).

Table 45. Summary of effects determinations for shale barren rock cress.

Description	Effect Determination
Direct Effects	May Affect – Likely to Adversely Affect
Indirect Effects	May Affect – Likely to Adversely Affect
Collective Determination	May Affect – Likely to Adversely Affect

7.13 Small Whorled Pogonia

The Project will not directly or indirectly impact known-occupied habitats of small whorled pogonia. Critical habitats have not been designated for the species and the nearest known populations of small whorled pogonia occur outside of the Action Area in Greenbrier County, West Virginia. Small whorled pogonia individuals were not found in the Project Area during USFWS approved plant surveys. As of the writing of this document, 0.19 kilometer / 11.94 hectares (0.12 mi / 29.5 ac) of the project remains unsurveyed and the species is presumed present there; thus, project activities **May Affect– Likely to Adversely Affect** small whorled pogonoia (Table 46).

Table 46. Summary of effects determinations for small whorled pogonia.

Description	Effect Determination
Direct Effects	May Affect – Likely to Adversely Affect
Indirect Effects	May Affect – Likely to Adversely Affect
Collective Determination	May Affect – Likely to Adversely Affect

7.14 Smooth Coneflower

The Project will not directly or indirectly impact known-occupied habitats of smooth coneflower. Critical habitats have not been designated for the species and the nearest known populations of smooth coneflower occur outside of the Action Area in Montgomery County, Virginia. Smooth conflower individuals were not found in the Project Area during USFWS approved plant surveys. Thus, project activities **May Affect – Not Likely to Adversely Affect** smooth coneflower (Table 47).

Table 47. Summary of effects determinations for smooth coneflower.

Description	Effect Determination
Direct Effects	May Affect – Not Likely to Adversely Affect
Indirect Effects	May Affect – Not Likely to Adversely Affect
Collective Determination	May Affect – Not Likely to Adversely Affect

7.15 Virginia Spiraea

The Project will not directly or indirectly impact known-occupied habitats of Virginia spiraea. Critical habitats have not been designated for the species and the nearest known populations of smooth coneflower occur outside of the Action Area in Nicholas County, West Virginia. Virginia spiraea individuals were not found in the Project Area during USFWS approved plant surveys. As of the writing of this document, 0.14 kilometer / 1.73 hectares (0.09 mi / 4.28 acres) of the project remains unsurveyed and the species is presumed present there; thus, project activities **May Affect– Likely to Adversely Affect** Virginia spiraea (Table 48).

Table 48. Summary of effects determinations for Virginia spiraea.

Description	Effect Determination
Direct Effects on Individuals	May Affect – Likely to Adversely Affect
Indirect Effects on Individuals	May Affect – Likely to Adversely Affect
Collective Determination	May Affect – Likely to Adversely Affect

8.0 Proposed Voluntary Conservation Measures

Even with implementation of reasonable and prudent measures to avoid and minimize, the MVP Project will have impacts to federally listed species. As such, this section details Voluntary Conservation Measures that MVP will employ to offset impacts to species by the Project, as identified under Section 7(a)(1) of the Act. The phrase “carrying out programs for the conservation of endangered species” may be interpreted broadly; MVP proposes to meet this objective by funding compensatory mitigation to offset habitat losses associated with project construction.

As identified in the Interim Guidance for Implementing the Endangered Species Act Compensatory Mitigation Policy (USFWS, 2017), “Mitigation projects may rely on a range of strategies including, but not limited to: 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 MVP’s proposed compensatory mitigation projects is provided below; a complete mitigation proposal will be submitted to USFWS.

8.1 Bats

MVP has acquired a 121-acre property crossed by the project in Braxton County, West Virginia. There are five NLEB captures roughly four miles north, one NLEB capture three miles south. The parcel has a small stream on the southern end and 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 is a 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, providing excellent travel/foraging corridors for bats. There are numerous existing snags throughout the property. The project crosses the property roughly 860 feet on the eastern portion of the parcel. Post construction approximately 106 acres will remain as interior forest as classified by the state of West Virginia and will be maintained as such in perpetuity. There is a stream on the southern end of the project although it is somewhat ephemeral. 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 will work with state agencies in West Virginia and Virginia to identify opportunities for enhancement to public lands including wildlife management areas or preserves.

8.2 Logperch

North Fork Roanoke River is crossed by the MVP project and is known to support populations of a wide variety of native fish, including the Roanoke logperch. The USFWS 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 up and downstream of the Project's crossing of the river. These activities include 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. MVP will 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.

MVP will 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) improved water quality, augmentation of habitat diversity, reestablish 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.

8.3 Funding

8.3.1 Bats

As part of MVP'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.

8.3.2 Logperch

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

8.3.3 Financial Assurances

Prior to commencement of construction, MVP will place funding (the amount to be determined in coordination with USFWS and applicable state agencies) in an interest-bearing escrow account fund to be used as described above. MVP will identify an appropriate third-party, non-profit conservation organization(s) that will develop a Memorandum of Understanding (MOU) with the agencies establishing 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 will be responsible for documenting that MVP 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 MVP and USFWS in coordination with applicable state agencies. MVP will develop a separate agreement with the third-party organization to address how the third-party organization will disburse funds.

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