DIRECT TESTIMONY
OF
BRIAN CONROY, P.E.

ON BEHALF OF
LOUDOUN COUNTY, VIRGINIA
BEFORE THE
STATE CORPORATION COMMISSION OF VIRGINIA
CASE NOS. PUR-2024-00032 AND PUR-2024-00044
(COLLECTIVELY, THE CONSOLIDATED CASES)

Q. PLEASE STATE YOUR NAME, OCCUPATION, WHERE YOU WORK, AND YOUR WORK ADDRESS.

A. Brian A. Conroy
Manager of Power System Studies
RLC Engineering, PLLC
176 Gannett Drive
South Portland, Maine 04105

Q. WHAT IS YOUR EDUCATION AND PROFESSIONAL EXPERIENCE?

A. I graduated from the University of Maine in 1986 with BS in electrical engineering. I subsequently earned an MBA degree from Thomas College in 1992. From 1986 to 2019, I worked at Central Maine Power Company, along with its affiliates NYSEG, RG&E, and UI. My responsibilities have included metering, distribution automation, distribution engineering and planning, smart grid planning, and directing the electric system engineering functions (transmission, substation, protection, distribution, technical metering, and meter labs) across all Avangrid electric OpCos before becoming a consultant. Since 2019, I have worked at RLC Engineering in the Power System Studies group. I manage a group of 32 engineers in the Transmission and Distribution Planning groups. I am a registered Professional Engineer in the States of Maine and New York. My most recent resume is attached to this testimony as **Exhibit BC-1**.

Q. WHAT IS YOUR PROFESSIONAL EXPERIENCE AS IT RELATES TO ELECTRICAL POWER SYSTEM STUDIES, AND ELECTRICAL POWER SYSTEM ECONOMIC ANALYSIS?

A. As a Distribution Engineer, I performed distribution analyses, studies, protection coordination, and distribution system designs. As a Control Center Manager, I participated in operational studies associated with new or upgraded high voltage lines and substations, and was NERC certified as a Reliability Coordinator. I have represented my company and affiliates at the NPCC Reliability Coordinating Committee, the New York Joint Utilities Steering Committee, and EPRI. I have also participated in regulatory proceedings in Maine, New York, and Connecticut.

As a Principal Power System Engineer at RLC Engineering, I performed distribution system impact studies. As Manager of Power System Studies at RLC Engineering, I oversee and participate in the transmission and distribution studies performed for our utility and ISO/RTO clients. These studies may include estimating, forecasting, production modeling, and other economic analyses.

Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY?

A. My testimony will provide an independent evaluation of Dominion Virginia Power's siting and transmission proposal to the Virginia State Corporation Commission, and specifically, the proposed Aspen-Golden 500 and 230 kV lines in the vicinity of Route 7, between Belmont Ridge Road and Claiborne Parkway. My testimony will discuss a hybrid alternative involving an underground option in an area which includes:

- Inova Loudoun Hospital Heliport

- Loudoun Freedom Center Cemetery – African American Burial Ground for the Enslaved at Belmont
- Lansdowne Scenic Easement
- Belmont Viewshed Easement
- Belmont Manor
- Existing Planned Residential Development

Q. HAVE YOU REVIEWED AND ANALYZED THE COMPANY'S APPLICATION FOR PROPOSED TRANSMISSION LINES SUBMITTED IN CASE NO. PUR-2024-00032 (THE "ASPEN-GOLDEN APPLICATION")?

A. Yes. I have reviewed the application.

Q. ON BEHALF OF LOUDOUN COUNTY, DID YOU CONDUCT A REVIEW OF ALTERNATIVE SOLUTIONS, INCLUDING AN UNDERGROUND OPTION FOR PART OF THE ROUTE, RUNNING MOSTLY ALONG ROUTE 7?

A. Yes, we did.

Q. PLEASE EXPLAIN THE SCOPE OF THE REVIEW AND THE PROCESSES UTILIZED TO UNDERTAKE IT.

A. To become familiar with the proposed project, and assess the need and the alternatives, RLC began with a document review, including:

- PJM 2022 Regional Transmission Expansion Plan (RTEP) to verify the need and drivers for the project.
- Responses to Lansdowne Conservancy Questions Sent 8-28-23
- NOVA | Dominion Energy
- Loudoun Reliability Projects Map (azureedge.net)

- Route Corridors Map (azureedge.net)
- aspen-golden-outreach-map.pdf (azureedge.net)
- Routing Constraints Aspen to Golden Map (azureedge.net)
- Dulles Greenway constraints map (azureedge.net)
- W&OD Trail Corridor Constraints Map (azureedge.net)
- Dominion Energy Projects: Twin Creeks to Apollo and Aspen to Golden - Loudoun Wildlife Conservancy

After assessing the alternate routes and associated constraints, we focused on alternatives for the Route 7 corridor. In seeking to minimize negative impacts along this corridor, RLC developed a conceptual underground layout and estimate in January of 2024. This report was subsequently shared with Dominion and a meeting was held on February 15, 2024 to discuss this alternative. Based upon feedback received at the meeting and in the Dominion filing in March (PUR-2024-0032), RLC updated the report and includes it as **Exhibit BC-3** of this testimony.

Q. WHAT WERE THE CONCLUSIONS OF YOUR REVIEW?

A. We concluded that this hybrid alternative mitigated negative impacts to facilities in the area and was feasible.

Q. DID YOU SUCCEED IN DEVELOPING A FEASIBLE UNDERGROUND HYBRID PROJECT PROPOSAL TO UNDERGROUND PART OF THE TRANSMISSION LINE PROPOSED IN THE ASPEN-GOLDEN APPLICATION?

A. Yes, we did.

Q. CAN YOU BRIEFLY DESCRIBE THE NATURE OF THE UNDERGROUND HYBRID PROJECT PROPOSAL?

A. Yes. The underground hybrid project proposal is attached to this testimony as **Exhibit BC-3.** The hybrid underground proposal would follow Dominion's proposed route from the Aspen Substation to nearby the proposed Sycolin Substation. A transition station is proposed at this location, with a 3-mile underground segment, generally following the proposed OH line route, running to the East of the Community Church in Ashburn. At that point, a second transition station is proposed, with the remaining route to Golden Substation following Dominion's proposal. The basic difference between the Dominion proposal and this hybrid proposal is this 3-mile proposed underground segment. See Figure 1 - Proposed Transmission Line Routing, in **Exhibit BC-3**. An illustrative plan of the potential underground route we designed is also attached to this testimony as **Exhibit BC-4.** Additionally, a context illustration of the Aspen-Golden potential underground route is attached to this testimony as **Exhibit BC-5**.

Q. BEFORE YOU DEVELOPED THE FINAL PROPOSAL, DID YOU PRESENT AN EARLIER ITERATION OF THE UNDERGROUND HYBRID PROJECT TO DOMINION? DID THEY REVIEW IT AND PROVIDE FEEDBACK?

A. Yes, we provided Dominion with a copy of our initial proposal and we met with them to discuss it. At that meeting, Dominion provided feedback on the proposal.

Q. WHAT WERE THE COMPANY'S COMMENTS AND CONCERNS REGARDING RLC'S PRIOR VERSION OF THE UNDERGROUND PROPOSAL?

A. Dominion's comments and concerns regarding the initial hybrid proposal were:

- Cables Per Phase: There were not enough cables per phase in the design to meet the required MVA ratings (provided at the meeting).
- Vault Size: The vault sized appeared too small.

- Transition Station Footprint: The transition stations footprints were too small.
- Common Duct Bank: The cables for both lines were contained in a common duct bank.
- Regulatory Approvals and Permitting:
- Cable Distances Between Splices: The distance between splice vaults was too long.
- Geologic Conditions: Rock and fractured rock are common geological conditions in the vicinity.
- Right-of-Way Width: The right-of-way was not wide enough to accommodate the design modifications warranted.

Q. DID YOU MAKE REVISIONS TO THE PRIOR VERSION OF THE UNDERGROUND PROPOSAL IN RESPONSE TO THE COMPANY'S STATED CONCERNS? IF SO, PLEASE DESCRIBE THEM, AND EXPLAIN HOW THEY WERE TARGETED TO ADDRESS THE COMPANY'S CONCERNS, REGARDING FEASIBILITY, COST, CONSTRUCTION TIME, OR OTHERWISE.

A. Yes, we did. We made the following conceptual design changes:

- Cables Per Phase: The design was modified to include 4 cables per phase for both the 230 kV and 500 kV lines.
- Vault Size: The vault size was adjusted to 10'x30'x10'.
- Transition Station Footprint: The transition stations footprints were adjusted to 470'x700' and 539'x550'.
- Common Duct Bank: The design was modified to provide separate 230 kV and 500 kV duct banks.
- Cable Distances Between Splices: The distance between splice vaults was adjusted to meet Dominion criteria.

- Geologic Conditions: Available geological surveys on adjacent parcels were reviewed. The cost estimate assumed to encounter 30% rock.

Right-of-Way Width: The right-of-way was adjusted to 100’ for duct banks and 150’ at splice vault locations.

Q. DID YOUR REVISIONS ADDRESS ALL OF DOMINION’S STATED CONCERNS AS YOU UNDERSTOOD THEM?

A. They addressed as many of the concerns as possible with a conceptual design. Geological and environmental details will be assessed in the detail design as is the case in all transmission line applications. These, regulatory and environmental permitting risks, and other risks are factored into the conceptual estimate.

Q. BASED ON YOUR ANALYSIS, WHAT IS YOUR CONCLUSION REGARDING DOMINION’S PROPOSED ROUTE IN THE ASPEN-GOLDEN APPLICATION, SPECIFICALLY ITS PROPOSAL TO PLACE THE ENTIRE ROUTE OVERHEAD, INCLUDING THAT PORTION OF THE ROUTE THAT RUNS ALONG OR NEAR THE UNDERGROUND PROPOSAL?

A. My conclusion regarding Dominion’s proposed route is that they considered but did not fully evaluate the alternative of placing portions of the line underground as a feasible alternative to minimize the negative impact to adjacent facilities and uses.

Q. WHAT IS THE BASIS FOR YOUR ASSESSMENT?

A. This assessment is based upon the negative impacts to the area in question, including:

- Inova Loudoun Hospital Heliport
- Loudoun Freedom Center Cemetery – African American Burial Ground for the Enslaved at Belmont

- Lansdowne Scenic Easement
- Belmont Viewshed Easement
- Belmont Manor
- Existing Planned Residential Development

Please see the photo renditions in **Exhibit BC-2** to compare the impact of the OH and hybrid options.

Q. PLEASE DESCRIBE ANY VIABLE ALTERNATIVES THAT YOU BELIEVE SHOULD BE CONSIDERED BY THE COMMISSION.

A. By designing the section of this route underground from Belmont Ridge Road through the Claiborne Parkway, the negative impact to the uses, easements, and historic sites can be greatly mitigated. *See* Figure 1 - Proposed Transmission Line Routing, in **Exhibit BC-3** – Transmission Line Summary Estimate.

Q. IN SECTION 5.3.2. UNDERGROUND FEASIBILITY, PAGES 30 THROUGH 33 OF THE ENVIRONMENTAL ROUTING STUDY FILED AS PART OF VOLUME 3 OF DOMINION'S ASPEN-GOLDEN APPLICATION, DOMINION PROVIDES ANALYSIS SUPPORTING ITS DETERMINATION THAT UNDERGROUNDING ALL OR PART OF THE ROUTE IS UNFEASIBLE. WHAT IS YOUR OPINION OF THAT ANALYSIS?

A. I disagree based on the items mentioned below:

Example Projects: The Chino Hills, California example was dismissed as it used an existing overhead transmission right-of-way which bisected existing developments. The Aspen to Golden project uses substantially the same proposed right-of-way as Dominion's

plan which bisects existing and proposed developments. The undergrounding of this segment mitigates negative impacts, regardless of the OH line's feasibility.

Cost: As the hybrid UG segment includes only 3 miles of the proposed 9.4 mile Aspen to Golden line, the cost of this hybrid alternative is estimated at $1,112M, compared to $689M for the OH line (a $423M or 61% difference). See Table 1 – Cost Estimate Summary, in **Exhibit BC-3**.

In-Service Date: RLC assumed the following project milestone dates in the development of this underground estimate:

- Engineering: 10/01/2024 - 12/31/2025 (electrical/civil)
- Permitting/Approvals: 03/01/2024 - 10/01/2026 (environment/Utility/FERC/State/Local, etc.)
- Cable Procurement: 06/01/25 - 12/31/2026 (assume 18month lead time)
- Construction: 10/01/2026 - 06/01/2028

Transition stations: RLC has adjusted the area needed to accommodate transition stations and has located viable sites for these stations. The proposed transition stations are estimated to be 470'x700', and 540'x550'. Please see Figure 1 - Proposed Transmission Line Routing, in **Exhibit BC-3**.

Trenchless Crossings: The hybrid OH-UG proposal does not cross Goose Creek or Broad Run. An allowance for 1,000' of trenchless construction was included in the cost estimate.

Wetland areas and water bodies: The planned hybrid UG line will cross streams by the planned extension of Russell Branch Parkway in the vicinity of Russell Branch Road.

Once the UG line is constructed, these areas will remain undisturbed for the life of the project.

Future delivery point requests: Below are the planned data center developments in the proposed UG area, along with options to provide service (reference Figure 1 - Proposed Transmission Line Routing, in **Exhibit BC-3**. Other residential and commercial delivery requests in the area could be served by the local distribution system.

- Belmont Innovation – may be served from OH section of the line.
- Vantage – may be served by OH section of the line
- Belmont Data Center – planned substation to serve this development is adjacent to the planned duct bank and provisions can be made to accommodate service.
- Belmont Park – may be served by local distribution.
- Ashburn Chase – may be served by local distribution

Fault location and restoration: With the ability to isolate individual cables, 75% of the line flow can be maintained until the repair is complete on a faulted cable (assuming 4 cables per phase). With an OH line, no flow is available until the repair is completed. This represents an increase in resiliency/redundancy. Also, with fault detection technology, the location of a fault can be identified between the nearest vaults/splices to facilitate repairs.

In summary, our analysis shows the hybrid alternative is feasible and preferred to minimize the negative impact to these adjacent facilities.

Q. ON PAGES 32 AND 33 OF THE ROUTING STUDY, DOMINION PROVIDES ANALYSIS OF AN UNDERGROUND PROPOSAL PRESENTED TO THE COMPANY BY RLC, WHICH THE COMPANY SAYS SUPPORTS ITS

DETERMINATION THAT RLC'S UNDERGROUNDING PROPOSAL WAS INFEASIBLE. WHAT IS YOUR OPINION OF THAT ANALYSIS?

A. I disagree with that opinion. The concept of the hybrid system is feasible but required adjustments to meet Dominion's requirements. As a result of our discussion with the Dominion team, RLC addressed each of the points made during the February 15, 2024, meeting with Dominion. Please see **Exhibit BC-3** for an updated conceptual design. Specifically:

- Number of cables per phase: RLC revised the design to 4 cables per phase to meet Dominion's loading specifications conveyed during the meeting (1,573 MVA for 230 kV and 4,357 MVA for 500 kV).
- Cable and ductbank spacing: RLC revised the ductbank cable spacing and separated the 230 kV and 500 kV into two separate ductbanks. See Figure 2 – Example of Concrete Duct Bank Arrangement, in **Exhibit BC-3** for a typical duct bank section.
- Size and location of temporary workspace: Temporary workspace was added to the routing plan.
- Width of permanent right-of-way needed: The width of the needed permanent right-of way is indicated on the routing plan.
- Visual Impact: The allegation that the visual impact of the transition stations would be exacerbated with this alternative is unfounded. Please see the photo renditions in **Exhibit BC-2** to compare the visual impact of the OH and hybrid options. The transition stations are located on properties zoned for data center use and will blend in with substations located on the property.

Q. HAVE YOU REVIEWED DOMINION'S RESPONSE TO QUESTION NO. 13(a) OF THE THIRD SET OF INTERROGATORIES AND REQUESTS FOR PRODUCTION OF DOCUMENTS PROPOUNDED BY COMMISSION TO STAFF, IN WHICH THE COMPANY PROVIDES ADDITIONAL ANALYSIS ON THE FEASIBILITY OF UNDERGROUNDING IN THIS CASE, INCLUDING A CASE COMPARISON?

A. Yes, I have. It is attached to this testimony as **Exhibit BC-6**.

Q. WHAT IS YOUR OPINION OF THAT ANALYSIS?

A. I have the following clarifications and corrections to make on this response:

Project Timeline: RLC assumes a 45-month project timeline, compared to 47-month timeline based on Dominion's estimates. Further, Dominion's estimate assumes an all-underground alternative which envisions many additional conflicts beyond those presented by this hybrid proposal. The following project milestone dates were used in the development of this underground estimate:

- Engineering: 10/01/2024 - 12/31/2025 (electrical/civil)
- Permitting/Approvals: 03/01/2024 - 10/01/2026 (environment/Utility/FERC/State/Local, etc.)
- Cable Procurement: 06/01/25 - 12/31/2026 (assume 18-month lead time)
- Construction: 10/01/2026 - 06/01/2028

UG Line Length: The proposed hybrid UG proposal includes a 3-mile UG segment which is shorter than the length of the 3.7-mile Chino Hills 500 kV UG line, whereas the Dominion response assumes an all-underground alternative.

Right-of-Way: The hybrid UG route uses substantially the same right-of-way as that proposed by Dominion. The procurement of right-of-way would be substantially equivalent to the proposed OH route. Here again, Dominion is assuming an all-underground alternative.

Geologic Conditions: Geologic conditions will have to be verified during detailed design. The geotechnical exploration will verify the soil thermal values and depth to bedrock, and the thermal values will be used in calculating the cable rating. The depth of bedrock will have an impact on the ease of excavation. RLC has looked at available geotechnical reports for properties in the area and found that the depth to bedrock varies from 2.5 to 13.5 feet. Contrary to this response, the proposed hybrid UG solution is not planned to cross Goose Creek.

Planned Developments: Please see Figure 1 - Proposed Transmission Line Routing, in **Exhibit BC-3**. This routing anticipates known future developments, including:

- Belmont Innovation
- Vantage
- Belmont Data Center
- Belmont Park
- Ashburn Chase

Transition Stations: Once again, Dominion is assuming an all-underground alternative with transition stations at the Aspen and Golden Substations. This hybrid proposal shows transition stations on data center zoned property at each end of the proposed 3-mile underground segment.

Q. DESCRIBE THE SALIENT FEATURES OF THE UNDERGROUND PROPOSAL THE COUNTY WISHES TO PUT FORWARD.

A. The hybrid underground proposal would follow Dominion's proposed route from the Aspen Substation to nearby the proposed Sycolin Substation. A transition station is proposed at this location, with a 3-mile underground segment, generally following the proposed OH line route, running to the East of the Community Church in Ashburn. At that point, a second transition station is proposed, with the remaining route to Golden Substation following Dominion's proposal. The basic difference between the Dominion proposal and this hybrid proposal is this 3-mile proposed underground segment. See Figure 1 - Proposed Transmission Line Routing, in **Exhibit BC-3**.

Q. WHAT ARE THE KEY PERFORMANCE CHARACTERISTICS OF THE UNDERGROUND PROPOSAL? IN TERMS OF RELIABILITY, REDUNDANCY, AND OTHER KEY PERFORMANCE CHARACTERISTICS?

A. For a fault on an underground cable, with the ability to isolate individual cables, 75% of the line flow can be maintained until the repair is complete on a faulted cable (assuming 4 cables per phase). With an OH line, no flow is available until the repair is completed. This represents an increase in resiliency/redundancy. Also, with fault detection technology, the location of a fault can be identified between the nearest vaults/splices to facilitate repairs.

Q. HOW DO THE PERFORMANCE CHARACTERISTICS OF THE UNDERGROUND PROPOSAL COMPARE TO THE PERFORMANCE CHARACTERISTICS FOR THE COMPANY'S PROPOSED OVERHEAD TRANSMISSION LINE IN THE ASPEN-GOLDEN APPLICATION?

A. The 'all lines in' rating of the UG proposal will match the rating of the OH lines (4,000 A at 230 kV and 5,000 A at 500 kV). However, when the OH line has a fault, the entire line is lost, and alternate paths must carry the full flows of the line until it is repaired and put back into service. Whereas, when an UG cable has a fault, it can be isolated and the remaining cables carry 75% of the rated load (in the case of 4 cables per phase) until it is repaired. This provides a resiliency/redundancy benefit over the OH alternative.

Q. DESCRIBE YOUR EXPECTED CONSTRUCTION TIMELINE FOR THE UNDERGROUND PROPOSAL AND HOW YOU ARRIVED AT THAT ESTIMATE. HOW MUCH OF A CONSTRUCTION DELAY TO YOU ESTIMATE FOR THE UNDERGROUND PROPOSAL OVER THE ESTIMATED TIMELINE FOR THE OVERHEAD PROPOSAL IN THE ASPEN-GOLDEN APPLICATION, IF ANY?

A. RLC assumed the following project milestone dates in the development of this underground estimate, based in industry knowledge and recent experience, including material lead times:

- Engineering: 10/01/2024 - 12/31/2025 (electrical/civil)
- Permitting/Approvals: 03/01/2024 - 10/01/2026 (environment/Utility/FERC/State/ Local, etc.)
- Cable Procurement: 06/01/25 - 12/31/2026 (assume 18month lead time)
- Construction: 10/01/2026 - 06/01/2028

Q. DESCRIBE THE COST ESTIMATE YOU REACHED IN THE UNDERGROUND PROPOSAL AND EXPLAIN HOW YOU ARRIVED AT THAT ESTIMATE.

A. The hybrid project cost estimates used the values provided by Dominion Energy for the overhead portion of this transmission line and the required substation construction.

The cost per mile of the OH line ($18.2M) was subtracted for the 3-mile portion of the UG plan. RLC then provided a conservative high-level cost estimate for the underground transmission line portion, including transition stations, of the project and combined it with the cost estimates for the Aspen to Golden overhead transmission line project provided by Dominion.

This hybrid alternative is estimated at $1,112M, compared to $689M for the OH line (a $423M or 61% difference). The results of this estimate are summarized in Table 1 – Cost Estimate Summary, in **Exhibit BC-3**.

Q. DESCRIBE ANY CONSTRAINTS YOU ENCOUNTERED RELATED TO DIGGING, BURROWING, OR GEOTECHNICAL ISSUES AND EXPLAIN THE STEPS TAKEN IN THE UNDERGROUND PROPOSAL TO MITIGATE THOSE.

A. RLC has looked at available geotechnical reports for properties in the area and found that the depth to bedrock varies from 2.5 to 13.5 feet. Geologic conditions will have to be verified during detailed design. The geotechnical exploration will verify the soil thermal values and depth to bedrock, and the thermal values will be used in calculating the cable rating. The depth of bedrock will have an impact on the ease of excavation.

With the hybrid alternative, only Belmont Ridge Road, Claiborne Parkway, and the yet-to-be-constructed section of Russell Branch Parkway would be crossed. An allowance for 1,000’ of trenchless construction was included in the cost estimate.

The planned hybrid UG line will cross streams by the planned extension of Russell Branch Parkway in the vicinity of Russell Branch Road. Once the UG line is constructed, these areas will remain undisturbed for the life of the project.

Q. WHAT ARE THE CRITICAL ROUTING AND LOCATION DECISIONS THAT HAD TO BE MADE IN DEVELOPING THE UNDERGROUND PROPOSAL AND CAN YOU EXPLAIN THOSE?

A. Critical routing and location decisions made in developing the UG proposal include transition station locations, required right-of-way width, splice vault spacing, current and proposed developments, culturally significant sites, existing uses, and existing easements.

- Transition station had to be located where these is accommodating space;
- the route had to be located where there is accommodating width;
- the splice vaults (with their expanded right-of-way requirement) had to be located where these is accommodating width, yet spaced close enough together for acceptable cable pulling and reel size;
- the route had to accommodate both existing and planned developments;
- the route could not disturb culturally significant sites;
- the route was chosen to accommodate existing uses (e.g., helipad); and
- the segment was chosen to preserve existing viewshed and scenic easements.

Q. WHAT ARE YOUR OVERALL CONCLUSIONS ABOUT THE FEASIBILITY AND PROSPECTIVE PERFORMANCE OF THE UNDERGROUND PROPOSAL?

A. The underground proposal is feasible, performs better than the OH alternative, and reasonably minimizes adverse impacts to the surrounding area.

Q. IN YOUR OPINION, WILL THERE BE ANY MATERIAL PERFORMANCE DROPOFF IF THE COMMISSION ORDERS DOMINION TO UNDERGROUND THE PORTION OF THE ROUTE DESIGNATED BY THE UNDERGROUND PROPOSAL?

A. No, there will not be any material performance drop-off with the UG alternative.

Q. ARE THERE ANY OTHER ADVANTAGES EXCLUSIVE TO THE UNDERGROUND PROPOSAL?

A. The surrounding residents and community will enjoy the benefits of the reduced negative impacts of the UG segment for the life of the project.

Q. WHAT ARE YOUR OVERALL CONCLUSIONS REGARDING DOMINION'S ASPEN-GOLDEN APPLICATION?

A. My overall conclusions are as follows:

- Dominion has identified and evaluated multiple routes for its planned 230/500 kV Aspen-Golden line.
- Dominion's evaluation of the OH line alternative routes appears feasible, but does not reasonably minimize adverse impact on the scenic assets, historic districts, and environment of the hybrid UG area concerned.
- The option of UG construction was not adequately considered, particularly in the most sensitive areas along the path.
- The hybrid Aspen-Golden option presented above, would minimize impacts in a sensitive area along the route.
- This hybrid alternative is feasible.

Q. IS THERE ANYTHING ELSE YOU WOULD LIKE TO ADD TO YOUR TESTIMONY?

A. Not at this time.

Attachments:

1) **Exhibit BC-1 – Resume**

2) **Exhibit BC-2 – Photographs Showing Impacts of OH Lines**

3) **Exhibit BC-3 – Transmission Line Summary Estimate and Underground Hybrid Proposal (August 2024)**

4) **Exhibit BC-4 – Aspen-Golden Potential Underground Route, Illustrative Plan**

5) **Exhibit BC-5 – Aspen-Golden Potential Underground Route, Context Plan**

6) **Exhibit BC-6 – Excerpt from Dominion's Responses to SCC Staff's Third Set of Discovery**

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(COLLECTIVELY, THE CONSOLIDATED CASES)

Exhibit BC-1 (Resume)

BRIAN A. CONROY, P.E.

EDUCATION & TRAINING

Masters Degree in Business Administration
Thomas College; Waterville, Maine
June 1992

Bachelor of Science in Electrical Engineering
University of Maine; Orono, Maine
May 1986
Graduated with High Distinction

Registered Professional Engineer
- State of Maine
- State of New York

PROFESSIONAL EXPERIENCE

Manager of Power System Studies, RLC Engineering; South Portland, Maine. Leading a high performance Distribution and Transmission Planning groups in steady-state, dynamic, and EMT system studies, including DER interconnection, reliability/resiliency, protection, scripting and modeling, arc hazard analyses, etc. (7/2019 – present)

Director – Network Projects & Initiatives, AVANGRID; Portland, Maine. Responsible for delivering an integrated Energy Management, Distribution Management, Geographic Information, and Outage Management System for the AVANGRID network companies, and continuing to plan and develop the smart grid technology platform required to operate the electric utility of the future. (4/2014 – 7/2019)

Director – Electric Systems Engineering, Iberdrola USA; Augusta, Maine. Responsible for transmission, substation, protection, and distribution engineering functions across the Iberdrola USA operating companies [Rochester Gas & Electric, New York State Electric & Gas, and Central Maine Power Company]. (1/2010 – 3/2014)

Manager – Dispatch & Energy Control Center, Central Maine Power Company; Augusta, Maine. Manager responsible for Maine Local Control Center which oversees the operations of the 345 kV and 115 kV transmission systems in Maine, along with the 35 kV sub-transmission system for Central Maine Power Company. NERC Certified System Operator – Reliability (7/2006 – 12/2009)

Lead Electrical Engineer, Distribution Engineering Department, Central Maine Power Company; Augusta, Maine. Electrical engineer responsible for the planning, design, construction, operation and maintenance of the distribution system, including underground secondary network system. (7/1995 – 6/2006)

Engineer, Load Management Operations Department, Central Maine Power Company; Augusta, Maine. Project engineer responsible for specification, bid review, technical design review, and acceptance testing of real-time computer system. Also responsible for the design and installation of substation, communications (telecommunications and

power line carrier), and metering equipment for Load Management System. (12/1988 - 7/1995)

Engineer, Meter Operations Department, Central Maine Power Company; Augusta, Maine. Designed metering installations, equipment specifications, and construction standards. (6/1986 - 12/1988)

PAPERS


PCGBTSUSD.pdf


MPAPSTSUSD.pdf

PUBLICATIONS

"Flexibility Is Key in New York: New Tools and Operational Solutions for Managing Distributed Energy Resources (Currie, et al., May/June 2017)" IEEE Power and Energy Magazine, May/June 2017, pp 20-29. http://ieeexplore.ieee.org/document/7900480/

VOLUNTEER EXPERIENCE

Maine Engineering Promotional Council Board – Organized the annual National Engineers Week Banquet and EXPO. 2020 President. www.engineeringme.com (2014 – present)

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Exhibit BC-2 (Photo Renditions)

ASPEN TO GOLDEN

Loudoun County, VA

EXISTING & PROPOSED VIEWS

08.13.2024

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ASPEN TO GOLDEN

Loudoun County, VA

EXISTING & PROPOSED VIEWS

08.13.2024

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EXISTING CONDITIONS

PROPOSED CONDITIONS

ASPEN TO GOLDEN

Loudoun County, VA

EXISTING & PROPOSED VIEWS

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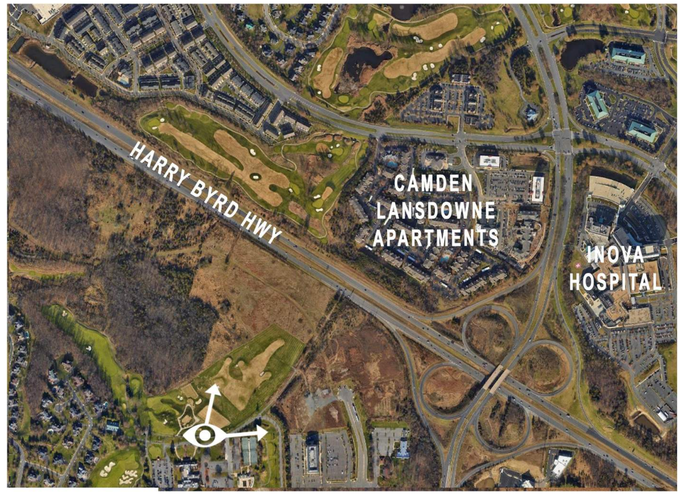

EXISTING CONDITIONS

PROPOSED CONDITIONS

ASPEN TO GOLDEN

Loudoun County, VA

EXISTING & PROPOSED VIEWS

08.13.2024

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LOUDOUN COUNTY, VIRGINIA
BEFORE THE
STATE CORPORATION COMMISSION OF VIRGINIA
CASE NOS. PUR-2024-00032 AND PUR-2024-00044
(COLLECTIVELY, THE CONSOLIDATED CASES)

Exhibit BC-3 (Proposed Transmission Line Routing)

RLC ENGINEERING

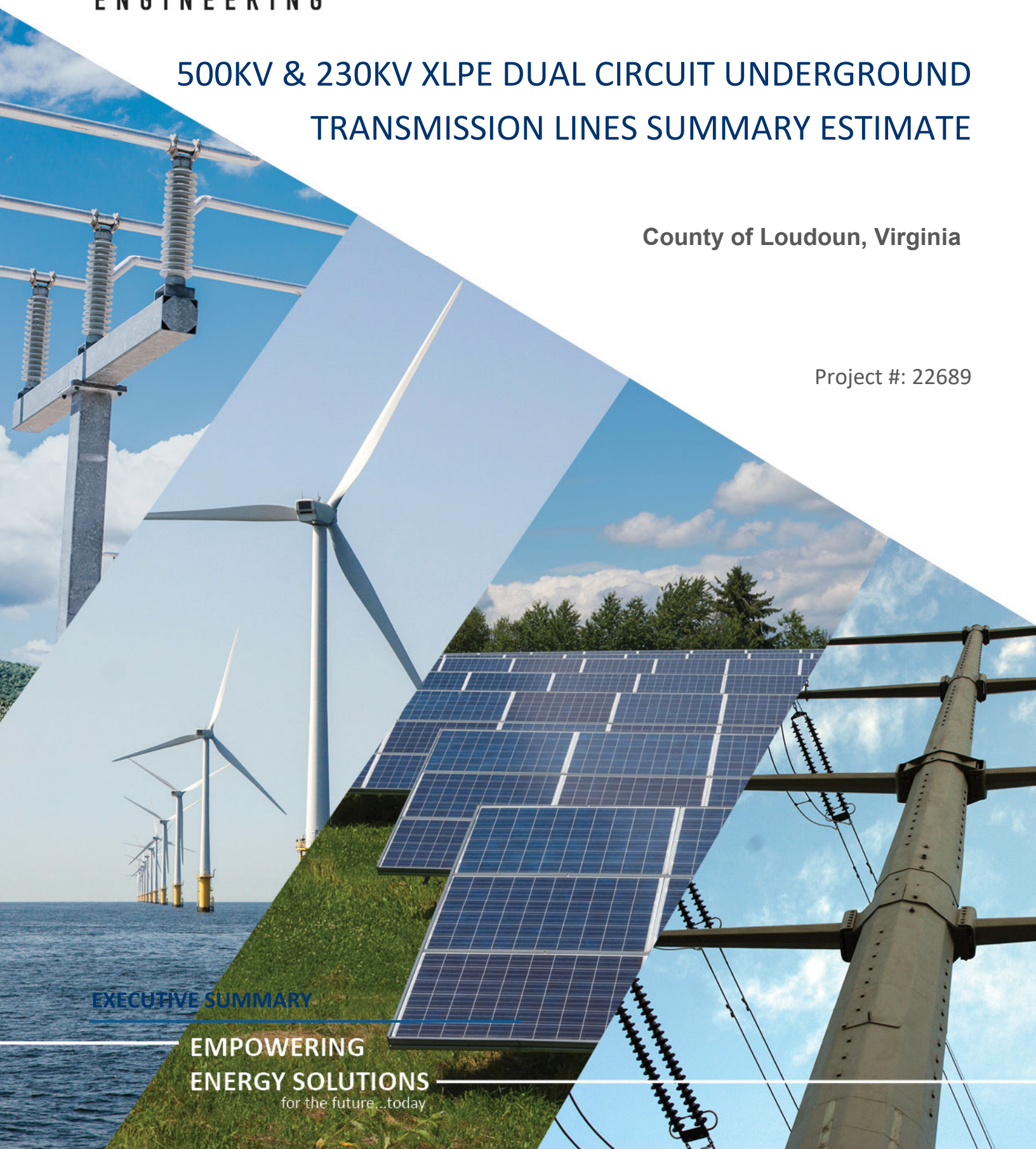
UPDATED ROUTING REPORT

AUGUST 12TH, 2024

500KV & 230KV XLPE DUAL CIRCUIT UNDERGROUND TRANSMISSION LINES SUMMARY ESTIMATE

County of Loudoun, Virginia

Project #: 22689



EXECUTIVE SUMMARY

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RLC Engineering, LLC (RLC) has prepared this report to develop a high level feasibility and conceptual grade cost estimate for the proposed 500kV and 230kV Dual Circuit XLPE Underground Transmission Line Installation (Project) located in Loudoun County, VA. The Project is a 16,000' (3.03-mile) long underground installation of two (2) transmission lines in duct banks. These underground transmission lines will be a section of a larger 500kV/230kV overhead transmission line, which will run 9.4 miles from the proposed Aspen Substation to the proposed Golden Substation. The transmission lines will be installed by and constructed to Dominion Energy specifications and approvals. Project cost estimates for the overhead portion of this transmission line and required substation construction have been provided by Dominion Energy. The County of Loudoun, Lansdowne Conservancy, and RLC Engineering met with Dominion on February 15, 2024 to discuss this underground solution proposal. This report represents a revised underground solution to incorporate the comments made by Dominion in that meeting.

The proposed underground routing of the Project has been established and provided to RLC by the client, see Figure 1 below. Based on the limited amount of project information available, RLC has made a number of assumptions in order to compile the required information to provide this feasibility analysis and cost estimate for the underground transmission line installation, these assumptions are listed in this report below. The proposed layout and assumptions cover many of the concerns with constructing the line underground versus overhead. Further details will need to be addressed during detail design.

RLC Engineering has provided a high-level cost estimate for the underground transmission line portion of the project and combined it with the cost estimates for the Aspen to Golden overhead transmission line project provided by Dominion. The cost estimate summary shown in Table 1 below shows a total project cost for a hybrid overhead and underground dual circuit transmission line. RLC displaced approximately 3 miles of overhead double circuit tower lines with the underground solution. This hybrid variant on the project represents a $423M difference in the original OH cost estimate provided by Dominion.

Table 1 Cost Estimate Summary

Cost (million)	Description
$518	Dominion estimate for line terminals
$171	Dominion estimate for 9.4 mile OH DCT line ($18.2/mile)
$689	Dominion estimate for Aspen-to-Golden Project (Overhead Construction)
-$55	Reduction of 3 miles of OH DCT line ($18.2M x 3miles)
$478	Addition for 3 miles UG construction
$1,112	Hybrid estimate for Aspen-to-Golden (OH and UG Construction)

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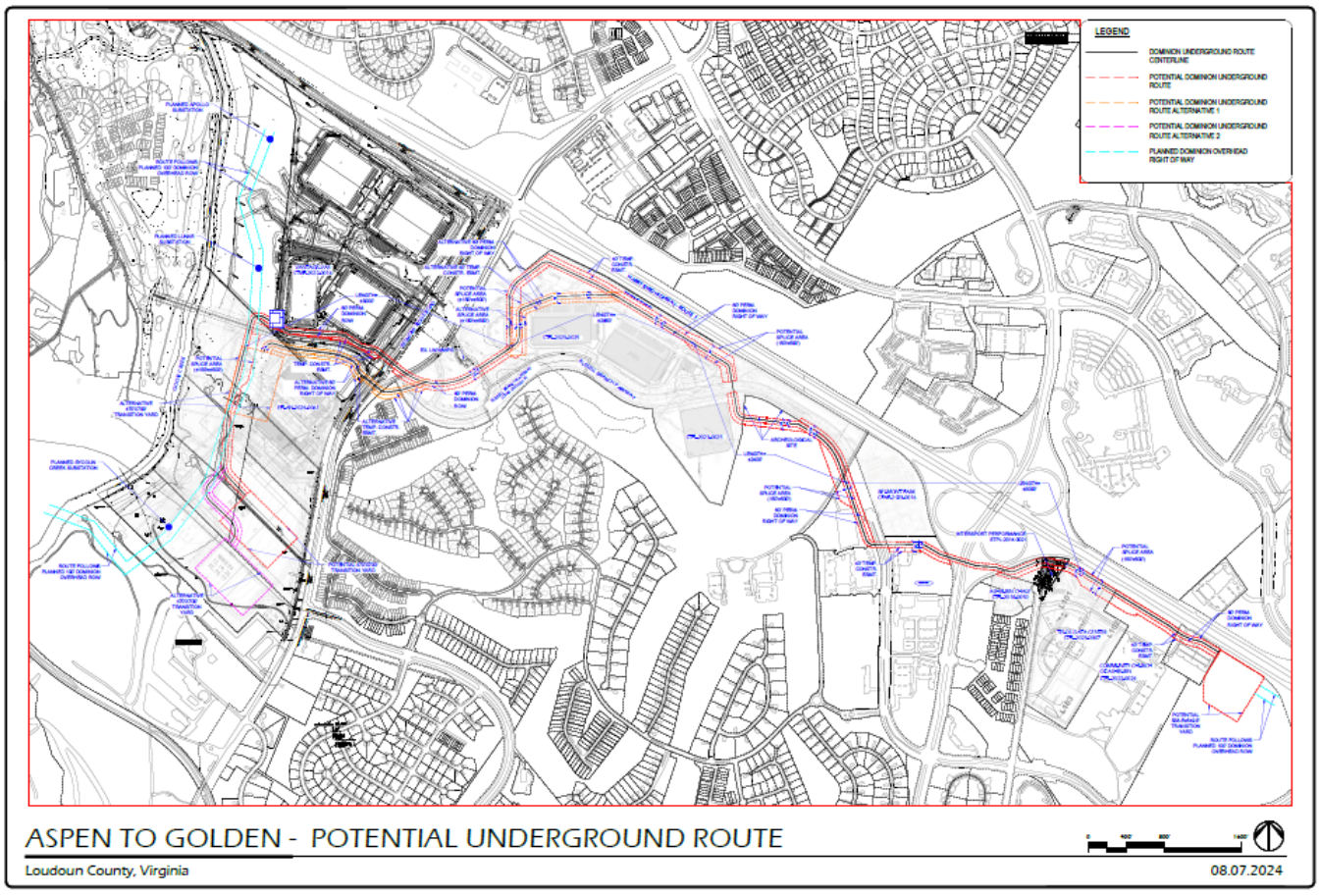
1. UNDERGROUND TRANSMISSION LINE PROJECT DESCRIPTION

1.1. General Underground Transmission line Information

The potential underground routing consists of the installation of a 16,000' section of new underground transmission lines along Route 7 in Loudoun County, VA (See Figure 1). The 500 kV and 230 kV dual circuit underground transmission lines will be a section of a longer 500kV/230kV overhead transmission line, which will run from the proposed Aspen Substation to the proposed Golden Substation and will require a total of two (2) overhead-to-underground transition yards consisting of approximately seven-acre lots; one (1) at each proposed start and finish location (see Figure 1). Each of the transition yards will require two (2) take-off structures; one (1) for the 500kV conductors, and one (1) for the 230kV conductors. Both transmission lines will be run in one (1) common trench in separate concrete encased duct banks, with a series of splice vaults to accommodate the proposed routing and conductor splicing. The location of the transition yards and vaults, and distance between them, was estimated using the map provided and Google Earth imagery as well as estimated cable lengths. No right-of-way (ROW) reviews, environmental permitting or inspections were completed on this project routing, which could impact the final locations of the structures and vaults.

Figure 1 - Proposed Transmission Line Routing



1.2. Underground Transmission Line Scope of Work

The following is a list of major equipment that was included in the cost estimate for the proposed underground portion of project: (see Figure 3 for an example sketch of the transition yards and transmission duct bank routing)

- **Two (2) – Seven-acre transition yards (one at either end of the underground transmission lines routing)**
    - Two (2) 500kV take-off structures
        - (19) Concrete Foundations
        - Structure Steel and associated bus work
        - (75) Insulators
        - (12) 500kV Underground Cable Terminations (4 per phase)
    - Two (2) 230kV take-off structures (H-Frame)
        - (20) Concrete Foundations
        - Structural sell and associated bus work
        - (36) Insulators
        - (12) 230kV Underground Cable Terminations (4 per phase)
    - 2,200’ perimeter, 8’ high chain-link security fencing, with access gates
    - Allowance for additional transition yard equipment
    - 500,000 sq/ft transition yard site work and finish materials
    - 400’ of access road
    - Site Lighting
    - Ground Grid
    - Storm Water Drainage
- **500kV Underground Transmission Line**
    - 192,000’ of 5000kcmil XLPE conductors (4 per phase – 12 total)
    - 16,000’ #500kcmil grounding conductor
    - (36) – 10’x30’x10’ splice vaults located along proposed routing
        - 10’x30’x10’ concrete vaults
        - Cable supports, splicing, grounding
        - Excavation and grading work
- **230kV Underground Transmission Line**
    - 192,000’ of 5000kcmil XLPE conductors (4 per phase – 12 total)
    - 16,000’ of #500kcmil grounding conductor
    - (36) - 10’x30’x10’ splice vaults located along proposed routing
        - 10’x30’10’ concrete vaults
        - Cable supports, splicing, grounding
        - Excavation and grading work

- **Dual Duct Banks (6x3 concrete encased duct bank, 10’W x8’ deep)**
    - 192,000’ of 8’’ PVC conduit (for 500kV line: 16,000’ x 12)
    - 192,000’ of 8’’ PVC conduit (for 230kV line: 16,000’ x 12)
    - 32,000’ of 6’’ PVC conduit (for grounding)
    - 32,000’ of 4’’ PVC conduit (for communications)

Figure 2 - Example Concrete Duct Bank Arrangement

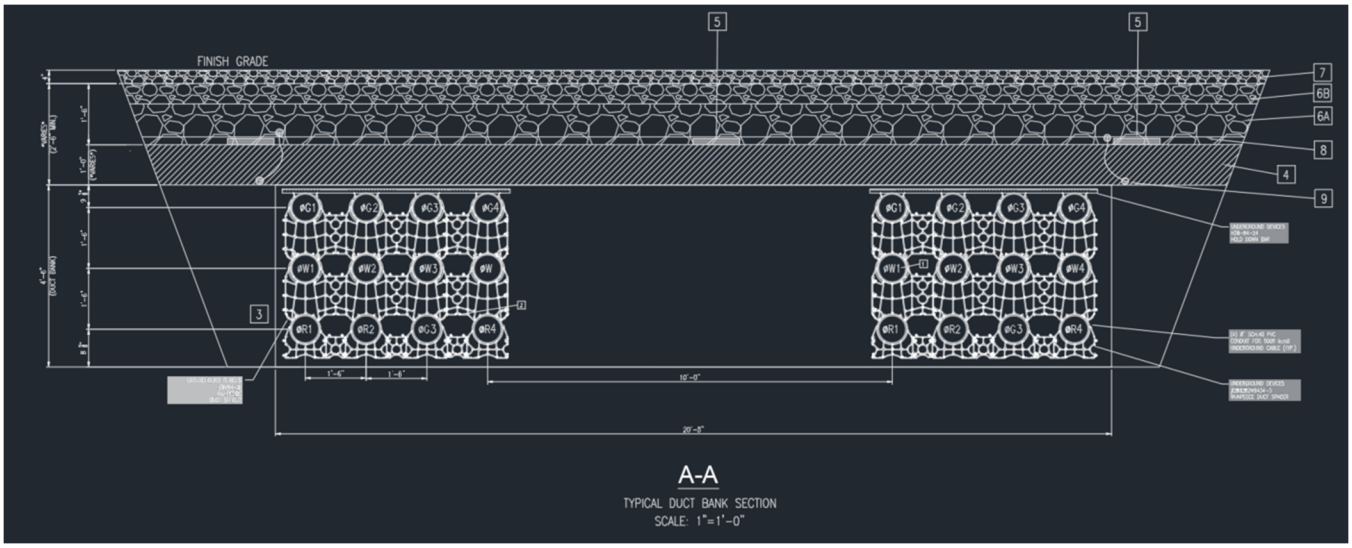
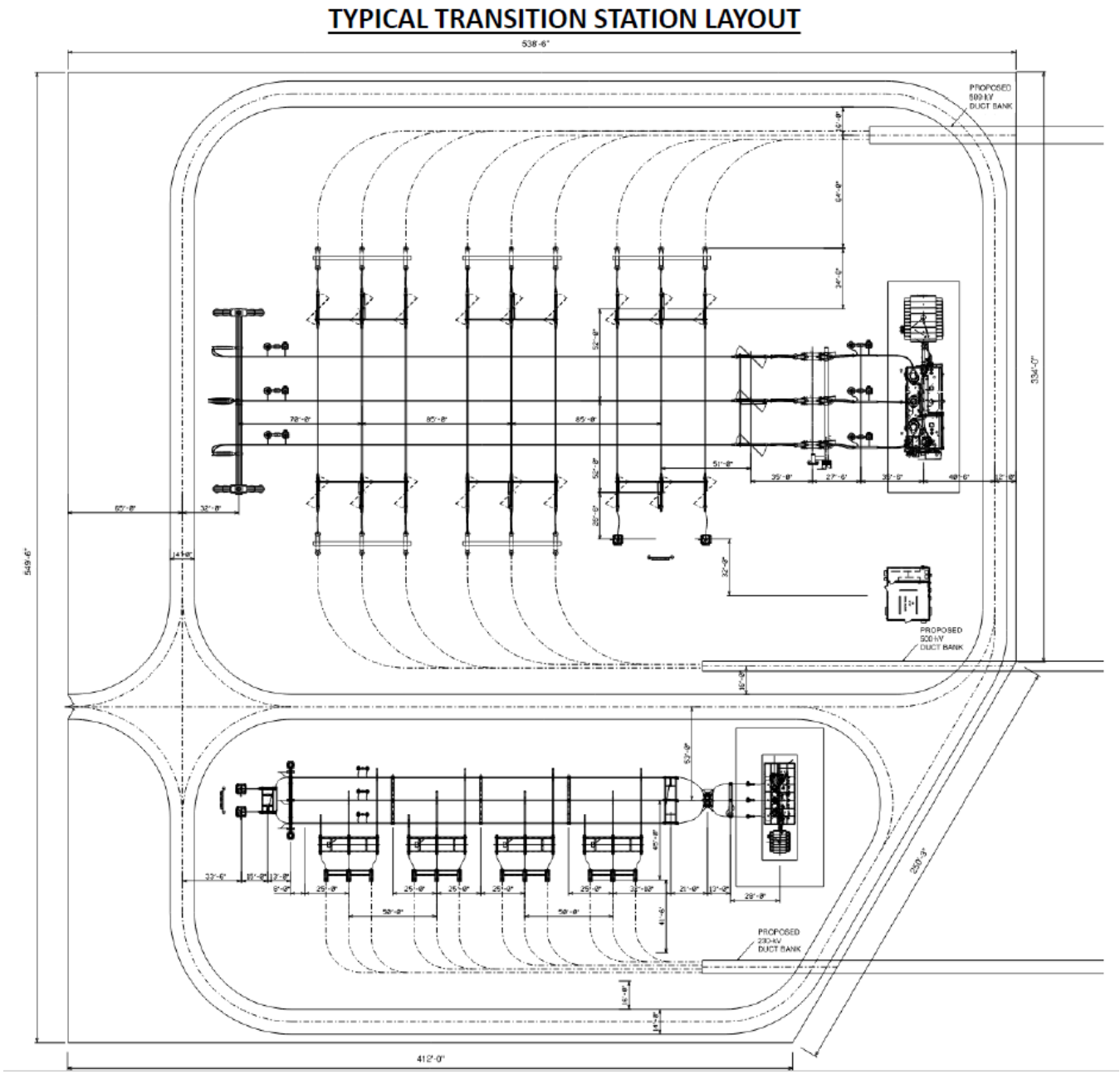


Figure 3 – Example Transition Yard Drawing



1.3. Assumptions and Clarifications

RLC made the following assumptions and clarifications while developing this analysis and cost estimate:

- Conductor sizing/quantity will vary depending on loading and soil conditions, the exact quantities will need to be established during the conductor design.
- Dominion's cost estimates were the source of Overhead transmission costs included in this estimate
- Dominion's cost estimates for the source of remote end substation updates/modifications are included in this analysis. The remote end substations are the 500/230 kV Aspen and Golden Substations.
- No protection and control equipment installed at transition yards

- Location of underground routing is based on “Aspen to Golden alignment (2024-08-07)” map set.
- Assumed all ROW and real estate rights are existing, and allow for transmission lines installation.
- Assumed all Regulatory approvals can be obtained.
- Proposing to use 100’ ROW for 500 kV & 230 kV UG duct banks with 150’ ROW at splice vault locations.
- Assumed temporary road closures can be obtained to install duct bank across roads.
- Cable manufacturer can produce a 500 kV XLPE cable to meet specifications.
- Concrete vaults for conductor splicing will be installed in a staggered manor to reduce overall width of ROW required for the transmission line routing.
- Disposal of contaminate soils not included for any excavations
- Limited Environmental permitting is included in the estimate
- Locations for splice vaults based on review of google earth, final locations would need to be coordinated with cable manufactures as well as existing site conditions.
- A high-level investigation reveals some existing utilities. Future inspection will be required. Relocation of existing utilities has not been included in this estimate.
- Assumed external engineering with internal (Dominion) reviews
- Assumed external construction with both internal and external construction reps
- Assumed to encounter 30% rock
- Assumed (5) splice locations for each of the 500 kV and 230 kV underground transmission lines
- Assumed approximately 3% escalation per year. This is to cover increases in cost of labor, equipment and material due to continuing price changes over time.

1.4. Underground Transmission line Cost Estimating

The costs identified in this study, for the underground portion of the hybrid routing, are estimated costs for the design, procurement, construction, and commissioning of a 500 kV and 230 kV dual circuit underground transmission line. This is a conceptual grade estimate that will be refined as the projects progresses through the design process. This margin is based on the limited design information available for the project. The quantities and costs included in the estimate were established based on standard electric underground transmission design criteria and installation practices for XLPE conductors. This estimate includes risks and escalation associated with the procurement of a custom 500kV XLPE conductor as well as the required splicing vaults and termination structures. The final conductor design could have major impacts to the project design and routing of the underground transmission line. The cost for the 500kV and 230kV conductors in this estimate were obtained from a distributor and cable manufacturer based on basic design information.

RLC Engineering has provided a high-level cost estimate and combined it with the cost estimates for the Aspen to Golden Project provided by Dominion. RLC displaced approximately 3 miles of overhead DCT Lines with the underground solution. This hybrid variant on the project represents a $423M difference in the original overhead cost estimate provided by Dominion. A cost estimate for the Aspen – Golden hybrid solution shown in Table 1 above.

1.5. Schedule

RLC assumed the following project milestone dates in the development of this underground estimate:

- Engineering: 10/01/2024 - 12/31/2025 (electrical/civil)
- Permitting/Approvals: 03/01/2024 – 10/01/2026 (environment/Utility/FERC/State/Local, etc.)

- Cable Procurement: 06/01/25 – 12/31/2026 (assume 18month lead time)
- Construction: 10/01/2026 – 06/01/2028

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DIRECT TESTIMONY
OF
BRIAN CONROY, P.E.

ON BEHALF OF
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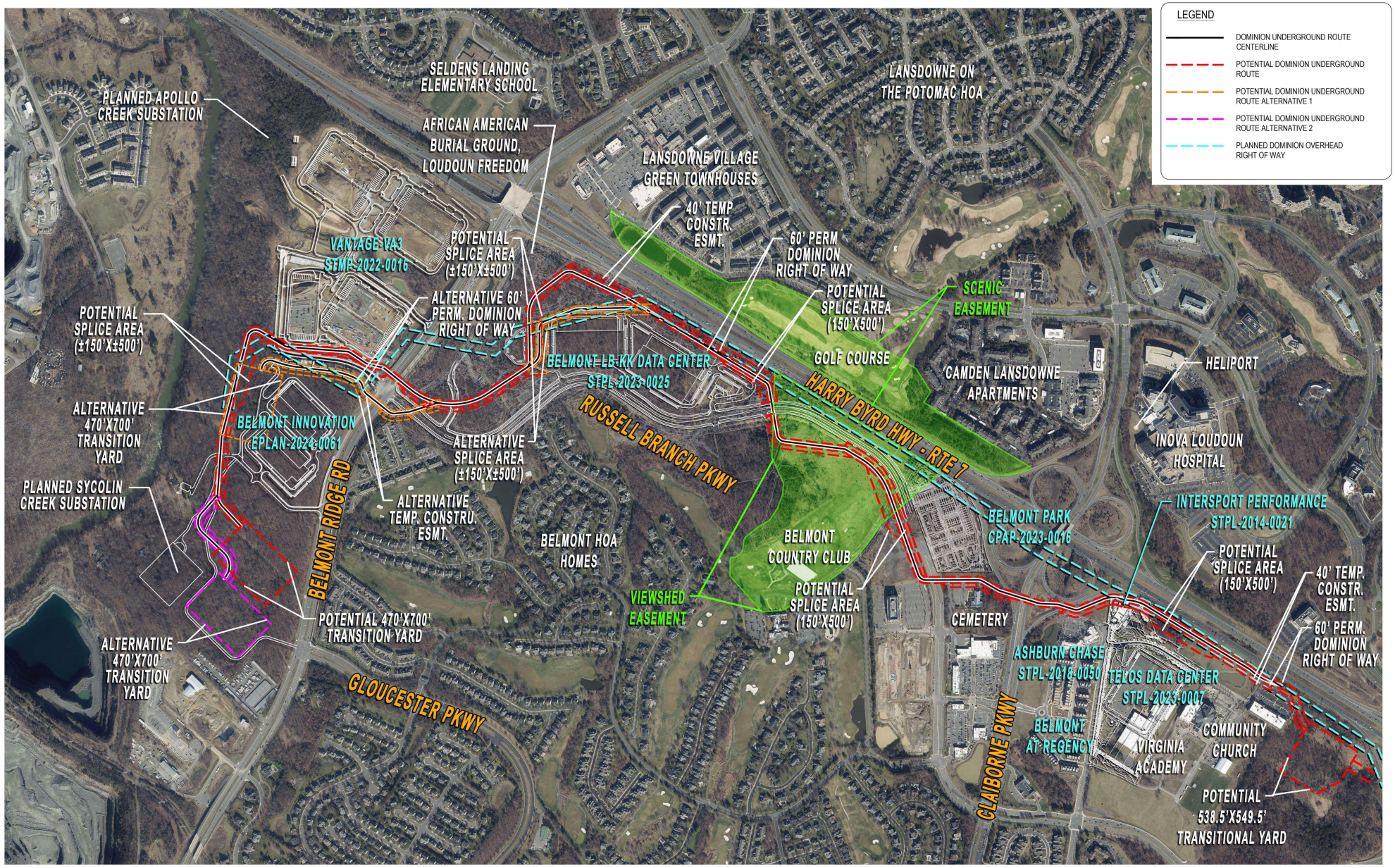
Exhibit BC- (Aspen to Golden Potential Underground Route, Illustrative Plan)



ASPEN TO GOLDEN - POTENTIAL UNDERGROUND ROUTE

0 400' 800' 1600'

Loudoun County, Virginia

08.09.2024

DIRECT TESTIMONY
OF
BRIAN CONROY, P.E.

ON BEHALF OF
LOUDOUN COUNTY, VIRGINIA
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Exhibit BC-5 (Aspen to Golden Potential Underground Route, Context Plan)

ASPEN TO GOLDEN - POTENTIAL UNDERGROUND ROUTE

0 400' 800' 1600'

Loudoun County, Virginia

08.09.2024

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Exhibit BC-6 (Excerpt from Dominion's Responses to SCC Staff's Third Set of Discovery)

Virginia Electric and Power Company
Case No. PUR-2024-00032
Virginia State Corporation Commission Staff
Third Set

The following response to Question No. 13(a) of the Third Set of Interrogatories and Requests for Production of Documents propounded by the Virginia State Corporation Commission Staff received on July 18, 2024, has been prepared under my supervision.

Jacob M. Rosenberg
Principal Consultant
Environmental Resource Management

The following response to Question No. 13(b) of the Third Set of Interrogatories and Requests for Production of Documents propounded by the Virginia State Corporation Commission Staff received on July 18, 2024, has been prepared under my supervision.

Kunal S. Amare
Consulting Engineer
Virginia Electric and Power Company

Question No. 13

Please reference page 31 of the Environmental Routing Study, which states that the schedule is one of the factors in determining the infeasibility of the underground option. Please answer the following questions:

(a) Please describe the feasibility of utilizing a similar plan of action identified by the Company if the Project is delayed, as mentioned in the Company's response to Staff Interrogatory No. 12, to allow for the required time needed for undergrounding.

(b) Please describe the feasibility of altering the load ramping to allow for the required time needed for undergrounding.

Response:

(a) The potential minimum six- to twelve-month delay referenced in the application and in Staff Set 03-12 would apply to either the Project's overhead facilities or an underground alternative, including a duct bank XLPE underground option as described on page 31 of the Routing Study. This underground alternative has a longer construction timeline and is further subject to the same categories of potential delays beyond the Company's control as the proposed Project.

As noted in Section 5.3.2 of the Routing Study, even a conservative estimate of underground construction (47 months based on the Company's preliminary estimates) does not account for

timing of several critical variables. For example, timelines for existing utility relocation (to the extent that utility relocation and outages are physically and legally possible), the duration of horizontal directional drilling ("HDD") operations under three waterbody and wetland crossings through hard diabase bedrock, as well as the need for field investigations, topographic survey, subsurface utility investigation, and geotechnical investigations could not be accurately estimated.

As such, the Company looked to other similar projects to gain a better understanding of the potential timing estimates for these critical variables. Unfortunately, there are so few examples of underground electric transmission projects at this scale that it makes it difficult to develop accurate estimates. The closest precedent for an Aspen-Golden Lines underground solution in the United States is also the longest existing underground alternating current 500 kV line in the United States: the 3.7-mile-long underground portion of the Tehachapi Renewable Transmission Line located in Chino Hills, California ("Chino Hills Line"). The Chino Hills Line and the Aspen-Golden Lines are similar in a few ways, including the need for transition stations and use of HDDs for an underground installation. However, the ways in which the projects differ is striking and greatly differentiate the feasibility of undergrounding the Chino Hills Lines versus undergrounding the Aspen-Golden Lines.

- First, an all-underground XLPE in duct bank option for the Aspen-Golden Lines (approximately 8.5 miles of the route) would be more than twice as long as the underground portion of the Chino Hills Line (3.7 miles). Greater line length would likely result in commensurately longer construction times and greater chances for delay.

- Second, an all-underground Aspen-Golden Lines option requires almost all new right-of-way; whereas, the underground portion of the Chino Hills Lines was built almost entirely within existing right-of-way owned by the incumbent electric utility, Southern California Edison ("SCE"). This means that the SCE was able to construct the underground portion of that project in SCE's own unencumbered right-of-way. In contrast, the Aspen-Golden Lines underground option would cross mostly privately-owned lands, impact several planned developments currently under construction, and would also cross and/or parallel an extensive network of existing buried utilities and infrastructure that already have rights within their right-of-way easements. Therefore, not only would Aspen-Golden underground construction entail the installation of the United States' longest underground 500 kV line, the Company would also bear responsibility for building around or relocating fiber, gas, water, and sewer infrastructure along existing easements where the Company has no authority to do so without the consent of multiple SCC-regulated utilities.

- Third, the two projects cross vastly different geologic conditions impacting all aspects of underground construction, but especially HDDs. Specifically, the Aspen-Golden Lines cross an area of shallow, hard diabase bedrock; whereas, the Chino Hills Line crossed relatively softer sedimentary rock. Even with the more favorable geologic conditions, the Chino Hills HDD construction crews had several failed bore attempts resulting in lost equipment underground, then having to rebore along a new path, causing significant

delays and incurring additional construction costs. The Chino Hills Line underground segment required two HDD installations whereas the Aspen-Golden Lines underground option would require three HDDs with twice as many bores to accommodate both the 230 kV and 500 kV cables/phases. Considering the relative length of each project's HDDs, the length of the Aspen-Golden Lines HDD bores would then be twice the total length of the Chino Hills Line bores. SCE originally planned for 13 months of HDD installation work. In the end, the Chino Hills HDDs took 24 months, working 12 hours a day, six days a week.

Ultimately, the underground segment of the Chino Hills Line took 30 months to construct, taking into account the issues described above. Considering the Aspen-Golden Lines underground option would be more than twice as long as the 3.7-mile underground segment of the Chino Hills Line, and with many more routing and engineering constraints, the Company concluded that the feasibility of constructing an underground option with a one-year delay of the target in-service date (June 1, 2029) seemed unachievable even in a best-case scenario.

Moreover, it is notable that an underground option for the Aspen-Golden Lines would be even less feasible now than when it was first studied. Underground routes would need to be rerouted and restudied given the rapid progress of several planned developments, including two new potential delivery points and several utility extension projects. The Apollo-Twin Creeks Project, whose substations and overhead right-of-way were intentionally collocated with Aspen-Golden Lines, would also need to be rerouted, re-sited, and impact (and likely require the demolition of) a portion of a data center campus with buildings located partially within the HDD workspaces and permanent right-of-way. Two additional data center campuses would also be impacted by the underground right-of-way, particularly the extra workspace needed to set up the HDDs across Goose Creek. It is likely that all three planned data center campuses would need to be reconfigured, as well as four of the proposed Apollo-Twin Creeks substations, to accommodate an underground route option.

In order to keep the Aspen-Golden Lines underground XPLE option as short (and feasible) as possible, the route would also need to deviate from the overhead alignment to turn south and parallel Loudoun County Parkway south of Rt. 7 and closer to residential areas. The underground route would cross through a stream bed, floodplain, and wetlands next to several residential developments already approved or under construction. Again, the routing and additional right-of-way needed for the underground XPLE options eliminates overhead structures but at the expense of placing the right-of-way closer to existing and future residences and aggravating environmental issues, especially USACE wetland permitting where the underground route would result in the permanent conversion of wetlands. As mentioned previously, all of this would be contingent on the relocation of existing gas and water utilities crossed by the underground route option.

Undergrounding the Aspen-Golden Lines would also require the construction of transition stations at Aspen Substation, Golden Substation, as well as anywhere along the route with a delivery point request. Not only does the proposed Golden Substation lack sufficient space to accommodate a transition station, but there are at least two other potential delivery point

requests along Rt. 7 that would require transition stations. The siting of additional Aspen-Golden transitions stations would greatly negate the advantages that undergrounding has in terms of visual impacts. Instead, delivery point transition stations would localize visual impacts to specifics area where the 230 kV circuits would need to transition aboveground to tie into substations. The transition stations would also be subject to permit approval by the Loudoun County Board of Supervisors, constituting another permitting variable outside the purview of the underground study.

All of these activities present significant schedule risk.

(b) The Aspen-Golden Project was identified through the PJM Open Window as a reliability project; it is not a customer-driven project. To the extent this request is referring to load growth identified in the PJM load forecast as "load ramping," the Company cannot independently alter PJM's load forecast. See the Company's response to Staff Set 03-09(a).