3 PROJECT ALTERNATIVES

3.1 Introduction

This section discusses the Project alternatives that NEP identified and evaluated for their potential to address the transmission resource needs identified in *Section 2*. Recent analyses and studies demonstrate that these century-old transmission lines are in poor condition and need to be rebuilt. Specifically:

- The Existing Lines have a history of poor performance related to their age and the original design of their structures.
- The most recent five-year inspection of the Existing Lines found physical issues on all of the structures examined, which pose a threat to the reliability of the transmission system.
- Inherent design issues contribute to the poor performance of the Existing Lines.
- Increased fiber optic capability is needed to serve fault protection and telecommunications needs.
- Reliable capacity will likely be needed on the E5/F6 Lines to support anticipated future loads.

The sections below describe the Project alternatives considered, including a No-Build Alternative (*Section 3.2*); Non-Wires Alternatives (*Section 3.3*); two Partial Rebuild Alternatives (*Section 3.4*); and a Complete Line Rebuild Alternative (*Section 3.5*). Of these, only the Complete Line Rebuild Alternative addresses the full range of needs identified in *Section 2*.

In addition, the Company considered two transmission structure designs for the Rebuilt Lines: one that complies with NEP's 115 kV design standards, and a second that complies with NEP's 69 kV design standards. *Section 3.7* compares these two structure designs with respect to transmission system reliability, environmental impacts, and project cost. This comparison also considers the ability of the two designs to support long-term electric load growth driven by regional commitments to address climate change through electrification and a deeper integration of renewable resources. These analyses demonstrate that the replacement of the Existing Lines with overhead lines built within the existing ROW to 115 kV specifications is the superior approach in terms of its ability to meet the identified need at the lowest reasonable cost, with the fewest environmental impacts, and with a high degree of reliability.

3.2 No-Build Alternative

Under the No-Build Alternative, the Existing Lines would remain in place and NEP would not execute a capital project to address performance issues and physical issues on the Existing Lines or the need for increased fiber optic capability. The Company would continue to address line components that are imminently about to fail on an ad hoc basis, as it does with all its transmission assets. Accordingly, the Company would repair or replace structures on an as-needed basis to address deterioration.

This approach is inferior to the Project for several reasons. As discussed in *Section 2*, the Existing Lines are experiencing poor performance, are in deteriorating condition, have inherent design issues and will have insufficient capacity to meet anticipated future needs. While repairing and replacing structures on an as-needed basis would address physical issues on individual structures, it would not address the inherent design issues that affect the entire line. Replacing individual structures in a piecemeal fashion would not allow for all structures to be taller to improve the insulation level and shielding angle; therefore, a piecemeal approach to replacing the structures would not reduce the potential for outages due to lightning strikes. Further, because OPGW cannot be added to the Existing Lines, the No-Build Alternative would not provide fiber optic capability that would improve communication between substations. In short, the Existing Lines should be rebuilt to improve their performance and reliability. Because the No-Build Alternative would not meet the identified need, it was eliminated from further consideration.

3.3 Non-Wire Alternatives

NWAs use some combination of energy efficiency and demand response programs, distributed generation, and energy storage facilities as alternative means of deferring or addressing the underlying need for a transmission or distribution project. NWAs generally are appropriate when the underlying need for a project is driven by increasing load levels, so that the load reductions provided by the NWAs allow an increasing number of electric customers to be served with the existing transmission and distribution infrastructure.

While the Project will provide additional reliability and capacity, the underlying Project need is driven by the deteriorating condition and design of the Existing Lines, which are among the least reliable on NEP's transmission system, as well as the need for increased fiber optic capability. The implementation of an NWA would not address the inherent structure constraints that predispose the Existing Lines to outages from lightning strikes, or the proximity of tall, dense vegetation outside of the Company's control that exposes the lines to tree falls and dropped limbs, nor would it enable the Company to enhance its protection and telecommunication abilities. For these reasons, NWAs would not meet the identified resource needs and the Company eliminated them from further consideration.

3.4 Partial Rebuild Alternatives

The Company considered two Partial Rebuild Alternatives, one with minimal work and one with more extensive work. The Partial Rebuild Alternatives are targeted structure repair programs that would address the most pressing concerns regarding the deteriorating structures. Under the minimal work alternative, the Company would repair twenty lattice towers with deflecting or damaged components and replace one lattice tower that is leaning. The Company also would update grounding on five lattice towers and complete routine structure maintenance on lattice towers and routine foundation maintenance on both the lattice towers and steel pole structures. Under a more extensive Partial Rebuild Alternative, the Company would also replace ten wood pole structures with steel structures.

Under either Partial Rebuild Alternative, the existing structures, conductor and shield wire would remain in place. ROW and access improvements would be needed but would be limited to what is required to complete the structure repair work. Actions to address most of the needs identified in *Section 2* would be deferred until a later date.

Targeted repair programs like the Partial Rebuild Alternatives can be low-cost, low-impact strategies for extending the life of transmission lines if the primary issue is a limited number of damaged structures. However, this approach is not appropriate for the Existing Lines because it would leave all, or the majority of existing structures in place and, therefore, would not address the underlying reliability issues associated with the inherent design issues (i.e., poor shielding angle and inadequate conductor spacing).

Given that the original structures would mostly be retained rather than replaced, the Partial Rebuild Alternatives would not reduce the incidence of line outages associated with lightning strikes, downed trees, thunderstorms, and avian interference. Even under the more extensive Partial Rebuild Alternative, reliability improvements would be limited because these individual replacement structures would need to be physically consistent with the existing towers, which would remain unimproved. In addition, because OPGW would not be installed on each line, the Existing Lines would not be adequately protected from lighting strikes and the added benefit of high-speed communications between substations would not be realized. Lastly, these alternatives would not provide the additional capacity to meet future energy needs. At best, the Partial Rebuild Alternatives would extend the life of individual structures without providing improved reliability, better communications capability or increased capacity.

Because these alternatives do not address the key structure design issues associated with the poor reliability of the Existing Lines nor meet the other identified needs, they were dismissed from further consideration.

3.5 Complete Line Rebuild Alternative (Project)

The Project consists of rebuilding the Existing Lines and Taps within existing ROWs, completely replacing the existing structures, conductor, and shield wire. All steel pole suspension structures will have either direct-buried foundations or micropile foundations and all dead end or angle structures will be supported by drilled shaft foundations. Key components of this alternative include:

- Installing new, davit arm, steel monopole structures, on the Existing Lines and Taps and thereafter removing the existing the 538 lattice towers, 75 steel pole structures, and 98 wood poles,
- Removing the existing conductor and OPGW on both the Existing Lines and Taps and replacing with larger aluminum conductor,
- Installing two new OPGWs, one on the E5 Line and one on the F6 Line, and
- Performing vegetation management, upgrading existing access, and creating new access as required to construct and maintain the Rebuilt Lines.

Rebuilding the Existing Lines will address all the needs identified in *Section 2*. Replacing the existing structures with taller structures will correct the poor shielding angle and avoid many of the outages caused by lightning. In addition, the new, taller monopole structures will reduce opportunities for trees striking the line and for bird nesting. Taken together, these design changes will significantly reduce the frequency of outages on the Existing Lines and increase their reliability. In addition, access improvements will improve NEP's ability to quickly repair damage to the lines when an outage does occur. Lastly, replacing the existing conductors with 795 thousand circular mils ("kcmil") ACSS conductor will increase normal thermal capacity by 172% compared to the Existing Lines will provide additional thermal capacity needed both to interconnect future DER, such as photovoltaic projects and battery energy storage systems, and to support projected electric load growth without the need for additional line upgrades in the foreseeable future. Replacing the single existing shield wire with two OPGW (one for each circuit) allows for increased fault protection and high-speed communication between substations along the Rebuilt Lines.

The Complete Line Rebuild Alternative is the only alternative that will improve performance of the Existing Lines and Taps by addressing all of the issues and provide the additional thermal capacity required to support future load growth. Accordingly, NEP selected it and dismissed other alternatives from further consideration.

3.6 Design Alternatives

Having determined that a complete replacement of the Existing Lines and Taps is necessary, NEP then evaluated whether a 69 kV structure design or a 115 kV structure design would best meet the identified need while minimizing cost and environmental impacts and providing for the long-term reliability of the electric transmission system. The Company considered two transmission structure design alternatives: one that complies with NEP's 115 kV design standards ("115 kV Design"), and a second that complies with NEP's 69 kV design standards ("69 kV Design").

3.6.1 69 kV and 115 kV Designs

The Company has established design criteria for its transmission lines to assure acceptable reliability of its bulk transmission system facilities. These criteria apply to conductors, structures, and equipment and establish insulation levels and required clearances for various voltage transmission lines. For this Project, the Company evaluated the 69 kV and the 115 kV Design options.

Both structure designs would support the new conductors and would be contained within NEP's existing E5/F6 ROW. In addition, both designs elevate the new conductors above the existing locations. However, the 115 kV Design provides additional insulation and, more importantly, the ability to operate at a higher voltage in the future if conditions warrant. Figure 3-1 depicts typical 69 kV and 115 kV structure designs for the Project. The 69 kV and 115 kV Designs both use double circuit, vertically configured, davit arm, steel monopole structures with 795 kcmil ACSS "Drake" conductor installed on new lines and all taps. However, as seen in Figure 3-1, each insulator string on the 69 kV structure would carry seven insulators, while the 115 kV insulators strings would carry ten insulators. The additional spacing required to accommodate the longer insulator strings and larger required phase-to-phase and phase-to-ground clearance results in an approximately five to ten-foot increase in structure height for the 115 kV Design.

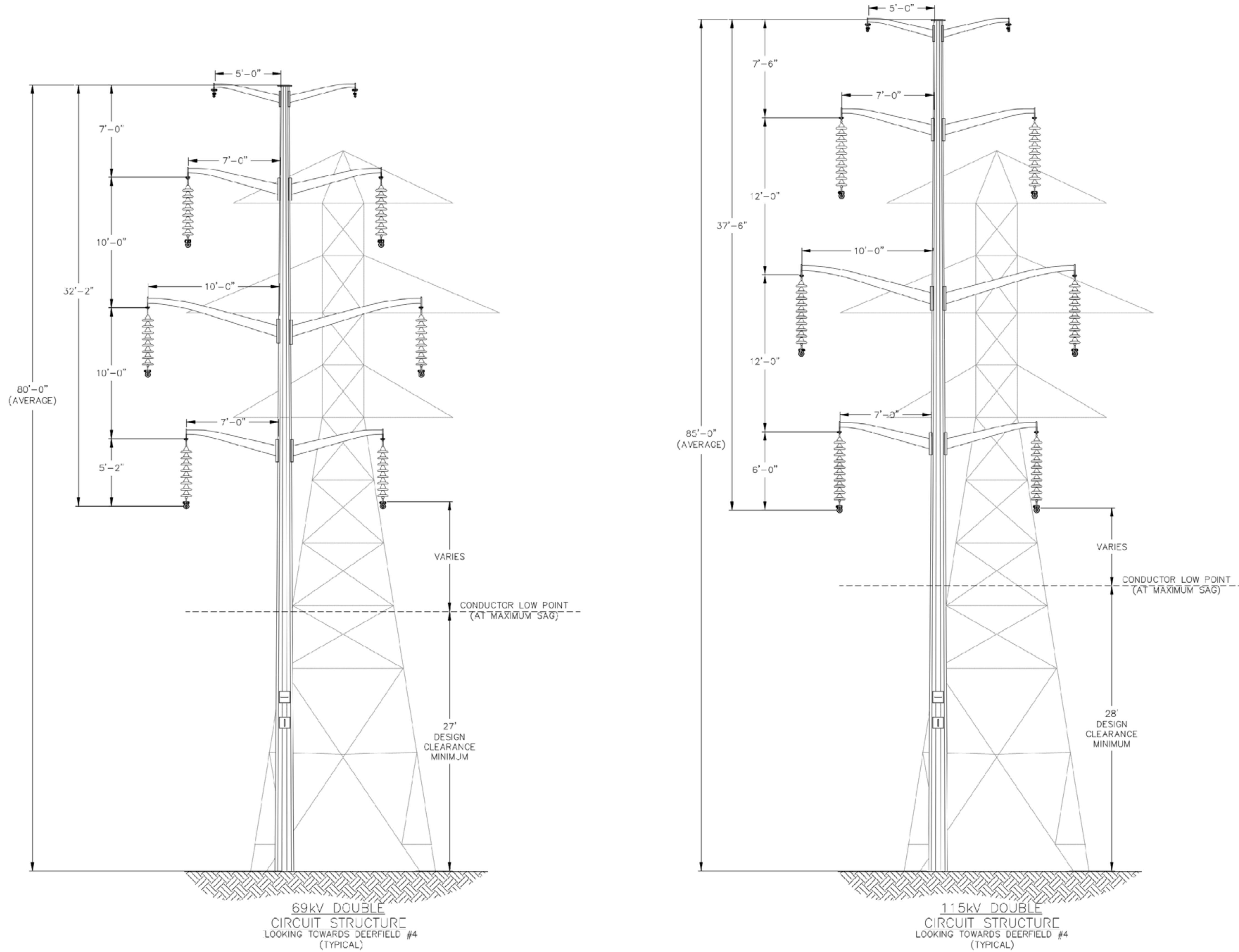

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Figure 3-1

Typical 69kV and 115kV Structure Design

As discussed below, the Company evaluated reliability, environmental and cost considerations of constructing the Rebuilt Lines and Taps to 115 kV Design standards. The Company notes that the Existing Lines and Taps operate at 69 kV. There are no immediate reliability needs that would now necessitate the operation of the Rebuilt Lines and Taps at 115 kV within the 10-year planning horizon. If future planning studies find that increased DER penetration and/or increased load growth require the operation of the lines at 115 kV, NEP will advance any remaining upgrades required for such operation. As noted above, use of 795 kcmil ACSS conductor with either the 69 kV or 115 kV Design option will increase thermal capacity of the Rebuilt Line by up to 172% compared to the Existing Line.

3.6.2 Reliability Comparison

The 69 kV and 115 kV Designs both address the design issues associated with the poor performance record of the Existing Lines. In particular, the replacement structures under either design would have an approximately 15 degree shielding angle, consistent with the current industry practice of limiting the shielding angle to 30 degrees or less. Similarly, the higher elevation of the conductors on the Rebuilt Lines will reduce the probability of faults resulting from off-ROW vegetation striking the energized lines. In addition, the change in structure type from lattice towers to monopole structures will reduce the potential for avian-related outages. Birds are prone to use horizontal members on the existing lattice towers to construct nests, which results in greater opportunity for avian interaction to create momentary outages on the circuits. Overall, either design will result in significant improvements in line performance.

Notably, however, construction of the Rebuilt Lines and Taps to the 115 kV Design standard, even if operated at 69 kV, will provide both near-term and longer-term transmission system reliability benefits that the 69 kV Design would not.

In the short term, some physical differences between the 69 kV and 115 kV Designs will result in reliability benefits from operating the 115 kV Design at 69 kV namely, the length of the insulator string, phase spacing at the top of each monopole structure, and the distance in clearance to ground and nearby objects. The additional insulation and increased spacing between the conductor phases for the 115 kV Design would provide increased resilience to lightning and tree-related events. The increase in structure height, while limited, will provide additional vertical clearance that may further reduce the probability of off-ROW vegetation striking the energized conductor. In addition, the lowest conductor, which is the most likely to be struck by vegetation, will be elevated higher with the 115 kV Design, thus improving reliability for the 115 kV Design option.

In the longer term, future operation of the Rebuilt Lines and Taps at 115 kV will increase the thermal capacity of the Rebuilt Line by 66%, which will support future load growth and enable the future interconnection of DER. Table 3-1 shows the higher thermal ratings that can be achieved by operating the proposed 795 ACSS conductor at 115 kV rather than at 69 kV.

Table 3-1: Thermal Ratings of Proposed 795 kcmil ACSS Conductor at 69 kV and 115 kV

Overhead Line Conductor	Thermal Ratings when Operated at 69 kV	Thermal Ratings when Operated at 115 kV
795 kcmil ACSS DRAKE (Proposed)	220/220 Mega Volt-Amp ("MVA") (Summer Normal/Long Term Emergency)	366/366 MVA (Summer Normal/Long Term Emergency)
477 kcmil ACSR HAWK (Existing)	98/98 MVA (Summer Normal/Long Term Emergency)	--
336.4 kcmil ACSR LINNET	81/100 MVA (Summer Normal/Long Term Emergency)	--

Additionally, 115 kV lines characteristically have lower impedance than 69 kV lines on a per Mega Volt-Amp ("MVA") basis – that is, there is less reactance along the line and, therefore, less reactive power is required to maintain voltage. In practice, this helps avoid the need for additional transmission switching stations, capacitor banks, reactors, or dynamic voltage control devices to support new load.

Finally, future operation of the lines at 115 kV would facilitate interconnection with nearby transmission facilities and networks that currently operate at 115 kV. For example, Deerfield #4 Substation is also connected to the S197 115 kV transmission lines, and Millbury #5. is connected to several 115 kV tie lines to Millbury #2 Substation. Future operation of the lines at 115 kV would increase the thermal capacity by 66% as compared to 69 kV operation.

3.6.3 Environmental Comparison

Section 5 provides a detailed analysis of the environmental impacts of the Project using the 115 kV Design, which includes temporary and permanent impacts to wetlands and water resources, impacts associated with vegetation management and removal, access improvements, visual impacts associated with the proposed increase in structure heights, construction noise and traffic impacts. *Section 5* also summarizes the measures that NEP has taken during Project design and engineering to reduce and mitigate these impacts.

NEP anticipates that use of the 69 kV Design would not significantly reduce any of these impacts compared to the 115 kV Design. The same construction techniques would be used and, as a result, construction-related impacts, including vegetative clearing, access improvements, wetlands and water resource impacts, and construction noise and traffic, would be similar or identical. Although there would be an approximately five to ten-foot difference in structure height, visual impacts from the new structures will be minimal in either case. Magnetic fields at any given load level would marginally increase for the same reason.

Finally, the use of the 115 kV Design for the Project obviates the possible need to construct a new 115 kV line when reliability needs call for additional capacity. Using the 69 kV Design for the Rebuilt Line now would require the future construction of a new line using the 115 kV Design, including replacement of all structures because the structures would not have the appropriate phase-to-phase separation to allow for insulation or operation at 115 kV. This would require a re-mobilization and significant redundant construction efforts, which would place a repeat burden on the abutters along this ROW, as well as create an approximate doubling of environmental impacts.

On balance, NEP considers the 115 kV Design to be preferable to the 69 kV Design from the perspective of environmental impacts.

3.6.4 Cost Comparison

At the time the 115 kV Design was selected as the preferred alternative, the estimated cost of the Project, using the 115 kV Design, is approximately $896.9 million, while the estimated cost for the Project using the 69 kV Design is approximately $875.0 million. Most of the cost difference is associated with increased materials costs for the 115 kV Design.

The cost difference would amount to approximately $21.9 million, or less than 2% of the estimated cost of the Project. If the Existing Lines are built using the 69 kV Design, should the need arise to operate the lines at 115 kV in the future, not only would the full material, labor, and equipment costs associated with the structure replacements be incurred again, but the costs associated with engineering, permitting and construction would be incurred as well. Specifically, construction matting in sensitive areas, as well as associated mitigation costs, would be required where permanent access is not being constructed. These costs would far exceed the small percentage increase in cost at the time the Existing Lines are replaced. In addition, if the Company fails to take advantage of the opportunity to rebuild to 115 kV standards now and a second project is required later, it will not only be more costly, but likely result in wasted costs because the Rebuilt Lines will have to be removed well before their useful life has expired.

By constructing the lines to the Company's 115 kV Design standard now, no physical upgrades to the Rebuilt Lines would be required for future operation at 115 kV. The cost of moving from 69 kV to 115 kV operation would be limited to planning costs and crew time to implement the voltage switch. Note, however, that future operation of the Rebuilt Lines at 115 kV would require some substation upgrades. The Company anticipates that these station upgrade projects would be undertaken when needed in the future to address reliability or asset condition issues and would be independent of the selected design voltage for this Project.

3.6.5 Summary of 69 kV and 115 kV Designs

The Company proposes to construct the Rebuilt Lines with the 115 kV Design because the conductor phase spacing and increased insulation provide significant reliability benefits even when operated at 69 kV. Moreover, building to the 115 kV Design now provides the ability to operate the line at 115 kV in the future without constructing a new line when such need arises. If the Company fails to take advantage of the opportunity to rebuild the new line to 115 kV Design standards now, when the additional capacity of a 115 kV line is needed in the future, the Company would need to either replace the Rebuilt Lines with a new 115 kV line, or construct a second transmission line in the same area, both of which would result in a duplication of costs and impacts. As discussed above, the environmental impacts of the Project would be similar regardless of the structure design. The incremental cost of the 115 kV Design is low relative to the overall cost of the Project and ensures the ability to maximize the utilization of the line by enabling future operation at 115 kV without undertaking another new construction project.

NEP believes that constructing the Rebuilt Line to 115 kV Design is a prudent decision, particularly in light of the findings of ISO-NE's 2050 Transmission Study, which highlights the need for additional transmission capacity across New England to accommodate the electrification of heating and transportation systems and the large-scale integration of on-shore and off-shore wind, solar, and storage resources. It is also consistent with the FERC's recent findings that underscore the need for transmission planning and grid enhancement to take advantage of "right-sizing" opportunities to cost effectively and efficiently add to the long-term reliability of transmission service. See generally, "Building for the Future Through Electric Regional Transmission Planning and Cost Allocation," 187 FERC ¶ 61,068 (2024). "Right-sizing" promotes efficiency by providing cost savings for customers and reducing construction impacts to both abutters and the community as would otherwise be experienced by a second cycle of construction to add needed equipment in the future.

The 115 kV Design provides reliability benefits and gives NEP the flexibility to operate the Rebuilt Line at 115 kV in the future without a costly upgrade project if needed to support large-scale electrification and interconnection of renewable energy sources. For these reasons, NEP selected the 115 kV Design for the Rebuilt Line.

3.7 Conclusion

As described in *Sections 3.2* through *3.6*, above, the Company initially considered various alternatives to meet the identified resource need. The No-Build, Non-Wires and two Partial Rebuild Alternatives were rejected because they would neither address the asset condition and design issues of the Existing Line, nor enable the Company to add OPGW.

NEP therefore determined that the needs identified in *Section 2* could only be met by replacing both the existing structures and conductor, as well as by adding OPGW to the entirety of the Existing Lines and Taps. In *Section 3.7*, NEP compared the cost, environmental impact, and reliability benefits associated with the use of a 69 kV structure design and a 115 kV structure design and concluded that the additional capacity and flexibility provided by the 115 kV Design outweighed the minor additional costs. Consequently, NEP concluded that the replacement of the Existing Lines in the existing ROW, using the 115 kV Design, would best address the identified needs at a low cost while minimizing environmental impact.