



COMMONWEALTH of VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY

Street address: 629 East Main Street, Richmond, Virginia 23219

Mailing address: P.O. Box 1105, Richmond, Virginia 23218

Fax: 804-698-4019 - TDD (804) 698-4021

www.deq.virginia.gov

Molly Joseph Ward
Secretary of Natural Resources

David K. Paylor
Director

(804) 698-4020
1-800-592-5482

ATTACHMENT B: DETAILED COMMENTS FROM REVIEWERS

Detailed comments submitted by reviewers are included in this attachment. When applicable, the comments were included in previous sections of this response. As stated previously, the Commonwealth recommends that FERC consider every comment, correction or recommendation detailed in Attachment B that FERC did not already address during the consideration of Attachment A. To the extent practicable, the Commonwealth recommends that the Bureau of Land Management and U.S. Forest Service also consider these recommendations to the degree that they relate to decisions under their jurisdiction.

Impacts of the Proposed Mountain Valley Pipeline on Virginia's Forests and Mitigation Recommendations

Loss of upland forests is specifically addressed in Sections 4.4 *Vegetation* and 4.5 *Wildlife* of the Mountain Valley Pipeline (MVP) Draft Environmental Impact Statement (DEIS), where significant adverse impacts are acknowledged to upland forests and specifically forested cores, as identified by the Virginia Natural Landscape Assessment (VaNLA), developed by the Department of Conservation and Recreation (DCR) - Division of Natural Heritage. These impacts are also recognized to be long-term and/or permanent, and thus, the MVP DEIS recommends the development of a mitigation plan for upland forest impacts in coordination with state and federal agencies. The DCR concurs with this recommendation, and the following summarizes direct and indirect impacts to upland forests as well as *initial* long-term and landscape-level mitigation recommendations to address those impacts in the MVP project area.

I. Background and Need

To the extent that direct and indirect impacts to upland forests from the MVP cannot be avoided, they should be mitigated. Forests are ecologically and economically beneficial to the Commonwealth, and approximately 16,000 acres per year have been lost in the period between 2000 and 2010. The current alternative for the Virginia segment of the Mountain Valley Pipeline (Rev 5, as of November 2016) intersects some of the largest blocks of unfragmented forest in Virginia.

Conserving forest cover and improving forest productivity is critical for maintaining functioning forest ecosystems and the Commonwealth's robust forest industry. Virginia's forests provide a range of important benefits including forest products, recreational opportunities, wildlife habitat, aesthetic values, and protections for air and water quality. Forests contribute the lowest nutrient and sediment loadings to Virginia's waterways of any type of land cover. In addition, forests are the best land cover for intercepting precipitation required for the recharge of groundwater aquifers. Forests also sequester carbon dioxide and produce oxygen. Large scale forest conversion activities, such as those imposed by a pipeline and associated infrastructure, reduce the area and ability of forests to provide these services,

via loss of forests in the project footprint and fragmentation of intact forest expanses. For the purposes of this document and the analysis described herein, the project footprint is defined as the limit of direct disturbance during pipeline construction.

II. Fragmentation

Unfragmented, large patches of forest contribute greater ecological benefits than the same total area of forest distributed among smaller patches. Larger forested patches exhibit increased resource availability to support a greater richness (i.e. number) of plant and animal species populations, of greater genetic diversity than those in smaller patches. In general, biodiversity approximately doubles with every tenfold increase in habitat area. Species populations and natural communities in larger forested cores are more resilient to various landscape-level disturbances (Didham 2010). When forest cover is fragmented, biodiversity and habitat value for forest interior species diminishes. Large patches also insulate species from “edge effects” that adversely affect their ability to survive and reproduce. For example, forest-dwelling migratory songbird populations in large forest blocks experience less brood parasitism, nest-cavity competition, and nest predation than those in fragmented forests with more edge habitat.

Fragmentation also impacts the forest’s ability to prevent erosion, retain soil, harbor pollinators that are important for agricultural lands, remove carbon from the air and store it within trees, slow and absorb runoff so groundwater is recharged, absorb solar energy keeping local areas cooler, and provide protection from storm and flood damage. For these reasons, the Commonwealth’s natural resource agencies, including DCR, the Department of Forestry (DOF), and the Department of Game and Inland Fisheries (DGIF), are looking beyond the currently forested areas of the MVP project footprint (i.e. direct forest losses) to measure the indirect impacts of forest fragmentation, so that mitigation can also address significant indirect losses, and thus the full MVP forest impact.

III. Identifying Direct and Indirect Impacts

Direct impacts are defined as “those impacts caused by the proposed action that occur at the same time and place” and indirect impacts are “caused or induced by the action but occur later in time or are removed in distance” (DEQ, 2013). Therefore, this analysis assesses not only the footprint of the pipeline route that would be converted from forest to non-forest (direct impact), but also the extent to which the functions and values of the remaining forest are diminished due to fragmentation (indirect impact).

Within the forest context:

- *Direct impacts* consist of loss of forest cover within the project footprint, and the associated losses of forest-dwelling species habitat; ecosystem services pertaining to filtration and recharge of groundwater and clean air; economic losses of forest products; and loss of forest area for recreational uses. In our approach, direct impact forest loss was quantified and addressed anywhere that the proposed route intersected a forest patch with more than 10 acres of interior (defined below).
- *Indirect impacts* include significant alteration of the conditions in the forest surrounding the directly impacted area and the separation of previously unified patches of habitat. In our approach, indirect impacts were only assessed where the project footprint would traverse patches of forest habitat containing at least 100 acres of intact, interior forest. Interior is defined as the area of a forest patch minus the 100-meter transition zone around its perimeter within which edge effects diminish forest values. This 100-acre interior forest area criterion is also the basis for the designation of a forest core in the VaNLA, which we used to quantify impacts to forests (discussed later). Indirect impacts were not assessed in the smaller non-core forest blocks because these areas were assumed to be already fragmented. Accounting for indirect impacts is also the practice of the U.S. Fish and Wildlife Service (USFWS) when accounting for impacts of pipeline

projects on migratory bird habitat to account for fragmentation impacts on the surrounding forest (Gosse 2016).

Failing to account for indirect impacts of the MVP to forests would gravely underestimate the extent to which Virginia's forest habitat would be affected by the project. Long linear disturbances (e.g. pipelines) have the potential to ribbon through the forested landscape creating extensive and degrading edge effects in what was previously interior forest habitat. The US EPA Office of Sustainable Communities report, "Our Built and Natural Environments: A Technical Review of the Interactions Among Land Use, Transportation and Environmental Quality"¹ (USEPA 2013) noted that impacts caused by fragmentation extend far into the interior of the remaining forest. The report cites a study of the fragmenting impact of a Massachusetts suburban highway that found that while the road-effect zone tends to be asymmetric and variable, in general it extended more than 328 feet (100 meters) and some effects occurred more than 0.62 miles (1 kilometer) from the road.

Indirect impacts significantly degrade forest ecosystems, as is evidenced in a very large body of peer reviewed research. Haddad et al (2015), synthesized fragmentation experiments spanning multiple habitats and scales, five continents, and 35 years, concluding that habitat fragmentation reduces biodiversity by as much as 75% and impairs key ecosystem functions by decreasing biomass and altering nutrient cycles. Across the experiments surveyed, effects were greatest in the smallest and most isolated fragments, and increased over time.

IV. The Virginia Natural Landscape Assessment (VaNLA)

We calculated impacts of direct and indirect forest loss using the VaNLA (Bulluck et al. 2007), which identifies, classifies, and ranks all existing "ecological cores" (≥100-interior-acre forest patches) and smaller non-core (10-99-interior-acre) habitat fragments in Virginia based on several key indicators of ecological functions of forests. The VaNLA was designed to facilitate conservation of significant forests that protect biodiversity and provide essential ecosystem services, and has been used by various Virginia state agencies, local governments,

¹ The impact of the long, linear footprint of roads is analogous to that of pipelines and is therefore relevant to this case.

federal agencies, Planning District Commissions, universities, and conservation non-profit organizations for land and species conservation as well as local and regional planning. Moreover, the VaNLA has received repeated recognition outside the Virginia border as an exemplary landscape level assessment of ecological integrity of forests.

The VaNLA methodology builds on pioneering work done by the Chesapeake Bay Program's Resource Lands Assessment, Maryland's Green Infrastructure Assessment, and the Delmarva Conservation Corridor Initiative, and is accepted by the scientific community. This approach is based upon thousands of scientific studies on the effects of fragmentation on species populations, natural communities and ecosystem function and services (Didham 2010).

In short, the VaNLA consists of a statewide spatial dataset of all remaining intact forest habitat or "ecological cores" with at least 100 acres of interior (Bulluck et al. 2007). These cores are attributed with over 50 variables pertaining to a variety of environmental and natural resource values, and statistically analyzed to assess their ecological value relative to the surrounding landscape based on key variables including core size and isolation; topographic variability; depth of interior; length of interior streams; wetland habitats; rare species habitats; presence of exemplary natural communities; and availability of habitat for Species of Greatest Conservation Need (SGCN), identified in the Virginia State Wildlife Action Plan. This results in an ecological integrity score for each core, ranging from 1-Outstanding to 5-General Significance.

In general, larger, more biologically diverse cores are assigned higher ecological integrity scores. Scores are also higher if the core or habitat fragment is part of a larger complex of natural lands, when it is known to provide significant species habitat, and/or when cores, via extensive inclusion of forested streams and wetlands, contribute to water quality enhancement. The VaNLA, as a statewide assessment of all remaining forested cores based upon these key indicators of ecological values, is most appropriate and the best available statewide dataset for addressing the impacts of landscape level impacts to forest values in Virginia.

V. Methodology to Assess Direct and Indirect Impacts

The following summarizes how we analyzed the VaNLA forested cores intersected by the MVP Rev 5 alignment, access roads, pipeyards/laydown yards, and staging areas to calculate acres of direct and indirect impacts to forests. As discussed previously, direct impacts are those resulting at the same time and place of the proposed action. Direct impact acres were calculated using the VaNLA and encompass the currently forested areas of the pipeline construction footprint (i.e. Rev 5 alignment, access roads, pipeyards/laydown yards, and staging areas). Indirect impacts are those occurring later in time and/or farther removed from the construction footprint; the diminished ecological integrity of forests caused by fragmentation. Calculation of indirect impact acres required more in depth spatial analysis, as discussed in more detail below.

A. Addressing Indirect Impacts with the VaNLA

Specifically, the VaNLA enables the quantification of indirect impacts pertaining to three fragmentation effects: increased edge effects, creation of smaller fragments from once larger forest cores, and reduced size of original forest cores (Didham 2010).

Increased edge effects: Edge effects result from the creation of non-forest within what was previously forest habitat and may decrease the amount of interior. Forest edges have greater exposure to wind and longer and more intense exposure to sunlight, which means that plant and animal species within newly created edges experience hotter and drier conditions to which they may not be adapted. Edges resulting from long linear disturbances facilitate the spread of non-native and invasive species, because the disturbed areas alongside roads or within transmission ROW provide long corridors of uninterrupted habitat in which weeds can thrive with little competition from woody plants (EPA 2013). The modified habitat within the forest edge is vulnerable to changes in species composition and structure, as plants and animals that can out-compete interior forest-dependent species gain access through the newly created ROW. New pests and pathogens, invasive plant species and predators are thus introduced to the forest communities, disrupting the ecological function of the forest, at least 100 meters into the adjacent forested area (Graham 2002).

Creation of forest fragments from cores: Transecting intact forest with pipelines, roads, or transmission ROW can result in patches that no longer contain the minimum area of interior forest habitat to qualify as cores. The VaNLA methodology sets the minimum size for a viable forest core to 100 acres of interior (Bulluck et al. 2007). Similar assessments have used 250 acres as the minimum size criterion (SWCA 2010). New smaller patches behave more like edge habitat and may become population sinks to which species are drawn but within which they cannot reproduce successfully due to predation or lack of critical resources (Robinson and Wilcove 1994).

Reduced size of forest cores: Ensuring that the forest patches remaining on the landscape meet the established minimum size criterion does not avoid fragmentation impacts. Even smaller interior forest patches exhibit decreased resource availability, lower species richness, lower genetic diversity, and thus, less capacity for species populations to adapt to various natural and human-induced changes on the landscape. Thus, when edge effects permeate a landscape, creating relatively smaller forest patches, the compounding negative indirect impacts to forests are exacerbated (Didham 2010, Haddad et al 2015).

B. Quantifying Indirect Impacts with the VaNLA

We quantified fragmentation effects (indirect impacts to forests) via use of the VaNLA to calculate a Core Integrity Impact. This approach allowed us to translate the three effects of fragmentation - edge effects, creation of non-core forest patches, and resulting cores of reduced size and ecological integrity – to area in acres. The Core Integrity Impact for Virginia was calculated using both a Fragmentation Factor and Depth Factor, each of which is discussed in more detail below.

i. Fragmentation Factor

For purposes of illustration and description, we use the term “parent core” to refer to a forest core in its current, pre-impact condition. The parent core represents the baseline condition that is permanently degraded by the habitat loss and fragmentation imposed by the MVP. In order to estimate the degree of degradation of the parent core, we used the size and shape statistics of the (pre-impact) parent core to quantify the increase in edge effects and

creation of smaller cores and non-core forest fragments. Edge effect is commonly quantified and expressed by the ratio of interior forest area to the perimeter of each core (i.e. IA/P ratio). These statistics enable calculation of a Fragmentation Factor for every intersected core, which helps to calculate the Core Integrity Impact for each core.

Figure 1, below, provides a representative example that illustrates the Fragmentation Factor calculation of the overall Core Integrity Impact for a single core. All area calculations were conducted in square meters to retain precision, and later converted to acres. Interior area is the area of the parent core minus the 100 meter transition zone to existing non-forest vegetation cover. In this example, when the parent core is intersected by the pipeline, two smaller cores (upper right and lower right lobes) are created, as well as two non-core fragments, which are considered lost and no longer meet the criterion for 100 acres of intact interior. The fragmented core interior area is the sum of all the remaining areas meeting the 100 acres of intact interior criterion. The before-impact perimeter is the overall perimeter of the parent core and the after-impact perimeter is the cumulative perimeter of all the resulting fragments. The IA/P ratio is calculated by dividing the interior area by the perimeter for each core.

The Fragmentation Factor quantifies the degree to which the proposed pipeline route changes the size and shape of a core, thereby diminishing the ecological integrity of the core. It is calculated by taking the inverse of the relative proportion of change in the IA/P ratio, brought about by the fragmenting pipeline feature. By relying on the change in these size and shape statistics, the Fragmentation Factor measures a relative loss, in area, of the indirect loss of forest values due to edge effects and the creation of smaller cores and non-core fragments. Note that these calculations do not address the footprint of the pipeline itself, which is accounted for in the calculation of direct impacts and represents 92 acres in the example.

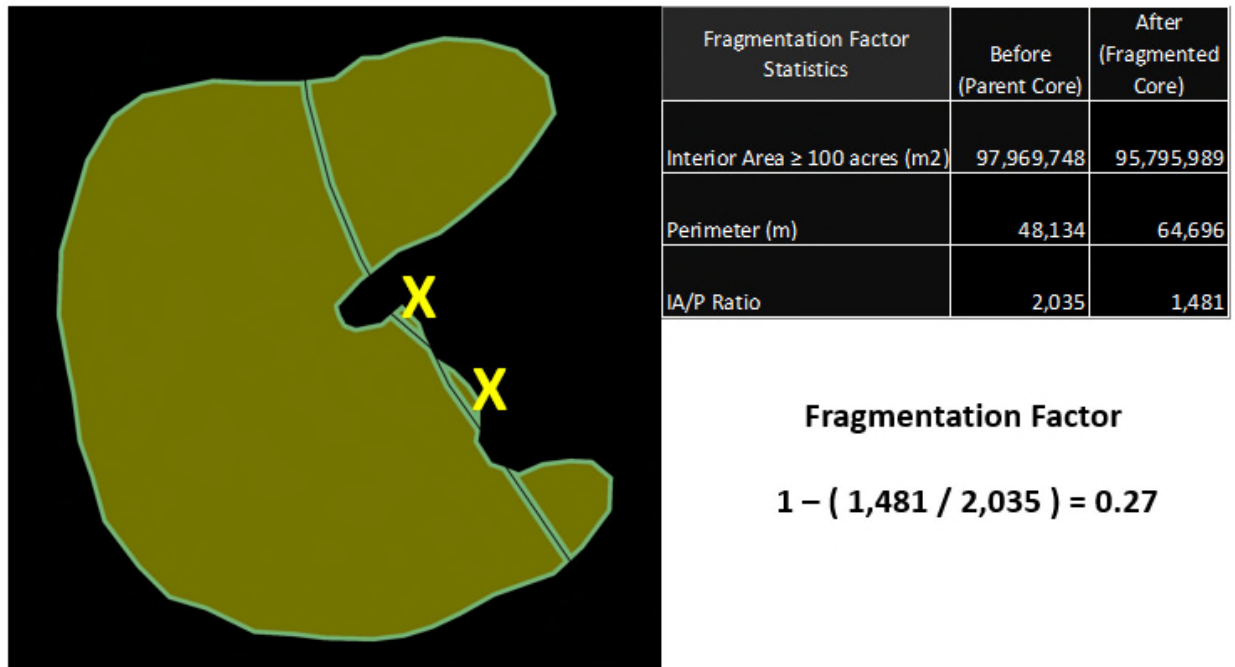


Figure 1. Calculation of the Fragmentation Factor Variable in the Core Integrity Impact

The Fragmentation Factor does not address the degree to which a pre-impact core is divided into smaller cores. For example, indirect impacts to a forested core, due to the nature of edge effects, are considered less where a disturbance is located closer to the periphery of the original parent core. In other words, impacts to the outer portions of a core have relatively less detrimental impacts on the original core due to the fact that deeper interior conditions are retained in the resulting parent core. Conversely, impacts to deeper areas of a core have relatively greater indirect impacts to a pre-impact core by leaving a smaller remaining cores. Therefore, a Depth Factor was calculated to address the location of the pipeline within a core and the resulting depth of penetration.

ii. Depth Factor

Using 100-meter inward buffers of the outmost pre-impact parent core perimeter, the maximum depth of every core was calculated via measurement to the most central ring. In the representative example provided in Figure 2, the maximum core depth is 3,400 meters. Likewise, the depth of penetration of the pipeline was also measured at the deepest point of

penetration: 2,100 meters. The Depth Factor was then calculated as the proportion of overall depth that is penetrated by the pipeline, and thus represents the depth of interior conditions where edge effects would occur and interior forest conditions would be lost. Note the influence of the location of the pipeline within a core. Impacts to outer depth bands result in a smaller Depth Factor, thereby also decreasing the Core Integrity Impact.

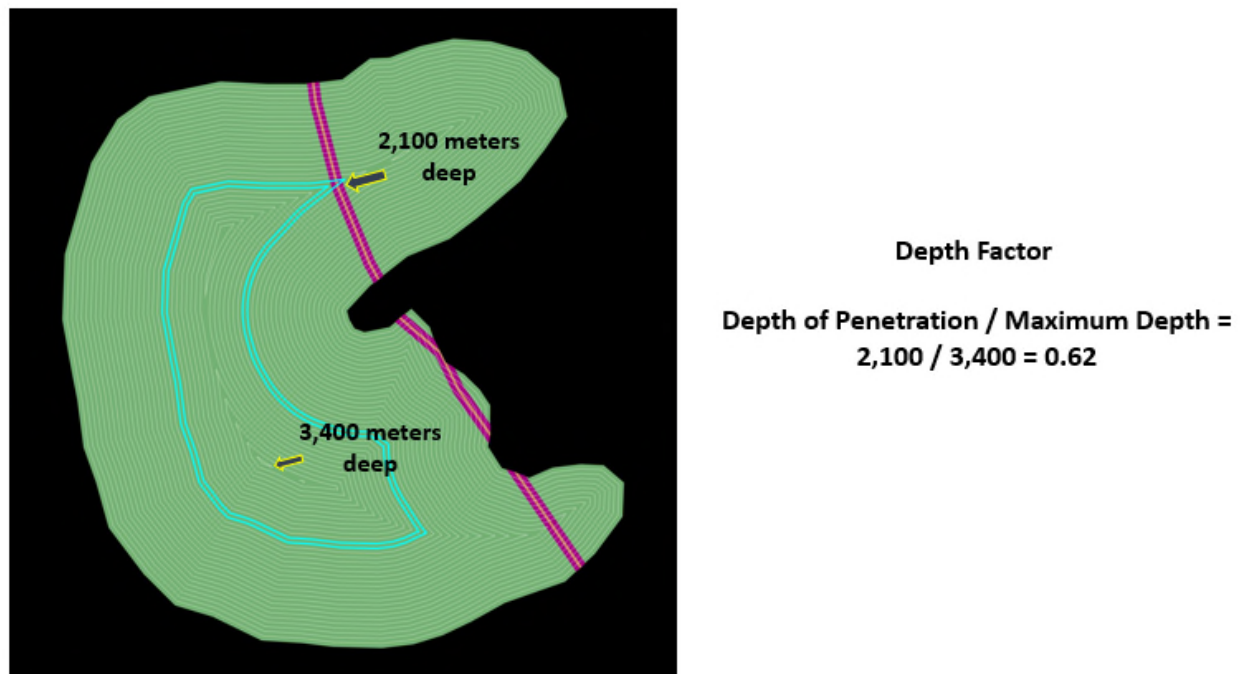


Figure 2. Calculation of the Depth Factor Variable in the Core Integrity Impact

iii. Calculation of Indirect Effects

After calculating both the Fragmentation Factor and the Depth Factor for each core that is at least 100 acres of intact interior forest, we applied these calculations to determine the indirect impact to each forest core, also known as the Core Integrity Impact, using the following equation: *Parent Core Size (acres) x Fragmentation Factor x Depth Factor = Core Integrity Impact*.

Applying this formula to the example provided in Figures 1 and 2, the Core Integrity Impact would be: *25,389 acres x 0.27 x 0.61 = 4,182 acres*.

The total impacts include both the direct impacts from the construction footprint of the pipeline and the indirect impacts calculated through the Core Integrity Impact formula. As such, the total impacts to the core are provided through the following summation: *Direct Impacts + Core Integrity Impact = Total Impact*.

Therefore, per the example provided in Figures 1 and 2, the total impact is calculated as: *92 acres + 4,182 acres = 4,274 acres*.

C. Summary of Total Impacts with the VaNLA

Overall, the MVP Rev 5 alignment, access roads, pipeyards/laydown yards, and staging areas intersect 79 features in the VaNLA representing 24 forested cores and 33 non-core habitat fragments (Table 1).

VaNLA features intersected	Number intersected
C1 core	3
C2 core	6
C3 core	9
C4 core	4
C5 core	24
Total cores	46
Non-core forest	33
Total VaNLA features	79

Table 1. Summary of Cores and Non-core fragments impacted by the MVP

The total impact (i.e. Direct + Indirect) was calculated for each of the 46 cores intersected by the Rev 5 alignment and associated infrastructure footprint of the MVP. Additional direct impacts were calculated for the 33 non-core forest patches intersected by the pipeline alignment, but these non-core forests were excluded from calculations of indirect

impacts because these non-core patches do not meet the ecological core criteria of 100 interior acres.

We also separated direct and indirect impacts based on the ecological integrity scores of the intersected cores; C1-Outstanding and C2-Very High ranked cores were treated separately than cores ranked C3, C4 and C5. Based on the higher ecological value of C1 and C2 cores, we felt this separation to be necessary in order to allow mitigation ratios and mitigation activities to account for the fact that some forest cores would receive disproportionately greater impacts. In other words, mitigation measures for a core of highest ecological integrity should be greater to attempt to sufficiently address the loss in ecological values to that exceptional forest core. Table 2 summarizes the acres of impact anticipated with the MVP Rev 5 alignment and associated supporting infrastructure areas.

Summary of Forest Impact (acres)		
	Direct	Indirect
C1 and C2 Cores	348	7,217
C3 – C5 Cores	549	8,378
Non-Core Forest Blocks	119	n/a
TOTAL	1,016	15,596

Table 2. Summary of Forest Impacts

Though the pipeline ROW and associated access roads and construction areas have a narrow footprint (i.e. the direct impact area), the indirect effects extend 100 meters beyond both sides of the project footprint into the surrounding forest (Graham 2002) to impact additional area of the parent core. The ratio of direct to indirect impacts is a function of: 1) the length of edge created and the area of core forest converted to non-core forest (fragmentation factor), and 2) the amount of fragmentation of large intact cores (depth factor). The ratio of direct to indirect impacts is large in this specific case because the proposed construction right

of way deeply penetrates many large forest cores with high ecological integrity. If the project avoided deeply penetrating large intact forest cores, a commensurately smaller ratio of direct to indirect impacts would result, as indirect impacts would also be less.

VI. Proposed Mitigation Activities

As discussed previously, to the extent that direct and indirect impacts to the Commonwealth's forests may not be avoided, they must be mitigated. The Commonwealth's natural resource agencies, representing a breadth of expertise in the ecological, environmental and economic values of upland forests, suggest three activities to address the direct and indirect impacts to forests that we quantified in the preceding section: afforestation, avoided deforestation, and forest enhancement. We agree with the recommendation in the DEIS to develop a mitigation plan for upland forest impacts, and we believe that these three activities should be utilized in analyzing and quantifying the scale of mitigation.

In addition, and as discussed in more detail in the sections below, we recommend that the mitigation plan include mitigation ratios that are developed for each of the three mitigation activities. A different ratio of mitigation acres to impact acres should be identified for each mitigation activity to ensure that an MVP forest mitigation program results in effective conservation benefits. Also, separate mitigation ratios should be developed to specifically account for the impacts to C1 and C2 cores; C3, C4 and C5 cores; and non-core forest blocks intersected by the pipeline and associated infrastructure. In general, factors to consider in the assignment of ratios should include the time lag between the impact and the restoration of ecosystem services through the mitigation activity, the risk of failure, the difference between what is lost and what is replaced, the ability to offset the full suite of negative impacts occurring at the project site, and the extent to which the respective mitigation activity results in no net loss of forest habitat.

The following summarizes each of the three recommended mitigation activities and provides additional detail regarding considerations in the development of mitigation ratios.

A. Afforestation (Restoration)

This mitigation activity consists of converting open land to forest by planting native trees appropriate for the ecoregion in which the impact being mitigated for occurred. This activity offsets the forest conversion that occurs in the project footprint by creating additional forestland. The planted acres should be protected from conversion to any other land use in perpetuity through the use of a protective instrument that overlays the mitigation acreage. The USFWS recommends this as the primary mitigation activity for pipeline impacts (Gosse 2016), and habitat restoration is an analogous activity that is accepted for mitigation of wetland impacts. The Virginia Department of Forestry expects that it will be difficult to meet all the mitigation acres needed to compensate for impacts from the MVP through this activity alone, and therefore recommends that a portion of the mitigation need be achieved through other activities pursuant to the Council on Environmental Quality's NEPA guidelines (40 Code of Federal Regulations (CFR) 1508.20).

In developing mitigation ratios for this activity, we recommend following the rationale of Virginia's wetland mitigation program whose guiding principal is to achieve "no net loss" of wetlands in Virginia. As such, the total acreage of mitigation activities from afforestation (forest restoration/replacement) should exceed the direct impact acreage. In addition, the ratios must account for the risk of failure inherent within any restoration/afforestation project. The ratios also must account for the time lag, which is significant, between mitigation put on the ground (acreage of planted trees) and a mature forest with its intact ecological functions that is similar to what is lost. Finally, we recommend that the ratios should be larger for those impacted habitats that have the highest pre-impact ecological integrity (i.e., those ranked C1 and C2).

B. Avoided Deforestation (Preservation)

This mitigation activity consists of permanently protecting existing forested habitat on private lands from conversion to other land uses. This activity offsets ROW clearing and fragmentation impacts by ensuring that other nearby forestland that could otherwise be at risk of conversion will be maintained in forestland in perpetuity. As with afforestation acres, this

mitigation activity requires that a perpetually protective instrument overlay the mitigation acreage. These protected forest acres remain as forest, although harvesting timber may be allowed as long as the harvested area is allowed to regrow as forest or is replanted. We recommend that this mitigation activity be applied to both direct and indirect impacts associated with pipeline construction and long-term corridor maintenance.

In developing mitigation ratios for this activity, we again recommend following Virginia's wetland mitigation principle of achieving "no net loss." While this activity is analogous to preservation in the wetland mitigation realm, it does not result in no net loss of forest. As such, the ratios for this activity should be greater than those for afforestation to account for the fact that avoided deforestation results in permanent protection from conversion of *already forested* habitats and does not add "new forest" on the landscape. As with the afforestation mitigation activity ratios, the ratios for this activity should be larger for those impacted habitats that have the highest pre-impact ecological integrity.

Finally, because we recommend that avoided deforestation be applied to both direct and indirect impacts, the ratios should reflect the differences between these impacts. The ratios for indirect impacts should be smaller than for direct impacts in recognition of the fact that although indirect impacts result in conversion of habitat from core habitat to edge habitat, the woody structure and some of its ecological function may remain, although in a diminished or different state.

C. Forest Habitat Improvement (Enhancement)

This mitigation activity consists of implementing appropriate silvicultural practices that result in the improvement of ecological functions of forests on public and private lands. This mitigation activity offsets fragmentation impacts by increasing the ecological integrity of nearby forests. As such, we recommend that this mitigation activity only be applied to the indirect effects upon core forests. The forest improvement achieved should persist for a "significant period of time" or until the lift in ecological value is sustainable with little or no management. This is analogous to wetland enhancement in the wetland mitigation realm. As with

afforestation and avoided deforestation mitigation activities, this mitigation activity requires that a perpetually protective instrument overlay the mitigation acreage.

In developing mitigation ratios for this activity, we recommend that the ratios for forest habitat improvement activities should be smaller than those developed for avoided deforestation. The rationale behind this is that the risk of failure with these types of projects is relatively small, they appropriately compensate for forested habitat degradation associated with fragmentation (indirect effects), and there are likely many opportunities to generate habitat lift in this way across the Commonwealth. As with the prior mitigation activities, we recommend that the ratios for this activity should be larger for those impacted habitats that have the highest pre-impact ecological integrity.

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