MVP Southgate Project

Docket No. CP19-14-000

Post-Application
Environmental Information Request #2

Attachments

May 2019

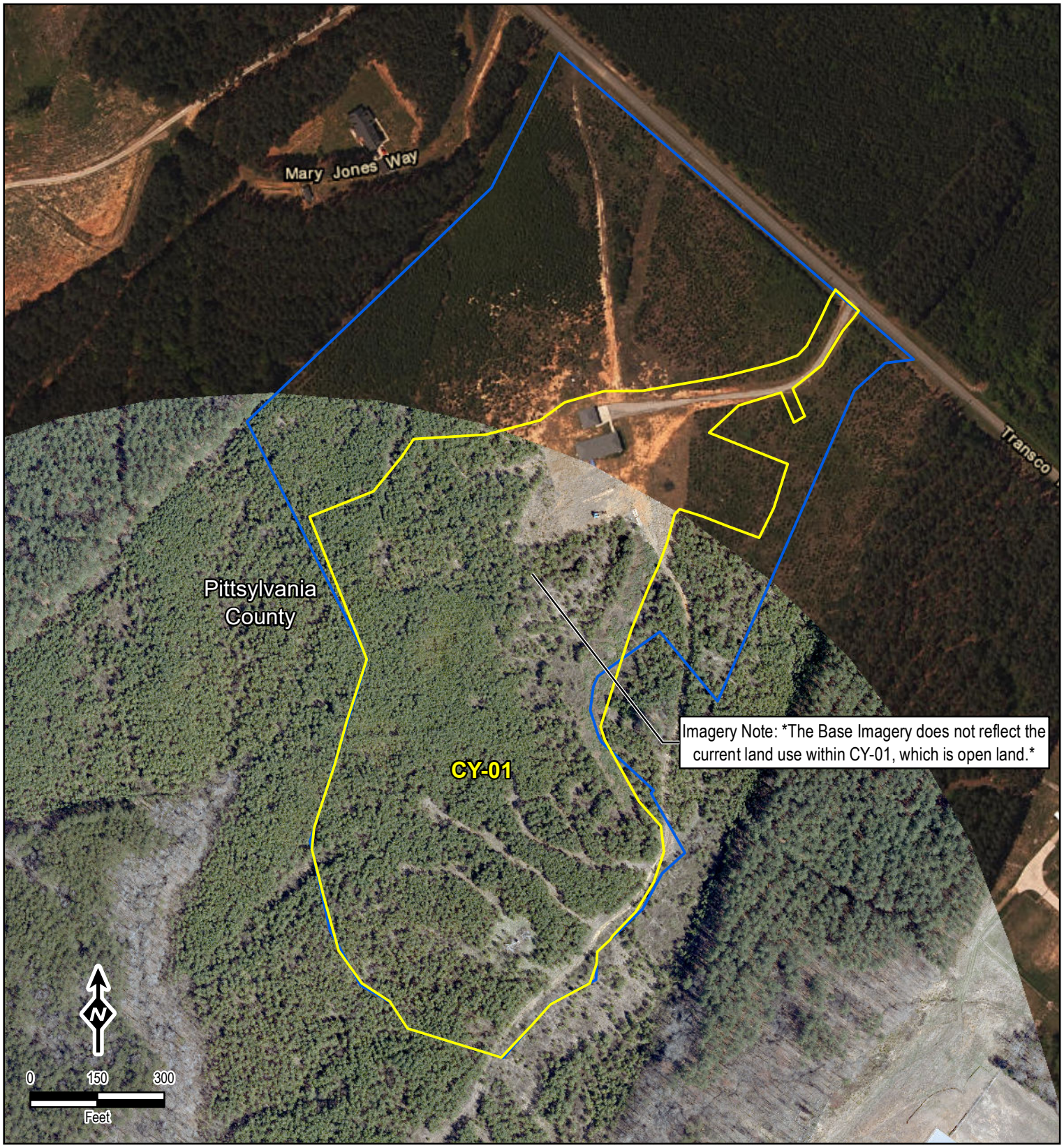
MVP Southgate Project

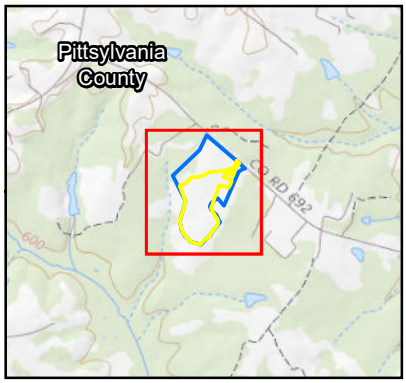
Docket No. CP19-14-000

Attachment 1-1

Figure 1-1 - Contractor Yard CY-01 and CY-03

May 2019





Legend

- Contractor Yard Footprint (March Supplemental)
- Contractor Yard Footprint (May 2, 2019)

Base Imagery: Project Imagery 4/2018 & ESRI Imagery
Data Sources: EQT, ESRI, NRCS, USGS, TRC

1 inch = 300 Feet
When Printed 8.5x11

Mountain Valley PIPELINE LLC

Figure 1-1
Contractor Yard CY-01

Pittsylvania County, Virginia

TRC Results you can rely on

600 Willowbrook Ln
West Chester, PA 19382

Date: May 2019

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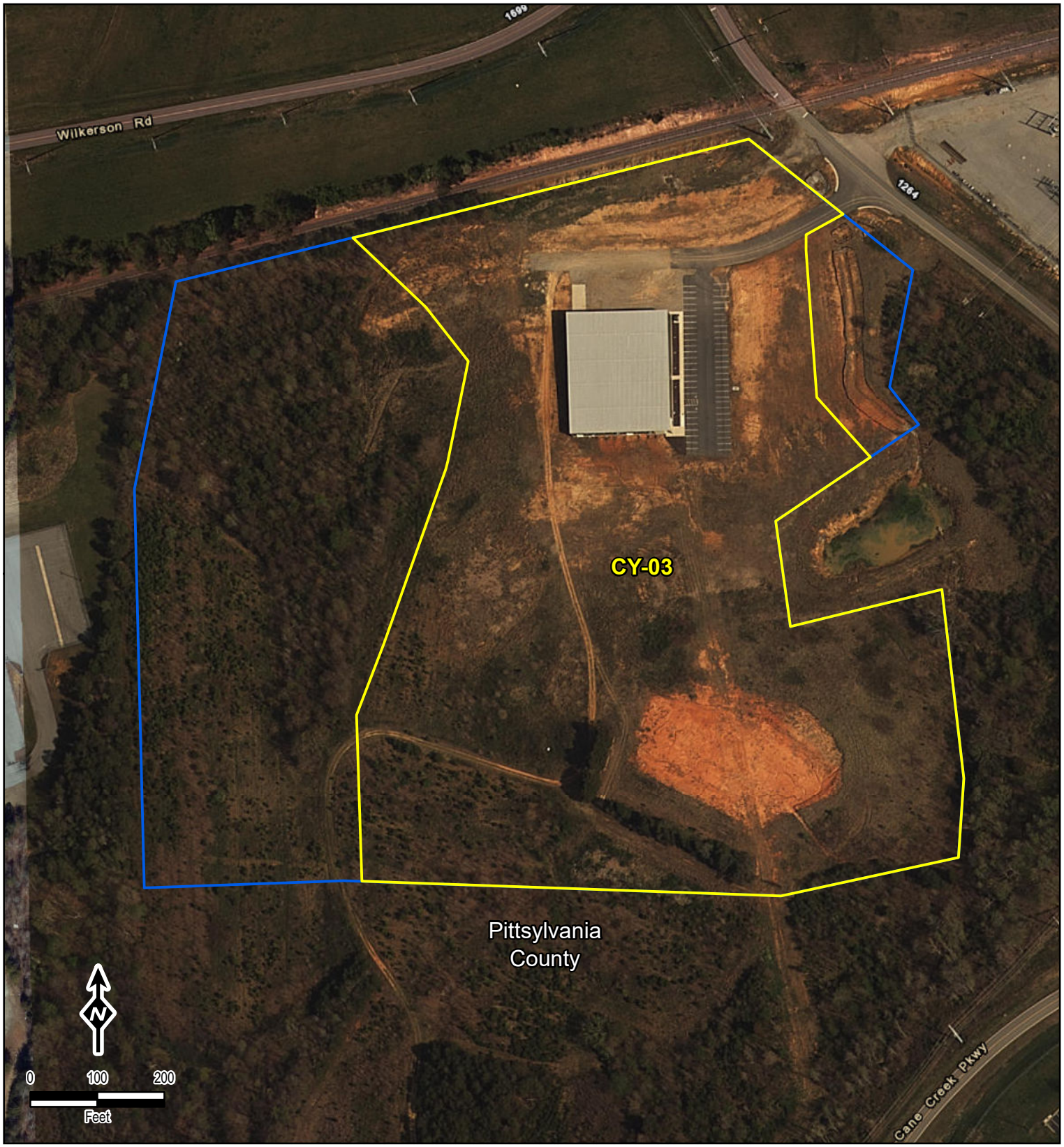
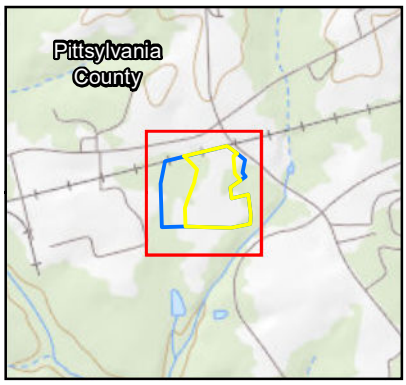




Legend

- Contractor Yard Footprint (March Supplemental)
- Contractor Yard Footprint (May 2, 2019)

Base Imagery: Project Imagery 4/2018 & ESRI Imagery
Data Sources: EQT, ESRI, NRCS, USGS, TRC

1 inch = 200 Feet
When Printed 8.5x11

Mountain Valley PIPELINE LLC

Figure 1-1
Contractor Yard CY-03

Pittsylvania County, Virginia

TRC Results you can rely on

600 Willowbrook Ln
West Chester, PA 19382

Date: May 2019

S:\1-PROJECTS\NEXTERA\300423_MVP_Southgate\6-MXD\Resource_Reports\FERC_Requests\Figure_1_1_MVP Southgate CY01_CY03_March_Sup_May2_Comparison_20190507.mxd

MVP Southgate Project

Docket No. CP19-14-000

Attachment 2-1

Cumulative Impacts

May 2019

1.10 CUMULATIVE IMPACTS [REVISED]

The Council on Environmental Quality regulations that implement the National Environmental Policy Act define cumulative effects as "the impact on the environment which results from the incremental consequences of an action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency or person undertakes such other actions" (40 CFR § 1508.7). Cumulative effects include both direct and indirect, or induced, effects that would result from the Project, as well as the effects from other projects (past, present, and reasonably foreseeable future actions) not related to or caused by the Project. Cumulative impacts may result when the environmental effects associated with a Project are added to temporary (construction-related) or permanent (operations-related) impacts associated with other past, present, or reasonably foreseeable future projects. Although the individual impact of each separate project might not be significant, the additive or synergistic effects of multiple projects could be significant. The cumulative effects analysis evaluates the magnitude of cumulative effects on natural resources such as wetlands, water quality, floodplains, and threatened and endangered species, as well as cumulative effects on land use, socioeconomics, air quality, noise, and cultural resources. The Council on Environmental Quality regulations (40 CFR § 1508.8) also require that the cumulative effects analysis consider the indirect effects which are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable.

The purpose of the cumulative impacts analysis is to identify and describe cumulative impacts that would potentially result from implementation of the Project. Inclusion of actions within the analysis is based on identifying commonalities of impacts from other actions to potential impacts that would result from the Project. To avoid unnecessary discussions of insignificant impacts and projects and to adequately address and accomplish the purposes of this analysis, the cumulative impacts analysis for the Project will be conducted using the following guidelines:

- A project must impact a resource category potentially affected by the Project. For the most part, these projects are located in the same general area that would be directly affected by construction of the Project. The effects of more distant projects are in most cases not assessed, because their impacts would tend to be localized and not contribute significantly to the impacts of the Project. Potential cumulative impacts on air quality and watersheds, however, were considered on a broader, more regional basis.

- The distance into the past and future which other projects could potentially cumulatively impact the area of the Project was based on whether the impacts are short-term, long-term, or permanent. Most of the impacts related to the other Projects would occur during the construction phase, and would be short-term impacts. Timing will be evaluated based on the submittal date of the Project's certificate application and the proposed in-service date. "Past" projects were identified as those where impacts from construction and/or operation of the completed project continue to affect resources. "Present" projects are those currently under construction. Projects will be determined to be "reasonably foreseeable" when information about the project is publicly available.

1.10-1 Region of Influence for Cumulative Impact Analysis

Projects meeting one or more of the criteria listed below are considered in this cumulative analysis. These criteria define the projects' regions of influence, which were used in this analysis to describe the general area for which the projects could potentially contribute to cumulative impacts. The region of influence varies depending on the resource being discussed. Specifically, the cumulative impacts analysis for the Project includes:

- Minor projects, such as residential development, small commercial development, and small transportation projects within 0.25 mile of the Project area;
- Major projects, such as large commercial, industrial, transportation and energy development projects within a 10-mile corridor of the Project area (5 miles of the Project centerline). This includes natural gas well permitting and development projects;
- Major projects within watersheds crossed by the Project. Watershed boundaries are identified using the Hydrologic Unit Code (HUC) 10 watershed for surface water resources, and HUC 12 watershed for groundwater resources, wetlands, vegetation and wildlife; and
- Projects with the potential to result in longer-term impacts on air quality (for example natural gas pipeline compressor stations) located within air quality control regions crossed by the other Projects and organized by county, within 50 kilometers from the Project emissions source. If the other projects are near the county border, the adjoining county will also be reviewed.

Projects older than 5 years will not be evaluated unless they have ongoing air emissions. Table 1.10-1 outlines the geographic scope for the cumulative impact analysis.

Table 1.10-1

Geographic Scope for Cumulative Impacts Analysis

Environmental Resource	Geographic Scope
Soils and Geology	Construction workspaces
Groundwater Resources, Wetlands, Vegetation, Wildlife	Hydrologic Unit Code (HUC) 12 Watershed
Surface Water Resources	HUC-10 watershed. For direct in-water work includes potential overlapping impacts from sedimentation, turbidity, and water quality
Cultural Resources	0.5 mile from centerline
Land Use, Recreation, Visual Resources	1.0 mile from the pipeline centerline and existing visual access points (e.g., road crossings)
Visual Resources	For aboveground facilities, distance that the tallest feature at the planned facility would be visible from neighboring communities; for pipelines, 0.25 mile and existing visual access points (e.g., road crossings)
Air Quality - construction	0.25 mile from construction workspaces
Air Quality - operation	50 kilometers from the Project emissions source.
Noise – construction	0.25 mile (general construction) to 0.5 mile (HDD construction) from the Project area
Noise - operation	Facilities that would impact any Noise Sensitive Areas (NSAs) located within 1 mile of noise emitting permanent aboveground facility
Socioeconomics	Affected counties and municipalities
Environmental Justice	Census tracts that are affected by and adjacent to project facilities

An assumption related to identifying projects to include in the cumulative impact analysis is that information necessary to compile the analysis is available to the public from various local, county, state,

and federal sources, and is up to date and accurate. The level of information available varies considerably based on the source. For example, information is available to interested parties in a variety of formats regarding natural gas exploration and production, and current and future natural gas related projects; however, providing an informed cumulative impact analysis requires the gathering of pertinent information from a number of different sources for an individual project. Where publicly available information does not include estimates of disturbance or environmental impacts associated with identified projects the quantitative impacts could not be determined. In these instances, the Project will use a qualitative comparison for the cumulative impacts assessment.

The following are sources of projects included in this evaluation:

- Federal Agencies – Information on projects pending before the FERC (either in the Pre-filing Process or with a filed Certificate application) is available through FERC's eLibrary system. USACE regional websites provide information regarding recently approved permits and pending USACE permits that are available for public comment. Available information varies by website but a brief description of the activity requiring the permit and the applicant is provided.

- State Agencies – Information on projects recently reviewed or under review for the Virginia and North Carolina state agencies. Available information varies by agency; however, projects that are publically posted will be included.

- County Agencies – County and local government websites are possible sources of information about natural gas or energy-related projects. In addition, each county has been contacted directly for information related to potential developments within 0.5 mile from the pipeline corridor. In cases where individual counties do not maintain a comprehensive list for planned development, the individual townships have also been contacted.

- Private Companies – Information on projects listed by their owners and developers on their public websites is included.

Projects with potential cumulative impacts on resources within the Project area are listed in Table 1.10-2 and shown in Figure 1.10-1.

REVISED Table 1.10-2

Projects with Potential Cumulative Impacts

Project	Acres Affected a/, b/, c/	NRCS Mapped Prime Farmland Acres Affected (Within 1 mile of the Southgate Project) a/, b/, c/	HUC 10 Acres (in Shared HUC 10) a/, b/, c/	HUC 12 Acres (in Shared HUC 12) a/, b/, c/	Description	County/ State	Shared Watershed (5th Level/ HUC10)	Shared Watershed (Level/HUC12)	Shared Air Quality Control Region	Approximate Distance from Project	Direction	Status	Cumulative Resources potentially within the Geographic Scope	Potential Permits
Energy Projects														
Reidsville Energy Center NCUC EMP-92, Sub 0	Total Project: 20 acres (forest land)	N/A	N/A	N/A	NTE Energy is developing and plans to construct, own and operate the Reidsville Energy Center, an approximately 500 MW natural gas electric generating facility in Rockingham County, North Carolina.	Rockingham, NC	N/A	N/A	81.150 Northern Piedmont	12 miles	West	Construction to start Summer 2019, pending financing Projected commercial operation date is October 1, 2021, with expected final completion date of January 1, 2022	Air Quality (Operation), Socioeconomics	FERC, State and Local (NCDEQ Air Permit receive, USACE Nationwide Permit received, NCDEQ Section 401 WQC received)
Virginia Southside Expansion FERC Docket CP13-30 b/	Total Project Acres: (Construction / Operation) 1,454 / 119 Wetland acres: (Construction / operation): PEM 24.9 / 0.3; PSS 3.3 / 0.0; PFO 23.3 / 4.5 Upland Forest acres (Construction / Operation): 482 / 89	17.1 acres Construction / 14.1 acres operation (including CS 166 and pipeline right-of-way within one-mile of the Southgate Project)	18 acres (Cherrystone Creek – Banister River) 63.2 acres (Stinking River – Banister River)	18 acres (Cherrystone Creek) 58 acres (Shockoe Creek – Banister River)	100 miles of new 24-inch diameter pipeline extending from the Transco mainline in Pittsylvania County, Va., and into Halifax, Charlotte, Mecklenburg, and terminating in Brunswick County, Va. Also construction of a 21,800 horsepower compressor station in Pittsylvania County, VA.	Pittsylvania County, VA	Cherrystone Creek-Banister River, Stinking River-Banister River	Cherrystone Creek Shockoe Creek-Banister River	81.143 Central Virginia	0 miles (PA-PI-001A)	North (CS 166)	In-service September 2015	Groundwater Resources, Wetlands, Vegetation, Wildlife, Surface Water Resources, Cultural Resources, Land Use, Recreation, Visual Resources, Air Quality (Construction and Operation), Noise (Construction and Operation), Socioeconomics	FERC, State and Local

REVISED Table 1.10-2

Projects with Potential Cumulative Impacts

Project	Acres Affected a/, b/, c/	NRCS Mapped Prime Farmland Acres Affected (Within 1 mile of the Southgate Project) a/, b/, c/	HUC 10 Acres (in Shared HUC 10) a/, b/, c/	HUC 12 Acres (in Shared HUC 12) a/, b/, c/	Description	County/ State	Shared Watershed (5th Level/ HUC10)	Shared Watershed (Level/HUC12)	Shared Air Quality Control Region	Approximate Distance from Project	Direction	Status	Cumulative Resources potentially within the Geographic Scope	Potential Permits
Transco Southeastern Trail FERC Docket CP18-186 c/	Total Project acres (construction / operation): 466 / 42.6 Station 165 only: 82.1 acres construction / 10.0 acres operation Upland Forest Acres (construction / operation): 66.6 / 12.5 Wetland acres (construction / Operation): PEM 1.0 / 0.2, PFO 1.0 / 0.4	Station 165: 63.4 acres for construction / 10.0 acres for operation	19.2 acres (Cherrystone Creek – Banister River) 62.9 acres (Stinking River – Banister River)	19.2 acres (Cherrystone Creek) 62.9 acres (Shockoe Creek – Banister River)	Transco Southeastern Trail expansion project will consist of 7.7 miles of 42-in. pipeline looping facilities in Virginia, horsepower additions at existing compressor stations in Virginia, and piping and valve modifications on other existing facilities in South Carolina, Georgia, and Louisiana to allow for bidirectional flow. Compressor Station 165 upgrade in Chatham, VA within Pittsylvania County, VA.	Various; Pittsylvania County, VA	Cherrystone Creek-Banister River Stinking River – Banister River	Cherrystone Creek Shockoe Creek – Banister River	81.143 Central Virginia	0 miles (PA-PI-001A and PA-PI-001C)	Northeast (CS 165)	FERC Application Filed April 2018; Construction to start August 2019; Transco anticipates in-service in November 2020	Soils and Geology, Groundwater Resources, Wetlands, Vegetation, Wildlife, Surface Water Resources, Cultural Resources, Land Use, Recreation, Visual Resources, Air Quality (Construction and Operation), Noise (Construction and Operation), Socioeconomics	FERC, State and Local
Mountain Valley Pipeline FERC Docket CP16-10	Total Project acres (construction / operation): 6,363.4 / 2,117.8 Wetland acres (construction / operation): PEM 23.9 / 0.8; PSS 2.5 / 2.5; PFO 4.6 / 4.6 Upland forest acres (construction / operation): 4,453.1 / 1,596.9	49.8 acres construction / 8.7 acres operation	182.3 acres (Cherrystone Creek – Banister River) 49.3 acres (Stinking River – Banister River)	182.3 acres (Cherrystone Creek) 15.5 acres (Shockoe Creek – Banister River)	Natural gas pipeline system that spans approximately 303 miles from northwestern West Virginia to southern Virginia	Various; ends at Pittsylvania, VA	Cherrystone Creek-Banister River (2 perennial stream crossings and 1 intermittent stream crossing in common with the Project) Stinking River-Banister River	Cherrystone Creek (2 perennial stream crossings, and one intermittent stream crossing in common with the Project) Shockoe Creek-Banister River	81.143 Central Virginia	0 miles	Overlaps	Under Construction; 2019 In-Service Date anticipated fourth quarter 2019	Soils and Geology, Groundwater Resources, Wetlands, Vegetation, Wildlife, Surface Water Resources, Cultural Resources, Land Use, Recreation, Visual Resources, Air Quality (Construction and Operation), Noise (Construction and Operation), Socioeconomics	FERC, State and Local
Solar Projects														
Sigora Solar NCUC SP 15803	N/A (no ground disturbance)	N/A	N/A (no ground disturbance)	N/A (no ground disturbance)	7.44 kW residential rooftop installation – 2144 Waterview Drive, Graham, NC 27253	Alamance, NC	Back Creek – Haw River	Boyds Creek Haw River	81.150 Northern Piedmont	1.5 miles	Southeast	Application filed 2019	No impact anticipated, no ground disturbance proposed	State and Local

REVISED Table 1.10-2

Projects with Potential Cumulative Impacts

Project	Acres Affected a/, b/, c/	NRCS Mapped Prime Farmland Acres Affected (Within 1 mile of the Southgate Project) a/, b/, c/	HUC 10 Acres (in Shared HUC 10) a/, b/, c/	HUC 12 Acres (in Shared HUC 12) a/, b/, c/	Description	County/ State	Shared Watershed (5th Level/ HUC10)	Shared Watershed (Level/HUC12)	Shared Air Quality Control Region	Approximate Distance from Project	Direction	Status	Cumulative Resources potentially within the Geographic Scope	Potential Permits
Kimrey Road Solar NCUC SP 16880	N/A (no ground disturbance)	N/A	N/A (no ground disturbance)	N/A (no ground disturbance)	7.6 kilowatt (AC) residential rooftop installation - Kimrey Road Solar – 1900 Kimrey Road, Haw River, NC	Alamance, NC	Back Creek – Haw River	Lower Back Creek	81.150 Northern Piedmont	1.5 miles	East	In Development; Application filed 2016. Pending intent to construct approval	No impact anticipated, no ground disturbance proposed	State and Local
Southwick Solar Farm, LLC NCUC SP 7968	Total Project: 26 acres (Agricultural Land)	N/A	N/A	N/A	4,000 MW (AC) Solar photovoltaic electric generation facility - Southwick Solar Farm – 3110 Boywood Road, Graham, NC	Alamance, NC	N/A	N/A	81.150 Northern Piedmont	2.5 miles	South	Application filed 2017; pending planning site review	Air Quality (Operation), Socioeconomics	Federal, Stata and Local
Woodgriff Solar Farm NCUC SP 7992	Total Project: 38 acres Upland Forest: 10 acres	N/A	38 acres	38 acres	4,000 MW (AC) Solar photovoltaic electric generation facility - Woodgriff Solar Farm, 221 Southern High School Road, Graham NC	Alamance, NC	Big Alamance Creek	Lower Little Alamance Creek	81.150 Northern Piedmont	3.2 miles	Southwest	Intent to construct permit expires June, 2019	Groundwater Resources, Wetlands, Vegetation, Wildlife, Surface Water Resources, Air Quality (Operation), Socioeconomics	Federal, State and Local
Cypress Creek Renewables Solar Farm - Williamsburg Solar, LLC NCUC SP 11809	Total Project: 341 acres Upland Forest: 229 acres	248 acres (construction and operation)	341 acres	147 acres (Giles Creek Haw River) 182 acres (Town of Altamahaw – Haw River)	Cypress Creek Renewables Williamsburg Solar, LLC 174,000 MW 600 acre solar farm. Adjacent to Project at MP 50	Rockingham, NC	Headwaters Haw River	Giles Creek Haw River Town of Altamahaw-Haw River	81.150 Northern Piedmont	0 miles	East/West	Permitted; Construction to begin in 2019	Soils and Geology, Groundwater Resources, Wetlands, Vegetation, Wildlife, Surface Water Resources, Cultural Resources, Land Use, Recreation, Visual Resources, Air Quality (Construction and Operation), Noise (Construction and Operation), Socioeconomics	Federal, State and Local
Husky Solar Farm - Husky Solar, LLC NCUC SP 2848	Total Project: 29 acres (Commercial / Industrial Land)	24 acres (construction and operation)	29 acres	29 acres	Husky Solar Farm, a 7.02 megawatt DC solar photovoltaic facility located on both sides of North Carolina Highway 87 adjacent to Project at MP 49	Rockingham, NC	Headwaters Haw River	Giles Creek-Haw River	81.150 Northern Piedmont	0 miles	North/South	In operation; Permitted prior to 2015	Soils and Geology, Groundwater Resources, Wetlands, Vegetation, Wildlife, Surface Water Resources, Cultural Resources, Land Use, Recreation, Visual Resources, Air Quality (Construction and Operation), Noise (Construction and Operation), Socioeconomics	Federal, State and Local

REVISED Table 1.10-2

Projects with Potential Cumulative Impacts

Project	Acres Affected a/, b/, c/	NRCS Mapped Prime Farmland Acres Affected (Within 1 mile of the Southgate Project) a/, b/, c/	HUC 10 Acres (in Shared HUC 10) a/, b/, c/	HUC 12 Acres (in Shared HUC 12) a/, b/, c/	Description	County/ State	Shared Watershed (5th Level/ HUC10)	Shared Watershed (Level/HUC12)	Shared Air Quality Control Region	Approximate Distance from Project	Direction	Status	Cumulative Resources potentially within the Geographic Scope	Potential Permits
Gallant Solar Farm NCUC SP 10241	Total Project: 276 acres Upland Forest: 35 acres	N/A	276 acres	N/A	45,000 MW (AC) PV array – Koger Road and Meadow Branch Road, Reidsville, NC	Rockingham, NC	Headwaters Haw River	N/A	81.150 Northern Piedmont	10 miles	West	The projected in-service date is 6/1/2019 Annual Certification issued 4/2/2019	Surface Water Resources, Air Quality (Operation), Socioeconomics	Federal, State and Local
Washington Solar NCUC SP 6053	Total Project: 30 acres Upland Forest: 10 acres	N/A	30 acres	N/A	5.0 MW (AC) PV array - South side of US Route 158 in Reidsville, NC	Rockingham, NC	Headwaters Haw River	N/A	81.150 Northern Piedmont	13 miles	West	The projected in-service date was December 2016 – no constructed facility visible on aerials – timeframe unknown. Annual Certification issued 4/1/2016, 3/17/2017, 3/23/2018, and 3/21/2019	Surface Water Resources, Air Quality (Operation), Socioeconomics	Federal, State and Local
Old Road Solar NCUC SP 6991	Total Project: 18 acres Upland Forest: 8.5 acres	N/A	18 acres	N/A	4.99 MW (AC) system - Off Mt. Herman Church Road	Rockingham, NC	Cascade Creek – Dan River	N/A	81.150 Northern Piedmont	8 miles	East	The projected in-service date was October 15, 2016 – no constructed facility visible on aerials – timeframe unknown. Annual Certification issued 3/16/2018	Surface Water Resources, Air Quality (Operation), Socioeconomics	Federal, State and Local
Green Level-Charles Drew Solar Energy Farm NCUC SP 13214	Total Project: 5 acres Upland Forest	2.5 acres (construction and operation)	5 acres	5 acres	5 MW PV array – 1248 Yanceyville Road, Green Level, NC	Alamance, NC	Back Creek – Haw River	Boyds Creek – Haw River	81.150 Northern Piedmont	0.9 mile	East	The projected in-service date was March 30, 2019 Application filed 8/24/2018	Groundwater Resources, Wetlands, Vegetation, Wildlife, Surface Water Resources, Cultural Resources, Land use, Recreation, Visual Resources, Air Quality (Construction and Operation), Noise (Construction and Operation), Socioeconomics, Environmental Justice	Federal, State and Local

REVISED Table 1.10-2

Projects with Potential Cumulative Impacts

Project	Acres Affected a/, b/, c/	NRCS Mapped Prime Farmland Acres Affected (Within 1 mile of the Southgate Project) a/, b/, c/	HUC 10 Acres (in Shared HUC 10) a/, b/, c/	HUC 12 Acres (in Shared HUC 12) a/, b/, c/	Description	County/ State	Shared Watershed (5th Level/ HUC10)	Shared Watershed (Level/HUC12)	Shared Air Quality Control Region	Approximate Distance from Project	Direction	Status	Cumulative Resources potentially within the Geographic Scope	Potential Permits
Osceola Solar Project NCUC SP 7976	Total Project: 70 acres Upland Forest: 16 acres	N/A	70 acres	70 acres	4.9 MW (AC) System – 3935 Osceola Road, Elon, NC	Alamance, NC	Headwaters Haw River	Town of Altamahaw – Haw River	81.150 Northern Piedmont	1.8 mile	West	The projected in-service date was September 1, 2017 – no constructed facility visible on aerials – timeframe unknown. Annual Certification issued 3/30/2017, 3/16/2018, and 4/1/2019	Groundwater Resources, Wetlands, Vegetation, Wildlife, Surface Water Resources, Air Quality (Operation), Socioeconomics	Federal, State and Local
Bakatsias Solar Farm NCUC SP 7457	Total Project: 24 acres Upland Forest: 8.4 acres	5.5 acres (construction and operation)	24 acres	24 acres	4.9 MW (AC) System – 150 Kronbergs Ct. Haw River, NC	Alamance, NC	Back Creek – Haw River	Lower Back Creek	81.150 Northern Piedmont	0.4 mile	East	Constructed; Amended Certificate issued 11/6/2017	Groundwater Resources, Wetlands, Vegetation, Wildlife, Surface Water Resources, Cultural Resources, Land Use, Recreation, Visual, Air Quality (Construction and Operation), Noise (Construction and Operation), Socioeconomics, Environmental Justice	Federal, State and Local
Norris Solar Farm NCUC SP 7785	Total Project: 24 acres Upland Forest: 21.5 acres	N/A	24 acres	24 acres	5.0 MW (AC) solar PV system – 1865 US 70 Highway, Mebane, NC	Alamance, NC	Back Creek – Haw River	Lower Back Creek	81.150 Northern Piedmont	1.9 mile	East	The projected in-service date was 12/31/2017- no constructed facility visible on aerials – timeframe unknown. Annual Certification issued 4/13/2017 and 1/9/2018	Groundwater Resources, Wetlands, Vegetation, Wildlife, Surface Water Resources, Air Quality (Operation), Socioeconomics	Federal, State and Local

REVISED Table 1.10-2

Projects with Potential Cumulative Impacts

Project	Acres Affected a/, b/, c/	NRCS Mapped Prime Farmland Acres Affected (Within 1 mile of the Southgate Project) a/, b/, c/	HUC 10 Acres (in Shared HUC 10) a/, b/, c/	HUC 12 Acres (in Shared HUC 12) a/, b/, c/	Description	County/ State	Shared Watershed (5th Level/ HUC10)	Shared Watershed (Level/HUC12)	Shared Air Quality Control Region	Approximate Distance from Project	Direction	Status	Cumulative Resources potentially within the Geographic Scope	Potential Permits
Necal Solar Farm NCUC SP 8039	Total Project: 42 acres Upland Forest (pine plantation)	N/A	42 acres	N/A	5.0 MW (AC) Solar PV System – South of NC Highway 49, Pleasant Grove, NC	Alamance, NC	Back Creek – Haw River	Quaker Creek – Quaker Creek Reservoir	81.150 Northern Piedmont	5.3 miles	Northeast	The projected in-service date was August 2017 - no constructed facility visible on aerials – timeframe unknown. Annual Certification issued 5/30/2018	Groundwater Resources, Wetlands, Vegetation, Wildlife, Surface Waters, Air Quality (Operation), Socioeconomics	Federal, State and Local
Transportation Projects														
Route 58 over Route 311	Total Project: 8 acres (commercial / industrial land)	N/A	8 acres	8 acres	About 3.3 million in upgrades to the intersection of Berry Hill Road and U.S. 58 West of Danville to accommodate traffic for the nearby Berry Hill Road industrial Park	Pittsylvania County, VA	Wolf Island Creek-Dan River	Lower Sandy River	81.143 Central Virginia	2 miles	East	In Design	No resources expected to be cumulatively affected given the unknown construction timeframe	State and Local
Berry Hill Road	Not Available	N/A	Not Available	Not Available	Reconstruction of Berry Hill Road in order to accommodate more traffic- 23.7 million.	Pittsylvania County, VA	Wolf Island Creek-Dan River Cascade Creek-Dan River	Trotters Creek - Dan River	81.143 Central Virginia	2 miles	East	Planning	No resources expected to be cumulatively affected given the unknown construction timeframe	State and Local
Stony Mill Road (Route 869 / Tunstall High Road (Route 869)	Total Project: 0.4 acres (commercial / industrial land)	0.0 acre	0.4 acres	0.4 acres	The construction of a single lane roundabout at the intersection of Stony Mill Road and Tunstall High Road- 2.2 million	Pittsylvania County, VA	Wolf Island Creek-Dan River	Lower Sandy River	81.143 Central Virginia	0.5 mile	East	Planning	No resources expected to be cumulatively affected given the unknown construction timeframe	State and Local
Mount Cross Road (Route 844)	Total Project: 3.3 acres (commercial / industrial land)	N/A	3.3 acres	1.6 acres (Lower Sandy River) 1.7 acres (Sandy Creek [West] – Dan River)	A two-phase plan to widen Mount Cross Road to the city limits, making the road a five-lane section with a two-way center turn lane with a new park and ride lot and sidewalk -17 million	Pittsylvania County, VA	Wolf Island Creek-Dan River	Lower Sandy River Sandy Creek (West) – Dan River	81.143 Central Virginia	5 miles	East	Planning	No resources expected to be cumulatively affected given the unknown construction timeframe	State and Local
Climax Road	Not Available	N/A	Not Available	Not Available	Widening Climax Road to a minimum of 20 feet to accommodate traffic- 1.3 million	Pittsylvania County, VA	Cherrystone Creek – Banister River	Cherrystone Creek	81.143 Central Virginia	12 miles	Northwest	Planning	No resources expected to be cumulatively affected given the unknown construction timeframe	State and Local
U. S. Route 29 South over Norfolk Southern Railroad	Total Project: 0.4 acres (commercial / industrial land)	N/A	0.4 acre	N/A	Replacement of the structurally deficient bridge on U.S. Route 29 South over Norfolk Southern Railroad with approaches on this Principal Rural Arterial roadway in Pittsylvania County	Pittsylvania County, VA	Stinking River-Banister River	N/A	81.143 Central Virginia	10 miles	East	Complete 2017	Surface Water Resources, Air Quality (Operation), Socioeconomics	State and Local

REVISED Table 1.10-2

Projects with Potential Cumulative Impacts

Project	Acres Affected a/, b/, c/	NRCS Mapped Prime Farmland Acres Affected (Within 1 mile of the Southgate Project) a/, b/, c/	HUC 10 Acres (in Shared HUC 10) a/, b/, c/	HUC 12 Acres (in Shared HUC 12) a/, b/, c/	Description	County/ State	Shared Watershed (5th Level/ HUC10)	Shared Watershed (Level/HUC12)	Shared Air Quality Control Region	Approximate Distance from Project	Direction	Status	Cumulative Resources potentially within the Geographic Scope	Potential Permits
Future I-73	Total Project: 183.0 acre (commercial / industrial land)	N/A	N/A	N/A	Construction of a 9.4-mile, four-lane interstate from Joseph M. Bryan Boulevard/Airport Parkway interchange to U.S. 220 near the Haw River	Guilford, NC	N/A	N/A	81.150 Northern Piedmont	25 miles	West	Complete October 2017	Air Quality (Operation), Socioeconomics	State and Local
Greensboro Urban Loop	Total Project: 30 acres Upland Forest: Approx. 10 acres	N/A	N/A	N/A	Completion of the Greensboro Urban Loop to help relieve I-40 congestion at I-85 Business and U.S. routes 29, 70, 220 and 421. Four projects to complete the remaining 15 miles of the 44-mile loop around the city.	Guilford, NC	N/A	N/A	81.150 Northern Piedmont	10 miles	West	Under Construction; Anticipated Completion December 2020	Air Quality (Operation), Socioeconomics	State and Local
Macy Grove Road Improvements	Total Project: 10 acres Upland Forest: Approx. 2.5 acres	N/A	N/A	N/A	Proposed improvements and an extension to Macy Grove Road in Forsyth and Guilford counties	Forsyth/Guilford, NC	N/A	N/A	81.150 Northern Piedmont	32 miles	West	In Development	No resources expected to be cumulatively affected given the unknown construction timeframe	State and Local
NC 119 Relocation	Total Project: 12 acres Upland Forest: Approx. 4 acres	N/A	12	N/A	Proposed relocation of a portion of N.C. 119 in Mebane – from I-85 to existing the N.C. 119 near Mrs. White Lane	Alamance, NC	Back Creek-Haw River	N/A	81.150 Northern Piedmont	5 miles	East	In Development	No resources expected to be cumulatively affected given the unknown construction timeframe	State and Local
N.C. 62 Widening - Ramada Road to U.S. 70	Total Project: 9 acres (commercial / industrial land)	N/A	9	N/A	Proposed widening an approximately 1-mile stretch of N.C. 62 to improve traffic flow and safety	Alamance, NC	Big Alamance Creek	N/A	81.150 Northern Piedmont	4 miles	West	In Development	No resources expected to be cumulatively affected given the unknown construction timeframe	State and Local
U.S. 158 (Reidsville Road) Improvements	Total Project: 71 acres (commercial / industrial land)	N/A	11	N/A	Proposed 18.8-mile widening of U.S. 158 from U.S. 421/Business 40 in Winston-Salem to U.S. 220 in Guilford County	Guilford, NC	Headwaters Haw River	N/A	81.150 Northern Piedmont	18 miles	West	In Development	No resources expected to be cumulatively affected given the unknown construction timeframe	State and Local
Commercial, Industrial, Residential Projects														
Berry Hill Industrial Park	Total Project: 133 acres Open Field	N/A	133 acres	133 acres	A 3,500 acres mega-park owned by Danville and Pittsylvania Counties through the Regional Industrial Facilities Act. Phase I activities began in March 2017 and include approximately 133 acres of site preparation. Schedule for additional phases is unknown.	Pittsylvania County, VA	Cascade Creek – Dan River	Trotters Creek – Dan River	81.143 Central Virginia	1.3 miles	East	In Development	Groundwater Resources, Wetlands, Vegetation, Wildlife, Surface Water Resources, Air Quality (Operation), Socioeconomics	State and Local
Panaceutics Research and Development Facility	Total Project: 112 acres (commercial / industrial)	N/A	112 acres	N/A	Panaceutics, a manufacturer of personalized medicine and nutrition solutions, will invest $5.8 million to establish a research and development and high-tech manufacturing facility in the Ringgold East Industrial Park in Pittsylvania County, Virginia.	Pittsylvania, VA	Hogans Creek-Dan River	N/A	81.143 Central Virginia	10 miles	East	Under Construction	Surface Water Resources, Air Quality (Operation), Socioeconomics	State and Local

REVISED Table 1.10-2

Projects with Potential Cumulative Impacts

Project	Acres Affected a/, b/, c/	NRCS Mapped Prime Farmland Acres Affected (Within 1 mile of the Southgate Project) a/, b/, c/	HUC 10 Acres (in Shared HUC 10) a/, b/, c/	HUC 12 Acres (in Shared HUC 12) a/, b/, c/	Description	County/ State	Shared Watershed (5th Level/ HUC10)	Shared Watershed (Level/HUC12)	Shared Air Quality Control Region	Approximate Distance from Project	Direction	Status	Cumulative Resources potentially within the Geographic Scope	Potential Permits
Carter Ridge	Total Project: 30 acres Upland Forest: 3.5 acres	N/A	30 acres	30 acres	Carter Ridge new construction homes, Carter Ridge Drive, Reidsville, NC	Rockingham, NC	Headwaters Haw River	Little Troublesome Creek	81.150 Northern Piedmont	5 miles	West	Under Construction; land associated with the development appears cleared since 2005 on Google Earth imagery; all house lots currently constructed except for two.	Groundwater Resources, Wetlands, Vegetation, Wildlife, Surface Water Resources, Air Quality (Operation), Socioeconomic	State and Local
LGI Homes-Bedford Hills	Total Project: 95 acres Upland Forest: 25 acres	N/A	95 acres	95 acres	New construction housing development single family homes near 111 Pillow Ln., Burlington, NC	Alamance, NC	Back Creek-Haw River	Lower Back Creek	81.150 Northern Piedmont	1.5 miles	East	Under Construction; land associate with the development appears cleared since 2016/2017 on Google Earth imagery; approximately half of the house lots currently constructed.	Groundwater Resources, Wetlands, Vegetation, Wildlife, Surface Water Resources, Air Quality (Operation), Socioeconomics	State and Local
Forest Creek	Total Project: 40 acres Upland Forest: 5 acres	N/A	40 acres	40 acres	New construction housing development 5 new homes in development	Alamance, NC	Back Creek-Haw River	Travis Creek – Haw River	81.150 Northern Piedmont	3.5 miles	Southwest	Under Construction; majority of land associated with the development appears cleared since 2006 on Google Earth imagery; five house lots left under construction	Groundwater Resources, Wetlands, Vegetation, Wildlife, Surface Water Resources, Air Quality (Operation), Socioeconomics	State and Local
Brassfield Meadows	Total Project: 5 acres Upland Forest: 5 acres	N/A	5 acres	5 acres	New construction housing development; 18 units	Alamance, NC	Back Creek – Haw River	Boyds Creek – Haw River	81.150 Northern Piedmont	1.7 miles	South	Under Construction; land associated with development appears cleared in 2017/2018 on Google Earth Imagery; all units to be constructed	Groundwater Resources, Wetlands, Vegetation, Wildlife, Surface Water Resources, Air Quality (Operation), Socioeconomics	State and Local

REVISED Table 1.10-2

Projects with Potential Cumulative Impacts

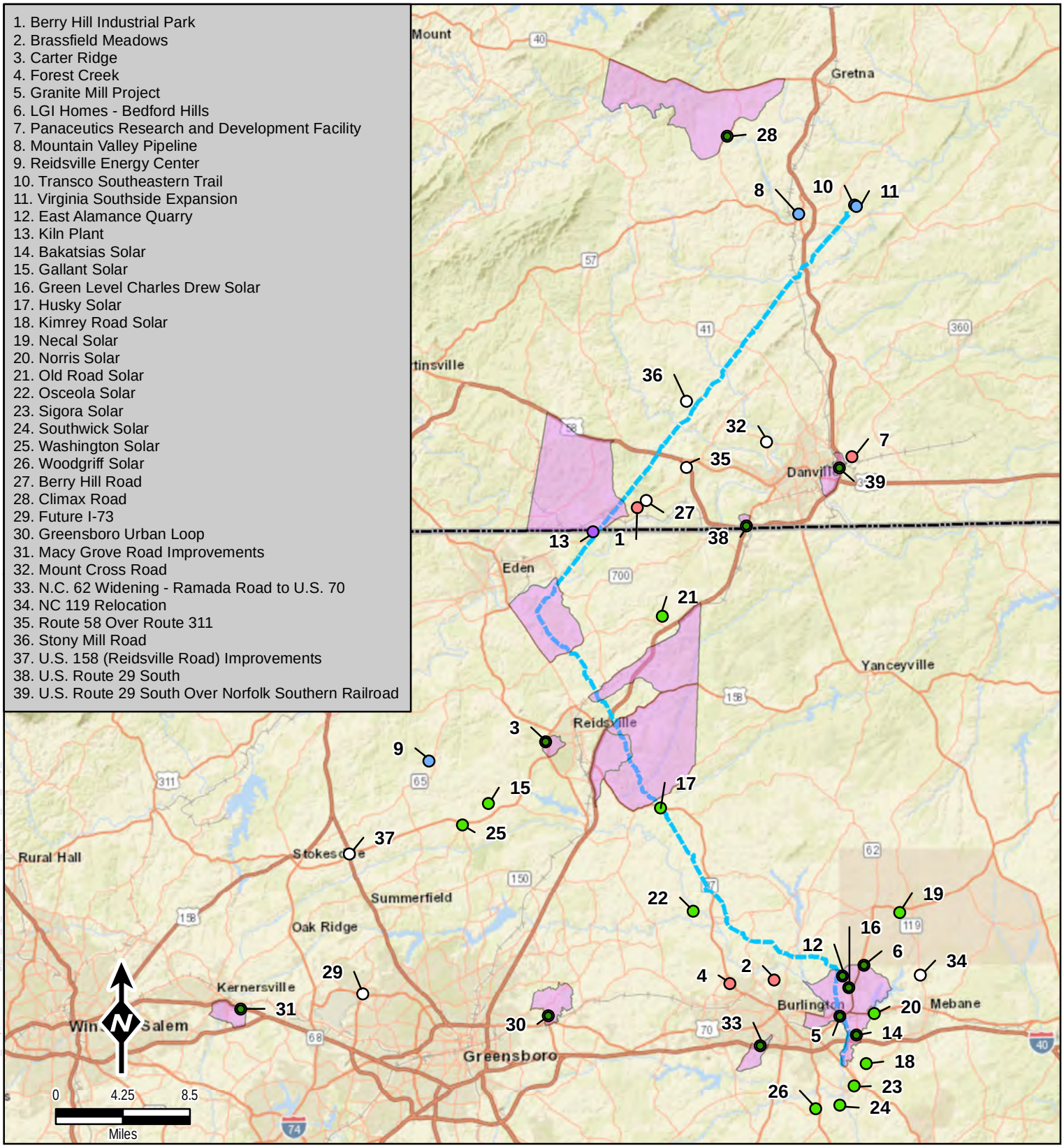
Project	Acres Affected a/, b/, c/	NRCS Mapped Prime Farmland Acres Affected (Within 1 mile of the Southgate Project) a/, b/, c/	HUC 10 Acres (in Shared HUC 10) a/, b/, c/	HUC 12 Acres (in Shared HUC 12) a/, b/, c/	Description	County/ State	Shared Watershed (5th Level/ HUC10)	Shared Watershed (Level/HUC12)	Shared Air Quality Control Region	Approximate Distance from Project	Direction	Status	Cumulative Resources potentially within the Geographic Scope	Potential Permits
Granite Mill Project	Total Project: 6 acres (commercial / Industrial land)	0 acre	6 acres	6 acres	Redevelopment of an abandoned mill including 176 apartments and 15,000 square feet of commercial space located at 122 East Main Street, Haw River, NC	Alamance, NC	Back Creek – Haw River	Boyds Creek – Haw River	81.150 Northern Piedmont	0 (TA-AL-187)	West	Completion of the residential units on north side of Main Street along the river anticipated in December 2019. Mixed use portions on the south side of Main Street is scheduled to start construction in late 2020/early 2021, with completion anticipated for the end of 2022.	Soils and Geology, Groundwater Resources, Wetlands, Vegetation, Wildlife, Surface Water Resources, Cultural Resources, Land Use, Recreation, Visual Resources, Air Quality (Construction and Operation), Noise (Construction and Operation), Socioeconomics, Environmental Justice	State and Local
Mineral Extraction Operations														
Kiln Plant	Not Available	Not Available	Not Available	Not Available	The site is identified by the USGS as a plant including a rotary kiln and with a commodity type of bloating materials (i.e., for lightweight aggregate concrete products).	Rockingham, NC	Cascade Creek – Dan River	Cascade Creek	81.150 Northern Piedmont	0.2 mile	West	No active plant site is visible in this location based on review of available aerial photography.	No resources expected to be cumulatively affected given the absence of any visible development at the identified location.	State and Local
East Alamance Quarry	Total Project: 240 acres Commercial / Industrial Land	17 acres (construction and operation)	240 acres	240 acres	Ongoing quarry operation. Products include crushed stone, gravel, and sand.	Alamance, NC	Back Creek – Haw River	Boyds Creek – Haw River	81.150 Northern Piedmont	0.1 mile	East	Ongoing operation	Groundwater Resources, Wetlands, Vegetation, Wildlife, Surface Water Resources, Cultural Resources, Land Use, Recreation, Visual Resources, Air Quality (construction and operation), Noise (construction), Socioeconomics, Environmental Justice	State and Local

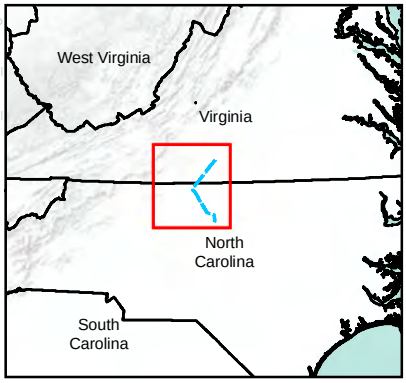
a/ All acres affected identified in this table are estimated based on information available from various sources including the FERC eLibrary, the North Carolina Utilities Commission Website, the Virginia and North Carolina Department of Transportation websites, County websites, Bing aerials, and Google Earth imagery. Estimated acres affected are not based on final engineered project designs, as that level of detail is not available for all other projects. With the exception of the Virginia Southside Expansion project, the Transco Southeastern Trail project, and the MVP Pipeline project, acres affected by construction and operation are assumed to be the same.

b/ The Project used the topographic mapping available in the Virginia Southside Expansion Project Environmental Assessment (Accession Number 20130614-4004) Appendix A Topographic Maps of pipeline Route and Facilities Map 1 of 28 to estimate shared HUC 10, HUC 12, and Prime Farmland acres within 1-mile. The one mile of pipeline right-of-way was multiplied by the construction width of 85 feet provided in Figure 3 (Typical Right-of-Way Cross-Section Collocated) in the Environmental Assessment to estimate construction pipeline acres. The one mile of pipeline right-of-way was multiplied by the operation width of 25 feet provided in the Environmental Assessment to estimate operation pipeline acres.

c/ The Project used the aerial photography Mapping available in the Transco Southeastern Trail Project Certificate Application (Accession Number 20180411-5132) to estimate shared HUC 10 and HUC 12 and Prime Farmland acres within 1-mile.

1. Berry Hill Industrial Park
2. Brassfield Meadows
3. Carter Ridge
4. Forest Creek
5. Granite Mill Project
6. LGI Homes - Bedford Hills
7. Panaceutics Research and Development Facility
8. Mountain Valley Pipeline
9. Reidsville Energy Center
10. Transco Southeastern Trail
11. Virginia Southside Expansion
12. East Alamance Quarry
13. Kiln Plant
14. Bakatsias Solar
15. Gallant Solar
16. Green Level Charles Drew Solar
17. Husky Solar
18. Kimrey Road Solar
19. Necal Solar
20. Norris Solar
21. Old Road Solar
22. Osceola Solar
23. Sigora Solar
24. Southwick Solar
25. Washington Solar
26. Woodgriff Solar
27. Berry Hill Road
28. Climax Road
29. Future I-73
30. Greensboro Urban Loop
31. Macy Grove Road Improvements
32. Mount Cross Road
33. N.C. 62 Widening - Ramada Road to U.S. 70
34. NC 119 Relocation
35. Route 58 Over Route 311
36. Stony Mill Road
37. U.S. 158 (Reidsville Road) Improvements
38. U.S. Route 29 South
39. U.S. Route 29 South Over Norfolk Southern Railroad





Legend

- Proposed Pipeline Route
- Commercial / Industrial / Residential Projects
- Energy Projects
- Mineral Extraction Operations
- Solar Projects
- Transportation Projects
- Potential Environmental Justice Area
- State Boundary

Data Sources: ESRI, US Census, TRC, EQT

1 inch = 8.5 miles
When Printed 8.5x11

Mountain Valley PIPELINE

1.10-1

Projects with Potential Cumulative Impacts

TRC
600 Willowbrook Ln
West Chester, PA 19382
October 2018

S:\1-PROJECTS\NEXTERA\300423_MVP_Southgate\6-MXD\Resource_Reports\RR1\Fig_1_10_1_Cumulative_Impacts_EJ_May_2019.mxd

1.10-2 FERC-jurisdictional Natural Gas Interstate Transportation Projects

FERC-regulated natural gas projects identified within the proximity of the Project are summarized in more detail in this section. Additional information regarding these projects may be obtained through the FERC website utilizing the FERC docket numbers, as provided below.

Reidsville Energy Center

Reidsville Energy Center is an approximately 500 megawatt natural gas electric generating facility proposed in Rockingham County, North Carolina. Siting authority was received from the North Carolina Utilities Commission in January 2017, and the air quality permit was received in July 2017. The projected commercial operation date is October 1 2021 with an expected final completion date of January 1, 2022.

This facility will discharge low volume wastes and cooling tower blowdown in the Dan River in the Roanoke River Basin. Currently total residual chlorine and temperature are water quality limited. This discharge may affect future allocations in this portion of the Dan River Basin (NCDEQ 2018).

Major environmental permits, licenses, approvals and consultations applicable to this project include Federal, State and local permits. Additional permits required for this project include Clean Water Act Section 404 and 401, National Pollution Discharge Elimination System, and Federal Aviation Administration permits as well as local permits.

Virginia Southside Expansion

The Virginia Southside Expansion includes approximately 98 miles of new 24-inch natural gas pipeline in Pittsylvania, Halifax, Charlotte, Mecklenburg, and Brunswick Counties, Virginia with a new compressor station in Pittsylvania County, Virginia and appurtenances and upgrades in New Jersey, North Carolina, Maryland and Pennsylvania. Information for the Virginia Southside Expansion was obtained from the *Virginia Southside Expansion Project Environmental Assessment, June 2013 (*FERC Docket CP13-30). The Virginia Southside Expansion is currently in-service.

The Environmental Assessment stated construction of the project would affect approximately 1,454 acres of land, including pipeline construction rights-of-way, additional temporary workspace, pipe and contractor yards, temporary and permanent access roads, and new and modified aboveground facilities. Following construction, approximately 1,335 acres would revert to pre-construction conditions and uses. The remaining approximately 119 acres, including the permanent pipeline easements, permanent aboveground facility sites, and permanent access roads, would be retained for operation of the project.

Transco would disturb approximately 51 acres of wetlands during construction of the Virginia Southside Expansion. Of the total construction-related impacts, approximately 4.8 acres of wetlands would be permanently affected by operation of the project. Transco would disturb about approximately 322 acres (24 percent of total vegetative disturbance) of non-silviculture upland forest. Transco would disturb an additional 160 acres (11 percent) of forested silviculture species; of which 15 acres would be logged by the landowner prior to construction. The Virginia Southside Project would impact approximately 703 acres of prime and statewide important soils, and 65 acres of highly erodible soils.

The operation of this project would result in emissions typical of those from natural gas project with compressor stations and associated equipment. The Environmental Assessment concluded that there would be no regionally significant impacts to air quality.

Major environmental permits, licenses, approvals and consultations applicable to this project include Federal, State and local permits: a FERC Certificate; Clean Water Act, Section 404 Permit, Nationwide 12; Section 10 and Section 401; Section 7 consultation with the U.S. Fish and Wildlife Service; and other state and local permits for the states of Virginia, Maryland, North Carolina, and Pennsylvania.

Transco Southeastern Trail Project

The Southeastern Trail Project is proposed to consist of approximately 7.7 miles of new natural gas pipeline (Manassas Loop) located along the existing Transco Mainline, compressor station horsepower additions at three existing facilities in Virginia (Station 185, Station 175, and Station 165), reversal and / or deodorization modifications at eight existing MLVs in South Carolina, Georgia, and Louisiana, and modifications at 13 existing MLVs in South Carolina and Georgia. Information regarding this project was obtained from the FERC Application, dated April 2018 under Docket CP18-186. Construction of the project is anticipated to start in August 2019 with an anticipated in-service date in November 2020.

Approximately 2 acres of wetlands and 67 acres of upland forest are anticipated to be impacted as a result of project activities. Prime farmland impacts are expected to be approximately 162 acres. Highly erodible wind soil impacts are expected to be approximately 209 acres and highly erodible water soils impacts are approximately 40 acres.

The operation of this project would result in emissions typical of those from natural gas project with compressor stations and associated equipment. Operational emissions from the proposed modifications to Station 175 and Station 165 involve installation of combustion turbines that burn pipeline-quality natural gas, resulting in combustion emissions, along with pipeline natural gas venting, and piping component fugitive emissions. Anticipated pollutants associated with the Southeastern Trail Project do not exceed the major source threshold for each of the criteria pollutants Therefore, the new compressor stations would be considered minor sources.

Major environmental permits, licenses, approvals and consultations applicable to this project include Federal, State and local permits: Section 7(c) NGA Certificate; CWA 404; Section 7 consultation; Section 106 consultation; Section 401 of the Clean Water Act Water Quality Certification; and other state and local permits.

Mountain Valley Pipeline

Mountain Valley Pipeline Project would involve construction and operation of about 303 miles of new 42-inch-diameter natural gas pipeline and associated facilities in West Virginia and Virginia and three new compressor stations and appurtenances. Construction of the Mountain Valley Pipeline Project would affect approximately 6,363 acres. Information for the Mountain Valley Pipeline Project was obtained from the *Mountain Valley Project and Equitrans Expansion Project Final Environmental Impact Statement, June 2017* (FERC Docket CP16-10). The Mountain Valley Pipeline Project and the Equitrans Expansion Project are two separate projects; however, as the projects are interrelated and connected actions, they were analyzed together in the Final Environmental Impact Statement. Equitrans Expansion Project involves construction and operation of a total of approximately 7.4 miles of various diameter natural gas pipelines, one new compressor station, appurtenances, and decommissioning of an existing compressor station, in Pennsylvania and West Virginia.

Construction of the Mountain Valley Pipeline would impact approximately 31 acres of wetlands and operation would affect approximately 8 acres of wetlands. During construction, approximately 2,902 acres

of prime farmland are anticipated to be impacted, and 5,053 acres of soils with a high water erodibility. No soils with a high wind erodibility were identified within the project area.

Operation of the Mountain Valley Pipeline and Equitrans Expansion projects would result in emissions typical of those from a natural gas project with compressor stations and associated equipment.

Major environmental permits, licenses, approvals and consultations applicable to the projects include Federal, State and local permits: Section 7(c) NGA Certificate; Federal Temporary Use Permit from USDA Forest Service; CWA 404; Section 7 consultation; Section 106 consultation; Section 401 CWA Water Quality Certification; and other state and local permits.

1.10-3 Solar Projects

The Project identified fourteen solar generation projects through document searches on the NCUC website conducted in 2018 and 2019. Summary information regarding the identified solar facilities identified are included in Table 1.10-2. Project-specific information for solar facilities were obtained from the North Carolina Public Utilities Commission website, county GIS websites and conversations with County Planning officials. Potential cumulative impacts resulting from these projects within the major projects geographic scope (5 miles from the Project) are similar to other construction projects in the area. These impacts are expected to be temporary and minor.

Based on application maps available on the NCUC website and available aerial imagery, the Project estimates the identified solar projects in the geographic scopes for the Project would affect approximately 923 acres of land, approximately 385 of which are estimated to be forest land. Approximately 280 of the estimated acres consist of mapped Prime Farmland within one-mile of the Project, 897 acres are located within a shared HUC 10 watershed, and 523 acres are located within a shared HUC 12 watershed (see Table 1.10-2). Several of the solar project sites have passed the construction date indicated on the available application materials by more than one year, and no constructed facility is visible on available aerial photography. Therefore the timeframe for construction of these solar projects is unknown. Two of the identified solar projects are located directly adjacent to the existing Transco right-of-way at mileposts (MP) 49 to 51.

The Williamsburg Solar, LLC 80MW solar generation facility (Cypress Creek Renewables Solar Farm) in Gibsonville, North Carolina is a proposed 341-acre facility located immediately adjacent to and east and west of the Project between approximate MP 49 to 51. The facility is also immediately adjacent to the Transco right-of-way. The Certificate for Public Convenience and Necessity for the Williamsburg Solar Project was issued in September 2018, and construction is anticipated to begin in 2019. Cumulative impacts resulting from the project would be associated with soils and geology, water resources and wetlands, cultural resources, visual resources, land use and recreation, vegetation and wildlife, air and noise, and socioeconomics as described in Resource Report 1 section 1.10.5.

Husky Solar Farm, owned by Husky Solar, LLC, located in Reidsville, North Carolina is a 29–acre, 7.02 megawatt Direct Current solar photovoltaic facility located on both sides of North Carolina Highway 87. The Project is adjacent to the solar farm between approximate MP 48.7 to 49.0. This facility was permitted prior to 2015, and is currently in operation. Project was issued in September 2018, and construction is anticipated to begin in 2019. Cumulative impacts resulting from the project would be negligible because construction of the project is complete and temporarily disturbed areas have been restored.

Solar projects are typically sited in a manner to avoid wetland and waterbody impacts due to state and local requirements. As such, significant cumulative impacts on wetland and water resources are not anticipated.

Additionally, based on the unknown construction timeframe for several of the solar projects, significant cumulative impacts relating to soils and geology, cultural resources, land use, visual resources, and environmental justice are not anticipated.

1.10-4 Transportation Projects

The Project identified transportation projects within the geographic scope of the Project through review of Virginia and North Carolina Department of Transportation websites. Transportation projects identified include those that may potentially impact water resources within a shared watershed (HUC 10) or sub watershed (HUC 12). The majority of transportation projects identified in Table 10.1-2 are greater than two miles from the Project, and, therefore, will not contribute to cumulative impacts for soils and geology, cultural resources, land use, visual resources, and environmental justice. The identified transportation projects are unlikely to contribute significantly to cumulative impacts for air and noise due to short construction timeframes. The majority of the transportation projects identified share a watershed with the Project, therefore potentially contributing to cumulative impacts relating to water resources. Impacts to groundwater, wetlands, and surface waters are unknown for the identified projects.

Based on application maps available on the Virginia and North Carolina Department of Transportation websites and available aerial imagery, the Project estimates the transportation projects in the geographic scopes for the Project would affect approximately 327 acres of land. The majority of transportation projects consist of improvements, widening, or lengthening of existing roads in developed areas; therefore no significant cumulative impacts on forest land from construction of the Project and the transportation projects are anticipated. Approximately 44 of the estimated acres are located within a shared HUC 10 watershed, and 3.7 acres are located within a shared HUC 12 watershed (see Table 1.10-2). Only one of the transportation projects (i.e., Stony Mill Road / Turnstall High Road) is located within one mile of the Project, and no prime farmland would be affected by the Stony Mill Road / Turnstall High Road project. The identified transportation projects are anticipated to have short-term and small geographic impact during construction; it is anticipated long term environmental resources will not result in significant impacts.

1.10-5 Commercial, Industrial, Residential Development Projects

Development projects identified within the vicinity of the project range from small housing developments to large scale industrial park and a research and development facility. The majority of these projects share a watershed with the Project and could potentially have cumulative impacts to water resources within a shared watershed (HUC 10) or sub watershed (HUC 12) such as a specific waterway or wetland. Information regarding development projects was obtained using available online resources.

It is assumed permit approvals are pending or planned coordination is pending for impacts to wetlands and other water resources within the Project vicinity. Long term air and noise impacts are not expected to result from the construction of the listed development projects in Table 1.10-2. Based on information available from County websites and county planning departments, commercial, industrial, and residential development projects in the geographic scopes of the Project are estimated to impact a total of approximately 421 acres, which are located within shared HUC 10 watersheds for the Project. The Project estimates that approximately 309 acres of this area is located within shared HUC 12 watersheds for the Project (see Table 1.10-2). The identified projects are anticipated to have short-term and small geographic impact and will not result in significant cumulative impacts to the area.

1.10-6 Mining Operations

Information regarding mineral resources in Virginia and North Carolina were obtained through the Virginia Department of Mines, Minerals, and Energy (VDMME) mineral resources (all commodities) database (accessed May 2, 2019) and the United States Geological Survey (USGS) Mineral Resources Data System (2016). Two mining operations were identified within 0.25 mile of the Project. A kiln plant was identified 0.2 mile from MP 26.6 and the East Alamance Quarry was identified 0.1 mile from MP 66.8. The Project reviewed aerial photography at the kiln plant location and no operation was visible in this location; therefore, no cumulative impacts from the kiln plant are anticipated.

An additional 21 active mining operations were identified through review of the USGS Mineral Resources Data System (2016) located more than 0.25 mile from the Project (with locations as far as 20 miles from the Project), within shared HUC 10 and HUC 12 watersheds. The identified operations include quarries, mines, pits, and a brick plant. The active operations were identified within shared HUC 10 watersheds including Cherrystone Creek – Banister River, Hogans Creek – Dan River, Cascade Creek – Dan River, Lower Smith River, Headwaters Haw River, Big Alamance Creek, and Back Creek – Haw River. Ongoing operations at these locations require surface clearing, excavation, mineral extraction, and reclamation. These activities are presently ongoing and could occur into the reasonably foreseeable future. These activities are also regulated by state and local authorities.

Review of the VDMME mineral resources database identified an additional 27 mineral resource sites located between one and 13 miles from the Project in Virginia and North Carolina. The Project viewed the locations on available aerial imagery and no active mining was visible at the VDMME mineral resource locations. The sites were located in forested areas or areas with residential structures. Based on review of the VDMME database and available aerial imagery, no significant cumulative impact is anticipated from the mineral resource locations and construction of the Project.

Mining operations are typically conducted incrementally, as extraction expands in one area, other excavated areas are reclaimed in accordance with state or local permit requirements. Affected acres continuously change as extraction and reclamation activities occur over time at any one site. State permits may also pose limits on maximum amount of active area at one time. Given the nature of these mining activities, it is assumed that some amount of area would be impacted within the geographic scope of the Project; however, this area would be subject to state and local permit conditions to protect surface and groundwater, and to reclaim areas were extraction is complete. The Project estimated actively mined area at the East Alamance Quarry at approximately 240 acres, based on available aerial imagery. Assuming each of the 21 active mineral operations identified in the USGS Mineral Resources Data System are similar in size (approximately 300 acres), an estimated 6,540 acres would be affected by ongoing mining operations within the geographic scopes of the Project. Because mining operations in the geographic scopes for the Project would be subject to acreage limitations, erosion and sediment control, and reclamation requirements in state and local permits issued for the operations; no significant cumulative impact is anticipated from continued operation of mining sites and construction of the Project.

1.10-7 Potential Cumulative Impact on Resources within the Project Area

Soils and Geology – The facilities associated with the Project are expected to have a temporary but direct impact on near-surface geology, soils, and sediments. Clearing and grading associated with construction of the Project and the other projects listed in Table 1.10-2 could accelerate the soil erosion process and, without adequate protection, could result in discharge of sediment to adjacent waterbodies and wetlands. Since the direct effects will be localized and limited primarily to the period of construction, cumulative

impacts on geology, soils, and sediments will only occur if other projects are constructed at the same time and general location as the proposed Project facilities. Of the projects listed in Table 1.10-2, the only projects that may overlap in time and location with construction of the Project are the Granite Mill project and the Transco Southeastern Trail. Although the Project proposes to use a temporary access road along the Granite Mill site, no significant cumulative impacts on soils or geology are anticipated from use of the access road for both projects. The Project will apply dust control measures in accordance with its Project plans as necessary and will coordinate with the landowner for use of the road. Similarly, the Project and the Transco Southeastern Trail project propose to use the same permanent access road (PA-PI-001A and PA-PI-001C). Use of the same permanent access road for both projects minimizes the amount of soils disturbed for both projects. Each project will implement their respective dust control plans to minimize disturbance on soils; therefore, no significant cumulative impacts on soils and geology are anticipated from construction or operation of the projects.

The Project will implement the provisions of the FERC Plan and Procedures and its Project-specific E&SCP to establish a baseline for minimizing the potential for erosion as a result of water or wind action and to aid in reestablishing vegetation after construction. In addition, disturbance associated with construction activities will be minimized and mitigated through the application of BMP's that are incorporated in the Project-specific E&SCP. Should hazardous materials or contaminated soils and/or sediments be encountered during construction, they will be disposed of at fully licensed and permitted disposal facilities in accordance with applicable state and federal laws and regulations. As a result, the cumulative effect on geological resources, soils, and sediments are expected to be temporary and minor.

Water Resources and Wetlands – Cumulative effects on groundwater resources are expected to be temporary and limited to areas that are affected by each project listed in Table 1.10-2. Impacts on groundwater could include turbidity, reduced water levels, and contamination. Construction activities such as blasting could negatively impact wells close to the Project; however, the Project will implement the measures described in its Water Resources Identification and Testing Plan (see Resource Report 2, Appendix 2-E). Cumulative effects on surface water resources affected by the Project would be limited to waterbodies that are affected by other projects located within the same major watersheds. No permanent diversions or dams are planned, so any impacts from construction on surface waters would be temporary. The greatest potential impacts of pipeline construction on surface waters would result from an increase in sediment loading to surface waters and an increase in internal sediment loading due to channel/floodplain instability as a result of a change in erosion deposition patterns.

Table 1.10-3 below summarizes the estimated acres of land affected for the other projects identified in Table 1.10-2, and identified for the MVP Southgate Project, within shared HUC 10 watersheds. Table 1.0-4 below summarizes the estimated acres of land affected for the other projects identified in Table 1.10-2, and identified within the MVP Southgate Project, within shared HUC 12 watersheds.

Table 1.10-3

HUC 10 Watersheds Affected by the MVP Southgate Project and Other Projects

Activity	Acres	Percent of Watershed
Virginia		
Watershed: Cascade Creek-Dan River	**49,809.80**	
Other Identified Projects a/	133.00	0.3
MVP Southgate and Associated Facilities	105.00	0.2
Watershed: Cherrystone Creek-Banister River	**88,668.20**	
Other Identified Projects a/	219.50	0.2
MVP Southgate and Associated Facilities	243.90	0.3
Watershed: Hogans Creek-Dan River	**52,924.80**	
Other Identified Projects a/	112.00	0.2
MVP Southgate and Associated Facilities	26.10	0.05
Watershed: Stinking River- Banister River	**148,876.80**	
Other Identified Projects a/	175.80	0.12
MVP Southgate and Associated Facilities	11.00	0.01
Watershed: Wolf Island Creek- Dan River	**97,896.40**	
Other Identified Projects a/	11.70	0.01
MVP Southgate and Associated Facilities	153.20	0.2
Estimated Virginia Total:	**1,191.20**	
North Carolina		
Watershed: Back Creek- Haw River	**160,350.90**	
Other Identified Projects a/	493.00	0.3
MVP Southgate and Associated Facilities	284.70	0.2
Watershed: Big Alamance Creek	**167,769.50**	
Other Identified Projects a/	47.00	0.03
MVP Southgate and Associated Facilities	4.60	0.003
Watershed: Cascade Creek- Dan River	**83,792.70**	
Other Identified Projects a/	18.00	0.02
MVP Southgate and Associated Facilities	262.30	0.3

Table 1.10-3

HUC 10 Watersheds Affected by the MVP Southgate Project and Other Projects

Activity	Acres	Percent of Watershed
Watershed: Headwaters Haw River	**120,671.80**	
Other Identified Projects a/	787.00	0.7
MVP Southgate and Associated Facilities	136.40	0.1
Watershed: Hogans Creek-Dan River	**128,257.40**	
Other Identified Projects a/	0.00	N/A b/
MVP Southgate and Associated Facilities	150.10	0.1
Watershed: Lower Smith River	**6,785.50**	
Other Identified Projects a/	0.00	NA b/
MVP Southgate and Associated Facilities	5.30	0.1
Estimated North Carolina Total:	**2,188.40**	
Estimated Shared HUC10 Impact Total:	**3,379.60**	

a/ Includes estimated values (see Table 1.10-2)

b/ Not applicable - No other projects identified in the watershed

Table 1.10-4

HUC 12 Watersheds Affected by the MVP Southgate Project and Other Projects

Activity	Acres	Percent of Watershed
Virginia		
Watershed: Cane Creek-Dan River	**14,461.8**	
Other Identified Projects a/	0.0	N/A b/
MVP Southgate and Associated Facilities	26.1	0.2
Watershed: Cherrystone Creek	**29,131.7**	
Other Identified Projects a/	219.5	0.8
MVP Southgate and Associated Facilities	105.3	0.4
Watershed: Lower Sandy River	**34,709.0**	
Other Identified Projects a/	10.0	0.0
MVP Southgate and Associated Facilities	83.4	0.2
Watershed: Sandy Creek (West)-Dan River	**20,670.4**	

Table 1.10-4

HUC 12 Watersheds Affected by the MVP Southgate Project and Other Projects

Activity	Acres	Percent of Watershed
Other Identified Projects a/	1.7	0.0
MVP Southgate and Associated Facilities	69.8	0.3
Watershed: Shockoe Creek-Banister River	**18,805.6**	
Other Identified Projects a/	136.4	0.7
MVP Southgate and Associated Facilities	11.0	0.1
Watershed: Trotters Creek-Dan River	**18,049.6**	
Other Identified Projects a/	133.0	0.7
MVP Southgate and Associated Facilities	105.0	0.6
Watershed: White Oak Creek-Banister River	**23,127.8**	
Other Identified Projects a/	0.0	N/A b/
MVP Southgate and Associated Facilities	138.5	0.6
Estimated Virginia Total:	**1,039.7**	
North Carolina		
Watershed: Boyds Creek-Haw River	**19,153.0**	
Other Identified Projects a/	256.0	1.3
MVP Southgate and Associated Facilities	132.0	0.7
Watershed: Cascade Creek	**6,121.3**	
Other Identified Projects a/	0.0	N/A b/
MVP Southgate and Associated Facilities	59.8	1.0
Watershed: Fall Creek-Smith River	**6,738.9**	
Other Identified Projects a/	0.0	N/A b/
MVP Southgate and Associated Facilities	5.3	0.1
Watershed: Giles Creek-Haw River	**10,519.9**	
Other Identified Projects a/	176.0	1.7
MVP Southgate and Associated Facilities	17.5	0.2
Watershed: Lick Fork	**12,923.0**	

Table 1.10-4

HUC 12 Watersheds Affected by the MVP Southgate Project and Other Projects

Activity	Acres	Percent of Watershed
Other Identified Projects a/	0.0	N/A b/
MVP Southgate and Associated Facilities	46.6	0.4
Watershed: Little Troublesome Creek	**8,323.9**	
Other Identified Projects a/	30.0	0.4
MVP Southgate and Associated Facilities	11.6	0.1
Watershed: Lower Back Creek	**21,357.5**	
Other Identified Projects a/	143.0	0.7
MVP Southgate and Associated Facilities	6.4	0.03
Watershed: Lower Little Alamance Creek	**19,489.7**	
Other Identified Projects a/	38.0	0.2
MVP Southgate and Associated Facilities	4.6	0.02
Watershed: Stony Creek-Stony Creek Reservoir	**20,308.4**	
Other Identified Projects a/	0.0	N/A b/
MVP Southgate and Associated Facilities	48.8	0.2
Watershed: Town Creek-Dan River	**22,520.2**	
Other Identified Projects a/	0.0	N/A b/
MVP Southgate and Associated Facilities	142.5	0.6
Watershed: Town of Altamahaw-Haw River	**13,012.8**	
Other Identified Projects a/	252.0	1.9
MVP Southgate and Associated Facilities	107.3	0.8
Watershed: Travis Creek-Haw River	**22,306.2**	
Other Identified Projects a/	40.0	0.2
MVP Southgate and Associated Facilities	97.5	0.4
Watershed: Trotters Creek-Dan River	**9,738.4**	
Other Identified Projects a/	0.0	N/A b/
MVP Southgate and Associated Facilities	4.0	0.04
Watershed: Upper Hogans Creek	**29,143.8**	

Table 1.10-4

HUC 12 Watersheds Affected by the MVP Southgate Project and Other Projects

Activity	Acres	Percent of Watershed
Other Identified Projects a/	0.0	N/A b/
MVP Southgate and Associated Facilities	103.5	0.4
Watershed: Upper Wolf Island Creek	**18,148.1**	
Other Identified Projects a/	0.0	N/A b/
MVP Southgate and Associated Facilities	56.0	0.3
Estimated North Carolina Total:	**1,778.4**	
Estimated HUC10 Impact Total:	**2,818.1**	
a/ Includes estimated values (see Table 1.10-2)		
b/ Not applicable - No other projects identified in the watershed		

The Mountain Valley Pipeline and the MVP Southgate Project pipeline both cross perennial streams Little Cherrystone Creek (S-F18-65, Project MP 0.4) and Cherrystone Creek (S-D18-18, Project MP 1.7) in the Cherrystone Creek-Banister River HUC-10 watershed. Neither crossing location is located within overlapping workspace areas for the projects. The Mountain Valley Pipeline crosses Little Cherrystone Creek approximately 3.5 miles upstream of the MVP Southgate Project pipeline crossing. The Mountain Valley Pipeline crosses Cherrystone Creek approximately 10.0 miles upstream of the MVP Southgate Project pipeline crossing. MVP proposes to construct the stream crossings for the projects in accordance with the FERC (2013) Wetland and Waterbody Construction Procedures to minimize impacts on the streams. The stream crossings are separated by construction schedule and distance, and the crossings will be restored to pre-construction profiles. Therefore, no cumulative impacts on the streams are anticipated from construction or operation of the MVP projects.

Based on review of field survey data for the MVP Southgate Project, and review of the United States Geological Survey National Hydrography Dataset, there are no streams within the workspace for the Cypress Creek Renewables Solar Farm or the Husky Solar Farm; therefore, no cumulative impacts on surface waters are anticipated from construction of the projects.

Table 1.10-5 below identifies the number of waterbodies affected in Shared HUC 10 watersheds for the MVP Southgate Project and other projects in Table 1.10-2 based on available information.

Table 1.10-5

Waterbodies Affected in Shared HUC 10 Watersheds for the Southgate Project and Other Projects

Watershed (10-Digit HUC)	Number of Waterbodies Crossed by the Southgate Project[a/]				Number of Waterbodies Crossed by the Other Relevant Projects[b/]			
	Ephemeral	Intermittent	Perennial	Pond	Ephemeral	Intermittent	Perennial	Pond
Cherrystone Creek-Banister River (0301010501)	0	13	10	1	0	11	5	0
Stinking River - Banister River (0301010502)	0	0	0	0	0	5	2	0
Back Creek – Haw River (0303000204)	8	24	22	1	0	4	1	0
Total Streams Crossed	**8**	**37**	**32**	**2**	**0**	**20**	**8**	**0**

a/ Field delineated streams through January 22, 2019 crossed by the MVP Southgate Project pipelines.

b/ Mapping included in the FERC eLibrary, available aerial imagery, and the USGS National Hydrography Dataset, were used to determine number of stream crossings for other projects in HUC 10 watersheds shared with the Southgate Project

Each of the project proponents in Table 1.10-2 will minimize the project-related effects including sediment loading and channel/floodplain instability by implementing wetland and waterbody construction and mitigation measures, including erosion control measures by complying with applicable federal and state permit requirements. Construction of the Project facilities will result in temporary impacts to wetlands. However, each proponent for the projects listed in Table 1.10-2 that affects wetlands will be required by the terms and conditions of their respective Section 404 permits to provide compensatory mitigation for unavoidable wetland impacts. The cumulative effect on water resources and wetlands will be temporary and minor.

Vegetation and Wildlife – The Project traverses deciduous forest, evergreen forest, mixed deciduous-evergreen forest, scrub-shrub land, herbaceous upland, wetlands, and agricultural lands. The Project identified 17 projects within the geographic scope of vegetation and wildlife resources (i.e., HUC 12). These projects consist of three energy projects, six solar projects, six commercial / industrial / residential projects, and two mineral extraction operations (see Table 1.10-2). With the exception of the Granite Mill Project, all of these projects are anticipated to impact vegetated land, which provides habitat for wildlife. Cumulative impacts on vegetation and wildlife in conjunction with other projects can be expected. When projects are constructed at or near the same time, the combination of construction activities could have a cumulative impact on vegetation and wildlife in the immediate area. Clearing and grading and other construction activities associated with the projects will result in the removal of vegetation, alteration of wildlife habitat, displacement of wildlife, and other secondary effects such as forest fragmentation and establishment of invasive plant species.

The total amount of vegetation that may be affected by these projects could appear significant but is still relatively minor compared to the abundance of similar vegetation cover types and wildlife habitats in the Project area. In addition, for some of the projects listed in Table 1.10-2 impacts on vegetation will be temporary. As part of each project's permit conditions, mitigation measures should be implemented to

minimize the potential for erosion, revegetate disturbed areas, increase the stabilization of site conditions, and control the spread of noxious weeds. Therefore, the degree and duration of the cumulative impact on vegetation and terrestrial wildlife from these projects will be minimized.

Land Use – The Project and several other projects listed in Table 1.10-2 will result in both temporary and permanent modifications to existing land uses. The Project identified 11 projects within the geographic scope of land use resources (i.e., one-mile). These projects consist of three energy projects, four solar projects, one road project, one commercial / residential project, and two mineral extraction operations (see Table 1.10-2). The pipeline is located parallel to or collocated with existing utility corridors, trails, and roads for approximately 54 percent (40 miles) of the proposed alignment. New permanent effects on land use will be minimal because approximately 70 percent of the land affected by construction of the Project facilities will be allowed to revert to pre-construction uses following construction, except for the habitat conversion of forest to open within 15 feet of the pipeline along the permanent right-of-way to ensure that root systems do not affect the exterior coating of the pipeline.

Following construction, the majority of affected areas will be restored and relinquished back to the landowner without restrictions. Some new restrictions will be imposed on the new (no greater than 50-foot-wide) permanent right-of-way, but primarily these will be limited to activities such as deep excavations or the construction of new, permanent structures or planting of trees that could threaten the integrity of the pipeline or preclude the Project's ability to maintain the pipeline. Because a relatively small area of land used by the Project will be converted to another land use type and because construction will be short term, the cumulative effect on land use will be temporary and minor.

Construction and operation of the new aboveground facilities associated with the Project as well as those associated with the Transco Southeastern Trail and the Virginia Southside Expansion would result in changes to existing viewsheds within the project areas. The Project's impacts on visual resources would be greatest near the new Lambert Compressor Station. The Project has sited the Lambert Compressor station adjacent to existing compatible development associated with natural gas infrastructure to minimize impacts on visual resources. As described in Resource Report 8, the Lambert Compressor Station will be set back from the road far enough so that the grade of the terrain and existing wooded vegetation provides adequate visual screening for the facility from the road. The outdoor lighting for the new compressor station will be limited to the minimum required for operation and security. Additionally, lighting at the station will have directional control. No significant cumulative effect on visual resources is anticipated from the construction and operation of the Lambert Compressor Station or the other projects in the vicinity of the station. A significant portion of the pipeline will be located adjacent to and collocated with existing utility rights-of-way, and because of the existing field and forest patchwork landscape, and the generally low relief in the Southgate Project area, visual impacts during operation of the pipeline are expected to be minimal. Cumulative impacts on visual resources from construction and operation of the pipeline would be temporary and minor.

As discussed in Resource Report 8, Section 8.4, several public and private recreational or special interest areas will be crossed or adjacent to the Southgate Project. Some of these areas may be utilized for ecotourism (e.g., the Banister River, Sandy River, Dan River, Haw River, and the Mountains-To-Sea Trail). Cumulative impacts on these resources could result if the Southgate Project and other projects listed in Table 1.10-2 are constructed in the same area during the same timeframe. Recreational or special interest areas impacts associated with construction and operation of the Southgate Project and other projects may result from the removal of vegetation, particularly in forested areas. To the extent practicable, the Project has attempted to avoid large tracts of forest land to reduce potential visual impacts on the landscape. A

significant portion of the pipeline will be located adjacent to and collocated with existing utility rights-of-way. The Project will avoid impacts on the Dan River Trail and the Mountains-to-Sea trail by using trenchless construction methods in these locations. Noise and visual disturbance associated with construction activities is anticipated to be minor based on the distance of public recreation lands from the Project. As a result, cumulative impacts from construction and operation of the Project and from the other projects in Table 1.10-2 are anticipated to be temporary and minor, if any.

The Project estimated approximately 427 acres of prime farmland would be affected by the other projects located within one-mile of the Southgate Project during construction, and approximately 330 acres would be affected during operation of the other projects. The estimated prime farmland acreage affected by other projects within one-mile of the Southgate Project is summarized in the table below.

Table 1.10- 6

Estimated Prime Farmland Acres Affected by Other Projects within one-mile of the Southgate Project

Other Projects	Construction Acres	Operation Acres
Virginia Southside Expansion	17	14
Transco Southeastern Trail	63	10
MVP Pipeline	50	9
Cypress Creek Renewables Solar Farm	248	248
Husky Solar Farm	24	24
Green Level - Charles Drew Solar Energy Farm	3	3
Bakatsias Solar	6	6
Stony Mill Road (Route 869 / Tunstall High Road Route 869)	0	0
Granite Mill Project	0	0
East Alamance Quarry	17	17
Total Estimated Prime Farmland Impacts for Other Projects	**427**	**330**
Southgate Project Prime Farmland Impacts	**521**	**163**
Estimated Cumulative Prime Farmland Impacts	**948**	**493**

Notes: Sums may not equal total of addends due to rounding.

As described in Resource Report 7, the fact that a particular soil is considered prime farmland or farmland of statewide importance does not mean that it is currently in agricultural use. Some prime farmland or farmland of statewide importance soils may be located in developed, forested, or open uncultivated or non-pasture areas. Similarly, the Environmental Assessment for the Transco Southeastern Trail Project (FERC Accession Number 20190208-3010) states that approximately 82 acres (about 100 percent) of Station 165 is considered prime farmland or farmland of statewide importance. However, none of this land is currently used for agricultural purposes.

Impacts on active agricultural land from construction of the Project will be minimized by implementing measures in the Project E&SCP and FERC May 2013 version of the Upland Erosion Control, Revegetation, and Maintenance Plan. These measures include, but are not limited to, installation of erosion control devices, topsoil segregation, soil decompaction, revegetation, and drain tile restoration. Agricultural activities are not precluded within the permanent right-of-way of the Project; therefore, impacts on prime

farmland within temporary workspace will be limited to the construction phase and will be minor and temporary. The Southgate Project has attempted to avoid locating aboveground facilities within active agricultural areas to avoid permanent impacts on these areas. However, where construction and operation of aboveground facilities will result in temporary or permanent impacts on active agriculture, the Project will compensate the landowner(s) accordingly. Additionally, the amount of land affected will be small compared to the total area of agricultural land in each county. For these reasons, no significant cumulative impacts on soils identified as prime farmland from construction or operation of the Project and the other projects identified above are anticipated.

Cultural Resources – Past disturbances to cultural resources in the Project area are typically related to urban development, accidental disturbances, intentional destruction or vandalism, lack of awareness of historic value, and construction, maintenance, and operations associated with existing infrastructure. The Project identified 10 projects within the geographic scope for cultural resources (0.5 mile). These projects consist of three energy projects, three solar projects, one commercial / residential project, one road project, and two mineral extraction operations (see Table 1.10-2). Federally regulated projects, such as the three energy projects, will include mitigation measures designed to avoid or minimize additional direct impacts on cultural resources. Non-federal actions will need to comply with any identification procedures and mitigation measures required by the states of Virginia and North Carolina. Cumulative effects on cultural resources are not anticipated.

Socioeconomics – All of the projects included in Table 1.10-2 are within the geographic scope for socioeconomics. The Project and the projects listed in Table 1.10-2 will generate temporary construction jobs. The local supply of construction workers needed for these projects may be derived from workers employed in the area, which will provide a direct economic benefit to those individuals and the communities in which they reside. The non-local laborers could represent an increase in the percent of the total population in the Project area (assuming half the construction workers are non-local); however, the existing local infrastructure and housing availability in the Project area is expected to be sufficient to provide for the needs of non-local workers. There will be both short and long term positive cumulative economic benefits from these projects. Taxes generated from operation of the projects will result in an annual tax revenue increase. Permanent employment will also increase as a result of the operation of many of these projects, with the cumulative benefit of potentially lowering local unemployment rates.

Air Quality – Construction equipment and vehicles emit air pollutants in the immediate vicinity of construction, and fugitive dust emissions are generated by soil excavation and other construction activities. Other projects within 0.25 mile of construction workspaces for the Southgate Project include the Virginia Southeast Expansion project, the Transco Southeastern Trail, MVP pipeline, Cypress Creek Renewables Solar Farm, Husky Solar Farm, Granite Mill project, kiln plant, and East Alamance Quarry. Of these projects, the construction timeframe for the Transco Southeastern Trail and the Granite Mill project may overlap with construction of the Southgate Project. The East Alamance Quarry is an ongoing operation that is anticipated to continue to operate during construction of the Southgate Project.

The projects within 50 kilometers of the Project operations are provided in Table 1.10-7 below. The air emissions for major sources located within 50 kilometers of the Lambert Compressor Station are provided in Table 1.10-8 below.

Table 1.10-7

Facilities with Air Quality Impacts within 50-km of MVP Southgate Operations

County / State	Facility	Approximate Distance to the MVP Southgate Project (kilometers)
Pittsylvania, VA	Transcontinental Gas Pipe Line Company, LLC – Station 165	1
Rockingham, NC	Duke Energies Carolinas, LLC – Dan River Combined Cycle Facility	2
Alamance, NC	APAC-Atlantic, Inc. – Plant #8	13
Pittsylvania, VA	Owens-Brockway Glass Container Inc – Ringgold	16
Rockingham, NC	Transcontinental Gas Pipe Line Company, LLC – Station 160	17
Rockingham, NC	Rockingham County Landfill	18
Alamance, NC	Alamance Aggregates, LLC	20
Guilford, NC	City of Greensboro – T.Z. Osborne Water Reclamation Facility	20
Randolph, NC	Norcraft Companies, LP, - UltraCraft Cabinetry	26
Orange, NC	The University of North Carolina at Chapel Hill	31
Guilford, NC	N.S. Flexibles, LLC	36
Stokes, NC	Duke Energy Carolinas, LLC – Belews Creek Steam Station	41
Guilford, NC	Plantation Pipe Line Company	41
Guilford, NC	City of High Point – Eastside Wastewater Treatment Plant	45
Durham, NC	NIEHS	47

Table 1.10-8

Project Emissions for Major Air Quality Projects within 50-km of Lambert Compressor Station

County / State	Facility	Annual Project Emission Potential (tons per year)			
		NOx	VOC	SO_2	Particulates
Pittsylvania, VA	Transcontinental Gas Pipe Line Company, LLC – Station 165	182.3	35.4	12	23.3

Table 9.2-9 of Resource Report 9, presents the list of the major existing and reasonably foreseeable future projects that may cumulatively or additively impact air quality that could be affected by the construction and operation of the Project along with an approximate distance from the Lambert Compressor Station. Operation of the existing and reasonably foreseeable major air emissions sources listed in Table 9.2-9 will have air emissions associated with them; however, the other sources of air emissions from operation of these recent or planned projects are or will be controlled in accordance with state and federal air pollution laws and regulations.

The existing and proposed offsite major air emissions sources are or will be operated in compliance with all applicable state and federal air regulations; including, stack testing, recordkeeping, reporting, and monitoring requirements in order to establish compliance with federally enforceable emissions standards. Because operation of the Project along with the other existing and proposed major Title V projects/facilities, will be regulated by the Virginia Department of Environmental Quality through the air permitting process, the cumulative effect of operation of the Project with other projects is not expected to result in adverse air quality impacts.

Noise Quality – Construction activities also have the potential to produce an increase in noise levels. Similar to potential cumulative air quality impacts, cumulative impacts from construction noise from the Project and the other projects listed in Table 1.10-2 also depends on the type of construction activities that are taking place at the same time and how close in proximity the construction activities are occurring. Other

projects within 0.25 mile of the general construction for the Southgate Project include the Virginia Southeast Expansion project, the Transco Southeastern Trail, MVP pipeline, Cypress Creek Renewables Solar Farm, Husky Solar Farm, Granite Mill project, kiln plant, and East Alamance Quarry. Of these projects, the construction timeframe for the Transco Southeastern Trail and the Granite Mill project may overlap with construction of the Southgate Project. The East Alamance Quarry is an ongoing operation that is anticipated to continue to operate during construction of the Southgate Project. Because the noise generated by construction activities will be temporary and localized, construction activities for the Project along with the other projects are not expected to result in significant adverse noise impacts.

There are no projects included in the list of reasonably foreseeable actions that are within 0.5 mile of a proposed drill or direct pipe site. Due to the relatively short duration of the planned construction activities at the proposed drill and direct pipe sites, and the remote nature of the crossing locations, it is unlikely that there will be any construction projects occurring during nighttime hours in close enough proximity to cause cumulative impacts.

The only projects included in the list of reasonably foreseeable actions that are within one mile of the Project permanent noise emitting facilities are the Virginia Southside Expansion Project, the Transco Southeastern Trail, and the Mountain Valley Pipeline project. The Mountain Valley Pipeline project does not include any noise emitting facilities that are within one-mile of any of the Project facilities.

The design of the proposed compressor station, and compressor stations 165 and 166 associated with the Transco Southeastern Trail and Virginia Southside Expansion, will include noise abatement measures, as applicable, to ensure the off-site impact of the noise generated by operation of the compressor station is in compliance with all applicable noise standards, including the FERC sound level limits.

Environmental Justice - The Project evaluated other projects within potential environmental justice communities shared by the Southgate Project and other projects that occur in potential environmental justice communities not shared by the Project (see Figure 1.10-1). Other projects that are within potential environmental justice communities shared by the Southgate Project are in North Carolina and include the Granite Mill project, the East Alamance Quarry, Bakatsias Solar Farm, and Green Level – Charles Drew Solar Farm in Alamance County.

The Southgate Project and the other shared projects are not expected to result in disproportionate impacts on the health, social conditions, or economic conditions of minority or low-income communities. The primary adverse impacts associated with the construction of these projects include temporary noise, dust, and traffic impacts. None of these impacts are considered significant given the temporary nature of the impacts and measures that each project would implement to minimize such impacts. In addition, construction of the Bakatsias Solar Farm is complete, and would not overlap with construction of the Project. Construction related impacts associated with the Southgate Project will occur in areas with a variety of socioeconomic backgrounds.

Positive cumulative economic benefits will be generated from the Southgate Project and other shared projects, including an increase in annual tax revenue from project operations and an increase in permanent employment with the cumulative benefit of potentially lowering local unemployment rates. The Granite Mill project would have a positive impact on jobs and housing as it includes mixed use development. Existing operations at the East Alamance Quarry also contribute local jobs and the local economy. The construction and operation of the Southgate Project and the other shared projects would not cause a disproportionate share of adverse environmental or socioeconomic impacts on any racial, ethnic, or socioeconomic groups that meet the environmental justice criteria; therefore, it is not anticipated cumulative

impacts on environmental justice communities will result from the construction of the Southgate Project when considered with the other shared projects in the area.

1.10-8 Conclusion

The majority of cumulative impacts associated with the Southgate Project would be temporary and minor when considered in combination with past, present, and reasonably foreseeable activities.

The primary factors associated with the Southgate Project that will minimize its contribution to cumulative impacts are as follows:

- The impacts resulting from the Project pipeline facilities will primarily be short-term and constitute temporary impacts associated with construction;
- Approximately 54 percent of the Project pipeline facilities will be parallel to existing utility corridors and other rights-of-way; thereby minimizing impacts associated with construction; and
- The Project has been designed to avoid and minimize impacts to the extent practicable and will implement various plans and techniques to ensure potential impacts are further minimized (e.g., Project-specific E&SCP).

In addition, significant long-term cumulative benefits to the communities in the Project area will also be realized from increased tax revenues, and short-term cumulative benefits will also be realized through jobs and wages and purchases of goods and materials for the Project.

MVP Southgate Project

Docket No. CP19-14-000

Attachment 14-1

Sandy River Site-specific Construction Mitigation and Restoration Plan

May 2019

STREAM CROSSINGS:

1. VERIFY WEATHER CONDITIONS ARE FAVORABLE FOR CONSTRUCTION ACTIVITY AND VERIFY SITE ACCESSIBILITY IS STABLE AND PREPARED FOR CONSTRUCTION ACTIVITY.
2. HAVE ALL MATERIALS NECESSARY ON SITE FOR CROSSING, INCLUDING BUT NOT LIMITED TO PUMPS (PRIMARY AND BACKUP), HOSES, FILTRATION DEVICES, SECONDARY CONTAINMENT, SPILL KITS, LIGHTING, APPROPRIATE PERMANENT AND TEMPORARY SEED MIXES, AND OTHER APPROPRIATE BMPS (FILTER BAGS, STRAW BALES, SILT FENCE, COMPOST FILTER SOCK, JUTE MATTING, GEOTEXTILE FABRIC, TURBIDITY CURTAINS, ETC.) TO FACILITATE MAINTENANCE AND UPKEEP DURING OPERATION OF THE CROSSING.
3. IDENTIFY AND CONFIRM (WITH EI) LOCATION OF DEWATERING STRUCTURE AND INSTALL WITHIN A WELL VEGETATED UPLAND AREA PRIOR TO ANY INSTREAM WORK. IF A WELL VEGETATED AREA IS NOT AVAILABLE, IMPLEMENT APPROPRIATE MEASURES TO MINIMIZE EROSION AND SEDIMENT LOSS.
4. CONDUCT PRE (AND POST CONSTRUCTION) CIVIL SURVEY OF TOP OF BANKS AND STREAM CENTERLINE (PLAN AND CROSS SECTIONS); PHOTOGRAPH UPSTREAM, WORK AREA, AND DOWNSTREAM OF CROSSING. STREAM MUST BE RETURNED TO ORIGINAL CONTOURS AND CONDITIONS, PER NWP 12 REQUIREMENTS.
5. INSTALL TEMPORARY EQUIPMENT BRIDGE, BYPASS HOSES, FLUMES, PUMPS, AND COFFERDAM AS DESCRIBED IN STREAM CROSSING DETAILS AROUND THE WORK AREA. INSTALLATIONS SHALL BE SIZED TO ACCOMMODATE STREAM FLOW RATES AT TIME OF CONSTRUCTION. TEMPORARY EQUIPMENT BRIDGE TO REMAIN IN PLACE FOR DURATION OF THE PROJECT TO FACILITATE EQUIPMENT PASSAGE.
6. BYPASS HOSE WILL REQUIRE ENERGY DISSIPATER – PLASTIC SHEETING, ROCKSHIELD, AND/OR RIPRAP MAY BE REQUIRED AND WILL BE DIRECTED BY MVP REPRESENTATIVE. THE EI MAY APPROVE AN ALTERNATIVE OR ADDITIONAL ENERGY DISSIPATER DEVICES SUCH AS (NATIVE) ROCK CHECK DAM TO FURTHER MITIGATE EROSIVE POTENTIAL.
7. DEWATER WORK AREA UTILIZING PUMP WATER FILTER BAGS WITHIN DEWATERING STRUCTURE. WHERE POSSIBLE, EXCAVATION WILL BE CONDUCTED WITH EQUIPMENT OPERATING FROM THE TOP OF THE STREAM SEGREGATE, AT MINIMUM THE UPPER 12–INCHES OF STREAM BED MATERIAL SEPARATELY FROM SUBSOILS FOR USE DURING STREAM RESTORATION ACTIVITIES. SEGREGATE STREAMBED MATERIAL BEFORE ANY INSTREAM ACTIVITIES BEGIN, INCLUDING PRE–DRILL FOR BLASTING.
8. ASSEMBLE PIPE SEGMENT PRIOR TO ESTABLISHING PUMP AROUND TO MINIMIZE DURATION OF THE CROSSING. EXCAVATE TRENCH TO PROPER DEPTH, INSTALL PIPE, TRENCH PLUGS, AND BACKFILL. STOCKPILED STREAM BED MATERIAL WILL BE USED TO BACKFILL THE UPPER 12 INCHES OF THE TRENCH. MAKE SURE STREAMBED AND BANK CONTOURS ARE RETURNED TO PRE-CONSTRUCTION CONDITIONS USING SURVEY INFORMATION OBTAINED PRIOR TO DISTURBANCE (SEE ITEM 4).
9. STABILIZE CHANNEL AND STREAM BANKS PRIOR TO RETURNING STREAM FLOW TO THE CHANNEL.
10. APPLY VEGETATIVE SEED MIXTURES AND APPROPRIATE BLANKET PER REQUIREMENTS.
11. REMOVE TEMPORARY COFFERDAM BY HAND RETURNING FLOW TO STREAM CHANNEL SLOWLY. ONCE FLOW HAS BEEN RETURNED TO THE STREAM CHANNEL, SHUT OFF PUMPS, REMOVE BYPASS HOSE, FLUME PIPE (WHERE APPLICABLE), PUMP, AND REMAINING COMPONENTS UTILIZED IN THE CROSSING INSTALLATION.
12. CONDUCT POST-CONSTRUCTION CIVIL SURVEY OF TOP OF BANKS AND STREAM CENTERLINE (PLAN AND CROSS SECTIONS); PHOTOGRAPH UPSTREAM, WORK AREA, AND DOWNSTREAM OF CROSSING. STREAM MUST BE RETURNED TO ORIGINAL CONTOURS AND CONDITIONS, PER NWP 12 REQUIREMENTS
13. TEMPORARY BRIDGE MAY REQUIRE INSTREAM SUPPORTS.
14. FLUME SIZE WILL BE DEPENDENT ON FLOW CALC DATA TO ENSURE NO NET CHANGE IN FLOW REGIME.

ADDITIONAL PROTECTIVE MEASURES WILL BE EMPLOYED AT CROSSINGS OF TIER 3 AND TROUT STREAMS (REFER TO TABLE 1 IN ATTACHMENT 2) SUCH AS:

- THE USE OF REINFORCED FILTRATION DEVICES (DEFINED AS BELTED SILT RETENTION FENCE, TRIPLE STACKED COMPOST FILTER SOCK OR SUPER SILT FENCE) AT ALL DOWNSLOPE PERIMETERS.
- DISTURBANCE WILL BE LIMITED AS MUCH AS PRACTICABLE (I.E. REDUCED LOD WITHIN BUFFER ZONES, ETC).

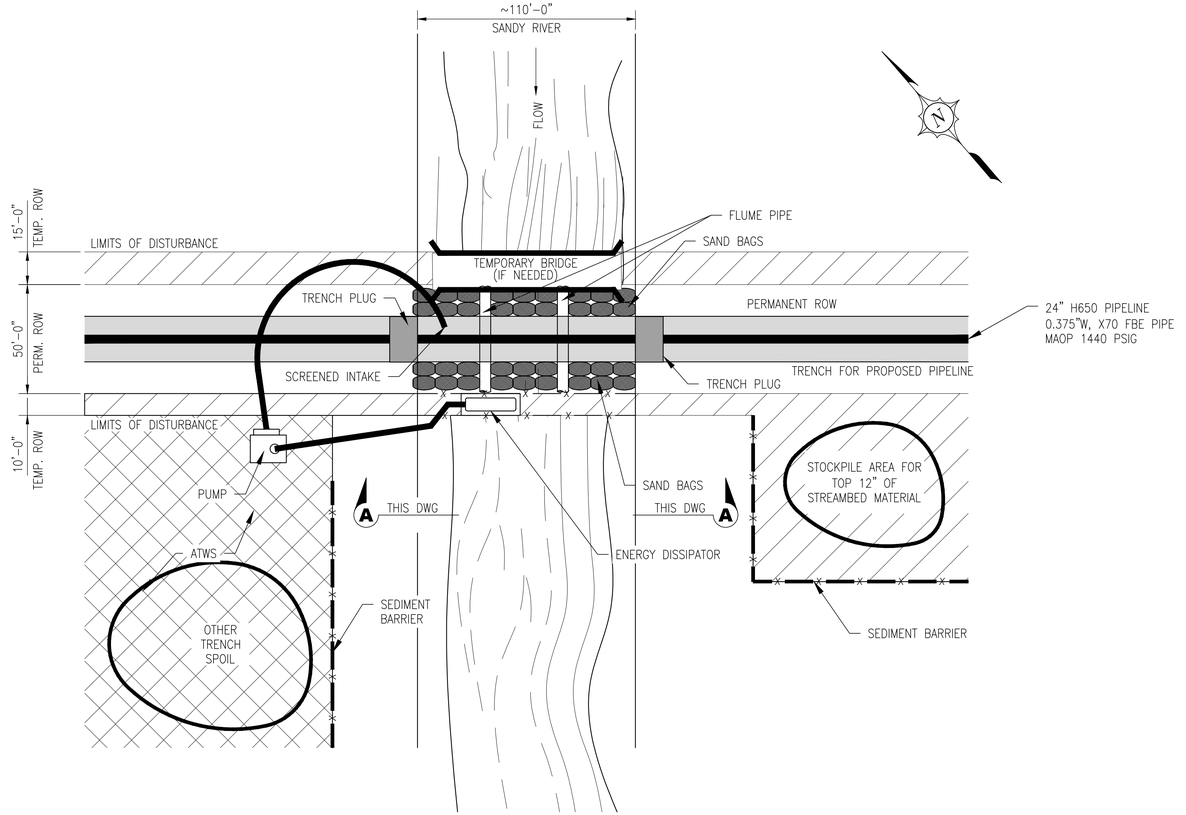
INSTREAM BMPS:

- MINIMUM PROCEDURES THAT WILL BE FOLLOWED AT STREAM CROSSING LOCATIONS INCLUDE THE FOLLOWING:
- ONLY THAT AREA WHICH IS REQUIRED FOR PIPELINE INSTALLATION SHALL BE DISTURBED WITHIN THE PROPOSED LOD AT STREAM CROSSINGS;
- LOCATING STAGING AREAS 50 FEET AWAY FROM THE STREAMBANKS, WHERE POSSIBLE.
- STORING CHEMICALS OR EQUIPMENT, AS WELL AS WASHING OR REFUELING OF EQUIPMENT IS PROHIBITED WITHIN 100 FEET OF STREAMS; REFUELING WITHIN 100 FEET IS ONLY ALLOWED WHEN NO OTHER ALTERNATIVE IS PRESENT AND IS APPROVED BY THE ENVIRONMENTAL INSPECTOR
- OVERNIGHT PARKING OF VEHICLES/EQUIPMENT WITHIN 100 FEET OF A STREAM CROSSING IS PROHIBITED;
- SPOIL PLACEMENT AND BMPS WILL BE MONITORED AT ALL TIMES DURING STREAM CROSSING PROCEDURES; ONCE WORK WITHIN A STREAM AREA IS STARTED, IT WILL BE CONDUCTED CONTINUOUSLY TO COMPLETION, TO MINIMIZE DURATION DISTURBANCE ACTIVITIES ARE ONGOING.
- SPOILS FROM STREAM CROSSINGS MUST BE PLACED AT LEAST 10 FEET FROM THE WATER'S EDGE; AND CONSTRUCTION EQUIPMENT WILL NOT BE ALLOWED IN THE STREAM CHANNEL WHEN EXCAVATION CAN BE DONE FROM EITHER SIDE OR A TEMPORARY CROSSING WHILE WORKING AT THE STREAM CROSSING.

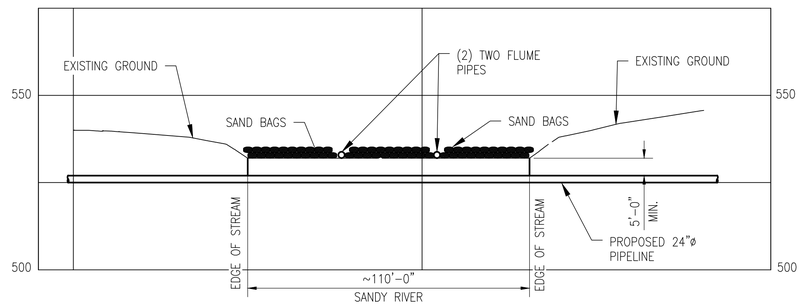
STREAM BANK STABILIZATION

PERMANENT STABILIZATION SHALL OCCUR IMMEDIATELY UPON INSTALLATION, BACKFILLING, AND GRADING AT EACH STREAM CROSSING.

WATERBODY WIDTH AT PIPELINE CROSSING (FT)	STREAM LENGTH WITHIN CONSTRUCTION WORKSPACE (LINEAR FT)	LATITUDE	LONGITUDE
85	77.29	36.63557	-79.5402



PLAN VIEW
SCALE: 1/32" = 1'–0"



STREAM CROSSING PROFILE
SCALE: 1" = 20'

IF WORKING WITHIN A WETLAND AREA, FOLLOW THE GENERALIZED CONSTRUCTION SEQUENCE BELOW:

1. 1 AT MINIMUM, INSTALL APPROPRIATE BMPS PER THE APPROVED E&S CONTROL PLANS. ADDITIONAL CONTROLS MAY BE NEEDED TO ADDRESS SITE CONDITIONS AT TIME OF CONSTRUCTION.
2. TIMBER MATS,EQUIPMENT PADS, OR SIMILAR DEVICES WILL BE USED DURING EQUIPMENT CROSSINGS OF WETLANDS TO PREVENT RUTTING OR MIXING OF WETLAND SOILS. ORIGINAL GRADES THROUGH WETLANDS MUST BE RESTORED FOLLOWING BACKFILLING. ANY EXCESS FILL MATERIALS MUST BE REMOVED FROM THE WETLAND AND DISPOSED OF IN AN UPLAND (NON□FLOODPLAIN) AREA.
3. AT MINIMUM, THE UPPER 12" OF TOPSOIL WILL BE SEGREGATED FROM THE PIPELINE TRENCH IN WETLANDS. SEGREGATED SOIL WILL BE STOCKPILED OUTSIDE OF THE WETLAND SEPARATELY FROM SUBSOIL AND BE USED DURING RESTORATION OF THE WETLAND.
4. DEWATER WORK AREA UTILIZING PUMP WATER FILTER BAGS PLACED IN A DEWATERING STRUCTURE. DEWATERING LOCATION SHALL BE DETERMINED BY EI AND SIZED ACCORDING TO THE ANTICIPATED VOLUME OF WATER TO BE HANDLED DURING CROSSING INSTALLATION.
5. PIPELINE SEGMENT SHALL BE ASSEMBLED AND READY FOR INSTALLATION PRIOR TO INITIATING EXCAVATION ACTIVITIES WITHIN WETLAND BOUNDARY.
6. LOWER PIPE SEGMENT INTO WETLAND AND INSTALL TRENCH PLUGS WHERE PIPELINE ENTERS/EXITS WETLAND TO PREVENT THE TRENCH FROM DRAINING THE WETLAND OR CHANGING ITS HYDROLOGY.
7. BACKFILL THE TOP 12-INCHES OF THE EXCAVATED TRENCH WITH THE SEGREGATED WETLAND SOIL TO MATCH ORIGINAL SURFACE GRADES. SEGREGATED SOILS WILL PRESERVE THE NATIVE WETLAND SEEDBANK TO ALLOW WETLAND TO REVEGETATE WITH NATIVE PLANT SPECIES.
8. COMPACT BACKFILL (TO MINIMIZE SETTLING OF TRENCH) AND GRADE THE SURFACE OF THE TRENCH AREA TO ALLOW FOR POSITIVE DRAINAGE TO ESCs AND TO PREPARE DISTURBED AREAS FOR PERMANENT RESTORATION.
9. REMOVE ALL EXCESS SOIL AND ASSOCIATED CONSTRUCTION MATERIALS FROM WORK AREA.
10. MAINTAIN ESCSs DEVICES UNTIL SITE WORK IS COMPLETE AND THE AREA IS PERMANENTLY STABILIZED WITH PERENNIAL VEGETATION AS REQUIRED BY PERMIT CONDITIONS.
11. ONCE THE AREA IS PERMANENTLY STABILIZED WITH VEGETATION PER PERMIT CONDITIONS, REMOVE ESC MEASURES AND DISPOSE OF PROPERLY.

LEGEND

ADDITIONAL TEMPORARY WORKSPACE (ATWS)

STOCKPILE AREA FOR TOP 12" OF STREAMBED MATERIAL

THIS TYPICAL CONSTRUCTION DETAIL IS INTENDED TO PROVIDE GUIDANCE TO THE PIPELINE CONTRACTOR. THE ACTUAL CONSTRUCTION TECHNIQUES MAY DIFFER DEPENDING UPON FIELD CONDITIONS AND OR REGULATORY REQUIREMENTS.

DRAWING ASSUMES TYPE "C" SOIL

REFERENCE DRAWINGS		NO.	DATE	REVISION	BY	CHK	APPD
DRAWING NUMBER	DRAWING TITLE	0	05/03/2019	PRELIMINARY FOR REVIEW	JIL	AAL	NFF
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NO.	DATE	REVISION	BY	CHK	APPD
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TO THE BEST OF MY KNOWLEDGE, ALL COMPONENTS OF THIS DRAWING ARE DESIGNED IN ACCORDANCE WITH APPLICABLE GUIDELINES AND SPECIFICATIONS

ALINA LAWRENCE — MECHANICAL DESIGN ENGINEER — 5/03/2019 — DATE

ELECTRICAL DESIGN ENGINEER — DATE

NOTE: ANY CHANGES TO THE DESIGN SHOWN ON THIS DRAWING MUST BE APPROVED BY THE DESIGN ENGINEER.

Mountain Valley Pipeline, LLC

DESIGN ENGINEERING

PROJECT ID: ####

DRAWING SCALE: NTS

DRAWING TITLE:
MAINLINE CONSTRUCTION
SANDY RIVER WATERBODY CROSSING (MP – 17.7)
OPEN CUT – FLUME

FACILITY	STATE	IDENTIFICATION	SERIES	SHEET	REVISION
MVP	VA/NC	H–650	33	1	0

Plotted by: Irwin, Thomas on: May 10, 2019 - 12:19 PM

File Path: C:\Vault Working\Systems\MVP\SouthGate\Construction Typicals\MVP-33.dwg

MVP Southgate Project

Docket No. CP19-14-000

Attachment 18-1

VDCR Correspondence

May 2019

TELEPHONE / PERSONAL CONVERSATION REPORT

PROJECT NAME:	MVP Southgate Pipeline Project
MVP TEAM CALLER:	Stephanie Frazier
CONVERSATION WITH:	René Hypes
AGENCY:	VDCR
EMAIL ADDRESS:	rene.hypes@dcr.virginia.gov
PHONE NUMBER:	804-371-2708
SUBJECT:	Survey methods
DATE AND TIME:	May 2, 2019 at 3:30 pm

SUMMARY OF CONVERSATION:

I contacted Ms. Hypes to discuss survey methods for three species including Piedmont Barbara's buttons (*Marshalia obovata*), downy phlox (*Phlox pilosa*), and American bluehearts (*Buchneria Americana*). I asked if plants could be surveyed during a single mobilization; according to ESI's review of these species, diagnostic features other than the flower can be used to identify each of these plants. Ms. Hypes asked to see resumes of ESI's botanists and indicated she would discuss with her staff botanist and respond to me.

MVP asked VDCR for technical assistance identifying discrete potential suitable habitats for the three plant species. Ms. Hypes reply on April 23 indicated that occurrences of these resources surround the entire project area and the geology within the project area is appropriate to support these rare plants, and so VDCR was unable to identify discrete locations to target for survey. However, she recommended surveys target the existing maintained right-of-way that provides open canopy habitat within the project area. MVP agreed to survey within the co-located portions of the project in open canopy habitats.

In a previous conversation, Ms. Hypes indicated that avoidance of the resource is preferred by VDCR if a rare plant species is found in the Project footprint. I asked about other mitigations VDCR would consider if avoidance isn't practicable, however, Ms. Hypes was not able to provide further comment in absence of survey data.

Contact Signature: 

Stephanie Frazier

From: Stephanie Frazier
Sent: Thursday, May 02, 2019 5:02 PM
To: Rene Hypes
Cc: 'Megan D. Stahl (MStahl@equitransmidstream.com)'
Subject: MVP Southgate - botanist resumes
Attachments: 1219.03_MVPSG Federal Plant Plan_Resumes.pdf; Brewer L resume.doc

Good afternoon, Rene'

Thank you again for discussing plant survey questions with me this afternoon. For your consideration, attached please find resumes for our project botanists; the short forms are excerpts from the federal plant study plan that was provided to your office last year, but I also wanted to include the long form CV for Mr. Larry Brewer, who will lead our efforts. ESI is confident in his ability to identify the three species of interest (Piedmont Barbara's buttons, downy phlox and American bluehearts). As discussed this afternoon, we are tentatively planning a single field survey of these species beginning June 1. The survey will focus on areas where the Project and the Transco right-of-way are co-located in open canopy habitat. Survey results would be provided to VDCR for its review.

Please let me know if you have questions,
Stephanie

ESI
Stephanie Frazier
Senior Project Manager
Environmental Solutions & Innovations, Inc.
1341 Old Freedom Rd | Cranberry Twp., PA 15212
office: 513.591.4335 **cell:** 412.553.9457
SFrazier@envsi.com | www.envsi.com

APPENDIX B
QUALIFIED SURVEYORS

Environmental Solutions & Innovations, Inc.
Real Science, Real Solutions

Lawrence G. Brewer
Plant Taxonomist
4525 Este Avenue
Cincinnati, OH 45232
513-451-1777

EDUCATION

M.A., Biology, Western Michigan University, 1982

B.A., Biology, Hope College, 1975

PROFESSIONAL CERTIFICATIONS

U.S Army Corps of Engineers Wetland Training Course, Ann Arbor, MI, 1996

Gopher Tortoise Training Course, Hattiesburg, MS, 1997

Geographic Positioning System (GPS) Field Training, Cincinnati, OH, 1998

Pesticide Training, Florence, KY, 2004

Ohio Department of Transportation – Ecological Training, 2011

USFWS QUALIFIED PLANT SURVEYOR:

Northeast bulrush (PA)
Small whorled pogonia (PA, VA, OH)

Smooth coneflower (VA)

Running buffalo clover, Eastern prairie fringed orchid (OH)

Virginia spiraea (VA)

PROFESSIONAL AFFILIATIONS

Ecological Society of America

Ohio Academy of Sciences

Torrey Botanical Club

Southern Appalachian Botanical Society

Society for Ecological Restoration

Lucy Braun Association

Natural Areas Association

The Nature Conservancy

QUALIFICATIONS AND EXPERIENCE

Larry Brewer is an experienced and trained Plant Taxonomist. He has conducted a wide variety of plant and natural community surveys over the last 35 years. His experience includes rare plant surveys on public and private lands throughout the Midwest and eastern United States to address National Environmental Policy Act and Endangered Species Act concerns in environmental reports and permit applications. Mr. Brewer routinely conducts field surveys for federal and state listed threatened and endangered plants; plant community assessments; vegetation mapping; and habitat characterization. He writes technical sections of documents, prepares taxonomic plant lists, and conducts impact analyses for multidisciplinary environmental documents for federal and state agencies including Federal Energy Regulatory Commission (FERC), Departments of Transportation (DOT), Federal Aviation Administration (FAA), U. S. Army Corps of Engineers (ACOE), U. S. Fish and Wildlife Service (USFWS), and Department of Defense (DoD).

Mr. Brewer is experienced with wetland determination, delineation, habitat restoration, and preparation of detailed mitigation plans. He was the plant ecologist and wetland scientist for a project involving restoration and creation of 400 acres of wetlands for Indianapolis Airport Authority in Indiana. Mr. Brewer worked nine field seasons for the Michigan Natural Features Inventory where he did ecological assessments in 30 different plant community types. For a 3-year study, he completed quantitative sampling of over 80 wetlands around the Great Lakes region. While at Western Michigan University, Mr. Brewer mapped the presettlement vegetation of 10 counties in southwestern Michigan.

Over the last six years, Mr. Brewer has been Senior Plant Ecologist for the Center of Applied Ecology at the Northern Kentucky University and permanent employee at ESI, Inc.

PROJECTS

AT&T Fiber Optic Line

North Carolina — *Project Botanist*

Survey for federally threatened *Virginia spiraea* and other plants of concern along AT&T's proposed 30.4-mile fiber optic line in Buncombe and Madison counties.

American Electric Power, Bland Area Improvements

Virginia — *Project Botanist*

Rare plant surveys along 138 kV Transmission Line Rebuild Project crossing Jefferson National Forest in Bland County. Surveys included federally endangered northeastern bulrush, smooth coneflower, and small whorled pogonia.

MVP, Mountain Valley Pipeline
Virginia and West Virginia *Project Botanist*

Rare plant surveys along 300-mile natural gas pipeline crossing seventeen counties. Surveys include federally endangered species: northeastern bulrush, running buffalo clover, shale barren rock cress, small whorled pogonia, smooth coneflower, and Virginia spiraea. Surveys also focused on state listed species and species of concern.

Dominion Transmission, Jetersville to Ponton 115 kV Transmission Line
Virginia *Project Botanist*

Presence and absence surveys for smooth coneflower along 8-mile corridor and multiple access roads in Amelia County.

Appalachian Power Company, Wythe Area Improvements
Virginia *Project Botanist*

Presence and absence surveys for smooth coneflower and Virginia spiraea along 15-mile transmission line in Wythe County.

Appalachian Transmission Company, Inc., Cloverdale-Lexington 500 kV transmission Line
Virginia *Project Botanist*

Habitat Assessments and surveys for smooth coneflower and shale barren rock cress in Botetourt and Rockbridge counties.

Appalachian Power Company, Richland's-Whitewood 138 kV Transmission Line
Virginia *Project Botanist*

Presence/absence surveys for federally listed Virginia spiraea along 10-mile line in Buchanan and Tazewell counties.

American Electric Power Fleming to Jenkins Rebuild to Ferrus
Virginia *Project Botanist*

Habitat assessments for small whorled pogonia and surveys for Virginia spiraea in Letcher County, Kentucky and Dickenson County, Virginia.

American Electric Power, Sunscape and Matt Funk Transmission Lines
Virginia *Project Botanist*

Smooth coneflower and piratebush surveys along two transmission line corridors and associated access roads in Roanoke County, Virginia.

Dominion Transmission, 138 kV Hybrid Energy/Clinch River Transmission Line
Virginia *Project Botanist*

Surveys for federally threatened small whorled pogonia and one state-listed plant celadine poppy (*Stylophorum diphyllum*) along 9-mile transmission line corridor in Wise and Russell counties.

American Electric Power, Penhook-Westlake 138 kV Line
Virginia *Project Botanist*

Habitat survey for federally endangered smooth coneflower along 14-mile transmission line corridor in Franklin County.

American Electric Power, Penhook-Westlake 138 kV Line
Virginia *Project Botanist*

Habitat survey for federally endangered smooth coneflower along 14-mile transmission line corridor in Franklin County.

Environmental Solutions & Innovations, Inc.
Real Science, Real Solutions

Fred Huber
Botanist
4525 Este Avenue
Cincinnati, OH 45232
513-451-1777

EDUCATION

M.S., Botany, North Carolina State University, 1976

B.A., Biology, Gettysburg College, 1972

CERTIFICATIONS

Wild Plant Management Permit, Pennsylvania Department of Conservation and Natural Resources

QUALIFICATIONS AND EXPERIENCE

Mr. Huber is an experienced botanist and completes field surveys and monitoring for rare plant species. Much of his work is completed in North Carolina, Pennsylvania, Tennessee, West Virginia, and Virginia. A recent retiree of the U.S. Forest Service (USFS), Mr. Huber's experience encompasses 26 years of experience as Forest Botanist on the 1.8-million acre George Washington and Jefferson National Forests in Virginia and West Virginia where he monitored multiple federally listed plant species including: Virginia roundleaf birch (*Betula uber*), shale barren rockcress (*Boechera serotina*), rock gnome lichen (*Cetradonia linearis*), smooth purple coneflower (*Echinacea laevigata*), Virginia sneezeweeed (*Helenium virginicum*), swamp pink (*Helonias bullata*), small whorled pogonia (*Isotria medeloides*), northeastern bulrush (*Scirpus ancistrochaetus*), and Virginia meadowsweet (*Spiraea virginiana*).

Mr. Huber's extensive history in botany includes preparation of Biological Evaluations (BE) evaluating effects of proposed projects on rare plant species in support of National Environmental Policy Act (NEPA) documentation. His experience also includes reviewing Environmental Impact Statements (EIS); providing input to the forest planning process; and developing plant management strategies, including treatment for non-native plant infestations.

PROJECTS

USDA Forest Service, George Washington and Jefferson National Forests

Virginia, West Virginia, and Kentucky — *Forest Botanist*

Duties included conducting field surveys for federally and state listed plant species, as well as Regional Forester's Sensitive Species, in areas of Forest Service activity such as timber sales, road construction, recreation developments, and prescribed burns. Field surveys and monitoring were also conducted in support of endangered and threatened species recovery. Surveys were often in conjunction with cooperators such as the West Virginia Division of Natural Resources, the Virginia Natural Heritage Program, the Massey Herbarium at Virginia Tech, and the U.S. Fish and Wildlife Service. Averaged approximately 60 days a year in the field.

Served as forest coordinator for non-native invasive plant species management. Completed field surveys for non-native plant infestations; implemented treatments for those infestations; advised district offices on treatments; and coordinated with state, federal, and non-governmental organizations.

In addition, prepared BEs for plants on the federal threatened and endangered list and on the Regional Forester's Sensitive Species list. Bes were prepared as part of the NEPA process for evaluating the effects of proposed projects on rare species.

University of North Carolina, Chapel Hill
North Carolina — *Research Associate*

Field research in Great Smoky Mountains National Park for Dr. Peter White. Established and inventoried the vegetation in long-term monitoring plots in old growth forest.

Western Carolina University
North Carolina — *Research Associate*

Summarized research completed in the Great Smoky Mountains National Park for Dr. John McCrone in support of the establishment of the Great Smoky Mountains Biosphere Reserve.

USDA Forest Service
North Carolina — *Botanist*

Field inventory and monitoring, including for mountain golden heather (*Hudsonia montana)*, and providing botanical input to the Forest Planning process. Organized symposium on management of grass bald habitats in the southern Appalachia.

North Carolina Natural Heritage Program
North Carolina — *Botanist*

First botanist on staff. Acquired data on endangered, threatened, and state rare plant species and significant plant communities for entry into the Natural Heritage database. This included visiting herbaria throughout the state, reviewing scientific field reports, and conducting field inventories. Also reviewed environmental impact statements, organized a team of plant ecologists to establish a plant community classification system for the new program, and helped identify significant natural areas for protection.

ENVIRONMENTAL SOLUTIONS & INNOVATIONS, INC.
Résumé
Lawrence G. Brewer

EDUCATION

Botany Coursework, Michigan State University, 1983-1987
M.A., Biology, Western Michigan University, 1982
Botany Coursework, University of Michigan Biological Station, 1979
B.A., Biology, Hope College, 1975

CERTIFICATIONS AND TRAINING

U.S Army Corps of Engineers Wetland Training Course, Ann Arbor, MI, 1996
Gopher Tortoise Training Course, Hattiesburg, MS, 1997
Writing and Grammar Skills Course, Cincinnati, OH, 1997
Geographic Positioning System (GPS) Field Training, Cincinnati, OH, 1998
Pesticide Training, Florence, KY, 2004
Ohio Department of Transportation – Ecological Training, 2011

USFWS QUALIFIED PLANT SURVEYOR:

Northeast bulrush (PA)
Small whorled pogonia (PA, VA, OH)
Smooth coneflower (VA)
Running buffalo clover, Eastern prairie fringed orchid (OH)
Virginia spiraea (VA)

QUALIFICATIONS AND EXPERIENCE

Larry Brewer is an experienced and trained Plant Taxonomist. He has conducted a wide variety of plant and natural community surveys over the last 35 years. He has conducted numerous rare plant surveys on public and private lands throughout the Midwest and eastern United States to address National Environmental Policy Act and Endangered Species Act concerns in environmental reports and permit applications. Mr. Brewer routinely conducts field surveys for federal and state listed threatened and endangered plants; plant community assessments; vegetation mapping; and habitat characterization. He writes technical sections of documents, prepares taxonomic plant lists, and conducts impact analyses for multidisciplinary environmental documents for federal and state agencies including Federal Energy Regulatory Commission (FERC), Departments of Transportation (DOT), Federal Aviation Administration (FAA), U. S. Army Corps of Engineers (ACOE), U. S. Fish and Wildlife Service (USFWS), and Department of Defense (DoD).

Mr. Brewer is experienced with wetland determination, delineation, habitat restoration, and preparation of detailed mitigation plans. He was the plant ecologist and wetland scientist for a project involving restoration and creation of 400 acres of wetlands for Indianapolis Airport Authority in Indiana. Mr. Brewer worked nine field seasons for the Michigan Natural Features Inventory where he did ecological assessments in 30

different plant community types. For a 3-year study, he completed quantitative sampling of over 80 wetlands around the Great Lakes region. While at Western Michigan University, Mr. Brewer mapped the presettlement vegetation of 10 counties in southwestern Michigan. He has performed several wetland delineations throughout the Midwest and eastern US including Ohio, Indiana, Kentucky, West Virginia, Kansas and New York. One such project was at the Wright-Patterson Air Force Base, Ohio which also involved development of a wetland management plan. He is trained in GPS and regularly implements mapping procedures during field surveys while assessing wetland and terrestrial ecosystems.

Over the last six years, Mr. Brewer has been Senior Plant Ecologist for the Center of Applied Ecology at the Northern Kentucky University and permanent employee at ESI, Inc. Some of Mr. Brewer's research interests include the following: rare plant species studies, changes in composition and structure of Ohio's oak savannas in relation to natural and human disturbances, distribution and causes for the existence of Michigan's plant tension zone using presettlement tree disturbances, causes for the biodiversity of plant species in mixed mesophytic forest, changes in the herb layer of Indiana Dunes Oak savannas following fire, ecology of the survival and recovery from blight in American chestnut trees, presettlement vegetation mapping, and factors affecting the distribution of *Hydrastis canadensis* in Hoosier National Forest.

PROJECT EXPERIENCE

Project Botanist – EQT, Equitrans Expansion Project: 2016. Directed surveys for rare plants, invasive species, and assessment of landcover along portions of proposed natural gas pipeline traversing Allegheny, Washington, and Greene counties, Pennsylvania. Most of the Project is dominated by disturbed forest and exotic species have invaded many areas. Despite finding none of the six species identified by the Pennsylvania Department of Conservation and Natural Resources rare plants were found including nodding rattlesnakeroot (*Prenanthes crepidinea*) and goldenseal (*Hydrastis canadensis)*.

Project Botanist – Natural Fuel Gas Supply, Tidioute to Queen Storage Pipeline: 2016. Completed rare plant survey on Alleghany National Forest for proposed pipeline in Warren and Forest counties, Pennsylvania.

Project Botanist – American Electric Power, Bland Area Improvements: 2015-2016. Completed rare plant surveys along 138 kV Transmission Line Rebuild Project crossing Jefferson National Forest in Bland County, Virginia. Surveys included federally endangered northeastern bulrush, smooth coneflower, and small whorled pogonia.

Project Botanist – MVP, Mountain Valley Pipeline: 2015-2016. Completing rare plant surveys along 300-mile natural gas pipeline crossing seventeen counties in Virginia and West Virginia. Surveys include federally endangered species: northeastern bulrush, running buffalo clover, shale barren rock cress, small whorled pogonia, smooth coneflower, and Virginia spiraea. Surveys also focused on state listed species and species of concern.

Biologist – Confidential Client: 2014-2016. Completed rare plant surveys for multiple species along 8-mile electric transmission line in Erie County, Pennsylvania. Canada yew (*Taxus canadensis*) and shellbark hickory (*Carya laciniosa*) were found during the 2015 survey.

Project Botanist – New York Power Authority, SMART Path Rebuild Project: 2015. Completed land cover and invasive plant species surveys for 85-mile long electrical transmission line rebuild project in St. Lawrence and Lewis Counties, New York. One hundred and sixty-seven invasive plant locations comprising six species were identified with common buckthorn (Rhamnus cathartica) the most prevalent. Results of this field survey effort will be compiled into an invasive plant management plan for use during construction.

Project Botanist – American Electric Power, Fayette County Area Improvement Plan: 2015. Completed pedestrian survey for federally endangered running buffalo clover and Virginia spiraea along electric "Super Program" in Fayette County, West Virginia. Neither running buffalo clover nor Virginia spiraea were documented; however, bushy bluestem, designated as Imperiled by the State of West Virginia, was found.

Project Botanist – Dominion Transmission, Jetersville to Ponton 115 kV Transmission Line: 2015. Completed presence and absence surveys for smooth coneflower along 8-mile transmission line and multiple access roads in Amelia County, Virginia.

Biologist – Confidential Client, Natural Gas Pipeline: 2014. Delineated wetlands and vegetation covertypes for Michigan portion of international gas pipeline extending from Ontario, Canada to Illinois. Identified, estimated percent coverage, and determined dominance for all plants in paired wetland/upland sample plots for 100+ wetlands.

Biologist – Appalachian Power Company, Wythe Area Improvements 138 kV Transmission Line: 2014. Completed presence and absence surveys for smooth coneflower and Virginia spiraea along 15-mile transmission line in Wythe County, Virginia.

Biologist – Texas Eastern, LLP, Bailey East Longwall Mine Panel 2l - Subsidence: 2014. Conducted rare plant surveys for wild senna, single-headed pussy-toes, and leaf-cup in Greene County, Pennsylvania.

Biologist – Appalachian Transmission Company, Inc., Cloverdale-Lexington 500 kV transmission Line: 2014. Habitat Assessments and surveys for smooth coneflower and shale barren rock cress in Botetourt and Rockbridge counties, Virginia.

Biologist – WPX, Energy Marcellus Gathering System: 2014 (ongoing). Conducted weekly and post rainfall event E&S inspections along 30 miles of restored natural gas pipeline right-of-way in northeastern Pennsylvania. Conducted E&S inspections using site restoration plans and permits approved by the PADEP. Completed E&S inspection reports following all inspections.

Biologist – Appalachian Power Company, Richland's-Whitewood 138 kV Transmission Line: 2014. Conducted presence/absence surveys for federally listed Virginia spiraea along 10-mile line in Buchanan and Tazewell counties, Virginia.

Wetlands Scientist – Crosstex, Lowell North Pipeline: 2013-2014. Conducted wetlands and waterways delineation along 35 miles of proposed liquefied gas pipeline right-of-way in eastern Ohio.

Biologist – EQT, Valley View Well Line: 2013. Delineated aquatic resources on approximately 17-acre site in Greene County, Pennsylvania.

Biologist – Hawks Nest & Glen Ferris Hydroelectric Project (FERC): 2013. Conducted field reconnaissance surveys including wetlands and waterways delineation, Indiana bat habitat assessment, acoustic surveys for endangered bats, and surveys for rare plants and animals along 10-mile stretch of the New River Gorge. Field studies are in support of preparation of FERC relicensing report for two Hydrolectric Projects.

Wetlands Scientist – First Energy, 345 kV Glenwillow Transmission Line: 2013. Conducted wetlands and waterways delineation along 22 miles of proposed access roads associated with proposed electrical transmission line in eastern Ohio.

Wetlands Scientist – Tenaska Blue River Natural Gas-Fueled Electrical Generation Power Plant: 2013. Conducted wetlands delineation on 111-acre parcel located in the Town of Morristown, Shelby County, Indiana. Wetlands were delineated consistent with the USACE regional supplement. Tasks included preparation of endangered species screening for those species known to occur in the vicinity of the proposed project.

Wetlands Scientist – First Energy, 345 kV Glenwillow Transmission Line Project: 2012. Conducted wetlands and waterways delineation along 75 miles of proposed electrical transmission line right-of-way in eastern Ohio. Wetlands delineation was conducted consistent with the USACE regional supplement. All wetland areas were assessed as waters of the U.S. subject to USACE jurisdiction. Wetlands were evaluated consistent with the ORAM (Version 5.0), developed by the OEPA. The federally regulated OHW mark of streams within each site was delineated utilizing the definitional criteria as presented in Title 33, Code of Federal Regulations, Part 328. Streams were evaluated using OEPA HHEI or QHEI as appropriate and scored. The delineation encountered approximately 500 wetland and stream features.

Wetlands Scientist – Confidential Client: 2012. Conducted wetlands and waterways delineation along 68 miles of electrical transmission line right-of-way in eastern Ohio. Wetlands delineation was conducted consistent with the USACE regional supplement. All wetland areas were assessed as waters of the U.S. subject to USACE jurisdiction. Wetlands were evaluated consistent with the ORAM (Version 5.0), developed by the OEPA. The federally regulated OHW mark of streams within each site was delineated utilizing the definitional criteria as presented in Title 33, Code of Federal Regulations, Part 328. Streams were evaluated using OEPA HHEI or QHEI as appropriate and scored.

Wetlands Scientist – Indiana Department of Transportation: 2012. Co-authored conceptual wetland and stream mitigation plan for proposed SR 641 Bypass Project in Terre Haute, Vigo County, Indiana. Tasks included wetland delineation on three parcels totaling approximately 126 acres, and reviewing each parcel for potential to create, restore, or preserve resources.

Wetlands Scientist – Confidential Client: 2012. Conducted wetland and waterway delineations on multiple proposed gas well pad construction sites in several eastern Ohio townships. Wetland areas were assessed as waters of the U.S. subject to USACE jurisdiction, and classified consistent with the Classification of Wetlands and Deepwater Habitats of the United States. Evaluated isolated wetlands consistent with the Ohio Rapid Assessment Method (ORAM) (Version 5.0), developed by the Ohio Environmental Protection Agency (OEPA).

Project Botanist – American Electric Power, Huntington Court-Roanoke 138 kV Line: 2011. Completed presence/absence surveys for smooth coneflower and small-whorled pogonia along 5-mile transmission line in Roanoke, Virginia.

Project Botanist – AmerenUE, Taum Sauk Pumped Storage Project: 2010. Conducted survey for federally threatened and Missouri endangered Mead's milkweed (Asclepias meadii) in Reynolds County, Missouri.

Project Botanist – Transco, Mid-South Expansion: 2010. Conducted overall survey for sensitive plants concurrent with wetlands and water bodies field studies.

Project Botanist – Superior Appalachian Pipeline, LLC, Snow Shoe Pipeline: 2010. Conducted survey for federally endangered northeastern bulrush (*Scirpus ancistrocheatus*) in Centre County, Pennsylvania.

Project Botanist – Williams, Northeast Supply Link: 2010. Surveyed for federally endangered northeastern bulrush (*Scirpus ancistrochaetus*) in three wetlands identified on gas pipeline loop in Monroe County, Pennsylvania.

Project Botanist – American Electric Power, Saltville-Kingsport 138 kV Rebuild: 2010. Conducted survey for federally listed smooth coneflower (*Echinacea laevigata*) and Virginia spiraea (*Spiraea virginiana*) along four new access road sites (approximately 2,200 feet) in Washington County, Virginia.

Project Botanist – Superior Appalachian Pipeline, LLC, Black Moshannon Pipeline: 2010. Conducted survey for federally endangered northeastern bulrush (*Scirpus ancistrochaetus*) and state endangered Carey's smartweed (*Polygonum careyi*) along 8-mile natural gas pipeline in Centre County, Pennsylvania.

Project Botanist – American Electric Power Fleming to Jenkins Rebuild to Ferrus: 2010. Conducted habitat assessments for small whorled pogonia and surveys for Virginia spiraea in Letcher County, Kentucky and Dickenson County, Virginia.

Project Botanist – Superior Appalachian Pipeline, LLC, Karthaus Pipeline: 2010. Conducted survey for federally endangered northeastern bulrush (*Scirpus ancistrochaetus*) and state endangered Carey's smartweed (*Polygonum careyi*) along 7-mile natural gas pipeline in Centre and Clearfield counties, Pennsylvania.

Project Botanist – Metropolitan Sewer District of Greater Cincinnati, Mt. Airy Forest Sewer Replacement: 2009. Completed presence/absence survey for running buffalo clover along 2 miles of sewer lines proposed for replacement in Hamilton County, Ohio.

Project Botanist – American Electric Power, Sunscape 138 kV Extension: 2009. Completed smooth coneflower survey along 1.4-mile transmission line and associated access roads in Roanoke County, Virginia.

Project Botanist – American Electric Power, Matt Funk 138 kV Line: 2009. Completed smooth coneflower and piratebush surveys along 4.5-mile transmission line in Roanoke County, Virginia. Surveyed entire length of proposed project right-of-way and associated access roads.

Project Botanist – Tennessee Gas Pipeline Company, 300 Line: 2009 and 2010. Completed plant surveys in Sussex and Passaic counties, New Jersey and Potter, Tioga, Bradford, Susquehanna, Wayne, Pike, and Venango, counties, Pennsylvania. Surveyed for several New Jersey and Pennsylvania state listed plant species. Re-surveyed for red spruce in Sussex County, New Jersey in 2010.

Project Botanist – Ozark and Saint Francis National Forests: 2009. Conducted rare plant surveys and habitat delineations in select areas of Ozark and Saint Francis National Forests in Arkansas.

Biologist – Tennessee Gas Pipeline Company, 300 Line: 2009. Completed bird habitat surveys in Sussex and Passaic counties, New Jersey. Surveyed for suitable habitat for listed bird species including barred owl, Cooper's, Goshawk, and red-shouldered hawks, and red-headed woodpecker.

Project Botanist – TW Philips, Bionol Clearfield Pipeline: 2008. Completed surveys for Allegheny plum along proposed 8-mile pipeline right-of-way and associated access roads and work spaces in Clearfield County, Pennsylvania.

Project Botanist – American Electric Power, Hickman-Riverbend 69 kV Line: 2008. Completed endangered smooth coneflower (*Echinacea laevigata*) survey along proposed 4.6-mile transmission line in Pulaski County, Virginia.

Project Botanist – Monongahela National Forest: 2008. Completed botanical survey including species inventory and identification for threatened and non-native invasive plants in selected stands in Greenbrier Ranger District. 2004 & 2005. Surveyed for threatened, endangered and rare plants in Greenbrier, Nicholas, Tucker and Webster counties, West Virginia. Survey to identify the locations and types of Forest-listed and non-native, invasive plant species within the Cherry River watershed of the Gauley Ranger District, the Lower Clover Run watershed of the Cheat Ranger District, Greenbrier and Marlinton Ranger Districts. Requirements for this project included use of GPS equipment and delivery of all database files for GIS utilization. The data dictionary developed included Forest-listed plants, non-native invasive plants, and survey routes.

Project Botanist – Equitable Resources, Amity Pipeline: 2008. Completed threatened and endangered plant surveys for leaf-cup, gray-headed prairie coneflower, and mistflower along 12-mile pipeline corridor in Greene and Washington counties, Pennsylvania.

Project Botanist – Chestnut Flats Wind, LLC, Wind Farm: 2008. Completed endangered northeastern bulrush surveys for project involving construction of all aspects of a wind farm including clearing/grubbing and subsequent construction of concrete pads, towers, access roads, buried cable lines, overhead transmission line and electrical substation near Altoona, Blair and Cambria counties, Pennsylvania.

Project Botanist – Dominion, North Summit: 2008. Completed sensitive plant surveys which included 17 state listed species on 18.14-square mile gas storage field seismic project in Fayette County, Pennsylvania.

Project Biologist – Confidential Client, Treated Effluent Line: 2008. Conducted wetland delineation and wetland functional assessment along proposed 10-mile corridor in Stark County, Ohio.

Project Botanist – Dominion Transmission, 138 kV Hybrid Energy/Clinch River Transmission Line: 2008. Conducted survey for federally threatened small whorled pogonia and one state-listed plant celadine poppy (*Stylophorum diphyllum*) along 9-mile transmission line corridor in Wise and Russell counties, Virginia.

Project Botanist – Columbia Gas, Ohio Storage Expansion: 2008. Conducted survey for federally endangered small whorled pogonia (*Isotria medeoloides*) and federally threatened eastern prairie fringed orchid (*Platanthera leucophaea*) in natural gas storage fields and along proposed natural gas pipeline rights-of-way in Hocking and Fairfield counties, Ohio.

Project Botanist – American Electric Power, Penhook-Westlake 138 kV Line: 2008. Conducted habitat survey for federally endangered smooth coneflower along 14-mile transmission line corridor in Franklin County, Virginia.

Project Botanist – Confidential Client, Proposed 250-mile Natural Gas Transmission Pipeline: 2008. Conducted surveys for rare, threatened and endangered plants along ROW in Ohio, West Virginia and Pennsylvania.

Project Botanist – Dominion Transmission, Cove Point Pipeline Expansion TL-492 Extension 3: 2006. Conducted survey for leaf-cup (*Polymnia uvedalia*) along 11 miles of proposed natural gas transmission line in Greene County, Pennsylvania and Wetzel County, West Virginia.

Project Biologist – American Electric Power, 765 kV Transmission Line Mitigation Ponds/Wetlands Creation: 2006. Involved with site selection and creation of three wetlands for bat habitat mitigation in an electric transmission line corridor in Virginia.

Project Botanist – Indiana Department of Transportation, Interstate 69, Section 2 Environmental Studies Sensitive Plant Survey: 2005. Survey to identify federal and state listed and heritage plants within 29-mile interstate corridor in central Indiana. All natural habitats located along the corridor were surveyed for presence of threatened and endangered species. Locations of all listed species found in the field were recorded using hand-held GPS. In addition, ecological assessment of plant communities along the corridor was made to determine presence of any unique habitat. Each natural area examined was given an ecological quality rating.

Biologist – Indiana Department of Transportation, Interstate 69, Segments 1 and 6: 2005. Participated in spring bird surveys and habitat assessments along a 40-mile proposed highway corridor in central and southern Indiana.

Project Botanist – Dominion Transmission, Cove Point Pipeline Expansion PL-1 Extension 2: 2005. Survey for the federally endangered northeastern bulrush (Scirpus

ancistrocheatus) in a proposed 80-mile pipeline corridor in Pennsylvania. A total of 194 wetlands within the project area were surveyed.

Project Botanist – Centerpoint Energy Pipeline: 2004. Survey for federally listed decurrent false aster (*Boltonia decurrens*) along 3.6 miles of new natural gas pipeline and associated compressor station in Madison and St. Clair counties, Illinois.

Project Botanist – Monongahela National Forest: 2004. The largest known population of running buffalo clover (*Trifolium stoloniferum*), a federally endangered species, was discovered during the 2004 sensitive plant survey.

Project Botanist – Department of Defense, Fort Leonard Wood: 1992-1994. Survey for threatened and endangered species at U.S. Army facility in Pulaski County, Missouri.

Project Botanist – Ecological assessment and management plan for Cincinnati Nature Center, Ohio.

Project Botanist – Survey for running buffalo clover, false mermaid-weed, and red back salamanders along TEPPO's proposed 286-13-TO1 extension in Boone County, Kentucky.

Project Botanist – Vegetative and floristic survey of the Greenbelt II Proposed Impact Area with special reference habitat for Karner blue butterflies (10 listed plant species found).

Project Botanist – Survey for federally threatened *Virginia spiraea* and other plants of concern along AT&T's proposed 30.4-mile fiber optic line in Buncombe and Madison Counties, North Carolina.

Project Botanist – Threatened and endangered species survey and wetland delineation for proposed 15.8-mile natural gas pipeline corridor located in Shelby County, Ohio.

Project Botanist – Survey of plant communities and wetlands for I-70 expansion project near Indianapolis Airport, Indiana.

Project Botanist – Survey of plant communities, wetlands, and endangered species for 15-mile pipeline near Avoca, New York.

Project Botanist – Survey of rare plants and plant communities in a six square mile area in Lawrence County, Ohio (23 state-listed species found, including a federally endangered species and a new species to the state).

Project Botanist – Survey of plant communities, wetlands, and endangered species for a 20-mile pipeline near Bath, New York.

Project Manager – Survey for state threatened Purple Fringeless Orchid in Summerset County, Pennsylvania.

Project Botanist – Survey of rare plants in openings in Wayne National Forest, Ohio.

Project Manager – Inventory of rare plant and animal species in tornado blow down area of the pleasant run unit in the Brownstown district of the Hoosier National Forest, Indiana.

Project Botanist – Wetland and endangered species survey of 125 miles in New York (Niagara expansion project).

Project Botanist – Wetland and endangered species survey through Grand Bay National Refuge and Desoto National Forest, Mississippi.

Project Botanist – Wetland and endangered species survey for 17 miles of gas pipeline in Union County, Kentucky.

Project Manager – Survey for rare plants in Buzzard Roost Area of the Hoosier National Forest, Indiana.

Project Botanist – Survey for rare plants and animals on Wright-Patterson Airforce Base, Ohio.

Project Botanist – Ecological assessment of Big Bone Lick State Park, Boone County, Kentucky. Section of report for the U.S. Army Corps of Engineers.

Project Botanist – Natural areas inventory: qualitative look at forests on the campus of Northern Kentucky University. Northern Kentucky University.

Project Botanist – Preliminary ecological assessment and prioritization of natural areas, eastern corridor, Hamilton and Clermont counties, Ohio. Meisner & Associates, Cincinnati, Kentucky.

Project Botanist – Greenspace inventory and prioritization for southern section of Erlanger in the vicinity of Doe Run Lake in Kenton County, Kentucky. City of Erlanger, Kentucky.

Project Botanist – Field survey for federally endangered running buffalo clover (*Trifolium stoloniferum*) in stream restoration section of the Adair Wildlife Management Area, Boone County, Kentucky. U.S. Fish and Wildlife Service.

Project Botanist – Preliminary ecological survey of St. Mary's Parish Property, Campbell County, Kentucky. Prepared for St. Mary's Parish, Alexandria, Kentucky.

Project Manager – Wetland survey and delineation for portions of proposed 87-mile gas pipeline in Breckinridge County, Kentucky and Butler and Warren counties, Ohio.

Project Manager – Wetland survey and delineation for Complete General Construction Proposed Summitcrest Lakes Subdivision.

Project Manager – Wetland survey and delineation for Indianapolis Metropolitan Airport proposed development area, Hamilton County, Indiana.

Project Manager – Wetland survey and delineation for proposed Center Point 70 Industrial Park Development, Montgomery County, Ohio.

Project Manager – Wetland delineation and terrestrial resource survey for proposed natural gas pipeline crossing of the Maumee River by Columbia Gas of Ohio.

Project Manager – Wetland survey and delineation for CNG Transmission Corporation's proposed replacement pipelines from ten locations in Boone, Chanukah, and Wyoming counties, West Virginia.

Project Ecologist – Survey of plant communities and wetlands for I-70 expansion project near Indianapolis Airport.

Project Ecologist – Monitored survey of wetland for Columbia Gas of Ohio in Lorain County, Ohio.

Project Ecologist – Wetland delineation and terrestrial resources survey for the Cincinnati / Northern Kentucky Airport proposed runway expansion, Boone County, Kentucky. Landrum and Brown, Airport Consultants.

PUBLICATIONS

Brewer, L. G. and J. L. Vankat. 2007. A four-year study on the germination, survival, and flowering of *Lupinus perennis* (wild lupine) along a prairie to forest gradient in the Oak Openings of northwestern Ohio. Accepted to Castanea.

Brewer, L. G. and J. L. Vankat. 2006. Richness and diversity of oak savanna in northwestern Ohio: proximity to possible sources of propagules. American Midland Naturalist 155:1-10.

Scott R. Abella, John F. Jaeger, and Lawrence G. Brewer. 2004. Fifteen years of plant community dynamics in a restored northwest Ohio Oak Savanna. The Michigan Botanist 43:117-127.

Brewer, L. G. and J. L. Vankat. 2004. Description of vegetation of the Oak Openings of Northwestern Ohio at the time of Euro-American settlement. Ohio Journal of Science 104(4):76-85 .

Brewer, L. G., S. M. Dougherty, M. A. Leopold, B. R. Dalton, and D. L. Greis. 2002. Landscape changes in the forests of Boone County, Kentucky from 1954 to 1998. Abstract. 29th Annual Natural Areas Conference. p.4.

Brewer, L. G. and J. L. Vankat. 2001. The vegetation of the Oak Openings of northwestern Ohio at the time of Euro-American settlement. Ohio Biological Survey. 36" x 46" Map.

Dalton, B. R., and L. G. Brewer. 1997. A closer look at the shrub and herb layers of an old-growth remnant at the Curtis Gates Lloyd recreational and wildlife area in Crittenden, Kentucky. Abstract: Ancient Eastern United States Old-growth.

Brewer, L. G. 1995. Ecology of survival and recovery from blight in American chestnut trees (*Castanea dentata* (Marsh.) Borkh.) in Michigan. Bulletin of Torrey Botanical Club 122:40-57.

Dalton, B., H. Kunz, H., L. G. Brewer, B. Dalton, and V. R. Holmes. 1994. Mortality and condition assessment of 53 species of native trees and shrubs planted to restore a palustrine forested wetland in central Indiana. Abstract: Ecological Society of America Vol 72.

Brewer, L. G. and M. Grigore. 1993. Restoring oak savannas in Northwest Ohio: monitoring the progress. In *Proceedings of the Midwest Oak Savanna Conference*, ed. R. Sterns and K. Holland. Chicato, Ill.: U.S. Environmental Protection Agency, Great Lakes National Program Office. Internet document. Address: Http://www.epa.gov/glnpo/oak/ .

Brewer, L. G. and J. L. Vankat. 1992. Vegetational changes in Ohio's Oak Savannas. Abstract: Bulletin of the Ecological Society of America. p.122.

Brewer, L. G. and J. L. Vankat. 1992. A photo-print guide to the flora of Ohio's Unglaciated Region. Volume III: Dicots, from Ericaceae to Composite. Miami University, Oxford, Ohio, 245 pp. Prepared for Hoosier-Wayne National Forest.

Brewer, L. G. and J. L. Vankat. 1992. A photo-print guide to the flora of Ohio's Unglaciated Region. Volume II: Dicots, from Sururaceae to Cornaceae. Miami University, Oxford, Ohio. 330 pp. Prepared for Hoosier-Wayne National Forest.

Brewer, L. G. and J. L. Vankat. 1992. A photo-print guide to the flora of Ohio's Unglaciated Region. Volume I: Lower vascular plants, Gymnosperms, and Monocots. Miami University, Oxford, Ohio. 185 pp. Prepared for Hoosier-Wayne National Forest.

Brewer, L.G. 1992. Environmental factors responsible for the decline of selective savanna herbs and oak seedlings as oak savanna succeeds to forest. Abstract: The Ohio Journal of Science 92(2): 16.

Brewer, L. G. and J. L. Vankat. 1990. Vegetation changes in the oak savannas and woodlands of northwestern Ohio: 1989 final report. Submitted to Ohio Department of Natural Resources, Division of Natural Areas and Preserves, Columbus, Ohio, 61 pp.

Brewer, L. G. 1989. The natural recovery of Michigan's American chestnut (*Castanea dentata*) trees. Abstract: American Journal of Botany 76: 93.

Albert, D. A., M. R. Penskar, G. A. Reese, W. Brodowicz, L. G. Brewer, E.M. Chittenden, and U. C. Peterson. 1989. Factors affecting regional diversity of Great Lakes marshes in Michigan. Abstract: 2nd Indiana Dunes Research Conference: Restoration and Preservation of Great Lakes Coastal Ecosystems.

Brewer, L. G. 1989. A survey of the oak barrens and savannas of the Oak Openings Preserve Metropark. Submitted to the Nature Conservancy, Ohio Chapter, Columbus, Ohio, 54 pp.

Raup, H. A., T. W. Hodler, and L. G. Brewer. 1987. The presettlement vegetation of southwestern Michigan. The East Lakes Geographer 22: 216-217 + map.

Graber, R. E. and L. G. Brewer. 1985. Changes in the population of the rare and endangered plant *Potentilla robbinsiana* Oakes during the period 1973 to 1983. Rhodora 87: 449-457.

Brewer, L. G., T. W. Hodler, and H. A. Raup. 1984. The presettlement vegetation of southwestern Michigan. Michigan Botanist 23: 153-156.

Brewer, L. G., T. W. Hodler, and H. A. Raup. 1984. The presettlement vegetation of southwestern Michigan. Department of Geography, Western Michigan University. Map.

Brewer, L. G. 1982. The distribution of surviving American chestnuts in Michigan. Pp. 94-100. In H. Smith and W. MacDonald (eds.), Proceedings of the USDA Forest Service American Chestnut Cooperators' Meeting. University of West Virginia Agricultural Experiment Station and USDA.

Brewer, L. G. 1982. The present status and future prospect for the American chestnut in Michigan. Michigan Botanist 21: 117-128.

Hodler, T. W., R. Brewer, L. G. Brewer, and H. A. Raup. 1981. The presettlement vegetation of Kalamazoo County. Department of Geography, Western Michigan University. Map.

Brewer, L. G. 1981. Mapping chestnuts in Michigan. Pp. 15-17 in D. Fulbright, Proceedings of the Michigan American Chestnut Workshop. MSU.

Brewer, L. G. 1981. The American chestnut in Michigan. Northern Nut Growers Annual Report 71: 26-28.

My American chestnut research was described in "Research News" of the journal Science (Vol. 209, August 22, 1980).

MANUSCRIPTS IN PREPARATION

Brewer, L. G. 2008. Factors affecting the distribution of *Hydrastis canadensis* (goldenseal) in Hoosier National Forest. In preparation for Journal of Torrey Botanical Society.

Brewer, L. G. and J. L. Vankat. 2008. An experimental study on the environmental factors affecting the regeneration of black oak (*Quercus velutina*) and white oak (*Quercus alba*) in a former oak savanna in northwestern Ohio. In preparation for Canadian Journal of Forest Research.

Brewer, L. G. 2008. Michigan’s plant tension zone as described by presettlement tree surveys. In preparation for American Midland Naturalist.

Brewer, L. G. 2008. The flora and vegetation of a six square mile area of Lawrence County, Ohio. In preparation for Ohio Journal of Science.

Brewer, L. G., B. R. Dalton, M. A. Leopold, and M. K. Reif. 2008. Landscape changes in the forests of Boone County, Kentucky from 1954 to 1998. In preparation for Natural Areas Journal.

SCIENTIFIC PRESENTATIONS

Brewer, L. G., B. R. Dalton, M. A. Leopold, S. M. Dougherty, M. K. Reif, D. L. Greis, and N. W. Wilson. 2002. Boone County forest quality assessment: an ecological evaluation, prioritization, and mapping. Kentucky Academy of Sciences, Northern Kentucky Universe, Highland Heights, Kentucky.

Brewer, L. G. 2000. Vegetation changes in Ohio's Oak Savannas. Illinois Natural History Survey, Campaign, Illinois.

Brewer, L. G. and S. Olson. 2000. Factors affecting the distribution of *Hydrastis canadensis* (goldenseal) in Hoosier National Forest. Natural Areas Meeting St. Louis, Missouri.

Brewer, L. G. 1997. Vegetation changes in Ohio's Oak Savannas. Midwest Oak Savanna and Woodland Conference. University of Wisconsin-Madison, Wisconsin.

Dalton, B.R. and L. G. Brewer. 1997. A closer look at the shrub and herb layers of and old-growth remnant of the Curtis Gates Lloyd Recreational and Wildlife Area in Crittenden, Kentucky. Ancient Eastern United States Forests. Process, Value, and Management. Clarion University, Clarion, Pennsylvania.

Brewer, L. G. and B. R. Dalton. 1995. A survey of rare plants and plant communities in a six square mile area in southern Lawrence County, Ohio. Lucy Braun Association for the Mixed Mesophytic Forest, Marshall University, Huntington, West Virginia.

Dalton, B. R., H. Kunz, V. R. Holmes, and L. G. Brewer. 1994. Mortality and condition assessment of 53 species of native trees and shrubs planted to restore a palustrine forested wetland in central Indiana. Ecological Society of America, University of Tennessee, Knoxville, Tennessee.

Brewer, L. G. and M. Grigore. 1993. Restoring oak savannas in northwest Ohio: monitoring the progress. Midwest Oak Savanna Conference, Northern Illinois University, Chicago, Illinois.

Brewer, L. G. 1993. The presettlement vegetation of northwestern Ohio. Midwest Oak Savanna Conference, Northeastern Illinois University, Chicago, Illinois.

Albert, D. A., M. R. Penskar, G. A. Reese, W. Brodowicz, L.G. Brewer, E. M Chittenden, and U. C. Peterson. 1989. Factors affecting regional diversity of Great Lakes marshes in Michigan. Second Indiana Dunes Research Conference: Restoration and Preservation of Great Lakes Coastal Ecosystems. Indiana National Lake Shore, Portage, Indiana.

Brewer, L. G. 1989. The natural recovery of Michigan's American chestnut (*Castanea dentata*) trees. AIBS Meeting, Toronto, Ontario, Canada.

Brewer, L. G. 1982. A study on the vegetational tension zone using pre and post-settlement surveys. Michigan Academy of Science, Arts, and Letters, Kalamazoo, Michigan.

Brewer, L. G. 1982. The distribution of healing American chestnut trees in Michigan. U.S. Forest Service American Chestnut Symposium, Morgantown, West Virginia.

Brewer, L. G. 1982. The distribution of healing American chestnut trees in Michigan. U.S. Forest Service and American Chestnut Symposium, Morgantown, West Virginia.

Brewer, L. G. 1981. Mapping chestnuts of Michigan. American Chestnut Workshop, Sponsored by Michigan State University and Consumers Power Company, Tippy Dam, Wellston, Michigan.

Brewer, L. G. 1981. The chestnuts of Michigan. Northern Nut Growers Association Annual Meeting, Geneseo, New York.

Brewer, L. G. 1980. The American chestnut (*Castanea dentata*) in Michigan. Michigan Audubon Annual Meeting, Traverse City, Michigan.

Brewer, L. G. 1980. The present status and future prospect for the American chestnut (*Castanea dentata*). Michigan Academy of Science, Arts, and Letters, Wayne State University, Detroit, Michigan.

PROFESSIONAL MEMBERSHIPS

Ecological Society of America (ESA)
Ohio Academy of Sciences
Torrey Botanical Club
Southern Appalachian Botanical Society
Society for Ecological Restoration
Lucy Braun Association
Natural Areas Association
The Nature Conservancy

TELEPHONE / PERSONAL CONVERSATION REPORT

PROJECT NAME:	MVP Southgate Pipeline Project
MVP TEAM CALLER:	Megan Stahl
CONVERSATION WITH:	John Ellis, FWS Sarah McRae, FWS Alex Miller, NextEra Cory Chalmers, Equitrans Midstream Stephanie Frazier, ESI Taina Pankiewics, ESI
AGENCY:	(As listed)
EMAIL ADDRESS:	
PHONE NUMBER:	
SUBJECT:	Aquatic species treatment discussion
DATE AND TIME:	29 April 2019, 10:00 am

SUMMARY OF CONVERSATION:

This meeting was held to understand information FWS would need to consider regarding aquatics species consultation. Agenda topics circulated prior to the meeting are summarized below.

Agenda:

1. Follow up items from our last conversation regarding consideration of potential indirect impacts associated with sedimentation
    a. MVP recommends including this analysis in an aquatic species report (to be combined with mussel survey results)

    – FWS agreed with this approach; indicated this document is not a biological assessment; and indicated that results of the sedimentation analysis can be included in this document.

    b. Plan to utilize the recent FWS data request on MVP mainline to guide the analysis

    – FWS agreed with this approach

    c. Can you provide additional detail on what, if any, additional data you would like us to include?

– FWS advised that sedimentation analysis should consider sedimentation issues in past projects and how those issues were addressed, and relate how these "lessons learned" are carried forward to the Southgate Project

2. Hydrotest withdrawal and discharge – MVP is considering withdrawal from the Dan River and discharge near the Dan River
    a. Recommendations from FWS regarding withdrawal avoidance and minimization measures – minimum baseflow, screened intake, etc.

    – MVP is evaluating VDEQ's request of 1 mm screened intakes and minimum intake velocity

    – FWS advised that waters can be withdrawn from the Dan River, but conservation measures need to be in effect:
        - no withdrawals during critical life stages of anadromous, rare, threatened or endangered species. For the Dan River, this timeframe is between March – June;
        - maintain minimum baseflow, using withdrawal rates less than 25% of water body discharge from nearest gauged stream or as ratioed from an adjacent gauged watershed;
        - withdrawals should made from the surface and from deeper areas of the waterbody;
        - withdrawals should not be made during times of drought.

    – if Project water withdrawals cannot meet the time of year restrictions (March – June), then FWS would ask for additional conservation measures; review Atlantic Coast Pipeline's water withdrawal information.

    b. Recommendations from FWS regarding discharge including sampling, distance from River, set up, etc.

    – FWS advised that MVP discuss chemical additives (e.g., biocides, dechlorinators, etc) as part of its water withdrawal plan to avoid impacts on receiving waters. Discharge rate should not cause erosion and sedimentation issues. FWS does not have specific guidance on freshwater discharge.

    – FWS requested a copy of the VADEQ guidance for screen size and withdrawal velocity restrictions as well as MVPs best management practices for discharging to avoid erosion.

Contact Signature: _____Stephanie Frazier /s/_____

Stephanie Frazier

From: rene.hypes@dcr.virginia.gov on behalf of nhreview, rr <nhreview@dcr.virginia.gov>
Sent: Tuesday, April 23, 2019 2:04 PM
To: Stephanie Frazier
Cc: mstahl@eqt.com
Subject: Re: MVP Southgate - rare plants review in Pittsylvania Co

Ms. Frazier,

Thank you for your request to identify suitable habitat for the rare plants (American bluehearts, Downy phlox, and Piedmont Barbara's-button) DCR recommended surveys for the MVP Southgate project. Upon further review of the project area by a DCR botanist, it was noted other occurrences of these resources are surrounding the entire project area and the geology within the project area is appropriate to support these rare plants. Therefore, we are unable to identify discrete suitable habitat areas along the proposed pipeline where surveys for these species should be conducted. Instead, we can only recommend surveys for these rare plants species in the existing maintained right-of-way providing open canopy habitat within the project area.

Please note, no fee will be assessed for the requested information service. Let us know if you have any questions.

Sincerely,

S. Rene' Hypes

Project Review Coordinator

Department of Conservation and Recreation

Division of Natural Heritage

600 East Main Street, 24th Floor

Richmond, Virginia 23219

804-371-2708 (phone)

804-371-2674 (fax)

rene.hypes@dcr.virginia.gov

Conserving VA's Biodiversity through Inventory, Protection and Stewardship

http://www.dcr.virginia.gov/natural-heritage

Rene'

On Mon, Apr 22, 2019 at 1:10 PM <SFRAZIER@envsi.com> wrote:

> Customer Project reference ID is **19042213105638**.
>
> Detail: www.dcr.virginia.gov/login/detail.php?app=2014-06-14-11-06-18-49117&id=2019-04-22-13-10-56-384780-1rd
>
> Application: www.dcr.virginia.gov/natural-heritage/nhserviceform/?id=2019-04-22-13-10-56-384780-1rd
>
> Additional Files:

Stephanie Frazier

From: Stancil, Vann F <vann.stancil@ncwildlife.org>
Sent: Wednesday, April 17, 2019 10:00 AM
To: Stahl, Megan D.
Cc: John_Ellis@fws.gov; Taina Pankiewicz; Stephanie Frazier; Russ, W. Thomas; Jones, Brena K.; Munzer, Olivia
Subject: RE: [External] MVP Southgate Carolina Ladle Crayfish Surveys

Follow Up Flag: Follow up
Flag Status: Flagged

Categories: Yellow Category

Megan, thanks for the information on stream crayfish surveys. We concur with your approach to do mussel and crayfish surveys on the same day. Note that mussel surveys should be conducted before crayfish surveys so that habitat is not altered prior to mussel surveys. To keep info together, I've included the section from our 10 Aug. 2018 comments that pertain to surveys for the Carolina Ladle Crayfish:

- Stream crayfish surveys should be conducted in all first to third order streams in the Dan and Haw river basins. These surveys should include 20 kicks into a seine approximately 8 feet wide. The area upstream of the seine should be disturbed by flipping rocks or kicking under banks or root wads to dislodge crayfish. The primary purpose of these surveys is to determine abundance and distribution of the Carolina Ladle Crayfish, *Cambarus davidi*, but other crayfish species may also be encountered. Collected crayfish should be identified, photographed, and enumerated. Seining effort should be spaced to include the 400-meter mussel survey area that extends above and below the proposed crossing location.

Thanks,
Vann

From: Stahl, Megan D. <MStahl@equitransmidstream.com>
Sent: Tuesday, April 16, 2019 2:38 PM
To: Stancil, Vann F <vann.stancil@ncwildlife.org>
Cc: John_Ellis@fws.gov; Taina Pankiewicz (TPankiewicz@envsi.com) <TPankiewicz@envsi.com>; Stephanie Frazier <SFrazier@envsi.com>
Subject: [External] MVP Southgate Carolina Ladle Crayfish Surveys

Hi Vann,
As I mentioned in my voicemail to you today. MVP plans to proceed with Carolina ladle crayfish surveys at 17 of the first to third order streams within the Dan and Haw river basins, concurrent with freshwater mussel surveys. In order to capitalize on the current mobilization for mussel surveys, I am providing the following information to you in lieu of a study plan. Please review and let me know if you concur with this plan, or if you need additional information.

The survey locations:

River Basin	County Name	Mile Post	Stream ID	Waterbody Name
Dan	Rockingham	27.5	S-A18-42	Cascade Creek
Dan	Rockingham	27.7	S-A18-40	Cascade Creek
Dan	Rockingham	31.4	S-B18-95	Rock Creek
Dan	Rockingham	32.2	S-A18-147	Machine Creek
Dan	Rockingham	32.7	S-A18-151_A	Town Creek
Dan	Rockingham	33.1	S-A18-151_B	Town Creek
Dan	Rockingham	38.8	S-A18-8	Wolf Island Creek
Dan	Rockingham	41.2	S-B18-56	Lick Fork
Dan	Rockingham	43.3	S-A18-176	Jones Creek
Dan	Rockingham	47	S-C18-76/ AS-C18-76	Hogans Creek
Haw	Rockingham	48.7	S-A18-60	Giles Creek
Haw	Rockingham	50.9	AS-NHD-305	UNT Haw River
Haw	Alamance	52.8	S-B18-94	UNT Haw River
Haw	Alamance	53.7	S-A18-84	UNT Haw River
Haw	Alamance	58.7	S-C18-11	UNT Haw River
Haw	Alamance	64	AS-NHD-1547	Deep Creek
Haw	Alamance	67.1	AS-NHD-1558	Boyds Creek

Survey efforts for the stream-dwelling crayfish are completed by performing a given number of seine hauls sampling the best available habitat (slab boulders, rootwads, logs, etc.) within the stream reach using a 2.4-meter (8-ft) wide seine. The seine is held by one crew member and spread approximately 2 meters (6.5 ft) wide, with handles held at a 40 to 50° angle from the stream surface. The lead line makes contact with the stream substrate at all times. Once the net is arranged, other surveyor(s) begin overturning substrate items immediately upstream, and kicking in the direction of the net. At the end of the haul, the lead line is removed from the water before the float line to ensure items caught within the seine do not fall back into the stream prior to sample processing. Dislodged substrate items are returned to their original locations once sample processing is complete. For smaller streams where the seine may be cumbersome, hand collecting is implemented and consists of one person-hour of search time including flipping best available habitat (slab boulders and large cobble). Dip nets may be utilized while hand collecting.

Collected crayfish are identified to species, sexed, and carapace length is measured. A photographic voucher of each crayfish species is taken. All data are recorded on a standard Crayfish Morphometric Datasheet. MVP will provide survey results to NCWRC.

Please let me know if you have questions or would like to discuss further.

Thank you,
Megan

From: Stancil, Vann F <vann.stancil@ncwildlife.org>
Sent: Monday, March 25, 2019 2:27 PM
To: Stahl, Megan D. <MStahl@equitransmidstream.com>
Subject: [EXTERNAL] FW: MVP Southgate Mussel Study Plan

From: Stancil, Vann F
Sent: Wednesday, March 20, 2019 5:23 PM
To: Stahl, Megan D. <MStahl@eqt.com>
Cc: Jones, Brena K. <Brena.Jones@ncwildlife.org>; thomas.russ@ncwildlife.org; Munzer, Olivia <olivia.munzer@ncwildlife.org>
Subject: MVP Southgate Mussel Study Plan

Hey Megan, I've looked over the study plan a couple of times now and can see that our comments from 20 Sep. 2018 were well incorporated. NCWRC concurs that surveys for the sites listed can begin, as long as the project route remains unchanged. In addition, these survey results are valid for 2 years, per NCWRC review. Procedures to relocate mussels can be addressed later.

While an updated version of the mussel study plan is not necessary, I do want to point out that we requested that beaver ponds be surveyed for mussels. The study plan does not address this; i.e., it does not say that beaver ponds will be surveyed, nor does it say that they will not be surveyed. RTE mussel species have been found in beaver ponds and there are very recent discoveries of RTE mussel species in reservoirs in the Catawba basin.

Also, as noted in our comment letter, biologists should be on the lookout for crayfish and fish during mussel surveys and document (notes, locations, photographs) any encounters. The Study Plan does address this for mussels and crayfish near the bottom of page 6.

Please let me know if you would prefer a formal letter and if we can assist further with this. We look forward to seeing the results of the mussel surveys.

Thanks,
Vann

Vann Stancil // Research Coordinator
Habitat Conservation Division

NC Wildlife Resources Commission
215 Jerusalem Church Road
Kenly, North Carolina 27542
office: 919-284-5218
fax: 919-284-5218
vann.stancil@ncwildlife.org

ncwildlife.org

Stephanie Frazier

From: Stahl, Megan D. <MStahl@equitransmidstream.com>
Sent: Monday, April 15, 2019 9:59 AM
To: Stephanie Frazier; Taina Pankiewicz
Cc: Chalmers, Cory M.
Subject: FW: [EXTERNAL] MVP Southgate -Rare Plant Species Suitable Habitat

From: Hypes, Rene' <rene.hypes@dcr.virginia.gov>
Sent: Monday, April 15, 2019 7:18 AM
To: Stahl, Megan D. <MStahl@equitransmidstream.com>
Cc: Townsend, John <john.townsend@dcr.virginia.gov>; Meader, Tyler (DCR) <tyler.meader@dcr.virginia.gov>
Subject: Re: [EXTERNAL] MVP Southgate -Rare Plant Species Suitable Habitat

Hi Megan,

Yes please complete the information services order form ahead of time requesting custom maps of suitable habitat for the three rare plant species (American bluehearts, Downy phlox, and Piedmont Barbara's-button) within the MVP Southgate project area. Upon receipt of the completed information services order form, we will provide the custom maps within two weeks. Please let me know if you have any additional questions.

Thank you.

Rene'

On Fri, Apr 12, 2019 at 1:50 PM Stahl, Megan D. <MStahl@equitransmidstream.com> wrote:

> Hi Renee
>
> Thank you for the information below. I apologize for the delayed response. This ended up in my junk mail, which may have been due to my new email address.
>
> Regardless, we would like to proceed with having DCR's botanist identify suitable habitat. What is the next step? Do we complete the information services form ahead of time?
>
> Thank you,
> Megan
>
> **From:** Hypes, Rene' <rene.hypes@dcr.virginia.gov>
> **Sent:** Wednesday, March 20, 2019 5:35 PM
> **To:** Stahl, Megan D. <mstahl@eqt.com>
> **Cc:** Bulluck, Jason <jason.bulluck@dcr.virginia.gov>
> **Subject:** [EXTERNAL] MVP Southgate -Rare Plant Species Suitable Habitat

Hi Megan,

As a follow-up to our phone conversation today, I spoke to John Townsend, DCR botanist in regards to identifying suitable habitat for the three rare plant species (American bluehearts, Downy phlox, and Piedmont Barbara's-button) to inform surveys for the MVP Southgate Project. Mr. Townsend can identify potential suitable areas within the proposed November 2018 pipeline footprint with associated infrastructure (FERCFiled_20180928.zip). There will be an hourly fee ($80) associated with the development of these custom maps and/or shapefile for identified suitable habitat areas (see information services order form). Please let me know if EQT is interested in the DCR-Natural Heritage Program developing this spatial information or if additional information is needed for these resources.

Thank you.

Rene'

--

S. Rene' Hypes

Project Review Coordinator

Department of Conservation and Recreation

Division of Natural Heritage

600 East Main Street, 24th Floor

Richmond, Virginia 23219

804-371-2708 (phone)

804-371-2674 (fax)

rene.hypes@dcr.virginia.gov

Conserving VA's Biodiversity through Inventory, Protection and Stewardship

http://www.dcr.virginia.gov/natural-heritage

--

S. Rene' Hypes

Project Review Coordinator

Department of Conservation and Recreation

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Conserving VA's Biodiversity through Inventory, Protection and Stewardship

http://www.dcr.virginia.gov/natural-heritage

Stephanie Frazier

From: Ellis, John <john_ellis@fws.gov>
Sent: Thursday, April 11, 2019 1:28 PM
To: John Spaeth
Cc: Stancil, Vann F; Brena.Jones@ncwildlife.org; thomas.russ@ncwildlife.org; olivia.munzer@ncwildlife.org; sarah_mcrae@fws.gov; john_ellis@fws.gov; Stahl, Megan D.; Alex.Miller@nexteraenergy.com; Stephanie Frazier; Taina Pankiewicz; Casey Swecker; Jo Garofalo; Adam Benshoff; David Foltz; Brandon Yates
Subject: Re: [EXTERNAL] MVP Southgate Mussel Study Plan & Survey Commencement

USFWS is ok with the plan.

John

On Tue, Apr 2, 2019 at 4:23 PM John Spaeth <jspaeth@envsi.com> wrote:

> Vann,
>
> Next week, we plan to initiate mussel surveys in North Carolina along MVP Southgate. Surveys will begin within the Dan River basin and generally head in a southerly direction. The commencement of surveys is contingent upon the weather and water conditions so let's hope that Mother Nature cooperates. Surveys will be conducted as outlined in the MVP Southgate mussel survey study plan. Although not explicitly stated in the study plan, we acknowledge your comment regarding surveys in beaver ponds and can accommodate the request.
>
> I wanted to notify you of our plans in case you had any further comments prior to initiating surveys. Please note that mussel relocations will not occur. In the event a federally threatened or endangered species is encountered, USFWS-Raleigh and NCWRC will be notified within 24 hours via phone or email.
>
> Please let me know if you have any questions or comments.
>
> Thanks,
>
> -John
>
> ESI **John Spaeth**
> Aquatic Scientist / Project Manager
> Environmental Solutions & Innovations, Inc.
> 4525 Este Ave. | Cincinnati, OH 45232 | USA

mobile: 513.377.0443 **direct:** 513.451.4329

office: 513.451.1777 **fax:** 513.451.3321
jspaeth@envsi.com | www.envsi.com

From: Stancil, Vann F
Sent: Wednesday, March 20, 2019 5:23 PM
To: Stahl, Megan D. <MStahl@eqt.com>
Cc: Jones, Brena K. <Brena.Jones@ncwildlife.org>; thomas.russ@ncwildlife.org; Munzer, Olivia <olivia.munzer@ncwildlife.org>
Subject: MVP Southgate Mussel Study Plan

Hey Megan, I've looked over the study plan a couple of times now and can see that our comments from 20 Sep. 2018 were well incorporated. NCWRC concurs that surveys for the sites listed can begin, as long as the project route remains unchanged. In addition, these survey results are valid for 2 years, per NCWRC review. Procedures to relocate mussels can be addressed later.

While an updated version of the mussel study plan is not necessary, I do want to point out that we requested that beaver ponds be surveyed for mussels. The study plan does not address this; i.e., it does not say that beaver ponds will be surveyed, nor does it say that they will not be surveyed. RTE mussel species have been found in beaver ponds and there are very recent discoveries of RTE mussel species in reservoirs in the Catawba basin.

Also, as noted in our comment letter, biologists should be on the lookout for crayfish and fish during mussel surveys and document (notes, locations, photographs) any encounters. The Study Plan does address this for mussels and crayfish near the bottom of page 6.

Please let me know if you would prefer a formal letter and if we can assist further with this. We look forward to seeing the results of the mussel surveys.

Thanks,
Vann

Vann Stancil // Research Coordinator

Habitat Conservation Division

NC Wildlife Resources Commission

215 Jerusalem Church Road

Kenly, North Carolina 27542

office: 919-284-5218

fax: 919-284-5218

vann.stancil@ncwildlife.org

ncwildlife.org

<image001.jpg><image002.jpg><image003.jpg><image004.jpg>

Stephanie Frazier

From: John Spaeth
Sent: Tuesday, April 02, 2019 4:23 PM
To: Stancil, Vann F
Cc: Brena.Jones@ncwildlife.org; thomas.russ@ncwildlife.org; olivia.munzer@ncwildlife.org; sarah_mcrae@fws.gov; john_ellis@fws.gov; Stahl, Megan D.; Alex.Miller@nexteraenergy.com; Stephanie Frazier; Taina Pankiewicz; Casey Swecker; Jo Garofalo; Adam Benshoff; David Foltz; Brandon Yates
Subject: MVP Southgate Mussel Study Plan & Survey Commencement

Vann,
Next week, we plan to initiate mussel surveys in North Carolina along MVP Southgate. Surveys will begin within the Dan River basin and generally head in a southerly direction. The commencement of surveys is contingent upon the weather and water conditions so let's hope that Mother Nature cooperates. Surveys will be conducted as outlined in the MVP Southgate mussel survey study plan. Although not explicitly stated in the study plan, we acknowledge your comment regarding surveys in beaver ponds and can accommodate the request.

I wanted to notify you of our plans in case you had any further comments prior to initiating surveys. Please note that mussel relocations will not occur. In the event a federally threatened or endangered species is encountered, USFWS-Raleigh and NCWRC will be notified within 24 hours via phone or email.

Please let me know if you have any questions or comments.
Thanks,
-John

ESI
John Spaeth
Aquatic Scientist / Project Manager
Environmental Solutions & Innovations, Inc.
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mobile: 513.377.0443 **direct:** 513.451.4329
office: 513.451.1777 **fax:** 513.451.3321
jspaeth@envsi.com | www.envsi.com

From: Stancil, Vann F
Sent: Wednesday, March 20, 2019 5:23 PM
To: Stahl, Megan D. <MStahl@eqt.com>
Cc: Jones, Brena K. <Brena.Jones@ncwildlife.org>; thomas.russ@ncwildlife.org; Munzer, Olivia <olivia.munzer@ncwildlife.org>
Subject: MVP Southgate Mussel Study Plan

Hey Megan, I've looked over the study plan a couple of times now and can see that our comments from 20 Sep. 2018 were well incorporated. NCWRC concurs that surveys for the sites listed can begin, as long as the project route remains

unchanged. In addition, these survey results are valid for 2 years, per NCWRC review. Procedures to relocate mussels can be addressed later.

While an updated version of the mussel study plan is not necessary, I do want to point out that we requested that beaver ponds be surveyed for mussels. The study plan does not address this; i.e., it does not say that beaver ponds will be surveyed, nor does it say that they will not be surveyed. RTE mussel species have been found in beaver ponds and there are very recent discoveries of RTE mussel species in reservoirs in the Catawba basin.

Also, as noted in our comment letter, biologists should be on the lookout for crayfish and fish during mussel surveys and document (notes, locations, photographs) any encounters. The Study Plan does address this for mussels and crayfish near the bottom of page 6.

Please let me know if you would prefer a formal letter and if we can assist further with this. We look forward to seeing the results of the mussel surveys.

Thanks,
Vann

Vann Stancil // Research Coordinator
Habitat Conservation Division

NC Wildlife Resources Commission
215 Jerusalem Church Road
Kenly, North Carolina 27542
office: 919-284-5218
fax: 919-284-5218
vann.stancil@ncwildlife.org

ncwildlife.org

Stephanie Frazier

From: Stahl, Megan D. <MStahl@equitransmidstream.com>
Sent: Monday, March 25, 2019 4:12 PM
To: Miller, Alex; Stephanie Frazier
Subject: FW: MVP Southgate Mussel Study Plan

From: Stancil, Vann F
Sent: Wednesday, March 20, 2019 5:23 PM
To: Stahl, Megan D. <MStahl@eqt.com>
Cc: Jones, Brena K. <Brena.Jones@ncwildlife.org>; thomas.russ@ncwildlife.org; Munzer, Olivia <olivia.munzer@ncwildlife.org>
Subject: MVP Southgate Mussel Study Plan

Hey Megan, I've looked over the study plan a couple of times now and can see that our comments from 20 Sep. 2018 were well incorporated. NCWRC concurs that surveys for the sites listed can begin, as long as the project route remains unchanged. In addition, these survey results are valid for 2 years, per NCWRC review. Procedures to relocate mussels can be addressed later.

While an updated version of the mussel study plan is not necessary, I do want to point out that we requested that beaver ponds be surveyed for mussels. The study plan does not address this; i.e., it does not say that beaver ponds will be surveyed, nor does it say that they will not be surveyed. RTE mussel species have been found in beaver ponds and there are very recent discoveries of RTE mussel species in reservoirs in the Catawba basin.

Also, as noted in our comment letter, biologists should be on the lookout for crayfish and fish during mussel surveys and document (notes, locations, photographs) any encounters. The Study Plan does address this for mussels and crayfish near the bottom of page 6.

Please let me know if you would prefer a formal letter and if we can assist further with this. We look forward to seeing the results of the mussel surveys.

Thanks,
Vann

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fax: 919-284-5218
vann.stancil@ncwildlife.org

ncwildlife.org

Stephanie Frazier

From: Stahl, Megan D. <MStahl@equitransmidstream.com>
Sent: Wednesday, March 20, 2019 9:57 AM
To: Miller, Alex; Stephanie Frazier
Subject: SG Call to Rene Hypes

Follow Up Flag: Follow up
Flag Status: Flagged

Categories: Red Category

I spoke to Renee this morning regarding the request for rare plant surveys in the email below. I let her know that we would like guidance on DCR's recommendations if one of the species is found if MVP would do surveys. She said that avoidance would be their first recommendation. DCR has not supported translocation in the past because they like to see the habitat be maintained as well. She said that although the DCR botanist said there is potential for these species along the entire line she expects they might be found in pockets and not everywhere. I suggested a desktop review to help focus on areas of higher probability and she said she would go back to the DCR botanist to ask him if he can narrow down areas for recommended surveys. She said she will try to get back to me today.

From: Hypes, Rene' <rene.hypes@dcr.virginia.gov>
Sent: Tuesday, February 26, 2019 1:38 PM
To: Stahl, Megan D. <MStahl@equitransmidstream.com>
Cc: Bulluck, Jason <jason.bulluck@dcr.virginia.gov>; Weber Joseph xpg48711 <joseph.weber@dcr.virginia.gov>; Miller, Alex <Alex.Miller@nexteraenergy.com>; Stephanie Frazier <SFrazier@envsi.com>
Subject: Re: [EXTERNAL] Re: MVP Southgate Project Update

Hi Megan,

Thank you for your follow-up email and information.

Assuming presence of Piedmont barbara's-buttons (*Marshallia obovata* var. *obovata*, G4G5TNR/S1/NL/NL), Downy phlox (*Phlox pilosa*, G5/S2/NL/NL) and American Bluehearts (*Buchnera americana*, G5?/S1S2/NL/NL) along the entire pipeline will most likely include areas that do not support natural heritage resources. As indicated in the FERC Plan, one of the environmental inspector's responsibilities include "Verifying the location of signs and highly visible flagging marking the boundaries of **sensitive resource areas...**". In order to identify where these sensitive resource areas are along the pipeline and avoid them, DCR continues to recommend a rare plant survey be conducted for the project in the growing season. According to the Flora of Virginia, the survey windows in Virginia for these species are as follows: Piedmont Barbara's-buttons (mid-May through early June), Downy phlox (April through May) and American bluehearts (July to early September). For additional information, please contact John Townsend, DCR botanist at John.Townsend@dcr.virginia.gov or 804-225-4855.

As the seed mixes are not currently available for review, in addition to inclusion of the DCR Invasive Species List as part of the Exotic and Invasive Plant Species Control Plan, DCR continues to recommend the ROW restoration and maintenance practices planned include appropriate revegetation using native species in a mix of grasses and forbs, robust monitoring and adaptive management plan to provide guidance if initial revegetation efforts are unsuccessful or if invasive species outbreaks occur.

Please complete and submit the information services order form on-line by checking the box for a Custom NHR Report and including "this is a follow-up review for the MVP Southgate project" in the project description. Upon checking the box that you accept the conditions and entry of contact information the form can be submitted by clicking on the submit button below the human check field.

Please let me know if you have any additional questions and thank you for the opportunity to provide input for this project.

Rene'

On Mon, Feb 25, 2019 at 6:51 PM Stahl, Megan D. <MStahl@equitransmidstream.com> wrote:

> Hi Rene',
>
> Thank you for your emails from Thursday and today. In regards to your requests I am providing the following information.
>
> VA state rare Piedmont plant species (American bluehearts, downy phlox, and Piedmont Barbara's-button) are addressed in the 2018 federal plants survey report (let me know if you need another copy). In summary, the Project assumes that Barbara's buttons, downy phlox and American bluehearts are present and impacts will be minimized by following the FERC Plan and Procedures (hyperlinks) and the Project Exotic and Invasive Plant Species Control Plan. I will address your comment regarding the Exotic and Invasive Plant Species Control Plan to include and reference the entire VA DCR Invasive Species List, not only the medium and high invasive species in Table 1 (pages 2-4) of the plan.
>
> Surveys for freshwater mussels in the Banister River are addressed in the VA Mussel Study Plan (which you now have). As requested, upon completion of all surveys, the Project will provide DCR with a copy of the survey reports.
>
> Seed mixes to be used during restoration are still in development. Upon completion I will provide the proposed seed mixes for your review. In the meantime, the Project welcomes your input.
>
> Do you need me to submit the information services order form to your attention to allow you to invoice the Project?
>
> Please let me know if you have additional questions or feedback.
>
> Thank you,
>
> Megan

From: Hypes, Rene' <rene.hypes@dcr.virginia.gov>
Sent: Monday, February 25, 2019 3:23 PM
To: Stahl, Megan D. <MStahl@equitransmidstream.com>
Cc: Bulluck, Jason <jason.bulluck@dcr.virginia.gov>; Weber Joseph xpg48711 <joseph.weber@dcr.virginia.gov>; Miller, Alex <Alex.Miller@nexteraenergy.com>; Stephanie Frazier <SFrazier@envsi.com>
Subject: [EXTERNAL] Re: MVP Southgate Project Update

Hi Megan,

I am confirming the receipt of the Study Plan for the Freshwater Mussel Surveys Along the Proposed Southgate Project in Virginia on Friday, Feb. 22, 2019. Upon completion of all surveys, DCR requests a copy of the survey reports. In addition, DCR recommends the Resource Report 3-Fish, Wildlife-Appendix 3-B January 2019 Exotic and Invasive Plant Species Control Plan include and reference the entire VA DCR Invasive Species List not only the medium and high invasive species in Table 1 (pages 2-4) of the plan.

Please note, in order to fund soft money staff working on this project we will need to invoice your company for additional follow-up information and review. An information services order form can be found here for your convenience and the custom report hourly rate is $60. Please let me know if you have any questions.

Thank you.

Rene'

On Thu, Feb 21, 2019 at 2:19 PM Hypes, Rene' <rene.hypes@dcr.virginia.gov> wrote:

> Megan,
>
> I have some follow-up questions in regards to your request.
>
> In looking at the documents posted on the link (http://www.mvpsouthgate.com/news-info/) provided in a previous email for Resource Report 3 (11-2-2018) , the document posted for both Resource Report 3 and Resource Report 3A is the same, Resource Report 3A. The Resource Report 3A provides survey methods for rare plants (Smooth Coneflower and Small whorled pogonia in NC), bats in VA and NC, and freshwater mussels in NC but does not reference surveys for freshwater mussels in the Bainster River in VA and/or VA state rare Piedmont plant species (American bluehearts,

downy phlox, and Piedmont Barbara's-button). Is there an update to Resource Report 3 available that you could send to us for review?

Resource Report 3-Fish, Wildlife and Vegetation -Appendix 3-B

The January 2019 Exotic and Invasive Plant Species Control Plan includes a reference to seed mixes *(3. Seed mixes used during restoration will include native species within the seed mix*). Are these seed mixes available for review?

Thank you.

Rene'

On Wed, Feb 20, 2019 at 3:58 PM Stahl, Megan D. <MStahl@equitransmidstream.com> wrote:

> Hi Rene',
>
> As I mentioned in my voicemail, I am reaching out to check in on the Southgate project. Specifically:
>
> 1. Have you had time to review Resource Report 3 (link below) to confirm whether you agree with the Project's approach to minimizing impacts on American bluehearts, downy phlox, and Piedmont Barbara's-button?
> 2. The attached Exotic and Invasive Plant Species Control Plan was filed with FERC on January 24. Do you have any comments, or can you provide approval of the Plan?
>
> Please feel free to call to discuss (note that my contact information below has changed).
>
> Thank you,
>
> Megan
>
> Megan Stahl
>
> Manager Environmental
>
> 2200 Energy Drive

Canonsburg, PA 15317

T 412-553-7783

C 412-737-2587

mstahl@equitransmidstream.com

Please note my new email address

From: Stahl, Megan D.
Sent: Tuesday, November 06, 2018 5:09 PM
To: John_Ellis@fws.gov; Troy Andersen <troy_andersen@fws.gov>; 'Stancil, Vann F' <vann.stancil@ncwildlife.org>; 'Ernst Aschenbach' <ernie.aschenbach@dgif.virginia.gov>; 'rr ProjectReview (DGIF)' <projectreview@dgif.virginia.gov>; 'Hypes, Rene'' <rene.hypes@dcr.virginia.gov>; 'Bulluck, Jason' <jason.bulluck@dcr.virginia.gov>; Weber Joseph xpg48711 <joseph.weber@dcr.virginia.gov>
Cc: Miller, Alex <Alex.Miller@nexteraenergy.com>; Stephanie Frazier <SFrazier@envsi.com>
Subject: MVP Southgate Project Update

Good evening,

On behalf of the MVP Southgate project team, I am reaching out to notify you that we filed our formal Application today requesting certification of public convenience and necessity from the Federal Energy Regulatory Commission. We will continue to update our company webpage throughout the process with pertinent FERC filings. The entire Application can be found on our docket (CP19-14-000) in the FERC's eLibrary.

Attached you will find the public news release and an updated kmz file of the MVP Southgate Project workspace that was used for the Application. MVP Southgate will continue to update stakeholders throughout the FERC process. Please feel free to reach out to me with any questions or concerns.

Please also feel free to forward this email to others within your agency that would be interested in this information.

Thank you,

Megan

Megan Stahl

Permitting Supervisor

625 Liberty Avenue, Suite 1700

Pittsburgh, PA 15222

T 412-553-7783

C 412-737-2587

www.eqt.com

--

S. Rene' Hypes

Project Review Coordinator

Department of Conservation and Recreation

Division of Natural Heritage

600 East Main Street, 24th Floor

Richmond, Virginia 23219

804-371-2708 (phone)

804-371-2674 (fax)

rene.hypes@dcr.virginia.gov

Conserving VA's Biodiversity through Inventory, Protection and Stewardship

http://www.dcr.virginia.gov/natural-heritage

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http://www.dcr.virginia.gov/natural-heritage

Stephanie Frazier

From: Stahl, Megan D. <MStahl@equitransmidstream.com>
Sent: Tuesday, March 19, 2019 12:19 PM
To: Miller, Alex; Stephanie Frazier
Subject: FW: [EXTERNAL] Southgate Fragmentation Review

Follow Up Flag: Follow up
Flag Status: Flagged

From: Weber, Joseph <joseph.weber@dcr.virginia.gov>
Sent: Tuesday, March 19, 2019 12:12 PM
To: Stahl, Megan D. <MStahl@eqt.com>
Subject: [EXTERNAL] Southgate Fragmentation Review

Hi Megan,

Sorry for the delay in getting back to you. My analysis and response are in the last stage of the review process by upper management and I hope to be able to get it to you this week.

Thanks,
Joe

--

~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

Joe Weber
Natural Heritage Information Manager
Virginia Department of Conservation and Recreation
600 East Main St, 16th Floor
Richmond, VA 23219
(804) 371-2545

Conserving Virginia's biodiversity through
inventory, information management,
protection, and stewardship


VIRGINIA NATURAL HERITAGE PROGRAM
DEPARTMENT OF CONSERVATION AND RECREATION

Stephanie Frazier

From: Stahl, Megan D. <MStahl@equitransmidstream.com>
Sent: Monday, March 18, 2019 11:12 AM
To: Miller, Alex; Stephanie Frazier
Subject: SG Call to John Ellis 3/18/19

I spoke to John Ellis this morning about the mussel study plan. He said he has it but has not heard feedback from Sarah McRae yet. I told him we plan to start surveys in April as long as conditions are favorable. He said Sarah is not in the office today but that he would nudge her.

Megan Stahl
Manager Environmental
2200 Energy Drive
Canonsburg, PA 15317
T 412-553-7783
C 412-737-2587
mstahl@equitransmidstream.com
Please note my new email address

Stephanie Frazier

From: Stahl, Megan D. <MStahl@equitransmidstream.com>
Sent: Wednesday, March 13, 2019 4:37 PM
To: Alex.Miller@nexteraenergy.com; Stephanie Frazier
Subject: SG DCR Contact - Forest fragmentation analysis

I called Joe Weber from DCR today to discuss his analysis of potential forest fragmentation for the Southgate project in VA. I left a voicemail asking him to call me back or send an email to me to provide a status update.

Sent from my iPhone

Stephanie Frazier

From: Ernst Aschenbach <ernie.aschenbach@dgif.virginia.gov>
Sent: Monday, March 11, 2019 2:02 PM
To: Stahl, Megan D.; alex.miller@nexteraenergy.com; Stephanie Frazier; troy_andersen@fws.gov; rr ProjectReview (DGIF)
Subject: ESSLog 39178; RE: MVP Southgate TOYR

Importance: High

The information you provided below appears to be correct. One clarification. The Time of Year Restrictions (TOYRs) you cited are followed by the customary statement, "…of any given year," to cover situations where a project continues more than one year.

We support coordinating with the USFWS regarding federally listed species. Thanks.

Ernie Aschenbach
Environmental Services Biologist
P 804.367.2733
Email: Ernie.Aschenbach@dgif.virginia.gov
Virginia Department of Game & Inland Fisheries
CONSERVE. CONNECT. PROTECT.
A 7870 Villa Park Drive, P.O. Box 90778, Henrico, VA 23228-0778
www.dgif.virginia.gov

From: Stahl, Megan D. <MStahl@equitransmidstream.com>
Sent: Monday, March 11, 2019 10:43 AM
To: Ernst Aschenbach <ernie.aschenbach@dgif.virginia.gov>; rr ProjectReview (DGIF) <projectreview@dgif.virginia.gov>
Cc: alex.miller@nexteraenergy.com; Stephanie Frazier <SFrazier@envsi.com>
Subject: MVP Southgate TOYR

Good morning Ernie,

We are continuing to develop the plans for the MVP Southgate Pipeline Project and would appreciate VDGIF's guidance on time of year restrictions (TOYRs) associated with fishes and mussels in the Virginia portion of the Project. The MVP Southgate Pipeline Project crosses Dan River basin including the Banister and Sandy river watersheds in Pittsylvania County. Can you please confirm that the following TOYRs from VDGIF's Time of Year Restrictions and Other Guidance Document (July 5 2018) are applicable to the project?

Trout Streams
At this time, neither native trout streams nor stockable trout waters are crossed by the Project in Virginia and so time of year restrictions do not apply to any proposed MVP Southgate stream crossings. If plans change and MVP Southgate will cross stockable trout streams, the Project will contact the Aquatic Regional Area Manager for guidance.

Fishes

Our search of the WERMs database did not identify any streams potentially supporting populations of Roanoke logperch in Virginia. During our July 6, 2018 teleconference, VDGIF and USFWS indicated that federal and state listed fishes were not likely to occur in waters crossed by the Project in Virginia and that surveys for fishes would not be requested. MVP Southgate plans to minimize instream effects to aquatic life by completing fish removals in perennial streams where instream substrates will be exposed (e.g., dewatered). Roanoke logperch TOYRs do not apply to any proposed MVP Southgate stream crossings.

Mussels

VDGIF and VDCR indicated that rare mussels are thought to occur in the Banister and Sandy rivers. Mussel surveys are planned in these two waterbodies for spring 2019; if live Atlantic pigtoe, James spinymussel, green floater, or yellow lampmussel are encountered then the Project will implement the applicable TOYRs listed below for those affected waters. The mussel survey study plan was recently accepted by VDGIF (February 27, 2019) and is still under review by USFWS.

- Short-term brooders - Atlantic pigtoe (*Fusconaia masoni*) and James spinymussel (*Parvaspina collina*) – May 15 – July 31
- Long-term brooders - Green floater (*Lasmigona subviridis*) and Yellow lampmussel (*Lampsilis cariosa*)– April 15 – June 15 and August 15 - September 30

Please confirm you agree with the determinations of these TOYRs.

Thank you,
Megan

Megan Stahl
Manager Environmental
2200 Energy Drive
Canonsburg, PA 15317
T 412-553-7783
C 412-737-2587
mstahl@equitransmidstream.com
Please note my new email address

Stephanie Frazier

From: Stahl, Megan D. <MStahl@equitransmidstream.com>
Sent: Monday, March 11, 2019 11:29 AM
To: Ernst Aschenbach; rr ProjectReview (DGIF)
Cc: alex.miller@nexteraenergy.com; Stephanie Frazier
Subject: MVP Southgate comments to FERC

Ernie,
The last time we spoke you mentioned that you were planning to summarize VDGIF comments by fauna on the Southgate project and submit to FERC, and I mentioned I would check into when comments should be submitted. There is really no deadline for filing comments with FERC, but the timing of submission will dictate when FERC will address the comments (either in the DEIS or FEIS).
Let me know if you would like to discuss further.
Thanks,
Megan

Megan Stahl
Manager Environmental
2200 Energy Drive
Canonsburg, PA 15317
T 412-553-7783
C 412-737-2587
mstahl@equitransmidstream.com
Please note my new email address

MVP Southgate Project

Docket No. CP19-14-000

Attachment Resource Report 20-1

Virginia and North Carolina SHPO Correspondence

CUI//PRIV - DO NOT RELEASE

(Provided Under Separate Cover)

May 2019

MVP Southgate Project

Docket No. CP19-14-000

Attachment 22-1

Nottoway Indian Tribe of Virginia Correspondences

May 2019

MVP SOUTHGATE TELEPHONE LOG

DATE: May 7, 2019		
FROM/TO: Beth Roach	**AFFILIATION:** Nottoway Tribe of Indians (Virginia State Recognized)	**TOPIC:** Tribal Coordination
On April 23, 2018, the Project contacted the Nottoway Indian Tribe of Virginia (the Tribe) via email expressing the Project's desire to coordinate regarding the Project's cultural resources investigations and supplied a Confidentiality Agreement for the Tribe's signature. Ms. Roach, a Tribal Council Member, returned a call to Agnes Ramsey and informed her that the Tribe would be signing the Confidentiality Agreement. Once a signed Confidentiality Agreement is received, the Project will supply the Tribe with copies of all archaeological investigation reports produced to date. The Project has committed to meeting with them to discuss after the Tribe has reviewed the reports.		
MVP Southgate Representative: Agnes S. Ramsey, Tribal Relations Project Manager		

From: Ramsey, Agnes
Sent: Tuesday, April 23, 2019 5:09 PM
To: Beth Roach (egroach@gmail.com) <egroach@gmail.com>; 'hardyfamilyfarm@gmail.com' <hardyfamilyfarm@gmail.com>
Cc: Miller, Alex <Alex.Miller@nexteraenergy.com>; Kyle Martin (Kyle.Martin@nexteraenergy.com) <Kyle.Martin@nexteraenergy.com>; Lavarco, William <William.Lavarco@nexteraenergy.com>
Subject: MVP Southgate Coordination

Ms. Roach and Mr. Hardy,
I am the Tribal Relations Project Manager for the MVP Southgate natural gas pipeline project. I would like to coordinate with the Nottoway Indian Tribe of Virginia to provide information on the project and to receive your feedback. After trying to reach Ms. Roach, I spoke with Mr. Hardy who recommended that I forward this email to initiate our coordination. In order to begin sharing information, we request that you provide a signed copy via email of the attached Confidentiality Agreement. This is a standard requirement as we may share and discuss sensitive cultural information during our discussions. If you have any questions or concerns, feel free to contact me via return email or my phone numbers below.

I look forward to hearing from you,

Agnes S. Ramsey
Project Manager - Tribal Relations
Phone (561) 691-2820
Cell (561) 385-9018

MVP SOUTHGATE

MVP Southgate Project

Docket No. CP19-14-000

Attachment 23-1

Emergency Services Correspondences

May 2019

Subject: FW: [EXTERNAL] Fwd: Pittsylvania County Emergency Management Update

From: Maurice <mroyster@embarqmail.com>
Date: May 7, 2019 at 4:36:53 PM EDT
To: Chris.Slemp@pittgov.org
Subject: Pittsylvania County Emergency Management Update

Good afternoon Chris!
I'm glad we got to catch up again last week.
As per our conversation, I will follow up with you later in the summer to schedule the Pittsylvania County Emergency Medical Services update meetings regarding the MVP Southgate pipeline project.
Don't hesitate to call my cell if you have any questions.
All the best!
/m

Maurice Royster
Equitrans Midstream
The Olde Fire Hall
1007 East Watauga Ave
Johnson City TN 37601

From: Shawn Day
To: Rodney Cates
Subject: RE: Rockingham County Emergency Services

Hi Rodney,

Just wanted to follow up, per our phone conversation the other day and for our records, that we'll circle back with you later this summer, likely in July or August, to discuss the project, construction and operations in more detail.

Thanks,

Shawn

From: Rodney Cates [mailto:rcates@co.rockingham.nc.us]
Sent: Monday, April 29, 2019 4:51 PM
To: Shawn Day
Subject: Re: Rockingham County Emergency Services

Sounds good.

On Mon, Apr 29, 2019 at 3:46 PM Shawn Day <shawn@capresults.net> wrote:

> Perfect. I will call your cell. Thanks!
>
> Shawn
>
> **From:** Rodney Cates [mailto:rcates@co.rockingham.nc.us]
> **Sent:** Monday, April 29, 2019 3:37 PM
> **To:** Shawn Day
> **Subject:** Re: Rockingham County Emergency Services
>
> Yes Sir. Thursday afternoon around 2 will be fine.
>
> On Mon, Apr 29, 2019 at 3:08 PM Shawn Day <shawn@capresults.net> wrote:
>
> > Thanks, Lance. Hi, Rodney. Are you available to talk briefly, perhaps on Thursday afternoon around 2 p.m.?
> >
> > Shawn
> >
> > **From:** Lance Metzler [mailto:lmetzler@co.rockingham.nc.us]
> > **Sent:** Monday, April 29, 2019 2:28 PM
> > **To:** Shawn Day
> > **Cc:** Rodney Cates
> > **Subject:** Re: Rockingham County Emergency Services
> >
> > Shawn,

You can contact Rodney Cates as he is our Director of Emergency Services. I have carbon copied him and his cell number is (336) 932-1478.

Lance

Lance L. Metzler, ICMA-CM
Rockingham County Manager
371 NC 65, Reidsville, NC 27320
PO Box 101, Wentworth, NC 27375
Office: 336-342-8101
Fax: 336-342-8105
Email: lmetzler@co.rockingham.nc.us
Website: www.co.rockingham.nc.us

On Mon, Apr 29, 2019 at 1:50 PM Shawn Day <shawn@capresults.net> wrote:

> Hi Lance,
>
> I hope you are doing well. The project continues to move along in the regulatory process, and we're pulling together additional information requested by the FERC ahead of the Draft EIS, which is still targeted for July.
>
> In the meantime, the project team would like to start coordinating introductory discussions with the appropriate emergency services personnel in the county in order to share information about the project, its scope of construction, operations, our security plan and circumstances and procedures related to emergency response. Can you point me in the right direction as to whom the appropriate individuals would be?
>
> Thanks very much,
>
> Shawn
>
> Shawn Day
> Public Relations Manager | MVP Southgate
> Office: 804.771.5306
> http://www.mvpsouthgate.com

--

Rodney M Cates
Emergency Services Director
Rockingham County
rcates@co.rockingham.nc.us
336-634-3017

--

Rodney M Cates
Emergency Services Director
Rockingham County
rcates@co.rockingham.nc.us
336-634-3017

From: Debbie Hatfield
To: Shawn Day; Bryan Hagood
Cc: John Payne
Subject: RE: Alamance County emergency services
Date: Thursday, May 2, 2019 9:21:13 AM
Attachments: image002.png

I am good on Wednesday, Thursday or Friday.

Debbie D. Hatfield
Emergency Management Coordinator
Alamance County Emergency Management Office
Billing Address: 124 West Elm Street, Graham, NC 27253
Physical Address: 1950 Martin Street, Burlington, NC 27215
Debbie.hatfield@alamance-nc.com
Office: 336-227-1365 or 336-570-4075
Fax: 336-570-6784

From: Shawn Day [mailto:shawn@capresults.net]
Sent: Wednesday, May 01, 2019 3:48 PM
To: Bryan Hagood <Bryan.Hagood@alamance-nc.com>
Cc: Debbie Hatfield <Debbie.Hatfield@alamance-nc.com>; John Payne <John.Payne@alamance-nc.com>
Subject: Re: Alamance County emergency services

Thanks, Bryan. Hi, Debbie and John. Do the two of you have time for a brief conversation by phone late next week, perhaps on Thursday or Friday? I would anticipate no more than 15 to 20 minutes.

Thanks,

Shawn

Shawn Day
Capital Results

From: Bryan Hagood
Sent: Tuesday, April 30, 12:32 PM
Subject: RE: Alamance County emergency services
To: Shawn Day
Cc: Debbie Hatfield, John Payne

Good afternoon, Shawn! Thanks for the email. I think if you contact Debbie Hatfield of Ala Co Emerg Serv and John Payne of the Ala Co Fire Marshal's Office they can help get you all touch with the right folks. I have copied both Debbie and John with this email. Please feel free to reach out to them directly. Thanks again!

Bryan Hagood
Ala Co Manager

From: Shawn Day <shawn@capresults.net>
Sent: Monday, April 29, 2019 1:53 PM
To: Bryan Hagood <Bryan.Hagood@alamance-nc.com>
Subject: Alamance County emergency services

WARNING: *This email originated outside Alamance County's email system.*
Please be very careful when clicking on links or opening attachments.
Good afternoon Bryan:

I hope you are doing well! It has been a while since we last spoke, but I wanted to provide you with a quick update and request. The project continues to move along in the regulatory process, and we're pulling together additional information requested by the FERC ahead of the Draft EIS, which is still targeted for July. Surveying is continuing along the route; we have now surveyed more than 90 percent of the proposed route and continue to evaluate potential variations.

In the meantime, the project team would like to start coordinating introductory discussions with the appropriate emergency services personnel in the county in order to share information about the project, its scope of construction, operations, our security, and circumstances and procedures related to public emergency response. Can you point me in the right direction as to whom the appropriate individuals would be?

Thanks very much,

Shawn

Shawn Day
Public Relations Manager | MVP Southgate
Office: 804.771.5306

http://www.mvpsouthgate.com

MVP Southgate Project

Docket No. CP19-14-000

Attachment 28-1

Naturally Occurring Radioactive Material Report

May 2019

NATURALLY OCCURING RADIOACTIVE MATERIALS (NORM) REPORT

Pittsylvania County, Virginia
(excluding Coles Hill Uranium Deposit)

Prepared For:

Mountain Valley Pipeline – MVP Southgate Project

Equitrans Midstream

2200 Energy Drive

Canonsburg, PA 15317

May 3, 2019

Prepared By:

Draper Aden Associates

Engineering • Surveying • Environmental Services

DAA Project Number: B14188B-33

Draper Aden Associates (DAA) prepared this document (which may include drawings, specifications, reports, studies and attachments) in accordance with the agreement between DAA and Mountain Valley Pipeline.

The standard of care for all professional engineering, environmental and surveying and related services performed or furnished by DAA under this Agreement are the care and skill ordinarily used by members of these professions practicing under similar circumstances at the same time and in the same locality. DAA makes no warranties, express or implied, under this Agreement in connection with DAA's services.

Conclusions presented are based upon a review of available information, the results of our field studies, and/or professional judgment. To the best of our knowledge, information provided by others is true and accurate, unless otherwise noted.

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Table 1 Summary of Common Sources of Terrestrial NORMs

LIST OF FIGURES

Figure 1 Compilation of Uranium Occurrences in Virginia

1.0 INTRODUCTION

Mountain Valley Pipeline, LLC (Mountain Valley) is seeking a Certificate of Public Convenience and Necessity from the Federal Energy Regulatory Commission (FERC) pursuant to Section 7(c) of the Natural Gas Act to construct and operate the MVP Southgate Project (Project). The Project facilities will be located in Pittsylvania County, Virginia and Rockingham and Alamance counties, North Carolina. See Resource Report #1 (General Project Description) for additional Project information.

Construction of the proposed Project will require ground disturbance (e.g., clearing, trenching, excavation, force-assisted excavation, etc.,). Resource Report #6 was prepared in accordance with the FERC Guidance Manual for Environmental Report Preparation (February 2017) to address geologic resources and potential hazards that may be encountered during ground disturbance for construction.

Given the unique geology of Pittsylvania County, Virginia, the presence of elevated terrestrial naturally-occurring radioactive materials (NORMs) (i.e., bedrock mineralogy containing uranium, thorium and radium) was specifically addressed in Resource Report #6. The most notable occurrence of terrestrial NORMs in the vicinity of the Project occurs at the Coles Hill Uranium Deposit, Pittsylvania County, Virginia, (addressed in Resource Report #6) which is located approximately 3.5 miles north of the Lambert Compressor Station. The FERC provided the following comment in their April 2019 Environmental Information Request specifically regarding uranium and radium (e.g., terrestrial NORMs) in soil and groundwater, in response to Resource Report #6:

> "*Pursuant to the February 13, 2019 EIR item #105, as previously requested describe known concentrations of uranium and radium in soil and groundwater in the Project vicinity (other than the Coles Hill uranium deposit) and discuss the potential for uranium to be exposed or mobilized (into surface water) [sedimentation into streams], groundwater, and air [fugitive dust missions and radiation] during construction in Pittsylvania County, Virginia."*

2.0 OVERVIEW OF TERRESTRIAL NORMS

Terrestrial NORMs are naturally occurring in minerals that make up many types of rocks and derivative overburden (Duval et al., 2005). If sufficiently concentrated above background by natural geologic processes, the radioactive decay of terrestrial NORMs can be measured using remote sensing instruments (NRC, 2012). The principal terrestrial NORMs are uranium-238 (uranium series), uranium-235 (actinium series), and thorium-232 (thorium series) (see **Table 1**, below).

Table 1 Summary of Common Sources of Terrestrial NORMs (ISU, 2015)

Nuclide	Symbol	Half-life	Natural Activity
Uranium 235/238	$^{235}U/^{238}U$	4.47×10^9 yr	$^{238}U + ^{235}U$ is 99.99% of all natural uranium (99.3% ^{238}U; 0.6% ^{235}U). Background total uranium ranges from 0.5 to 4.7 ppm in common rock types.
Thorium 232	^{232}Th	1.41×10^{10} yr	Thorium ranges from 1.6 to 20 ppm in the common rock types.

Terrestrial radioactive elements uranium and thorium have always been present in the Earth's crust and atmosphere, and when sufficiently concentrated by geologic processes are identified as orebodies that may be mined. Uranium and thorium decay through numerous radionuclides, (principally radium and radon which are relevant for potential human exposure) before reaching a stable end point at the element lead. This naturally occurring decay series contributes up to 80% of the natural background terrestrial radiation to which all humans are continuously exposed (NRC, 2012).

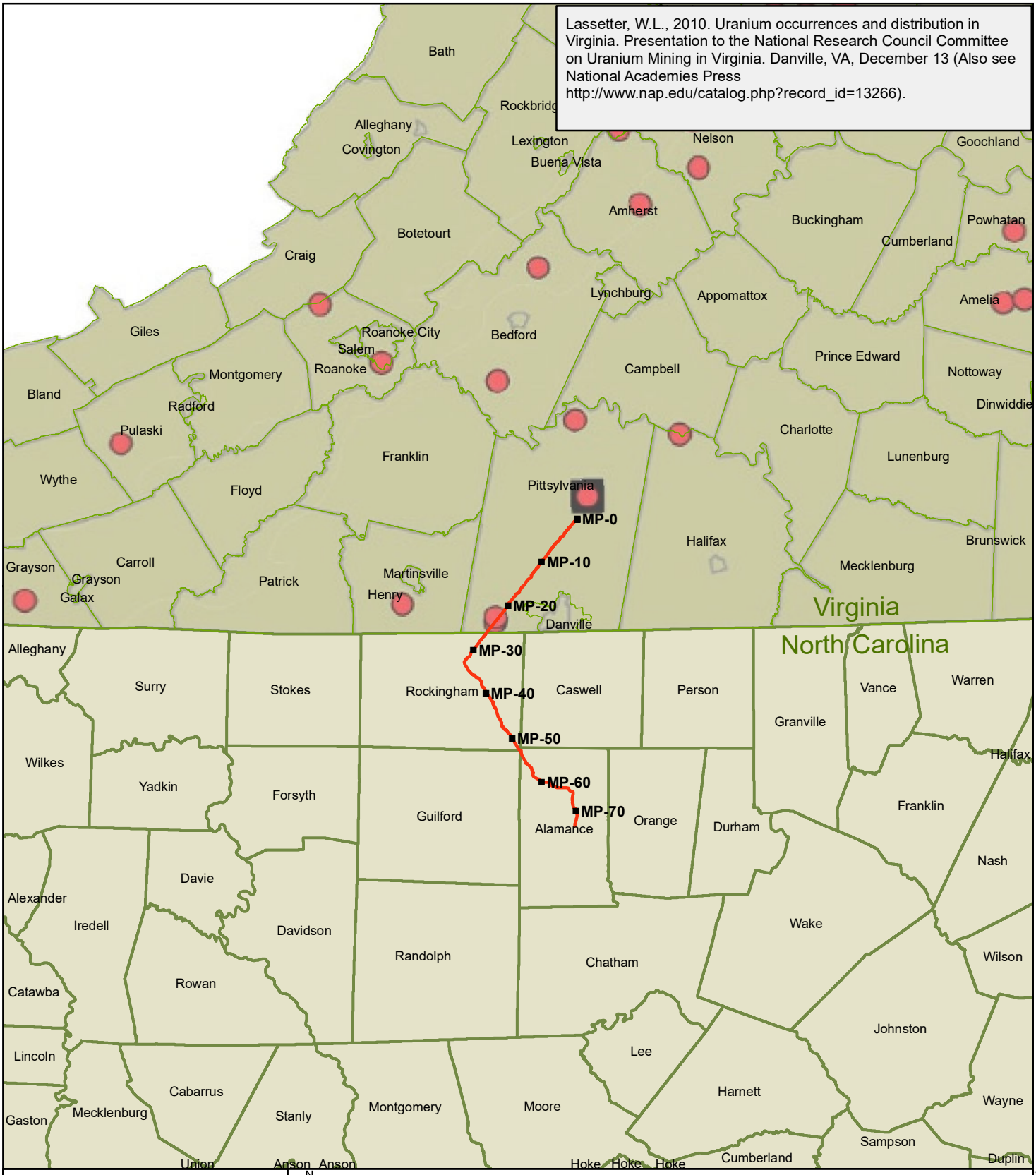
3.0 DISTRIBUTION OF NORMS RELATIVE TO THE PROJECT

Uranium and other terrestrial NORMs typically occur in shale, marine phosphatic sedimentary rocks, coal, certain types of sandstones, and certain igneous and metamorphic bedrock where hydrothermal alteration has concentrated radioactive minerals.

In Virginia, Lassetter (2010) identified approximately 50 terrestrial uranium occurrences in diverse geologic settings (**Figure 1**). Of these occurrences, only the Coles Hill uranium deposit, located in Pittsylvania County, is notable for relative enrichment above background (VDMME, 2015). The Coles Hill deposit is hosted within mylonitized Leatherwood Granite gneiss and amphibolite in the footwall of the Chatham Fault that forms the boundary between the Virginia western piedmont province to the northwest and the Danville Triassic basin to the southeast (Levitan, 2014). In addition to the Coles Hill deposit, Lassetter (2010) identified two other uranium occurrences in Pittsylvania County, located to the southwest along bedrock strike from the Coles Hill deposit (**Figure 1**). Given that these exposures are on-strike with Coles Hill, it is assumed that they are associated with similar geology, but at much less concentration and more indicative of local and regional background NORMs occurrence.

As noted in Resource Report #6, the Project alignment is southwest of, and does not encounter the Coles Hill deposit. However, it does trend in the vicinity of the two other uranium occurrences that were identified by Lassetter (2010), between approximately milepost (MP) 20 and MP 26 (see **Figure 1**). There is no information readily available in the public domain to identify the nature and extent of these two occurrences. Based on a personal communication with Mr. Lassetter on May 3, 2019, one of the occurrences was identified from a single privately-held field data point, and the other was a location where an exploration bore was drilled by Marline Corporation (circa 1980s) as part of the Coles Hill uranium investigation. It is reasonably certain that there is no specific and discrete boundaries associated with these features, that NORMs levels are likely to be generally representative of local and regional background, and therefore these possible exposures present no new or cumulative risk for exposure or mobilization.

Review of the USGS Mineral Resources Data System (USGS, 2019) identified several aggregate quarries, and four mines located in Pittsylvania County to the southwest of Coles Hill (i.e., in


Lassetter, W.L., 2010. Uranium occurrences and distribution in Virginia. Presentation to the National Research Council Committee on Uranium Mining in Virginia. Danville, VA, December 13 (Also see National Academies Press http://www.nap.edu/catalog.php?record_id=13266).
Bath
Alleghany
Covington
Rockbridge
Lexington
Buena Vista
Nelson
Goochland
Amherst
Buckingham
Powhatan
Cumberland
Botetourt
Craig
Lynchburg
Appomattox
Amelia
Giles
Roanoke City
Salem
Roanoke
Bedford
Prince Edward
Nottoway
Montgomery
Bland
Radford
Pulaski
Campbell
Dinwiddie
Charlotte
Lunenburg
Wythe
Floyd
Franklin
Pittsylvania
MP-0
Halifax
Brunswick
Carroll
Grayson
Galax
Patrick
Martinsville
Henry
MP-10
MP-20
Danville
Mecklenburg
Virginia
North Carolina
Alleghany
Surry
Stokes
Rockingham
MP-30
MP-40
Caswell
Person
Vance
Warren
Granville
MP-50
Wilkes
Yadkin
Forsyth
Guilford
MP-60
MP-70
Alamance
Orange
Durham
Halifax
Franklin
Nash
Davie
Alexander
Iredell
Davidson
Randolph
Wake
Chatham
Wilson
Catawba
Rowan
Johnston
Lincoln
Lee
Cabarrus
Harnett
Wayne
Gaston
Mecklenburg
Stanly
Montgomery
Moore
Sampson
Union
Anson
Hoke
Cumberland
Duplin
Southgate Project
N
NAD 1983 UTM 17N
1:1,500,000
All Locations Approximate
Legend
Uranium Occurance
Coles Hill Uranium Deposit Southgate
Proposed Route (May 2019)
No occurance records found in this area of North Carolina
Mountain Valley PIPELINE
Figure 1:
Compilation of Uranium Occurrences in Virginia
05-09-19
Draper Aden Associates
Engineering • Surveying • Environmental Services
http://www.nap.edu/catalog.php?record_id=13266
Document Path: P:\B14100\B14188\B14188B-33\GIS\Uranium Fig 1 Lassiter.mxd

vicinity of the unnamed exposures depicted in Lassetter, 2010) and in the vicinity of the proposed Project. The four mines are:

- Hopewell Project, -79.47198, 36.75285 (WGS84), gold, located approximately 2.15 miles northwest of the Project near MP 9;
- Dalton Prospects, -79.63557, 36.64758 (WGS84), mica, located approximately 4.69 miles northwest of the Project near MP 20;
- Dalton Prospects, -79.63617, 36.65008 (WGS84) feldspar, located approximately 4.81 miles northwest of the Project near MP 20;
- W. M. Carpenter prospect, -79.52836, 36.58588 (WGS84), mica, located approximately 2.61 miles southeast of the Project near MP 20.

There is no information on other uranium mines, prospects, etc., provided in the USGS (2019) database in the vicinity of the Project alignment in Pittsylvania County, Virginia.

In summary, only the Coles Hill deposit appears to warrant attention as far as NORMs are concerned, and the Project alignment does not encounter this deposit. Other speculative occurrences of NORMs along the Project alignment are likely representative of local and regional background, and do not present a notable concern for pipeline construction.

3.1 Known Concentrations of Uranium and Radium in Soil and Sediment

Other than site-specific studies of the Coles Hill deposit, there is limited readily-available public-domain soil or sediment concentration data for uranium and radium in Pittsylvania County.

One public domain source of soil and sediment data for uranium is available from the National Uranium Resource Evaluation (NURE) database, currently administered by the United States Geological Survey (USGS). The following discussion describes the NURE effort and current status (USGS, 2019):

> *The National Uranium Resource Evaluation (NURE) program was initiated by the Atomic Energy Commission (AEC) in 1973 with a primary goal of identifying uranium resources in the United States. When the AEC was abolished by act of*

Congress (Oct. 11, 1974), the NURE program was transferred to the newly created Energy Research and Development Administration (ERDA). On Aug. 4, 1977, Congress terminated ERDA and all functions - including the NURE program - were transferred to the new Cabinet-level Department of Energy (DOE).

The Hydrogeochemical and Stream Sediment Reconnaissance (HSSR) program (initiated in 1975) was one of nine components of NURE. Planned systematic sampling of the entire United States began in 1976 under the responsibility of four DOE national laboratories: Lawrence Livermore Laboratory (LLL), Los Alamos Scientific Laboratory (LASL), Oak Ridge Gaseous Diffusion Plant (ORGDP), and Savannah River Laboratory (SRL). Each DOE laboratory developed its own sample collection, analytical, and data management methodologies and hired contractors to do much of the actual work.

In 1977, the entire NURE program changed from a study area basis (State, County, or geomorphic provinces) to a 1° x 2° quadrangle basis. Many of the early study areas were not coincident with quadrangle boundaries and so additional sampling was done later to complete the quadrangle studies. Some quadrangles were never completed. Originally, all samples were only analyzed for uranium. Analyses for additional elements, other than uranium, were also authorized in 1977 and many - but not all - early samples were reanalyzed.

The NURE program effectively ended about 1983-84 when funding disappeared. Out of a total of 625 quadrangles that cover the entire lower 48 States and Alaska, only 307 quadrangles were completely sampled and another 86 quadrangles were partially sampled.

For this analysis, NURE data for uranium in soil and sediment from the USGS Greensboro quadrangle were used to estimate minimum, maximum and median concentrations to generally represent the Project area in Pittsylvania County, Virginia.

Radium results were not found in the NURE database for the Greensboro quadrangle.

Based on the NURE data for uranium in soil, as described above, 12 samples were included for the Greensboro Quadrangle, and all were below the laboratory reporting limit.

Based on the NURE data for uranium in sediment, minimum uranium concentration was 1.4 mg/kg maximum uranium concentration was 45 mg/kg and the median concentration was 7.2 mg/kg. The sample population was 334.

Geochemical parameters such as soil, sediment or water concentration data, are generally considered to demonstrate a log-normal distribution, such that the median value best describes expected concentration.

Note that there is no discernable and verifiable quality assurance and quality control associated with the specific results used herein to approximate the minimum, maximum and median concentrations.

3.2 Known Concentrations of Uranium and Radium in Groundwater and Surface Water

Other than site-specific studies of the Coles Hill deposit, there is limited readily-available public-domain groundwater or surface water concentration results for uranium and radium in Pittsylvania County.

One published study that dates from 2014 conducted by the Virginia Department of Health (VDH, 2014) presented uranium and radium results from periodic sampling of one private residential water well identified only as RW-1, which is (was) located in the vicinity of the Coles Hill deposit. Uranium from 2008 to 2012 ranged from 86 to 312 µg/L, compared to the public drinking water standard (not applicable to private wells, but included here for reference) of 30 µg/L. Radium from 2008 to 2012 ranged from 3.8 to 3.3 pCi/L, compared to a public drinking water standard of 5 pCi/L.

As referenced above for soil and sediment, uranium results for groundwater wells and springs in the Greensboro quadrangle were taken from the USGS (2019 accessed) NURE database to represent the Project area of Pittsylvania County. Note that the NURE database did not contain any data for streams in the Greensboro quadrangle dataset.

Radium results were not found in the NURE database for groundwater wells or springs, for this analysis.

Based on the NURE database described above for groundwater wells, minimum uranium concentration was 0 µg/L (i.e., non-detect), maximum uranium concentration was 729.4 µg/L, and the median concentration was 0.054 µg/L. The sample population was 332. The minimum and median concentrations from the NURE database are lower than the VDH study for the residential well RW-1, however, RW-1 is proximal to, or within, the Coles Hill deposit, and thus should represent elevated uranium concentrations.

Based on the NURE database described above for springs, minimum uranium concentration was 0 µg/L (i.e., non-detect), maximum uranium concentration was 34.14 µg/L, and the median concentration was 0.052 µg/L. The sample population was 16.

As noted above, geochemical parameters are generally considered to demonstrate a log-normal distribution, such that the median value best describes expected concentration.

Note that there is no discernable and verifiable quality assurance and quality control associated with the specific results used herein to approximate the minimum, maximum and median concentrations.

4.0 POTENTIAL FOR EXPOSURE AND MOBILIZATION

The FERC requested information from Mountain Valley on the potential for uranium to be exposed or mobilized into surface water (via sedimentation into streams), groundwater or air (fugitive dust emissions and radiation) during construction in Pittsylvania County, Virginia.

As discussed above, the Project alignment does not encounter the Coles Hill uranium deposit. No other NORMs occurrence in Pittsylvania County is documented to be notably elevated in concentration (e.g., uranium) or radiation (e.g., radium) compared to ambient background, which is represented in this report by public domain data for soil, sediment, springs and groundwater wells in Pittsylvania County (discussed above; USGS, 2019).

Therefore, it is concluded that land disturbance for construction activities will not encounter or mobilize NORMs to any greater extent that other construction projects that have been, or will be undertaken in Pittsylvania County. Furthermore, the Project generally entails a narrow linear limit of disturbance and shallow trenching (typically less than 10 feet) for pipeline installation. It is reasonably certain that NORMs are heavily leached from the shallow soil throughout most of the Project alignment. Where shallow bedrock is encountered, it is anticipated that NORMs levels will be similar to regional background (notwithstanding the specific Coles Hill deposit), and not warrant a particular concern other than industry standard construction practices.

4.1 Mitigation

Industry-standard practices for stormwater control, erosion and sediment control (ESC) and fugitive dust mitigation will be implemented during pipeline construction and the redress of disturbed ground in accordance with MVP's approved construction plans, and in accordance with state and local regulations and ordinances. Industry standard measures to protect worker health and safety will also be implemented by Mountain Valley, as documented to the FERC.

As discussed above, there does not appear to be an enhanced risk for exposure to NORMs along the Project alignment in Pittsylvania County, Virginia, compared to other construction practices in the County. Normal and appropriate construction best management practices will be undertaken by Mountain Valley to protect soil, sediment, surface water, groundwater and air quality.

5.0 BIBLIOGRAPHY

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MVP Southgate Project

Docket No. CP19-14-000

Attachment 32-1

Revised
Site-specific Residential Construction Plans

May 2019

MVP SOUTHGATE PROJECT

PROPOSED H-650 PIPELINE
ENGINEERING SERVICES DESIGN; JOB NUMBERS 300423
RESIDENTIAL DRAWINGS

DRAWING NO.	DRAWING TITLE	REV.
RES-COV	MOUNTAIN VALLEY PIPELINE PROJECT PROPOSED H650 PIPELINE RESIDENTIAL DRAWINGS	P3
RES-NOTES	MOUNTAIN VALLEY PIPELINE PROJECT PROPOSED H650 PIPELINE RESIDENTIAL NOTES	P
RES-NOTES (CONT.)	MOUNTAIN VALLEY PIPELINE PROJECT PROPOSED H650 PIPELINE RESIDENTIAL NOTES	P
RES-NOTES SITE SPECIFIC	MOUNTAIN VALLEY PIPELINE PROJECT PROPOSED H650 PIPELINE RESIDENTIAL NOTES	P
RSS-H650-001	MOUNTAIN VALLEY PIPELINE PROJECT PROPOSED H650 PIPELINE ROCKINGHAM COUNTY NORTH CAROLINA	P2
RSS-H650-002	MOUNTAIN VALLEY PIPELINE PROJECT PROPOSED H650 PIPELINE ROCKINGHAM COUNTY NORTH CAROLINA	P3
RSS-H650-003	MOUNTAIN VALLEY PIPELINE PROJECT PROPOSED H650 PIPELINE ROCKINGHAM COUNTY NORTH CAROLINA	P3
RSS-H650-004	MOUNTAIN VALLEY PIPELINE PROJECT PROPOSED H650 PIPELINE PITTSYLVANIA COUNTY VIRGINIA	P3
RSS-H650-005	MOUNTAIN VALLEY PIPELINE PROJECT PROPOSED H650 PIPELINE PITTSYLVANIA COUNTY VIRGINIA	P3
RSS-H650-006	MOUNTAIN VALLEY PIPELINE PROJECT PROPOSED H650 PIPELINE ALAMANCE COUNTY NORTH CAROLINA	P2
RSS-H650-008	MOUNTAIN VALLEY PIPELINE PROJECT PROPOSED H650 PIPELINE ALAMANCE COUNTY NORTH CAROLINA	P3
RSS-H650-009	MOUNTAIN VALLEY PIPELINE PROJECT PROPOSED H650 PIPELINE ALAMANCE COUNTY NORTH CAROLINA	P2
RSS-H650-015	MOUNTAIN VALLEY PIPELINE PROJECT PROPOSED H650 PIPELINE ALAMANCE COUNTY NORTH CAROLINA	P3
RSS-H650-016	MOUNTAIN VALLEY PIPELINE PROJECT PROPOSED H650 PIPELINE PITTSYLVANIA COUNTY VIRGINIA	P1
RSS-H650-017	MOUNTAIN VALLEY PIPELINE PROJECT PROPOSED H650 PIPELINE ALAMANCE COUNTY NORTH CAROLINA	P2
RSS-H650-018	MOUNTAIN VALLEY PIPELINE PROJECT PROPOSED H650 PIPELINE ALAMANCE COUNTY NORTH CAROLINA	P2
RSS-H650-024	MOUNTAIN VALLEY PIPELINE PROJECT PROPOSED H650 PIPELINE PITTSYLVANIA COUNTY VIRGINIA	P1
RSS-H650-025	MOUNTAIN VALLEY PIPELINE PROJECT PROPOSED H650 PIPELINE ROCKINGHAM COUNTY NORTH CAROLINA	P1
RSS-H650-026	MOUNTAIN VALLEY PIPELINE PROJECT PROPOSED H650 PIPELINE ROCKINGHAM COUNTY NORTH CAROLINA	P1
RSS-H650-027	MOUNTAIN VALLEY PIPELINE PROJECT PROPOSED H650 PIPELINE ROCKINGHAM COUNTY NORTH CAROLINA	P1
RSS-H650-028	MOUNTAIN VALLEY PIPELINE PROJECT PROPOSED H650 PIPELINE ALAMANCE COUNTY NORTH CAROLINA	P1
RSS-H650-029	MOUNTAIN VALLEY PIPELINE PROJECT PROPOSED H650 PIPELINE PITTSYLVANIA COUNTY VIRGINIA	P
RSS-H650-030	MOUNTAIN VALLEY PIPELINE PROJECT PROPOSED H650 PIPELINE ROCKINGHAM COUNTY NORTH CAROLINA	P
RSS-H650-031	MOUNTAIN VALLEY PIPELINE PROJECT PROPOSED H650 PIPELINE ROCKINGHAM COUNTY NORTH CAROLINA	P
RSS-H650-032	MOUNTAIN VALLEY PIPELINE PROJECT PROPOSED H650 PIPELINE ROCKINGHAM COUNTY NORTH CAROLINA	P
RSS-H650-033	MOUNTAIN VALLEY PIPELINE PROJECT PROPOSED H650 PIPELINE PITTSYLVANIA COUNTY VIRGINIA	P
RSS-H650-034	MOUNTAIN VALLEY PIPELINE PROJECT PROPOSED H650 PIPELINE ROCKINGHAM COUNTY NORTH CAROLINA	P
RSS-H650-035	MOUNTAIN VALLEY PIPELINE PROJECT PROPOSED H650 PIPELINE ROCKINGHAM COUNTY NORTH CAROLINA	P

DRAWN TRC	DATE 10/30/2018
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APP'D	DATE
SCALE N.T.S.	SHEET 1 OF 1
JOB NO.	
PROJECT ID:	

RESIDENTIAL DETAIL COVER

MOUNTAIN VALLEY PIPELINE
SOUTHGATE PROJECT
PROPOSED H-650 PIPELINE
RESIDENTIAL DRAWINGS

DRAWING NO.	REV.
RES-COVER	P3

ISSUED FOR FERC SUPPLEMENTAL FILING
05/13/19

MVP SOUTHGATE PROJECT

PROPOSED H-650 PIPELINE
ENGINEERING SERVICES DESIGN; JOB NUMBERS 300423
RESIDENTIAL DRAWING NOTES

GENERAL NOTES:

SAFETY FENCE, IN CONJUNCTION WITH ANY PROPOSED EROSION AND SEDIMENTATION CONTROL DEVICES, WILL BE INSTALLED AT THE EDGE OF THE LIMIT OF DISTURBANCE (LOD) FOR A DISTANCE OF 100 FEET ON EITHER SIDE OF THE RESIDENCE OR COMMERCIAL ESTABLISHMENT. FENCING WILL BE MAINTAINED THROUGHOUT ACTIVE CONSTRUCTION IN THE AREA. WHERE NECESSARY, HARD BARRIERS SUCH AS JERSEY BARRIERS WILL BE INSTALLED TO PROVIDE A SOLID, PROTECTIVE BARRIER.

STRUCTURES WITHIN LOD WILL BE REMOVED, RELOCATED, OR PROTECTED PER LAND OWNER AGREEMENT.

PROPERTY LINES DEPICTED ON THIS PLAN ARE BASED ON GIS TAX MAP DATA AND/OR FIELD LOCATED PROPERTY EVIDENCE. THEY SHOULD NOT BE RELIED ON AS AN ACCURATE DEPICTION OF THE ACTUAL PROPERTY LINE LOCATIONS. THEY MAY NOT REPRESENT THE RESULTS OF A BOUNDARY SURVEY.

AREAS OF PERMANENT EASEMENT WILL BE PERMANENTLY MAINTAINED PER USDOT PHMSA REQUIREMENTS. TEMPORARY WORKSPACES WOULD BE ALLOWED TO REVERT BACK TO PRE-EXISTING USES. OTHER MINOR ITEMS WILL BE ADDRESSED THROUGH LANDOWNER STIPULATIONS SPECIFIC TO THE PROPERTY.

CONSTRUCTION CREWS WILL UTILIZE DUST CONTROLS MEASURES AS NEEDED, INCLUDING WETTING AND BRUSHING OF ROADS.

WORK HOURS WILL BE LIMITED TO 7 AM TO 7 PM OR SUNSET (WHICHEVER IS LATER) UNLESS OTHER ARRANGEMENTS HAVE BEEN AGREED UPON WITH LANDOWNER.

CONSTRUCTION METHODS:

THE STOVE PIPE METHOD IS A LESS EFFICIENT ALTERNATIVE TO THE MAINLINE METHOD OF CONSTRUCTION. IT IS TYPICALLY USED WHEN THE PIPELINE IS TO BE INSTALLED IN VERY CLOSE PROXIMITY TO AN EXISTING STRUCTURE OR WHEN AN OPEN DITCH WOULD ADVERSELY IMPACT A COMMERCIAL/RESIDENTIAL ESTABLISHMENT. THE TECHNIQUE INVOLVES INSTALLING PIPE ONE JOINT AT A TIME WHEREBY THE WELDING, X-RAY AND COATING ACTIVITIES ARE ALL PERFORMED IN THE OPEN TRENCH. AT THE END OF EACH DAY THE NEWLY INSTALLED PIPE IS BACKFILLED OR THE OPEN TRENCH IS COVERED WITH STEEL PLATES OR TIMBER MATS.

THE DRAG SECTION CONSTRUCTION METHOD, WHILE LESS EFFICIENT THAN MAINLINE METHODS, IS NORMALLY PREFERRED OVER THE STOVE PIPE ALTERNATIVE. THIS TECHNIQUE INVOLVES THE TRENCHING, INSTALLATION AND BACKFILL OF A PREFABRICATED LENGTH OF PIPE CONTAINING SEVERAL SEGMENTS ALL IN ONE DAY. AT THE END OF EACH DAY THE NEWLY INSTALLED PIPE IS BACKFILLED AND/OR COVERED WITH STEEL PLATES OR TIMBER MATS.

MAINLINE CONSTRUCTION IS THE MOST EFFICIENT CONSTRUCTION METHOD. THIS METHOD IS SIMILAR TO STOVE PIPE AND DRAG SECTION INSTALLATION, BUT ON A LARGER SCALE. ALL STEPS OF THE CONSTRUCTION PROCESS (CLEARING, GRADING, TRENCHING, STRINGING & BENDING, WELDING & COATING, LOWERING & BACKFILL) OCCUR OVER LARGE STRETCHES OF RIGHT-OF-WAY TO MAXIMIZE EFFICIENCY OF THE CONSTRUCTION SPREADS. MAINLINE CONSTRUCTION IS TYPICALLY UTILIZED WHERE LARGE STRETCHES OF PIPELINE ROW ARE UNINTERRUPTED. THIS METHOD MAY BE USED NEAR STRUCTURES WHERE OFFSET FROM WORKSPACES IS LARGE ENOUGH TO FACILITATE SAFE AND PRACTICAL IMPLEMENTATION

DRAWN TRC	DATE 05/01/2019
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SCALE N.T.S.	SHEET 1 OF 2
JOB NO.	
PROJECT ID:	

RESIDENTIAL NOTES

MOUNTAIN VALLEY PIPELINE
SOUTHGATE PROJECT
PROPOSED H-650 PIPELINE
RESIDENTIAL DRAWING NOTES

DRAWING NO.	REV.
RES-NOTES	P

ISSUED FOR FERC SUPPLEMENTAL FILING
05/13/19

MVP SOUTHGATE PROJECT

PROPOSED H-650 PIPELINE
ENGINEERING SERVICES DESIGN; JOB NUMBERS 300423
RESIDENTIAL DRAWING NOTES

CLEANUP AND REVEGETATION PLANS

SUBSOIL AND TOPSOIL (UP TO 12 INCHES) IN RESIDENTIAL AREAS WILL BE SEGREGATED AND RETURNED TO PRE-CONSTRUCTION GRADE AS SHOWN ON DRAWINGS.

IF SOILS ARE REQUIRED TO BE IMPORTED (E.G. IF TOP SOILING IS NOT PRACTICAL), THEY WILL BE CERTIFIED AS FREE OF NOXIOUS WEEDS AND SOIL PESTS, UNLESS OTHERWISE APPROVED BY THE LANDOWNER. IF TREES ARE NEEDED TO BE REMOVED FROM THE LANDSCAPE FOR CONSTRUCTION, THEY WILL BE REPLACED WITH THE SAME SPECIES OR SIMILAR BASED ON LANDOWNER REQUESTS.

RESTORE ALL TURF, ORNAMENTAL SHRUBS, AND SPECIALIZED LANDSCAPING IN ACCORDANCE WITH THE LANDOWNER'S REQUEST, OR COMPENSATE THE LANDOWNER. RESTORATION WORK MUST BE PERFORMED BY PERSONNEL FAMILIAR WITH LOCAL HORTICULTURAL AND TURF ESTABLISHMENT PRACTICES.

ALL DISTURBED RESIDENTIAL UPLAND AREAS WILL BE MULCHED BEFORE SEEDING IF FINAL GRADING AND INSTALLATION OF PERMANENT EROSION CONTROL MEASURES WILL NOT BE INSTALLED WITHIN 10 DAYS OF COMPLETION.

ALL LAWN AREAS AND IMPACTED LANDSCAPING WILL BE RESTORED FOLLOWING CLEAN-UP OPERATIONS AS SOON AS REASONABLY POSSIBLE, OR AS SPECIFIED IN THE LANDOWNER AGREEMENT. IF SEASONAL OR OTHER WEATHER CONDITIONS PREVENT COMPLIANCE WITH THESE TIME FRAMES, TEMPORARY EROSION CONTROLS (SEDIMENT BARRIERS AND MULCH) WILL BE MAINTAINED UNTIL CONDITIONS ALLOW COMPLETION OF RESTORATION.

IF CRUSHED STONE ACCESS PADS ARE USED IN RESIDENTIAL AREAS THEY WILL BE INSTALLED ON TOP OF SYNTHETIC FABRIC TO FACILITATE EASY REMOVAL.

EXCESS ROCK FROM THE TOP 12 INCHES OF SOIL IN RESIDENTIAL AREAS WILL BE REMOVED UNLESS OTHER ARRANGEMENTS WITH LANDOWNER HAVE BEEN AGREED UPON.

TOPSOIL AND SUBSOIL COMPACTION WILL MEET PRECONSTRUCTION CONDITIONS AND WHERE NECESSARY, SOIL COMPACTION MITIGATION MAY BE REQUIRED TO MITIGATE FOR SEVERELY COMPACTED RESIDENTIAL AREAS.

OTHER RESTORATION DETAILS, INCLUDING REVEGETATION REQUIREMENTS RELATED TO LAWNS, MAY BE SPECIFIC TO LANDOWNER STIPULATIONS.

CONDUCT FOLLOW-UP INSPECTIONS OF ALL DISTURBED AREAS, AS NECESSARY, TO DETERMINE THE SUCCESS OF REVEGETATION AND ADDRESS LANDOWNER CONCERNS. AT A MINIMUM, CONDUCT INSPECTIONS AFTER THE FIRST AND SECOND GROWING SEASONS.

LANDOWNER COMPLAINT RESOLUTION PROCESS

IN THE EVENT OF AN ISSUE, LANDOWNERS ARE DIRECTED TO CONTACT THEIR LOCAL MVP SOUTHGATE LAND REPRESENTATIVE. LANDOWNERS CAN ALSO REACH PROJECT PERSONNEL BY CALLING 1-833-MV-SOUTH OR EMAILING MAIL@MVPSOUTHGATE.COM

AFTER WORKING WITH THE SOUTHGATE PROJECT REPRESENTATIVE AND APPROPRIATE RIGHT-OF-WAY AGENT, IF THE LANDOWNER IS STILL NOT COMPLETELY SATISFIED WITH THE RESOLUTION, THE INDIVIDUAL SHOULD CONTACT THE COMMISSION'S LANDOWNER HELPLINE AT (877) 337-2237, OR BY EMAIL, LANDOWNERHELP@FERC.GOV.

DRAWN TRC	DATE 05/08/2019
CHECKED	DATE
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SCALE N.T.S.	SHEET 2 OF 2
JOB NO.	
PROJECT ID:	

RESIDENTIAL NOTES

MOUNTAIN VALLEY PIPELINE
SOUTHGATE PROJECT
PROPOSED H-650 PIPELINE
RESIDENTIAL DRAWING NOTES

DRAWING NO.	REV.
RES-NOTES CONT.	P

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05/13/19

MVP SOUTHGATE PROJECT

PROPOSED H-650 PIPELINE
ENGINEERING SERVICES DESIGN; JOB NUMBERS 300423
RESIDENTIAL DRAWING NOTES

Residential Plan Drawing	Anticipated Construction Method	Approximate Construction Duration	Additional Measures	Restoration Plans
RSS-H650-001	Mainline	15 Days	None identified at this time.	See General Restoration Notes
RSS-H650-002	Mainline	15 Days	None identified at this time.	See General Restoration Notes
RSS-H650-003	NA - Yard	400 Days	Install hard barriers	See General Restoration Notes
RSS-H650-004	Mainline	15 Days	None identified at this time.	See General Restoration Notes
RSS-H650-005	Mainline	15 Days	None identified at this time.	See General Restoration Notes
RSS-H650-006	Stove Pipe	35 Days	None identified at this time.	See General Restoration Notes
RSS-H650-008	Mainline	15 Days	None identified at this time.	See General Restoration Notes
RSS-H650-009	Mainline	15 Days	None identified at this time.	See General Restoration Notes
RSS-H650-015	Mainline / Drag	15 Days	None identified at this time.	See General Restoration Notes
RSS-H650-016	Mainline	15 Days	None identified at this time.	See General Restoration Notes
RSS-H650-017	Stove Pipe	50 Days	Install hard barriers	See General Restoration Notes
RSS-H650-018	Stove Pipe	75 Days	None identified at this time.	See General Restoration Notes

Residential Plan Drawing	Anticipated Construction Method	Approximate Construction Duration	Additional Measures	Restoration Plans
RSS-H650-024	NA - Access Road	200 Days	Install hard barriers	See General Restoration Notes
RSS-H650-025	NA - Access Road	200 Days	None identified at this time.	See General Restoration Notes
RSS-H650-026	NA - Access Road	200 Days	Install hard barriers	See General Restoration Notes
RSS-H650-027	NA - Access Road	200 Days	None identified at this time.	See General Restoration Notes
RSS-H650-028	NA - Access Road	200 Days	None identified at this time.	See General Restoration Notes
RSS-H650-029	NA - Access Road	200 Days	None identified at this time.	See General Restoration Notes
RSS-H650-030	NA - Access Road	200 Days	Install hard barriers	See General Restoration Notes
RSS-H650-031	Mainline	25 Days	None identified at this time.	See General Restoration Notes
RSS-H650-032	Mainline	15 Days	None identified at this time.	See General Restoration Notes
RSS-H650-033	NA - Yard	400 Days	Install hard barriers	See General Restoration Notes
RSS-H650-034	Mainline	35 Days	None identified at this time.	See General Restoration Notes
RSS-H650-035	Mainline	15 Days	None identified at this time.	See General Restoration Notes

NOTE:

CONSTRUCTION METHOD AND DURATION MAY CHANGE DUE TO LANDOWNER REQUESTS, FIELDS CONDITIONS, AND OTHER CONSIDERATIONS.

DRAWN TRC	DATE 05/08/2019
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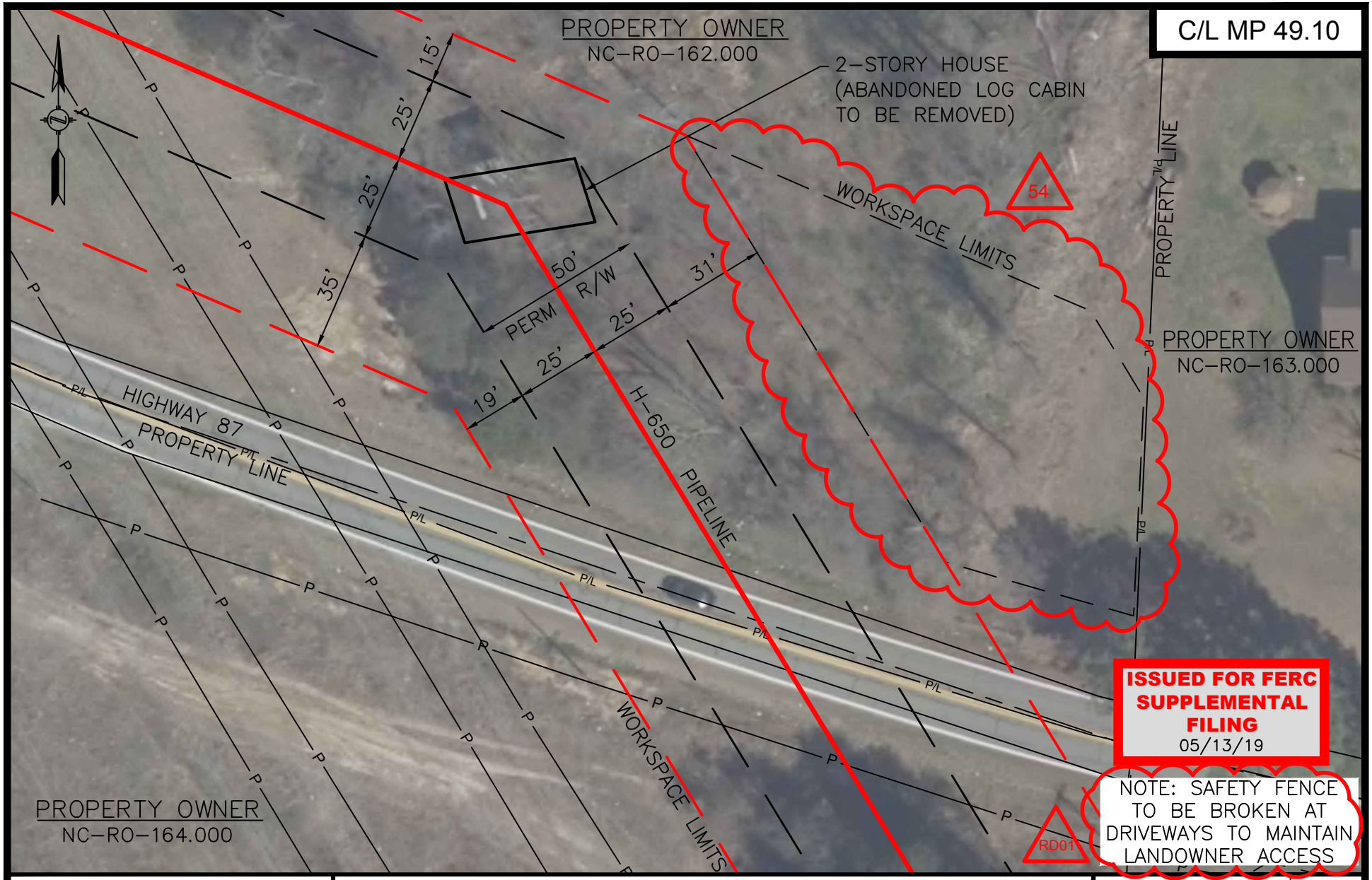
APP'D	DATE
SCALE N.T.S.	SHEET 1 OF 2
JOB NO.	
PROJECT ID:	

RESIDENTIAL NOTES

MOUNTAIN VALLEY PIPELINE
SOUTHGATE PROJECT
PROPOSED H-650 PIPELINE
RESIDENTIAL DRAWING NOTES

DRAWING NO.	REV.
RES-NOTES SITE SPECIFIC	P

ISSUED FOR FERC SUPPLEMENTAL FILING
05/13/19



TRC
Results you can rely on

Mountain Valley PIPELINE LLC

CONSTRUCTION DETAILS - RESIDENTIAL SITE SPECIFIC

MVP SOUTHGATE PROJECT
PROPOSED H-650 PIPELINE
ROCKINGHAM COUNTY, NORTH CAROLINA

SHEET 1 OF 1

DRAWN BY:	TBH	10/05/18
DRAFTING CK:	SJO	10/19/18
ENVIRONMENTAL CK:		
ENGINEERING CK:	.	.
DETAIL SHEET:		
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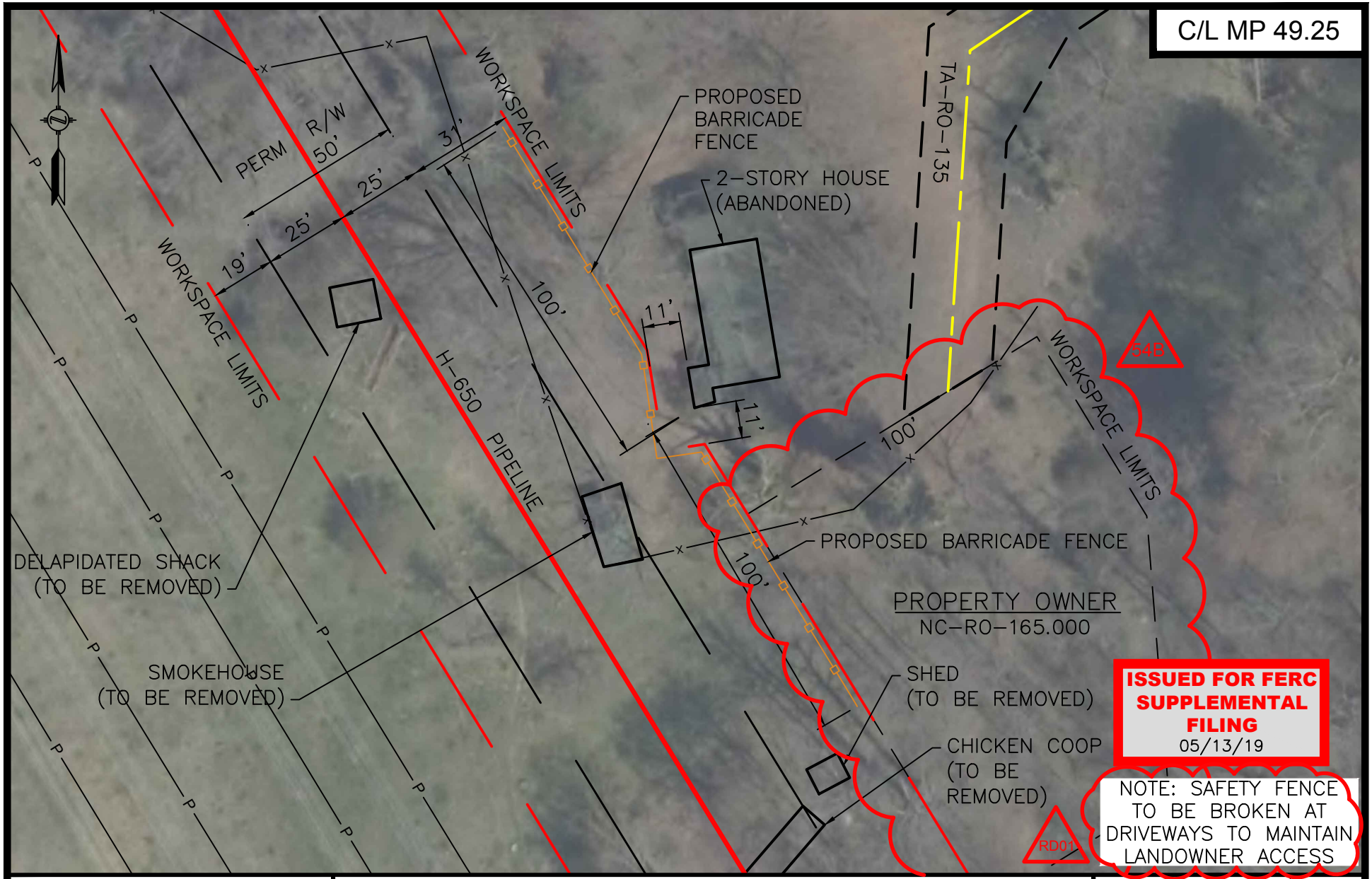

TRC
Results you can rely on

Mountain Valley PIPELINE LLC

CONSTRUCTION DETAILS - RESIDENTIAL SITE SPECIFIC

MVP SOUTHGATE PROJECT
PROPOSED H-650 PIPELINE
ROCKINGHAM COUNTY, NORTH CAROLINA

SHEET 1 OF 1

DRAWN BY:	TBH	10/05/18
DRAFTING CK:	SJO	10/19/18
ENVIRONMENTAL CK:		
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DRAWING NO.:	**RSS-H650-002**	
SCALE: 1" = 40'		REV. P3
DATE OF PLOT: 5/10/2019 3:10 PM		

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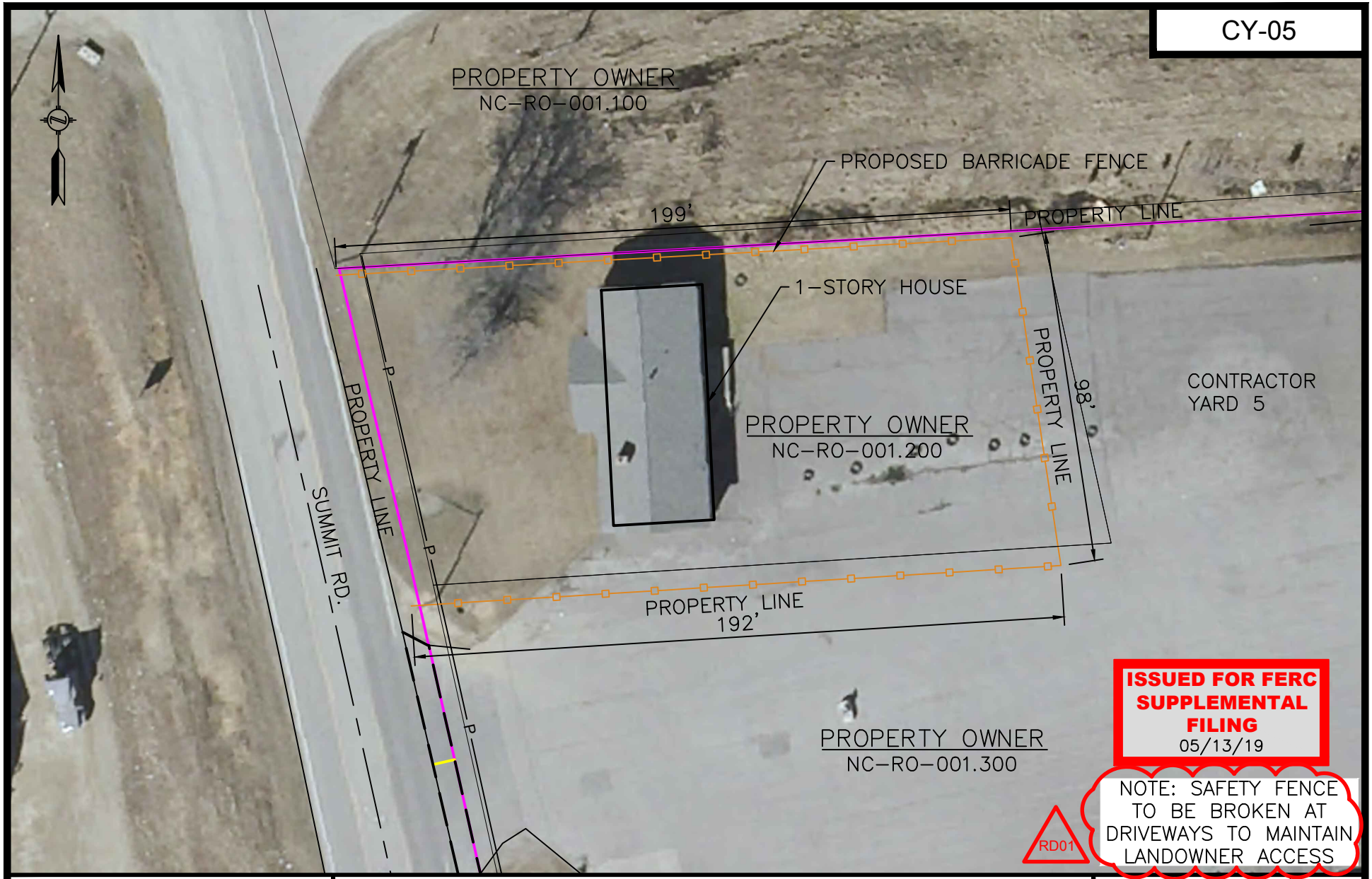

TRC
Results you can rely on

Mountain Valley PIPELINE LLC

CONSTRUCTION DETAILS - RESIDENTIAL SITE SPECIFIC

MVP SOUTHGATE PROJECT
PROPOSED H-650 PIPELINE
ROCKINGHAM COUNTY, NORTH CAROLINA

SHEET 1 OF 1

DRAWN BY:	TBH	10/08/18
DRAFTING CK:	SJO	10/19/18
ENVIRONMENTAL CK:		
ENGINEERING CK:	.	.
DETAIL SHEET:		
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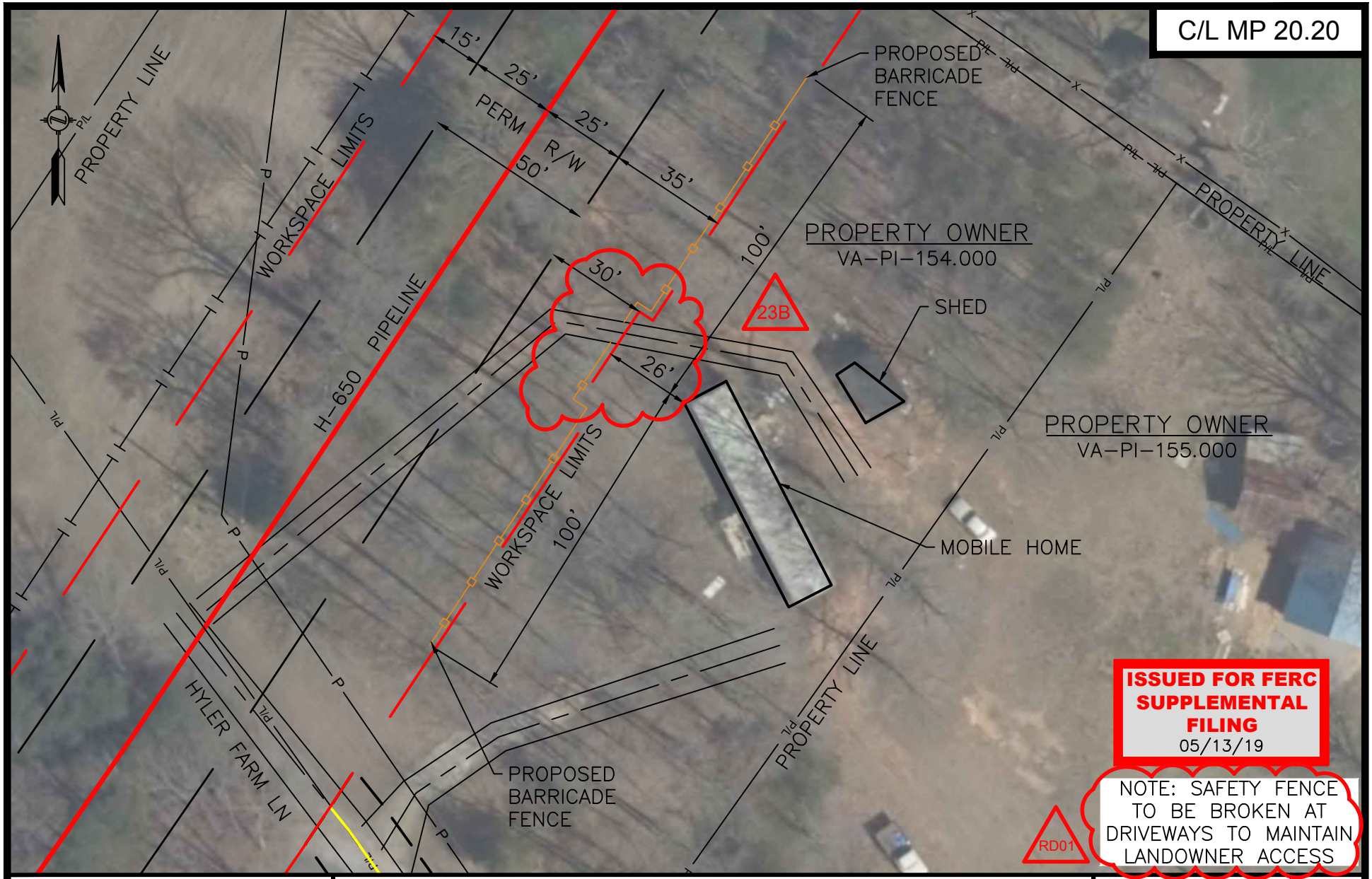
DATE OF PLOT: 5/10/2019 3:11 PM		



TRC
Results you can rely on

Mountain Valley PIPELINE LLC

CONSTRUCTION DETAILS - RESIDENTIAL SITE SPECIFIC

MVP SOUTHGATE PROJECT
PROPOSED H-650 PIPELINE
PITTSYLVANIA COUNTY,VIRGINIA

SHEET 1 OF 1

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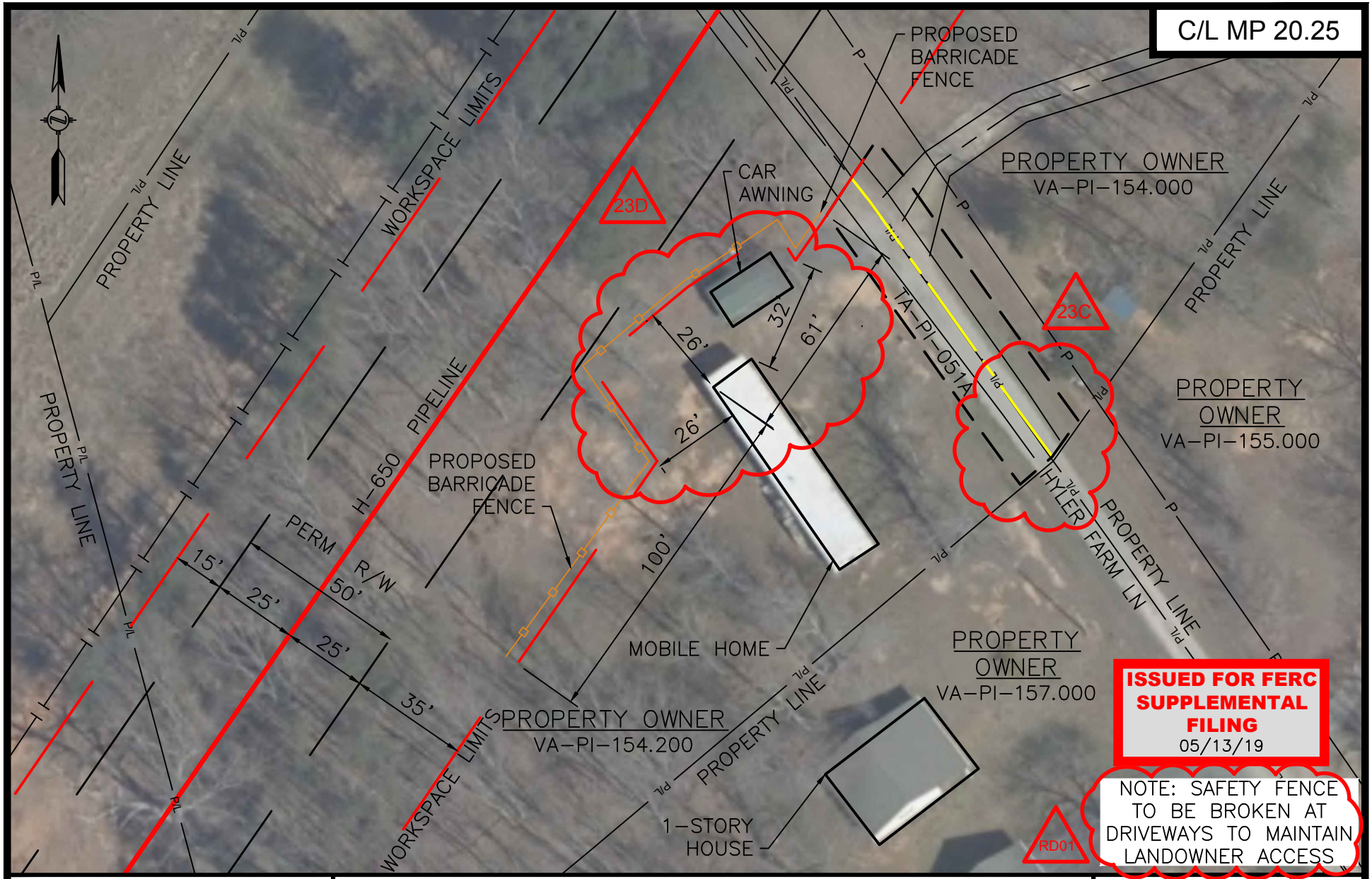

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MVP SOUTHGATE PROJECT
PROPOSED H-650 PIPELINE
PITTSYLVANIA COUNTY, VIRGINIA

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ALAMANCE COUNTY, NORTH CAROLINA

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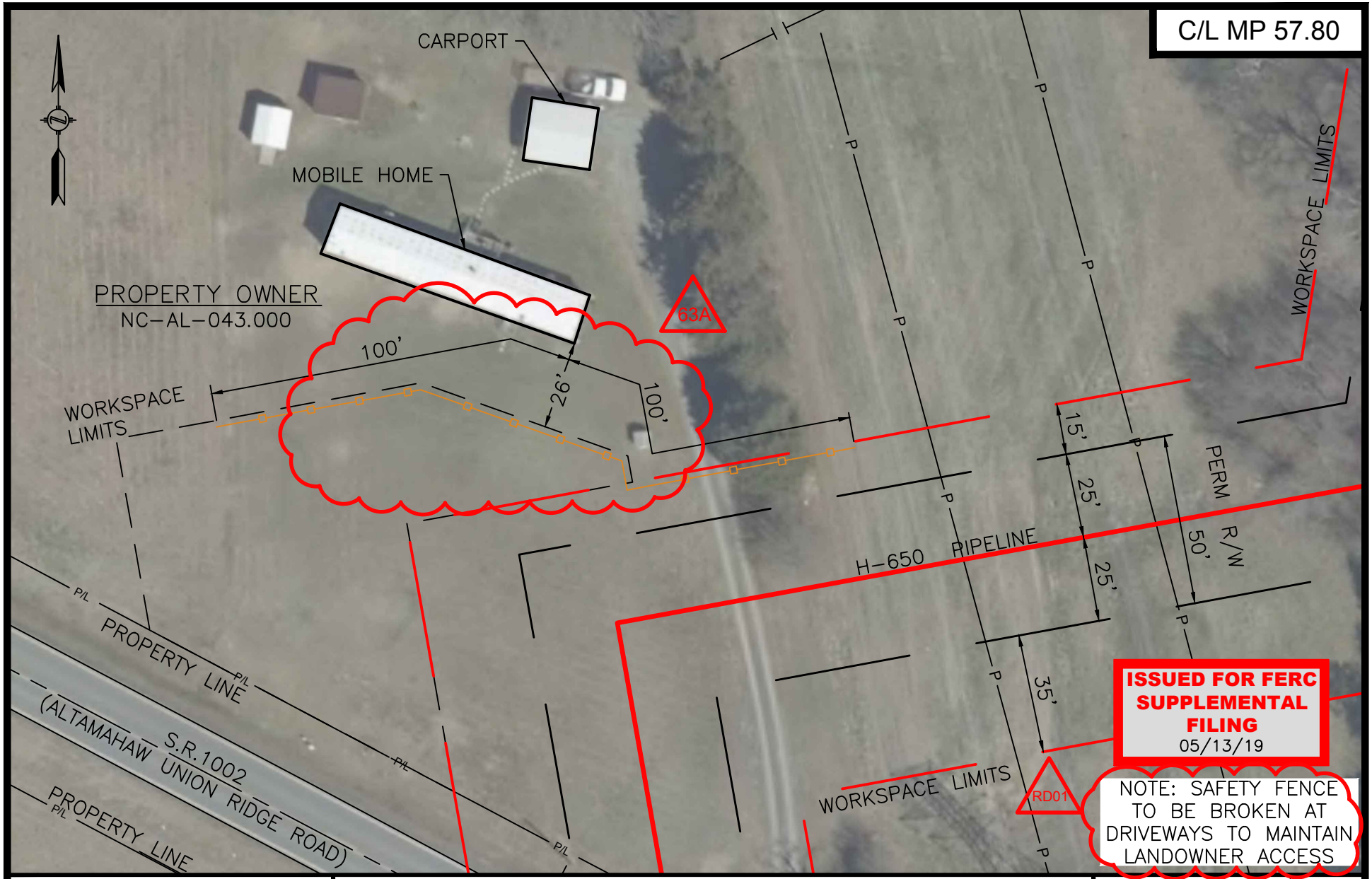

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PROPOSED H-650 PIPELINE
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PROPOSED H-650 PIPELINE
ALAMANCE COUNTY, NORTH CAROLINA

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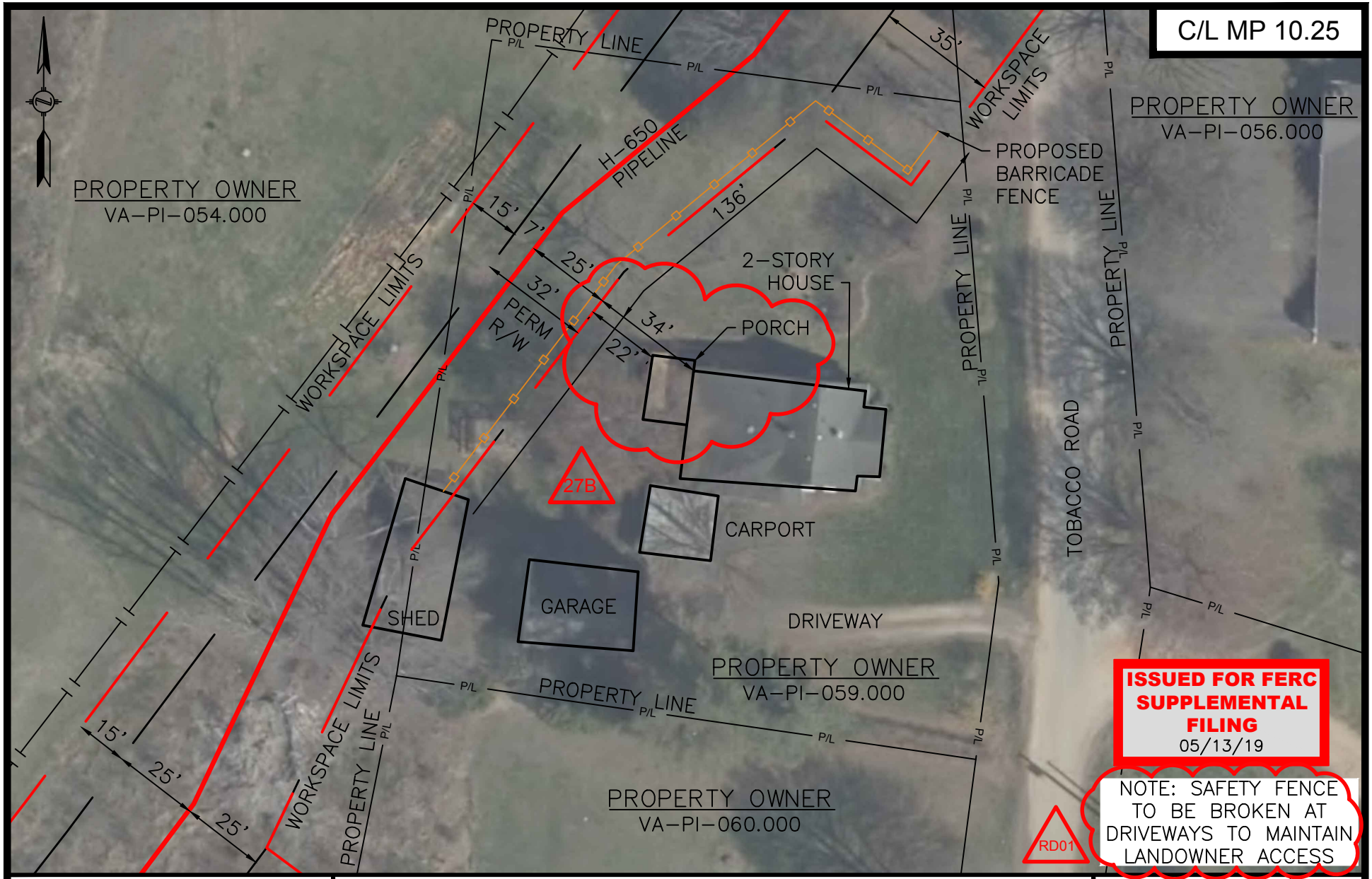

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VA 0407006097

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CONSTRUCTION DETAILS - RESIDENTIAL SITE SPECIFIC

MVP SOUTHGATE PROJECT
PROPOSED H-650 PIPELINE
PITTSYLVANIA COUNTY, VIRGINIA

SHEET 1 OF 1

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PROPOSED H-650 PIPELINE
ALAMANCE COUNTY, NORTH CAROLINA

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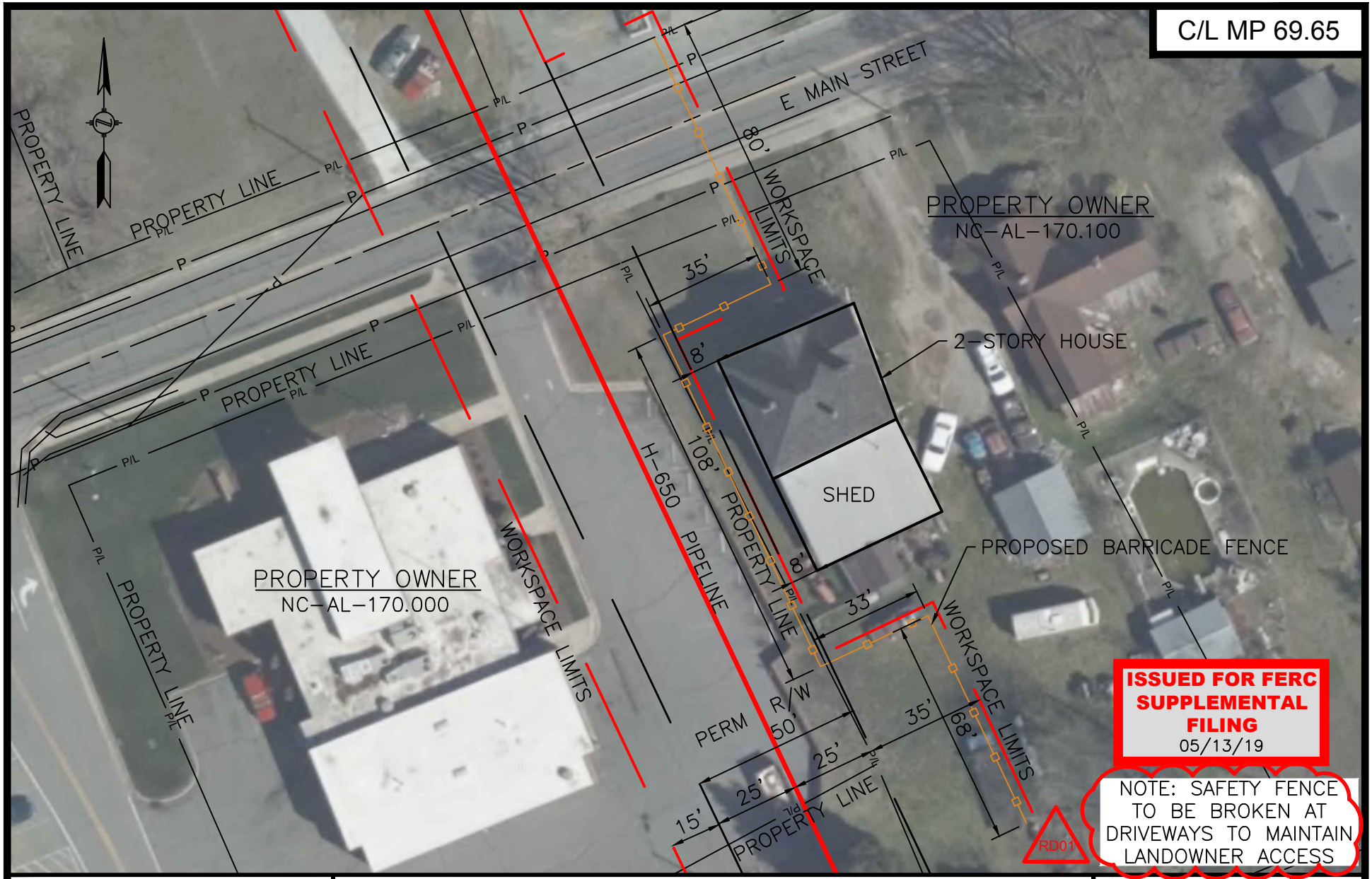

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PROPOSED H-650 PIPELINE
ALAMANCE COUNTY, NORTH CAROLINA

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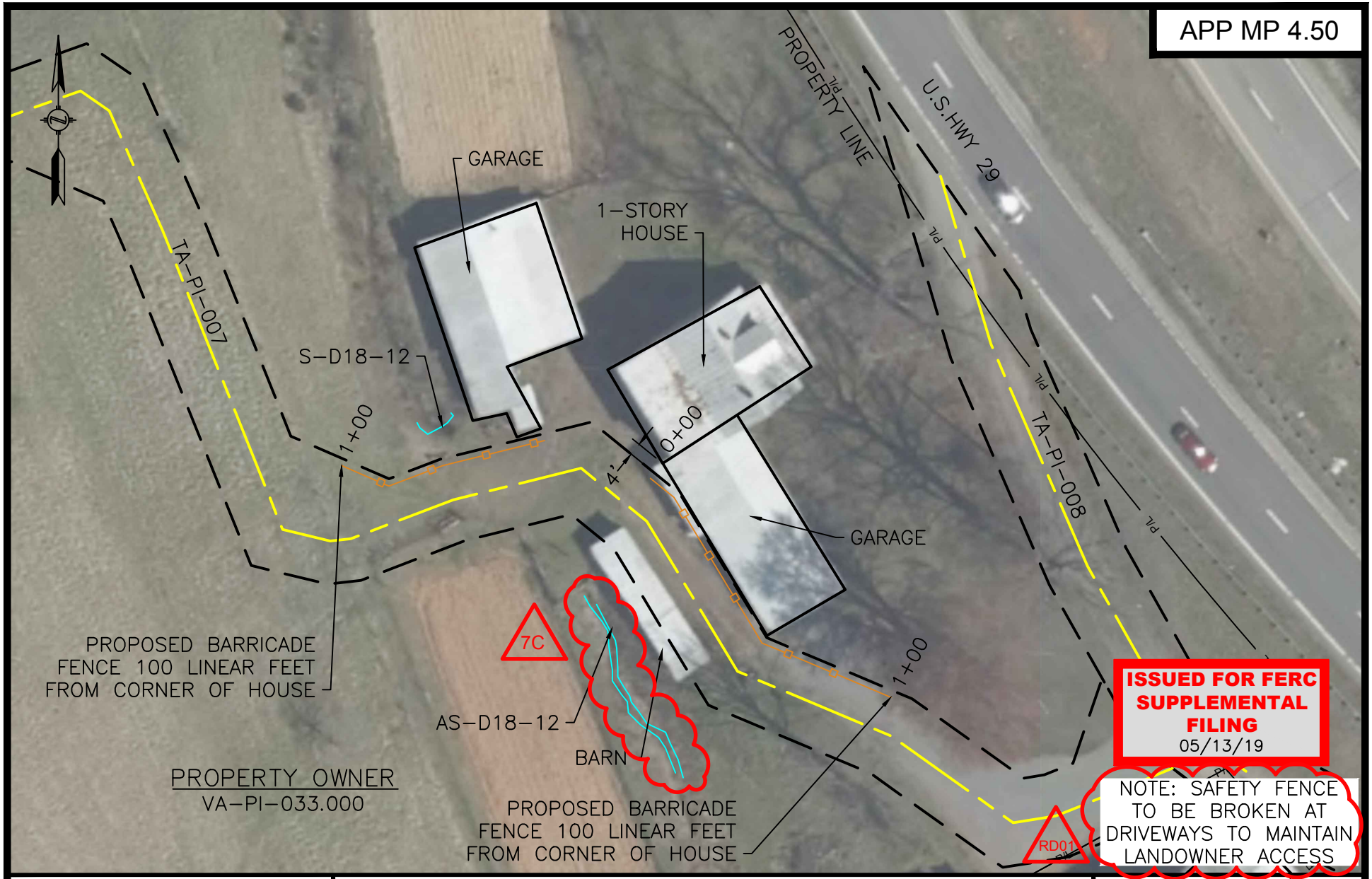

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PITTSYLVANIA COUNTY,VIRGINIA

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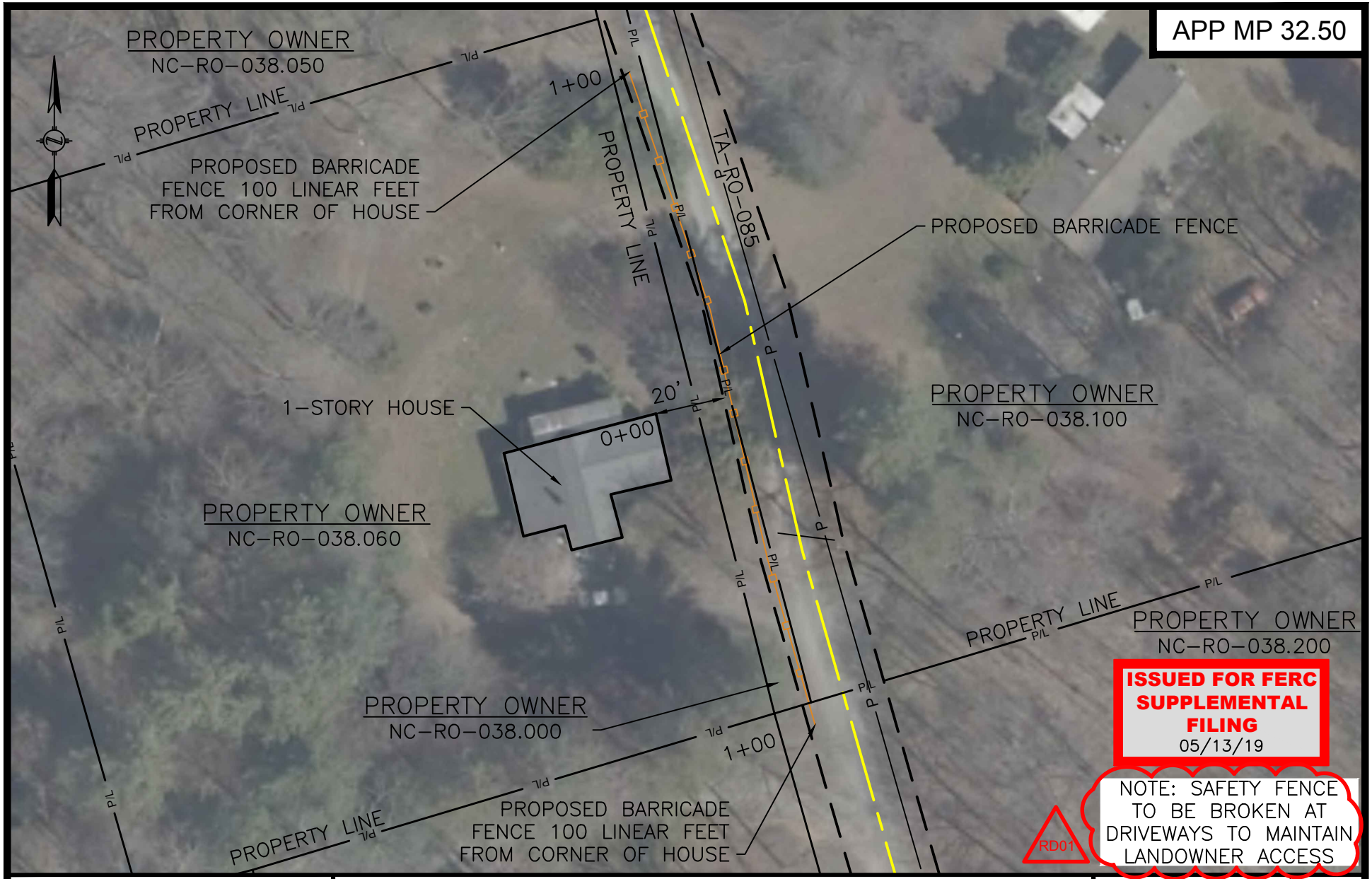

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MVP SOUTHGATE PROJECT
PROPOSED H-650 PIPELINE
ROCKINGHAM COUNTY, NORTH CAROLINA

SHEET 1 OF 1

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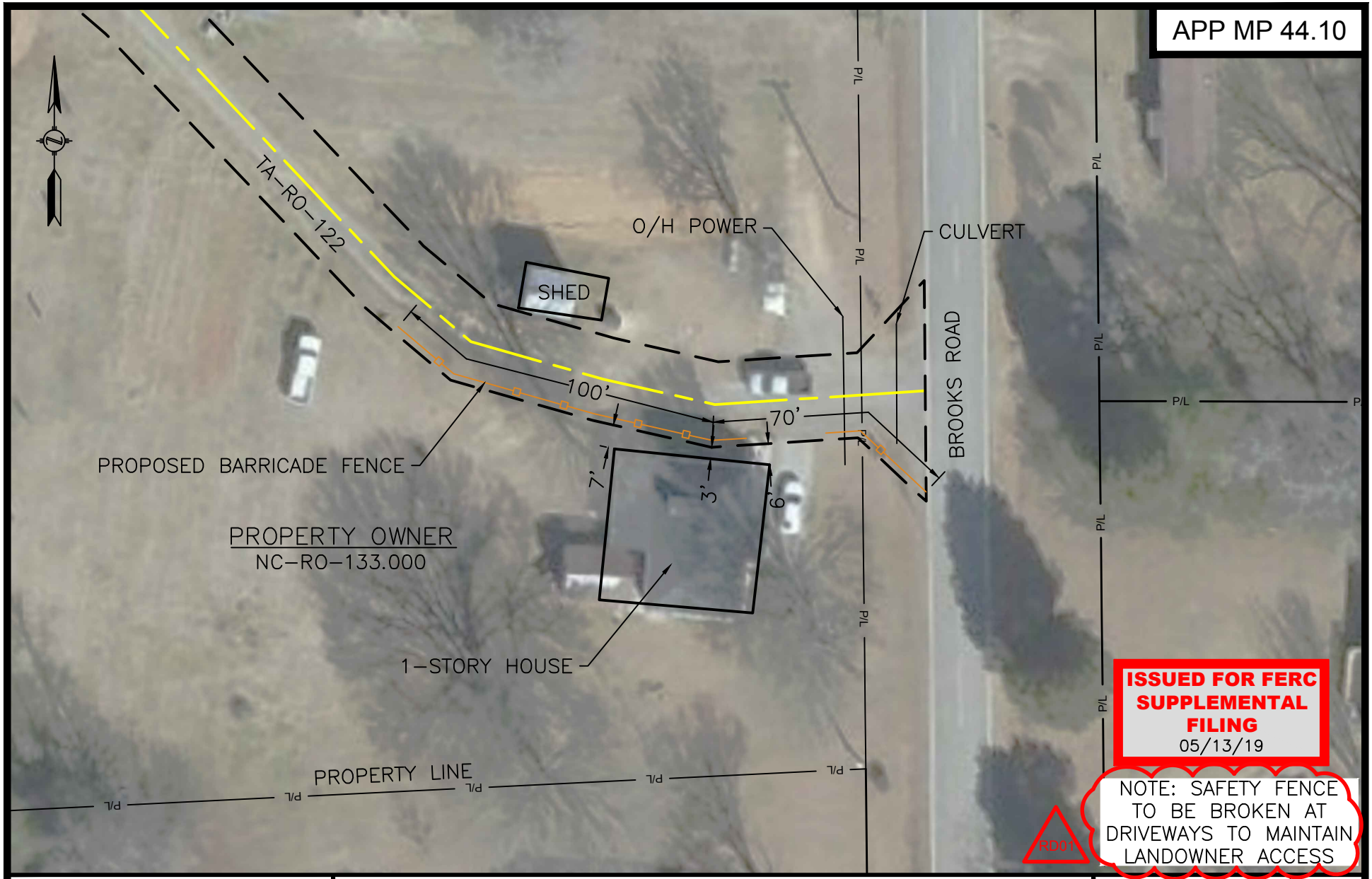

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MVP SOUTHGATE PROJECT
PROPOSED H-650 PIPELINE
ROCKINGHAM COUNTY, NORTH CAROLINA

SHEET 1 OF 1

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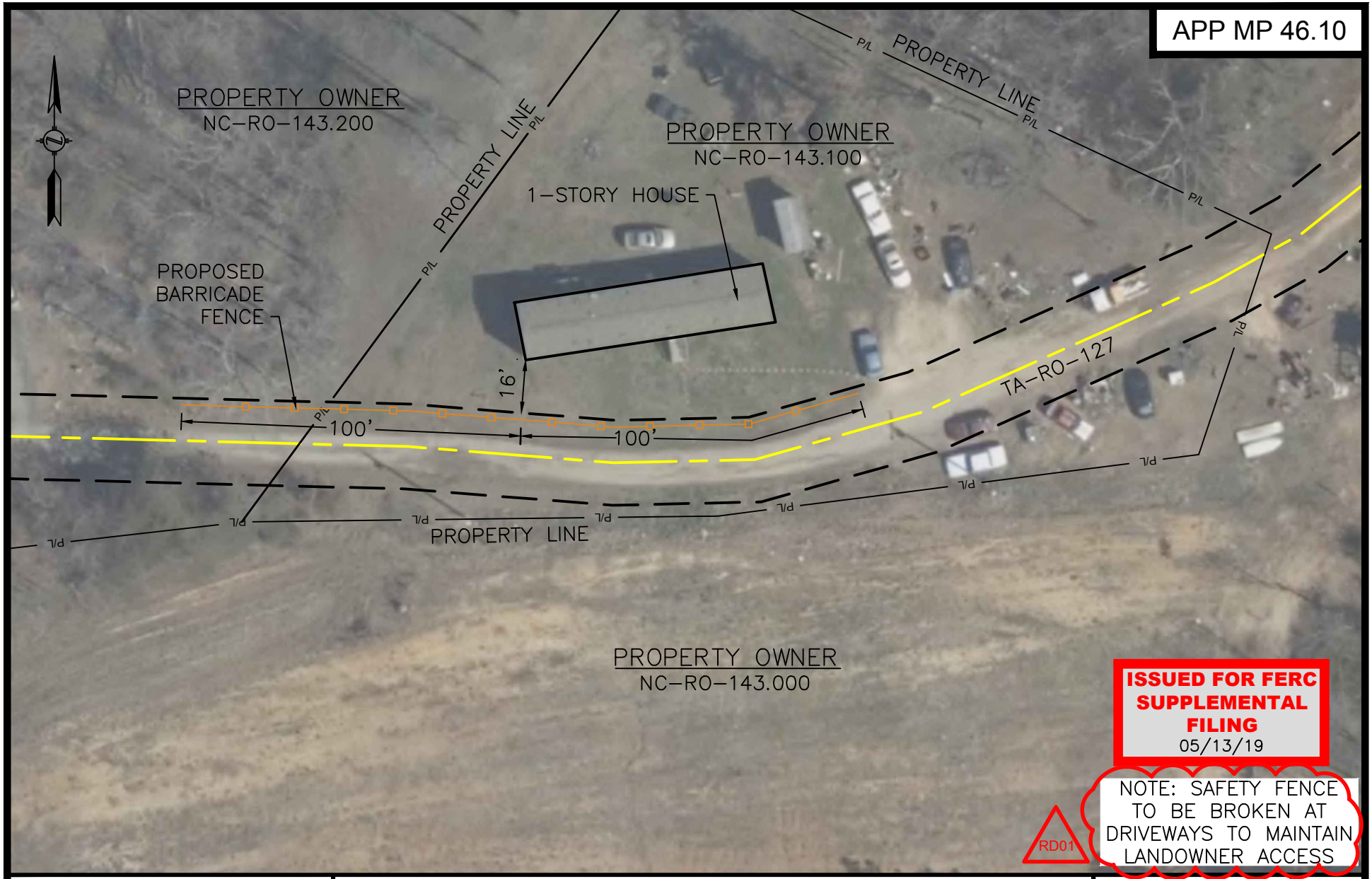

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RD01

NOTE: SAFETY FENCE TO BE BROKEN AT DRIVEWAYS TO MAINTAIN LANDOWNER ACCESS

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PROPOSED H-650 PIPELINE
ROCKINGHAM COUNTY, NORTH CAROLINA

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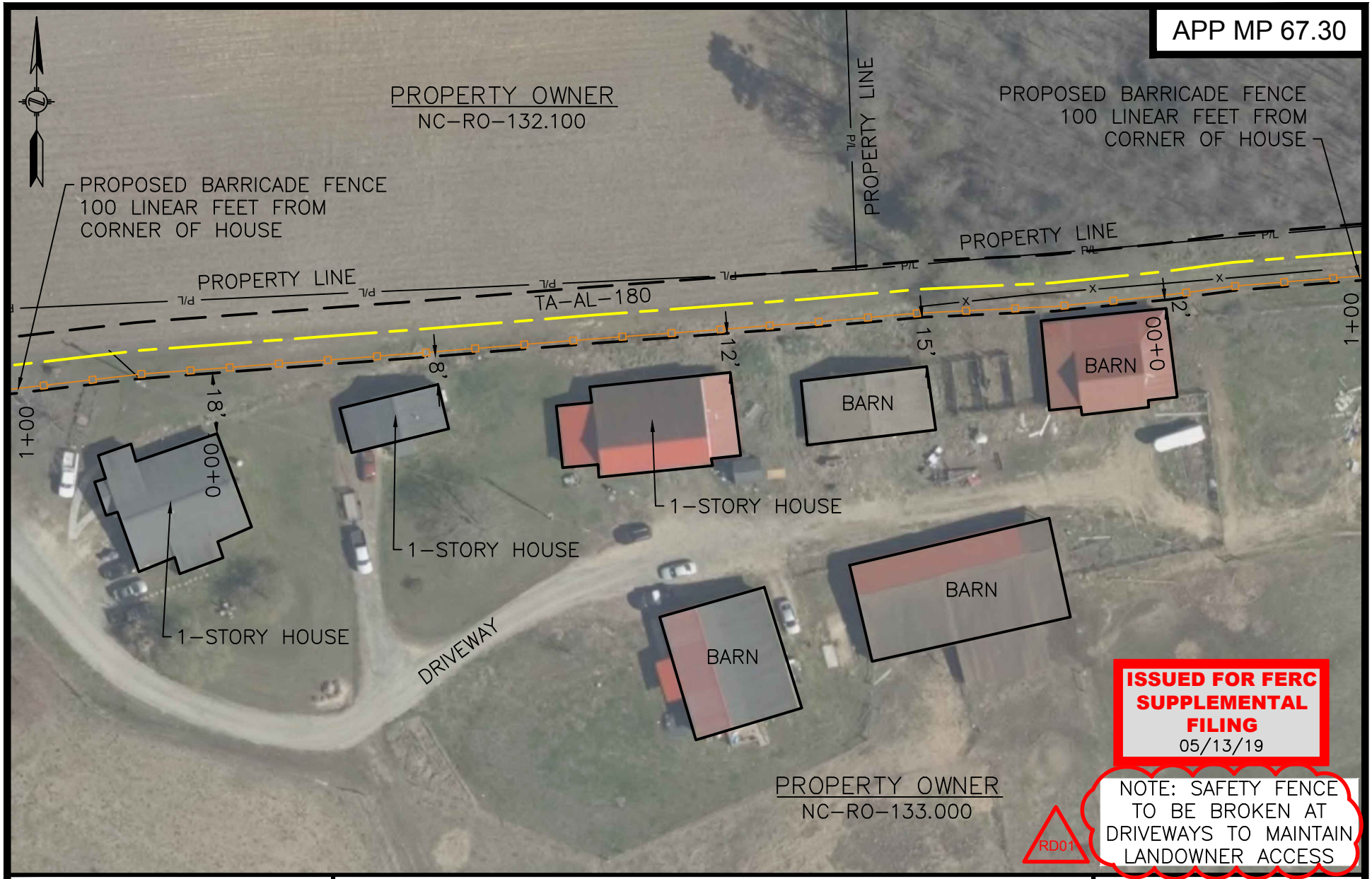

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PROPOSED H-650 PIPELINE
ALAMANCE COUNTY, NORTH CAROLINA

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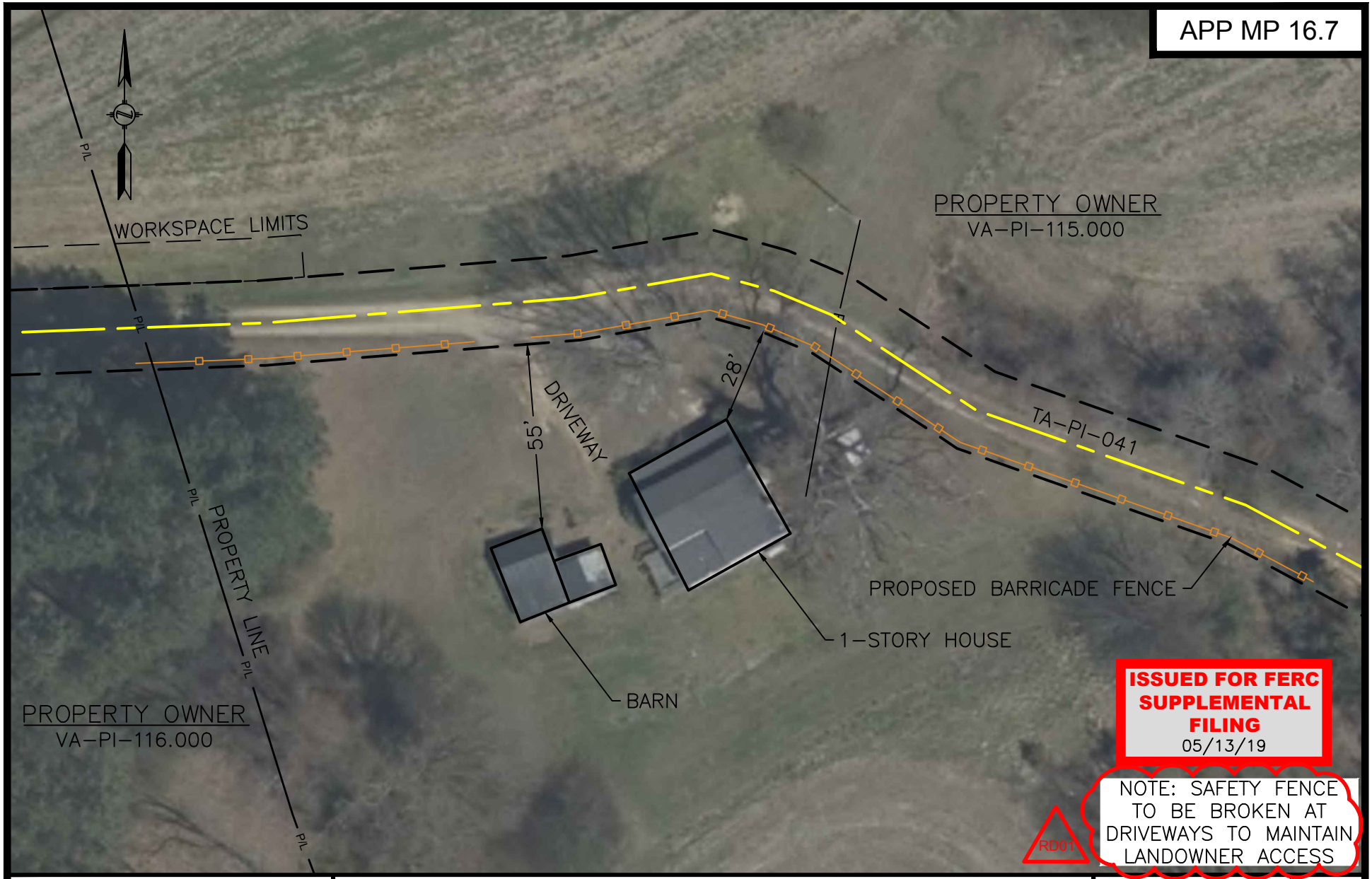

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MVP SOUTHGATE PROJECT
PROPOSED H-650 PIPELINE
PITTSYLVANIA COUNTY, VIRGINIA

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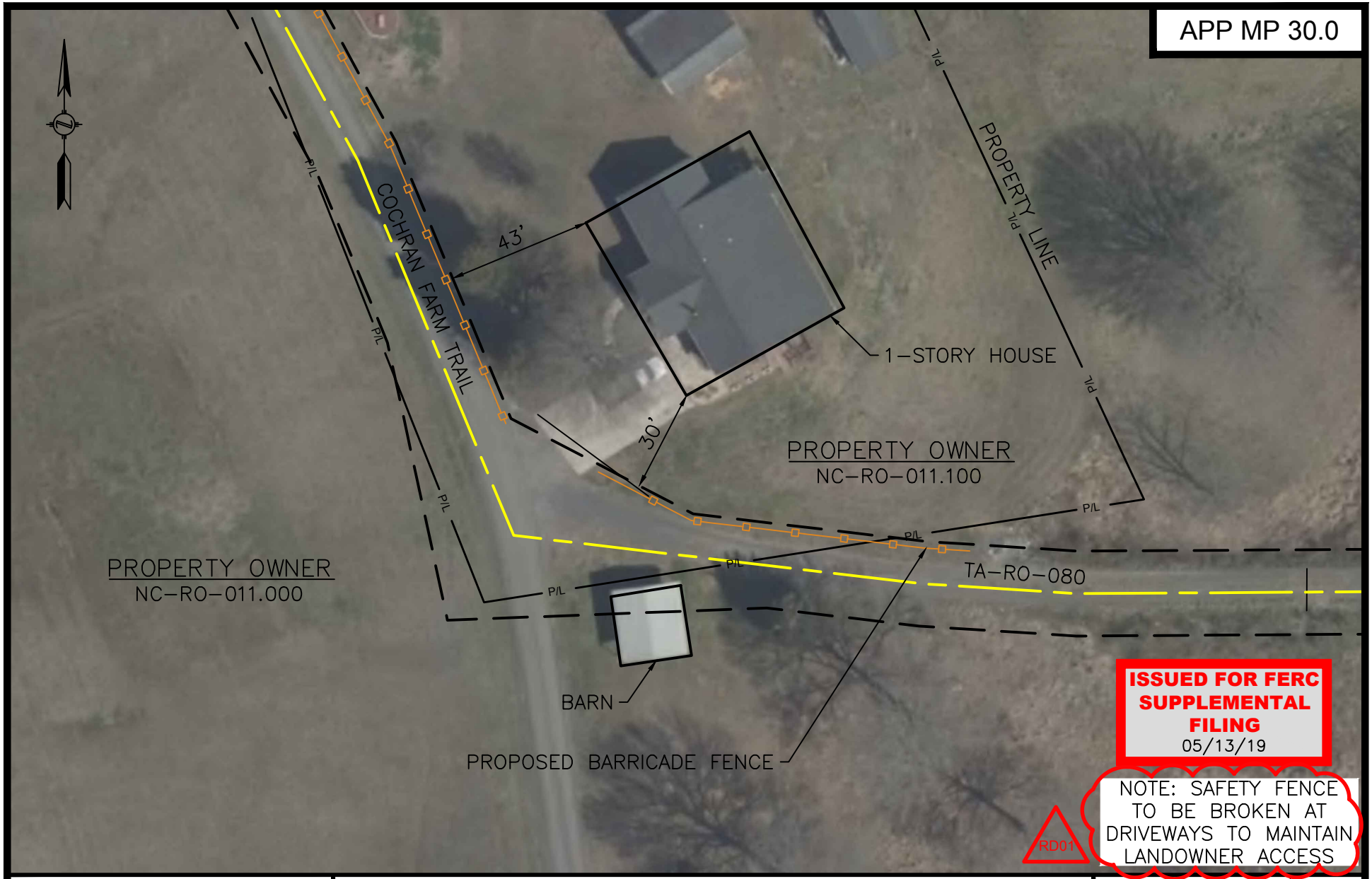

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MVP SOUTHGATE PROJECT
PROPOSED H-650 PIPELINE
ROCKINGHAM COUNTY, NORTH CAROLINA

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PROPOSED H-650 PIPELINE
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PROPOSED H-650 PIPELINE
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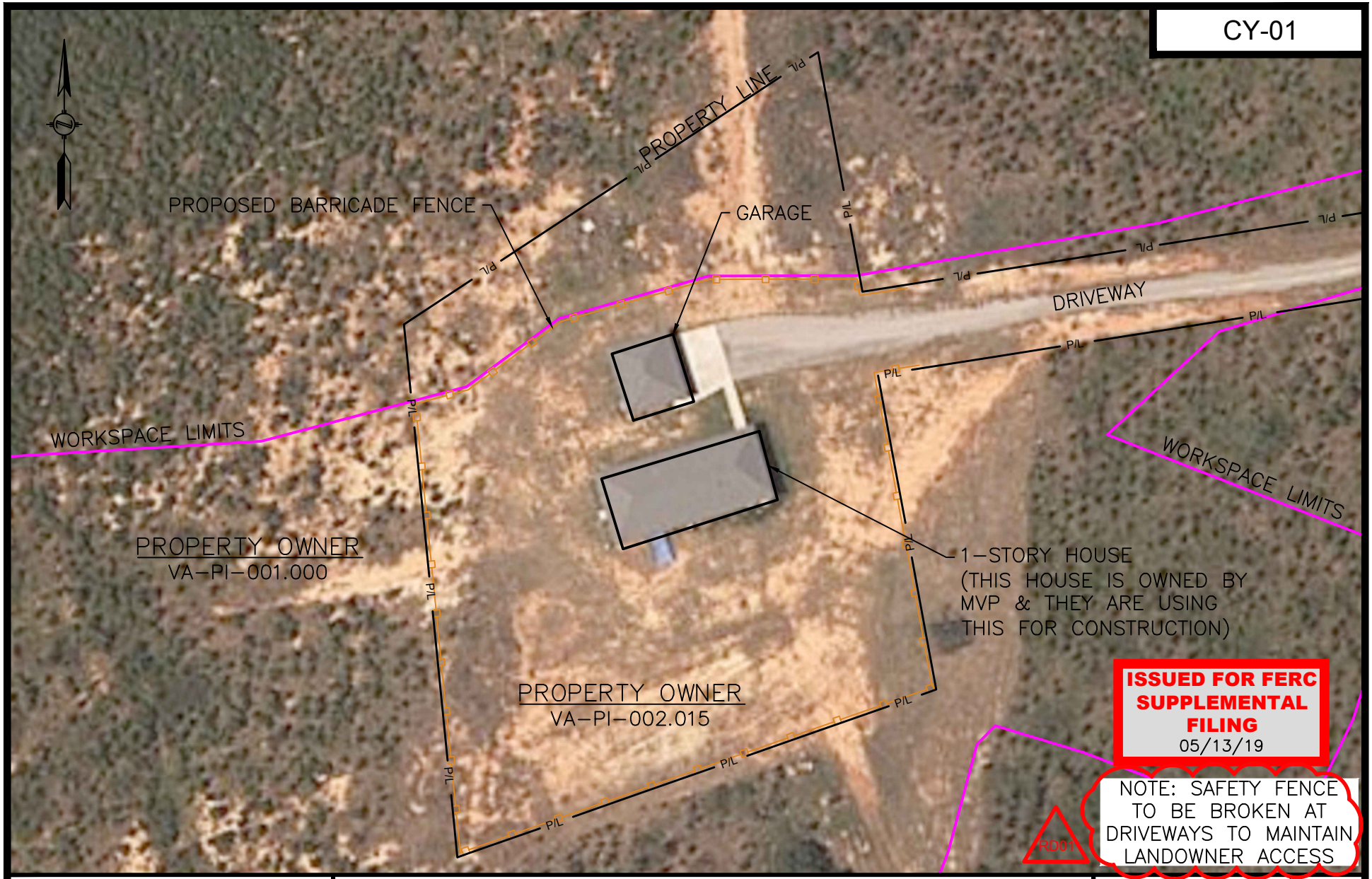

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PROPOSED H-650 PIPELINE
ROCKINGHAM COUNTY, NORTH CAROLINA

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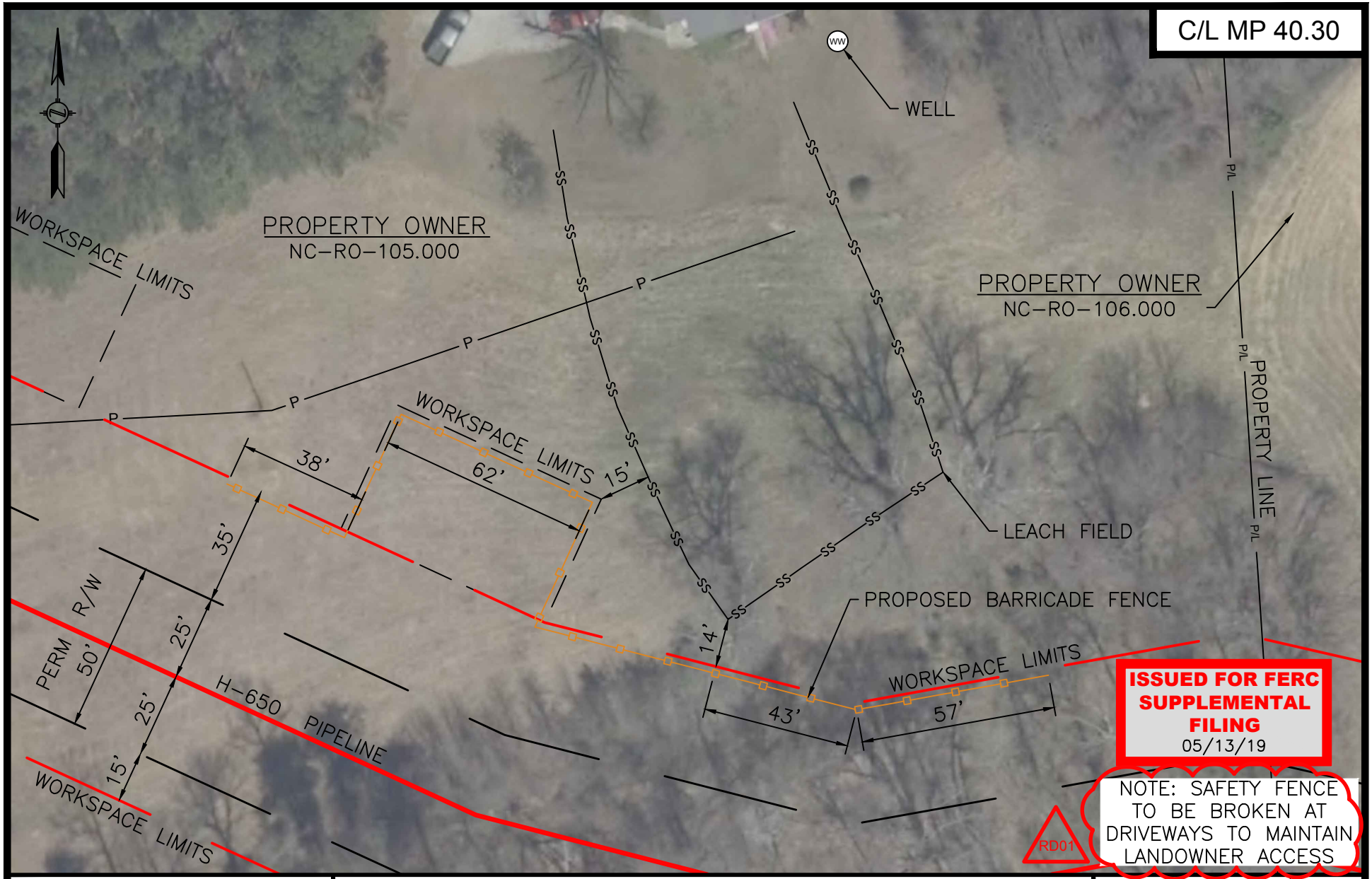

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MVP Southgate Project

Docket No. CP19-14-000

Attachment 34-1

VADEQ Correspondence

May 2019

625 Liberty Avenue, Suite 1700 | Pittsburgh, PA 15222
833-MV-SOUTH | mail@mvpsouthgate.com
www.mvpsouthgate.com

Ms. Anita Walthall
Air Permit Writer
Virginia DEQ – Blue Ridge Regional Office
901 Russel Drive
Salem, VA 24153

April 25, 2019

Re: MVP Southgate Project – Lambert Compressor Station
Minor New Source Article 6 Air Permit Application – Revision 1

Dear Ms. Walthall,

Mountain Valley Pipeline, LLC ("Mountain Valley") filed the initial minor new source review Article 6 air permit application for the new Lambert Compressor Station on November 8, 2018. Mountain Valley previously responded to the December 5, 2018 VADEQ information request on December 14, 2018 with the requested additional air permit information. Based on information previously submitted as well as proposed station design changes in response to the VADEQ's BACT letter on February 15, 2019 and meetings with the VADEQ, Mountain Valley has developed the enclosed update to the proposed Lambert Compressor Station air permit application.

The purpose of this update is to provide revised performance data for the proposed Solar Mars 100 and Solar Taurus 70 compressor turbines at the Station, including the associated reductions in the potential to emit for the Station. The turbines are proposed to be equipped with Solar's Advanced SoloNOx combustor technology for additional NOx emissions control. Based on the updated Solar compressor turbine technology and performance data, an updated Best Available Control Technology (BACT) analysis is provided in Section 4 of the Application.

Specific revisions to this application include:

- Updated potential to emit calculations to reflect the revised performance data for the Solar Turbines that will be now equipped with Solar's Advanced SoloNOx combustor technology;

- Updated blowdown emission calculations to include the use of emergency blowdown (EBD) valves to control emissions from emergency shutdown (ESD) tests.
- Updated HAP emissions to include an operational margin on hexane content in natural gas. Hexane mass content increased from 0.04% to 0.08%;
- Updated air toxics analysis; and
- Updated BACT analysis consistent with the proposed revisions.

The modeling protocol and analysis is currently being revised and will be submitted to your office as soon as completed. We are working with Mr. Mike Kiss at the Central Office to fulfill VADEQ's modeling requirements.

A signed document certification form is provided in Appendix A of the enclosed update to the Lambert Compressor Station air permit application.

We look forward to continue working with you and your staff on this project. If you have any questions or comments regarding the information provided in the attached Article 6 air permit application, or need additional information, please do not to hesitate to contact me at 713-204-3729, alex.miller@nee.com or Christina Akly at 561-691-7065, christina.akly@nee.com.

Sincerely,

Alex Miller
MVP Southgate Environmental Permitting Lead

CC: Paul Jenkins, VADEQ – Blue Ridge Regional Office
Mike Kiss, VADEQ – Central Office
Tamera Thompson, VADEQ – Central Office
Christina Akly, NextEra Energy, Inc
Kristin Ryan, EQM Midstream Partners, LP

Mountain Valley Pipeline, LLC
Lambert Compressor Station
Southgate Project
Article 6 Air Permit Application

Prepared for:

Mountain Valley Pipeline, LLC

Prepared by:

TRC Environmental Corporation
1200 Wall Street West, 5th Floor
Lyndhurst, New Jersey 07071

Revision 1 – April 2019

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1.0 INTRODUCTION

1.1 Project Overview

Mountain Valley Pipeline, LLC ("Mountain Valley") is seeking a Certificate of Public Convenience and Necessity ("Certificate") from the Federal Energy Regulatory Commission ("FERC") pursuant to Section 7(c) of the Natural Gas Act to construct and operate the MVP Southgate Project ("Project"). The Project will be located in Pittsylvania County, Virginia and Rockingham and Alamance counties, North Carolina. Mountain Valley proposes to construct approximately a 0.4-mile-long 24-inch-diameter pipeline (H-605) and 73 miles of 24- and 16-inch-diameter natural gas pipeline (H-650) to provide timely, cost-effective access to new natural gas supplies to meet the growing needs of natural gas users in the southeastern United States ("U.S."), including for the Project's anchor shipper, a local distribution company serving customers in North Carolina.

The proposed pipeline will interconnect with and receive gas from the existing Mountain Valley Pipeline near Chatham, Virginia, and deliver to or receive gas from the East Tennessee Natural Gas, LLC mainline near Eden, North Carolina, and will deliver gas to connections with customers' existing facilities in Eden and Graham, North Carolina. The Project is a stand-alone project from the Mountain Valley Pipeline and has an expected in-service date of late 2020.

In addition to the proposed pipeline, Mountain Valley proposes to construct and operate a new compressor station (Lambert Compressor Station) near the beginning of the pipeline at milepost 0.0. As part of the Southgate Project and in order to boost pressures on Mountain Valley's transmission pipeline system, Mountain Valley is proposing to construct and operate one Solar Taurus 70 compressor turbine (11,792 hp) and one Solar Mars 100 compressor turbine (17,124 hp) at the Lambert Compressor Station. The Lambert Compressor Station (CS) will be a new natural gas transmission facility covered by Standard Industrial Classification (SIC) 4922. Ancillary project emission sources include five (5) Capstone microturbines rated at 200 kW each, one (1) 0.77 MMBtu/hr natural gas fired heater, and two (2) 10,000 gallon produced fluids tanks.

1.2 Application Summary

The Lambert Compressor Station (Project or Lambert Station) is a proposed minor stationary source (as defined under the Prevention of Significant Deterioration of Air

Quality (PSD) and Title V rules) located in Pittsylvania County, Virginia. As demonstrated in Section 3 of this application, the proposed project is not subject to major source air permitting requirements.

The Project will be located near the town of Chatham, Pittsylvania County, Virginia, which is part of the Central Virginia Interstate Air Quality Control Region (AQCR) in Virginia. Pittsylvania County is considered attainment or unclassifiable for all criteria pollutants.

The air quality regulations for the Commonwealth of Virginia are codified in Title 9 of the Virginia Administrative Code (9 VAC) Agency 5, State Air Pollution Control Board. The proposed project involves the installation of new emission units and will be considered a minor source with respect to New Source Review (NSR) permitting requirements at 9 VAC 5-80-1100 and Title V major source permitting requirements at 9 VAC-5-80-50. This Article 6 Air Permit Application package per 9 VAC 5-80-1100 is designed to address the air regulatory requirements of Virginia Department of Environmental Quality (VADEQ). As such, Mountain Valley is submitting this revised minor source State Facility air permit application for the new Lambert Compressor Station. The new Solar Taurus 70 and Mars 100 combustion turbines will be subject to 40 CFR 60 Subpart KKKK, New Source Performance Standards for Stationary Gas Turbines as well as the applicable state regulations as outlined in Section 3 of this application.

Appendix A of this Article 6 Air Permit application contains the VADEQ Form 7 application forms. Emission calculation spreadsheets providing supporting calculations for the application forms are included as Appendix B of this application.

2.0 PROJECT DESCRIPTION

2.1 Site Location and Surroundings

The proposed Lambert Compressor Station, as shown in Figure 2-1, is proposed to be located on an undeveloped parcel of land in a rural area near to Chatham, Virginia. The Lambert Compressor Station will be constructed at the beginning of the pipeline at milepost 0.0 in Pittsylvania County, Virginia on a parcel of land owned by Mountain Valley.

The approximate Universal Transverse Mercator (UTM) coordinates of the facility are: 647,900 meters east and 4,076,900 meters north in Zone 17 (North American Datum of 1983(NAD83)). A detailed plot plan of the proposed facility is shown in Figure 2-2.

2.2 Facility Conceptual Design

As a part of the Southgate Project, Mountain Valley is proposing to install the following equipment at the Lambert Compressor Station:

- One Solar Taurus 70, 11,792 hp natural gas fired turbine-driven compressor unit
- One Solar Mars 100, 17,124 hp natural gas fired turbine-driven compressor unit
- Five (5) Capstone Microturbines each rated at 200 kW;
- One 0.77 MMBtu/hr heater
- Two 10,000 gallon produced fluids storage tanks

Potential Project emissions include station blowdowns consisting of two types of gas blowdown events that could occur at the Station: (1) a type of maintenance gas blowdown that could occur when a compressor is stopped and gas between the suction/discharge valves and compressors is vented to the atmosphere via a blowdown vent, and (2) an emergency full station shutdown (ESD) that would only occur infrequently at required U.S. Department of Transportation (DOT) test intervals or in an emergency situation.

The installation of the above equipment will include a number of piping components at the station which could result in additional fugitive emissions due to equipment leaks. Mountain Valley has provided fugitive emissions estimates for volatile organic compounds (VOCs) and greenhouse gases (GHGs). Estimates of fugitive emissions are required to be included for Title V applicability assessments, per 9VAC5-80-90. Typical sources of fugitive emissions from natural gas compressor stations include leaks from

piping components (valves, flanges, connectors and open-ended lines) as well as potential gas release events.

2.2.1 Compressor Turbines

The proposed Solar Taurus 70 and Mars 100 natural gas-fired turbines to be installed at the Lambert Compressor Station will be equipped with Solar's *Advanced* SoLoNOx dry low NOx combustor technology for NOx control. The Advanced SoLoNOx system provides a 9 ppmvd NOx warrantee which is possible due the improved hardware and software changes and advances compared to the 15 ppm NOx units. The specific improvements to the turbines that allow for the lower NOx emissions are provided in Appendix B. Potential emissions for the Solar Turbines conservatively assume that the units will operate up to 8,760 hours per year and up to 100% rated output. The vendor provided emission rates for normal operating conditions are provided below (all emissions rates are in terms of parts per million dry volume (ppmvd) @ 15% O2). Normal operating conditions include loads between 50% to 100% and temperatures between 0°F and 100°F.

Solar Mars 100

- 9 ppmvd NOx
- 25 ppmvd CO
- 25 ppmvd unburned hydrocarbons (UHC)
- 5 ppmvd VOC

Solar Taurus 70

- 9 ppmvd NOx
- 15 ppmvd CO
- 15 ppmvd unburned hydrocarbons (UHC)
- 3 ppmvd VOC

Depending upon demand, the turbines may operate at loads ranging from 50% to 100% of full capacity. Because of the different emission rates and exhaust characteristics that occur at different loads and ambient temperatures, a matrix of operating modes is presented in this air permit application. Emission parameters for three turbine loads (50%, 75%, and 100%) and six ambient temperatures (0°F, 20°F, 40°F, 60°F, 80 °F, and 100°F) are accounted for in this air permit application to cover the range of steady-state turbine operations.

At very low load and cold temperature extremes, the turbine system must be controlled differently in order to assure stable operation. The required adjustments to the turbine controls at these conditions cause emissions of NOx, CO and VOC to increase (emission rates of other pollutants are unchanged). Low-load operation (non-normal SoLoNOx operation) of the turbines is expected to occur only during periods of startup and shutdown and for maintenance or unforeseen emergency events.

The start-up process for the Solar Taurus 70 and Mars 100 turbines takes approximately 10 minutes from the initiation of start-up to normal operation (equal to or greater than 50% load). Shutdown takes approximately 10 minutes. Mountain Valley has estimated there would be 52 start-up/shutdown events per year. Emissions per start-up and shutdown event for the turbine were estimated based on Table 2 from the Solar PIL 170, Revision 9 ("Emission Estimates at Start-up, Shutdown, and Commissioning for SoLoNOx Combustion Products"). Appendix B contains these per-event emission calculations for start-up and shutdown and the associated Solar PIL 170.

Similarly, Solar has provided emission estimates for low temperature operation (inlet combustion air temperature less than 0°F and greater than -20°F) in Solar PIL 167, Revision 6 ("SoLoNOx Products: Emissions in Non-SoLoNOx Modes," Table 1). The turbines will be equipped with Pilot Active Control Logic to minimize emissions during very low temperature operation (<0°F). Pilot active control logic employs active oscillations feedback to increase pilot and reduce oscillations, which results in lower emissions.

Mountain Valley reviewed historic meteorological data from the previous five years for the region to estimate the worst case number of hours per year under sub-zero (less than 0°F) conditions. Based on that review, the annual hours of operation during sub-zero conditions was assumed to be not more than 24 hours per year.

Table 2-1 below summarizes the emission factors used for low temperature operation and startup and shutdown operations.

Table 2-1: Emission Factors for Low Temperature Operation and Startup/Shutdown Operations

Turbine Type	Solar Taurus 70 Turbine					Solar Mars 100 Turbine				
Pollutant	**NOx**	**CO**	**UHC**	**VOC**	**CO2**	**NOx**	**CO**	**UHC**	**VOC**	**CO2**
Low Temperature Operation (ppm @ 15% O2)	42	100	50	10	NA	42	100	50	10	NA
Startup Operations (lb/event)	1	88	88	18	381	1	46	20	4	385
Shutdown Operations (lb/event)	1	62	40	8	473	1	82	26	5	676

2.2.2 Ancillary Equipment

Mountain Valley is proposing to install five (5) new natural gas fired Capstone C200 (200 kW) microturbines to provide electrical power to the Station. Maximum hourly and annual emission rates for the microturbines are provided in Appendix B. Emissions of NOx, CO, and VOC are based on vendor data. Emission rates for SO_2, particulates, and hazardous air pollutants (HAPs) are based on USEPA AP-42 emission factors (Table 3.1-2a). GHG emissions are based on 40 CFR Part 98 Tables A-1, C-1, and C-2. The emission rates are based on the microturbines operating at peak load.

Mountain Valley is also proposing to install one new 0.77 MMBtu/hr (heat input) heater. The emission factors used to calculate emissions from the heater re based on USEPA AP-42 emission factors (Section 1.4).

2.3 Fuel

The Lambert Station will utilize pipeline natural gas as the sole fuel for all proposed equipment. The natural gas is assumed to have a higher heating value (HHV) of approximately 1,102 Btu/standard cubic foot (SCF) and will contain no more than 2.0 grains of sulfur per 100 SCF of gas on an annual average basis.

2.4 Fugitive Emissions and Tanks

Fugitive emissions are defined as those emissions which do not pass through a stack, vent, or other functionally equivalent opening, and include natural gas leaks from valves, flanges, pumps, compressors, seals, connections, etc. Vented emissions are defined as those emissions which pass through a stack, vent, or equivalent opening. A compressor may be vented for startup, shutdown, maintenance, or for protection of gas

seals from contamination. An individual compressor or the entire station may be blown down (i.e., vented) for testing, or in the event of an emergency. The facility will use an emergency blowdown (EBD) valve to control the emissions vented during emergency shutdown (ESD) tests. Block valves will be permanently installed immediately downstream of the ESD blowdown valve using blind flanges. During the capped ESD test, these block valves are closed and the ESD test is initiated to ensure that the ESD blowdown valves have moved to the correct position. Once the test has been documented and the ESD blowdown valves demonstrated to have worked properly, the ESD blowdown valves are closed. The use of an EBD valve ensures that there is no gas vented or released from the system during a capped ESD test. The blowdown emission calculations include an annual ESD test event, which should not result in any blowdown emissions, and they also include an actual ESD event to account for a potential actual emergency shutdown during the year, which would result in blowdown emissions. However, it should be noted that these emergency events are very uncommon, so an annual event should represent a conservative estimate of fugitive blowdown emissions.

Fugitive emissions at natural gas compressor stations also include leaks from piping components (valves, flanges, connectors and open-ended lines) as well as potential gas release events. The vast majority of gas release events are associated with startup, shutdown, or maintenance activities. Mountain Valley has provided fugitive emissions estimates for VOCs, HAPs and GHGs in Appendix B.

Proposed tanks at the Lambert Station may have associated emissions, such as the flashing losses that occur when the pressure of a liquid is decreased or the temperature is increased. At the Lambert Station, flashing losses will occur at the 10,000 gallon produced fluids storage tanks and include VOCs, HAPs and GHGs as provided in Appendix B.

2.5 Proposed Project Emission Potential

Table 2-2 presents project emission potentials from the new units and activities to be installed as a part of the proposed Lambert Compressor Station. For new emission units, project emission potential is equal to potential to emit. Detailed emission calculations and supporting vendor data can be found in Appendix B of this permit application.

Table 2-2: Proposed Facility Emissions in Tons Per Year (tpy)

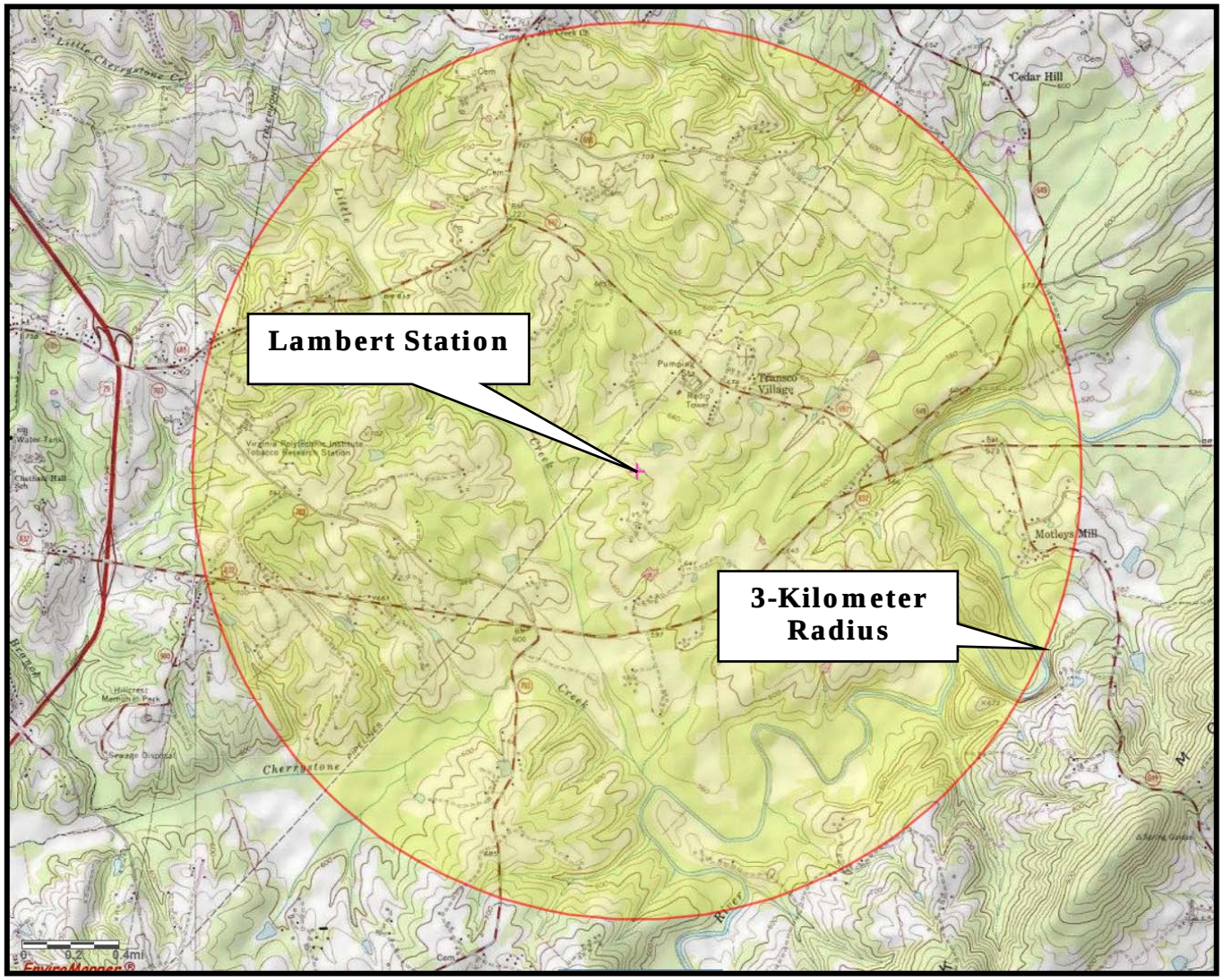
Pollutant	Solar Mars 100 Turbine (tpy)	Solar Taurus 70 Turbine (tpy)	Capstone Microturbines (5 Units) (tpy)	Heater (tpy)	Produced Fluids Tanks (tpy)	Station Blowdowns (tpy)	Station Fugitives (tpy)	Proposed Project Total[4] (tpy)
NO_x	19.58	13.17	1.81	0.31	-	-	-	**34.86**
CO	36.26	17.27	4.79	0.26	-	-	-	**58.58**
VOC	3.99	2.20	0.44	0.02	0.43	0.61	0.75	**8.44**
SO2	3.10	2.09	0.17	0.018	-	-	-	**5.38**
PM/PM_{10}/$PM_{2.5}$	5.97	4.02	0.33	0.02	-	-	-	**10.35**
CO_2e[1]	69,982	47,063	5,847	395	4.2	1,411	1,740	**126,442**
Total HAPs	2.55	1.62	0.21	0.01	0.004	0.06	0.07	**4.52**
Maximum Individual HAP[2] (Formaldehyde)	1.95	1.37	0.15	0.00025	-	-	-	**3.47**

(1) Greenhouse gases calculated as CO_2e.

(2) The individual HAP with the highest total annual emission rate is formaldehyde.

(3) Emissions are in units of tons per year.

(4) The proposed project total represents the total Uncontrolled Emissions Rate.

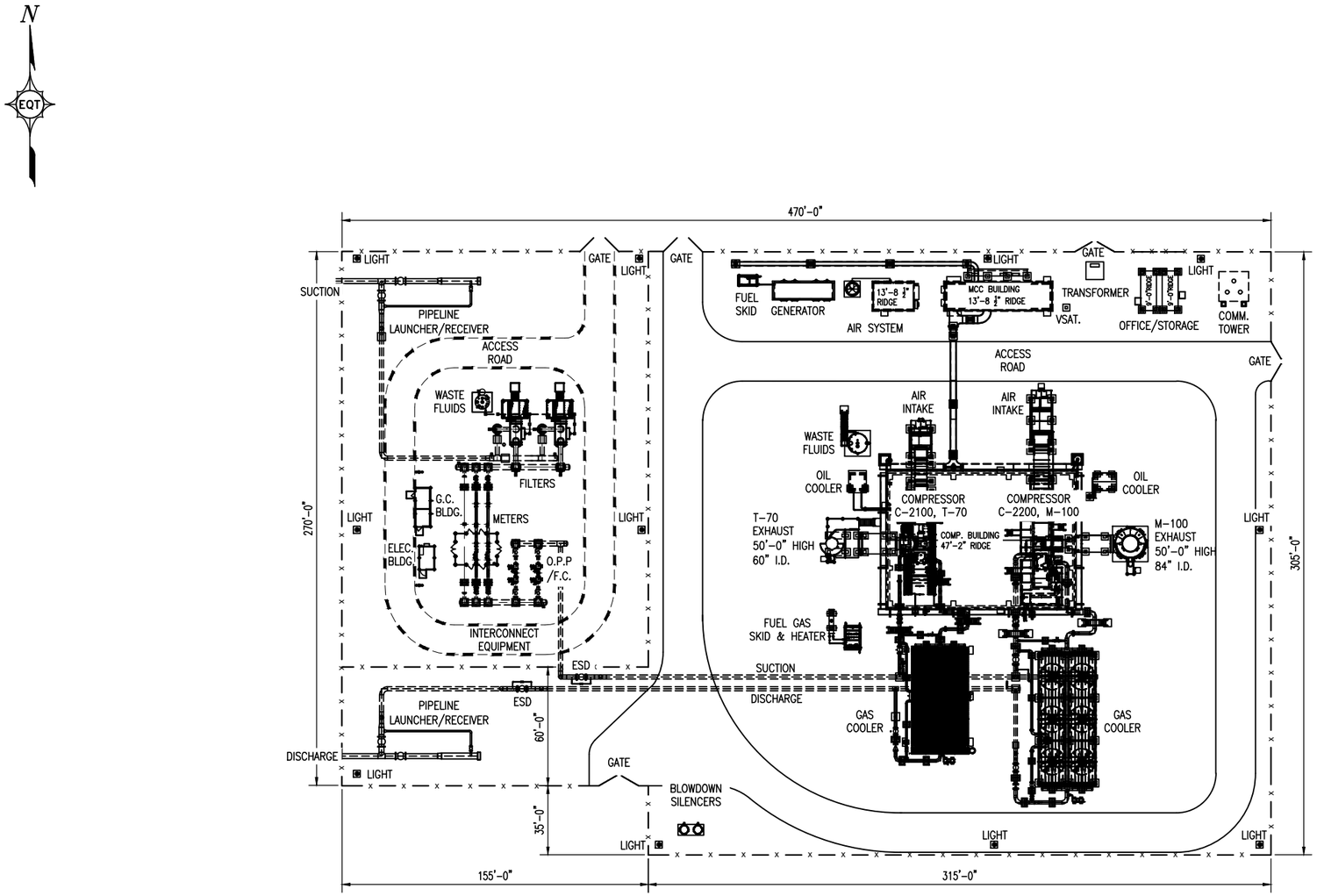


Mountain Valley Pipeline, LLC
Lambert Compressor Station
Pittsylvania County, Virginia

Figure 2-1. Site Location Map

Source: USGS, USEPA EJSCREEN

Figure 2-2: Facility Plot Plan



REFERENCE DRAWINGS		NO.	DATE	REVISION	BY	CHK	APPD	NO.	DATE	REVISION	BY	CHK	APPD
DRAWING NUMBER	DRAWING TITLE	P	8-14-2018	PRELIMINARY	#	#	#	#	#	#	#	#	#
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— ELECTRICAL DESIGN ENGINEER — # — DATE

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Mountain Valley PIPELINE, LLC

PROJECT ID: ######

DRAWING SCALE: 1/32" = 1'-0"

DRAWING TITLE:
LAMBERT COMPRESSOR STATION
MECHANICAL
PIPING
PLOT PLAN

FACILITY	STATE	IDENTIFICATION	SERIES	SHEET	REVISION
C	V	LAM	1100	01	P

Plotted by: Mace, Doug on: October 10, 2018 - 2:49 PM

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3.0 RULE APPLICABILITY ANALYSIS

This section contains an analysis of the applicability of federal and state air quality regulations to the proposed Project. The specific regulations included in this applicability review are the Federal New Source Performance Standards (NSPS), Prevention of Significant Deterioration (PSD) and New Source Review (NSR) requirements, Maximum Achievable Control Technology (MACT) requirements for HAPs, and VADEQ Regulations and Policy.

3.1 Federal New Source Performance Standards

The 40 CFR 60 NSPS are technology-based standards that apply to new, modified, and reconstructed stationary sources. The 40 CFR 60 NSPS requirements have been established for approximately 70 source categories. The proposed Project is subject to the following three subparts: General Provisions (40 CFR Part 60, Subpart A), Standards of Performance for Stationary Combustion Turbines (40 CFR Part 60, Subpart KKKK), and the Standards of Performance for Oil and Natural Gas Sector: Emission Standards for New, Reconstructed, and Modified Sources (40 CFR Part 60, Subpart OOOOa).

3.1.1 40 CFR Part 60, Subpart A – General Provisions

The new Solar Taurus 70 and Mars 100 turbines are subject to the general provisions for NSPS units in 40 CFR Part 60 Subpart A. These include the requirements for notification, record keeping, and performance testing contained in 40 CFR Parts 60.7 and 60.8.

3.1.2 40 CFR Part 60 Subpart Kb - Volatile Organic Liquid Storage Vessels

Subpart Kb potentially applies to storage vessels with a capacity greater than 75 cubic meters (m^3) (19,813 gallons) that will store volatile organic liquids. Tanks with a capacity greater than 75 m^3 are not proposed to be constructed, reconstructed, or modified at the Lambert Compressor Station. Therefore, this subpart will not apply. The only 2 tanks that will be installed at this site have a 10,000 gallon capacity each.

3.1.3 40 CFR Part 60, Subpart KKKK – Stationary Combustion Turbines

On July 6, 2006, the USEPA promulgated Subpart KKKK to establish emission standards and compliance schedules for the control of emissions from new stationary

combustion turbines that commence construction, modification, or reconstruction after February 18, 2005. Note that stationary combustion turbines regulated under Subpart KKKK are exempt from Subpart GG requirements, which are applicable to units constructed, modified, or reconstructed prior to February 18, 2005.

Pursuant to 40 CFR 60.4305(a), the new Solar Taurus 70 and Mars 100 gas turbines are subject to requirements of 40 CFR 60 Subpart KKKK, because the heat input at peak load will be greater than or equal to 10 MMBtu/hr (HHV) and Mountain Valley will have commenced the construction or modification of the turbines after February 18, 2005. Pursuant to 40 CFR 60.4320(a) and Table 1 to Subpart KKKK of Part 60 – Nitrogen Oxide Emission Limits for New Stationary Combustion Turbines, the new gas turbines, which will have HHV heat inputs of between 50 and 850 MMBtu/hr, will comply with a NOx emission standard of 25 ppm at 15 percent O_2 or 1.2 lb/MWh useful output as indicated by the vendor guarantee of 9 ppm shown in Appendix B. Subpart KKKK also includes a NOx limit of 150 ppmvd at 15% O2 or 8.7 lb/MWh for turbine operation at temperatures less than 0°F and turbine operation at loads less than 75 % of peak load which the new turbine will meet as indicated by the vendor guarantee shown in Appendix B. The new turbines will not burn any fuel that has the potential to emit in excess of 0.060 lb/MMBtu SO_2 heat input, pursuant to 40 CFR 60.4330(a)(1) and (2), respectively.

3.1.4 40 CFR 60, Subparts OOOO and OOOOa – Crude Oil and Natural Gas Production, Transmission and Distribution

Subpart OOOO currently applies to affected facilities that commenced construction, reconstruction, or modification after August 23, 2011 and on or before September 18, 2015. The equipment at the proposed Lambert Compressor station will have a construction date after September 18, 2015, and therefore will not be subject to Subpart OOOO.

Oil and gas facilities constructed, modified or reconstructed after September 18, 2015, such as the proposed compressor station, are subject to the requirements under NSPS 60 Subpart OOOOa. Potential equipment at compressor stations regulated under Subpart OOOOa includes storage tanks, continuous bleed pneumatic controllers, pneumatic pumps, reciprocating and wet seal centrifugal compressors, and fugitive emission components. The Lambert compressor station will not include continuous bleed pneumatic controllers, pneumatic pumps or reciprocating or wet seal centrifugal compressors. The storage vessels that will be located at the facility have the potential for VOC emissions less than or equal to 6 tons per year, so they are not subject to this

subpart. Fugitive emissions components at the facility will be subject to Subpart OOOOa. For equipment leaks, Subpart OOOOa requires quarterly surveys using optical gas imaging (OGI) technology and subsequent repair of any identified leaks. The project will comply with all applicable leak detection and repair provisions of Subpart OOOOa.

3.2 Prevention of Significant Deterioration (PSD)

Preconstruction air permitting programs that regulate the construction of new stationary sources of air pollution and the modification of existing stationary sources are commonly referred to as NSR. NSR can be divided into major NSR and minor NSR. Major NSR is comprised of the PSD program. Major NSR requirements are established on a federal level but may be implemented by state or local permitting authorities under either a delegation agreement with USEPA or as a state implementation plan (SIP) program approved by USEPA.

The Lambert Compressor Station is not classified as one of the 28 named source categories listed in Section 169 of the Clean Air Act. Therefore, to be considered a "major stationary source" subject to PSD, the facility would need to have potential emissions of 250 tons per year or more of any regulated pollutant (except CO_2). The final PSD and Title V GHG Tailoring Rule was published in the Federal Register on June 3, 2010 (75 FR 31514) but was ultimately overturned on June 23, 2014 by the US Supreme Court. Under the formerly effective rule, GHGs could, as of July 1, 2011, become "subject to regulation" under the PSD program for construction projects that would result in potential GHG emissions of 100,000 tons per year (tpy) carbon dioxide equivalents (CO2e) or more. However, the June 23, 2014 Supreme Court Decision clarifies that construction projects cannot trigger major NSR for GHGs unless major NSR is otherwise triggered for any other criteria pollutants.

As shown in Table 3-1, the proposed Lambert Compressor Station is a minor stationary source with respect to NSR as all pollutants with the exception of CO2e are below the PSD source thresholds. Therefore, the Project is not subject to PSD requirements.

Table 3-1: PSD/NNSR Applicability Assessment

Pollutant	PSD/NNSR Major Source Threshold (tpy)	Total Facility Emissions (tpy)	Emissions Exceed PSD/NNSR Major Source Threshold
Nitrogen Oxides (NOx)	250	34.86	No
Carbon Monoxide (CO)	250	58.58	No
VOC	250	8.44	No
Sulfur Dioxide (SO2)	250	5.38	No
PM Total	250	10.35	No
PM10	250	10.35	No
PM2.5	250	10.35	No
Greenhouse Gases (CO2e)	100,000	126,442	Yes(1)
Total HAP	25	4.52	No
Individual HAP - Formaldehyde	10	3.47	No

(1) GHGs cannot trigger major NSR unless major NSR is otherwise triggered for any other criteria pollutants as per June 23, 2014 US Supreme Court decision.

3.3 Title V Operating Permit and State Preconstruction and Operating Permit Programs

The Title V permit program in 40 CFR Part 70 requires major sources of air pollutants to obtain federal operating permits. The major source thresholds under the Title V program, as defined in 40 CFR 70.2 and which are different from the federal NSR major source thresholds, are 100 tpy of any air pollutant, 10 tpy of any single hazardous air pollutant (HAP), or 25 tpy of total HAPs.

Virginia's Title V Operating Permit Program is administered through a USEPA-approved program at 9 VAC-5-80. The Lambert Compressor Station will have two Solar turbines with heat inputs greater than 50 MMBtu/hr and as a such, is required to obtain a State Article 6 Construction Air Permit per 9 VAC 5-80-1100. Emission sources or activities listed under 9VAC5-80-1105 are exempt from the registration and permitting provisions of 9 VAC 5-80-1100.

As shown in Table 3-2, potential emissions of all regulated pollutants are below the Title V major source thresholds of 100 tpy. As such, the facility is not subject to Title V

permitting requirements for these pollutants and is required to obtain a State Article 6 Air Permit per 9 VAC 5-80-1100. The VADEQ issues minor NSR permits to sources whose uncontrolled emission rate for a regulated criteria pollutant is above exemption thresholds and permitting allowable emissions are below Title V thresholds and issued to sources whose potential to emit for a toxic pollutant is above state toxic exemption thresholds and permitting allowable emissions are below Title V thresholds.

The uncontrolled emission rates from the Lambert Compressor Station are below the major source thresholds and above the VADEQ exemption thresholds only for PM2.5 and formaldehyde. Thus, the Project will be permitted as a true minor source (i.e., not a synthetic minor source) with a State Article 6 Construction Permit.

Table 3-2: Title V and VA DEQ Minor NSR Permit Applicability Assessment

Pollutant	Title V Source Threshold (tpy)	VADEQ Minor Source Permit Threshold (tpy)	Total Facility Emissions (tpy)	Emissions Exceed Title V Source Threshold	Emissions Exceed VADEQ Minor Source Permit Threshold
Nitrogen Oxides (NOx)	100	40	34.86	No	No
Carbon Monoxide (CO)	100	100	58.58	No	No
VOC	100	25	8.44	No	No
Sulfur Dioxide (SO2)	100	40	5.38	No	No
PM Total	100	25	10.35	No	No
PM10	100	15	10.35	No	No
PM2.5	100	10	10.35	No	**Yes**
Greenhouse Gases (CO2e)	NA	NA	126,442	NA	NA
Total HAP	25	10	4.52	No	No
Individual HAP - Formaldehyde	10	0.17	3.47	No	**Yes**

3.4 National Emission Standards for Hazardous Air Pollutants

The USEPA has established National Emission Standards for Hazardous Air Pollutants (NESHAP) for specific pollutants and industries in 40 CFR Part 61. The Project does not include any of the specific sources for which NESHAP have been established in Part 61. Therefore, Part 61 NESHAP requirements will not apply to the proposed facility. The USEPA has also established NESHAP requirements in 40 CFR Part 63 for various source categories. The applicability to the Project of several NESHAP rules is discussed below. The applicability analysis shows that Part 63 NESHAP requirements will not apply to the proposed facility.

3.4.1 40 CFR Part 63 Subpart HHH (NESHAP from Natural Gas Transmission and Storage Facilities)

Subpart HHH applies to natural gas transmission and storage facilities that are major sources of HAPs and that transport or store natural gas prior to entering the pipeline to a local distribution company or to a final end user (if there is no local distribution company). The Lambert Station is an area (minor) source (i.e., not major source) of HAPs. Therefore, this subpart will not apply because it only applies to major sources of HAPs.

3.4.2 40 CFR Part 63 Subpart YYYY (NESHAP for Stationary Combustion Turbines)

Subpart YYYY applies to stationary combustion turbines at major sources of HAPs. Emissions and operating limitations under Subpart YYYY apply to new and reconstructed stationary combustion turbine. The Lambert Station is an area source (i.e., not major source) of HAPs. Therefore, this subpart will not apply because it only applies to major sources of HAPs.

3.4.3 40 CFR Part 63 Subpart DDDDD (NESHAP for Major Sources: Industrial, Commercial, and Institutional Boilers and Process Heaters)

Subpart DDDDD applies to certain new and existing boilers and process heaters at major HAP sources. The Lambert Station is an area source (i.e., not major source) of HAPs. Therefore, this subpart will not apply because it only applies to major sources of HAPs.

3.4.4 40 CFR Part 63 Subpart JJJJJJ (NESHAP for Area Sources: Industrial, Commercial, and Institutional Boilers)

The area source regulation for boilers, Subpart JJJJJJ, exempts all process heaters and also exempts boilers that are natural gas-fired. The proposed unit at the site is a natural gas fired heater which is exempted from the area source NESHAP under subpart JJJJJJ.

3.5 Greenhouse Gas Reporting Rule

Per 40 CFR 98.2(a)(2), facilities that contain a source category listed in Table A-4 and emit 25,000 metric tons or more per year of carbon dioxide equivalent ("CO2e") in combined emissions from stationary fuel combustion units, miscellaneous uses of carbonate, and all applicable source categories in Tables A-3 and A-4 are subject to reporting under the Greenhouse Gas Mandatory Reporting Rule ("MRR"). Table A-4 of 40 CFR 98 Subpart A includes Petroleum and Natural Gas Systems. Greenhouse gas emissions from the compressor station are over 25,000 metric tpy on a potential basis. The actual emissions will be calculated annually following subpart W applicability and calculation methodology and compared with the 25,000 metric tpy of CO2 to address the applicability of the rule. The Project will meet all requirements of the MRR for the new compressor station, as applicable. No other subparts under the MRR are applicable to the compressor station.

3.6 Virginia Regulations

The air quality regulations for the Commonwealth of Virginia are codified in Title 9 of the Virginia Administrative Code (9 VAC) Agency 5, State Air Pollution Control Board. Potentially applicable regulations are identified below:

- 9 VAC 5-30 "Ambient Air Quality Standards" are required to assure that ambient concentrations of air pollutants are consistent with established criteria and shall serve as the basis for effective and reasonable management of the air resources of the Commonwealth of Virginia. An air quality analysis utilizing dispersion modeling was conducted and will be updated to account for changes in the application and modeling protocol to demonstrate compliance with the NAAQS as discussed in Section 5.0.
- 9 VAC 5-50-260 "Best Available Control Technology (BACT)" is a requirement to reduce emissions through the use of available reduction techniques (i.e., control devices, adjustments to prevent pollution formation, work practices, etc.). This requirement considers whether or not the emission reduction is BACT using various

factors including the cost effectiveness of the control system. BACT review is relative to a specific pollutant and a specific type of operation. Generally, for BACT, minor sources in Virginia undergo a review to compare the relative level of control with other similar Virginia sources.

BACT applicability is determined pollutant-by-pollutant, based on the corresponding permit applicability thresholds. For a new stationary source, BACT shall apply for each pollutant with an increase in the uncontrolled emission rate equal to or greater than the levels in 9VAC 5-80-1105C. Each affected emissions unit emitting a pollutant that is subject to permitting shall apply BACT for that pollutant (9VAC5-50-260B). For the proposed Lambert Compressor Station, as shown in Table 4-1, BACT is applicable for PM2.5. A BACT analysis is provided in Section 4.0.

- 9 VAC 5-60 "State Toxics Rule" contains the emissions standards for toxic air pollutants from new and modified sources. Emissions of toxic air pollutants discharged into the atmosphere from any affected facility may not cause, or contribute to, the endangerment of human health. Facilities that have a potential to emit toxic air pollutants in quantities that endanger human health are required to employ BACT for the control of toxic air pollutants. The proposed new facility emissions of toxic air pollutants were compared to the exemption thresholds contained in 9VAC5-60-300C. The only toxic air pollutant that is potentially emitted above the exemption thresholds is formaldehyde. The ambient air quality modeling analysis in Section 5 demonstrates that the proposed facility will not cause or contribute to any significant ambient air concentration that may cause, or contribute to, the endangerment of human health.

4.0 BEST AVAILABLE CONTROL TECHNOLOGY REVIEW

Consistent with Virginia's June 12, 2015 memo APG-354; Permitting and BACT Applicability under Chapter 80 Article 6 (VADEQ, 2015), Mountain Valley has reviewed the proposed sources to determine applicability of BACT review. Per 9 VAC 5-80-1005C, new stationary sources with uncontrolled emission rates less than all of the emission rates specified shall be exempt from the provisions of Chapter 80 Article 6. The uncontrolled emission rate of a new stationary source is the sum of the uncontrolled emission rates of the individual affected emission units. A summary of the VADEQ procedure is provided below:

Step 1: List all of the emission units at the new stationary source.

Step 2: Delete from the list developed in Step 1, any emission units that are individually exempt under 9 VAC 5-80-105B.

Step 3: Calculate the annual uncontrolled emission rate (UER) for each regulated pollutant listed in 9 VAC 5-80-1105C for each of the affected emissions units. Include fugitive emissions unless all of the emissions at the new stationary source are fugitive.

Step 4: Sum the annual UER from the affected emission units and compare the result with the exempt emission rates listed in 9 VAC 5-80-1105C.

A new stationary source is required to apply BACT for each regulated pollutant for which there would be an UER equal to or greater than the exemption levels in 9 VAC 5-80-1105C. Mountain Valley conducted a BACT analysis for the Lambert Compressor Station as shown below.

Step 1 – Emission Units

Mountain Valley seeks the authority to construct and operate several new emission sources as shown below:

- One Solar Taurus 70, 11,792 hp natural gas fired turbine-driven compressor unit;
- One Solar Mars 100, 17,124 hp natural gas fired turbine-driven compressor unit;
- Five (5) Capstone Microturbines each rated at 200 kW;
- One 0.77 MMBtu/hr heater; and
- Two 10,000 gallon produced fluids storage tanks.

Potential Project emissions also include trivial station blowdowns and fugitive emissions as detailed in Appendix B. The fugitive emissions at natural gas compressor stations

include leaks from piping components (valves, flanges, connectors and open-ended lines).

Step 2 – Individually Exempt Equipment

The emission units exempted under 9 VAC 5-80-1105B are listed below:

- One 0.77 MMBtu/hr heater – exempt as a combustion source < 50 MMBtu/hr; and
- Two 10,000 gallon produced fluids storage tanks – exempt as storage tanks < 40,000 gallons.

Step 3 – Annual UER Increase

The Uncontrolled Emission Rate (UER) for each new stationary source is summarized in Table 4-1 below.

Table 4-1: BACT Exemption Analysis

Pollutant	Solar Mars 100 Turbine (tpy)	Solar Taurus 70 Turbine (tpy)	Capstone Micro-turbines (tpy)	Station Blow-downs (tpy)	Station Fugitives (tpy)	Proposed Project Total (tpy)	BACT Exemption Levels (tpy)	Triggers BACT?
NO_X	19.58	13.17	1.81	-	-	**34.56**	40	No
CO	36.26	17.27	4.79	-	-	**58.32**	100	No
VOC	3.99	2.20	0.44	0.61	0.75	**7.99**	25	No
SO_2	3.10	2.09	0.17	-	-	**5.36**	40	No
PM	5.97	4.02	0.33	-	-	**10.32**	25	No
PM_{10}	5.97	4.02	0.33	-	-	**10.32**	15	No
$PM_{2.5}$	5.97	4.02	0.33	-	-	**10.32**	10	**Yes**

Step 4 –UER Increases vs. Exempt Emission Rates

As shown in Table 4-1, the total UER for $PM_{2.5}$ is the only pollutant UER that exceeds the BACT exemption threshold values and thus, $PM_{2.5}$ is subject to BACT review. Accordingly, Mountain Valley conducted a BACT analysis for the $PM_{2.5}$ emissions from the Solar Taurus 70 turbine, Solar Mars 100 turbine, and five Capstone microturbines.

4.1 Approach used in BACT Analysis

The BACT analysis for the proposed Project was conducted consistent with the USEPA's five step "top-down" BACT process as discussed in the USEPA's October 1990 draft New Source Review Workshop Manual. This methodology results in the selection of the most stringent control technology in consideration of the technical feasibility and the energy, environmental, and economic impacts. Control options are first identified for each pollutant subject to BACT and evaluated for their technical feasibility. Options found to be technically feasible are ranked in order of their effectiveness and then evaluated for their energy, economic, and environmental impacts. In the event that the most stringent control identified is selected, no further analysis of impacts is performed. If the most stringent control is ruled out based upon economic, energy, or environmental impacts, the next most stringent technology is similarly evaluated until BACT is determined.

The "top-down" procedure followed for each pollutant subject to BACT is outlined as follows:

Step 1: Identify available control options from review of agency permits for similar sources, literature review and contacts with air pollution control system vendors.

Step 2: Eliminate technically infeasible options - evaluation of each identified control to rule out those technologies that are not technically feasible (i.e., not available and applicable per USEPA guidance).

Step 3: Rank remaining control technologies - "Top-down" analysis, involving ranking of control technology effectiveness.

Step 4: Evaluate most effective controls and document results - Economic, energy, and environmental impact analyses are conducted if the "top" or most stringent control technology is not selected to determine if an option can be ruled out based on unreasonable economic, energy or environmental impacts.

Step 5: Select the BACT based upon the highest ranked option that cannot be eliminated, which includes development of an achievable emission limitation based on that technology.

4.2 BACT for Particulate Matter ($PM_{2.5}$)

The Solar Taurus 70, Solar Mars 100, and Capstone C200 combustion turbines are all sources of $PM_{2.5}$ emissions. The following provides the $PM_{2.5}$ BACT evaluation conducted for the Lambert Compressor Station.

Step 1 – Identify Potential Control Technologies

The major sources of $PM_{2.5}$ emissions from the gaseous fuel-fired combustion turbines are:

- The conversion of any fuel sulfur to sulfates and ammonium sulfates; and
- Unburned hydrocarbons that can lead to the formation of PM in the exhaust stack.

Pre-Combustion Control Technologies

Pre-combustion technologies that minimize the formation of $PM_{2.5}$ include:

- Use of clean-burning, low-sulfur gaseous fuels
- Good combustion practices.

The use of clean-burning, low-sulfur gaseous fuels will result in minimal formation of $PM_{2.5}$ during combustion. Good combustion practices will ensure proper air/fuel mixing ratios to achieve complete combustion, which will minimize emissions of unburned hydrocarbons that can lead to the formation of $PM_{2.5}$ emissions.

Post-Combustion Control Technologies

There are several post-combustion PM control systems potentially feasible to reduce $PM_{2.5}$ emissions from the combustion turbine including:

- Cyclones/centrifugal collectors;
- Fabric filters/baghouses;
- Electrostatic precipitators (ESPs); and
- Scrubbers.

Cyclones/centrifugal collectors are generally used in industrial applications to control large diameter particles (>10 microns). Cyclones impart a centrifugal force on the gas stream, which directs entrained particles outward. Upon contact with an outer wall, the particles slide down the cyclone wall, and are collected at the bottom of the unit. The design of a centrifugal collector provides for a means of allowing the clean gas to exit through the top of the device. However, cyclones are inefficient at removing small particles, such as $PM_{2.5}$.

Fabric filters/baghouses use a filter material to remove particles from a gas stream. The exhaust gas stream flows through filters/bags onto which particles are collected.

Baghouses are typically employed for industrial applications to provide particulate emission control at relatively high efficiencies.

ESPs are used on a wide variety of industrial sources, including certain boilers. ESPs use electrical forces to move particles out of a flowing gas stream onto collector plates. The particles are given an electric charge by forcing them to pass through a region of gaseous ion flow called a "corona." An electrical field generated by electrodes at the center of the gas stream forces the charged particles to ESP's collecting plates.

Removal of the particles from the collecting plates is required to maintain sufficient surface area to clean the flowing gas stream. Removal must be performed in a manner to minimize re-entrainment of the collected particles. The particles are typically removed from the plates by "rapping" or knocking them loose, and collecting the fallen particles in a hopper below the plates.

Scrubber technology may also be employed to control PM in certain industrial applications. With wet scrubbers, flue gas passes through a water (or other solvent) stream, whereby particles in the gas stream are removed through inertial impaction and/or condensation of liquid droplets on the particles in the gas stream.

Step 2 - Eliminate Technically Infeasible Options

Pre-Combustion Control Technologies

The pre-combustion control technologies identified above (i.e., clean-burning, low-sulfur fuels and good combustion practices) are available and technically feasible for reducing $PM_{2.5}$ emissions from the combustion turbine exhaust streams.

Post-Combustion Control Technologies

Each of the post-combustion control technologies described above (i.e., cyclones, baghouses, ESPs, scrubbers) are generally available. However, none of these technologies are considered practical or technically feasible for installation on gaseous fuel-fired combustion turbines. Post combustion controls, such as baghouses, scrubbers and electrostatic precipitators are impractical due to the high pressure drops associated with these units, the large flue gas volumes, and the low concentrations of $PM_{2.5}$ present in the exhaust gas.

The particles emitted from gaseous fuel-fired combustion turbines are typically less than 1 micron in diameter. Cyclones are not effective on particles with diameters of 10 microns or less. Therefore, a cyclone/centrifugal collection device is not a technically feasible alternative.

Baghouses, ESPs, and scrubbers have not been applied to commercial combustion turbines burning gaseous fuels. Baghouses, ESPs, and scrubbers are typically used on solid or liquid-fuel fired sources with high PM emission concentrations, and are not used in gaseous fuel-fired applications, which have inherently low PM emission concentrations. None of these control technologies are appropriate for use on gaseous fuel-fired combustion turbines because of their very low PM emissions levels, and the small aerodynamic diameter of PM from gaseous fuel combustion. Therefore, the use of baghouses, ESPs, and scrubbers is not considered technically feasible.

Step 3 - Rank Remaining Control Technologies by Control Effectiveness

The use of clean-burning fuels and good combustion practices are technically feasible technologies to control $PM_{2.5}$ emissions.

Step 4 - Evaluate Most Effective Controls and Document Results

Based on the information presented in this BACT analysis, using the proposed good combustion practices and natural gas fuel to control $PM_{2.5}$ emissions are considered BACT. This is consistent with BACT at other similar sources. Therefore, an assessment of the economic and environmental impacts is not necessary.

Step 5 – Select BACT

Mountain Valley's proposed BACT for $PM_{2.5}$ emissions from the combustion turbines is the use of clean-burning fuels and good combustion practices.

Furthermore, the combustion turbines will be equipped with self-cleaning inlet air filters to reduce the entrainment of particulate matter into the turbine and to reduce the PM exhaust emissions.

5.0 AIR QUALITY MODELING ANALYSIS

At the federal level, because the emission increases from the Lambert Compressor Station equipment are less than applicable major source thresholds, the Project will not trigger federal NSR requirements for any regulated air pollutant under either PSD or NNSR permitting programs. At the state level, the Project triggers air permitting through the VADEQ as a minor source of air emissions. If the agency considers that any project triggering minor NSR permitting could threaten attainment with the National Ambient Air Quality Standards (NAAQSs), VADEQ can require air dispersion modeling for the Project.

A revised modeling protocol and a supplemental air quality modeling report will be submitted to the VADEQ, which will provide the detailed modeling methodology and results of the NAAQS and toxic air pollutant modeling assessments based on this revised application.

APPENDIX A
VADEQ APPLICATION FORMS

AIR PERMIT APPLICATION
CHECK ALL PAGES ATTACHED AND LIST ALL ATTACHED DOCUMENTS

1	Local Government Certification Form, Page 3
___	Application Fee Form, Pages 4-6
1	Document Certification Form, Page 7
1	General Information, Pages 8-9
1	Fuel Burning Equipment, Page 10
___	Stationary Internal Combustion Engines, Page 11
___	Incinerators, Page 12
___	Processing, Page 13
___	Inks, Coatings, Stains, and Adhesives, Page 14
1	VOC/Petroleum Storage Tanks, Pages 15-16
___	Loading Rack and Oil-Water Separators, Page 17
___	Fumigation Operations, Page 18
___	Air Pollution Control and Monitoring Equipment, Page 19
___	Air Pollution Control/Supplemental Information, Page 20
1	Stack Parameters and Fuel Data, Page 21
1	Proposed Permit Limits for Criteria Pollutants, Page 22
1	Proposed Permit Limits for Toxic Pollutants/HAPs, Page 23
___	Proposed Permit Limits for Other Reg. Pollutants, Page 24
___	Proposed Permit Limits for GHGs on Mass Basis, Page 25
___	Proposed Permit Limits for GHGs on CO_2e Basis, Page 26
___	BAE for Criteria Pollutants, Page 27
___	BAE for GHGs on Mass Basis, Page 28
___	BAE for GHGs on CO_2e Basis, Page 29
1	Operating Periods, Page 30
___	ATTACHED DOCUMENTS:
1	Map of Site Location
1	Facility Site Plan
___	Process Flow Diagram/Schematic
___	MSDS or CPDS Sheets
1	Estimated Emission Calculations
___	Stack Tests
1	Air Modeling Data
___	Confidential Information (see Instructions)
1	BACT Analysis
1	Permit Application Narrative
1	Equipment Vendor Specifications

Check added form sheets above; also indicate the number of copies of each form in blank provided.

DOCUMENT CERTIFICATION FORM

I certify under penalty of law that this document and all attachments [as noted above] were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering and evaluating the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

I certify that I understand that the existence of a permit under [Article 6 of the Regulations] does not shield the source from potential enforcement of any regulation of the board governing the major NSR program and does not relieve the source of the responsibility to comply with any applicable provision of the major NSR regulations.

SIGNATURE: Clifford W Baker DATE: 4-24-19

NAME: Clifford Baker REGISTRATION NO:

TITLE: Senior VP of Midstream Field Operations COMPANY: Mountain Valley Pipeline, LLC

PHONE: 412-395-3654 ADDRESS: 625 Liberty Ave, Suite 1700

EMAIL: CBaker@eqt.com Pittsburgh, PA 15222

References: Virginia Regulations for the Control and Abatement of Air Pollution (Regulations), 9 VAC 5-20-230B and 9 VAC 5-80-1140E.

GENERAL INFORMATION

Person Completing Form: Darin Ometz	Date:11/6/18	Registration Number:
Company and Division Name: Mountain Valley Pipeline, LLC		FIN:
Mailing Address:		
Exact Source Location – Include Name of City (County) and Full Street Address or Directions: Chatham, Pittsylvania County, Virginia (See Figures 2-1 and 2-2 of Application)		
Telephone Number: 713-374-1599	No. of Employees:	Property Area at Site: 3.8 acres
Person to Contact on Air Pollution Matters – Name and Title: Christina Akly Senior Environmental Specialist	Phone Number: 561-691-7065 Fax: Email: Christina.Akly@fpl.com	
Latitude and Longitude Coordinates **OR** UTM Coordinates of Facility: 647,900 meters East, 4,076,900 meter North (UTM – NAD83, Zone 17)		

Reason(s) for Submission (Check all that apply):

☐ State Operating Permit

This permit is applied for pursuant to provisions of the Virginia Administrative Code, 9 VAC 5 Chapter 80, Article 5 (SOP)

☒ New Source

☐ Modification of a Source

☐ Relocation of a Source

This permit is applied for pursuant to the following provisions of the Virginia Administrative Code:

- ☒ 9 VAC 5 Chapter 80, Article 6 (Minor Sources)
- ☐ 9 VAC 5 Chapter 80, Article 8 (PSD Major Sources)
- ☐ 9 VAC 5 Chapter 80, Article 9 (Non-Attainment Major Sources)

☐ Amendment to a Permit Dated: _____ Permit Type: ☐ SOP (Art. 5) ☐ NSR (Art. 6, 8, 9)

Amendment Type:

- ☐ Administrative Amendment
- ☐ Minor Amendment
- ☐ Significant Amendment

This amendment is requested pursuant to the provisions of:

- ☐ 9 VAC 5-80-970 (Art. 5 Adm.)
- ☐ 9 VAC 5-80-980 (Art. 5 Minor)
- ☐ 9 VAC 5-80-990 (Art. 5 Sig.)
- ☐ 9 VAC 5-80-1270 (Art. 6 Adm.)
- ☐ 9 VAC 5-80-1280 (Art. 6 Minor)
- ☐ 9 VAC 5-80-1290 (Art. 6 Sig.)
- ☐ 9 VAC 5-80-1935 (Art. 8 Adm.)
- ☐ 9 VAC 5-80-1945 (Art. 8 Minor)
- ☐ 9 VAC 5-80-1955 (Art. 8 Sig.)
- ☐ 9 VAC 5-80-2210 (Art. 9 Adm.)
- ☐ 9 VAC 5-80-2220 (Art. 9 Minor)
- ☐ 9 VAC 5-80-2230 (Art. 9 Sig.)

☐ Other (specify): _____

Explanation of Permit Request (attach documents if needed):

Mountain Valley Pipeline, LLC ("Mountain Valley") is proposing to construct and operate the MVP Southgate Project ("Project"). The Project will be located in Pittsylvania County, Virginia and Rockingham and Alamance counties, North Carolina. Mountain Valley proposes to construct approximately 73 miles of 24- and 16-inch diameter natural gas pipeline. In addition to the pipeline, Mountain Valley proposes to construct and operate a new compressor station (Lambert Compressor Station) near the beginning of the pipeline at milepost 0.0.
The proposed Project involves the installation of new emission units and will be considered a minor source with respect to New Source Review (NSR) permitting requirements at 9 VAC 5-80-1100 and Title V major source permitting requirements at 9 VAC-5-80-50.
See Application Narrative for Additional Details.

GENERAL INFORMATION (CONTINUED)

For Portable Plants:

Is this facility designed to be portable? ☐ Yes ☒ No

- If yes, is this facility already permitted as a portable plant? ☐ Yes ☐ No Permit Date: _____

If not permitted, is this an application to be permitted as a portable plant? ☐ Yes ☐ No

If permitted as a portable facility, is this a notification of relocation? ☐ Yes ☐ No

- Describe the new location or address (include a site map): _____

- Will the portable facility be co-located with another source? ☐ Yes ☐ No Reg. No. _____
- Will the portable facility be modified or reconstructed as a result of the relocation? ☐ Yes ☐ No
- Will there be any new emissions other than those associated with the relocation? ☐ Yes ☐ No
- Is the facility suitable for the area to which it will be located? (attach documentation) ☐ Yes ☐ No

Describe the products manufactured and/or services performed at this facility:

The facility will serve as a natural gas compression and transmission station along the proposed 73-mile pipeline. This pipeline will receive natural gas from the existing Mountain Valley Pipeline near Chatham, VA and deliver or receive natural gas to the East Tennessee Natural Gas, LLC Mainline near Eden, NC.

List the Standard Industrial Classification (SIC) Code(s) for the facility:

4	9	2	2																

List the North American Industry Classification System (NAICS) Code(s) for the facility:

4	**8**	**6**	**2**	**1**	**0**																		

List all the facilities in Virginia under common ownership or control by the owner of this facility:

Milestones: This section is to be completed if the permit application includes a new emissions unit or modification to existing operations.

Milestones*:	Starting Date:	Estimated Completion Date:
New Equipment Installation	Q1 2020	Q4 2020
Modification of Existing Process or Equipment		
Start-up Dates		Q4 2020

*For new or modified installations to be constructed in phased schedule, give construction/installation starting and completion date for each phase.

FUEL BURNING EQUIPMENT: (Boilers, Turbines, Kilns, and Other External Combustion Units)

Company Name: Mountain Valley Pipeline, LLC	**Date:** 11/6/18	**Registration Number:**

Unit Ref. No.	Equipment Manufacturer, Type, and Model Number	Date of Manuf.	Date of Const.	Max. Rated Input Heat Capacity For Each Fuel (Million Btu/hr)	Type of Fuel	Type of Equip. (use Code A)	Usage (use Code B)	Requested Throughput* (hrs/yr OR fuel/yr)	Federal Regulations that Apply
CT-01	Solar, Mars 100		Q1-2020	140.85	Natural Gas	19	8	8760 hrs/year	NSPS Subpart KKKK, NSPS Subpart OOOOa 40 CFR Part 98
CT-02	Solar, Taurus 70		Q1-2020	93.04	Natural Gas	19	8	8760 hrs/year	NSPS Subpart KKKK, NSPS Subpart OOOOa 40 CFR Part 98
MT-01	Capstone Microturbine, C200		Q1-2020	2.28	Natural Gas	19	6	8760 hrs/year	40 CFR Part 98
MT-02	Capstone Microturbine, C200		Q1-2020	2.28	Natural Gas	19	6	8760 hrs/year	40 CFR Part 98
MT-03	Capstone Microturbine, C200		Q1-2020	2.28	Natural Gas	19	6	8760 hrs/year	40 CFR Part 98
MT-04	Capstone Microturbine, C200		Q1-2020	2.28	Natural Gas	19	6	8760 hrs/year	40 CFR Part 98
MT-05	Capstone Microturbine, C200		Q1-2020	2.28	Natural Gas	19	6	8760 hrs/year	40 CFR Part 98
HT-01	Gas Heater, TBD		Q1-2020	0.77	Natural Gas	12	4	8760 hrs/year	40 CFR Part 98

[X] Estimated Emission Calculations Attached (include references of emission factors) and/or Stack Test Results if Available

Code A – Equipment

BOILER TYPE:
1. Pulverized Coal - Wet Bottom
2. Pulverized Coal - Dry Bottom
3. Pulverized Coal - Cyclone Furnace
4. Circulating Fluidized Bed
5. Spreader Stoke
6. Chain or Travelling Grate Stoker
7. Underfeed Stoker
8. Hand Fired Coal
9. Oil, Tangentially Fired
10. Oil, Horizontally Fired (except rotary cup)
11. Gas, Tangentially Fired
12. Gas, Horizontally Fired
13. Wood with Flyash Reinjection
14. Wood without Flyash Reinjection
15. Other (specify) _____

OTHER COMBUSTION UNITS:
16. Oven / Kiln
17. Rotary Kiln
18. Process Furnace
19. Other (specify):Turbine_____

Code B - Usage

1. Steam Production
2. Drying / Curing
3. Space Heating
4. Process Heat
5. Food Processing
6. Electrical Generation
7. Mechanical Work
8. Other (specify) : Gas Compression

***Pick only one option for a requested throughput.**

NOTE: Dryers, kilns, and furnaces also have to fill out Page 13.

VOLATILE ORGANIC COMPOUND (VOC)/PETROLEUM LIQUID STORAGE TANKS:

Company Name: Mountain Valley Pipeline, LLC	**Date:** 11/6/18	**Registration Number:**

Unit Ref. No.	Tank Type (use Code H)	Source of Tank Contents (use Code I)	Date of Manuf.	Date of Const.	Material Stored - Name and CAS # (include Reid Vapor Pressure for Gasoline)	Max. True Vapor Pressure (psia)	Density* (lbs/gal)	Max. Average Storage Temp. (°F)	Tank Diameter (feet)	Tank Capacity (gal)	Requested Throughput (gal/yr)	Federal Regulations that Apply
TK-01	1a	5		Q1-2020	Condensate Liquids	10.6	Varies	Ambient	10	10,000	126,000	None
TK-02	1a	5		Q1-2020	Condensate Liquids	10.6	Varies	Ambient	10	10,000	126,000	None

[X] Estimated Emission Calculations Attached (include TANKS Program printouts)

Code H – Tank Type		**Code I – Source of Tank Contents**
1. Fixed Roof a. Vertical Tank b. Horizontal Tank 2. Floating Roof a. Internal (welded deck) b. Internal (bolted deck) – Specify Panel or Sheet c. External (welded deck) d. External (riveted deck)	3. Variable Vapor Space 4. Pressure Tank (over 15 psig) 5. Underground Splash Loading 6. Underground Submerged Loading 7. Underground Submerged Loading, Balanced 8. Other:_____	1. Pipeline 2. Rail Car 3. Tank Truck 4. Ship or Barge 5. Process

*** Specify the ASTM temperature standard at which the density was measured.**

VOLATILE ORGANIC COMPOUND (VOC)/PETROLEUM LIQUID STORAGE TANKS (CONTINUED):

Company Name: Mountain Valley Pipeline, LLC	**Date:** 11/6/18	**Registration Number:**

Unit Ref. No.	Tank Color		Fixed Roof Only					Floating Roof Only				
	Shell	Roof	Internal Tank Height or Length (feet)	Max. Hourly Filling (gallons)	External Fixed Roof			Seal Type (use Code J)	Max. Hourly Withdrawal (gallons)	Internal Floating Roof		
					Type of Roof (cone or dome)	Cone height (ft) and slope (ft/ft)	Dome height (ft) and radius (ft)			Self Supporting?	If no,	
											No. of Columns	Column Diameter (ft)
TK-01	Light Gray	Light Gray	15.5									
TK-02	Light Gray	Light Gray	15.5									

Code J – Seal Type (Pontoon External Only)	**(Double Deck External Only)**	**(Internal Only)**
1. Mechanical Shoe a. Primary only b. Shoe mounted secondary c. Rim mounted secondary 2. Liquid Mounted a. Primary only b. Weather shield secondary c. Rim mounted secondary 3. Vapor Mounted a. Primary only b. Weather shield secondary c. Rim mounted secondary	4. Mechanical Shoe a. Primary only b. Shoe mounted secondary c. Rim mounted secondary 5. Liquid Mounted a. Primary only b. Weather shield secondary c. Rim mounted secondary 6. Vapor Mounted a. Primary only b. Weather shield secondary c. Rim mounted secondary	7. Mechanical Shoe a. Primary only b. Shoe mounted secondary c. Rim mounted secondary 8. Liquid Mounted a. Primary only b. Rim mounted secondary 9. Vapor Mounted a. Primary only b. Rim mounted secondary

LOADING RACKS AND OIL-WATER SEPARATORS:

Company Name: Mountain Valley Pipeline, LLC	**Date:** 11/6/18	**Registration Number:**

Unit Ref. No.	Vent/ Stack No.	Vent/Stack or Exhaust Data						Fuel(s) Data				
		Vent/Stack Config. (use Code O)	Vent/Stack Height (feet)	Exit Diameter (feet)	Exit Gas Velocity (ft/sec)	Exit Gas Flow Rate (acfm)	Exit Gas Temp. (°F)	Type of Fuel	Heating Value* (Btu/scf)	Max. Rated Burned/hr (specify units)	Max. Sulfur %	Max. Ash %
CT-01	CT-01	5	50.0	7.0	84.7	195,588	893	Natural Gas	1,102	140.85 mmBtu	2.0 grains/ 100 scf	0
CT-02	CT-02	5	50.0	5.0	109.3	128,767	920	Natural Gas	1,102	93.04 mmBtu	2.0 grains/ 100 scf	0
MT-01	MT-01	5	12.75	1.0	105.6	4,975	535	Natural Gas	1,102	2.28 mmBtu	2.0 grains/ 100 scf	0
MT-02	MT-02	5	12.75	1.0	105.6	4,975	535	Natural Gas	1,102	2.28 mmBtu	2.0 grains/ 100 scf	0
MT-03	MT-03	5	12.75	1.0	105.6	4,975	535	Natural Gas	1,102	2.28 mmBtu	2.0 grains/ 100 scf	0
MT-04	MT-04	5	12.75	1.0	105.6	4,975	535	Natural Gas	1,102	2.28 mmBtu	2.0 grains/ 100 scf	0
MT-05	MT-05	5	12.75	1.0	105.6	4,975	535	Natural Gas	1,102	2.28 mmBtu	2.0 grains/ 100 scf	0
HT-01	HT-01	6	14.8	0.67	49.0	330	460	Natural Gas	1,102	0.77 mmBtu	2.0 grains/ 100 scf	0

Code O – Vent/Stack Configuration

1. Stack discharging downward, or nearly download
2. Equivalent stack representing a combination of multiple actual stacks
3. Gooseneck stack
4. Stack discharging in a horizontal direction
5. Stack with an unobstructed opening discharge in a vertical direction
6. Vertical stack with a weather cap or similar obstruction in exhaust system

*** Specify units for each heating value in Btus per unit of fuel.**

PROPOSED PERMIT LIMITS FOR CRITERIA POLLUTANTS:

Company Name: Mountain Valley Pipeline, LLC	Date: 11/6/18	Registration Number:

Unit Ref. No.	Proposed Permit Limits for Criteria Pollutants															
	PM [a] (Particulate Matter)		PM-10 [a,b] (10 µM or smaller particulate matter)		PM 2.5 [a,b] (2.5 µM or smaller particulate matter)		SO_2 (Sulfur Dioxide)		NO_X (Nitrogen Oxides)		CO (Carbon Monoxide)		VOC [a] (Volatile Organic Compounds)		Pb (Lead)	
	lbs/hr	tons/yr	lbs/hr	tons/yr	lbs/hr	tons/yr	lbs/hr	tons/yr	lbs/hr	tons/yr	lbs/hr	tons/yr	lbs/hr	tons/yr	lbs/hr	tons/yr
CT-01[1]	1.37	5.98	1.37	5.98	1.37	5.98	0.71	3.10	4.42	19.58	7.47	36.26	0.86	3.99	-	-
CT-02[1]	0.92	4.02	0.92	4.02	0.92	4.02	0.48	2.09	2.97	13.17	3.01	17.27	0.35	2.20	-	-
MT-01	0.02	0.066	0.02	0.066	0.02	0.066	0.008	0.034	0.08	0.36	0.22	0.96	0.02	0.088	-	-
MT-02	0.02	0.066	0.02	0.066	0.02	0.066	0.008	0.034	0.08	0.36	0.22	0.96	0.02	0.088	-	-
MT-03	0.02	0.066	0.02	0.066	0.02	0.066	0.008	0.034	0.08	0.36	0.22	0.96	0.02	0.088	-	-
MT-04	0.02	0.066	0.02	0.066	0.02	0.066	0.008	0.034	0.08	0.36	0.22	0.96	0.02	0.088	-	-
MT-05	0.02	0.066	0.02	0.066	0.02	0.066	0.008	0.034	0.08	0.36	0.22	0.96	0.02	0.088	-	-
HT-01	0.005	0.023	0.005	0.023	0.005	0.023	0.004	0.017	0.070	0.31	0.06	0.26	0.004	0.017	-	-
TK-01	-	-	-	-	-	-	-	-	-	-	-	-	0.049	0.21	-	-
TK-02	-	-	-	-	-	-	-	-	-	-	-	-	0.049	0.21	-	-
TOTAL:	NA	10.35	NA	10.35	NA	10.35	NA	5.38	NA	34.86	NA	58.58	NA	8.44	-	-

[X] Estimated Emission Calculations Attached (totals and per Unit Ref. No.)

[a] PM, PM-10, PM 2.5, and VOC should also be split up by component and reported under the Proposed Permit Limits for Toxic Pollutants/HAPs.

[b] PM-10 and PM 2.5 includes filterable and condensable.

Notes: [1] The lb/hr emissions presented are for steady state operation of the turbine. Startup, Shutdown, and extremely low temperature operation emissions are included in Appendix B. Emissions in tons per year include all operating modes.

[2] Total emissions include those from fugitives and natural gas blowdowns as provided in Appendix B.

PROPOSED PERMIT LIMITS FOR TOXIC POLLUTANTS/HAPS:

Company Name: Mountain Valley Pipeline, LLC	Date: 11/6/2018	Registration Number:

Unit Ref. No.	Proposed Permit Limits for Toxic/HAP Pollutants*															
	HAP Name: Formaldehyde CAS #: 50-00-0		HAP Name: CAS #:		HAP Name: CAS #:		HAP Name: CAS #:		HAP Name: CAS #:		HAP Name: CAS #:		HAP Name: CAS #:		HAP Name: CAS #:	
	lbs/hr	tons/yr	lbs/hr	tons/yr	lbs/hr	tons/yr	lbs/hr	tons/yr	lbs/hr	tons/yr	lbs/hr	tons/yr	lbs/hr	tons/yr	lbs/hr	tons/yr
CT-01	4.64	1.95														
CT-02	4.82	1.37														
MT-01	0.007	0.03														
MT-02	0.007	0.03														
MT-03	0.007	0.03														
MT-04	0.007	0.03														
MT-05	0.007	0.03														
HT-01	0.000057	0.00025														
TK-01	-	-														
TK-02	-	-														
TOTAL:	9.5	3.47														

[X] Estimated Emission Calculations Attached (totals and per Unit Ref. No.)

*** Specify the name of the toxic pollutant/HAP for each Unit Ref. No. along with the respective CAS Number**. Toxic Pollutant means a pollutant on the designated list in the Form 7 Instructions document. Particulate matter and volatile organic compounds are not toxic pollutants as generic classes of substances, but individual substances within these classes may be toxic pollutants because their toxic properties or because a TLV (tm) has been established.

PROPOSED PERMIT LIMITS FOR OTHER REGULATED POLLUTANTS:

Company Name: Mountain Valley Pipeline, LLC	**Date:** 11/6/2018	**Registration Number:**

Unit Ref. No.	**Proposed Permit Limits for Other Regulated Pollutants***															
	Pollutant Name:		**Pollutant Name:**		**Pollutant Name:**		**Pollutant Name:**		**Pollutant Name:**		**Pollutant Name:**		**Pollutant Name:**		**Pollutant Name:**	
	lbs/hr	**tons/yr**	**lbs/hr**	**tons/yr**	**lbs/hr**	**tons/yr**	**lbs/hr**	**tons/yr**	**lbs/hr**	**tons/yr**	**lbs/hr**	**tons/yr**	**lbs/hr**	**tons/yr**	**lbs/hr**	**tons/yr**
No additional proposed permit limits																
TOTAL:																

☐ Estimated Emission Calculations Attached (totals and per Unit Ref. No.)

*** Other Regulated Pollutant** include Fluorides, Sulfuric Acid Mist, Hydrogen Sulfide (H_2S), Total Reduced Sulfur (including H_2S), Reduced Sulfur Compounds (including H_2S), Municipal Waste Combustor Organics (measured as total tetra-through octa-chlorinated dibenzo-p-dioxins and dibenzofurans), Municipal Waste Combustor Metals (measured as particulate matter), Municipal Waste Combustor Acid Gases (measured as the sum of SO_2 and HCl), and Municipal Solid Waste Landfill Emissions (measured as nonmethane organic compounds).

OPERATING PERIODS:

Company Name: Mountain Valley Pipeline, LLC	**Date:** 11/6/2018	**Registration Number:**

Unit Ref. No.	Percent Annual Use/Throughput by Season				Normal Process/Equipment Operating Schedule			Maximum Process/Equipment Operating Schedule		
	December / February	March / May	June / August	September / November	Hours per Day	Days per Week	Weeks per Year	Hours per Day	Days per Week	Weeks per Year
CT-01	25	25	25	25	24	7	52	24	7	52
CT-02	25	25	25	25	24	7	52	24	7	52
MT-01	25	25	25	25	24	7	52	24	7	52
MT-02	25	25	25	25	24	7	52	24	7	52
MT-03	25	25	25	25	24	7	52	24	7	52
MT-04	25	25	25	25	24	7	52	24	7	52
MT-05	25	25	25	25	24	7	52	24	7	52
HT-01	25	25	25	25	24	7	52	24	7	52
TK-01	25	25	25	25	24	7	52	24	7	52
TK-02	25	25	25	25	24	7	52	24	7	52

Maximum Facility Operating Schedule		
Hours per Day	**Days per Week**	**Weeks per Year**
24	**7**	**52**

Attachment A
Local Governing Body Certification Form

MVP SOUTHGATE

625 Liberty Avenue, Suite 1700 | Pittsburgh, PA 15222
833-MV-SOUTH | mail@mvpsouthgate.com
www.mvpsouthgate.com

Ms. Karen Hayes
Deputy Director
Community Development
Pittsylvania County
P.O. Drawer D
Chatham, Virginia 24531

November 6, 2018

Re: MVP Southgate Project – Lambert Compressor Station
VADEQ Local Certification Form

Dear Ms. Hayes,

Mountain Valley Pipeline, LLC ("Mountain Valley") is seeking a Certificate of Public Convenience and Necessity from the Federal Energy Regulatory Commission pursuant to Section 7(c) of the Natural Gas Act to construct and operate the MVP Southgate Project ("Project"). The Project will be located in Pittsylvania County, Virginia and Rockingham and Alamance, North Carolina. Mountain Valley proposes to construct approximately a 0.4-mile-long 24-inch-diameter pipeline (H-605) and 73 miles of 24- and 16-inch-diameter natural gas pipeline (H-650) to provide timely, cost-effective access to new natural gas supplies to meet the growing needs of natural gas users in the southeastern United States.

In addition to the pipeline, Mountain Valley proposes to construct and operate a new compressor station (Lambert Compressor Station) near the beginning of the pipeline at milepost 0.0. As part of the Southgate Project and in order to boost pressures on Mountain Valley's transmission pipeline system, Mountain Valley is proposing to construct and operate one Solar Taurus 70 compressor turbine (11,792 hp) and one Solar Mars 100 compressor turbine (17,123 hp) at the Lambert Compressor Station.

Mountain Valley is currently coordinating with the Virginia Department of Environmental Quality (VADEQ) to obtain a minor New Source Review (NSR) air permit in order to construct and operate the new compressor station. The VADEQ air permit application requires a Pittsylvania County representative certify that the facility location and operation are consistent with applicable local ordinances. Attached is the VADEQ Local Governing Body Certification form for your review and signature. In addition to the certification form, enclosed is a site map and proposed plot plan.

Upon your approval, please provide a signed copy of the certification form to: Mr. Paul Jenkins, Air Permitting Manager, VADEQ Blue Ridge Regional Office, 3019 Peters Creek Road, Roanoke, Virginia 24019. An electronic copy for Mountain Valley's records can be sent to my email address below.

If you have any questions or comments regarding the attached certification form, or need additional information for the Project, please do not hesitate to contact me at 412-400-6887 or via email at KrRyan@eqt.com.

Regards,

Kristin Ryan
Engineer III

Enclosures

LOCAL GOVERNING BODY CERTIFICATION FORM

Facility Name: Lambert Compressor Station	Registration Number:
Applicant's Name: Mountain Valley Pipeline, LLC	Name of Contact Person at the site: Kristin Ryan
Applicant's Mailing address: 2200 Energy Drive, Canonsburg, PA 15317	Contact Person Telephone Number: 412-400-6887
Facility location (also attach map): Chatham, Pittsylvania County, Virginia (See Figures 2-1 and 2-2 of Application)	
Facility type, and list of activities to be conducted: Natural Gas Compressor Station for MVP Southgate pipeline.	

The applicant is in the process of completing an application for an air pollution control permit from the Virginia Department of Environmental Quality. In accordance with § 10.1-1321.1. Title 10.1, Code of Virginia (1950), as amended, before such a permit application can be considered complete, the applicant must obtain a certification from the governing body of the county, city or town in which the facility is to be located that the location and operation of the facility are consistent with all applicable ordinances adopted pursuant to Chapter 22 (§§ 15.2-2200 et seq.) of Title 15.2. The undersigned requests that an authorized representative of the local governing body sign the certification below.

Applicant's signature:	Date: 10/31/2018

The undersigned local government representative certifies to the consistency of the proposed location and operation of the facility described above with all applicable local ordinances adopted pursuant to Chapter 22 (§§15.2-2200 et seq.) of Title 15.2. of the Code of Virginia (1950) as amended, as follows:

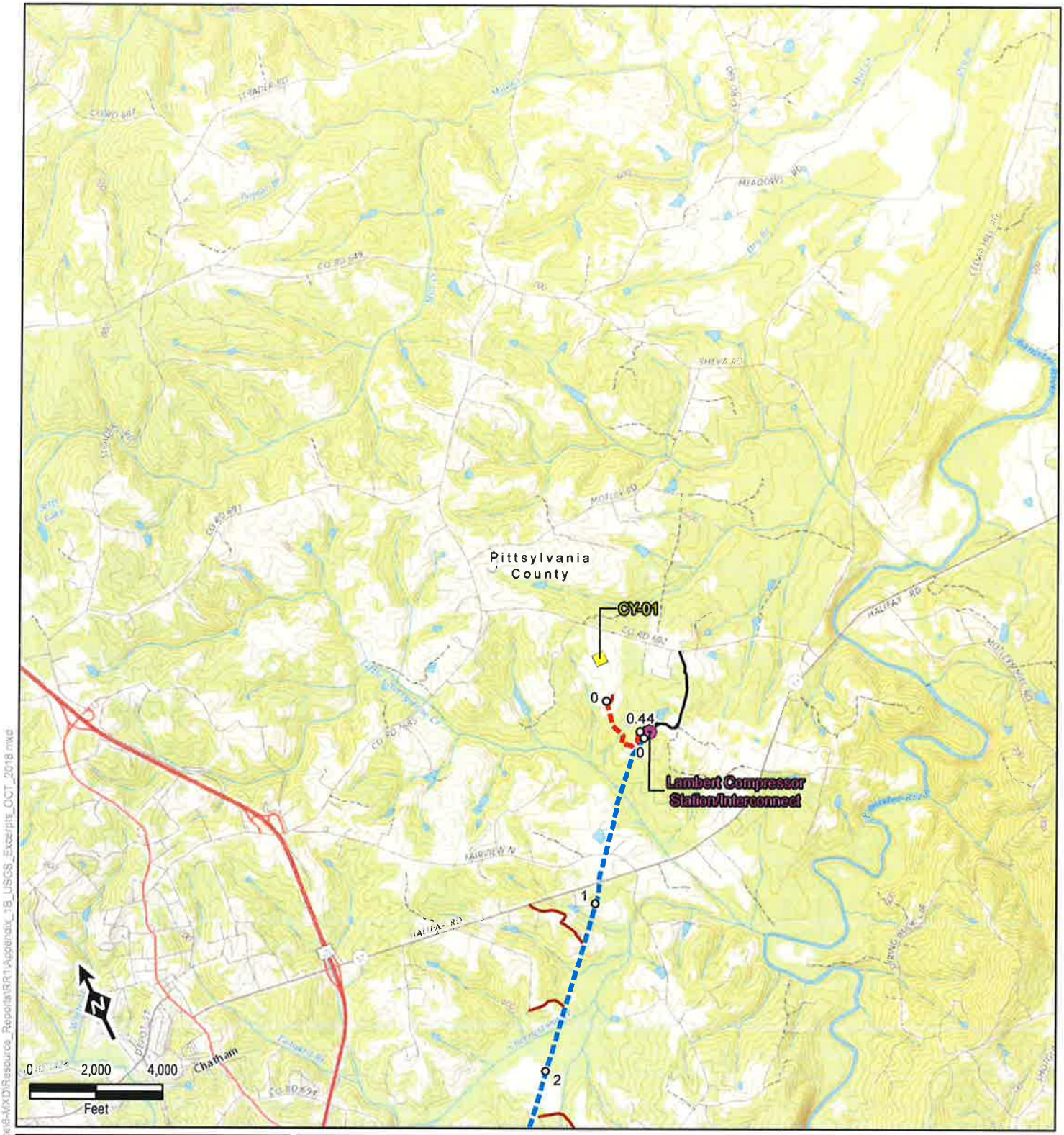
(**Check one block**)

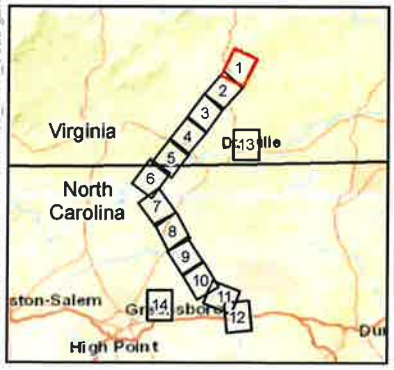
☐ The proposed facility is **fully consistent** with all applicable local ordinances.

☐ The proposed facility is **inconsistent** with applicable local ordinances; see attached information.

Signature of authorized local government representative:	Date:
Type or print name:	Title:
County, city or town:	

[THE LOCAL GOVERNMENT REPRESENTATIVE SHOULD FORWARD THE SIGNED CERTIFICATION TO THE APPROPRIATE DEQ REGIONAL OFFICE AND SEND A COPY TO THE APPLICANT.]





Legend

- Mileposts
- Compressor Station
- Contract Yard
- Meter Station
- Valve Site
- Permanent Access Road
- Temporary Access Road
- H-605 Pipeline
- H-650 Pipeline
- County Boundary
- State Boundary

Data Sources: ESRI, USGS, TRC, EQT

1 inch = 4,000 feet
When Printed 8.5x11

Mountain Valley PIPELINE, LLC

Appendix 1-B

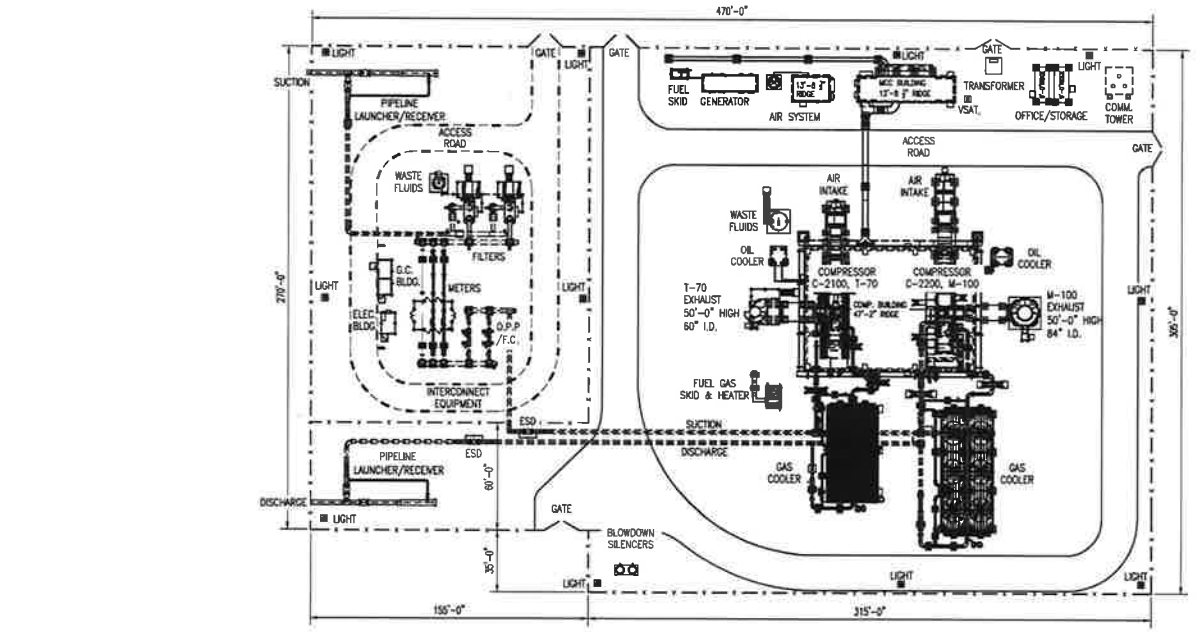
USGS Quadrangle Excerpts

Sheet 1 of 14

TRC

600 Willowbrook Ln
West Chester, PA 19382
October 2018

S:\1_PROJECTS\NEXTERA-302423_MVP_Southgate\8-MXD\Resource_Reports\RR1\Appendix_1B_USGS_Excerpts_OCT_2018.mxd



REFERENCE DRAWINGS		NO.	DATE	REVISION	BY	CHK	APPD	NO.	DATE	REVISION	BY	CHK	APPD
DRAWING NUMBER	DRAWING TITLE	P	8-14-2018	PRELIMINARY									
		P	10-08-2018	PRELIMINARY									
		P	10-10-2018	PRELIMINARY									

TO THE BEST OF MY KNOWLEDGE, ALL COMPONENTS OF THIS DRAWING ARE DESIGNED IN ACCORDANCE WITH APPLICABLE GUIDELINES AND SPECIFICATIONS

DOUG MACE — MECHANICAL DESIGN ENGINEER — 8-14-2018 DATE

/ — ELECTRICAL DESIGN ENGINEER — / DATE

NOTE: ANY CHANGES TO THE DESIGN SHOWN ON THIS DRAWING MUST BE APPROVED BY THE DESIGN ENGINEER.

Mountain Valley Pipeline, LLC

PROJECT ID: ######

DRAWING SCALE: 1/32" = 1'-0"

DRAWING TITLE: LAMBERT COMPRESSOR STATION MECHANICAL PIPING PLOT PLAN

FACILITY	STATE	IDENTIFICATION	SERIES	SHEET	REVISION
C	V	LAM	1100	01	P

Plotted by: Mark.Dang on October 10, 2018 - 2:43 PM

File Path: C:\Working\PROJECTS\SOUTHGATE\PLOT PLAN\Lambert CS 10-10-2018 DEVLDWG

Attachment B
Copy of Application Fee

625 Liberty Avenue, Suite 1700 | Pittsburgh, PA 15222
833-MV-SOUTH | mail@mvpsouthgate.com
www.mvpsouthgate.com

Via certified mail/return receipt requested

Virginia Department of Environmental Quality
Receipts Control
P.O. Box 1104
Richmond, Virginia 23218

December 11, 2018

Re: MVP Southgate Project – Lambert Compressor Station
Air Permit Application Fee
Air Permit Registration No. 21652

Dear Receipts Control,

Mountain Valley Pipeline, LLC ("Mountain Valley") filed the Article 6 Air Permit Application for the new Lambert Compressor Station on November 8, 2018. Enclosed is a copy of the Air Permit Application Form 7 that Mountain Valley is submitting to the Virginia Department of Environmental Quality (VADEQ) Blue Ridge Regional Office. Also enclosed is a check made payable to the "Treasurer of Virginia" for $3,000 in accordance with the permit fee requirements of a minor New Source Review (NSR) permit.

If you have any questions or comments regarding the information provided in the attached form, please do not to hesitate to contact me 713-204-3729 or via email at alex.miller@nexteraenergy.com or Christina Akly (561-691-7065; christina.akly@nee.com).

Regards,

Alex Miller
MVP Southgate Environmental Permitting Lead

Enclosures: Copy of VADEQ Form 7
Permit Application Fee

CC: Kristin Ryan, EQM Midstream Partners, LP
Darin Ometz, TRC

VADEQ Form 7

MVP SOUTHGATE

VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY – 2018 AIR PERMIT APPLICATION FEES

Air permit applications are subject to a fee. The fee does not apply to administrative amendments or true minor sources. Applications will be considered incomplete if the proper fee is not paid and will not be processed until full payment is received. Air permit application fees are not refundable.

Fees are adjusted January 1 of each calendar year. THIS FORM IS VALID JANUARY 1, 2018 TO DECEMBER 31, 2018.

Send this form and a check (or money order) payable to "Treasurer of Virginia" to:

Department of Environmental Quality
Receipts Control
P.O. Box 1104
Richmond, VA 23218

Send a copy of this form with the permit application to:
The DEQ Regional Office

Please retain a copy for your records. Any questions should be directed to the DEQ regional office to which the application will be submitted. **Unsure of your fee? Contact the Regional Air Permit Manager.**

COMPANY NAME:	**Mountain Valley Pipeline, LLC**	**FIN:**	
COMPANY REPRESENTATIVE:	**Clifford Baker**	**REG. NO.**	**21652**
MAILING ADDRESS:	**625 Liberty Avenue, Suite 1700 Pittsburgh, PA 15222**		
BUSINESS PHONE:	**412-395-3654**	**FAX:**	
FACILITY NAME:	**Lambert Compressor Station**		
PHYSICAL LOCATION:	**Chatham, VA**		

PERMIT ACTIVITY	APPLICATION FEE AMOUNT	CHECK ONE
Sources subject to Title V permitting requirements:		
• Major NSR permit (Articles 7, 8, 9)	$63,000	
• Major NSR permit amendment (Articles 7, 8, 9)*	$10,000	
• State major permit (Article 6)	$25,000	
• Title V permit (Articles 1, 3)	$35,000	
• Title V permit renewal (Articles 1, 3)	$15,000	
• Title V permit modification (Articles 1, 3)	$4,000	
• Minor NSR permit (Article 6)	$5,000	
• Minor NSR amendment (Article 6)*	$2,500	
• State operating permit (Article 5)	$10,000	
• State operating permit amendment (Article 5)*	$4,000	
Sources subject to Synthetic Minor permitting requirements:		
• Minor NSR permit (Article 6)	$3,000	X
• Minor NSR amendment (Article 6)*	$1,000	
• State operating permit (Article 5)	$5,000	
• State operating permit amendment (Article 5)*	$2,500	
***FEES DO NOT APPLY TO ADMINISTRATIVE AMENDMENTS AIR PERMIT APPLICATION FEES ARE NOT REFUNDABLE**		

DEQ OFFICE TO WHICH PERMIT APPLICATION WILL BE SUBMITTED (check one)

☐ **SWRO/Abingdon**	☐ **NRO/Woodbridge**	☐ **PRO/Richmond**
☐ **VRO/Harrisonburg**	X **BRRO/Roanoke**	☐ **TRO/Virginia Beach**

FOR DEQ USE ONLY
Date: _____
DC #: _____
Reg. No.: _____

Application Fee Check

MVP SOUTHGATE

TRC

21 Griffin Road North
Windsor, CT 06095

1154903

Citizens Bank
CONNECTICUT
51-7011/2111

CHECK DATE
December 10, 2018

PAY Three Thousand and 00/100 Dollars

AMOUNT
$ 3,000.00

PAY TO THE ORDER OF
TO Treasurer Of Virginia
Department of Environmental Quality
Receipts Control
P.O. Box 1104
Richmond, VA 23218

By _____ MP
VOID AFTER 90 DAYS AUTHORIZED SIGNATURE

Security Check features included. Details on back.

⑈1154903⑈ ⑆211170114⑆ 223203710⑆4⑈

APPENDIX B
EMISSION CALCULATIONS AND VENDOR DATA

MVP Southgate Project
Lambert Compressor Station

Table B-1. Total Facility Potential Emissions Summary

		Criteria Pollutants					Greenhouse Gases (GHGs)				HAPs
Proposed Sources	**Unit Reference No.**	**NOx**	**CO**	**VOC**	**SO_2**	**$PM/PM_{10}/PM_{2.5}$**	**CO_2**	**CH_4**	**N_2O**	**CO_2e**	**Total HAPs**
		(tpy)	**(tpy)**	**(tpy)**	**(tpy)**	**(tpy)**	**(tpy)**	**(tpy)**	**(tpy)**	**(tpy)**	**(tpy)**
Solar Mars 100	CT-01	19.58	36.26	3.99	3.10	5.97	69,909	1.32	0.13	69,982	2.55
Solar Taurus 70	CT-02	13.17	17.27	2.20	2.09	4.02	47,014	0.89	0.09	47,063	1.62
Capstone C200 Microturbines (5 Units)	MT-01 to MT-05	1.81	4.79	0.44	0.17	0.33	5,841.0	0.11	0.011	5,847	0.21
Fuel Gas Heater	HT-01	0.31	0.26	0.02	0.018	0.02	394.5	0.01	0.001	395	0.01
Produced Fluids Tanks	TK-01, TK-02	-	-	0.43	-	-	-	-	-	4.2	0.004
Blowdowns (uncontrolled)		-	-	0.61	-	-	0.29	56.43	-	1,411	0.06
Station Fugitives		-	-	0.75	-	-	0.36	69.59	-	1,740	0.07
Totals (tons/year)		**34.86**	**58.58**	**8.44**	**5.38**	**10.35**	**123,160**	**128.34**	**0.23**	**126,442**	**4.52**

MVP Southgate Project
Lambert Compressor Station

Table B-2. Solar Mars 100 Potential to Emit

Operations	Normal Ambient Temperatures (>0 degrees F)		Startup[1,2]		Shutdown[1,2]		Potential to Emit Including Startup/Shutdown during Normal Temperature Operation	Low Ambient Temperatures (<0 degrees F)		Maximum Annual Potential to Emit (Includes Startup, Shutdown, and Low Temperature Operation)
Maximum Annual Combined Event Frequency	8,760 hrs/yr		52 Events/Yr (10 Minute Event Duration)		52 Events/Year (10 Minute Event Duration)		8,742.7 hrs/yr Normal 17.3 hrs/yr SU/SD	24 hrs/yr		8,718.7 hrs/yr Normal 17.3 hrs/yr SU/SD 24 hrs/yr Low Temp.
Pollutant	Hourly (lb/hr)	Maximum Annual (tpy)	Event (lb/event)	Maximum Annual (tpy)	Event (lb/event)	Maximum Annual (tpy)	Maximum Annual (tpy)	Hourly (lb/hr)	Maximum Annual (tpy)	**Maximum Annual (tpy)**
NO_X	4.42	19.36	1.00	0.03	1.00	0.03	19.37	21.28	0.26	**19.58**
CO	7.47	32.72	46.00	1.20	82.00	2.13	35.98	30.84	0.37	**36.26**
SO_2	0.71	3.11	0.02	0.00045	0.03	0.0008	3.10	0.73	0.01	**3.10**
$PM/PM_{10}/PM_{2.5}$	1.37	5.98	0.03	0.00086	0.06	0.0015	5.97	1.41	0.02	**5.97**
TOC (Total)	4.28	18.75	20.00	0.52	26.00	0.68	19.91	8.84	0.11	**19.96**
VOC (Total)	0.86	3.75	4.00	0.10	5.00	0.13	3.98	1.77	0.02	**3.99**
CO_2e	15,976	69,976	385.4	10.02	676.7	17.59	69,865	16,481	197.77	**69,982**
CO_2	15,960	69,903	385	10.01	676	17.58	69,793	16,464	197.57	**69,909**
N_2O	0.03	0.13	0.001	0.00002	0.001	0.000033	0.13	0.03	0.00	**0.13**
CH_4	0.30	1.32	0.01	0.00019	0.0127	0.00033	1.32	0.31	0.00	**1.32**

Notes:

(1) Start-up emissions of NOx, CO, VOC, and CO_2 based on Solar Turbines Incorporated PIL 170: Emission Estimates at Start-up, Shutdown, and Commissioning for SoLoNOx Combustion Products

(2) Emissions of SO_2, PM, N_2O, and CH_4 based on Solar estimated heat input during startup and shutdown events.

(3) NOx, CO and VOC emission factors used for "Normal Ambient Temperatures" conditions conservatively use the factors at 20°F and 100% load.

(4) The maximum annual potential to emit includes the combination of operating modes that results in the highest annual emissions total.

MVP Southgate Project
Lambert Compressor Station

Table B-3. Solar Mars 100 Specifications

Fuel	Natural Gas																				
Load (%)	50	50	50	50	50	50	50	75	75	75	75	75	75	75	100	100	100	100	100	100	100
Hp Output (Net)	8,562	8,562	8,300	7,959	7,521	6,986	6,393	12,842	12,842	12,450	11,939	11,281	10,479	9,589	17,124	17,124	16,600	15,919	15,042	13,973	12,786
Ambient Temperature (F)	below 0	0	20	40	60	80	100	below 0	0	20	40	60	80	100	below 0	0	20	40	60	80	100
% RH	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
Elevation ft	660	660	660	660	660	660	660	660	660	660	660	660	660	660	660	660	660	660	660	660	660
Fuel LHV (Btu/scf)	990.30	990.30	990.30	990.30	990.30	990.30	990.30	990.30	990.30	990.30	990.30	990.30	990.30	990.30	990.30	990.30	990.30	990.30	990.30	990.30	990.30
Heat Inpu LHV (MMBtu/hr) by volume	71.43	71.43	90.64	86.80	82.93	78.41	74.07	112.88	112.88	108.69	104.25	99.18	93.60	87.86	126.61	126.61	122.73	118.31	113.23	107.44	101.48
Heat Input HHV (MMBtu/hr) (=LHV*1.1125)	79.47	79.47	100.84	96.57	92.26	87.23	82.40	125.58	125.58	120.92	115.98	110.34	104.13	97.74	140.85	140.85	136.54	131.62	125.97	119.53	112.90
Exhaust lb/hr	291,039	291,039	297,636	282,271	267,925	251,219	234,805	346,742	346,742	333,011	318,192	301,449	283,285	264,650	358,089	358,089	349,342	338,653	325,256	309,605	291,080
Exhaust ACFM	137,830	137,830	171,718	166,278	161,599	155,290	148,483	196,727	196,727	190,991	184,857	177,567	169,886	162,347	202,402	202,402	199,463	195,588	190,478	184,076	176,181
Stack Height (ft)	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Stack Height (m)	15.24	15.24	15.24	15.24	15.24	15.24	15.24	15.24	15.24	15.24	15.24	15.24	15.24	15.24	15.24	15.24	15.24	15.24	15.24	15.24	15.24
Stack Equiv Diameter (ft)	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00
Stack Exhaust Velocity (m/s)	18.19	18.19	22.67	21.95	21.33	20.50	19.60	25.97	25.97	25.21	24.40	23.44	22.43	21.43	26.72	26.72	26.33	25.82	25.14	24.30	23.26
Exhaust Temperature (F)	651	651	893	920	951	981	1010	871	871	885	901	918	938	966	866	866	879	893	910	926	947
Exhaust Temperature (K)	617.0	617.0	751.5	766.5	783.7	800.4	816.5	739.3	739.3	747.0	755.9	765.4	776.5	792.0	736.5	736.5	743.7	751.5	760.9	769.8	781.5
NOx ppm@ 15% O_2	42	9	9	9	9	9	9	42	9	9	9	9	9	9	42	9	9	9	9	9	9
NOx lb/hr	11.947	2.560	3.260	3.110	2.960	2.780	2.600	18.947	4.060	3.910	3.740	3.550	3.330	3.090	21.280	4.560	**4.420**	4.250	4.050	3.820	3.560
NOx g/s	1.505	0.323	0.411	0.392	0.373	0.350	0.328	2.387	0.512	0.493	0.471	0.447	0.420	0.389	2.681	0.575	0.557	0.536	0.510	0.481	0.449
CO ppm@ 15% O_2	100	25	25	25	25	25	25	100	25	25	25	25	25	25	100	25	25	25	25	25	25
CO lb/hr	17.320	4.330	5.510	5.270	5.010	4.710	4.400	27.480	6.870	6.610	6.330	6.000	5.620	5.220	30.840	7.710	**7.470**	7.190	6.850	6.460	6.030
CO g/s	2.182	0.546	0.694	0.664	0.631	0.593	0.554	3.462	0.866	0.833	0.798	0.756	0.708	0.658	3.886	0.971	0.941	0.906	0.863	0.814	0.760
UHC ppm@ 15% O_2	50	25	25	25	25	25	25	50	25	25	25	25	25	25	50	25	25	25	25	25	25
UHC lb/hr	4.960	2.480	3.150	3.020	2.870	2.700	2.520	7.860	3.930	3.790	3.620	3.440	3.220	2.990	8.840	4.420	**4.280**	4.120	3.920	3.700	3.450
VOC ppm@ 15% O_2 (20% of UHC)	10	5	5	5	5	5	5	10	5	5	5	5	5	5	10	5	5	5	5	5	5
VOC lb/hr	0.992	0.496	0.630	0.604	0.574	0.540	0.504	1.572	0.786	0.758	0.724	0.688	0.644	0.598	1.768	0.884	**0.856**	0.824	0.784	0.740	0.690
sulfur gr/100 scf	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
SO2 lb/hr	0.413	0.413	0.524	0.502	0.480	0.453	0.428	0.653	0.653	0.629	0.603	0.574	0.541	0.508	0.732	0.732	**0.710**	0.684	0.655	0.621	0.587
SO2 g/s	0.052	0.052	0.066	0.063	0.060	0.057	0.054	0.082	0.082	0.079	0.076	0.072	0.068	0.064	0.092	0.092	0.089	0.086	0.083	0.078	0.074
Particulates lb/MMBtu	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
$PM_{10/2.5}$ lb/hr	0.79	0.79	1.01	0.97	0.92	0.87	0.82	1.26	1.26	1.21	1.16	1.10	1.04	0.98	1.41	1.41	**1.37**	1.32	1.26	1.20	1.13
$PM_{10/2.5}$ g/s	0.100	0.100	0.127	0.122	0.116	0.110	0.104	0.158	0.158	0.152	0.146	0.139	0.131	0.123	0.177	0.177	0.172	0.166	0.159	0.151	0.142
CO2 lb/mmBtu	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117
CO_2 lb/hr	9,289	9,289	11,787	11,287	10,784	10,196	9,632	14,679	14,679	14,134	13,557	12,897	12,172	11,425	16,464	16,464	**15,960**	15,385	14,724	13,971	13,196
CH_4 lb/mmBtu	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022
CH_4 lb/hr	0.1752	0.1752	0.2223	0.2129	0.2034	0.1923	0.1817	0.2769	0.2769	0.2666	0.2557	0.2433	0.2296	0.2155	0.3105	0.3105	**0.3010**	0.2902	0.2777	0.2635	0.2489
N_2O lb/mmBtu	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
N_2O lb/hr	0.0175	0.0175	0.0222	0.0213	0.0203	0.0192	0.0182	0.0277	0.0277	0.0267	0.0256	0.0243	0.0230	0.0215	0.0311	0.0311	**0.0301**	0.0290	0.0278	0.0264	0.0249
CO_2e lb/mmBtu	117.0	117.0	117.0	117.0	117.0	117.0	117.0	117.0	117.0	117.0	117.0	117.0	117.0	117.0	117.0	117.0	117.0	117.0	117.0	117.0	117.0
CO_2e lb/hr	9,298	9,298	11,799	11,299	10,795	10,207	9,642	14,694	14,694	14,149	13,571	12,911	12,184	11,437	16,481	16,481	**15,976**	15,401	14,740	13,986	13,210

Notes

1. Data provided by Solar for 100%, 75%, and 50% load cases: net output power, fuel flow (MMBtu/hr, LHV), exhaust flow (lb/hr), exhaust temperature, NO X/CO/UHC concentrations and lb/hr.
2. Below zero and low load operation uses 0ºF for operating parameters and uses concentrations from Solar PIL 167. Data for Particulate Matter based upon Solar PIL 171.
3. Greenhouse gases are calculated using emission factors from Part 98, Tables C -1 and C-2 and global warming potentials from Table A-1 (CO_2 = 1, CH_4 = 25, N_2O = 298).
4. VOC as 20% of UHC based on Solar PIL 168 for natural gas.

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Table B-4. Solar Taurus 70 Potential to Emit

Operations	Normal Ambient Temperatures (>0 degrees F)		Startup[1,2]		Shutdown[1,2]		Potential to Emit Including Startup/Shutdown during Normal Temperature Operation	Low Ambient Temperatures (<0 degrees F)		Maximum Annual Potential to Emit (Includes Startup, Shutdown, and Low Temperature Operation)
Maximum Annual Combined Event Frequency	8,760 hrs/yr		52 Events/Yr (10 Minute Event Duration)		52 Events/Year (10 Minute Event Duration)		8,742.7 hrs/yr Normal 13.3 hrs/yr SUSD	24 hrs/yr		8,742.7 hrs/yr Normal 13.3 hrs/yr SUSD 24 hrs/yr Low Temp.
Pollutant	Hourly (lb/hr)	Maximum Annual (tpy)	Event (lb/event)	Maximum Annual (tpy)	Event (lb/event)	Maximum Annual (tpy)	Maximum Annual (tpy)	Hourly (lb/hr)	Maximum Annual (tpy)	**Maximum Annual (tpy)**
NO_X	2.97	13.01	1.00	0.03	1.00	0.03	13.03	14.05	0.17	**13.17**
CO	3.01	13.18	88.00	2.29	62.00	1.61	17.06	20.40	0.24	**17.27**
SO_2	0.48	2.09	0.08	0.0021	0.08	0.0021	2.09	0.48	0.01	**2.09**
$PM/PM_{10}/PM_{2.5}$	0.92	4.02	0.15	0.0040	0.15	0.0040	4.02	0.93	0.01	**4.02**
TOC (Total)	1.73	7.58	88.00	2.29	40.00	1.04	10.89	5.83	0.07	**10.94**
VOC	0.35	1.52	18.0	0.47	8.00	0.21	2.19	1.17	0.01	**2.20**
CO_2e	10,745	47,061	382.8	9.95	474.8	12.35	46,990	10,886	130.64	**47,063**
CO_2	10,733	47,012	381.0	9.91	473	12.30	46,942	10,875	130.50	**47,014**
N_2O	0.02	0.09	0.003	0.0001	0.003	0.0001	0.09	0.02	0.0002	**0.09**
CH_4	0.20	0.89	0.03	0.0009	0.0337	0.0009	0.89	0.21	0.0025	**0.89**

Notes:

(1) Start-up emissions of NOx, CO, VOC, and CO_2 based on Solar Turbines Incorporated PIL 170: Emission Estimates at Start-up, Shutdown, and Commissioning for SoLoNOx Combustion Products

(2) Emissions of SO_2, PM, N_2O, and CH_4 based on Solar estimated heat input during startup and shutdown events.

(3) NOx, CO and VOC emission factors used for "Normal Ambient Temperatures" conditions conservatively use the factors at 20°F and 100% load.

(4) The maximum annual potential to emit includes the combination of operating modes that results in the highest annual emissions total.

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Table B-5. Solar Taurus 70 Specifications

Fuel	Natural Gas																				
Load (%)	50	50	50	50	50	50	50	75	75	75	75	75	75	75	100	100	100	100	100	100	100
Hp Output (Net)	5,896	5,896	5,791	5,679	5,251	4,765	4,213	8,844	8,844	8,686	8,519	7,876	7,148	6,319	11,792	11,792	11,582	11,358	10,502	9,530	8,425
Ambient Temperature (F)	below 0	0	20	40	60	80	100	below 0	0	20	40	60	80	100	below 0	0	20	40	60	80	100
% RH	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
Elevation ft	660	660	660	660	660	660	660	660	660	660	660	660	660	660	660	660	660	660	660	660	660
Fuel LHV (Btu/scf)	990.30	990.30	990.30	990.30	990.30	990.30	990.30	990.30	990.30	990.30	990.30	990.30	990.30	990.30	990.30	990.30	990.30	990.30	990.30	990.30	990.30
Heat Input LHV (MMBtu/hr)	60.79	60.79	58.84	56.89	53.59	50.22	46.71	73.56	73.56	71.10	68.60	64.39	60.11	55.59	83.63	83.63	82.54	81.49	76.97	72.04	66.63
Heat Input HHV (MMBtu/hr) (=LHV*1.1125)	67.63	67.63	65.46	63.29	59.62	55.87	51.96	81.84	81.84	79.10	76.32	71.63	66.87	61.84	93.04	93.04	91.83	90.66	85.63	80.14	74.13
Exhaust lb/hr	193,732	193,732	184,510	175,525	164,700	154,859	144,522	218,894	218,894	209,715	200,410	187,413	174,270	159,826	231,766	231,766	225,330	218,824	207,302	194,518	179,092
Exhaust ACFM	111,154	111,154	107,946	104,560	100,113	95,919	91,764	124,005	124,005	120,456	116,564	111,040	105,409	99,556	130,013	130,013	129,425	128,767	124,151	118,654	112,482
Stack Height (ft)	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Stack Height (m)	15.24	15.24	15.24	15.24	15.24	15.24	15.24	15.24	15.24	15.24	15.24	15.24	15.24	15.24	15.24	15.24	15.24	15.24	15.24	15.24	15.24
Stack Equiv Diameter (ft)	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Stack Exhaust Velocity (m/s)	28.76	28.76	27.93	27.05	25.90	24.82	23.74	32.08	32.08	31.16	30.16	28.73	27.27	25.76	33.64	33.64	33.49	33.32	32.12	30.70	29.10
Exhaust Temperature (F)	886	886	912	937	964	989	1016	869	869	887	904	928	955	988	856	856	887	920	943	967	1000
Exhaust Temperature (K)	747.6	747.6	762.0	775.9	790.9	804.8	819.8	738.2	738.2	748.2	757.6	770.9	785.9	804.3	730.9	730.9	748.2	766.5	779.3	792.6	810.9
NOx ppm@ 15% O_2	42	9	9	9	9	9	9	42	9	9	9	9	9	9	42	9	9	9	9	9	9
NOx lb/hr	10.220	2.190	2.110	2.040	1.920	1.780	1.640	12.367	2.650	2.560	2.460	2.300	2.140	1.950	14.047	3.010	**2.970**	2.930	2.760	2.560	2.340
NOx g/s	1.288	0.276	0.266	0.257	0.242	0.224	0.207	1.558	0.334	0.323	0.310	0.290	0.270	0.246	1.770	0.379	0.374	0.369	0.348	0.323	0.295
CO ppm@ 15% O_2	100	15	15	15	15	15	15	100	15	15	15	15	15	15	100	15	15	15	15	15	15
CO lb/hr	14.800	2.220	2.150	2.070	1.940	1.810	1.660	17.933	2.690	2.590	2.500	2.340	2.170	1.980	20.400	3.060	**3.010**	2.970	2.800	2.600	2.380
CO g/s	1.865	0.280	0.271	0.261	0.244	0.228	0.209	2.260	0.339	0.326	0.315	0.295	0.273	0.249	2.570	0.386	0.379	0.374	0.353	0.328	0.300
UHC ppm@ 15% O_2	50	15	15	15	15	15	15	50	15	15	15	15	15	15	50	15	15	15	15	15	15
UHC lb/hr	4.233	1.270	1.230	1.190	1.110	1.040	0.950	5.133	1.540	1.490	1.430	1.340	1.240	1.130	5.833	1.750	**1.730**	1.700	1.600	1.490	1.360
VOC ppm@ 15% O_2 (20% of UHC)	10	3	3	3	3	3	3	10	3	3	3	3	3	3	10	3	3	3	3	3	3
VOC lb/hr	0.847	0.254	0.246	0.238	0.222	0.208	0.190	1.027	0.308	0.298	0.286	0.268	0.248	0.226	1.167	0.350	**0.346**	0.340	0.320	0.298	0.272
sulfur gr/100 scf	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
SO2 lb/hr	0.352	0.352	0.340	0.329	0.310	0.290	0.270	0.425	0.425	0.411	0.397	0.372	0.348	0.321	0.484	0.484	**0.477**	0.471	0.445	0.417	0.385
SO2 g/s	0.044	0.044	0.043	0.041	0.039	0.037	0.034	0.054	0.054	0.052	0.050	0.047	0.044	0.041	0.061	0.061	0.060	0.059	0.056	0.052	0.049
Particulates lb/MMBtu	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
$PM_{10/2.5}$ lb/hr	0.68	0.68	0.65	0.63	0.60	0.56	0.52	0.82	0.82	0.79	0.76	0.72	0.67	0.62	0.93	0.93	**0.92**	0.91	0.86	0.80	0.74
$PM_{10/2.5}$ g/s	0.085	0.085	0.082	0.080	0.075	0.070	0.065	0.103	0.103	0.100	0.096	0.090	0.084	0.078	0.117	0.117	0.116	0.114	0.108	0.101	0.093
CO2 lb/mmBtu	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117
CO_2 lb/hr	7,905	7,905	7,651	7,398	6,969	6,531	6,074	9,566	9,566	9,246	8,921	8,373	7,817	7,229	10,875	10,875	**10,733**	10,597	10,009	9,368	8,664
CH_4 lb/mmBtu	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022
CH_4 lb/hr	0.1491	0.1491	0.1443	0.1395	0.1314	0.1232	0.1146	0.1804	0.1804	0.1744	0.1683	0.1579	0.1474	0.1363	0.2051	0.2051	**0.2024**	0.1999	0.1888	0.1767	0.1634
N_2O lb/mmBtu	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
N_2O lb/hr	0.0149	0.0149	0.0144	0.0140	0.0131	0.0123	0.0115	0.0180	0.0180	0.0174	0.0168	0.0158	0.0147	0.0136	0.0205	0.0205	**0.0202**	0.0200	0.0189	0.0177	0.0163
CO_2e lb/mmBtu	117.0	117.0	117.0	117.0	117.0	117.0	117.0	117.0	117.0	117.0	117.0	117.0	117.0	117.0	117.0	117.0	117.0	117.0	117.0	117.0	117.0
CO_2e lb/hr	7,913	7,913	7,659	7,406	6,976	6,537	6,080	9,576	9,576	9,255	8,930	8,382	7,825	7,236	10,886	10,886	**10,745**	10,608	10,019	9,378	8,673

Notes

1. Data provided by Solar for 100%, 75%, and 50% load cases: net output power, fuel flow (MMBtu/hr, LHV), exhaust flow (lb/hr), exhaust temperature, NO X/CO/UHC concentrations and lb/hr.
2. Below zero and low load operation uses 0ºF for operating parameters and uses concentrations from Solar PIL 167. Data for Particulate Matter based upon Solar PIL 171.
3. Greenhouse gases are calculated using emission factors from Part 98, Tables C -1 and C-2 and global warming potentials from Table A-1 (CO_2 = 1, CH_4 = 25, N_2O = 298).
4. VOC as 20% of UHC based on Solar PIL 168 for natural gas.

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Table B-6. Capstone Microturbine Potential Emissions Summary (C200)

Engine parameters

Power output base load	268.2	hp
Power output base load	200	kW
Heat Input Capacity (HHV)	2.28	MMBtu/hr
Maximum Annual Operation	8760	hr/yr
Number of Units	5	Units

Pollutant	Potential Emissions				
	g/bhp-hr[1]	lb/MMBtu[2]	lb/hr	PTE per Unit (tpy)	Total Annual for 5 Units[3] (tpy)
NO_x	0.14		0.08	0.36	1.81
CO	0.37		0.22	0.96	4.79
VOC	0.03		0.02	0.088	0.44
$PM/PM_{10}/PM_{2.5}$		0.0066	0.02	0.066	0.330
SO_2		0.0034	0.008	0.034	0.1698
CO_2e		117.1	267.0	1,169	5,847
CO_2		117.0	266.7	1,168	5,841
CH_4		0.0022	0.005	0.02	0.11
N_2O		0.0002	0.001	0.00	0.011

Notes:

[1] NOx, CO, VOC based on vendor data (Table 2 in vendor's Technical Reference)

[2] Emissions for $PM/PM_{10}/PM_{2.5}$ and SO_2 calculated using AP-42 emission factors (Table 3.1-2a).
Emission for GHGs based upon 40 CFR Part 98, Subpart C.

[3] Represents 5 x Capstone C200 Microturbines, each limited to 8,760 hours / year.

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Table B-7. Gas-Fired Heater Potential Emissions Summary

Heater parameters

Heat Input Capacity (HHV)	0.77	MMBtu/hr
Fuel Firing Rate	699	SCF/hr
Maximum Annual Operation	8,760	hr/yr

Pollutant	Potential Emissions		
	lb/mmscf	lb/hr	Total Annual (ton/yr)
NO_x	100	0.07	0.31
CO	84	0.06	0.26
VOC	5.5	0.004	0.017
$PM/PM_{10}/PM_{2.5}$	7.6	0.005	0.023
SO_2	5.71	0.0040	0.017
CO_2e	129,011	90.17	394.93
CO_2	128,878	90.07	394.53
CH_4	2.43	0.0017	0.01
N_2O	0.24	0.00017	0.0007

Notes:

(1) NOx, CO, VOC and PM emissions are based upon AP-42 Emission Factors

(2) Emissions of SO2 from based on mass balance of sulfur in fuel:

Sulfur Content =	2.0	grains/100 SCF
Higher Heating Value =	1,102	Btu/SCF
Molecular Weight of S =	32	lb/lbmol
Molecular Weight of SO_2 =	64	lb/lbmol

(3) GHG Emissions are based upon 40 CFR Part 98, Subpart C

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Table B-8. Fugitive Blowdowns Potential Emissions Summary

Natural Gas Specifications

Constituent	Mol Percent (%mol)	Molecular Weight	Lb/Lb-Mol NG	Mass Percent	VOC?	HAP?
CO_2	0.165	44.01	0.073	0.41%	No	No
Nitrogen	0.396	28.01	0.111	0.62%	No	No
Methane	87.823	16.04	14.089	79.08%	No	No
Ethane	11.303	30.07	3.399	19.08%	No	No
Oxygen	0.00	16.00	0.000	0.00%	No	No
Propane	0.28	44.10	0.123	0.69%	Yes	No
i-Butane	0.009	58.12	0.005	0.03%	Yes	No
i-Pentane	0.003	72.15	0.002	0.01%	Yes	No
N-Pentane	0.003	72.15	0.002	0.01%	Yes	No
N-Hexane	0.008	86.18	0.007	***0.08%***	Yes	Yes
N-Butane	0.01	58.12	0.006	0.03%	Yes	No

Notes: Based upon representative gas analyses for Project.
Hexane mass percentage increased by 100% to provide conservative HAP emissions potential.

Natural Gas Properties	
Molecular Weight	17.817
Specific Gravity	0.615
lb/Scf	0.047
Scf/lb	21.26
HAP Content (% mass)	0.08%
VOC Content (%mass)	0.86%

Parameter	Blowdown Events									
	Taurus 70 Shutdown	Mars 100 Shutdown	Pig Receiver	Pig Launcher	Suction Filter	Miscellaneous Filters	Emergency Station Shutdown (ESD) Test[2]	ESD Test Purge Post Blowdown	Actual Emergency Station Shutdown (ESD)[3]	Total Blowdown Emissions[4]
Gas Blowdown (scf/event)	55,700	85,200	8,600	14,900	38,000	350	0	28,030	280,300	511,080
Gas Blowdown with Purge Post Blowdown (scf/event)[1]	61,270	93,720	9,460	16,390	41,800	385	0	28,030	308,330	559,385
Blowdowns per Year	12	12	2	2	12	12	1	1	1	55.0
Total Blowdown Volume Vented (scf)	735,240	1,124,640	18,920	32,780	501,600	4,620	0	28,030	308,330	2,754,160
VOC Emissions (lb/event)	24.7	37.8	3.8	6.6	16.8	0.2	0.0	11.3	124.2	101.1
CO_2 Emissions (lb/event)	11.7	18.0	1.81	3.14	8.0	0.1	0.0	5.4	59.1	48.1
CH_4 Emissions (lb/event)	2,278.7	3,485.5	351.8	609.6	1,554.6	14.3	0.0	1,042.4	11,466.9	9,336.9
CO_2e Emissions (lb/event)	56,978.3	87,155.3	8,797.4	15,241.9	38,872.1	358.0	0.0	26,066.6	286,732.7	233,469.6
HAP Emissions (lb/event)	2.23	3.41	0.34	0.60	1.52	0.01	0.00	1.02	11.22	9.1
VOC Emissions (tpy)	0.1481	0.2266	0.0038	0.0066	0.1010	0.0009	0.0000	0.0056	0.0621	0.61
CO_2 Emissions (tpy)	0.0705	0.1078	0.0018	0.0031	0.0481	0.0004	0.0000	0.0027	0.0296	0.29
CH_4 Emissions (tpy)	13.7	20.9	0.35	0.61	9.3	0.1	0.0	0.5	5.7	56.43
CO_2e Emissions (tpy)	341.9	522.9	8.8	15.2	233.2	2.1	0.0	13.0	143.4	1,410.95
HAP Emissions (tpy)	0.013	0.020	0.00034	0.00060	0.009	0.0001	0.0000	0.0005	0.006	0.06

Notes:

(1) All blowdown volumes take into account the gas volume that is purged after equipment or piping is blown down. This purge volume was conservatively assume to be 10% of the event total blowdown volume.

(2) Facility-wide blowdown events may occur for unplanned reasons (e.g. when an unsafe operating condition is detected). To prepare for such events, Mountain Valley Pipeline, LLC must perform ESD testing once every 2 years or so to ensure proper operation of the ESD system. An annual ESD testing event will use an emergency blowdown (EBD) valve, so no emissions will be vented during this test. Therefore, the emissions calculatued for this blowdown event are shown as 0. However, uncontrolled emissions for this event are included in the total tpy emissions in Table B-1 to establish total uncontrolled emissions rate for the site.

(3) Actual emergency events are expected to be very infrequent and cannot be predicted. The emissions in the case of an actual emergency event are included under actual ESD emissions, and these were conservatively estimated to occur once a year.

(4) Total blowdown emissions in tpy include "uncontrolled" emissions from ESD test, which would normally be zero as these will be controlled by an EDB valve.

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Table B-9. Produced Fluids Tank Potential Emissions Summary

Storage Tank Design Data

Capacity (gal)	10,080
Liquids Input Rate (gal/yr)	126,000
Number of Turnovers	12.5
Daily Input Rate (bbl/day)	8
Percent Condensate (%)	1
Condensate Throughput (bbl/day)	0.1
Number of Tanks	2
Max. Hours of Operation	8760

Pollutant	Single Tank Total Emissions (Working + Breathing + Flashing)			Combined Produced Fluids Tanks Emissions
	lbs/hr	lbs/year	tons/year	tons/year
VOC (Total)	0.049	429.2	0.21	0.43
Total HAPs	0.0005	4.0	0.002	0.004
CO_2e	0.475	4161.0	2.10	4.20

Notes:
(1) Calculations conducted using E&P Tanks 2.0

Emissions Composition from E&P Tanks 2.0 Software

Components	Total Emissions		HAP?
	lb/hr	tpy	tpy
CO_2	0	0.002	No
C1 (Methane)	0.019	0.084	No
C3	0.025	0.109	No
i-C4	0.005	0.023	No
n-C4	0.01	0.045	No
i-C5	0.003	0.014	No
n-C5	0.003	0.012	No
C6	0.001	0.003	No
C7	0.001	0.004	No
C8	0	0.001	No
C9	0	0	No
C10+	0	0	No
Benzene	0	0	Yes
Toluene	0	0	Yes
E-benzene	0	0	Yes
Xylenes	0	0	Yes
n-C6	0.00046	0.002	Yes

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Table B-10. Summary of Potential Fugitive Emissions from Equipment Leaks

Component	CH_4 Emission Factor[1,2]	CO_2 Emission Factor[1,2]	Units
Compressor Station Fugitives	135,260.0	7,813.1	lb/station-yr
Centrifugal Compressor Fugitives	467,660.0	27,013.7	lb/compressor-yr

Notes:
(1) Greenhouse Gas Emission Estimation Guidelines for Natural Gas Transmission and Storage, Volume 1 - GHG Emission Estimation Methodologies and Procedures , Interstate Natural Gas Association of America (INGAA), September 28, 2005. See Table 4.4.
(2) Based on 93.4 vol% CH_4 and 2 vol% CO_2 in natural gas, per INGAA Guideline

Natural Gas Specifications

Constituent	Mol Percent	Molecular Weight	Lb/Lb-Mol NG	Mass Percent	VOC	HAP?
CO_2	0.165	44.01	0.073	0.41%	No	No
Nitrogen	0.396	28.01	0.111	0.62%	No	No
Methane	87.823	16.04	14.089	79.08%	No	No
Ethane	11.303	30.07	3.399	19.08%	No	No
Propane	0.28	44.10	0.123	0.69%	Yes	No
i-Butane	0.009	58.12	0.005	0.03%	Yes	No
i-Pentane	0.003	72.15	0.002	0.01%	Yes	No
N-Pentane	0.003	72.15	0.002	0.01%	Yes	No
N-Hexane	0.008	86.18	0.007	***0.08%***	Yes	Yes
N-Butane	0.01	58.12	0.006	0.03%	Yes	No

Notes: Hexane mass percentage increased by 100% to provide conservative HAP emissions potential.

Natural Gas Properties	
Molecular Weight (lb/mol)	17.817
Specific Gravity	0.615
lb/Scf	0.047
Scf/lb	21.26
HAP Content (% mass)	0.08%
VOC Content (%mass)	0.86%

Fugitive Component Leak Emissions

Component Type	Estimated Component Count	Gas Leak Emission Factor		Hourly Average Gas Leak Rate	Annual Gas Leak Rate		Potential VOC Emissions	Potential HAP Emissions	CO_2 Emissions	CH_4 Emissions	CO_2e Emissions
		(scf/hr/component)	Factor Source	(scf/hr)	(scf/year)	lb/year	(tpy)	(tpy)	(tpy)	(tpy)	(tpy)
Connectors	1000	0.003	40 CFR 98, Table W-1A	3.00	26,280	1,236	0.01	0.0005	0.003	0.49	12.22
Flanges	500	0.003	40 CFR 98, Table W-1A	1.50	13,140	618	0.00	0.0002	0.001	0.24	6.11
Open-Ended Lines	0	0.061	40 CFR 98, Table W-1A	0	0	0	0	0	0	0	0
Pump Seals	0	13.300	40 CFR 98, Table W-1A	0	0	0	0	0	0	0	0
Valves	100	0.027	40 CFR 98, Table W-1A	2.70	23,652	1,112	0.00	0.0004	0.002	0.44	11.00
Other	0	0.040	40 CFR 98, Table W-1A	0	0	0	0	0	0	0	0

Notes:
1. "Other" equipment types include compressor seals, relief valves, diaphragms, drains, meters, etc
2. The component count is a preliminary estimate based on the proposed design of the station
3. VOC, HAP, CO2, and CH4 emissions are based on fractions of these pollutants in the site -specific gas analysis
4. CO2e calculated using global warming potentials from Part 98, Table A -1 (CO2 = 1, CH4 = 25)

Dry Seal Emissions

Number of Compressors	Leak Rate (scf/hr/compressor)	Annual Natural Gas Released (scf/yr)	Annual Natural Gas Released (lb/yr)	Potential VOC Emissions (tpy)	Potential HAP Emissions (tpy)	CO_2 Emissions (tpy)	CH_4 Emissions (tpy)	CO_2e Emissions (tpy)
2	210	3,679,200	173,037	0.74	0.07	0.35	68.4	1,710.7

Notes:
1. Leak rate and seal information from EPA Natural Gas Star Program (https://www.epa.gov/sites/production/files/2016-06/documents/ll_wetseals.pdf)
2. VOC, HAP, CO_2, and CH_4 emissions are based on fractions of these pollutants in the site -specific gas analysis
3. CO_2e calculated using global warming potentials from Part 98, Table A -1 (CO_2 = 1, CH_4 = 25)

Fugitive Emissions Summary

Segment	Potential VOC Emissions (tpy)	Potential HAP Emissions (tpy)	CO_2 Emissions (tpy)	CH_4 Emissions (tpy)	CO_2e Emissions (tpy)
Compressor Station Fugitives	0.01	0.001	0.01	1.2	29.3
Dry Seal Emissions	0.74	0.07	0.35	68.4	1,710.7
Total	**0.75**	**0.07**	**0.36**	**69.6**	**1,740.1**

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Table B-11. Proposed Project Potential HAP Emissions Summary

		Solar Taurus 70					Solar Mars 100					Fuel Gas Heater			Capstone Microturbines			
Hazardous Air Pollutants (HAPs)	AP-42 Emission Factor [1] lb/MMBtu	Emission Factor Basis [1] lb/MMBtu	Max Hourly lb/hr	Startup lb/event	Shutdown lb/event	Annual Potential tons/year	Emission Factor Basis [1] lb/MMBtu	Max Hourly lb/hr	Startup lb/event	Shutdown lb/event	Annual Potential tons/year	Emission Factor Basis [2] lb/MMBtu	Max Hourly lb/hr	Annual Potential tons/year	EF Basis [3] lb/MMBtu	Max Hourly lb/hr	Annual Potential tons/year	Facility PTE tons/yr
VOC-HAP																		
Acetaldehyde	4.00E-05	7.24E-05	6.73E-03	3.78E-02	2.52E-02	3.11E-02	1.20E-04	1.69E-02	2.52E-02	3.78E-02	7.55E-02				1.68E-04	3.82E-04	8.37E-03	1.15E-01
Acrolein	6.40E-06	1.16E-05	1.08E-03	6.05E-03	4.03E-03	4.97E-03	1.92E-05	2.70E-03	4.03E-03	6.05E-03	1.21E-02				2.68E-05	6.11E-05	1.34E-03	1.84E-02
Benzene	1.20E-05	2.17E-05	2.02E-03	1.13E-02	7.56E-03	9.32E-03	3.60E-05	5.07E-03	7.56E-03	1.13E-02	2.27E-02	2.06E-06	1.59E-06	6.94E-06	5.03E-05	1.15E-04	2.51E-03	3.45E-02
1,3-Butadiene	4.30E-07	7.78E-07	7.24E-05	4.07E-04	2.71E-04	3.34E-04	1.29E-06	1.82E-04	2.71E-04	4.07E-04	8.12E-04				1.80E-06	4.11E-06	9.00E-05	1.24E-03
Dichlorobenzene												1.18E-06	9.06E-07	3.97E-06				3.97E-06
Ethylbenzene	3.20E-05	5.79E-05	5.39E-03	3.03E-02	2.02E-02	2.49E-02	9.60E-05	1.35E-02	2.02E-02	3.03E-02	6.04E-02				1.34E-04	3.06E-04	6.70E-03	9.20E-02
Formaldehyde	7.10E-04	2.88E-03	2.68E-01	4.60E+00	3.20E+00	1.37E+00	2.88E-03	4.06E-01	2.40E+00	4.30E+00	1.95E+00	7.35E-05	5.66E-05	2.48E-04	2.98E-03	6.78E-03	1.49E-01	3.47E+00
Hexane												1.76E-03	1.36E-03	5.95E-03				5.95E-03
Naphthalene	1.30E-06	2.35E-06	2.19E-04	1.23E-03	8.19E-04	1.01E-03	3.90E-06	5.49E-04	8.19E-04	1.23E-03	2.45E-03	5.98E-07	4.60E-07	2.02E-06	5.45E-06	1.24E-05	2.72E-04	3.74E-03
PAH	2.20E-06	3.98E-06	3.70E-04	2.08E-03	1.39E-03	1.71E-03	6.60E-06	9.30E-04	1.39E-03	2.08E-03	4.15E-03				9.22E-06	2.10E-05	4.60E-04	6.32E-03
Propylene Oxide	2.90E-05	5.25E-05	4.88E-03	2.74E-02	1.83E-02	2.25E-02	8.70E-05	1.23E-02	1.83E-02	2.74E-02	5.48E-02				1.22E-04	2.77E-04	6.07E-03	8.34E-02
Toluene	1.30E-04	2.35E-04	2.19E-02	1.23E-01	8.19E-02	1.01E-01	3.90E-04	5.49E-02	8.19E-02	1.23E-01	2.45E-01	3.33E-06	2.57E-06	1.12E-05	5.45E-04	1.24E-03	2.72E-02	3.74E-01
Xylenes	6.40E-05	1.16E-04	1.08E-02	6.05E-02	4.03E-02	4.97E-02	1.92E-04	2.70E-02	4.03E-02	6.05E-02	1.21E-01				2.68E-04	6.11E-04	1.34E-02	1.84E-01
Polycyclic Organic Compounds (POM)																		
Acenaphthene												1.76E-09	1.36E-09	5.95E-09	0.00E+00	0.00E+00	0.00E+00	5.95E-09
Acenaphthylene												1.76E-09	1.36E-09	5.95E-09	0.00E+00	0.00E+00	0.00E+00	5.95E-09
Anthracene												2.35E-09	1.81E-09	7.94E-09	0.00E+00	0.00E+00	0.00E+00	7.94E-09
Benz(a)anthracene												1.76E-09	1.36E-09	5.95E-09	0.00E+00	0.00E+00	0.00E+00	5.95E-09
Benzo(a)pyrene												1.18E-09	9.06E-10	3.97E-09	0.00E+00	0.00E+00	0.00E+00	3.97E-09
Benzo(b)fluoranthene												1.76E-09	1.36E-09	5.95E-09	0.00E+00	0.00E+00	0.00E+00	5.95E-09
Benzo(g,h,i)perylene												1.18E-09	9.06E-10	3.97E-09	0.00E+00	0.00E+00	0.00E+00	3.97E-09
Benzo(k)fluoranthene												1.76E-09	1.36E-09	5.95E-09	0.00E+00	0.00E+00	0.00E+00	5.95E-09
Chrysene												1.76E-09	1.36E-09	5.95E-09	0.00E+00	0.00E+00	0.00E+00	5.95E-09
Dibenzo(a,h)anthracene												1.18E-09	9.06E-10	3.97E-09	0.00E+00	0.00E+00	0.00E+00	3.97E-09
7,12-Dimethylbenz(a)anthracene												1.57E-08	1.21E-08	5.29E-08	0.00E+00	0.00E+00	0.00E+00	5.29E-08
Fluoranthene												2.94E-09	2.26E-09	9.92E-09	0.00E+00	0.00E+00	0.00E+00	9.92E-09
Fluorene												2.75E-09	2.11E-09	9.26E-09	0.00E+00	0.00E+00	0.00E+00	9.26E-09
3-Methylchloranthrene												1.76E-09	1.36E-09	5.95E-09	0.00E+00	0.00E+00	0.00E+00	5.95E-09
2-Methylnaphthalene												2.35E-08	1.81E-08	7.94E-08	0.00E+00	0.00E+00	0.00E+00	7.94E-08
Indeno(1,2,3-cd)pyrene												1.76E-09	1.36E-09	5.95E-09	0.00E+00	0.00E+00	0.00E+00	5.95E-09
Phenanthrene												1.67E-08	1.28E-08	5.62E-08	0.00E+00	0.00E+00	0.00E+00	5.62E-08
Pyrene												4.90E-09	3.77E-09	1.65E-08	0.00E+00	0.00E+00	0.00E+00	1.65E-08
Total POM												8.65E-08	6.66E-08	2.92E-07	0.00E+00	0.00E+00	0.00E+00	2.92E-07
Total HAPs (tpy)						**1.62**					**2.55**			**0.01**			**0.21**	**4.4**
																	Maximum Individual HAP:	**3.5**
																	Total Project HAPs:	**4.4**

[1] Emissions based on AP-42 5th Edition, Section 3.1, except for formaldehyde. Formaldehyde emissions obtained from PIL 168, Table 1. All other HAP emissions based on scaling of AP-42 values using Vendor Guarantee for TOC.
[2] Emissions based on AP-42 5th Edition, Section 1.4.
[3] Emissions based on AP-42 5th Edition, Section 3.1.
[4] Emissions based on Solar Estimates
[5] Calculated based on AP-42 Chapter 3, Section 3.1, Table 3.1-3 emission factors.

Solar Turbine Emissions - Startup			
Pollutant		Emission Rates (lb/event) [4]	
		Mars 100	Taurus 70
Total HAP		2.6	4.9
Formaldehyde		2.4	4.6
Non-Formaldehyde HAP		0.2	0.3

Solar Turbine Emissions - Shutdown			
Pollutant		Emission Rates (lb/event) [4]	
		Mars 100	Taurus 70
Total HAP		4.6	3.4
Formaldehyde		4.3	3.2
Non-Formaldehyde HAP		0.3	0.2

Solar Turbine Emissions - Startup			
Pollutant	Non-Formaldehyde HAP Composition [5]	Emission Rates (lb/event)	
		Mars 100	Taurus 70
Acetaldehyde	12.605%	2.52E-02	3.78E-02
Acrolein	2.017%	4.03E-03	6.05E-03
Benzene	3.782%	7.56E-03	1.13E-02
1,3-Butadiene	0.136%	2.71E-04	4.07E-04
Dichlorobenzene	0.000%	0.00E+00	0.00E+00
Ethylbenzene	10.084%	2.02E-02	3.03E-02
Formaldehyde	---	2.40E+00	4.60E+00
Hexane	0.000%	0.00E+00	0.00E+00
Naphthalene	0.410%	8.19E-04	1.23E-03
PAH	0.693%	1.39E-03	2.08E-03
Propylene Oxide	9.139%	1.83E-02	2.74E-02
Toluene	40.967%	8.19E-02	1.23E-01
Xylenes	20.168%	4.03E-02	6.05E-02

Solar Turbine Emissions - Shutdown			
Pollutant	Non-Formaldehyde HAP Composition [5]	Emission Rates (lb/event)	
		Mars 100	Taurus 70
Acetaldehyde	12.605%	3.78E-02	2.52E-02
Acrolein	2.017%	6.05E-03	4.03E-03
Benzene	3.782%	1.13E-02	7.56E-03
1,3-Butadiene	0.136%	4.07E-04	2.71E-04
Dichlorobenzene	0.000%	0.00E+00	0.00E+00
Ethylbenzene	10.084%	3.03E-02	2.02E-02
Formaldehyde	---	4.30E+00	3.20E+00
Hexane	0.000%	0.00E+00	0.00E+00
Naphthalene	0.410%	1.23E-03	8.19E-04
PAH	0.693%	2.08E-03	1.39E-03
Propylene Oxide	9.139%	2.74E-02	1.83E-02
Toluene	40.967%	1.23E-01	8.19E-02
Xylenes	20.168%	6.05E-02	4.03E-02

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Table B-12. Toxic Air Pollutant (TAP) Emissions comparison to VADEQ TAP Exemption Rates

Pollutant	CAS No.	TLV (mg/m³)[1]			Exemption Threshold (ET)[1]	
					Hourly	Annual
		TWA	STEL	CEIL	lb/hr	ton/yr
Acetaldehyde	75070	180	270	-	8.91	26.1
Acrolein	107028	0.23	0.69	-	0.02277	0.03335
Benzene	71432	32	-	-	2.112	4.64
1,3-Butadiene	106990	22	-	-	1.452	3.19
Ethylbenzene	100414	434	543	-	17.919	62.93
Formaldehyde	50000	1.2	2.5	-	0.0825	0.174
Hexane	110543	176	-	-	11.616	25.52
Naphthalene	91203	52	79	-	2.607	7.54
PAH[2]	---	52	79	-	2.607	7.54
Propylene Oxide	75569	48	-	-	3.168	6.96
Toluene	108883	377	565	-	18.645	54.665
Xylenes	1330207	434	651	-	21.483	62.93

Potential Hourly Emissions (lb/hr)[3]

Pollutant	Mars 100	Taurus 70	Microturbines	Gas Heater	Condesate Tanks	Fugitive Leaks	Blowdown Events									Total (lb/hr)	ET (lb/hr)
							Taurus 70 Shutdown	Mars 100 Shutdown	Pig Receiver	Pig Launcher	Suction Filter	Miscellaneous Filters	ESD Test (Controlled)	ESD Test Purge Post Blowdown	Actual ESD		
Acetaldehyde	5.19E-02	4.34E-02	1.91E-03	0.00E+00	0.00E+00	0.00E+00	---	---	---	---	---	---		---	---	0.097	8.91
Acrolein	8.30E-03	6.95E-03	3.06E-04	0.00E+00	0.00E+00	0.00E+00	---	---	---	---	---	---		---	---	0.016	0.02277
Benzene	1.56E-02	1.30E-02	5.73E-04	1.59E-06	0.00E+00	0.00E+00	---	---	---	---	---	---		---	---	0.029	2.112
1,3-Butadiene	5.58E-04	4.67E-04	2.05E-05	0.00E+00	0.00E+00	0.00E+00	---	---	---	---	---	---		---	---	0.001	1.452
Ethylbenzene	4.15E-02	3.47E-02	1.53E-03	0.00E+00	0.00E+00	0.00E+00	---	---	---	---	---	---		---	---	0.078	17.919
Formaldehyde	4.64E+00	4.82E+00	3.39E-02	5.66E-05	0.00E+00	0.00E+00	---	---	---	---	---	---		---	---	9.495	0.0825
Hexane[4]	0.00E+00	0.00E+00	0.00E+00	1.36E-03	4.57E-04	1.55E-02	2.230	3.411	0.344	0.597	1.521	0.014	0.000	1.020	11.222	9.155 / 11.222	11.616
Naphthalene	1.69E-03	1.41E-03	6.21E-05	4.60E-07	0.00E+00	0.00E+00	---	---	---	---	---	---		---	---	0.003	2.607
PAH	2.85E-03	2.39E-03	1.05E-04	0.00E+00	0.00E+00	0.00E+00	---	---	---	---	---	---		---	---	0.005	2.607
Propylene Oxide	3.76E-02	3.15E-02	1.39E-03	0.00E+00	0.00E+00	0.00E+00	---	---	---	---	---	---		---	---	0.070	3.168
Toluene	1.69E-01	1.41E-01	6.21E-03	2.57E-06	0.00E+00	0.00E+00	---	---	---	---	---	---		---	---	0.316	18.645
Xylenes	8.30E-02	6.95E-02	3.06E-03	0.00E+00	0.00E+00	0.00E+00	---	---	---	---	---	---		---	---	0.156	21.483

Potential Annual Emissions (ton/yr)[3]

Pollutant	Mars 100	Taurus 70	Microturbines	Gas Heater	Condesate Tanks	Fugitive Leaks	Blowdown Events									Total (tpy)	ET (tpy)
							Taurus 70 Shutdown	Mars 100 Shutdown	Pig Receiver	Pig Launcher	Suction Filter	Miscellaneous Filters	ESD Test	ESD Test Purge Post Blowdown	Actual ESD		
Acetaldehyde	7.55E-02	3.11E-02	8.37E-03	0.00E+00	0.00E+00	0.00E+00	---	---	---	---	---	---		---	---	0.115	26.1
Acrolein	1.21E-02	4.97E-03	1.34E-03	0.00E+00	0.00E+00	0.00E+00	---	---	---	---	---	---		---	---	0.018	0.03335
Benzene	2.27E-02	9.32E-03	2.51E-03	6.94E-06	0.00E+00	0.00E+00	---	---	---	---	---	---		---	---	0.034	4.64
1,3-Butadiene	8.12E-04	3.34E-04	9.00E-05	0.00E+00	0.00E+00	0.00E+00	---	---	---	---	---	---		---	---	0.001	3.19
Ethylbenzene	6.04E-02	2.49E-02	6.70E-03	0.00E+00	0.00E+00	0.00E+00	---	---	---	---	---	---		---	---	0.092	62.93
Formaldehyde	1.95E+00	1.37E+00	1.49E-01	2.48E-04	0.00E+00	0.00E+00	---	---	---	---	---	---		---	---	3.470	0.174
Hexane	0.00E+00	0.00E+00	0.00E+00	5.95E-03	2.00E-03	6.81E-02	1.34E-02	2.05E-02	3.44E-04	5.97E-04	9.13E-03	8.41E-05	0.00E+00	5.10E-04	5.61E-03	0.126	25.52
Naphthalene	2.45E-03	1.01E-03	2.72E-04	2.02E-06	0.00E+00	0.00E+00	---	---	---	---	---	---		---	---	0.004	7.54
PAH	4.15E-03	1.71E-03	4.60E-04	0.00E+00	0.00E+00	0.00E+00	---	---	---	---	---	---		---	---	0.006	7.54
Propylene Oxide	5.48E-02	2.25E-02	6.07E-03	0.00E+00	0.00E+00	0.00E+00	---	---	---	---	---	---		---	---	0.083	6.96
Toluene	2.45E-01	1.01E-01	2.72E-02	1.12E-05	0.00E+00	0.00E+00	---	---	---	---	---	---		---	---	0.374	54.665
Xylenes	1.21E-01	4.97E-02	1.34E-02	0.00E+00	0.00E+00	0.00E+00	---	---	---	---	---	---		---	---	0.184	62.93

Key:
Potential Emissions Exceed Exemption Threshold

Notes:
1. TLV and ET values from "Toxics_Spreadsheet.xlsx", downloaded from the Virginia DEQ - Air Toxics website, and calculated as per Rule 9VAC5-60-300.C
2. PAH not listed in Virginia DEQ toxics spreadsheet; to be conservative, assumed the same TLV and ET values as naphthalene.
3. Based on maximum emissions per Table B11. The Mars 100 and Taurus 70 lb/hr emissions include the maximum emissions from startup and shutdown events with the balance of the hour at the maximum potential normal operating emission rate.
4. Conservatively assumes that all blowdown emissions could occur within the same hour. Blowdowns from an actual ESD are not included in the lb/hr total as ESD emissions in the case of a true emergency will not occur during the same hour as all other blowdowns. Actual ESD blowdowns lb/hr emissions for hexane (11.2 lb/hr) are more than the sum of all other blowdown emissions (9.2 lb/hr), but still below the threshold. Actual ESD blowdown emissions in tpy are included with the total hexane emissions.

Primary Technology (Hardware and Software) Changes/ Advances From 15 ppm to 9 ppm NOx Warranty Products

- Combustor Liner Design
- Fuel Injector Design
- High Pressure Pilot
- Engine Fuel System Design
- Bleed Shield Changes, Where Applicable
- Jump Cooling on Affected Products
- Primary Zone Temperature (TPZ) Control (With Some Products Migrating to Enhanced Emissions Control)
- Burner Acoustic Monitoring Upgrades (with Migration to BAM 2.0 with Active Control)
- Parallel Electronic High Force Fuel Control Valves
- Turbotronic 4 (with Migration to Turbotronic 5 Control Systems)
- Energy Balance Fuel Control Algorithm With %pilot Calculation
- Additional Specific Acceptance Test Data Points and Validation Setup
- Note: The technology and controls systems on each selected model was assessed to determine the hardware and software development necessary to achieve a robust 9 ppm warranty level. Each model/rating is/was on its development path and production schedule. It is a multi-year process to design, test, and qualify hardware and software, and develop tooling.

Solar Turbines
A Caterpillar Company

PREDICTED EMISSION PERFORMANCE

Customer	Engine Model: MARS 100-16000S CS/MD STANDARD
Job ID	
Inquiry Number	Fuel Type: CHOICE GAS; Water Injection: NO
Run By: David Anthony Pocengal; Date Run: 21-Mar-19	Engine Emissions Data: REV. 1.0

	NOx EMISSIONS	CO EMISSIONS	UHC EMISSIONS
1 — 8562 HP — 50.0% Load — Elev. 660 ft — Rel. Humidity 60.0% — Temperature 0 Deg. F			
PPMvd at 15% O2	9.00	25.00	25.00
ton/yr	11.22	18.98	10.87
lbm/MMBtu (Fuel LHV)	0.036	0.061	0.035
lbm/(MW-hr)	0.40	0.68	0.39
(gas turbine shaft pwr) lbm/hr	2.56	4.33	2.48
2 — 8300 HP — 50.0% Load — Elev. 660 ft — Rel. Humidity 60.0% — Temperature 20.0 Deg. F			
PPMvd at 15% O2	9.00	25.00	25.00
ton/yr	14.26	24.12	13.82
lbm/MMBtu (Fuel LHV)	0.036	0.061	0.035
lbm/(MW-hr)	0.53	0.89	0.51
(gas turbine shaft pwr) lbm/hr	3.26	5.51	3.15
3 — 7959 HP — 50.0% Load — Elev. 660 ft — Rel. Humidity 60.0% — Temperature 40.0 Deg. F			
PPMvd at 15% O2	9.00	25.00	25.00
ton/yr	13.64	23.06	13.21
lbm/MMBtu (Fuel LHV)	0.036	0.061	0.035
lbm/(MW-hr)	0.52	0.89	0.51
(gas turbine shaft pwr) lbm/hr	3.11	5.27	3.02

Notes

1. For short-term emission limits such as lbs/hr., Solar recommends using "worst case" anticipated operating conditions specific to the application and the site conditions. Worst case for one pollutant is not ecessarily the same for another.
2. Solar's typical SoLoNOx warranty, for ppm values, is available for greater than 0 deg F or -20 deg F, and between 50% and 100% load for gas fuel, and between 65% and 100% load for liquid fuel (except fo r the Centaur 40). An emission warranty for non-SoLoNOx equipment is available for greater than 0 deg F or -20 deg F and between
3. Fuel must meet Solar standard fuel specification ES 9-98. Emissions are based on the attached fuel composition, or, San Diego natural gas or equivalent.
4. If needed, Solar can provide Product Information Letters to address turbine operation outside typical warranty ranges, as well as non-warranted emissions of SO2, PM10/2.5, VOC, and formaldehyde.
5. Solar can provide factory testing in San Diego to ensure the actual unit(s) meet the above values within the tolerances quoted. Pricing and schedule impact will be provided upon request.
6. Any emissions warranty is applicable only for steady-state conditions and does not apply during start-up, shut-down, malfunction, or transient event.

Solar Turbines
A Caterpillar Company

PREDICTED EMISSION PERFORMANCE

Customer	Engine Model: MARS 100-16000S CS/MD STANDARD
Job ID	
Inquiry Number	Fuel Type: CHOICE GAS; Water Injection: NO
Run By: David Anthony Pocengal; Date Run: 21-Mar-19	Engine Emissions Data: REV. 1.0

	NOx EMISSIONS	CO EMISSIONS	UHC EMISSIONS
4 — 7521 HP — 50.0% Load — Elev. 660 ft — Rel. Humidity 60.0% — Temperature 60.0 Deg. F			
PPMvd at 15% O2	9.00	25.00	25.00
ton/yr	12.98	21.96	12.58
lbm/MMBtu (Fuel LHV)	0.036	0.060	0.035
lbm/(MW-hr)	0.53	0.89	0.51
(gas turbine shaft pwr) lbm/hr	2.96	5.01	2.87
5 — 6986 HP — 50.0% Load — Elev. 660 ft — Rel. Humidity 60.0% — Temperature 80.0 Deg. F			
PPMvd at 15% O2	9.00	25.00	25.00
ton/yr	12.20	20.63	11.81
lbm/MMBtu (Fuel LHV)	0.036	0.060	0.034
lbm/(MW-hr)	0.53	0.90	0.52
(gas turbine shaft pwr) lbm/hr	2.78	4.71	2.70
6 — 6393 HP — 50.0% Load — Elev. 660 ft — Rel. Humidity 60.0% — Temperature 100.0 Deg. F			
PPMvd at 15% O2	9.00	25.00	25.00
ton/yr	11.39	19.26	11.03
lbm/MMBtu (Fuel LHV)	0.035	0.059	0.034
lbm/(MW-hr)	0.55	0.92	0.53
(gas turbine shaft pwr) lbm/hr	2.60	4.40	2.52

Notes

1. For short-term emission limits such as lbs/hr., Solar recommends using "worst case" anticipated operating conditions specific to the application and the site conditions. Worst case for one pollutant is not ecessarily the same for another.
2. Solar's typical SoLoNOx warranty, for ppm values, is available for greater than 0 deg F or -20 deg F, and between 50% and 100% load for gas fuel, and between 65% and 100% load for liquid fuel (except fo r the Centaur 40). An emission warranty for non-SoLoNOx equipment is available for greater than 0 deg F or -20 deg F and between
3. Fuel must meet Solar standard fuel specification ES 9-98. Emissions are based on the attached fuel composition, or, San Diego natural gas or equivalent.
4. If needed, Solar can provide Product Information Letters to address turbine operation outside typical warranty ranges, as well as non-warranted emissions of SO2, PM10/2.5, VOC, and formaldehyde.
5. Solar can provide factory testing in San Diego to ensure the actual unit(s) meet the above values within the tolerances quoted. Pricing and schedule impact will be provided upon request.
6. Any emissions warranty is applicable only for steady-state conditions and does not apply during start-up, shut-down, malfunction, or transient event.

Solar Turbines
A Caterpillar Company

PREDICTED ENGINE PERFORMANCE

Customer	Model: MARS 100-16000S
Job ID	Package Type: CS/MD
Run By: David Anthony Pocengal — Date Run: 21-Mar-19	Match: STANDARD
Engine Performance Code: REV. 4.20.1.23.12 — Engine Performance Data: REV. 1.0	Fuel System: GAS
	Fuel Type: CHOICE GAS

DATA FOR NOMINAL PERFORMANCE

Elevation	feet	660
Inlet Loss	in H2O	4.0
Exhaust Loss	in H2O	5.0
Accessory on GP Shaft	HP	27.8

		1	2	3	4	5	6
Engine Inlet Temperature	deg F	0	20.0	40.0	60.0	80.0	100.0
Relative Humidity	%	60.0	60.0	60.0	60.0	60.0	60.0
Driven Equipment Speed	RPM	6802	7506	7364	7173	7003	6853
Specified Load	HP	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%
Net Output Power	HP	8562	8300	7959	7521	6986	6393
Fuel Flow	mmBtu/hr	71.43	90.64	86.80	82.93	78.41	74.07
Heat Rate	Btu/HP-hr	8343	10920	10906	11026	11224	11587
Therm Eff	%	30.499	23.300	23.330	23.077	22.670	21.960
Engine Exhaust Flow	lbm/hr	291039	297636	282271	267925	251219	234805
PT Exit Temperature	deg F	651	963	980	1004	1028	1054
Exhaust Temperature	deg F	651	893	920	951	981	1010

Fuel Gas Composition (Volume Percent)

Methane (CH4)	87.71
Ethane (C2H6)	11.29
Propane (C3H8)	0.30
I-Butane (C4H10)	0.10
Carbon Dioxide (CO2)	0.20
Nitrogen (N2)	0.40
Sulfur Dioxide (SO2)	0.0001

Fuel Gas Properties

LHV (Btu/Scf)	990.3	Specific Gravity	0.6165	Wobbe Index at 60F	1261.3

This performance was calculated with a basic inlet and exhaust system. Special equipment such as low noise silencers, special filters, heat recovery systems or cooling devices will affect engine performance. Performance shown is "Expected" performance at the pressure drops stated, not guaranteed.

Solar Turbines
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PREDICTED EMISSION PERFORMANCE

Customer	Engine Model: MARS 100-16000S CS/MD STANDARD
Job ID	
Inquiry Number	Fuel Type: CHOICE GAS; Water Injection: NO
Run By: David Anthony Pocengal; Date Run: 21-Mar-19	Engine Emissions Data: REV. 1.0

	NOx EMISSIONS	CO EMISSIONS	UHC EMISSIONS
1 — 12842 HP — 75.0% Load — Elev. 660 ft — Rel. Humidity 60.0% — Temperature 0 Deg. F			
PPMvd at 15% O2	9.00	25.00	25.00
ton/yr	17.79	30.09	17.23
lbm/MMBtu (Fuel LHV)	0.036	0.061	0.035
lbm/(MW-hr)	0.42	0.72	0.41
(gas turbine shaft pwr) lbm/hr	4.06	6.87	3.93
2 — 12450 HP — 75.0% Load — Elev. 660 ft — Rel. Humidity 60.0% — Temperature 20.0 Deg. F			
PPMvd at 15% O2	9.00	25.00	25.00
ton/yr	17.12	28.95	16.58
lbm/MMBtu (Fuel LHV)	0.036	0.061	0.035
lbm/(MW-hr)	0.42	0.71	0.41
(gas turbine shaft pwr) lbm/hr	3.91	6.61	3.79
3 — 11939 HP — 75.0% Load — Elev. 660 ft — Rel. Humidity 60.0% — Temperature 40.0 Deg. F			
PPMvd at 15% O2	9.00	25.00	25.00
ton/yr	16.39	27.72	15.87
lbm/MMBtu (Fuel LHV)	0.036	0.061	0.035
lbm/(MW-hr)	0.42	0.71	0.41
(gas turbine shaft pwr) lbm/hr	3.74	6.33	3.62

Notes

1. For short-term emission limits such as lbs/hr., Solar recommends using "worst case" anticipated operating conditions specific to the application and the site conditions. Worst case for one pollutant is not ecessarily the same for another.
2. Solar's typical SoLoNOx warranty, for ppm values, is available for greater than 0 deg F or -20 deg F, and between 50% and 100% load for gas fuel, and between 65% and 100% load for liquid fuel (except fo r the Centaur 40). An emission warranty for non-SoLoNOx equipment is available for greater than 0 deg F or -20 deg F and between
3. Fuel must meet Solar standard fuel specification ES 9-98. Emissions are based on the attached fuel composition, or, San Diego natural gas or equivalent.
4. If needed, Solar can provide Product Information Letters to address turbine operation outside typical warranty ranges, as well as non-warranted emissions of SO2, PM10/2.5, VOC, and formaldehyde.
5. Solar can provide factory testing in San Diego to ensure the actual unit(s) meet the above values within the tolerances quoted. Pricing and schedule impact will be provided upon request.
6. Any emissions warranty is applicable only for steady-state conditions and does not apply during start-up, shut-down, malfunction, or transient event.

Solar Turbines
A Caterpillar Company

PREDICTED EMISSION PERFORMANCE

Customer	Engine Model: MARS 100-16000S CS/MD STANDARD
Job ID	
Inquiry Number	Fuel Type: CHOICE GAS; Water Injection: NO
Run By: David Anthony Pocengal; Date Run: 21-Mar-19	Engine Emissions Data: REV. 1.0

	NOx EMISSIONS	CO EMISSIONS	UHC EMISSIONS
4 — 11281 HP 75.0% Load; Elev. 660 ft; Rel. Humidity 60.0%; Temperature 60.0 Deg. F			
PPMvd at 15% O2	9.00	25.00	25.00
ton/yr	15.54	26.28	15.05
lbm/MMBtu (Fuel LHV)	0.036	0.060	0.035
lbm/(MW-hr)	0.42	0.71	0.41
(gas turbine shaft pwr) lbm/hr	3.55	6.00	3.44
5 — 10479 HP 75.0% Load; Elev. 660 ft; Rel. Humidity 60.0%; Temperature 80.0 Deg. F			
PPMvd at 15% O2	9.00	25.00	25.00
ton/yr	14.57	24.63	14.11
lbm/MMBtu (Fuel LHV)	0.036	0.060	0.034
lbm/(MW-hr)	0.43	0.72	0.41
(gas turbine shaft pwr) lbm/hr	3.33	5.62	3.22
6 — 9589 HP 75.0% Load; Elev. 660 ft; Rel. Humidity 60.0%; Temperature 100.0 Deg. F			
PPMvd at 15% O2	9.00	25.00	25.00
ton/yr	13.51	22.85	13.09
lbm/MMBtu (Fuel LHV)	0.035	0.059	0.034
lbm/(MW-hr)	0.43	0.73	0.42
(gas turbine shaft pwr) lbm/hr	3.09	5.22	2.99

Notes

1. For short-term emission limits such as lbs/hr., Solar recommends using "worst case" anticipated operating conditions specific to the application and the site conditions. Worst case for one pollutant is not ecessarily the same for another.
2. Solar's typical SoLoNOx warranty, for ppm values, is available for greater than 0 deg F or -20 deg F, and between 50% and 100% load for gas fuel, and between 65% and 100% load for liquid fuel (except fo r the Centaur 40). An emission warranty for non-SoLoNOx equipment is available for greater than 0 deg F or -20 deg F and between
3. Fuel must meet Solar standard fuel specification ES 9-98. Emissions are based on the attached fuel composition, or, San Diego natural gas or equivalent.
4. If needed, Solar can provide Product Information Letters to address turbine operation outside typical warranty ranges, as well as non-warranted emissions of SO2, PM10/2.5, VOC, and formaldehyde.
5. Solar can provide factory testing in San Diego to ensure the actual unit(s) meet the above values within the tolerances quoted. Pricing and schedule impact will be provided upon request.
6. Any emissions warranty is applicable only for steady-state conditions and does not apply during start-up, shut-down, malfunction, or transient event.

Solar Turbines
A Caterpillar Company

PREDICTED ENGINE PERFORMANCE

Customer	Model: MARS 100-16000S
Job ID	Package Type: CS/MD
Run By: David Anthony Pocengal — Date Run: 21-Mar-19	Match: STANDARD
Engine Performance Code: REV. 4.20.1.23.12 — Engine Performance Data: REV. 1.0	Fuel System: GAS
	Fuel Type: CHOICE GAS

DATA FOR NOMINAL PERFORMANCE

Elevation	feet	660
Inlet Loss	in H2O	4.0
Exhaust Loss	in H2O	5.0
Accessory on GP Shaft	HP	27.8

		1	2	3	4	5	6
Engine Inlet Temperature	deg F	0	20.0	40.0	60.0	80.0	100.0
Relative Humidity	%	60.0	60.0	60.0	60.0	60.0	60.0
Driven Equipment Speed	RPM	8663	8559	8423	8249	8032	7778
Specified Load	HP	75.0%	75.0%	75.0%	75.0%	75.0%	75.0%
Net Output Power	HP	12842	12450	11939	11281	10479	9589
Fuel Flow	mmBtu/hr	112.88	108.69	104.25	99.18	93.60	87.86
Heat Rate	Btu/HP-hr	8790	8730	8732	8792	8931	9163
Therm Eff	%	28.948	29.145	29.140	28.942	28.489	27.770
Engine Exhaust Flow	lbm/hr	346742	333011	318192	301449	283285	264650
PT Exit Temperature	deg F	903	911	920	933	950	976
Exhaust Temperature	deg F	871	885	901	918	938	966

Fuel Gas Composition (Volume Percent)

Methane (CH4)	87.71
Ethane (C2H6)	11.29
Propane (C3H8)	0.30
I-Butane (C4H10)	0.10
Carbon Dioxide (CO2)	0.20
Nitrogen (N2)	0.40
Sulfur Dioxide (SO2)	0.0001

Fuel Gas Properties

LHV (Btu/Scf)	990.3	Specific Gravity	0.6165	Wobbe Index at 60F	1261.3

This performance was calculated with a basic inlet and exhaust system. Special equipment such as low noise silencers, special filters, heat recovery systems or cooling devices will affect engine performance. Performance shown is "Expected" performance at the pressure drops stated, not guaranteed.

Solar Turbines
A Caterpillar Company

PREDICTED EMISSION PERFORMANCE

Customer	Engine Model: MARS 100-16000S CS/MD STANDARD
Job ID	
Inquiry Number	Fuel Type: CHOICE GAS; Water Injection: NO
Run By: David Anthony Pocengal; Date Run: 21-Mar-19	Engine Emissions Data: REV. 1.0

	NOx EMISSIONS	CO EMISSIONS	UHC EMISSIONS
1 — 17124 HP 100.0% Load — Elev. 660 ft — Rel. Humidity 60.0% — Temperature 0 Deg. F			
PPMvd at 15% O2	9.00	25.00	25.00
ton/yr	19.97	33.77	19.34
lbm/MMBtu (Fuel LHV)	0.036	0.061	0.035
lbm/(MW-hr)	0.36	0.60	0.35
(gas turbine shaft pwr) lbm/hr	4.56	7.71	4.42
2 — 16600 HP 100.0% Load — Elev. 660 ft — Rel. Humidity 60.0% — Temperature 20.0 Deg. F			
PPMvd at 15% O2	9.00	25.00	25.00
ton/yr	19.34	32.71	18.73
lbm/MMBtu (Fuel LHV)	0.036	0.061	0.035
lbm/(MW-hr)	0.36	0.60	0.35
(gas turbine shaft pwr) lbm/hr	4.42	7.47	4.28
3 — 15919 HP 100.0% Load — Elev. 660 ft — Rel. Humidity 60.0% — Temperature 40.0 Deg. F			
PPMvd at 15% O2	9.00	25.00	25.00
ton/yr	18.61	31.47	18.03
lbm/MMBtu (Fuel LHV)	0.036	0.061	0.035
lbm/(MW-hr)	0.36	0.61	0.35
(gas turbine shaft pwr) lbm/hr	4.25	7.19	4.12

Notes

1. For short-term emission limits such as lbs/hr., Solar recommends using "worst case" anticipated operating conditions specific to the application and the site conditions. Worst case for one pollutant is not ecessarily the same for another.
2. Solar's typical SoLoNOx warranty, for ppm values, is available for greater than 0 deg F or -20 deg F, and between 50% and 100% load for gas fuel, and between 65% and 100% load for liquid fuel (except fo r the Centaur 40). An emission warranty for non-SoLoNOx equipment is available for greater than 0 deg F or -20 deg F and between
3. Fuel must meet Solar standard fuel specification ES 9-98. Emissions are based on the attached fuel composition, or, San Diego natural gas or equivalent.
4. If needed, Solar can provide Product Information Letters to address turbine operation outside typical warranty ranges, as well as non-warranted emissions of SO2, PM10/2.5, VOC, and formaldehyde.
5. Solar can provide factory testing in San Diego to ensure the actual unit(s) meet the above values within the tolerances quoted. Pricing and schedule impact will be provided upon request.
6. Any emissions warranty is applicable only for steady-state conditions and does not apply during start-up, shut-down, malfunction, or transient event.

Solar Turbines
A Caterpillar Company

PREDICTED EMISSION PERFORMANCE

Customer	Engine Model: MARS 100-16000S CS/MD STANDARD
Job ID	
Inquiry Number	Fuel Type: CHOICE GAS; Water Injection: NO
Run By: David Anthony Pocengal; Date Run: 21-Mar-19	Engine Emissions Data: REV. 1.0

	NOx EMISSIONS	CO EMISSIONS	UHC EMISSIONS
4 — 15042 HP 100.0% Load; Elev. 660 ft; Rel. Humidity 60.0%; Temperature 60.0 Deg. F			
PPMvd at 15% O2	9.00	25.00	25.00
ton/yr	17.75	30.02	17.19
lbm/MMBtu (Fuel LHV)	0.036	0.061	0.035
lbm/(MW-hr)	0.36	0.61	0.35
(gas turbine shaft pwr) lbm/hr	4.05	6.85	3.92
5 — 13973 HP 100.0% Load; Elev. 660 ft; Rel. Humidity 60.0%; Temperature 80.0 Deg. F			
PPMvd at 15% O2	9.00	25.00	25.00
ton/yr	16.73	28.29	16.20
lbm/MMBtu (Fuel LHV)	0.036	0.060	0.034
lbm/(MW-hr)	0.37	0.62	0.36
(gas turbine shaft pwr) lbm/hr	3.82	6.46	3.70
6 — 12786 HP 100.0% Load; Elev. 660 ft; Rel. Humidity 60.0%; Temperature 100.0 Deg. F			
PPMvd at 15% O2	9.00	25.00	25.00
ton/yr	15.61	26.41	15.12
lbm/MMBtu (Fuel LHV)	0.035	0.059	0.034
lbm/(MW-hr)	0.37	0.63	0.36
(gas turbine shaft pwr) lbm/hr	3.56	6.03	3.45

Notes

1. For short-term emission limits such as lbs/hr., Solar recommends using "worst case" anticipated operating conditions specific to the application and the site conditions. Worst case for one pollutant is not ecessarily the same for another.
2. Solar's typical SoLoNOx warranty, for ppm values, is available for greater than 0 deg F or -20 deg F, and between 50% and 100% load for gas fuel, and between 65% and 100% load for liquid fuel (except fo r the Centaur 40). An emission warranty for non-SoLoNOx equipment is available for greater than 0 deg F or -20 deg F and between
3. Fuel must meet Solar standard fuel specification ES 9-98. Emissions are based on the attached fuel composition, or, San Diego natural gas or equivalent.
4. If needed, Solar can provide Product Information Letters to address turbine operation outside typical warranty ranges, as well as non-warranted emissions of SO2, PM10/2.5, VOC, and formaldehyde.
5. Solar can provide factory testing in San Diego to ensure the actual unit(s) meet the above values within the tolerances quoted. Pricing and schedule impact will be provided upon request.
6. Any emissions warranty is applicable only for steady-state conditions and does not apply during start-up, shut-down, malfunction, or transient event.

Solar Turbines
A Caterpillar Company

PREDICTED ENGINE PERFORMANCE

Customer	Model: MARS 100-16000S
Job ID	Package Type: CS/MD
Run By: David Anthony Pocengal — Date Run: 21-Mar-19	Match: STANDARD
Engine Performance Code: REV. 4.20.1.23.12 — Engine Performance Data: REV. 1.0	Fuel System: GAS
	Fuel Type: CHOICE GAS

DATA FOR NOMINAL PERFORMANCE

Elevation	feet	660
Inlet Loss	in H2O	4.0
Exhaust Loss	in H2O	5.0
Accessory on GP Shaft	HP	27.8

		1	2	3	4	5	6
Engine Inlet Temperature	deg F	0	20.0	40.0	60.0	80.0	100.0
Relative Humidity	%	60.0	60.0	60.0	60.0	60.0	60.0
Driven Equipment Speed	RPM	9382	9308	9200	9042	8844	8607
Specified Load	HP	FULL	FULL	FULL	FULL	FULL	FULL
Net Output Power	HP	17124	16600	15919	15042	13973	12786
Fuel Flow	mmBtu/hr	126.61	122.73	118.31	113.23	107.44	101.48
Heat Rate	Btu/HP-hr	7394	7394	7432	7527	7689	7937
Therm Eff	%	34.414	34.414	34.236	33.803	33.091	32.058
Engine Exhaust Flow	lbm/hr	358089	349342	338653	325256	309605	291080
PT Exit Temperature	deg F	866	879	893	910	926	947
Exhaust Temperature	deg F	866	879	893	910	926	947

Fuel Gas Composition (Volume Percent)

Methane (CH4)	87.71
Ethane (C2H6)	11.29
Propane (C3H8)	0.30
I-Butane (C4H10)	0.10
Carbon Dioxide (CO2)	0.20
Nitrogen (N2)	0.40
Sulfur Dioxide (SO2)	0.0001

Fuel Gas Properties

LHV (Btu/Scf)	990.3	Specific Gravity	0.6165	Wobbe Index at 60F	1261.3

This performance was calculated with a basic inlet and exhaust system. Special equipment such as low noise silencers, special filters, heat recovery systems or cooling devices will affect engine performance. Performance shown is "Expected" performance at the pressure drops stated, not guaranteed.

Solar Turbines
A Caterpillar Company

PREDICTED EMISSION PERFORMANCE

Customer	Engine Model: TAURUS 70-10802S CS/MD STANDARD
Job ID	
Inquiry Number	Fuel Type: CHOICE GAS; Water Injection: NO
Run By: David Anthony Pocengal; Date Run: 21-Mar-19	Engine Emissions Data: REV. 0.1

	NOx EMISSIONS	CO EMISSIONS	UHC EMISSIONS
1 — 5896 HP — 50.0% Load — Elev. 660 ft — Rel. Humidity 60.0% — Temperature 0 Deg. F			
PPMvd at 15% O2	9.00	15.00	15.00
ton/yr	9.57	9.71	5.56
lbm/MMBtu (Fuel LHV)	0.036	0.036	0.021
lbm/(MW-hr)	0.50	0.50	0.29
(gas turbine shaft pwr) lbm/hr	2.19	2.22	1.27
2 — 5791 HP — 50.0% Load — Elev. 660 ft — Rel. Humidity 60.0% — Temperature 20.0 Deg. F			
PPMvd at 15% O2	9.00	15.00	15.00
ton/yr	9.26	9.40	5.38
lbm/MMBtu (Fuel LHV)	0.036	0.036	0.021
lbm/(MW-hr)	0.49	0.50	0.28
(gas turbine shaft pwr) lbm/hr	2.11	2.15	1.23
3 — 5679 HP — 50.0% Load — Elev. 660 ft — Rel. Humidity 60.0% — Temperature 40.0 Deg. F			
PPMvd at 15% O2	9.00	15.00	15.00
ton/yr	8.94	9.07	5.20
lbm/MMBtu (Fuel LHV)	0.036	0.036	0.021
lbm/(MW-hr)	0.48	0.49	0.28
(gas turbine shaft pwr) lbm/hr	2.04	2.07	1.19

Notes

1. For short-term emission limits such as lbs/hr., Solar recommends using "worst case" anticipated operating conditions specific to the application and the site conditions. Worst case for one pollutant is not ecessarily the same for another.
2. Solar's typical SoLoNOx warranty, for ppm values, is available for greater than 0 deg F or -20 deg F, and between 50% and 100% load for gas fuel, and between 65% and 100% load for liquid fuel (except fo r the Centaur 40). An emission warranty for non-SoLoNOx equipment is available for greater than 0 deg F or -20 deg F and between
3. Fuel must meet Solar standard fuel specification ES 9-98. Emissions are based on the attached fuel composition, or, San Diego natural gas or equivalent.
4. If needed, Solar can provide Product Information Letters to address turbine operation outside typical warranty ranges, as well as non-warranted emissions of SO2, PM10/2.5, VOC, and formaldehyde.
5. Solar can provide factory testing in San Diego to ensure the actual unit(s) meet the above values within the tolerances quoted. Pricing and schedule impact will be provided upon request.
6. Any emissions warranty is applicable only for steady-state conditions and does not apply during start-up, shut-down, malfunction, or transient event.

Solar Turbines
A Caterpillar Company

PREDICTED EMISSION PERFORMANCE

Customer	Engine Model: TAURUS 70-10802S CS/MD STANDARD
Job ID	
Inquiry Number	Fuel Type: CHOICE GAS; Water Injection: NO
Run By: David Anthony Pocengal; Date Run: 21-Mar-19	Engine Emissions Data: REV. 0.1

	NOx EMISSIONS	CO EMISSIONS	UHC EMISSIONS
4 — 5251 HP — 50.0% Load — Elev. 660 ft — Rel. Humidity 60.0% — Temperature 60.0 Deg. F			
PPMvd at 15% O2	9.00	15.00	15.00
ton/yr	8.39	8.51	4.88
lbm/MMBtu (Fuel LHV)	0.036	0.036	0.021
lbm/(MW-hr)	0.49	0.50	0.28
(gas turbine shaft pwr) lbm/hr	1.92	1.94	1.11
5 — 4765 HP — 50.0% Load — Elev. 660 ft — Rel. Humidity 60.0% — Temperature 80.0 Deg. F			
PPMvd at 15% O2	9.00	15.00	15.00
ton/yr	7.81	7.93	4.54
lbm/MMBtu (Fuel LHV)	0.036	0.036	0.021
lbm/(MW-hr)	0.50	0.51	0.29
(gas turbine shaft pwr) lbm/hr	1.78	1.81	1.04
6 — 4213 HP — 50.0% Load — Elev. 660 ft — Rel. Humidity 60.0% — Temperature 100.0 Deg. F			
PPMvd at 15% O2	9.00	15.00	15.00
ton/yr	7.18	7.28	4.17
lbm/MMBtu (Fuel LHV)	0.035	0.036	0.020
lbm/(MW-hr)	0.52	0.53	0.30
(gas turbine shaft pwr) lbm/hr	1.64	1.66	0.95

Notes

1. For short-term emission limits such as lbs/hr., Solar recommends using "worst case" anticipated operating conditions specific to the application and the site conditions. Worst case for one pollutant is not ecessarily the same for another.
2. Solar's typical SoLoNOx warranty, for ppm values, is available for greater than 0 deg F or -20 deg F, and between 50% and 100% load for gas fuel, and between 65% and 100% load for liquid fuel (except fo r the Centaur 40). An emission warranty for non-SoLoNOx equipment is available for greater than 0 deg F or -20 deg F and between
3. Fuel must meet Solar standard fuel specification ES 9-98. Emissions are based on the attached fuel composition, or, San Diego natural gas or equivalent.
4. If needed, Solar can provide Product Information Letters to address turbine operation outside typical warranty ranges, as well as non-warranted emissions of SO2, PM10/2.5, VOC, and formaldehyde.
5. Solar can provide factory testing in San Diego to ensure the actual unit(s) meet the above values within the tolerances quoted. Pricing and schedule impact will be provided upon request.
6. Any emissions warranty is applicable only for steady-state conditions and does not apply during start-up, shut-down, malfunction, or transient event.

Solar Turbines
A Caterpillar Company

PREDICTED ENGINE PERFORMANCE

Customer	Model: TAURUS 70-10802S
Job ID	Package Type: CS/MD
Run By: David Anthony Pocengal — Date Run: 21-Mar-19	Match: STANDARD
Engine Performance Code: REV. 4.20.1.23.12 — Engine Performance Data: REV. 2.0	Fuel System: GAS
	Fuel Type: CHOICE GAS

DATA FOR NOMINAL PERFORMANCE

Elevation	feet	660
Inlet Loss	in H2O	4.0
Exhaust Loss	in H2O	5.0
Accessory on GP Shaft	HP	23.8

		1	2	3	4	5	6
Engine Inlet Temperature	deg F	0	20.0	40.0	60.0	80.0	100.0
Relative Humidity	%	60.0	60.0	60.0	60.0	60.0	60.0
Driven Equipment Speed	RPM	9599	9490	9371	9103	8832	8473
Specified Load	HP	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%
Net Output Power	HP	5896	5791	5679	5251	4765	4213
Fuel Flow	mmBtu/hr	60.79	58.84	56.89	53.59	50.22	46.71
Heat Rate	Btu/HP-hr	10309	10161	10018	10206	10539	11088
Therm Eff	%	24.681	25.040	25.400	24.931	24.142	22.948
Engine Exhaust Flow	lbm/hr	193732	184510	175525	164700	154859	144522
PT Exit Temperature	deg F	964	974	984	1003	1022	1045
Exhaust Temperature	deg F	886	912	937	964	989	1016

Fuel Gas Composition (Volume Percent)

Methane (CH4)	87.71
Ethane (C2H6)	11.29
Propane (C3H8)	0.30
I-Butane (C4H10)	0.10
Carbon Dioxide (CO2)	0.20
Nitrogen (N2)	0.40
Sulfur Dioxide (SO2)	0.0001

Fuel Gas Properties

LHV (Btu/Scf)	990.3	Specific Gravity	0.6165	Wobbe Index at 60F	1261.3

This performance was calculated with a basic inlet and exhaust system. Special equipment such as low noise silencers, special filters, heat recovery systems or cooling devices will affect engine performance. Performance shown is "Expected" performance at the pressure drops stated, not guaranteed.

Solar Turbines
A Caterpillar Company

PREDICTED EMISSION PERFORMANCE

Customer	Engine Model: TAURUS 70-10802S CS/MD STANDARD
Job ID	
Inquiry Number	Fuel Type: CHOICE GAS; Water Injection: NO
Run By: David Anthony Pocengal; Date Run: 21-Mar-19	Engine Emissions Data: REV. 0.1

	NOx EMISSIONS	CO EMISSIONS	UHC EMISSIONS
1 — 8844 HP — 75.0% Load — Elev. 660 ft — Rel. Humidity 60.0% — Temperature 0 Deg. F			
PPMvd at 15% O2	9.00	15.00	15.00
ton/yr	11.59	11.76	6.74
lbm/MMBtu (Fuel LHV)	0.036	0.037	0.021
lbm/(MW-hr)	0.40	0.41	0.23
(gas turbine shaft pwr) lbm/hr	2.65	2.69	1.54
2 — 8686 HP — 75.0% Load — Elev. 660 ft — Rel. Humidity 60.0% — Temperature 20.0 Deg. F			
PPMvd at 15% O2	9.00	15.00	15.00
ton/yr	11.20	11.36	6.51
lbm/MMBtu (Fuel LHV)	0.036	0.036	0.021
lbm/(MW-hr)	0.39	0.40	0.23
(gas turbine shaft pwr) lbm/hr	2.56	2.59	1.49
3 — 8519 HP — 75.0% Load — Elev. 660 ft — Rel. Humidity 60.0% — Temperature 40.0 Deg. F			
PPMvd at 15% O2	9.00	15.00	15.00
ton/yr	10.79	10.94	6.27
lbm/MMBtu (Fuel LHV)	0.036	0.036	0.021
lbm/(MW-hr)	0.39	0.39	0.23
(gas turbine shaft pwr) lbm/hr	2.46	2.50	1.43

Notes

1. For short-term emission limits such as lbs/hr., Solar recommends using "worst case" anticipated operating conditions specific to the application and the site conditions. Worst case for one pollutant is not ecessarily the same for another.
2. Solar's typical SoLoNOx warranty, for ppm values, is available for greater than 0 deg F or -20 deg F, and between 50% and 100% load for gas fuel, and between 65% and 100% load for liquid fuel (except fo r the Centaur 40). An emission warranty for non-SoLoNOx equipment is available for greater than 0 deg F or -20 deg F and between
3. Fuel must meet Solar standard fuel specification ES 9-98. Emissions are based on the attached fuel composition, or, San Diego natural gas or equivalent.
4. If needed, Solar can provide Product Information Letters to address turbine operation outside typical warranty ranges, as well as non-warranted emissions of SO2, PM10/2.5, VOC, and formaldehyde.
5. Solar can provide factory testing in San Diego to ensure the actual unit(s) meet the above values within the tolerances quoted. Pricing and schedule impact will be provided upon request.
6. Any emissions warranty is applicable only for steady-state conditions and does not apply during start-up, shut-down, malfunction, or transient event.

Solar Turbines
A Caterpillar Company

PREDICTED EMISSION PERFORMANCE

Customer	Engine Model: TAURUS 70-10802S CS/MD STANDARD
Job ID	
Inquiry Number	Fuel Type: CHOICE GAS; Water Injection: NO
Run By: David Anthony Pocengal; Date Run: 21-Mar-19	Engine Emissions Data: REV. 0.1

	NOx EMISSIONS	CO EMISSIONS	UHC EMISSIONS
4 — 7876 HP — 75.0% Load — Elev. 660 ft — Rel. Humidity 60.0% — Temperature 60.0 Deg. F			
PPMvd at 15% O2	9.00	15.00	15.00
ton/yr	10.09	10.24	5.86
lbm/MMBtu (Fuel LHV)	0.036	0.036	0.021
lbm/(MW-hr)	0.39	0.40	0.23
(gas turbine shaft pwr) lbm/hr	2.30	2.34	1.34
5 — 7148 HP — 75.0% Load — Elev. 660 ft — Rel. Humidity 60.0% — Temperature 80.0 Deg. F			
PPMvd at 15% O2	9.00	15.00	15.00
ton/yr	9.36	9.49	5.44
lbm/MMBtu (Fuel LHV)	0.036	0.036	0.021
lbm/(MW-hr)	0.40	0.41	0.23
(gas turbine shaft pwr) lbm/hr	2.14	2.17	1.24
6 — 6319 HP — 75.0% Load — Elev. 660 ft — Rel. Humidity 60.0% — Temperature 100.0 Deg. F			
PPMvd at 15% O2	9.00	15.00	15.00
ton/yr	8.55	8.68	4.97
lbm/MMBtu (Fuel LHV)	0.035	0.036	0.020
lbm/(MW-hr)	0.41	0.42	0.24
(gas turbine shaft pwr) lbm/hr	1.95	1.98	1.13

Notes

1. For short-term emission limits such as lbs/hr., Solar recommends using "worst case" anticipated operating conditions specific to the application and the site conditions. Worst case for one pollutant is not ecessarily the same for another.
2. Solar's typical SoLoNOx warranty, for ppm values, is available for greater than 0 deg F or -20 deg F, and between 50% and 100% load for gas fuel, and between 65% and 100% load for liquid fuel (except fo r the Centaur 40). An emission warranty for non-SoLoNOx equipment is available for greater than 0 deg F or -20 deg F and between
3. Fuel must meet Solar standard fuel specification ES 9-98. Emissions are based on the attached fuel composition, or, San Diego natural gas or equivalent.
4. If needed, Solar can provide Product Information Letters to address turbine operation outside typical warranty ranges, as well as non-warranted emissions of SO2, PM10/2.5, VOC, and formaldehyde.
5. Solar can provide factory testing in San Diego to ensure the actual unit(s) meet the above values within the tolerances quoted. Pricing and schedule impact will be provided upon request.
6. Any emissions warranty is applicable only for steady-state conditions and does not apply during start-up, shut-down, malfunction, or transient event.

Solar Turbines
A Caterpillar Company

PREDICTED ENGINE PERFORMANCE

Customer	Model: TAURUS 70-10802S
Job ID	Package Type: CS/MD
Run By: David Anthony Pocengal — Date Run: 21-Mar-19	Match: STANDARD
Engine Performance Code: REV. 4.20.1.23.12 — Engine Performance Data: REV. 2.0	Fuel System: GAS
	Fuel Type: CHOICE GAS

DATA FOR NOMINAL PERFORMANCE

Elevation	feet	660
Inlet Loss	in H2O	4.0
Exhaust Loss	in H2O	5.0
Accessory on GP Shaft	HP	23.8

		1	2	3	4	5	6
Engine Inlet Temperature	deg F	0	20.0	40.0	60.0	80.0	100.0
Relative Humidity	%	60.0	60.0	60.0	60.0	60.0	60.0
Driven Equipment Speed	RPM	10836	10756	10671	10400	10056	9603
Specified Load	HP	75.0%	75.0%	75.0%	75.0%	75.0%	75.0%
Net Output Power	HP	8844	8686	8519	7876	7148	6319
Fuel Flow	mmBtu/hr	73.56	71.10	68.60	64.39	60.11	55.59
Heat Rate	Btu/HP-hr	8317	8186	8053	8175	8410	8797
Therm Eff	%	30.591	31.085	31.595	31.124	30.255	28.922
Engine Exhaust Flow	lbm/hr	218894	209715	200410	187413	174270	159826
PT Exit Temperature	deg F	897	905	915	935	960	991
Exhaust Temperature	deg F	869	887	904	928	955	988

Fuel Gas Composition (Volume Percent)

Methane (CH4)	87.71
Ethane (C2H6)	11.29
Propane (C3H8)	0.30
I-Butane (C4H10)	0.10
Carbon Dioxide (CO2)	0.20
Nitrogen (N2)	0.40
Sulfur Dioxide (SO2)	0.0001

Fuel Gas Properties

LHV (Btu/Scf)	990.3	Specific Gravity	0.6165	Wobbe Index at 60F	1261.3

This performance was calculated with a basic inlet and exhaust system. Special equipment such as low noise silencers, special filters, heat recovery systems or cooling devices will affect engine performance. Performance shown is "Expected" performance at the pressure drops stated, not guaranteed.

Solar Turbines
A Caterpillar Company

PREDICTED EMISSION PERFORMANCE

Customer	Engine Model: TAURUS 70-10802S CS/MD STANDARD
Job ID	
Inquiry Number	Fuel Type: CHOICE GAS; Water Injection: NO
Run By: David Anthony Pocengal; Date Run: 21-Mar-19	Engine Emissions Data: REV. 0.1

	NOx EMISSIONS	CO EMISSIONS	UHC EMISSIONS
1 — 11792 HP 100.0% Load — Elev. 660 ft — Rel. Humidity 60.0% — Temperature 0 Deg. F			
PPMvd at 15% O2	9.00	15.00	15.00
ton/yr	13.19	13.38	7.66
lbm/MMBtu (Fuel LHV)	0.036	0.037	0.021
lbm/(MW-hr)	0.34	0.35	0.20
(gas turbine shaft pwr) lbm/hr	3.01	3.06	1.75
2 — 11582 HP 100.0% Load — Elev. 660 ft — Rel. Humidity 60.0% — Temperature 20.0 Deg. F			
PPMvd at 15% O2	9.00	15.00	15.00
ton/yr	13.01	13.20	7.56
lbm/MMBtu (Fuel LHV)	0.036	0.037	0.021
lbm/(MW-hr)	0.34	0.35	0.20
(gas turbine shaft pwr) lbm/hr	2.97	3.01	1.73
3 — 11358 HP 100.0% Load — Elev. 660 ft — Rel. Humidity 60.0% — Temperature 40.0 Deg. F			
PPMvd at 15% O2	9.00	15.00	15.00
ton/yr	12.82	13.01	7.45
lbm/MMBtu (Fuel LHV)	0.036	0.036	0.021
lbm/(MW-hr)	0.35	0.35	0.20
(gas turbine shaft pwr) lbm/hr	2.93	2.97	1.70

Notes

1. For short-term emission limits such as lbs/hr., Solar recommends using "worst case" anticipated operating conditions specific to the application and the site conditions. Worst case for one pollutant is not ecessarily the same for another.
2. Solar's typical SoLoNOx warranty, for ppm values, is available for greater than 0 deg F or -20 deg F, and between 50% and 100% load for gas fuel, and between 65% and 100% load for liquid fuel (except fo r the Centaur 40). An emission warranty for non-SoLoNOx equipment is available for greater than 0 deg F or -20 deg F and between
3. Fuel must meet Solar standard fuel specification ES 9-98. Emissions are based on the attached fuel composition, or, San Diego natural gas or equivalent.
4. If needed, Solar can provide Product Information Letters to address turbine operation outside typical warranty ranges, as well as non-warranted emissions of SO2, PM10/2.5, VOC, and formaldehyde.
5. Solar can provide factory testing in San Diego to ensure the actual unit(s) meet the above values within the tolerances quoted. Pricing and schedule impact will be provided upon request.
6. Any emissions warranty is applicable only for steady-state conditions and does not apply during start-up, shut-down, malfunction, or transient event.

Solar Turbines
A Caterpillar Company

PREDICTED EMISSION PERFORMANCE

Customer	Engine Model: TAURUS 70-10802S CS/MD STANDARD
Job ID	
Inquiry Number	Fuel Type: CHOICE GAS; Water Injection: NO
Run By: David Anthony Pocengal; Date Run: 21-Mar-19	Engine Emissions Data: REV. 0.1

	NOx EMISSIONS	CO EMISSIONS	UHC EMISSIONS
4 — 10502 HP 100.0% Load; Elev. 660 ft; Rel. Humidity 60.0%; Temperature 60.0 Deg. F			
PPMvd at 15% O2	9.00	15.00	15.00
ton/yr	12.07	12.25	7.01
lbm/MMBtu (Fuel LHV)	0.036	0.036	0.021
lbm/(MW-hr)	0.35	0.36	0.20
(gas turbine shaft pwr) lbm/hr	2.76	2.80	1.60
5 — 9530 HP 100.0% Load; Elev. 660 ft; Rel. Humidity 60.0%; Temperature 80.0 Deg. F			
PPMvd at 15% O2	9.00	15.00	15.00
ton/yr	11.22	11.38	6.52
lbm/MMBtu (Fuel LHV)	0.036	0.036	0.021
lbm/(MW-hr)	0.36	0.37	0.21
(gas turbine shaft pwr) lbm/hr	2.56	2.60	1.49
6 — 8425 HP 100.0% Load; Elev. 660 ft; Rel. Humidity 60.0%; Temperature 100.0 Deg. F			
PPMvd at 15% O2	9.00	15.00	15.00
ton/yr	10.26	10.41	5.96
lbm/MMBtu (Fuel LHV)	0.035	0.036	0.020
lbm/(MW-hr)	0.37	0.38	0.22
(gas turbine shaft pwr) lbm/hr	2.34	2.38	1.36

Notes

1. For short-term emission limits such as lbs/hr., Solar recommends using "worst case" anticipated operating conditions specific to the application and the site conditions. Worst case for one pollutant is not ecessarily the same for another.
2. Solar's typical SoLoNOx warranty, for ppm values, is available for greater than 0 deg F or -20 deg F, and between 50% and 100% load for gas fuel, and between 65% and 100% load for liquid fuel (except fo r the Centaur 40). An emission warranty for non-SoLoNOx equipment is available for greater than 0 deg F or -20 deg F and between
3. Fuel must meet Solar standard fuel specification ES 9-98. Emissions are based on the attached fuel composition, or, San Diego natural gas or equivalent.
4. If needed, Solar can provide Product Information Letters to address turbine operation outside typical warranty ranges, as well as non-warranted emissions of SO2, PM10/2.5, VOC, and formaldehyde.
5. Solar can provide factory testing in San Diego to ensure the actual unit(s) meet the above values within the tolerances quoted. Pricing and schedule impact will be provided upon request.
6. Any emissions warranty is applicable only for steady-state conditions and does not apply during start-up, shut-down, malfunction, or transient event.

Solar Turbines
A Caterpillar Company

PREDICTED ENGINE PERFORMANCE

Customer	Model: TAURUS 70-10802S
Job ID	Package Type: CS/MD
Run By: David Anthony Pocengal — Date Run: 21-Mar-19	Match: STANDARD
Engine Performance Code: REV. 4.20.1.23.12 — Engine Performance Data: REV. 2.0	Fuel System: GAS
	Fuel Type: CHOICE GAS

DATA FOR NOMINAL PERFORMANCE

Elevation	feet	660
Inlet Loss	in H2O	4.0
Exhaust Loss	in H2O	5.0
Accessory on GP Shaft	HP	23.8

		1	2	3	4	5	6
Engine Inlet Temperature	deg F	0	20.0	40.0	60.0	80.0	100.0
Relative Humidity	%	60.0	60.0	60.0	60.0	60.0	60.0
Driven Equipment Speed	RPM	11860	11842	11765	11495	11189	10795
Specified Load	HP	FULL	FULL	FULL	FULL	FULL	FULL
Net Output Power	HP	11792	11582	11358	10502	9530	8425
Fuel Flow	mmBtu/hr	83.63	82.54	81.49	76.97	72.04	66.63
Heat Rate	Btu/HP-hr	7092	7127	7175	7330	7559	7909
Therm Eff	%	35.880	35.702	35.462	34.715	33.660	32.173
Engine Exhaust Flow	lbm/hr	231766	225330	218824	207302	194518	179092
PT Exit Temperature	deg F	856	887	920	943	967	1000
Exhaust Temperature	deg F	856	887	920	943	967	1000

Fuel Gas Composition (Volume Percent)

Methane (CH4)	87.71
Ethane (C2H6)	11.29
Propane (C3H8)	0.30
I-Butane (C4H10)	0.10
Carbon Dioxide (CO2)	0.20
Nitrogen (N2)	0.40
Sulfur Dioxide (SO2)	0.0001

Fuel Gas Properties

LHV (Btu/Scf)	990.3	Specific Gravity	0.6165	Wobbe Index at 60F	1261.3

This performance was calculated with a basic inlet and exhaust system. Special equipment such as low noise silencers, special filters, heat recovery systems or cooling devices will affect engine performance. Performance shown is "Expected" performance at the pressure drops stated, not guaranteed.

SoLoNOx Products: Emissions in Non-SoLoNOx Modes

Leslie Witherspoon
Solar Turbines Incorporated

PURPOSE

Solar's gas turbine dry low NOx emissions combustion systems, known as *SoLoNOx*™, have been developed to provide the lowest emissions possible during normal operating conditions. In order to optimize the performance of the turbine, the combustion and fuel systems are designed to reduce NOx, CO and unburned hydrocarbons (UHC) without penalizing stability or transient capabilities. At very low load and cold temperature extremes, the *SoLoNOx* system must be controlled differently in order to assure stable operation. The required adjustments to the turbine controls at these conditions cause emissions to increase.

The purpose of this Product Information Letter is to provide emissions estimates, and in some cases warrantable emissions for NOx, CO and UHC, at off-design conditions.

The expected emissions values that follow are typically used to estimate emissions for annual emissions inventory purposes, for New Source Review applicability determinations, for air dispersion modeling, and for air permitting.

EMISSIONS ESTIMATES IN NON-SOLONOX MODE (LOW LOAD)

At operating loads < ~50%[1] on natural gas fuel and < ~65%[2] on liquid fuels, *SoLoNOx* engines are controlled to increase stability and transient response capability. The control steps that are required affect emissions in two ways: 1) pilot fuel flow is increased, increasing NOx emissions, and 2) airflow through the combustor is increased, increasing CO emissions. Engine controls are triggered either by power output for single-shaft engines or gas producer speed for two-shaft engines.

Emissions at lower loads vary by model and by the generation of control system. NOx can range from 40 to 70 ppm (raw) and CO and UHC emissions can vary from 25 to 10000 ppm (raw).

For emissions estimates at part-load conditions (idle to SoLoNOx mode) contact Solar's Environmental Programs Group (Anthony Pocengal 858.505.8554 or Leslie Witherspoon 858.694.6609).

As an alternative, a conservative method for estimating emissions of NOx at low loads is to use the applicable New Source Performance Standard (NSPS): 40CFR60 subpart GG or KKKK. For projects that commence construction after February 18, 2005, subpart KKKK is the applicable NSPS and contains a NOx level of 150 ppm @ 15% O_2 for operating loads less than 75%.

[1] <~40% load for the *Titan* 250
[2] < ~80% load for *Centaur* 40

COLD AMBIENT EMISSIONS ESTIMATES

Solar's standard temperature range warranty for gas turbines with *SoLoNOx* combustion is ≥ 0°F. At ambient temperatures below 0°F, Solar's turbine models are controlled to increase pilot fuel which improves flame stability but leads to higher emissions. Without the increase in pilot fuel at temperatures below 0°F the turbine may exhibit combustor rumble, as operation may be near the lean stability limit. The *Titan*™ 250 is an exception, with a lower standard warranty at ≥ –20°F.

If a cold ambient emissions warranty is requested, the turbine must be configured with the appropriate combustion hardware and software. For new production hardware this refers to the inclusion of "Pilot Active Control Logic". Pilot Active Control Logic employs active oscillations feedback to increase pilot and reduce oscillations.

A cold ambient emissions warranty is only available on gas turbines being fired on natural gas and is not offered for ambient temperatures below –20°F. Standard natural gas as defined in Solar's fuel spec, ES9-98, is required to offer a cold ambient warranty, but non-standard fuels on a project basis can be reviewed by Solar to determine applicability. Cold ambient emissions warranties cannot be offered for the *Centaur*® 40 turbine. In addition, a cold ambient warranty cannot be offered for liquid fuel operation at this time.

Table 1 provides expected and warrantable cold ambient emissions levels for Solar's *SoLoNOx* combustion turbines. Refer to Product Information Letter 205 for *Mercury*™ 50 turbine emissions estimates.

Table 1. ***Expected and/or Warrantable Emissions Between 0°F and –20°F for Turbines Equipped with Pilot Active Control Logic***
Natural Gas Fuel
NOx ppm values corrected to 15% O2

Turbine Model	Fuel System	Fuel	Applicable Load	NOx, ppm	CO, ppm	UHC, ppm
Centaur 50	Gas Only	Gas	50 to 100% load	42	100	50
	Dual Fuel	Gas	50 to 100% load	72	100	50
Taurus™ 60	Gas Only or Dual Fuel	Gas	50 to 100% load	42	100	50
Taurus 65	Gas Only	Gas	50 to 100% load	42	100	50
Taurus 70	Gas Only or Dual Fuel	Gas	50 to 100% load	42	100	50
Mars® 90	Gas Only	Gas	50 to 100% load	42	100	50
Mars 100	Gas Only or Dual Fuel	Gas	50 to 100% load	42	100	50
Titan 130	Gas Only or Dual Fuel	Gas	50 to 100% load	42	100	50
Titan 250	Gas Only	Gas	40 to 100% load	25	50	25
	Gas Only	Gas	40 to 100% load	15	25	25

A cold ambient warranty is available for new equipment and will expire along with the new equipment warranty. A cold ambient warranty is available for existing equipment if the cold ambient upgrade is done at the time of overhaul. If an existing eligible turbine undergoes a "field retrofit" of the Pilot Active Control Logic, emissions values as shown in Table 1 are "expected" but not warranted. A warranty can be activated at the next engine overhaul and will expire along with the engine overhaul warranty. **Not all legacy models/ratings will have a cold ambient warranty option.**

For information on the availability and approvals for cold ambient temperature emissions warranties, please contact Solar's sales representatives.

Table 2 summarizes "expected" emissions levels for ambient temperatures below 0°F for Solar's *SoLoNOx* turbines that are not equipped with the Pilot Active Control Logic or do not have the a generation of hardware that can be equipped with Pilot Active Control Logic. The emissions levels are extrapolated from San Diego factory tests and may vary at extreme temperatures and as a result of variations in other parameters, such as fuel composition, fuel quality, etc.

Table 3 summarizes "expected" emissions levels for ambient temperatures below –20°F for the *Titan* 250.

Table 2. Expected Emissions below 0°F for SoLoNOx Combustion Turbines without Pilot Active Control Logic
NOx ppm values corrected to 15% O2

Turbine Model	Fuel	Applicable Load	NOx, ppm	CO, ppm	UHC, ppm
Centaur 40	Gas	50 to 100% load	120	150	50
Centaur 50	Gas	50 to 100% load	120	150	50
	Gas	50 to 100% load	120	150	50
Taurus 60	Gas	50 to 100% load	120	150	50
Taurus 65	Gas	50 to 100% load	120	150	50
Taurus 70	Gas	50 to 100% load	120	150	50
Mars 90	Gas	50 to 100% load	120	150	50
Mars 100	Gas	50 to 100% load	120	150	50
Titan 130	Gas	50 to 100% load	120	150	50
Centaur 40	Liquid	80 to 100% load	150	150	75
Centaur 50	Liquid	65 to 100% load	150	150	75
Taurus 60	Liquid	65 to 100% load	150	150	75
Taurus 70	Liquid	65 to 100% load	150	150	75
Mars 100	Liquid	65 to 100% load	150	150	75
Titan 130	Liquid	65 to 100% load	150	150	75

Table 3. Expected Emissions below –20°F for the Titan 250 SoLoNOx Combustion Turbine
NOx ppm values corrected to 15% O2

Turbine Model	Fuel	Applicable Load	NOx, ppm	CO, ppm	UHC, ppm
Titan 250	Gas	40 to 100% load	70	150	50

For a more conservative NOx emissions estimate than shown in Table 2 or 3, customers can refer to the NSPS 40CFR60, Subpart KKKK, where the allowable NOx emissions level for ambient temperatures < 0°F is 150 ppm NOx at 15% O_2. For pre-February 18, 2005, *SoLoNOx* combustion turbines subject to 40CFR60 subpart GG, a conservative estimate is the appropriate subpart GG emissions level. Subpart GG levels range from 150 to 214 ppm NOx at 15% O_2 on natural gas (and 150-210 on liquid fuel) depending on the turbine model.

COLD AMBIENT PERMITTING STRATEGY OPTIONS

When permitting in cold ambient climates, customers can use a “tiered emissions” permitting approach, choose to permit a single emission rate over all temperatures, use 40CFR60 Subpart KKKK, or develop another strategy to satisfy air permitting requirements.

In a “tiered” approach, a digital thermometer is installed to record ambient temperature. The amount of time is recorded that the ambient temperature falls below 0°F. The amount of time below 0°F is then used with the emissions estimates shown in Tables 1 and 2 to estimate “actual” emissions during sub-zero operation.

For customers who wish to permit at a single emission rate over all ambient temperatures, inlet air heating can be used to raise the engine inlet air temperature (T_1) above 0°F. With inlet air heating to keep T_1 above 0°F, standard emission warranty levels may be offered. Inlet air heating technology options include an electric resistance heater, an inlet air to exhaust heat exchanger and a glycol heat exchanger.

A conservative alternative to using the NOx values in Tables 1, 2 and 3 is to reference 40CFR60 subpart KKKK, which allows 150 ppm NOx at 15% O_2 for sub-zero operation.

Solar Turbines Incorporated
9330 Sky Park Court
San Diego, CA 92123-5398

Volatile Organic Compound, Sulfur Dioxide, and Formaldehyde Emission Estimates

Leslie Witherspoon
Solar Turbines Incorporated

PURPOSE

This Product Information Letter (PIL) summarizes recommended emission factors often utilized to estimate emissions of volatile organic compounds (VOC), sulfur dioxide (SO_2), and formaldehyde from gas turbines.

INTRODUCTION

Emissions estimates of VOC, SO2, and formaldehyde are often necessary during the air permitting process. In absence of manufacturer, site-specific or representative source test data, gas turbine users often refer to EPA (or state) reference documents or databases. The emissions estimates in this PIL are assumed valid at ambient temperatures >0 °F and for natural gas from 50-100% load (40-100% load for the *Titan*™ 250 and 80-100% load for the *Saturn*® 20) or for liquid fuel from 65-100% load (80-100% for the *Saturn* 20 and *Centaur*® 40).

Volatile Organic Compounds

Permitting agencies usually require gas turbine users to include emissions of VOC, a subpart of the unburned hydrocarbon (UHC) emissions, during the air permitting process. Volatile organic compounds, non-methane hydrocarbons (NMHC), and reactive organic gases (ROG) are some of the ways of referring to the non-methane (and non-ethane) portion of an “unburned hydrocarbon” emission estimate.

For natural gas fuel, most Solar customers use a 5 ppm VOC level to estimate emissions for the air permit. For liquid fuel, Solar’s customers usually assume UHC emissions equal VOC emissions. The UHC/VOC value typically used is 25 ppm.

EPA’s AP-42[1] document and WebFIRE[2] database also contain VOC emissions estimates for gas turbines. These sources are seldom used by Solar’s customers.

Sulfur Dioxide

Sulfur dioxide emissions are produced by conversion of sulfur in the fuel to SO_2. Solar customers usually either use a mass balance calculation or AP-42/WebFIRE to estimate SO_2 emissions. Because Solar does not control the amount of sulfur in the fuel, no SO_2 emissions warranty is available.

The mass balance method assumes that any sulfur in the fuel converts to SO_2. For reference, the typical mass balance equation is shown below.

$$\frac{\text{lb } SO_2}{\text{hr}} = \left(\frac{\text{wt\% Sulfur}}{100}\right)\left(\frac{\text{lb fuel}}{\text{Btu}}\right)\left(\frac{10^6 \text{ Btu}}{\text{MMBtu}}\right)\left(\frac{\text{MMBtu fuel}}{\text{hr}}\right)\left(\frac{\text{MW } SO_2}{\text{MW Sulfur}}\right)$$

[1] AP-42 is an EPA document containing a compilation of air pollutant emission factors by source category.
[2] WebFIRE is an EPA electronic based repository and retrieval tool for emission factors.

Variables: wt % of sulfur in fuel
Btu/lb fuel (LHV)
MMBtu/hr fuel flow (LHV)

As an alternative to the mass balance calculation, EPA's AP-42 document can be used. AP-42 (Table 3.1-2a, April 2000) suggests emission factors of 0.94S lb/MMBtu (HHV) (where S=sulfur % in fuel) or 0.0034 lb/MMBtu (HHV) for gas fuel and 1.01S lb/MMBtu (HHV) (where S=sulfur % in fuel) or 0.033 lb/MMBtu (HHV) for liquid fuel.

Formaldehyde

For gas turbines, formaldehyde emissions are a result of incomplete combustion. Formaldehyde in the exhaust stream is unstable and difficult to measure. In addition to turbine characteristics including combustor design, size, maintenance history, and load profile, the formaldehyde emissions level is also affected by: ambient temperature, humidity, atmospheric pressure, fuel quality, formaldehyde concentration in the ambient air, test method measurement variability, and operational factors.

The emission factor data in Table 1 is an excerpt from an EPA memo: "Revised HAP Emission Factors for Stationary Combustion Turbines, 8/22/03." The memo presents hazardous air pollutant (HAP) emission factor data in several categories. The emission factors in the memo are a compilation of the HAP data EPA collected during the Maximum Achievable Control Technology (MACT) standard development process. The emission factor documentation shows there is a high degree of variability in formaldehyde emissions from gas turbines, depending on the manufacturer, rating size of equipment, combustor design, and testing events.

Table 1. EPA's Total HAP and Formaldehyde Emission Factors for <50 MW Lean-Premix Gas Turbines burning Natural Gas

(Source: Revised HAP Emission Factors for Stationary Combustion Turbines, OAR-2002-0060, IV-B-09, 8/22/03)

Pollutant	Engine Load	95% Upper Confidence of Mean, lb/MMBtu HHV	95% Upper Confidence of Data, lb/MMBtu HHV	Memo Reference
Total HAP	> 90%	0.00144	0.00258	Table 19
Total HAP	All	0.00160	0.00305	Table 16
Formaldehyde	> 90%	0.00127	0.00241	Table 19
Formaldehyde	All	0.00143	0.00288	Table 16

AP-42 and the California Air Toxics Emission Factor (CATEF) database also contain formaldehyde emission factors. Both sources reference data that is older than the data summarized in Table 1.

To estimate formaldehyde emissions from gas turbines, users should use the emission factor that best represents the gas turbine's actual/planned operating profile. Solar does not offer a formaldehyde emissions warranty.

Solar Turbines Incorporated
9330 Sky Park Court
San Diego, CA 92123-5398

Emission Estimates at Start-up, Shutdown, and Commissioning for SoLoNOx Combustion Products

Leslie Witherspoon
Solar Turbines Incorporated

PURPOSE

The purpose of this Product Information Letter (PIL) is to provide emission estimates for start-up and shutdown events for *Solar*® gas turbines with *SoLoNOx*™ dry low emissions combustion systems.[1] For start-up and shutdown emissions estimates for conventional combustion turbines, landfill gas, digester gas, or other alternative fuel applications, contact Solar's Environmental Programs Department.

INTRODUCTION

The information presented in this document is representative for both generator set (GS) and compressor set / mechanical drive (CS/MD) combustion turbine applications. Operation of duct burners and/or any add-on control equipment is not accounted for in the emissions estimates. Emissions estimates related to the start-up, shutdown, and commissioning of combustion turbines will not be warranted. The estimates in this document are based on limited engine testing and analysis. The engine testing was conducted at idle and other non-*SoLoNOx* mode load points. An actual SU/SD event was not measured.

The estimates are most commonly used for potential to emit calculations to determine air permitting status. **Solar discourages customers from accepting the estimates as start-up and shutdown event permit limits with or without source testing requirements.** Accurately measuring emissions during a – non-steady state - start-up or shutdown event with steady state source test methods may prove to be very challenging. In the event customers take permit limits and accept compliance testing permit conditions, Solar recommends adding significant margin to the estimates in this document.

START-UP PROCESS

The duration of a nominal start-up is the same for a cold start, warm start, or hot start (e.g. a Solar Turbine is programmed to start-up in "x" minutes whether it's a cold, warm, or hot start).

The start-up and shutdown time for a *Solar* turbine in a simple-cycle or combined heat and power application is the same. Heat recovery steam generator (HRSG) steam pressure is usually 250 psig or less. At 250 psig or less, thermal stress within the HRSG is minimized and, therefore, firing ramp-up/ramp-down is not limited. However, some combined heat and power plant applications will desire or dictate longer start-up/shutdown times due to external requirements.

The start-up sequence and attaining *SoLoNOx* combustion mode, takes three steps:

1. Purge-crank
2. Ignition and acceleration to idle
3. Loading / thermal stabilization

[1] Start-up and shutdown emissions estimates for the *Mercury*™ 50 engine are found in PIL 205.

During the “purge-crank” step, rotation of the turbine shaft is accomplished with a starter motor to remove any residual fuel gas in the engine flow path and exhaust. During “ignition and acceleration to idle,” fuel is introduced into the combustor and ignited in a diffusion flame mode and the engine rotor is accelerated to idle speed.

The third step consists of applying up to 50% load[2] while allowing the combustion flame to transition and stabilize. Once 50% load is achieved, the turbine transitions to *SoLoNOx* combustion mode and the engine control system begins to maintain the combustion primary zone temperature and limit pilot fuel to achieve the targeted nitrogen oxides (NOx), carbon monoxide (CO), and unburned hydrocarbons (UHC) emission levels.

SHUTDOWN PROCESS

Normal, planned cool down/shutdown duration varies by engine model. Once the shutdown process starts the engine unloads and moves into a cooldown mode.

START-UP AND SHUTDOWN EMISSIONS ESTIMATES

Tables 1 through 5 summarize the estimated pounds of emissions per start-up and shutdown event for *SoLoNOx* products. The mass emissions estimates are calculated using exhaust characteristics at ISO conditions in conjunction with ppm emissions estimates at various load points. The estimates in Tables 1 and 2 are representative of new production units ordered from 2006 up until the implementation of Enhanced Emissions Control. Tables 3 and 4 summarize emissions estimates for turbine models and ratings equipped with Enhanced Emissions Control. Enhanced Emissions Control is a new control regime that will result in lower CO and UHC values at lower loads thus reducing the estimated emissions per start-up and shutdown sequence. The *Titan*™ 250 and the *Titan* 130 23001/23502 (and 22401/22402) ratings have always been equipped with Enhanced Emissions Control. As testing is completed and other models/ratings are qualified and able to be equipped with the updated controls, PIL170 will be updated. Reference PIL 220, specifically pages 7 and 8, for additional information about Enhanced Emissions Control. Table 5 summarizes start-up and shutdown emissions estimates for liquid fuel applications.

Please contact Environmental Programs, Leslie Witherspoon (858.694.6609) or Anthony Pocengal (858.505.8554) for support.

COMMISSIONING EMISSIONS

Commissioning generally takes place over a two-week period. Static testing, where no combustion occurs, usually requires one week and no emissions are expected. Dynamic testing, where combustion will occur, typically includes a number of engine start and shutdown cycles and a variety of loads will be placed on the system. It is impossible to predict how long the turbine will run and in what combustion / emissions mode it will be running. The dynamic testing period is generally followed by one to two days of final commissioning during which the turbine is running at various loads.

Solar Turbines Incorporated
9330 Sky Park Court
San Diego, CA 92123-5398

[2] 40% load for the *Titan* 250 engine on natural gas. 65% load for all engines on liquid fuel (except 80% load for the *Centaur* 40).

Table 1. Estimation of Start-up and Shutdown Emissions (lbs/event) for SoLoNOx Generator Set Applications
Nominal Start-up and Shutdown, Natural Gas Fuel

Production Units from 2006 and without Enhanced Emissions Control

Emissions estimates will NOT be warranted.

	Centaur 40 4701S					Centaur 50 6201S					Taurus 60 7901S					Taurus 65 8701S				
	NOx	CO	UHC	VOC	CO2	NOx	CO	UHC	VOC	CO2	NOx	CO	UHC	VOC	CO2	NOx	CO	UHC	VOC	CO2
Total Emissions per Start (lbs)	2	158	83	17	247	1	67	84	17	333	1	86	110	22	338	1	74	67	13	376
Total Emissions per Shutdown (lbs)	2	149	74	15	286	1	65	75	15	367	1	79	92	18	392	1	73	54	11	435

	Taurus 70 10801S					Mars 90 13000S GSC					Mars 100 15000/16000S GSC					Titan 130 20501S				
	NOx	CO	UHC	VOC	CO2	NOx	CO	UHC	VOC	CO2	NOx	CO	UHC	VOC	CO2	NOx	CO	UHC	VOC	CO2
Total Emissions per Start (lbs)	1	78	67	13	544	1	84	41	8	640	1	81	39	8	669	3	172	138	28	832
Total Emissions per Shutdown (lbs)	1	77	52	10	513	1	91	33	7	711	1	91	33	7	775	3	169	111	22	961

Assumes ISO conditions: 59F, 60% RH, sea level, no losses

Assumes unit is operating at >50% load prior to shutdown.

Assumes natural gas fuel; ES 9-98 (Fuel Air and Water or Steam for Solar Gas Turbine Engines) compliant.

Table 2. ***Estimation of Start-up and Shutdown Emissions (lbs/event) for SoLoNOx CS/MD Applications***
Nominal Start-up and Shutdown, Natural Gas Fuel

Production Units from 2006 and without Enhanced Emissions Control

Emissions estimates will NOT be warranted.

	Centaur 40 4702S					Centaur 50 6102S					Taurus 60 7802S				
	NOx	CO	UHC	VOC	CO2	NOx	CO	UHC	VOC	CO2	NOx	CO	UHC	VOC	CO2
Total Emissions per Start (lbs)	1	48	24	5	188	0.3	21	17	3	184	0.4	22	17	3	180
Total Emissions per Shutdown (lbs)	1	81	37	7	285	1	37	23	5	318	1	40	25	5	319

	Taurus 70 10802S					Mars 90 13000S CS/MD					Mars 100 15000S/16000S CS/MD				
	NOx	CO	UHC	VOC	CO2	NOx	CO	UHC	VOC	CO2	NOx	CO	UHC	VOC	CO2
Total Emissions per Start (lbs)	1	88	88	18	381	1	45	20	4	437	1	46	20	4	385
Total Emissions per Shutdown (lbs)	1	62	40	8	473	1	79	26	5	674	1	82	26	5	676

	Titan 130 20502S				
	NOx	CO	UHC	VOC	CO2
Total Emissions per Start (lbs)	1	55	37	7	662
Total Emissions per Shutdown (lbs)	2	91	46	9	945

Assumes ISO conditions: 59F, 60% RH, sea level, no losses.

Assumes unit is operating at >50% load prior to shutdown.

Assumes natural gas fuel; ES 9-98 (Fuel Air and Water or Steam for Solar Gas Turbine Engines) compliant.

Table 3. Estimation of Start-up and Shutdown Emissions (lbs/event) for SoLoNOx Generator Set Applications
Nominal Start-up and Shutdown, Natural Gas Fuel

Production Units with Enhanced Emissions Control

Emissions estimates will NOT be warranted.

	Taurus 70 10801S* / 11101S GSC (Post 2/2018 Orders)					Mars 100 16000S GSC (Post 8/2017 Orders)				
	NOx (lbs)	CO (lbs)	UHC (lbs)	VOC (lbs)	CO2 (lbs)	NOx (lbs)	CO (lbs)	UHC (lbs)	VOC (lbs)	CO2 (lbs)
Total Emissions per Start (lbs)	1	39	50	10	544	1	31	23	5	669
Total Emissions per Shutdown (lbs)	1	26	32	6	513	1	24	20	4	775

* For <15 ppm NOx 10801S units, use Table 1. PIL170 will be updated when Enhanced Emissions Control is available on <15 ppm NOx warranted 10801S units.

	Titan 130 20501S GSC (Post 2/2018 Orders)					Titan 130 23001S GSC (All Units)					Titan 250 30000S GSC (All Units)					Titan 250 31900S GSC (All Units)				
	NOx (lbs)	CO (lbs)	UHC (lbs)	VOC (lbs)	CO2 (lbs)	NOx (lbs)	CO (lbs)	UHC (lbs)	VOC (lbs)	CO2 (lbs)	NOx (lbs)	CO (lbs)	UHC (lbs)	VOC (lbs)	CO2 (lbs)	NOx (lbs)	CO (lbs)	UHC (lbs)	VOC (lbs)	CO2 (lbs)
Total Emissions per Start (lbs)	2	78	89	18	832	1	41	46	9	905	2	38	14	3	1445	2	38	14	3	1455
Total Emissions per Shutdown (lbs)	2	56	64	13	961	2	30	34	7	1030	2	23	9	2	1200	2	23	9	2	1217

Assumes ISO conditions: 59F, 60% RH, sea level, no losses

Assumes unit is operating at >50% load prior to shutdown.

Assumes natural gas fuel; ES 9-98 (Fuel Air and Water or Steam for Solar Gas Turbine Engines) compliant.

Table 4. Estimation of Start-up and Shutdown Emissions (lbs/event) for SoLoNOx CS/MD Applications
Nominal Start-up and Shutdown, Natural Gas Fuel

Production Units with Enhanced Emissions Control

Emissions estimates will NOT be warranted.

	Taurus 70 10802S* CS/MD (Post 2/2018 Orders)				
	NOx (lbs)	CO (lbs)	UHC (lbs)	VOC (lbs)	CO2 (lbs)
Total Emissions per Start (lbs)	1	37	52	10	381
Total Emissions per Shutdown (lbs)	1	13	17	3	473

* For <15 ppm NOx 10801S units, use Table 1. PIL170 will be updated when Enhanced Emissions Control is available on <15 ppm NOx warranted 10801S units.

	Mars 100 16000S CS/MD (Post 8/2017 Orders)					Titan 130 22402S CS/MD (All Units)					Titan 130 23502S CS/MD (All Units)				
	NOx (lbs)	CO (lbs)	UHC (lbs)	VOC (lbs)	CO2 (lbs)	NOx (lbs)	CO (lbs)	UHC (lbs)	VOC (lbs)	CO2 (lbs)	NOx (lbs)	CO (lbs)	UHC (lbs)	VOC (lbs)	CO2 (lbs)
Total Emissions per Start (lbs)	1	17	12	2	385	1	27	31	6	690	1	22	25	5	717
Total Emissions per Shutdown (lbs)	1	23	16	3	676	1	24	27	5	1044	1	21	24	5	1064

	Titan 250 30000S CS/MD (All Units)					Titan 250 31900S CS/MD (All Units)				
	NOx (lbs)	CO (lbs)	UHC (lbs)	VOC (lbs)	CO2 (lbs)	NOx (lbs)	CO (lbs)	UHC (lbs)	VOC (lbs)	CO2 (lbs)
Total Emissions per Start (lbs)	2	32	12	2	1135	2	32	12	2	1130
Total Emissions per Shutdown (lbs)	2	21	8	2	1122	2	20	8	2	1111

Assumes ISO conditions: 59F, 60% RH, sea level, no losses.

Assumes unit is operating at >50% load prior to shutdown.

Assumes natural gas fuel; ES 9-98 (Fuel Air and Water or Steam for Solar Gas Turbine Engines) compliant.

Table 5. Estimation of Start-up and Shutdown Emissions (lbs/event) for SoLoNOx Generator Set Applications Nominal Start-up and Shutdown, Liquid Fuel (Diesel #2)

Emissions estimates will NOT be warranted.

	Centaur 40 4701S					Centaur 50 6201S					Taurus 60 7901S				
	NOx	CO	UHC	VOC	CO2	NOx	CO	UHC	VOC	CO2	NOx	CO	UHC	VOC	CO2
Total Emissions per Start (lbs)	4	140	23	23	419	3	130	22	22	472	4	147	25	25	483
Total Emissions per Shutdown (lbs)	4	126	21	21	452	3	103	17	17	536	4	116	19	19	580

	Taurus 70 10801S					Mars 100 16000S GSC					Titan 130 20501S				
	NOx	CO	UHC	VOC	CO2	NOx	CO	UHC	VOC	CO2	NOx	CO	UHC	VOC	CO2
Total Emissions per Start (lbs)	6	251	42	42	754	4	119	20	20	854	8	336	57	57	1164
Total Emissions per Shutdown (lbs)	4	144	24	24	737	5	128	20	20	1135	8	265	44	44	1374

	Titan 130 23001S					Titan 250 30000S					Titan 250 31900S				
	NOx	CO	UHC	VOC	CO2	NOx	CO	UHC	VOC	CO2	NOx	CO	UHC	VOC	CO2
Total Emissions per Start (lbs)	8	321	54	54	1206	9	320	53	53	2189	8	291	48	48	2112
Total Emissions per Shutdown (lbs)	7	239	39	39	1444	8	215	34	34	2076	8	204	32	32	2080

Assumes ISO conditions: 59F, 60% RH, sea level, no losses.

Assumes unit is operating at >50% load prior to shutdown.

Assumes #2 Diesel fuel; ES 9-98 (Fuel Air and Water or Steam for Solar Gas Turbine Engines) compliant.

Particulate Matter Emission Estimates

Leslie Witherspoon
Solar Turbines Incorporated

PURPOSE

This document summarizes Solar's recommended $PM_{10/2.5}$ emission levels for our combustion turbines. The recommended levels are based on an analysis of emissions tests collected from customer sites.

Particulate Matter Definition

National Ambient Air Quality Standards (NAAQS) for particulate matter were first set in 1971. Total suspended particulate (TSP) was the first indicator used to represent suspended particles in the ambient air. Since July 1, 1987, the Environmental Protection Agency (EPA) has used the indicator PM_{10}, which includes only the particles with aerodynamic diameter smaller than 10 micrometers (µm). PM_{10} (coarse particles) come from sources such as windblown dust from the desert or agricultural fields and dust kicked up on unpaved roads by vehicle traffic.

The EPA added a $PM_{2.5}$ ambient air standard in 1997. $PM_{2.5}$ includes particles with an aerodynamic diameter less than 2.5 µm. $PM_{2.5}$ (fine particles) are generally emitted from industrial and residential combustion and from vehicle exhaust. Fine particles are also formed in the atmosphere when gases such as sulfur dioxide, nitrogen oxides, and volatile organic compounds, emitted by combustion activities, are transformed by chemical reactions.

Nearly all particulate matter from gas turbine exhaust is less than one micrometer (micron) in diameter. Thus the emission rates of TSP, PM_{10}, and $PM_{2.5}$ from gas turbines are theoretically equivalent although source testing will show variation due to test method detection levels and processes.

TESTING FOR PARTICULATE MATTER

The turbine combustion process has little effect on the particulate matter generated and measured. The largest contributor to particulate matter emissions for gas and liquid fired combustion turbines is measurement technique and error. Other, minor contributing, sources of particulate matter emissions include carbon, ash, fuel-bound sulfur, artifact sulfate formation, compressor/lubricating oils, and inlet air.

Historical customer particulate matter source test data show that there is significant variability from test to test. The source test results support the common industry argument that particulate matter from natural gas fired combustion sources is difficult to measure accurately. The reference test methods for particulate matter were developed primarily for measuring emissions from coal-fired power plants and other major emitters of particulates. Particulate concentrations from gas turbine can be 100 to 10,000 times lower than the "traditional" particulate sources. The test methods were not developed or verified for low emission levels. There are interferences, insignificant at higher exhaust particulate matter concentrations that result in emissions greater than the actual emissions from gas turbines. New methods are being developed to address this problem.

Due to measurement and procedural errors, the measured results may not be representative of actual particulate matter emitted. There are many potential error sources in measuring particulate matter. Most of these have to do with contamination of the samples, material from the sampling apparatus getting into the samples, and human error in samples and analysis. Over the past few years, source test firms are gaining experience in measuring particulate matter and the historical variability from test to test and the emissions levels measured have decreased.

Recommended Particulate Matter Emission Factors

When necessary to support the air permitting process Solar recommends the following $PM_{10/2.5}$ emission factors for all models and ratings except for the *Mercury* 50. Please refer to PIL 205 for the *Mercury* 50. The emission factors below are intended to include both the front half (filterable) and the back half (condensable).

- Pipeline Natural Gas*: 0.01 lb/MMBtu fuel input (HHV)
- Landfill/Digester Gas†: 0.03 lb/MMBtu fuel input (HHV)
- Liquid Fuel#: 0.02 lb/MMBtu fuel input (HHV)

* Pipeline natural gas emissions factor assumes <1 grains of Sulfur per 100 standard cubic feet.
† Landfill/digester gas emissions factor assumes <0.15 lb SO2/MMBtu heat input.
# Liquid fuel emission factor assumes fuel sulfur content is <500 ppm and ash content is <0.005% by wt.

Contact Solar's Environmental Programs group for particulate matter emissions estimates for fuels not listed above.

The conversion of a particulate matter emissions request from mg/Nm^3 to lb/MMBtu (HHV) units involves several specific turbine parameters. Please contact Solar if you need the calculation performed.

Recent customer source testing has shown that AP-42 (EPA AP-42 "Compilation of Air Pollutant Emission Factors.") emission factors for natural gas are achievable in the field, when the test method recommendations shown below are followed. Customers generally choose a particulate matter emissions factor at or above the AP-42 level that works for their site permitting recognizing that the lower the emissions factor the higher the risk for source testing.

Test Method Recommendation

Solar recommends that EPA Methods 201/201A[1] be used to measure the "front half". "Front half" represents filterable particulate matter.

EPA Method 202[2] (with nitrogen purge and field blanks) should be used to measure the "back half". "Back half" measurements represent the condensable portion of particulate matter.

EPA Method 5[3], which measures the front and back halves may be substituted (e.g. where exhaust temperatures do not allow the use of Method 202).

The turbine should have a minimum of 300 operating hours prior to conducting particulate matter source testing. The turbine should be running for 3-4 hours prior to conducting a particulate matter source test so that the turbine and auxiliary equipment is in a sustained "typical" operating mode prior to gathering samples.

Testing should include three 4-hour test runs.

Solar recommends using the aforementioned test methods until more representative test methods are developed and widely commercially available.

References

[1] EPA Method 201, Determination of PM10 Emissions, Exhaust Gas Recycle Procedure. EPA Method 201A, Determination of PM10 Emissions, Constant Sampling Rate Procedure, 40 CFR 60, Part 60, Appendix A.

[2] EPA Method 202, Determination of Condensible Particulate Emissions from Stationary Sources, 40 CFR 60, Part 60, Appendix A.

[3] EPA Method 5, Determination of Particulate Emissions from Stationary Sources, 40 CFR 60, Part 60, Appendix A.

Solar Turbines Incorporated
9330 Sky Park Court
San Diego, CA 92123-5398

Midstream TEG Dehydration Data Sheet

Project: **Lambert Compressor Station** **Rev 0: 10 Oct 2018**

Gas Sample:

Design / Operating Conditions			
Ambient Temperature Range:		-20 F to 100 F	
Site Elevation above Sea Level:		660 ft	
Site Address:		Transco Ln, Chatham, VA 24531	
Site Coordinates:	36.8269°, -79.3414°	**County**:	
Media:	Natural Gas	S.G.	.62
Gas Composition:		See Analysis	
EQT Project Engineer	Doug Mace	Email:	dmace@eqt.com

GAS PROPERTIES			
COMPONENT	**MOLE %**		
NITROGEN	0.396		**BTU/SCF (DRY)**
CARBON DIOXIDE	0.165		1097.6
OXYGEN	0.000		
METHANE	87.823		**BTU/SCF (SAT)**
ETHANE	11.303		1078.9
PROPANE	0.280		
ISO-BUTANE	0.009		**IDEAL GRAVITY**
N-BUTANE	0.010		.6152
ISO-PENTANE	0.003		
N-PENTANE	0.003		**REAL GRAVITY**
HEXANES (PLUS)	0.008		.6164
TOTAL	100		

Capstone Turbine Corporation • 21211 Nordhoff Street • Chatsworth • CA 91311 • USA
Phone: (818) 734-5300 • Fax: (818) 734-5320 • Web: www.microturbine.com

Technical Reference

Capstone MicroTurbine™ Systems Emissions

Summary

Capstone MicroTurbine™ systems are inherently clean and can meet some of the strictest emissions standards in the world. This technical reference is to provide customers with information that may be requested by local air permitting organizations or to compare air quality impacts of different technologies for a specific project. The preferred units of measure are "output based"; meaning that the quantity of a particular exhaust emission is reported relative to the useable output of the microturbine – typically in pounds per megawatt hour for electrical generating equipment. This technical reference also provides volumetric measurements in parts per million and milligrams per normal cubic meter. A conversion between several common units is also provided.

Maximum Exhaust Emissions at ISO Conditions

Table 1 below summarizes the exhaust emissions at full power and ISO conditions for different Capstone microturbine models. Note that the fuel can have a significant impact on certain emissions. For example landfill and digester gas can be made up of a wide variety of fuel elements and impurities, and typically contains some percentage of carbon dioxide (CO_2). This CO_2 dilutes the fuel, makes complete combustion more difficult, and results in higher carbon monoxide emissions (CO) than for pipeline-quality natural gas.

Table 1. Emission for Different Capstone Microturbine Models in [lb/MWhe]

Model	Fuel	NOx	CO	VOC (5)
C30 NG	Natural Gas (1)	0.64	1.8	0.23
CR30 MBTU	Landfill Gas (2)	0.64	22.0	1.00
CR30 MBTU	Digester Gas (3)	0.64	11.0	1.00
C30 Liquid	Diesel #2 (4)	2.60	0.41	0.23
C65 NG Standard	Natural Gas (1)	0.46	1.25	0.10
C65 NG Low NOx	Natural Gas (1)	0.17	1.30	0.10
C65 NG CARB	Natural Gas (1)	0.17	0.24	0.05
CR65 Landfill	Landfill Gas (2)	0.46	4.0	0.10
CR65 Digester	Digester Gas (3)	0.46	4.0	0.10
C200 NG	Natural Gas (1)	0.40	1.10	0.10
C200 NG CARB	Natural Gas (1)	0.14	0.20	0.04
CR200 Digester	Digester Gas (3)	0.40	3.6	0.10

Notes:

(1) Emissions for standard natural gas at 1,000 BTU/scf (HHV) or 39.4 MJ/m3 (HHV)
(2) Emissions for surrogate gas containing 42% natural gas, 39% CO2, and 19% Nitrogen
(3) Emissions for surrogate gas containing 63% natural gas and 37% CO2
(4) Emissions for Diesel #2 according to ASTM D975-07b
(5) Expressed as Methane

Table 2 provides the same output-based information shown in Table 1, but expressed in grams per horsepower hour (g/hp-hr).

Table 2. Emission for Different Capstone Microturbine Models in [g/hp-hr]

Model	Fuel	NOx	CO	VOC (5)
C30 NG	Natural Gas (1)	0.22	0.60	0.078
CR30 MBTU	Landfill Gas (2)	0.22	7.4	0.340
CR30 MBTU	Digester Gas (3)	0.22	3.7	0.340
C30 Liquid	Diesel #2 (4)	0.90	0.14	0.078
C65 NG Standard	Natural Gas (1)	0.16	0.42	0.034
C65 NG Low NOx	Natural Gas (1)	0.06	0.44	0.034
C65 NG CARB	Natural Gas (1)	0.06	0.08	0.017
CR65 Landfill	Landfill Gas (2)	0.16	1.4	0.034
CR65 Digester	Digester Gas (3)	0.16	1.4	0.034
C200 NG	Natural Gas (1)	0.14	0.37	0.034
C200 NG CARB	Natural Gas (1)	0.05	0.07	0.014
CR200 Digester	Digester Gas (3)	0.14	1.3	0.034

Notes: - same as for Table 1

Emissions may also be reported on a volumetric basis, with the most common unit of measurement being parts per million. This is typically a measurement that is corrected to specific oxygen content in the exhaust and without considering moisture content. The abbreviation for this unit of measurement is “ppmvd” (parts per million by volume, dry) and is corrected to 15% oxygen for electrical generating equipment such as microturbines. The relationship between an output based measurement like pounds per MWh and a volumetric measurement like ppmvd depends on the characteristics of the generating equipment and the molecular weight of the criteria pollutant being measured. Table 3 expresses the emissions in ppmvd at 15% oxygen for the Capstone microturbine models shown in Table 1. Note that raw measurements expressed in ppmv will typically be lower than the corrected values shown in Table 3 because the microturbine exhaust has greater than 15% oxygen.

Another volumetric unit of measurement expresses the mass of a specific criteria pollutant per standard unit of volume. Table 4 expresses the emissions in milligrams per normal cubic meter at 15% oxygen. Normal conditions for this purpose are expresses as one atmosphere of pressure and zero degrees Celsius. Note that both the ppmvd and mg/m3 measurements are for specific oxygen content. A conversion can be made to adjust either unit of measurement to other reference oxygen contents, if required. Use the equation below to convert from one reference oxygen content to another:

$$\text{Emissions at New } O_2 = \frac{(20.9 - \text{New } O_2 \text{ Percent})}{(20.9 - \text{Current } O_2 \text{ Percent})} \text{ X Emissions at Current } O_2$$

For example, to express 9 ppmvd of NOx at 15% oxygen to ppmvd at 3% oxygen:

$$\text{Emissions at 3\% } O_2 = \frac{(20.9 - 3.0)}{(20.9 - 15.0)} \text{ X } 9 = 27 \text{ ppmvd}$$

Table 3. Emission for Different Capstone Microturbine Models in [ppmvd] at 15% O_2

Model	Fuel	NOx	CO	VOC
C30 NG	Natural Gas (1)	9	40	9
CR30 MBTU	Landfill Gas (2)	9	500	40
CR30 MBTU	Digester Gas (3)	9	250	40
C30 Liquid	Diesel #2 (4)	35	9	9
C65 NG Standard	Natural Gas (1)	9	40	7
C65 NG Low NOx	Natural Gas (1)	4	40	7
C65 NG CARB	Natural Gas (1)	4	8	3
CR65 Landfill	Landfill Gas (2)	9	130	7
CR65 Digester	Digester Gas (3)	9	130	7
C200 NG	Natural Gas (1)	9	40	7
C200 NG CARB	Natural Gas (1)	4	8	3
CR200 Digester	Digester Gas (3)	9	130	7

Notes: same as Table 1

Table 4. Emission for Different Capstone Microturbine Models in [mg/m3] at 15% O_2

Model	Fuel	NOx	CO	VOC (5)
C30 NG	Natural Gas (1)	18	50	6
CR30 MBTU	Landfill Gas (2)	18	620	30
CR30 MBTU	Digester Gas (3)	18	310	30
C30 Liquid	Diesel #2 (4)	72	11	6
C65 NG Standard	Natural Gas (1)	19	50	5
C65 NG Low NOx	Natural Gas (1)	8	50	5
C65 NG CARB	Natural Gas (1)	8	9	2
CR65 Landfill	Landfill Gas (2)	18	160	5
CR65 Digester	Digester Gas (3)	18	160	5
C200 NG	Natural Gas (1)	18	50	5
C200 NG CARB	Natural Gas (1)	8	9	2
CR200 Digester	Digester Gas (3)	18	160	5

Notes: same as Table 1

The emissions stated in Tables 1, 2, 3 and 4 are guaranteed by Capstone for new microturbines during the standard warranty period. They are also the expected emissions for a properly maintained microturbine according to manufacturer's published maintenance schedule for the useful life of the equipment.

Emissions at Full Power but Not at ISO Conditions

The maximum emissions in Tables 1, 2, 3 and 4 are at full power under ISO conditions. These levels are also the expected values at full power operation over the published allowable ambient temperature and elevation ranges.

Emissions at Part Power

Capstone microturbines are designed to maintain combustion stability and low emissions over a wide operating range. Capstone microturbines utilize multiple fuel injectors, which are switched on or off depending on the power output of the turbine. All injectors are typically on when maximum power is demanded, regardless of the ambient temperature or elevation. As the load requirements of the microturbine are decreased, injectors will be switched off to maintain stability and low emissions. However, the emissions relative to the lower power output may increase. This effect differs for each microturbine model.

Emissions Calculations for Permitting

Air Permitting agencies are normally concerned with the maximum amount of a given pollutant being emitted per unit of time (for example pounds per day of NOx). The simplest way to make this calculation is to use the maximum microturbine full electrical power output (expressed in MW) multiplied by the emissions rate in pounds per MWhe times the number of hours per day. For example, the C65 CARB microturbine operating on natural gas would have a NOx emissions rate of:

NOx = .17 X (65/1000) X 24 = .27 pounds per day

This would be representative of operating the equipment full time, 24 hours per day, at full power output of 65 kWe.

As a general rule, if local permitting is required, use the published agency levels as the stated emissions for the permit and make sure that this permitted level is above the calculated values in this technical reference.

Consideration of Useful Thermal Output

Capstone microturbines are often deployed where their clean exhaust can be used to provide heating or cooling, either directly or using hot water or other heat transfer fluids. In this case, the local permitting or standards agencies will usually consider the emissions from traditional heating sources as being displaced by the useful thermal output of the microturbine exhaust energy. This increases the useful output of the microturbine, and decreases the relative emissions of the combined heat and power system. For example, the CARB version C65 ICHP system with integral heat recovery can achieve a total system efficiency of 70% or more, depending on inlet water temperatures and other installation-specific characteristics. The electric efficiency of the CARB version C65 microturbine is 28% at ISO conditions. This means that the total NOx output based emissions, including the captured thermal value, is the electric-only emissions times the ratio of electric efficiency divided by total system efficiency:

NOx = .17 X 28/70 = .068 pounds per MWh (based on total system output)

This is typically much less than the emissions that would result from providing electric power using traditional central power plants, plus the emissions from a local hot water heater or boiler. In fact microturbine emissions are so low compared with traditional hot water heaters that installing a Capstone microturbine with heat recovery can actually decrease the local emissions of NOx and other criteria pollutants, without even considering the elimination of emissions from a remote power plant.

Greenhouse Gas Emissions

Many gasses are considered "greenhouse gasses", and agencies have ranked them based on their global warming potential (GWP) in the atmosphere compared with carbon dioxide (CO_2), as well as their ability to maintain this effect over time. For example, methane is a greenhouse gas with a GWP of 21. Criteria pollutants like NOx and organic compounds like methane are monitored by local air permitting authorities, and are subject to strong emissions controls. Even though some of these criteria pollutants can be more troublesome for global warming than CO_2, they are released in small quantities – especially from Capstone microturbines. So the major contributor of concern is carbon dioxide, or CO_2. Emission of CO_2 depends on two things:

1. Carbon content in the fuel
2. Efficiency of converting fuel to useful energy

It is for these reasons that many local authorities are focused on using clean fuels (for example natural gas compared with diesel fuel), achieving high efficiency using combined heat and power systems, and displacing emissions from traditional power plants using renewable fuels like waste landfill and digester gasses.

Table 5 shows the typical CO_2 emissions due to combustion for different Capstone microturbine models at full power and ISO conditions. The values do not include CO_2 that may already exist in the fuel itself, which is typical for renewable fuels like landfill and digester gas. These values are expressed on an output basis, as is done for criteria pollutants in Table 1. The table shows the pounds per megawatt hour based on electric power output only, as well as considering total useful output in a CHP system with total 70% efficiency (LHV). As for criteria pollutants, the relative quantity of CO_2 released is substantially less when useful thermal output is also considered in the measurement.

Table 5. CO_2 Emission for Capstone Microturbine Models in [lb/MWh]

Model	Fuel	CO_2	
		Electric Only	70% Total CHP
C30 NG	Natural Gas (1)	1,690	625
CR30 MBTU	Landfill Gas (1)	1,690	625
CR30 MBTU	Digester Gas (1)	1,690	625
C30 Liquid	Diesel #2 (2)	2,400	855
C65 NG Standard	Natural Gas (1)	1,520	625
C65 NG Low NOx	Natural Gas (1)	1,570	625
C65 NG CARB	Natural Gas (1)	1,570	625
CR65 Landfill	Landfill Gas (1)	1,520	625
CR65 Digester	Digester Gas (1)	1,520	625
C200 NG	Natural Gas (1)	1,330	625
C200 NG CARB	Natural Gas (1)	1,330	625
CR200 Digester	Digester Gas (1)	1,330	625

Notes:

(1) Emissions due to combustion, assuming natural gas with CO_2 content of 117 lb/MMBTU (HHV)

(2) Emissions due to combustion, assuming diesel fuel with CO_2 content of 160 lb/MMBTU (HHV)

Useful Conversions

The conversions shown in Table 6 can be used to obtain other units of emissions outputs. These are approximate conversions.

Table 6. Useful Unit Conversions

From	Multiply By	To Get
lb/MWh	0.338	g/bhp-hr
g/bhp-hr	2.96	lb/MWh
lb	0.454	kg
kg	2.20	lb
kg	1,000	g
hp (electric)	.746	kW
kW	1.34	hp (electric)
MW	1,000	kW
kW	0.001	MW

Definitions

- ISO conditions are defined as: 15 °C (59 °F), 60% relative humidity, and sea level pressure of 101.3 kPa (14.696 psia).
- HHV: Higher Heating Value
- LHV: Lower Heating Value
- kW_{th}: Kilowatt (thermal)
- kW_e : Kilowatt (electric)
- MWh: Megawatt-hour
- hp-hr: horsepower-hour (sometimes referred to as “electric horsepower-hour”)
- Scf: Standard cubic foot (standard references ISO temperature and pressure)
- m3: Normal cubic meter (normal references 0 °C and one atmosphere pressure)

Capstone Contact Information

If questions arise regarding this technical reference, please contact Capstone Turbine Corporation for assistance and information:

Capstone Applications

Toll Free Telephone: (866) 4-CAPSTONE or (866) 422-7786

Fax: (818) 734-5385

E-mail: applications@capstoneturbine.com

****
* Project Setup Information *
****
Project File : \\Pit-dc1\p\Client\EQT Corporation\Corporate\02 Projects\143901.0087 Mountain Valley

Flowsheet Selection : Oil Tank with Separator
Calculation Method : RVP Distillation
Control Efficiency : 0.0%
Known Separator Stream : Low Pressure Oil
Entering Air Composition : No

Filed Name :
Well Name : PTE
Date :

****
* Data Input *
****

Separator Pressure : 414.00[psig]
Separator Temperature : 60.00[F]
Ambient Pressure : 14.70[psia]
Ambient Temperature : 55.00[F]
C10+ SG : 0.8024
C10+ MW : 163.342

-- Low Pressure Oil ----------

No.	Component	mol %
1	H2S	0.0000
2	O2	0.0000
3	CO2	0.0840
4	N2	0.0000
5	C1	9.9570
6	C2	8.1140
7	C3	6.8240
8	i-C4	1.8640
9	n-C4	4.8700
10	i-C5	2.9440
11	n-C5	3.3610
12	C6	2.2410
13	C7	9.7080
14	C8	11.4500
15	C9	8.4380
16	C10+	25.3730
17	Benzene	0.0910
18	Toluene	0.7580
19	E-Benzene	0.1130
20	Xylenes	1.3570
21	n-C6	2.4330
22	224Trimethylp	0.0200

-- Sales Oil ----------

Production Rate : 0.1[bbl/day]
Days of Annual Operation : 365 [days/year]
API Gravity : 59.11
Reid Vapor Pressure : 10.60[psia]

****

* Calculation Results *

****

-- Emission Summary ----------

Item	Uncontrolled [ton/yr]	Uncontrolled [lb/hr]	Controlled [ton/yr]	Controlled [lb/hr]
Total HAPs	0.000	0.000	0.000	0.000
Page 1---------- E&P TANK				
Total HC	0.423	0.097	0.423	0.097
VOCs, C2+	0.339	0.077	0.339	0.077
VOCs, C3+	0.213	0.049	0.213	0.049

Uncontrolled Recovery Info.

Vapor 28.1600 x1E-3 [MSCFD]
HC Vapor 28.0700 x1E-3 [MSCFD]
GOR 281.60 [SCF/bbl]

-- Emission Composition ----------

No	Component	Uncontrolled [ton/yr]	Uncontrolled [lb/hr]	Controlled [ton/yr]	Controlled [lb/hr]
1	H2S	0.000	0.000	0.000	0.000
2	O2	0.000	0.000	0.000	0.000
3	CO2	0.002	0.000	0.002	0.000
4	N2	0.000	0.000	0.000	0.000
5	C1	0.084	0.019	0.084	0.019
6	C2	0.125	0.029	0.125	0.029
7	C3	0.109	0.025	0.109	0.025
8	i-C4	0.023	0.005	0.023	0.005
9	n-C4	0.045	0.010	0.045	0.010
10	i-C5	0.014	0.003	0.014	0.003
11	n-C5	0.012	0.003	0.012	0.003
12	C6	0.003	0.001	0.003	0.001
13	C7	0.004	0.001	0.004	0.001
14	C8	0.001	0.000	0.001	0.000
15	C9	0.000	0.000	0.000	0.000
16	C10+	0.000	0.000	0.000	0.000
17	Benzene	0.000	0.000	0.000	0.000
18	Toluene	0.000	0.000	0.000	0.000
19	E-Benzene	0.000	0.000	0.000	0.000
20	Xylenes	0.000	0.000	0.000	0.000
21	n-C6	0.002	0.000	0.002	0.000
22	224Trimethylp	0.000	0.000	0.000	0.000
	Total	0.424	0.097	0.424	0.097

-- Stream Data ----------

No.	Component	MW	LP Oil	Flash Oil	Sale Oil	Flash Gas	W&S Gas	Total Emissions

			mol %	mol %	mol %	mol %	mol %	mol %
1	H2S	34.80	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	O2	32.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
3	CO2	44.01	0.0840	0.0069	0.0001	0.3251	0.3289	0.3254
4	N2	28.01	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
5	C1	16.04	9.9570	0.2491	0.0001	40.3145	12.0792	38.6045
6	C2	30.07	8.1140	1.3061	0.2375	29.4027	52.0759	30.7759
7	C3	44.10	6.8240	3.2946	2.8877	17.8607	22.6275	18.1494
8	i-C4	58.12	1.8640	1.5368	1.5034	2.8873	3.1206	2.9014
9	n-C4	58.12	4.8700	4.6049	4.5743	5.6989	6.0623	5.7209
10	i-C5	72.15	2.9440	3.4237	3.4639	1.4439	1.5163	1.4483
11	n-C5	72.15	3.3610	4.0550	4.1140	1.1907	1.2521	1.1944
12	C6	86.16	2.2410	2.8819	2.9372	0.2370	0.2510	0.2378
13	C7	100.20	9.7080	12.7165	12.9774	0.3002	0.3211	0.3015
14	C8	114.23	11.4500	15.0807	15.3960	0.0965	0.1043	0.0969
15	C9	128.28	8.4380	11.1296	11.3633	0.0212	0.0250	0.0215
16	C10+	163.34	25.3730	33.4860	34.1908	0.0030	0.0034	0.0030
17	Benzene	78.11	0.0910	0.1181	0.1204	0.0064	0.0068	0.0064
18	Toluene	92.13	0.7580	0.9963	1.0170	0.0128	0.0138	0.0128
19	E-Benzene	106.17	0.1130	0.1490	0.1521	0.0005	0.0006	0.0005
20	Xylenes	106.17	1.3570	1.7892	1.8267	0.0056	0.0061	0.0056
21	n-C6	86.18	2.4330	3.1494	3.2114	0.1926	0.2046	0.1933
22	224Trimethylp	114.24	0.0200	0.0262	0.0268	0.0005	0.0005	0.0005

MW		95.74	116.43	118.13	31.04	35.93	31.33
Stream Mole Ratio		1.0000	0.7577	0.7421	0.2423	0.0156	0.2579
Heating Value	[BTU/SCF]				1808.07	2072.28	1824.07
Gas Gravity	[Gas/Air]				1.07	1.24	1.08
Bubble Pt. @ 100F	[psia]	406.75	28.61	13.23			
RVP @ 100F	[psia]	101.88	15.92	10.81			

Spec. Gravity @ 100F	0.685	0.715	0.717

LAFAYETTE AREA LABORATORY
4790 N.E. EVANGELINE THRUWAY
CARENCRO, LA 70520
PHONE (337) 896-3055
FAX (337) 896-3077

Certificate of Analysis : 13050161-002A

Company:	Gas Analytical Services	**For:**	Gas Analytical Services
Well:	OXF 131 Pad		Alan Ball
Field:	EQT Production		PO Box 1028
Sample of:	Condensate-Spot		
Conditions:	414 @ N.G.		Bridgeport, WV, 26330
Sampled by:	GR-GAS		
Sample date:	5/14/2013	**Report Date:**	5/29/2013
Remarks:	Cylinder No.: GAS		
Remarks:			

Analysis: (*GPA 2186M*)	**Mol. %**	**MW**	**Wt. %**	**Sp. Gravity**	**L.V. %**
Nitrogen	0.000	28.013	0.000	0.8094	0.000
Methane	9.957	16.043	1.664	0.3000	3.884
Carbon Dioxide	0.084	44.010	0.039	0.8180	0.033
Ethane	8.114	30.070	2.542	0.3562	4.991
Propane	6.824	44.097	3.135	0.5070	4.324
Iso-butane	1.864	58.123	1.129	0.5629	1.403
N-butane	4.870	58.123	2.948	0.5840	3.533
Iso-pentane	2.944	72.150	2.213	0.6244	2.479
N-pentane	3.361	72.150	2.526	0.6311	2.801
i-Hexanes	2.241	86.177	1.990	0.6795	2.104
n-Hexane	2.433	85.734	2.184	0.6640	2.288
2,2,4 trimethylpentane	0.020	114.231	0.024	0.6967	0.024
Benzene	0.091	78.114	0.065	0.8846	0.059
Heptanes	9.708	98.181	9.953	0.7010	9.943
Toluene	0.758	92.141	0.641	0.8719	0.588
Octanes	11.450	107.956	13.087	0.7510	12.206
E-benzene	0.113	106.167	0.053	0.8718	0.102
M-,O-,P-xylene	1.357	106.167	1.501	0.8731	1.214
Nonanes	8.438	122.962	11.137	0.7603	10.366
Decanes Plus	25.373	163.342	43.169	0.8024	37.658
	100.000		100.000		100.000

Calculated Values	**Total Sample**	**Decanes Plus**
Specific Gravity at 60 °F	0.6999	0.8024
Api Gravity at 60 °F	70.675	44.841
Molecular Weight	96.001	163.342
Pounds per Gallon (in Vacuum)	5.835	6.690
Pounds per Gallon (in Air)	5.829	6.683
Cu. Ft. Vapor per Gallon @ 14.73 psia	23.120	15.507

Brian Gaspard

Southern Petroleum Laboratories, Inc.

MVP Southgate Project

Docket No. CP19-14-000

Attachment 37-1

Mr. Robert Pollok Correspondence

CUI//PRIV - DO NOT RELEASE

(Provided Under Separate Cover)

May 2019

MVP Southgate Project

Docket No. CP19-14-000

Attachment 38-1

Shambley Route Variation Analysis

May 2019

Comparison of the Current Pipeline and Shambley Variation 1 (MP 59.0 – 59.58)

As requested by FERC, the Project evaluated a route variation that would avoid or reduce impacts at the Shambley property where they plan to construct a new home and install a septic system. The Project evaluated Shambley Variation 1 between MP 59.0 and MP 59.58 (see Figure 38-1). At MP 59.0, this variation extends east-southeast for approximately 0.22 mile and crosses forested land. It then turns east-southeast for approximately 0.34 mile and crosses a combination of agricultural/open land and Danieley Water Wheel Road before it rejoins the current pipeline route at MP 59.58.

As shown in New Table 38-1a, the primary advantages of the Shambley Variation 1 are:

- slightly shorter length and associated land disturbance; and
- affect less forest land.

The primary disadvantages of the Shambley Variation 1 are:

- affects slightly more residential land; and
- affects more agricultural land.

Potential constructability concerns of the Shambley Variation 1 are:

- none identified based on initial review.

The Shambley Variation 1 does not offer a significant environmental advantage over the current pipeline route but does impact landowners that are not currently impacted by the pipeline. The Project is committed to finding the best route to address the situation.

At the time of this filing, the Project has not been granted permission to survey the property to better obtain information related to the construction of the house and septic system but continues to work with Mr. and Mrs. Shambley and anticipates completing surveys in the summer of 2019. The Project will continue to work with the landowner on minimizing impacts to the Shambley property.

New Table 38-1a

Comparison of the Current Pipeline Route and Shambley Variation 1 (MP 59.0 – 59.58)

Feature	Current Pipeline Route	Shambley Variation 1 (MP 59.0 – 59.58)	Difference
Total length (miles)	0.58	0.56	-0.02
Construction right-of-way (acres) a/	7.2	7.0	-0.2
Permanent right-of-way (acres) a/	3.6	3.5	-0.1
Total number of parcels crossed	7	6	-1
Number of residences within 25 and 50 feet of the edge of the construction ROW (and associated additional temporary workspace)	0	0	0
Residential Land (miles)	0	0.03	+0.03
Commercial/Industrial land (miles)	0.01	0.01	0
Unlisted/Potential Eligible Historic Properties (number)	0	0	0
National Trails, Recreation Trails, and Other Recreational Areas (number)	0	0	0
Number of waterbodies crossed	1	1	0
Number of NWI wetlands crossed	0	0	0
Total NWI wetland crossing length (feet)	0	0	0
NWI wetlands within construction ROW (acres) b/	0	0	0

New Table 38-1a

Comparison of the Current Pipeline Route and Shambley Variation 1 (MP 59.0 – 59.58)

Feature	Current Pipeline Route	Shambley Variation 1 (MP 59.0 – 59.58)	Difference
Agricultural land within construction ROW (acres) c/	1.3	2.0	+0.7
Forest Areas (miles)	0.3	0.2	-0.1
Forested land affected during construction (acres)	4.1	2.9	-1.2
Forested land affected during operation (acres)	2.1	1.4	-0.7
Length parallel or adjacent to existing ROW (miles)	0	0	0

a/ Assuming 100-foot-wide construction ROW and 50-foot-wide permanent ROW.
b/ Assuming 75-foot-wide construction ROW.
c/ Includes pasture/hay and cultivated crops.
ROW = right-of-way. NWI = National Wetland Inventory
Information Sources:
GIS – Analysis based on Geodatabase layers and shapefiles.
NC Parcel Boundaries and Standard Fields - http://data.nconemap.gov/geoportal/catalog/search/resource/details.page
NLCD – 2006 National Land Cover Data - http://www.epa.gov/mrlc/nlcd-2006.html
NWI – National Wetlands Inventory - http://www.fws.gov/wetlands/
USGS – U.S. Geological Survey - http://www.usgs.gov/
NHD – National Hydrography Dataset - http://nhd.usgs.gov/
ESRI - GIS Mapping - http://www.esri.com/

Comparison of the Current Pipeline Route and Shambley Variation 2 (MP 59.4 to MP 59.77)

As requested by FERC, the Project evaluated a route variation that would avoid or reduce impacts at the Shambley property where they plan to construct a new home and install a septic system. The Project evaluated Shambley Variation 2 between MP 59.4 and MP 59.77 (see Figure 38-1). At MP 59.4, this variation extends southeast for approximately 0.13 mile and crosses forested land. It then turns in a southerly direction for approximately 0.27 mile and crosses a combination of forest and agricultural/open land before it rejoins the current pipeline route at MP 59.77.

As shown in New Table 38-1b, the primary advantages of the Shambley Variation 2 are:

- affects slightly less agricultural.

The primary disadvantages of the Shambley Variation 2 are:

- greater length and associated land disturbance;
- affects slightly more residential land; and
- affects more forested land.

Potential constructability concerns of the Shambley Variation 2 are:

- none identified based on initial review.

The Shambley Variation 2 does not offer a significant environmental advantage over the current pipeline route but does impact landowners that are not currently impacted by the pipeline. The Project is committed to finding the best route to address the situation.

At the time of this filing, the Project has not been granted permission to survey the property to better obtain information related to the construction of the house and septic system but continues to work with Mr. and Mrs. Shambley and anticipates completing surveys in the summer of 2019. The Project will continue to work with the landowner on minimizing impacts to the Shambley property.

New Table 38-1b

Comparison of the Current Pipeline Route and Shambley Variation 2 (MP 59.40 to MP 59.77)

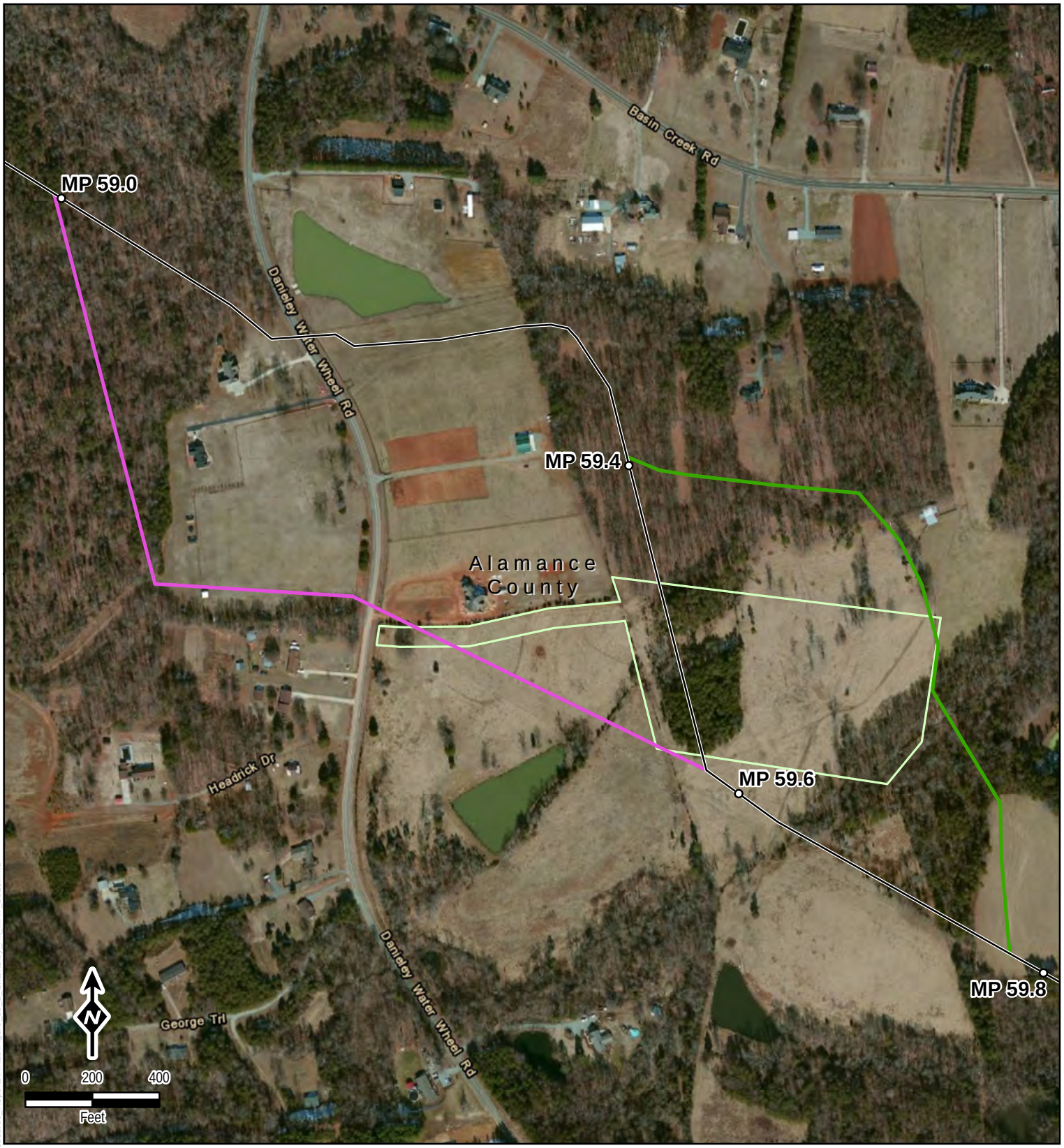
Feature	Current Pipeline Route	Shambley Variation 2 (MP 59.40 to MP 59.77)	Difference
Total length (miles)	0.38	0.42	+0.04
Construction right-of-way (acres) a/	4.8	5.2	+0.4
Permanent right-of-way (acres) a/	2.4	2.6	+0.2
Total number of parcels crossed	5	6	+1
Number of residences within 25 and 50 feet of the edge of the construction ROW (and associated additional temporary workspace)			
Residential Land (miles)	0	0.1	+0.1
Commercial/Industrial land (miles)	0	0	0
Unlisted/Potential Eligible Historic Properties (number)	0	0	0
National Trails, Recreation Trails, and Other Recreational Areas (number)	0	0	0
Number of waterbodies crossed	1	1	0
Number of NWI wetlands crossed	0	0	0
Total NWI wetland crossing length (feet)	0	0	0
NWI wetlands within construction ROW (acres) b/	0	0	0

New Table 38-1b

Comparison of the Current Pipeline Route and Shambley Variation 2 (MP 59.40 to MP 59.77)

Feature	Current Pipeline Route	Shambley Variation 2 (MP 59.40 to MP 59.77)	Difference
Agricultural land within construction ROW (acres) c/	2.8	2.4	-0.4
Forest Areas (miles)	0.2	0.2	0
Forested land affected during construction (acres)	2.1	2.7	+0.6
Forested land affected during operation (acres)	1.0	1.3	+0.3
Length parallel or adjacent to existing ROW (miles)	0.2	0	-0.2

a/ Assuming 100-foot-wide construction ROW and 50-foot-wide permanent ROW.
b/ Assuming 75-foot-wide construction ROW.
c/ Includes pasture/hay and cultivated crops.
ROW = right-of-way. NWI = National Wetland Inventory
Information Sources:
GIS – Analysis based on Geodatabase layers and shapefiles.
NC Parcel Boundaries and Standard Fields - http://data.nconemap.gov/geoportal/catalog/search/resource/details.page
NLCD – 2006 National Land Cover Data - http://www.epa.gov/mrlc/nlcd-2006.html
NWI – National Wetlands Inventory - http://www.fws.gov/wetlands/
USGS – U.S. Geological Survey - http://www.usgs.gov/
NHD – National Hydrography Dataset - http://nhd.usgs.gov/
ESRI - GIS Mapping - http://www.esri.com/



Legend

- Mileposts
- Current Pipeline Route
- Shambley Variation 1 (MP 59.00 to 59.58)
- Shambley Variation 2 (59.40 to 59.77)
- Approximate Parcel Boundary

Data Sources: ESRI, USGS, EQT

1 inch = 400 feet
When Printed 8.5x11

Mountain Valley PIPELINE LLC

Figure 38-1

Sheet 1 of 1

Shambley Variations
(MP 59.00 to MP 59.58) & (MP 59.40 to 59.77)

(ESRI World Imagery)

TRC
600 Willowbrook Ln
West Chester, PA 19382

May 2019

S:\1-PROJECTS\NEXTERA\300423_MVP_Southgate\6-MXD\Resource_Reports\RR10\Figure_38_1_Shambley_Alt_MAY_2019.mxd

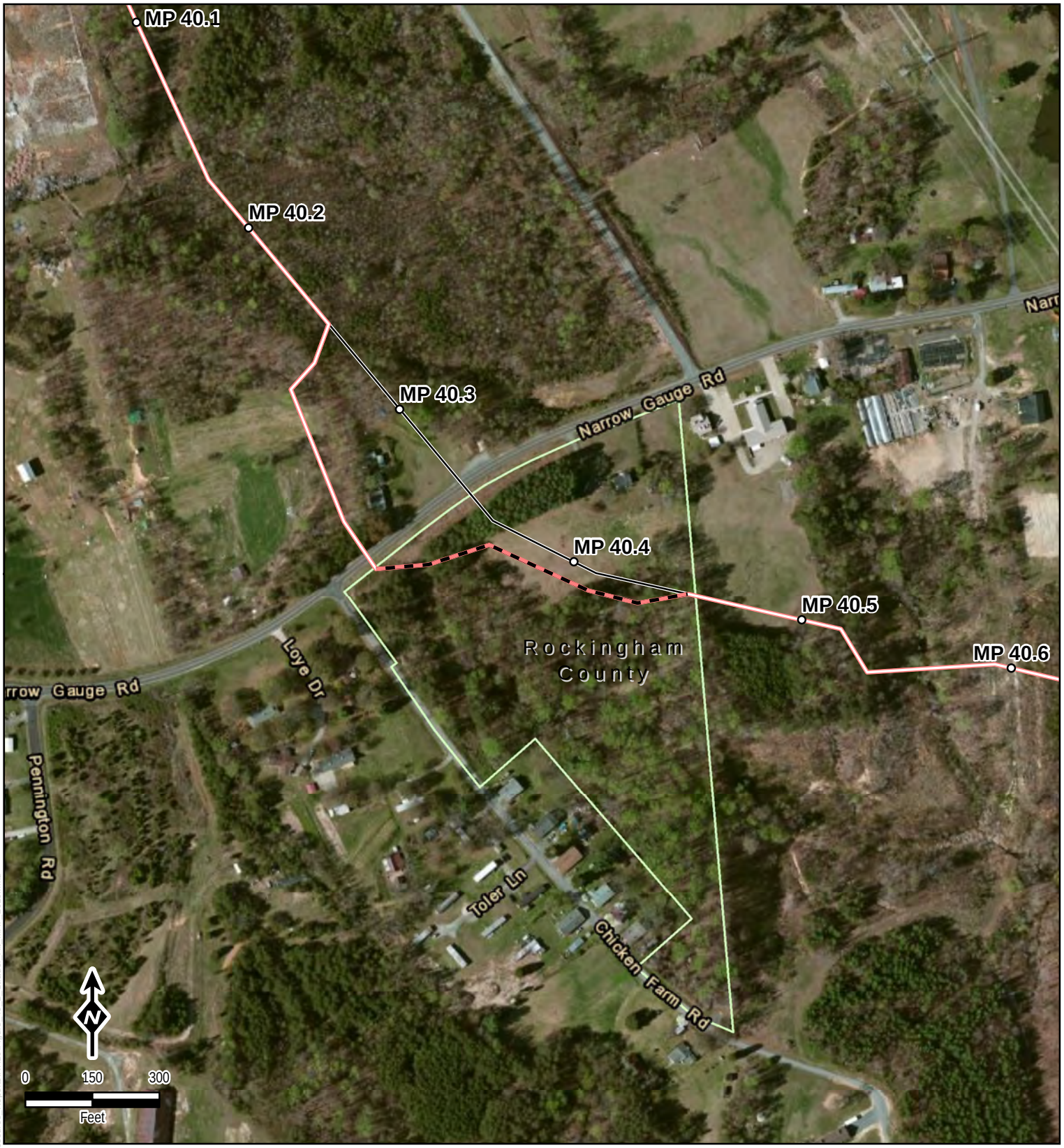
MVP Southgate Project

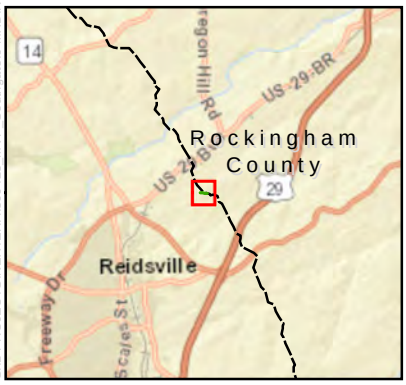
Docket No. CP19-14-000

Attachment 40-1

Figure 40-1 - Strader Route Variation

May 2019





Legend

- Mileposts
- Current Pipeline Route
- Modified Pipeline Route
- Strader Variation
- Approximate Parcel Boundary
- County Boundary

Data Sources: ESRI, USGS, EQT

1 inch = 300 feet
When Printed 8.5x11

Mountain Valley PIPELINE LLC

Figure 40-1

Sheet 1 of 1

Strader Variation

(ESRI World Imagery)

TRC
600 Willowbrook Ln
West Chester, PA 19382

May 2019

MVP Southgate Project

Docket No. CP19-14-000

Attachment 41-1

Revised Alignment Sheets for Adjusted ATWS

(Provided Under Separate Cover)

May 2019

MVP-VRA3-115-1251
ATWS REMOVAL TO
REDUCE TREE CLEARING.

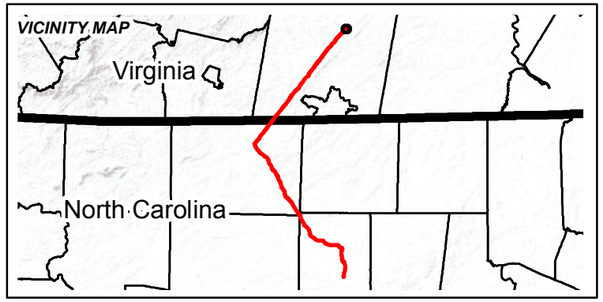
MVP-VRA3-115-1253
ATWS REMOVAL TO
REDUCE TREE CLEARING.

MVP-VRA3-115-1254
ATWS REMOVAL TO
REDUCE TREE CLEARING.

1001A
1001B
1001C
1001D
1001E
1001F
1008

N

VICINITY MAP



LEGEND

MODIFICATIONS	SUBJECT ATWS	FACILITY SITE
ACCESS ROADS	PERMANENT EASEMENT	ACCESS ROADS LIMITS
SURVEY CANOPY TREE LINES	TEMPORARY WORKSPACE	WETLAND
PROPOSED CENTERLINE	ATWS	STREAM / DRAINAGE LINES

Mountain Valley PIPELINE, LLC

FERC Data Responce 41 "ATWS 1001E"

MVP Southgate

TRC
Results you can rely on
16350 Park Ten Pl Ste 101
Houston, Texas 77084

MVP-VRA3-115-1255
MOVED ATWS TO NORTH
TO REDUCE TREE CLEARING

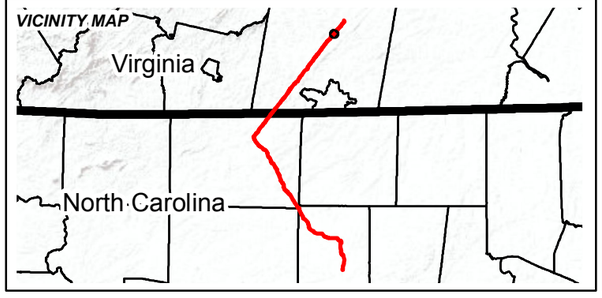
1035

FERC SUPPLEMENTAL 2

1036

N

VICINITY MAP



LEGEND

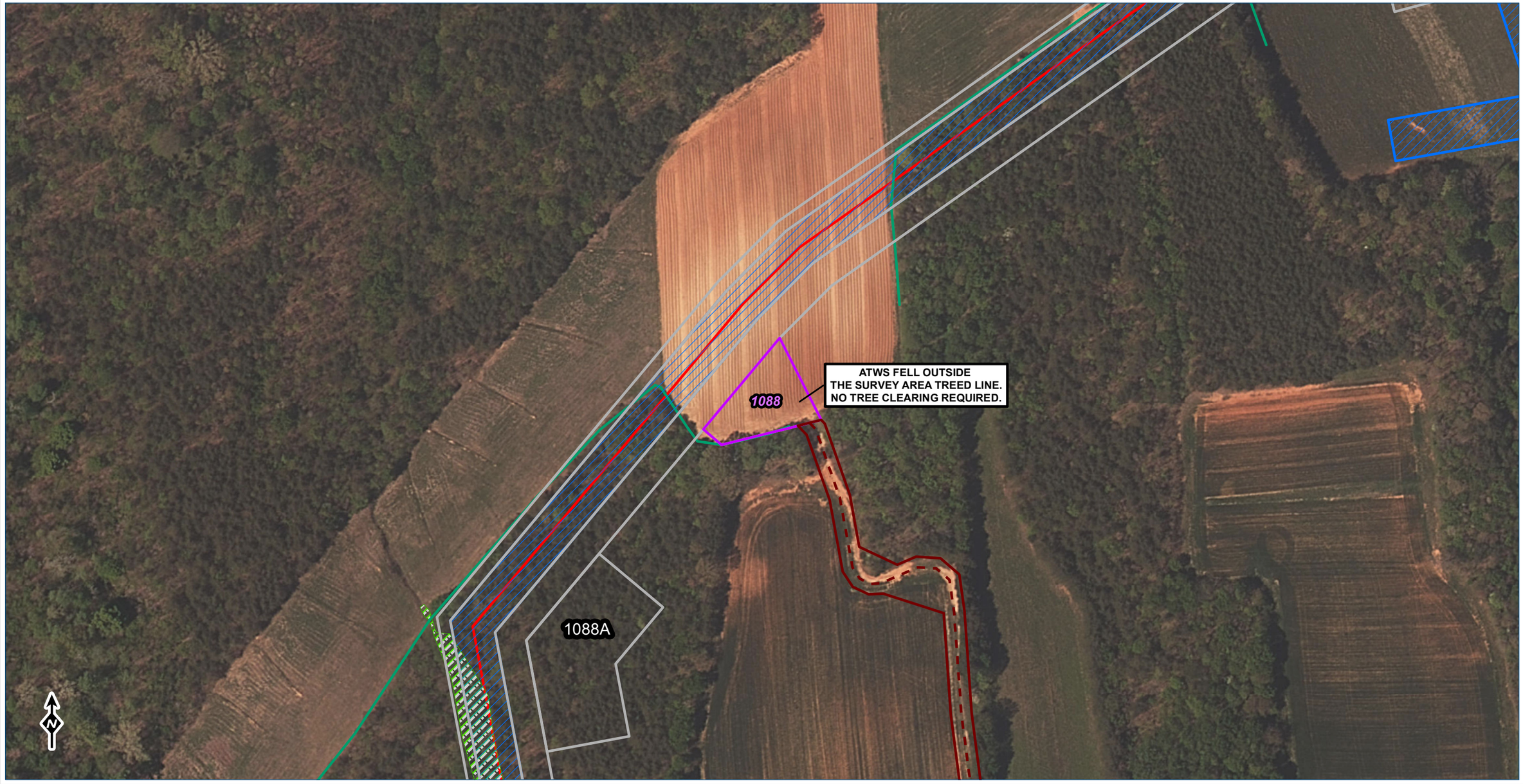
MODIFICATIONS	SUBJECT ATWS	FACILITY SITE
ACCESS ROADS	PERMANENT EASEMENT	ACCESS ROADS LIMITS
SURVEY CANOPY TREE LINES	TEMPORARY WORKSPACE	WETLAND
PROPOSED CENTERLINE	ATWS	STREAM / DRAINAGE LINES

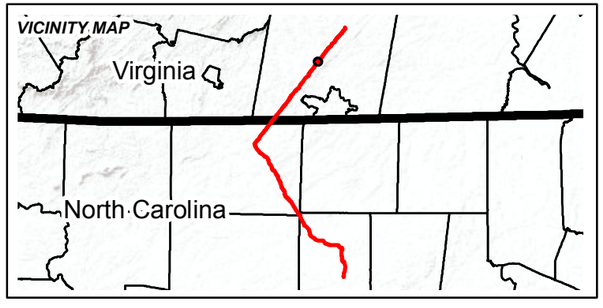
Mountain Valley PIPELINE, LLC

FERC Data Responce 41 "ATWS 1035"

MVP Southgate

TRC
Results you can rely on
16350 Park Ten Pl Ste 101
Houston, Texas 77084





LEGEND

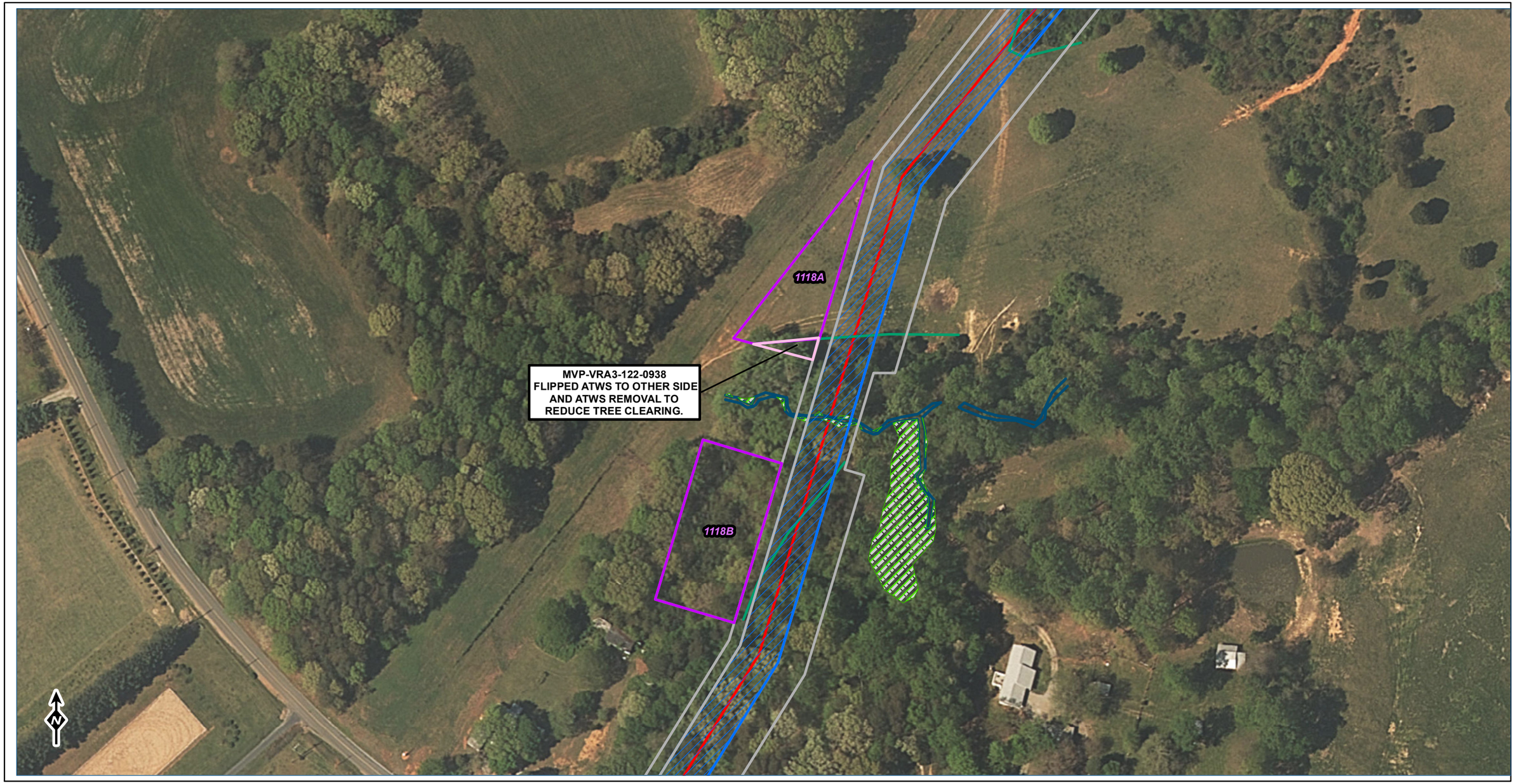
- MODIFICATIONS
- ACCESS ROADS
- SURVEY CANOPY TREE LINES
- PROPOSED CENTERLINE
- SUBJECT ATWS
- PERMANENT EASEMENT
- TEMPORARY WORKSPACE
- ATWS
- FACILITY SITE
- ACCESS ROADS LIMITS
- WETLAND
- STREAM / DRAINAGE LINES

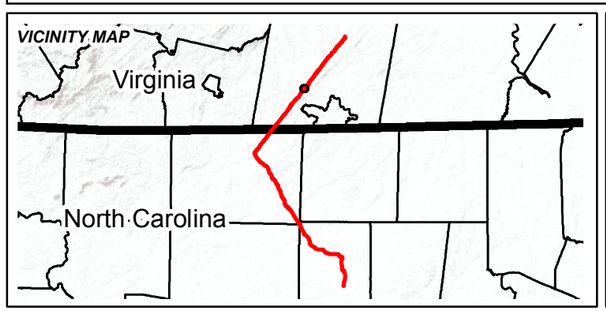
Mountain Valley PIPELINE, LLC

FERC Data Responce 41 "ATWS 1088"

MVP Southgate

TRC
Results you can rely on
16350 Park Ten Pl Ste 101
Houston, Texas 77084





LEGEND

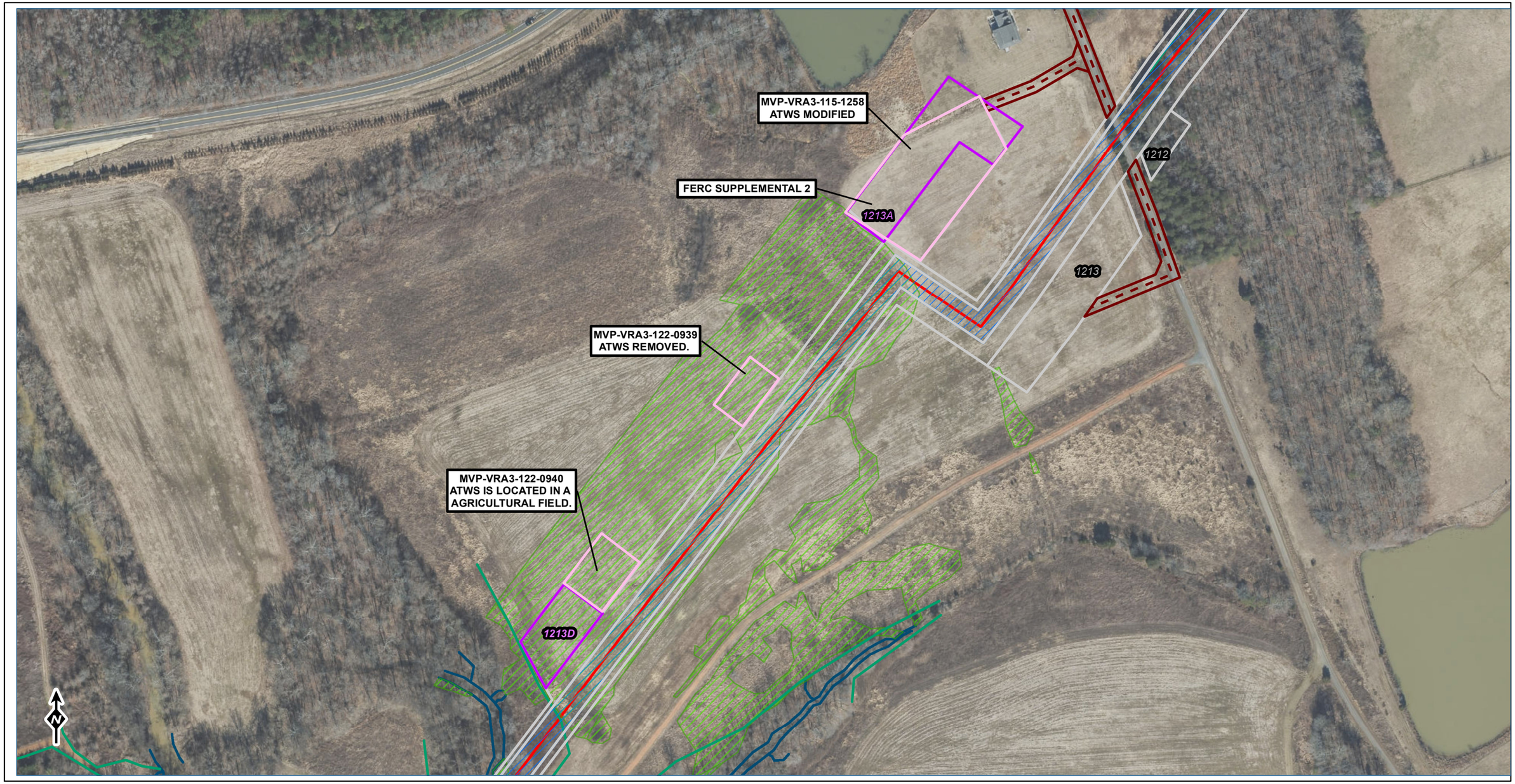
- MODIFICATIONS
- ACCESS ROADS
- SURVEY CANOPY TREE LINES
- PROPOSED CENTERLINE
- SUBJECT ATWS
- PERMANENT EASEMENT
- TEMPORARY WORKSPACE
- ATWS
- FACILITY SITE
- ACCESS ROADS LIMITS
- WETLAND
- STREAM / DRAINAGE LINES

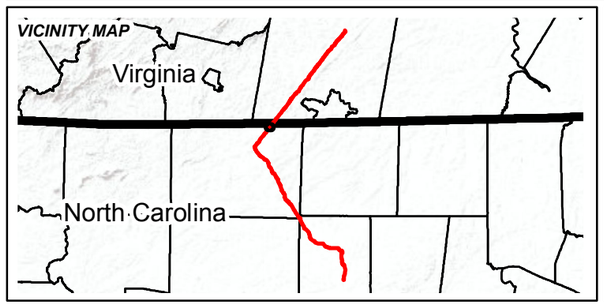
Mountain Valley PIPELINE, LLC

FERC Data Responce 41 "ATWS 1118A"

MVP Southgate

TRC Results you can rely on
16350 Park Ten Pl Ste 101
Houston, Texas 77084





LEGEND

- MODIFICATIONS
- ACCESS ROADS
- SURVEY CANOPY TREE LINES
- PROPOSED CENTERLINE
- SUBJECT ATWS
- PERMANENT EASEMENT
- TEMPORARY WORKSPACE
- ATWS
- FACILITY SITE
- ACCESS ROADS LIMITS
- WETLAND
- STREAM / DRAINAGE LINES

Mountain Valley PIPELINE, LLC

FERC Data Responce 41 "ATWS 1213A, 1213D "

MVP Southgate

TRC Results you can rely on
16350 Park Ten Pl Ste 101
Houston, Texas 77084

ATWS IS NEEDED FOR HDD BORING OPERATIONS

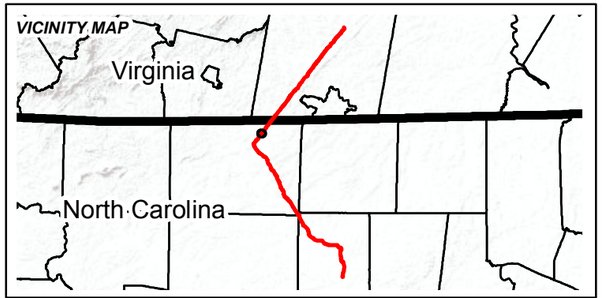
ATWS IS NEEDED FOR HDD BORING OPERATIONS

1244

1244A

N

VICINITY MAP



LEGEND

- MODIFICATIONS
- ACCESS ROADS
- SURVEY CANOPY TREE LINES
- PROPOSED CENTERLINE
- SUBJECT ATWS
- PERMANENT EASEMENT
- TEMPORARY WORKSPACE
- ATWS
- FACILITY SITE
- ACCESS ROADS LIMITS
- WETLAND
- STREAM / DRAINAGE LINES

Mountain Valley PIPELINE, LLC

FERC Data Responce 41 "ATWS 1244,1244A"

MVP Southgate

TRC Results you can rely on

16350 Park Ten Pl Ste 101
Houston, Texas 77084