



Mountain Valley Pipeline Project

Docket No. CP16-10-000

HABITAT MITIGATION PLAN

May 2017

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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 (Appendix A, Figure 1). 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.

2.0 Net Ecological Impact

Direct impacts from construction of the project include the loss of functions and services that result from forest removal. There are a variety of metrics for understanding and quantifying ecological impacts associated with the MVP project. The intensity of direct impacts is a function of what type of habitat is being removed, where it is located in the context of the overall landscape, how it will ultimately be restored, and how long it will take for restoration to occur. Indirect impacts result from forest fragmentation leading to diminished functions and services in remaining forest habitat adjacent to the project footprint; sometimes referred to as “edge effects”.

2.1 Habitat Equivalency Analysis

In order to estimate the impacts of the Mountain Valley Pipeline on forest function and services, a service-to-service scaling approach known as a Habitat Equivalency Analysis (HEA) is used. The HEA approach assesses the loss of ecosystem services from an action by comparing pre- and post-disturbance function levels of the system, and how these levels change with time due to disturbance and restoration. As a

result, this analysis accounts for not only the immediate impacts of disturbance, but also temporal effects on ecosystem service. The HEA facilitates the quantification of impacts and determination of appropriate mitigation requirements. This approach is particularly well suited to the MVP project because although there is a significant amount of forest impacts, this removal represents a total impact of less than 0.4% of forested land within 5 miles of the project footprint thus the “value per unit of service” is independent of the change in service levels in the landscape.

The major components of an HEA are:

- Estimation of the extent of ecosystem service loss from disturbance over time,
- Estimation of the extent of service recovery from habitat restoration and enhancement over time,
- Calculation of habitat replacement required to offset ecosystem service loss from project construction.

Because this analysis looks at impacts at present, and considers time to recover, implicit within the mechanics of the analysis is the temporal loss of system function. Thus a HEA facilitates quantification of impacts that are repeatable and comparable across projects (where resource impacts are similar in character, even if not in magnitude).

2.2 Functional Metrics

The success of a HEA in accurately determining impacts is a consequence of appropriateness of the functional metrics chosen to value ecosystem services and functions. Functional metrics are specific aspects of the ecosystem, which are assigned values, and become parameters of the HEA equation. The MVP Project HEA focuses on how construction will impact ecosystem services provided by migratory bird habitat. Accordingly, the functional metrics used in this model are:

- Runoff/sedimentation control services
- Carbon sequestration services
- Habitat quality relative to forested baseline
- Support of global biodiversity (How important is this habitat to rare species?)
- Recreational use and aesthetic value

These metrics were chosen because their veracity as indicators of ecosystem services provided by forests has already been established by forest service reports from the states of WV (2005) and VA (2016).

2.3 Habitat Service Value

Once the appropriate functional metric(s) has been determined, the next step in a HEA is to determine how particular landcover types compare to one another with regard to functional value. For example, interior deciduous forest is expected to provide higher quality habitat for a multitude of taxa than areas of shrub/scrub, which in turn is expected to provide higher quality habitat than areas of hay/pasture. To compare relative values of individual habitat types, a matrix is created with land cover types along one axis and functional metric value along the other. The values assigned within the matrix are designed to compare relative value of one landcover type to another, and in this case, relative to interior deciduous forest.

A comprehensive literature review was used to assign relative values for each metric to each land cover classification based on ecological principles. Because it was determined *a priori* that interior deciduous forest was the standard to which all other land cover classes were compared, assigned values are meant to be interpreted as the level of ecosystem services provided by a particular land cover relative to that provided by interior deciduous forest.

Given the multi-taxa nature of this habitat valuation and presupposed importance of interior forest, habitat comparisons were focused on fragmentation and edge effects, the importance of landscape heterogeneity, and how complex landscape mosaics influence wildlife diversity. Habitats providing a mixture of breeding, foraging, and sheltering opportunities for a diversity of wildlife, like wetlands or interior forest, were valued highly (Landres et al. 1999, Uezu et al. 2005). Habitats that tend to be characterized by more homogeneous cover, like hay/pasture, may provide specific benefits to wildlife (Benton et al. 2003). However, these are unlikely to be as critically important to a large number of taxa, and were therefore devalued as multi-taxa habitat relative to interior forest.

To account for influences of fragmentation and edge effects, such as increases in nest predation, exposure to non-native species, and changes in abiotic environments (e.g. soil moisture), edge forest was devalued relative to interior forest (Fahrig 2003, Batary and Baldi 2004, Banks-Leite et al. 2010). Intermediate quality values were assigned to those habitats that may serve as important areas for particular taxa or groups, such as open water providing for amphibians and water fowl (Semlitsch and Bodie 2003), or shrub/scrub providing for small mammals and loggerhead shrike (*Lanius ludovicianus*), but may not support the same level of diversity as wetlands or interior forest. Table 1, Appendix B shows the relative values assigned to each functional land cover type for the MVP project HEA.

A 0 to 10 scale is used to rank the value of ecosystem services provided by each land cover. It is important to note that in reality, all interior forests are not likely to perform as a 10, the highest level of functional value. An old growth deciduous

forest, for instance, may provide a greater variety of habitat types than will a younger, even-age monoculture. Thus, scoring all interior deciduous forests as 10 is a conservative approach to ensure that resource loss is not underestimated.

Once the functional metric values for each land cover type are determined, they are compared against the value for “interior deciduous forest” to calculate the number of “effective acres” (represented as b^A in subsequent calculations within this document). “Effective acres” is the fraction of ecosystem service a given land cover type provides, as compared to an acre of “interior forest”. For example, Table 2, Appendix B indicates that 1 acre of “edge deciduous forest” provides only 86% of the ecosystem services of 1 acre of “interior forest”. It is necessary to calculate “effective acres” because this provides a consistent unit of measurement for the analysis, rather than trying to compare land covers of varying habitat quality.

2.4 Define Baseline

In order to effectively quantify construction impacts, the baseline level of services provided by the area before disturbance is required. This is accomplished by assessing both the functional value of particular land covers and their prevalence within the landscape. The overall functional quality of the landscape and the amount of area impacted are then used to estimate service loss due to Project construction.

2.4.1 Project Footprint

Direct Impacts are those that occur within the project LOD. This includes all areas where ground disturbance will occur: permanent and temporary ROW, access roads, compressor stations and all ancillary facilities (Table 3, Appendix B).

2.4.2 Indirect Effects and Fragmentation

The main indirect impact associated with construction of the Project results from interior forest fragmentation as addressed in Section 7.3. It is generally accepted that “edge effects” from fragmentation extend approximately 100 meters (328 feet) inward from the forest boundary (Robbins 1988, Jones et al. 2000, Rodewald 2001). Thus, anywhere that the project footprint intersects an interior forest land class, a 100 meter buffer was placed around the footprint (Figure 2, Appendix A). The lateral dissipation of edge effects over the 100 meter buffer was assumed to be linear, resulting in a 1% decrease in impact per meter. Baseline effective acres of the indirect impact area is shown in Table 4, Appendix B.

MVP’s HEA addresses fragmentation with a conservative approach. As stated above, interior forest areas are not the same. Smaller Core Forest Areas may have the same intrinsic values as larger Core Forest Areas. Therefore, when using the 0 to 10 scale to rank the value of ecosystem services provided, a larger Core Forest area is likely to perform as a 10, the highest level of functional value. Conversely, a smaller Core Forest Area may perform at a value lower than 10. Thus, by scoring all

interior deciduous forests as 10, MVP's HEA overvalues the forest resources, ensuring that resource loss is not underestimated. In addition, the HEA devalues edge forest compared to interior forest.

2.4.3 Pre-construction Service Level

The overall pre-construction service level of the impact areas is determined by multiplying the percentage of the impact area made up of a particular land cover by the functional value of that land cover. Summing the products for all land cover types in the impact area provides a weighted mean functional value. The weighted mean functional value represents the overall functional quality of the impact area. Mean functional value calculations are found in Table 5, Appendix B.

2.5 Recovery

To accurately determine the impacts of the project, the recovery of services provided by restoration efforts must be quantified. This is accomplished by evaluating the functional level provided by restoration actions and over what time period that functional level is achieved or maintained. The overall recovery of services is a function of the habitat value of particular restoration types and how large an area is restored.

2.5.1 Project Footprint

Sections 5 and 6 of this document define the landscape restoration activities MVP will undertake within the project area. Generally, restoration efforts include reseeding the permanent ROW with native vegetation, reseeding all temporary impact areas that occur within forest lands with woody seed mixes, and hand planting woody vegetation at 55 sensitive stream crossings, loggerhead shrike habitat, and forested wetlands. These activities are detailed in MVP's Restoration and Rehabilitation Plan (Appendix C). Due to these restoration efforts, the Project area will recover substantial functional value relative to initial loss due to construction.

Although the majority of the LOD will be restored in some fashion, be it with an herbaceous layer or a return to forest, ecological recovery takes time. The HEA captures this temporal difference in function loss and recovery by assessing functions and values at various points in time. While herbaceous vegetation is expected to recover in 3 years, and planted shrub/scrub within 5 years, woody vegetation is expected to take longer.

Oak trees, one of the dominant taxa within the Project area, may begin producing acorns and become an important food source in approximately 30 years (University of Missouri Extension 2013). With regard to habitat quality however, the impact of forest age can be highly variable. Mature trees with cavities, for example, may provide important nesting and shelter areas from some bird species. Based on estimated rotational ages of dominant species identified through detailed habitat

assessments, including oak, hickory, beech and maple, and the results from a biomass study within the region (Adams and Kochendenfer [sic] 2014), the MVP HEA estimates that woody vegetation grown from seed mixes will mature in approximately 80 years. Table 6, Appendix B, identifies recovery periods used within the MVP HEA for the various types of restoration planting types and methods proposed.

Where t represents time:

t_M is the time until the restoration area reaches full service value

t_L is the time when the restoration area no longer provides valued services. For the purposes of this analysis, it is assumed that the restored areas exist in their natural state in perpetuity, and end of the functions and services they provide coincides with the impact measurement period.

Functional value at each point in time is based on the rate of recovery (Table 6, Appendix B) and effective acres per acre of each land cover classification (Table 7, Appendix B). The combination of time and value allow an estimation of functional values at various points in time during recovery. Impacts and recovery over the course of the entire measurement period are in units of Effective Acre Years (EAY), which simply represents the amount of functional services provided by each habitat over time (Table 8, Appendix B). Overall, or composite recovery of the ROW is based on the weighted mean of services provided by the restoration types (Table 9, Appendix B).

For clarity, and because effective acres in perpetuity are equal to effective acres at maturity, t_L has been omitted from the table.

2.5.2 Edge Habitats

Calculation of indirect impacts associated with edge effects are understood as a two-step process. First, at the boundary of the LOD, the forest interior habitat is converted to forest edge habitat, decreasing their functional values by approximately 14% (Table 1, Appendix B). However, edge effects dissipate as distance from the edge increases. For the purposes of this HEA, it is assumed that impairment of the forest due to edge effects decrease linearly by 1% per meter. As a result, the total reduction in services across 100 meters is roughly to equal to one half of the decrease from preconstruction baseline levels, or 0.7 effective acres. Secondly, after 80 years, temporary LOD areas will have recovered and 15 meters of the buffer farthest from the ROW will convert back to interior forest in year 80, the final year of measurement (Table 10, Appendix B).

Mathematical Calculations

The HEA analysis formula is as follows (NOAA 2000):

$$Ecological\ Loss = \left[\sum_{t=0}^L r_t * (b^A - x_t^A) / b^A \right] * A$$

$$Ecological\ Recovery = \left[\sum_{t=l}^L r_t * (x_t^p - b^p) / b^p \right] * B$$

Where:

t is time in years

t_0 is the time when disturbance takes place

t_l is the Initial time period when the restored area begins to provide services

t_L is the time when the restored area no longer provides services

x_t^A is the level of services per acre provided by the impacted area at the end of year t

b^A is the baseline level of services per acre of impacted habitat

x_t^p is the level of services per acre provided by the restored area at the end of year t .

b^p is the initial level of services provided, per acre, in the restored area, at t_0

r_t is the rate of discount during year t ; for this analysis 3% is used based on [NOAA 1999].

A is acreage of disturbance

B is acreage of restoration

2.5.3 Ecological Loss Calculation

This portion of the HEA equation estimates the ecological service loss associated with project construction. The term $(b^A - x_t^j) / b^A$ represents the percent reduction in services per acre at the disturbed site relative to the baseline functional value during year t . This term does not account for service gains at the site resulting from primary restoration. This ratio is then multiplied by $[1 / (1.03^t)]$, where t is the number of years since disturbance to calculate future discount of services. This set of functions is completed for every year, from 0 to 80. Then all of those results are summed, and the result is multiplied by the number of acres impacted by construction, including both the direct and indirect impact area.

Example 1

For Permanent LOD conversion from Interior Deciduous Forest to Barren Land in Year 0:

$$Ecological\ Loss = \left[r_t * \frac{b^A - x_t^A}{b^A} \right] * A = \left[1 * \frac{1 - 0}{1} \right] * 667.5 = \mathbf{667.5\ EAY}$$

Example 2

For Permanent LOD conversion from Interior Deciduous Forest to Barren Land in Year 2:

$$Ecological\ Loss = \left[r_t * \frac{b^A - x_t^A}{b^A} \right] * A = \left[0.943 * \frac{1 - 0}{1} \right] * 667.5 = \mathbf{629.5\ EAY}$$

2.5.4 Ecological Recovery Calculation

This portion of the HEA equation estimates the ecological service gain associated with project restoration activities. The term $(x_t^p - b^p)/b^A$ represents the percent increase in services per acre of the restoration area relative to the baseline functional value of the impacted area during year t . This ratio is then multiplied by $[1/(1.03^t)]$, where t is the number of years since project initiation, to calculate future discount of services. This set of functions is completed for every year, from 0 to 80. Then all of those results are summed. This is completed for *each* restored land cover type within both the direct and indirect impact area. Recovery values for each restored land cover type are used to estimate the amount of restoration acres required to offset functional loss.

Example 1

For Permanent LOD restoration with native grass seeding in Year 1:

$$Ecological\ Recovery = \left[r_t * \frac{x_t^p - b^p}{b^A} \right] * B = \left[1 * \frac{0.193 - 0}{1} \right] * 1884.3 = \mathbf{363.7\ EAY}$$

Example 2

For Permanent LOD restoration with native grass seeding in Year 2:

$$\begin{aligned} Ecological\ Recovery &= \left[r_t * \frac{x_t^p - b^p}{b^A} \right] * B = \left[0.971 * \frac{0.387 - 0}{1} \right] * 1884.3 \\ &= \mathbf{708.1\ EAY} \end{aligned}$$

2.5.5 Net Ecological Impact

Net Ecological Loss

$$= \left\{ \left[\sum_{t=0}^L r_t * (b^A - x_t^A)/b^A \right] * A \right\} - \left\{ \left[\sum_{t=1}^L r_t * (x_t^p - b^p)/b^A \right] * B \right\}$$

For the Permanent LOD over the entire Project area, the total net ecological loss is **10564.3 EAY**. For the Temporary LOD over the entire Project area, the total net ecological loss is **9880.3 EAY**. For the Indirect Impact area, the total net loss is **19008.7 EAY**.

Net ecological impact is a function of both Ecological Loss and Ecological Recovery, and varies with time. The response of the impact area to construction and restoration over time may be illustrated with recovery curves. The recovery curves for the entire Project are found in Figure 3, Appendix A while the curves separated by state are found in Figure 4, Appendix A.

It is important to note that this loss is represented as “effective acres”. Therefore, if the goal is convert this functional value loss to dollars, the appropriate unit conversion would be based on the cost of an acre of deciduous interior forest.

2.5.6 Replacement Habitat Size

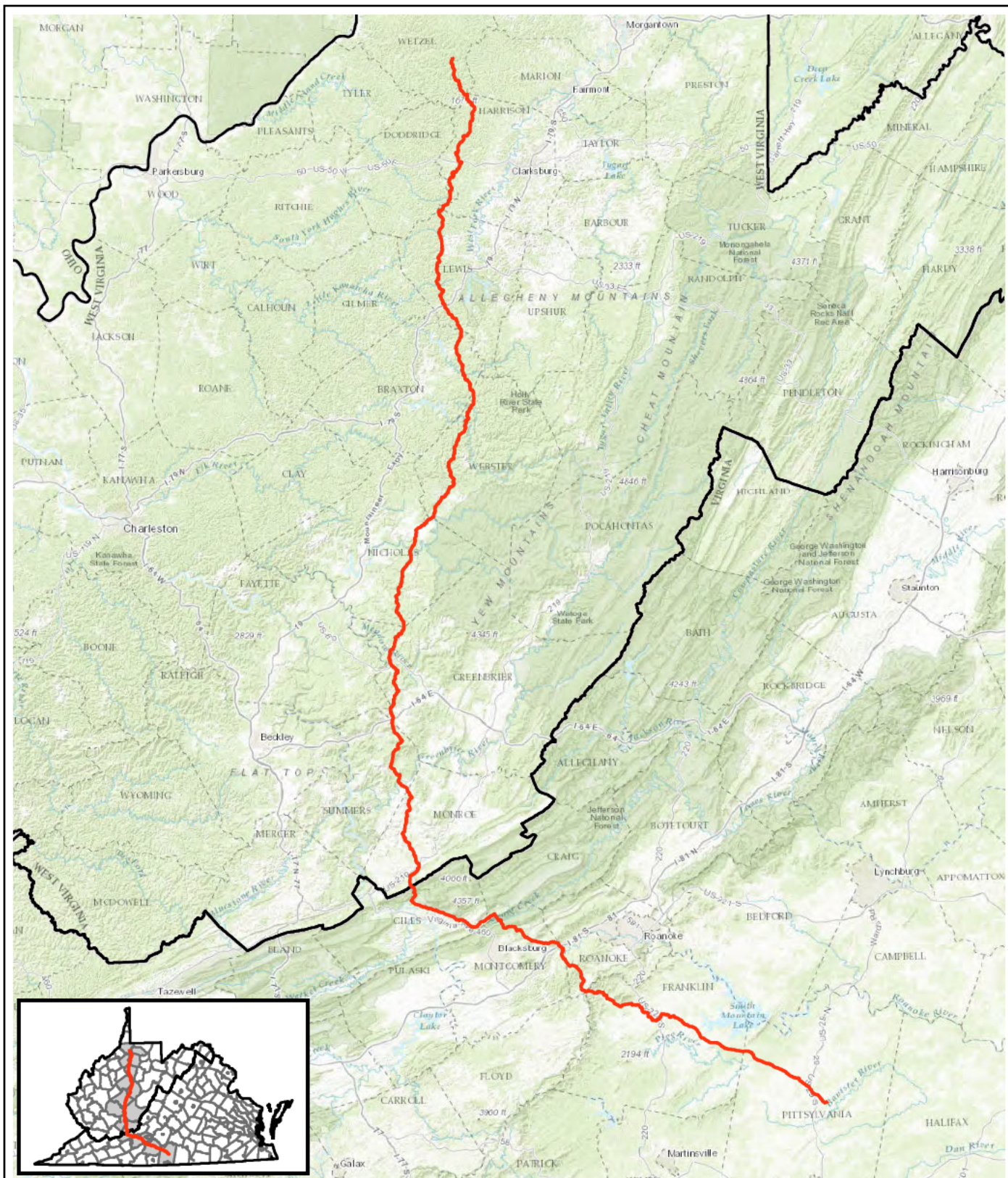
Visual_HEA (Kohler and Dodge 2006) software was used to determine the replacement habitat size required to offset Project impacts. Estimated habitat replacement size in Virginia totals 1270 acres, whereas estimated habitat replacement size in West Virginia totals 5001 acres.

3.0 Literature Cited

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APPENDIX A FIGURES



State Border Proposed Route

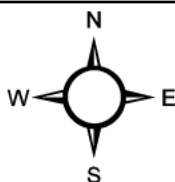


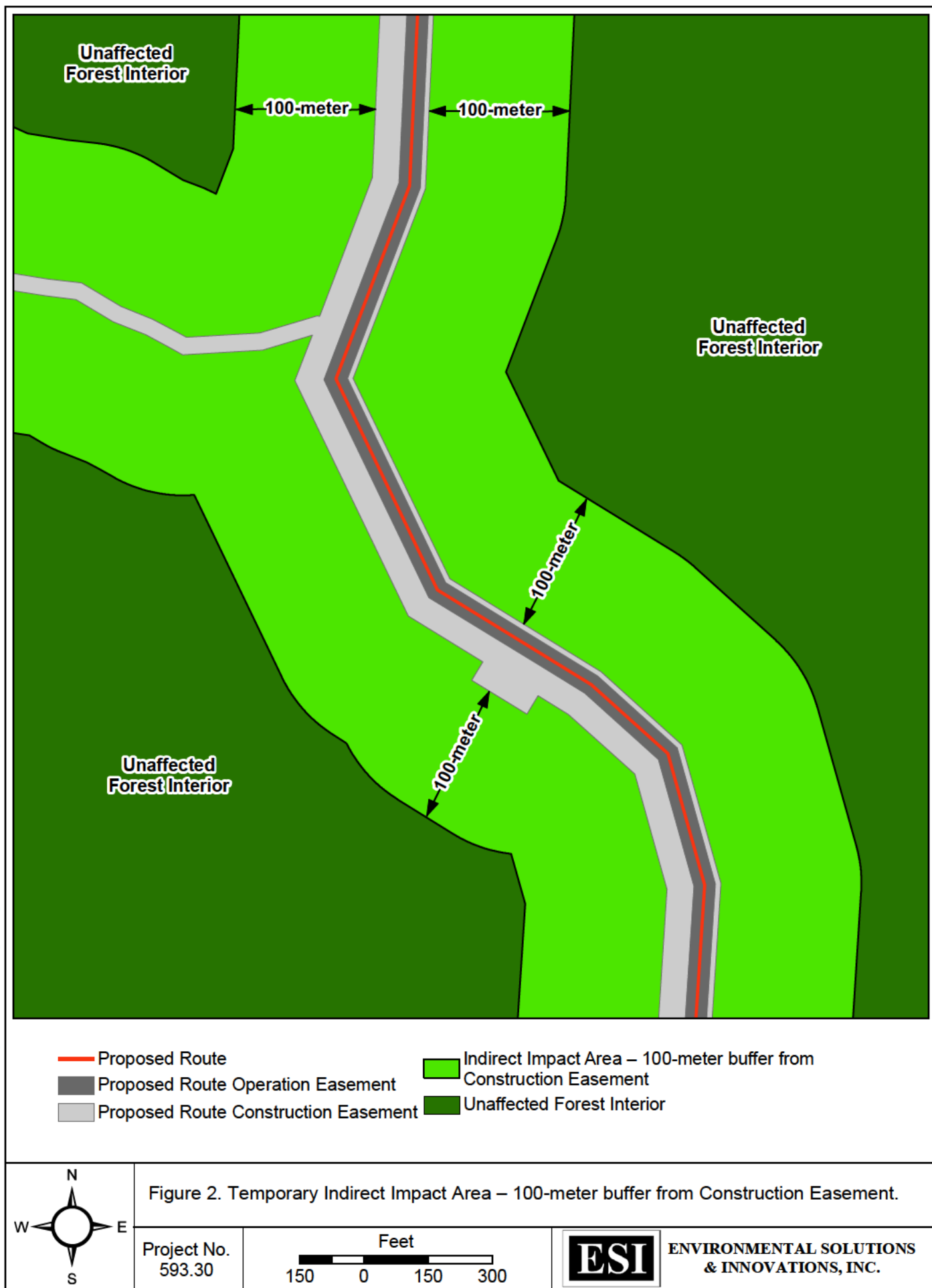
Figure 1. Location of the Mountain Valley Pipeline Project in West Virginia and Virginia (Revised December 2017).

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& INNOVATIONS, INC.



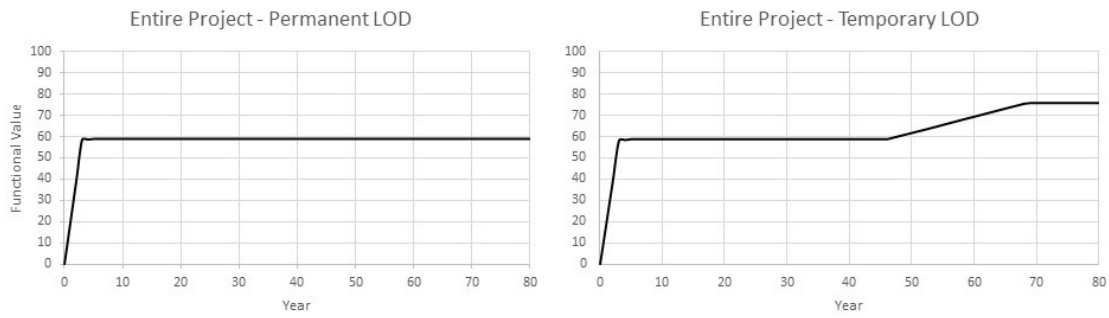


Figure 3. Habitat quality recovery curves for the Permanent and Temporary LOD over the entire Project area.

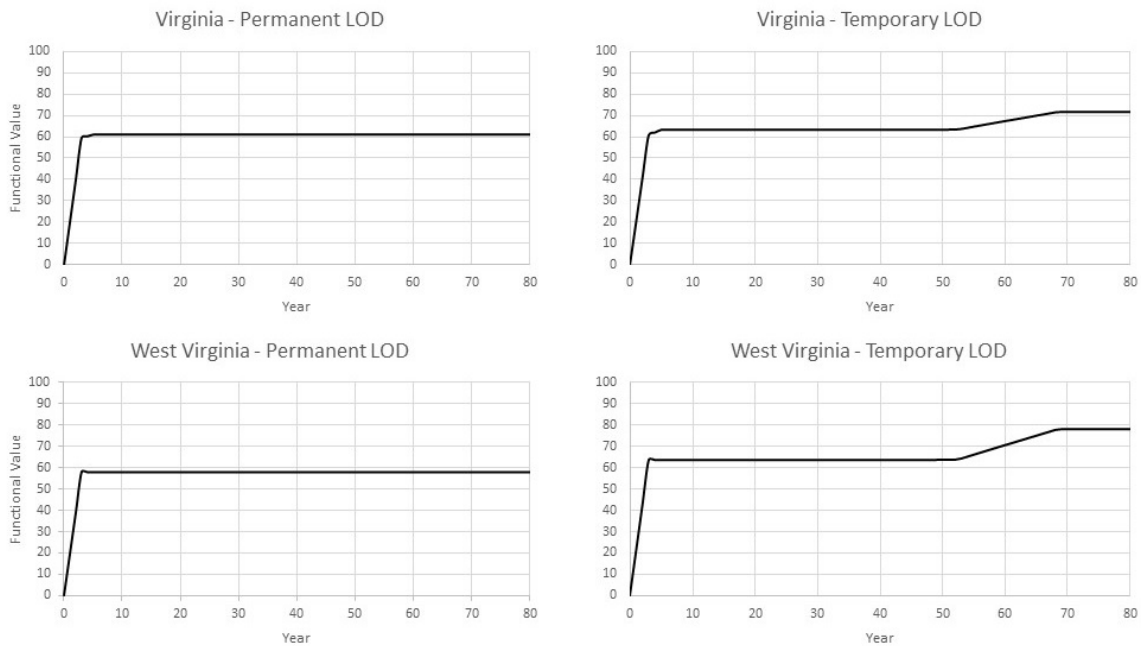


Figure 4. Habitat quality recovery curves for the Permanent and Temporary LOD for the states of Virginia and West Virginia.

APPENDIX B TABLES

Table 1. Functional Metric Values by Land Cover Classification.

Land Cover	Habitat Quality	Global Biodiversity	Runoff Prevention	Aesthetics/ Recreation	Carbon Sequestration	Total
Interior Deciduous Forest	10	10	10	10	10	50
Interior Evergreen Forest	6	6	10	10	9	41
Interior Mixed Forest	10	11	10	10	10	51
Edge Deciduous Forest	7	7	10	9	10	43
Edge Evergreen Forest	4	4	10	8	8	34
Edge Mixed Forest	7	8	10	9	10	44
Non-Forested						
Wetlands	10	11	10	10	9	51
Forested Wetlands	10	12	10	10	10	52
Hay/Pasture	3	3	5	4	6	21
Herbaceous	6	6	6	5	6	29
Open Water	6	7	8	7	6	34
Shrub/Scrub	7	6	8	6	6	33

Table 2. Effective Acres, per Acre, by Land Cover Classification

Land Cover	Total	Possible Total	Effective Acres <i>b</i> ^A
Interior Deciduous Forest	50	50	1
Interior Evergreen Forest	41	50	0.82
Interior Mixed Forest	51	50	1.02
Edge Deciduous Forest	43	50	0.86
Edge Evergreen Forest	34	50	0.68
Edge Mixed Forest	44	50	0.88
Non-Forested Wetlands	51	50	1.02
Forested Wetlands	52	50	1.04
Hay/Pasture	21	50	0.42
Herbaceous	29	50	0.58
Open Water	34	50	0.68
Shrub/Scrub	33	50	0.66

Table 3. Preconstruction Effective Acres for the Direct Impact Area.

Land Cover	Acres of Impact			Effective Acres per Acre	Effective Acres at Baseline		
	Virginia	West Virginia	Entire Project		Virginia	West Virginia	Entire Project
Interior Deciduous Forest	361.86	1410.89	1772.75	1.0	361.86	1410.89	1772.75
Interior Evergreen Forest	15.89	3.74	19.63	0.82	13.03	3.07	16.10
Interior Mixed Forest	36.96	125.05	162.01	1.02	37.70	127.55	165.25
Edge Deciduous Forest	679.98	1466.60	2146.58	0.86	584.78	1261.28	1846.06
Edge Evergreen Forest	78.48	20.80	99.28	0.68	53.37	14.14	67.51
Edge Mixed Forest	46.52	206.51	253.03	0.88	40.94	181.73	222.67
Non-Forested Wetlands	5.78	28.73	34.51	1.02	5.90	29.30	35.20

Land Cover	Acres of Impact			Effective Acres per Acre	Effective Acres at Baseline		
	Virginia	West Virginia	Entire Project		Virginia	West Virginia	Entire Project
Forested Wetlands	3.83	3.07	6.90	1.04	3.98	3.19	7.18
Hay/Pasture	579.96	423.72	1003.68	0.42	243.58	177.96	421.55
Herbaceous	122.74	60.03	182.77	0.58	71.19	34.82	106.01
Open Water	6.24	13.62	19.86	0.68	4.24	9.26	13.50
Shrub/Scrub	21.32	50.09	71.41	0.66	14.07	33.06	47.13

Table 4. Preconstruction Effective Acres, per Acre for the Indirect Impact Area.

Land Cover	Acres of Impact			Effective Acres per Acre	Effective Acres at Baseline		
	Virginia	West Virginia	Entire Project		Virginia	West Virginia	Entire Project
Interior Deciduous Forest	2542.63	9032.39	11575.02	1.0	2542.63	9032.39	11575.02
Interior Evergreen Forest	133.13	45.23	178.36	0.82	109.17	37.09	146.26
Interior Mixed Forest	73.28	254.08	327.36	1.02	74.75	259.16	333.91

Table 5. Weighted mean habitat value for the Permanent and Temporary LOD in Virginia and West Virginia.

Land Cover	Percentage of Impact Area				Effective Acres per Acre	Weighted Mean Habitat Value			
	Permanent		Temporary			Permanent		Temporary	
	Virginia	West Virginia	Virginia	West Virginia		Virginia	West Virginia	Virginia	West Virginia
Interior Deciduous Forest	0.209	0.406	0.171	0.352	1	0.209	0.406	0.171	0.352
Interior Evergreen Forest	0.010	0.001	0.007	0.001	0.82	0.008	0.001	0.006	0.001
Interior Mixed Forest	0.019	0.036	0.019	0.031	1.02	0.019	0.037	0.019	0.032
Edge Deciduous Forest	0.369	0.379	0.335	0.388	0.86	0.317	0.326	0.288	0.334
Edge Evergreen Forest	0.043	0.005	0.038	0.005	0.68	0.029	0.003	0.026	0.003
Edge Mixed Forest	0.025	0.053	0.023	0.055	0.88	0.022	0.047	0.020	0.048
Non-Forested Wetlands	0.005	0.005	0.002	0.009	1.02	0.005	0.005	0.002	0.009
Forested Wetlands	0.002	0.001	0.002	0.001	1.04	0.002	0.001	0.002	0.001
Hay/Pasture	0.253	0.083	0.319	0.126	0.42	0.106	0.035	0.134	0.053
Herbaceous	0.050	0.016	0.070	0.016	0.58	0.029	0.009	0.041	0.009
Open Water	0.005	0.005	0.002	0.003	0.68	0.003	0.003	0.001	0.002
Shrub/Scrub	0.010	0.011	0.011	0.014	0.66	0.007	0.007	0.007	0.009
Total						0.758	0.880	0.718	0.853

Table 6. Recovery Periods by Recovery Planting Type, in years.

Recovery Planting	Years Until Maturity t_M	Years Until Service "End" t_L
Steep Slope Grasses – Seeded	3	80
Pollinator/Native Grasses – Seeded	3	80
Deciduous Woody – Seeded	80	80
Riparian Wooded – Planted	75	80
Shrub/Scrub – Planted	5	80

Table 7. Future Condition Effective Acres per Acre by Land Classification, at Construction and Maturity.

Recovery Planting	Restored Land Cover	Services at x_0^p	Services at Maturity x_t^p
Steep Slope Grasses – Seeded	Herbaceous	$x_0^p = 0$	$x_3^p = 0.58$
Pollinator/Native Grasses – Seeded	Herbaceous	$x_0^p = 0$	$x_3^p = 0.66$
Deciduous Woody – Seeded	Edge Deciduous Forest	$x_0^p = 0$	$x_{80}^p = 0.86$
Riparian Wooded – Planted	Edge Deciduous Forest	$x_0^p = 0$	$x_{75}^p = 0.86$
Shrub/Scrub – Planted	Shrub/Scrub	$x_0^p = 0$	$x_5^p = 0.80$

Table 8. Total Post-Construction Future Condition Effective Acres, within the LOD, by Land Classification, at 2 Recovery Benchmarks.

Recovery Planting	Restored Land Cover	Acres Immediately Post Impact				Effective Acres per Acre	Total Effective Acres at Maturity			
		Permanent		Temporary			Permanent		Temporary	
		Virginia	West Virginia	Virginia	West Virginia		Virginia	West Virginia	Virginia	West Virginia
Steep Slope Grasses – Seeded	Herbaceous	526.69	1357.58	613.49	794.98	0.58	305.48	787.40	355.82	461.09
Pollinator/Native Grasses – Seeded	Herbaceous	161.8	32.99	90.2	9.8	0.66	106.79	21.77	59.53	6.47
Deciduous Woody – Seeded	Edge Deciduous Forest	0	0.10	567.57	2028.88	0.86	0.00	0.09	488.11	1744.84
Riparian Wooded – Planted	Edge Deciduous Forest	0	0	10.11	15.73	0.86	0.00	0.00	8.69	13.53
Shrub/Scrub – Planted	Shrub/Scrub	35.22	0	108.04	0	0.80	28.18	0.00	86.43	0.00

Table 9. Composite recovery for Permanent and Temporary LOD by state.

Impact Area	Measurement Period (years)	Composite Recovery Maximum			Composite Recovery Mean		
		Virginia	West Virginia	Entire Project	Virginia	West Virginia	Entire Project

Permanent LOD	80	0.609	0.582	0.591	0.593	0.568	0.576
Temporary LOD	80	0.719	0.781	0.761	0.639	0.657	0.624

Table 10. Total Future Condition Effective Acres, within the Buffer, by Land Classification, at 2 Recovery Benchmarks.

Land Cover	Services at x_{0-79}^p	Acres Immediately Post Impact		Services at Maturity x_{80}^p	Acres at Maturity	
		Virginia	West Virginia		Virginia	West Virginia
Edge Deciduous Forest	0.86	2542.63	9032.39	0.86	2161.24	7677.53
Edge Evergreen Forest	0.68	133.13	45.23	0.68	113.16	38.45
Edge Mixed Forest	0.82	73.28	254.08	0.88	62.29	215.97
Interior Deciduous Forest	0	0	0	1.0	381.39	1354.86
Interior Evergreen Forest	0	0	0	0.82	19.97	6.78
Interior Mixed Forest	0	0	0	1.02	11.0	38.11

APPENDIX C
MVP'S RESTORATION AND REHABILITATION PLAN



Mountain Valley Pipeline Project

Docket No. CP16-10-000

Restoration and Rehabilitation Plan

May 2017

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Appendix A – USFS Recommended Species for Seed Mixes

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1.0 Introduction

1.1 Project Description

Mountain Valley Pipeline, LLC (MVP), a joint venture of EQT Midstream Partners, LP, a subsidiary of NextEra Energy, Inc., Con Edison Gas Midstream, LLC, WGL Holdings, Inc., and RGC Midstream, LLC, plans to construct the Mountain Valley Pipeline (Project), an approximately 303-mile, 42-inch diameter natural gas pipeline, to provide timely, cost-effective access to the growing demand for natural gas for use by local distribution companies, industrial users and power generation in the Mid-Atlantic and southeastern markets, as well as potential markets in the Appalachian region. MVP 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 Project located in 17 counties in West Virginia and Virginia.

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. 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.

The Project area consists of the temporary and permanent right-of-way (ROW) established for construction, operation, and maintenance of the pipeline, access roads, and aboveground facilities. The pipeline will require a 125-foot construction ROW and a 50-foot permanent, operational ROW. MVP will neck down to a 75-foot construction ROW in streams and wetlands wherever possible.

1.2 Project Timeline

Tree clearing is expected to occur as early as November 2017, continuing through May 31, 2018 and resuming August 1, 2018 through November 15, 2018. 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.

1.3 Purpose of Plan

This *Restoration and Rehabilitation Plan* was prepared to address post-construction restoration, rehabilitation, and habitat mitigation activities. This plan will be implemented in conjunction with the FERC's 2013 *Upland Erosion Control, Revegetation, and Maintenance Plan* (Plan) and 2013 *Wetland and Waterbody Construction and Mitigation Procedures* (Procedures) as well as MVP's other construction, restoration, and mitigation plans (e.g., project-specific erosion and sedimentation control plans, *Spill Prevention, Control, and Countermeasure Plans*, *Karst Mitigation Plan*, and *Exotic and Invasive Species Control Plan*). The following sections provide details regarding MVP's proposed seed mixes, restoration procedures, maintenance and monitoring, and habitat enhancement within select areas of the Project.

2.0 Seed Mixes

MVP is partnering with the Wildlife Habitat Council (WHC), a nonprofit organization dedicated to assisting corporations, conservation organizations, and individuals with restoration and enhancement of wildlife habitat. The WHC is working with MVP on their commitment toward restoration of the Project ROW and establishment of perennial vegetation using native seed mixes created in collaboration with local seed supplier, Ernst Conservation Seeds, Inc. These seed mixes or an approved equivalent from another supplier will be applied along the Project's ROW except where landowners request a specific seed mix or on state or federally managed land where agencies request alternative seed mixes.

Proposed seed mixes will be distributed to representatives within state and federal agencies for approval and comment. These agencies include the United States Forest Service (USFS), West Virginia Department of Environmental Protection (WVDEP), West Virginia Division of Natural Resources (WVDNR), Virginia Department of Environmental Quality (VDEQ), and the Virginia Department of Conservation and Recreation – Division of Natural Heritage (VDCR-DNH).

2.1 Herbaceous Seed Mixes

A temporary cover crop containing oats (*Avena sativa*), grain rye (*Elymus* spp.), or Japanese millet (*Echinochloa esculenta*) will be applied at 30 pounds per acre to prevent encroachment of non-favorable vegetation and provide erosion control until permanent vegetation can establish.

An upland herbaceous seed mix (Table 1) containing of forbs and grasses capable of establishing quickly to provide soil stabilization and revegetation will be applied at 20 pounds per acre in areas of the ROW not considered riparian, wetland, or within pollinator enhancement areas. In areas highly susceptible to erosion and characterized as steep slope, the upland mix will be applied at 45 pounds per acre. In West Virginia, slopes are considered steep when above a 3:1 grade (33%). In Virginia, the definition of a steep slope varies by county:

- Craig County – slopes greater than 20%
- Giles County – slopes greater than 25%
- Montgomery County – slopes greater than 33%
- Roanoke County – slopes greater than 25%
- Franklin County – slopes greater than 25%
- Pittsylvania County – slopes greater than 20%

Table 1. Upland, steep slope herbaceous seed mix and recommended application rates.

Species	Common Name	WV Seeding Rate (lbs/acre)	VA Seeding Rate (lbs/acre)	pH	Bloom Period (if applicable)
<i>Agrostis perennans</i>	Autumn Bentgrass	3.15	3.15	5.5 - 7.5	Midsummer
<i>Elymus virginicus</i>	Virginia Wildrye	9.45	9.05	5.0 - 7.4	June to October
<i>Panicum clandestinum</i>	Deertongue	4.50	4.50	4.0 - 7.5	May to September
<i>Schizachyrium scoparium</i>	Little Bluestem	11.70	11.25	5.0 - 7.4	July to October
<i>Sorghastrum nutans</i>	Indiangrass	13.59	14.40	5.0 - 7.8	August to October
<i>Asclepias syriaca</i>	Common Milkweed	0.23	0.09		June to August
<i>Aster novae-angliae</i>	New England Aster	0.09	n/a	5.1 - 6.8	August to October
<i>Aster pilosus</i>	Heath Aster	0.05	0.05	5.4 - 7.0	After fall frost
<i>Aster prenanthoides</i>	Zigzag Aster	0.09	n/a	5.5 - 7.2	August to October
<i>Chamaecrista fasciculata</i>	Partridge Pea	n/a	0.45	5.5 - 7.5	July to September
<i>Coreopsis lanceolata</i>	Lanceleaf Coreopsis	0.45	0.45	6.0 - 7.0	April to July
<i>Desmodium paniculatum</i>	Panicleleaf Ticktrefoil	0.14	n/a	6.0 - 7.0	July to August
<i>Eupatorium coelestinum</i>	Mistflower	0.05	0.05	5.5 - 7.5	July to August
<i>Heliopsis helianthoides</i>	Oxeye Sunflower	0.36	0.45	5.5 - 7.0	July to August
<i>Liatris graminifolia</i>	Grassleaf Blazing Star	n/a	0.09	5.8 - 6.8	August to October
<i>Monarda fistulosa</i>	Wild Bergamot	0.18	0.23	6.0 - 8.0	June to September
<i>Pycnanthemum incanum</i>	Hoary Mountainmint	0.05	0.05	< 6.8	Summer
<i>Rudbeckia hirta</i>	Blackeyed Susan	0.45	0.45	6.0 - 7.0	May to July
<i>Senna hebecarpa</i>	Wild Senna	0.18	0.23		July to August
<i>Solidago juncea</i>	Early Goldenrod	0.09	n/a		June to July
<i>Solidago nemoralis</i>	Gray Goldenrod	0.14	0.05	6.5 - 7.5	August to September
<i>Tradescantia ohiensis</i>	Ohio Spiderwort	0.09	0.05		late April to mid-July
		45.00	45.00		

An herbaceous seed mix containing facultative wetland species will be applied to forested, emergent, and shrub/scrub wetlands where appropriate (Table 2). In forested wetlands, the herbaceous seed mix will be augmented with the planting of bare-root saplings and shrubs at specified distances from the pipeline centerline. See Section 5.3.1 for more details.

An herbaceous seed mixture containing warm season grass and wildflower species well suited to vegetate the banks of water features will be used within a 100-foot riparian buffer at perennial waterbody crossings (Table 3). At forested perennial stream crossings, a woody seed mixture specific to forest type will be applied with the herbaceous seed mix to temporary workspaces (see Section 2.2), and at 55 select perennial crossings planting of bare root seedlings will occur at specified distances from the pipeline centerline (see Section 5.3.1).

Table 2. Wetland herbaceous seed mix and recommended application rates.

Species	Common Name	WV Seeding Rate (lbs/acre)	VA Seeding Rate (lbs/acre)	pH	Bloom Period (if applicable)
<i>Alisma subcordatum</i>	Mud Plantain	0.04	0.04	5.0 - 7.0	Midsummer
<i>Asclepias incarnata</i>	Swamp Milkweed	n/a	0.40		July to August
<i>Aster novae-angliae</i>	New England Aster	0.16	n/a		August to October
<i>Aster prenanthoides</i>	Zigzag Aster	0.14	n/a	5.5 - 7.2	August to October
<i>Aster umbellatus</i>	Flat Topped White Aster	0.10	n/a		August to Late Summer
<i>Carex gynandra</i>	Fringed Sedge	0.10	0.10		May to June
<i>Carex lupulina</i>	Hop Sedge	1.00	1.00	6.2 - 7.0	June to October
<i>Carex lurida</i>	Shallow Sedge	3.00	3.00	4.9 - 6.8	June to July
<i>Carex scoparia</i>	Blunt Broom Sedge	1.00	1.00	4.6 - 6.9	July to August
<i>Carex vulpinoidea</i>	Fox Sedge	7.00	6.90	6.8 - 8.9	June to August
<i>Cinna arundinacea</i>	Wood Reedgrass	0.40	0.40	4.0 - 8.5	August to September
<i>Elymus virginicus</i>	Virginia Wildrye	4.00	4.00	5.0 - 7.4	June to October
<i>Eupatorium coelestinum</i>	Mistflower	0.10	0.10	5.5 - 7.5	July to October
<i>Eupatorium fistulosum</i>	Joe Pye Weed	0.14	0.14	4.5 - 7.0	July to September
<i>Eupatorium perfoliatum</i>	Boneset	0.20	0.20		July to October
<i>Helenium autumnale</i>	Common Sneezeweed	n/a	0.10		July to October
<i>Heliopsis helianthoides</i>	Oxeye Sunflower	0.40	0.40		July to August
<i>Juncus effusus</i>	Soft Rush	0.60	0.60	5.5 - 7.0	May to June
<i>Ludwigia alternifolia</i>	Seedbox	0.10	0.10		August to September
<i>Mimulus ringens</i>	Square Stemmed Monkeyflower	0.10	0.10		June to September
<i>Onoclea sensibilis</i>	Sensitive Fern	0.20	0.20		June to October
<i>Scirpus cyperinus</i>	Woolgrass	0.20	0.20	4.8 - 7.2	July to September
<i>Scirpus polyphyllus</i>	Many-leaved Bulrush	0.20	0.20		July to August
<i>Verbena hastata</i>	Blue Vervain	0.72	0.72		June to October
<i>Vernonia noveboracensis</i>	New York Ironweed	0.10	0.10	4.5 - 8.0	July to September
		20.00	20.00		

Table 3. Riparian herbaceous seed mix and recommended application rates.

Species	Common Name	WV Seeding Rate (lbs/acre)	VA Seeding Rate (lbs/acre)	pH	Bloom Period (if applicable)
<i>Agrostis perennans</i>	Autumn Bentgrass	0.54	0.50	5.5 - 7.5	Midsummer
<i>Andropogon gerardii</i>	Big Bluestem	3.00	3.00	6.0 - 7.5	July to October
<i>Elymus virginicus</i>	Virginia Wildrye	4.00	4.00	5.0 - 7.4	June to October
<i>Juncus effusus</i>	Soft Rush	0.20	0.20	5.5 - 7.0	May to June
<i>Juncus tenuis</i>	Path Rush	0.20	0.20	4.5 - 7.0	May to June
<i>Panicum clandestinum</i>	Deertongue	5.60	5.40	4.0 - 7.5	May to September
<i>Sorghastrum nutans</i>	Indiangrass	3.60	3.60	5.0 - 7.8	August to October
<i>Asclepias incarnata</i>	New England Aster	0.20	n/a	5.0 - 8.0	June to July
<i>Aster novae-angliae</i>	Swamp Milkweed	0.20	0.20		Late Summer
<i>Chamaecrista fasciculata</i>	Partridge Pea	n/a	0.40	5.5 - 7.5	July to September
<i>Eupatorium coelestinum</i>	Mistflower	0.20	0.20	5.5 - 7.5	July to October
<i>Eupatorium fistulosum</i>	Joe Pye Weed	0.14	0.14	4.5 - 7.0	July to September
<i>Eupatorium perfoliatum</i>	Boneset	0.10	0.10		July to October
<i>Geum canadense</i>	White Avens	0.20	0.20	4.5 - 7.5	May to June
<i>Helenium autumnale</i>	Common Sneezeweed	n/a	0.10	4.0 - 7.5	August to September
<i>Heliopsis helianthoides</i>	Oxeye Sunflower	0.40	0.40		July to August
<i>Monarda fistulosa</i>	Wild Bergamot	0.10	0.10	6.0 - 8.0	June to September
<i>Pycnanthemum tenuifolium</i>	Slender Mountainmint	0.06	0.06		July to September
<i>Rudbeckia hirta</i>	Blackeyed Susan	0.60	0.60	6.0 - 7.0	May to October
<i>Senna hebecarpa</i>	Wild Senna	0.08	0.10		July to August
<i>Senna marilandica</i>	Maryland Senna	0.08	n/a	4.0 - 7.0	Summer
<i>Verbena hastata</i>	Blue Vervain	0.40	0.40		June to October
<i>Vernonia noveboracensis</i>	New York Ironweed	0.10	0.10	4.5 - 8.0	July to September
		20.00	20.00		

Portions of the ROW within Braxton, Lewis, Fayette, and Nicholas counties, West Virginia and Giles and Montgomery counties, Virginia not considered as steep slope, riparian, or wetland will receive an herbaceous seed mix designed for native pollinators (Table 4). These select counties crossed by the Project contain either historical or extant records for presence of the federally endangered rusty patch bumblebee (*Bombus affinis*). MVP will voluntarily apply the aforementioned pollinator seed mix in an attempt to provide or enhance available foraging habitat necessary for the rusty patched bumblebee's recovery efforts in West Virginia and Virginia.

Table 4. Upland meadow, pollinator herbaceous seed mix and recommended application rates.

Species	Common Name	WV Seeding Rate (lbs/acre)	VA Seeding Rate (lbs/acre)	pH	Bloom Period (if applicable)
<i>Elymus virginicus</i>	Virginia Wildrye	4.00	4.00	5.0 - 7.4	June to October
<i>Schizachyrium scoparium</i>	Little Bluestem	11.66	11.68	5.0 - 7.4	July to October
<i>Sorghastrum nutans</i>	Indiangrass	1.00	1.00	5.0 - 7.8	August to October
<i>Asclepias syriaca</i>	Common Milkweed	n/a	0.10	June to August	<i>Asclepias syriaca</i>
<i>Asclepias tuberosa</i>	Butterfly Milkweed	0.20	0.10	4.8 - 6.8	June to August
<i>Aster novae-angliae</i>	New England Aster	0.14	n/a	5.1 - 6.8	August to October
<i>Chamaecrista fasciculata</i>	Partridge Pea	n/a	0.60	5.5 - 7.5	July to September
<i>Chamaecrista nictitans</i>	Sensitive Partridge Pea	n/a	0.06		June to October
<i>Coreopsis lanceolata</i>	Lanceleaf Coreopsis	0.40	0.44	6.0 - 7.0	June to August
<i>Echinacea purpurea</i>	Purple Coneflower	0.60	n/a	6.5 - 7.2	Late Summer
<i>Eupatorium coelestinum</i>	Mistflower	0.10	0.04	5.5 - 7.5	July to October
<i>Heliopsis helianthoides</i>	Oxeye Sunflower	0.40	0.40	5.5 - 7.0	July to August
<i>Lespedeza virginica</i>	Slender Bushclover	n/a	0.10		July to September
<i>Liatris graminifolia</i>	Grassleaf Blazing Star	n/a	0.10	5.8 - 6.8	August to October
<i>Liatris spicata</i>	Marsh Blazing Star	0.16	n/a	5.6 - 7.5	July to September
<i>Monarda fistulosa</i>	Wild Bergamot	0.12	0.10	6.0 - 8.0	June to September
<i>Parthenium integrifolium</i>	Wild Quinine	0.10	n/a	unknown	Late May to Late August
<i>Penstemon laevis</i>	Appalachian Beardtongue	0.20	0.10	unknown	May to June
<i>Pycnanthemum incanum</i>	Hoary Mountainmint	0.04	0.20	< 6.8	Summer
<i>Rudbeckia fulgida</i> var. <i>fulgida</i>	Orange Coneflower	0.04	0.02		July to October
<i>Rudbeckia hirta</i>	Blackeyed Susan	0.60	0.04	6.0 - 7.0	May to July
<i>Senna hebecarpa</i>	Wild Senna	0.10	0.60		July to August
<i>Solidago juncea</i>	Early Goldenrod	0.04	0.10		June to July
<i>Solidago nemoralis</i>	Gray Goldenrod	0.04	0.04	6.5 - 7.5	August to September
<i>Tradescantia ohimensis</i>	Ohio Spiderwort	0.06	0.04		Late April to Mid-July
<i>Tradescantia virginiana</i>	Virginia Spiderwort	n/a	0.10		late April to mid-July
		20.00	20.00		

2.2 Woody Seed Mix

Herbaceous seed mixes will be augmented with an oak-hickory forest woody seed mix to revegetate temporary workspaces and access roads within impacted forested areas. All species proposed within the woody seed mix are native to the Project area and are summarized in Table 5. At minimum, three of the five overstory, four of the seven understory, and two of the four shrub species will comprise the woody seed mix.

Table 5. Oak-hickory forest woody seed mix and recommended application rate.

Layer	Species	Common Name	Seeding Rate (lbs/acre)
Overstory	<i>Fagus grandifolia</i>	American Beech	0.3
	<i>Liriodendron tulipifera</i>	Tulip Poplar	0.3
	<i>Pinus strobus</i>	White Pine	0.3
	<i>Pinus virginiana</i>	Virginia Pine	0.3
	<i>Prunus serotina</i>	Black Cherry	0.3
Understory	<i>Amelanchier canadensis</i>	Canadian Serviceberry	0.3
	<i>Cercis canadensis</i>	Eastern Redbud	0.3
	<i>Cornus florida</i>	Flowering Dogwood	0.3
	<i>Diospyros virginiana</i>	Persimmon	0.3
	<i>Ilex opaca</i>	American Holly	0.3
	<i>Nyssa sylvatica</i>	Black Gum	0.3
	<i>Sassafras albidum</i>	Sassafras	0.3
Shrub	<i>Hamamelis virginiana</i>	Witch Hazel	0.3
	<i>Lindera benzoin</i>	Spicebush	0.3
	<i>Vaccinium angustifolium</i>	Lowbush Blueberry	0.3
	<i>Viburnum acerifolium</i>	Mapleleaf Viburnum	0.3
	<i>Vitis aestivalis</i>	Grape	0.3

2.3 Jefferson National Forest

MVP will follow the USFS's recommendations for restoration and rehabilitation of the permanent ROW, as defined in the Plan of Development, to reduce impacts to visual resources, in a manner that preserves MVP's ability to access, monitor, patrol, and inspect the ROW in accordance with PHMSA requirements (49 CFR Part 192). MVP consulted with the USFS regarding appropriate seed mixtures for use within the Jefferson National Forest (JNF). The USFS indicated that the initial goal of seeding on the JNF is to establish vegetative cover to minimize surface erosion and sedimentation, while the secondary goal is to establish an assortment of native species congruent with local ecological communities and benefits for wildlife and pollinators. Species recommended by the USFS (Appendix A) for use in upland, riparian, and steep slope areas are comparable to those species contained in the seed mixes prepared by Ernst Conservation Seeds, Inc. As such, MVP will apply the herbaceous seed mixes described in Section 2.1 in appropriate areas within the JNF. In addition, MVP will add the woody seed mix described in Section 2.2 to herbaceous seed mixes applied within temporary workspaces of the ROW.

As requested by the USFS, all leguminous seeds shall be either pre-inoculated, or mixed with inoculant specified for use on that particular seed according to manufacturer's directions. Inoculants shall be manually applied at double the manufacturer's rate and inoculant shall be mixed with legume seed prior to mixing with other seeds. For hydroseeding, a minimum of five times the dry seeding rate of inoculant will be used.

3.0 Restoration Procedures

As mentioned above, MVP will follow the directions and requirements in FERC's Plan and Procedures during restoration efforts. However, MVP will also follow any requirements set forth by federal and state agencies where the Project crosses land under their jurisdiction. These additional requirements and measures that have been identified to-date have been incorporated into this plan.

3.1 Topsoil and Spoil Treatment

MVP will identify and segregate the topsoil layer from the subsoil layer as described in FERC's Plan and Procedures. Within residential, agricultural areas, and the JNF, MVP will prevent the mixing of topsoil and subsoil during construction by stripping topsoil from the permanent and temporary ROW during construction. The stockpiled topsoil and subsoil will be stored separately within the 125-foot construction ROW, and will be replaced in the proper order during backfilling and final grading in order to prevent mixing of the soil horizons. All stockpiled spoils will be stored at least 10 feet from waterbodies, and within approved construction areas (as required by FERC's Plan and Procedures). Erosion controls will be installed around stockpiled spoils to ensure that they do not erode and impact adjacent areas.

3.2 Installation of Erosion Controls

Temporary erosion Best Management Practices (BMPs) will be installed prior to construction activities that can disturb soils, and these BMPs will be inspected and maintained throughout the construction process. The inspections will be conducted on a daily basis in areas that are under active construction or equipment operation, on a weekly basis in areas where no active construction is currently occurring, and within 24 hours in areas that have just received a rainfall event of at least 0.5 inch. Any necessary repairs that are identified during these inspections will be conducted within 24 hours or as soon as conditions allow if compliance with this time frame would result in greater environmental impacts.

Inspection and repair of temporary erosion BMPs will continue until they are replaced by permanent erosion controls or until the area is restored. Temporary erosion BMPs include temporary slope breakers, sediment barriers, trench plugs, and mulch. As requested by the USFS for implementation on the JNF, erosion and sediment control BMPs will be promptly removed after soils are stable and vegetative cover is established.

Temporary slope breakers are intended to reduce runoff velocities and divert water to vegetated areas off the construction ROW. Temporary sediment barriers are installed to stop the movement of sediments and to prevent the deposition of sediments beyond

approved workspaces or into sensitive areas. As indicated in FERC's Plan, these structures can be constructed of materials such as soil (e.g., diversion ditches), sand bags, silt-fences, or other approved materials. As requested by the USFS, within the JNF silt fences reinforced with metal or plastic mesh will be avoided if possible. In the case of the temporary slope breaker, water will be directed to a stable well-vegetated area or to an energy-dissipating device. The required spacing for these controls will be outlined in erosion and sedimentation control sheets.

Temporary trench plugs are intended to segment a continuous open trench prior to backfilling in order to prevent pooling and movement of water along the open trench. These plugs will consist of unexcavated portions of the trench (i.e., undisturbed soils), compacted subsoils, sandbags, or some functional equivalent.

If permanent seeding cannot occur immediately following final grading, mulch will be applied to all disturbed slopes that have the potential to erode in order to stabilize the soil and to reduce wind and water erosion. Mulch will be spread uniformly over an affected area to at least 75 percent coverage at a rate of 2-4 tons/acre. In wetland areas FERC's Plan requires that mulch applications will be increased to 3 tons/acre. This rate can be increased or decreased on the JNF based on slope classes. The following describes the USFS requirements regarding mulch applications, which would be followed on the JNF:

- Materials will be certified weed free or be accompanied by vendor's test results for noxious weed content. Hay will not be used on the JNF.
- Seeded areas can be mulched with weed free straw at a rate of 2-4 tons/acre (hand spread or blown), fiber mulch hydro-seeded at 1-2 tons/acre or other appropriate material.
- Natural biodegradable products will be used and materials will be demonstrated to be free of invasive species, including but not limited to plants, pests, and pathogens.
- If the use of stabilization netting is required/permitted, wildlife friendly geotextiles will be used. These products must either be free of netting or netting must be made of 100% biodegradable non-plastic materials such as jute, sisal, or coir fiber. Plastic netting (such as polypropylene, nylon, polyethylene, and polyester), even if advertised as biodegradable, is not an acceptable alternative. Any netting used must also have a loose-weave design with movable joints between horizontal and vertical twines to reduce the chance for wildlife entanglement, injury, or death.
- Water used for any products that require mixing with water will come from a USFS-approved water source. The source of water must not be contaminated with non-native invasive organisms that could spread into streams.

Permanent erosion controls will be installed following completion of construction. Permanent erosion controls consist of vegetation, permanent trench breakers and slope breakers. The placement, number, and composition of these permanent erosion controls will be illustrated on the erosion and sediment control plans and supplemented as determined by the EI, the applicable land management agency, and the FERC Plan and Procedures.

3.3 Re-contouring

All disturbed areas will be regraded and re-contoured to blend into the surrounding landscape, reestablish natural drainage patterns, and be compatible with surrounding drainage patterns, except at locations where permanent changes in drainage will be required to prevent erosion, scour, and possible exposure of the pipeline. The emphasis during re-contouring will be returning the entire ROW to its approximate original contours, stabilize slopes, control surface drainage, and aesthetically blend the area with the contours of adjacent lands. The re-contouring and replacement of topsoil in areas of disturbed wetlands to their original grade is especially critical to maintain wetland hydrology. If existing culverts are damaged or removed during construction, they will be replaced to their original condition in order to maintain the original hydrology.

3.4 Cleanup

Cleanup of an area (including final grading and installation of permanent erosion control structures) will be completed within 20 days after backfilling the trench (10 days in residential areas). All construction debris (e.g., mats, garbage, etc.) will be cleared from the construction area and disposed of in accordance with state and local regulations. Excess rock and spoil materials will be distributed along the construction ROW or disposed of in existing quarries or in permanent disposal sites. Hazardous materials will be handled and disposed of as described in the Project's *Hazardous Materials Management Plan*.

All non-merchantable brush and slash will be windrowed to the edge of the ROW, utilized in downslope areas of the ROW and access roads, burned and chipped, or removed from the area in accordance with local, state, or federal requirements. Windrowing of non-merchantable brush and slash along the ROW will result in habitat for many types of wildlife including: rabbits and other small mammals, ruffed grouse, song birds and reptiles. Over time the windrows will provide food for wildlife as insects will establish residence in the materials. The windrows can serve as escape cover from predators, locations for nesting and shelter from inclement weather. The windrows will generally range from 10 to 20 feet in width and 6 to 8 feet in height. Breaks will be left in the windrows at approximately 100 feet in order to provide for fire breaks and wildlife crossings.

Non-merchantable brush and slash can be utilized in downslope areas of the ROW and access roads to aide in soil stabilization and erosion control. Layering the brush and slash at the toe of a low-side slope along an access road provides for physical protection in the form of soil stabilization, and erosion and sediment control. Layering of brush and slash can promote physical protection to the downslope areas of the ROW. Additionally, the layering can provide long-term support for revegetation in downslope areas of the ROW.

3.5 Seeding

The goals of permanent seeding are to establish a dense, self-propagating, low maintenance ground cover in order to minimize erosion and sedimentation while also providing wildlife habitat.

Seeding will occur promptly after construction is complete; however, if ground conditions delay restoration until the following spring, the ground will be mulched and seeding will take place during the next growing season. A *Winter Construction Plan* has been prepared to address how restoration and revegetation would proceed if seeding could not be completed before the onset of winter. Additionally, if seeding must occur outside the normal seeding season a temporary erosion control seed mix will be applied, and either a permanent erosion control seed mix or native seed mix will be applied during the next normal seeding season. Seed will be uniformly applied using a broadcast seeder, drill, or hydroseeder. These methods are described in more detail below. When dryseeding, the seeding depth should be $\frac{1}{4}$ to $\frac{1}{2}$ inch. Following application of seed mix, mulch will be applied as described in Section 3.5.5.

3.5.1 Seedbed Preparation

Areas targeted for restoration will be prepared for reseeding before applying the seed in order to establish an environment that is conducive to seed placement and moisture retention (as described in FERC's Plan and Procedures). Permanent erosion control devices will be installed to minimize the risk of erosion and mulch will be used to prevent soils from eroding or desiccating.

Soil compaction can reduce the likelihood of disturbed areas being successfully revegetated. In order to minimize soil compaction, construction activities will be timed to dry periods when possible, and construction mats will be used in wetland habitats. On the JNF, no heavy equipment will be used on plastic soils when the water table is within 12 inches of the surface, or when soil moisture exceeds the plastic limit. Also, on the JNF, heavy equipment will not be used during site preparation on sustained slopes over 35 percent, or on sustained slopes over 20 percent when soils have a high erosion hazard or are failure-prone. If compacted soils are identified by the EI or the USFS within areas targeted for restoration, the compacted soils will be ripped to a depth of at least 6 to 8 inches.

As stated in Section 3.1, MVP will identify and segregate the topsoil layer from the subsoil layer as described in FERC's Plan and Procedures. Stockpiled topsoil and subsoil will be stored separately, and will be replaced in the proper order during backfilling and final grading, and prior to seeding. Following topsoil placement, dry fertilizer and lime will be applied. Unless site-specific recommendations are received from local, state or federal agencies, MVP will incorporate up to 4,000 lbs/acre of agricultural lime and 500 lbs/acre of 10-20-10 (Nitrogen [N], Phosphorous [P], Potassium [K]) fertilizer into the soil.

The following are guidelines for fertilizer and lime application rates recommended by the USFS to be used on JNF:

Fertilizer:

- 600 – 800 lbs/acre of 10-20-10 (N-P-K) fertilizer;
- 400 lbs/acre of 15-30-15 (N-P-K) fertilizer; or
- 800-1,000 lbs/acre of 10-10-10 (N-P-K)

Lime:

- 1,500-4,000 lbs/acre (pelletized or dust); or
- 4,000 lbs/ac of Hydro Lime (2.5 gal container is equivalent to 1000 lbs limestone; 5-10 containers /acre.

3.5.2 Drill Seeding

Drill seeding is a mechanical seeding method which places seed directly into the soil. Due to the equipment required; however, drill seeding is generally limited to areas with slopes less than 3:1 (USDA 2005). Because native seed mixes need to be drilled or otherwise covered to enhance germination success, drill seeding is the preferred option to be used in areas where a native seed mix will be applied.

3.5.3 Broadcast Seeding

Broadcast seeding will be the preferred seeding method used on steep slopes (i.e., slopes greater than 3:1) or other areas that cannot be accessed with other seeding equipment; areas that will be covered with erosion control fabric; or other areas determined to be appropriate for broadcast seeding by the EI and/or USFS. Seeds will be broadcast with a mechanical seeder immediately after the seedbed has been prepared and the soil is loose. This will allow the seeds to be lightly covered as the soil settles. The seeded area may also be disrupted by lightly dragging the area with chains or other appropriate harrows to lightly cover the seed. Broadcast seeding will occur immediately prior to installation of erosion control fabric or the application of mulch.

3.5.4 Hydroseeding

Hydroseeding may be used in upland areas that can be safely accessed with hydroseeding equipment, on slopes where drill seeding is not feasible (i.e., slopes greater than 3:1), and in areas determined to be appropriate for this method by the EI and/or USFS. Hydroseeding equipment shall be equipped with sufficient tanks, pumps, nozzles, and other devices required for mixing and hydraulically applying the seed, lime, fertilizer, wood fiber mulch, and tackifier mix in slurry form onto the prepared ground. The hydroseeding equipment shall have built-in agitators, which will keep the seed, mulch, tackifier, and water mixed homogeneously until pumped from the tank. Hydroseeding and hydromulching will be done from two directions (e.g., left and right or up and down), where feasible, to ensure maximum coverage of the soil. The amount of tackifier will be adjusted based on the slope of area being hydroseeded. For example, typical application rates for guar (a plant based tackifier) range from 40 lbs/acre for flat areas to 50 lbs/acre for 33 percent (3:1) slopes (CASQA 2003). During hydroseeding, it is recommended to add 50% more seed to the tank if a machinery breakdown occurs. Five times the recommended rate of inoculant will be used during hydroseeding.

In addition, the following USFS recommendations will be implemented in areas that are hydroseeded within the JNF:

- Hydroseeding will occur during a periods of dry weather, whenever possible, as wood-fiber hydraulic mulches are generally short-lived and require a 24-hour period to dry before rainfall occurs.
- Materials or additives used as binders or emulsifiers will not be toxic to soil organisms or otherwise prevent or inhibit seed germination.
- Only products suitable for wildlife will be used.
- Tackifiers will be non-toxic and organic based (e.g., guar, psyllium, or pitch and rosin emulsions).
- Tackifiers to be used, as well as, application rates, and methods of application will be submitted to the USFS for approval prior to use.

3.5.5 Mulching

After dry seeding, mulch will be applied to help the seed remain in place, protect seed from scavengers, and retain soil moisture. Mulch can consist of straw, erosion control fabric, or some functional equivalent, and will be certified as free of noxious weeds. Recommended loose mulch and application rates are provided in Table 6.

Table 6. Recommended mulch and application rates.

Mulch Application	Rate (lbs/acre)	Notes
Straw	4,000	Free from weeds and coarse matter. Must be anchored. Spread with mulch blower or by hand.
Fiber Mulch	1,500	Do not use as mulch for winter cover or during hot, dry periods. Apply as slurry.
Corn Stalks	8,000-12,000	Cut or shredded in 4 – 6 inch lengths. Air-dried. Do not use in fine turf areas. Apply with mulch blower or by hand.
Wood Chips	8,000-12,000	Free of coarse matter. Air-dried. Do not use in fine turf areas. Apply with mulch blower, chip handler, or by hand. Apply additional 12 lbs slow-release nitrogen/ton of wood chips.

3.5.6 Agricultural Lands

MVP will work with individual landowners to address restoration of active agricultural areas. Following construction, impacted agricultural land will be restored to pre-construction conditions in accordance with the FERC Plan, and any specific requirements identified by landowners, or state or federal agencies with regulatory jurisdiction over or interest in agricultural land. Agricultural land affected by the construction ROW and additional temporary workspace will be allowed to revert to prior use, with the exception of tree crops within the permanent ROW.

4.0 Bare-Root Sapling and Shrub Planting

Planting of bare-root saplings and shrubs will occur within select areas of the Project (Table 7 and Table 8). The purpose of these plantings is to establish target native tree species comparable to the region, site characteristics (e.g., topography; soil characteristics; adjacent vegetation), and adjacent forest composition in order to encourage the timely reestablishment of habitat removed during Project construction. For small mammals and birds, adequate spacing of planted shrubs can form a large clump or thicket and provide excellent cover, refuge, or brood-rearing habitat often absent in open landscapes. Furthermore, planting a diverse array of native shrubs and saplings with varying blooming periods will provide reliable sources of pollen and nectar for pollinator species during spring, summer, and autumn.

All species planted will be native to the area, and the seed source or ecotype of the saplings and shrubs will be as local as possible with preference given to within-state, then mountainous regions of an adjacent state, followed by within the Appalachian Mountain range.

Handling and storage of saplings is important to ensure viability and to limit loss prior to planting. To the extent practicable, time between delivery of saplings to the restoration site and planting will be limited. In an effort to prevent desiccation and preserve moisture, saplings will be kept in original shipping container (e.g., sack; box) and stored in cool, moist, and shady locations not within direct sunlight and wind. Refrigerated storage will be used when possible. Only one bag or bundle of saplings will be opened at a time, and partially used bundles will be rolled or tied closed to prevent exposure of roots to air. Saplings will be protected from harsh materials such as gasoline, diesel fuels, oils, or other chemicals. Immediately prior to planting, saplings will be inspected for damage that may result in mortality. Saplings will be discarded if the following are present: broken stems or main roots, mold or mildew, stems with missing bark, desiccated roots, or a root system less than 5 inches long.

Saplings deemed suitable will be planted using a spade, auger, or dibble bar between October 1 and April 30 following seed mix application (Section 3.5). Only one sapling at a time will be removed from the planting bag after a suitable hole is dug. Holes will be dug to a depth where groundline is at approximate root collar level, typically between 8 and 10 inches. Before being placed in a vertical position within the debris-free hole, roots will be moistened and treated with root dip absorbent polymers and mycorrhizal root dip inoculates in accordance with manufacturer's recommendations. One sapling will be placed in each hole with the roots inserted to the bottom and then lifted upward slightly so that the root collar is at or slightly below the finished grade. Each sapling will be fertilized with a 5 gram tablet of controlled release fertilizer. The

spade, planting bar, or shovel is inserted behind the planting hole and tilted back to close the bottom of the planting hole. The tool is then tilted forward to close the top of the hole. Soil will be firmly packed around each planting to fill any remaining voids. Tree tubes (minimum of 5 feet tall) will be used to protect saplings from browse damage caused by local wildlife or livestock. In areas experiencing higher than average browse damage or when planting species highly preferred by wildlife (e.g., apple, plum, hazelnut, or persimmon trees), 5- to 6-foot tall, 12- to 14-gauge welded wire fence with 2-inch by 4-inch openings is recommended to protect saplings.

4.1 Riparian Stabilization and Restoration

The stabilization of streambanks and areas adjacent to waterbodies is critical to minimize the risk of erosion, slope failure, and impacts to sensitive aquatic species. In general, all affected riparian areas will be revegetated using native species and appropriate seeding prescriptions based upon the preexisting vegetative community within the disturbed area. MVP will restore waterbody banks to preconstruction contours to the extent practical following pipe installation and initial bank stabilization. Permanent bank stabilization and erosion control devices will be installed as necessary to minimize sediment deposition into waterbodies. Areas with steep slopes may require additional grading to reestablish contours capable of supporting preconstruction drainage patterns.

If grubbing has not been extensive, then native shrub and tree species are expected to sprout and regenerate naturally within temporary workspaces. To further avoid and minimize impacts to sensitive wildlife, temporary workspaces at select streams with known or potentially suitable habitat for sensitive aquatic species (i.e., freshwater mussels and fish) MVP is committed to be hand planting with bare-root live shrubs and tree saplings in addition to installing a prescribed herbaceous seed mix (Table 7).

Table 7. Stream crossings proposed for bare-root seedling plantings.

Waterbody Name	MP	County	State	Valuable Resource
Leading Creek		Lewis	WV	Headwaters of Group 2 Mussel Stream, warmwater
Sand Fork		Lewis	WV	Non-listed freshwater mussel stream, warmwater
Little Kanawha River		Braxton	WV	Group 2 Mussel Stream, warmwater
Elk River		Webster	WV	Headwaters of Group 2 Mussel Stream, coldwater stream, B2 trout stream, Elk River Crayfish
Gauley River		Nicholas	WV	candy darter, warmwater stream, whitewater recreational uses
Hominy Creek		Nicholas	WV	candy darter, coldwater stream, B2 trout stream
Meadow River		Greenbrier	WV	candy darter, B2 trout stream, Swainson's Warbler
Greenbrier River		Summers	WV	Non-listed mussels, candy darter, warmwater stream

Waterbody Name	MP	County	State	Valuable Resource
Indian Creek	█	Monroe	WV	possible hellbenders and mussels (historic); bald eagle
Kimballton Branch	█	Giles	VA	headwaters of wild trout stream, coldwater stream
Stony Creek	█	Giles	VA	candy darter, green floater, coldwater stream, wild trout stream
Little Stony Creek	█	Giles	VA	coldwater stream, wild trout stream
Sinking Creek	█	Giles	VA	candy darter, green floater, coldwater stream, wild trout stream, non-listed mussels
UNT Craig Creek	█	Montgomery	VA	Headwaters of James spiny mussel occurrences, USFS lands area
UNT Craig Creek	█	Montgomery	VA	Headwaters of James spiny mussel occurrences, USFS lands area
Craig Creek	█	Montgomery	VA	Headwaters of James spiny mussel occurrences, USFS lands area
Craig Creek	█	Montgomery	VA	Headwaters of James spiny mussel occurrences, USFS lands area
UNT Craig Creek	█	Montgomery	VA	Headwaters of James spiny mussel occurrences, USFS lands area
UNT Craig Creek	█	Montgomery	VA	Headwaters of James spiny mussel occurrences, USFS lands area
Mill Creek	█	Montgomery	VA	upstream of Roanoke logperch suitable habitat, orange fin madtom, coldwater stream, wild trout
North Fork Roanoke River	█	Montgomery	VA	Roanoke logperch present, non-listed mussels present, orange fin madtom, coldwater stream, wild trout
North Fork Roanoke River	█	Montgomery	VA	Roanoke logperch present, non-listed mussels present, orange fin madtom, coldwater stream, wild trout
Bradshaw Creek	█	Montgomery	VA	Roanoke logperch suitable habitat, orange fin madtom, coldwater stream, wild trout
Bradshaw Creek	█	Montgomery	VA	Roanoke logperch suitable habitat, orange fin madtom, coldwater stream, wild trout
Roanoke River	█	Montgomery	VA	Roanoke logperch present, orange fin madtom, non-listed mussels present
Bottom Creek	█	Roanoke	VA	upstream of Bottom Creek Gorge, orange fin madtom, coldwater stream, wild trout
Bottom Creek	█	Roanoke	VA	upstream of Bottom Creek Gorge, orange fin madtom, coldwater stream, wild trout
Mill Creek	█	Roanoke	VA	upstream of Bottom Creek Gorge, orange fin madtom, coldwater stream, wild trout
Green Creek	█	Franklin	VA	upstream of Bottom Creek Gorge, orange fin madtom, coldwater stream, wild trout
Green Creek	█	Franklin	VA	upstream of Bottom Creek Gorge, orange fin madtom, coldwater stream, wild trout

Waterbody Name	MP	County	State	Valuable Resource
North Fork Blackwater River	█	Franklin	VA	Roanoke logperch suitable habitat, coldwater stream wild trout stream
Teels Creek	█	Franklin	VA	upstream of Roanoke logperch suitable habitat, one of numerous project crossings of Teels Creek
Teels Creek	█	Franklin	VA	upstream of Roanoke logperch suitable habitat, one of numerous project crossings of Teels Creek
Teels Creek	█	Franklin	VA	upstream of Roanoke logperch suitable habitat, one of numerous project crossings of Teels Creek
Teels Creek	█	Franklin	VA	upstream of Roanoke logperch suitable habitat, one of numerous project crossings of Teels Creek
Teels Creek	█	Franklin	VA	Roanoke logperch suitable habitat, one of numerous project crossings of Teels Creek contributing sediment impacts
Little Creek	█	Franklin	VA	Roanoke logperch suitable habitat, numerous crossings upstream contributing sediment impacts
Little Creek	█	Franklin	VA	Roanoke logperch suitable habitat, non-listed mussels present, numerous crossings upstream contributing sediment impacts
Maggodee Creek	█	Franklin	VA	Roanoke logperch suitable habitat
Blackwater River	█	Franklin	VA	Roanoke logperch present, non-listed mussels present
UNT to Jacks Creek	█	Franklin	VA	orangeфин madtom
Turkey Creek	█	Franklin	VA	orangeфин madtom
Strawfield Creek	█	Franklin	VA	orangeфин madtom
Parrot Branch	█	Franklin	VA	orangeфин madtom
Jonnikin Creek	█	Pittsylvania	VA	orangeфин madtom
UNT to Rocky Creek	█	Pittsylvania	VA	orangeфин madtom
Pigg River	█	Pittsylvania	VA	Roanoke logperch present, orangeфин madtom, mussels present including yellow lampmussel (VA threatened)
Harpen Creek	█	Pittsylvania	VA	Roanoke logperch suitable habitat, orangeфин madtom
Harpen Creek	█	Pittsylvania	VA	orangeфин madtom

Table 8 lists suitable bare-root native tree and shrub species for use in restoring riparian areas and palustrine forested wetlands. The final species mix will depend on nursery stocks, availability, soil condition, and nearby species composition; however, six different tree species and four different shrub species, at minimum, will be planted at each riparian target area. In general, live, bare-root saplings and shrubs will be at least 18 inches in height, a minimum two years old, and planted no closer than 8 – 10 feet at a rate of approximately 300 to 500 stems per acre. A 10-foot strip centered on the pipeline will be maintained in an herbaceous state and no trees will be planted within 15 feet on either side of the pipeline to avoid the possibility of roots reaching the

pipeline and compromising the integrity of the pipeline coating. A mix of shrubs and trees will be planted within the remaining sections of the ROW parallel to the waterbody and extending up to 100 feet, where possible, from the top of either side of the stream bank. Stream banks will be treated with lime and fertilizer, then the bare-root saplings and a riparian herbaceous cover seed will be applied and lightly covered with soil before mulch is added to the area. A sediment barrier will be maintained at the edge of the water until revegetation is successful. Plantings will be completed between October 1 and April 30 of the same year as construction, and no plantings will occur when soils are frozen.

Table 8. Native tree and shrub species for bare root plantings within riparian areas and forested wetlands.

Species	Common Name	Indicator Status	Riparian Planting	Forested Wetland Planting
Native Trees				
<i>Acer rubrum</i>	Red Maple	FAC	X	X
<i>Acer saccharinum</i>	Silver Maple	FACW	X	X
<i>Betula nigra</i>	River Birch	FACW	X	X
<i>Carpinus caroliniana</i>	American Hornbeam	FAC	X	X
<i>Carya glabra</i>	Pignut Hickory	FACU	X	
<i>Carya ovata</i>	Shagbark Hickory	FACU	X	
<i>Chionanthus virginicus</i>	White Fringe Tree	FAC+	X	
<i>Diospyros virginiana</i>	Common Persimmon	FAC-	X	
<i>Fraxinus pennsylvanica</i>	Green Ash	FACW	X	X
<i>Juniperus virginiana</i>	Eastern Red Cedar	FACU	X	X
<i>Liquidambar styraciflua</i>	Sweet Gum	FAC	X	X
<i>Liriodendron tulipifera</i>	Tuliptree	FACU	X	X
<i>Nyssa sylvatica</i>	Black Gum	FAC	X	
<i>Platanus occidentalis</i>	American Sycamore	FACW-	X	X
<i>Populus deltoids</i>	Eastern Cottonwood	FAC	X	
<i>Quercus bicolor</i>	Swamp White Oak	FACW+	X	X
<i>Quercus falcata</i>	Cherrybark Red Oak	FACW	X	X
<i>Quercus phellos</i>	Willow Oak	FAC+	X	X
<i>Quercus nigra</i>	Water Oak	FAC	X	
<i>Quercus palustris</i>	Pin Oak	FACW	X	X
<i>Salix nigra</i>	Black Willow	FACW	X	X
<i>Ulmus americana</i>	American Elm	FACW-	X	X
Native Shrubs				
<i>Alnus serrulata</i>	Brook-side Alder	OBL		X
<i>Amelanchier canadensis</i>	Canada Serviceberry	FAC	X	
<i>Aronia arbutifolia</i>	Red Chokecherry	FACW	X	X
<i>Baccharis halimifolia</i>	Groundsel Bush	FACW-	X	X
<i>Cephalanthus occidentalis</i>	Buttonbush	OBL		X
<i>Cornus amomum</i>	Silky Dogwood	FACW	X	X
<i>Cornus stolonifera</i>	Red-osier Dogwood	FAC	X	X

Species	Common Name	Indicator Status	Riparian Planting	Forested Wetland Planting
<i>Hamamelis virginiana</i>	American Witchhazel	FAC-	X	
<i>Ilex verticillata</i>	Common Winterberry	FACW+	X	X
<i>Itea virginica</i>	Virginia Willow	OBL		X
<i>Iva frutescens</i>	Marsh Elder	FACW+	X	X
<i>Leucothoe racemosa</i>	Fetter-bush	FACW	X	X
<i>Lindera benzoin</i>	Spicebush	FACW-	X	X
<i>Lyonia ligustrina</i>	Maleberry	FACW	X	X
<i>Magnolia virginiana</i>	Sweetbay Magnolia	FACW+	X	X
<i>Physocarpus opulifolius</i>	Eastern Ninebark	FACW-	X	X
<i>Sambucus canadensis</i>	American Elder	FACW-	X	X
<i>Vaccinium corymbosum</i>	Highbush Blueberry	FACW-	X	X
<i>Virburnum dentatum</i>	Arrow-wood	FAC	X	
<i>Viburnum prunifolium</i>	Black-haw	FACU	X	

4.2 Forested Wetlands

Bare-root saplings and shrubs (Table 8) will be planted in combination with an herbaceous wetland seed mix (Table 2) to ultimately restore of the impacted palustrine forested wetlands within the temporary ROW and the non-maintained portion of the permanent ROW to their pre-construction condition. Similarly, native shrubs (Table 8) will be planted in combination with an herbaceous wetland seed mix (Table 2) to revegetate the 50-foot-wide portion of the permanent ROW. The final species mix will depend on nursery stocks, availability, soil condition, and nearby species composition; however, six different tree species and four different shrub species, at minimum, will be planted at each forested wetland.

4.3 Loggerhead Shrike Foraging and Nesting Habitat

The Project is expected to impact a total of 57.04 hectares (140.95 ac) of habitat suitable for nesting and foraging, and 1.45 hectares (3.59 ac) of foraging habitat. Of this, 16.01 hectares (39.56 ac) of nesting and foraging habitat and 0.41 hectare (1.01 ac) of foraging habitat will be permanently impacted. Within the permanently impacted areas and temporarily impacted foraging habitat, a native herbaceous vegetation seed mix or landowner-approved seed mix matching pre-construction conditions will be used for revegetation. For temporarily, disturbed areas that are considered suitable for nesting and foraging, either of the aforementioned seed mixes will be used for revegetation along with planting of native shrubs/trees. As recommended by the VDGIF, native shrubs/trees removed from suitable habitat will be replaced with the same native species (e.g., eastern red cedar [*Juniperus virginiana*] will be replaced with eastern red cedar). Nonnative shrubs/trees that provide suitable nesting substrate and are removed as a result of Project-related activities will be replaced with its native, functional counterpart (e.g., Osage orange [*Maclura pomifera*], which is a nonnative,

thorny tree, should be replaced with hawthorn [*Crataegus* spp.]). In some cases, it may be beneficial to promote a diversity of shrub/tree species in disturbed areas. For example, if an area is heavily dominated by eastern red cedar, MVP may choose to plant a combination of another native species (e.g., hawthorn) along with red cedar to avoid the potential loss of all red cedar in the event of a pest-infestation or spread of pathogen that may result in death of entire stands of the species. This may also be advantageous in areas where impaling stations (e.g., thorny vegetation; barbed wire) are limited.

Based on field habitat assessments and review of aerial imagery, approximately 1,225 preferred broadleaf shrubs/trees and 1,100 preferred coniferous shrubs/trees will be planted within temporarily disturbed nesting and foraging habitat (41.04 ha [101.41 ac]) and adjacent area (4.52 ha [11.16 ac]) to compensate for the removal of 1,221 broadleaf and 1,085 coniferous shrubs/trees. Shrubs/trees will be planted following completion of construction activities in suitable habitat. While quantity and general assemblage of shrubs and trees planted will be similar to pre-construction conditions, spatial arrangement of plantings will vary from where trees were removed. Spatial arrangement of plantings will be dependent on site conditions (e.g., topography; existing vegetation), proximity to the permanent ROW and roadways, planting technique, and what will best promote habitat enhancement for loggerhead shrike. Shrub/tree-planting efforts may focus more on areas with higher landowner-interest and engagement, as well as areas recommended by the VDGIF.

Of the shrubs/trees proposed for removal in suitable habitat, approximately 63.49 percent are of the preferred shrubs/trees noted by the VDGIF (i.e., eastern red cedar; hawthorn; black locust; Osage orange). MVP is committed to improving habitat quality where feasible and, therefore, have agreed to replace all removed shrubs/trees in suitable habitat in order to enhance conditions for loggerhead shrike. Increasing the number of preferred shrubs/trees within areas containing suitable loggerhead shrike habitat will potentially enhance the overall quality of nesting habitat promoting the conservation of this state-threatened species.

5.0 Maintenance and Monitoring

5.1 Permanent Right-of-Way

A 50-foot-wide permanent ROW will be maintained in a grassland/low-shrub state above the pipeline by periodic mechanical mowing, cutting, and trimming. Mechanical removal of vegetation will not occur more frequently than every three years (per standard FERC procedures) and not during the period of April 15 to August 1 in order to avoid impacts to ground-nesting migratory birds. This permanent ROW will maintain MVP's access to the pipeline's routes for terrestrial patrols, visibility of the pipeline's route for aerial patrols, and maintaining access in the event of emergency repairs. In upland areas, trees or deep-rooted shrubs will not be allowed to grow within the 15 feet of either side of the centerline in order to maintain the integrity of the pipe. Within wetlands or adjacent to waterbodies, MVP will maintain vegetation in a 10-foot corridor centered over the pipeline by mechanical means. Vegetation maintenance is not expected to be required in agricultural areas.

MVP will monitor disturbed areas where seed mixes were applied after the first and second growing seasons to determine the success of revegetation. The permanently maintained ROW will be considered successfully restored when the soils have been stabilized, and a native vegetation community is established (i.e., native grasses and shallow-rooted shrubs). In agricultural areas of the permanent ROW, revegetation will be considered successful when the area has been revegetated and is similar to adjacent undisturbed areas within the same field. As needed, additional seed and fertilizer will be applied to areas where revegetation is not deemed successful.

Management and control of invasive species is critical if disturbed areas are to be successfully revegetated and restored, as invasive species can outcompete and exclude native species. MVP will utilize techniques approved by the FERC and USFS to control invasive species along the construction areas, which will include mechanical methods (e.g., pulling, mowing, disking, etc.) as well as chemical treatments (e.g., herbicides). MVP will comply with all local, state, and federal requirements related to the use of herbicides, including any requirements specified by the USFS on the JNF. See Section 5.4 below for more details.

5.1.1 Jefferson National Forest

MVP will follow the USFS's recommendations for restoration and rehabilitation of the permanent ROW, as defined in the Plan of Development, to reduce impacts to visual resources, in a manner that preserves MVP's ability to access, monitor, patrol, and inspect the ROW in accordance with PHMSA requirements (49 CFR Part 192).

5.2 Temporary Right-of-Way

Along the portion of the Project allowed to return to pre-construction conditions (e.g., areas beyond the permanent ROW), successful restoration will be determined by monitoring reclaimed areas for up to two growing seasons and comparing them to adjacent, undisturbed areas. Restoration in these areas will be determined successful if the seeded areas germinate and demonstrate, over time, an ability to achieve species distribution and diversity comparable to the pre-established targeted conditions.

5.3 Bare-Root Sapling and Shrub Plantings

5.3.1 Riparian and Forested Wetland Restoration

Assuming a 70% survival rate (Davis et al. 2010), approximately 380 stems per acre per Planting Area (stems/ac/PA) are expected to be present following the Year 1 planting. During Year 2 (first growing season), habitat assessments will be performed to determine whether the expected average survived. If not, the ratio of surviving stems to total stems planted will be calculated to determine the stem survival rate. The actual survival rate will be used to determine the number of trees necessary to plant in Year 2 in order to achieve the desired average in Year 3. Annual habitat assessments will occur as necessary beyond Year 2 until an average of 300 stems/ac/PA have survived.

5.3.2 Loggerhead Shrike Shrub Plantings

MVP will monitor habitat restoration and enhancement activities by evaluating survival of planted shrubs/trees.

Planted shrubs/trees will be monitored for a minimum of two growing seasons following the initial planting. Planting efforts will be deemed successful with 70 percent survival of shrubs/trees initially planted. This threshold will ensure that there is a net gain in preferred shrubs/trees throughout the study area (i.e., Giles, Craig, Montgomery, and Roanoke counties, Virginia) to promote conservation of loggerhead shrike and other shrub-nesting birds. If survivability drops below this threshold between initial planting and the end of the second growing season, shrubs/trees will be replaced to meet the 70 percent threshold.

The purpose of shrub/tree planting is to promote shrub-nesting bird species, such as loggerhead shrike. Along with monitoring the survival of shrubs/trees, MVP will provide VDGIF with locations as well as pre-construction and post-planting photos of the restored areas so that VDGIF can conduct future surveys of the restored habitat areas.

5.4 Exotic and Invasive Plant Species Control

The introduction and spread of exotic, noxious, and/or invasive plant species can cause significant ecological and/or economic impacts (Pimentel et al. 2005). Excavation for pipeline placement and other construction activities expose the topsoil surface to potential entrance of exotic, noxious, and/or invasive plant species. This can

occur either by physical transport onto the exposed soil site by way of equipment, machinery or vehicles, through windborne or wildlife dissemination of seeds, or by introduction of seeds or plant parts contained in mulch or straw bales. Physical disturbance of topsoil can also promote germination of seeds of nonnative, invasive vegetation that already occur in the local seed bed.

MVP will implement the following measures to prevent and control the introduction and spread of nonnative, invasive plant species during construction and operation of the Project:

- Identifying areas supporting significant populations of invasive plants;
- Pre-treating areas with invasive plants prior to construction;
- Avoiding the introduction and spread of invasive plants from construction activities;
- Selecting native seed mixes appropriate for local site conditions (e.g., soils) for restoration efforts;
- Post-construction monitoring of vegetation in areas disturbed by construction in order to identify potential invasive plant infestations;
- Addressing invasive plant infestations that manifest following construction and during restoration.

5.4.1 Pre-Construction Measures

Surveyors noted several non-native plant species during on-site field assessments along the Project's proposed route (Appendix B).

Problem areas will be flagged, staked, or otherwise marked for clear identification. Identifying these problem areas prior to construction will help reduce the potential risk of further spread of invasive plant infestations.

Mechanical (e.g., mowing) and/or chemical measures (i.e., herbicide-application) will be implemented in order to eradicate invasive plants from the identified problem areas. Specific measures will be determined based on site conditions, seasonality, proximity to sensitive resources (e.g., known occurrences of rusty patched bumble bee), and through consultation with appropriate agencies.

Herbicides can be a safe and effective means of controlling both perennial and annual invasive vegetation. MVP will coordinate with appropriate land management agencies when applying herbicides for invasive plant control. The preferred method will be spot application; however, large infestations may require a broader application. Use of herbicides will be dependent on a variety of factors related to specific species (e.g., annual or perennial; woody or herbaceous), site-characteristics (e.g., soils; proximity

to wetlands/open water), time of year, and weather conditions. Herbicide-use will be restricted when invasive plant species occur in close proximity to documented occurrences of sensitive resources that may potentially be affected (e.g., rare, threatened, or endangered plants). Other control measures may be used to address invasive plants in areas where herbicide-use is restricted.

A variety of equipment may be used to apply herbicides and will all be inspected on a daily basis, maintained as needed, and in accordance with applicable regulations, including maintaining Safety Data Sheets for all herbicides/materials. For rough terrain and/or areas with low densities of invasive plant species, backpack sprayers or other hand application methods will be used. For open areas that require intensive work and allow access for vehicles, mounted sprayers may be used. Care will be given to avoid excessive quantities of an herbicide on any given site, to the extent practical. The amount of herbicide located at any given site will be dependent on the quantity and density of invasive plants present. All concentrate will be in approved containers and transported using measures to avoid tipping and spilling. Mixing of concentrate will be completed in upland areas away from waterbodies and wetlands (>100 ft), private wells (>200 ft; identified through assistance with landowner), karst features (>300 ft), and public wells (>400 ft).

MVP developed a Project-specific *Spill Prevention, Control, and Countermeasure Plan and Unanticipated Discover of Contamination Plan for Construction Activities* in West Virginia and Virginia. One goal of these documents is to avoid or minimize the risk and potential impact of hazardous material spills during construction and operation. All herbicide applicators/contractors will be responsible for keeping and maintaining spill kits in their vehicles and at herbicide storage areas to ensure quick response to any spills. Spills are handled based on the herbicide/material type, scale, and location of the spill. Priorities of addressing the spill are as follows, 1) ensure safety of personnel and public; 2) contain spill to minimize risk to the environment; 3) complete initial clean-up; and 4) conduct remediation activities. Any spills will be reported to appropriate agencies in accordance with applicable laws and agreements.

5.4.2 Construction Measures

All equipment used for construction will be cleaned and inspected before arriving on site, and the EI will verify that equipment is free of soil and debris that may harbor invasive plant propagules. Cleaning stations will be established along the Project in areas without sensitive resources (e.g., wetlands). All soil/debris is removed from equipment by hand or compressed air. Equipment is also cleaned prior to moving from one construction spread to the next. The EI will maintain a log documenting cleaning and inspection of equipment. Visual markers (e.g., stickers) will be used to identify that equipment has been cleaned and inspected.

Topsoil and vegetation cleared from areas with invasive plants will be marked and stockpiled adjacent to the areas from which they were removed to ensure propagules are not spread to other areas. Barriers will be placed around topsoil and vegetation to eliminate the risk of material being moved. Signs identifying that piles contain invasive plant materials will be placed on barriers. Materials will be returned to areas from which they were removed during the reclamation process. Only certified weed-free mulch, straw and hay bales will be used to construct sediment control devices during construction.

5.4.3 Post-Construction Measures

MVP will adhere to the FERC's Plan and Procedures. Monitoring measures included in these documents and those proposed in the following section will help ensure invasive plant species are identified and addressed through appropriate control measures. Mechanical and chemical control measures—dependent on species, time of year, and site characteristics—will be implemented to reduce the risk of invasive plants becoming heavily established in and adjacent to the Project footprint. MVP is committed to working with adjacent landowners to ensure Project activities have a limited potential to result in the establishment of novel invasive plant species.

Revegetation measures will be performed immediately following construction or the following spring/summer depending on soil conditions (i.e., frozen versus not frozen). MVP will reseed and replant areas of the permanent and temporary ROW using only native species (see Section 2.0).). Immediate revegetation, as soon as practical, will reduce the time that bare soil is exposed and, therefore, minimize the opportunity for invasive plant species to become established.

MVP will monitor the ROW annually after the first and second growing seasons following construction to allow for early detection of exotic or invasive species infestations. If invasive plant species are found in numbers that are substantially greater than adjacent locations, MVP will conduct selective eradications of those species. Mechanical and chemical control measures will be completed, to the degree feasible, prior to maturation of seeds of invasive plants to avoid seed dispersal. As previously mentioned with pre-treatment and preventative measures to control invasive plants, herbicide types will be determined based on species requiring control, time of year, and site characteristics. Spot application of herbicide is the preferred method; however, dense infestations may be more appropriately addressed with a broader application. All herbicides will be applied by applicators appropriately licensed or certified by the state in which the work is conducted. Following herbicide application and based on the specific persistence of the herbicide in the soil, areas treated will be seeded with a native seed mix.

When implementing chemical control measures, as previously mentioned, care is taken to avoid sensitive resources that may be affected by herbicides (e.g., rare,

threatened, and/or endangered plants; existing or created habitat for rusty patched bumble bee). In these areas, mechanical control measures, such as mowing or cutting/pulling by hand, will be the preferred method. If these methods result in a disturbance to topsoil, native seed will be applied to the affected area to reduce the risk of subsequent invasive species establishment.

5.4.4 Jefferson National Forest

An Exotic and Invasive Species Control Plan was developed and included in MVP's Plan of Development for the JNF. The document provides four strategies that will be implemented to avoid and minimize the exotic and invasive species introduction and infestation: 1) identifying and subsequent treatment of exotic and invasive species occurring in the Project area prior to any Project-related disturbance; 2) avoiding transportation of exotic and invasive species propagules through cleaning equipment between construction sites, using certified weed-free mulch and straw bales, and using locally sourced topsoil; 3) monitoring and treating any exotic and invasive species encountered during construction and post-construction; and 4) using seed mixes that do not contain any invasive plant species and which have been approved by the USFS for use on the JNF.

MVP will avoid the introduction of novel invasive species and utilize pre- and post-construction techniques approved by the FERC and USFS to control invasive species along construction areas, which will include mechanical methods (e.g., pulling, mowing, disking, etc.) as well as chemical treatments (e.g., herbicides) on the JNF, as requested by the USFS. MVP will comply with all local, state, and federal requirements related to the use of herbicides, including any specified by the USFS on the JNF. Herbicides to be used on the JNF will be approved by the USFS prior to use. For additional details regarding exotic and invasive vegetation control and herbicide use, refer to the Plan of Development for the JNF.

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APPENDIX A
USFS RECOMMENDED SPECIES FOR SEED MIXES

Table 1. USFS recommended species for upland areas within the Jefferson National Forest.

Scientific Name	Common Name	Growth Habit	pH Preference
Non-native Species for Erosion Control			
<i>Lolium perenne</i> subsp. <i>multiflorum</i>	Italian ryegrass; Annual ryegrass	Graminoid	5.0 – 7.9
<i>Urochloa ramosa</i> (<i>Panicum ramosum</i>)	Browntop millett	Graminoid	5.5 – 6.9
<i>Secale cereale</i>	Cereal rye	Graminoid	5.2 – 8.0
<i>Setaria italica</i>	Foxtail millet	Graminoid	5.3 – 6.9
Native Species			
<i>Chasmanthium laxum</i> ^a	Slender woodoats	Graminoid	4.5 – 7.0
<i>Eragrostis spectabilis</i> ^a	Purple lovegrass	Graminoid	4.0 – 7.5
<i>Panicum virgatum</i>	Switchgrass	Graminoid	4.5 – 8.0
<i>Sorghastrum nutans</i>	Indiangrass	Graminoid	5.0 – 7.8
<i>Tridens flavus</i> ^a	Purpletop	Graminoid	4.5 – 6.5
<i>Apocynum cannabinum</i> ^a	Indian hemp	Forb	4.5 – 7.0
<i>Chamaecrista fasciculata</i>	Partridge pea	Forb	5.5 – 7.5
<i>Desmodium canadense</i>	Showy ticktrefoil	Forb	wide tolerance
<i>Desmodium paniculatum</i>	Panicledleaf ticktrefoil	Forb	6.0 – 7.0
<i>Elymus virginicus</i> ^b	Virginia wildrye	Graminoid	5.0 – 7.4
<i>Geum canadense</i> ^a	White avens	Forb	4.5 – 7.5
<i>Heliopsis helianthoides</i>	Oxeye sunflower; Smooth oxeye	Forb	unknown
<i>Monarda fistulosa</i> ^b	Wild bergamot	Forb	6.0 – 8.0
<i>Pycnanthemum</i> spp. ^b	Mountain mint	Forb	unknown
<i>Rubus allegheniensis</i> ^a	Common blackberry; Allegheny blackberry	Forb/ Subshrub	4.6 – 7.5
<i>Rudbeckia hirta</i>	Blackeyed Susan	Forb	6.0 – 7.0
<i>Solidago canadensis</i> ^a	Canada goldenrod	Forb	4.8 – 7.5
<i>Tradescantia virginiana</i> ^a	Virginia spiderwort	Forb	4.0 – 8.0

a/ This species is more tolerant of low pH soils

b/ Species is a good choice for higher elevation (i.e., areas higher than 3,000 feet or lower sites where the presence of red spruce indicates cold conditions) areas.

Table 2. USFS recommended species for riparian areas within the Jefferson National Forest.

Scientific Name	Common Name	Habit	pH Preference
Non-native Species for Erosion Control			
<i>Lolium perenne</i> subsp. <i>multiflorum</i>	Italian ryegrass; Annual ryegrass	Graminoid	5.0 – 7.9
<i>Urochloa ramosa</i> (<i>Panicum ramosum</i>)	Browntop millet	Graminoid	5.5 – 6.9
<i>Secale cereale</i>	Cereal rye	Graminoid	5.2 – 8.0
<i>Setaria italic</i>	Foxtail millet	Graminoid	5.3 – 6.9
Native Species			
<i>Agrostis perennans</i>	Autumn bentgrass; upland bentgrass	Graminoid	5.5 – 7.5
<i>Elymus virginicus</i>	Virginia Wildrye	Graminoid	5.0 - 7.4
<i>Sorghastrum nutans</i>	Indiangrass	Graminoid	5.0 – 7.8
<i>Asclepias incarnata</i>	Swamp milkweed	Forb	5.0 – 8.0
<i>Chamaecrista fasciculata</i>	Partridge pea	Forb	5.5 – 7.5
<i>Eutrochium fistulosum</i> (<i>Eupatorium fistulosum</i>)	Joe pye weed	Forb	4.5 – 7.0
<i>Eupatorium maculatum</i>	Spotted joe pye weed	Forb	5.5 – 7.0
<i>Eupatorium perfoliatum</i>	Boneset	Forb	unknown
<i>Helenium autumnale</i>	Common sneezeweed	Forb	4.0 – 7.5
<i>Senna hebecarpa</i>	Wild senna; American senna	Forb	unknown
<i>Senna marilandica</i>	Maryland senna	Forb / Subshrub	4.0 – 7.0
<i>Vernonia noveboracensis</i>	New York ironweed	Forb	4.5 -8.0

Table 3. USFS recommended species for steep slope areas within the Jefferson National Forest.

Scientific Name	Common Name	Growth Habit	pH Preference
Non-native Species for Temporary Erosion Control			
<i>Lolium perenne</i> subsp. <i>multiflorum</i>	Italian ryegrass; Annual ryegrass	Graminoid	5.0 – 7.9
<i>Urochloa ramosa</i> (<i>Panicum ramosum</i>)	Browntop millet	Graminoid	5.5 – 6.9
<i>Secale cereale</i>	Cereal rye	Graminoid	5.2 – 8.0
<i>Setaria italic</i>	Foxtail millet	Graminoid	5.3 – 6.9
Native – Highly Preferred			
<i>Sorghastrum nutans</i>	Indiangrass	Graminoid	5.0 – 7.8
<i>Tridens flavus</i>	Purpletop	Graminoid	4.5 – 6.5
Native – Preferred			
<i>Agrostis perennans</i>	Autumn bentgrass; Upland bentgrass	Graminoid	5.5 – 7.5
<i>Dichanthelium clandestinum</i>	Deertongue	Graminoid	4.0 – 7.5
<i>Elymus canadensis</i>	Canada wildrye	Graminoid	5.0 – 7.9
<i>Desmodium canadense</i>	Showy ticktrefoil	Forb	wide tolerance
<i>Heliopsis helianthoides</i>	Oxeye sunflower; Smooth oxeye	Forb	unknown
<i>Lespedeza virginica</i>	Slender bushclover; Slender lespedeza	Forb	acid tolerant
<i>Liatris spicata</i>	Dense blazing star; Spiked gayfeather	Forb	5.6 - 7.5
<i>Senna hebecarpa</i>	Wild senna; American senna	Forb	unknown
Native – Moderately Preferred			
<i>Panicum virgatum</i>	Switchgrass	Graminoid	4.5 – 8.0
<i>Chamaecrista fasciculata</i>	Partridge pea	Forb	5.5 – 7.5
<i>Rudbeckia hirta</i>	Blackeyed Susan	Forb	6.0 – 7.0

APPENDIX B
LIST OF POTENTIAL EXOTIC AND INVASIVE PLANT SPECIES

Common Name	Scientific Name	Growth Form	Typical Habitat(s)
Amur Honeysuckle	<i>Lonicera maackii</i>	Shrub	Pastures, fields, forest, forest edges, roadsides
Autumn Olive	<i>Elaeagnus umbellata</i>	Shrub	Pastures, fields, roadsides
Asian Bittersweet	<i>Celastrus orbiculata</i>	Vine	Fields, forest edges, roadsides, grasslands
Beefsteak Plant	<i>Perilla frutescens</i>	Herb	Roadsides
Bell's Honeysuckle	<i>Lonicera bella</i>	Shrub	Fields, pastures, forest edge, roadsides
Bishop's Goutweed	<i>Aegopodium podagraria</i>	Herb	Forests
Border Privet	<i>Ligustrum obtusifolium</i>	Shrub	Old fields, forest gaps
Bradford Pear	<i>Pyrus calleryana</i>	Tree	Full sun, orchards, parks, roadsides, yards, forest edge
Brittle Naiad	<i>Najas minor</i>	Herb	Ponds, streams, lakes, wetlands
Bull Thistle	<i>Cirsium vulgare</i>	Herb	Pastures, fields
Bush Honeysuckles	<i>Lonicera</i> spp.	Shrub	Pastures, fields, forest edges, roadsides
Butter-and-Eggs	<i>Linaria vulgaris</i>	Herb	Fields, pastures, roadsides, disturbed areas
Canada Bluegrass	<i>Poa compressa</i>	Grass	Fields, pastures, forest edge, wet sites, forest openings, waste areas
Canada Thistle	<i>Cirsium arvense</i>	Herb	Pastures, fields
Celandine	<i>Chelidonium majus</i> var. <i>majus</i>	Herb	Fields, roadsides, waste areas, dry to moist woodlands
Cheatgrass	<i>Bromus tectorum</i>	Grass	Pastures, fields
Chinese Bushclover	<i>Lespedeza cuneata</i>	Herb	Roadsides, rights-of-way, old fields, pasture, woodlands
Chinese Privet	<i>Ligustrum sinense</i>	Shrub	Pastures, fields, forest, forest edges, roadsides
Chinese Wisteria	<i>Wisteria sinensis</i>	Woody Vine	Forest, forest edges, roadsides, disturbed areas
Chinese Yam	<i>Dioscorea oppositifolia</i>	Vine	Streambanks, floodplain forests
Cinnamon Vine	<i>Dioscorea polystachya</i>	Vine	Forests, woodlands, thickets
Colonial Bent-grass	<i>Agrostis capillaris</i>	Grass	Pastures, fields
Common Buckthorn	<i>Rhamnus catharticus</i>	Shrub	Wetlands, old fields
Common Chickweed	<i>Stellaria media</i>	Herb	Fields, floodplain forests, disturbed areas, waste areas
Common Privet	<i>Ligustrum vulgare</i>	Shrub	Forests, fields, rights-of-way
Common Reed	<i>Phragmites australis</i>	Grass	Wetlands
Common Sheep Sorrel	<i>Rumex acetosella</i>	Herb	Fields, roadsides, disturbed areas, waste areas
Common Velvetgrass	<i>Holcus lanatus</i>	Grass	Meadows, wetlands, riparian areas
Cork Tree	<i>Phellodendron japonicum</i>	Tree	Residential, parks, open woodlands, roadsides
Crown Vetch	<i>Coronilla varia</i>	Herb	Pastures, fields
Curled Thistle	<i>Carduus crispus</i>	Herb	Pastures, fields
Curlyleaf Pondweed	<i>Potamogeton crispus</i>	Herb	Wetlands, ponds, lakes
Cut-leaf Teasel	<i>Dipsacus laciniatus</i>	Herb	Fields, pastures, roadsides, waste areas
Dame's Rocket	<i>Hesperis matronalis</i>	Herb	Fields, forest edges

Common Name	Scientific Name	Growth Form	Typical Habitat(s)
Drooping Star of Bethlehem	<i>Ornithogalum nutans</i>	Herb	Fields, floodplains, waste areas
English Ivy	<i>Hedera helix</i>	Vine	Forests, disturbed areas
Eurasian Water-milfoil	<i>Myriophyllum spicatum</i>	Herb	Aquatic ponds, ditches, wetlands
European Barberry	<i>Berberis vulgaris</i>	Shrub	Forests, wetlands, pastures
European Privet	<i>Ligustrum vulgare</i>	Shrub	Pastures, fields, forests, forest edges, roadsides, streams
European Stinging Nettle	<i>Urtica dioica</i>	Herb	Stream edges, marsh, meadows, moist woodlands
Field Hawkweed	<i>Hieracium caespitosum</i>	Herb	Fields, pastures, prairies, waste areas, disturbed areas
Fiveleaf Akebia	<i>Akebia quinata</i>	Vine	Forests
Fuller's Teasel	<i>Dipsacus fullonum</i>	Herb	Riparian areas, meadows, fields, forest openings, disturbed areas
Garden Yellow-rocket	<i>Barbarea vulgaris</i>	Herb	Pastures, fields, roadsides, moist meadows
Garlic Mustard	<i>Alliaria petiolata</i>	Herb	Forests
Giant Hogweed	<i>Heracleum mantegazzianum</i>	Herb	Right-of-ways, riverbanks, ditches
Glossy Buckthorn	<i>Frangula alnus</i>	Shrub	Wetlands, old fields
Goatsrue	<i>Galaga officinalis</i>	Herb	Pastures, streambanks
Goldern Bamboo	<i>Phyllostachys aurea</i>	Grass	Roadsides, disturbed areas, forest openings, forest edge
Goutweed	<i>Aegopodium podagraria</i>	Herb	Forests, fields, pastures
Great Mullein	<i>Verbascum thapsus</i>	Herb	Fields, meadows, forests, roadsides, disturbed areas
Ground Ivy	<i>Glechoma hederacea</i>	Herb	Open forests, disturbed areas, waste areas, lawn
Guelder Rose	<i>Viburnum opulus</i>	Shrub	Forests, wetlands, fields
Gypsy-flower	<i>Cynoglossum officinale</i>	Herb	Fields, pastures, forest edge, roadsides, disturbed areas
Hairy Cat's Ear	<i>Hypochaeris radicata</i>	Herb	Fields, pastures, grasslands, roadsides, disturbed areas
Hydrilla	<i>Hydrilla verticillata</i>	Herb	Wetlands, ponds
Indian-strawberry	<i>Duchesnea indica</i>	Herb	Fields, prairies, open woodlands, disturbed areas
Ivy-leaved Speedwell	<i>Veronica hederifolia</i>	Herb	Fields, forest edge, roadsides, disturbed areas
Japanese Barberry	<i>Berberis thunbergii</i>	Shrub	Forests, wetlands, pastures
Japanese Bromegrass	<i>Bromus japonicus</i>	Grass	Pastures, fields
Japanese Honeysuckle	<i>Lonicera japonica</i>	Vine	Forests, wetlands, fields
Japanese Hops	<i>Humulus japonicus</i>	Vine	Roadsides, streambanks, drainage ditch, meadows, disturbed areas, waste areas
Japanese Knotweed	<i>Polygonum cuspidatum</i>	Shrubby herb	Wetlands, streambanks, roadsides
Japanese Spiraea	<i>Spiraea japonica</i>	Shrub	Fields, forest openings
Japanese Stilt Grass	<i>Microstegium vimineum</i>	Grass	Pastures, fields, forests, wetlands
Jetbed	<i>Rhodotypos scandens</i>	Shrub	Forests, forest edge, roadsides
Jimsonweed	<i>Datura stramonium</i>	Herb	Pastures, fields
Johnson Grass	<i>Sorghum halepense</i>	Grass	Fields, wetlands, open forests

Common Name	Scientific Name	Growth Form	Typical Habitat(s)
Kentucky Bluegrass	<i>Poa pratensis</i> ssp. <i>pratensis</i>	Grass	Fields, grasslands, forest edge
Kudzu	<i>Pueraria lobata</i>	Vine	Forests
Lesser Burdock	<i>Arctium minus</i>	Herb	Fields, meadows, disturbed areas
Lesser Celandine	<i>Ranunculus ficaria</i> var. <i>bulbifera</i>	Herb	Forests
Lesser Periwinkle	<i>Vinca minor</i>	Vine	Fields, forest edge, forest openings
Linden Arrowwood	<i>Viburnum dilatatum</i>	Shrub	Forests, wetlands, disturbed areas
Long-bristled Smartweed	<i>Persicaria longiseta</i>	Herb	Lawns, roadsides, wet meadows, waste areas
Maiden Grass	<i>Miscanthus sinensis</i>	Grass	Pastures, fields
Marsh Dewflower	<i>Murdannia keisak</i>	Herb	Wetlands
Meadow Brome	<i>Bromus commutatus</i>	Grass	Pastures, fields
Meadow Fescue	<i>Schedonorus pratensis</i>	Grass	Pastures, fields
Mile-a-minute Vine	<i>Polygonum perfoliatum</i>	Vine	Fields, forest edges, roadsides, ditches
Mimosa	<i>Albizia julibrissin</i>	Tree	Forest edges, residential areas, roadsides
Moneywort	<i>Lysimachia nummularia</i>	Herb	Moist forests, streambanks, wet meadows, wetlands, roadsides, fields
Multiflora Rose	<i>Rosa multiflora</i>	Shrub	Pastures, fields, forest edges
Musk Thistle	<i>Carduus nutans</i>	Herb	Pastures, fields
Nodding Plumeless-thistle	<i>Carduus nutans</i> ssp. <i>marcolepis</i>	Herb	Disturbed sites, waste areas, roadsides
Norway Maple	<i>Acer platanoides</i>	Tree	Forests
Oriental Bittersweet	<i>Celastrus orbiculatus</i>	Vine	Forest edges, old fields
Oriental Lady's Thumb	<i>Polygonum caespitosum</i> var. <i>longisetum</i>	Herb	Wetlands, floodplain forests, upland forests
Oxeye Daisy	<i>Leucanthemum vulgare</i>	Herb	Fields, pastures, grasslands, roadsides, disturbed areas
Parrot Feather	<i>Myriophyllum aquaticum</i>	Herb	Wetlands, ponds
Perennial Ryegrass	<i>Lolium perenne</i> ssp. <i>multiflorum</i>	Grass	Pastures, fields
Plumeless Thistle	<i>Carduus acanthoides</i>	Herb	Pastures, fields, roadsides
Poison-hemlock	<i>Conium maculatum</i>	Herb	Fields, pastures, roadsides, forest edge, degraded wetlands and prairies
Porcelain Berry	<i>Ampelopsis brevipedunculata</i>	Vine	Forests, stream banks, old fields
Poverty Brome	<i>Bromus sterilis</i>	Grass	Pastures, fields
Princess Tree	<i>Paulownia tomentosa</i>	Tree	Forests
Purple Crown-vetch	<i>Coronilla varia</i>	Herb	Pastures, fields, roadsides, utility right-of-ways
Purple Loosestrife	<i>Lythrum salicaria</i>	Herb	Aquatic ponds, ditches, wetlands
Reed Canary Grass	<i>Phalaris arundinacea</i>	Grass	Wetlands
Rough Bluegrass	<i>Poa trivialis</i>	Grass	Pastures, fields, roadsides,
Russian Olive	<i>Elaeagnus angustifolia</i>	Shrub	Pastures, fields, roadsides

Common Name	Scientific Name	Growth Form	Typical Habitat(s)
Rye Brome	<i>Bromus secalinus</i>	Grass	Pastures, fields
Shattercane	<i>Sorghum bicolor</i>	Grass	Pastures, fields
Shrubby Bushclover	<i>Lespedeza bicolor</i>	Shrub	Forest edges, field edges, forest openings
Siberian Elm	<i>Ulmus pumila</i>	Tree	Forests
Small Carpgrass	<i>Arthraxon hispidus</i>	Grass	Wetlands, ponds, streams, river floodplains
Smooth Brome	<i>Bromus inermis</i> ssp. <i>inermis</i> var. <i>inermis</i>	Grass	Fields, Pastures
Spotted Knapweed	<i>Centaurea stoebe</i> ssp. <i>micranthos</i>	Herb	Pastures, fields, roadsides
Star of Bethlehem	<i>Ornithogallum umbellatum</i>	Herb	Forests, fields
Standish's Honeysuckle	<i>Lonicera standishii</i>	Shrub	Fields, pastures, forest edge, roadsides, disturbed areas
St, John's-Wort	<i>Hypericum perforatum</i>	Herb	Fields, pastures, disturbed areas
Stonecrop	<i>Sedum sarmentosum</i>	Herb	Forest, forest edge
Sweetclover	<i>Melilotus officinalis</i>	Herb	Fields, pastures, roadsides, waste areas
Sycamore Maple	<i>Acer Pseudoplatanus</i>	Tree	Forests
Tall Fescue	<i>Schedonorus phoenix</i>	Grass	Pastures, fields
Tartarian Honeysuckle	<i>Lonicera tatarica</i>	Shrub	Pastures, fields, roadsides, utility right-of-ways, forest edge
Tree of Heaven	<i>Ailanthus altissima</i>	Tree	Forests
Viper's Bugloss	<i>Echium vulgare</i>	Herb	Pastures, fields, roadsides, waste areas
Water Chestnut	<i>Trapa natans</i>	Herb	Wetlands
Watercress	<i>Rorippa nasturtium-aquaticum</i>	Herb	Wetlands, streams, springs
Water Shield	<i>Brasenia schreberi</i>	Herb	Ponds, lakes
Wild Carrot	<i>Daucus carota</i>	Herb	Fields, pastures, roadsides, degraded prairie, forest edge
Wild Parsnip	<i>Pastinaca sativa</i>	Herb	Roadsides
Wine Berry	<i>Rubus phoenicolasius</i>	Shrub	Forests, fields
Winged Euonymus	<i>Euonymus alatus</i>	Shrub	Forests
Winter Creeper	<i>Euonymus fortunei</i>	Vine	Forests, fields
Wocheiner knapweed	<i>Centaurea nigrescens</i>	Herb	Fields, pastures, grasslands, field edge, open forests
Yellow Flag	<i>Iris pseudocorus</i>	Herb	Wetlands

Source: USDA (2015), VDCR-DNH (2015), WVDNR (2009), WVDNR (2010)