TEST AREA STORMWATER MANAGEMENT NARRATIVE
01/22/2018

Preface

In an effort to address DEQ comments regarding Spread 8 stormwater management plans, a test watershed was used for development of the proposed stormwater management methodology. The following narrative provides some background on the Project as a whole, and details how the methodology applied in the test area will meet both water quality and quantity requirements (including channel, flood, and sheet flow requirements) in accordance with Chapter 870 of the Virginia Administrative Code (9VAC25-870). Channel protection for concentrated flows shall be met via the Energy Balance Method. Flood protection for concentrated flows shall be met via reduction in the 10-year 24-hour runoff. Sheet flow requirements will be met via no increases in sheet flow volumes and physical spreading via water bar end treatments. Additional information is also provided for site conditions that may be experienced in other Project areas that are not located within this test watershed. When approved, this methodology will be implemented across the remainder of the Project.

Contents

I. Project Description

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

II. Typical Pipeline Corridor Post-Development Condition

The typical 125-foot wide pipeline construction corridor within the site area will be restored following construction in the manner described below. Refer to the *Section 4.1 Post-Development Condition* of the PSS&S for additional information. **Figure 1** below shows the typical pipeline corridor.

A. 75-foot temporary construction ROW will be restored to pre-development conditions.

   i. If forested, post-development condition will be brush (seeded with herbaceous and woody species per *Section 2.9.2 Permanent Seeding* and *MVP-ES11* of the PSS&S) and allowed to naturally return to forest condition subject to landowner actions.
   ii. If agricultural land, post-development condition will return the temporary ROW to agricultural use and will be modeled as such in the stormwater calculations.
   iii. If pre-development conditions included any impervious cover, such as asphalt or gravel access roads, these impervious surfaces will remain and/or be restored in the post-development condition.
   iv. Other pre-development conditions such as meadow, wetland, lawn, etc. will be restored to pre-development conditions and will be modeled as such in the stormwater calculations.
   v. NOTE: where applicable for water quantity purposes, the entire Limits of Disturbance (LOD), including both the temporary and permanent ROW, will be analyzed.

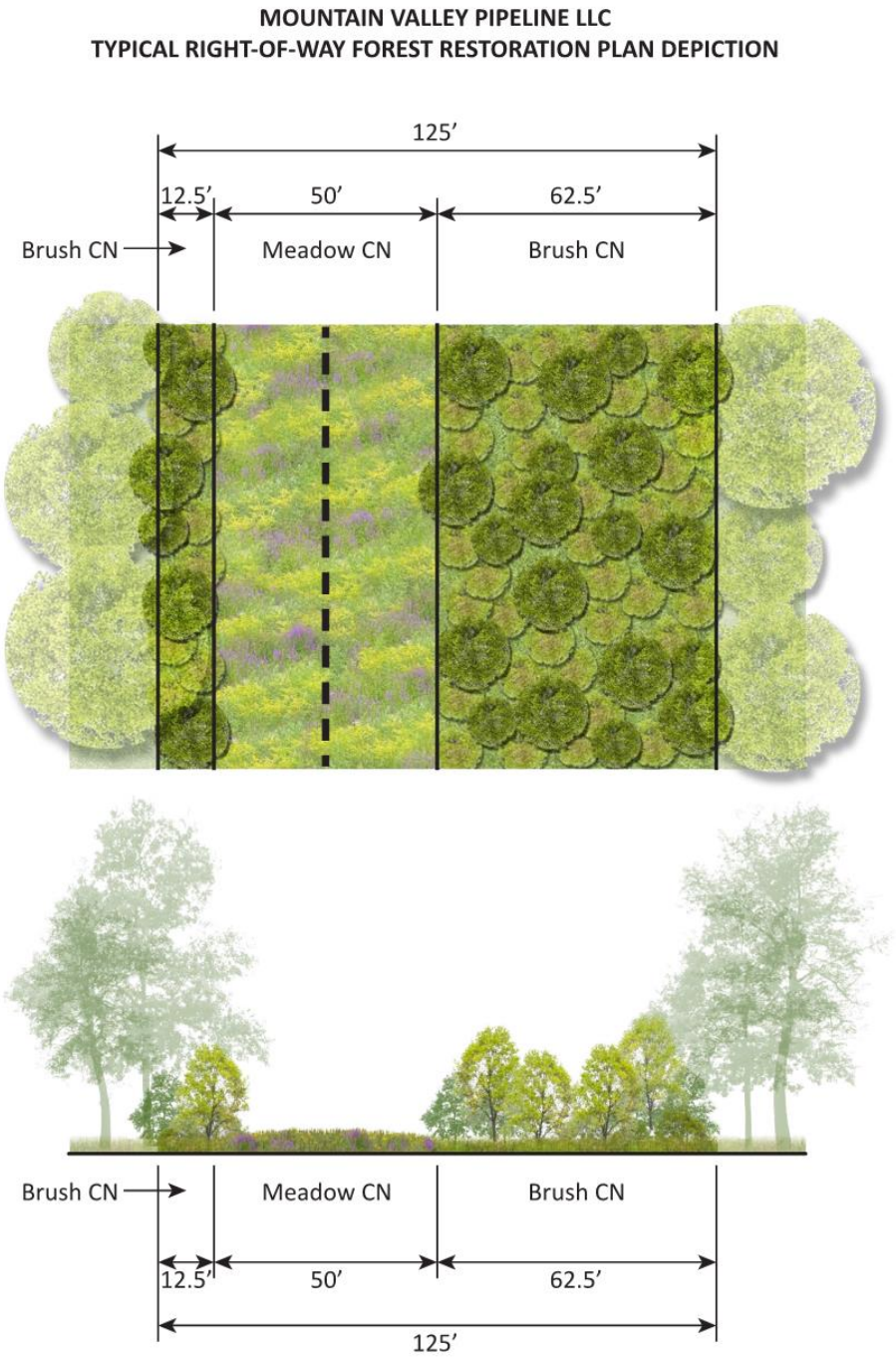
B. 50-foot permanent ROW will be seeded and restored to meadow conditions if the pre-development land use is not agricultural. The following practices will apply:

   i. Mowing and general maintenance will be consistent with the "Forest & Open Space" practices listed in the Virginia Runoff Reduction Method (VRRM) Compliance Spreadsheet User's Guide & Documentation (April 2016), Table 1. *Land Cover Guidance for VRRM Compliance Spreadsheets*.
   ii. The full width permanent ROW will not be mowed any more frequently than once every three (3) years.

iii. A corridor not exceeding 10 feet in width located directly over the pipeline will be mowed annually for inspection purposes in accordance with Federal Energy Regulatory Commission (FERC) PLAN and PROCEDURES.

iv. NOTE: where applicable for water quality purposes, only the permanent ROW will be analyzed.

Figure 1. Typical Right-of-Way Forest Restoration Plan Depiction



III. Project Stormwater Methodology

The Mountain Valley Pipeline Project (Project) traverses agricultural and forested lands along its 106-mile route from Giles to Pittsylvania County. The Project will meet all Virginia Department of Environmental Quality (DEQ) requirements as detailed in this and additional reference documents. Runoff conditions are not degraded and water quality requirements are met or exceeded. Where water bars spaced per *M.V.P. 17.2 Slope Breaker/Right-of-Way Diversion/Waterbar* are instituted to slow water flows, end treatments have been designed to further assure that sheet flow conditions and non-erosive velocities are maintained. Land use changes from pre- to post-construction are categorized below, along with discussion on how stormwater management requirements will be satisfied per land use category.

The 2015 Environmental Systems Research Institute (ESRI) World Imagery aerial photography digitized land use is used for land cover data. This may be superseded if field survey is present (e.g. existing gravel roads). See PSS&S *Appendix D Section 1.2.3.3 Curve Number* for additional information.

A. Prior Developed Lands

Portions of pipeline easements which traverse prior developed lands (e.g. access roads, agricultural areas, pasture, etc.), will be restored to existing predevelopment conditions with no improvements. Per Guidance Memo No. 15-2003 *Postdevelopment Stormwater Management Implementation Guidance for Linear Utility Projects*, preparation and implementation of stormwater management calculations is unnecessary for these areas. DEQ has clarified that it is not their expectation that permanent best management practices (BMPs) be installed on restored ROW.

Areas where predevelopment land cover conditions will be altered and MVP will comply with post-construction stormwater quality and quantity requirements, including the preparation of stormwater management calculations and a stormwater management plan per 9VAC25-870 and 9VAC25-880. In such instances, the outfall within the project must comply with Part IIB of the stormwater regulations, thereby addressing water quantity criteria for channel and flood protection.

B. Pre-construction Agricultural Lands

Pre-construction agricultural areas/fields will be returned to crop production, pasture, meadow, hay fields, etc., in identical condition (i.e. with topsoil stocked, respreads, disked and seeded), upon completion of pipeline construction. Agricultural areas are therefore exempt from meeting the Virginia Water Quality (9VAC25-870-63) and Water Quantity (9VAC25-870-66) requirements per § 62.1-44.15:34 and 9VAC25-870-300.

C. Pre-construction Non-Agricultural Lands with no Impervious Cover

i. Water Quality

Pre-construction non-agricultural and forested areas will satisfy Virginia Water Quality new development requirements per the most recent version of Virginia's 6th order National Watershed Boundary Dataset via the Virginia Runoff Reduction Method (9VAC25-870-63.A.1 and 9VAC25-870-65.A, respectively).

Under normal operating conditions, the post construction permanent right-of-way (ROW) will be considered "Forest/Open Space" land cover for VRRM water quality calculations per *Section 4.3 Stormwater Quality Calculations* of the *Project Specific Standards and Specifications for Virginia* (PSS&S). As such, the ROW phosphorus loading will always be less than the 0.41 pounds per acre per year maximum for new development, as shown in the following table:

TP Load per acre based on VRRM Land Cover and HSG (lb TP/ac/yr) *

Cover Type	**A Soils**	**B Soils**	**C Soils**	**D Soils**
Forest/Open Space	0.05	0.07	0.09	0.11

*Based on the following default VRRM values:
Annual rainfall for the state of Virginia = 43 inches
Target Rainfall Event = 1 inch
Total Phosphorus Event Mean Concentration = 0.26 mg/L

Therefore, no phosphorus reduction is required.

ii. Water Quantity: Concentrated Flow

Pre-construction non-agricultural and forested areas resulting in concentrated flow will satisfy Virginia Water Quantity channel and flood protection requirements (9VAC25-870-66.B.3.a and 9VAC25-870-66.C.2.b, respectively). Both channel and flood protection requirements compare runoff volumes and peak flows from pre- to post-construction condition. These values are based on curve numbers associated with land use. The Project will always result in lower post-development curve numbers in pre-construction non-agricultural areas with no impervious cover.

The restored ROW will be a brush/meadow combination and, therefore, result in a *lower* CN than that for "Woods, Good" condition for all Hydrologic Soil Groups (HSG's), with the exception of "A" soils where it will be equivalent, as explained in *Section 4.2.2 Curve Numbers* of the PSS&S and depicted in the following table:

TR-55 Runoff Curve Numbers

Cover Type	A Soils	B Soils	C Soils	D Soils
Woods, Good	30	55	70	77
Pipeline, 125-ft Right-of-Way*	30	52	67	75

*These are weighted curve numbers based on 50-feet of meadow and 75-feet of brush conditions of the same HSG soils within the restored ROW per *Section II. Typical Pipeline Corridor Post-Development Condition*.

Channel protection requirements can be satisfied using the Energy Balance Method per 9VAC25-870-66.B.3.a. The Energy Balance Method is intended for post-development runoff to mimic forested conditions, and states the following:

> Under no condition shall … $Q_{Developed}$ be required to be less than that calculated in the equation $(Q_{Forest} * RV_{Forest})/RV_{Developed}$; where
> $Q_{Developed}$ = The allowable peak flow rate of runoff from the developed site.
> $RV_{Developed}$ = The volume of runoff from the site in the developed condition.
> Q_{Forest} = The peak flow rate of runoff from the site in a forested condition.
> RV_{Forest} = The volume of runoff from the site in a forested condition;

Flood protection requirements can be satisfied using 9VAC25-870-66.C.2.b. The MVP project is assuming a worst-case scenario in which localized flooding currently occurs during the 10-year 24-hour storm event. Therefore, the post-development peak flow rate for the 10-year 24-hour storm event must be "less than the pre-development peak flow rate".

Because the post-construction ROW always results in a CN less than or equal to that of woods, and time of concentration will never decrease due to possible retention behind the water bar end treatments, peak flows will never exceed those of forested conditions. Therefore, the Energy Balance Method requirements are automatically satisfied, and channel protection requirements are met. Additionally, based on CN reduction from pre- to post-construction conditions, 10-year 24-hour storm volumes will also always be reduced, thereby satisfying flood protection requirements.

D. Post-Construction New Impervious Cover

New impervious cover may include access roads and main line valve pad sites. Stormwater analysis and BMP designs will be performed for all Project site areas with new impervious cover to ensure that the following Virginia state regulations have been satisfied:

- Water Quality (9VAC25-870-63)
- Water Quantity (9VAC25-870-66)
- Offsite Compliance Options (9VAC25-870-69)

i. Water Quality

Areas with new impervious cover in the post-construction permanent condition will satisfy Virginia Water Quality requirements via one of two ways. First, pre-construction non-agricultural areas will result in low phosphorus loading (see *III.C.i* above). These low loading areas will offset higher loading from new impervious cover, resulting in a balance or load reduction over each 6th order, or Hydrologic Unit Code (HUC) 12, boundary. Alternatively, if phosphorus load reductions are required for individual locations, water quality requirements could be met via offsite compliance options (9VAC25-870-69) or onsite BMPs.

ii. Water Quantity

Areas with new impervious cover in the post-construction condition will satisfy Virginia Water Quantity requirements via appropriate stormwater management controls. These controls may include BMPs designed in accordance with the Virginia Stormwater BMP Clearinghouse (9VAC25-870-65.B), BMPs referenced in the PSS&S, physical spreading of runoff into sheet flow via water bar end treatments (see *I.D* below), level spreaders, other specific water quantity control measures, or a combination thereof.

E. Sheet Flow

Water quantity regulations for any ROW land use can be satisfied via sheet flow conditions (9VAC25-870-66.D). There are two instances where runoff will be in the form of sheet flow. The first is in areas where runoff leaves the site ROW as sheet flow in existing conditions, does not re-concentrate within 100 feet downstream, and the proposed condition will maintain existing sheet flow. The second is where runoff diverted by water bars installed per *M.V.P. 17 Slope Breaker/Right-of-Way Diversion/Waterbar* will be redistributed as sheet flow via water bar end treatments.

i. Project Limits

In a similar manner to the concentrated flow scenarios described above, the CN's in the post-construction condition will be less than or equal to the pre-construction condition. In areas of sheet flow where no water bars are present in the post-construction condition, existing grades will be re-established to ensure sheet flow in the post-construction condition. Therefore, <u>sheet flow volumes will never increase, there will be no downstream impacts, and "no further quantity controls are required" per *9VAC25-870-66.D*.</u>

Additional information on sheet flow, including calculations for non-erosive velocities, is available in *Section 4.4.5 Sheetflow* and *Appendix D Section 1.2.2 Sheet Flow* of the PSS&S.

ii. Water Bars

M.V.P. 17.3 Water Bar End Treatment Sizing details the methodology for ensuring sheet flow from water bars throughout the Project is achieved. To summarize, Rational Method calculations, including the use of Pittsylvania County precipitation data as a worst-case scenario (i.e. all other Project areas have lower rainfall levels), demonstrate non-erosive velocities and 0.1-foot depth across the end treatment weirs. For ease of construction, the level weir sections of the end treatments are conservatively sized to three standard lengths based on drainage area inspection:

Water Bar End Treatment Level Weir Section Lengths	
D.A. (ac)	**Length (ft)**
≤ 0.5	10
0.5 ≤ 1.0	15
1.0 ≤ 1.5	20
> 1.5*	Site Specific

*or Curve Numbers > 71

Water bar spacing is based on slope as shown in *M.V.P. 17.2 Slope Breaker/Right-of-Way Diversion/Waterbar*, reproduced here:

RECOMMENDED MAXIMUM SPACING FOR PERMANENT SLOPE BREAKERS	
PIPELINE GRADE	**DISTANCE (FEET)**
<2%	N/A
2-5%	400
6-15%	200
16-30%	100
>31%	50

Maximum water bar spacing of 400 ft with a 50 ft permanent ROW results in a drainage area of 20,000 sf (0.46 acre) per water bar. Therefore, water bars located in series, perpendicular to slope will always have drainage areas less than 0.5 acres and will be assigned the 10-ft water bar end treatment.

Rather than performing a detailed measurement of each water bar drainage area, the proposed methodology is to select the 10-foot water bar end treatment for all water bars located in series, perpendicular to slope.

Drainage areas for water bars at the top and bottom of any series, as well as any water bars not in series or on cross-slopes, will be delineated to determine drainage area size, CN, and appropriate water bar end treatment length.

This process should yield repeatable, conservative results in terms of selecting end treatment lengths. For larger watersheds or on cross-slopes, site specific analyses will be performed to determine if a maximum 20-ft end treatment length will suffice, an additional water bar is needed to reduce the drainage area, or if a site-specific design is required.

In a similar manner to the concentrated flow scenarios described above, the CN's in the post-construction condition will be less than or equal to the pre-construction condition. However, because the drainage area to the water bar end treatment is slightly larger in post-construction than in pre-construction condition, sheet flow volumes at the end of the water bar do increase. However, cumulatively the watershed sheet flow volumes do not increase because the post-construction CNs are less than or equal to the pre-construction CNs of the watershed. Additionally, water bar end treatments are designed to ensure sheet flow and non-erosive velocities, resulting in no impacts to down-gradient properties. Therefore, the conditions of 9VAC25-870-66.D are satisfied and "no further quantity controls are required."

F. Pre-Construction Rock Outcroppings

During planning of the project, MVP route survey and development specifically avoided construction constraints like rock outcrops because of the significant difficulties associated with constructing in these types of areas. If any rock outcrops are present they will consist of minor areas that represent a small amount of the area of disturbance and will, therefore, not affect stormwater management calculations.

Pre-construction curve numbers are based on overall land use. Existing rock outcroppings would be categorized as disconnected impervious cover and have a negligible effect on curve numbers of the surrounding area. During construction, rock outcroppings within the permanent ROW will be blasted in trenching activities. Blasting will convert large single pieces of impervious rock to small-sized (less than 6-inch diameter) rock pieces mixed with native soil, resulting in a post-construction increase in infiltration rate and a resulting curve number reduction. Post-construction curve numbers are conservative because they do not include this improved infiltration.

G. Karst Features

MVP's Karst Hazards Assessment (KHA) and Karst Mitigation Plan (KMP) are consistent with applicable sections of the Virginia Department of Conservation and Recreation (DCR) Technical Bulletin No. 2, Hydrologic Modeling and Design in Karst Guidance. The Technical Bulletin is intended to guide large-scale, long-duration development projects in karst terrain, while the MVP Project constitutes a shallow, linear short-term construction project with strict environmental controls and land reclamation to pre-construction conditions.

The KHA was initially prepared as part of the FERC Environmental Report (Resource Report #6 Geological Resources), with the most recent update submitted to the FERC in February 2017. The KHA involved detailed desktop review of public and proprietary data to identify karst features, with field verification to confirm and enhance the desktop review. This is consistent with the karst investigation criteria presented in the DCR Technical Bulletin No. 2. MVP considered the results of the KHA and implemented hundreds of alignment adjustments to avoid sensitive karst features. MVP completed field verification on all parcels along the current MVP Route (certain property owners had previously denied access to all MVP surveyors), and MVP will update the KHA for submittal to the FERC prior to initiating land disturbance.

The KMP was most recently updated in October 2017 to incorporate FERC Environmental Conditions (Implementation Plan #21). The KHA was also incorporated in the PSS&S, which is reviewed by the DEQ on an annual basis. MVP received approval on the PSS&S on June 20, 2017. The KMP requires that MVP Karst Specialist inspectors be on-site during all phases of land disturbing activities in karst terrain. In addition, the KMP requires the Karst Specialists to conduct a field review of the karst areas following tree felling activities to verify that no karst features were overlooked. The KMP includes inspection protocols for newly identified karst features (if any are found during tree felling activities or land disturbance), outreach instructions for the DCR Karst Protection Coordinator, erosion and sediment control and stormwater management Best Management Practices, as well as avoidance and mitigation strategies for karst features. In summary, the KMP is consistent with applicable guidance in the DCR Technical Bulletin No. 2 for karst evaluations during construction, erosion and sediment control, and stormwater management.

During planning of the project, MVP route survey and development specifically avoided construction constraints involving sensitive karst features, based on the results of the KHA, because of the potential difficulties associated with construction in the vicinity of sensitive karst features. As noted, MVP implemented several major and hundreds of minor route adjustments to avoid sensitive karst features to the extent practical, with the current alignment having only a minimal number of minor karst features (e.g., sinkholes) and sensitive water resources that were identified in the KHA. Based on the recommendations of the MVP and DCR's onsite Karst Specialist inspectors, additional minor alignment adjustments within the confines of the LOD may be coordinated with

MVP and implemented to avoid remaining features to the extent practical. The KMP includes stabilization and mitigation measures recommended for karst features that cannot be avoided.

MVP provided the KHA and KMP to the DCR - Karst Protection Coordinator for review, and incorporated recommendations from the agency. MVP also collaborated with the DCR - Karst Protection Coordinator to complete supplemental karst hydrogeologic evaluations (including dye trace studies) in the vicinity of the proposed alignment, in specifically-identified karst areas, as a contingency planning effort.

The KMP directs, based on observations of the Karst Specialist inspectors, additional avoidance or mitigation that may be necessary if any new karst features are encountered during land disturbance. As noted, the Karst Specialist inspectors will be on-site during all phases of land disturbance in karst terrain, and upon initial land clearing will inspect the LOD for karst features that may have been obscured by vegetation.

Per Section 4.0-5 of the KMP, the intent of ESC and related BMPs is to confine project-related disturbance to the LOD, protect sensitive karst features, and minimize erosion and enhance revegetation in those areas. In addition to ESC BMPs for standard pipeline construction, which includes specifications by regulatory agencies, additional BMPs will be implemented as specified by the Karst Specialist.

IV. Test Area Analysis

A test area was used to demonstrate the Project Stormwater Methodology. The test area is located at the start of Spread 8, within the Jefferson National Forest. Spread 8 consists of approximately 9.6 miles of 42" natural gas pipeline, constructed entirely within Giles County, with portions of the Spread passing through the Jefferson National Forest. The Spread starts at the Virginia / West Virginia State line and ends at the intersection of the pipeline and Kow Camp Road (State Route 615).

The test area existing conditions include forest with steep slopes and one existing access road. The existing road will not be improved and is, therefore, considered prior developed land. No agricultural land use is contained within the test area and no new impervious cover is proposed. Additional information is provided in *Appendix D Section 1.3 Stormwater BMP Design* of the PSS&S.

The remainder of this memo provides detailed information on how the proposed stormwater management methodology is in full compliance with VSMP requirements through a detailed analysis of the test area.

A. Pre-Construction Forested Lands

The test area is predominantly pre-construction forested lands, with the only exception being the existing access road. Runoff CN's for the main line pipeline running through forested lands will always be less than or equal to a "Woods, Good" condition, assuming there are no new impervious surfaces or changes to prior developed lands proposed in the drainage area (as is the case for this drainage area). As depicted in the table below, the restored ROW will result in a *lower* CN than that for "Woods, Good" condition for all Hydrologic Soil Groups (HSG's), with the exception of "A" soils where it will be equivalent. The implication of this CN Analysis will be discussed in more detail below.

TR-55 Runoff Curve Numbers

Cover Type	**A Soils**	**B Soils**	**C Soils**	**D Soils**
Woods, Good	30	55	70	77
Pipeline, 125-ft Right-of-Way*	30	52	67	75

*These are weighted curve numbers based on 50-feet of meadow and 75-feet of brush conditions of the same HSG soils within the restored ROW per *Section II. Typical Pipeline Corridor Post-Development Condition*.

B. Water Quality

Per *9VAC-25-870-63.A.1*, the test area is considered new development and must not exceed a total phosphorus load of 0.41 pounds per acre per year. No new impervious cover is proposed within the test area and the entire site post-development condition is "Forest/Open Space" land cover. This land use category has a loading rate dependent on HSG as shown below.

TP Load per acre based on VRRM Land Cover and HSG (lb TP/ac/yr)

Cover Type	**A Soils**	**B Soils**	**C Soils**	**D Soils**
Forest/Open Space	0.05	0.07	0.09	0.11

The test area consists of HSG A and B soils. As a result, phosphorus loading for the entire test area is less than the 0.41 pounds per acre per year maximum and, therefore, no phosphorus reduction is required. The difference between 0.41 and the actual loading per soil type can be used to offset loading reductions required for new impervious cover within the same 6th order, or HUC 12, boundary. In such cases, the calculations shall be provided to evaluate pollutant loading and pollutant removal requirements for the specific spread.

C. Water Quantity

Because the test area consists entirely of either prior developed areas (the existing gravel road) or pre-construction non-agricultural lands, no analysis was needed. To reiterate from Section III.C.2 above:

Because the post-construction ROW always results in a CN less than or equal to that of woods, and time of concentration will never decrease due to possible retention behind the water bar end treatments, peak flows will never exceed those of forested conditions. Therefore, the Energy Balance Method requirements are automatically satisfied, and channel protection requirements are met. Additionally, based on CN reduction from pre- to post-construction conditions, 10-year 24-hour storm volumes will also always be reduced, thereby satisfying flood protection requirements.

D. Sheet Flow Protection

This analysis includes a drainage area delineation for each water bar within the test area, excluding those in series and perpendicular to slope (numbered 8 through 17 in this analysis). Water bar end treatment lengths were assigned based on drainage area size and curve number per *M.V.P. 17.3 Water Bar End Treatment Sizing.*

Note that the test area contains four water bars with drainage areas greater than 1.5 acres. Site-specific calculations for these water bars were completed with the following results:

Water Bar	Drainage Area (ac)	Tc (min)	Post CN	Calculated End Treatment Length (ft)	Proposed End Treatment Length (ft)
6	1.57	28	30	5	20
18	2.04	41	49	10	20
45	1.57	27	55	10	20
46	1.82	20	54	13	20

For consistency with the conservative design standard table (refer to detail), all four water bars will use a 20-foot end treatment length. See *Post Construction Drainage Area Maps, revised 1-9-2018* for more information.