

**PJM Facilities Study Report**  
**For**  
**Network Upgrade N9191**  
**Transition Cycle #1**

June 2025

## Introduction

This Facilities Study has been prepared in accordance with the PJM Open Access Transmission Tariff and PJM Manuals. The Transmission Owner (TO) is Virginia Electric and Power Company (VEPCO or Dominion).

### A. Project Description

The System Impact Study for PJM Interconnection Transition Cycle #1 has identified the need for PJM Network Upgrade N9191. The scope of this Network Upgrade includes the following:

- Upgrade 41.13 Miles of 500kV transmission line 576 from North Anna Substation to Midlothian Substation

### B. Transmission Owner Facilities Study Results

#### 1. Detailed Scope of work for Network Upgrade N9191:

The following is a detailed description of Transmission Owner Upgrades for Network Upgrade N9191. These facilities shall be designed according to the Transmission Owner's Applicable Technical Requirements and Standards. Once built the Transmission Owner will own, operate, and maintain these facilities.

See Preliminary Scoping Summaries located in the Appendices, Attachment #1, #2 and #3.

#### 2. MILESTONE SCHEDULE FOR COMPLETION OF DOMINION WORK

Facilities outlined in this report are estimated to take 74 months to construct, from the time of full execution of the Generation Interconnection Agreement and completion of a construction kickoff call. This schedule may be impacted by the timeline for procurement and installation of long lead items and the ability to obtain outages to construct and test the proposed facilities.

Description	Start month	Finish month
Engineering	1	30
Permitting/Procurement	3	38
Construction	36	74

Due to outage congestion, Network Upgrades and/or internal Dominion projects have been identified as having possible outage conflicts with this network upgrade that may affect the estimated milestones listed above. Additional outage sequencing may be required that includes, but not limited to the following projects:

- AF1-125
- Coordinate with other work on the 563 line.
- Coordinate with other work on the 576 line.

### **3. ASSUMPTIONS IN DEVELOPING SCOPE/COST/SCHEDULE**

- The preliminary construction schedule is dependent on outage availability.
- See Attachment 1 and 2– Preliminary Scoping Summary – Substation for additional assumptions
- See Attachment 3 – Preliminary Scoping Summary – Transmission line for additional assumptions

### **4. LAND REQUIREMENTS**

Dominion will be responsible for the following expectations in the area of Real Estate:

- Any additional land needed for Storm Water Management, Landscaping, and Wetlands/Wetlands Mitigation.
- Any other Land/Permitting requirements required by the Network Upgrade

### **5. ENVIRONMENTAL AND PERMITTING**

Dominion will be responsible for the following expectations in the area of Environmental and Permitting:

- Assessment of environmental impacts related to the Network Upgrade including:
  - Environmental Impact Study requirements
  - Environmental Permitting
- A stormwater easement and/or specific stormwater design BMP's to allow access to and use of the facilities, including a maintenance agreement for said stormwater facilities.
- Conditional Use Permit for Substation
- Any additional land needed for Storm Water Management, Landscaping, and Wetlands/Wetlands Mitigation
- Any other Permitting requirements required by the Network Upgrade

**C. APPENDICES**

- Attachment #1: Preliminary Scoping Summary – Substation North Anna  
Attachment #2: Preliminary Scoping Summary – Substation Midlothian  
Attachment #3: Preliminary Scoping Summary – Transmission



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Project Number: N9191 – North Anna Substation

Project Description: ***SUBSTATION SCOPE OF WORK*** Replace Line Lead for Line 576 & Wave Trap Removal

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Date: 7/1/2025

Revision Number: 0

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### Project Summary

Network upgrade N9191 provides for the upgrade of line 576 at North Anna Substation in Louisa County, Virginia. Remove line 576 wave trap due to the power line carrier function now being performed over fiber optics. Transmission engineering will terminate the fiber at one of the backbone legs, and substation engineering will install 2" PVC conduits from the backbone leg to the control enclosure.

#### *Assumptions & Clarifications:*

- 1. The scope of work depicted on the drawings assumes that there is no overlap with other designs and construction activities, except if mentioned in this Project Summary.*
- 2. 4-hole pad connections must be replaced with 6-hole and 8-hole pad connections to maintain 5000A ratings.*

#### **Purchase and install substation material – Network Upgrade:**

1. Two (2) runs of 2" conduits from the backbone leg to the cable trough
2. Conduit tracer res, 1/C #10, green
3. Conductors, connectors, and grounding materials as per engineering standards

#### **Remove substation material – Network Upgrade:**

1. One (1), 500kV, 5000A, Wave Trap
2. Conductor, connectors, conduit control cable, foundations, structures, and grounding material as per engineering standards

**Purchase and install relay material – Network Upgrade:**

1. One (1), 1340 – 24” dual SEL-411L CD/Fiber, DCB/Fiber line panel

**Remove relay material – Network Upgrade:**

1. Remove Panel No. 10
2. Remove Panel No. 61



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Project Number: N9191 - Midlothian Substation

***SUBSTATION SCOPE OF WORK***  
Project Description: Replace Line Lead for Line 576 & Wave Trap Removal

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Date: 7/01/2025

Revision Number: 0

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### Project Summary

Network upgrade N9191 provides for the upgrade of line 576 at Midlothian Substation in Chesterfield County, Virginia. Remove line 576 wave trap due to the power line carrier function now being performed over fiber optics. Transmission engineering will terminate the fiber at one of the backbone legs, and substation engineering will install 2" PVC conduits from the backbone leg to the control enclosure.

#### *Assumptions & Clarifications:*

3. *The scope of work depicted on the drawings assumes that there is no overlap with other designs and construction activities, except if mentioned in this Project Summary.*
4. *4-hole pad connections must be replaced with 6-hole and 8-hole pad connections to maintain 5000A ratings.*

#### **Purchase and install substation material – Network Upgrade:**

1. Three (3), 396kV, 318kV MCOV surge arresters
2. Two (2) runs of 2" conduits from the backbone leg to the cable trough
3. Conduit tracer wires, 1/C #10, green
4. Conductors, connectors, steel, foundations and grounding materials as per engineering standards

**Relocate substation material – Network Upgrade:**

1. Three (3), 500kV, relay accuracy CCVT

**Remove substation material - Network Upgrade:**

4. One (1), 500kV, 4000A wave trap

**Purchase and install relay material – Network Upgrade:**

2. One (1), 1340 – 24” dual SEL-411L CD/Fiber, DCB/Fiber line panel

**Remove relay material – Network Upgrade:**

1. Retire Panels No. 308
2. Retire Panels No. 310



500 kV LINE #576  
North Anna Substation - Midlothian Substation  
PROJECT N9191

**PRELIMINARY SCOPING SUMMARY**

This project serves to rebuild 500 kV line 576 from North Anna Substation to Midlothian Substation for approximately 41.13 miles, which is located in Louisa, Hanover, Goochland, Powhatan, and Chesterfield Counties, VA. See **Figure 1** for the project location. The proposed work requires no additional land and will all be completed within existing right of way. The project will install a total of two hundred-fourteen (214) new structures. A certificate of public convenience and necessity (CPCN) will be required for this project.

The existing line consists mainly of 500 kV single circuit weathering steel towers built in 1979. The proposed structures to be installed are 500 kV engineered steel single circuit suspension monopole structures and 500 kV engineered steel single circuit double deadend monopole structures. The existing twin bundled (2) 2500 ACAR conductor will be replaced with triple bundled (3) 1351 ACSS/TW/HS. The existing one (1) 7#7 Alumoweld shield wire and one (1) 45/45 mm<sup>2</sup> OPGW will be replaced with two (2) DNO-10100 OPGW.

This scope has overlap with Open Window 2024 project 993410, which plans to rebuild line 576 as a 500/230 kV line with towers to utilize the entire right of way. For project N9191, the line will be rebuilt as a single circuit 500 kV line with monopoles to allow for additional space in the right of way for future circuits. It is assumed that this project would move forward independently of project 993410. This project will run parallel to a new greenfield line project N9248 in the same right of way.

**Design Considerations:**

**EXISTING FACILITIES TO BE REMOVED:**

1. Remove two (2) existing 500 kV single circuit double dead-end weathering steel 5DE tower structures as follows:
  - a. Structures 576/1 and 209
2. Remove nine (9) existing 500 kV single circuit double dead-end weathering steel 5HA tower structures as follows:
  - a. Structures 576/130, 136, 143, 154, 161, 163, 172, 203, and 208
3. Remove two (2) existing 500 kV single circuit suspension weathering steel 5HT tower structures as follows:
  - a. Structures 576/8 and 149
4. Remove ten (10) existing 500 kV single circuit suspension weathering steel 5LA tower structures as follows:
  - a. Structures 576/6, 16, 24, 52, 70, 119, 146, 151, 191, and 205

5. Remove one hundred sixty-six (166) existing 500 kV single circuit suspension weathering steel 5LT tower structures as follows:
  - a. Structures 576/2-5, 7, 9-15, 17-18, 21, 23, 25-26, 28-29, 31, 33-51, 53-69, 71-72, 74, 76-102, 104-107, 111-115, 118, 120-121, 123-125, 127-129, 131, 133-135, 137-142, 144-145, 147-148, 150, 152-153, 155, 158-160, 164-171, 173-190, 192-202, 204, and 206-207.
6. Remove five (5) existing 500 kV single circuit running angle weathering steel 5MA tower structures as follows:
  - a. Structures 576/30, 32, 73, 75, and 108
7. Remove fourteen (14) existing 500 kV single circuit suspension weathering steel 5MT tower structures as follows:
  - a. Structures 576/19-20, 22, 27, 103, 109-110, 116-117, 122, 126, 132, and 156-157
8. Remove one (1) existing 500 kV single circuit suspension weathering steel 2-pole H-Frame structure as follows:
  - a. Structure 576/162
9. Remove approximately 41.13 miles of 2-2500 ACAR (84/7) conductor from existing backbone 576/1A to existing backbone 576/209A (563/209A).
10. Remove approximately 56.88 miles of one (1) 7#7 Alumoweld shield wire as follows:
  - a. Approximately 41.13 miles from existing backbone 576/1A to existing backbone 576/209A on the right side
  - b. Approximately 15.75 miles from existing structure 576/130 to existing backbone 576/209A on the left side
11. Remove approximately 0.39 miles of one (1) DNO-8482 fiber from existing structure 576/1 to existing structure 576/3.
12. Remove approximately 24.99 miles of one (1) 45/45 mm<sup>2</sup> OPGW as follows:
  - a. Approximately 0.13 miles from existing backbone 579/1A to 576/1.
  - b. Approximately 24.86 miles from existing structure 576/3 to 576/130.

**EXISTING FACILITIES TO BE MODIFIED:**

1. Install three (3) conductor crossing strain assemblies [Reference Drawing 35.252] and two (2) OPGW strain assemblies [Reference Drawing 96.061] on the following two structures:
  - a. Structures 576/1A and 576/209A (563/209A)

### **PERMANENT FACILITIES TO BE INSTALLED:**

1. Install one hundred seventy-eight (178) 500 kV engineered steel single circuit suspension monopole structures [Reference Drawing 15.200] on foundations as follows:
  - a. Structures 2-5, 7-15, 17-23, 25-29, 31, 33-51, 53-69, 71-72, 74, 76-107, 109-118, 120-128, 131-134, 138-142, 144-145, 147-150, 152-153, 155-160, 162, 164-171, 173-190, 192-202, and 206
  - b. See **Figure 2** for a visual of the proposed structure design.
  - c. Structures 46, 66, 89, 104, 186, and 199 would utilize deadend fiber assemblies to accommodate a fiber splice.
2. Install two (2) 500 kV engineered steel single circuit double deadend heavy angle monopole structures (0-90 degrees) [Reference Drawing 15.212] on foundations as follows:
  - a. Structures 576/1 and 576/209
  - b. See **Figure 3** for a visual of the proposed structure design.
3. Install nine (9) 500 kV engineered steel single circuit double deadend heavy angle monopole structures (0-60 degrees) [Reference Drawing 15.212] on foundations as follows:
  - a. Structures 576/130, 136, 143, 154, 161, 163, 172, 203, and 208.
  - b. See **Figure 3** for a visual of the proposed structure design.
4. Install fifteen (15) 500 kV engineered steel single circuit double deadend small/medium angle monopole structures [Reference Drawing 15.210] on foundations as follows:
  - a. Structures 576/6, 16, 24, 30, 32, 52, 70, 73, 75, 108, 119, 146, 151, 191, and 205
  - b. See **Figure 4** for a visual of the proposed structure design.
5. Install ten (10) 500kV engineered steel single circuit double deadend zero angle tension imbalance structures [Reference Drawing 15.210] on foundations as follows:
  - a. Structures 576/2A, 129, 130A, 135, 137, 160A, 163A, 202A, 204, & 207
  - b. Structures used to reduce loading on heavy angle structures to mitigate extreme deadend structural costs.
6. Install approximately 41.13 miles of 3-phase triple bundled (3) 1351 ACSS/TW/HS conductor from existing backbone 576/1A to existing backbone 576/209A (563/209A).
7. Install approximately 41.13 miles of two (2) DNO-10100 OPGW from existing backbone 576/1A to existing backbone 576/209A (563/209A).
  - a. This includes the installation of forty-two (42) splices as follows:
    - i. Two (2) on structures 576/1A, 6, 16, 24, 32, 46, 52, 66, 75, 89, 104, 108, 119, 130, 143, 154, 163, 172, 186, 199, and 209A

### **CONCEPTUAL SCOPE NOTES:**

1. The existing line consists primarily of 500 kV single circuit weathering steel towers installed in 1979. These structures are considered insufficient for the proposed conductor, resulting

in the need for the line to be rebuilt. No PLS-CADD modeling was done for this project. Structures were replaced like for like and estimated using typical transmission right of way characteristics.

2. Structures are designed based off the following NESC code parameters: NESC Heavy, 90 mph wind,  $\frac{3}{4}$ " Ice & 30 mph wind regardless of project location.
3. It is assumed for detailed engineering that a LiDAR survey will be required.
4. Any potential height restrictions were not accounted for in this design.
5. An existing right of way width for majority of the line of 235', 320', and 335' is assumed based on existing plan and profiles. No additional right of way will be required for this project.
6. A wetland delineation has not been completed as part of this conceptual package.
7. The design assumes 15,000 foot conductor and OPGW reels will be used, which result in needing conductor tension splices and OPGW deadends on tangent structures in six locations.
8. Alternative design options for the proposed structures are lattice towers and H-frames. Monopole structure designs were utilized to create additional space in the corridor to allow for future lines without acquiring right of way (specifically N9248). This results in approximately 60 feet of additional right of way that can be utilized by other projects.
9. Critical crossings on this project can be seen below:
  - a. Crossing Lake Anna between structures 576/10-11 and 17-22.
  - b. Crossing over 500 kV line between structures 576/108 and 109.
  - c. Crossing the Midlothian Turnpike from structures 576/204-205.
  - d. Crossing the James River from structures 576/161-163.
  - e. Crossing Broad Street Road from structures 576/130-131.
  - f. Crossing interstate 64 from structures 576/126-127.
  - g. Crossing Jefferson Highway from structures 576/67-68.
10. It is assumed that this project moves forward independently of and prior to the other Transition Cycle 1 Phase 3 projects. The following projects could impact this scope:
  - a. N8164: Rebuild Line 255 from North Anna and AF2-037 Tap
  - b. N9140: Greenfield 500kV line from Spotsylvania to North Anna
  - c. N9247: Rebuild Line 573 from Spotsylvania to North Anna
  - d. N9248: Greenfield 500kV line from North Anna to Midlothian
  - e. N9251: Greenfield 500kV line from North Anna to Possum Point
  - f. N9139: Rebuild line 563 from Midlothian to Carson
  - g. N9249: Greenfield 500kV line from Midlothian to Carson

- h. N8152: Add a 500/230kV transformer at Midlothian Substation.
- 11. Heavy deadends with line angles exceeding 25° may require tension imbalance deadends to lower the wire tensions on the angle structure. This is not required if the span lengths for the adjacent sections can be reduced to allow for lower tensions that still meet right of way clearance requirements.

#### **CONCEPTUAL ESTIMATE NOTES:**

1. Engineered steel pole costs were determined based off typical wind and weight spans, line angles, and average structure heights in the typical right of way associated with the structure type.
2. Steel pole foundation costs were based off the projects' location and structure type in the regional soil profile map. The regional soil profile map used for this project is Piedmont.
3. The conceptual estimate assumes that a laydown yard is required for this project.
4. Prior to detailed engineering, a full land rights review would be required. A desktop review was completed to estimate the project cost.
5. Access estimate cost inputs include the following assumptions:
  - a. Tangent Structures are allotted 40 mats. Angle structures are allotted 80 mats. Pull Pads are allotted 100 mats for the 500kV Wreck and Rebuild and New Lines.
  - a. DDE structures assumed based off of wire reel lengths – based off of pull pad locations.
  - b. Pull pad locations based on location of major road/water crossings and line mileage.
  - c. Assuming that existing stone in Substations will be used for access per SOW and that access is existing or will be built by others before the start of construction. Assumes that the substations will be constructed with access roads built to and from Substations and work from inside the substations for Backbone installation.
  - d. Assumes no delays due to permitting or real estate issues after working begins. Assume no schedule compressions from SOC/PJM.
  - e. Access matting costs not accounted for forestry work in between large spans that were not matted through for access.
  - f. Stream crossing based on estimates from aerial imagery.
  - g. Assumes that all existing roads may be dressed with stone that can remain at the end of the project. Assumes existing two track roads in many locations will be impermeable. No costs for stone road removal are included.
  - h. Assumes between a 10-20% Markup for contingency on Emtek specialty matting dependent on size and scope of material to be used in each project that requires the specialty matting in swamp/wetlands. Markup applied in Success.

Figure 1 – Project Location

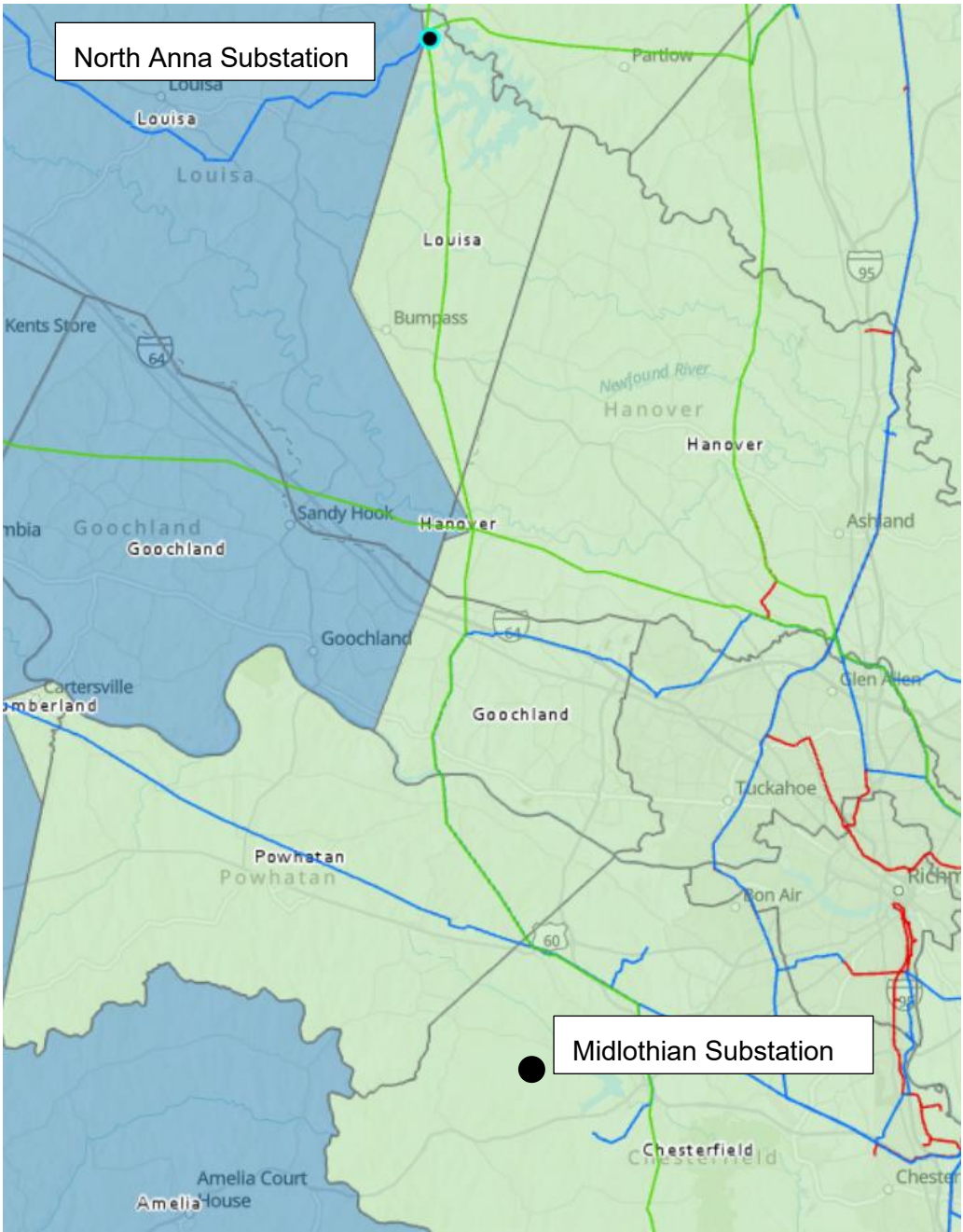


Figure 2 – Proposed Single Circuit Suspension Structure Configuration

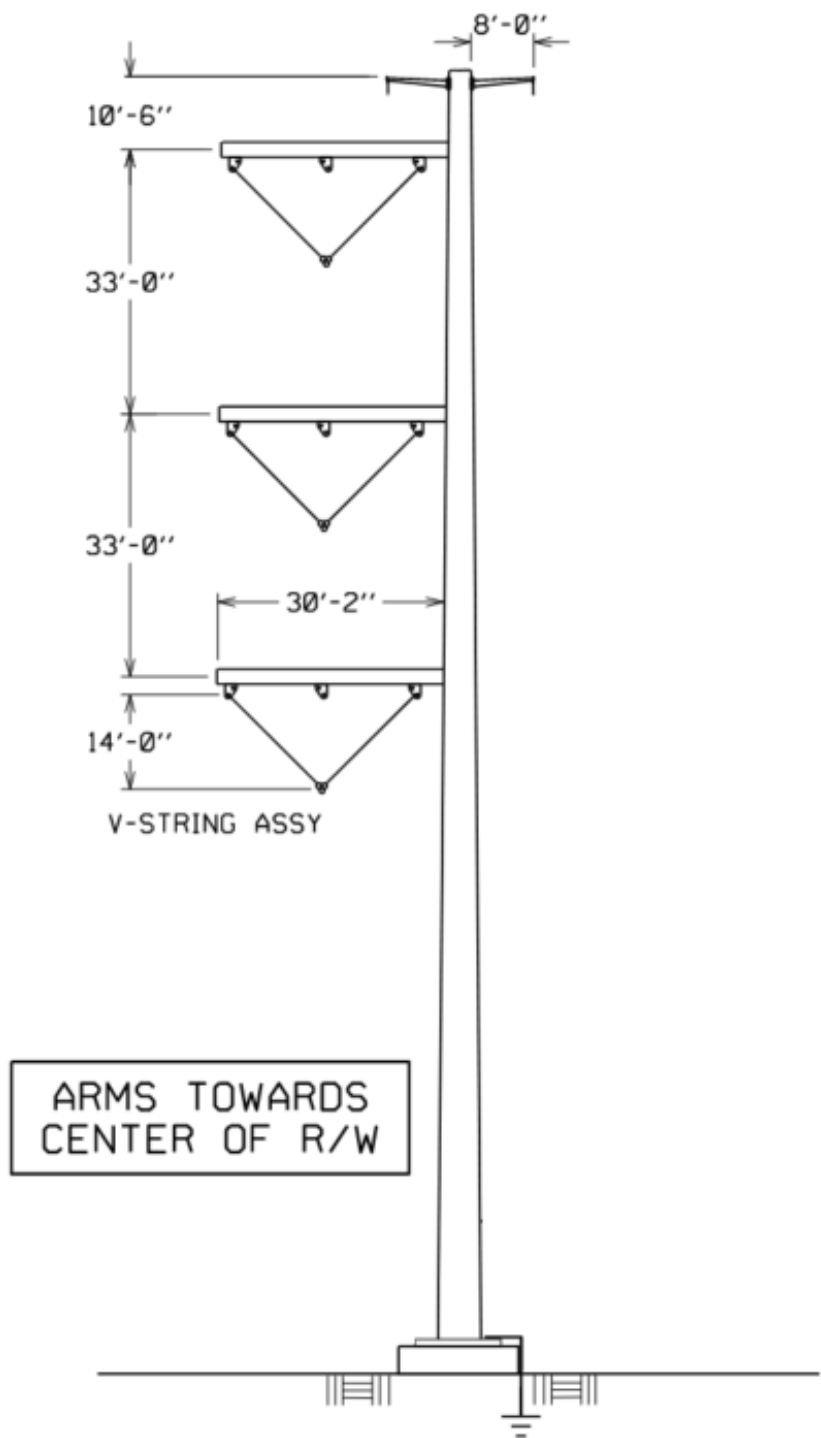
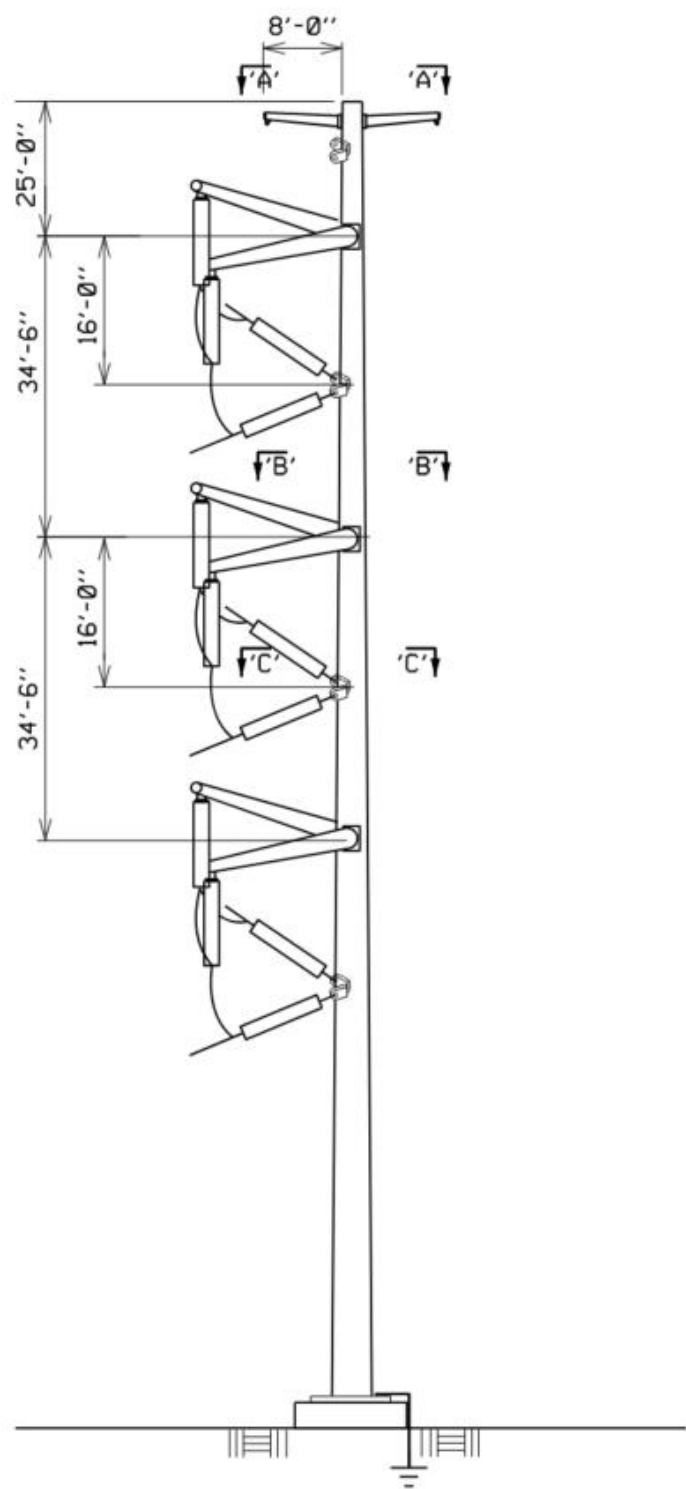
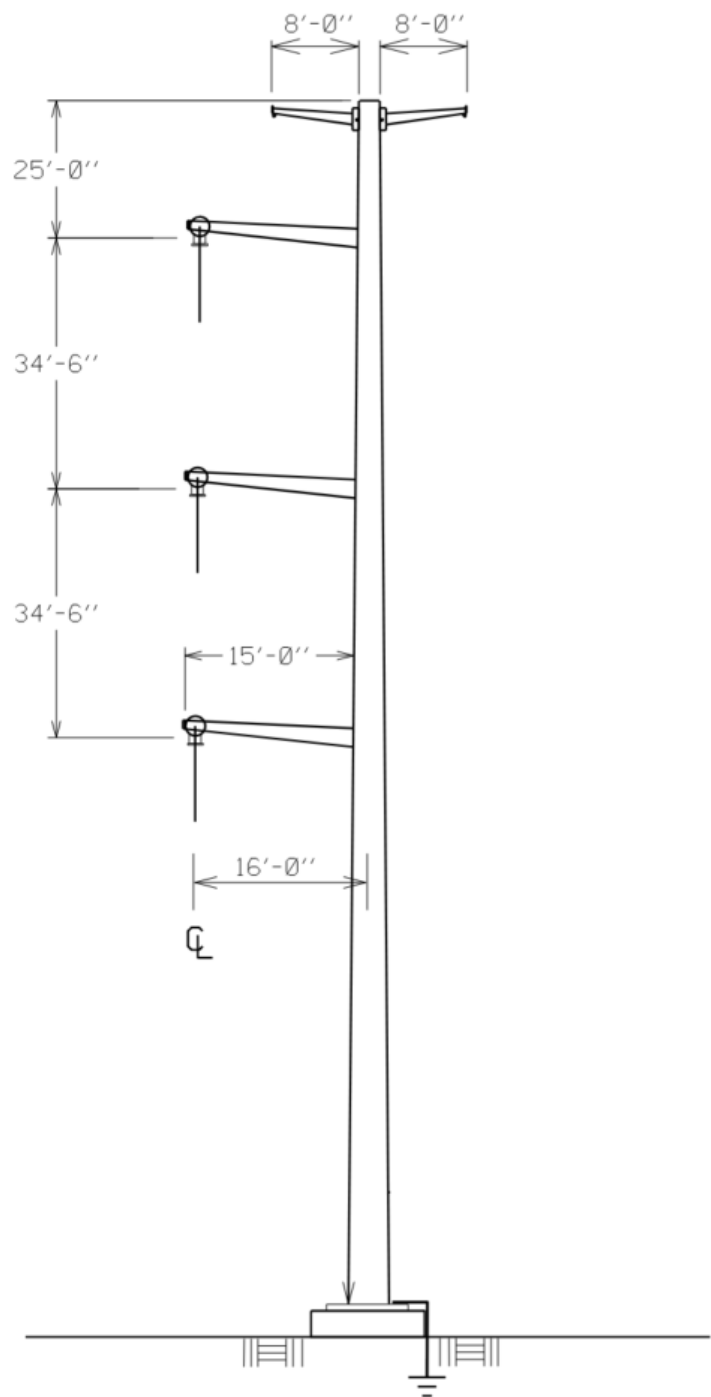


Figure 3 – Proposed Single Circuit Double Deadend Heavy Angle Structure Configuration





**Figure 4 – Proposed Single Circuit Double Deadend Small/medium Angle Structure Configuration**



### Required Material Summary

Item	Qty
Engineered Structures	214
15,000-Ft OPGW Reels	34
15,000-Ft Conductor Reels	153