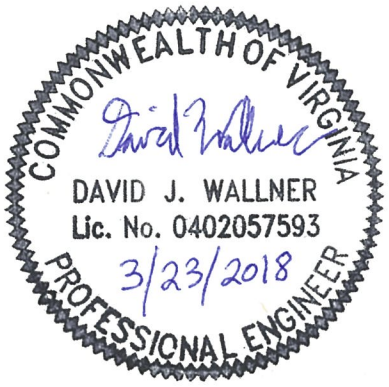
By virtue of this seal and signature, all supporting documents included in this package are accurate and support the design presented herein.



SPREAD 11 SWM NARRATIVE

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.

I. 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. THE TOTAL SPREAD 11 LOD IS 1083 ACRES.

FIGURE 1 BELOW SHOWS THE TYPICAL PIPELINE CORRIDOR.

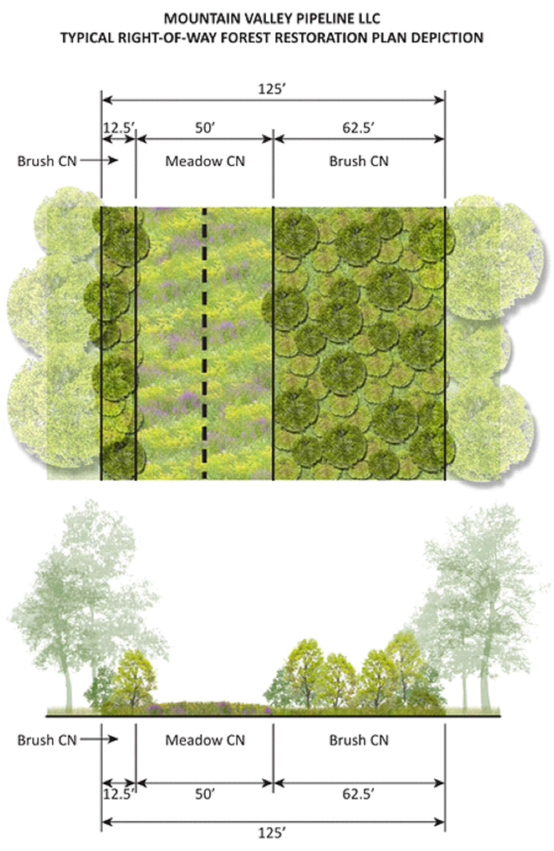
A. 75-FOOT TEMPORARY CONSTRUCTION ROW WILL BE RESTORED TO PRE-DEVELOPMENT CONDITIONS.

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



I. 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.

INFORMATION FROM THE VGIN LAND COVER DATASET AND TRANSPORTATION DATA FROM VITA MAP LAYER 2016 WERE USED FOR LAND USE. 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.

i. 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, SHEET FLOW VOLUMES WILL NEVER INCREASE, THERE WILL BE NO DOWNSTREAM IMPACTS, AND "NO FURTHER QUANTITY CONTROLS ARE REQUIRED" PER *9VAC25-870-66.D*.

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.

NO.:	DATE:	DRWN.:	CHKD.:	APPD.:	DESCRIPTION:
8	03/21/18	KAL	RE	DW	ADDRESS VADEQ COMMENTS
7	05/16/18	KAL	RE	DW	ADDRESS VADEQ COMMENTS
6	02/16/18	KAL	RE	DW	RESUBMISSION USING APPROVED STORMWATER METHODOLOGY
5	02/05/18	KAL	RE	DW	RESUBMISSION USING APPROVED STORMWATER METHODOLOGY
4	11/28/17	KAL	RE	DW	ADDRESS VADEQ COMMENTS
3	11/01/17	KAL	RE	DW	ADDRESS VADEQ COMMENTS

REVISIONS:

Mountain Valley PIPELINE

POST CONSTRUCTION (STORMWATER & RESTORATION) PLANS
MOUNTAIN VALLEY PIPELINE PROJECT – H600 LINE
SPREAD 8 – GILES COUNTY, VIRGINIA

MOUNTAIN VALLEY PIPELINE, LLC
555 SOUTHPOINTE BOULEVARD, SUITE 200
CANONSBURG, PA 15311

TETRA TECH
complex world | CLEAR SOLUTIONS™
661 ANDERSEN DRIVE
FOSTER PLAZA 7
PITTSBURGH, PA 15220

POST CONSTRUCTION (STORMWATER & RESTORATION) PLANS

COMMONWEALTH OF VIRGINIA
DAVID J. WALLNER
Lic. No. 0402057593
PROFESSIONAL ENGINEER

DRAWN BY:	KAL
CHECKED BY:	RE
APPROVED BY:	DW
DATE:	03/21/2018
SCALE:	AS SHOWN
REVISION	
NARRATIVE	1 OF 4

TETRA TECH CAD FILE PATH: X:\CADD_Pittsburgh\EQT\7157 – MVP\00 – General\E&S\Narratives\SWM_NARRATIVES\SPREAD_11\7157ES00ONARRATIVE-SW(S11).dwg PLOTTED ON: 3/21/2018 6:32 PM PLOTTED BY: Kusiowski, Jim PLOT FILE: ENVIRONMENTAL_COLOR.ctb

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.

I. SPREAD 11 ANALYSIS

SPREAD 11 CONSISTS OF APPROXIMATELY 39.2 MILES OF 42" NATURAL GAS PIPELINE, CONSTRUCTED WITHIN FRANKLIN AND PITTSYLVANIA COUNTIES. THE SPREAD STARTS JUST WEST OF STATE ROUTE 701 (FOGGY RIDGE RD) AND ENDS AT THE INTERCONNECT LOCATED IN TRANSCO VILLAGE.

EXISTING CONDITIONS WITHIN SPREAD 11 INCLUDE FORESTED LANDS, AGRICULTURAL LANDS, NON-AGRICULTURAL LANDS, AND PRIOR DEVELOPED LANDS. POST-CONSTRUCTION NEW IMPERVIOUS COVER IN SPREAD 11 INCLUDES THE TRANSCO INTERCONNECT SITE, MAIN LINE VALVE SITES AND CORRESPONDING ACCESS ROADS.

THE REMAINDER OF THIS NARRATIVE PROVIDES DETAILED INFORMATION ON HOW THE PROPOSED STORMWATER MANAGEMENT METHODOLOGY IS IN FULL COMPLIANCE WITH VSMP REQUIREMENTS THROUGH A DETAILED ANALYSIS OF SPREAD 11.

A. PRE-CONSTRUCTION FORESTED LANDS

PORTIONS OF SPREAD 11 ARE IN PRE-CONSTRUCTION FORESTED LANDS, WITH THE ONLY EXCEPTION BEING THE EXISTING ACCESS ROADS IN SOME AREAS. 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 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. PRIOR DEVELOPED LANDS

PORTIONS OF SPREAD 11 TRAVERSE PRIOR DEVELOPED LANDS INCLUDING ACCESS ROADS AND AGRICULTURAL AREAS, WHICH 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.

THE FOLLOWING IS A COMPLETE LIST OF EXISTING ACCESS ROADS WITHIN SPREAD 11:

a. *EXISTING ROADS USED FOR PERMANENT ACCESS*

i. MVP-FR-306.02
ii. MVP-FR-309.05
iii. MVP-FR-315
iv. ZEIGLER LANE (MVP-FR-322)
v. MVP-PI-325
vi. MVP-PI-337
vii. MVP-PI-338
viii. DUAL TRACK ROAD (MVP-PI-338.01)
ix. MVP-PI-340
x. MVP-PI-344

b. *EXISTING ROADS USED FOR TEMPORARY ACCESS*

i. MVP-FR-305
ii. MVP-FR-306.03
iii. MVP-FR-306.04
iv. MVP-FR-309
v. MVP-FR-309.06
vi. MVP-FR-310
vii. FLINT HILL ROAD (MVP-FR-311)
viii. BOARD LANE (MVP-FR-313)
ix. MVP-FR-314
x. MVP-FR-316
xi. MVP-FR-317
xii. MVP-FR-317.01
xiii. MVP-FR-318
xiv. MVP-FR-319
xv. MVP-FR-319.01
xvi. MVP-FR-320
xvii. HOLIDAY LANE (MVP-FR-321)
xviii. HOLIDAY LANE (MVP-FR-321.01)
xix. MVP-FR-323
xx. MVP-FR-324
xxi. MVP-PI-326
xxii. MVP-PI-328
xxiii. MVP-PI-329
xxiv. MVP-PI-330
xxv. MVP-PI-331
xxvi. MVP-PI-332
xxvii. MVP-PI-332.01
xxviii. MVP-PI-336.01
xxix. MVP-PI-339

C. POST-CONSTRUCTION NEW IMPERVIOUS COVER

NEW IMPERVIOUS COVER IN SPREAD 11 INCLUDES FIVE (5) MAIN LINE VALVE SITES (MVP-MLV-31 THROUGH -35) AND SIX (6) ACCESS ROADS (MVP-MLV-AR-31 THROUGH -35, AND MVP-PI-343). INCREASES IN TP LOADING WILL BALANCE OVER SPREAD 11 AS A WHOLE, DISCUSSED IN *SECTION IV.D. WATER QUALITY* IMMEDIATELY BELOW. INCREASES IN STORMWATER RUNOFF ASSOCIATED WITH THESE NEW IMPERVIOUS SURFACES HAS BEEN ACCOUNTED FOR THROUGH THE DETENTION OF STORMWATER WITHIN THE STONE MATRIX. THIS HAS BEEN ACCOMPLISHED WITH A SERIES OF STONE BAFFLES AND SUMP CONDITIONS, DESIGNED IN ACCORDANCE WITH *MVP-33.1 THROUGH MVP-33.3 GAP GRADED GRAVEL DETAIL*. THE RESULTING STORAGE ACCOMMODATES RUNOFF FROM THE 10-YR STORM AND THEREFORE COMPLIES WITH VIRGINIA STATE WATER QUANTITY REGULATIONS (9VAC25-870-66) AS DISCUSSED IN *SECTIONS IV.E.II AND III* BELOW.

NEW IMPERVIOUS COVER IN SPREAD 11 ALSO INCLUDES THE TRANSCO INTERCONNECT SITE, WHICH CONSISTS OF A PERMANENT 310-FT BY 295-FT PAD AREA AND 20-FT WIDE ACCESS ROAD (MVP-PI-343.01). A SEPARATE PLAN SET HAS BEEN DEVELOPED FOR THE TRANSCO INTERCONNECT SITE, WHICH INCLUDES ALL ASSOCIATED DETAILS AS WELL AS SITE-SPECIFIC ESC AND SWM NARRATIVES; THIS PLAN SET IS REFERENCED ON SHEETS 15.78, 15.92, AND 15.93 OF THE SPREAD 11 ESC AND PC PLAN SETS. REFER TO THE PLAN SET FOR THE TRANSCO INTERCONNECT SITE FOR INFORMATION REGARDING THE MEASURES TAKEN TO ACHIEVE COMPLIANCE WITH THE APPLICABLE VIRGINIA STATE REGULATIONS.

D. WATER QUALITY

PER *9VAC25-870-63.A.1*, SPREAD 11 IS CONSIDERED NEW DEVELOPMENT AND MUST NOT EXCEED A TOTAL PHOSPHORUS LOAD OF 0.41 POUNDS PER ACRE PER YEAR. SPREAD 11 INCLUDES THE NEW TRANSCO-INTERCONNECT SITE. SPREAD 11 CROSSES EIGHT (8) 6TH ORDER, OR HUC 12, BOUNDARIES: 030101010503, 030101010504, 030101010601, 030101010804, 030101011001, 030101050104, 030101050201, AND 030101050203. LAND USE TOTAL ACREAGE FOR EACH 6TH ORDER BOUNDARY RESULT AS FOLLOWS:

30101010503

Land Cover	A	B	C	D	Totals
Forest/Open Space (ROW)	0	68.897	0	0	68.897
Managed Turf	0	0	0	0	0
Ag Lands	0	0	0	0	0
Ex. Impervious Cover	0	5.194	0	0	5.194
New Impervious Cover	0	0.099	0	0	0.099
	0	74.19	0	0	74.19

30101010504

Land Cover	A	B	C	D	Totals
Forest/Open Space (ROW)	0	22.63	0	0	22.63
Managed Turf	0	0	0	0	0
Ag Lands	0	0	0	0	0
Ex. Impervious Cover	0	3.095	0	0.107	3.202
New Impervious Cover	0	0.151	0	0	0.151
	0	25.876	0	0.107	25.983

30101010601

Land Cover	A	B	C	D	Totals
Forest/Open Space (ROW)	0	123.434	4.631	0	128.065
Managed Turf	0	0	0	0	0
Ag Lands	0	0	0	0	0
Ex. Impervious Cover	0	12.972	0.556	0.144	13.672
New Impervious Cover	0	0	0	0	0
	0	136.406	5.187	0.144	141.737

30101010804

Land Cover	A	B	C	D	Totals
Forest/Open Space (ROW)	0	89.883	16.01	0	105.893
Managed Turf	0	0	0	0	0
Ag Lands	0	0	0	0	0
Ex. Impervious Cover	0	11.417	0.015	0	11.432
New Impervious Cover	0	0.005	0	0	0.005
	0	101.305	16.025	0	117.33

30101011001

Land Cover	A	B	C	D	Totals
Forest/Open Space (ROW)	1.42	158.405	2.692	2.123	164.64
Managed Turf	0	0	0	0	0
Ag Lands	0	0	0	0	0
Ex. Impervious Cover	0.052	11.804	2.292	0.11	14.258
New Impervious Cover	0	0.082	0	0	0.082
	1.472	170.291	4.984	2.233	178.98

30101050104

Land Cover	A	B	C	D	Totals
Forest/Open Space (ROW)	0	166.161	0	9.207	175.368
Managed Turf	0	0	0	0	0
Ag Lands	0	0	0	0	0
Ex. Impervious Cover	0	4.307	0	0.05	4.357
New Impervious Cover	0	2.885	0	0.043	2.928
	0	173.353	0	9.3	182.653

30101050201

Land Cover	A	B	C	D	Totals
Forest/Open Space (ROW)	0	31.377	0	0.01	31.387
Managed Turf	0	0	0	0	0
Ag Lands	0	0	0	0	0
Ex. Impervious Cover	0	1.496	0	1.035	2.531
New Impervious Cover	0	0.071	0	0	0.071
	0	32.944	0	1.045	33.989

30101050203

Land Cover	A	B	C	D	Totals
Forest/Open Space (ROW)	0	14.442	0	0	14.442
Managed Turf	0	0	0	0	0
Ag Lands	0	0	0	0	0
Ex. Impervious Cover	0	0.76	0	0	0.76
New Impervious Cover	0	0.32	0	0	0.32
	0	15.522	0	0	15.522

PER SECTIONS III.A AND III.B ABOVE, PRIOR DEVELOPED LANDS INCLUDING EXISTING IMPERVIOUS COVER RETURNED TO PRE-CONSTRUCTION CONDITION ARE EXEMPT FROM SWM CALCULATIONS AND HAVE BEEN REMOVED FROM THE VRRM AREA TOTALS. PHOSPHORUS LOADING FROM EXISTING IMPERVIOUS COVER AND AGRICULTURAL LANDS IS, THEREFORE, NOT APPLICABLE AS LISTED AS "N/A" IN THE TOTAL PHOSPHORUS LOADING PER 6TH ORDER HUC BELOW. VRRM SITE DATA TABS FOR EACH OF THE EIGHT SPREAD 11 6TH ORDER BOUNDARIES ARE ATTACHED.

FOR THE REMAINING AREAS, VRRM CALCULATIONS SHOW THAT THE LOW PHOSPHORUS LOADING IN THE PRE- AND POST-CONSTRUCTION FORESTED AREAS OFFSET LOADING INCREASES FROM NEW IMPERVIOUS COVER, PER *SECTION III.D.I. WATER QUALITY* ABOVE. ADDITIONAL ANALYSIS INCLUDED CALCULATING LOADING BASED ON THE VARYING ANNUAL PRECIPITATION VALUES ALONG SPREAD 11 PER *PSS&S SECTION 4.2.1 ANNUAL PRECIPITATION,* AS OPPOSED TO THE DEFAULT 43-INCH ANNUAL PRECIPITATION VALUE USED IN THE VRRM SPREADSHEET.

30101010503

Total Phosphorus Loading [lb/yr]

Land Cover	A	B	C	D	Totals
Forest/Open Space (ROW)	0	5.076	0	0	5.076
Managed Turf	0	0	0	0	0
Ag Lands	N/A	N/A	N/A	N/A	N/A
Ex. Impervious Cover	N/A	N/A	N/A	N/A	N/A
New Impervious Cover	0	0.229	0	0	0.229
	0	5.305	0	0	5.305

30101010504

Total Phosphorus Loading [lb/yr]

Land Cover	A	B	C	D	Totals
Forest/Open Space (ROW)	0	1.656	0	0	1.656
Managed Turf	0	0	0	0	0
Ag Lands	N/A	N/A	N/A	N/A	N/A
Ex. Impervious Cover	N/A	N/A	N/A	N/A	N/A
New Impervious Cover	0	0.35	0	0	0.35
	0	2.006	0	0	2.006

30101010601

Total Phosphorus Loading [lb/yr]

Land Cover	A	B	C	D	Totals
Forest/Open Space (ROW)	0	8.93	0.442	0	9.372
Managed Turf	0	0	0	0	0
Ag Lands	N/A	N/A	N/A	N/A	N/A
Ex. Impervious Cover	N/A	N/A	N/A	N/A	N/A
New Impervious Cover	0	0	0	0	0
	0	8.93	0.442	0	9.372

30101010804

Total Phosphorus Loading [lb/yr]

Land Cover	A	B	C	D	Totals
Forest/Open Space (ROW)	0	6.301	1.495	0	7.795
Managed Turf	0	0	0	0	0
Ag Lands	N/A	N/A	N/A	N/A	N/A
Ex. Impervious Cover	N/A	N/A	N/A	N/A	N/A
New Impervious Cover	0	0.011	0	0	0.011
	0	6.312	1.495	0	7.806

NO.:	DATE:	DWN.:	CHKD.:	APPD.:	DESCRIPTION:
8	03/21/18	KAL	RE	DW	ADDRESS VADEQ COMMENTS
7	03/16/18	KAL	RE	DW	ADDRESS VADEQ COMMENTS
6	02/16/18	KAL	RE	DW	RESUBMISSION USING APPROVED STORMWATER METHODOLOGY
5	02/05/18	KAL	RE	DW	RESUBMISSION USING APPROVED STORMWATER METHODOLOGY
4	11/28/17	KAL	RE	DW	ADDRESS VADEQ COMMENTS
3	11/01/17	KAL	RE	DW	ADDRESS VADEQ COMMENTS

REVISIONS:

Mountain Valley PIPELINE

POST CONSTRUCTION (STORMWATER & RESTORATION) PLANS
MOUNTAIN VALLEY PIPELINE PROJECT – H600 LINE
SPREAD 8 – GILES COUNTY, VIRGINIA

MOUNTAIN VALLEY PIPELINE, LLC
555 SOUTHPOINTE BOULEVARD, SUITE 200
CANONSBURG, PA 15311

TETRA TECH
complex world | CLEAR SOLUTIONS™
661 ANDERSEN DRIVE
FOSTER PLAZA 7
PITTSBURGH, PA 15220

POST CONSTRUCTION (STORMWATER & RESTORATION) PLANS

COMMONWEALTH OF VIRGINIA
DAVID J. WALLNER
Lic. No. 0402057593
PROFESSIONAL ENGINEER

DRAWN BY:	KAL
CHECKED BY:	RE
APPROVED BY:	DW
DATE:	03/21/2018
SCALE:	AS SHOWN
REVISION	

NARRATIVE 2 OF 4

30101011001

Total Phosphorus Loading [lb/yr]					
Land Cover	A	B	C	D	Totals
Forest/Open Space (ROW)	0.066	11.14	0.251	0.248	11.705
Managed Turf	0	0	0	0	0
Ag Lands	N/A	N/A	N/A	N/A	N/A
Ex. Impervious Cover	N/A	N/A	N/A	N/A	N/A
New Impervious Cover	0	0.182	0	0	0.182
	0.066	11.322	0.251	0.248	11.887

30101050104

Total Phosphorus Loading [lb/yr]					
Land Cover	A	B	C	D	Totals
Forest/Open Space (ROW)	0	11.898	0	1.099	12.997
Managed Turf	0	0	0	0	0
Ag Lands	N/A	N/A	N/A	N/A	N/A
Ex. Impervious Cover	N/A	N/A	N/A	N/A	N/A
New Impervious Cover	0	6.542	0	0.098	6.639
	0	18.439	0	1.196	19.636

30101050201

Total Phosphorus Loading [lb/yr]					
Land Cover	A	B	C	D	Totals
Forest/Open Space (ROW)	0	2.247	0	0.001	2.248
Managed Turf	0	0	0	0	0
Ag Lands	N/A	N/A	N/A	N/A	N/A
Ex. Impervious Cover	N/A	N/A	N/A	N/A	N/A
New Impervious Cover	0	0.161	0	0	0.161
	0	2.408	0	0.001	2.409

30101050203

Total Phosphorus Loading [lb/yr]					
Land Cover	A	B	C	D	Totals
Forest/Open Space (ROW)	0	1.034	0	0	1.034
Managed Turf	0	0	0	0	0
Ag Lands	N/A	N/A	N/A	N/A	N/A
Ex. Impervious Cover	N/A	N/A	N/A	N/A	N/A
New Impervious Cover	0	0.726	0	0	0.726
	0	1.76	0	0	1.76

THIS FURTHER ANALYSIS SUPPORTED THE CONCLUSION THAT TOTAL PHOSPHORUS LOADING IS LESS THAN THE 0.41 LB TP/AC/YR MAXIMUM WITHIN EACH 6TH ORDER BOUNDARY.

Spread 11

6th Order HUC 12	Total Area [ac]	TP Load Area[1] [ac]	TP Load [lb TP/yr]	TP Load[2] [lb TP/ac/yr]
Total ROW	770.38	714.98	60.18	0.08
030101010503 ROW	74.19	69.00	5.31	0.08
030101010504 ROW	25.98	22.78	2.01	0.09
030101010601 ROW	141.74	128.07	9.37	0.07
030101010804 ROW	117.33	105.90	7.81	0.07
030101011001 ROW	178.98	164.72	11.89	0.07
030101050104 ROW	182.65	178.30	19.64	0.11
030101050201 ROW	33.99	31.46	2.41	0.08
030101050203 ROW	15.52	14.76	1.76	0.12

[1] Area contributing to loading including: Forest/Open Space (ROW), Managed Turf, and New Impervious Cover.
[2]Cannot exceed 0.41 lb TP/ac/yr, or other reduction measures are required.

E. WATER QUANTITY

i. NO NEW IMPERVIOUS COVER

FOR PORTIONS OF SPREAD 11 CONSISTING OF EITHER PRIOR DEVELOPED AREAS (AGRICULTURAL AREAS AND EXISTING ACCESS ROADS) 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.

ii. NEW IMPERVIOUS COVER: ACCESS ROADS

NEW IMPERVIOUS COVER IN SPREAD 11 INCLUDES SIX (6) ACCESS ROADS (MVP-MLV-AR-31 THROUGH -35, AND PI-343). INCREASED VOLUMES OF STORMWATER RUNOFF RESULTING FROM ACCESS ROADS WILL BE CONTROLLED UTILIZING THE METHODOLOGY ESTABLISHED IN *MVP-33.1 THROUGH MVP-33.3 GAP GRADED GRAVEL DETAIL FOR MAINLINE VALVE PADS AND PERMANENT ACCESS ROADS.*

EACH ACCESS ROAD CONSISTS OF A GEOGRID, UNDERLAIN BY A 2-INCH LAYER OF CLEAN-WASHED CHOKER STONE, GEOTEXTILE FABRIC, AN OPEN-GRADED SUBBASE RESERVOIR, AND COMPACTED EARTHEN BAFFLES TO DETAIN WATER WITHIN THE ACCESS ROAD. THE ACCESS ROAD SURFACE WILL CONSIST OF TWO GRAVEL TRACKS, WITH A CENTER AISLE TOP-DRESSED WITH SOIL AND SEEDED WITH A MEADOW SEED MIX PER *MVP-ES11.2 UPLAND MEADOW SEED MIX AND APPLICATION RATES* OR *MVP-ES11.3 UPLAND STEEP SLOPE SEED MIX AND APPLICATION RATES.*

PRE- AND POST-CONSTRUCTION RUNOFF VOLUMES FOR THE 10-YEAR 24-HOUR STORM WERE CALCULATED USING THE FRANKLIN AND PITTSYLVANIA COUNTY DESIGN STORM VALUES OF 5.70 AND 5.20 INCHES, RESPECTIVELY, PER *PSS&S SECTION 4.2.2 DESIGN STORMS.* RUNOFF VOLUMES WERE CALCULATED FOR BOTH THE DRAINAGE AREA TO EACH GAP GRADED GRAVEL ACCESS ROAD AND FOR THE ACCESS ROAD FOOTPRINT ALONE. RESULTS ARE SHOWN BELOW.

10-YEAR STORM DATA FULL RUN-ON DRAINAGE AREA					
SITE	TIME OF CONCENTRATION (PRE / POST) [HR]	CURVE NUMBER (PRE / POST)	DRAINAGE AREA [FT^2]	Q_{10} PEAK FLOW (PRE / POST) [CFS]	Q_{10} VOLUME (PRE / POST) [FT^3]
MLV-AR-31	0.13 / 0.10	60 / 66	5,061	0.28 / 0.39	726 / 933
MLV-AR-32	0.13 / 0.13	62 / 63	71,529	4.32 / 4.52	11,227 / 11,712
MLV-AR-33	0.21 / 0.21	55 / 58	7,621	0.28 / 0.34	853 / 995
MLV-AR-34	0.10 / 0.10	64 / 72	2,185	0.13 / 0.18	310 / 426
MLV-AR-35	0.36 / 0.25	62 / 67	2,323	0.08 / 0.12	299 / 372
PI-343	0.32 / 0.31	56 / 63	86,795	2.15 / 3.45	8,234 / 11,772

10-YEAR STORM DATA ACCESS ROAD FOOTPRINT					
SITE	TIME OF CONCENTRATION (PRE / POST) [HR]	CURVE NUMBER (PRE / POST)	DRAINAGE AREA [FT^2]	Q_{10} PEAK FLOW (PRE / POST) [CFS]	Q_{10} VOLUME (PRE / POST) [FT^3]
MLV-AR-31	0.10 / 0.10	58 / 78	1,498	0.08 / 0.17	194 / 409
MLV-AR-32	0.10 / 0.10	58 / 78	3,441	0.18 / 0.40	456 / 961
MLV-AR-33	0.10 / 0.10	57 / 78	1,410	0.07 / 0.16	174 / 385
MLV-AR-34	0.10 / 0.10	56 / 79	915	0.03 / 0.10	87 / 218
MLV-AR-35	0.10 / 0.10	55 / 78	523	0.02 / 0.05	48 / 122
PI-343	0.10 / 0.10	56 / 79	12,840	0.92 / 2.67	2,439 / 6,360

INCREASES IN RUN-OFF VOLUMES FOR BOTH THE DRAINAGE AREA AND ACCESS ROAD ONLY ARE FURTHER SUMMARIZED BELOW.

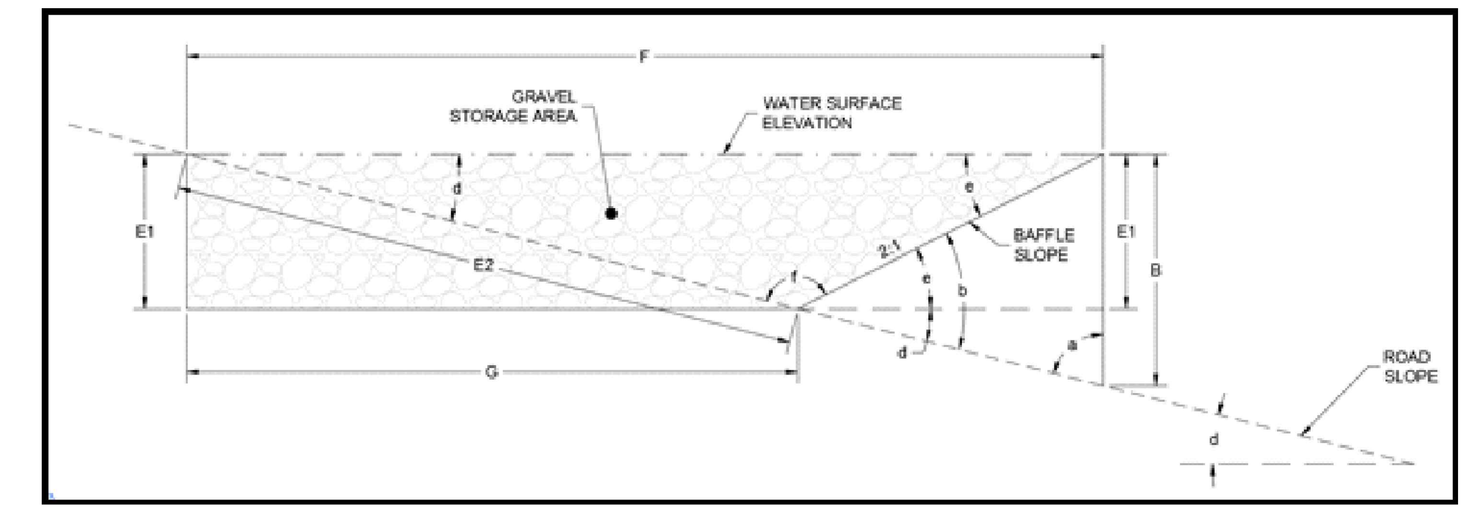
		Peak Flow (cfs)	Hydrograph Volume (ac-ft)	Hydrograph Volume (ft^3)	Required Treatment Volume (ft^3)
MLV-AR-31 FULL DA	Pre	0.28	0.01667	726	207
	Post	0.39	0.02142	933	
MLV-AR-31 AR ONLY	Pre	0.08	0.00445	194	215
	Post	0.17	0.00939	409	
MLV-AR-32 FULL DA	Pre	4.32	0.25774	11227	485
	Post	4.52	0.26887	11712	
MLV-AR-32 AR ONLY	Pre	0.18	0.01047	456	505
	Post	0.4	0.02206	961	
MLV-AR-33 FULL DA	Pre	0.28	0.01958	853	142
	Post	0.34	0.02284	995	
MLV-AR-33 AR ONLY	Pre	0.07	0.00399	174	211
	Post	0.16	0.00884	385	
MLV-AR-34 FULL DA	Pre	0.13	0.00712	310	116
	Post	0.18	0.00978	426	
MLV-AR-34 AR ONLY	Pre	0.03	0.002	87	131
	Post	0.1	0.005	218	
MLV-AR-35 FULL DA	Pre	0.08	0.00686	299	73
	Post	0.12	0.00854	372	
MLV-AR-35 AR ONLY	Pre	0.02	0.0011	48	74
	Post	0.05	0.0028	122	
MVP-PI-343 FULL DA	Pre	2.15	0.18903	8234	3538
	Post	3.45	0.27025	11772	
MVP-PI-343 AR ONLY	Pre	0.92	0.056	2439	3920
	Post	2.67	0.146	6360	

THE RUNOFF VOLUME INCREASE WHEN CONSIDERING ONLY THE ACCESS ROAD IS GREATER THAN THE RESULTING RUNOFF VOLUME INCREASE WHEN CONSIDERING THE FULL DRAINAGE AREA. AS A RESULT, THE RESERVOIR WITHIN THE ACCESS ROAD IS CONSERVATIVELY SIZED TO ACCOMMODATE THE REQUIRED VOLUME COMPUTED USING THE ROAD FOOTPRINT ONLY. ANY INCREASE IN RUNOFF VOLUME FROM PRE- TO POST-CONSTRUCTION CONDITION MUST BE STORED WITHIN THE GAP GRADED GRAVEL TO MEET FLOOD PROTECTION REQUIREMENTS PER 9VAC25-870-66.C.2.

A SITE-SPECIFIC ANALYSIS WAS PERFORMED FOR ALL ACCESS ROADS TO DETERMINE THE NUMBER OF EARTHEN BAFFLES, EARTHEN BAFFLE SPACING AND SUBBASE RESERVOIR DEPTH REQUIRED TO DETAIN THE INCREASED VOLUME FROM THE 10-YEAR STORM, AND ALLOW THE EXCESS STORMWATER TO INFILTRATE INTO THE UNDERLYING SOIL. DETAILS OF THE ANALYSIS ARE PROVIDED BELOW.

Site	Road Length (ft)	Road Slope (ft/ft)	# of Baffles	Baffle Spacing (ft)	Baffle Height (ft)
MVP-MLV-AR-31	125	0.100	6	20	1
MVP-MLV-AR-32	10	0.038	0	0	0
	30	0.069	1	30	1.5
	31	0.022	1	31	0.5
	27	0.023	1	27	0.5
	27	0.004	0	0	0
	21	0.031	1	21	0.5
	15	0.040	1	15	0.5
	75	0.026	1	75	1
	53	0.014	1	53	0.5
MVP-MLV-AR-33	33	0.012	1	32	0.25
	38	0.032	2	18	1
	27	0.008	0	0	0
	14	0.038	1	14	0.25
MVP-MLV-AR-34	6	0.028	0	0	0
	35	0.055	2	17	0.75
	36	0.075	2	18	1
MVP-MLV-AR-35	8	0.007	0	0	0
	33	0.019	1	33	1
MVP-PI-343	90	0.002	0	0	0
	437	0.05	10	43	1
	416	0.009	3	138	1
	270	0.052	5	54	1
	228	0.026	1	228	1
	75	0.187	1	75	1
	51	0.12	1	51	1
	75	0.046	1	75	1
	200	0.013	1	200	1
	186	0.045	1	186	1
	103	0.0098	1	103	1

BECAUSE THE SLOPES OF THE ACCESS ROADS VARY SIGNIFICANTLY, STORAGE CALCULATIONS WERE PERFORMED FOR EACH, USING THE FOLLOWING METHODOLOGY:



1. DETERMINE THE CROSS-SECTION AREA (CSA) OF STORAGE BEHIND EACH BAFFLE, ASSUMING A TRIANGLE BASED ON BOTTOM SLOPE.

CSA = 0.5 X A X F X SIN(E) + 0.5 X E1 X E2 X SIN(A)
WHERE CSA = CROSS-SECTIONAL AREA; FT2

$a = 90 - \tan^{-1}$(road slope)	A = B x (sin(a)/sin(b))
$b = \tan^{-1}$(road slope) + $\tan^{-1}$(baffle slope)	B = baffle height
$d = \tan^{-1}$(road slope)	E1 = A x sin(e)
$e = \tan^{-1}$(baffle slope)	E2 = A x (sin(e)/sin(d))
f = 180 - b	F = A x (sin(f)/sin(d))
	G = F - E1/baffle slope

2. DETERMINE THE STORAGE VOLUME AVAILABLE PER EARTHEN BAFFLE.

VAVAILABLE = CSA X W X N

where Vavailable = Storage volume per earthen baffle; ft^3
W = Stone width (12 ft)
n = Stone porosity (0.40)

3. DETERMINE THE NUMBER OF BAFFLE CELLS NEEDED BY DIVIDING THE STORAGE VOLUME PER EARTHEN BAFFLE INTO THE REQUIRED TREATMENT VOLUME. BECAUSE IT IS NECESSARY TO ROUND UP TO THE NEXT INTEGER, THE BAFFLE DESIGN VOLUME WILL ALWAYS EXCEED THE REQUIRED TREATMENT VOLUME.

4. DETERMINE THE BAFFLE CELL SPACING BY DIVIDING THE NUMBER OF BAFFLES NEEDED INTO THE ACCESS ROAD LENGTH.

TO ENSURE THE ROADS DRAIN WITH THE 72-HOUR MAXIMUM DRAWDOWN TIME, THE DESIGN VOLUMES WERE DIVIDED BY THE MOST CONSERVATIVE SATURATED HYDRAULIC CONDUCTIVITY (KSAT) OF THE UNDERLYING SOILS. EACH CALCULATED DRAWDOWN TIME USED THE MAXIMUM DEPTH OF EACH TRIANGULAR CSA AND WAS MULTIPLIED BY A SAFETY FACTOR OF 2, RESULTING IN THE FOLLOWING DRAWDOWN TIMES (ALL LESS THAN THE 72-HOUR MAXIMUM). NOTE THAT SEVERAL ACCESS ROADS SPAN MORE THAN ONE DIFFERENT SOIL TYPES WITH DIFFERENT KSAT RATES.

MVP-MLV-AR-31		
MUSYM	7C	[-]
HSG	B	[-]
K_{SAT}	1.28	[IN/HR]
Max Depth	0.83	[FT]
Drawdown Time	16	[HR]

MVP-MLV-AR-32		
MUSYM	11A	[-]
HSG	B	[-]
K_{SAT}	1.30	[IN/HR]
Max Depth	1.32	[FT]
Drawdown Time	24	[HR]
MUSYM	11A	[-]
HSG	B	[-]
K_{SAT}	1.30	[IN/HR]
Max Depth	1.32	[FT]
Drawdown Time	24	[HR]
MUSYM	11A	[-]
HSG	B	[-]
K_{SAT}	1.30	[IN/HR]
Max Depth	1.32	[FT]
Drawdown Time	24	[HR]
MUSYM	11A	[-]
HSG	B	[-]
K_{SAT}	1.30	[IN/HR]
Max Depth	1.32	[FT]
Drawdown Time	24	[HR]

MVP-MLV-AR-33		
MUSYM	27C	[-]
HSG	B	[-]
K_{SAT}	1.28	[IN/HR]
Max Depth	0.94	[FT]
Drawdown Time	18	[HR]
MUSYM	27C	[-]
HSG	B	[-]
K_{SAT}	1.28	[IN/HR]
Max Depth	0.94	[FT]
Drawdown Time	18	[HR]
MUSYM	27C	[-]
HSG	B	[-]
K_{SAT}	1.28	[IN/HR]
Max Depth	0.94	[FT]
Drawdown Time	18	[HR]

MVP-MLV-AR-34		
MUSYM	5B3	[-]
HSG	B	[-]
K_{SAT}	1.78	[IN/HR]
Max Depth	0.87	[FT]
Drawdown Time	12	[HR]
MUSYM	5B3	[-]
HSG	B	[-]
K_{SAT}	1.78	[IN/HR]
Max Depth	0.87	[FT]
Drawdown Time	12	[HR]
MUSYM	5B3	[-]
HSG	B	[-]
K_{SAT}	1.78	[IN/HR]
Max Depth	0.87	[FT]
Drawdown Time	12	[HR]

MVP-MLV-AR-35		
MUSYM	4B	[-]
HSG	B	[-]
K_{SAT}	1.47	[IN/HR]
Max Depth	0.72	[FT]
Drawdown Time	12	[HR]

MVP-PI-343		
MUSYM	23B	[-]
HSG	B	[-]
K_{SAT}	2.44	[IN/HR]
Max Depth	0.98	[FT]
Drawdown Time	10	[HR]
MUSYM	23C	[-]
HSG	B	[-]
K_{SAT}	2.44	[IN/HR]
Max Depth	0.98	[FT]
Drawdown Time	10	[HR]
MUSYM	9B	[-]
HSG	D	[-]
K_{SAT}	0.63	[IN/HR]
Max Depth	0.95	[FT]
Drawdown Time	36	[HR]

iii. NEW IMPERVIOUS COVER: MAIN LINE VALVE PADS

NEW IMPERVIOUS COVER IN SPREAD 11 ALSO INCLUDES FIVE (5) MAIN LINE VALVE SITES (MVP-MLV-31 THROUGH -35). INCREASED VOLUMES OF STORMWATER RUNOFF RESULTING FROM THE MAIN LINE VALVE PADS WILL BE CONTROLLED UTILIZING THE METHODOLOGY ESTABLISHED IN *MVP-33.1 THROUGH MVP-33.3 GAP GRADED GRAVEL DETAIL FOR MAINLINE VALVE PADS AND PERMANENT ACCESS ROADS.* ALL PADS WILL BE LOCATED ON RELATIVELY FLAT GROUND. THE RUNOFF VOLUME INCREASE WHEN CONSIDERING ONLY THE PAD IS GREATER THAN THE RESULTING RUNOFF VOLUME INCREASE WHEN CONSIDERING THE FULL DRAINAGE AREA. AS A RESULT, THE RESERVOIR WITHIN THE GAP GRADED GRAVEL PAD IS CONSERVATIVELY SIZED TO ACCOMMODATE THE REQUIRED VOLUME COMPUTED USING THE PAD FOOTPRINT ONLY.

NO.:	DATE:	DWN.:	CHKD.:	APPD.:	DESCRIPTION:
8	03/21/18	KAL	RE	DW	ADDRESS VADEQ COMMENTS
7	03/16/18	KAL	RE	DW	ADDRESS VADEQ COMMENTS
6	02/16/18	KAL	RE	DW	RESUBMISSION USING APPROVED STORMWATER METHODOLOGY
5	02/05/18	KAL	RE	DW	RESUBMISSION USING APPROVED STORMWATER METHODOLOGY
4	11/28/17	KAL	RE	DW	ADDRESS VADEQ COMMENTS
3	11/01/17	KAL	RE	DW	ADDRESS VADEQ COMMENTS

REVISIONS:

POST CONSTRUCTION (STORMWATER & RESTORATION) PLANS
MOUNTAIN VALLEY PIPELINE PROJECT – H600 LINE
SPREAD 8 – GILES COUNTY, VIRGINIA

Mountain Valley PIPELINE

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POST CONSTRUCTION (STORMWATER & RESTORATION) PLANS

COMMONWEALTH OF VIRGINIA
DAVID J. WALLNER
Lic. No. 0402057593
PROFESSIONAL ENGINEER

DRAWN BY: KAL
CHECKED BY: RE
APPROVED BY: DW
DATE: 03/21/2018
SCALE: AS SHOWN
REVISION
NARRATIVE 3 OF 4

PRE- AND POST-CONSTRUCTION RUNOFF VOLUMES FOR THE 10-YEAR 24-HOUR STORM WERE CALCULATED USING THE FRANKLIN AND PITTSYLVANIA COUNTY DESIGN STORM VALUES OF 5.70 AND 5.20 INCHES RESPECTIVELY, PER *PSS&S SECTION 4.2.2 DESIGN STORMS*.

10-YEAR STORM DATA					
SITE	TIME OF CONCENTRATION (PRE / POST) [HR]	CURVE NUMBER (PRE / POST)	DRAINAGE AREA [FT²]	Q_{10} PEAK FLOW (PRE / POST) [CFS]	Q_{10} VOLUME (PRE / POST) [FT³]
MLV-31	0.10 / 0.10	58 / 85	2,396	0.12 / 0.33	305 / 784
MLV-32	0.10 / 0.10	58 / 85	2,396	0.12 / 0.33	305 / 784
MLV-33	0.10 / 0.10	55 / 85	2,396	0.10 / 0.33	261 / 784
MLV-34	0.10 / 0.10	58 / 85	2,396	0.10 / 0.29	261 / 697
MLV-35	0.10 / 0.10	55 / 85	2,396	0.08 / 0.29	218 / 697

ANY INCREASE IN RUNOFF VOLUME FROM PRE- TO POST-CONSTRUCTION CONDITION MUST BE STORED WITHIN THE GAP GRADED GRAVEL TO MEET FLOOD PROTECTION REQUIREMENTS PER 9VAC25-870-66.C.2. THE CALCULATED TREATMENT VOLUME REQUIRED WAS THEN DIVIDED BY THE PAD FOOTPRINT AND 40% VOID SPACE TO DETERMINE THE DEPTH OF GRAVEL REQUIRED TO STORE THE 10-YEAR 24-HOUR STORM EVENT. IN THIS INSTANCE, CALCULATED GRAVEL DEPTHS FOR ALL PADS WERE LESS THAN THE 8-INCH MINIMUM REQUIRED PER *MVP-33.1 THROUGH MVP-33.3 GAP GRADED GRAVEL DETAIL FOR MAINLINE VALVE PADS AND PERMANENT ACCESS ROADS*. THEREFORE, GRAVEL DEPTHS FOR ALL PADS ARE 8 INCHES, PROVIDING STORAGE BEYOND THE 10-YEAR 24-HOUR STORM EVENT.

MLV-31 Pad	Vreq	479	cf
	Area	2376	sf
	Dreq	0.50	ft
	Ddesign	8	in
	Vdesign	634	cf

MLV-32 Pad	Vreq	479	cf
	Area	2376	sf
	Dreq	0.50	ft
	Ddesign	8	in
	Vdesign	634	cf

MLV-33 Pad	Vreq	523	cf
	Area	2376	sf
	Dreq	0.55	ft
	Ddesign	8	in
	Vdesign	634	cf

MLV-34 Pad	Vreq	436	cf
	Area	2376	sf
	Dreq	0.46	ft
	Ddesign	8	in
	Vdesign	634	cf

MLV-35 Pad	Vreq	479	cf
	Area	2376	sf
	Dreq	0.50	ft
	Ddesign	8	in
	Vdesign	634	cf

TO ENSURE THE GRAVEL PADS DRAIN WITH THE 72-HOUR MAXIMUM DRAWDOWN TIME, THE DESIGN VOLUMES WERE DIVIDED BY THE MOST CONSERVATIVE SATURATED HYDRAULIC CONDUCTIVITY (KSAT) OF THE UNDERLYING SOILS. EACH CALCULATED DRAWDOWN TIME WAS MULTIPLIED BY A SAFETY FACTOR OF 2, RESULTING IN THE FOLLOWING DRAWDOWN TIMES, ALL LESS THAN THE 72-HOUR MAXIMUM.

MVP-MLV-31		
MUSYM	7C	[-]
HSG	B	[-]
K_{SAT}	1.28	[IN/HR]
Depth	8	[IN]
Drawdown Time	13	[HR]

MVP-MLV-32		
MUSYM	11A	[-]
HSG	B	[-]
K_{SAT}	1.30	[IN/HR]
Depth	8	[IN]
Drawdown Time	12	[HR]

MVP-MLV-33		
MUSYM	27C	[-]
HSG	B	[-]
K_{SAT}	1.28	[IN/HR]
Depth	8	[IN]
Drawdown Time	13	[HR]

MVP-MLV-34		
MUSYM	593	[-]
HSG	B	[-]
K_{SAT}	1.78	[IN/HR]
Depth	8	[IN]
Drawdown Time	9	[HR]

MVP-MLV-35		
MUSYM	48	[-]
HSG	B	[-]
K_{SAT}	1.47	[IN/HR]
Depth	8	[IN]
Drawdown Time	11	[HR]

RESULTS SHOW THE 10-YEAR 24-HOUR STORM EVENT WILL BE STORED WITHIN THE GRAVEL LAYER WITH NO OVERTOPPING, AND WITH REASONABLE DRAWDOWN TIMES BEFORE THE NEXT STORM EVENT.

F. SHEET FLOW PROTECTION

THIS ANALYSIS INCLUDES A DRAINAGE AREA DELINEATION FOR EACH WATER BAR WITHIN SPREAD 11, EXCLUDING THOSE IN SERIES AND PERPENDICULAR TO SLOPE. 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*.

SPREAD 11 CONTAINS FOUR (4) 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)	Calculated End Treatment Length (ft)	Proposed End Treatment Length (ft)
1	1.68	29	10	20
19.1	1.66	24	11	20
23	2.84	22	20	20
25	1.81	20	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 THE *SPREAD 11 WATER QUANTITY EXHIBITS* AND *SPREAD 11 WATER QUANTITY CALCULATIONS* FOR MORE INFORMATION.

SPREAD 11 CONTAINS TWENTY-FOUR (24) WATER BARS WITH CURVE NUMBERS GREATER THAN 71. SITE-SPECIFIC CALCULATIONS FOR THESE WATER BARS WERE COMPLETED WITH THE FOLLOWING RESULTS:

Water Bar	Drainage Area (ac)	*Tc (min)	Calculated End Treatment Length (ft)	Proposed End Treatment Length (ft)
2	0.51	14	9	15
3	0.2	5	4	10
4	0.03	5	1	10
5	0.51	16	5	15
6	0.17	5	2	10
9	1.37	18	19	20
10	1.13	15	13	20
11	0.74	13	8	15
13	0.63	16	7	15
14	0.31	5	4	10
15	0.14	5	2	10
16	0.13	5	2	10
17	0.38	5	10	10
18	0.59	21	5	15
19	0.93	16	10	15
20	1.09	14	12	20
21	0.3	5	5	10
22	0.08	5	1	10
24	0.09	5	1	10
26	0.16	5	3	10
27	0.55	18	5	15
28	0.05	5	1	10
29	0.28	5	4	10
30	0.1	5	2	10

*A MINIMUM TIME OF CONCENTRATION OF 5 MINUTES WAS ASSUMED FOR WATER BAR DRAINAGE AREAS LESS THAN OR EQUAL TO 0.5 ACRES.

SEE THE *SPREAD 11 WATER QUANTITY EXHIBITS* AND *SPREAD 11 WATER QUANTITY CALCULATIONS* FOR MORE INFORMATION.

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COMMONWEALTH OF VIRGINIA
DAVID J. WALLNER
Lic. No. 0402057593
PROFESSIONAL ENGINEER

DRAWN BY:	KAL
CHECKED BY:	RE
APPROVED BY:	DW
DATE:	03/21/2018
SCALE:	AS SHOWN
REVISION	
NARRATIVE	4 OF 4