COMMONWEALTH of VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY

Street address: 1111 E. Main Street, Suite 1400, Richmond, Virginia 23219
Mailing address: P.O. Box 1105, Richmond, Virginia 23218
www.deq.virginia.gov

Matthew J. Strickler
Secretary of Natural Resources

David K. Paylor
Director

September 27, 2018

Mr. Brian Clauto
Senior Environmental Coordinator
EQT Corporation
555 Southpointe Blvd, Suite 200
Canonsburg, PA 15317

Transmitted electronically to: BClauto@eqt.com

Re: Mountain Valley Pipeline LLC
Project Location: MVP Earth Oven (Pipeline Right-of-way Reroutes)
DEQ SWM #: MVP-18-08
Erosion and Sediment Control (ESC) and Stormwater Management (SWM) Plans

Dear Mr. Clauto:

The Department of Environmental Quality (DEQ) received combined Stormwater Management and Erosion & Sediment Control Plans for supportive ancillary areas identified as MVP Earth Oven on September 14, 2018.

The plans received Earth Oven September 14, 2018 are found to be in accordance with the *Virginia Stormwater Management Act and Regulations* and the *Virginia Erosion and Sediment Control Law and Regulations* and are approved. This approval authorizes MVP to begin land disturbing activities consistent with these plans. **No modifications, updates or additions may be made to the approved Plans without obtaining prior approval from DEQ. Additionally, approval of the ESC and SWM Plans does not relieve the owner and/or operator of complying with all other federal, state, or local laws and regulations.**

As provided by Rule 2A:2 of the Supreme Court of Virginia, you have thirty (30) days from the date you received this decision within which to appeal this decision by filing a notice of appeal in accordance with the Rules of the Supreme Court of Virginia with the Director, Virginia Department of Environmental Quality.

It is the responsibility of the owner and/or operator to ensure that the project is constructed in accordance with the approved Plans and accompanying specifications. Upon completion of the project, the owner and/or operator will be required to submit construction record drawings for all permanent stormwater management facilities (i.e., post-development best management practices) constructed in accordance with the approved Plans.

Please contact Mr. Benjamin Leach at 804-698-4037 or Benjamin.leach@deq.virginia.gov if you have any questions about this letter.

Sincerely,

Jaime B. Robb

Jaime B. Robb, Manager
Office of Stormwater Management

Cc: Benjamin Leach, DEQ-CO
Jerome Brooks, Water Compliance Manager

Enclosure

September 14, 2018

Commonwealth of Virginia
Department of Environmental Quality
ATTN: Benjamin Leach
629 East Main Street
Richmond, Virginia 23218

Re: Spread 10 Modifications –Pipeline Re-Route from STA 13068+46 to 13117+12, Relocation of Mainline Valve No. 29 (MLV-29) Site and Access Road, and Other Changes to Associated Access Roads and Additional Temporary Work Spaces (ATWS)

Dear Mr. Leach:

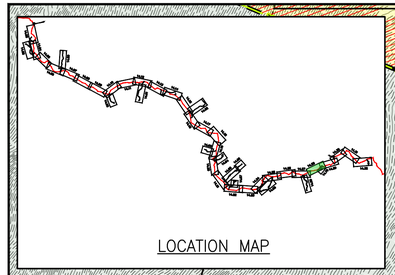
Mountain Valley Pipeline, LLC (MVP) plans to re-route the pipeline alignment from STA 13068+46 to 13117+12. Additionally, MVP-MLV-29 will be relocated to be in compliance with PHMSA required mainline valve spacing, and access road MVP-FR-292.01 has been renamed as MVP-MLV-AR-29.01 and redesignated as permanent to allow permanent access to the valve site; access road MVP-MLV-AR-29 has been renamed as MVP-FR-292.01A and redesignated as temporary. Other changes include the addition of MVP-ATWS-1483 and adjustment of MVP-ATWS-1482 due to the pipeline re-route. These changes are modifications to what was proposed per the Spread 10 Erosion and Sediment Control (ESC) and Stormwater Management (SWM) Plans that were submitted and approved on March 26, 2018. Therefore, the following deliverables are being submitted to the Commonwealth of Virginia (Commonwealth), Department of Environmental Quality (DEQ) for review and approval:

1. Spread 10 ESC Plans – Sheets No. 14.28ES, 14.29ES, and 14.30ES
2. Calculations supporting the sizing of the proposed temporary culvert shown on Sheet 14.30ES
3. Calculations supporting the sizing of the proposed riprap apron shown on Sheet 14.30ES
4. Spread 10 Clean Water Diversion Pipe Drainage Area Maps – Figure 6 of 11
5. Spread 10 PC Plans – Sheets No. 14.28PC, 14.29PC, and 14.30PC
6. Spread 10 General Details – Sheet No. 0.09
7. Spread 10 Drainage Maps (i.e., Spread 10 Water Quantity Exhibits) – Figures 26, 27, and 28 of 55
8. Spread 10 Water Quantity Calculations for New Impervious Cover
9. Spread 10 New Impervious Cover Stormwater Drainage Exhibits – Figure 007

Note that a complete list of waterbar end treatment and MLV Site coordinate locations, as well as updated Water Quality Exhibits/Calculations and ESC/SWM Narratives (if required), will be provided by spread after all modifications have been submitted and approved by the DEQ. MVP looks forward to continuing to work with the DEQ regarding this Project. Please feel free to contact me if you have questions or need any additional information.

Sincerely,

Brian M. Clauto
Senior Environmental Coordinator
EQT Corporation
724-873-3465
bclauto@eqt.com



PLAN

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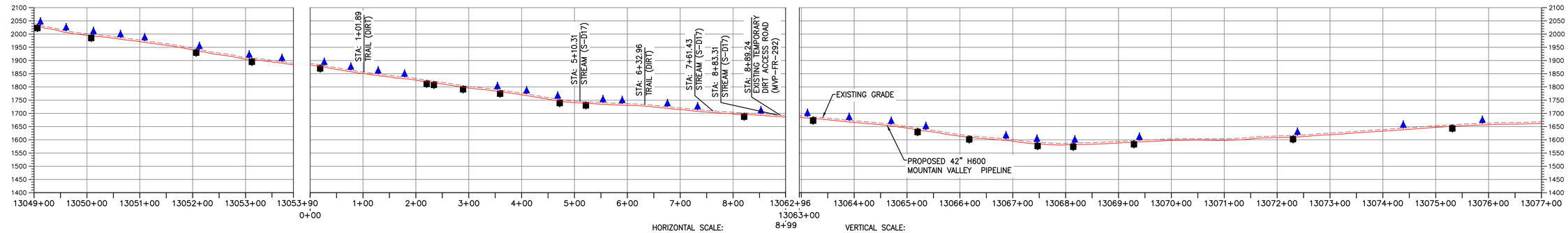

PROFILE

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VERTICAL SCALE: SCALE: 1" = 200'

LEGEND

- PROPOSED LIMIT OF DISTURBANCE
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NOTES:

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3. CONTRACTOR IS RESPONSIBLE TO IDENTIFY ALL UTILITIES. THE UTILITY LINES SHOWN ON THE PLAN ARE FOR INFORMATIONAL PURPOSES ONLY AND DO NOT REPRESENT SURVEYED LINE INFORMATION.
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REVISIONS:

Mountain Valley PIPELINE

EROSION AND SEDIMENT CONTROL PLANS

MOUNTAIN VALLEY PIPELINE PROJECT – H600 LINE

SPREAD 10 – FRANKLIN COUNTY, VIRGINIA

MOUNTAIN VALLEY PIPELINE, LLC
2200 ENERGY DRIVE
CANONSBURG, PA 15317

TETRA TECH
complex world | CLEAR SOLUTIONS™
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PITTSBURGH, PA 15220

EROSION AND SEDIMENT CONTROL PLANS

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

DRAWN BY:	JJZ
CHECKED BY:	RE
APPROVED BY:	DW
DATE:	08/03/2018
SCALE:	AS SHOWN
REVISION	8
SHT. NO.	14.28ES OF 14.81ES

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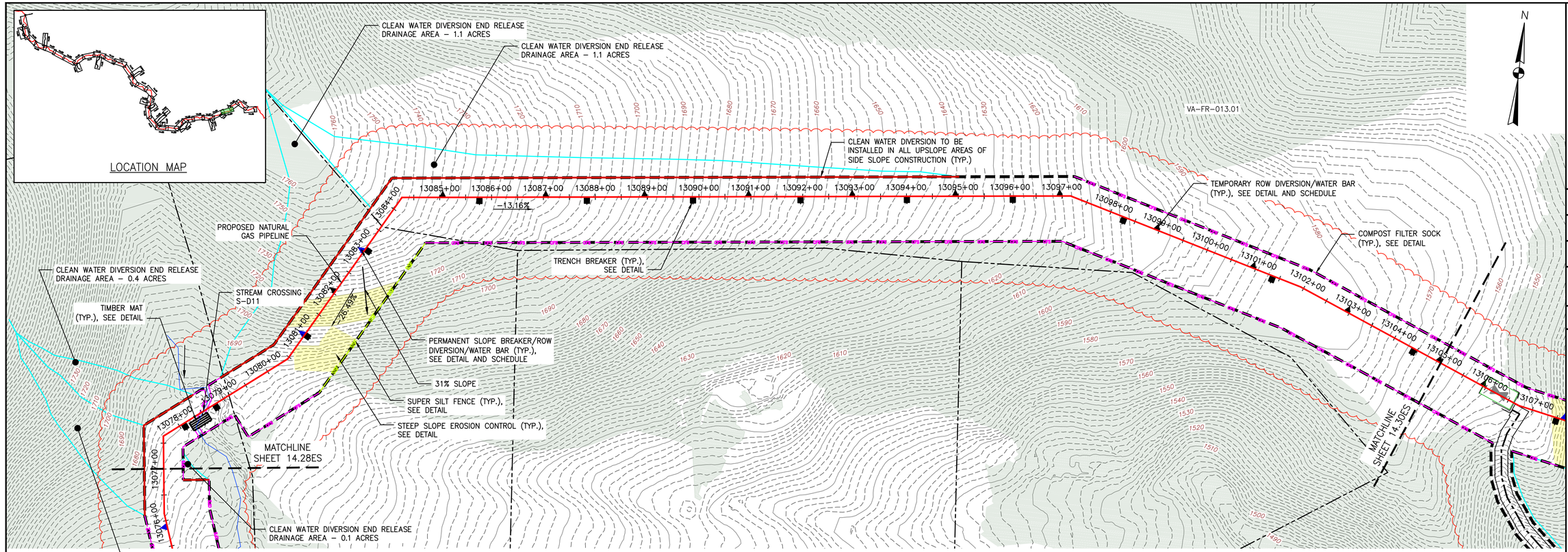

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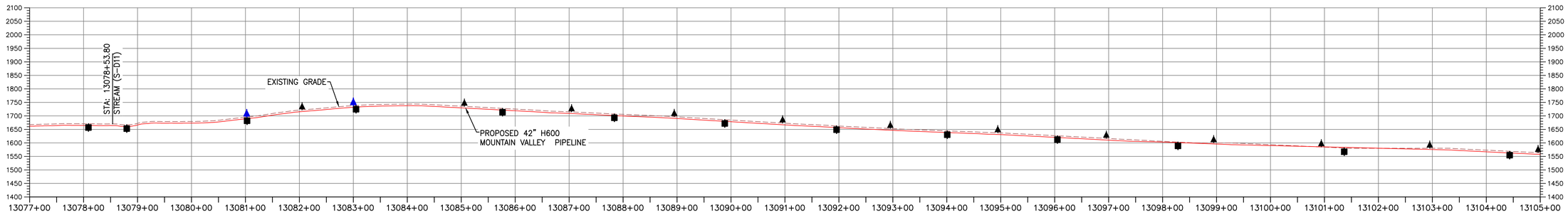

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DAVID J. WALLNER
Lic. No. 0402057593
PROFESSIONAL ENGINEER

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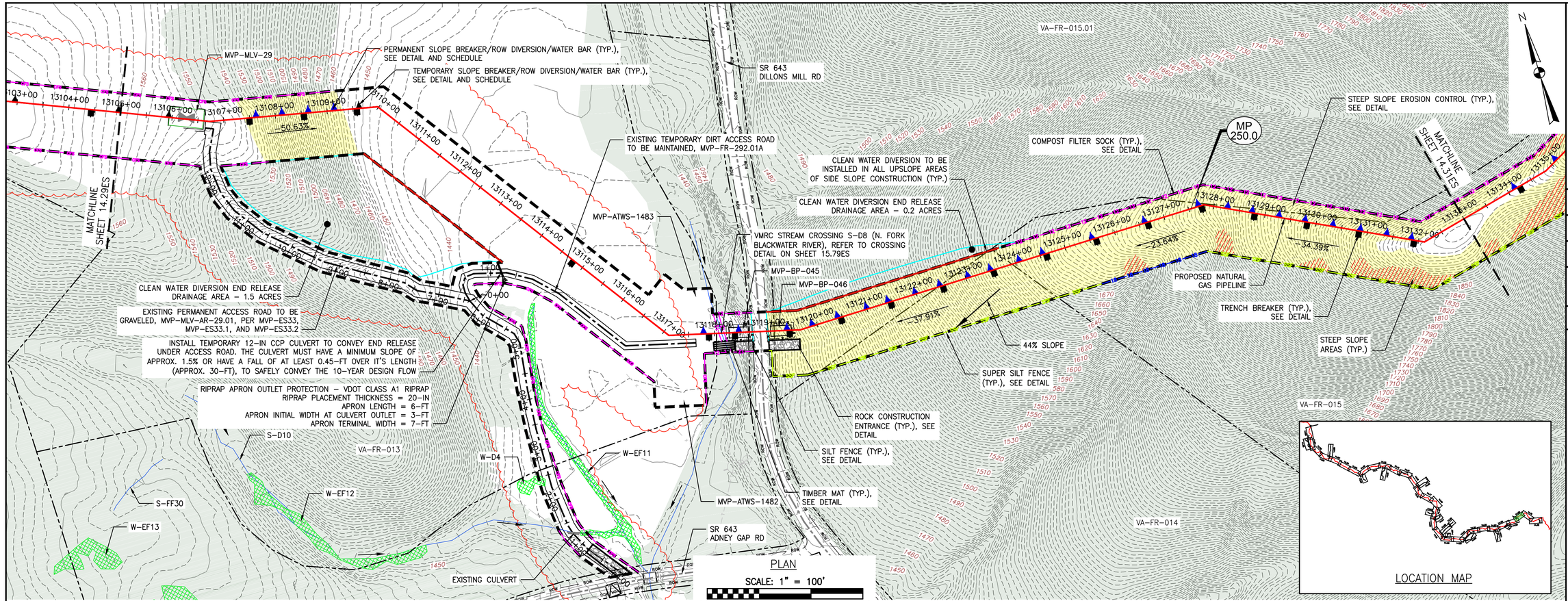
SHT. NO. 14.29ES OF 14.81ES



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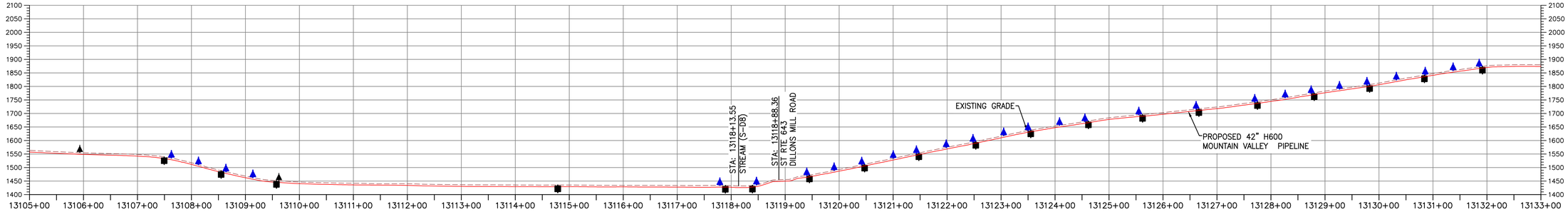

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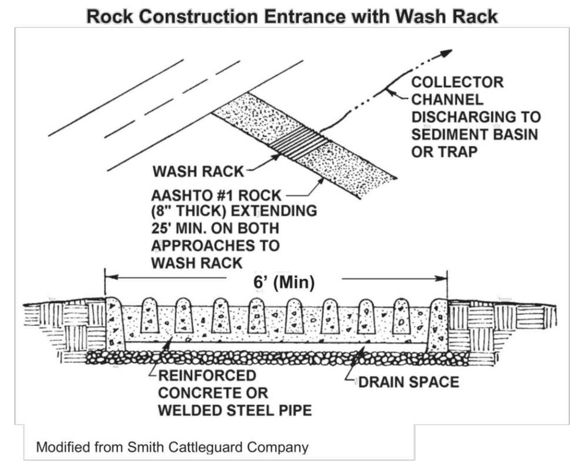
Rock Construction Entrance with Wash Rack



Modified from Smith Cattleguard Company

IF EXCESSIVE AMOUNTS OF SEDIMENT ARE BEING DEPOSITED ON ROADWAY, EXTEND LENGTH OF ROCK CONSTRUCTION ENTRANCE BY 70 FOOT INCREMENTS UNTIL CONDITION IS ALLEVIATED OR INSTALL WASH RACK.

Wash rack shall be 20 feet (min.) wide or total width of access.

Wash rack shall be designed and constructed to accommodate anticipated construction vehicular traffic.

A water supply shall be made available to wash the wheels of all vehicles exiting the site.

MAINTENANCE: Rock construction entrance thickness shall be constantly maintained to the specified dimensions by adding rock. A stockpile of rock material shall be maintained on site for this purpose. Drain space under wash rack shall be kept open at all times. Damage to the wash rack shall be repaired prior to further use of the rack. All sediment deposited on roadways shall be removed and returned to the construction site immediately. Washing the roadway or sweeping the deposits into roadway ditches, sewers, culverts, or other drainage courses is not acceptable.

A metal wash rack or livestock grate is an acceptable alternative to the reinforced concrete one shown in the standard detail. Approaches to the wash rack should be lined with aashto #1 at a minimum of 25' on both sides. The wash rack should discharge to a sediment removal facility, such as a vegetated filter strip or into a channel leading to a sediment removal device (e.g. a sediment trap or sediment basin). Rock construction entrances with wash racks should be maintained to the specified dimensions by adding rock when necessary at the end of each workday. A stockpile of rock material should be maintained on site for this purpose. Sediment deposited on paved roadways should be removed and returned to the construction site.

NOTE: Washing the roadway or sweeping the deposits into roadway ditches, sewers, culverts, or other drainage courses is not acceptable. Damaged wash racks should be repaired as necessary to maintain their effectiveness. In lieu of washrack installation, MVP will extend the RCE by 70' increments until mud tracking condition is alleviated.

DRAWN	DATE	Mountain Valley PIPELINE	ENVIRONMENTAL DETAIL
CHECKED	DATE		ROCK CONSTRUCTION ENTRANCE WITH WASH RACK
APP'D	DATE 08/11/17		
SCALE N.T.S.	SHEET 1 OF 1		
JOB NO.		DESIGN ENGINEERING	DRAWING NO. MVP–ES20 / REV. P
PROJECT ID: MVP – VA PORTION			

EARTHEN LEVEL SPREADER

LOCATION - Earthen level spreaders are normally used where diversion ditches or dikes outlet onto areas of established vegetation — grass, typically not brush or forested. They are **not** to be used below sediment traps, sediment basins, or stormwater pipes.

Earthen level spreaders may be used for drainage areas less than or equal to 1 acre where sediment-free stormwater runoff can be released in sheet flow down a stabilized slope without causing erosion. Where the downstream slope is stabilized with grass, a minimum uniform cover of 90% is required. Wooded areas, with little or no grass cover, are not considered stabilized areas for this purpose. Earthen level spreaders should only be used where there will be no construction traffic over the level spreader.

To avoid reconcentrating flow downstream of the spreader, the maximum distance from the earthen level spreader to an existing or constructed defined drainage course is 100 feet with a 6% maximum slope and where very uniform and very stable site conditions exist. Greater distances may be considered on a case-by-case basis for very mild slopes and heavily vegetated areas but should not normally exceed 150 feet.

Earthen level spreaders should be constructed on soil, not on fill.

MAXIMUM DRAINAGE AREA - Maximum drainage area to an earthen level spreader should not exceed 1 acre.

MAXIMUM DISCHARGE and MINIMUM LENGTH - The maximum discharge for earthen level spreaders should be 1 cfs per foot of length based on the peak rate of flow from a ten-year frequency rainfall event. An acceptable simplified method to determine the length (L_{min}) is that L_{min} is equal to five feet per acre of drainage area.

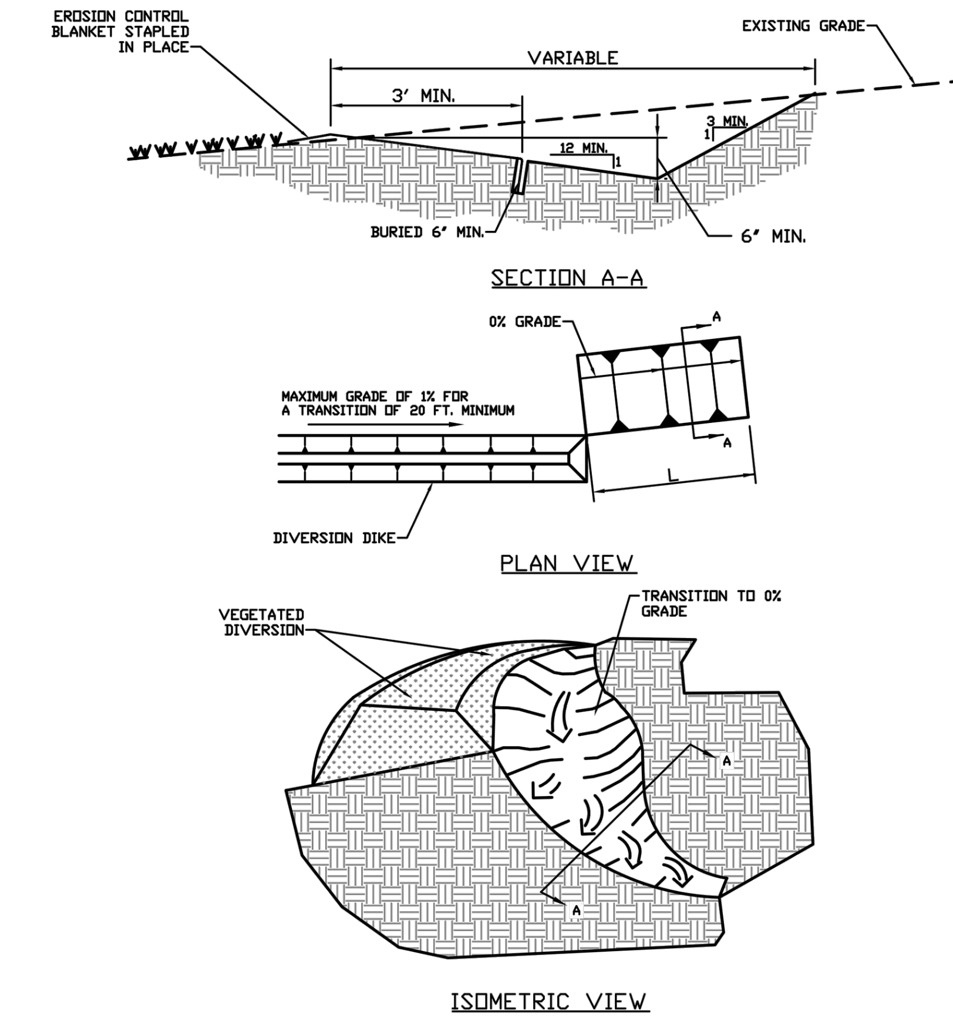
DESIGN - The grade of the last 20 feet of the diversion channel that feeds the earthen level spreader should create a smooth transition from the channel grade to the earthen level spreader and, where possible, should be less than or equal to 1 percent. Construct earthen level spreaders on zero percent grades to insure uniform spreading of sediment-free runoff. Minimum width of earthen level spreaders should be 6 feet. A transition section should be constructed between the diversion channel and the earthen level spreader if the widths are different.

Protect the lip of an earthen level spreader with an erosion-resistant material, such as a reinforced erosion control blanket or TRM, to prevent erosion and enable vegetation to become established. For a permanent installation, a rigid lip of non-erodible material, such as pressure-treated timbers or concrete curbing, should be used. A smooth transition should be provided between the level spreader and the native ground downslope.

For a vegetated lip, the erosion-control matting should be a minimum of 4 feet wide and extend 6 inches over the level lip. The upstream edge should be buried at least six inches deep in a vertical trench. The downstream edge should be securely held in place with closely spaced, heavy-duty staples, at least 12 inches long. A rigid level lip should be entrenched at least 2 inches below the ground surface and securely anchored to prevent displacement. Immediately after the earthen level spreader is constructed, the entire area of the spreader should be appropriately seeded and mulched.

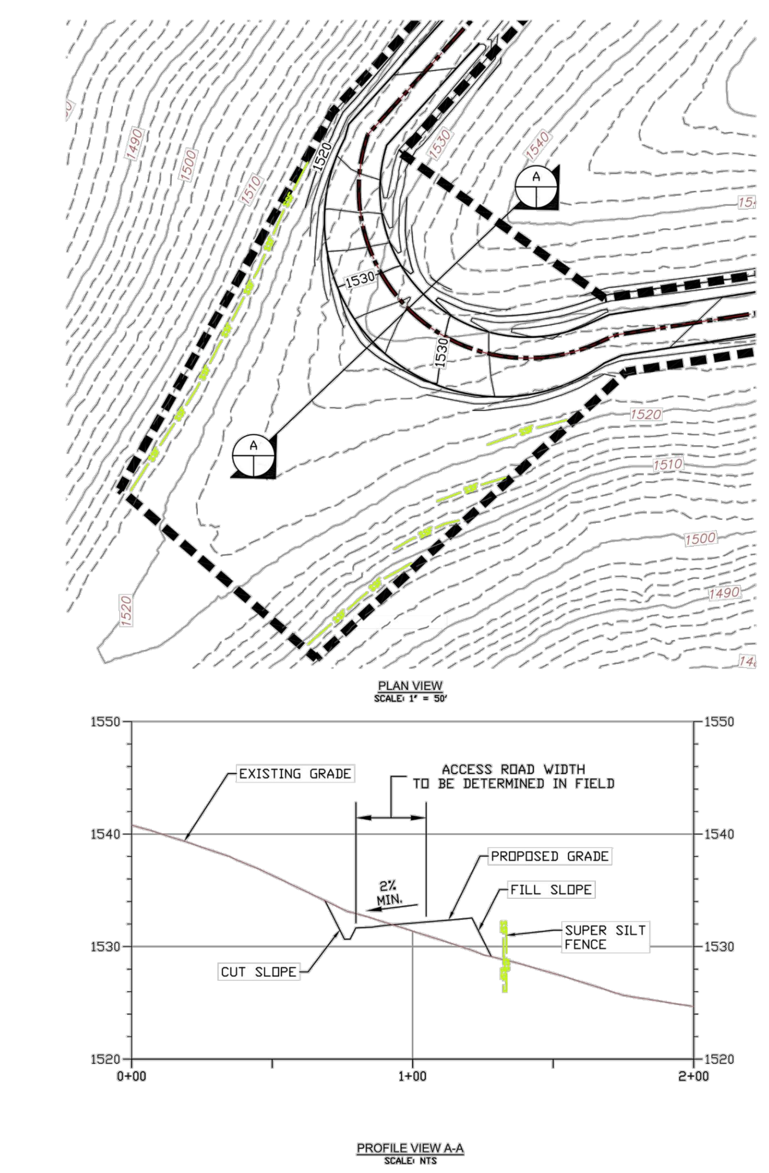
Typical details of earthen level spreaders are shown on Standard Construction Detail MVP-ES24.2.

DRAWN	DATE	Mountain Valley PIPELINE	ENVIRONMENTAL DETAIL
CHECKED	DATE		EARTHEN LEVEL SPREADER
APP'D	DATE 08/11/17		
SCALE N.T.S.	SHEET 1 OF 1		
JOB NO.		DESIGN ENGINEERING	DRAWING NO. MVP–ES24.1 / REV. P
PROJECT ID: MVP – VA PORTION			

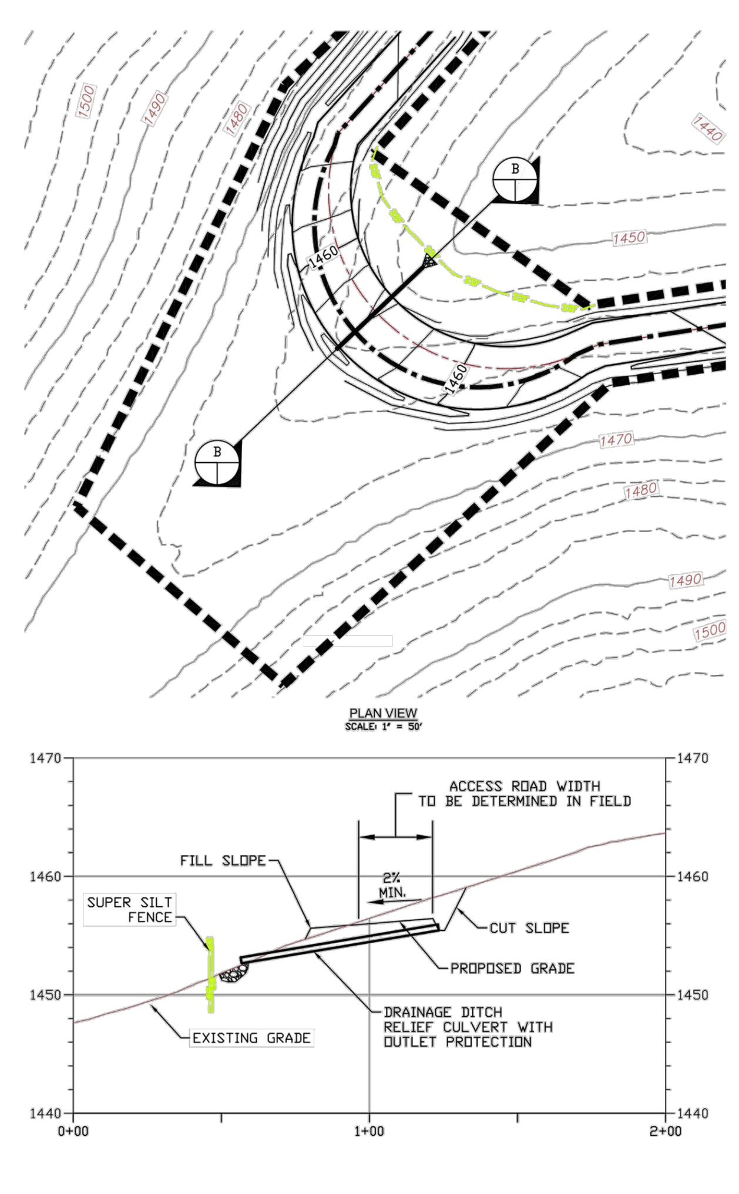


Level Spreader Schedule		
Drainage Area	ID No.	Design Length (ft)
DA-GI-021	LS-GI8-001	14

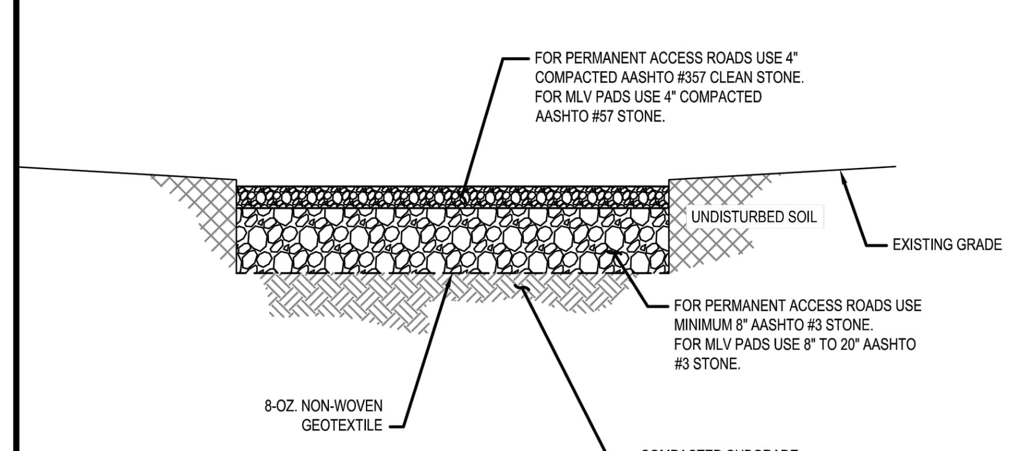
DRAWN	DATE	Mountain Valley PIPELINE	ENVIRONMENTAL DETAIL
CHECKED	DATE		EARTHEN LEVEL SPREADER
APP'D	DATE 08/11/17		
SCALE N.T.S.	SHEET 1 OF 1		
JOB NO.		DESIGN ENGINEERING	DRAWING NO. MVP–ES24.2 / REV. P
PROJECT ID: MVP – VA PORTION			



DRAWN	DATE	Mountain Valley PIPELINE	ENVIRONMENTAL DETAIL
CHECKED	DATE		ATWS VEHICLE TURNING RADIUS NOSE DETAIL
APP'D	DATE 08/11/17		
SCALE N.T.S.	SHEET 1 OF 1		
JOB NO.		DESIGN ENGINEERING	DRAWING NO. MVP–ES31 / REV. P
PROJECT ID: MVP – VA PORTION			



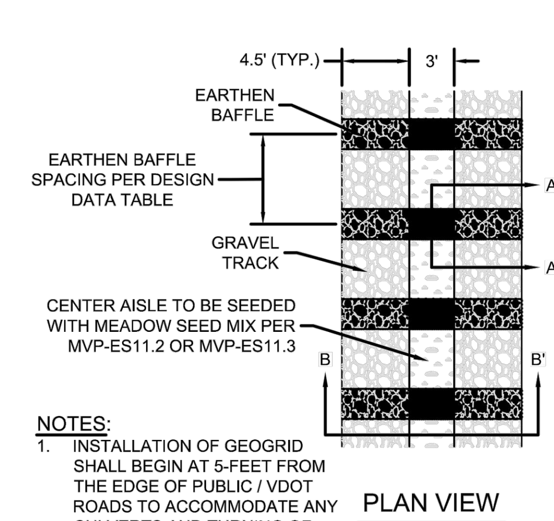
DRAWN	DATE	Mountain Valley PIPELINE	ENVIRONMENTAL DETAIL
CHECKED	DATE		ATWS VEHICLE TURNING RADIUS VALLEY DETAIL
APP'D	DATE 08/11/17		
SCALE N.T.S.	SHEET 1 OF 1		
JOB NO.		DESIGN ENGINEERING	DRAWING NO. MVP–ES32 / REV. P
PROJECT ID: MVP – VA PORTION			



NOTES:

1. THICKNESS OF AASHTO #3 STONE/AGGREGATE LAYER FOR MLV PADS TO BE BETWEEN 8" AND 20" DEPENDING ON THE STORAGE VOLUME NEEDED TO MEET STORMWATER QUANTITY REQUIREMENTS.
2. THICKNESS OF ASSHTO #3 STONE/AGGREGATE LAYER FOR ACCESS ROADS TO BE A MINUMUM OF 8" OR MORE AS DIRECTED.
3. COMPACT SUBGRADE PRIOR TO BACKFILL PLACEMENT. FOR BACKFILL, A MIN. 95% COMPACTION (ASTM D 698) IS REQUIRED.
4. UNSUITABLE MATERIAL SHALL BE REMOVED PRIOR TO SUBGRADE COMPACTION AND BACKFILL PLACEMENT. ADDITIONAL SUBGRADE COMPACTION NOT REQUIRED FOR MLV PADS.

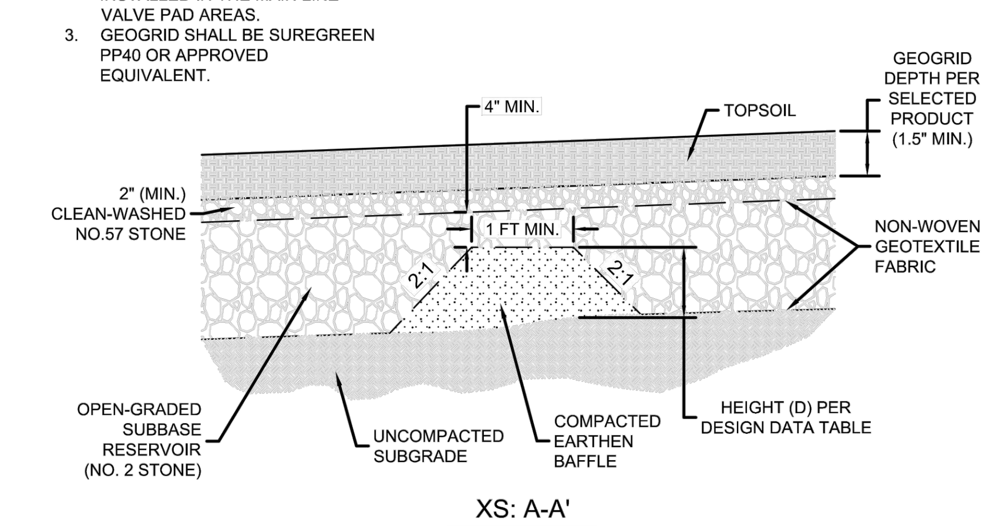
DRAWN	DATE	Mountain Valley PIPELINE	ENVIRONMENTAL DETAIL
CHECKED	DATE		GAP GRADED GRAVEL DETAIL FOR MAINLINE VALVE PADS & PERMANENT ACCESS ROADS
APP'D	DATE 08/11/17		
SCALE N.T.S.	SHEET 1 OF 1		
JOB NO.		DESIGN ENGINEERING	DRAWING NO. MVP–ES33 / REV. P
PROJECT ID: MVP – VA PORTION			



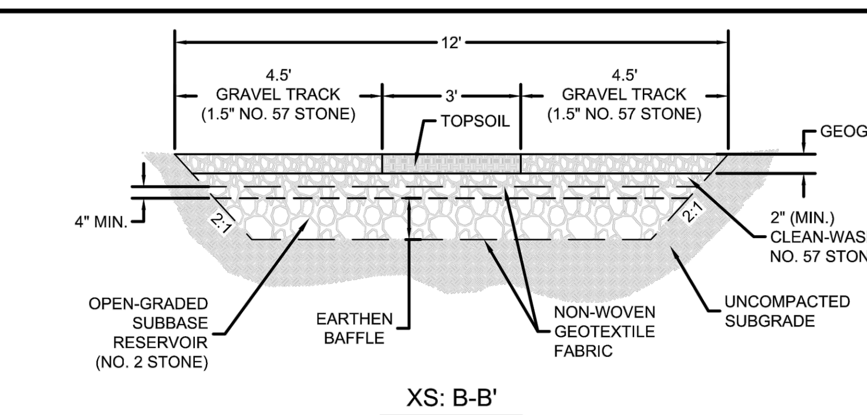
NOTES:
1. INSTALLATION OF GEOGRID SHALL BEGIN AT 5-FEET FROM THE EDGE OF PUBLIC / VDOT ROADS TO ACCOMMODATE ANY CULVERTS AND TURNING OF TIRES.
2. GEOGRID SHALL NOT BE INSTALLED IN THE MAIN LINE VALVE PAD AREAS.
3. GEOGRID SHALL BE SUREGREEN PP40 OR APPROVED EQUIVALENT.

DESIGN DATA					
Site	Road Length (ft)	Road Slope (ft/ft)	# of Baffles	Baffle Spacing (ft)	Baffle Height (ft)
MVP-MLV-AR-28	190	0.11	4	47	1
	170	0.14	2	85	1
	90	0.23	1	90	1
	92	0.09	2	46	1
	80	0.02	1	80	1
	106	0.08	4	26	1
	244	0.12	2	122	1
	141	0.05	2	70	1
	158	0.04	2	79	1
	100	0.11	4	25	1
	150	0.05	2	75	1
	293	0.29	4	73	1
	69	0.20	3	23	1
	28	0.07	1	28	1
MVP-MLV-AR-29	400	0.002	1	400	1
	270	0.026	1	270	1
	320	0.158	1	320	1
	257	0.211	1	257	1
	65	0.086	1	65	1
MVP-MLV-AR-30	70	0.00067	1	70	0.5

*Refer to Stormwater Management Narrative for baffle design equations.



DRAWN	DATE	Mountain Valley PIPELINE	ENVIRONMENTAL DETAIL
CHECKED	DATE		GAP GRADED GRAVEL DETAIL FOR MAINLINE VALVE PADS & PERMANENT ACCESS ROADS
APP'D	DATE 01/31/18		
SCALE N.T.S.	SHEET 1 OF 1		
JOB NO.		DESIGN ENGINEERING	DRAWING NO. MVP–ES33.1 / REV. P
PROJECT ID: MVP – VA PORTION			



CONSTRUCTION SEQUENCE
1. CONSTRUCTION OF THE ACCESS ROAD BAFFLES SHALL ONLY BEGIN AFTER THE ENTIRE CONTRIBUTING DRAINAGE AREA HAS BEEN STABILIZED.
2. INFILTRATION TESTS SHALL BE PERFORMED AT THE RATE OF ONE INFILTRATION TEST PER SOIL GROUP OR AT THE RATE OF ONE PER 500 LINEAR FEET OF ACCESS ROAD, WHICHEVER IS GREATER.
3. WHERE POSSIBLE, EXCAVATORS OR BACKHOES SHOULD WORK FROM THE SIDES TO EXCAVATE THE RESERVOIR LAYER TO ITS APPROPRIATE DESIGN DEPTH AND DIMENSIONS TO PREVENT COMPACTION.
4. NATIVE SOILS ALONG THE BOTTOM AND SIDES SHOULD BE SCARIFIED OR TILLED TO A DEPTH OF 3 TO 4 INCHES PRIOR TO THE PLACEMENT OF THE FILTER FABRIC.
5. INSTALL COMPACTED EARTHEN BAFFLES TO THE SPECIFIED DESIGN HEIGHT.
6. FILTER FABRIC SHOULD BE INSTALLED ON THE BOTTOM AND THE SIDES OF THE RESERVOIR LAYER, AND THE COMPACTED EARTHEN BAFFLE. FILTER FABRIC STRIPS SHOULD OVERLAP DOWN-SLOPE BY A MINIMUM OF 2-FEET, AND BE SECURED A MINIMUM OF 4-FEET BEYOND THE EDGE OF THE EXCAVATION. EXCESS FILTER FABRIC SHOULD NOT BE TRIMMED UNTIL THE SITE IS FULLY STABILIZED.
7. MOISTEN AND SPREAD 6-INCH LIFTS OF OPEN-GRADED NO. 2 STONE SUBBASE RESERVOIR. MAINTAIN 4-INCH MINIMUM DEPTH OF NO. 2 STONE LAYER OVER COMPACTED EARTHEN BAFFLE.
8. INSTALL FILTER FABRIC ON TOP OF SUBBASE RESERVOIR.
9. INSTALL 2-INCH LAYER OF CLEAN-WASHED CHOKER STONE.
10. PLACE GEOGRID AND FILL WITH GRAVEL AND TOPSOIL PER GRAVEL TRACK WIDTHS AND CENTER AISLE WIDTH. GRAVEL TRACKS SHALL BE NO. 57 STONE.
11. SEED CENTER AISLE WITH MEADOW SEED MIX PER MVP-ES11.2 OR MVP-ES11.3.

CONSTRUCTION INSPECTION
1. DAILY INSPECTION SHALL INCLUDE NUMBER AND LOCATION OF BAFFLES AS WELL AS CLEANLINESS AND SIZING OF STONE FOR ROAD AND MLV PADS. IN ADDITION GEOTEXTILE WILL BE INSPECTED FOR MATERIAL PROPERTIES AND CORRECT INSTALLATION.

MAINTENANCE
1. DURING MAIN LINE VALVE ANNUAL MAINTENANCE ACTIVITIES, PERFORM A VISUAL INSPECTION OF THE ACCESS ROAD TO IDENTIFY EROSION ISSUES, SEDIMENT DEPOSITION, ORGANIC DEBRIS AND STAINING OR PONDING THAT MAY INDICATE CLOGGING.
2. GRASSED CENTER AISLE SHALL BE MOWED AT THE SAME INTERVAL AS MAIN LINE VALVE MAINTENANCE ACTIVITIES.
3. GRASSED CENTER AISLE WILL NOT BE CONSIDERED ESTABLISHED UNTIL A GROUND COVER IS ACHIEVED THAT IS UNIFORM AND MATURE ENOUGH TO SURVIVE AND INHIBIT EROSION.

DRAWN	DATE	Mountain Valley PIPELINE	ENVIRONMENTAL DETAIL
CHECKED	DATE		GAP GRADED GRAVEL DETAIL FOR MAINLINE VALVE PADS & PERMANENT ACCESS ROADS
APP'D	DATE 01/31/18		
SCALE N.T.S.	SHEET 1 OF 1		
JOB NO.		DESIGN ENGINEERING	DRAWING NO. MVP–ES33.2 / REV. P
PROJECT ID: MVP – VA PORTION			

REVISIONS:

NO.:	DATE:	DWN.:	CHKD.:	APPD.:	DESCRIPTION:
9	08/09/18	GAR	RE	DW	FIELD MODIFICATION
8	03/21/18	KAL	RE	DW	ADDED DETAILS FOR ROADS AND PADS
7	01/31/18	KAL	RE	DW	ADDED DETAILS FOR ROADS AND PADS
6	01/26/18	KAL	RE	DW	ADDRESS VADEQ COMMENTS
5	01/08/18	KAL	RE	DW	ADDRESS VADEQ COMMENTS
4	11/28/17	KAL	RE	DW	ADDRESS VADEQ COMMENTS

Mountain Valley PIPELINE

EROSION AND SEDIMENT CONTROL PLANS

MOUNTAIN VALLEY PIPELINE PROJECT – H600 LINE

MOUNTAIN VALLEY PIPELINE, LLC
555 SOUTHPOINTE BOULEVARD, SUITE 200
CANONSBURG, PA 15317

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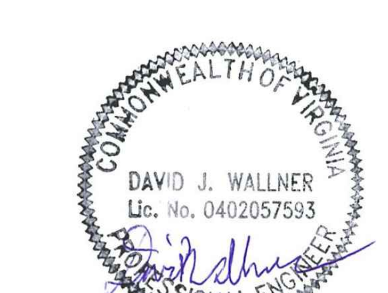
PITTSBURGH, PA 15220

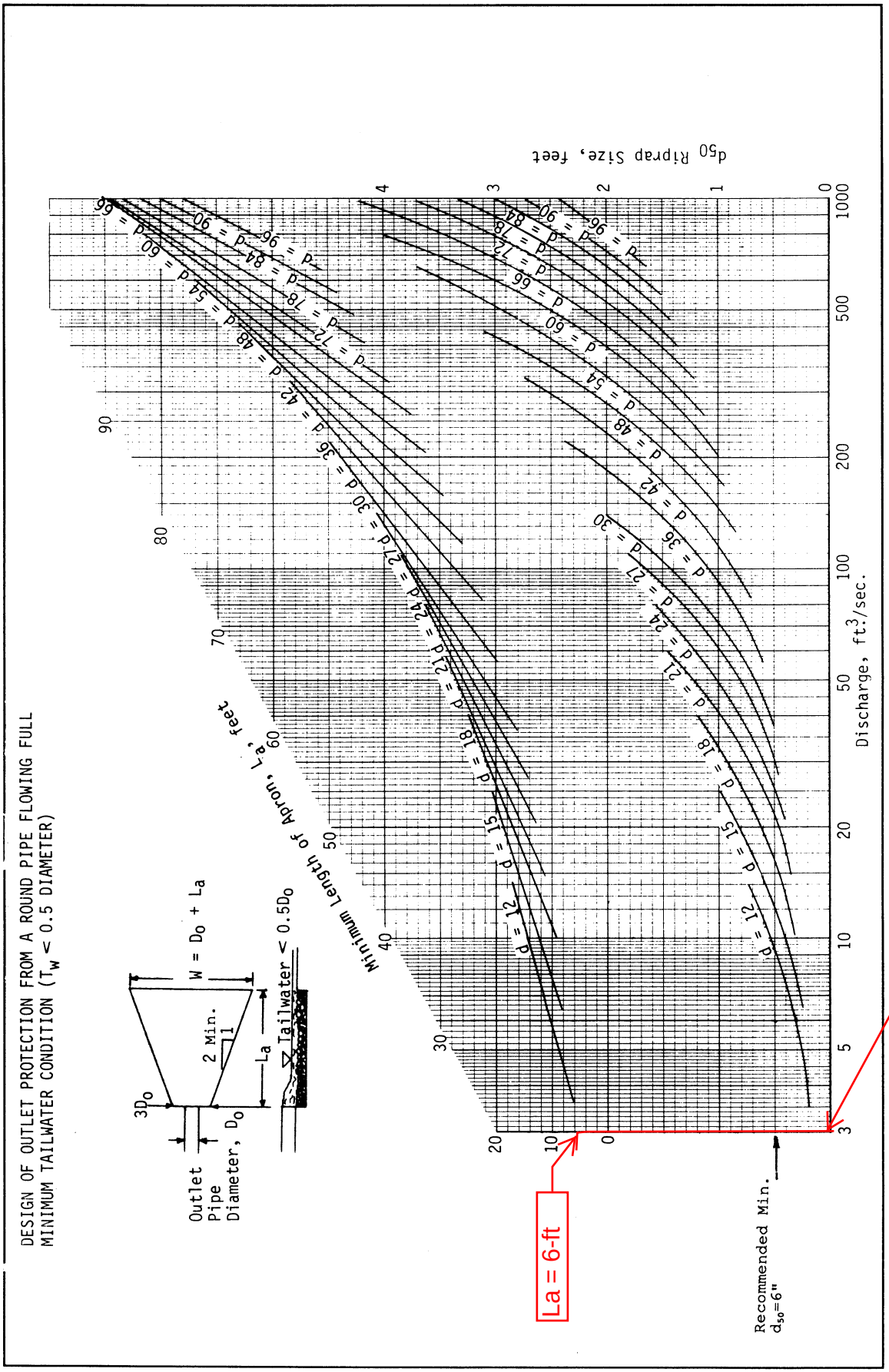
GENERAL DETAILS SET



DRAWN BY:	GAR
CHECKED BY:	RE
APPROVED BY:	DW
DATE:	08/09/2018
SCALE:	AS SHOWN
SHT. NO.	0.09 OF 0.23

REVISION 9

For 12-in pipe:
3D0 = 3-ft
La = 6-ft
W = 1-ft + 6-ft = 7-ft
Riprap d50 = 6-in (recommended minimum), so just **specify VDOT Class A1 which has a d50 = 0.8-ft and a placement thickness (d) of 20-in.**



Source: USDA-SCS Plate 3.18-3

10-Year Peak Flow Calculator

Enter Site Specific Data	T_c =	5	assumed time of concentration, min
	A =	1.5	clean water diversion drainage area, ac
	S =	0.5	weir discharge overland slope, ft/ft
Computed	i =	6.6	computed from IDF, in/hr
Enter Flow Parameters	C =	0.19	Composite runoff coefficient assuming 50% "Woods" and 50% "Pasture" land use conditions in HSG B soils with 6%+ slopes from VA SWM Handbook Volume II, Table 4-5b to be conservative

Computed 10-Year Peak Flow ------> **1.83 cfs**

Runoff	
A	***Q=CiA***
0.03	0.04
0.04	0.05
0.05	0.06
0.06	0.07
0.07	0.09
0.08	0.10
0.09	0.11
0.10	0.12
0.11	0.13
0.12	0.15
0.13	0.16
0.14	0.17
0.15	0.18
0.16	0.20
0.17	0.21
0.18	0.22
0.19	0.23
0.20	0.24
0.21	0.26
0.22	0.27
0.23	0.28

	Pittsylvania
Tc	i2
1	6.8
2	6.4
3	6.0
4	5.6
5	5.3
6	5.1
7	4.8
8	4.6
9	4.4
10	4.2
11	4.1
12	3.9
13	3.8
14	3.7
15	3.5
16	3.4
17	3.3
18	3.2
19	3.1
20	3.1
21	3.0
22	2.9
23	2.8
24	2.8
25	2.7
26	2.6
27	2.6
28	2.5
29	2.5
30	2.4

Temporary Culvert Pipe Sizing

Equations Used:

[1] $Q = CiA$

[2] $\theta = 2\arccos[(r-h)/r]$

[3] $K = [r^2*(\theta-\sin\theta)]/2$

[4] $s = r*\theta$

[5] $R = K/s$

[6] $Q_{pipe} = (1.49/n)(A)(R^{2/3})(S^{1/2})$

[1] Rational Equation for peak flow (Q)

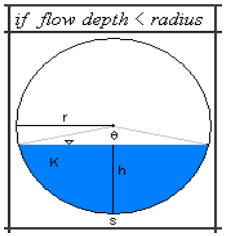
[2] Central angle as shown on figure

[3] Flow area as shown on figure

[4] Wetted perimetter, or arc length, as shown on figure

[5] Hydraulic Radius

[6] Manning Equation

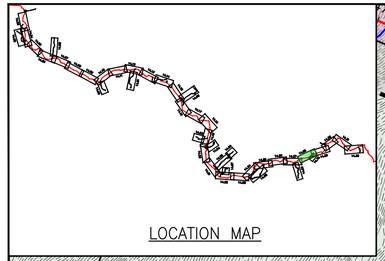


Inputs:

Inputs for ***Equation 1*** (10-Year Peak Flow Calculations)	Runoff Coefficient, C =	0.19	Composite runoff coefficient assuming 50% "Woods" and 50% "Pasture" land use conditions in HSG B soils with 6%+ slopes from VA SWM Handbook Volume II, Table 4-5b to be conservative
	10-Year Rainfall Intensity, I (in/hr) =	6.61	Used I-D-F Curve for Pittsylvania County, assuming a 5-minute time of concentration
	Contributing Drainage Area, A (acres) =	1.5	CWD drainage area as shown on ESC Plan
Inputs for ***Equation 5*** (Pipe Capacity Calculations)	Manning's Roughness Coefficient, n =	0.0120	Assume n=0.0120 for smooth HDPE
	Pipe Radius, r (ft) =	0.50	For 12-in pipe, the pipe radius is 6-in (or 0.5-ft)
	Flow Depth, h (ft) =	0.43	Assume that pipe capacity is limited to 40% of pipe-full-flow capacity to be conservative
	Central Angle, θ (radians) =	2.86	Assume that pipe capacity is limited to 40% of pipe-full-flow capacity to be conservative
	12-in Pipe Flow Area, K (sf) =	0.32	Assume that pipe capacity is limited to 40% of pipe-full-flow capacity to be conservative
	12-in Pipe Wetted Perimeter, s (ft) =	1.43	Assume that pipe capacity is limited to 40% of pipe-full-flow capacity to be conservative
	12-in Pipe Hydraulic Radius, R (ft) =	0.23	Assume that pipe capacity is limited to 40% of pipe-full-flow capacity to be conservative

Calculations:

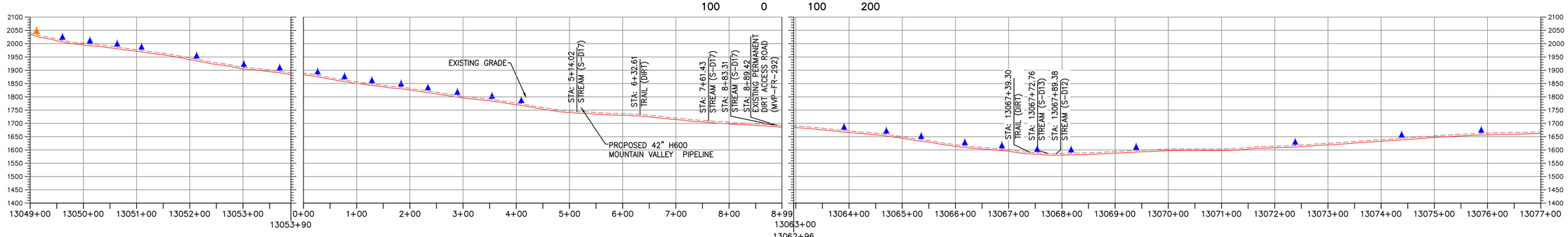
Equation 1 Results (10-Year Peak Flow Calculations)	10-Year Peak Flow, Q (cfs) =	1.83	Temporary culvert must be sized to safely convey the 10-year 24-hour minimum flood frequency per Chapter 8 of the VDOT Drainage Manual since it is a small road with minimal traffic flow
Equation 5 Results (Pipe Capacity Calculations)	*12-in Pipe, 1.5% Slope* Flow Capacity, Q_{pipe} (cfs) =	1.82	In order to safely convey the 10-year peak flow, the culvert must have a minimum slope of approx. 1.5%. Therefore, the pipe as shown on the ESC Plan would have to have a fall of at least 0.45-ft over its length (approx. 30-ft)
	12-in Pipe, 2.0% Slope Flow Capacity, Q_{pipe} (cfs) =	2.10	
	12-in Pipe, 2.5% Slope Flow Capacity, Q_{pipe} (cfs) =	2.35	
	12-in Pipe, 3.0% Slope Flow Capacity, Q_{pipe} (cfs) =	2.58	



PLAN

SCALE: 1" = 100'

100 0 100 200



LEGEND

- EXISTING CULVERT
- STREAM
- EXISTING PROPERTY LINE
- EXISTING STATE LINE
- EXISTING COUNTY LINE
- EXISTING ROAD/TRAIL
- USDA FOREST SERVICE (NATIONAL FOREST) LANDS
- APPALACHIAN NATIONAL SCENIC TRAIL
- ACID FORMING MATERIAL
- GRASS-LINED CHANNEL (SEE DETAIL MVP-ES39)
- PROPOSED LIMIT OF DISTURBANCE
- PROPOSED PERMANENT RIGHT OF WAY
- PROPOSED LEVEL SPREADER DIVERSION
- PROPOSED LEVEL SPREADER
- PROPOSED ACCESS ROAD CENTERLINE
- PROPOSED PIPELINE
- SURFACE WATER FLOW DIRECTION
- POND
- WETLAND
- PROPOSED CULVERT WITH OUTLET PROTECTION (SEE DETAILS MVP-ES7, 7.1)
- APPROXIMATE LOCATION OF WATER BAR END TREATMENTS (PENDING FIELD CONDITIONS)
- STREAM FLOW DIRECTION
- FEMA 100 YEAR FLOODPLAIN
- PERMANENT WATER BAR 10' END TREATMENT
- PERMANENT WATER BAR 15' END TREATMENT
- PERMANENT WATER BAR 20' END TREATMENT
- STEEP SLOPE AREA
- EXISTING FOREST
- PERMANENT EASEMENT RESTORED TO MEADOW CONDITION
- TEMPORARY EASEMENT RESTORED TO BRUSH CONDITION

PROFILE

HORIZONTAL SCALE: SCALE: 1" = 100'

100 0 100 200

VERTICAL SCALE: SCALE: 1" = 200'

200 0 200 400

NOTES:

1. NOTE THAT ALL WATER BARS REGARDLESS OF SPECIFIED CALCULATION LENGTH ARE TO BE INSTALLED WITH 20-FT END TREATMENT LENGTHS, EXCEPT AS NOTED IN NOTE 2 BELOW.
2. IN AREAS OF RIDGETOP AS NOTED IN THE TABLE ON THE KEY PLAN OF THIS PLAN SET, WATER BARS WITH END TREATMENT LENGTHS OF 10-FT WILL BE PLACED ON EITHER END.

TETRA TECH CAD FILE PATH: X:\CADD_Pittsburgh\EQT\7157 - MVP\15 - Franklin\PC\PC VERSION 5.0.0\SPREAD 10\7157PC14.28(S10).dwg PLOTTED ON: 8/2/2018 11:56 AM PLOTTED BY: Kusiowski, Jim PLOT FILE: ENVIRONMENTAL_COLOR.ctb

NO.	DATE:	DWN.:	CHKD.:	APPD.:	DESCRIPTION:
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3	02/22/18	KAL	RE	DW	RESUBMISSION USING APPROVED STORMWATER METHODOLOGY
4	03/04/18	KAL	RE	DW	ADDRESS VADEQ COMMENTS
5	03/16/18	KAL	RE	DW	ADDRESS VADEQ COMMENTS
6	03/21/18	KAL	RE	DW	ADDRESS VADEQ COMMENTS
6	06/22/18	KAL	RE	DW	FIELD MODIFICATION

REVISIONS:

Mountain Valley PIPELINE

POST CONSTRUCTION (STORMWATER & RESTORATION) PLANS

MOUNTAIN VALLEY PIPELINE PROJECT - H600 LINE

SPREAD 10 - FRANKLIN COUNTY, VIRGINIA

MOUNTAIN VALLEY PIPELINE, LLC
555 SOUTHPOINTE BOULEVARD, SUITE 200
CANONSBURG, PA 15317

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661 ANDERSEN DRIVE
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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:	HT
APPROVED BY:	RE
DATE:	06/22/2018
SCALE:	AS SHOWN

REVISION

SHT. NO. 14.28PC OF 14.77PC

LOCATION MAP

PROPOSED NATURAL GAS PIPELINE

STREAM CROSSING S-D11

MATCHLINE SHEET 14.28PC

MATCHLINE SHEET 14.30PC

PLAN

SCALE: 1" = 100'

100 0 100 200

EXISTING GRADE

PROPOSED 42" H600 MOUNTAIN VALLEY PIPELINE

PROFILE

HORIZONTAL SCALE: SCALE: 1" = 100'

100 0 100 200

VERTICAL SCALE: SCALE: 1" = 200'

200 0 200 400

LEGEND

- EXISTING CULVERT
- STREAM
- EXISTING PROPERTY LINE
- EXISTING STATE LINE
- EXISTING COUNTY LINE
- EXISTING ROAD/TRAIL
- USDA FOREST SERVICE (NATIONAL FOREST) LANDS
- APPALACHIAN NATIONAL SCENIC TRAIL
- ACID FORMING MATERIAL
- GRASS-LINED CHANNEL (SEE DETAIL MVP-ES39)
- PROPOSED LIMIT OF DISTURBANCE
- PROPOSED PERMANENT RIGHT OF WAY
- PROPOSED LEVEL SPREADER DIVERSION
- PROPOSED LEVEL SPREADER
- PROPOSED ACCESS ROAD CENTERLINE
- PROPOSED PIPELINE
- SURFACE WATER FLOW DIRECTION
- POND
- WETLAND
- PROPOSED CULVERT WITH OUTLET PROTECTION (SEE DETAILS MVP-ES7, 7.1)
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- PERMANENT WATER BAR 10' END TREATMENT
- PERMANENT WATER BAR 15' END TREATMENT
- PERMANENT WATER BAR 20' END TREATMENT
- STEEP SLOPE AREA
- EXISTING FOREST
- PERMANENT EASEMENT RESTORED TO MEADOW CONDITION
- TEMPORARY EASEMENT RESTORED TO BRUSH CONDITION

NOTES:

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2. IN AREAS OF RIDGETOP AS NOTED IN THE TABLE ON THE KEY PLAN OF THIS PLAN SET, WATER BARS WITH END TREATMENT LENGTHS OF 10-FT WILL BE PLACED ON EITHER END.

TETRA TECH CAD FILE PATH: X:\CADD_Pittsburgh\EQT\7157 - MVP\15 - Franklin\PC\PC VERSION 5.0.0\SPREAD 10\7157PC14.28(S10).dwg PLOTTED ON: 9/11/2018 3:58 PM PLOTTED BY: Rickabaugh, Greg PLOT FILE: ENVIRONMENTAL_COLOR.ctb

REVISIONS:

NO.:	DATE:	DWN.:	CHKD.:	APPD.:	DESCRIPTION:
6	06/22/18	KAL	RE	DW	FIELD MODIFICATION
6	03/21/18	KAL	RE	DW	ADDRESS VADEQ COMMENTS
5	03/16/18	KAL	RE	DW	ADDRESS VADEQ COMMENTS
4	03/04/18	KAL	RE	DW	ADDRESS VADEQ COMMENTS
3	02/22/18	KAL	RE	DW	RESUBMISSION USING APPROVED STORMWATER METHODOLOGY
2	11/21/17	KAL	RE	DW	ADDRESS VADEQ COMMENTS

Mountain Valley PIPELINE

POST CONSTRUCTION (STORMWATER & RESTORATION) PLANS

MOUNTAIN VALLEY PIPELINE PROJECT - H600 LINE

SPREAD 10 - FRANKLIN COUNTY, VIRGINIA

MOUNTAIN VALLEY PIPELINE, LLC

2200 ENERGY DRIVE

CANONSBURG, PA 15317

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FOSTER PLAZA 7
PITTSBURGH, PA 15220

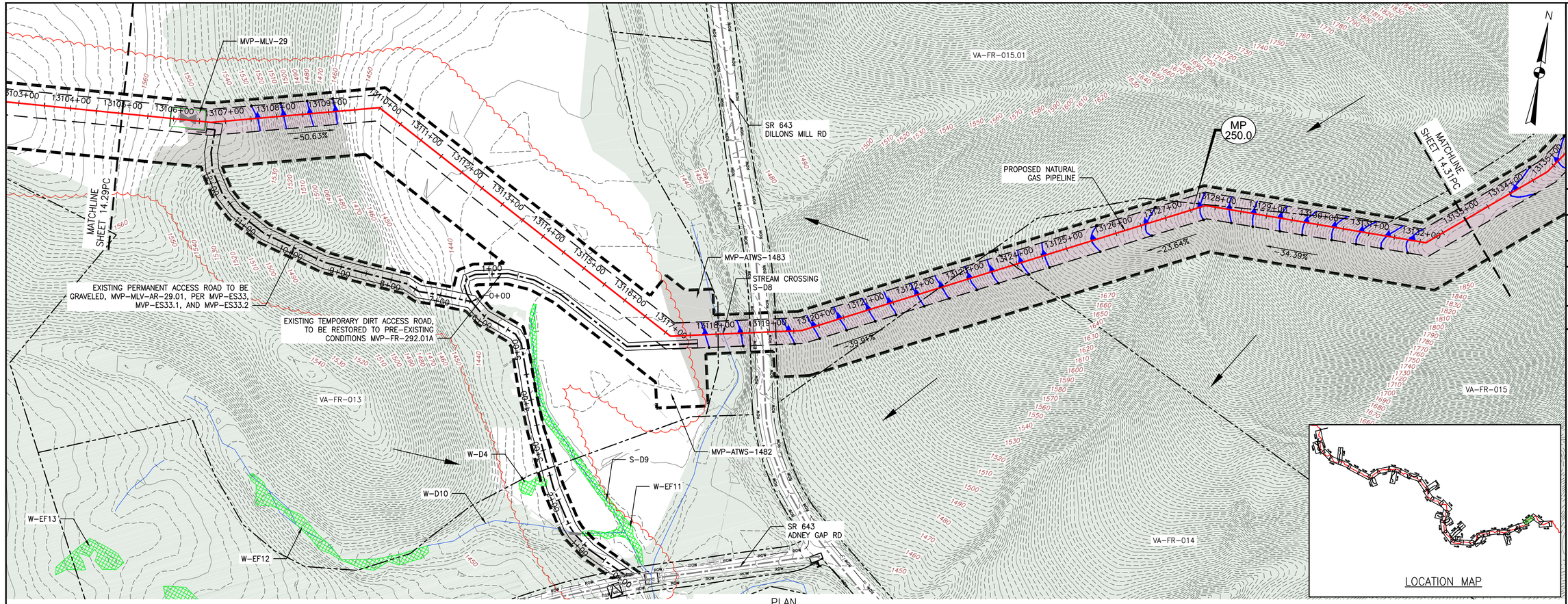
POST CONSTRUCTION (STORMWATER & RESTORATION) PLANS

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

DRAWN BY:	KAL
CHECKED BY:	HT
APPROVED BY:	RE
DATE:	06/22/2018
SCALE:	AS SHOWN

REVISION

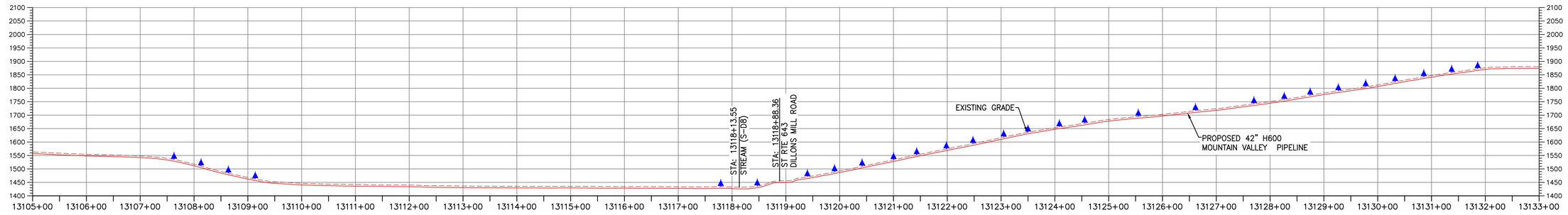
SHT. NO. 14.29PC OF 14.77PC



PLAN

SCALE: 1" = 100'

100 0 100 200



PROFILE

HORIZONTAL SCALE:

SCALE: 1" = 100'

100 0 100 200

VERTICAL SCALE:

SCALE: 1" = 200'

200 0 200 400

LEGEND

- EXISTING CULVERT
- STREAM
- EXISTING PROPERTY LINE
- EXISTING STATE LINE
- EXISTING COUNTY LINE
- EXISTING ROAD/TRAIL
- USDA FOREST SERVICE (NATIONAL FOREST) LANDS
- APPALACHIAN NATIONAL SCENIC TRAIL
- ACID FORMING MATERIAL
- GRASS-LINED CHANNEL (SEE DETAIL MVP-ES39)
- PROPOSED LIMIT OF DISTURBANCE
- PROPOSED PERMANENT RIGHT OF WAY
- PROPOSED LEVEL SPREADER DIVERSION
- PROPOSED LEVEL SPREADER
- PROPOSED ACCESS ROAD CENTERLINE
- PROPOSED PIPELINE
- SURFACE WATER FLOW DIRECTION
- POND
- WETLAND
- PROPOSED CULVERT WITH OUTLET PROTECTION (SEE DETAILS MVP-ES7, 7.1)
- APPROXIMATE LOCATION OF WATER BAR END TREATMENTS (PENDING FIELD CONDITIONS)
- STREAM FLOW DIRECTION
- FEMA 100 YEAR FLOODPLAIN
- PERMANENT WATER BAR 10' END TREATMENT
- PERMANENT WATER BAR 15' END TREATMENT
- PERMANENT WATER BAR 20' END TREATMENT
- STEEP SLOPE AREA
- EXISTING FOREST
- PERMANENT EASEMENT RESTORED TO MEADOW CONDITION
- TEMPORARY EASEMENT RESTORED TO BRUSH CONDITION

NOTES:

1. NOTE THAT ALL WATER BARS REGARDLESS OF SPECIFIED CALCULATION LENGTH ARE TO BE INSTALLED WITH 20-FT END TREATMENT LENGTHS, EXCEPT AS NOTED IN NOTE 2 BELOW.
2. IN AREAS OF RIDGETOP AS NOTED IN THE TABLE ON THE KEY PLAN OF THIS PLAN SET, WATER BARS WITH END TREATMENT LENGTHS OF 10-FT WILL BE PLACED ON EITHER END.

TETRA TECH CAD FILE PATH: X:\CADD_Pittsburgh\EQT\7157 - MVP\15 - Franklin\PC\PC VERSION 5.0.0\SPREAD 10\7157PC14.30(S10).dwg PLOTTED ON: 9/11/2018 3:27 PM PLOTTED BY: Rickabough, Greg PLOT FILE: ENVIRONMENTAL_COLOR.ctb

REVISIONS:

NO.	DATE:	DWN.:	CHKD.:	APPD.:	DESCRIPTION:
6	06/22/18	KAL	RE	DW	FIELD MODIFICATION
6	03/21/18	KAL	RE	DW	ADDRESS VADEQ COMMENTS
5	03/16/18	KAL	RE	DW	ADDRESS VADEQ COMMENTS
4	03/04/18	KAL	RE	DW	ADDRESS VADEQ COMMENTS
3	02/22/18	KAL	RE	DW	RESUBMISSION USING APPROVED STORMWATER METHODOLOGY
2	11/21/17	KAL	RE	DW	ADDRESS VADEQ COMMENTS

Mountain Valley PIPELINE

POST CONSTRUCTION (STORMWATER & RESTORATION) PLANS

MOUNTAIN VALLEY PIPELINE PROJECT - H600 LINE

SPREAD 10 - FRANKLIN COUNTY, VIRGINIA

MOUNTAIN VALLEY PIPELINE, LLC

2200 ENERGY DRIVE

CANONSBURG, PA 15317

TETRA TECH

complex world | CLEAR SOLUTIONS™

661 ANDERSEN DRIVE
FOSTER PLAZA 7
PITTSBURGH, PA 15220

POST CONSTRUCTION (STORMWATER & RESTORATION) PLANS

COMMONWEALTH OF PENNSYLVANIA
DAVID J. WALLNER
Lic. No. 042057593
PROFESSIONAL ENGINEER

DRAWN BY:	KAL
CHECKED BY:	HT
APPROVED BY:	RE
DATE:	06/22/2018
SCALE:	AS SHOWN

SHT. NO. 14.30PC OF 14.77PC

Legend

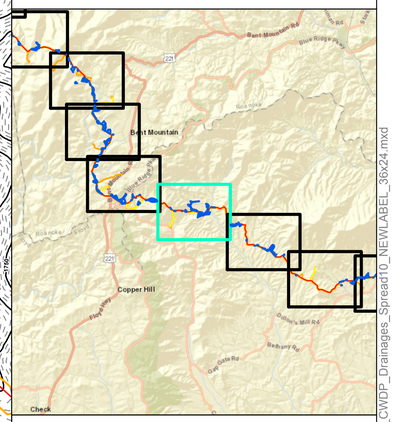
- Limit of Disturbance
- Alignment Centerline
- Permanent Access Road
- Existing 50' Contours
- Existing 10' Contours
- Drainage Area

NAD 1983 UTM 17N

N W E S

1:4,800

400 0 400 800 1,200 Feet



Mountain Valley Pipeline Project

Mountain Valley PIPELINE

Clean Water Diversion Pipe Drainage Area Map Spread 10

Figure 6 of 11
Franklin County

August, 2018

Data Sources: ESRI Streaming Data 2014.

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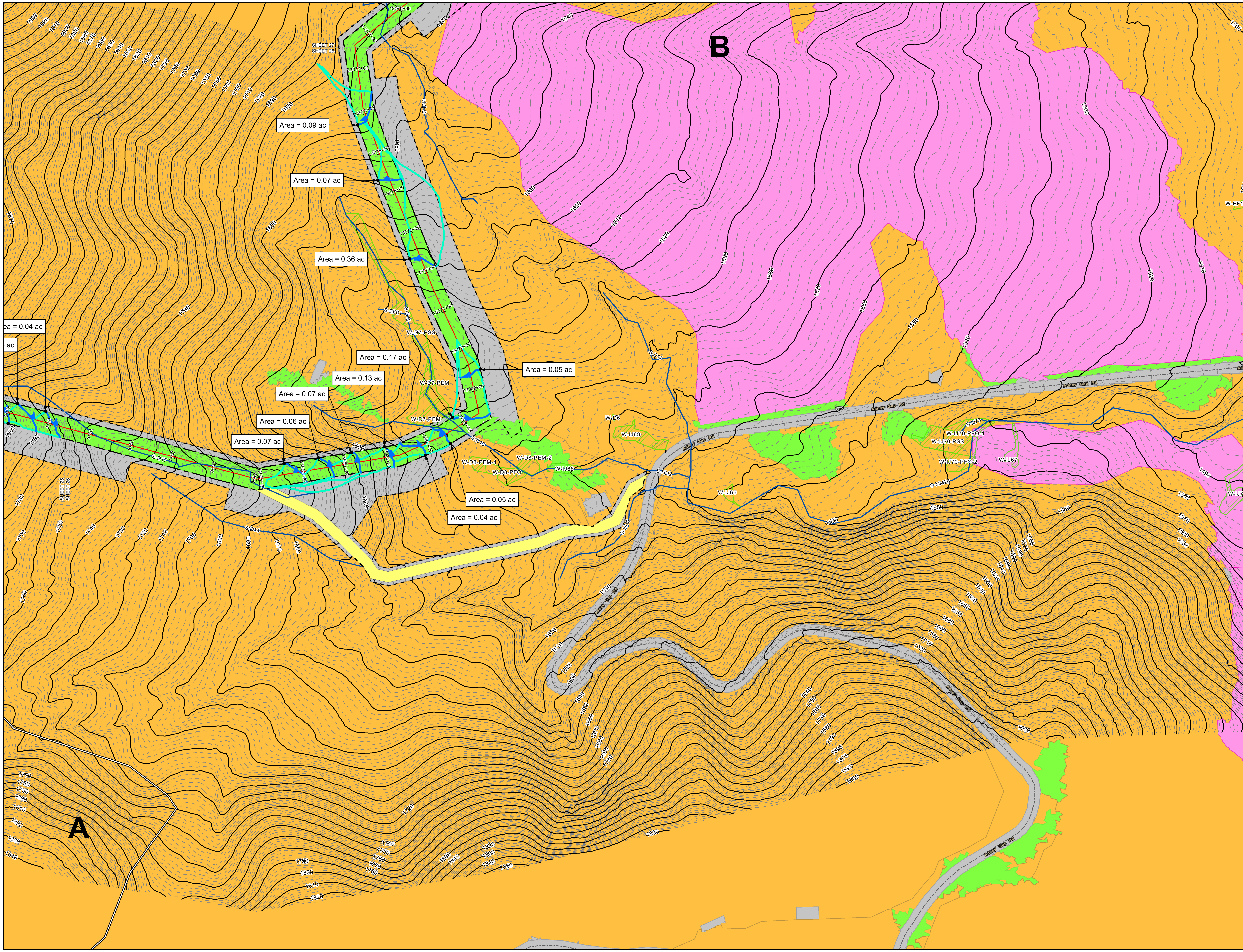


Legend

Karst Feature	Water Bar Drainage Area
Approximate Location of Water Bar End Treatment	100-year Floodplain
Permanent Water Bar 10-ft End Treatment	Pond
Permanent Water Bar 15-ft End Treatment	Wetland
Permanent Water Bar 20-ft End Treatment	Hydrologic Soil Groups
Sheetflow	100 ft Buffer off of Limits of Disturbance
Shallow Concentrated Flow	Agricultural
Streams	Barren
Alignment Centerline	Brush
Permanent Easement	Forest
MLV Site	Impervious
Access Road Permanent Easement	Meadow
Existing Impervious Surveyed Road Edge	Open Water
New/Proposed Impervious Road Edge	10-foot Contour
	2-foot Contour
	State Road Centerline
	Railroad

Notes:

1) Note that only waterbars with a number designation required site specific analysis. Refer to "Appendix – Spread 10 Site Specific Analyses" for all calculations related to waterbar end treatment and drainage area analysis.

2) Unless otherwise noted, the water bar drainage areas on this sheet are less than or equal to 1.5-acres and have a CN less than or equal to 71 and thus do not need a site specific calculation. In HSG A and B soils, it can be determined by inspection if the CN exceeds 71 because impervious cover must exceed 60% in A soils and 32% in B soils (assuming a worst case of meadow conditions in the remainder of the water bar drainage area). A weighted CN is provided for water bar drainage areas with HSG C soils and any impervious cover. Water bar drainage areas with HSG D soils are assumed to have a CN greater than 71. A site specific calculation is provided if the water bar drainage area is greater than 1.5-acres or has a CN greater than 71. Site specific calculations will use the Rational Method equation with runoff coefficients contained in VASWMH Table 4-5a and 4-5b.

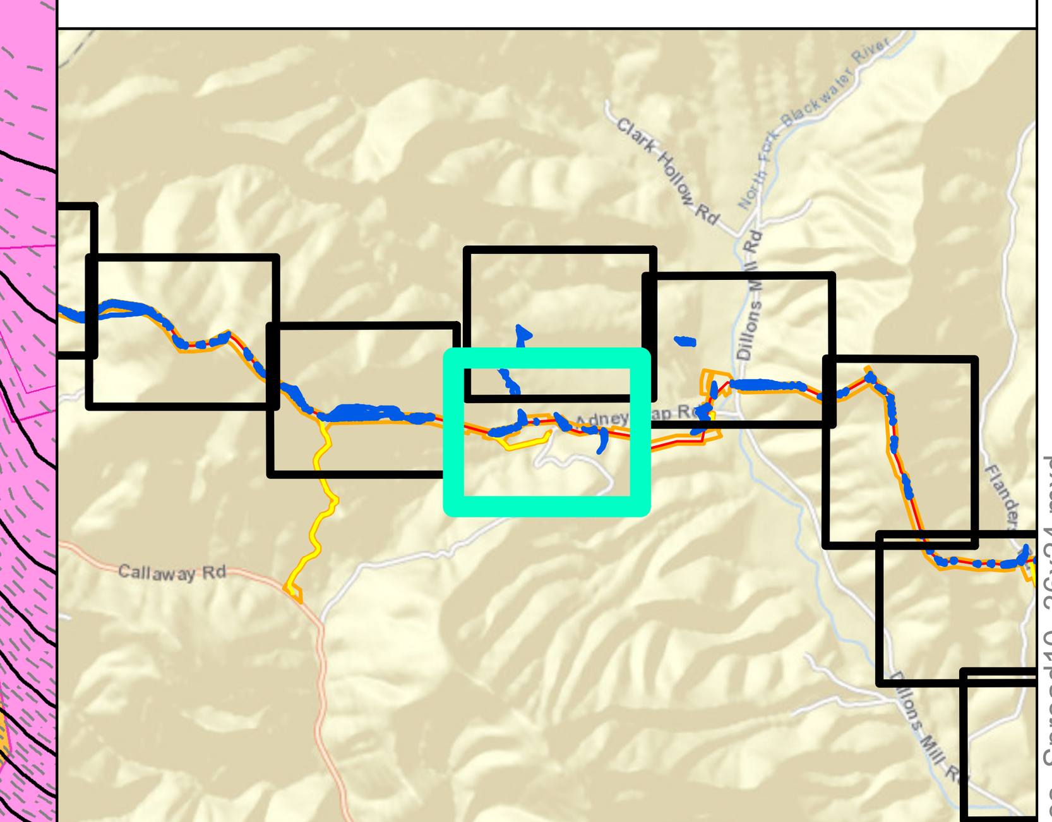
3) Per the Approved Test Area Stormwater Narrative (1/22/2018), Section II.A and II.B, the 75-foot temporary construction and 50-foot permanent ROW will be restored to predevelopment conditions except where that condition is forested. In this case the 75-foot temporary construction LOD post-development condition will be brush (seeded with a mix of herbaceous and woody species) and may naturally return to forest condition subject to landowner actions; and the 50-foot permanent ROW when indicated will be seeded and restored to meadow conditions.

NAD 1983 UTM 17N

1 " = 100 feet

100 0 100 Feet

N W E S



Mountain Valley Pipeline Project

Mountain Valley PIPELINE

Drainage Map Spread 10

Figure 26 of 55

Franklin County

August, 2018

	From	To
Pipeline Stationing -	13053+00-5+00	13079+00
Post Construction Plan No.	14.28PC	14.29PC

Data Sources: Imagery from ESRI Streaming Data 2014, Delineated streams surveyed by Tetra Tech Inc. 2014 to 2017, Elevation data derived from LiDAR provided by EQT 2016, Soils from NRCS Gridded Soil Survey Geographic (SSURGO) database 2014, Forest cover land use from the VGIN Land Cover Dataset, Transportation data from VITA map layer 2016, Existing and proposed roads were surveyed by EQT.

Document Path: PGH P:\GIS\EQT_MVP\Mapdocs\Drainage\MXD\MVP_Drainages_Spread10_36x24.mxd

A

B

Area = 0.18 ac

Area = 0.19 ac

Area = 0.09 ac

Area = 0.07 ac

Area = 0.36 ac

W-D7-RSS

W-EF13

W-D5

S-EF20

SHEET 27
SHEET 26

SHEET 27
SHEET 28

Legend

- Karst Feature
- Approximate Location of Water Bar End Treatment
- Permanent Water Bar 10-ft End Treatment
- Permanent Water Bar 15-ft End Treatment
- Permanent Water Bar 20-ft End Treatment
- Sheetflow
- Shallow Concentrated Flow
- Streams
- Alignment Centerline
- Permanent Easement
- MLV Site
- Access Road Permanent Easement
- Existing Impervious Surveyed Road Edge
- New/Proposed Impervious Road Edge
- Water Bar Drainage Area
- 100-year Floodplain
- Pond
- Wetland
- Hydrologic Soil Groups
- 100 ft Buffer off of Limits of Disturbance
- Agricultural
- Barren
- Brush
- Forest
- Impervious
- Meadow
- Open Water
- 10-foot Contour
- 2-foot Contour
- State Road Centerline
- Railroad

Notes:
1) Note that only waterbars with a number designation required site specific analysis. Refer to "Appendix – Spread 10 Site Specific Analyses" for all calculations related to waterbar end treatment and drainage area analysis.

2) Unless otherwise noted, the water bar drainage areas on this sheet are less than or equal to 1.5-acres and have a CN less than or equal to 71 and thus do not need a site specific calculation. In HSG A and B soils, it can be determined by inspection if the CN exceeds 71 because impervious cover must exceed 60% in A soils and 32% in B soils (assuming a worst case of meadow conditions in the remainder of the water bar drainage area). A weighted CN is provided for water bar drainage areas with HSG C soils and any impervious cover. Water bar drainage areas with HSG D soils are assumed to have a CN greater than 71. A site specific calculation is provided if the water bar drainage area is greater than 1.5-acres or has a CN greater than 71. Site specific calculations will use the Rational Method equation with runoff coefficients contained in VASWMH Table 4-5a and 4-5b.

3) Per the Approved Test Area Stormwater Narrative (1/22/2018), Section II.A and II.B, the 75-foot temporary construction and 50-foot permanent ROW will be restored to predevelopment conditions except where that condition is forested. In this case the 75-foot temporary construction LOD post-development condition will be brush (seeded with a mix of herbaceous and woody species) and may naturally return to forest condition subject to landowner actions; and the 50-foot permanent ROW when indicated will be seeded and restored to meadow conditions.

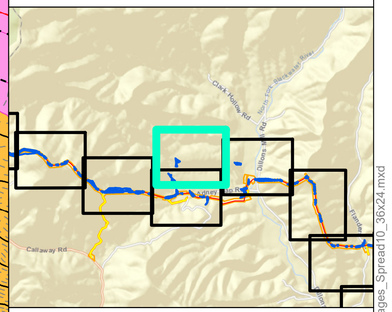
NAD 1983 UTM 17N

N
W E
S

1 " = 100 feet

100 0 100

Feet



Mountain Valley Pipeline Project

Mountain Valley PIPELINE

Drainage Map
Spread 10

Figure 27 of 55
Franklin County
August, 2018

	From	To
Pipeline Stationing -	13073+00	13102+00
Post Construction Plan No.	14.28PC	14.29PC

Data Sources: Imagery from ESRI Streaming Data 2014, Delineated streams surveyed by Tetra Tech Inc. 2014 to 2017, Elevation data derived from LiDAR provided by EQT 2016, Soils from NRCS Gridded Soil Survey Geographic (SSURGO) database 2014, Forest cover land use from the VGIN Land Cover Dataset, Transportation data from VITA map layer 2016, Existing and proposed roads were surveyed by EQT.

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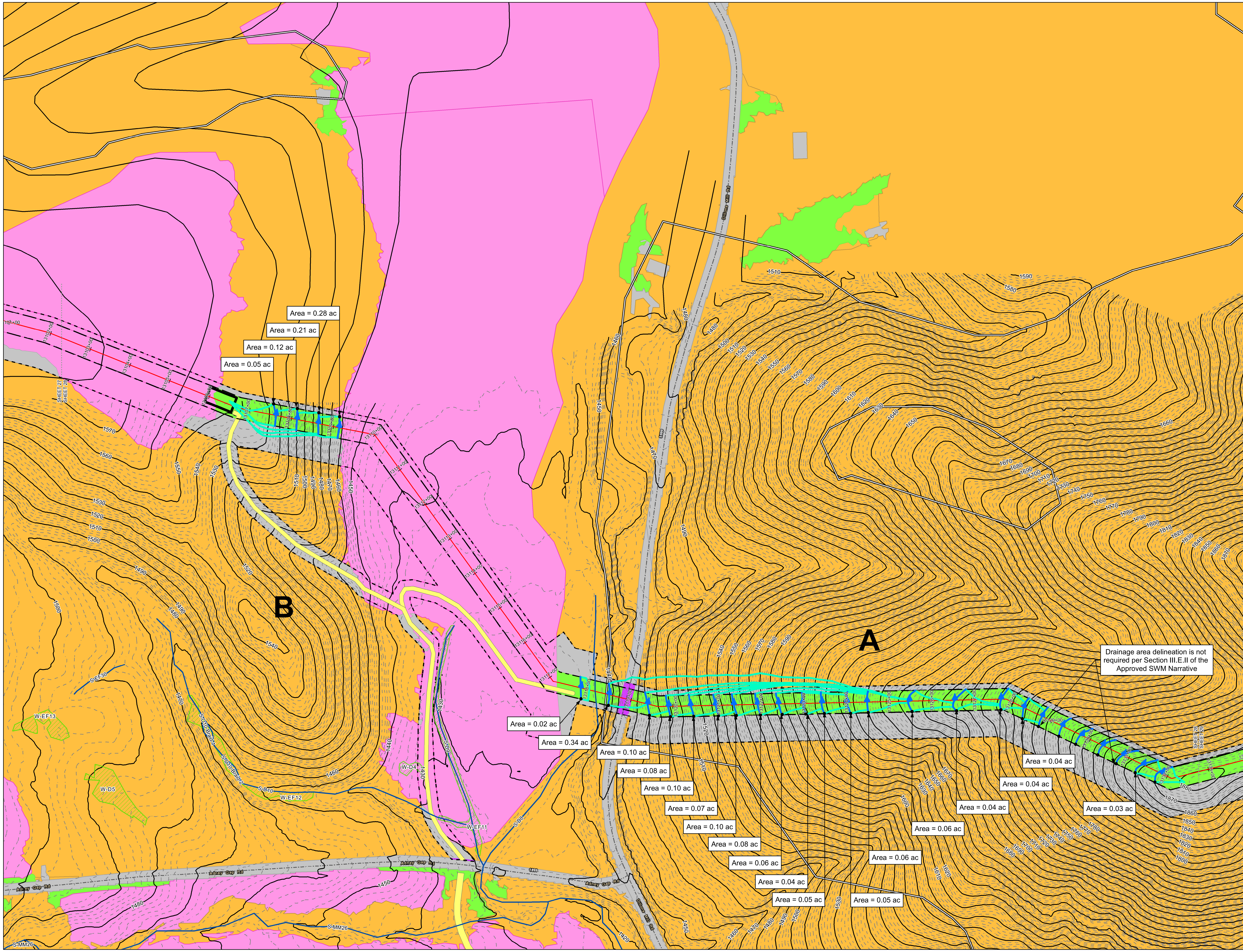


Legend

	Karst Feature		Water Bar Drainage Area
	Approximate Location of Water Bar End Treatment		100-year Floodplain
	Permanent Water Bar 10-ft End Treatment		Pond
	Permanent Water Bar 15-ft End Treatment		Wetland
	Permanent Water Bar 20-ft End Treatment		Hydrologic Soil Groups
	Sheetflow		100 ft Buffer off of Limits of Disturbance
	Shallow Concentrated Flow		Agricultural
	Streams		Barren
	Alignment Centerline		Brush
	Permanent Easement		Forest
	MLV Site		Impervious
	Access Road Permanent Easement		Meadow
	Existing Impervious Surveyed Road Edge		Open Water
	New/Proposed Impervious Road Edge		10-foot Contour
			2-foot Contour
			State Road Centerline
			Railroad

Notes:

1) Note that only waterbars with a number designation required site specific analysis. Refer to "Appendix – Spread 10 Site Specific Analyses" for all calculations related to waterbar end treatment and drainage area analysis.

2) Unless otherwise noted, the water bar drainage areas on this sheet are less than or equal to 1.5-acres and have a CN less than or equal to 71 and thus do not need a site specific calculation. In HSG A and B soils, it can be determined by inspection if the CN exceeds 71 because impervious cover must exceed 60% in A soils and 32% in B soils (assuming a worst case of meadow conditions in the remainder of the water bar drainage area). A weighted CN is provided for water bar drainage areas with HSG C soils and any impervious cover. Water bar drainage areas with HSG D soils are assumed to have a CN greater than 71. A site specific calculation is provided if the water bar drainage area is greater than 1.5-acres or has a CN greater than 71. Site specific calculations will use the Rational Method equation with runoff coefficients contained in VASWMH Table 4-5a and 4-5b.

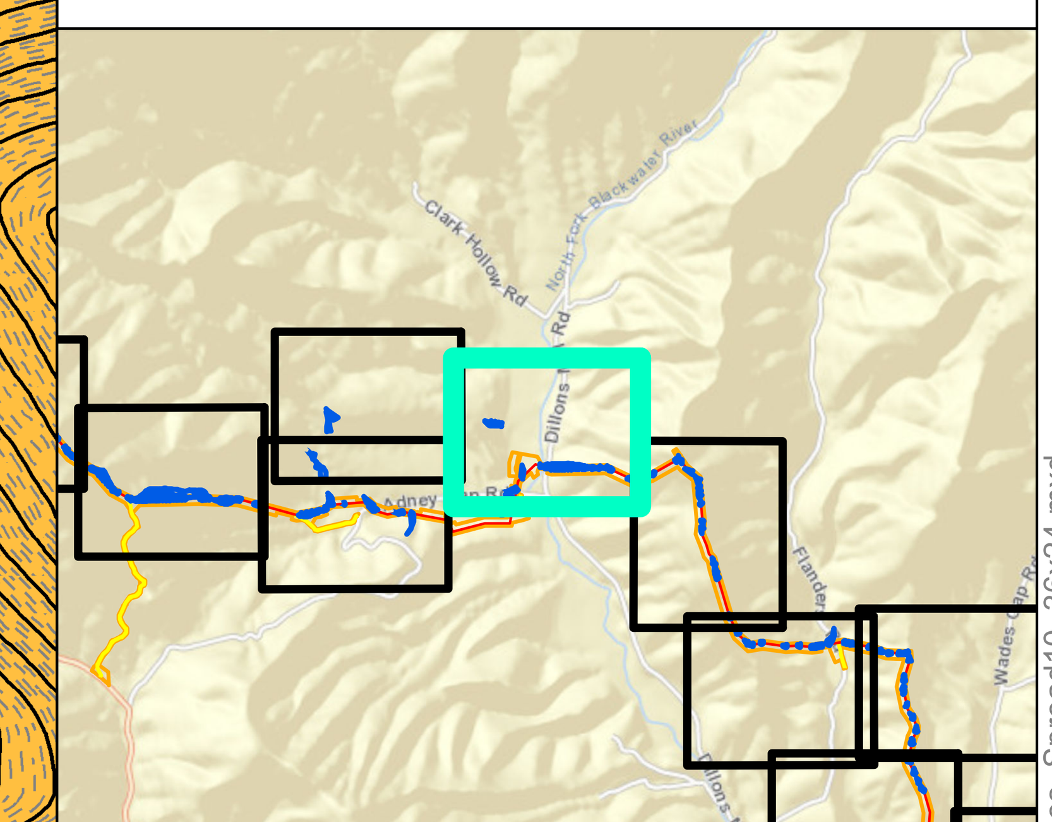
3) Per the Approved Test Area Stormwater Narrative (1/22/2018), Section II.A and II.B, the 75-foot temporary construction and 50-foot permanent ROW will be restored to predevelopment conditions except where that condition is forested. In this case the 75-foot temporary construction LOD post-development condition will be brush (seeded with a mix of herbaceous and woody species) and may naturally return to forest condition subject to landowner actions; and the 50-foot permanent ROW when indicated will be seeded and restored to meadow conditions.

NAD 1983 UTM 17N

1 " = 100 feet

N W E S

100 0 100 Feet



Mountain Valley Pipeline Project

Mountain Valley PIPELINE

Drainage Map Spread 10

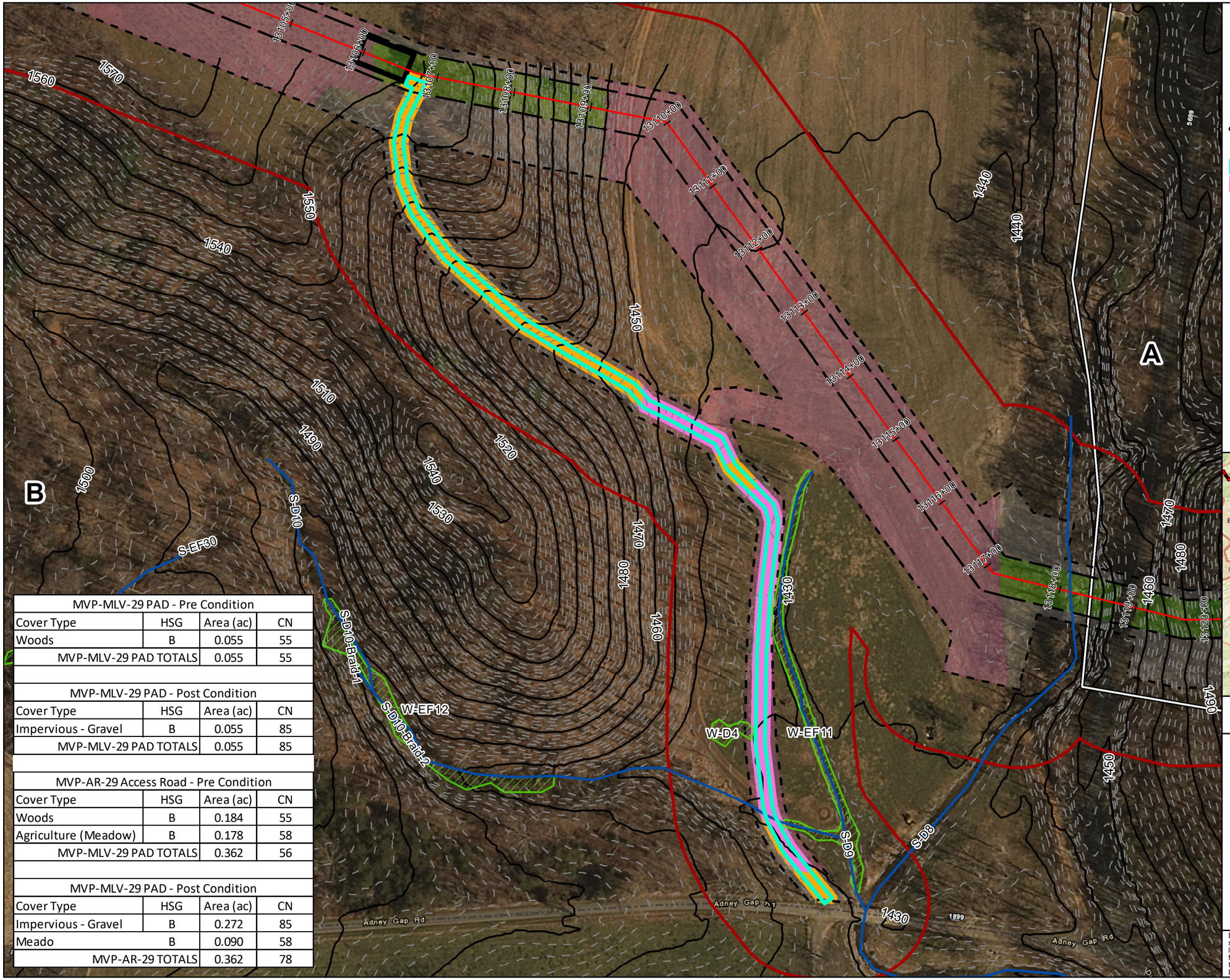
Figure 28 of 55

Franklin County

August, 2018

	From	To
Pipeline Stationing -	13102+00	13133+00
Post Construction Plan No.	14.29PC	14.31PC

Data Sources: Imagery from ESRI Streaming Data 2014, Delineated streams surveyed by Tetra Tech Inc. 2014 to 2017, Elevation data derived from LiDAR provided by EQT 2016, Soils from NRCS Gridded Soil Survey Geographic (SSURGO) database 2014, Forest cover land use from the VGIN Land Cover Dataset, Transportation data from VITA map layer 2016, Existing and proposed roads were surveyed by EQT.



MVP-MLV-29 PAD - Pre Condition			
Cover Type	HSG	Area (ac)	CN
Woods	B	0.055	55
MVP-MLV-29 PAD TOTALS		0.055	55

MVP-MLV-29 PAD - Post Condition			
Cover Type	HSG	Area (ac)	CN
Impervious - Gravel	B	0.055	85
MVP-MLV-29 PAD TOTALS		0.055	85

MVP-AR-29 Access Road - Pre Condition			
Cover Type	HSG	Area (ac)	CN
Woods	B	0.184	55
Agriculture (Meadow)	B	0.178	58
MVP-MLV-29 PAD TOTALS		0.362	56

MVP-MLV-29 PAD - Post Condition			
Cover Type	HSG	Area (ac)	CN
Impervious - Gravel	B	0.272	85
Meado	B	0.090	58
MVP-AR-29 TOTALS		0.362	78

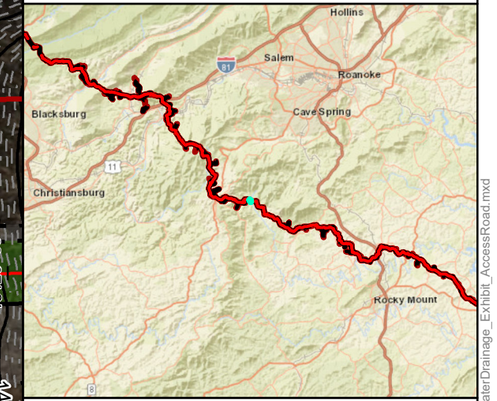
Legend

- Streams
- Stationing
- Alignment Centerline
- Permanent Easement
- Limit of Disturbance
- MLV Pad
- New Access Road
- Access Road Drainage Area
- 100-year Floodplain
- Pond
- Wetland
- Hydrologic Soil Groups
- 100 ft Buffer off of Limits of Disturbance
- Agricultural
- Barren
- Brush
- Meadow
- Agricultural
- Forest
- Existing Impervious
- Meadow
- State Road Centerline
- 10-foot Contour
- 2-foot Contour

NAD 1983 UTM 17N (feet)

1 in = 120 feet

120 60 0 120 Feet



Mountain Valley Pipeline Project

Mountain Valley PIPELINE

New Impervious Cover Stormwater Drainage Exhibits
MLV-29
Spread 10

Figure 007
Franklin County, Virginia
September 2018

Data Sources: Imagery from ESRI Streaming Data 2014, Delineated streams surveyed by Tetra Tech Inc. 2014 to 2017, Transportation data from VITA map layer 2016, Elevation data derived from LiDAR provided by EQT 2016, Soils from NRCS Gridded Soil Survey Geographic (SSURGO) database 2014, Land Use digitized from ESRI World Imagery 2015, Agricultural Area from National Land Cover Dataset 2011.

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i. New Impervious Cover: Access Roads

New impervious cover in Spread 10 includes three (3) access roads (MVP-MLV-AR-28 through -30). 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 Montgomery and Franklin County design storm values of 5.00 and 5.70 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-28	0.16 / 0.16	71 / 71	456,413	30.45 / 30.39	80,296 / 80,297
MLV-AR-29	0.50 / 0.50	56 / 56	2,415,652	58.37 / 58.37	283,396 / 283,396
MLV-AR-30	0.13 / 0.13	82 / 82	43,339	5.31 / 5.31	13,387 / 13,387

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-28	0.10 / 0.10	75 / 83	23,522	2.01 / 2.59	4,794 / 6,214
MLV-AR-29	0.10 / 0.10	56 / 78	15,784	0.72 / 1.83	1,865 / 4,351
MLV-AR-30	0.10 / 0.10	58 / 78	871	0.07 / 0.16	174 / 385

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-28 FULL DA	Pre	30.45	1.84334	80296	1
	Post	30.39	1.84337	80297	
MLV-AR-28 AR ONLY	Pre	2.01	0.11006	4794	1420
	Post	2.59	0.14265	6214	

MLV-AR-29 FULL DA	Pre	58.37	6.50588	283,396	0
	Post	58.37	6.50588	283,396	
MLV-AR-29 AR ONLY	Pre	0.72	0.04281	1,865	2,486
	Post	1.83	0.09989	4,351	

MLV-AR-30 FULL DA	Pre	5.31	0.30732	13387	0
	Post	5.31	0.30732	13387	
MLV-AR-30 AR ONLY	Pre	0.04	0.00262	114	126
	Post	0.1	0.00551	240	

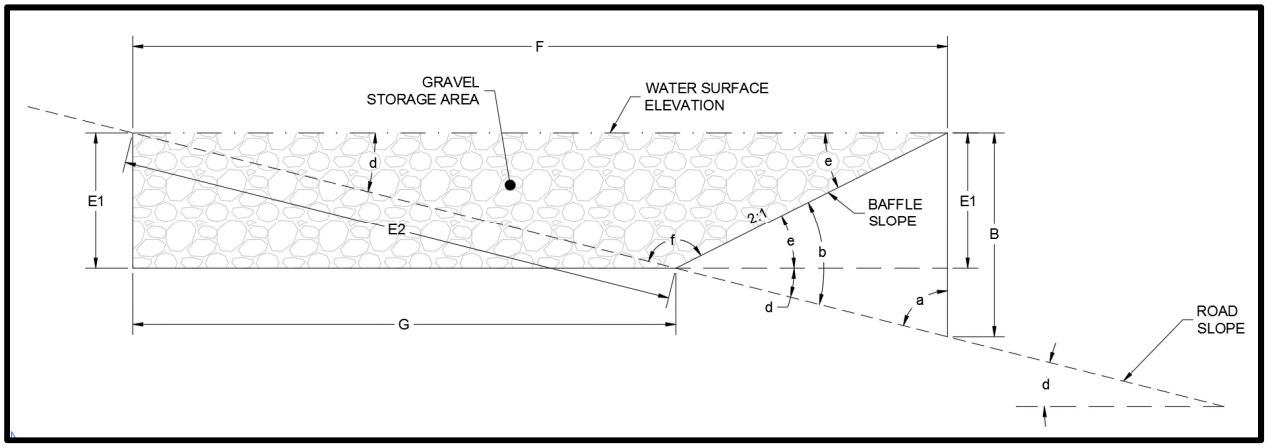
The runoff volume increase when considering only the access road is greater than the resulting runoff volume increase when considering the full drainage area. As a result, the reservoir within the access road is conservatively sized to accommodate the required volume computed using the road footprint 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-28	190	0.110	4	47	1
	170	0.142	2	85	1
	90	0.225	1	90	1
	92	0.087	2	46	1
	80	0.022	1	80	1
	106	0.082	4	26	1
	244	0.118	2	122	1
	141	0.050	2	70	1

	158	0.042	2	79	1
	100	0.115	4	25	1
	150	0.048	2	75	1
	293	0.291	4	73	1
	69	0.202	3	23	1
	28	0.067	1	28	1
MVP-MLV-AR-29	400	0.002	1	400	1
	270	0.026	1	270	1
	320	0.158	1	320	1
	257	0.211	1	257	1
	65	0.086	1	65	1
MVP-MLV-AR-30	70	0.001	1	70	.05

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.

$$CSA = 0.5 \times A \times F \times \sin(e) + 0.5 \times E1 \times E2 \times \sin(a)$$

where CSA = Cross-sectional area; ft^2

$a = 90 - \tan^{-1}(\text{road slope})$

$b = \tan^{-1}(\text{road slope}) + \tan^{-1}(\text{baffle slope})$

$d = \tan^{-1}(\text{road slope})$

$e = \tan^{-1}(\text{baffle slope})$

$f = 180 - b$

$A = B \times (\sin(a)/\sin(b))$

B = baffle height

$E1 = A \times \sin(e)$

$E2 = A \times (\sin(e)/\sin(d))$

$F = A \times (\sin(f)/\sin(d))$

G = F - E1/baffle slope

2. Determine the storage volume available per earthen baffle.

$$V_{available} = CSA \times W \times n$$

where $V_{available}$ = 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-28		
MUSYM	3E	[-]
HSG	B	[-]
K_{SAT}	1.46	[IN/HR]
Max Depth	0.96	[FT]
Drawdown Time	16	[HR]
MUSYM	29	[-]
HSG	D	[-]
K_{SAT**}	0.26	[IN/HR]
Max Depth	0.92	[FT]
Drawdown Time*	43	[HR]
MUSYM	29	[-]
HSG	D	[-]
K_{SAT**}	0.26	[IN/HR]
Max Depth	0.92	[FT]
Drawdown Time	43	[HR]

MVP-MLV-AR-29		
MUSYM	11A	[-]
HSG	B	[-]

K_{SAT}	1.30	[IN/HR]
Max. Depth	1.00	[FT]
Drawdown Time	18.4	[HR]
MUSYM	16E	[-]
HSG	B	[-]
K_{SAT}	1.98	[IN/HR]
Max. Depth	1.00	[FT]
Drawdown Time	11.0	[HR]
MUSYM	20E	[-]
HSG	B	[-]
K_{SAT}	1.99	[IN/HR]
Max. Depth	1.00	[FT]
Drawdown Time	7.2	[HR]
MUSYM	39C	[-]
HSG	B	[-]
K_{SAT}	1.50	[IN/HR]
Max. Depth	1.00	[FT]
Drawdown Time	8.5	[HR]

MVP-MLV-AR-30		
MUSYM	11A	[-]
HSG	B	[-]
K_{SAT}	1.3	[IN/HR]
Max Depth	0.50	[FT]
Drawdown Time	9	[HR]

*Note: 72-hour maximum drawdown time satisfied by reducing safety factor.
**Note: MUSYM 29 K_{SAT} assumed to equal MUSYM 25 K_{SAT}.

ii. 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.

Pre- and post-construction runoff volumes for the 10-year 24-hour storm were calculated using the Montgomery and Franklin County design storm values of 5.00 and 5.70 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 [FT^2]	Q_{10} PEAK FLOW (PRE / POST) [CFS]	Q_{10} VOLUME (PRE / POST) [FT^3]
MLV-28	0.10 / 0.10	55 / 85	2,396	0.07 / 0.28	174 / 653
MLV-29	0.10 / 0.10	55 / 85	2,376	0.10 / 0.26	269 / 617
MLV-30	0.10 / 0.10	58 / 85	2,396	0.12 / 0.33	305 / 784

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-28 Pad	Vreq	479	cf
	Area	2376	sf
	Dreq	0.50	ft
	Ddesign	8	in
	Vdesign	634	cf

MLV-29 Pad	Vreq	348	cf
	Area	2376	sf
	Dreq	0.37	ft
	Ddesign	8	in
	Vdesign	634	cf

MLV-30 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-28		
MUSYM	3E	[-]
HSG	B	[-]
K_{SAT}	1.46	[IN/HR]
Depth	8	[IN]
Drawdown Time	11	[HR]

MVP-MLV-29		
MUSYM	39C	[-]
HSG	B	[-]
K_{SAT}	1.50	[IN/HR]
Depth	8	[IN]
Drawdown Time	10.7	[HR]

MVP-MLV-30		
MUSYM	11A	[-]
HSG	B	[-]
K_{SAT}	1.3	[IN/HR]
Depth	8	[IN]
Drawdown Time	12	[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.